PowerLogic™ T300

Substation Controller

User Manual

Remote Terminal Unit for Distribution Networks

NT00378-EN-13
10/2025

www.se.com

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Foreword

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Safety Information

Important Information

Read these instructions carefully, and look at the equipment to become familiar with the device before trying to install, operate, service, or maintain it. The following special messages may appear throughout this documentation or on the equipment to warn of potential hazards or to call attention to information that clarifies or simplifies a procedure.

The addition of this symbol to a “Danger” or “Warning” safety label indicates that an electrical hazard exists which will result in personal injury if the instructions are not followed.

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, **will result in** death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, **could result in** death or serious injury.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, **could result** in minor or moderate injury.

NOTICE

NOTICE is used to address practices not related to physical injury.

Please Note

Electrical equipment should be installed, operated, serviced, and maintained only by qualified personnel. No responsibility is assumed by Schneider Electric for any consequences arising out of the use of this material.

A qualified person is one who has skills and knowledge related to the construction and operation of electrical equipment and its installation, and has received safety training to recognize and avoid the hazards involved.

About the Document

Purpose of this Guide

This guide gives a complete description of the T300 equipment for use, configuration, installation and maintenance. It can be used as a general reference.

Product Related Information

Refer to Product Related Information, page 16 chapter.

General Cybersecurity Information

In recent years, the growing number of networked machines and production plants has seen a corresponding increase in the potential for cyber threats, such as unauthorized access, data breaches, and operational disruptions. You must, therefore, consider all possible cybersecurity measures to help protect assets and systems against such threats.

To help keep your Schneider Electric products secure and protected, it is in your best interest to implement the cybersecurity best practices as described in the Cybersecurity Best Practices document.

Schneider Electric provides additional information and assistance:

- Subscribe to the Schneider Electric security newsletter.
- Visit the Cybersecurity Support Portal web page to:
  - Find Security Notifications.
  - Report vulnerabilities and incidents.
- Visit the Schneider Electric Cybersecurity and Data Protection Posture web page to:
  - Access the cybersecurity posture.
  - Learn more about cybersecurity in the cybersecurity academy.
  - Explore the cybersecurity services from Schneider Electric.

Product Related Cybersecurity Information

Refer to Product Related Cybersecurity, page 17 chapter.

Document Revision History

Document reference–revision	Release date	Modifications
NT00378–13	09/2025	Addition or modification about: • Port Hardening • MQTT protocol • VDIS • 3G removed • Modem status LEDs • HU250 general characteristics (Appendix A) • VT sensors • SC150 ANSI 67N • SC160 ANSI 67/ANSI 67N • up to 8 SC0x setting groups • Change password enforcement
NT00378–12	10/2023	T300 software upgrade to V2.9 Addition about: • Transport Layer Security (TLS) • ISaGRAF Port Management • Firmware downgrade • Factory Default Restoration Reorganization of *Centralized Authentication Protocols* section, in *Cyber Security* chapter. Addition of *LDAP protocol server* in *Centralized Authentication Protocols* section
NT00378–11	03/2023	Addition of HU250 (without wireless unit) T300 software upgrade to 2.8.2
NT00378–10	12/2022	T300 software upgrade to 2.8.1 Inclusive terminology applied Change in RoHs 3 Directive Addition of UKCA Directives PS50 characteristics appendix: changes to Dielectric Compatibility, RS-485 USB port removed PS25 removed (no longer commercialized)
NT00378–09	11/2021	Cyber Security
NT00378–08	09/2021	T300 software upgrade to V2.8
NT00378–07	11/2020	Light software evolutions
NT00378–06	11/2020	T300 software upgrade to V2.7

Related Documents

Document Title	Document Reference
HU250 Installation guide	NHA77925
HU250 (without wireless unit) Installation guide	PKR45928
SC150 Installation guide	NHA91857
SC160 Installation guide	GDE64933

Document Title	Document Reference
LV150 Installation guide	NHA92575
PS50 Installation guide	NT00375
T300 Quick Start Guide	NT00383
Easergy Builder User Manual	SE-S856-MSS

Information on Non-Inclusive or Insensitive Terminology

As a responsible, inclusive company, Schneider Electric is constantly updating its communications and products that contain non-inclusive or insensitive terminology. However, despite these efforts, our content may still contain terms that are deemed inappropriate by some customers.

Some of the T300 Web server screens shown in this document may have not been updated with the new terminology for this release.

Product Related Information

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FCC Part 15

This equipment is designed and tested with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with *PowerLogic™ T300 HU250 Installation Guide (reference NHA77925)*, it may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception which can be determined by turning the equipment off and on, the user is encouraged to try to help prevent interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device complies with FCC RF radiation exposure limits set forth for general population. This device must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

EU Directives

This equipment complies with the following Directives of the European Parliament and of the Council:

- EMC Directive 2014/30/EU
- LVD Directive 2014/35/EU
- RED Directive 2014/53/EU
- RoHS Directive 2015/863/EU

UKCA Directives

UK Regulation:

- The Electromagnetic Compatibility Regulations SI 2016 No. 1091
- The Electrical Equipment (Safety) Regulations SI 2016 No. 1101
- The Radio Equipment Regulations SI 2017 No. 1206
- The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 SI 2012 No. 3032

Product Related Cybersecurity

Cyber threats are part of the digital world of communicating products. The T300 is concerned about possible cyber security issues and offers different features to users to manage the Cyber security and reduce the risks.

Knowledge is the first step to help prevent cyber intrusions. It is important to review the best practices to increase your cybersecurity awareness. Read the Recommended Cybersecurity Best Practices.

⚠WARNING

HAZARD OF POTENTIAL COMPROMISE OF SYSTEM AVAILABILITY, INTEGRITY, SAFETY, AND CONFIDENTIALITY

- Change default passwords/passcodes to help prevent unauthorized access to device settings and information. Implement strong authentication controls, with high complexity passwords.
- Disable unused ports/services and default accounts where possible, to minimize pathways for malicious attacks.
- Place networked devices behind multiple layers of cyber defenses (such as firewall, network segmentation, and network intrusion detection and protection).
- Use cybersecurity best practices (for example: least privilege, separation of duties) to help prevent unauthorized exposure, loss, modification of data and logs, interruption of services, unintended operation, or potentially damaging the infrastructure or injuring operating people.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

NOTICE

HAZARD OF UNAUTHORIZED ACCESS

- Setup a security policy and procedure to back up the security administrator user account.
- Do not share a single user account with multiple users.
- Set one user account associated to roles and rights per user.

Failure to follow these instructions can result in loss of access to the device.

NOTE: In the event of loosing access to the device, the device must be returned to your respective Schneider Electric branch office.

Potential Risks and Compensating Controls

Cyber threats are part of the digital world of communicating products. The T300 offers several different features to users to manage cyber security risks.

NOTICE

HAZARD OF UNAUTHORIZED ACCESS

Follow all recommendations described below to decrease the risk of unauthorized access.

Failure to follow these instructions can result in equipment damage.

- **Insecure protocols**

  Modbus, DNP3, IEC 60870-5-101, IEC 61850 (IEC 61850 MMS (Manufacturing Message Specification) and IEC 61850 GOOSE (Generic Object Oriented System Event)) protocols, and some IT protocols (SNTP, DHCP, GPS, PPP) are insecure.

  The device does not have the capability to transmit data encrypted using these protocols. If a malicious user gained access to your network, transmitted information could be disclosed or subject to tampering.

  For transmitting data over an internal network, physically or logically segment the network and restrict access using standard controls such as firewalls and in particular IP Table allowlists.

  For transmitting data over an external network, encrypt protocol transmissions over all external connections using an encrypted tunnel, TLS wrapper or a similar solution.

  For PPP over GPRS/3G/4G network, the customer is responsible for verifying that the cellular network is a private and protected network.

- **4G communication security**

  When using 4G communication for remote access or data transmission, the end user must set up the connection through a secure Virtual Private Network. This provides encryption and helps protect data against unauthorized access or interception.

- **Enclosure**

  The physical integrity of the installation must be ensured by the end user. Physical access to the T300 and the operational area must be restricted.

  HU250 embeds a “door open” digital input (DI6) that can be used to report to the system a physical access to the cabinet or the room.

  The status is then reported to the control center using the variable HU01_DoorISAF1_Alm_stVal.

  Standard T300 cabinets are equipped with quarter turn for padlock, and an optional opened door contact (EMS59510).

  Refer to HU250 Module Settings \ Local I/O, page 167 for wiring of “door open” signal.

- **Port hardening**

  The following recommendations should be followed:

  - Firewall: use the IP allowlist to limit external accesses to known devices. Refer to PowerLogic T300 Port Hardening, page 141
  - Port configuration: disable unused physical ports. Refer to Port Configuration, page 141 for details.
  - Disable web pages for SC0x/LV0x module maintenance.

- **ISaGRAF®**

  For software versions 2.9 and higher, the TCP port used to transfer the **ISaGRAF®** program from **ISaGRAF®** programming workbench is closed. To open the port, refer to **ISaGRAF®** Port Management, page 113.

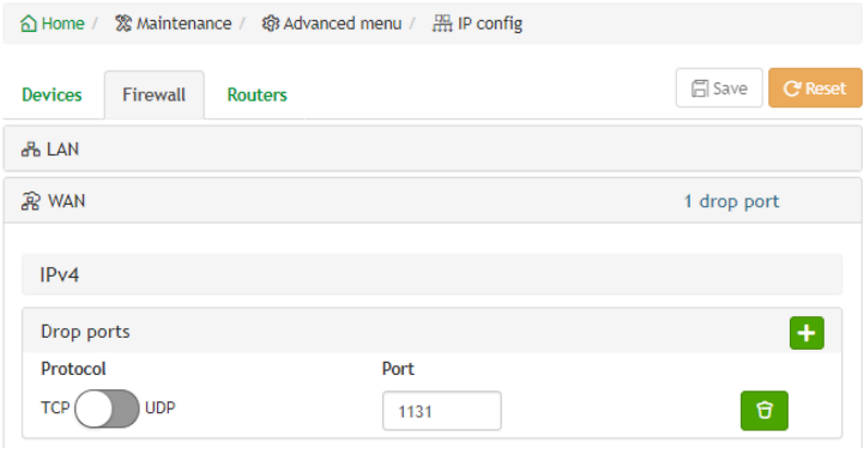
  For software versions 2.8.2 and lower, if the **ISaGRAF®** device is active in the configuration, the TCP port 1131 is opened to transfer the **ISaGRAF®** program from the **ISaGRAF®** programming workbench.

  An external access is then possible.

  The following setting is recommended depending on the context:

  - It is recommended to disable the **ISaGRAF®** TCP port 1131 during exploitation phase to help prevent any modification of the **ISaGRAF®** program.

    To do this, use the firewall as follows: add 1131 in the drop ports list, for WAN and LAN. Refer to Firewall, page 137 for details.



  - Remove 1131 port from the drop ports list during development or commissioning phases.

    When the final program is downloaded in the HU250, add 1131 port again to make sure the program cannot be accessible externally.

The product is constantly evolving and encryption of relevant communication channels is planned in upcoming releases. Contact your SE branch office or field service representative for more information about cyber security features on the T300 platform.

NOTE: Schneider Electric regularly posts security notifications with information on vulnerabilities and patches that it receives from its partners at the U.S. Department of Homeland Security's ICS-CERT and United States Computer Emergency Readiness Team (US-CERT), other ISACs, and cybersecurity firms, among others. These updates are designed to fix known vulnerabilities and are encouraged for any Internet-connected device. You can also subscribe to our newsletter to receive security notifications.

NOTICE

HAZARD OF CYBERSECURITY

Report a cybersecurity matter on a Schneider Electric product or solution via the Report a cybersecurity vulnerability page.

Failure to follow these instructions can result in equipment damage.

General Description

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Safety Instructions

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Apply appropriate personal protective equipment (PPE) and follow safe electrical work practices.
- This equipment must only be installed and serviced by an electrically qualified personnel.
- Turn off all power supplies of the equipment before working on or inside equipment.
- Respect the LOTO (Lock Out Tag Out) procedure according to OSHA requirements.
- Always use a properly rated voltage sensing device to confirm that power is off.
- Put all devices, doors, and covers back into place before turning on power to this equipment.
- Beware of potential hazards, and carefully inspect the work area for tools and objects that may have been left inside the equipment.
- Never go behind the cubicle when it is energized.

Failure to follow these instructions will result in death or serious injury.

Functional Description

PowerLogic™ T300 features a modular architecture designed for applications in MV network substations. The T300 offers the following functions:

- **Management of the open/close motor mechanism on MV switchgear**, compatible with any MV switchgear
- **Tripping protection** with a circuit breaker
- **Detection of ammetric and directional fault currents** on the MV network and tripping protection: operational on any neutral system with or without the presence of distributed power and including fault current algorithms based on the following international standards:
  - Phase overcurrent and ground fault detection and tripping protection (ANSI 50/51, ANSI 50N/51N)
  - Directional overcurrent and ground fault detection and tripping protection (ANSI 67/67N)
  - Cold Load PickUp (CLPU)
  - Auto-recloser (ANSI79)

  Two fault current detection methods are used:
  - Definite time (DT) curve
  - Inverse definite minimum time (IDMT) curve
- **MV network voltage and current monitoring**, for the following functions:
  - Undervoltage detection (ANSI 27)
  - Overvoltage detection (ANSI 59)
  - Neutral overvoltage detection (ANSI 59N)
  - Voltage broken conductor detection (ANSI 47)
  - Undercurrent detection (ANSI 37)
  - Active Overpower (ANSI 32P)
- **MV current measurement** using standard current sensors, compatible with standard IEC 61869-2, according to following possible configurations:
  - 3 phase CTs
  - 1 core balance CT
  - 2 phase CTs + 1 core balance CT
  - 3 phase CTs + 1 core balance CT
- **MV voltage measurement** using the following voltage sensors:
  - **LPVT** (low power voltage transformer) according to standard IEC 61869-7
  - **Standard MV/LV VTs** with secondary from 57 Vac to 220 Vac according to IEC 61869-3 (requires a VT adapter)
  - **VDS (voltage detecting system) indicator** with voltage output (standard IEC 61243-5)
  - **PPACS external capacitive divider** mounted at the head of the MV cable
  - **VPIS-V3 VO**
  - **VDIS**
- **MV power measurement** according to standard IEC 61557-12
- **Disturbance record** according to IEC 60255-24
- **Quality of the MV power supply** delivered, according to the principles of IEC 61000-4-30 class S (up to harmonic 40), for T300 RTUs equipped with LPVT and VT sensors

- **LV network voltage monitoring**, for the following functions:
  - Undervoltage detection (ANSI 27)
  - Overvoltage detection (ANSI 59)
  - Neutral overvoltage detection (ANSI 59N)
  - Voltage broken conductor detection (ANSI 47)
- **LV current measurement** using standard current sensors, compatible with IEC61869-2, according to two possible configurations:
  - 3 phase CTs
  - 3 phase cores + 1 neutral measuring sensor
- **LV voltage measurement** via a Voltage adapter measuring directly the voltage on the LV network
- **LV power measurement** according to IEC 61557-12
- **Quality of the LV power supply** delivered according to the principles of IEC 61000-4-30 class S (up to harmonic 40)
- **Transformer monitoring**:
  - Temperature monitoring with threshold alarm
  - Measurement of current peaks
- **Monitoring, remote indication, and local display** of T300 and substation data
- **Integrated automation functions** in the SC150/SC160 module (Sectionalizer, Tripping protection)
- **Substation thermal and environmental condition monitoring**
- **Recording of time- and date-stamped events in logs (SOE)**
- **Battery-backed power supply** with several hours independent operation in the event of an AC line outage
- **Local or remote communication** over 1 or more communication channels: local communication with auxiliary equipment; remote communication with the remote control center (SCADA system). The following modems are managed on the communication ports:
  - **4G** (standard EU version)
  - **RS-232/RS-485**
  - **Zigbee receiver**
- **Settings by protocol in the SC160 module**
- **Communication protocols** for communicating with the control center or with other devices:
  - **IEC 60870-5-101** and **IEC 60870-5-104** controlling station and controlled station. For controlled station, DLT634.5101-2002 and DLT634.5104-2009 profiles are supported
  - **DNP3** master station and outstation
  - **Modbus** client and server
  - **Modbus Sepam** client
  - **MQTT** publisher/subscriber
  - **IEC 61850** client and server
  - **Zigbee** (IEEE standard 802.15.4) client
- **Configuration of communication ports**
- **Device time synchronization**, can be set:
  - **Via the communication protocol**
  - **Via the SNTP server**
  - **Via GPS** (with 4G modem box)

- IEC 61131-3 PLC (**ISaGRAF®**) including text and graphics editors for executing specific custom applications in the following programming languages:
  - **SFC**: Sequential Function Chart
  - **FBD**: Function Block Diagram
  - **LD**: Ladder Diagram
  - **ST**: Structured Text
  - **IL**: Instruction List

Description of T300 Modules

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PowerLogic™ T300 comprises several communicating modules.

HU250 Module – CPU and Communication Gateway

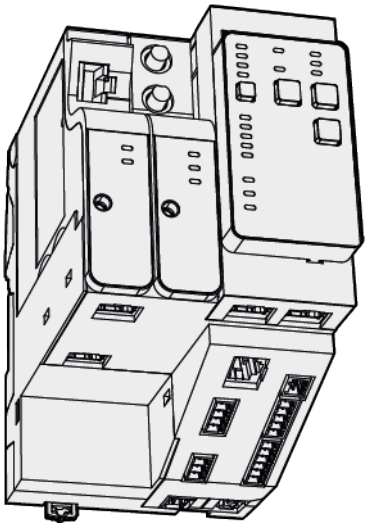
The T300 HU250 module manages the following functions:

- User database and access rights administration
- Remote communication with the control center (SCADA system) via the protocols (IEC 60870-5-101/IEC 61850 protocols) and the secure protocols (IEC 60870-5-104/DNP3/MQTT)
- Flexible local communication (Ethernet, Wi-Fi, Zigbee, RS-232)
- Flexible communication media (Ethernet, GPRS, 4G networks)
- Communication gateway for the T300 modules
- LAN communication for third-party devices (IED) in client/server station protocols (Modbus, IEC 60870-5-104, IEC 61850 protocols, DNP3, MQTT as IoT protocol)
- Access to local and remote configuration for all T300 modules
- Web server with local and remote access
- Integrated automation function with execution of programmable logic control
- Remote/local operation of global functions, enabling/disabling of PLC function

  NOTE: Wi-Fi and other wireless protocols are only available on the HU250 with part number EMS59000.

For more information regarding installation, connection, and use of:

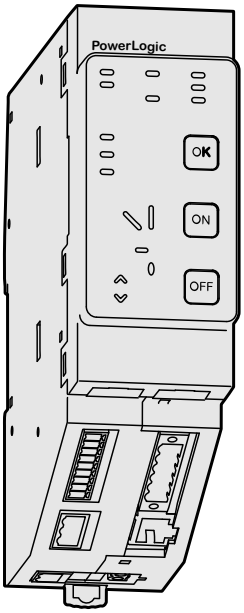
- HU250 module, refer to the HU250 Installation Guide (ref: NHA77925).
- HU250 module without wireless unit, refer to the HU250 Installation Guide (ref: PKR45928).



SC150 Module – Switch Control Unit

The T300 SC150 module manages the following functions:

- Control and monitoring of all switch types
- Detection of ammetric and directional fault currents:
  - Detection of Ammetric phase overcurrent and ground fault
  - Detection of Directional phase overcurrent and ground fault
- Detection of broken phase conductor
- Current measurements using standard current transformers
- MV Voltage measurements using different types of sensor: LPVT, VT, VDS, VPIS-V3, VDIS and external capacitive divider installed on the MV cables
- MV Power measurement in accordance with standard IEC 61557-12
- MV Power quality according to the principles of IEC 61000-4-30 class S (up to harmonic 40)
- Disturbance record according to IEC 60255-24
- Special integrated automation function: sectionalizer
- Port configuration



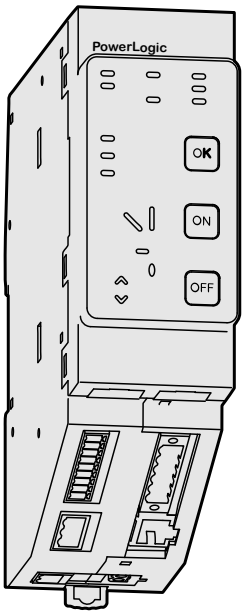
For more information regarding installing, connection, and use of SC150 module, refer to the *SC150 Installation Guide (ref: NHA91857)*.

SC160 Module – Switchgear Control, Protection Unit

The T300 SC160 module manages the following functions:

- Control and monitoring of all breaker types
- Detection or, detection and tripping protection of ammetric and directional fault currents:
  - Ammetric phase overcurrent and ground fault
  - Directional phase overcurrent and ground fault
- Cold Load PickUp function
- Detection of broken phase conductor
- Current measurements using standard current transformers
- MV Voltage measurements using different types of sensor: LPVT, VT, VPIS-V3
- MV Power measurement in accordance with standard IEC 61557-12

- MV Power quality according to the principles of IEC 61000-4-30 class S (up to harmonic 40)
- Disturbance record according to IEC 60255-24
- Special integrated automation function: sectionalizer
- Remote settings by protocols
- Port configuration

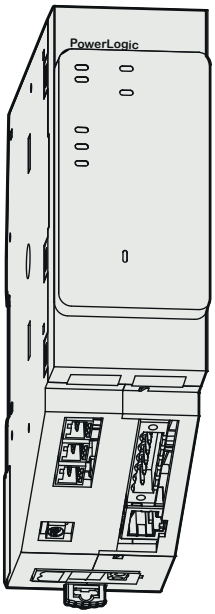


For more information regarding installing, connection, and use of SC160 module, refer to the *SC160 Installation Guide (ref: GDE64933)*.

LV150 Module – Low Voltage Measuring Unit

The T300 LV150 module manages the following functions:

- Current measurements using standard current transformers
- LV Voltage measurements using Voltage adaptor
- LV Power measurement in accordance with standard IEC 61557-12
- LV Power quality according to the principles of IEC 61000-4-30 class S (up to harmonic 40)
- Detection of broken phase conductor
- Port configuration



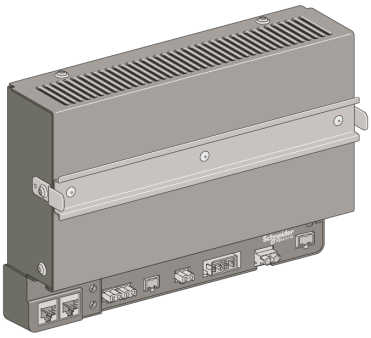
For more information regarding installing, connection, and use of LV150 module, refer to the *LV150 Installation Guide (ref: NHA92575)*.

PS50 Module – Backup Power Supply for Severe Environments

The PS50 is the default power supply for the T300. It supplies power to the system and allows, through a battery-backup power supply, continuity of operation for the equipment listed below in the event of a power outage:

- Motor mechanism for the MV switches and circuit breakers
- Transmission interfaces (radio, modem, etc.)
- T300 electronic modules
- Third-party devices, such as protection relays, fault current passage indicators, and other electronic equipment installed in the MV substation

The PS50 module can communicate on an RS485 Modbus link with the HU250 module to exchange information managed by the PS50 power supply. This communication also makes it possible to set the PS50 module from the T300 Web server.



For more information regarding installing, connection, and use of PS50 module, refer to the PS50 Installation Guide (ref: NT00375).

T300 Internal Architecture

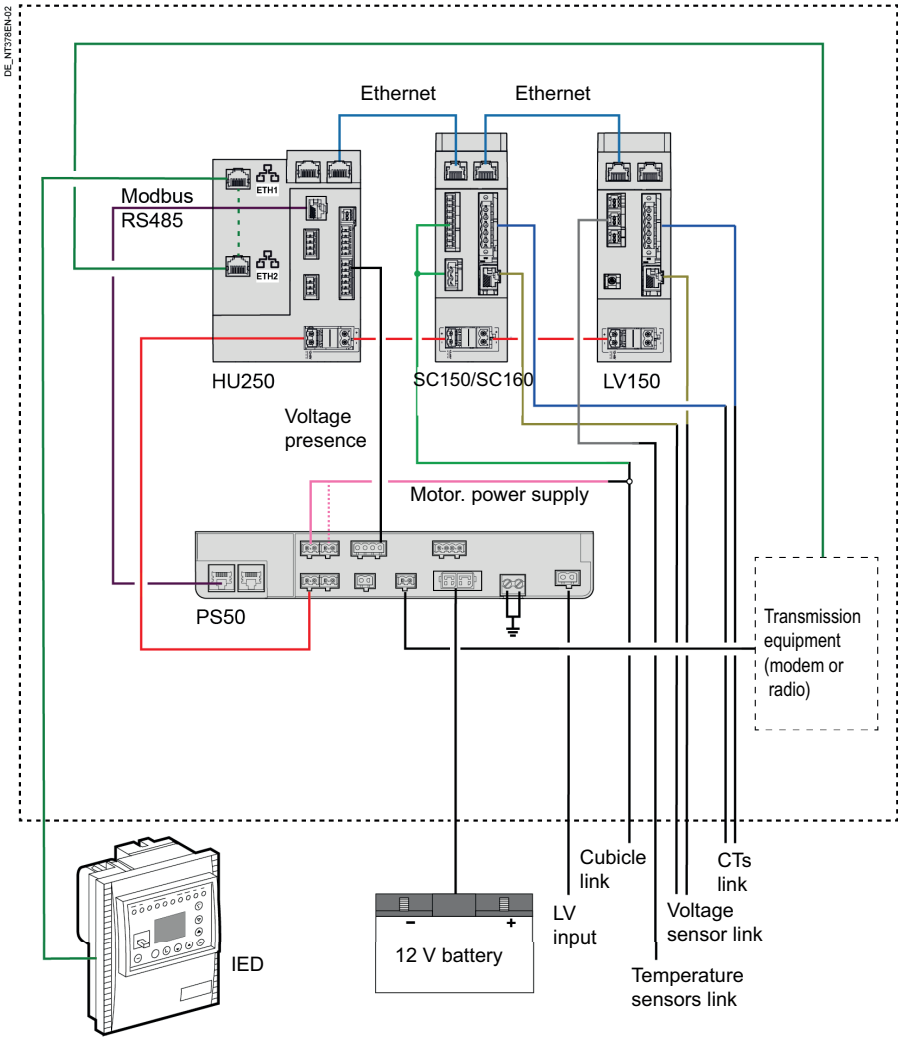
The diagram below shows an example of internal architecture for a T300 RTU comprising the following modules:

- 1 HU250
- 1 SC150/SC160
- 1 LV150
- 1 PS50

T300 platform offers a modular architecture. This means that multiple architectures can be implemented, for example more SC150/SC160 and LV150 modules can be added depending on the requirements. Expansion modules can be added to enhance the platform connectivity function.

There may be just the HU250 module used, or the PS50 module may be replaced with another type of power supply.

This diagram shows the various internal links between the component modules. The HU250 is the central interface for internal communication between all the modules as well as for external communication.



T300 Configuration Principle

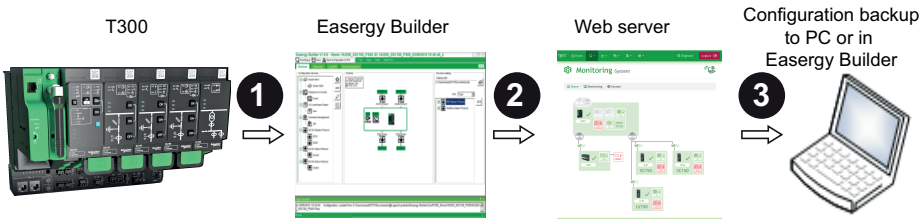
What's in This Chapter

Engineering in Easergy Builder.....30
Management of RBAC and Security Policy.....34

The T300 is delivered with a default factory configuration corresponding to the options ordered.

This initial configuration should then be customized to adapt it to the user application and requirements.

Configuration backup to PC or in Easergy Builder:



1. Default configuration
2. Custom configuration
3. Custom configuration with application parameter settings

There are some tools for this purpose:

- **Easergy Builder**: Engineering tool for adding or customizing specific operational options adapted to the application. Easergy Builder generates a custom configuration for the T300 based on the initial configuration modified by the addition of these options.
- **CAE** (Cybersecurity Administrator Expert): engineering tool for defining / changing the equipment security policy and roles assigned to users.
- **T300 Web server**: Commissioning tool for the end user. Using the configuration set up in Easergy Builder and loaded onto the equipment, the user can set the parameters for the T300 application program via the Web server. This step consists in customizing the parameters of the various functions, such as fault current detection, communication, switch control, measurement, etc.

  In contrast to Easergy Builder, the Web server does not allow functions to be added to the equipment. It only allows parameters to be set and customized for the application associated with the functions already selected.

Engineering in Easergy Builder

Before using the equipment, a certain number of functions need to be configured in Easergy Builder. These functions are not included in the factory configuration as they depend on the customer application.

The functions that required to be added/modified in Easergy Builder are listed below:

Adding/Deleting Channel and Modems

The setting of Channels and existing modems in the default configuration can be done via the T300 Web server. However, the addition or replacement of modems or the creation of Channels for the SCADA link, can only be done via Easergy Builder.

Refer to the *Easergy Builder User Manual* for more details on these custom settings.

T300 Synchronization

The default configuration does not include device synchronization. The choice of synchronization source can only be configured in Easergy Builder. The Web server only allows the synchronization parameters to be set once the function has been configured in Easergy Builder.

There are three possibilities for synchronizing the RTU:

- Automatically by the communication protocol (via the SCADA)
- Through an SNTP server, if the RTU is connected to an IP network
- By GPS satellites, if the HU250 module includes a 4G modem with GPS option.

You can define two channels of synchronization, the primary device and the secondary device. The secondary device will be used if the primary device is unavailable.

Instructions on how to configure synchronization are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

Sequence of Events (SOE)

An events file is automatically created in the T300 default configuration. This file corresponds to standard use of the equipment and includes a number of data for which events are generated on change of states.

The engineering phase is to modify or add additional variables to the file or to create additional events files (for example, measures backup file), or to change the default storage files.

The total capacity of event files is limited to maximum 4 files. Easergy Builder allows the management, creation or modification of these events files.

Note that this management cannot be done via the Web server. The Web server can only be used to operate these events files, that is, consulting, downloading, or deleting them.

Instructions on how to configure the SOE option are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

Historical Data according to DLT634.5101 / DLT634.5104 (HST)

DLT634.5101 / DLT634.5104 are Chinese standards based on IEC60870-5-101-2002 and IEC-60870-5-104-2009.

When this profile is used, historical data is created according to these standards.

This selection is done during the engineering phase with Easergy Builder.

The Web server can be used to consult and download this data.

Client and Server Protocols

The default configuration of the equipment is provided without addressing for the protocol since it must be adapted to the SCADA type used or the type of server to include in the configuration.

The Client Protocols

For client protocols, the engineering phase is to create first of all server devices in the system and the data that is associated to these devices. The data to create depend on the application and the connected device type.

The addressing protocol must be set for all data you wish to report the statements to the T300.

The list of client protocols that can be used is as follows:

- IEC 60870-5-101 (controlling station)
- IEC 60870-5-104 (controlling station)
- DNP3 (master station)
- Modbus (client)
- Modbus Sepam (client)
- IEC 61850 MMS or GOOSE (client)
- Zigbee - IEEE standard 802.15.4 (client)
- MQTT subscriber

The Server Protocols

For server protocols, the engineering phase consists of selecting in the system database, the data that must be reported to the SCADA and then to define the corresponding protocol addressing.

The list of server protocols that can be used is as follows:

- IEC 60870-5-101 (controlled station)
- IEC 60870-5-104 (controlled station)
- DNP3 (outstation)
- Modbus (server)
- IEC 61850 MMS or GOOSE (server)
- MQTT publisher

Instructions on how to configure the client and server protocol addressees are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

Personalization of LEDs

Some indicators used in front panel of the product and external lights can be customized to define the data that will trigger the lighting of these LEDs. This operation is made during the engineering phase via Easergy Builder advanced tool.

It is possible to customize the colors of the LEDs and set the I/O filter parameters via the Web server (see the Local I/O section). Note that for HU250, the same operations can also be carried out in Easergy Builder.

Instructions on how to assign the LEDs are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

Management of specific commands

A specific management function related to the switch controls voltage can be configured in the engineering phase via Easergy Builder.

Instructions on how to configure this specific command management option are given in the *Easergy Builder User Manual*. Refer to this document for more information.

Calculation Formulae

The calculation formulae are used to carry out math, combinational logic operations or others on T300 data in order to perform specific personalized functions.

These Calculation formulaes can be created via Easergy Builder.

The list of operations available are given in the *Easergy Builder User Manual*. Refer to this document for more information related to the calculation formulae.

IEC 61131-3 PLC

An IEC 61131-3 programming tool (ISaGRAF® platform) is available with the T300 for developing PLC programs. This ISaGRAF® platform is an external software tool to be installed on a PC. It is used to develop specific custom applications in the following programming languages:

- SFC: Sequential Function Chart
- FBD: Function Block Diagram
- LD: Ladder Diagram
- ST: Structured Text
- IL: Instruction List

Before developing and using a PLC program in the HU250, the interface must first be created with ISaGRAF® in Easergy Builder to define the links and the relationship between these 2 elements and the CoreDB.

Instructions on how to configure the interface with ISaGRAF® in Easergy Builder are given in the *Easergy Builder User Manual*. Refer to this document for more information.

Automatic Transfer Switching

If the T300 system has at least two SC150/SC160 modules, it can be configured with an Automatic Transfer Switching function (ATS).

The ATS system can use the values of CoreDB variables for dynamically blocking or allowing transfers. The particular variables to be used, for example, specific digital inputs, must be configured using Easergy Builder by defining the ATS bin controller as a destination. Different variables can be used for different blocking conditions, for example, blocking all transfers or blocking self-return transfers. Refer to the description of the Automatic Transfer Switching (ATS) settings, page 173 for more information.

Condition Monitoring

The T300 system is able to integrate the following sensors:

- Thermal PowerLogic TH110 Zigbee sensors to read cable connection temperature

- Environment PowerLogic CL110 Zigbee sensors to read environment humidity and temperature.

This data can be monitored and computed to generate monitoring information such as alarms.

Refer to Condition Monitoring, page 71 page.

Management of RBAC and Security Policy

The T300 is provided with a standard security policy and a default RBAC (roles assigned to a number of predefined users).

The T300 security policy is managed by a special tool - CAE (Cybersecurity Administrator Expert). The CAE can be used during the engineering phase to redefine or change the system access restrictions, including the access rights and responsibilities, via an RBAC (Role-Based Access Control) model.

RADIUS and LDAP protocol provide the capability to have a generalized and unique authentication policy on a dedicated server, rather than to define them locally on the various T300s of the network.

The commissioning phase done in the Web server will be only limited to adding or deleting users, to modify their associated passwords, and to assign or modify one or more of the roles pre-defined in the CAE to these users.

See the Managing Users and Roles, page 98 section for more information on how to set these parameters.

Instructions on how to configure the security policy in the CAE are given in the *CAE User Manual*. Refer to this document for more information.

To communicate a security topic affecting a Schneider Electric product or solution, go to: https://www.se.com/ww/en/work/support/cybersecurity/vulnerability-policy.jsp.

Initial Start-Up

Instructions relating to starting up the equipment are described in the T300 Quick Start Guide (reference NT00383). Refer to this document to get the following information:

- How to install Easergy Builder
- First local connection to the T300 Web server
  - Connecting to the T300 Web server via an Ethernet network
  - Connecting to the T300 Web server via a Wi-Fi network
- Configuring the SC150/SC160 and LV150 modules IP addresses
- Overview of Easergy Builder
- How to import a T300 configuration into Easergy Builder
- How to import a saved tar.gz T300 configuration into Easergy Builder
- How to customize the T300 configuration in Easergy Builder
- How to synchronize the T300
- How to send a configuration to the T300 via Easergy Builder.

Connection to the T300 Web Server

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Equipment Required for the T300 Connection 36
Principle of the T300 Embedded Web Server 37
IP Addresses for Connection to the T300.....38

PowerLogic™ T300 needs a connection from a PC, tablet, or smartphone to be able to configure, consult, or carry out maintenance on the equipment. This can be via a Wi-Fi or Ethernet connection (via the HU250 module).

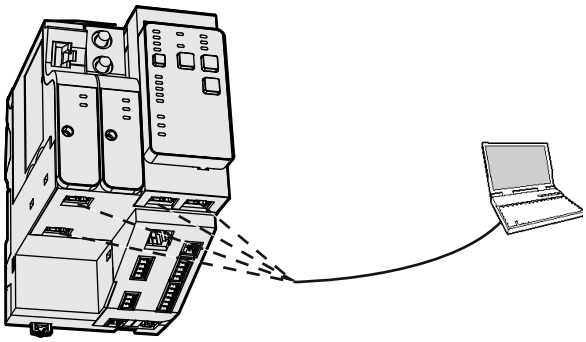
Instructions on how to connect to the T300 Web server are not given in this manual. Refer to the T300 Quick Start Guide (NT00383), for detailed instructions on how to connect via Ethernet or Wi-Fi technologies.

Equipment Required for the T300 Connection

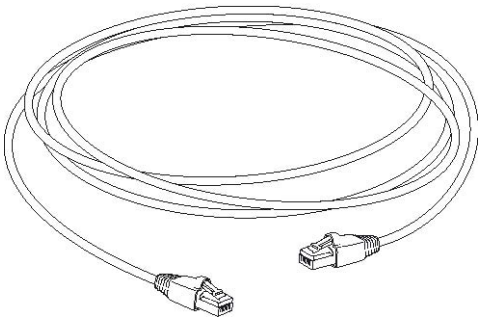
The T300 needs a PC with Windows XP, 7, or more recent operating system, and a web browser. It also needs:

- An Ethernet port (RJ45) on the PC to connect to the T300 via an Ethernet network or direct PC-T300 access
- Wi-Fi access on the PC to connect to the T300

Connection of a configuration/consultation/maintenance PC to one of the available ETH port:



Ethernet cable for the PC-T300 link



NOTE: The choice of Wi-Fi or Ethernet access to the T300 is up to the user. There is no difference in operation between the 2 types of link. However, Wi-Fi is considered as a local access mode and Ethernet a remote access mode, with the possibilities that relate to these two modes.

The T300 parameters and data are accessed directly via a web browser. No other additional software is required to access the embedded Web server.

Principle of the T300 Embedded Web Server

The T300 includes an embedded server that initializes automatically as soon as the connection is established with the T300.

The data displayed by the T300 via this embedded server is presented in the form of HTML pages.

Different pages and subpages can be accessed by the user depending on the user's rights.

The HTML pages displaying the data managed by the T300 Web server are refreshed in real time to help ensure they show the most up-to-date status information.

Access and connection are secured by a login and password. At the first connection with the default SecurityAdmin user and AAAAAAAA password, it is asked to change the default password, page 100 with a new one matching the security requirements.

From the embedded server you can do the following actions:

- Modify the fault current detection, communication, automation function, or system parameters.

  NOTE: The T300 is supplied with default parameters that can be modified as required by the user.
- View the states managed by the T300 (indicators, events, potential issues, measurements, counters, etc.).
- Save the T300 configuration to file or download it from a file already saved on the PC.
- Send remote control orders to the T300.
- Transfer diagnostics logs in .csv file format compatible with Excel application.
- Load a new version of the T300 application firmware (to the HU250 or the SC150/SC160 and LV150 modules).
- Download disturbance records from SC150/SC160 modules.
- Monitor protocol traces.
- Manage Zigbee network.

IP Addresses for Connection to the T300

As standard, the T300 integrates IP addresses for the local Ethernet connection from a PC as well as for Wi-Fi access. The following characteristics are needed to establish these connections:

- Default T300 Ethernet port address: https://192.168.1.10
- Wi-Fi access:
  - Wi-Fi SSID = PowerLogic T300
  - Password = PowerLogic T300
  - Wi-Fi IP address = https://192.168.2.254

NOTE: To avoid conflicts and for security purposes, it is advisable to configure a single and unique SSID for each T300. Refer to the corresponding section, page 130 in this manual for information on how to change these parameter settings. The default connection parameters are general purpose, but it is possible to modify them to meet your network specifications.

Overview of the T300 Web Server

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T300 Web Server Menu Overview 40
Data Consultation and Monitoring Pages 47
Measurements 79
Diagnostic Files 88
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IP Interfaces 130
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T300 Web Server Menu Overview

What's in This Chapter

Home 40
Monitoring and Control 41
MV/LV Measurements 42
Diagnostics 43
Maintenance 43
Settings 44

The T300 Web server is the local and remote user interface for consulting and monitoring T300 operating, maintenance, and application configuration data. Once the user name and password have been entered, all data in the HTML pages can be viewed simply by clicking on the links in the ribbon at the top of the screen.

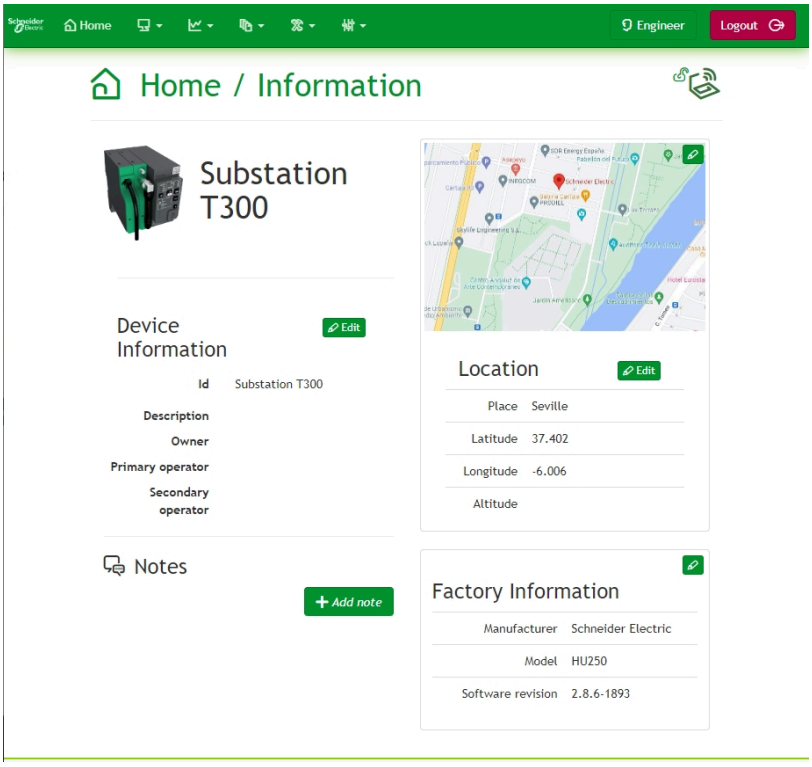
This ribbon contains five menus:

- Home
- Monitoring and Control
- MV/LV Measurements
- Diagnostics
- Maintenance
- Settings

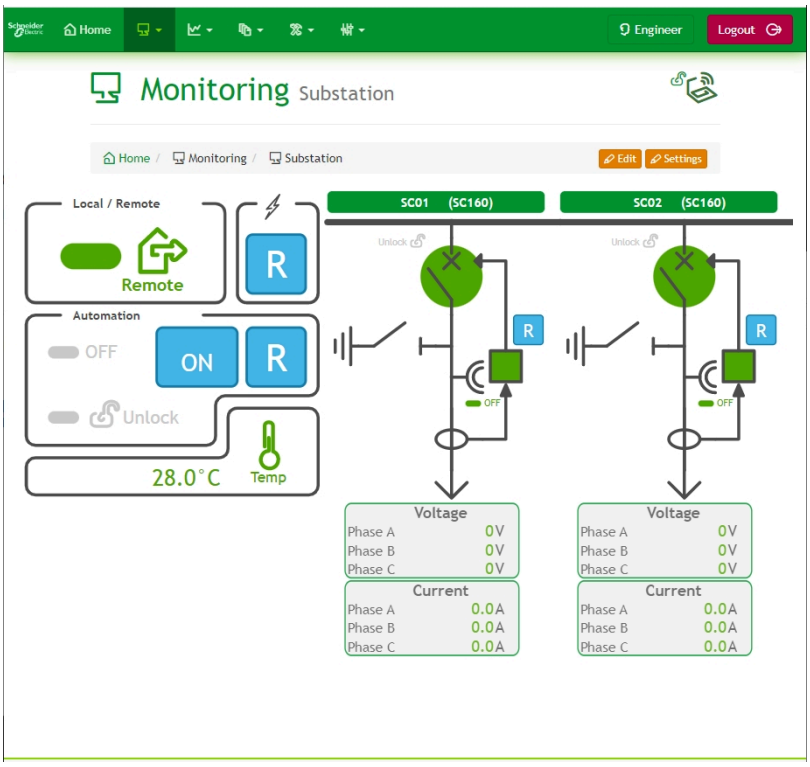
Home

The information on this page identifies the MV substation to which the user is connected.

- the substation GPS coordinates
- a location map created automatically and updated using the GPS data (if there is an Internet connection)
- the product ID with the option to add images
- notes added by the user.



Monitoring and Control



This menu is used to view the T300 status, monitor substation data, and control the breaking device:

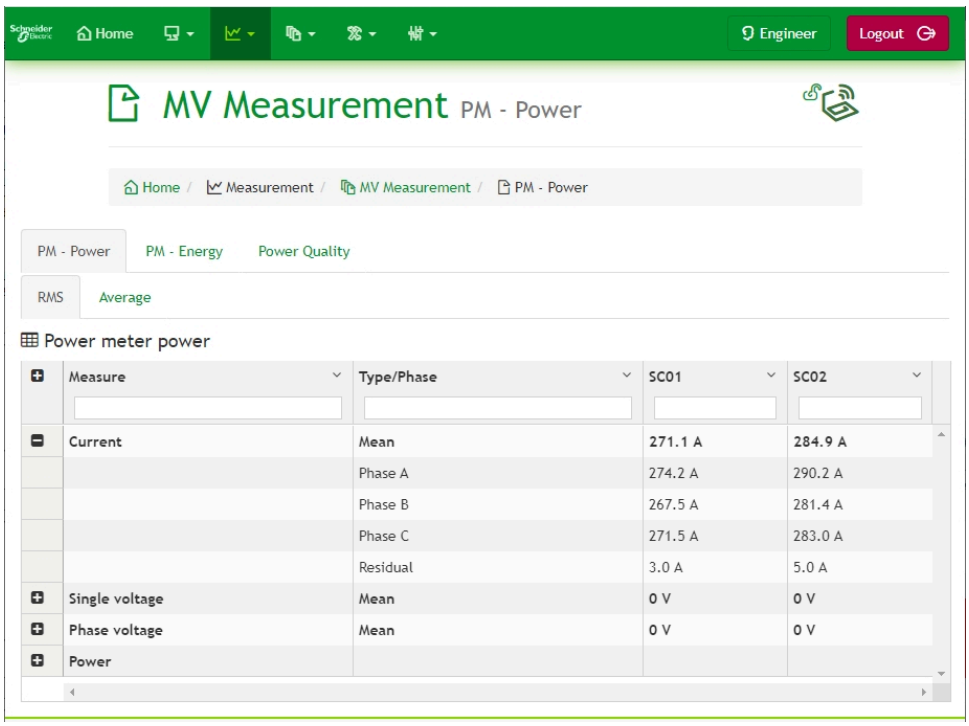
- Graphical representation of the substation and switchgear with electrical symbols
- Display of T300 status in the form of a data point list with the values associated with each type (state, command data, analog data, setpoint values)

- Option to set command and setpoint data parameters manually from the Web server and to assign a specific preset value (for security purposes, each command must be confirmed by the user)
- Environmental and thermal connection condition monitoring in cubicles and substation (Alarm, Warning, Normal status management)

  NOTE: The user can modify command data via the Web server:

  - Via the Wi-Fi network only if the T300 is in local mode
  - Via the LAN or WAN only if the T300 is in remote mode

MV/LV Measurements



This page is used to view the different measurements performed by the T300 (display of some measurements according to the options of the unit):

- Current measurements on each phase, residual current and mean current
- Average of the currents on each phase, the calculated or measured residual current and the average current
- Phase-to-neutral and phase-to-phase voltage measurements on each phase and indication of residual voltage and mean voltage measurements
- Average of the voltages on each phase, the calculated neutral voltage and the phase-to-neutral average voltage
- Active, reactive, and apparent power measurements on each phase
- Average of the active, reactive and apparent power on each phase and of the total power
- Power factor measurement on each phase
- Active, reactive, and apparent energy measurements on each phase
- Power quality measurement (statistics and counters for the voltage interruptions, sags, and swells on the MV network)
- Minimum and Maximum recorded for current averages, per day, week, month and year
- Harmonic distortions on each phase current and the average of the three phases
- Harmonic distortions on each phase voltage and the average of the three phases

- Harmonic magnitude 1 on each phase current
- Harmonic magnitude 1 on each phase voltage
- Harmonic 1 current and voltage on the average of the three phases
- Harmonic angle 1 on each phase current
- Harmonic angle 1 on each phase voltage

Diagnostics

This menu is used to view the data logs recorded in real time by the T300. Events are time-stamped with a 1 ms resolution.

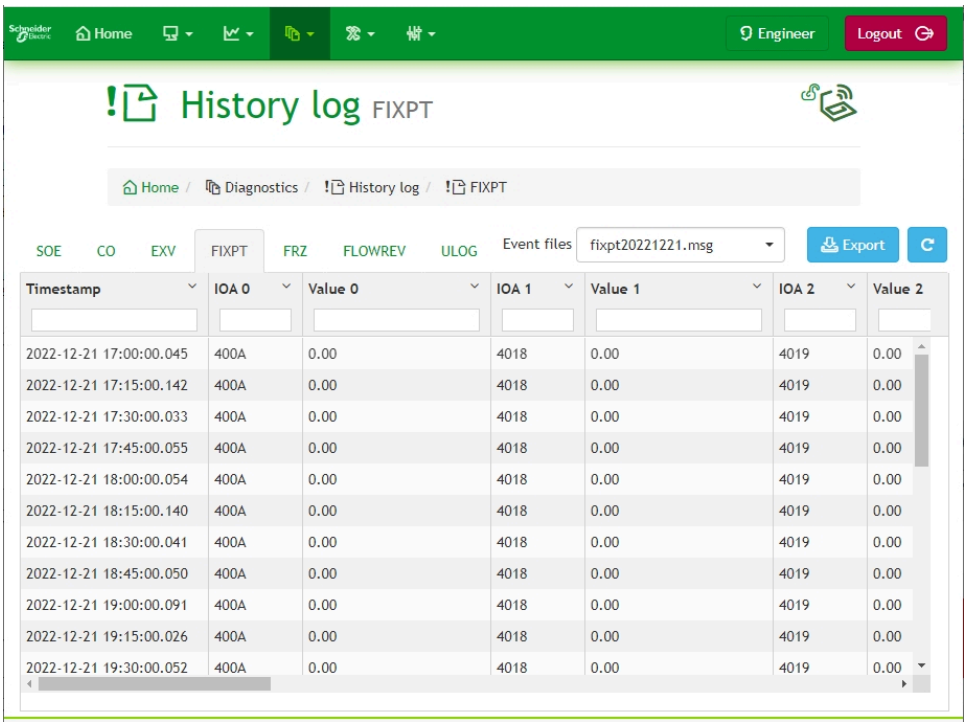
Recording of events: Data changes are recorded in log files according to the configuration.

The recording mode must be configured using the Easergy Builder configuration tool:

- It is possible to define up to 4 log files (Events).
- The size and name of each log file are configurable.
- Any data can be assigned to a log file.

  NOTE: By default, Event, Measurement and Alarm logs are created, with a capacity of 2,000 events.

Log files can be downloaded locally or remotely. For all logs, when the storage capacity is reached, the most recent event erases the oldest event from the list.



Maintenance

This menu helps with maintenance of the T300 by supplying the relevant information or by allowing configuration of the standard RTU applications:

- **Users:** managing the roles and passwords associated with each user.
- **Clock:** Synchronization of the device date and time.
- **IP configuration:** Definition of the IP addresses of the LAN, WAN, and Wi-Fi networks or the T300 router function.

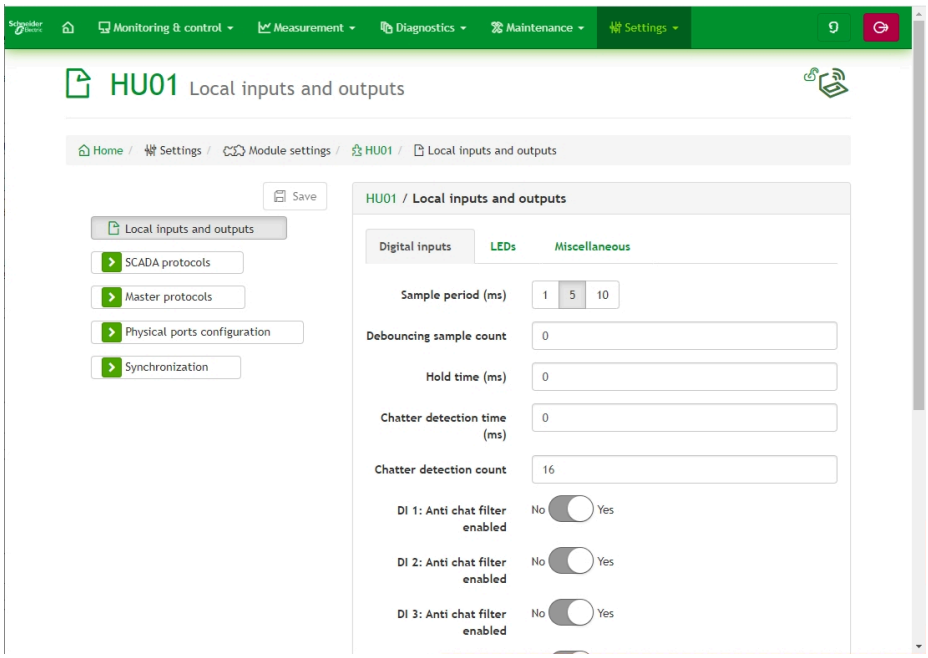
- **Physical port configuration:** Physical configuration of the Ethernet on HU250.
- **Modem configuration:** Configuration of the modem communication parameters, for the modems providing remote access, such as the 4G modem.
- **Firmware:** Information relating to the firmware for each module (version, date, and time) with the option to update it.
- **Configuration:** Information relating to the device configuration with the option to import/export the configuration in file format or saving/importing it into dedicated slot spaces in the device.
- **IEEE 802.15.4 network management:** (Option) Information relating to the IEEE 802.15.4 network that manages sensors to monitor the environmental and thermal conditions.

Settings

In the **Settings** window, you can access the pages dedicated to each T300 module and their configuration:

- HU250: Configuration of the HU250 module parameters

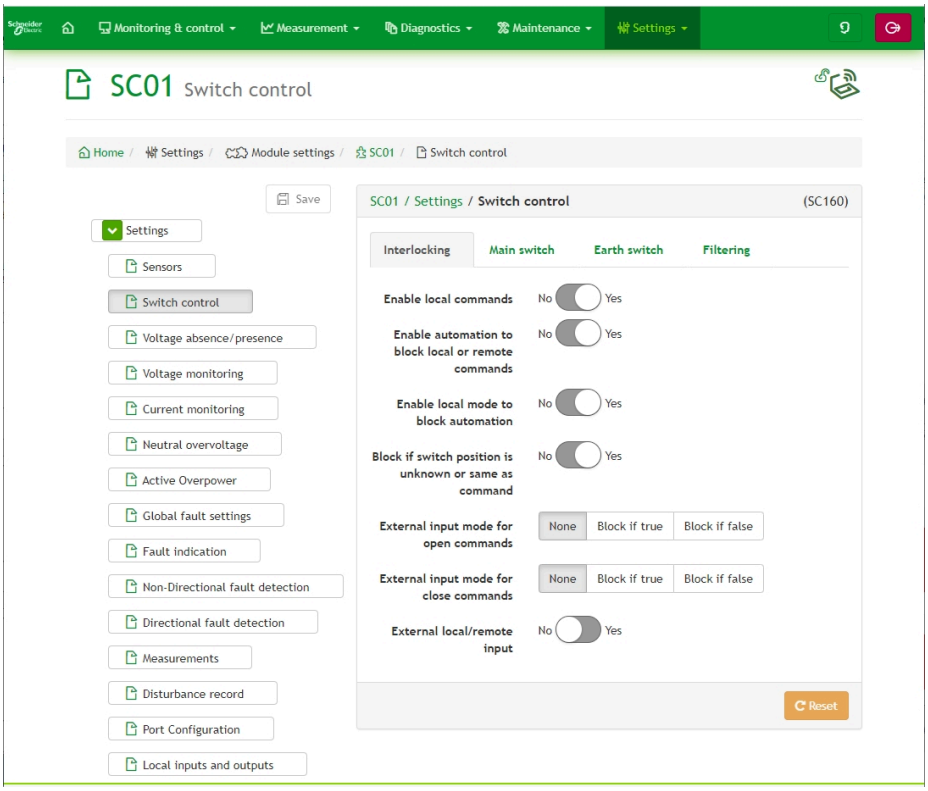
  Accessed via **HU01 Settings** page.



  - Local I/O
  - Automatic transfer switching (ATS)
  - Condition monitoring
  - Communication protocols
  - Communication ports and modems
  - Physical port configuration (for example, RS-485 for PS50 link, RS-232/485 modem box)
  - Time synchronization
  - Host monitoring

- SC0x: Configuration of the parameters of each SC150 or SC160 module

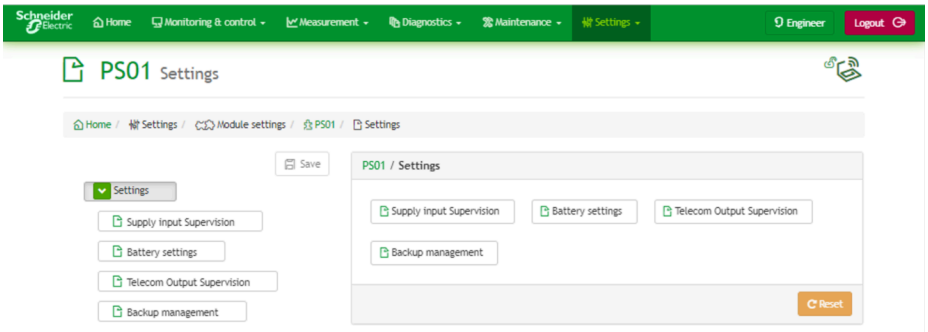
  Accessed via **SC01 Settings** page.



  - Current and voltage measurement sensors
  - Switch controls
  - Voltage presence/absence detection
  - Voltage monitoring
  - Neutral overvoltage
  - Non-Directional fault detection
  - Directional fault detection
  - Active overpower
  - Fault current indication
  - Fault current detection
  - Tripping protection (on SC160 module only)
  - Cold Load Pick-up function (on SC160 module only)
  - Broken conductor detection
  - MV Measurements
  - MV Power quality
  - Disturbance record
  - Sectionalizer automation function
  - Port configuration
  - Local I/O: User LED customization

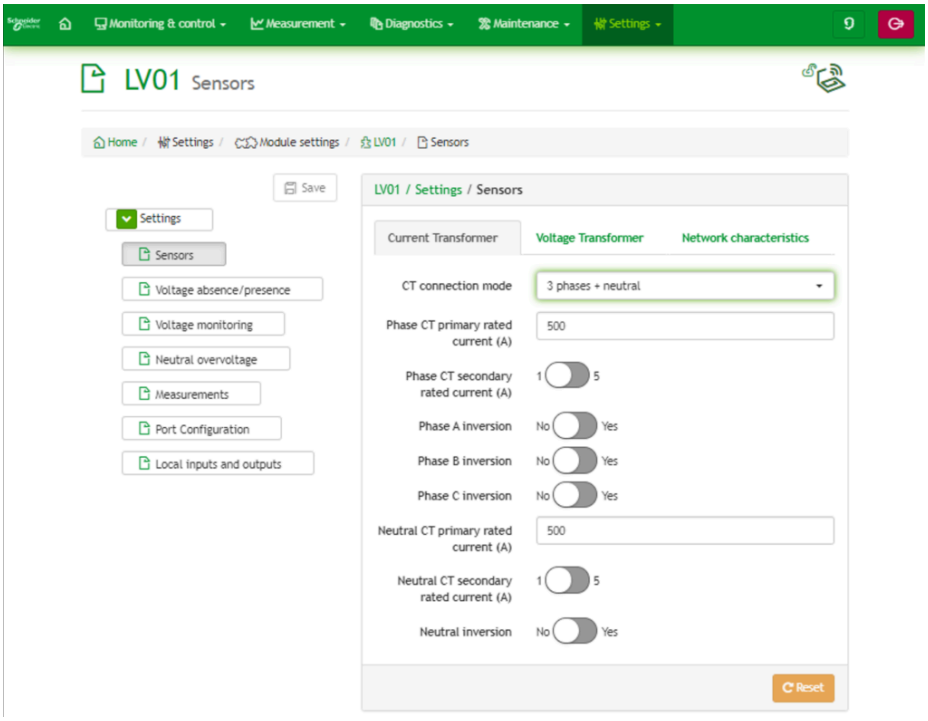
- PS50: Configuration of the parameters of each PS50 module:

  Accessed via **PS01 Settings** page.



  - Power supply input monitoring
  - Battery
  - Remote control order monitoring
  - Back-up power supply management
- LV0x: Configuration of the parameters of each LV150 module:

  Accessed via **LV01 Settings** page.



  - Current and voltage measurement sensors
  - LV Voltage monitoring
  - Broken conductor detection
  - LV Measurements
  - LV Power quality
  - Port configuration
  - Local I/O: User LED customization

Data Consultation and Monitoring Pages

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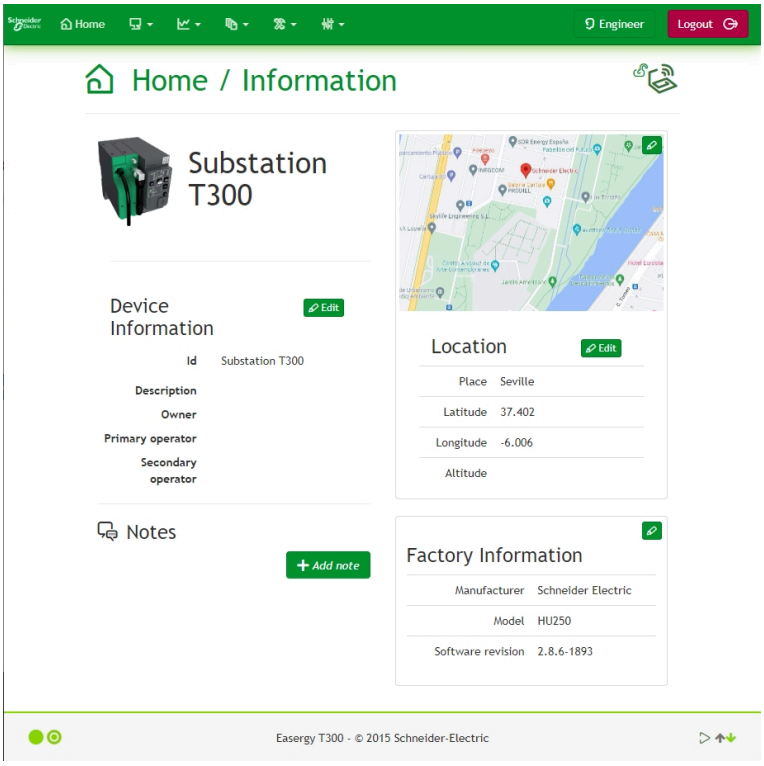
Home Page

Accessed via **Home** page

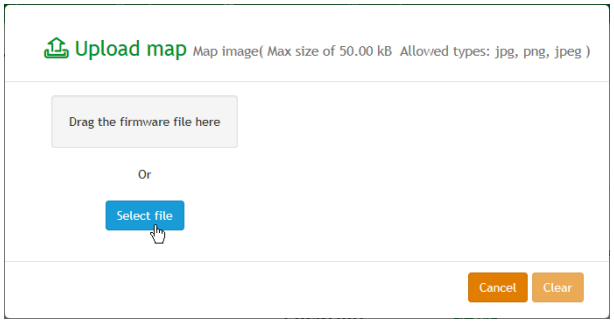


Once the username and password have been entered to access the T300 Web server, the Home page is displayed automatically.

This page contains the following general information about the MV substation:

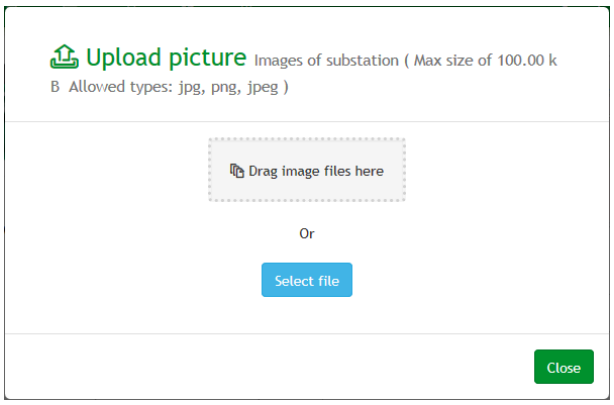
- **Device Information:** It is possible to add the names of the operators who have used or configured the equipment or a specific custom note that can be viewed each time a connection is established to this substation.
- **Location:** The GPS coordinates for the MV substation location (latitude, longitude, and altitude) can be entered here. If these coordinates are defined and there is an Internet connection, a Google map automatically appears in the Home page.

  It is possible to download another image manually by clicking the button next to the map. Then simply browse to select the relevant image file and click **Upload** to upload the map:



- **Factory Information:** This gives the product ID and the version of the software loaded on the HU250 module. It is also possible to include an image of the MV substation or a particular device here for identification purposes.

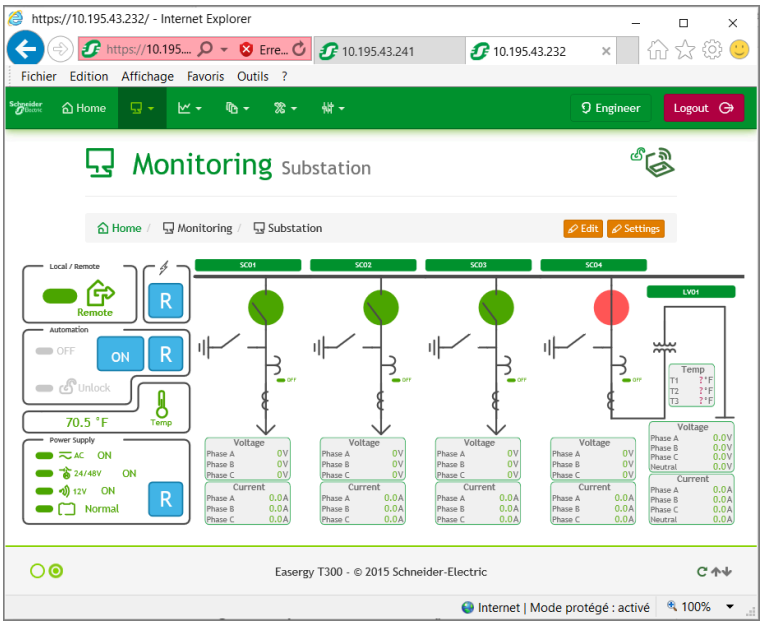
  To do this, click the , button to select the relevant file and click **Upload** to upload the image:



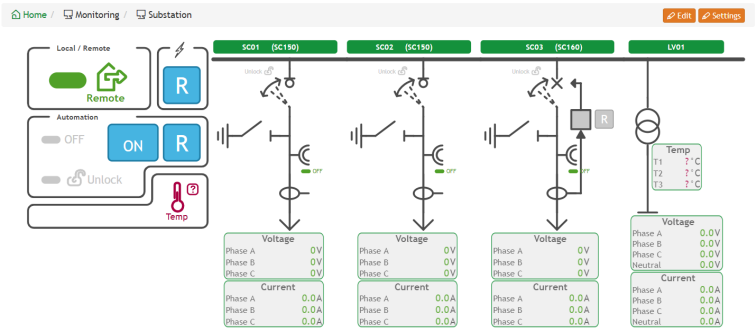
Substation Page

Access via **Monitoring & Control > Substation** page.

Substation with SC150 module:



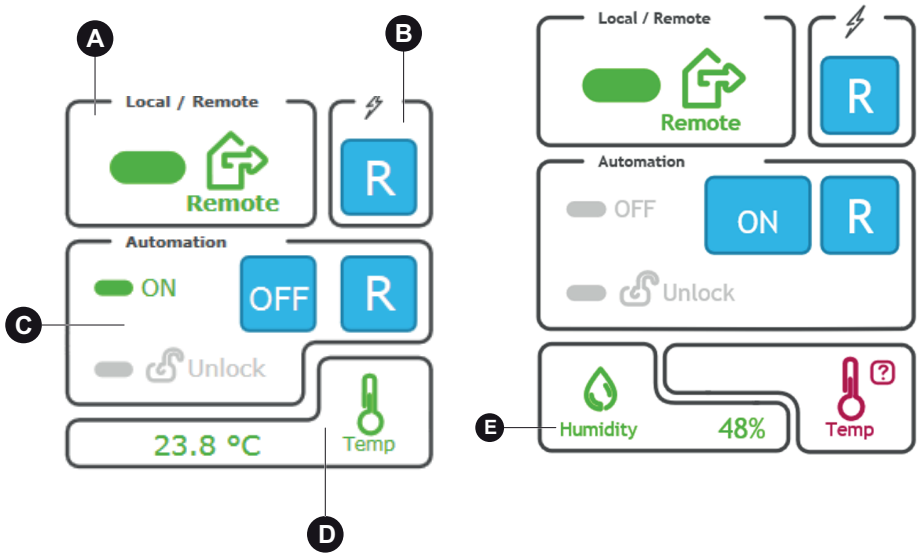
Substation with SC160 module:



The Substation page provides an overview of the information relating to the MV substation managed by the T300:

- The overall status of the T300 HU250 module (local/remote control, state of the automation function, etc.)
- The overall status of the power supplies managed by the PS50 module
- Information related to the MV switches and the associated measurements, with a graphical representation per channel (by SC150/SC160 module)
- The Low Voltage measurements managed by each LV150 module
- The environmental and thermal conditions in the substation, if the Condition Monitoring functionality is used.

Information Displayed for the HU250 Module



This graphical representation corresponds to the information displayed and the actions that are possible on the HU250 module, namely:

A. Indication of Local/Remote operation (this can be changed using the pushbutton on the HU250 module)

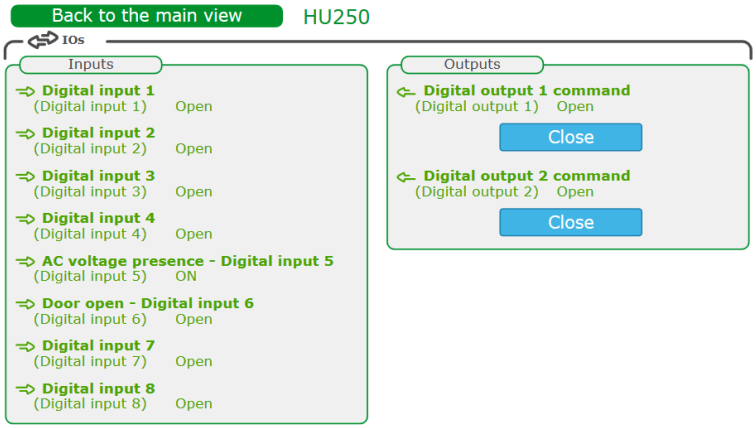
B. Reset button to clear the fault current indication

C. Automation function status (ON/OFF or locked), with the option to activate the automation function (by clicking the **ON** ON button) and to reset the automation function lock (by clicking the **Reset** R button)

D. Indication of the ambient temperature, if there is a PT100 temperature sensor connected to the HU250 module

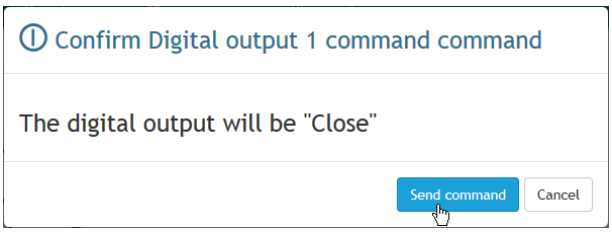
E. CL110 and TH110 sensors can also be connected to provide respectively temperature and humidity data, and connection temperature.

Extented Display for the HU250 Module



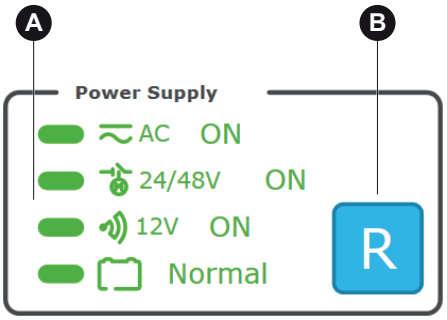
By clicking on the graphical representation of the HU250 above, an additional representation appears on the right-hand side of the screen indicating the states of all the digital I/O:

By clicking the **Close** button, the user has the option to change the state of the associated digital output:



NOTE: the labels of the displayed states can eventually be customized by changing the description of the corresponding data points in CoreDb via Easergy Builder. Refer to the Easergy Builder User's Manual for more information.

Information Displayed for the PS50 Module



This graphical representation contains the following information:

A. The status of the power supplies managed by the PS50 module, respectively:
   - The AC line supply
   - The 24/48 VDC power supply for the switch motor mechanism
   - The 12 VDC power supply for the transmission equipment
   - The battery

B. A Reset button for restarting the power supplies in the event of an outage following a potential issue on one of the outputs

Power supply shutdown

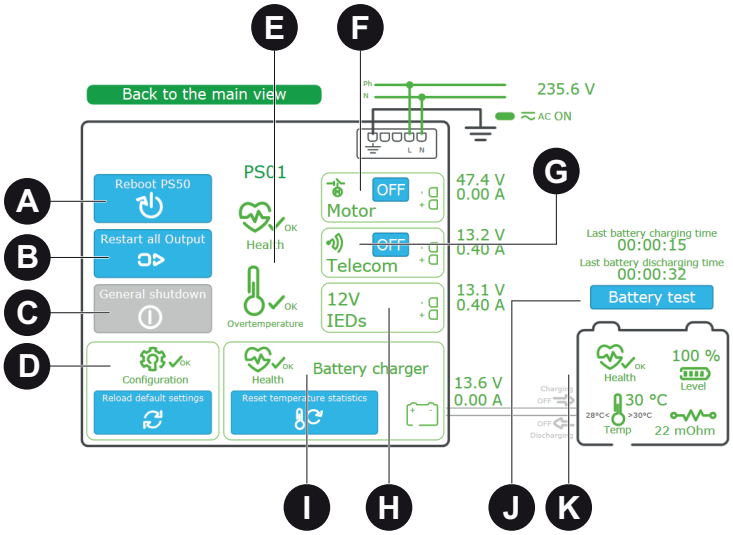
A power supply shutdown occurs when the mains power supply has been switched off for a long time, in order to limit the time on the backup power supply (battery). This power interruption preserves the capacity of the battery and its lifetime. Battery backup saving can be enabled or disabled by configuration. When this function is enabled, as soon as the MV network is switched off, the battery takes over the power supply for a configurable maximum period **Backup time duration** (default: 16 hours).

Beyond this period, an immediate alarm **General shutdown** is activated and then Power supply is switched off automatically. The power supply is also switched off if the battery reachs low level and then PS50 module enters sleep mode until the AC network voltage returns.

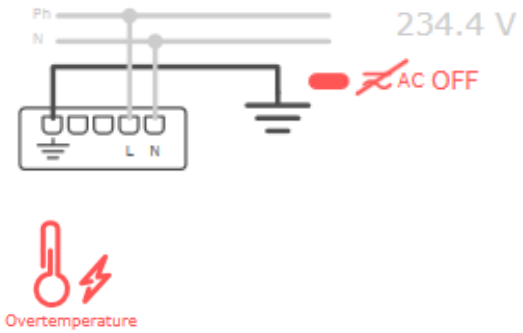
From this sleep mode, the 24/48 V & 12 V power supply outputs can be reactivated temporarily when the PS50 module is reset (**Reset** button **B**) or when the **External Reset** digital input of the PS50 module is activated. The power supply is switched off again and permanently if it reach the critical discharge threshold (< 10.8 V).

Extended Display for the PS50 Module

By clicking on the graphical representation of the PS50 above, additional information appears on the right-hand side of the screen including states, measurements, and the possible actions.

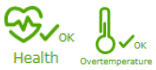
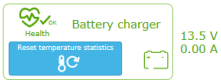
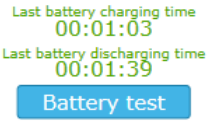
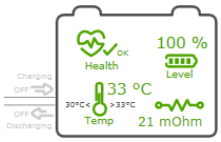


Under normal conditions, the information is displayed in green. In the event of an anomaly, the information is displayed in orange or red depending on the severity of the condition.



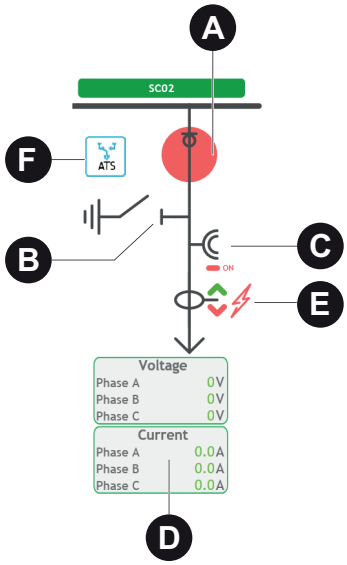
The extended information included in the detailed view of the PS50 module is described in the table below:

A	Reboot PS50	A **Reboot PS50** button for restarting the PS50 module. This action performs a complete reboot of the T300 device.
B	Restart all Output	A **Restart all outputs** button for restarting all outputs. This may reset the outputs to their initial state if this is possible and if the anomaly is temporary.
C	General shutdown	A **General shutdown** button that can only be activated if there is no AC line supply and power is supplied by the battery only. Click this button to switch all T300 power supplies to standby mode and thereby conserve battery power. It is possible to exit standby mode, either manually by pressing the Reset button on the front of the PS50, or automatically when the AC line supply is restored.
D	Configuration Reload default settings	A **Reload default settings** button for clearing the current parameters and returning to the PS50 module default parameters.

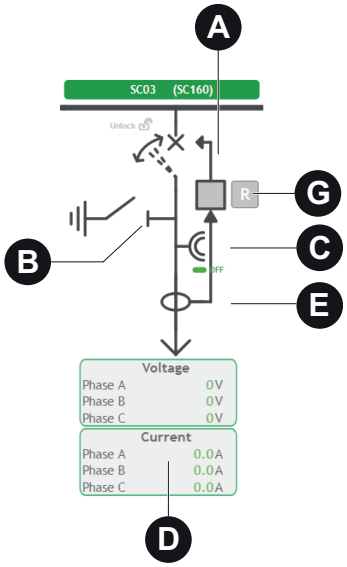
E		A **Health** symbol indicating the overall state of the PS50 and an Overtemperature symbol indicating the state of the PS50 module thermal protection.
F		A symbol indicating the state of the 24/48 V switch motor mechanism power supply with an **ON/OFF** button for turning this power supply on or off. A voltage measurement and a consumption measurement are also displayed for this power supply.
G		A symbol indicating the state of the 12 V transmission power supply with an **ON/OFF** button for turning this power supply on or off. A voltage measurement and a consumption measurement are also displayed for this power supply.
H		A symbol indicating the state of the general 12 V power supply for the T300 modules and IEDs. A voltage measurement and a consumption measurement are also displayed for this power supply.
I		This section displays the overall state of the battery charger with a **Reset temperature statistics** button to clear the stored minimum and maximum battery temperatures. A voltage measurement and a consumption measurement are also displayed for the battery.
J		A symbol for the presence/absence of the AC line supply with the corresponding voltage measurement.
K		Two time indications and a button: • **Last battery charging time**: Duration of the battery's last charging period • **Last battery discharging time**: Duration of the battery's last discharging period • **Battery test** button for activating the battery test immediately. The battery test is theoretically conducted automatically depending on the period defined in the Automatic test interval parameter (default setting: 1 day). **NOTE:** The Battery test button is not displayed if the battery is disconnected, if battery potential issue is detected, or if the AC supply is missing.
L		A graphical representation of the overall status of the battery, including: • Overall battery health indication • Percentage battery charge remaining • Internal resistance measurement in mOhm • The temperature measured in the PS50 operating environment (measurement made internally in the PS50 box) with an indication of the minimum and maximum values recorded since the last statistics reset (see **H**) • An indication of whether the battery is charging or discharging via arrows showing the direction of the current. The measurement indicated at the charger level (see **H**) gives a measurement value for this current.

Information Displayed for the SC150/SC160 Modules

SC150 module



SC160 module



Each switch managed by an SC150/SC160 module is represented graphically with the following indications:

A. Position of the switch or breaker (open or closed).

   On the SC160, square grayed when the protection mode is disabled.

B. Position of the ground switch (open or closed) or position of the earth switch and series disconnector

C. Presence of the MV voltage (ON or OFF)

D. Display of the RMS current and voltage measurements for each phase

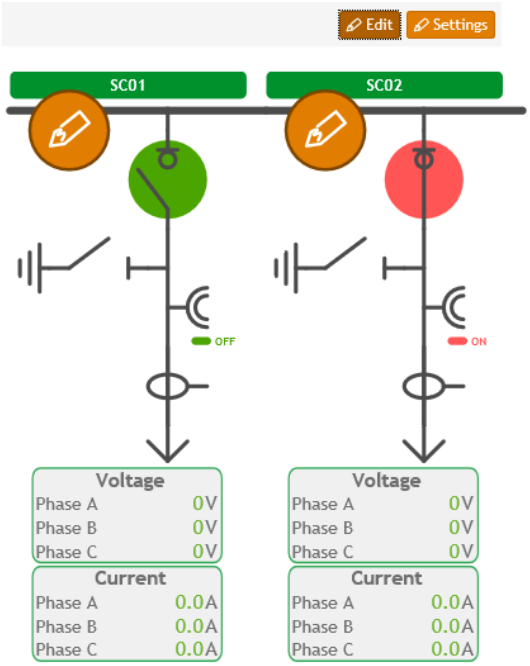
E. Indication of the presence of a fault current by a red flash and an arrow indicating the direction of the fault current (for directional fault current detection):

   - Green arrow = in the direction of the busbar
   - Red arrow = in the direction of the network

F. Indication that the ATS function is used in the module. For SC160 only, when it has tripped, the ATS commands are blocked.

G. Trip indication reset button

Button for editing the graphics parameters associated with switches:



Setting Graphical Representation of the Switch

The HMI provides essential information concerning the position of the switchgear, earthing switch and disconnector if applicable.

⚠ CAUTION

HAZARD OF UNINTENDED EQUIPMENT OPERATION

Ensure that the HMI configuration is consistent with the wiring and configuration for each SC module.

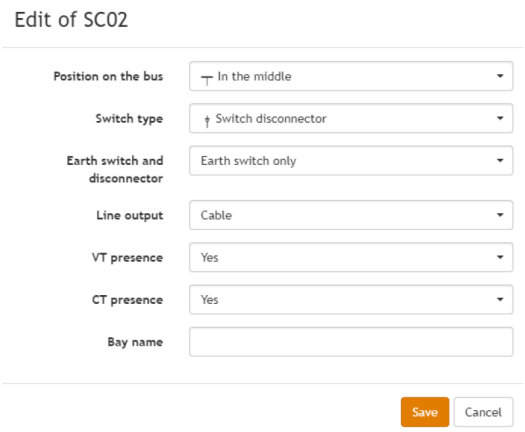
Failure to follow these instructions can result in injury or equipment damage.

It is possible to customize the graphical representation of each switch by clicking the Edit button at the top of the page.

Click the edit button that appears in the page to access the graphic parameters for the switch you want to customize.

A window appears offering the following choices:

For SC150 module:

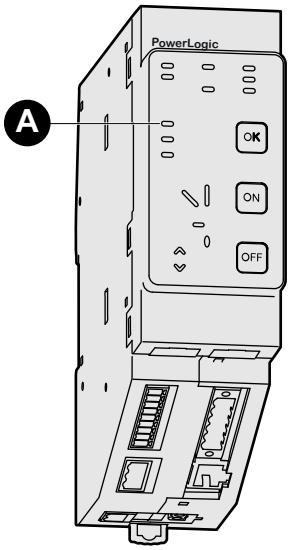


Parameter	Possible choices	Description
SC position on the bus	• Not connected • On the left • On the right • In the middle	Choice of position of the switch on the busbar: • No link with the busbar • On the left • On the right • In the middle
Switch type	• Disconnector • Load Switch • Switch disconnector • Circuit breaker	Choice of switchgear represented: • Disconnector • Load switch • Switch disconnector • Circuit breaker
Earth switch and disconnector	• Earth switch only • Downstream disconnector and earth switch • Upstream disconnector and earth switch	Choice of switchgear and disconnector represented: • Earth switch only • Downstream disconnector and earth switch • Upstream disconnector and earth switch
Line output	• Not any output • Cable • LV0x	Choice for the representation of the line downstream of the switch
VT presence	• No • Yes	Choice of whether or not to display the voltage measurement transformer
CT presence	• No • Yes	Choice of whether or not to display the current measurement transformer
Bay name		Name given to the channel

Extended Display for the SC150/SC160 Module

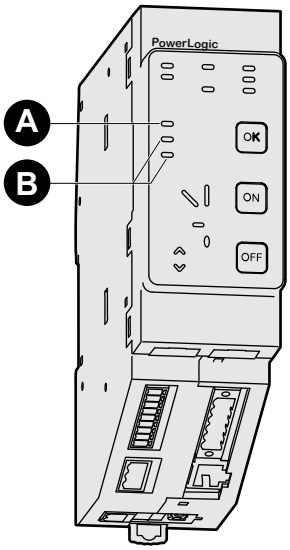
By clicking on the graphical representation of the switch, additional information appears on the right-hand side of the screen including counters and measurements:

Dummy switch position LED on the front panel of the SC150 modul
e



A. Dummy switch position

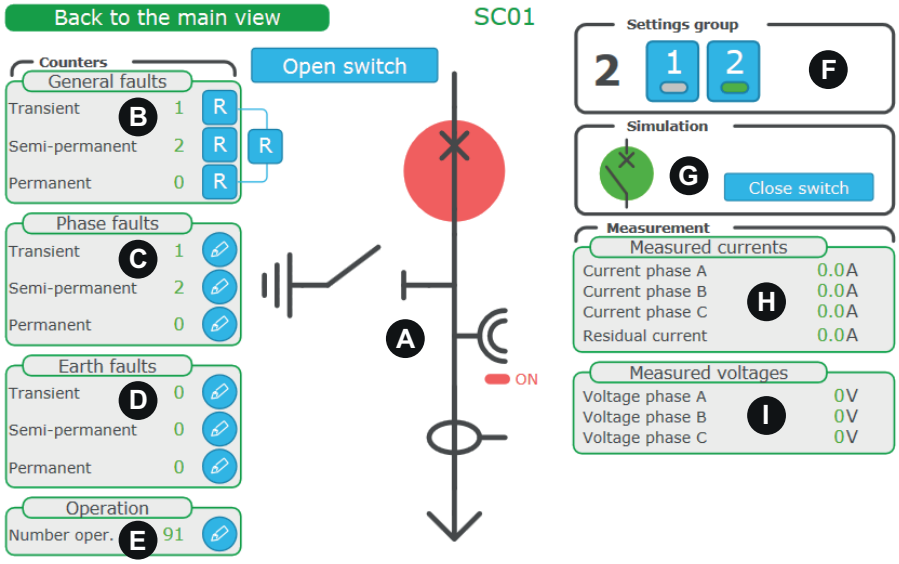
Dummy switch position LED on the front panel of the SC160 modul
e



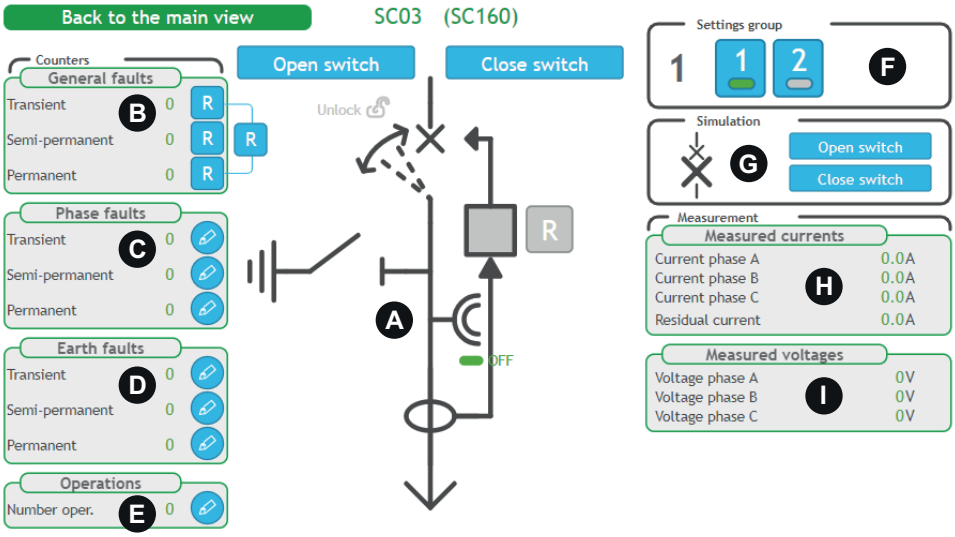
A. Tripping mode Enabled/Disabled

B. Dummy switch position if configured in Local inputs and outputs settings

For SC150 module



For SC160 module



A. Information relating to the switch is displayed in the same way as in the standard representation. There is also an option to send a command to the switch by clicking the Open switch or Close switch button (depending on its actual position). The graphical representation of the switch is automatically updated as soon as the change of state is detected.

B. The general fault current counters representing the total number of phase-to-phase and phase-to-ground (earth) fault currents detected are displayed by type (transient, semi-permanent, and permanent), with the option to reset the counter values by clicking the **Reset** button R.

C. The detected phase-to-phase fault current counters are displayed by type (transient, semi-permanent, and permanent), with the option to change the values by clicking the **Edit** button.

D. The detected phase-to-ground (earth) fault current counters are displayed by type (transient, semi-permanent, and permanent), with the option to change the values by clicking the **Edit** button.

E. The number of operations counted on the switch is given, with the option to change the value by clicking the **Edit** button.

F. The T300 includes the option to configure at least 2 sets of fault current detection parameters (with specific values for each set) in the Settings section, page 44 of the Web server. The option is given here to select which set of parameters to apply to fault current detection by clicking 1 or 2. The active group is indicated by a green LED.

> **NOTE:** The module SC150 allows the configuration up to 8 different groups of protection settings. Refer to Selecting the Active Setting Group, page 328.

G. A **Simulation** section that is used to test a command on a dummy switch without actually actuating it (this can be useful to test T300-SCADA communication when it is not physically possible to operate the switch due to an interruption on the MV network). To do this, click on the Open switch or Close switch button to operate dummy switch and, for instance, check the retransmission of the change of state remotely (e.g. at the SCADA end). The position of the dummy switch changes state in this **Simulation** section of the application but the actual position of the MV switch (indicated in **A**) does not change. After a command is sent to the dummy switch, its position is indicated for 30 seconds on the first customized LED on the SC150/SC160 module.

H. The instantaneous current measurements for each phase as well as the residual current

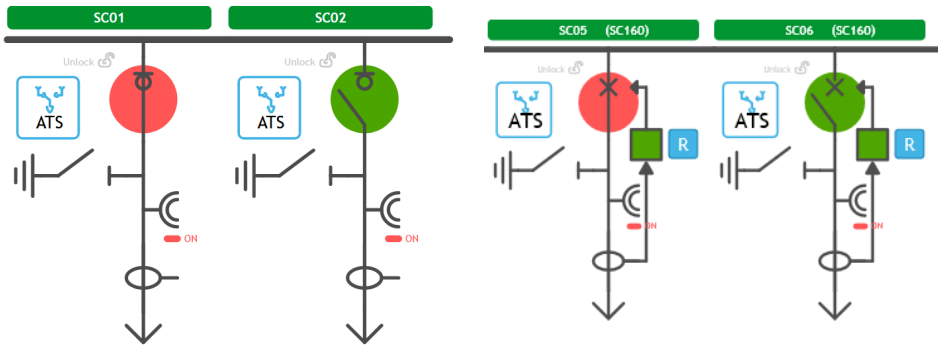
I. The instantaneous voltage measurements for each phase.

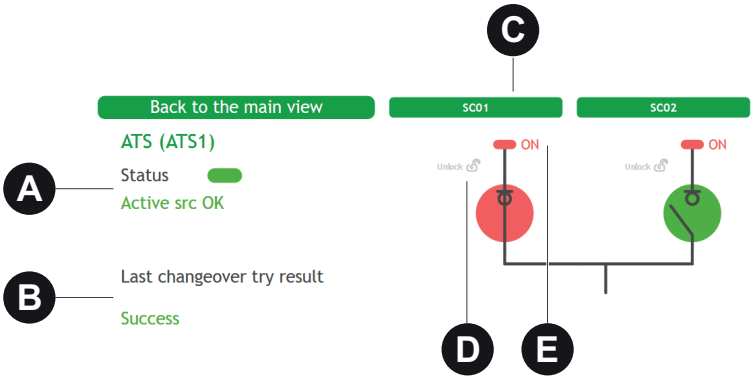
Extended Display for the ATS Function

Example for configuration with ATS enabled in case of switch 1 closed and switch 2 open:

Main view in **Monitoring & Control > Substation page** – Web server

Display for the SC150 Display for the SC160





Additional information when ATS function is activated (see the Automatic Transfer Switching (ATS) section).

From the main view of the Substation page, click the ATS button to display detailed information about ATS:

A. ATS state:

Text	Description
Off	The automation is off.
Locked - invalid switch positions for initialisation	One switch must be closed and the other switch must be open(1).
Waiting for voltage presence	Voltage is absent for at least one switch.
Ready - waiting for voltage absence	Voltage is present for both switches.
Checking transfer conditions following voltage absence	Checking blocking conditions when voltage absence has been detected on the active source.
Checking transfer conditions to return to normal	Checking blocking conditions when voltage presence has been detected on the normal active source.
Transfer in progress	Transfer in progress.
Locked - blocking condition(s) for transfer	The ATS has detected a blocking condition (1).

Text	Description
Locked - switch operation failure	The ATS attempted a switch operation, but the switch did not reach the desired position (1).
(1) If the ATS goes to a Locked state, then it can only be unlocked via a reset using the R button on the HU250 front panel, the T300 Web server, or SCADA command.	

B. Result of the last source transfer:

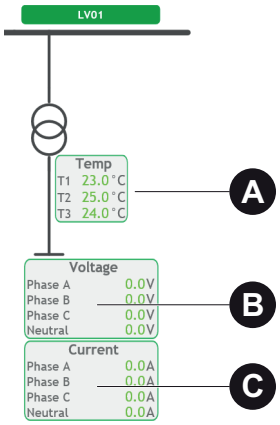
Text	Description
Success	The source transfer was successful.
Active switch position open or unknown	The active switch was not in the closed state.
Active switch operations blocked	The active switch was blocked.
Inactive switch position closed or unknown	The inactive switch was not in the open state.
Inactive switch operation blocked	The inactive switch was blocked.
Voltage present for active switch	The voltage on the active switch was not absent.
Voltage absent for inactive switch	The voltage on the inactive switch was not present.
Switch control power absent	The power to control switches was absent
Transfer blocked	The ATS has detected a blocking condition.
Transfer to inactive source blocked	The changeover to the inactive source was blocked.
Transfer blocked due to a fault indication	The changeover was blocked due to an active fault indication on one of the SC150/SC160 modules.
Maximum try count reached while checking transfer conditions	In the case where the voltage on the current active source repeatedly changes between present and absent, the maximum try count has been reached.
Active switch did not open	The active switch has not been able to execute the command.
Inactive switch did not close	The inactive switch has not been able to execute the command.
Maximum operation time exceeded while checking transfer conditions	In the case where the voltage on the current active source repeatedly changes between present and absent, the maximum operation time has been reached.

C. Representation of the SC150/SC160 modules, with the option to display the extended display for the SC150/SC160 by clicking the corresponding green header.

D. Position of the switch (open or closed)

E. Presence of the MV voltage (ON or OFF)

Information Displayed for the LV150 Modules



Each LV150 module has its own graphical representation including the display of the following information:

A. The temperature measurements provided by the three PT100 sensors connected to the LV150.

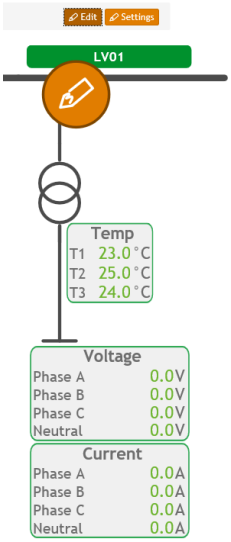
B. The LV current measurements on each phase and neutral.

C. The LV voltage measurements on each phase and neutral.

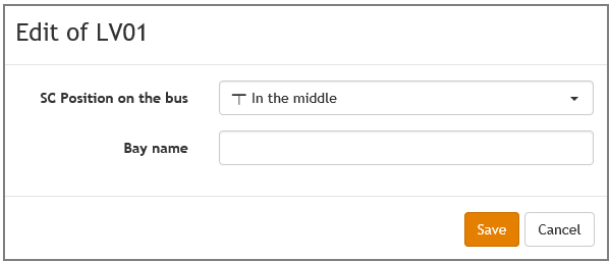
NOTE: The neutral current measurement displayed corresponds to a measured value in case the 3-phase + neutral sensors mounting is used and to a calculated value (by summing all 3 phases) when the neutral is not connected.

Graphical Representation of LV150

Button for editing the graphics parameters associated with LV150.



Window for setting the parameters of the graphic objects associated with LV150



It is possible to customize the graphical representation of each LV150 module by clicking the **Edit** button at the top of the page.

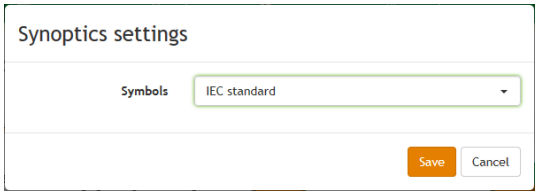
Click the button that appears in the page to access the graphic parameters for the LV150 you want to customize.

A window appears offering the following choices:

Parameter	Possible choices	Description
LV Position on the bus	• Not connected • On the left • On the right • In the middle	Choice of position of the LV150 on the busbar: • No link with the busbar • On the left • On the right • In the middle
Bay name		Name given to the channel

Synoptics Settings

Window for selecting the standard for the graphical representations

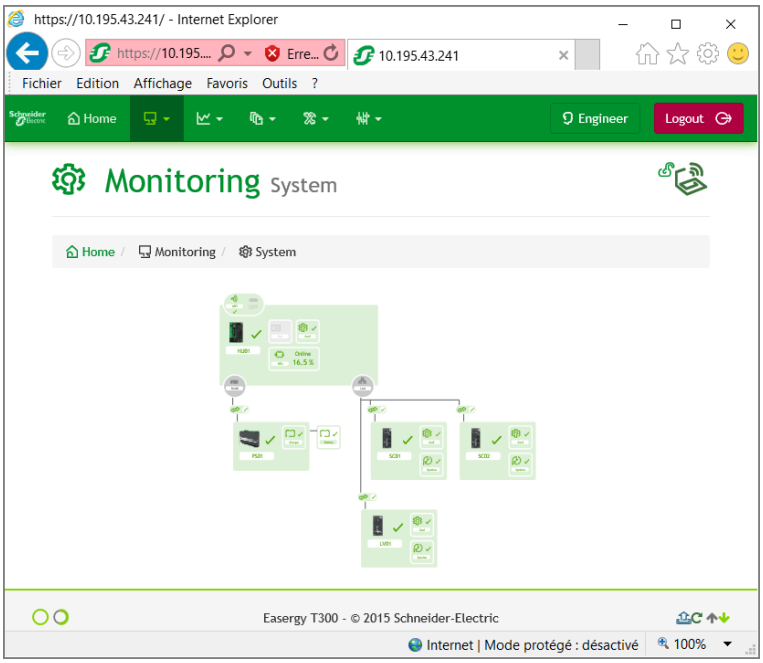


Click the button to define the type of graphical representation to apply for the objects displayed in the page's synoptics:

Parameter	Possible choices	Description
Symbols	• IEC standard • ANSI standard	The standard used relates to the representation of the switchgear, voltage and current transformers, and the ground switch: • Objects represented in accordance with the IEC standard. • Objects represented in accordance with the ANSI standard.

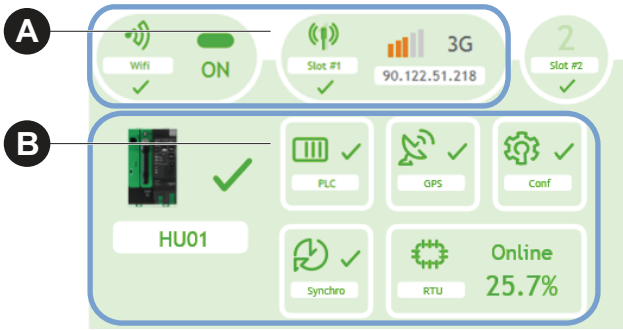
System Page

Accessed via **Monitoring & Control > System** page

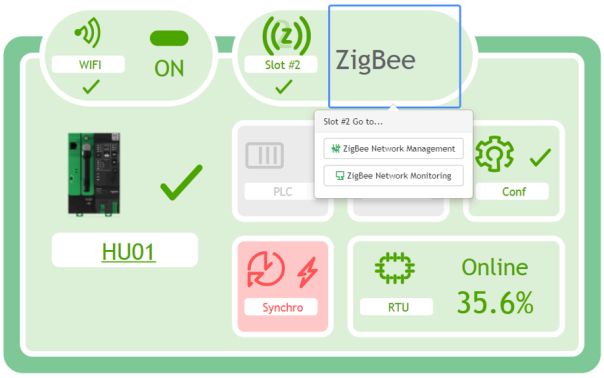


This page provides a general overview of the system. The states of the various items (modules) are given by symbols indicating a correct operation or potential issue conditions. The indications given by these states are detailed by module here after.

HU250 Module Status



Overall HU250 module status with Zigbee network status



A. The status of the Wi-Fi access, the K7 4G modem with a 5-bar GSM signal strength indicator and indication of the IP address if connected to the mobile network, and, if implemented, the status of the Zigbee network.

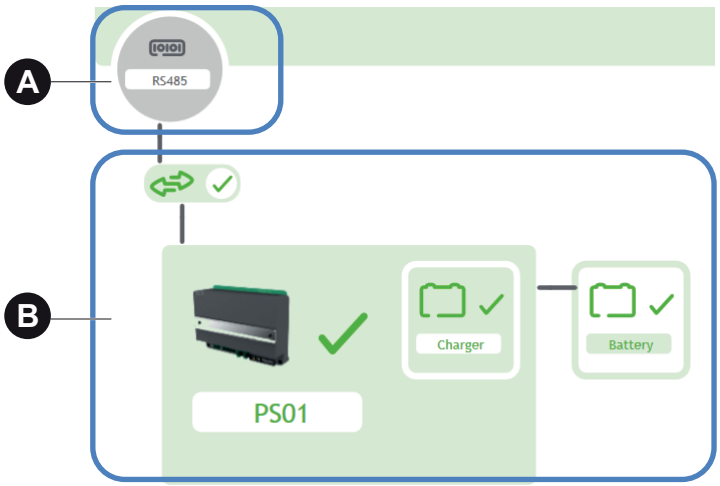
B. The status of the HU250 module itself, including the configuration, the PLC, the GPS reception, the synchronization of equipment and a percentage value representing the CPU usage level.

NOTE: The GPS reception symbol indicates the satus of GPS reception with a color:

- gray: unconfigured or invalid GPS reception
- green: operational GPS reception
- red: GPS reception potential issue.

NOTE: A GPS reception issue causes a loss of synchronization and the corresponding symbol becomes red.

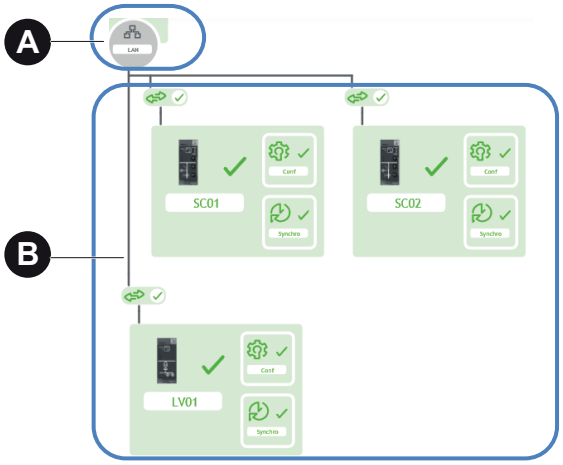
PS50 Module Status



A. An indication of the type of link used for the internal HU250-PS50 link (RS485 in Modbus protocol).

B. The status of the PS50 module, the charger, and the battery, as well as the overall status of the internal Modbus RS485 link.

LV150 and SC150/SC160 Modules Status



A. An indication of the type of link used for the internal link between HU250 module and SC150/SC160 or LV150 modules (Ethernet LAN in IEC 60870-5-104 protocol).

B. The status of the SC150/SC160 and LV150 modules, including for each the status of the configuration and synchronization, as well as the overall status of the internal IEC 60870-5-104 Ethernet LAN.

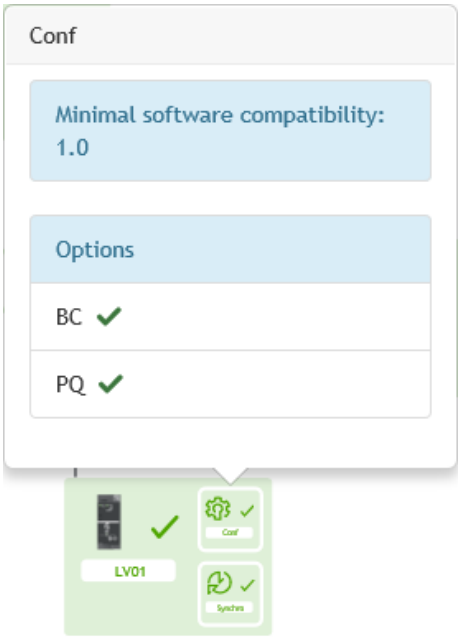
Extended Display

By passing the mouse over some graphical elements of the modules in the System page, a "pop up" window appears giving additional indications.

This additional display concerns the following:

1. **Configuration:** By passing the mouse over the **Conf** element of a module, the system indicates the following informations:
   - The minimum software required for compatibility with the module configuration.
   - The options installed on the module (eg details of installed power measurement options).

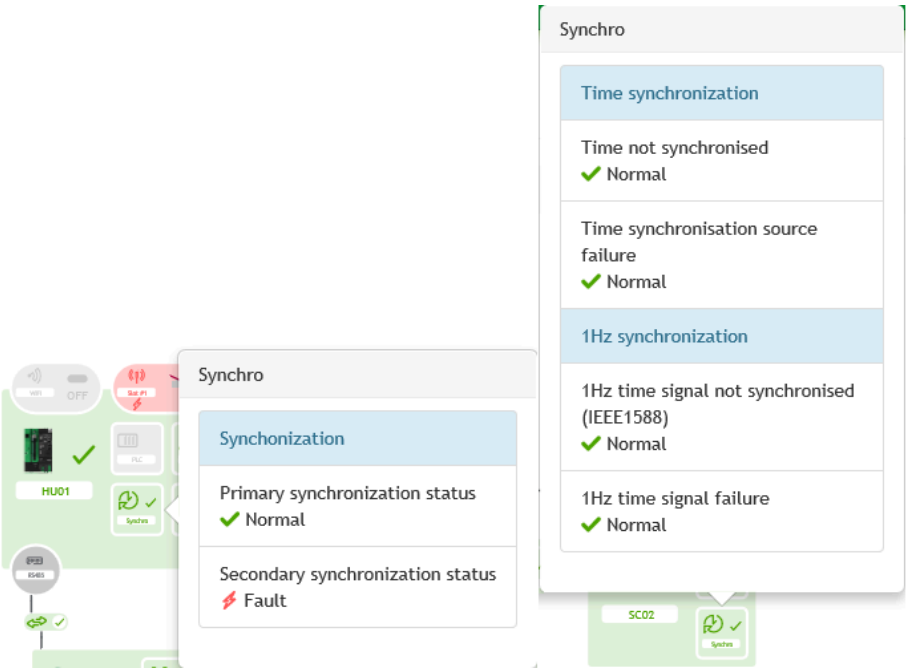
   Example of a pop-up window displayed for the **Configuration** section of a module:



2. **Synchronization:** By passing the mouse over the **Synchro** element of a module, the system gives the following indications:
   - For the HU250 module:
     - Status of the two synchronization sources (primary and secondary).
   - For the SC150/SC160 and LV150 modules:
     - Status of the module time synchronization and status of the synchronization source generating this synchronization.
     - Status of the "1 Hz" module synchronization as well as the status of this synchronization 1 Hz signal. This synchronization allows all the SC150/SC160 and LV150 modules to be synchronized to the same 1 Hz frequency top generated by the HU250 module.

       NOTE: SC150/SC160 and LV150 synchronization status remain "not synchronized" until the HU250 has synchronized itself when powering on.

   Example of a pop-up window displayed for the **Synchronization** section of a HU250 module and SC150/LV150 module:



3. **Modem:** by passing the mouse over the graphical representation of a 4G modem, the system indicates the following information:
   - Type of selected network (GPRS or 4G).
   - Received cellular signal strength, numbered from 0 to 99:
     - 0 to 10: insufficient signal

       11 to 31: correct signal
     - 99: undetectable signals.
   - The IP address obtained for the T300, assigned by the mobile operator.
   - The modem IMEI code, allowing identification of the equipment connecting to the mobile network.

4. **Zigbee Network:** by passing the mouse over the graphical representation of the Zigbee network, the following menus are displayed:
   - **Zigbee Network Management:** to access the page that displays all the devices (sensors) used to provide data for Condition Monitoring. Refer to Zigbee Network Management, page 450 page description in the Maintenance chapter.
   - **Zigbee Network Monitoring:** to access the page that displays the environmental conditions and cable thermal conditions in the substation and cubicles. Refer to Condition Monitoring page description in this chapter.

   Access to Zigbee network functionalities:

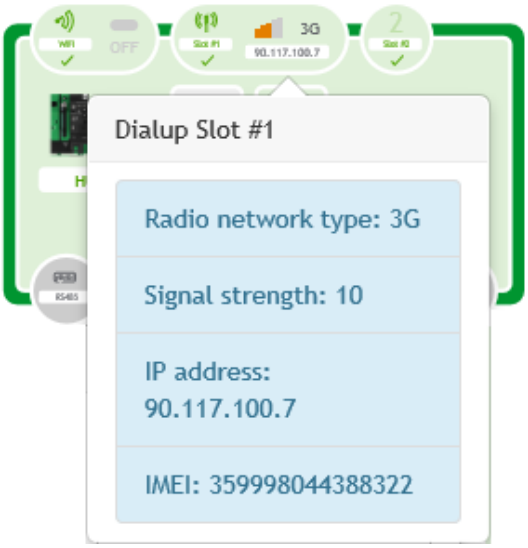
Shortcut to Pages

By clicking on the graphical representation of a module, a pop-up window appears giving the possibility to access directly certain pages of the Web server linked to this module, like shortcuts or quick accesses.

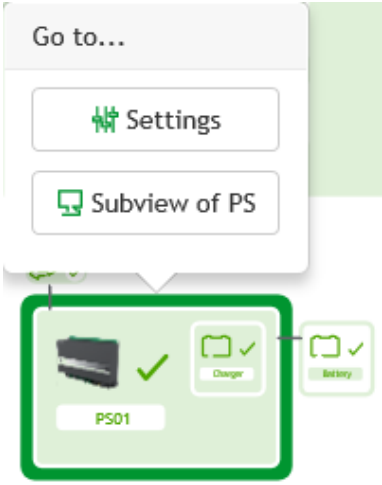
Depending on the type of module, quick access can be of different types:

- **PS50:** shortcuts to the PS50 module configuration page (**Settings** page) and the PS50 module status display page (**Subview of PS** page).
- **Other modules:** shortcuts to the system events page (**Diagnostics > System** page) and the module settings page (**Settings** page).

Example of a pop-up window displayed for the Modem section of a module:

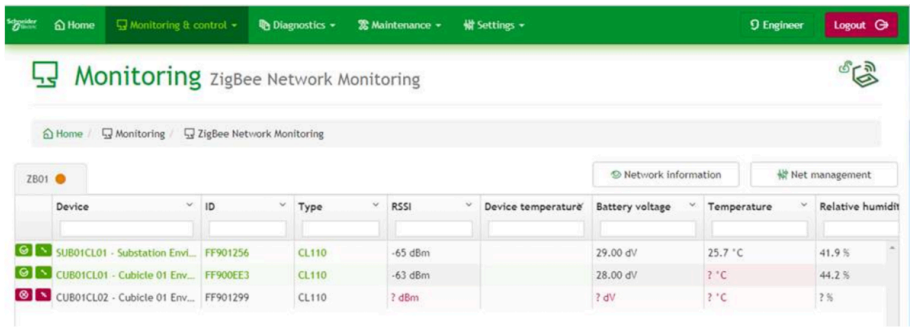


Example of shortcuts available by clicking on the module representation:



Zigbee Network Monitoring Page

Access via **System** view, pass the mouse over the **Zigbee** network to display the **Slot #**x menu, then select **Zigbee Network Monitoring**
Or
Access via **Maintenance > Zigbee Network Management** page, then click the **Net Monitor** button.



The **ZigBee Network Monitoring** page provides a general view of the Zigbee network used to manage the environmental and thermal conditions in the substation and various zones in the substation.

Description

- **Network information button:** allows you to display Zigbee network and box information:
  - Network parameters: Port, Transmission Channel, Transmission Power, Security
  - EPID: Extended Personal Network Identification
  - IEEE: address of the Zigbee box (or Zigbee K7) according to IEEE standard 802.15.4
  - Zigbee box firmware version
- **Network management** button: allows you to display the **Maintenance > Zigbee Network Management** page.

- **Network device tab and table:** displays information related to sensors configured in the Zigbee network, using Easergy Builder.
  - **Sensor status:** refer to **Maintenance > Zigbee Network Management** , page 450 for more information.

Sensor status	Description
	Offline and Not paired
	Online and Paired
	Online and Unpairing (previously paired, has been unpaired)
	Offline and Paired

A sensor is Offline when data is no longer received from the sensor, for example due to an incident on the sensor.

  - **Sensor name:** configured using Easergy Builder
  - **Sensor description:** also used to describe the sensor location, configured using Easergy Builder
  - **Sensor ID:** unique identifier of the sensor, generally configured using Easergy Builder. May be Unknown when a sensor has been unpaired. In this case, it must be configured in the Zigbee network device parameters, page 185 window.
  - **Sensor Type:** CL110 or TH110 types only, configured using Easergy Builder.
  - **Received Signal Strength Indicator:** signal value received from the Zigbee box (K7). Used to check the signal reception from the sensor. An RSSI < - 80 indicates a weak signal strength.
  - **Device temperature:** available for TH110 sensors only. Refer to **Condition Monitoring** for more details.
  - **Battery voltage:** available for CL110 sensor only.
  - **Temperature:** value measured by the sensor. Refer to Condition Monitoring, page 33 for more details.
  - **Relative humidity:** value measured by the sensor, only available on CL110 sensors. Refer to Condition Monitoring, page 33 for more details.
  - **?:** indicates that the sensor is not communicating or the value provided by the sensor is not valid.

Condition Monitoring Page

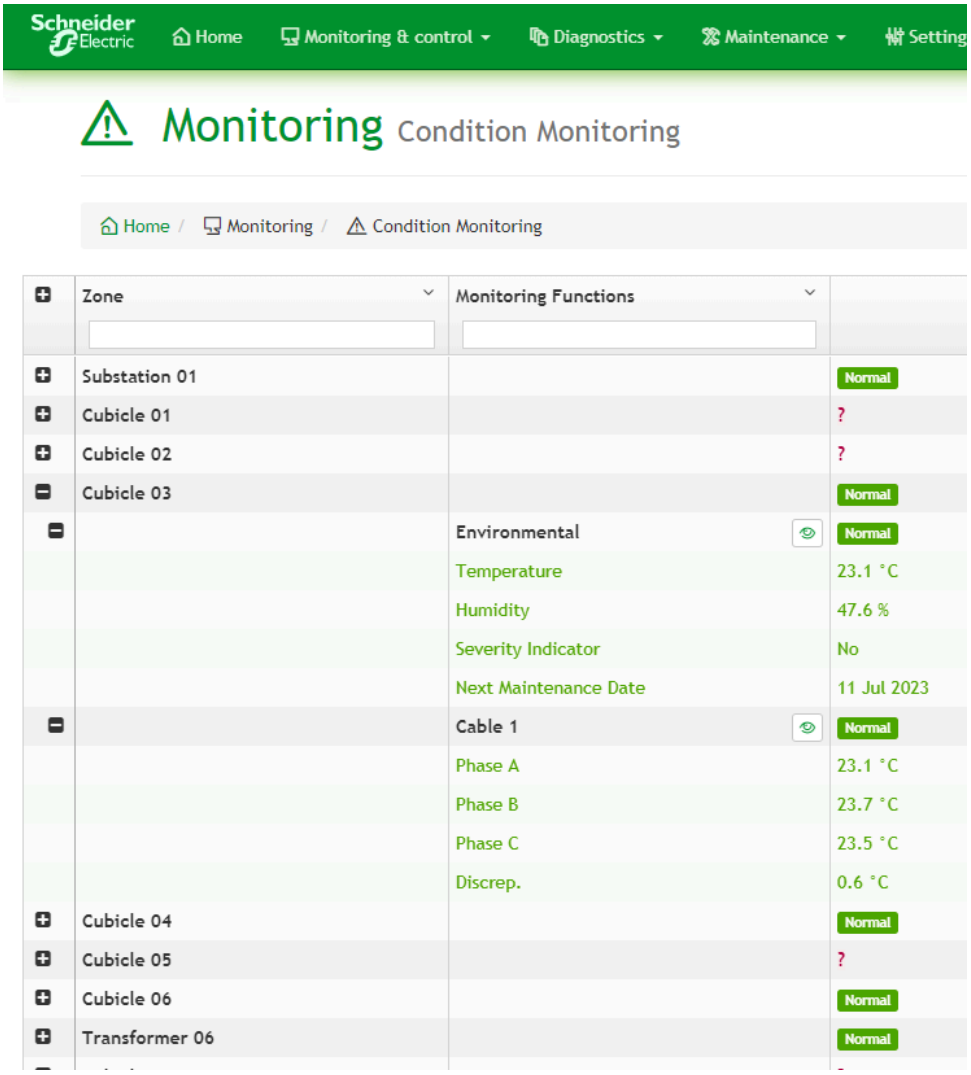
Accessed via **Monitoring & Control > Condition Monitoring**

The **Condition Monitoring** page provides a general view of the environmental and thermal conditions in the substation and various zones in the substation. Depending on data provided by sensors (through Zigbee protocol), and settings applied on this data, the condition states (Normal, Pre-alarm, or Alarm) are displayed for each zone (substation, cubicle and cable).

Information Displayed for the Substation Zones

The page opens on a general table view of the status of each zone of the substation where data can be provided.

Zone labels can be modified in Easergy Builder (in the **Description** field in CMON device; **zone_id** is fixed and cannot be changed after zone creation).



The provided data allows the following monitoring:

- Environmental monitoring: monitor climatic conditions (temperature, humidity, condensation, pollution) to evaluate the maintenance frequency.
- Connection monitoring: temperature of cable connections.

+/-	Zone	Monitoring Functions	Condition status / Data value
	Substation		Substation condition status: Normal, Pre-alarm, Alarm
	Cubicle 01		Zone (cubicle 01) condition status: Normal, Pre-alarm, Alarm, or ? (*)
		Environmental	Cubicle environmental condition status (**): Normal, Pre-alarm, Alarm
		Temperature	Temperature in the cubicle
		Humidity	Percentage of humidity in the cubicle
		Severity indicator	Indicator related to climatic conditions over time
		Next Maintenance date	Determined from the severity indicators
		Cable 1	Cable condition status: Normal, Pre-alarm, Alarm, or ? (*)
		Phase A	Temperature of connection point of phase A
		Phase B	Temperature of connection point of phase B
		Phase C	Temperature of connection point of phase C
		Discrepancy	Temperature discrepancy between 3 phase connections (discrepancy between current and temperature not provided)
(*): ? indicates that the status is undefined due to invalid or missing sensor values (broken or offline sensors). (**): Environmental Condition Status			

Environmental Condition Status:

Condition	Status
Temperature higher than the configured threshold (Temperature Maximum (ºC))	Pre-alarm
Humidity higher than the configured threshold for at least 24 h (Humidity Maximum (%))	Pre-alarm
Less than 2 months before the next maintenance date	Pre-alarm
Degrees of severity depending on condensation and pollution 1 or 2: • Severity 1: pollution level light and condensation level = 1 • Severity 2: condensation level = 2	Pre-alarm
Next maintenance date due	Alarm
Degrees of severity depending on condensation and pollution 3	Alarm
Other conditions	Normal

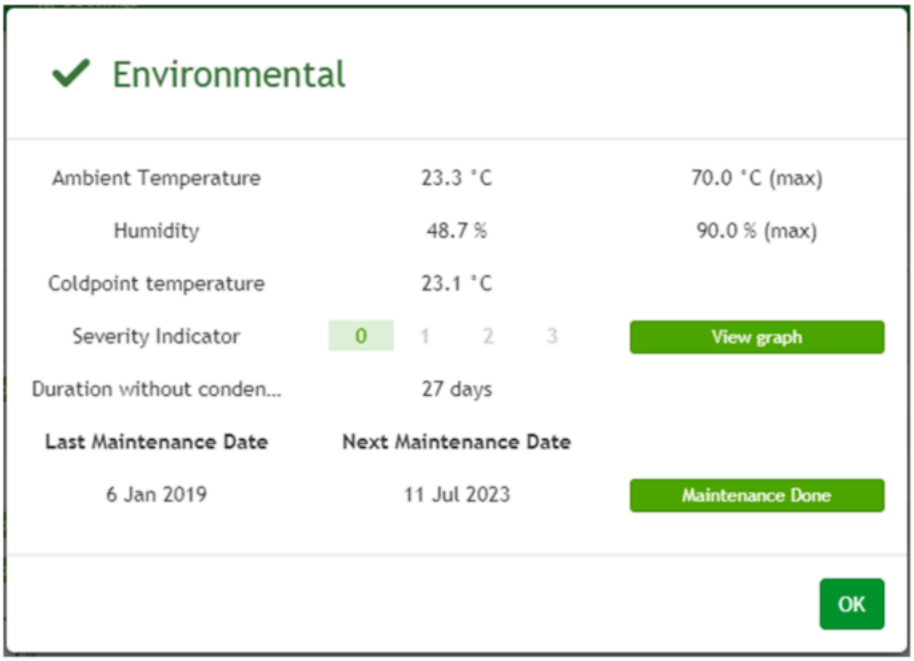
NOTE: Additional sensors can be installed and configured to provide other alarms, for example:

- Door open
- Gas Monitoring with manometer
- Flood detection

Cubicle environmental condition detailed view

Accessed via button in **Environmental** cell.

Example of Environmental condition data display



Data	Current value	Maximum value or access to other function
Ambient temperature	Provided by sensor	Maximum value before pre-alarm (refer to Settings)
Humidity	Provided by sensor	Maximum value before pre-alarm (refer to Settings)
Coldpoint temperature	Provided by sensor	
Severity indicator	Calculated according to condensation and pollution	View Graph: displays the Environment Severity Indicator Graph (*)
Duration without condensation	Calculated according to ambient/coldpoint temperatures and humidity	
(*): **Environment Severity Indicator Graph:** Based on standard IEC 62271-304, four levels of severity are defined. The indicators take into account the climatic conditions and the time spent in these conditions. This allows the determination of the condition status (Normal, Pre-alarm, Alarm) and the calculation of the maintenance frequency required and consequently, the **Next Maintenance Date**.		

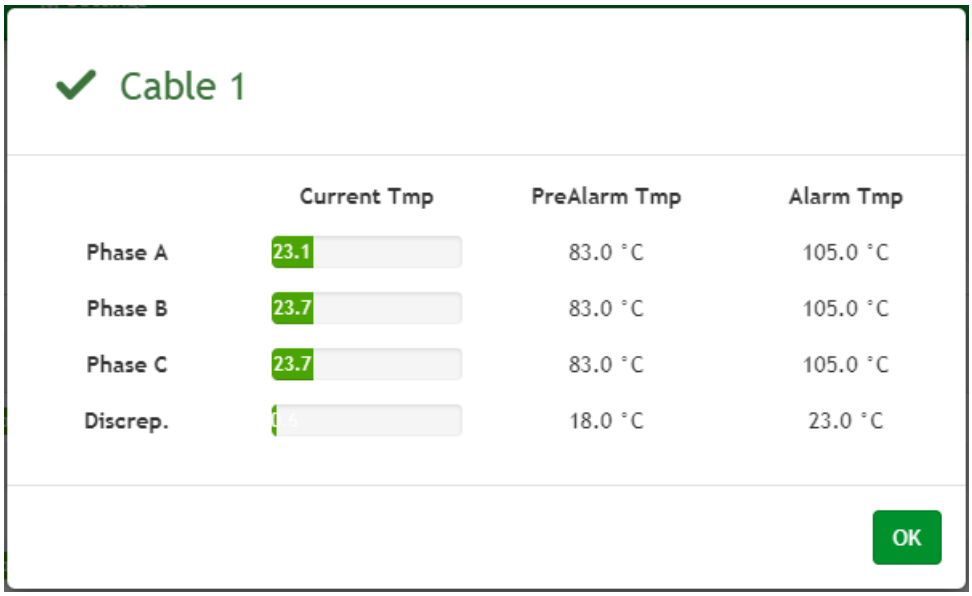
Data	Data	Access to other function
Last Maintenance date	Next Maintenance date	Maintenance Done

NOTE: In zones where the Cold Point Temperature is not measured, calculations related to Condensation and Maintenance Date cannot be done. In such cases alarms are generated taking into account only ambient temperature and humidity.

Cable temperature detailed view

Accessed via button in **Cable** cell.

Example of **Cable temperature** data display



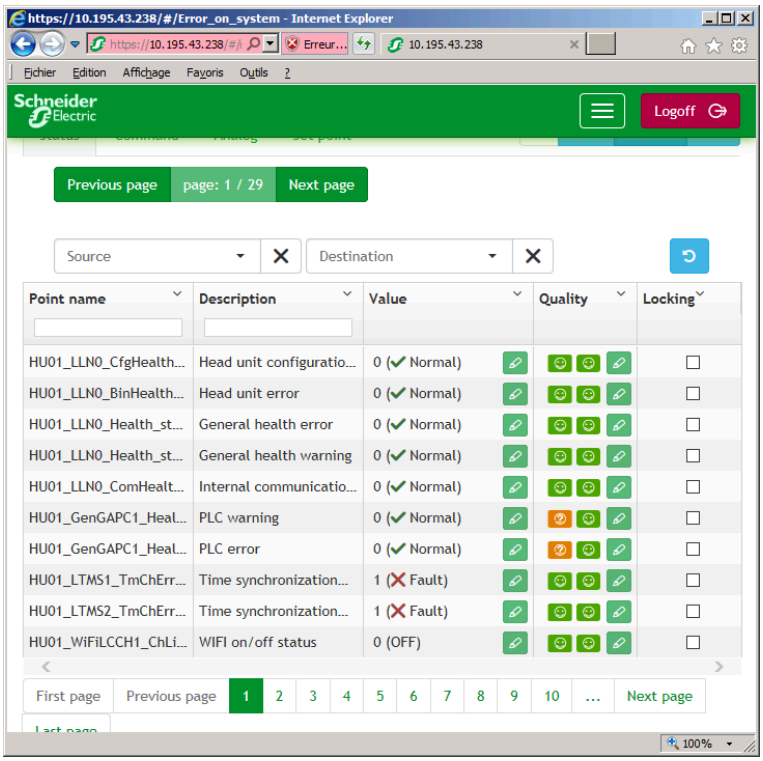
Data for each phase and discrepancy	Current Tmp	PreAlarm Tmp threshold	Alarm Tmp threshold
Phase A	Temperature of connection point of phase A	Configured (*)	Configured (*)
Phase B	Temperature of connection point of phase B	Configured (*)	Configured (*)
Phase C	Temperature of connection point of phase C	Configured (*)	Configured (*)
Discrepancy	Maximum difference between phases temperatures	Configured (*)	Configured (*)
(*): Refer to Settings.			

Data Pages

Accessed via **Monitoring & Control > Status-Command-Analog-Setpoint** page

There are 4 pages in the T300 Web server for viewing status and measurement data or for sending commands:

- **Status page:** For viewing the status of the digital data

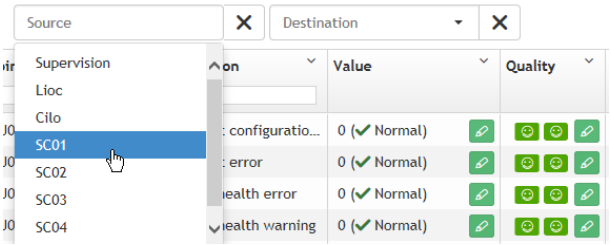


- **Command page:** For sending change of state commands based on the digital data
- **Analog page:** For viewing measurement values
- **Setpoint page:** For forcing parameter values

Each page has the same format, with the following information displayed on the screen:

- The data refresh period can be configured in 1 of 3 ways:
  - **Fast:** Data is refreshed every second
  - **Normal:** Data is refreshed every 4 seconds
  - **Slow:** Data is refreshed every 10 seconds

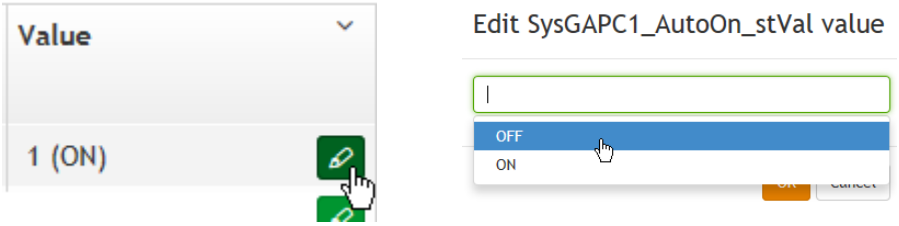
- It is also possible to set a filter to display data by Source or Destination to limit the amount of data displayed on screen:



- The description of a data item is displayed over 3 main columns:
  - **Point name:** Internal name of the data item in CoreDb (database)
  - **Description:** Data label
  - **Value:** Value of the data item

Point name	Description	Value
HU01_LLN0_CfgHealth_stVal_Fail	Head unit configuration error	0 (✔ Normal)
HU01_LLN0_BinHealth_stVal_Fail	Head unit error	0 (✔ Normal)

- By clicking the button associated with the **Value** field, you can manually edit the state or value of a **Command** or **Setpoint** data item:



NOTE: For switch control, it is advisable to use the interface in the **Substation** view.

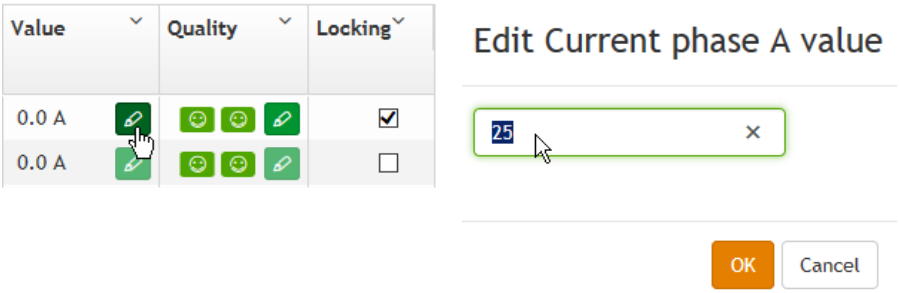
- Similarly, for a **Status** or **Analog** data item, you can force its status or value. However, this type of data is only processed in read mode; forcing is only applied in simulation.

Point name	Description	Value	Quality	Locking
HU01_LPHD1_C...	CPU usage	11.8 %		☐
HU01_SysSTMP1...	Temperature	408.4 °C		☐
SC01_PMr_MMX...	RMS current ph...	0.0 A		☑
SC01_PMr_MMX...	RMS current ph...	0.0 A		☐
SC01_PMr_MMX...	RMS current ph...	0.0 A		☐

To do this, the actual data item must first be locked by clicking the Locking option.

Once the data is locked, the button associated with the **Value** field then becomes accessible and can be used to change its status or value in simulation mode.

NOTE: The modified value also impacts the remote retransmission at the SCADA end. This allows you, for instance, to simulate the state of a variable and to test its retransmission at the SCADA end, without affecting the actual equipment operation.

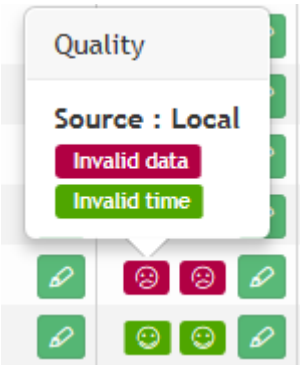


Disabling the **Locking** option cancels the simulation and returns to the actual status or value of the data item.

- Two icons displayed in the **Quality** column provide an indication of the data processing quality. The quality of a data item can give an indication of the validity of the status or value entered on the Web server page.

  This quality is indicated for the following 2 sources:

  - **Local source:** Reflects the quality of the data item from the viewpoint of its processing at the HU250 end.



  - **Remote source:** Reflects the quality of the data item sent by the information source (device) processing the data (e.g. SC150/SC160, PS50, etc.)

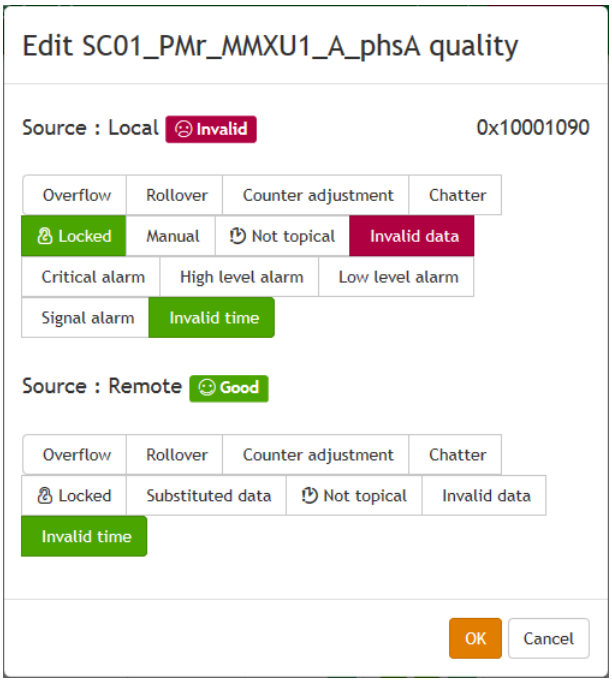
  In the same way as for a change of state or value for **Status** or **Analog** data, it is possible to manually simulate the quality of a data item.

  To do this you must first lock the data item using the **Locking** option, then click the button associated with the Quality field.

  The possible choices for the local and remote source quality are then displayed on screen.

  Disabling the **Locking** option cancels the simulation and returns to the actual quality of the data item.

Choice of quality options for the local and remote sources



The table below shows the correspondence of the different quality types that can be simulated after having locked a data item.

Note that this also gives an indication of the different quality types that can be obtained in actual operation:

Local source quality	Description
Overflow	An overflow has occurred on a counter
Rollover	An overflow and an automatic reset have occurred on a counter
Counter adjustment	The counter has been adjusted
Chatter	Excessive change on a digital input
Locked	The data item is locked
Manual	The data item has been manually replaced
Not typical	The data item has not yet been written to the database
Invalid data	Data item is invalid
Critical alarm	The value of the data item has exceeded the High-High alarm threshold
High level alarm	The value of the data item has exceeded the High alarm threshold
Low level alarm	The value of the data item is below the Low alarm threshold
Signal alarm	The value of the data item is below the Low-Low alarm threshold
Invalid alarm	The data item time-stamp is invalid or inaccurate (the HU250 is not synchronized by a source)

Remote source quality	Description
Overflow	An overflow has occurred
Rollover	A rollover has occurred on a counter
Counter adjustment	The counter has been adjusted
Chatter	Excessive change on a digital input
Locked	The data item is locked
Substituted data	The data item has been manually replaced
Not topical	The data item has not yet been written to the database
Invalid data	Data item is invalid
Invalid time	The data item time-stamp is invalid

Measurements

What's in This Chapter

Measurements Pages.....79

Measurements Pages

Accessed via **MV Measurements** and **LV Measurements > PM – Power** or **PM – Energy** or **Power Quality** page

The **MV Measurements** and **LV Measurements** pages in the Web server display the different types of power, energy, and quality measurements taken by the T300 on the MV and LV networks, in tabs including data tables based on the analog data received from the current and voltage sensors.

> **NOTE:** Regarding MV voltage measurement, the T300 takes the measurements using the same current and voltage sensors as those used to detect fault currents.

The power and energy measurements comply with standard IEC 61557-12.
The power quality measurements are completed according to the principles of IEC 61000-4-30 class S (up to harmonic 40).

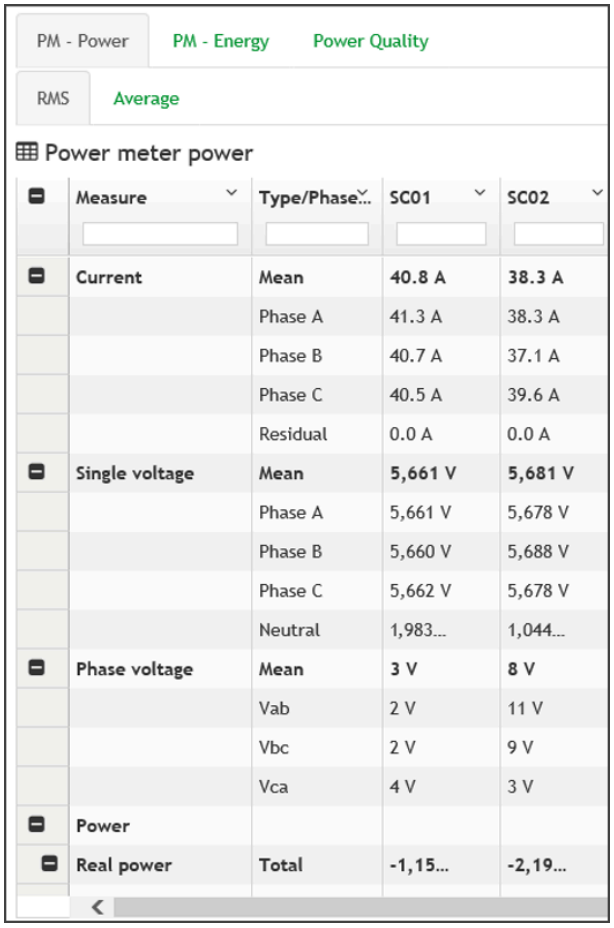
> **NOTE:** To comply with the accuracy required by the standards (1% accuracy), voltage measurements are only possible using LPVT or VT type adaptors (for LV measurement; only Voltage adaptor type).

Some measurements are optional for the T300 ("option" column in the table below). If the corresponding option is not present in the equipment, the associated data is not displayed in the **MV Measurements** and **LV Measurements** pages.

> **NOTE:** The PM option (and associated measurements) is included as standard for LV measurements, although this is optional for MV measurements.

The data displayed in the **MV Measurements** page depends on the parameter settings in the **Settings > SC0x > Measurements and Power Quality** pages. The data displayed in the **LV Measurements** page depends on the parameter settings in the **Settings > LV0x > Measurements and Power Quality** pages. Refer to the corresponding sections for more information on how to configure these parameters.

Example of measurements displayed – **MV** or **LV Measurement > PM – Power** page / **RMS** tab



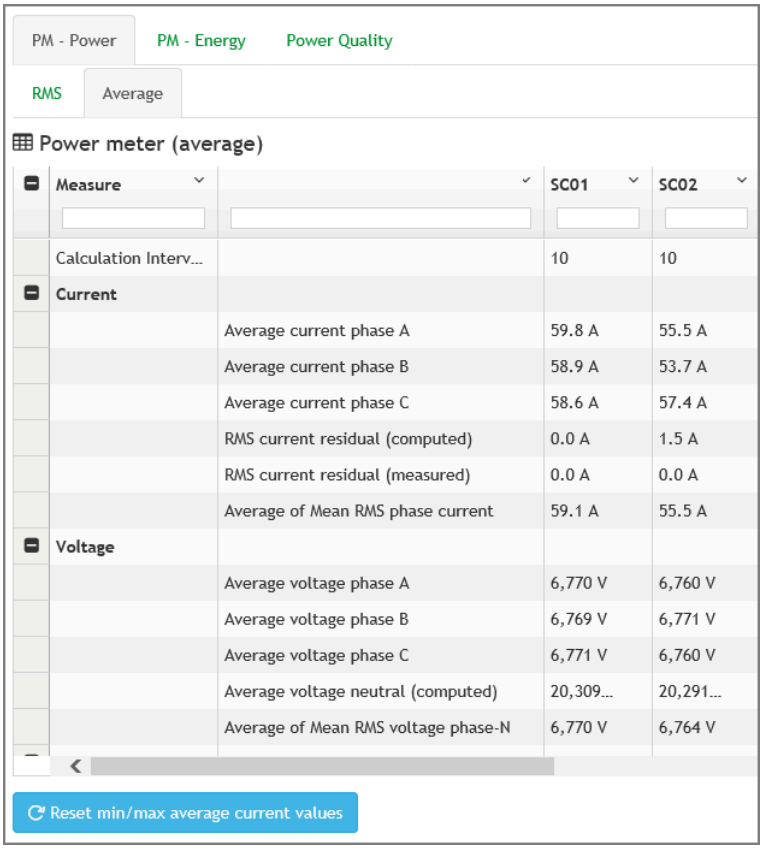
Measure	Type/Phase...	SC01	SC02
Current	**Mean**	**40.8 A**	**38.3 A**
	Phase A	41.3 A	38.3 A
	Phase B	40.7 A	37.1 A
	Phase C	40.5 A	39.6 A
	Residual	0.0 A	0.0 A
Single voltage	**Mean**	**5,661 V**	**5,681 V**
	Phase A	5,661 V	5,678 V
	Phase B	5,660 V	5,688 V
	Phase C	5,662 V	5,678 V
	Neutral	1,983...	1,044...
Phase voltage	**Mean**	**3 V**	**8 V**
	Vab	2 V	11 V
	Vbc	2 V	9 V
	Vca	4 V	3 V
Power			
Real power	**Total**	**-1,15...**	**-2,19...**

The list of measurements displayed in the **MV Measurements** and **LV Measurements** pages is identical and shown below:

Tab PM - Power			
Tab RMS			
Category	**Measure**	**Description**	**Option**
Current	Mean	Mean current on all 3 phases	Standard
	Phase A	Current on phase A	Standard
	Phase B	Current on phase B	Standard
	Phase C	Current on phase C	Standard
	Residual	Residual current	Standard
Single voltage	Mean	Mean phase-to-neutral voltage on all 3 phases	Standard
	Phase A	Phase-to-neutral voltage on phase A	Standard
	Phase B	Phase-to-neutral voltage on phase B	Standard
	Phase C	Phase-to-neutral voltage on phase C	Standard
	Neutral	Residual voltage	Standard
Phase voltage	Mean	Mean phase-to-phase voltage on all 3 phases	Standard
	Vab	Phase-to-phase voltage between phases A and B	Standard
	Vbc	Phase-to-phase voltage between phases B and C	Standard
	Vca	Phase-to-phase voltage between phases C and A	Standard
Real power	Total	Total active power	PM option (*)
	Phase A	Active power on phase A	PM option (*)

Tab PM - Power			
Tab RMS			
Category	**Measure**	**Description**	**Option**
	Phase B	Active power on phase B	PM option (*)
	Phase C	Active power on phase C	PM option (*)
Reactive power	Total	Total reactive power	PM option (*)
	Phase A	Reactive power on phase A	PM option (*)
	Phase B	Reactive power on phase B	PM option (*)
	Phase C	Reactive power on phase C	PM option (*)
Apparent power	Total	Total apparent power	PM option (*)
	Phase A	Apparent power on phase A	PM option (*)
	Phase B	Apparent power on phase B	PM option (*)
	Phase C	Apparent power on phase C	PM option (*)
Power factor	Total	Total power factor	PM option (*)
	Phase A	Power factor on phase A	PM option (*)
	Phase B	Power factor on phase B	PM option (*)
	Phase C	Power factor on phase C	PM option (*)
(*): PM option is incuded as standard for the LV measurements.			

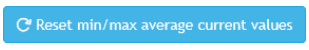
Example of measurements displayed – **MV** or **LV Measurement > PM – Power** page / **Average** tab



Tab PM - Power		
Tab Average (°) with PM option (*)		
Category	**Measure**	**Description**
Current	Average current phase A	Average current phase A

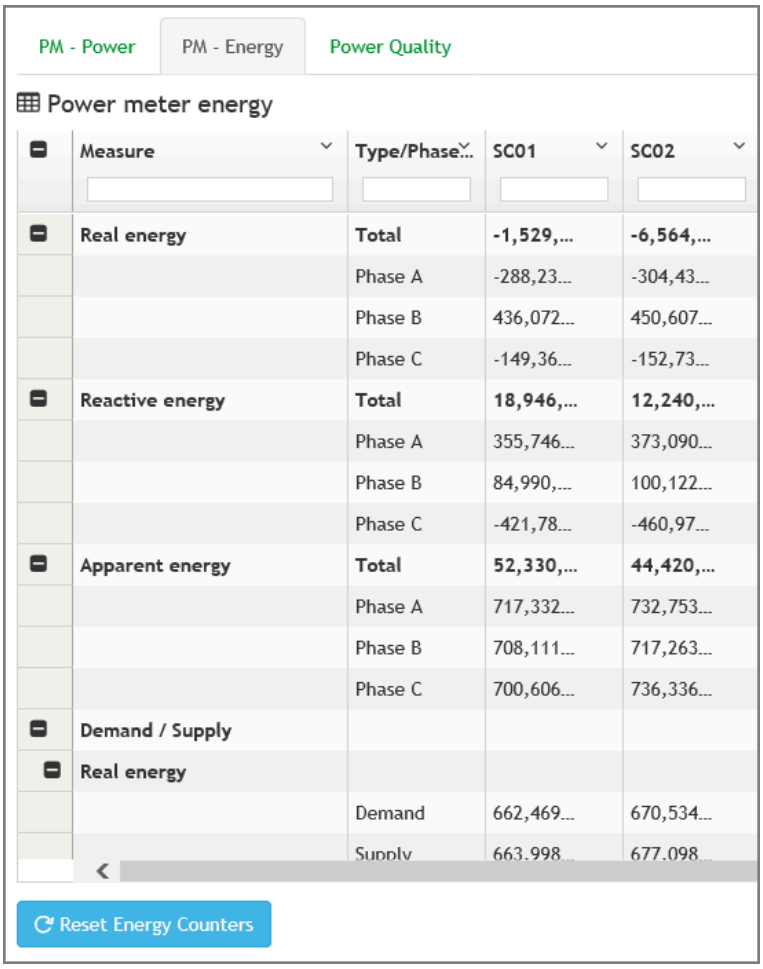
Tab PM - Power		
Tab Average (°) with PM option (*)		
Category	**Measure**	**Description**
	Average current phase B	Average current phase B
	Average current phase C	Average current phase C
	RMS current residual (computed)	RMS current residual (computed)
	RMS current residual (measured)	RMS current residual (measured)
	Average of Mean RMS phase current	Average of Mean RMS phase current
Voltage	Average voltage phase A	Average voltage phase A
	Average voltage phase B	Average voltage phase B
	Average voltage phase C	Average voltage phase B
	Average voltage neutral (computed)	Average voltage neutral (computed)
	Average of Mean RMS voltage phase-N	Average of Mean RMS voltage phase-N
Power	Average P Real power phase A	Average P Real power phase A
	Average P Real power phase B	Average P Real power phase B
	Average P Real power phase C	Average P Real power phase C
	Average P Real power total	Average P Real power total
	Average Q Reactive power phase A	Average Q Reactive power phase A
	Average Q Reactive power phase B	Average Q Reactive power phase B
	Average Q Reactive power phase C	Average Q Reactive power phase C
	Average Q Reactive power total	Average Q Reactive power total
	Average S Apparent power phase A	Average S Apparent power phase A
	Average S Apparent power phase B	Average S Apparent power phase B
	Average S Apparent power phase C	Average S Apparent power phase C
	Average S Apparent power total	Average S Apparent power total
Min/Max recording	Minimum of average of Mean RMS phase current day	Minimum of average of Mean RMS phase current day
	Minimum of average of Mean RMS phase current week	Minimum of average of Mean RMS phase current week
	Minimum of average of Mean RMS phase current month	Minimum of average of Mean RMS phase current month
	Minimum of average of Mean RMS phase current year	Minimum of average of Mean RMS phase current year
	Maximum of average of Mean RMS phase current day	Maximum of average of Mean RMS phase current day
	Maximum of average of Mean RMS phase current week	Maximum of average of Mean RMS phase current week
	Maximum of average of Mean RMS phase current month	Maximum of average of Mean RMS phase current month
	Maximum of average of Mean RMS phase current year	Maximum of average of Mean RMS phase current year

(*): PM option is incuded as standard for the LV measurements.

(°): A button **Reset min/max average current values** 

on the page manually resets the calculated averages on the currents.

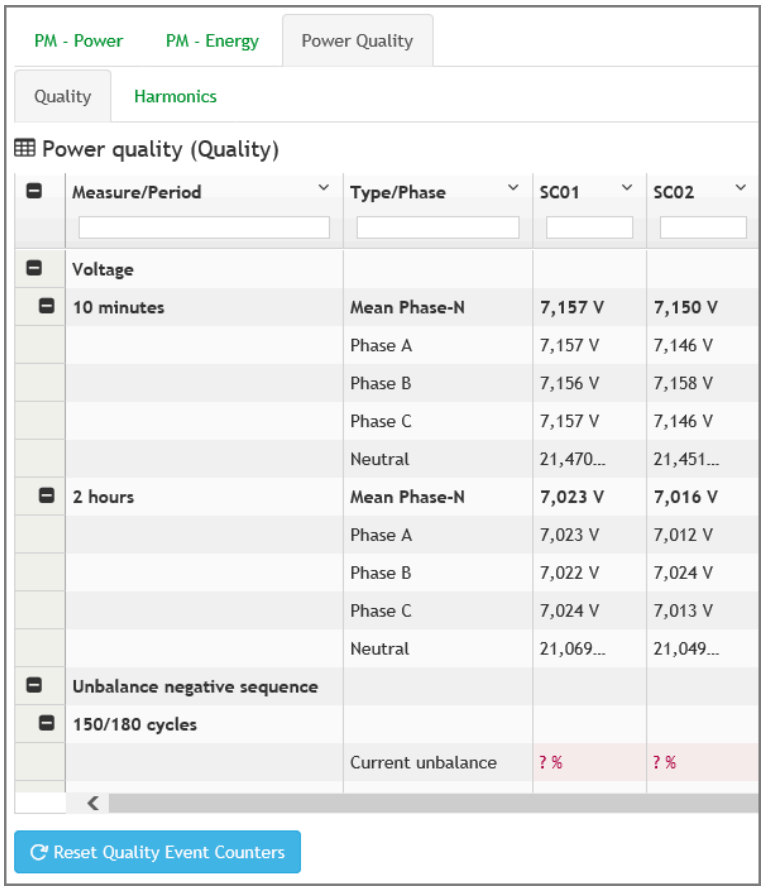
Example of measurements displayed: **MV** or **LV Measurement > PM – Energy**



Tab PM – Energy (°) with PM (*) option		
Category	**Measurement**	**Description**
Real energy	Total	Total active energy
	Phase A	Active energy on phase A
	Phase B	Active energy on phase B
	Phase C	Active energy on phase C
	Demand	Total active energy consumption
	Supply	Total active energy supplied
Reactive energy	Total	Total reactive energy
	Phase A	Reactive energy on phase A
	Phase B	Reactive energy on phase B
	Phase C	Reactive energy on phase C
	Demand	Total reactive energy consumption
	Supply	Total reactive energy in supply
Positive reactive energy	Demand	Total positive reactive energy consumption
	Supply	Total positive reactive energy in supply
Negative reactive energy	Demand	Total negative reactive energy consumption
	Supply	Total negative reactive energy in supply
Apparent energy	Total	Total apparent energy
	Phase A	Apparent energy on phase A

Tab PM – Energy (°) with PM (*) option		
Category	**Measurement**	**Description**
	Phase B	Apparent energy on phase B
	Phase C	Apparent energy on phase C
(*): PM option is incuded as standard for the LV measurements. (°): A button **Reset Energy Counters** on the page manually resets the energy counters.		

Example of measurements displayed: **MV** or **LV Measurement > Power Quality > Quality** tab

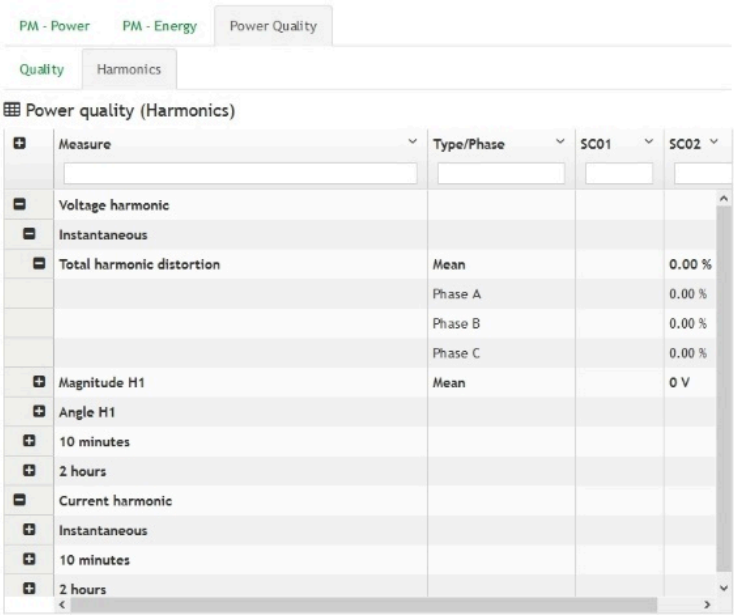


Tab Power Quality			
Tab Quality (°) with PQ option (*)			
Category	**Duration**	**Measurement**	**Description**
Voltage	10 min	Mean Phase-N	Mean voltage on each phase and neutral over 10 minute period
		Phase A	Mean voltage on phase A over 10 minute period
		Phase B	Mean voltage on phase B over 10 minute period
		Phase C	Mean voltage on phase C over 10 minute period
		Neutral	Mean residual voltage flowing in the neutral over 10 minute period
	2 hours	Mean Phase-N	Mean voltage on each phase and neutral over 2 hour period
		Phase A	Mean voltage on phase A over 2 hour period
		Phase B	Mean voltage on phase B over 2 hour period
		Phase C	Mean voltage on phase C over 2 hour period
		Neutral	Mean residual voltage flowing in the neutral over 2 hour period
Unbalance negative sequence	150/180 cycles (*)	Current unbalance	Current unbalance over 3 seconde period

Tab Power Quality			
Tab Quality (°) with PQ option (*)			
Category	**Duration**	**Measurement**	**Description**
		Voltage unbalance	Voltage unbalance over 3 seconde period
	10 min	Current unbalance	Current unbalance over 10 minute period
		Voltage unbalance	Voltage unbalance over 10 minute period
	2 hours	Current unbalance	Current unbalance over 2 hour period
		Voltage unbalance	Voltage unbalance over 2 hour period
Dips swells and interruption	Short	Dip	Short voltage sag indication
		Swell	Short voltage swell indication
		Interruption	Short voltage interruption indication
	Medium	Dip	Medium voltage sag indication
		Swell	Medium voltage swell indication
	Long	Dip	Long voltage sag indication
		Swell	Long voltage swell indication
		Interruption	Long voltage interruption indication
(*): 150 measurement cycles corresponds to 3 secondes at 50 Hz. 180 measurement cycles corresponds to 3 secondes at 60 Hz. (°): A button **Reset Quality Event Counters** on the page manually resets the quality event counters.			

NOTE: All Quality data are displayed in the **Monitoring & control > Data > Analog** pages. See also the T300 Database Manual (ref. NT00391), for the details of the variables corresponding to **Quality** data.

Example of measurements displayed: **MV** or **LV Measurement > Power Quality > Harmonics** tab



Tab Power Quality			
Tab Harmonics			
Period	**Feature**	**Measurement**	**Description**
Voltage harmonic (with PQ option)			
Instantaneous	Total harmonic distortion	Mean	Voltage total harmonic distortion mean of 3 phases
		Phase A	Voltage phase A total harmonic distortion

Tab Power Quality			
Tab Harmonics			
Period	**Feature**	**Measurement**	**Description**
Voltage harmonic (with PQ option)			
		Phase B	Voltage phase B total harmonic distortion
		Phase C	Voltage phase C total harmonic distortion
	Magnitude H1	Mean	Voltage harmonic 1 magnitude mean of 3 phases
		Phase A	Voltage phase A harmonic 1 magnitude
		Phase B	Voltage phase B harmonic 1 magnitude
		Phase C	Voltage phase C harmonic 1 magnitude
	Angle H1	Phase A	Voltage phase A harmonic 1 angle
		Phase B	Voltage phase B harmonic 1 angle
		Phase C	Voltage phase C harmonic 1 angle
10 minutes	Total harmonic distortion	Mean	Voltage total harmonic distortion mean of 3 phases- 10 minutes
		Phase A	Voltage phase A total harmonic distortion - 10 minutes
		Phase B	Voltage phase B total harmonic distortion - 10 minutes
		Phase C	Voltage phase C total harmonic distortion - 10 minutes
	Magnitude H1	Mean	Voltage harmonic 1 magnitude mean of 3 phases - 10 minutes
		Phase A	Voltage phase A harmonic 1 magnitude - 10 minutes
		Phase B	Voltage phase B harmonic 1 magnitude - 10 minutes
		Phase C	Voltage phase C harmonic 1 magnitude - 10 minutes
	Magnitude Hx (x is rank 2 to 40 harmonics)	Phase A	Voltage phase A harmonic x magnitude - 10 minutes
		Phase B	Voltage phase B harmonic x magnitude - 10 minutes
		Phase C	Voltage phase C harmonic x magnitude - 10 minutes
2 hours	Total harmonic distortion	Mean	Voltage total harmonic distortion mean of 3 phases - 2 hours
		Phase A	Voltage phase A total harmonic distortion - 2 hours
		Phase B	Voltage phase B total harmonic distortion - 2 hours
		Phase C	Voltage phase C total harmonic distortion - 2 hours
	Magnitude H1	Mean	Voltage harmonic 1 magnitude mean of 3 phases - 2 hours
		Phase A	Voltage phase A harmonic 1 magnitude - 2 hours
		Phase B	Voltage phase B harmonic 1 magnitude - 2 hours
		Phase C	Voltage phase C harmonic 1 magnitude - 2 hours
	Magnitude Hx (x is rank 2 to 40 harmonics)	Phase A	Voltage phase A harmonic x magnitude - 2 hours
		Phase B	Voltage phase B harmonic x magnitude - 2 hours
		Phase C	Voltage phase C harmonic x magnitude - 2 hours
Current harmonic (with PQ option)			
Instantaneous	Total harmonic distortion	Mean	Current total harmonic distortion mean of 3 phases
		Phase A	Current phase A total harmonic distortion
		Phase B	Current phase B total harmonic distortion
		Phase C	Current phase C total harmonic distortion
		Residual (*)	Residual current total harmonic distortion
	Magnitude H1	Mean	Current harmonic 1 magnitude mean of 3 phases
		Phase A	Current phase A harmonic 1 magnitude

Tab Power Quality			
Tab Harmonics			
Period	**Feature**	**Measurement**	**Description**
Voltage harmonic (with PQ option)			
		Phase B	Current phase B harmonic 1 magnitude
		Phase C	Current phase C harmonic 1 magnitude
		Residual	Residual current harmonic 1 magnitude
	Angle H1	Phase A	Current phase A harmonic 1 angle
		Phase B	Current phase B harmonic 1 angle
		Phase C	Current phase C harmonic 1 angle
		Residual	Residual current harmonic 1 angle
10 minutes	Total harmonic distortion	Mean	Current total harmonic distortion mean of 3 phases - 10 minutes
		Phase A	Current phase A total harmonic distortion - 10 minutes
		Phase B	Current phase B total harmonic distortion - 10 minutes
		Phase C	Current phase C total harmonic distortion - 10 minutes
		Residual	Residual current total harmonic distortion - 10 minutes
10 minutes	Magnitude H1	Mean	Current harmonic 1 magnitude mean of 3 phases - 10 minutes
		Phase A	Current phase A harmonic 1 magnitude - 10 minutes
		Phase B	Current phase B harmonic 1 magnitude - 10 minutes
		Phase C	Current phase C harmonic 1 magnitude - 10 minutes
		Residual	Residual current harmonic 1 - magnitude - 10 minutes
	Magnitude Hx (x is rank 2 to 40 harmonics)	Phase A	Current phase A harmonic x magnitude - 10 minutes
		Phase B	Current phase B harmonic x magnitude - 10 minutes
		Phase C	Current phase C harmonic x magnitude - 10 minutes
		Residual	Residual current harmonic x - magnitude - 10 minutes
2 hours	Total harmonic distortion	Mean	Current harmonic 1 magnitude mean of 3 phases - 2 hours
		Phase A	Current phase A total harmonic distortion - 2 hours
		Phase B	Current phase B total harmonic distortion - 2 hours
		Phase C	Current phase C total harmonic distortion - 2 hours
		Residual	Residual current total harmonic distortion - 2 hours
	Magnitude H1	Mean	Current harmonic 1 magnitude mean of 3 phases - 2 hours
		Phase A	Current phase A harmonic 1 magnitude - 2 hours
		Phase B	Current phase B harmonic 1 magnitude - 2 hours
		Phase C	Current phase C harmonic 1 magnitude - 2 hours
		Residual	Residual current harmonic 1 magnitude - 2 hours
	Magnitude Hx (x is rank 2 to 40 harmonics)	Phase A	Current phase A harmonic x magnitude - 2 hours
		Phase B	Current phase B harmonic x magnitude - 2 hours
		Phase C	Current phase C harmonic x magnitude - 2 hours
		Residual	Residual current harmonic x magnitude - 2 hours
(*): Only the residual current I0 measured is calculated in Power Quality. Residual current I0 calculated by adding the values of the three phases is not calculated in Power Quality.			

NOTE: All **Harmonics** data are displayed in the **Monitoring & control > Data > Analog** pages. See also the T300 Database Manual (ref. NT00391), for the details of the variables corresponding to harmonics.

Diagnostic Files

What's in This Chapter

Events Page 89
System Page 90
Cybersecurity Page 91
History Logs Page 92
Disturbance Records Page 92

The T300 includes log files that can be viewed in the Web server for performing diagnostics on the equipment.

Three files are created by default:

- An events file, displayed in the **Events** page (default capacity: 2,000 events).
- A system status file, displayed in the **System** page.
- A Cyber Security status file, displayed in the **Security** page.

The overall storage capacity for all diagnostic files is 500,000 events.

> **NOTE:** Other diagnostic files can be added by configuring them in the T300 Web server (a maximum of 4 diagnostic files in total). The Events file configuration can also be modified, for instance, to change the type of data displayed or to modify the file size. To do this, refer to the dedicated SOE User Manual or the T300 Quick Start Guide. Note that the **System** file cannot be modified by configuration.

The data recording parameters are saved in the log files according to the definition in Easergy Builder:

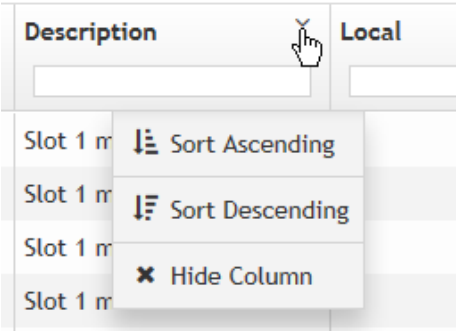
- It is possible to define up to 4 log files.
- The size and name of each log file is configurable.
- Any data can be assigned to a log file.

By clicking the **Export CSV** button, the log files can be downloaded locally and remotely in .csv format (respecting the standard RFC4180 format), which means they are compatible with Excel or any other spreadsheet package.

By clicking the **Refresh** button, the data displayed is immediately refreshed.

Clicking the **Clear** button clears all events at once. Confirmation is requested to help avoid the potential for inadvertant operator selection.

Sorting data displayed by column



Data can be sorted by clicking the title of a column and selecting the sort option required.

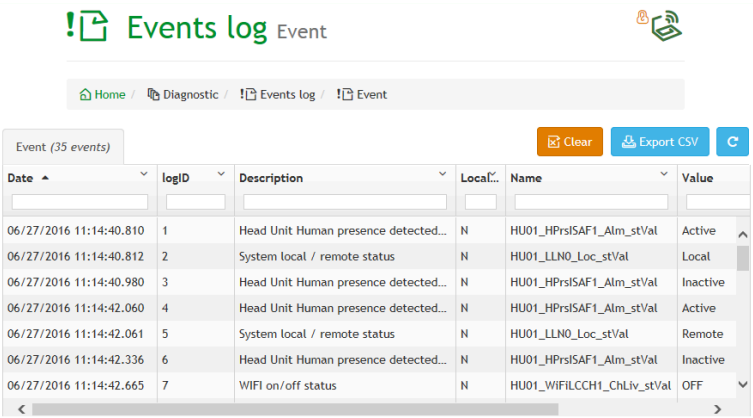
For all logs, when the storage capacity is reached, the most recent event erases the oldest event from the list.

Events Page

Accessed via **Diagnostic > Events** page

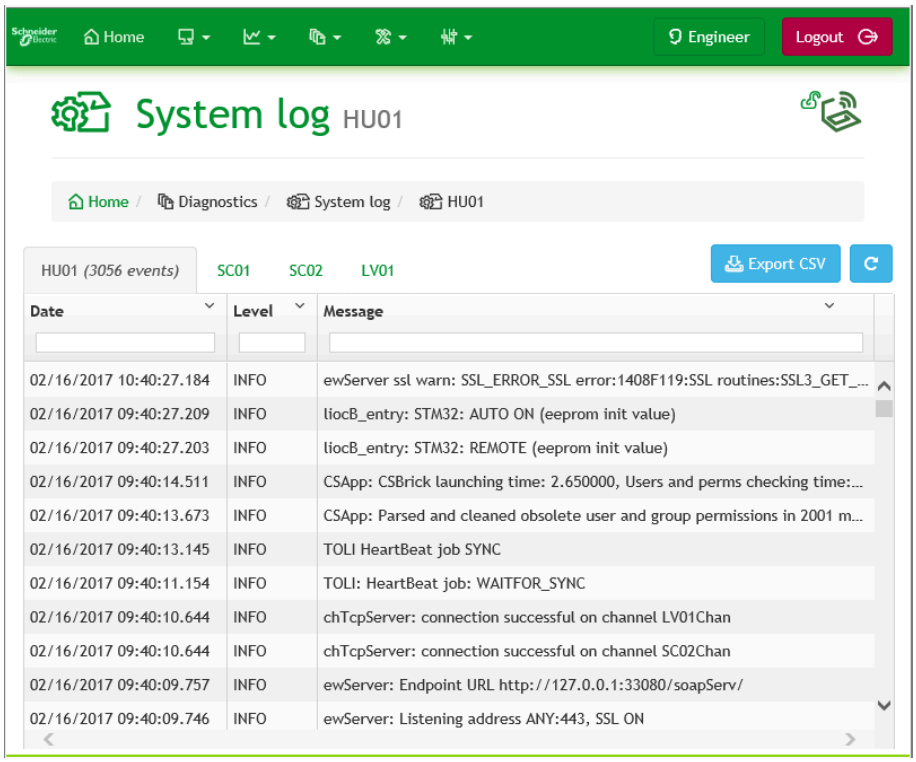
This page is used to view events associated with changes of state on data items. These are recorded in real time by the T300 and time-stamped with a 1 ms resolution.

On a change of state, an event is recorded in the file using predefined descriptions specific to each state or measurement unit. The name of the data item and its corresponding description are given on this page as well as the source that processed the data item that generated the event.



System Page

Access via **Diagnostic > System** page.



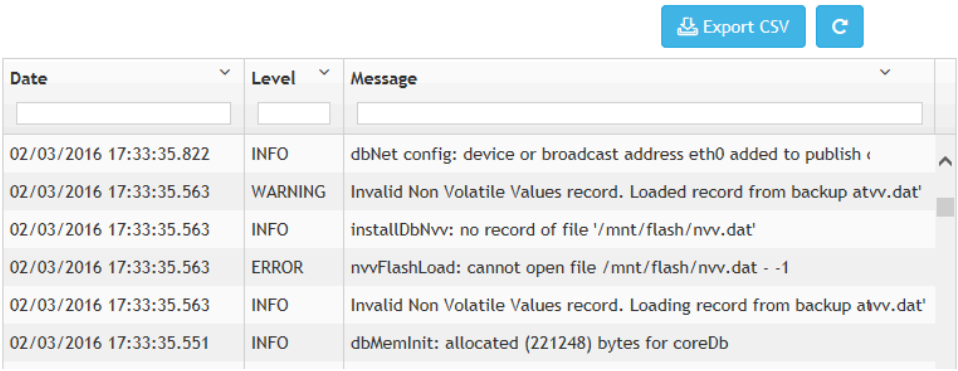
The T300 integrates the option to save additional internal system data for operation and maintenance purposes.

This data informs the user of any potential internal anomalies or potential operating issues in the system.

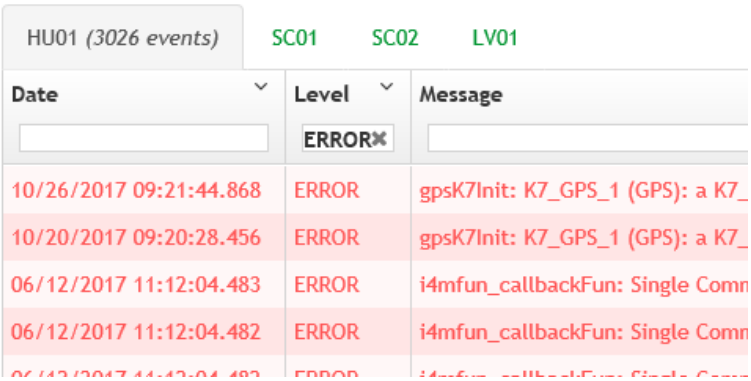
One tab per module is displayed on this page. Each tab contains the system information or the ERRORS generated by the module concerned (HU250, SC150/SC160 or LV150).

The messages displayed on each tab are categorized into 3 different types:

- INFO: Normal information on actions executed by the module
- WARNING: Messages that need to attract the user's attention regarding possible anomalies
- ERROR: Potential issue detected by the system that could downgrade operation

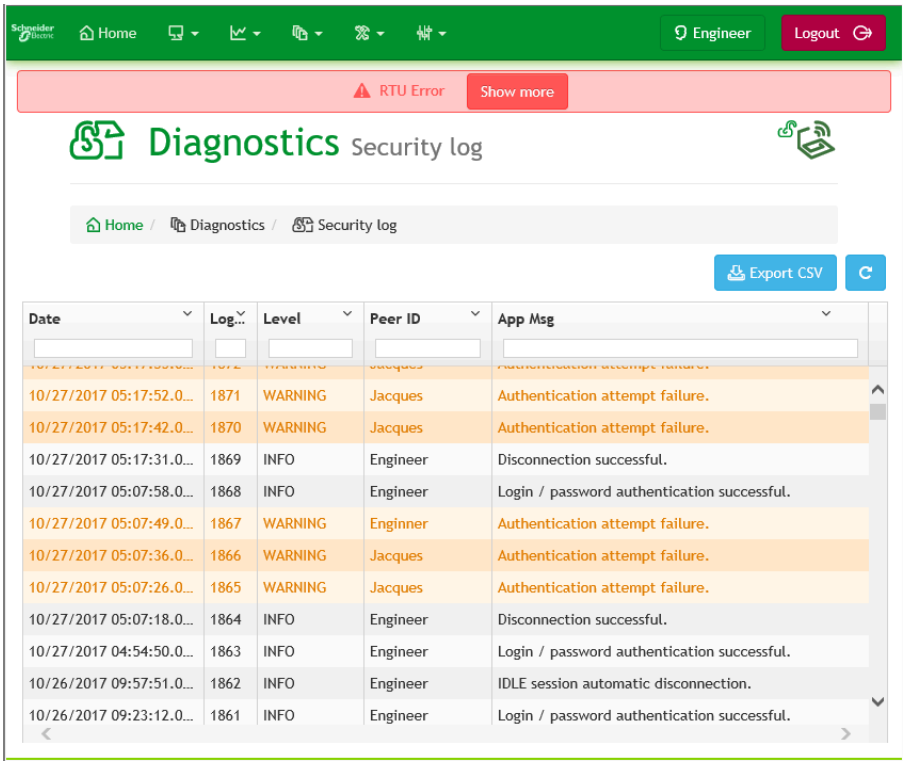


Tip: a sort in the Level column can be performed (by typing the first letters of the desired level) to display the information by category:



Cybersecurity Page

Accessed via **Diagnostic > Security log** page



This page displays the Cybersecurity logs. All information about user connections to the Web server is saved as simple information (INFO) or security alerts according to the level of importance (WARNING or EMERGENCY).

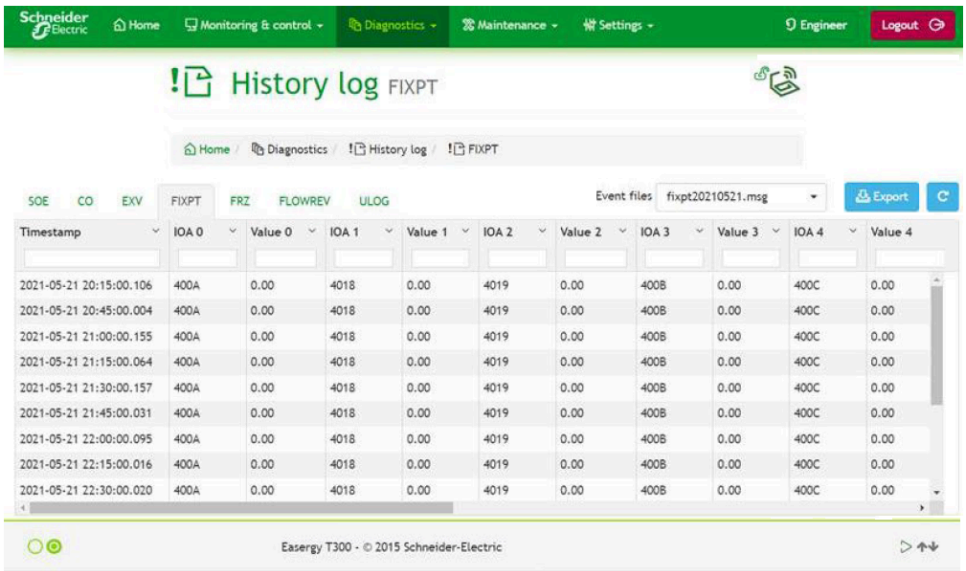
The name of the user making the connection is logged in order to identify who is trying to connect. A "WARNING" type message is logged for each authentication error. An "EMERGENCY" message is logged when users whose access is blocked after a certain number of failed attempts (see chapter **CAE and RBAC - System Security Parameters, page 97** for details on the T300 security policy).

> **NOTE:** This page can be accessed in the Web server only by users who have the "SECADM" role (see section Managing Users and Roles, page 98 for more information on user roles and access rights).

Date	Log...	Level	Peer ID	App Msg
05/09/2017 14:07:23.0...	1723	INFO	Engineer	Login / password authentication successful.
05/04/2017 16:35:13.0...	1717	WARNING	SecurityAdmin	Authentication attempt failure.
05/04/2017 12:31:46.0...	1714	EMERGENCY	SecurityAdmin	Authentication attempt failure (user already blocked).
05/04/2017 12:31:46.0...	1713	WARNING	SecurityAdmin	Authentication attempt failure.

History Logs Page

Accessed via **Diagnostic > History logs** page.



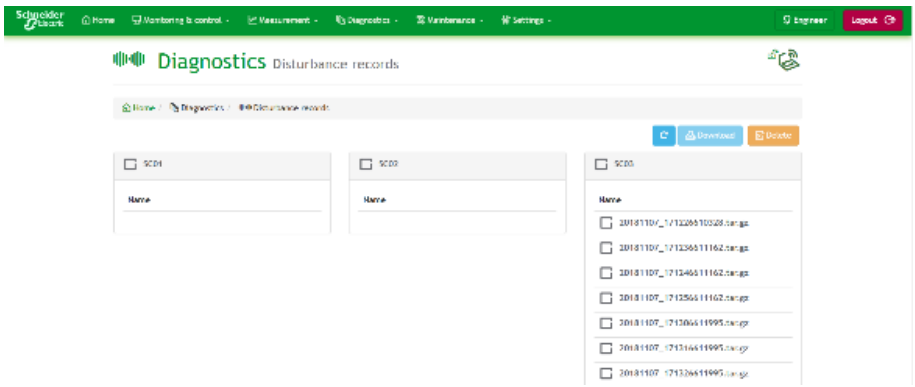
The semantic is detailed in DLT634.5101 / DLT634.5104 standards.

Click the **Export** button to download the log files locally and remotely in .msg format (according to the DLT634.5101 / DLT634.5104 standards).

Click the **Refresh** button to refresh the displayed data.

Disturbance Records Page

Accessed via **Diagnostics > Disturbance Records** page



This page displays disturbance records provided by each SC150/SC160 module. Up to 50 records are displayed.
In case of clock update of the T300 system, stored records are kept as they were recorded.

By clicking the button, data displayed is immediately refreshed.

Download and delete records:

- To download one record of the SC0x, select the check box next to the file name and click **Download**.
- To download all the records of the SC0x, select the check box of the SC0x section and click **Download**.
- To delete one record of the SC0x, select the check box next to the file name and click **Delete**.
- To delete all the records of the SC0x, select the check box of the SC0x section and click **Delete**.

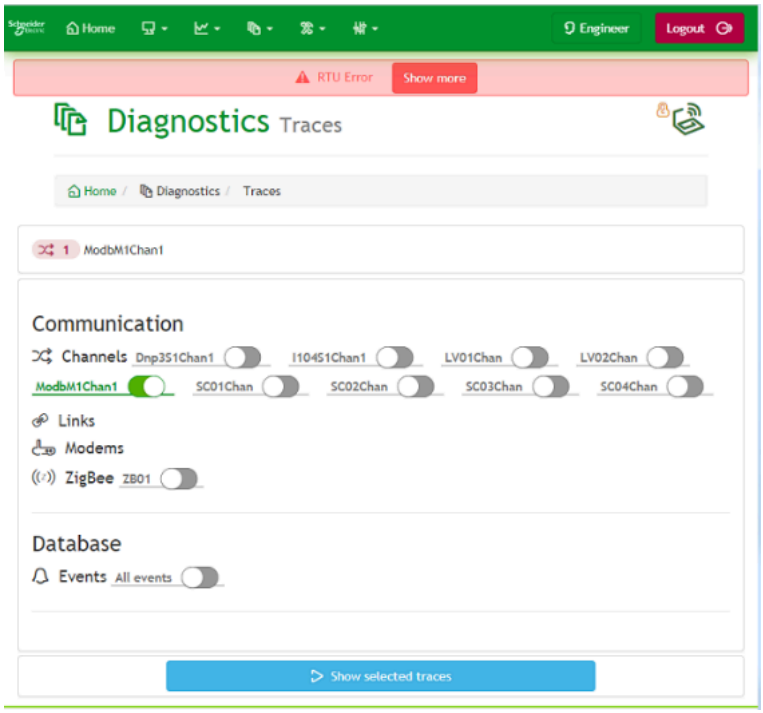
Traces

What's in This Chapter

Protocol Traces 94

Protocol Traces

Accessed via **Diagnostic > Trace** page



From the Trace pages, you can display the exchanges on the different communication channels of the T300. For example, you can view internal communications between the T300 modules, or external communications between the T300 and the IEDs or between the T300 and a SCADA.

In the **Communication** section, from the communication channels available in the unit, select the traces to display. The available channels depend on the initial configuration of the equipment.

It is also possible to display the communication of AT commands between the HU250 and the modems. To display the AT commands in a trace, select **Modems** and then select **Modem1**, **Modem2**, or both.

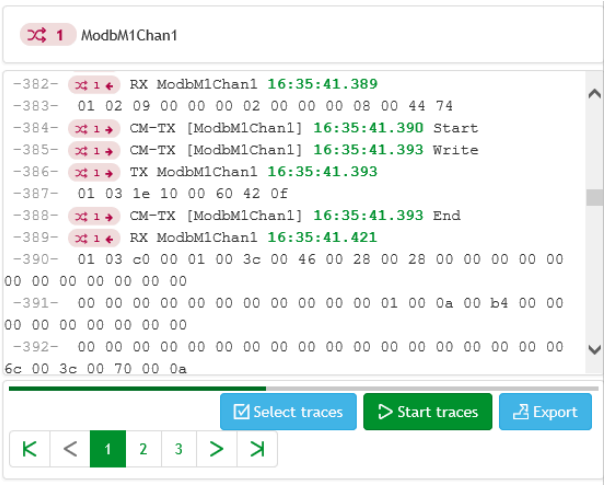
The communication between the HU250 and the Zigbee receiver can be monitored by selecting **Zigbee**. It is then possible to filter only application-level traces by selecting **app**.

In addition to the exchanges related to communication and modems instructions, it is also possible to display in the trace any new event occurring to the CoreDb database, by selecting **All events**.

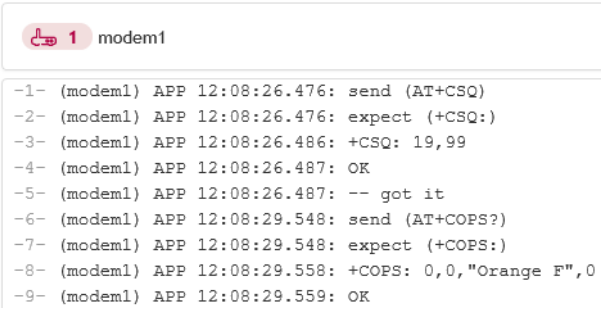
When the elements are selected for the trace, click the **Show selected traces** button to display the corresponding trace in a new page.

Trace display

Example of trace with a Modbus protocol (HU250-PS50 communication)



Example of trace with modem AT commands



In the Trace page, each frame received or sent by the T300 is identified by a symbol and a unique number at the beginning of the line. This number and this symbol make it possible to identify the corresponding communication channel, modem or event.

Each line in the trace contains a timestamp indicating when the communicaton was sent or received. For frames and AT commands, the timestamp is at the beginning of the line. For events, the timestamp is at the end of the line.

A frame corresponding to an exchange by a protocol is displayed in hexadecimal. An AT command instruction is displayed in text. A database event is displayed with the name of variable and the new state or value associated with it.

For certain protocols, the end of the line may give additional informations on the nature of the frame ("Read" or "Write" function, for example in Modbus protocol).

When the page capacity is reached (1000 lines maximum), the trace is recorded in sub-pages classified and numbered in order of trace appearance. To pause scrolling of the trace but continue to record trace information, click the **Suspend auto scrolling** button.

To stop recording trace information, click the **Stop traces** button.

To start or restart recording trace information, click the **Start traces** button.

To export trace information into a text file, click the **Export** button. The text file contains the information that is displayed on the Trace page.

The **Select traces** button is displayed when trace recording has been stopped manually. Click this button to return to the trace selection page.

NOTE: The IEC61850 protocol can not be displayed in the trace.

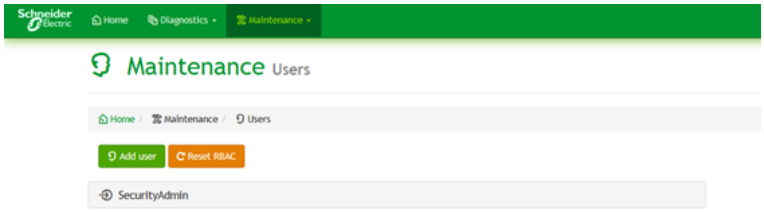
System Cybersecurity

What's in This Chapter

Users and roles 96
Centralized Authentication Protocols 117
Security Functionality Verification 127

Users and roles

Accessed via **Maintenance > Users** page.



CAE and RBAC

CAE is the T300 security administration tool for managing the security policy and defining the restrictions for accessing the system or the communication interfaces. It is a software tool for installing on a PC.
The T300 security policy consists defines the structure of the rights and responsibilities within the system, indicating who is authorized to do what, when, and how, based on an RBAC (role-based access control) model.

The access is controlled via roles. A role is a set of permissions, and users receive these permissions according to the role to which they are assigned.

This RBAC model allows the T300 to:

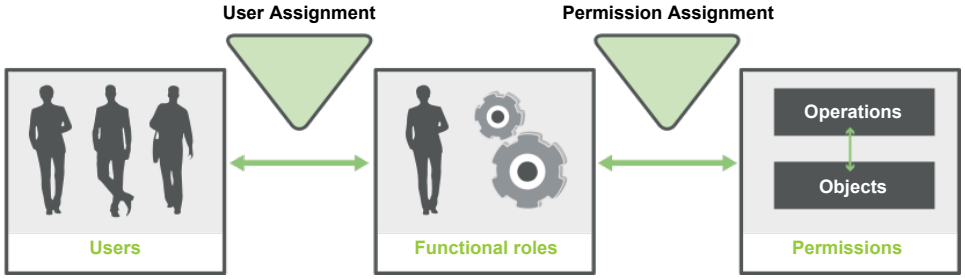
- help secure local and remote connections for maintenance: HTTPS, SSH
- help secure file transfer protocols: SFTP

The CAE can be used to create its own user database along with definition of its own roles, as well as to manage the RBAC models for each device centrally.

The CAE can be used to manage:

- User accounts (add/modify/delete user accounts)
- Security of the installed base in the T300

For more information on the CAE, refer to the specific user instructions.



System Security Parameters

Cybersecurity involves a certain number of system parameters that are applied to the security policy.

These parameters are summarized in the table below.

Use the CAE tool to modify the parameter values.

Refer to the CAE User Manual for more information on these functions. The default values in the CAE are given in brackets.

Parameter	Description
Idle session timeout	After a period of inactivity, user access to the Web server lapses. The user must re-enter their username and password to reconnect (default setting: 15 minutes).
Authorize user lockout	Option to lock/unlock a user account (function authorized by default)
Maximum number of connections	The maximum number of connection attempts a user can make (5 attempts by default)
Password timeout	Maximum time period allowed for entering password (3 minutes by default)
Account auto-unlock	Automatic unlocking of a user account after a defined duration (see below) if the account has been locked out (unlocking enabled by default)
Account lock duration	Maximum time period for an account to remain locked (240 seconds by default)
Password complexity	Choice of policy (strength) used for creating or modifying passwords. 3 levels of complexity are possible, compliant with standards: • **None**: ◦ 1 character minimum ◦ Valid characters: ASCII [33,122] • **IEEE Std 1686** (default): ◦ 8 characters minimum ◦ Allowed characters: ASCII[33,122], – lower case letter – upper case letter – numeric – non-alphanumeric (! " # $ % & ' ( ) * , - . / : ; < = > ? @ [ ] ^_ `) • **NERC**: ◦ 8 characters minimum ◦ Allowed characters: ASCII [33,122], with at least 3 or more different types of the following characters: – lower case letter – upper case letter – numeric – non-alphanumeric (! " # $ % & ' ( ) * , - . / : ; < = > ? @ [ ] ^_ `)
Monitoring and recording standards	List of supported standards: • **BDEW** (default) • **E3** • **NERC_CIP** • **IEEE 1686** • **IEC 62351** • **CS_PH1** Several standards can be selected in parallel.
Syslog server IP address (*)	IP address for the Syslog server (10.22.90.14 by default)
Syslog server IP port (*)	IP port number for the Syslog server (TCP 601 port by default)
SNMP Client/Server IP address	Function not developed in T300
Rights activation	Options for activating user rights: • Cybersecurity rights (default) • Generic rights
(*): A Syslog server has the ability to centralize cyber-security logs. Logs can be transmitted to the Syslog server, that is specified by these two parameters.	

First Time Connection

The T300 is supplied with a predefined RBAC model. The first access is only possible with the SecurityAdmin role. It is not strictly necessary, to modify the permissions and the role of this default RBAC model.
If required, use this SecurityAdmin role to define the different levels of user access adapted to T300 usage compliant with standard IEC 62351-8:2020.
If a restoration of the default RBAC is required, it can only be done with the SecurityAdmin role.

This RBAC contains one user with SecurityAdmin role. This user is configured with AAAAAAAA default password.

⚠WARNING

HAZARD OF UNAUTHORIZED ACCESS

Change the default passwords either via the CAE or via the T300 Web server.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Managing Users and Roles in the Web Server

Using the Web server, you can do the following actions:

- add or delete users, modify passwords, and assign or unassign one or more predefined roles to users (either default roles or those created in the CAE).
- act only on 1 single PowerLogic T300 at a time (HU250 to which you are connected).

In the default user database, the SecurityAdmin user is the only user with sufficient rights (SECADM role) to administer T300 cybersecurity actions (see table below). Consequently, this is the only user who can manage/modify user passwords and rights (roles).

Default User	Default Role
SecurityAdmin	SECADM

You need to connect to the T300 as a **SecurityAdmin** user to be able to perform the administration operations described below.

The rights defined for each role are detailed in the table below:

Rights Defined For Each Role/User			**INSTALLER**	**ENGINEER**	**VIEWER**	**OPERATOR**	**SECADM**	**SECAUD**	**RBACMNT**
Object	**Description**	**Action**							
CONF_DB	T300 application configuration (HU250, SC150/SC160)	CONFDB_READ	x	x	x	x			
		CONFDB_WRITE	x	x					
CONF_SYS	T300 system configuration (Ethernet, Wi-Fi, modem box, etc.)	CONFSYS_READ	x	x		x			
		CONFSYS_ WRITE	x	x					
FIRMWARE	HU250 firmware	FIRMWARE_ VIEW	x	x		x			
		FIRMWARE_ READ	x	x					
		FIRMWARE_ WRITE	x	x					

Rights Defined For Each Role/User			INSTALLER	ENGINEER	VIEWER	OPERATOR	SECADM	SECAUD	RBACMNT
Object	**Description**	**Action**							
WEBSERVICE	T300 Web server	WEBSERVICES_ ACCESS	x	x	x	x	x		
SSH	Easergy Builder, console	SSH_ACCESS	x	x					
OS_SHELL	Linux Shell, configuration import/ export service	OSSHELL_ ACCESS		x					
SYS_LOG	System and SOE log files	SYSLOG_READ	x	x		x			
		SYSLOG_WRITE	x	x					
RBAC	System security (users, passwords, access rights, certificate management)	RBAC_READ					x		CAE
		RBAC_WRITE					x		CAE
RBAC_LOG	Security log file	RBACLOG_READ					x	CAE	CAE
DATA	Device data (signals, measurements, controls, counters, PS50 settings, etc.)	DATA_READ	x	x	x	x			
		DATA_WRITE	x	x		x			
RESET	Device reset	RESET_ACCESS	x	x					

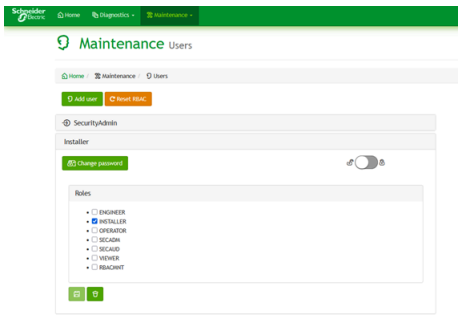
NOTE: "CAE" means that this user/role cannot access the Web server, but has the rights assigned via the CAE only.

NOTE: It is not possible to modify the rights assigned to a role via the T300 Web server. This can only be done via the CAE. Refer to the CAE manual for more information on how to administer the roles and associated rights in the RBAC model.

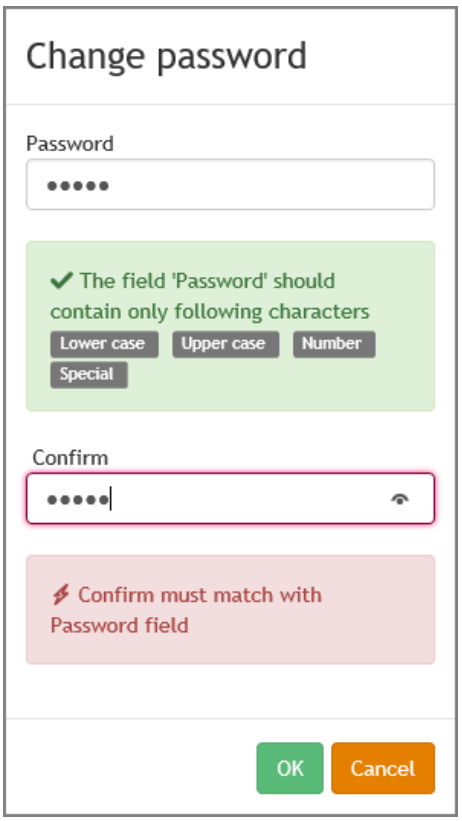
NOTE: To have full access to read and write a configuration in Easergy Builder, you need the services "SSH" and "OS_SHELL". So, only the access Engineer allows this possibility.

Modifying User Roles/Passwords

Example of default roles assigned to the **Installer** user



Changing a user password



Proceed as follows to change user roles and passwords:

- Connect to the T300 via the **SecurityAdmin** user.
- Go to the **Maintenance > Users** page in the Web server.
- This displays the list of existing users.
- Click on a user to display the roles assigned to this user.
- To assign or remove a role from a user, simply check or uncheck the box next to the specific role in the list. Several roles can be assigned to a single user, but there must be at least one role per user.
- Once the user roles have been modified, click the button to save the changes.
- To delete an existing user, click the button. Confirmation is requested to help avoid an inadvertent operator selection.
- Click the **Change password** button to change the user password. The new password must be entered twice to confirm it for security reasons. Password creation rules are defined in the CAE, refer to System Security Parameters, page 97. By default, the password must contain the following:
  - At least 1 lower case character
  - At least 1 upper case character
  - At least 1 number
  - At least 1 special character (limited to space character and !"#$%&'()*+,-./:;<=>?@ [\]^_`{|}~)
  - Valid characters: ASCII code [33,122]

- Click the **Add user** button to create new users.
  This opens a new window, requesting entry of the password and definition of the roles for this user. Click **OK** to confirm creation of this user.
- Click the **RBAC Reset** button to restore the default RBAC role definition, page 101.

  NOTE: It is possible to lock an existing user by enabling

  the lock . The user is then no longer able to connect.

  NOTE: It is possible to assign cybersecurity administrator rights to a predefined user other than **SecurityAdmin**. This other user can then perform the same role and password administration tasks for all other users, except their own.

Restoring the Default RBAC Model

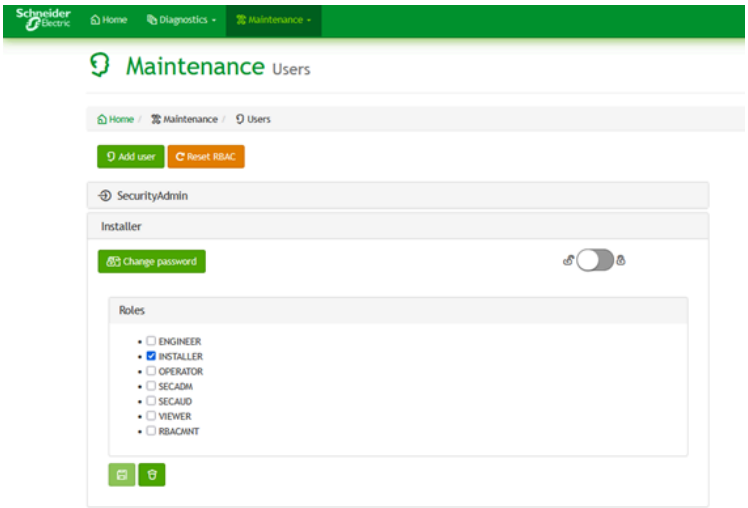
Restoring the default RBAC model allows for the deletion of the currently configured custom RBAC model and, if it was deployed, the CAE configuration.

The restoration of the default RBAC can be required in the following contexts:

- Cyber security requirements
- Decommissioning process
- Product end of life
- Instability issues
- Recovery purposes

This functionality is available for users with SECADM role.

1. Log in with the SECADM profile. If it is the first connection, refer to First time connection, page 98.
2. Open the **Maintenance** menu and select **Users**.



3. Click **Reset RBAC**.

   A warning message displays to check that you really want to restore the RBAC. Click **Continue**.

4. The RBAC restoration process starts and a message indicates it is in progress. The restoration process takes about two minutes.

   The restoration operation consists of the following steps:

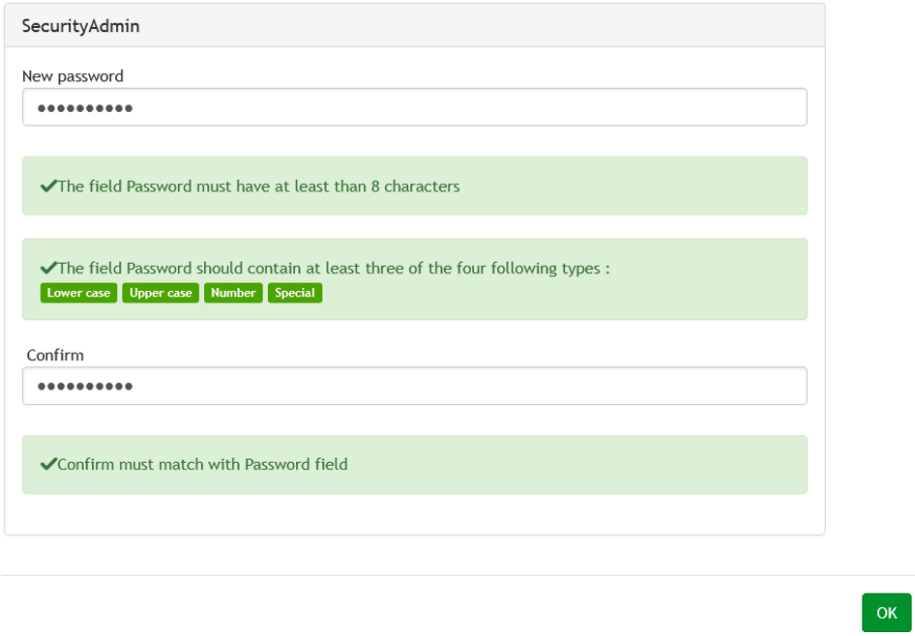
   A. Delete current RBAC configuration.

   B. Restart the application.

   C. Recover cyber security configuration and RBAC configuration.

   D. Create certificates

   After the RBAC reset, when logging in the fist time, the password change process is run, asking you to change the default password. Change the default password unless CAE has been used before the first login and the default RBAC model has already been modified, in such a case, you do not need to change the default password.



User Access Management

Using the T300 RBAC (Role-based Access Control), the Security Administrator can segregate duties within the customer organization, by applying the following recommendations:

- Grant users only the access they need to perform specific tasks, instead of giving everybody one type of permission.
- When planning the access control strategy, it is a best practice to grant users only the necessary rights to get their work done, and to define roles accordingly.
- Change all the default passwords immediately after the installation and responsibility transfer of the product.
- Create relevant user accounts and remove default ones, except SecurityAdmin.

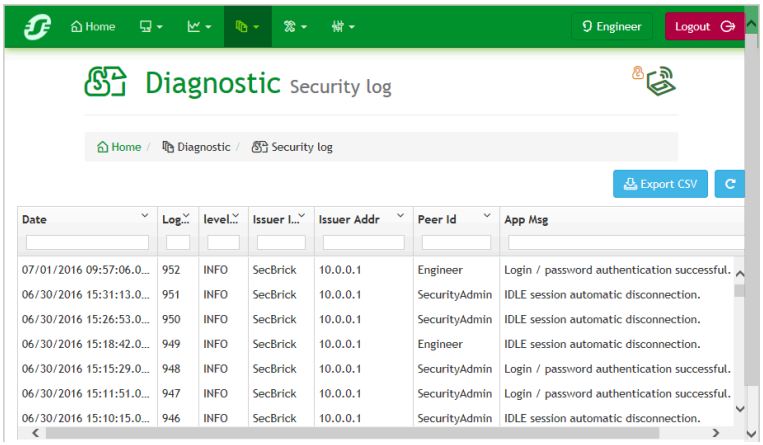
Access control coverage	Recommendation
Password management	Grant passwords only to users who need access. Prohibit password sharing.
Account management	Require Security Administrator to change passwords regularly (and not to use the last N passwords).
Account management	Remove employee access account when employment has terminated.

Access control coverage	Recommendation
Account management	Define and secure a backup Security Administrator account.
User account	Define different passwords for different accounts.
Password management	Do not transmit passwords via email or any other way over insecure internet.

Security Log Event File

A dedicated cybersecurity event file is created in T300. This file logs all events associated with connections to the T300 and all modification operations linked to the cybersecurity strategy.

This file can only be accessed by a user with cybersecurity access rights. It can be viewed and downloaded in the **Diagnostic > Security** log page in the Web server.

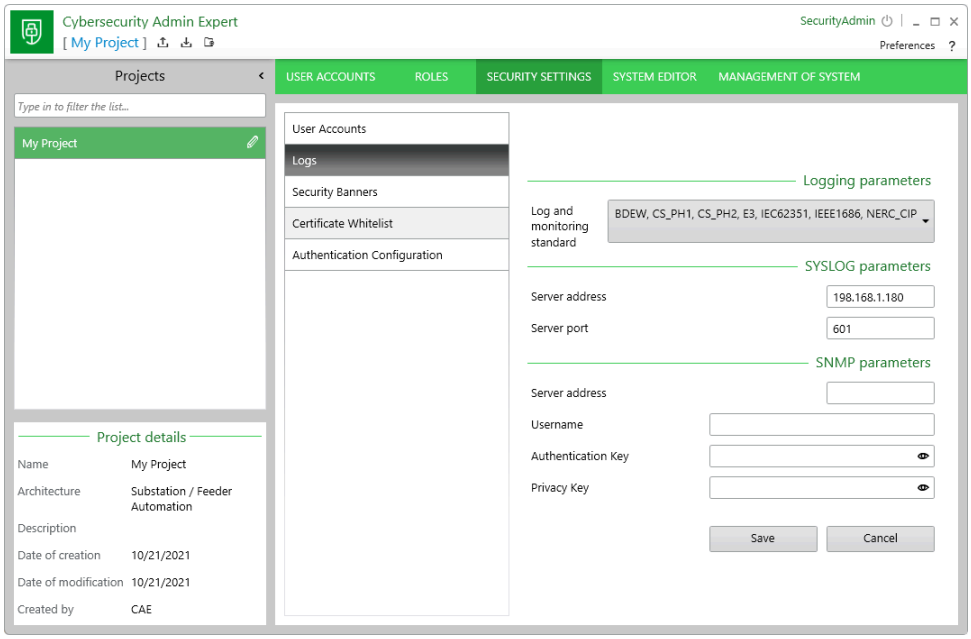


NOTE: The cybersecurity event file has 750 entries which are overwritten in a continuous loop.

Configuration of System Logging Protocol

If the Security Administrator has a System logging external server supporting SYSLOG protocol, it is possible to configure the HU250 to send Security Logs to this server.

The configuration is done using the CAE tool:



The supported logging standards are listed in the System Security Parameters table, page 97.

Refer to the CAE User Manual for more information on the Security Log configuration.

Certificate Management

TLS (Transport Layer Security) is a protocol used to help secure IP communications. It uses a certificate to generate a session key, used for encryption.

The T300 uses TLS with HTTPS protocol.

Device Identity

The T300 is identified by the remote clients thanks to its certificate.

The T300 is delivered with a self-generated self-signed certificate, there is no external Certification Authority (CA) to confirm the validity of the certificate.

The identity of the device, used for HTTPS and SSH communications, can be updated by the user.

The identity is generated and managed by a Public Key Infrastructure (PKI). This infrastructure is not detailed in this document. Only the update of the device identity is described here.

This operation requires:

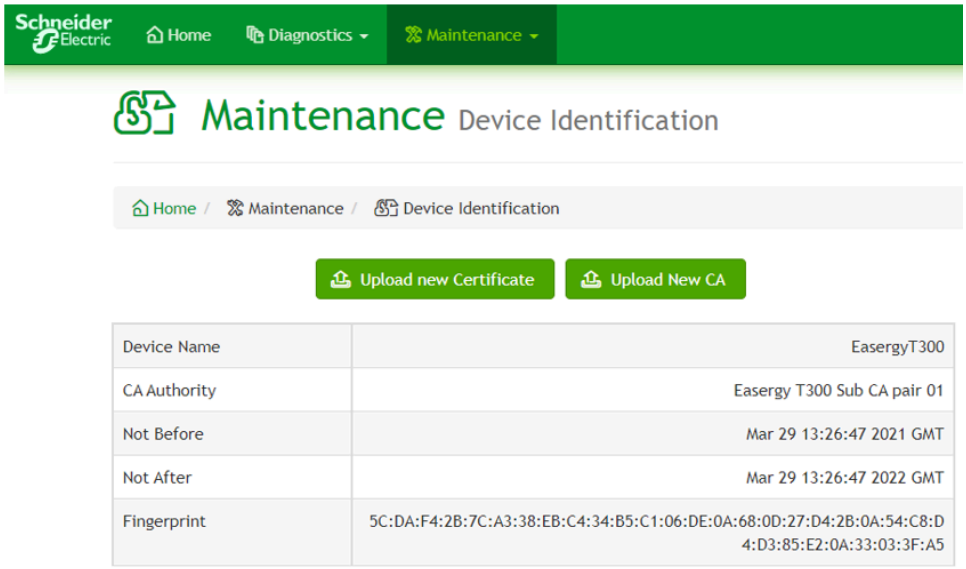
- A CA certificate (to identify the CA)
- A pfx file (one by T300) (generated by the CA, checked with the CA certificate during the import). It contains the certificate and a public key.

Installing the Certificate

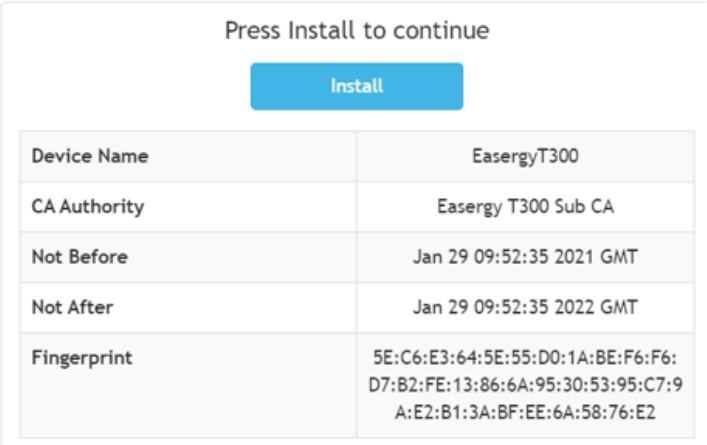
The T300 is delivered with a self-generated certificate. Users can install their own signed certificate with its associated CA by following this procedure. This is recommended to help enhance security of the system.

Access the Web server using SECADM role to display the **Device Identification** page.

Access via **Maintenance > Device Identification**.



1. Click on **Upload New CA**, then install it by clicking **Install** button.



2. Click on **Upload a new certificate**. Upload a .pfx file, protected by a password.

   Then install it by clicking **Install** button.

The content of the certificate can be checked at each step.

The T300 restarts after the import of the pfx file.

Recommendations

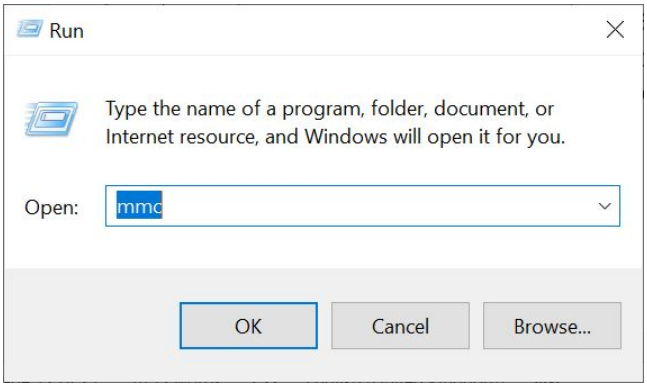
If the Security Administrator has a Public Key Infrastructure, it is recommended to generate a certificate and install it.

It is a best practice to install and renew the certificates in a timely manner.

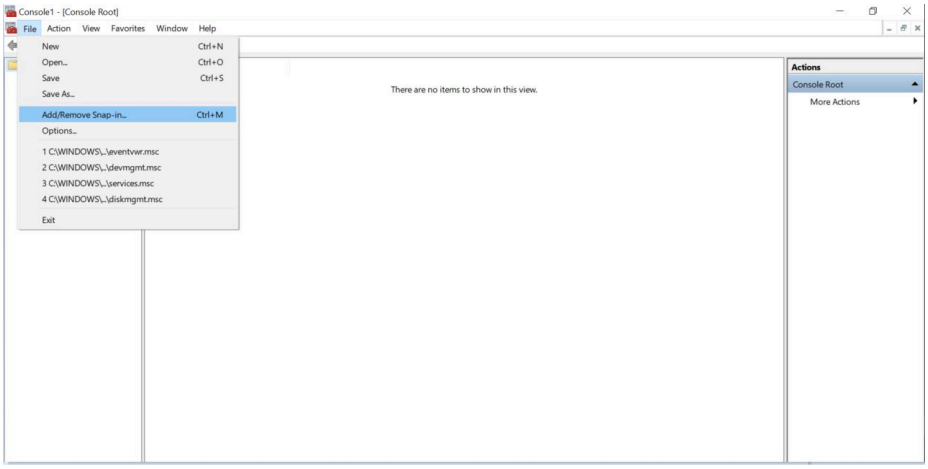
Importing CA in Windows 10 Client

Follow this procedure to import a CA in Windows 10:

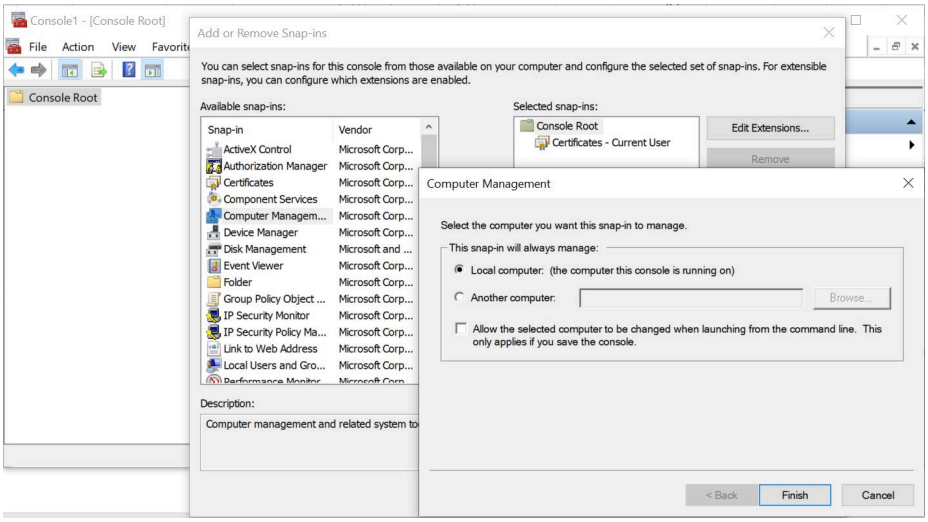
1. Start MMC. The Microsoft Management Console (MMC) hosts tools, known as “snap-ins”, that allow you to administer local and remote computers. To access the console, simultaneously press the **Windows** and **R** keys. The **Run** dialog box appears. Type **mmc.exe** in the text box.



2. A console opens. Go to **File > Add/Remove Snap-in**

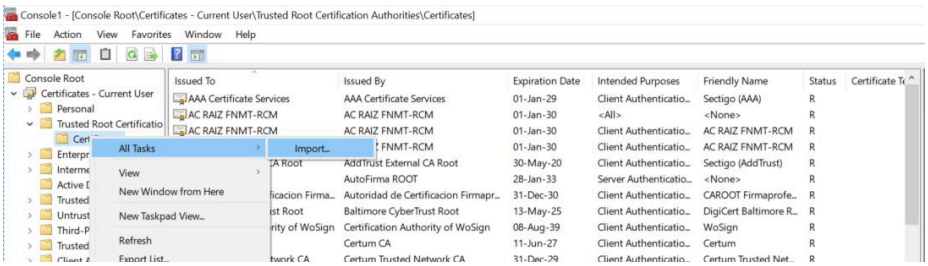


3. Select **Certificates** in the left-hand column and click **Add**.
4. Select **Computer account**.
5. Select **Local computer**.

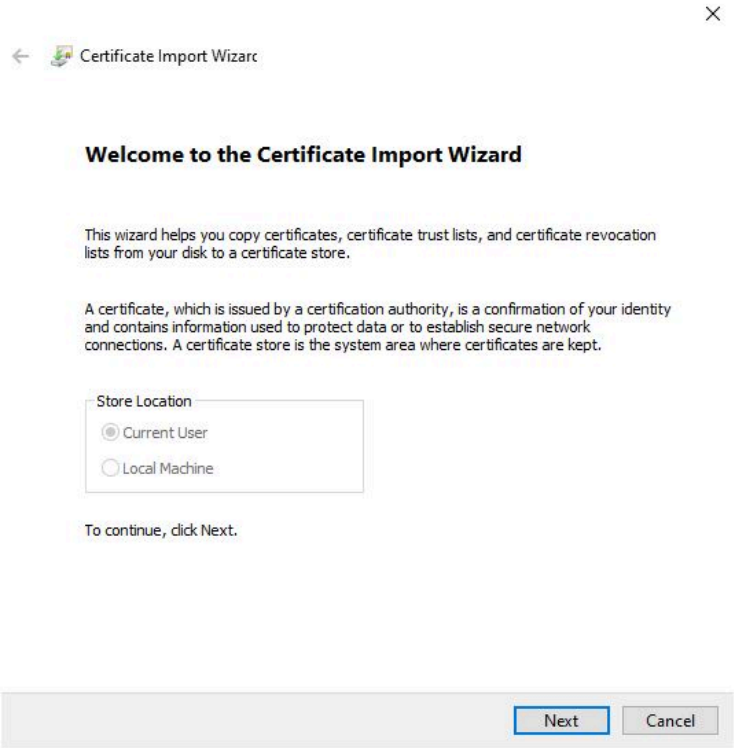


6. In MMC, expand the **Certificates** node and go to the **Trusted Root Certification Authorities** folder.

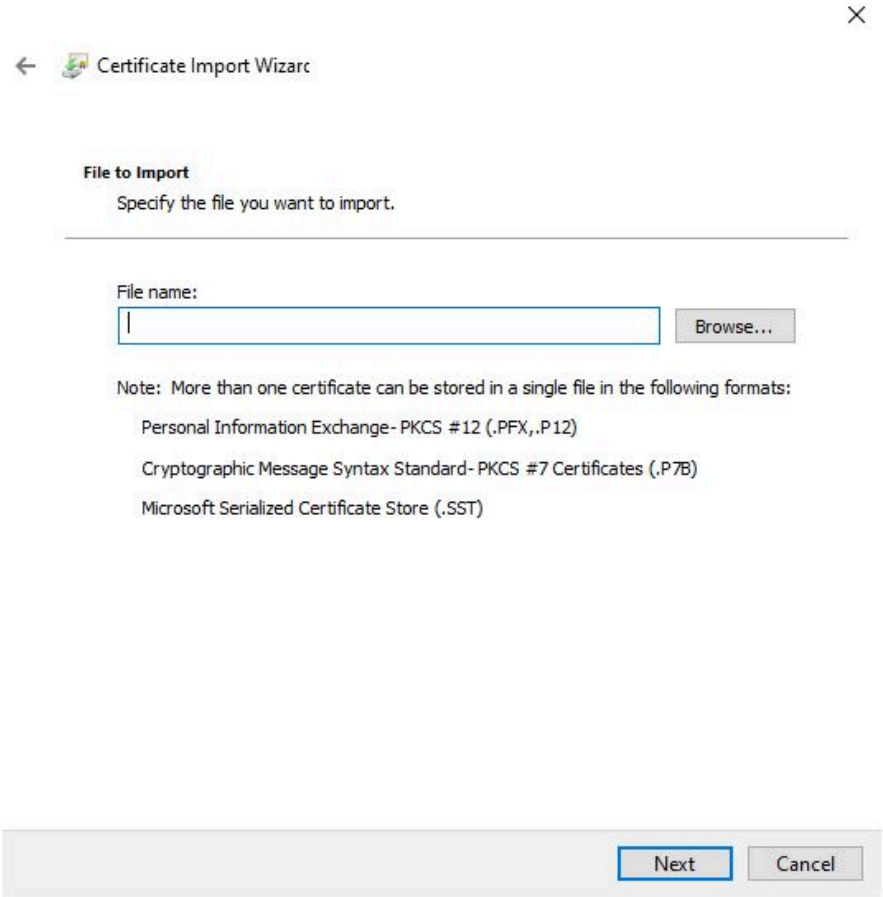
7. Right-click and select **All tasks > Import**.



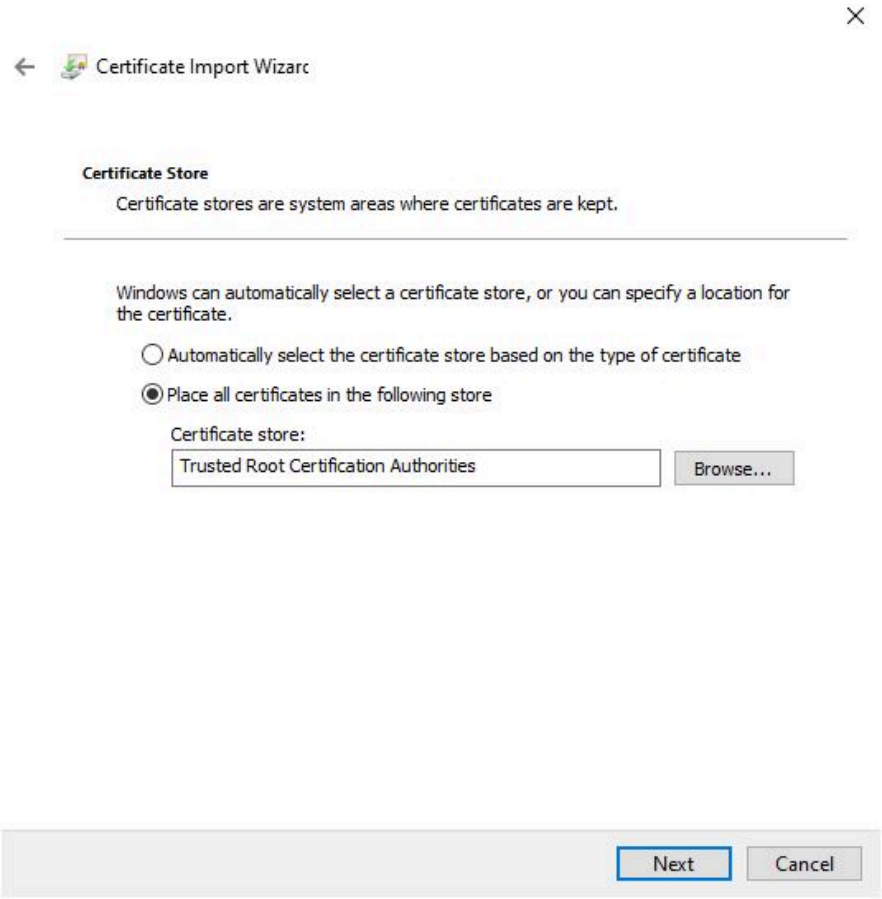
8. In the **Certificate Import** wizard, click **Next**.

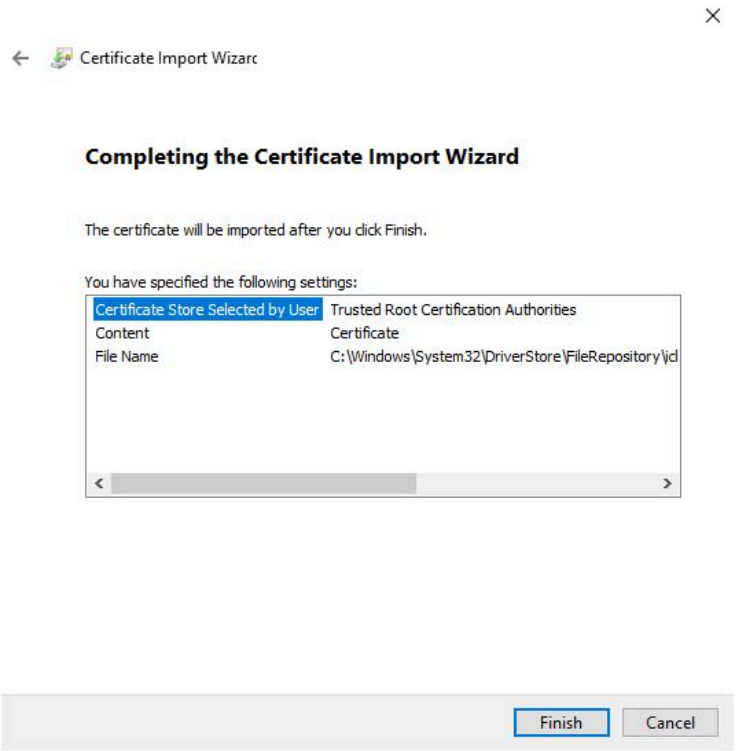


9. Browse to the location where the root CA certificate is stored and select the root CA certificate file. Click **Open**.

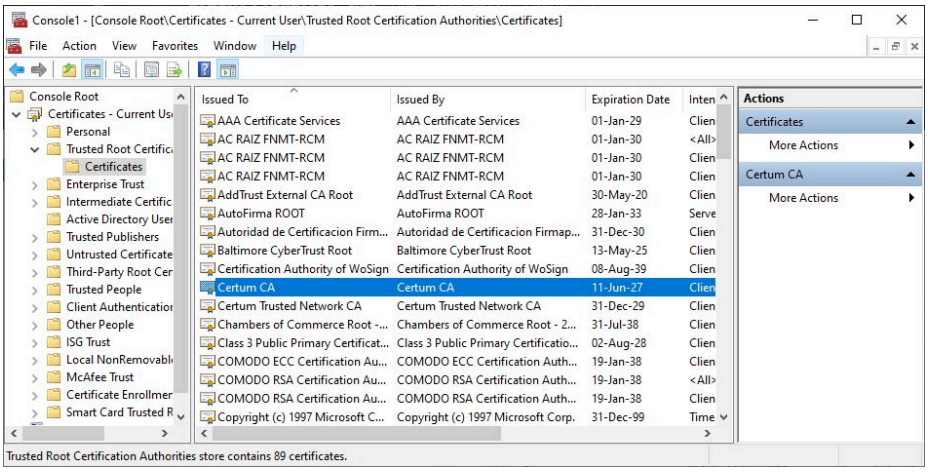


10. Click **Next**, **Next**, and **Finish**.

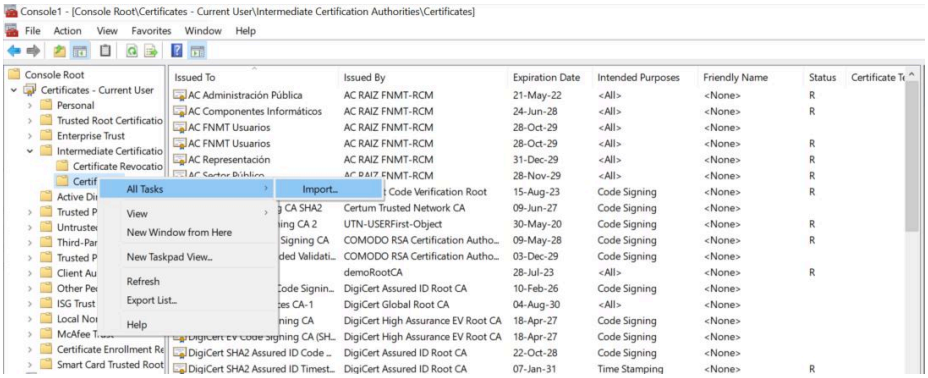


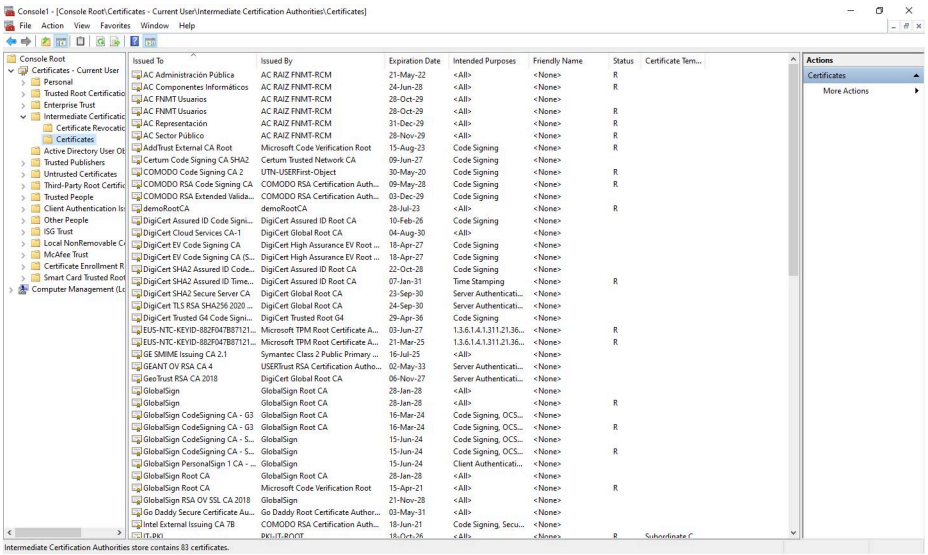


11. **Result**: The CA certificate is visible in the list.



12. Repeat steps 7 to 10 for any subordinate CAs in the **Intermediate certification authorities** folder.





Use of DNS

Web browsers checks the certificate only if the device is identified with a name, not with an IP address.

You can assign a name to an IP address by using a DNS server or adding the name and the IP address of the devices to the Windows Hosts file.

Using an external DNS server provides a more scalable, reliable, secure, and flexible method of resolving domain names to IP addresses than using the Windows hosts file.

In the example below, the name **t300_1** is assigned to the IP address 192.168.0.254.

```
# For example:
#
#      102.54.94.97     rhino.acme.com          # source server
#       38.25.63.10     x.acme.com              # x client host

# localhost name resolution is handled within DNS itself.
#   127.0.0.1       localhost
#   ::1             localhost

192.168.0.254     t300_1
```

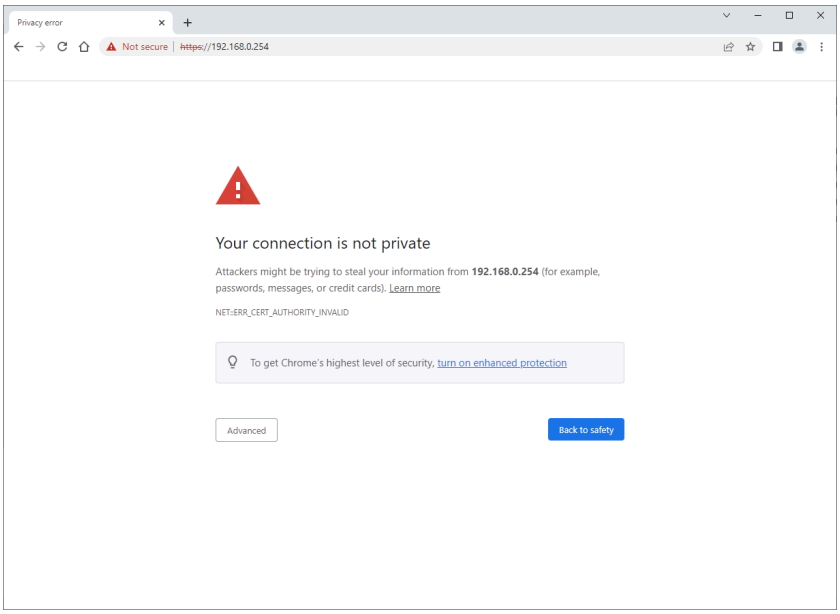
The name should be declared on the certificate as **subject alternate name**.

NOTE: Use different names to manage devices with different IP addresses.

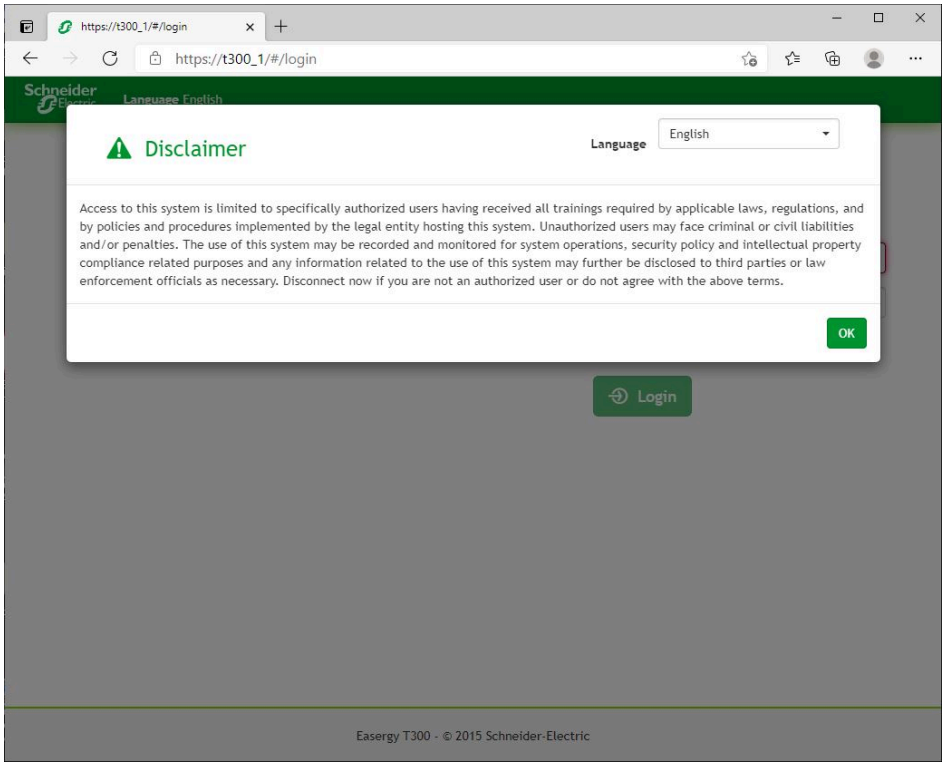
NOTE: Modifying the local Hosts file (with administrator role) can be considered a vulnerability.

NOTICE
HAZARD OF CYBERSECURITY Modify the local Hosts file only when strictly necessary. **Failure to follow these instructions can result in equipment damage.**

Example: The following image shows the type of warning message you may see if the browser does not check the certificate:



In the following example, the browser checks the certificate. The lock symbol is displayed with the name of the device. A disclaimer is displayed.



NOTE: Some web browsers use their own certificate store. In this case, add the certificate to the web browser certificate store.

Transport Layer Security (TLS)

Transport Layer Security (TLS) is a cryptographic protocol used to help secure communications over a computer network.

It is used to establish a more secure and encrypted connection between a client and a server. PowerLogic™ T300 features support this protocol.

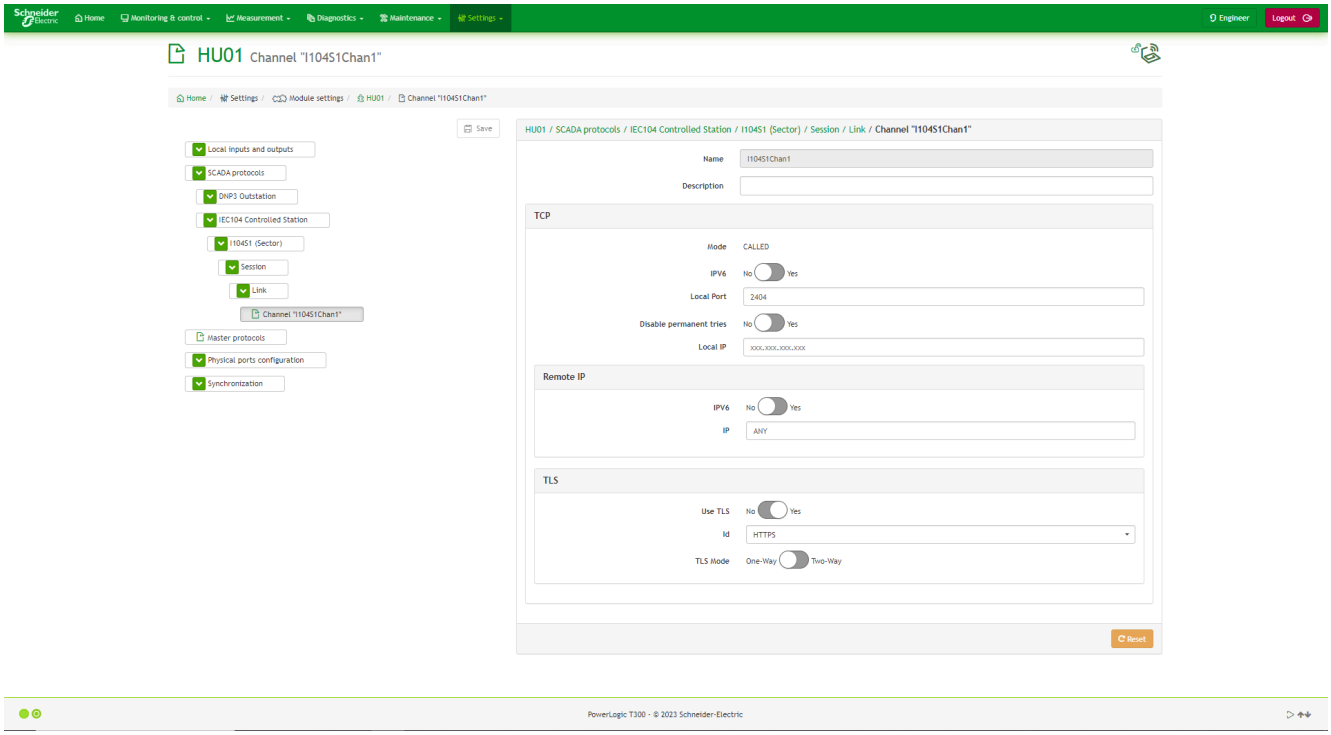
IEC 60870-5-104 over TLS

IEC 60870-5-104 over TLS authentication supports one-way and two-way authentication. To establish IEC 60870-5-104 authentication using TLS, the HU250 can only act as a controlled station.

One-Way Authentication

In order to activate one-way authentication for the T300, do as follows:

1. Open the HU250 web server, navigate to **Settings** menu and select **HU01**.
2. Select **SCADA protocols > IEC104 Slave**.
3. Select the corresponding **Sector** and navigate to **Session > Link > Channel**.
4. In **TLS** settings, set **Use TLS** to **Yes** and select **One-way** in **TLS Mode**.



In order to have IEC 60870-5-104 communication working it is necessary to have corresponding certificate loaded in the controlling station so that the identity can be verified during the TLS handshake.

This certificate contains the public key and is signed by a trusted certificate authority of HU250.

Two-Way Authentication

In order to activate a two-way authentication for T300, follow the procedure described above for **One-way authentication**, but select **Two-way** in step 4.

In order to enable the two-way authentication, it is necessary to upload a new CA to the HU250. For more information on how to upload a new CA refer to Certificate Management, page 104.

ISaGRAF® Port Management

ISaGRAF® Port Overview

For security reason, the port used by **ISaGRAF®** workbench is always closed, by default, and when starting the application.

The port used to communicate with **ISaGRAF®** workbench is port number 1131.

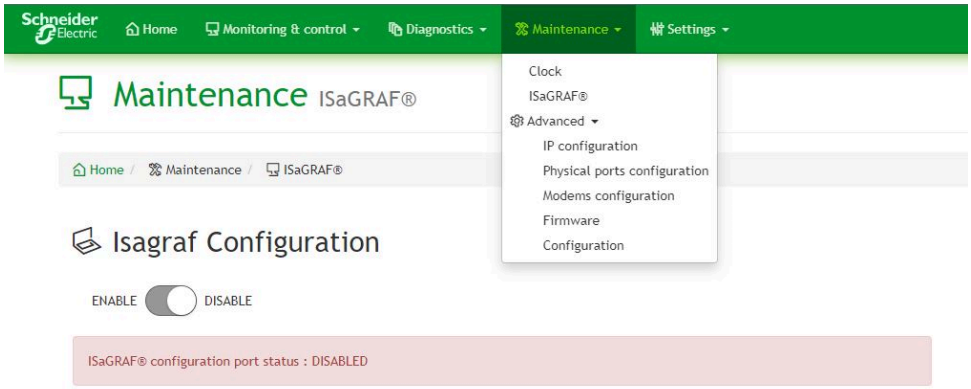
When required, this port can be enabled with user authentication.

If the port is enabled, it is automatically closed after a timeout of 60 seconds (time without any communication between **ISaGRAF®** workbench and the T300).

Enabling ISaGRAF® Port

With the required access right, the **ISaGRAF®** port can be enabled.

The **ISaGRAF** item in the **Maintenance** menu allows to enable the port.



This menu item is only available in the following conditions:

- the user has the required right/role: **Engineer** or **Installer**
- the installed configuration includes an **ISaGRAF®** component

To enable the **ISaGRAF®** port, select the **ENABLE** option.

To disable the **ISaGRAF®** port, select the **DISABLE** option.

> **NOTE:** The authorized user can force deactivation of the port even though there is communication between between **ISaGRAF®** workbench and the T300.

The status of this port is managed by the **PLC_ENABLE** supervision point. The **PLC_ENABLE** point is part of the status signals of CoreDB.

Every action on the **ISaGRAF®** Port, is logged in the system log.

Firmware Downgrade

Firmware Downgrade Context and Requirements

Downgrading the PowerLogic T300 firmware is an exceptional operation that can be used for example to replace the default software version installed in factory with an homologated software version.

This operation could be necessary for T300 version that have no longer USB port used for backup/restore operation for example.

A firmware downgrade happens when the version number of the software to be installed is less than the currently installed software, for example from 2.9.1 to 2.9.0.

This functionality is present from 2.9 software version of PowerLogic T300.

When a downgrade is performed, the current configuration is lost to help prevent a system malfunctioning.

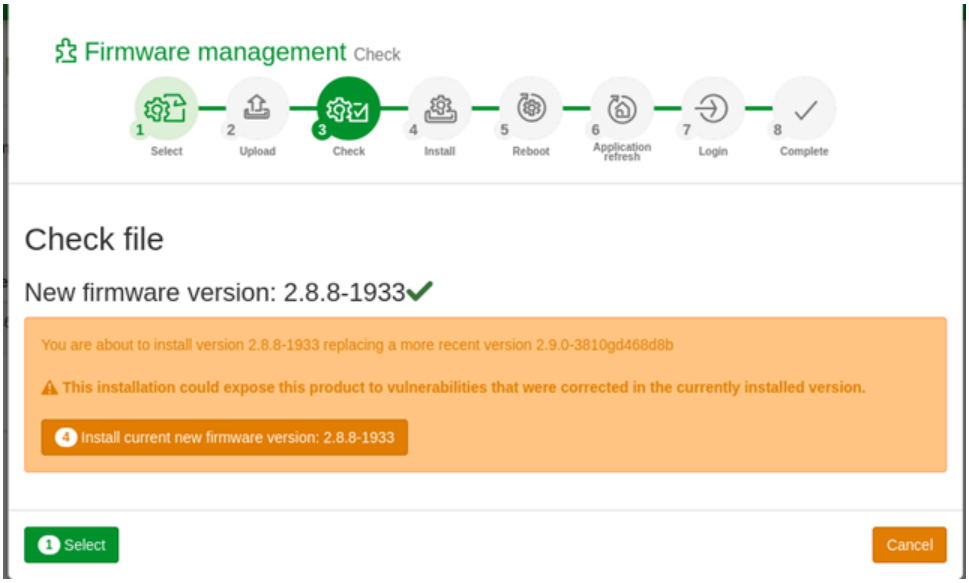
This functionality requires a specific RBAC version that is not installed if the software version has been previously upgraded from 2.9.x to 2.8 or 2.7. In this case, the required object included in CAE and security policy for 2.9 version, must be added.

This functionality is only available for users with SECADM role.

Downgrading the Software Version

Access via **Maintenance > Advanced > Firmware**

The system detects that the software version to install is lower than the current version. A message is displayed so that you can confirm the downgrade, or cancel it.



Click **Install current new firmware version: V.V.V-date** to continue the downgrade.

NOTE: When upgrading from 2.7 software version to 2.9, it is necessary to perform a Factory Default Restoration, page 115 prior to any configuration or use of the T300.

Factory Default Restoration

Context of a Default Factory Configuration Restoration

The restoration of the default factory configuration allows erase the configuration currently setup, as well as sensitive data (CAE configuration, certificates).

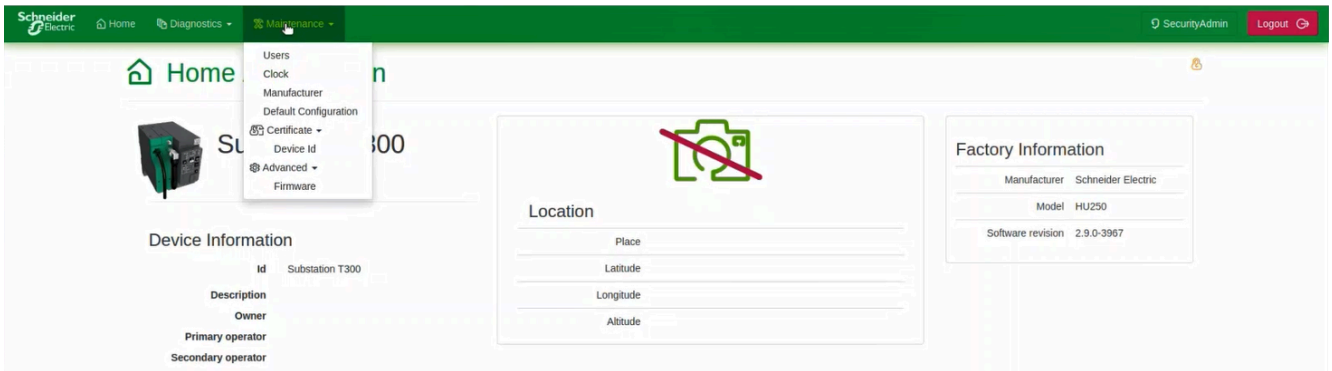
The restoration of the default factory configuration can be required in the following contexts:

- Cyber security requirements
- Decommissioning process
- Product end of life
- Instability issues
- Recovery purposes

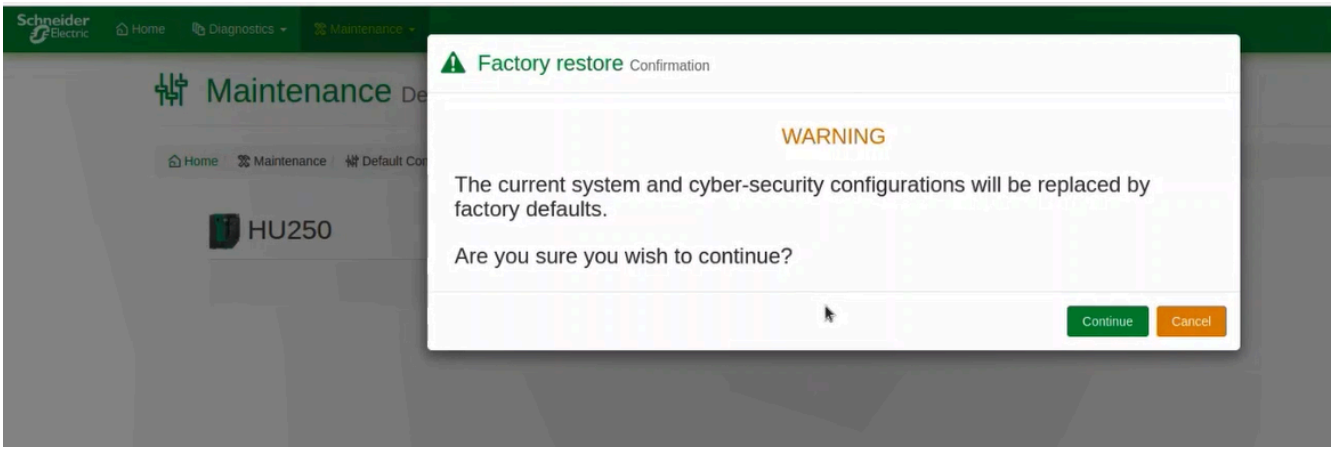
This functionality is available for users with SECADM role.

Running the Restoration Process

1. Log in with the SECADM profile.
2. Open the **Maintenance** menu and select **Default Configuration**.

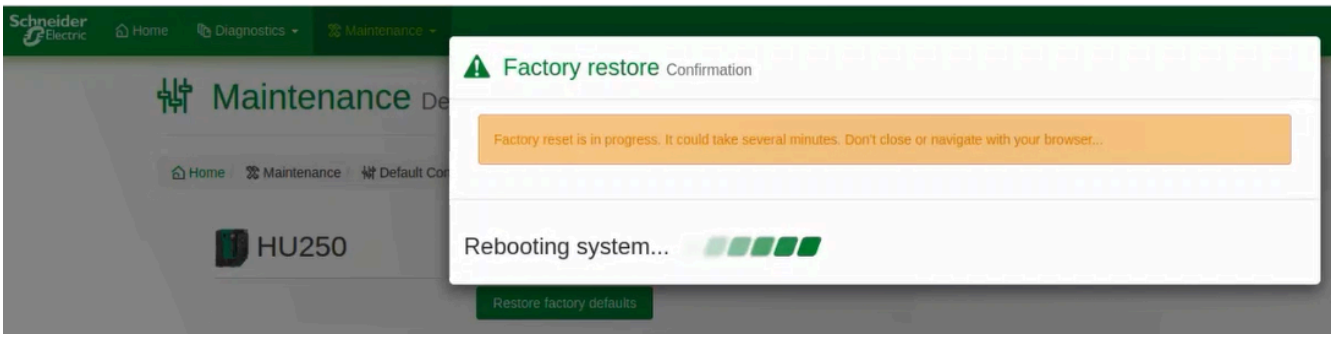


3. A warning message displays to check that you really want to restore the factory configuration. Click **Continue**.



.

4. The factory restoration process starts. The restoration process takes about three minutes.

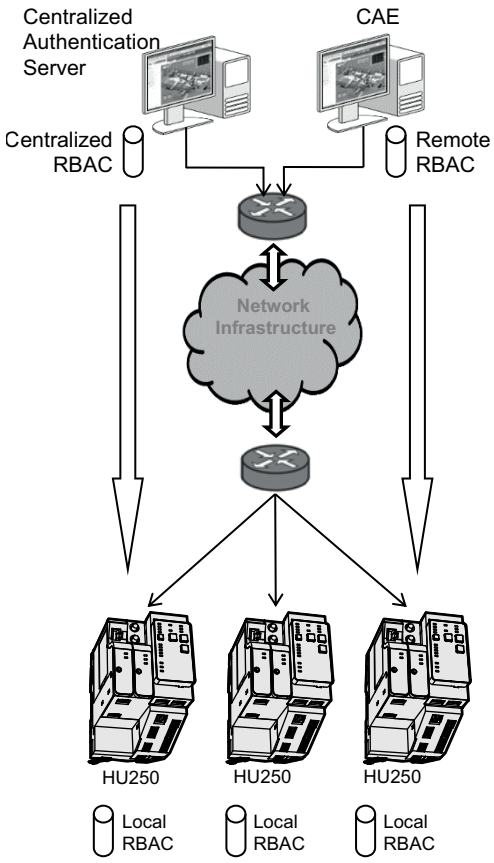


The restoration operation consists of the following steps:

a. Delete current configuration:
   (1) Delete current system configuration (modules).
   (2) Delete current cyber security policy.
   (3) Delete current RBAC configuration.
b. Restart the application.
c. Install factory default configuration:
   (1) Recover factory configuration.
   (2) Recover cyber security configuration and RBAC configuration.
   (3) Create certificates.

Centralized Authentication Protocols

Operating Principle



Centralized authentication provides the capability to use a centralized user database to authenticate users remotely and provide their RBAC Role on the local system (T300). This makes it possible to have a generalized and unique authentication policy on a dedicated server, rather than to define them locally on the various T300s of the network.

Network Infrastructure

Centralized authentication requires an architecture that includes T300s, a CAE server, and a centralized authentication server connected together via a remote network.

- The T300 includes the locally defined authentication policy in the unit. This policy is used in case of non-availability of centralized authentication.
- The CAE server includes the remote authentication policy. It includes all the individual authentications of each T300 on the same server. Rather than configuring it locally on each product, it may be useful to define it in one place on a dedicated server.
- The centralized authentication server includes the remote centralized authentication policy, enabling global authentication common to each T300.

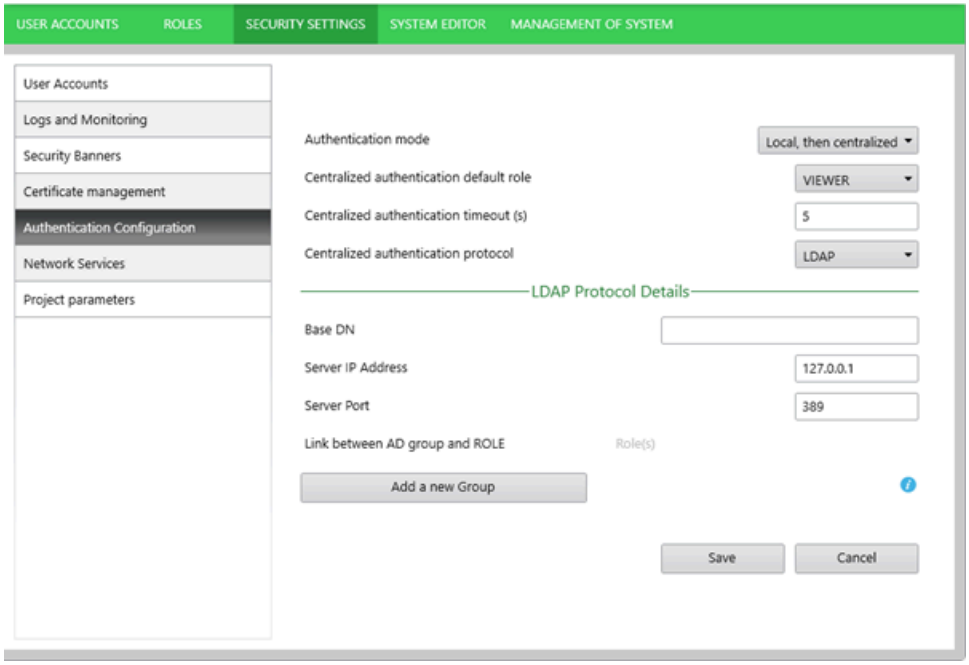
The exchange during an authentication between the centralized authentication server and the T300 depends on the authentication mode defined:

- Locally only (server not used)
- Locally then centralized, if the requested user is not locally found.
- Centralized then locally, if the requested user is not found in centralized.

The operating parameters of the authentication are configured in the CAE.

Common Authentication Configuration on the CAE

The common authentication parameters are defined in the CAE:



Name	Default	Description
Authentication mode	Local	Indicate the type of authentication used : 1. Local 2. Local then centralized 3. Centralized then local
Centralized authentication default role	VIEW-ER	Role assigned by default when the centralized access is used and that the role is not given by the centralized authentication protocol server. Available roles: • ENGINEER • INSTALLER • None • OPERATOR • RBACMNT • SECADM • SECAUD • VIEWER
Centralized authentication timeout (s)	5	Maximum time for which an authentication response is expected from each centralized authentication protocol server.
Centralized authentication protocol	LDAPS	This field is enabled when the Authentication mode is other than **Local**. Defines the current protocol used to reach a centralized authentication protocol server. 1. Centralized authentication protocol 2. LDAPS **NOTE:** If the centralized authentication protocol RADIUS or LDAPS is selected, then the administrator needs to fill up the **Protocol Details** section.

Remote Authentication Dial-In User Service (RADIUS) Server

RADIUS server is part of the network infrastructure in which HU250 (T300) device is connected to. It provides the centralized database of users and contains:

- **The dictionary:** definition of the list of attributes of user records.
- **User records:** list of the users, respecting the attributes specified in the dictionary.

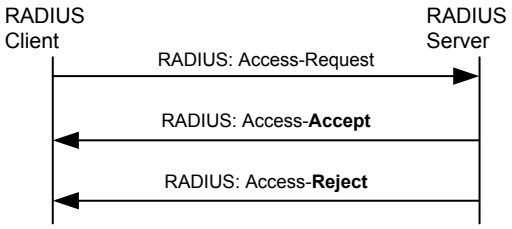
User attributes are provided to the RADIUS client once the user is authenticated.

Hence RADIUS server provides to HU250 device the following information related to the authenticated user:

- RBAC Roles
- Expiration date.

NOTE: The RADIUS client for the HU250 is not activated by default. It can be enabled through CAE.

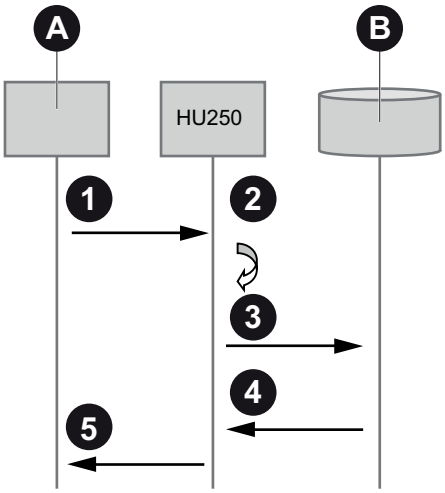
RADIUS Protocol



RADIUS has several authentication schemes.
The T300 implements RADIUS client with PAP scheme (EAP scheme is not supported for the moment).
In RADIUS PAP scheme, the client sends an Access request, and the server replies with Access Accept, or Access Reject.

The exchange uses UDP, on a configurable port (by default 1812).
In order to help secure exchanges between client and server (authentication of both parts, and ciphering of some part of the information), RADIUS uses a shared key mechanism. This shared secret is pushed using CAE to each HU250 configured to use this server.

RADIUS Remote Authentication Principle



A. User (Web server)

B. RADIUS

During an authentication request from a user connected to the Web server (or wishing to access the T300 via SSH), the procedure is as follows (example of a **Local then centralized** authentication mode):

1. The Web server requests an authentication test from the HU250.
2. The HU250 first checks if this user is present in the local user database.
3. If so, authentication is accepted. Otherwise, remote authentication is requested from the RADIUS server.
4. The RADIUS server responds to the HU250 request.
5. The HU250 responds to the user with an approval or a refusal depending on whether the user is recognized by the RADIUS server.

CAE RADIUS Authentification Configuration via the CAE

The CAE also allows you to define the configuration parameters of the RADIUS client in the HU250:

Name	Default	Description
Mode	**RADIUS_CLEAN**	Communication mode of the RADIUS client: • RADIUS_CLEAN • EAP-TTLS is not supported
IP address		The IP address of the RADIUS Server.
Port	**1812**	Port number used by the RADIUS Server to establish the communication with the Security Application.
Shared Secret		Text string that serves as a password between the RADIUS client and the RADIUS server.
Backup server IP address		IP address of the second server, used as backup (this field is optional).
Backup server port	**0**	Port number of the second server, used as backup (this field is optional).
Backup server shared secret		Text string that serves as a password between the RADIUS client and the second RADIUS server, used as backup (this field is optional).
Role attribute name		The role attribute name configured in the RADIUS server used.
AoR attribute name		Name of the AoR (Area Of Responsability) attribute in the RADIUS protocol accepted answer where the AoR assignment is stored..
Date attribute name		Name of the attribute in the RADIUS protocol accepted answer where the date assignment is stored.
Attributes separator		Character that splits the attributes in case of several attributes returned.
Dictionary		Long string storing contents of RADIUS dictionary.
Parsing debug	**Off**	ON/OFF for enable/disable parsing debug. If ON, it enables the generation of logs containing the response of external authentication server, for role list and AoR list.

The RADIUS server has a specific configuration as explained in the current chapter. HU250 device must know this configuration in order to be able to communicate with it.

This configuration is divided in 2 categories:

- **Networking information:** IP address, port, Shared Secret.
- **Protocol parameters:**
  - The structure of the user database: the dictionary.
  - The name of the attribute related to Role and Date in this dictionary, so that the client can extract them from the Access-Accept response.
  - The attributes separator in case an attribute contains a list of values (eg: multiple roles).

Example of RADIUS Server Use

This chapter describes a nominal use case with:

- Default CAE users that are pushed to HU250. Those users act as "recovery" users if network connection to the RADIUS server is not operational.
- Configured RADIUS server. Remote users in this server can connect to HU250 device.

The following use case is a suggestion of configuration and must be adapted to the network infrastructure. It assumes a network infrastructure including the following characteristics:

- Network: 192.168.1.0/24
- RADIUS server address: 192.168.1.84
- HU250 connected with WAN port to this network with following IP addresses: 192.168.1.10, 192.168.1.11…

RADIUS Server Configuration

The configuration detailed hereafter is provided as a minimal setup for evaluation purpose. For more information about configuring the RADIUS server, please refer to the Freeradius server documentation at the following Web address: http://freeradius.org/doc/.

Prerequisite

Host or VM running Ubuntu server 16.04 LTS

Configuration

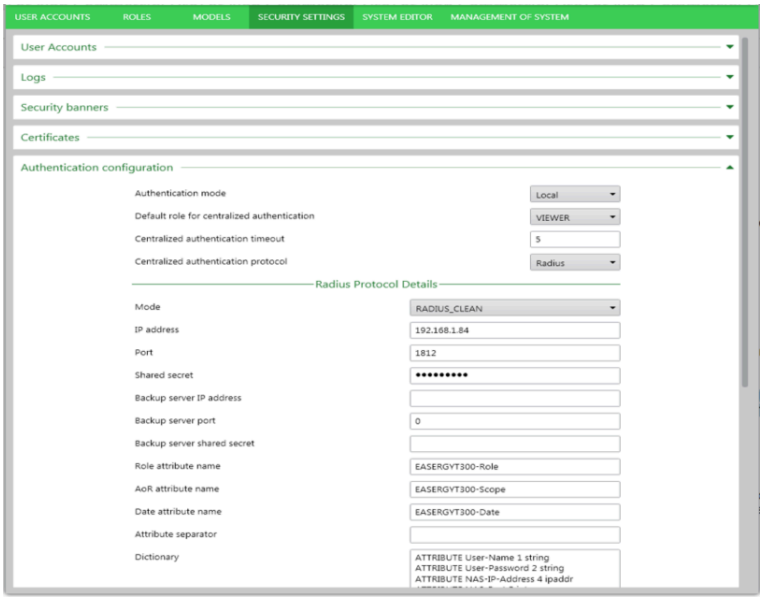
1. Install the RADIUS service using the following command:
```
# sudo apt-get install freeradius freeradius-utils
```
2. Replace the content of file **/etc/freeradius/client**.conf with:
```
client 192.168.1.0/24 {
secret = testing123
shortname = private-network-1
}
```
3. Replace the content of **/etc/freeradius/dictionary** with:
```
$INCLUDE /usr/share/freeradius/dictionary
# POWERLOGICT300 dictionary
VENDOR POWERLOGICT300 12345
BEGIN-VENDOR POWERLOGICT300
ATTRIBUTE POWERLOGICT300-Role 1 string
ATTRIBUTE POWERLOGICT300-Scope 2 string
ATTRIBUTE POWERLOGICT300-Date 3 date
END-VENDOR POWERLOGICT300
```
4. Add users in **/etc/freeradius/users**, as follows:
```
John Cleartext-Password := "John1!"
POWERLOGICT300-Role = "INSTALLER"
POWERLOGICT300-Scope = "France"
POWERLOGICT300-Date = 1577836800
Alice Cleartext-Password := "Alice1!"
POWERLOGICT300-Role = "ENGINEER"
POWERLOGICT300-Scope = "Spain"
POWERLOGICT300-Date = 1577836800
```

Cyber Security Configuration in CAE

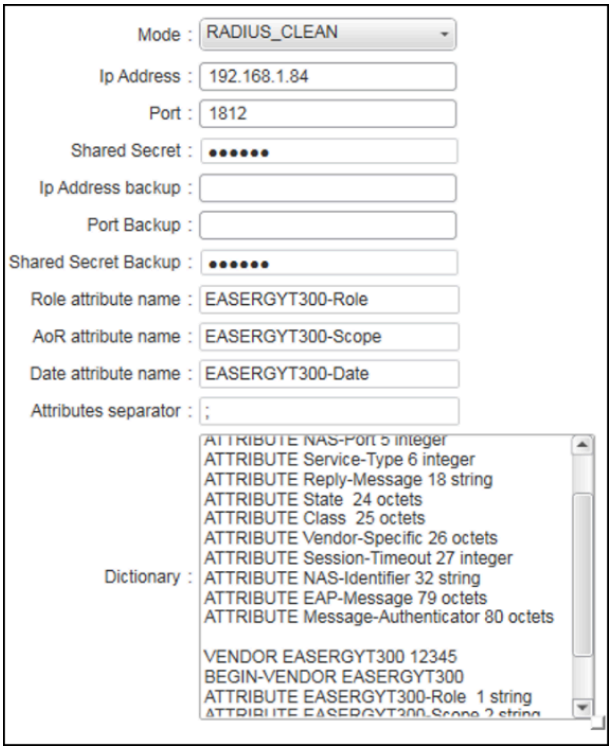
Start the CAE, select the “SECURITY SETTINGS” tab, then open Authentication configuration area by clicking on the green arrow. Configure the parameters as follow (see screenshot here after):

- **Authentication mode:** Local then Centralized
- **Default role for centralized authentication:** VIEWER
- **Centralized authentication protocol:** RADIUS

Click **Ok** to take into account the setting.



Example of RADIUS settings



Go to the "RADIUS" menu: in “Security Configuration” horizontal tab and “Authentication configuration” vertical tab, open the “RADIUS” horizontal tab and configure the following values (see screenshot RADIUS beside):

- **Mode:** RADIUS_CLEAN
- **IP Address:** 192.168.1.84
- **Port:** 1812
- **Shared Secret:** testing123
- **Role attribute name:** POWERLOGICT300-Role
- **AoR attribute name:** POWERLOGICT300-Scope
- **Date attribute name:** POWERLOGICT300-Date
- **Attribute separator:**

- **Dictionary:**

  ATTRIBUTE User-Name 1 string
  ATTRIBUTE User-Password 2 string
  ATTRIBUTE NAS-IP-Address 4 ipaddr
  ATTRIBUTE NAS-Port 5 integer
  ATTRIBUTE Service-Type 6 integer
  ATTRIBUTE Reply-Message 18 string
  ATTRIBUTE State 24 octets
  ATTRIBUTE Class 25 octets
  ATTRIBUTE Vendor-Specific 26 octets
  ATTRIBUTE Session-Timeout 27 integer
  ATTRIBUTE NAS-Identifier 32 string
  ATTRIBUTE EAP-Message 79 octets
  ATTRIBUTE Message-Authenticator 80 octets
  VENDOR POWERLOGICT300 12345
  BEGIN-VENDOR POWERLOGICT300
  ATTRIBUTE POWERLOGICT300-Role 1 string
  ATTRIBUTE POWERLOGICT300-Scope 2 string
  ATTRIBUTE POWERLOGICT300-Date 3 date
  END-VENDOR POWERLOGICT300

Click **Ok** to take into account the setting.

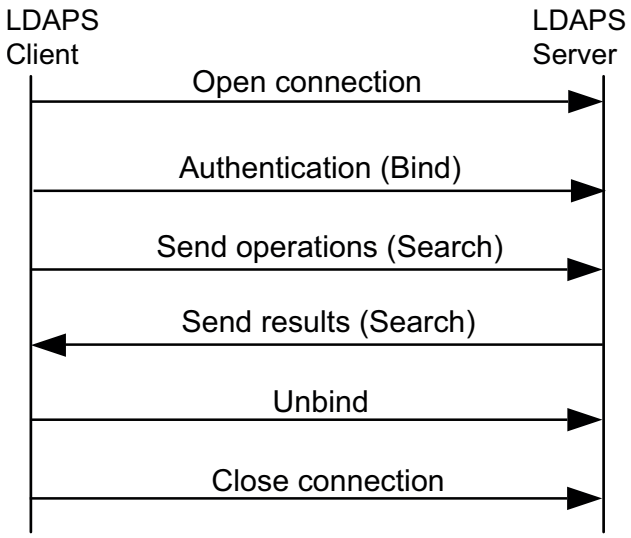
NOTE: A minimal list of “ATTRIBUTE”s must be added in order for the CAE to understand the dictionary. The list of attributes above the “VENDOR” shall simply be copied “as is” in CAE “Dictionary” field.

Lightweight Directory Access Protocol (LDAPS) Server

LDAPS Protocol

LDAPS authentication offers a standardized method for centralized user management and access control. Users provide their credentials, which are checked against stored directory data through a more secure connection. Successful authentication enables access to resources, while unsuccessful attempts are denied. This approach helps ensure a more efficient, secure, and scalable user authentication across diverse systems and applications in enterprise environments.

LDAPS Remote Authentication Principle



LDAPS authentication includes following steps:

1. User Initialization: the authentication process begins when a user attempts to access the T300 by providing their credentials.
2. LDAPS Client Communication: HU250 acting as an LDAPS client initiates a connection to the LDAPS server using the LDAPS protocol.

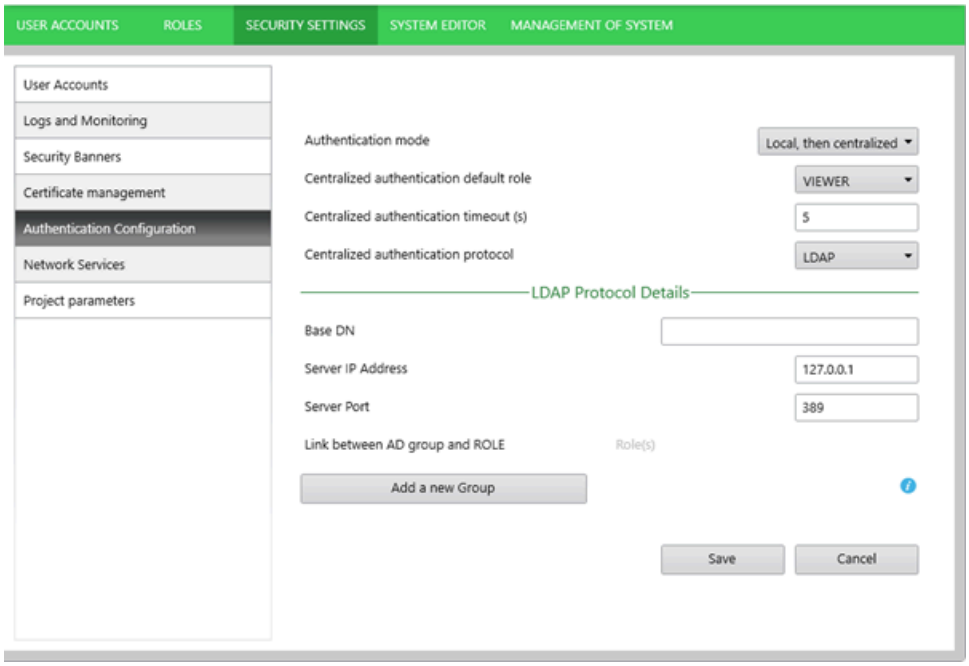
3. Binding: once connected, the LDAPS client sends a "bind" request to the server. The bind request includes the user's provided credentials (username and password). The server then attempts to match these credentials against the stored data in its directory.
4. Authentication Process: LDAPS server verifies the user's credentials by searching its directory for a matching user entry.

   If the username and password match the stored information, the server generates a successful authentication response.

   Otherwise, if the credentials are invalid, the server responds with an authentication failure.
5. Access Decision: T300 receives the authentication response from the server. If the response is positive (authentication successful), the client can proceed to grant the user access.
6. Unbind: the user's session remains active until he logs out, the session times out due to inactivity, or the user explicitly terminates the session. When the session ends, the user needs to re-authenticate when attempting to access resources again.

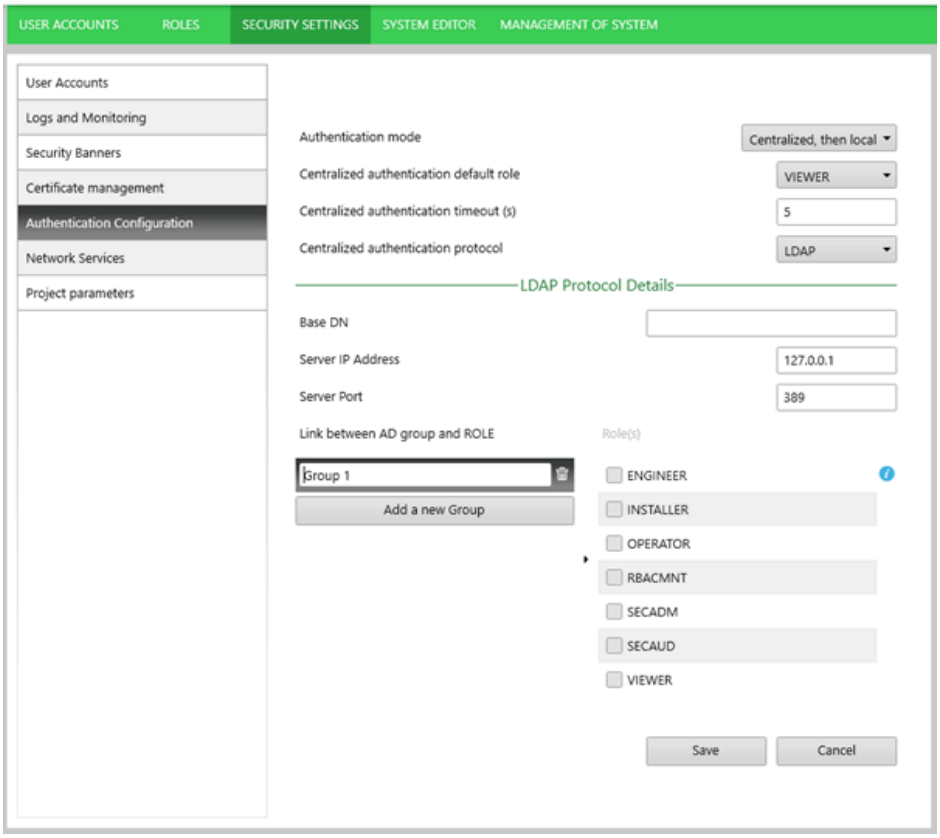
CAE LDAPS Authentication Configuration via CAE

CAE also allows you to define the configuration parameters of the LDAPS client in the HU250:



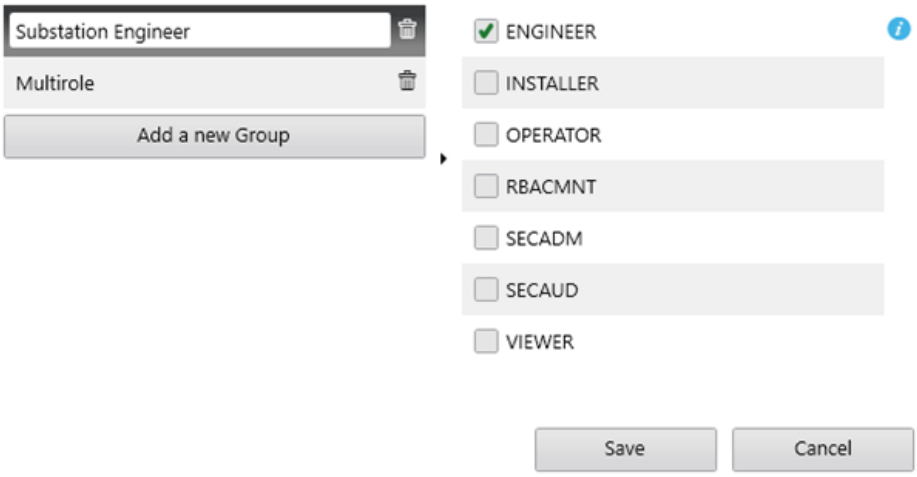
Name	Default	Description
Base DN		Domain name of the LDAPS server. It defines the base distinguished name (DN) used when searching for users, for example: DN=MyDomain, DC=com.
Server IP address		Server IP address of the domain controller expressed in the classic way of IP address: aaa.bbb.ccc.ddd
Server Port	389	Listening port of the domain controller. It is used by the LDAPS server to establish the communication with the Security Application: • TCP and UDP port 389 • TCP and UDP port 636 for LDAPS (LDAPS over TLS)
Link between AD group and ROLE		Configurable menu that enables link between LDAPS groups and RBAC roles of T300.

In order to add a group click on the **Add a new Group** button. An additional menu appears as shown below:

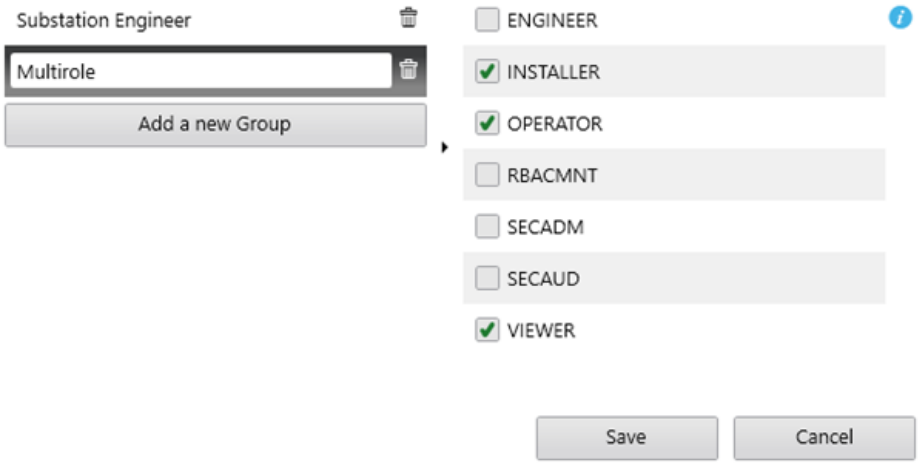


The LDAPS groups determine which group corresponds to RBAC role. Below is an example of two customized created groups:

Substation Engineer:



Multirole:



HU250 Cybersecurity Configuration Update via CAE

NOTICE

HAZARD OF UNINTENDED OPERATION

Remove undesired devices because the cybersecurity configuration update applies to all PowerLogic T300 in the list.

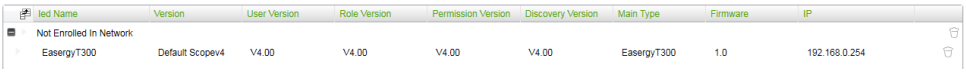
Failure to follow these instructions can result in equipment damage.

To remove the undesired devices:

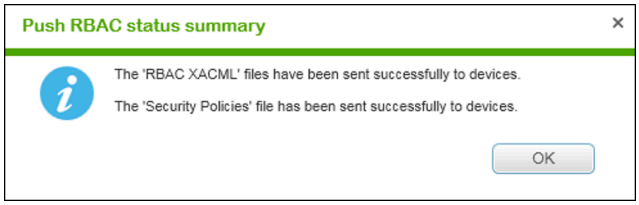
1. Open the list.
2. Remove the undesired devices by using the trash icon on the right.

Once the configuration has been made in CAE, this one must be loaded into the HU250 modules. To do this, do the following:

- Click on the green arrow at the top left of the page, then open the **Network Device List** tab
- Press the **Refresh** button on the bottom left
- Check that the PowerLogic T300 you want to configure is visible
- Press the **Send to all** button on the bottom right to send the configuration to all the T300.



Finally, CAE indicates successful operation:



HU250 User Login Sequence

Once the centralized authentication server is configured and cyber security configuration has been pushed accordingly to HU250 devices, authentication is ready to be tested.

Authentification Sequence

Testing can be done by connecting with one of the users defined in the centralized authentication server:

- Via an access to the T300 Web server
- Via a SSH connexion: access via Easergy Builder by a user with **Engineer** role.

Security Functionality Verification

NOTICE

HAZARD OF MISSING VERIFICATIONS

- When cybersecurity functionalities have been configured, verify that the functions listed below are working as intended.
- Repeat these verifications after firmware update or security policy update.

Failure to follow these instructions can result in equipment damage.

- Verify that the RBAC function helps prevent the user to perform actions for which he does not have priviledge.
- Verify that the security event logs (for cybersecurity advanced only) are properly generated locally in HU250, and that the remote Syslog server (if configured) keeps records of them.
- Verify that disabled logical and physical ports can no longer be accessed.

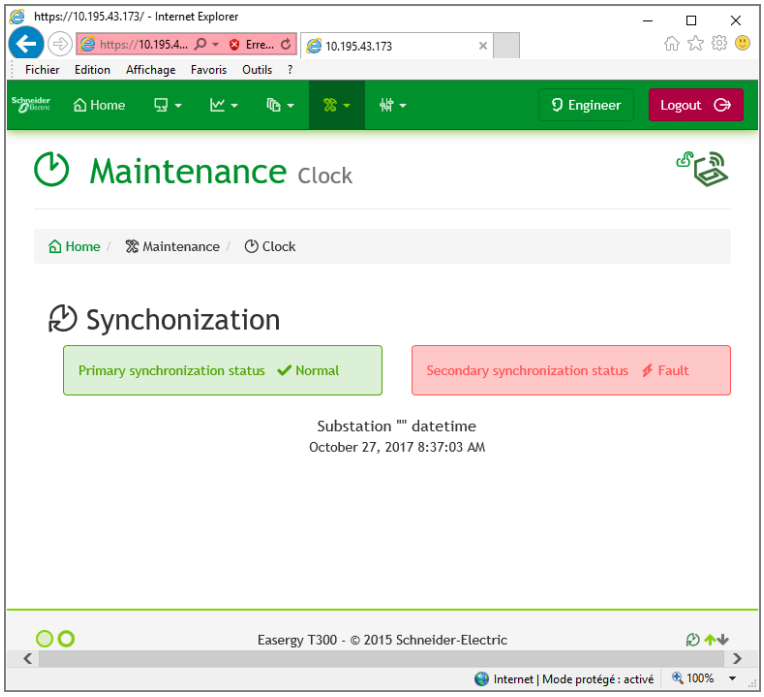
Device Synchronization

What's in This Chapter

Clock Page 128

Clock Page

Access via **Maintenance > Clock** page.



There are three ways to automatically synchronize the T300:

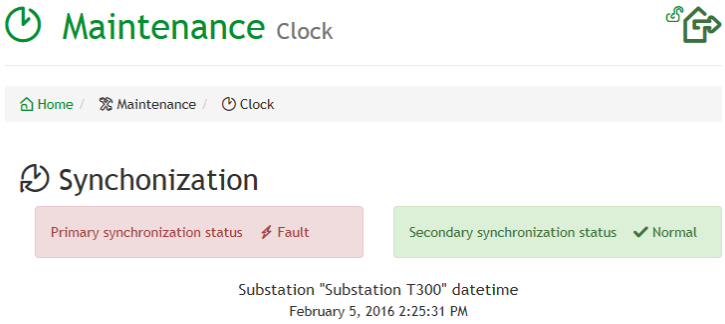
- Via the communication protocol (SCADA)
- Via an SNTP server, if the T300 is connected to an IP network
- By satellites, if the HU250 module includes a 4G modem with GPS option

Two synchronization channels can be defined using either of the synchronization modes above: the primary device and the secondary device.
The secondary device is automatically used if the primary device is unavailable.

The synchronization modes are configured in the **Settings > HU250 > Synchronization** page in the Web server. Refer to the corresponding parameter setting, page 192 section for more details.

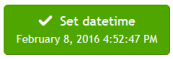
Automatic Synchronization

The **Clock** page displays the general status of both the primary and the secondary device (synchronization active or lost), which allows the user to determine the device synchronization status:



As soon as one of the synchronization modes becomes active, the equipment is automatically synchronized via the active device.

If no synchronization device is active, synchronization can be performed automatically via the PC date and time.

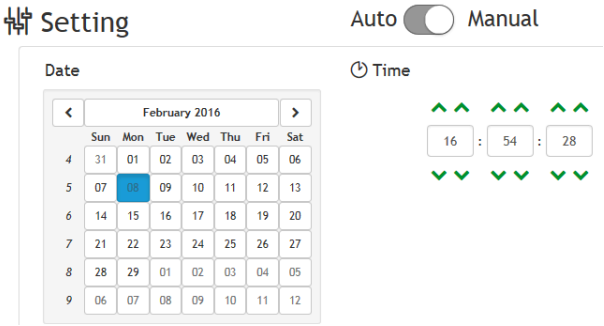
The **Set datetime** 

button then appears on the page, which performs an immediate synchronization as soon as it is clicked.

Manual Synchronization

If no synchronization device is active and the **Manual** option is selected by clicking the corresponding button,

, the system allows the date and time to be entered manually via the following interface on the **Clock** page:



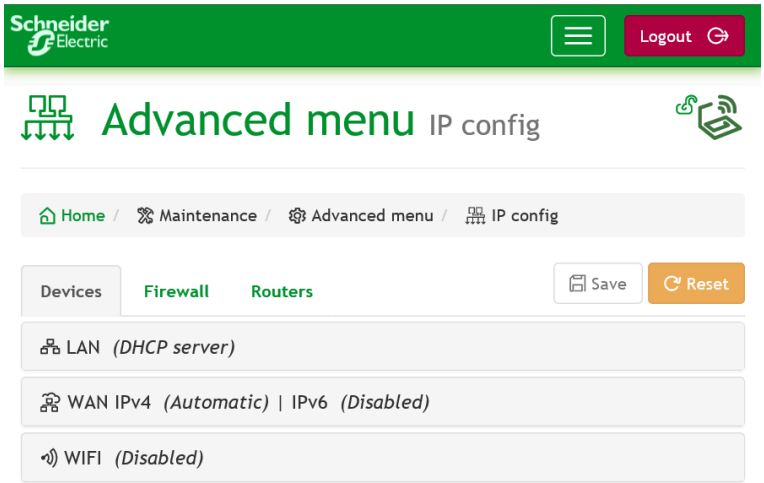
IP Interfaces

What's in This Chapter

IP Configuration Page..... 130

IP Configuration Page

Access via **Maintenance > IP configuration** page.



IP Configuration Prerequisites

- The configuration of the IP interfaces requires a good knowledge in TCP network management, to avoid losing the access to the equipment.
- Do not use Subnet masks : 255.255.255.255, as it is filtering all the IP addresses and no communication is possible with this mask.
- Do not set WAN and LAN in the same network range.
- Set up the routers carefully: "subnet IP" should be different from the local network range.

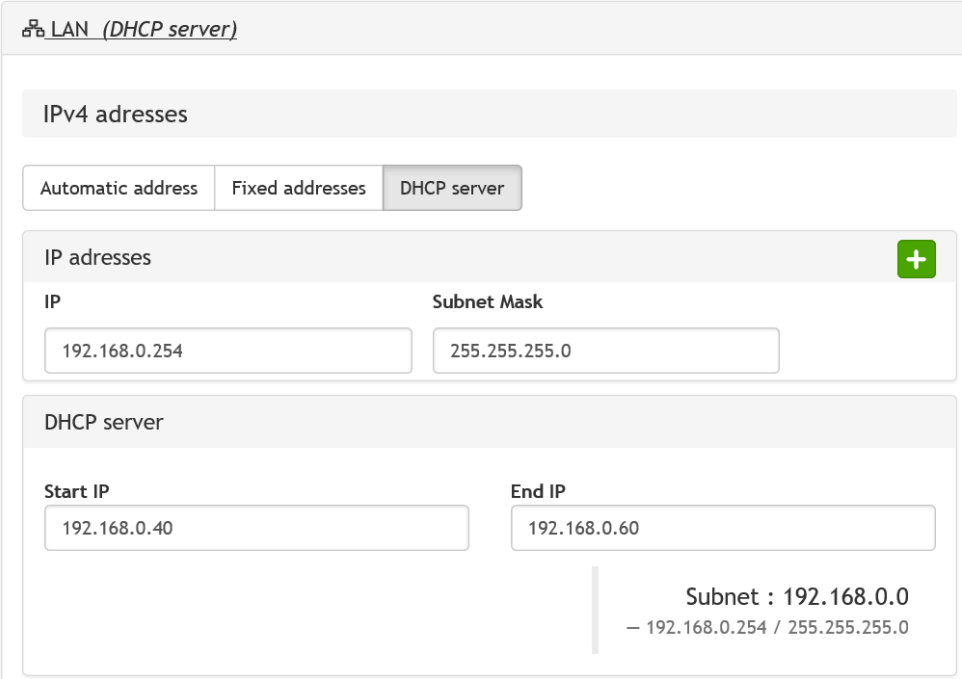
Devices

This page is used to set the parameters of the various T300 IP connection interfaces:

LAN

The LAN is the T300 internal local area network.
It corresponds to the IP network for internal communication between the T300 modules. It is also possible to connect to this LAN via a PC to establish an Ethernet connection to the equipment.

Setting the LAN parameters

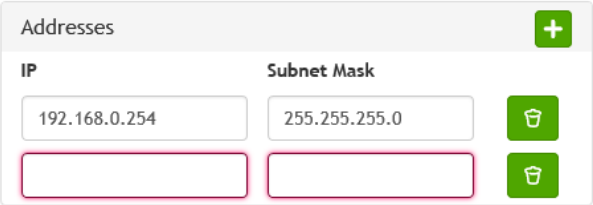


Three levels of setting are defined by the buttons **Automatic Address**, **Fixed addresses**, and **DHCP server**.

The settings corresponding to these levels are detailed below:

Parameter	Default	Description
Automatic address		
-	-	No parameters to configure. The address is assigned automatically by the DHCP router of the external network on which all the T300 modules are connected on the LAN. The IP address may change with each connection.
Fixed addresses		
IP	192.168.0.254	Fixed IP address defined for a host connexion to the LAN. It is recommended that this default IP address is not modified since any change may affect internal communication between the T300 modules. Additional host IP addresses and associated subnet masks can be added by clicking on the **+** button
Subnet Mask	255.255.255.0	Subnet mask linked to an IP address to define the range of IP address allowed on this subnet and thus to establish an access restriction for the hosts. Used to define the usable IP address range on this subnet and limit the possible number of hosts.
DHCP server		
Start IP	192.168.0.40	Enabling the DHCP function allows to automatically assign an IP address to a device connecting to this network according to the range of available addresses here after. Start address for the DHCP function.
End IP	192.168.0.60	End address for the DHCP function. The available address range for the DHCP function is the range between the start address and the end address.

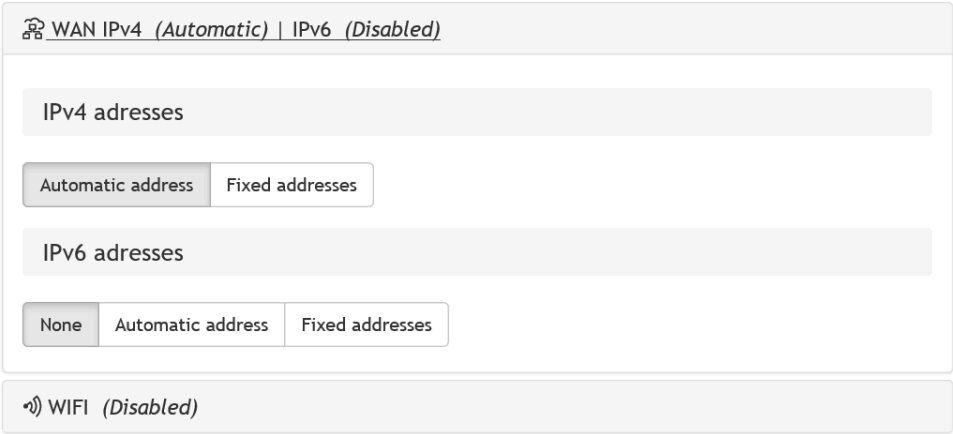
Adding an additional IP address by clicking on the **+** button



WAN

The WAN is the remote IP communication network for access via an external modem or router accessible, for example, via a SCADA system.

Setting the WAN parameters:



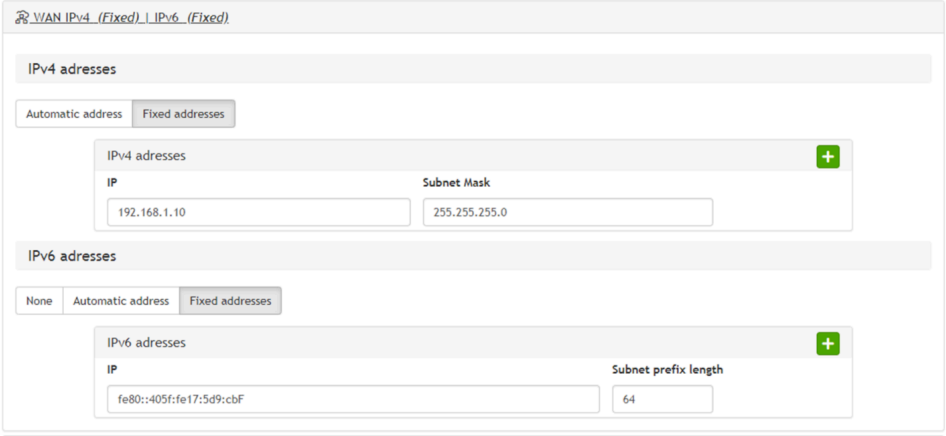
Two levels of setting are defined by the buttons **Automatic Address** and **Fixed addresses**.

The settings corresponding to these levels are detailed below:

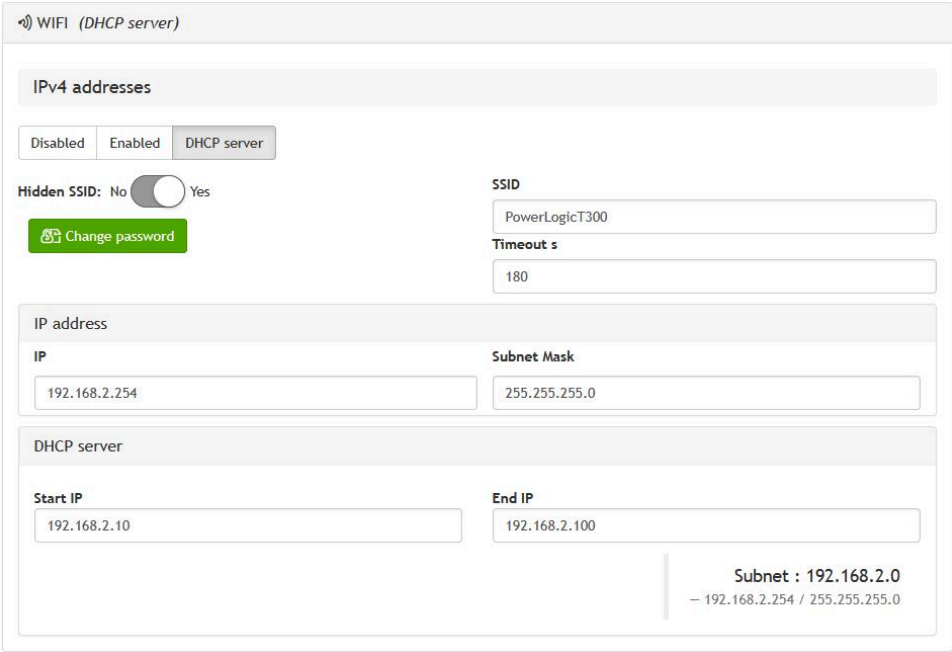
Parameter	Default	Description
Automatic address		
-	-	No parameters to configure. The address is assigned automatically by the DHCP router of the external network on the T300 is connected. The IP address may change with each connection.
Fixed addresses		
IP	192.168.1.10	Fixed IP address defined for accessing the WAN. This address should theoretically be modified and configured according to the static IP address to be used for the remote network. Other fixed IP addresses can be added by clicking on the **+** button.
Subnet Mask	255.255.255.0	Subnet mask linked to an IP address to define the range of IP address allowed on this subnet and thus to establish an access restriction for the hosts.

WAN also supports IPv6.

Parameter	Default	Description
Automatic address		
Automatic ID	Yes	Automatic addressing means the high part of the address is provided by a router. The low part of the address (Interface ID) can either be provided by the HU250 based on the MAC address, or defined manually.
Fixed addresses		
IP	Fe80::405:fe17:5d9:cbF	Fixed IP address defined for accessing the WAN. This address should theoretically be modified and configured according to the static IP address to be used for the remote network. Other fixed IP addresses can be added by clicking on the **+** button.
Subnet prefix length	-	64



Wi-Fi Network



The Wi-Fi network is the dedicated local connection for connecting to the equipment from a PC, smartphone, or a tablet, for operation, maintenance, or configuration purposes.

Three levels of setting are defined by the buttons **Disabled**, **Enabled** and **DHCP server**.

The settings corresponding to these levels are detailed below:

Parameter	Default	Description
		Disabled
-	-	No parameters to configure. The Wi-Fi is not activated. The user must activate this Wi-Fi connection manually for the first time, since by default the Wi-Fi connection is deactivated.

Parameter	Default	Description
		Enabled
Hidden SSID	No	The SSID is visible by default. Hiding it means that the T300 is invisible on the Wi-Fi network, which helps to secure access. In effect, the Wi-Fi access parameters are saved the first time they are defined on a PC, and only that PC can then connect automatically.
SSID	PowerLogic T300	Custom name used to identify the Wi-Fi network. It is essential that a single, unique SSID is configured for each T300 to help prevent conflicts and enhance network security.
Timeout s	180	Time of inactivity on the Wi-Fi network resulting in automatic disconnection of Wi-Fi link. This automatic Wi-Fi disconnection only works if it has been previously activated by the **WIFI ON/OFF**

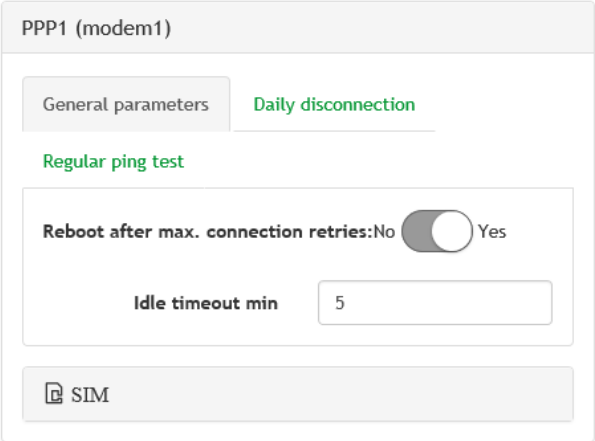
Parameter	Default	Description
		command of the **Monitoring/Data/Command** page. This disconnexion is not valid for an activation by the Local button on the front panel of the HU250.
IP	192.168.2.254	IP address defined for accessing the Wi-Fi network. In theory there is no need to modify this address unless there is an incompatibility issue with an IP gateway or router.
Subnet Mask	255.255.255.0	Subnet mask linked to an IP address to define the range of IP address allowed on this subnet and thus to establish an access restriction for the hosts.

Parameter	Default	Description
DHCP server		
Start IP	192.168.2.10	DHCP function enabled allows to automatically assign an IP address to a device connecting to this network according to the range of available addresses. Start address for the DHCP function.
End IP	192.168.2.100	End address for the DHCP function. The available address range for the DHCP function is the range between the start address and the end address.

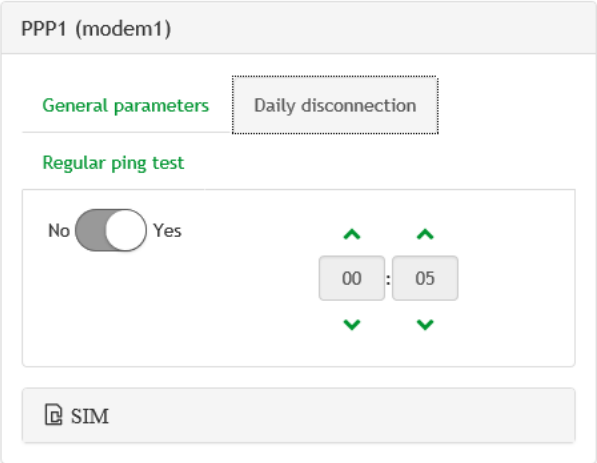
PPP Link

The PPP (Point-to-Point Protocol) is a remote link that requires a 4G modem on the T300 capable of establishing an IP connection between the T300 and a remote device.

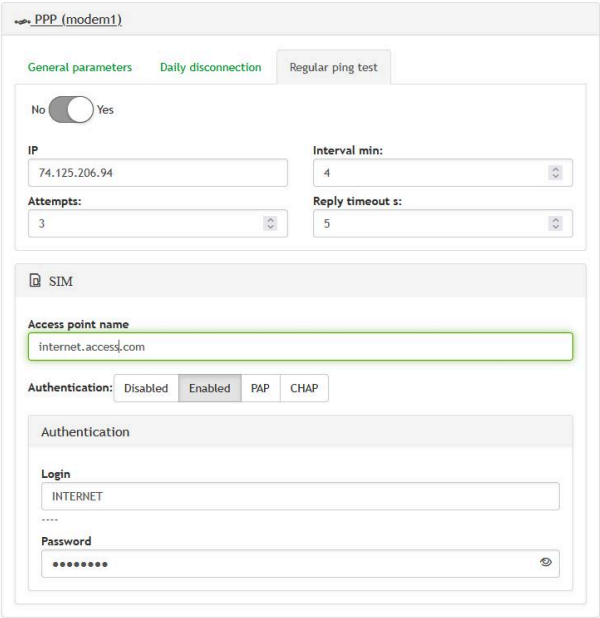
The parameter settings of this network are as follows:



Parameter	Default	Description
General parameters		
Reboot after max. connection retries	Yes	Enabling this option reinitializes the modem after a maximum number of attempts have been made to connect to the mobile network. Rebooting the modem re-establishes the network connection. It is recommended that this option is enabled to enhance operational reliability.
Idle timeout	5 min	Setting for the time delay after which the modem disconnects from the mobile network if no IP data flow is detected by the T300. Can be configured between 1 and 60 minutes.



Parameter	Default	Description
Daily disconnection		
Daily disconnection	Yes	Forced disconnection of the 4G modem every day at a set time. This allows reconnection to the mobile network immediately afterward.
Time	00:00	Time setting for the daily disconnection. This option should only be set if the **Daily disconnection** option is enabled.



Parameter	Default	Description
Regular ping test		
Regular ping test	Yes	Enables the ping test to run at a fixed interval according to the delay configured in the Interval parameter.
IP	-	IP address to which the data packet corresponding to the ping will be sent. Set an IP address for a known website or server, or even the SCADA system provided that this has a known static IP address. The configured address must correspond to a standard-format IP address.
Interval	4 min	Time delay between 2 successive ping tests. Can be configured between 1 and 360 minutes.
Attempts	3	Maximum number of attempts to run the ping test if no response is received from the remote IP address. Can be configured from 1 to 10.
Reply timeout	5 sec	Maximum delay to wait for a response during the ping test before declaring a detected potential test issue. Can be configured from 1 to 360 seconds.

Parameter	Default	Description
SIM		
Access point name	-	Name of the access point for connection to the mobile network. This name is given by the network operator.
Authentication	Disabled	Some mobile networks require authentication when establishing a connection. In this case, this option needs to be enabled. The encryption protocols authorized are: PAP or CHAP. If **Enabled**is selected, the default encryption protocol is PAP. If PAP is not accepted, it switches to CHAP. If **PAP** or **CHAP** is selected, the chosen protocol is used. Set to **Disabled** by default.
Login	-	Login for authentication for connection to the mobile network. Only to be filled in if the **Authentication** option is enabled.
Password	-	Password for authentication for connection to the mobile network. Only to be filled in if the **Authentication** option is enabled.

Operating Principle of the Regular Ping Test

In certain circumstances the SCADA system may no longer be capable of establishing communication with the T300 by means of a protocol even though the mobile network and the T300 are still operational.

The T300 therefore continuously monitors the IP data packet flow reaching it via the mobile network. A 5 minute Idle timeout delay automatically disconnects the modem from the mobile network if no IP data flow reaches the T300. After disconnection, the modem is rebooted, making the T300 unavailable for 1 minute, which is the time needed to reconnect the modem to the mobile network.

To help avoid this inconvenience of automatic disconnection and temporary unavailability, the regular ping test is used to test the connection to the mobile network. This helps prevent disconnection of the T300 when the problem is related to the SCADA system only and not the network. In other words, if the T300 is still connected to the mobile network, there is no reason to disconnect it because of a non-existent IP protocol flow.

As soon as the ping address has been configured in the **IP** field on the Regular ping test page, the T300 will try every 4 minutes (**Interval** setting) to send a ping to the specified IP address (note that this **Interval** must be less than the **Idle timeout**). An IP data flow will therefore return to the T300 so that it does not disconnect from the network.

If the result of the ping test is satisfactory, the T300 will remain connected to the network as it knows that it is available. The T300 will then do nothing in particular until the next ping test after the next 4 minutes has elapsed.

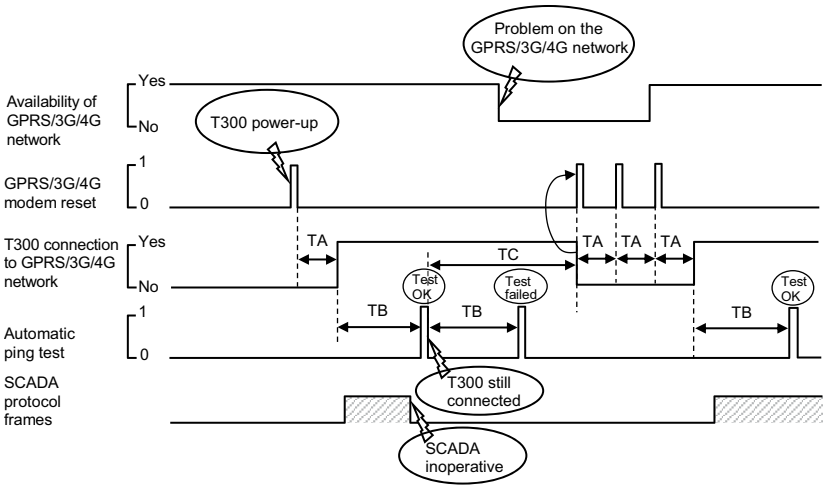
If the result of the ping test is unsatisfactory and the T300 has detected no IP data flow for 5 minutes (**Idle timeout** setting), the T300 will automatically disconnect from the network (to reset the modem), then try again (after the modem has rebooted) to reconnect to the network.

If the network is still not available, the T300 will send another request to the modem to reinitialize immediately, and will do so indefinitely until the network is finally detected.

This phase of rebooting and reconnection to the network requires approximately 1 minute for the modem (see diagram below).

NOTE: The regular ping test method is preferable to the "Daily disconnection" method because, for the regular ping test, network disconnection only lasts a maximum of 5 minutes.

NOTE: The regular ping test sends the smallest possible number of data packets (equivalent to 0 byte) to the specified IP address to help avoid the extra cost of an IP data flow transfer.



TA = Modem initialization time + connection to mobile network (approximately 1 minute)
TB = Ping test period (4 minutes)
TC = Modem reset time (= 5 minutes) if IP data flow non-existent on the T300

Modem Connection Status

It is possible to check the connection status of the 4G modem by the flashing of the LED on the front of the modem:

- **LED flickering slowly (200 ms ON/1800 ms OFF):** The modem is searching for a network.
- **LED flickering slowly (1800 ms ON/200 ms OFF):** The modem is idle.
- **LED flickering slowly (125 ms ON/125 ms OFF):** The modem is transferring data.
- **LED ON:** A voice is calling.

Firewall

This page is used to set the firewall parameters.

For each network interface (LAN, WAN, Wi-Fi, PPP), the firewall can be configured on the HU250 regarding:

- Dropped ports (to block TCP ports)
- A blocklist of IP addresses (IP addresses not authorized to access the HU250. Any try to access the HU250 from any of these addresses will be rejected.)

- An allowlist of IP addresses (IP addresses authorized to access the HU250 module)

The firewall parameter settings displayed under the LAN, WAN, Wi-Fi, PPP sections are identical and shown below:

Parameter	Default	Configuration Range	Description
LAN / WAN / Wi-Fi / PPP section			
Drop ports			
Protocol	TCP	• TCP • UDP	Port type of the port to block
Port	-	1-65,535	Port number of the port to block
Blocklist			
IP	-		IP address in the blocklist
Subnet mask	-		Mask linked to the corresponding IP address
Allowlist			
IP	-		IP address in the allowlist
Subnet mask	-		Mask linked to the corresponding IP address

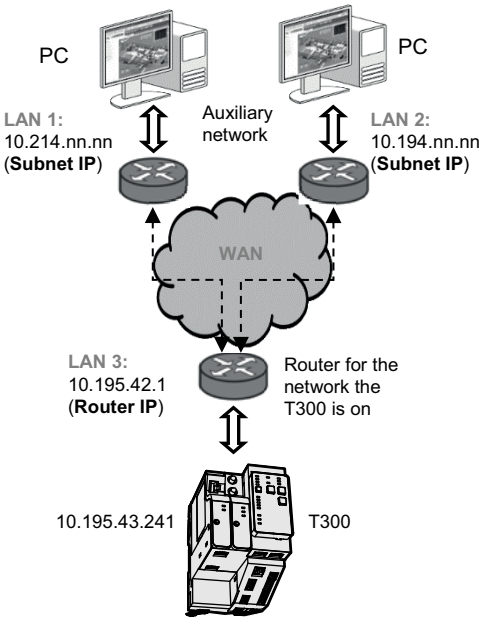
Parameter setting for WAN IPv6:

Parameter	Default	Configuration Range	Description
WAN IPv6 section			
Drop ports			
Protocol	TCP	• TCP • UDP	Port type of the port to block
Port	-		Port number of the port to block
Blocklist			
IP	-		IP address in the allowlist
Subnet prefix length	-		
Allowlist			
IP	-		IP address in the allowlist
Subnet mask	-		

Router Function

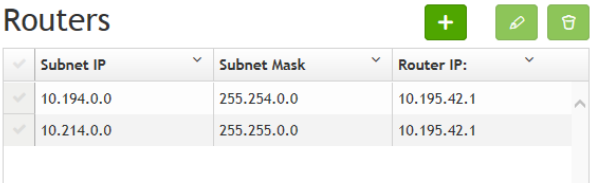
The Router function is used to define connection rules for accessing the T300 remotely via other IP networks. It allows devices, such as tablets or PCs that are connected to different auxiliary LANs than the T300, to access the T300 via a WAN within defined connection rules and limits.

Example of routing on the T300 network gateway



In the WAN IPv6 configuration, **Subnet Mask** field is replaced with **Prefix length**.

The parameter settings of this network are as follows:



Subnet IP	Subnet Mask	Router IP:
10.194.0.0	255.254.0.0	10.195.42.1
10.214.0.0	255.255.0.0	10.195.42.1

Parameter	Default	Description
Subnet IP	-	IP address of the auxiliary network that wants to access the T300
Subnet Mask / Prefix Length (For WAN IPv6)	-	Used to define the usable IP address range on the auxiliary network and limit the possible number of hosts
Router IP	-	Address of the IP network gateway to which the T300 is connected

NOTE: The **Router IP** address configured here must be authorized in the subnet mask defined for the T300 WAN address.

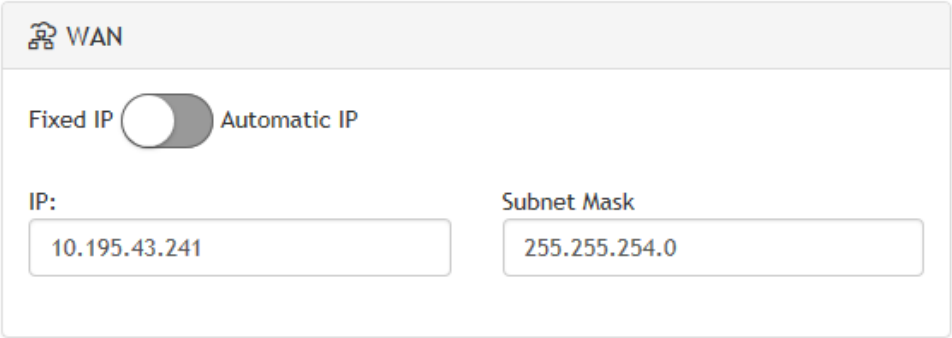
Default routing: It is possible to define a default route through which communication will be automatically routed by the router when a connection is established.

To do this, simply configure the router parameters as follows:

- **Subnet IP:** 0.0.0.0
- **Subnet Mask:** 0.0.0.0
- **Router IP:** IP address of the default gateway through which traffic is directed

  NOTE: If a PPP interface is configured with a modem, this interface is automatically defined as the T300 default router. It is therefore only necessary to define a default router if no PPP modem is used.

Example of WAN IP address settings for the T300

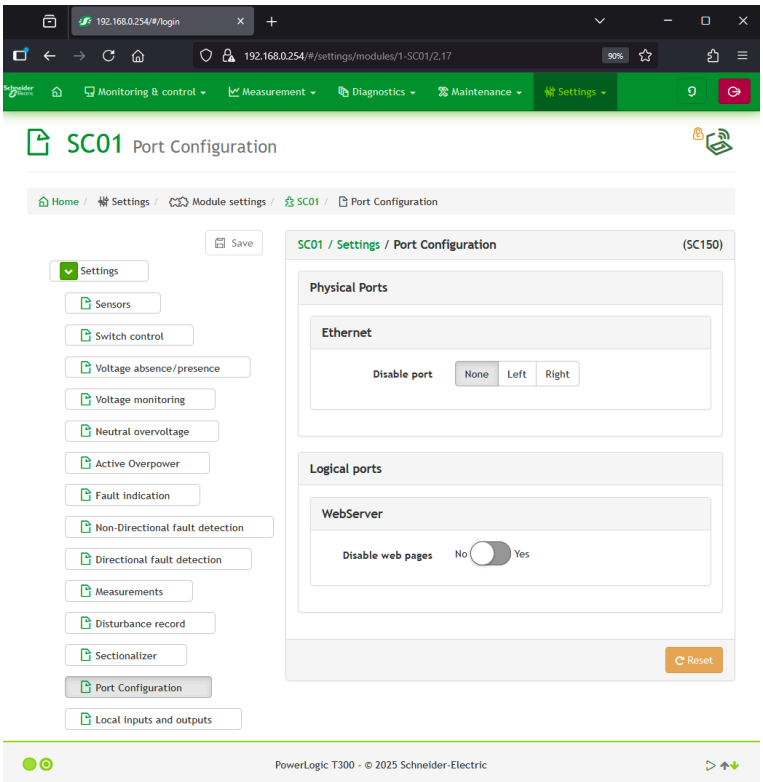


Port Configuration

What's in This Chapter

PowerLogic T300 Port Hardening 141
Port Configuration on HU250 147
Example of Physical Port Configuration of a T300 System 149

Access via **Settings > LV0x/SC0x > Port Configuration** page.



T300 manages port configuration to limit access to the minimal subset of required physical ports.

See also Port hardening on T300, page 141.

PowerLogic T300 Port Hardening

Introduction

This chapter describes the necessary steps to setup the port hardening on a T300.

Port hardening consists in hardening each port both physically and logically.

Physical port hardening: deactivate unused physical ports by hardware or software.

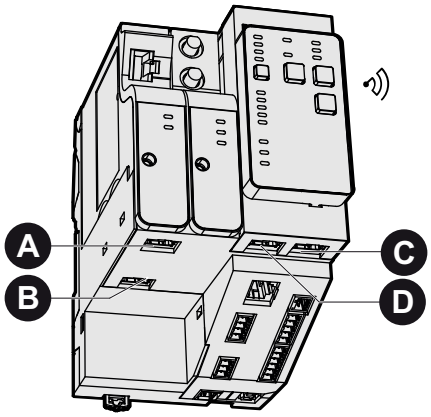
Logical port hardening:

- Restrict logical ports to only the required ports.
- Restrict access to logical port to only the minimal subset of required physical port.
- Disable web server on SC150/SC160/LV150 modules

Port Hardening on HU250

Physical Port Hardening

Port Identification



A. WAN EXT (ETH1)
B. WAN (ETH2)
C. LAN right
D. LAN left

Port Configuration

By default, all ports (excluding Wi-Fi connection) are enabled.

Each port can be disabled, independently from the others.

1. Access via **Maintenance > Advanced > Physical port configuration**

   Ports are presented by type: Ethernet, Wi-Fi.
2. For each port select **Yes** or **No** to enable or disable it.

   For each type of port, each port status is indicated as follows:
   - : port enabled
   - : port disabled

NOTICE
HAZARD OF INCORRECT CONFIGURATION • At least one of the Ethernet ports must remain enabled to access the equipment. • Do not disable the interface (LAN, WAN or WAN EXT) on which the WebApp is currently connected. **Failure to follow these instructions could result in no communication with the equipment**

3. Select **Save** to apply the changes.

Logical Port Hardening

Principle

A firewall can be set for each network interface (LAN/WAN/WiFi/PPP if present on configuration).

- Port forwarding can be enabled.

- **Drop ports**: list of logical ports (22, 443, ...) with protocol (TCP/UDP) which are dropped. It can be possible to deny any logical port.
  List of ports on the system:
  - Administration: SSH (22/TCP), HTTPS (443/TCP), Security Brick port for SAT (8443/TCP)
  - Infrastructure, depending on configuration: SNTP (53/UDP 53/TCP)
  - Operation, depending on configuration: 104 and 104 secure (2404/TCP), DNP3 and DNP3 secure (20000/TCP), 61850 MMS (102/ TCP), Modbus TCP (502/TCP)
- **Blocklist**: list of IP addresses and masks which are denied.
  Example: 1 IP: 192.168.0.123/255.255.255.255,
  entire class C network: 192.168.1.0/255.255.255.0
- **Allowlist**: list of IP addresses and masks which are authorized.

Firewall rules for each physical interface are applied in the following priority:

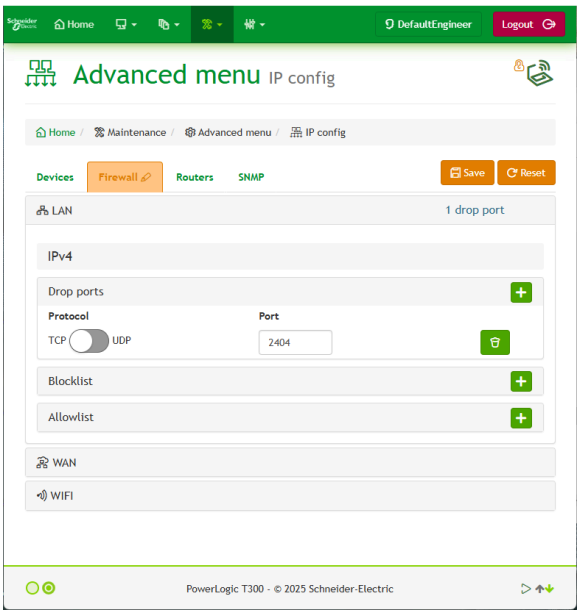
1. Deny logical port
2. Deny blocklist
3. Authorize allowlist
4. Drop everything else

Port Configuration

1. Access via **Maintenance > Advanced > IP configuration > Firewall** tab.

   The screen presents one section per each network interface (LAN, WAN, WiFi).

2. For each network interface, configure the ports as follows:



- **Forward: No/Yes**: the port can be forwarded
- **Drop ports**: select the protocol (**TCP**/**UDP**) and enter the number of the port to drop, then select button.

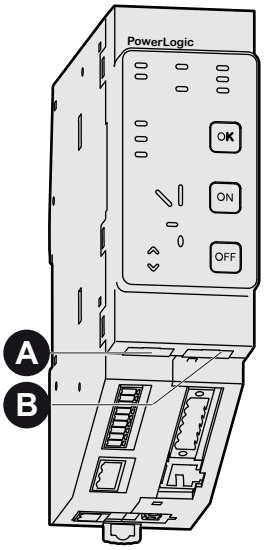
  Select the button to add another port to drop.
- **Blocklist**: use and buttons to add addressees in the blocklist.
- **Allowlist**

NOTICE
HAZARD OF INCORRECT CONFIGURATION • For the **LAN** network interface, check that the configuration enables communication with the SC and the LV modules that are connected through the LAN. • In case of an **Allowlist**, check that the SC and the LV module addresses are in the **Allowlist** below). • Check that the configuration enables dhcp server to operate on dhcp @range, otherwise any local configuration is forbidden. **Failure to follow these instructions could result in no communication with the equipment**

3. After configuration, you can expand each network interface to view the detailed configured firewall settings. The section header for each interface provides a summary of the number of dropped ports.

Port Hardening on SC160/SC150/LV150

Port Identification



A. LAN Left
B. LAN right

Port Configuration

For each SC160/SC150/LV150 module, the Ethernet ports can be deactivated.

1. To access the port configuration page for each module, select **Settings**, then select the module (SC160/SC150/LV150). In the displayed screen navigate to **Port configuration**.
2. In the **Physical ports** section (**Ethernet**), select the port to disable:
   - **None**
   - **Left**
   - **Right**

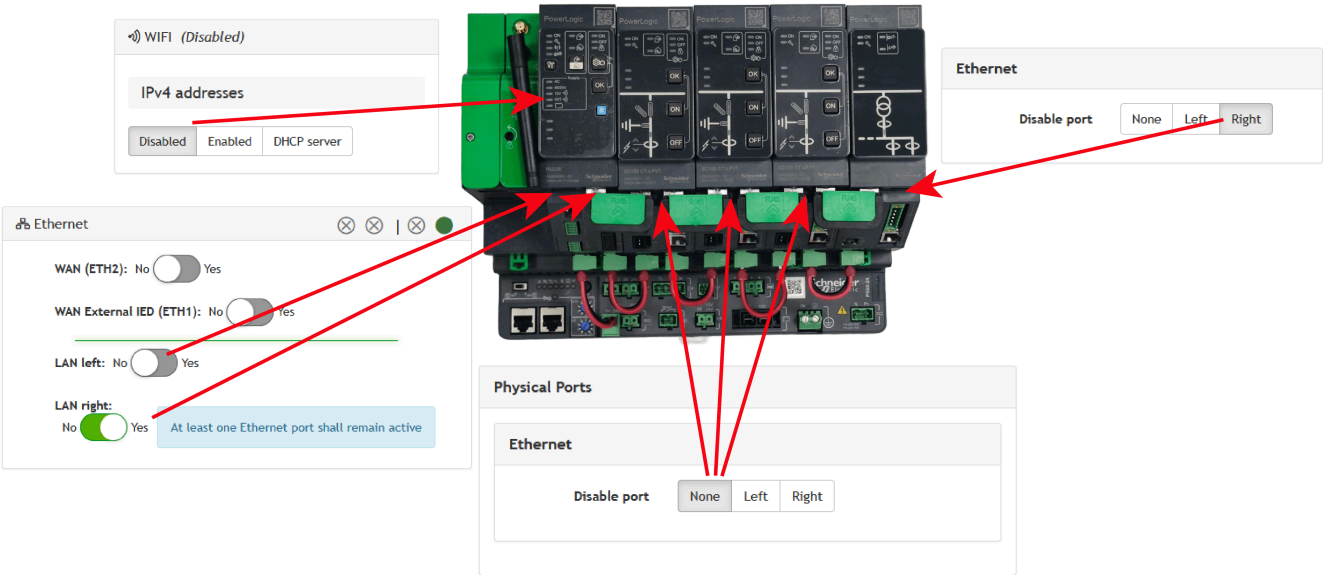
   By default, none of the ports are disabled. Left or right port can be disabled.

NOTICE
HAZARD OF INCORRECT CONFIGURATION Disable only one port at a time, to allow access to the equipment. **Failure to follow these instructions could result in no communication with the equipment**

3. In the **Logical ports** section, select whether the **WebServer** is disabled or not (**No**/**Yes**).

PowerLogic T300 Port Configuration Example

The image below shows how to disable all the ports that are not connected:



Configuring Port Hardening Using Easergy Builder

Port hardening settings for the HU250 module are available from version 1.3.x, and with T300 profile V1.4.

Refer to the Easergy Builder User Manual for more information about port hardening configuration.

SC150/LV150 modules cannot be set with Easergy Builder.

HU250 Physical Port Hardening Using Easergy Builder

From the RTU screen, in the **Hardening** tab and **Ethernet** section, select the ports used:

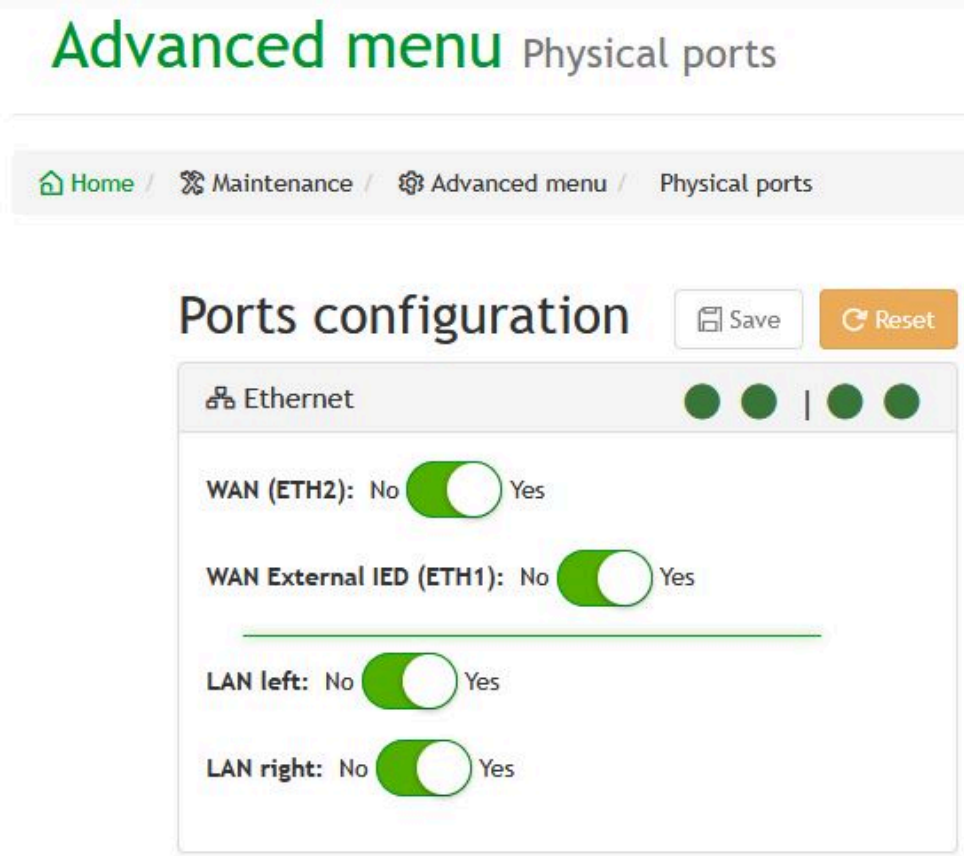
- WAN (ETH2)
- WAN EXT (ETH1)
- LAN_LEFT
- LAN_RIGHT

HU250 Logical Port Hardening Using Easergy Builder

1. From the RTU screen, in the **Network** tab, select the **Firewall** subtab.
2. Using the edit mode, for each network port, LAN, WAN, WIFI, select firewall rules to apply:
   - **Drop port**
   - **White list**
   - **Black list**

Port Configuration on HU250

Accessed via **Maintenance > Advanced > Physical port configuration** page.



⚠ WARNING
HAZARD OF INCORRECT SETTINGS To limit access to a physical port on the T300 equipment, deactivate ports from the Web server. **Failure to follow these instructions can result in death, serious injury, or equipment damage.**

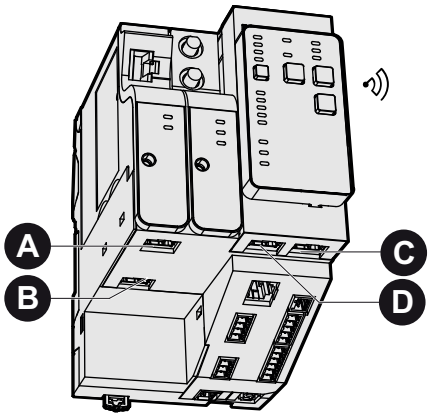
For physical port configuration on:

- HU250, see table below
- SC150/SC160, see page 138
- LV150, see page 151

In the T300 Web server:

- By default, all HU250 physical ports are enabled (parameter set to **Yes**).
- At least one of the Ethernet ports must be set to Yes to access the T300 equipment.
- Do not set to **No** the port of the interface (LAN, WAN, or WAN EXT) on which the Web server is connected. Otherwise, the communication with the T300 equipment is lost.

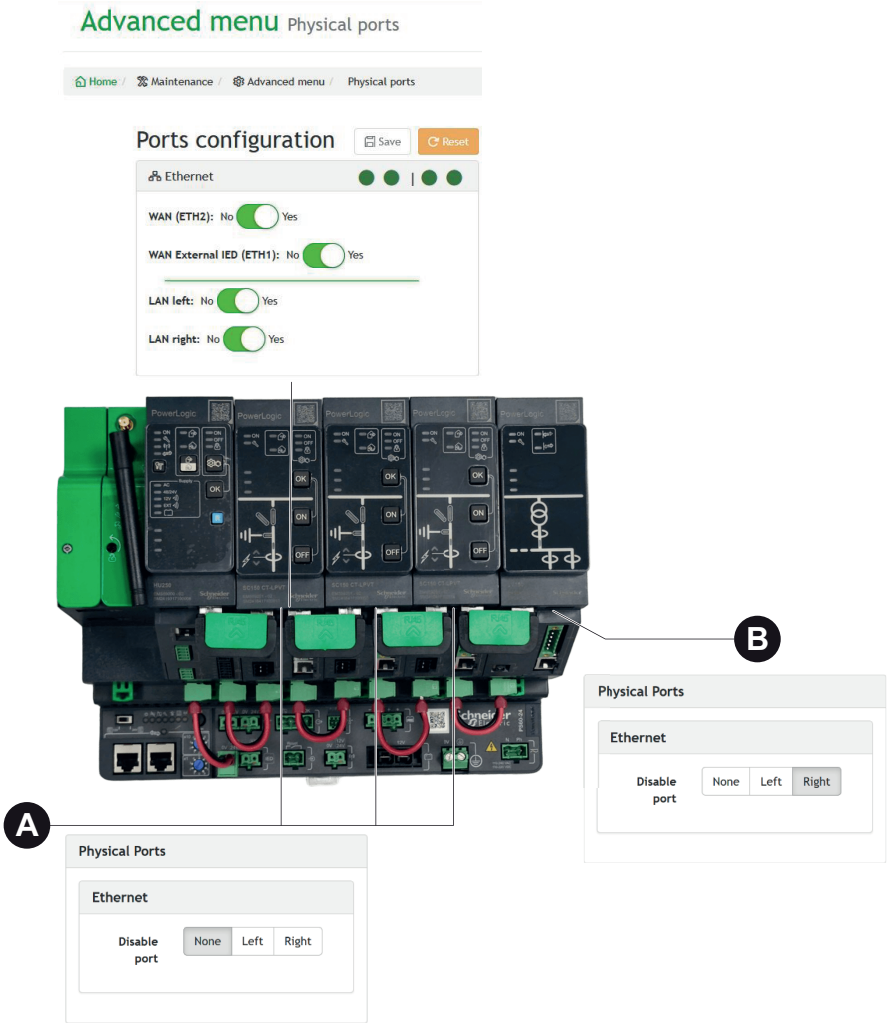
Port identification on HU250



The parameter settings of HU250 physical ports are presented by type (Ethernet, Wi-Fi) as follows:

Leg-end	Parameter	Default	Configuration Range	Description
Ethernet				
A	WAN External IED (ETH1)	Yes	• No • Yes	Local communication Ethernet port used for the link to an external device in the MV substation or for connection to a PC
B	WAN (ETH2)	Yes	• No • Yes	Ethernet port used for the remote communication with the control center, via a modem or router
C	LAN left	Yes	• No • Yes	Ethernet LAN port dedicated to internal communication between T300 modules or for connection to a PC
D	LAN right	Yes	• No • Yes	Ethernet LAN port dedicated to internal communication between T300 modules or for connection to a PC

Example of Physical Port Configuration of a T300 System



A.

1. **Settings > SC01 > Port Configuration**
2. **Settings > SC02 > Port Configuration**
3. **Settings > SC03 > Port Configuration**

B. **Settings > LV01 > Port Configuration**

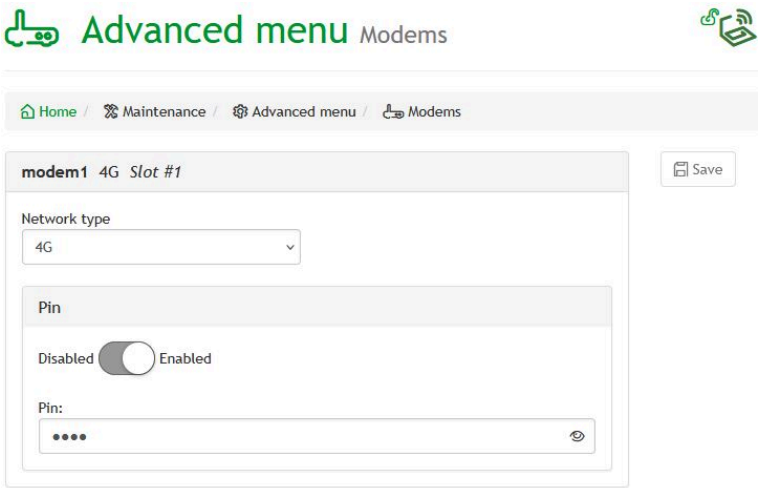
Dial-Up Modem Settings

What's in This Chapter

Modems Configuration Page 150

Modems Configuration Page

Access via **Maintenance > Modems configuration** page.



This page is used to configure the application parameters required for the modem connections.

The proposed configuration depends on the type of modem installed on the HU250 module ports (port 1 or port 2).

4G Modem

4G modems require a SIM card to be able to connect to the mobile network.

In order to have better security on the GPRS/4G network, it is recommended to require from the operator a private APN via a VPN network.

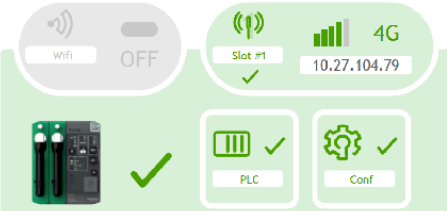
Modem parameter setting

Access via **Maintenance > Modems** page.

Parameter	Default	Description
Network type	AUTO	There are 3 possible choices for defining the IP network type: • **AUTO:** Automatic detection of the mobile network type by the T300 • **GPRS:** 2G network • **4G:** 4G network.
Pin	Enabled	Option to use the PIN code. Depends if the SIM card needs a PIN code to operate.
Pin code	-	4-digit PIN code for the SIM card. This parameter should only be entered if the **Pin** parameter is enabled. **NOTE:** After 3 validations of the settings on this page or 3 modem initializations with an incorrect PIN code, the SIM card is blocked. If this happens, the only solution is to call the network operator to unblock it.

Operating Conditions for Mobile Access

For mobile communication to be able to function between the T300 and the SCADA system, there are some conditions that must be fulfilled by the network operator:

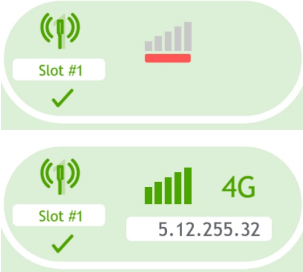


- **The T300 must have a static IP address assigned by the operator:**
  In fact, the mobile connection will not function if the T300 has a dynamic IP address, since the SCADA system will not be able to determine the new IP addresses allocated to the T300 by the operator when they are reassigned. It would therefore not be possible to initialize protocol communication from the SCADA system, nor would it be possible to connect to the T300 embedded Web server remotely over Ethernet.
  The only way to determine the T300 IP address would be to connect locally (on site) to the T300 embedded Web server, which is not particularly feasible as this would involve traveling to the site of each T300 each time the IP address is reassigned.

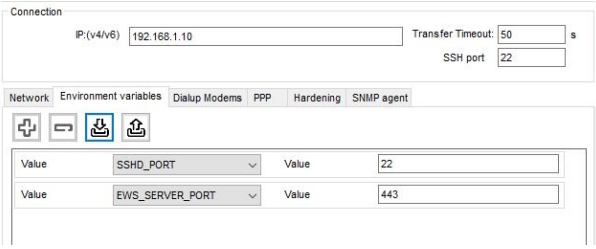
  Once the T300 connected to the mobile network, the IP address assigned to the T300 is displayed in the **Monitoring & Control/System** page (see image beside). This is the address that must be used by the SCADA system to connect to the T300 over Ethernet or via the protocol.

  NOTE: If connection to the mobile network is not established, "NA" is displayed instead of the IP address.

  - Connection to GPRS/4G network not established – IP address not available



- **The IP ports used by the T300 must be opened by the operator:**
  A certain number of ports are used for the T300 application. The list of default ports used can be viewed in the Easergy Builder **Workspace** page (**Environment variables** tab):
  - SSH port: 22
  - HTTPS port: 443



All the ports used by the application must be open at mobile operator level for the functions associated with these ports to be operational. If this is not the case, it is still possible to configure different port numbers in Easergy Builder to be consistent with the port numbers available at the operator end. Refer to the Easergy Builder Configuration Tool User Manual for more information on how to access and configure these ports.

Upgrading the Firmware

What's in This Chapter

Firmware Page..... 152

The T300 Web server shows the versions of firmware that are currently loaded (per module) and whether it is possible to upgrade to newer versions.

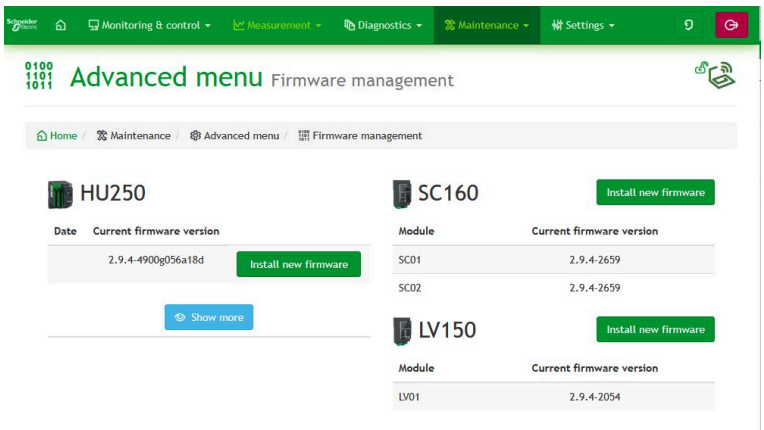
The T300 firmware is delivered as a single package that includes the firmware for all of the modules (HU250, SC150/SC160 and LV150). A Release Note provided with the package contains information about the compatibility between the firmware versions of the modules.

Respect the following rules during a firmware update:

- The firmware version to be installed on a module must be compatible with the firmware modules already installed on the other modules (see the Release Note).
- To maintain compatibility between the firmware versions of all modules, apply updates to all modules in a single operation.

Firmware Page

Access via **Maintenance > Firmware** page.



This page displays:

- The current HU250 firmware version with the option to check the version and date of the each BIN controller module firmware embedded in the HU250 by clicking the **Show more** button
- The version of the firmware in each SC150/SC160 module
- The version of the firmware in each LV150 module

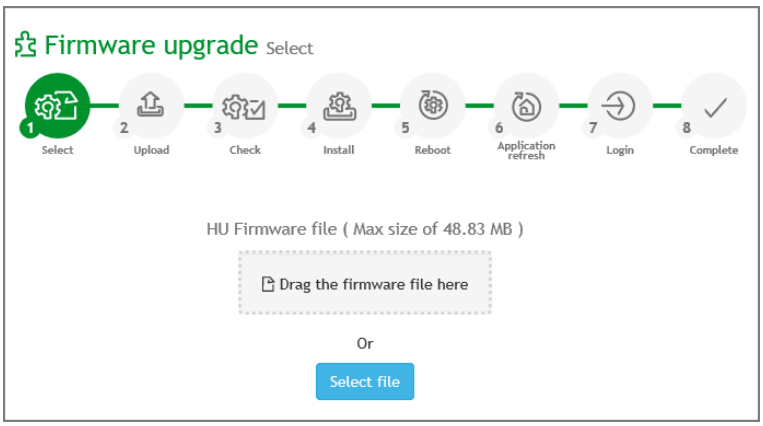
Firmware Upgrade

The current versions of the firmware embedded in the HU250, SC150/SC160 and LV150 modules are displayed in the **Firmware** page.

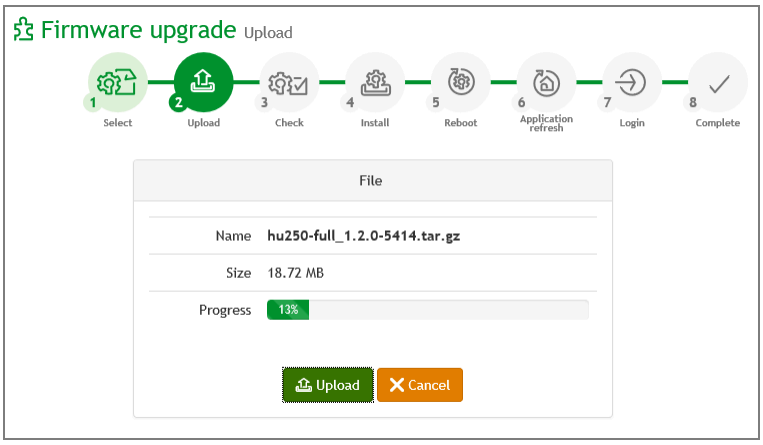
By clicking the **Install new firmware** button associated with the HU250 module, SC150/SC160 or LV150 modules, it is possible to update the firmware for each module.

After clicking this button, a window appears on screen showing the firmware upgrade procedure, which involves several steps:

1. Click the **Select file** button associated with the HU250 module or the SC150/SC160 modules, it is possible to update the firmware for each module. This compressed file with a .tar.gz extension must be available on the PC connected to the Web server. Contact Schneider Electric technical support to obtain this file.

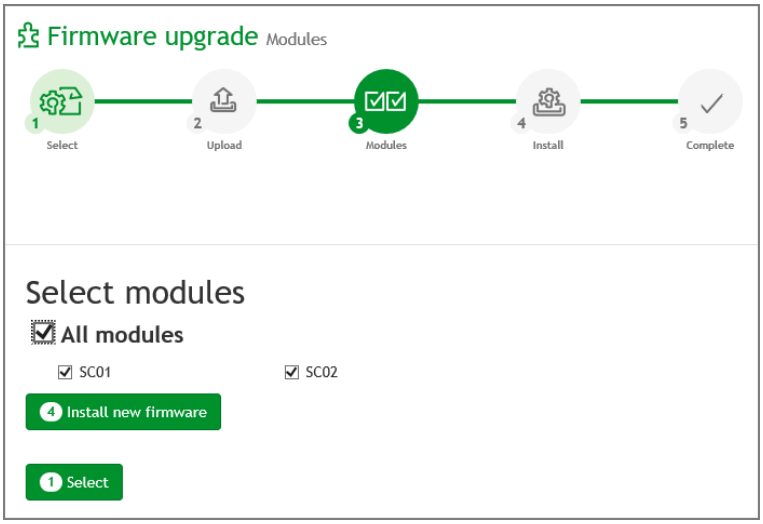


2. Click the **Upload** button to upload the file.



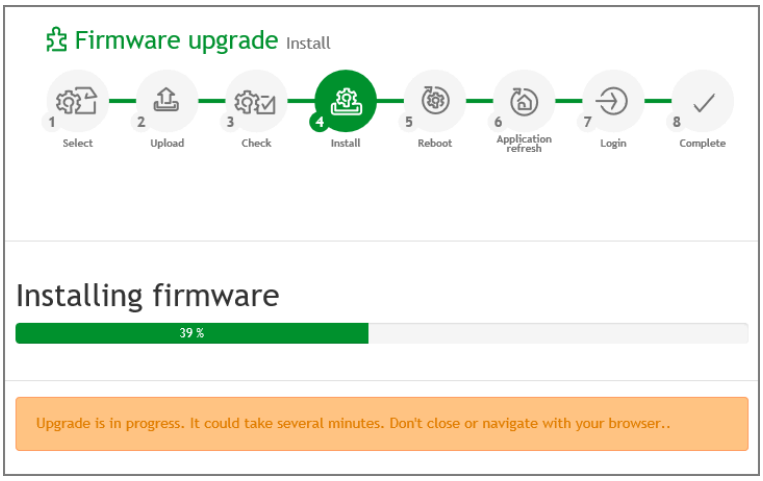
The upload progress is indicated as a percentage in a progress bar on screen.

3. This step differs depending on whether it relates to HU250 or SC150/SC160 and LV150 installation.

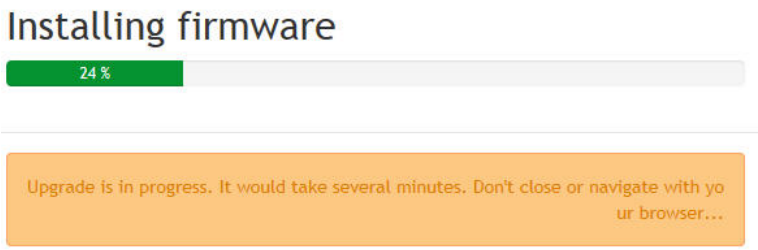


- **HU250:** Once the file is uploaded, the file consistency is checked automatically.
- **SC150/SC160 and LV150:** Before installing the firmware, select which modules are to be updated.

4. Click the **Install new firmware** button to install the new version.

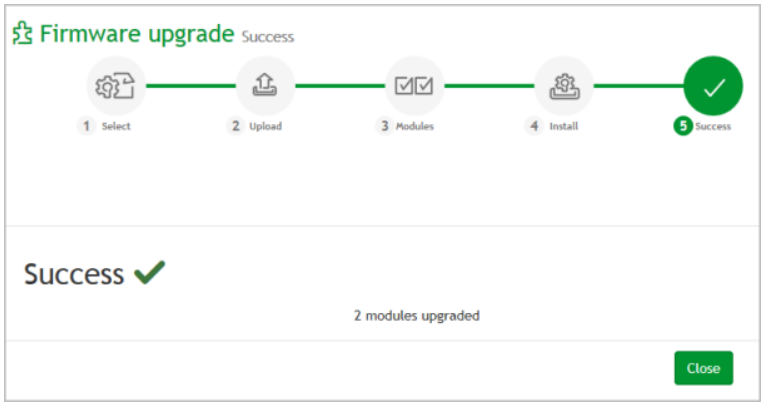


A progress bar indicates the installation progress.



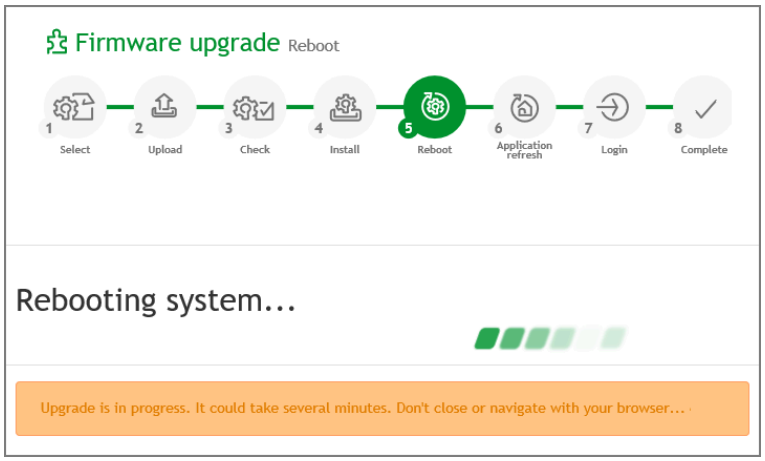
NOTE: Do not close the web browser during this stage otherwise you will lose the progress of the current step.

5. This step differs depending on whether it relates to HU250 or SC150/SC160 and LV150 modules.
   - **SC150/SC160 or LV150:** Once the firmware has been successfully installed ("Complete" indicated on screen), the process is complete. Click "**Close** to close the window and return to the Firmware page.



   - **HU250:** Once the firmware is installed, the system is automatically rebooted. Wait several minutes for the reboot to finish.

     NOTE: Do not close the web browser during this stage otherwise you will lose the progress of the current step.

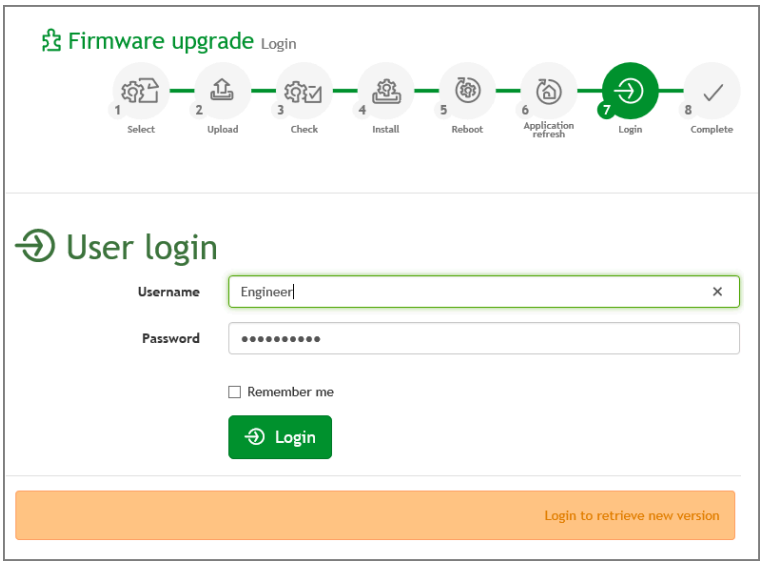


   If a potential issue occurs during installation of the firmware, or if the firmware installed is found to be corrupt, the system aborts the update and automatically reactive the previous firmware version.

6. **(HU250 only):** This step is transparent and is initiated automatically after the T300 is restarted. This step initiates the updating of the Web application in relation to the downloaded software.

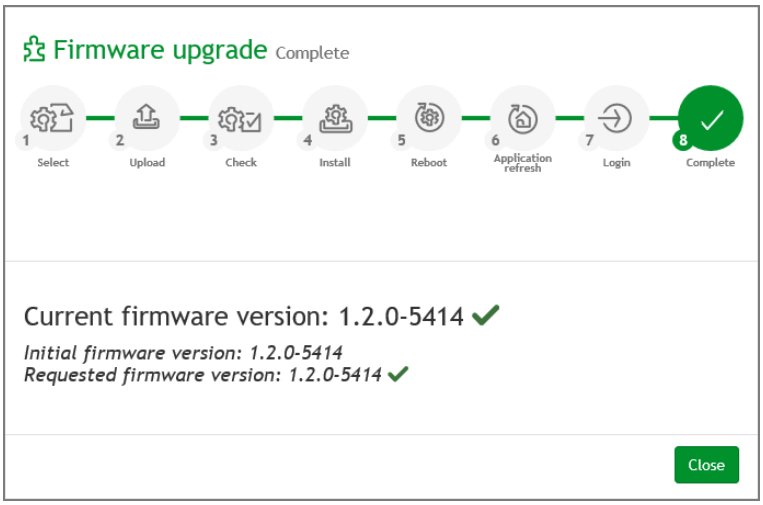
7. **(HU250 only):** Now the system has been rebooted, it needs to be reconnected to the Web server by entering one of the following default usernames and passwords and clicking the **Login** button:

USERS	Installer	Engineer	Viewer	Operator	SECADM
Username	Installer	Engineer	Viewer	Operator	SecurityAdmin
Password	Installer1!	Engineer1!	Viewer1!	Operator1!	Security1!



NOTE: For security purposes, the passwords must be changed during commissioning.

8. **(HU250 only):** Once the connection has been re-established, the newly installed version of the HU250 firmware and the previous version are displayed on the page to compare and check.



Click **Close** to close the window.

This completes the firmware installation process.

Managing the Configuration

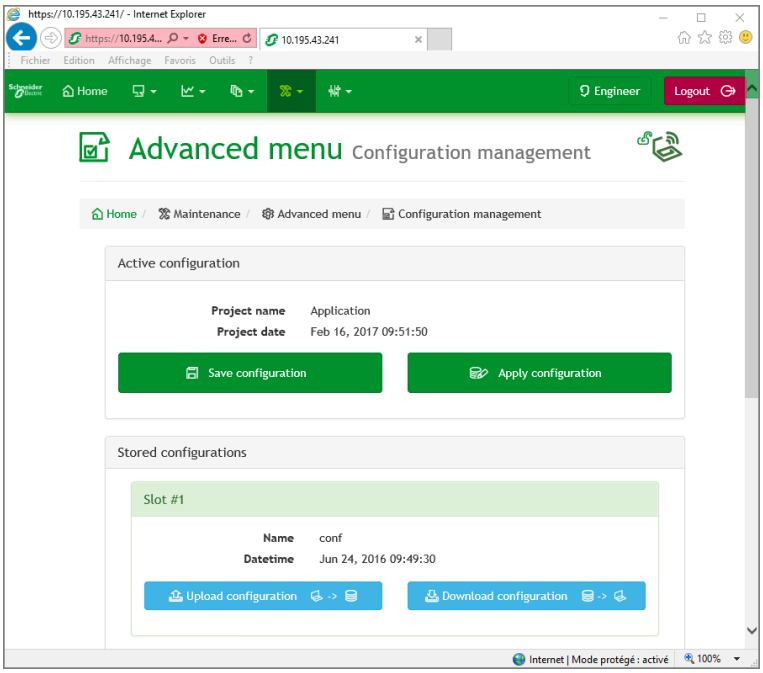
What's in This Chapter

Configuration Page..... 157

The Web server is used to manage the T300 configuration based on files stored locally in the HU250 memory or saved externally on a backup device (hard disk, etc.).

Configuration Page

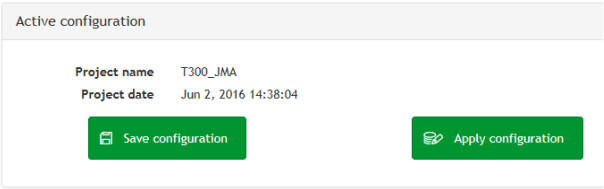
Access via **Maintenance > Configuration** page.



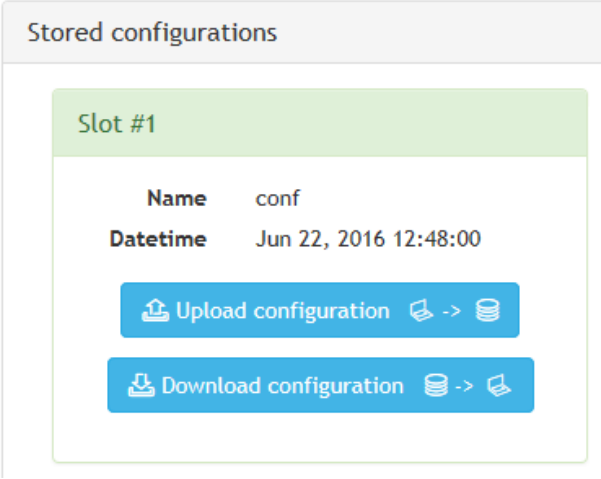
The configuration management page includes two distinct sections:

- One section for managing the **active configuration** of the T300 that can be saved in one of the HU250 memory slots (3 separate slots). It is also possible to overwrite this active configuration and replace it with a configuration already saved in one of these slots or with one saved externally, on a PC, for instance.

  The project name and date indicated in the **Active configuration** section correspond to the name given to the project and either the date the configuration was created or the date it was last modified in Easergy Builder.



- One section for managing the **stored configurations** that are saved in the memory (slots). It is possible to download each configuration stored in one of these slots to a PC or to replace them with another configuration saved previously as an external file, on a PC, for instance.



  The name and date indicated for each slot correspond to the name given to each backup and the date this backup was executed.

The T300 configuration uploaded into the product or saved externally is a compressed **.tar.gz** file type.

This file contains the entire equipment configuration, excluding the user parameters and RBAC access rights, which are stored in the rights management tool (CAE).

The file also contains the system parameters (IP address, modem parameters, etc.), and a copy of the K7 Zigbee internal memory.

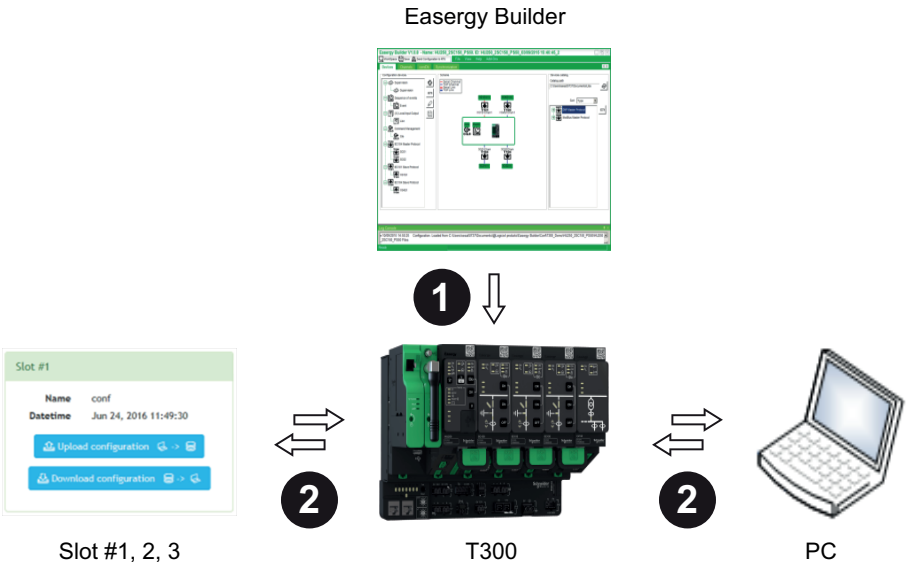
NOTE: It is possible to create a configuration file in Easergy Builder without integrating these system parameters for the purposes of importing into another device with the same application program configuration without overwriting the device system parameters.

Configuration Principle

The initial configuration is factory-loaded into the T300 before delivery. This configuration includes the equipment specifications and options. The delivered T300 therefore includes a default configuration adapted to the equipment's operating requirements.

This initial configuration then needs to be adapted. This is what is known as the engineering phase and should be completed in Easergy Builder to carry out the following operations:

- Configure the SCADA protocol addresses
- Configure device synchronization
- Configure the SOE
- etc.



1. Initial loading
2. Save/Restore

Once the configuration has been finalized, it is simply uploaded to the T300 via Easergy Builder or saved to PC as a backup file for subsequent import into the T300 via the Web server.
Refer to the Quick Start Guide for more information on these configuration operations and how to upload/save the configuration via Easergy Builder.

On commissioning, the configuration then needs to be customized via the Web server menus to define the application program parameters associated with communication, modems, fault current detection, switchgear monitoring, etc.

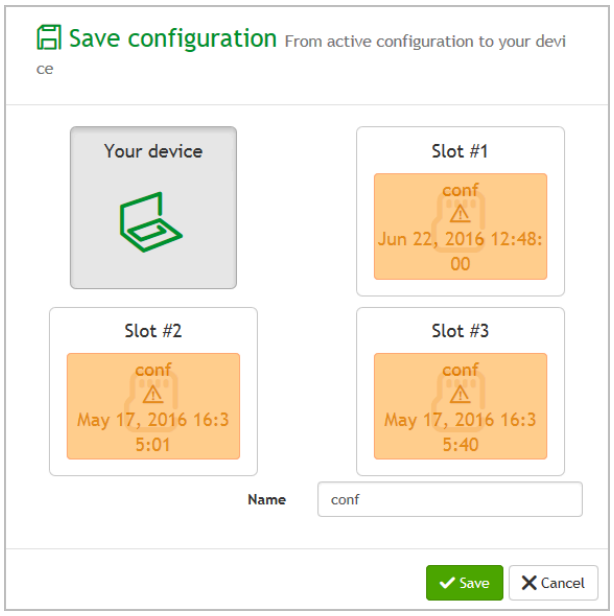
Once these parameters have been set, the configuration should be saved in the device memory (slot) and to an external backup device, or imported into Easergy Builder to create an archive.
These saved configuration files are compatible with Easergy Builder and can be imported and stored in the tool.

Before any changes are made to the SC150/SC160 configuration, it is recommended that a restore point is systematically created, i.e. that the current T300 configuration is saved before being stored to create a configuration archive.

For security reasons, it is advisable to regularly back up the active configuration to an external device, in addition to the local backups in the memory slots. An external backup can be used to retain the configuration even if the HU250 module is replaced.

Saving the Configuration

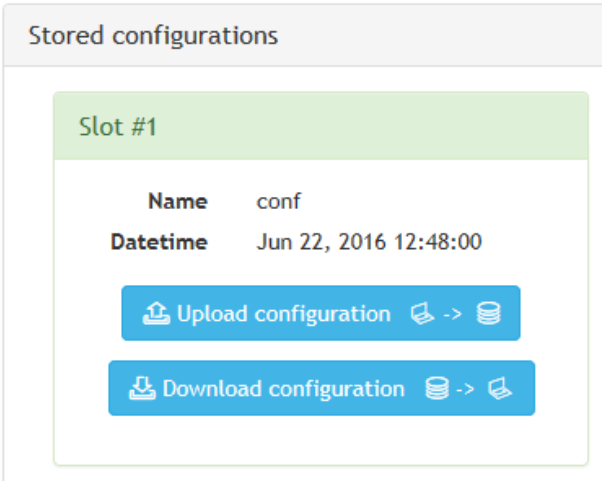
Saving the Active Configuration



Proceed as follows to save the active configuration:

- Click **Save configuration** button to open the window.
- Define a name for the backup ("conf" proposed by default), then select the destination for the file by clicking one of the following:
  - **Your device:** Saves the configuration to an external backup device (e.g. hard disk, etc.). A *.tar.gz compressed configuration file will be automatically saved to the PC in the normal location for web browser downloads.
  - **Slot #1, #2, or #3:** Saves the configuration in slots 1, 2, or 3. The date and name of the backup in the slot will be updated with the current date and time once the backup is complete.
- Click **Save** button to start the backup. A progress bar indicates the stage of progress.
- For a backup in one of the slots, the current date and time as well as the backup file name are updated in the slot once the save is complete.
- The backup is complete.

Saving a Stored Configuration

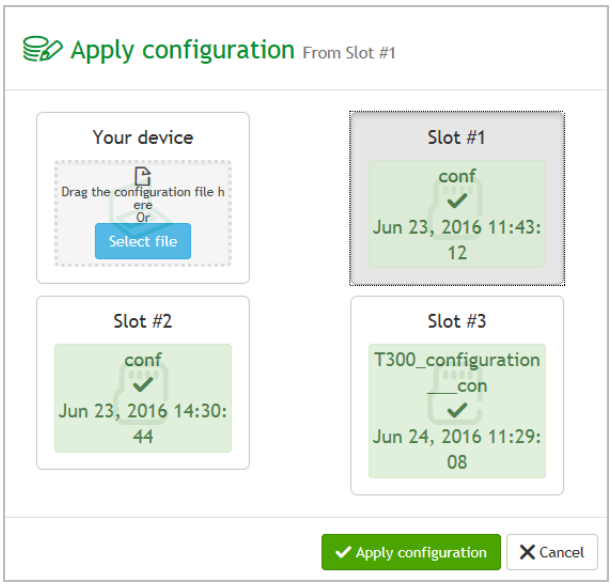


Proceed as follows to save a configuration stored in one of the slots to PC:

- Click the **Download configuration** button for the slot from which you want to download the configuration.
- A *.tar.gz compressed configuration file is automatically saved to the PC in the normal location for web browser downloads.
- The backup is complete.

Uploading the Configuration

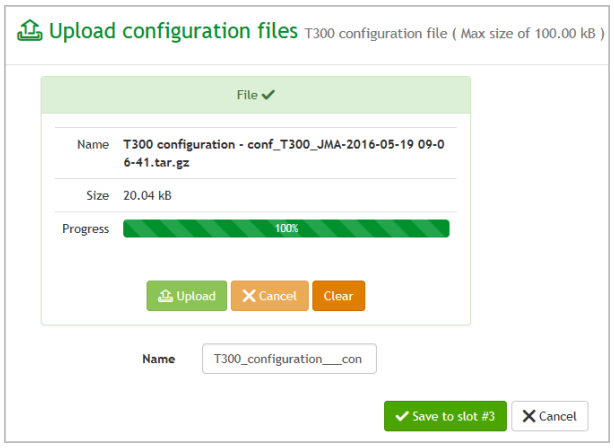
Uploading into the Active Configuration



Proceed as follows to replace the active configuration with a stored configuration:

- Click the **Apply configuration** button to open the **Apply configuration** window.
- Select the backup file source by clicking on one of the following:
  - **Your device:** Uploads the configuration from an external backup device (e. g. hard disk, etc.).
    Click **Select file** button, then select the corresponding configuration file from the PC or drag and drop the file onto the *Drag the configuration file here* section of the screen. This compressed file with a **.tar.gz** extension must be available on the PC connected to the Web server.
  - **Slot #1, #2, or #3:** Uploads the configuration directly from slot 1, 2, or 3.
- Click **Apply configuration** button to start uploading the configuration. A progress bar indicates the upload progress.
- Once the upload is complete, the T300 is automatically rebooted. Re-enter the username and password to access the T300 Web server.
- The configuration upload is complete.

Uploading into a Slot



Proceed as follows to upload a previously saved configuration from the PC into one of the slots:

- Click **Upload configuration** button to open the `Upload configuration files` window.
- Click **Select file** button then select the corresponding configuration file from the PC or drag and drop the file onto the *Drag the configuration file here*section of the screen.
  This compressed file with a **.tar.gz** extension must be available on the PC connected to the Web server.
- Click **Upload** button to start uploading the file. A progress bar indicates the upload progress:
- Click **Save to slot #3** button to confirm the save to the selected slot. A progress bar indicates the progress of the save to slot operation:
- The date and name of the backup are updated in the slot once the save is complete.
- The configuration upload is complete.

T300 Settings

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Introduction to T300 Settings

⚠WARNING

HAZARD OF LOSS OF CONTROL

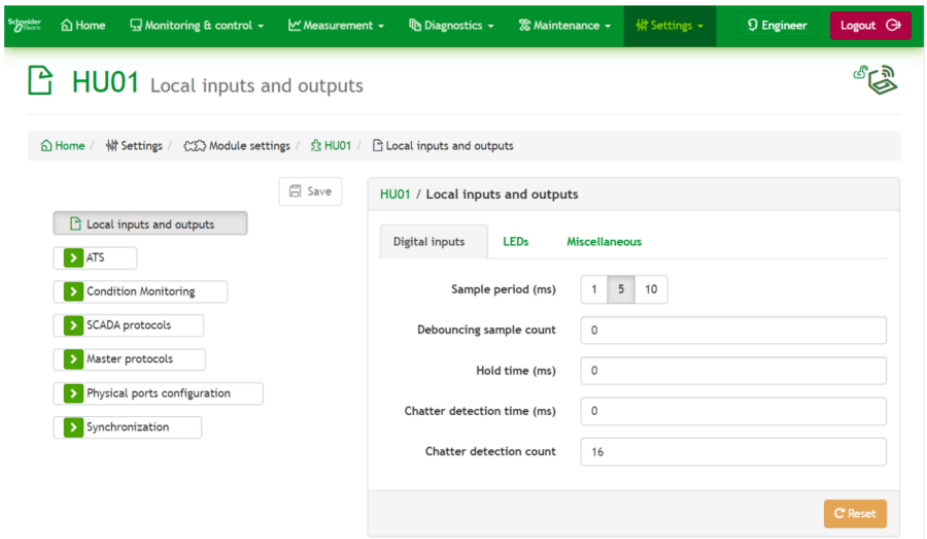
- The designer of any control scheme must consider the potential failure modes of control paths.
- For certain critical control functions, provide a means to achieve a safe state during and after a path failure. Example: Emergency Stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths must include communication links.
- Consideration must be given to the implications of anticipated transmission delays or failures of the link.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

The following pages give an overview of the various function configurations for each T300 module:

- HU250: Configuration of the HU250 module parameters:

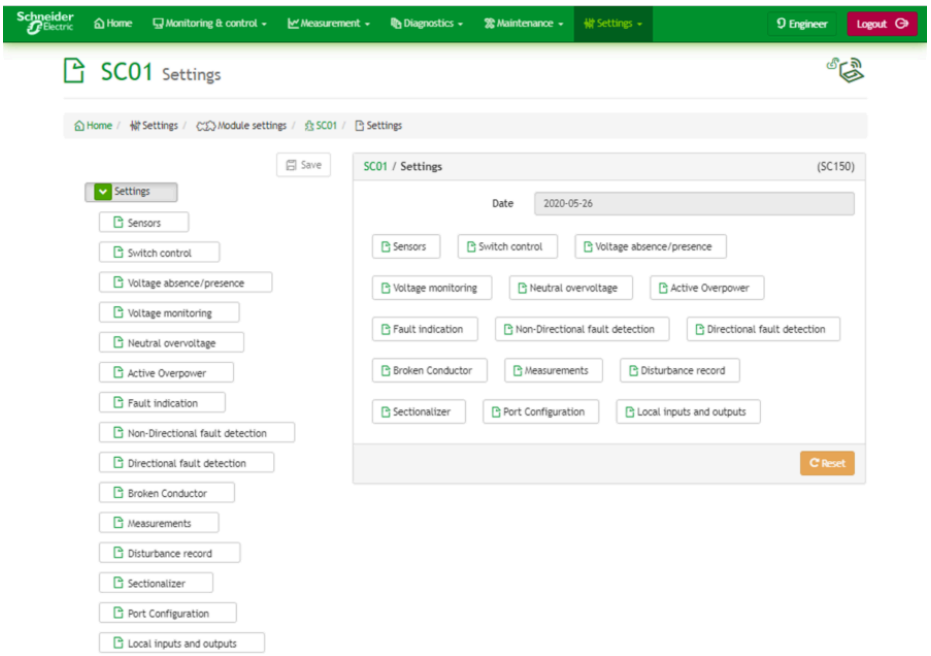
  Accessed via **HU01 Settings** page.



  - Local I/O
  - Automatic transfer switching (ATS)
  - Condition monitoring
  - Communication protocols
  - Communication ports and modems
  - Physical port configuration (for example, RS-485 for PS50 link, RS-232/485 modem box)
  - Time synchronization
  - Host monitoring

- SC150/SC160: Configuration of the parameters of each SC150 or SC160 module

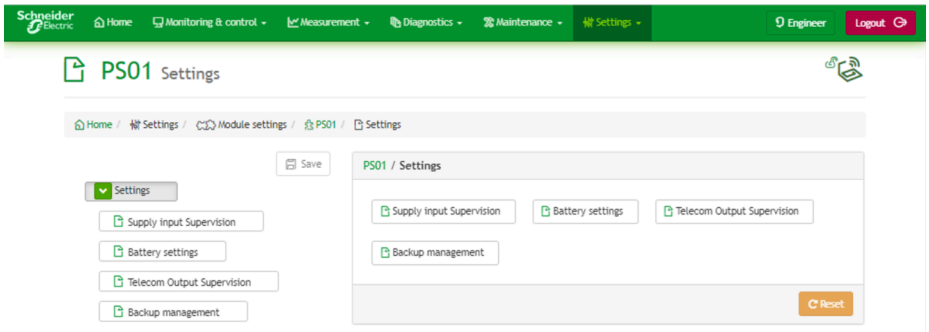
  Accessed via **SC0x Settings** page.



  - Current and voltage measurement sensors
  - Switch controls
  - Voltage presence/absence detection
  - Fault current indication
  - Fault current detection
  - Tripping protection (on SC160 module only)
  - Cold Load Pick-up function (on SC160 module only)
  - Broken conductor detection
  - MV Measurements
  - MV Power quality
  - Disturbance record
  - Sectionalizer automation function
  - Port configuration
  - Local I/O: User LED customization

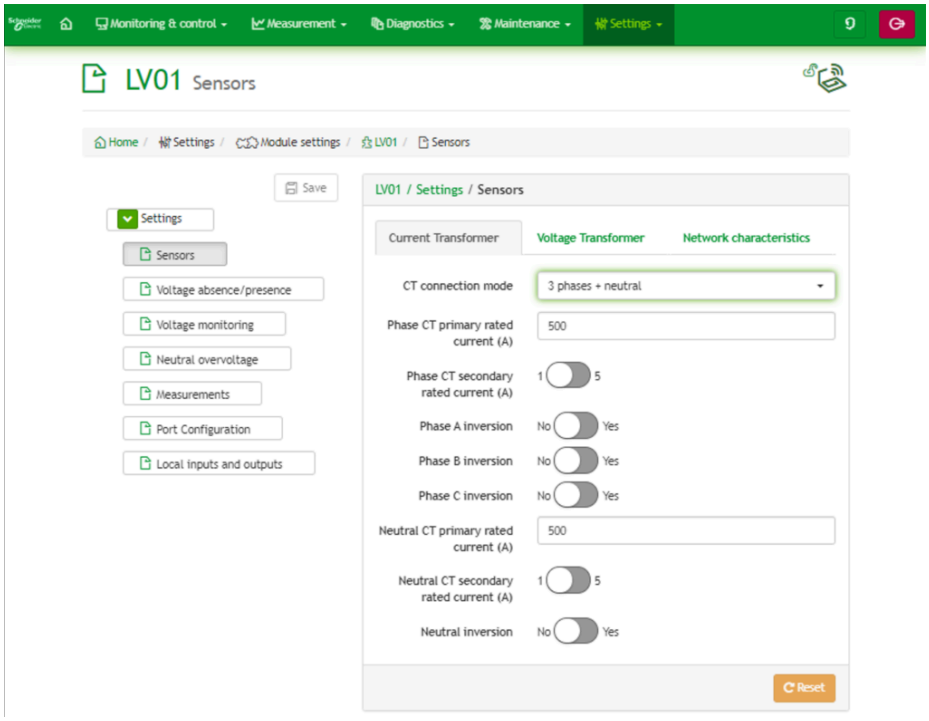
- PS50: Configuration of the parameters of each PS50 module:

  Accessed via **PS01 Settings** page.



  - Power supply input monitoring
  - Battery
  - Remote control order monitoring
  - Back-up power supply management
- LV0x: Configuration of the parameters of each LV150 module:

  Accessed via **LV01 Settings** page.



  - Current and voltage measurement sensors
  - LV Voltage monitoring
  - Broken conductor detection
  - LV Measurements
  - LV Power quality
  - Port configuration
  - Local I/O: User LED customization

HU250 Module Settings

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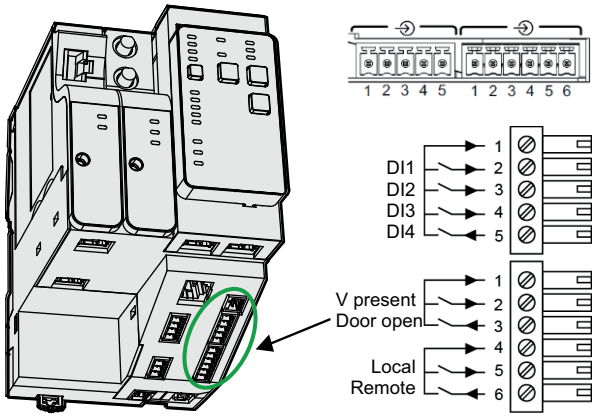
Local I/O

Accessed via **Settings > HU01 > Local inputs and outputs** page

The I/O and LEDs are managed via the T300 LIOC (Local Input Output Controller) BIN controller.

Slot for digital inputs on the HU250 module:



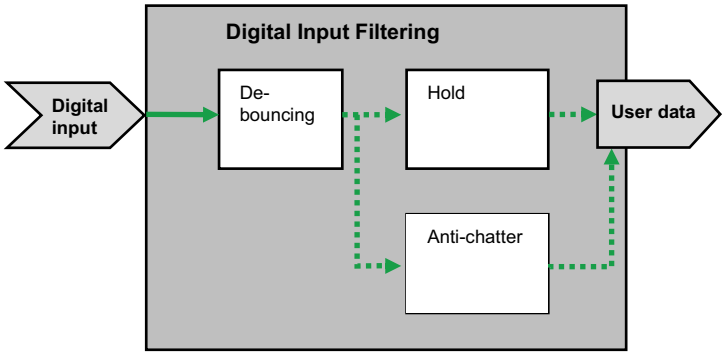
You can use the Web server to customize:

- Filters on the HU250 module local digital inputs
- The color of some of the LEDs on the front of the HU250 module

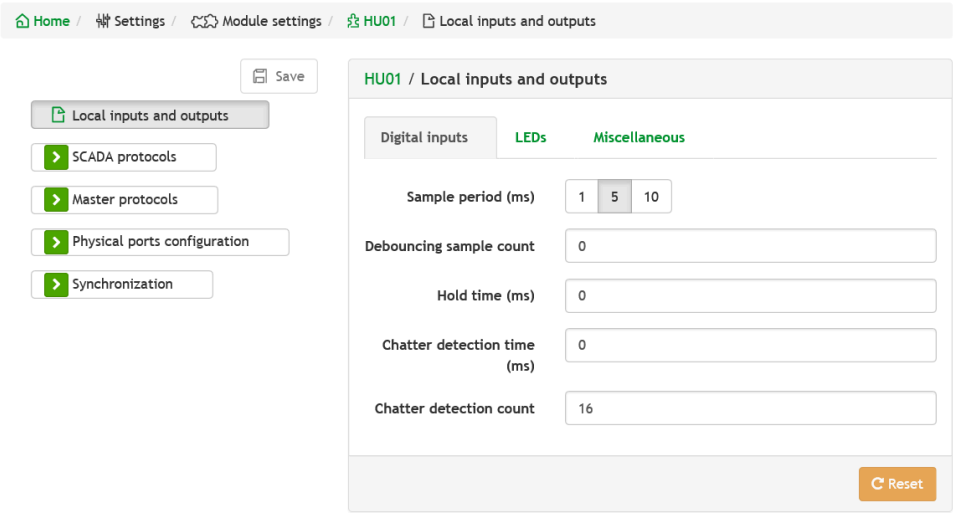
Customizing the Digital Inputs

Several filters can be activated and customized on the 8 digital inputs available on the HU250 module. Note that filter customization applies to all 8 digital inputs globally but you can choose to disable the customization for each digital input.

Digital Input Filtering:



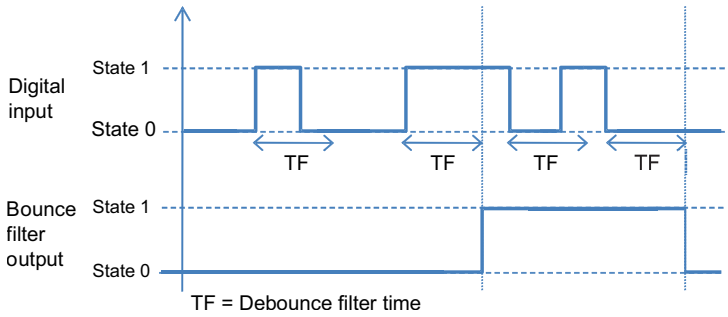
The digital input filter parameter settings:



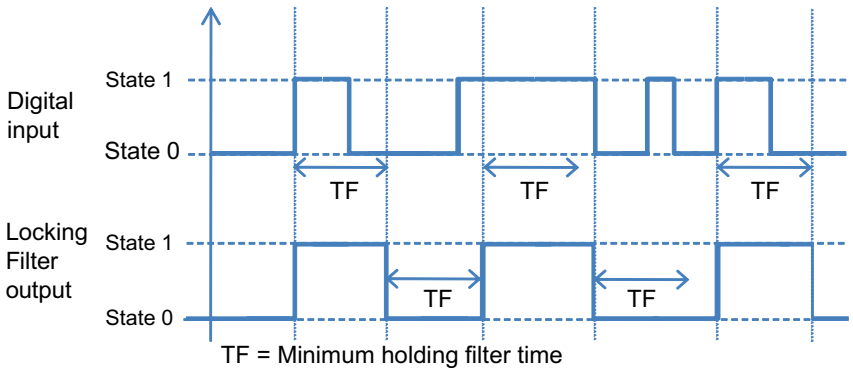
Parameter	Default	Configuration range	Description
Digital Inputs			
Sample period (ms)	5	• 1 • 5 • 10	Sampling period on the digital inputs for taking a state into account
Debouncing sample count	0	0 or 2-30 (increment = 1)	Filtering period for the bounce on a digital input. The value configured for the filter corresponds to a number of Sample periods. The digital input must remain in the same state for a period greater than the defined debouncing period for its state to be taken into account. A value of 0 inhibits the debouncing filter.
Hold time (ms)	0	0 or 5-2,000 (increment = 1 ms)	Holding period for a digital input. When a change of state (debouncing filtered) is detected on a digital input, the input is held in its new state until the Hold time period has elapsed. At the end of the period, the input returns to its actual value. A value of 0 inhibits the holding filter.
Chattering detection time (ms)	0	0 or 5-60,000 (increment = 1 ms)	Sliding time period corresponding to a window of observation and counting of the changes of state on a digital input. If during this period, the count becomes higher than the **Chatter detection count** value, the anti-chatter filter is activated, the state of the input is maintained at its last state. An event is signaled with the value maintained at its last state and with quality flags indicating “invalid”. The quality of the data is then signaled as bad. The anti-chatter filter becomes inactive again if, during the same period, no change of state is detected on the digital input. A value of 0 inhibits the anti-chatter filter.
Chattering detection count	16	1-255 (increment = 1)	Counts the number of changes of state on a digital input to define the anti-chatter filter action. The changes of state counted are only those filtered by the debouncing filter.

Block Diagrams for the Different Filters

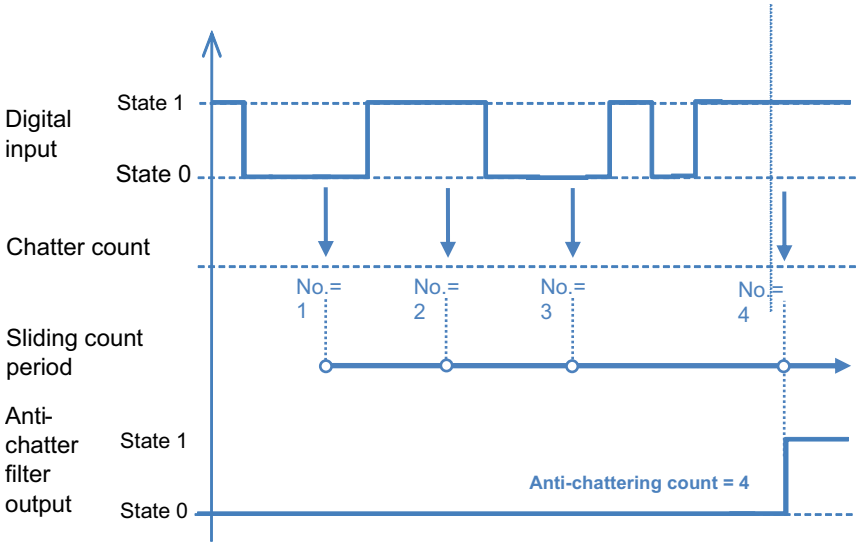
Debouncing filtering on digital inputs



Holding filtering on digital inputs



Anti-chatter filtering on digital inputs

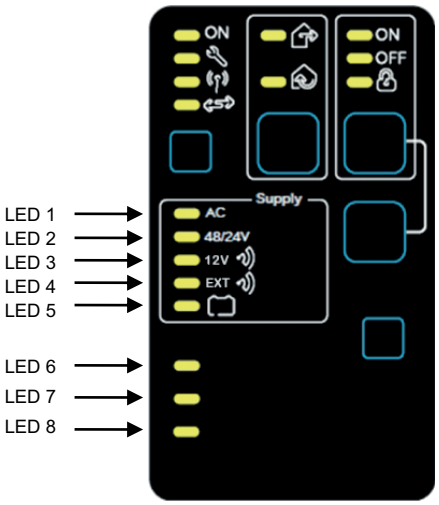


Customizing the LEDs

The color of 8 of the LEDs on the front of the HU250 module can be customized:

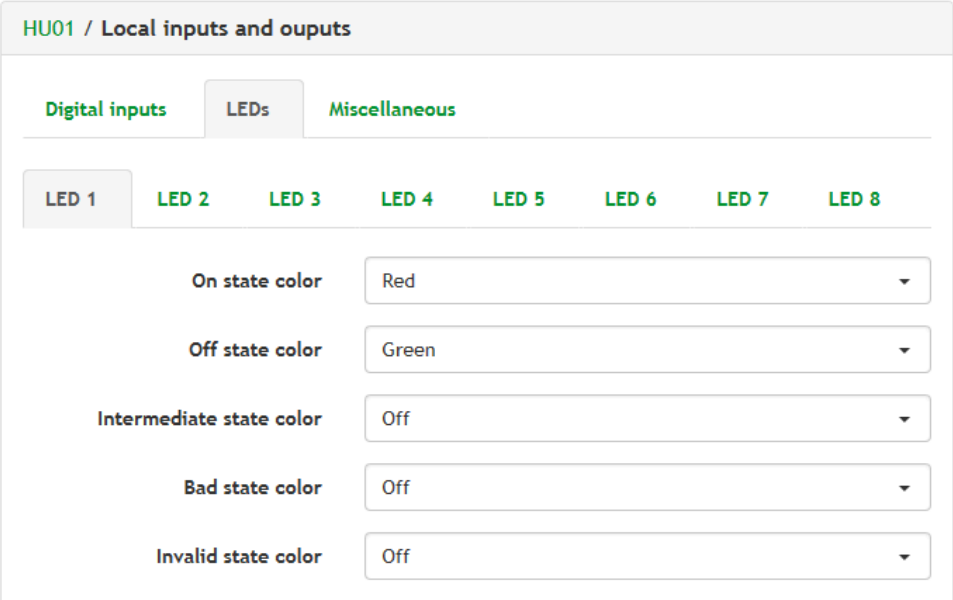
- LEDs 1 to 5 are assigned to potential issue indication functions relating to the PS50 module power supplies or battery (refer to the HU250 Installation Guide, reference NHA77925, or PKR45928 (for HU250 without wireless unit) for more information about each LED). The colors of these LEDs can be customized for each state.
- LEDs 6 to 8 are free to assign as required; their uses can be defined in the Easergy Builder tool (refer to the corresponding section in the Quick Start Guide (NT00383)). The colors of these 3 LEDs can also be customized for each state.

Customizable LEDs on the front of the HU250 module:



LED color parameter setting

Settings > HU01 > Local inputs and outputs page



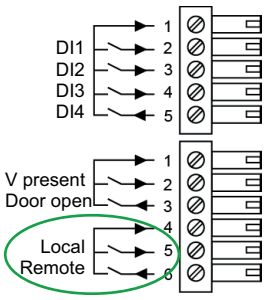
Parameter	Default	Configuration range	Description
LEDs 1 to 8			
On state color	Red (LED 1 to 5) Orange (LED 6 to 8)	• Off • Red • Green • Orange	Choice of color for LEDs 1 to 8 for the active state of the data.
Off state color	Green (LED 1 to 5) Off (LED 6 to 8)	• Off • Red • Green • Orange	Choice of color for LEDs 1 to 8 for the inactive state of the data.
Intermediate state color	Off (LED 1 to 5) Green (LED 6 to 8)	• Off • Red • Green • Orange	Choice of color for LEDs 1 to 8 for the intermediate state of the data. The intermediate state can be, for instance, the transitional phase of a change of state.
Bad state color	Off (LED 1 to 5) Red (LED 6 to 8)	• Off • Red • Green • Orange	Choice of color for LEDs 1 to 8 for a bad state of the data. A bad state may be an unexpected state for the data.
Invalid state color	Off (LED 1 to 8)	• Off • Red • Green • Orange	Choice of color for LEDs 1 to 8 for an invalid state of the data. An invalid state corresponds to a missing known state for the data.

External Local/Remote Switch

The last 2 digital inputs on the HU250 module terminal block are customizable. By configuration, it is possible to use them to connect an external local/remote switch if required (for dry loops).

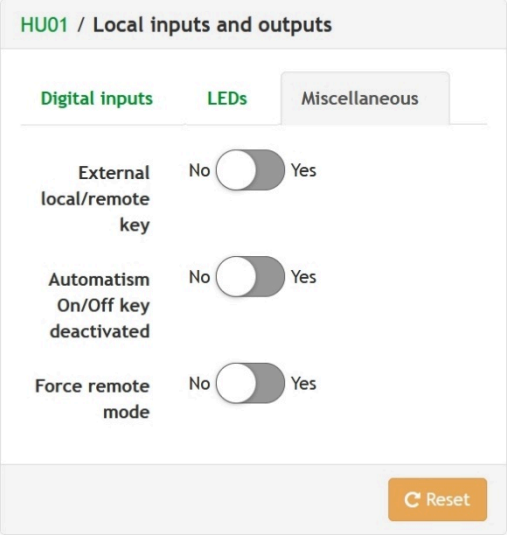
Note that if this option is used, the Local/Remote button on the front of the HU250 module becomes inoperative. Only the external switch can then be used to change from local to remote mode on the T300.

Local/Remote inputs on the HU250 module



External local/remote option parameter setting

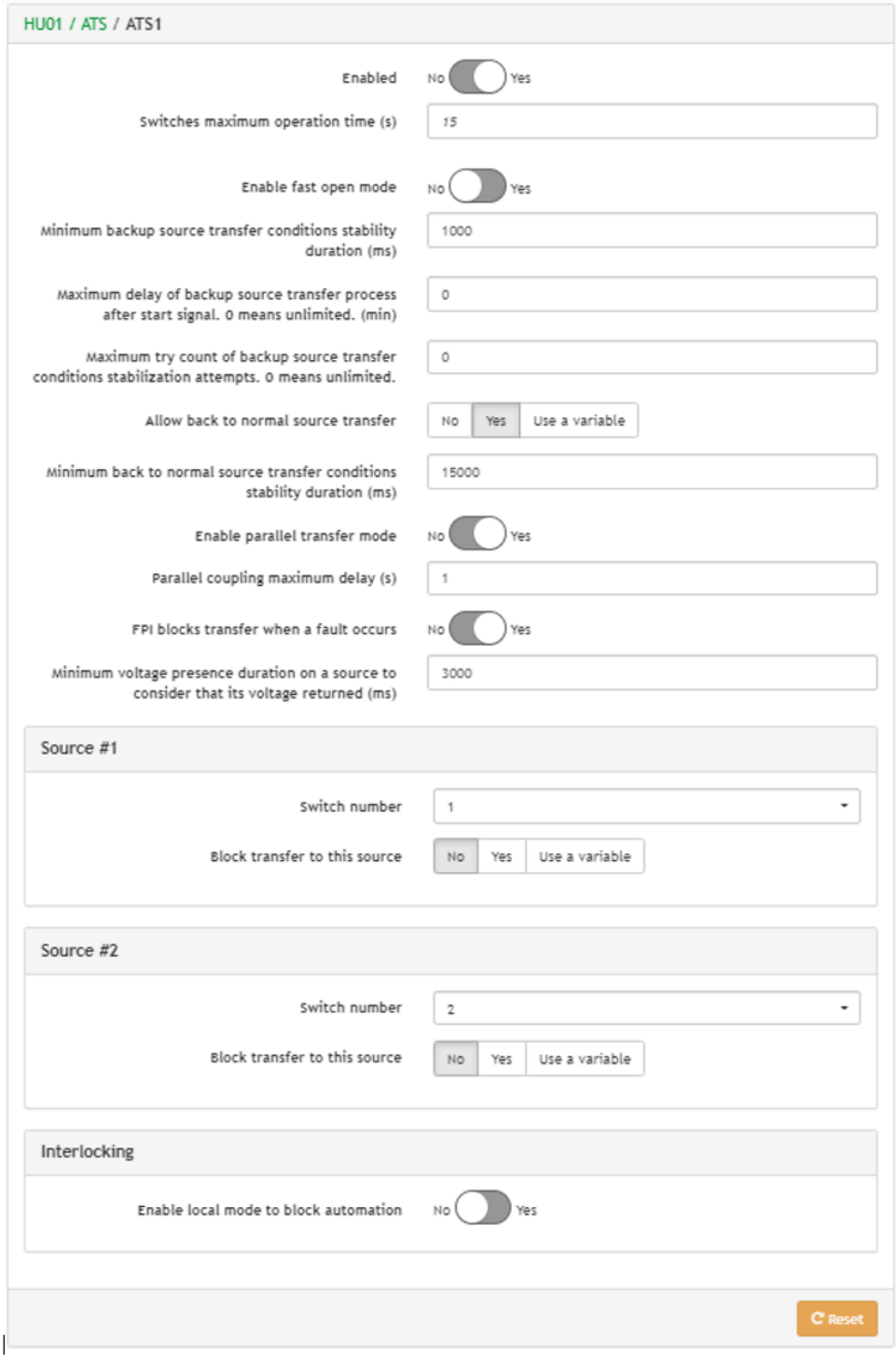
Settings > HU01 > Local inputs and outputs page



Parameter	Default	Configuration range	Description
Miscellaneous			
External local/remote key	No	• Yes • No	Enables the use of digital inputs "Local/Remote" to acquire dry loops from an external local/remote switch. If this parameter is set to No, both digital inputs can be used as any other standard digital input.
Automatism On/Off key deactivated	No	• Yes • No	Deactivation of the global automation ON/OFF function on all SC150/SC160 modules. If this parameter is set to Yes, the ON/OFF button to Enable/Disable the automation on the front panel of the HU250 becomes inoperative (the automation stays in OFF position). The Enable/Disable function of the automation via the Web interface (**Monitoring&Control** / **Substation** page) or via the Scada protocol are also inoperative. Note: This deactivation of the ON/OFF automation function can also concern the automation systems programmed on the HU250 via ISaGRAF®, if the ON/OFF command has been programmed on these automations.
Force remote mode	No	• Yes • No	Deactivation of the local/remote pushbutton on the HU250 module. When the setting value is Yes, the local/remote mode turns to Remote and the corresponding LED is lit on the front of the HU250 module. See section Local/Remote Mode for more information about the mode.

Automatic Transfer Switching (ATS)

Access via **Settings > HU01 > ATS** page.



This function is optional on the HU250. If the T300 system has at least two SC150/SC160 modules, it can be configured with an Automatic Transfer Switching function (ATS). If this option is not configured, the corresponding parameter setting page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the extended display for the ATS function from the main view of the Substation page. See the relevant section for more information on displaying these measurements

If an SC160 module has tripped and is in tripping locked out, it is not controlled by ATS or other automation running on the Head Unit.

ATS Automatic Control (Transfer of Source)

Automatic transfer switching minimises power interruptions by transferring the load from the normal source to an alternate source when the normal source is temporarily unavailable. When the normal source becomes unavailable, the system transfers to the alternate source. If configured, once voltage returns to the normal source, the system automatically switches back.

The ATS function for the T300 is designed for the case when both sources are connected to utility networks. The switch operations are executed as open operations first. In the case of back to normal operation (in **Self-return** mode), the parallel coupling is possible. In this case, the two sources must be synchronized (controlled by RSYN_REL signal).

The ATS function can be used with standby generators but this requires additional custom logic to be defined using formulas or ISaGRAF®.

NOTE: ATS requires a voltage presence/absence indication per module. This can either be the voltage measurement sensors or the digital input DI6. For more information, see the Front panel voltage indication section.

⚠ CAUTION

HAZARD OF UNEXPECTED EQUIPMENT OPERATION

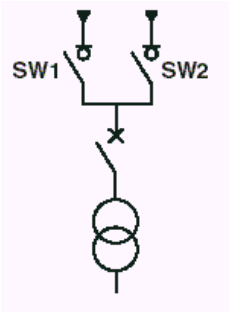
- In case of automatic parallel coupling management (with formulas or ISaGRAF®), both sources must be synchronized before the parallel coupling.
- Use a synchro-check relay to control the synchronization of both sources.
- Information from the synchro-check must be used by the automatism to enable the transfer.

Failure to follow these instructions can result in injury or equipment damage.

ATS Operating Modes

The ATS can operate in several different modes depending on the settings. The initial conditions are that voltage is present on both sources, the switch is closed for the active source, and the switch is open for the inactive (backup) source.

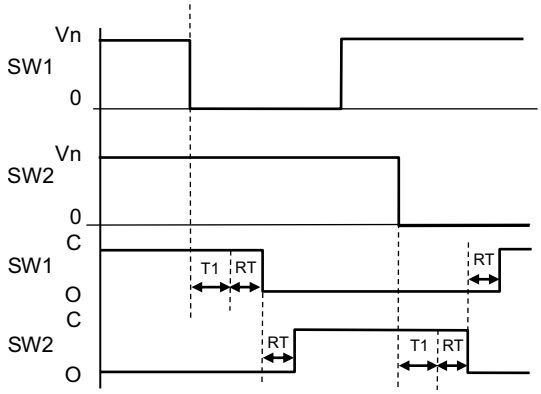
Network ATS used with T300:



Auto-Return mode SW1 ←→SW2 mode

In the event of a voltage loss for time delay T1 on the active source, the automatic transfer system switches to the other source. In this mode, there is no concept of priority source. After the voltage returns on the original source, the ATS remains in the ready state and only switches back when voltage is lost on the current active source.

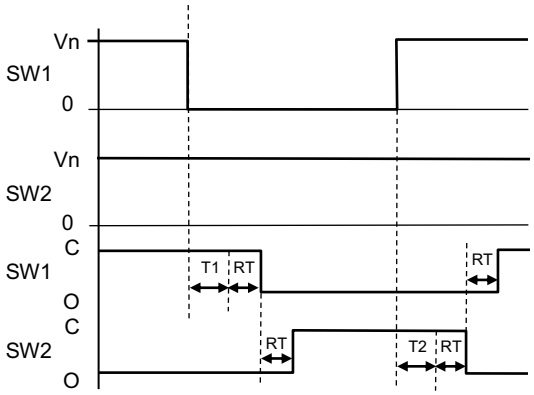
Auto mode:
RT = Switch response time



Self-Return mode

In this mode, **source #1** is considered the normal source and **source #2** is considered the backup source. In the event of a voltage loss for time T1 on the normal source, the ATS system switches to the backup source. The system remains in this state while the voltage is absent on the normal source. When the voltage returns on the original source for time T2, then the ATS automatically switches back.

Self-Return mode:
RT = Switch response time



No Return SW1 ➔SW2 or SW2 ➔SW1 mode

This mode only allows transfers in one direction. After a transfer, the system remains in that state whether or not the voltage returns on the original source.

To select a **No Return** mode, use the settings **Allow back to normal source transfer** = **No** and select the appropriate values for source settings **Block transfer to this source**.

Changeover sequence

The ATS goes to the ready state if the following conditions are met:

- ATS control enabled.
- Position of channel 1 and 2 switches complementary: SW1 in closed position and SW2 in open position (or SW2 closed and SW1 open).
- MV voltage present on both channels.

Changeover is triggered by MV voltage absence and takes place if the following conditions are met:

- ATS control enabled
- Position of channel 1 and 2 switches complementary: SW1 in closed position and SW2 in open position (or SW2 closed and SW1 open)
- Source transfer locking absent
- MV voltage absent on the active source
- MV voltage present on the inactive source

In the Self-Return mode, the changeover is triggered if:

- the normal source switch is open
- the MV voltage on the normal source is present.

Source Transfer Locking

Changeover can be blocked for the ATS by various inputs depending on the configuration.

The ATS system can use the values of CoreDB variables for dynamically blocking or allowing transfers. The particular variables to be used, for example, specific digital inputs, must be configured using Easergy Builder by defining the ATS bin controller as a destination. Different variables can be used for different blocking conditions, for example, blocking all transfers or blocking self-return transfers.

Automation enable/disable

The HU250 module has parameter settings to enable or disable the ATS automation. In addition, automation functions are enabled or disabled globally on the T300 either remotely from the SCADA system or locally:

- By pressing simultaneously the (automation state change) and **OK** buttons on the front of the HU250 module.
- Via the Web server (on the **Monitoring & control/Substation** page).

ATS Parameter Setting

ATS parameter setting for the HU250 module:

Parameter	Default	Configuration range	Description
		ATS0x	
Enabled	No	• Yes • No	Activation of automatic transfer switching function(1)
Switches maximum operation time (ms)	15,000	1,000-30,000	Maximum wait time for the switch to change position(2)
Enable fast open mode	No	• Yes • No	Activation of a faster mode. In fast open mode, the process is shortened by removing some controls. This mode is adapted to installations with hardware interlocking. It enables a faster transfer. This option should be activated only with specific installations that have mechanical interlocking between the two sources (eg: NSM cubicle). In this case; some firmware checks are skipped, allowing a faster transfer (<300 ms).
Minimum backup source transfer conditions stability duration (ms)	1,000	0-120,000	Time that voltage must be absent on the currently active source to trigger a transfer switching sequence. Note: not visible in **fast open mode**, where the transfer is immediately executed.

Parameter	Default	Configuration range	Description
Maximum delay of backup source transfer process after start signal. 0 means unlimited. (min)	0	0-10	Time before lockout, in the case where the voltage on the current active source repeatedly changes between present and absent. A value of 0 means that this delay is unlimited.
Maximum try count of backup source transfer conditions stabilization attempts. 0 means unlimited.	0	0-4	Maximum number of voltage absences before lockout, in the case where the voltage on the current active source repeatedly changes between present and absent. A value set to 0 means unlimited attempts.
Allow back to normal source transfer	No	• Yes • No • Use a varaible	Controls the behaviour after a transfer to the backup source and voltage returns on the normal source. **No** means that the ATS waits for voltage absence on the backup source. **Yes** means that the system transfers back to the normal source. **Use a variable** means that back to normal is enabled depending on the value of a variable (coordinate AATS_BLK_SELF_RE T).
Minimum back to normal source transfer conditions stability duration (ms)	15,000	0-21,600000	Timeout related to the Self-Return mode. If **Allow back to normal source transfer** is **Yes** or **enabled by a variable**, then when the voltage is detected as present on the normal source for this time period, and there are no other blocking conditions, a transfer switching sequence is be started.
Enable parallel transfer mode	No	• Yes • No	If **Allow back to normal source transfer** is **Yes** or **enabled by a variable**, the parallel mode is allowed in automatic mode. Activating this option enables paralleling of the channels by automatic control, during the phase of automatic return to the normal source. **NOTE:** Perform this operation when both sources are synchronized. The signal RSYN_REL (by default DI2 of the HU250) is used for this purpose and must be activated to authorize paralleling.
Parallel coupling maximum delay (s)	1	0-180	Maximum duration to wait for the synchronization of the sources. During this period, the transfer is launched as soon as RSYN_REL is present. If after this period the RSYN_REL is not present, the transfer is cancelled and the ATS is locked.
FPI blocks transfer when a fault occurs	Yes	• Yes • No	Controls whether transfers are blocked when the configured fault indication variable is active.
Minimum voltage presence duration on a source to consider that its voltage returned (ms)	3,000	0-30,000	After a reset, minimum voltage presence duration of the active source to consider that its voltage has returned. This timeout is used only on the first phase of the ATS after initialization, to check that the network is stable enough to start the process.
Source # 1			
Switch number	1	Undefined, 1-24	Number of SC150/SC160 switch control module for the normal source. For example, 1 means module SC01.
Block transfer to this source	No	• Yes • No • Use a variable	Blocks or allows transfer to this source. Use a variable means that the system uses the value of a variable(3). Value 0 means **Allow transfer**. Value 1 means **Block transfer**.
Source # 2			
Switch number		Undefined, 1-24	Number of the SC150/SC160 switch control module for the normal source. For example, 2 means module SC02.
Block transfer to this source		• Yes • No • Use a variable	Blocks or allows transfer to this source. Use a variable means that the system uses the value of a variable(3). Value 0 means **Allow transfer**. Value 1 means **Block transfer**.
Interlocking			
Enable local mode to block automation	Yes	• Yes • No	**Yes** means that the ATS automation is blocked when the control mode is **Local**. It will be operational only if the control mode is **Remote**. **No** means that the ATS automation is operational regardless of the control mode. See *Local/Remote Mode* section

(1): The Automation cannot be enabled if the switch number is undefined.

(2): The maximum switch number will be set to the number of SC150/SC160 modules configured for T300 system.

(3): The **Block transfer to this source** option **Use a variable** requires suitable configuration in CoreDB (see next page).

The ATS system can use the values of CoreDB variables for dynamically blocking or allowing transfers. The particular variables to be used (for example, digital inputs) must be configured using Easergy Builder by defining the ATS Device as a destination with the appropriate coordinates. If needed several variables can be defined with the same ATS destination coordinate. In this case, for that coordinate, the ATS function automatically uses the logical-OR of the variable values.

Destination Device	Destination Coordinate	Description
ATS1	AATS_BLK	If any of the variables with this destination coordinate have value 1 then all transfers are blocked with result "transfer blocked".
ATS1	AATS_PWR_BLK	If any of the variables with this destination coordinate have value 1 then all transfers are blocked with result "switch control power absent".
ATS1	AATS_BLK_RET	If any of the variables with this destination coordinate have value 1 then self-return transfers are blocked. Only applies if setting **Allow back to normal transfer** is **Yes**.
ATS1	AATS_BLK: SOURCE01	If any of the variables with this destination coordinate have value 1 then transfers to source 1 are blocked. Only applies if for source #1, the setting **Block transfer to this source** is **Use a Variable**.
ATS1	AATS_BLK: SOURCE02	If any of the variables with this destination coordinate have value 1 then transfers to source 2 are blocked. Only applies if for source #2, the setting **Block transfer to this source** is **Use a Variable**.

Refer to the *Easergy Builder User Manual* for more information on how to change configurations.

Zigbee Network for Condition Monitoring

The Zigbee network is used to manage the devices (sensors) installed to provide data to monitor the following conditions:

- Environmental conditions in the substation and cubicles, with CL110 sensors
- Thermal conditions on cables, busbars or transformers, with TH110 sensors

For specific use cases, you may need to review the Zigbee network settings. To set up the Zigbee Network for Condition Monitoring, proceed as follows:

1. Commission the Zigbee network. Refer to Zigbee network parameters, page 184.
2. Commission installed sensors by pairing them with the Zigbee network. Refer to the detailed procedure in the Maintenance/Zigbee Network Management, page 450 in the *Maintenance* chapter.
3. Set up the installed sensor parameters. Refer to Setting Zigbee Network Device Parameters, page 185.
4. Set up the Condition monitoring to set up the alarm display.

Up to 60 Zigbee devices can be defined.

Setting Condition Monitoring

Accessed via ***Settings/HU01/Condition Monitoring*** page.

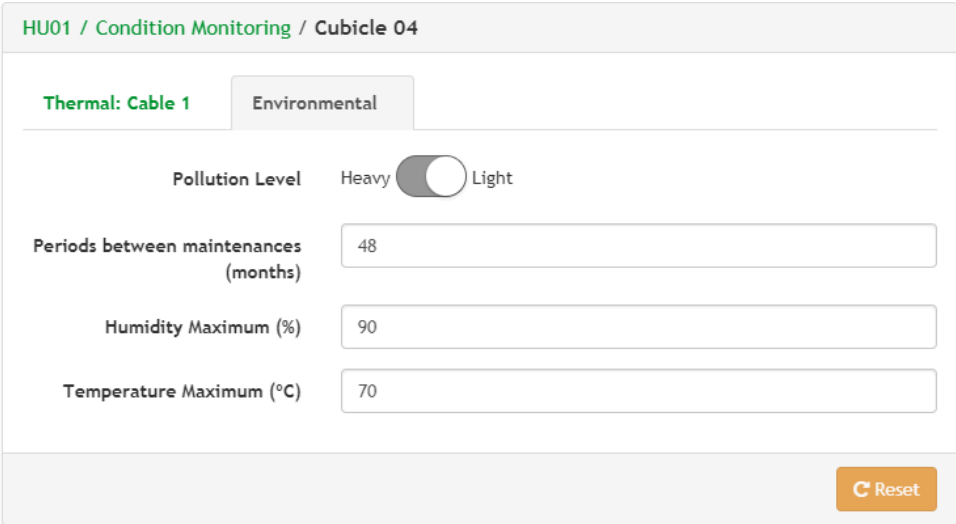
This page displays two tabs to define settings to monitor the following conditions:

- Environmental conditions in the substation and cubicles
- Thermal conditions on cables

Monitoring of the Environmental Conditions

Settings for environmental monitoring algorithm

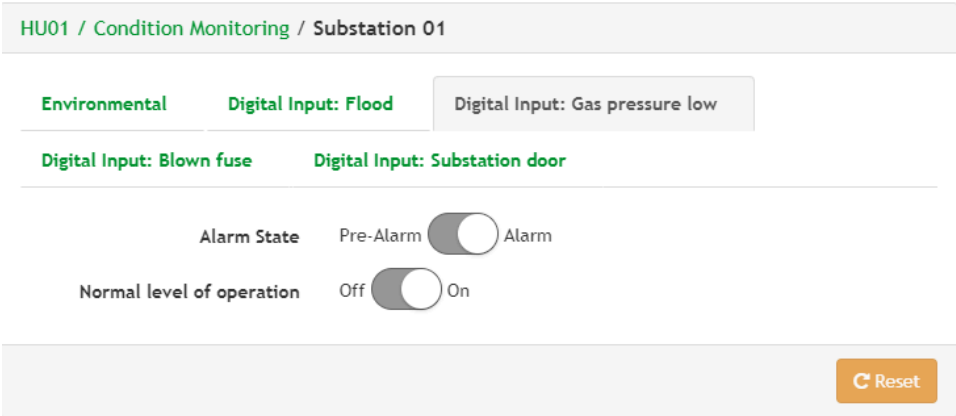
Example of **Environmental Condition Monitoring** settings



Parameter	Default	Configuration range	Description
Pollution Level	LIGHT	• HEAVY • LIGHT	Pollution Level
Periods between maintenances in months	60	1 – 240	Maximum period between maintenance inspections in months
Humidity Maximum (%)	90	50.0 – 95.0	Maximum value (%) of humidity that can be reached without triggering the pre-alarm
Temperature Maximum (ºC)	70	30.0 – 80.0	Maximum value of temperature (ºC) that can be reached without triggering the pre-alarm

Setting alarm on customized digital input

Example of a customized **Gas pressure low alarm** settings



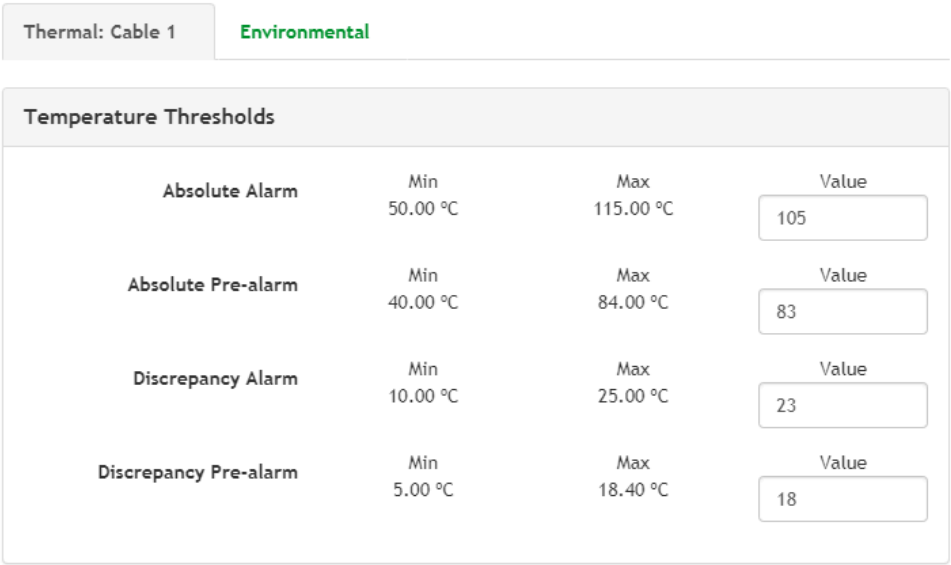
Parameter	Default	Configuration range	Description
Alarm State	Alarm	Alarm or Pre-alarm	To trigger an Alarm or a Pre-alarm when the state of data provided by the sensor is different from its normal level of operation
Normal level of operation	On	• On • Off	Define if the normal state of the data provided by the sensor is **On** or **Off**:

Monitoring Connection Temperature

Setting parameters

Parameter	Default	Configuration range	Description
Absolute Alarm (ºC)	75	50 – 115	Maximum value (ºC) before triggering an alarm (= TMPMAXPH)
Absolute Pre-alarm (°C)	60	40 – (0.8 * TMPMAXPH)	Maximum value (ºC) before triggering a pre-alarm
Discrepancy Alarm (ºC)	10	10 – 25	Maximum discrepancy between phases (ºC) before triggering an alarm (= TMPMAXDIS)
Discrepancy Pre-alarm (ºC)	8	5.00 – (0.8 * TMPMAXDIS)	Maximum discrepancy between phases (ºC) before triggering a pre-alarm

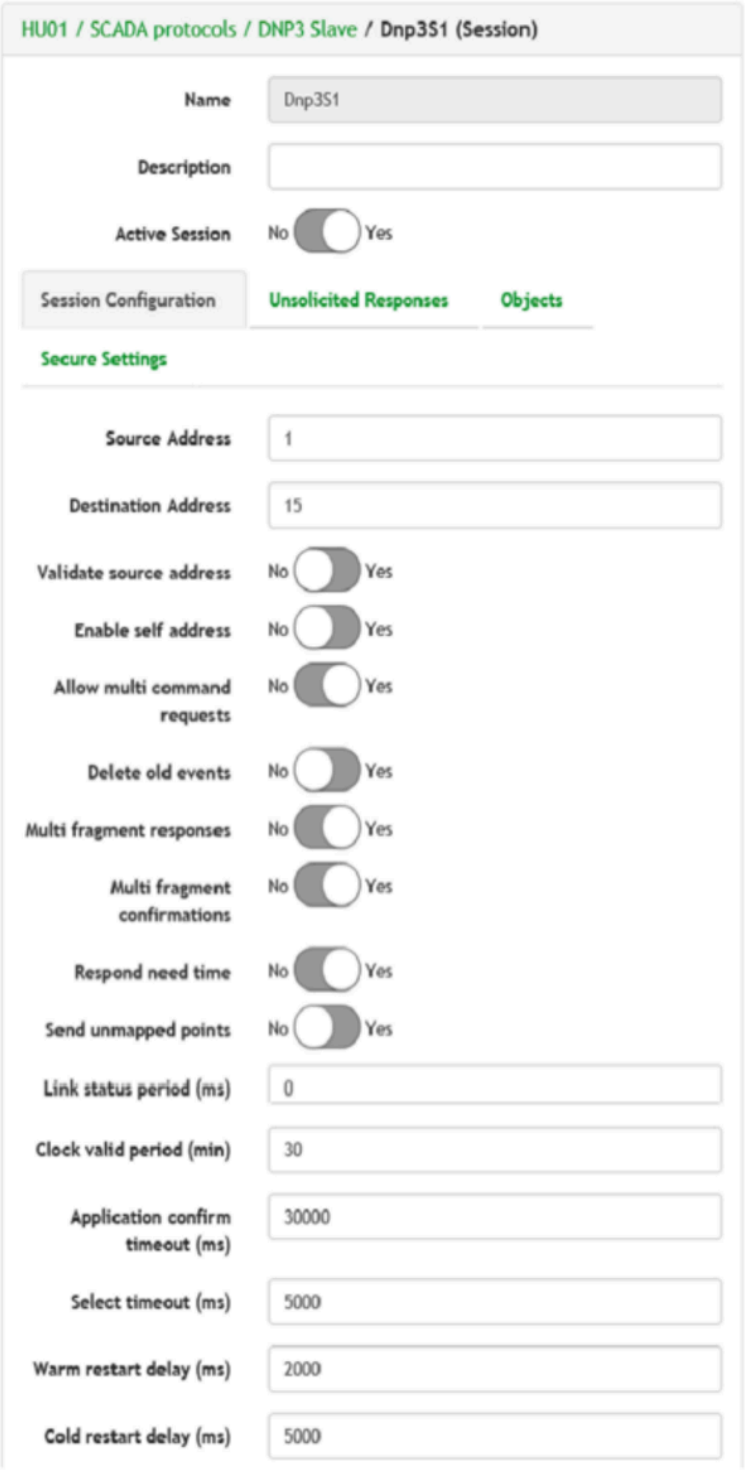
Example of connection temperature monitoring settings:



SCADA Protocols

Access via **Settings > HU01 > SCADA protocols** page.

Example of a SCADA protocol settings page - DNP3 outstation



The SCADA protocols are those protocols that can be used for remote communication between the T300 and the SCADA system via modems or IP access. These protocols are server type since the SCADA system is the client for communication management and the T300 is the server.

There are several SCADA protocols available on the T300. The protocol requested at the time of the order is configured in the product before delivery:

- DNP3 outstation
- IEC 60870-5-101 controlled station

- IEC 60870-5-104 controlled station
- Modbus server
- IEC 61850 protocols server
- MQTT publisher/subscriber

The parameters displayed in the Web page correspond to the application parameters of the protocol installed in the T300. These parameters can be adjusted according to the use and the protocol parameter settings at the SCADA system end.

In contrast to other protocols, the IEC 61850 application parameters can be configured only in Easergy Builder and do not appear in the Web server. Refer to the protocol user manual for details on parameter settings.

Easergy Builder is used for the advanced protocol configuration and SCADA addressing. Refer to the protocol User Manual and the Quick Start Guide (ref: NT00383) for more information on advanced configuration.

Client Protocols

Access via **Settings > HU250 > Client protocols** page.

The client protocols are those protocols allowing the HU250 to communicate as the client with auxiliary equipment or an external IED installed in the MV substation (server).

For example, communication between the HU250 and the PS50 power supply is via the RS485 serial link on the Modbus client protocol.

The following client protocols are available for the T300:

- Modbus client
- Modbus Sepam
- DNP3 Master station
- IEC 60870-5-101 controlling station
- IEC 60870-5-104 controlling station
- Zigbee client
- IEC 61850 MMS or GOOSE client
- MQTT publisher/subscriber
- SNMP manager

When installed on the T300, the Modbus client protocol parameters can be defined in the **Client Protocols** page in the Web server in the same way as the server protocols. These parameters can be adjusted according to the use and the equivalent protocol parameter settings at the external IED end.

In contrast to the Modbus client and Zigbee client protocols, the DNP3 Master station, Modbus Sepam, IEC 60870-5-101, IEC 60870-5-104 controlling stations and IEC61850 client protocol, and SNMP Manager application parameters can only be configured in Easergy Builder and do not appear in the Web server.

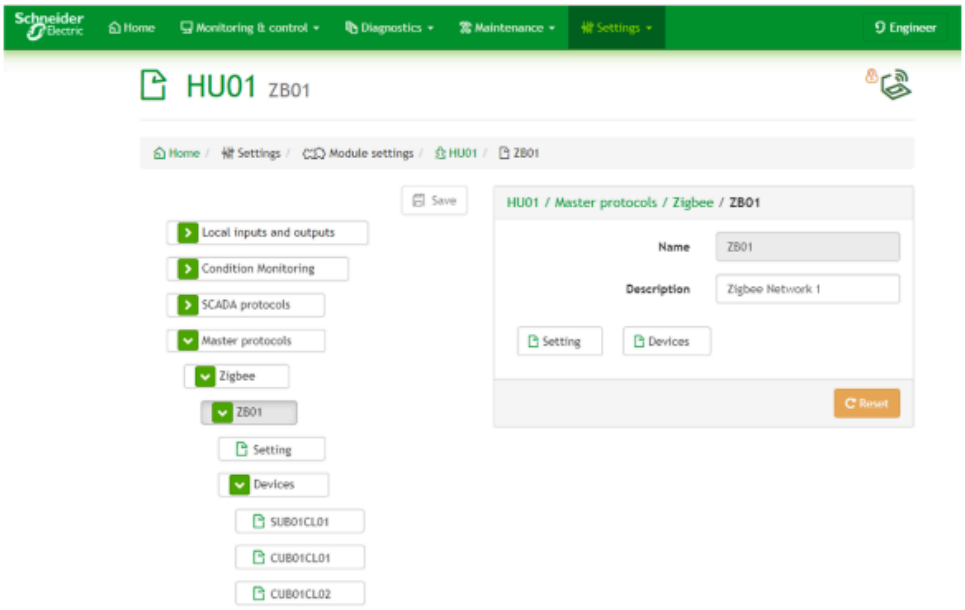
Refer to the User Manual for the protocol in question and the Easergy Builder manual for more information on parameter settings and advanced configuration.

Zigbee Client Protocol

Accessed via **Settings > Module settings > HU250 > Client protocols > Zigbee** page

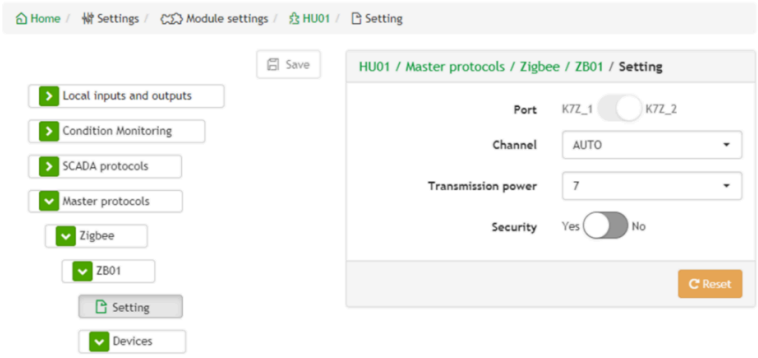
The Zigbee protocol is used to manage devices (sensors) to monitor the environmental conditions and the thermal conditions on the cables, in the substation or the cubicles.

Example of a Zigbee protocol definition page



Setting Zigbee Network Parameters

Access via **Settings > Module settings > HU250 > Client protocols > Zigbee** page, then click **Setting**.



Parameter setting:

The **Port** parameter, already set up, indicates where the Zigbee box (K7) is connected. Change default settings only if required.

Parameter	Default	Configuration range	Description
Channel	AUTO	• AUTO • 11 – 26	Zigbee radio channel configured. **AUTO**: the channel is selected automatically by K7Z at network creation. IMPORTANT: The change of the radio channel impacts the network creation. To change the channel, you must first unpaired all paired devices and create a new network. See *Maintenance/Zigbee Network Management* page.
Transmission power (db)	7	0 – 7	Transmission power expressed in decibels. Maximum value by default. Can be reduced in some cases, for example to avoid perturbations between different near sites.
Security	YES	• YES • NO	Not used. CL110, TH110 devices are always commissioned with authentication and encryption options.

Setting Zigbee Network Device Parameters

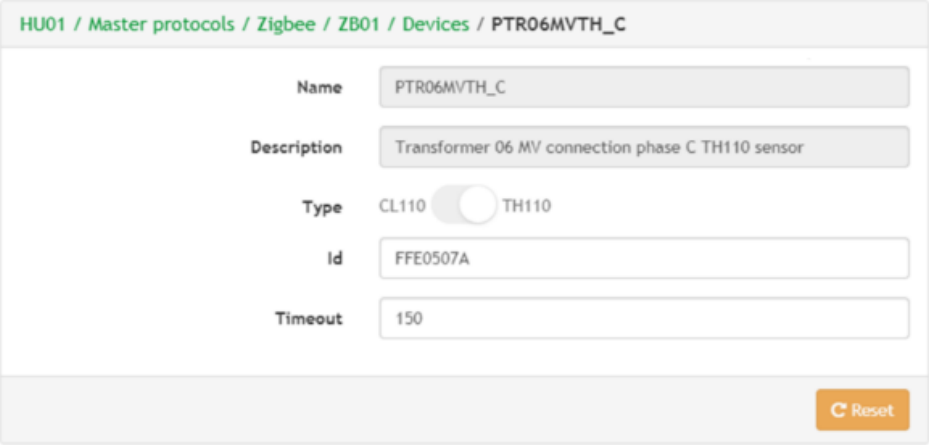
Accessed via **Settings > Module settings > HU250 > Client protocols > Zigbee** page, then click ***Devices***.

This page allows you to:

- Change the Zigbee sensor parameters
- Define the sensor ID for sensors with unknown IDs.

The environmental and connection temperature sensors are managed by the Zigbee network. Refer to the Maintenance/Zigbee Network Management, page 450 page in the *Maintenance* chapter for more details.

Example of a TH110 sensor commissioning:



Setting TH110 or CL110 sensors:

The **Name**, **Description** and **Type** data for the device is already configured (using Easergy Builder). The sensor ID is also pre-configured, but a Sensor ID can be defined when missing, for example when replacing a sensor.

Parameter	Default	Configuration range	Description
ID	FFFFFFFF	32 bits hexadecimal	Device unique identifier. The value FFFFFFFF is interpreted as “unknown” which means that the device is not configured but it is discovered during the “pairing process”. See Maintenance/Zigbee Network Management, page 450 page.
Timeout (seconds)	150 for TH110 300 for CL110	120 – 62535	Time in seconds without receiving data to consider that the device is “offline”.

When a Zigbee sensor is defined, it must be enabled on the Zigbee Network. This action is done from the Zigbee Network Management, page 450 page, described in the *Maintenance* chapter.

Configuring the Physical Ports

Accessed via: ***Settings/HU01/Physical ports configuration*** page

The physical ports correspond to the modems installed in the T300 managing "serial" type communications.

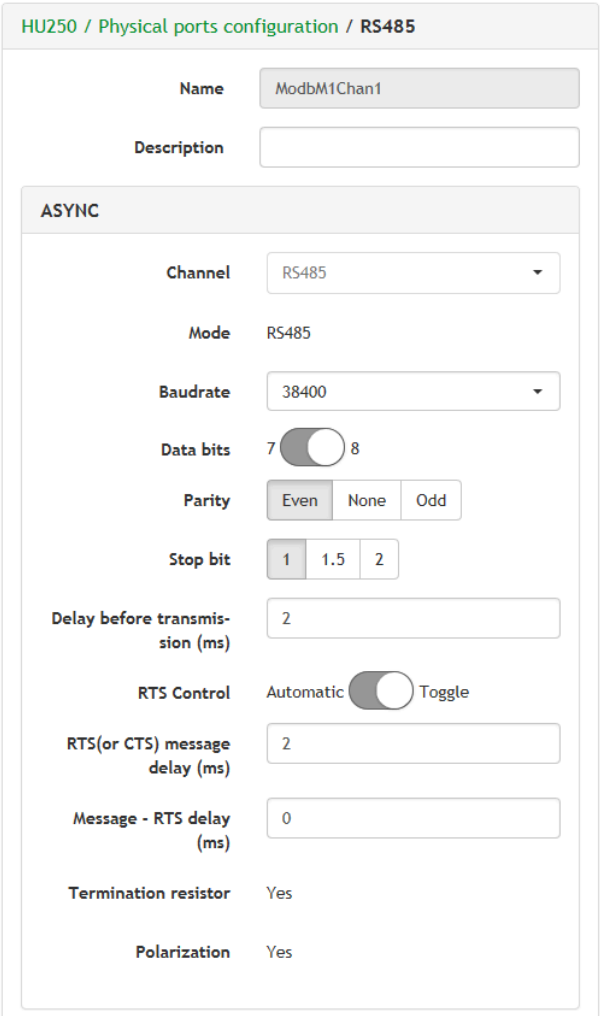
There are 2 types of physical port available:

- **RS-485**: RS-485 Modbus network port. This port is used for internal communication between the HU250 and the PS50 power supply.
- **RS MODEM BOX SLOT (1) or (2)**: Port that can be used for an RS-232/RS-422/RS-485 "serial" type link to the SCADA system or an external IED installed locally in the MV substation

Internal RS485

Since this type of link is used for internal communication between the HU250 and the PS50 power supply, it is recommended that this factory setting is not modified. If the setting is changed, take care not to modify the PS50 communication parameters as well as this link may cease to operate correctly.

Example of settings for the **Internal RS485** port:



Setting the Internal RS485 link

Parameter	Default	Configuration range	Description
Channel	RS485	RS485	Type of port/modem used
Transmission power (db)	RS485	RS485	Choice of link mode
Baudrate (bds)	38400	• 300 • 600 • 1200 • 2400 • 4800 • 9600 • 19200 • 38400	Transmission speed used on the internal RS485 link between the HU250 and the PS50 power supply.
Data bits	8	7 or 8 bits	Number of bits defining the frame. The 8th bit provides the required parity information.
Parity	Even	• Even • None • Odd	Parity method to be used. Parity allows errors to be detected during transmission. A binary word is even if the number of "1s" it contains is even.
Stop bit	1	1, 1.5, or 2 bits	Number of stop bits used to define the end of a frame
Delay before transmission (ms)	2	0 – 65532	Delay before transmission of a message (response). This delay helps prevent a potential signal overlap between the message received and the message transmitted.
RTS control	Auto-matic	• Automatic • Toggle	Method for managing the RTS signal: automatic or delayed
RTS (or (CTS) message delay (ms)	2	0 – 65532	This delay can only be configured if RTS Control is set to Toggle. It is the delay between the changeover to the active state of the RTS (or CTS if this signal is used) and the start of message transmission. Typically, this delay is used to help avoid the need to truncate the start of the message by the modem prematurely changing over to transmission mode.
Message – RTS delay (ms)	0	0 – 65532	This delay can only be configured if RTS Control is set to Toggle. It is the minimum wait time following transmission of a message before the RTS drops out. This delay is used to help avoid truncation of the end of the message by the modem prematurely dropping out of transmission mode.
Terminator resistor	Yes	Yes	Use of RS485 line termination resistors at the T300 end. In theory, the line terminator must be activated at both ends of the RS485 line, especially for long distance lines.
Polarization	Yes	Yes	Used to polarize the RS485 line at the T300 end. In theory, the RS485 line only needs to be polarized at one end, preferably at the Client (T300) end.

NOTE: The grayed-out parameters are fixed, they cannot be modified.

RS Modem Box

Since this type of link is used for connecting to a SCADA system, device, or external modem, the parameter settings need to be customized according to certain criteria.

Configuration Process

The T300 is supplied with a default factory configuration corresponding to the type of modem installed.

The settings of this modem (specifically the speed, modem management signals, and associated delays) may need to be adjusted according to the requirements of the external modems used or possibly the transmission network.

In terms of adjusting the transmission delays, start by configuring high values for all delays and check first whether dialog has been established between the T300 and the remote device.

You can then gradually reduce the first delay to determine the modem operating limit in relation to the adjusted signal.

Once this has been established, increase the delay by a few milliseconds to maintain a buffer. Continue in the same way for the other delays.

This method allows you to optimize the T300 transmission times.

If there is any doubt about the configuration, it is advisable to leave the default values.

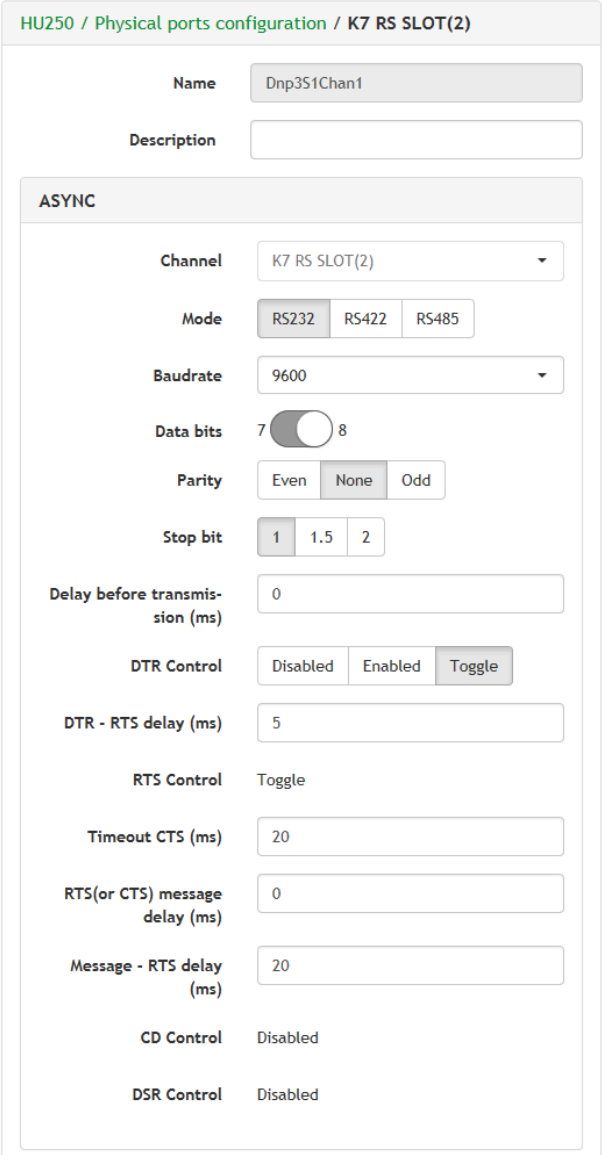
Setting RS modem box:

Parameter	Default	Configuration range	Description
Channel	K7 RS SLOT (i)	K7 RS SLOT (i)	Type of port/modem used (i = 1 or 2, depending on which slot the modem box is in on the HU250)
Mode	RS232	• RS232 • RS422 • RS485	Choice of link mode.
Baudrate (bds)	38400	• 300 • 600 • 1200 • 2400 • 4800 • 9600 • 19200 • 38400 • 56000 • 57600 • 115200	Transmission speed used on the external link between the HU250 and the other device. The speed used must be managed and configured in exactly the same way as the other remote modem.
Data bits	8	7 or 8 bits	Number of bits defining the frame. The 8th bit provides the required parity information.
Parity	Even	• Even • None • Odd	Parity method to be used. Parity allows errors to be detected during transmission. A binary word is even if the number of "1s" it contains is even.
Stop bit	1	1, 1.5, or 2 bits	Number of stop bits used to define the end of a frame.
Delay before transmission (ms)	2	0 – 65532	Delay before transmission of a message (response). This delay helps prevent a potential signal overlap between the message received and the message transmitted.
RTS control	Toggle	Toggle	Method for managing the RTS signal: automatically via the associated **RTS (or CTS) message delay**.
RTS (or (CTS) message delay (ms)	2	0 – 65532	This is the delay between the changeover to the active state of the RTS (or CTS if this signal is used) and the start of message transmission. Typically, this delay is used to help avoid the need to truncate the start of the message by the modem prematurely changing over to transmission mode. This delay is configurable only if the RTS control setting is configured to **Toogle**.
Message – RTS delay (ms)	0	0 – 65532	This is the minimum wait time following transmission of a message before the RTS drops out. This delay is used to help avoid truncation of the end of the message by the modem prematurely dropping out of transmission mode. This delay is configurable only if the RTS control setting is configured to **Toogle**.
Terminator resistor	No	• No • Yes	Parameter only available in RS-422 and RS-485 mode. Automatically set to **No** for RS-422. Use of RS-422/RS-485 line termination resistors at the T300 end. In theory, the line terminator must be activated at both ends of the RS-422/RS-485 line, especially for long distance lines.
Polarization	No	• No • Yes	Parameter only available in RS-422 and RS-485 mode. Automatically set to **No** for RS-422. Used to polarize the RS-485 line at the T300 end. In

Parameter	Default	Configuration range	Description
			theory, the RS-485 line only needs to be polarized at one end, preferably at the Client end.
Parameters only available for RS232 link			
DTR Control	Toggle	• Disabled • Enabled • Toggle	Method for managing the DTR signal. If **Toggle** is selected, DTR is managed via the associated **DTR - RTS delay**.
RTS Control	Toggle	• Automatic • Disabled • Enabled • Toggle	Method for managing the RTS signal. The choice of this management mode is configurable only if the DTR control parameter is set to **Enabled** or **Disabled**. Otherwise, this one is frozen at **Toggle**.
DTR – RTS delay (ms)	5	0 – 65532	Maximum wait time for the RTS signal after the DTR signal has been activated. If the RTS has not become active by the end of this delay, the T300 aborts transmission of the frame (see the description of the control signals below).
Timeout CTS (ms)	20	0 – 65532	Maximum wait time for the CTS signal after the RTS signal has been activated. If the CTS has not become active by the end of this delay, the T300 aborts transmission of the frame (see the description of the control signals below).
CD Control	Disa-bled	Disabled	If this parameter is enabled, the CD signal is managed during transmission exchanges with the modem.
DSR Control	Disa-bled	Disabled	If this parameter is enabled, the DSR signal is managed during transmission exchanges with the modem.

NOTE: The grayed-out parameters are fixed, they cannot be modified.

Example of settings for the K7 RS SLOT port in RS232 mode:



Modem Management Signals

The management signals below are listed in the order in which they come into play during communication between the T300 modem and the interface or the external modem, or even directly with the SCADA system.

- DSR (Data Set Ready):

  This signal may be sent to the T300 to indicate that the control center (or modem) is capable of transmitting (or simply that it is powered up). This signal is only used for an RS232 link (not used for radio link).

- CD (Carrier Detect):

  This signal, if it exists, is used to confirm receipt of the frame received. It may also serve to determine the occupancy on the transmission network.

- DTR (Data Terminal Ready):

  If the control center uses DSR, DTR is used to signal that the T300 is ready for the transmission (equivalent to DSR but in the other direction). For a radio link, this signal may be used by the T300 to command the changeover to transmission from a radio receiver if it requires different commands for the changeover to transmission mode and transmission of the carrier.

- RTS (Request To Send):

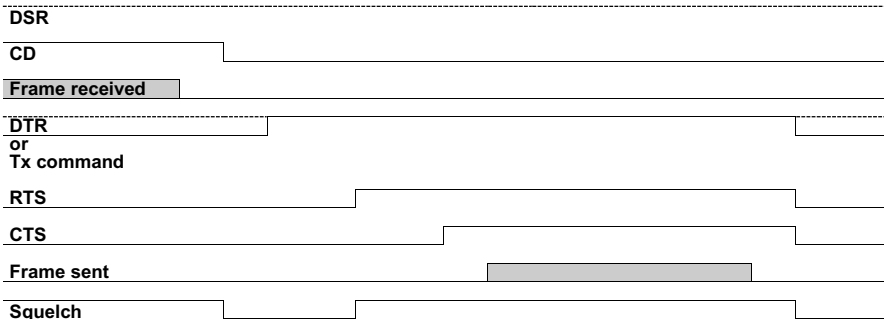
  This signal commands transmission of the carrier from the modem.

- CTS (Clear To Send)

  After the RTS signal has been picked up, the transmitter sometimes applies a power-up delay before being able to transmit the messages sent to it. This is especially true for radio devices. When the device is ready to send, it informs the T300 by sending the CTS signal. Waiting for the return of the CTS signal usually helps avoid the need to truncate the start of the message sent to the modem, simply because it is not ready to process the message.

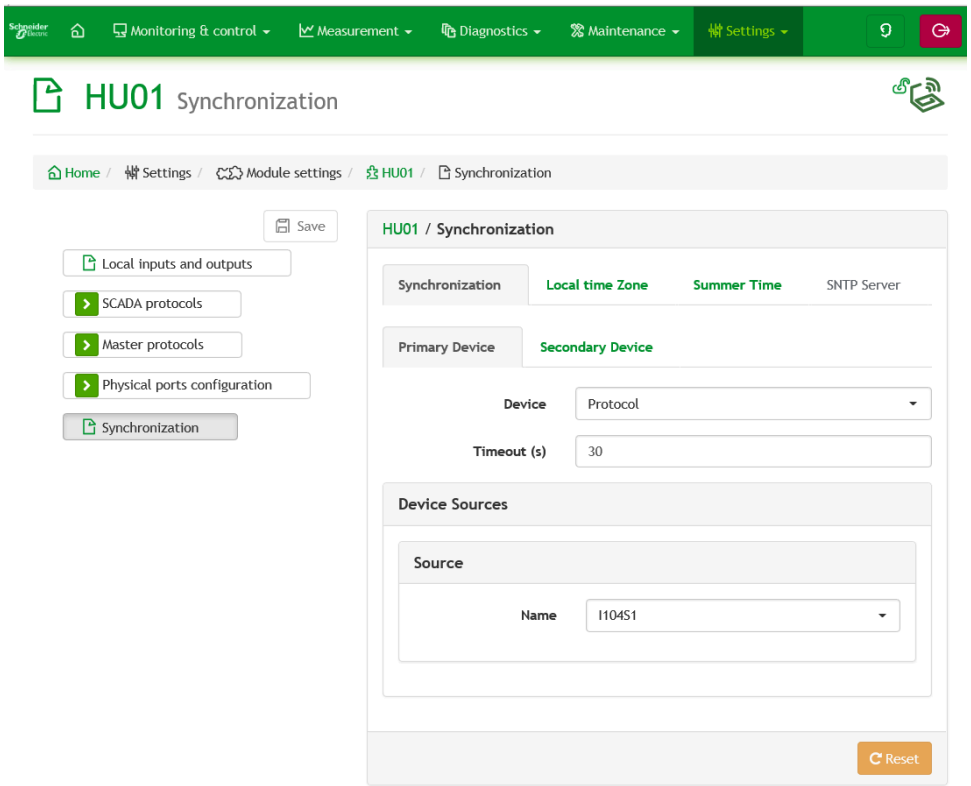
- Squelch:

  This signal is used in radio communications only to indicate the radio network occupancy status to the T300.



Synchronization

Access via **Settings > HU01 > Synchronization** page.



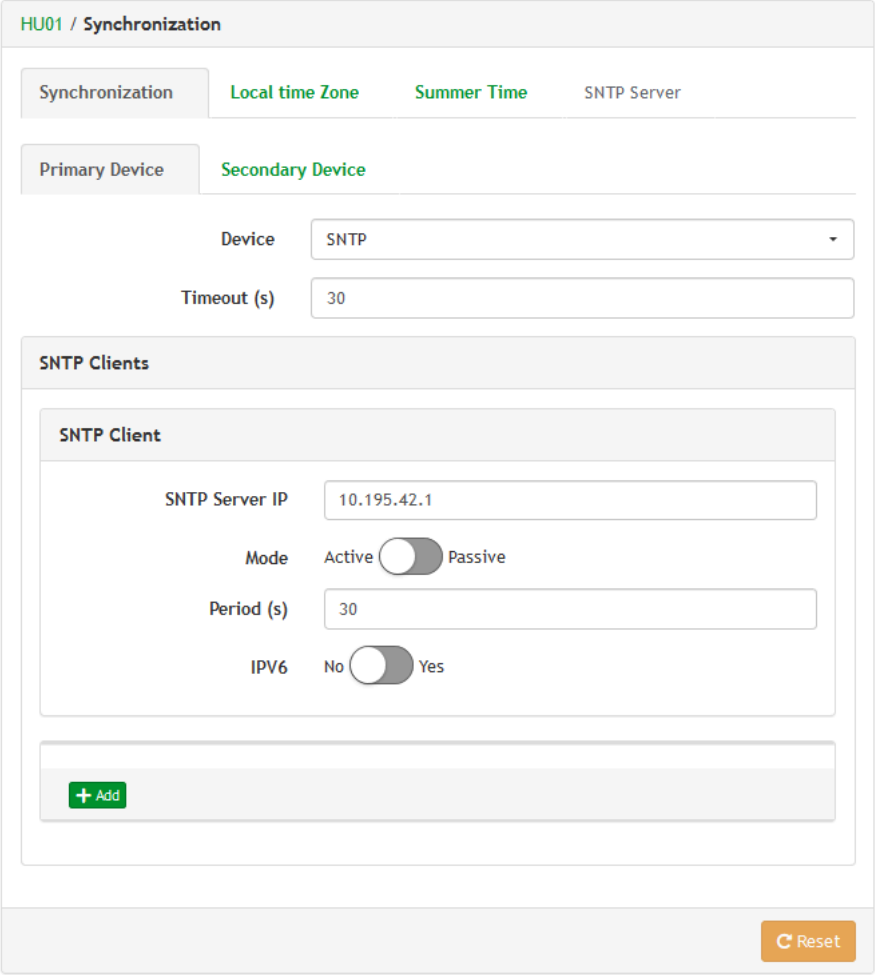
The T300 can be synchronized in several different ways:

- Automatically via the SCADA protocol.
- Automatically via an SNTP or NTP server, if the T300 is connected to an IP network.
- Automatically by GPS satellites reception, if the T300 includes a 4G modem with GPS option.

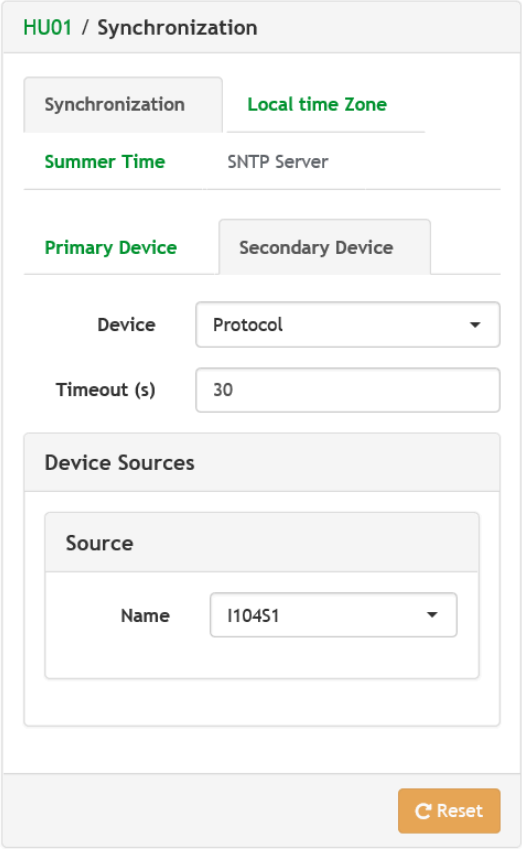
Two synchronization sources are defined in the T300: the primary device and the secondary device. The secondary device is used if the primary device is unavailable. Both these synchronization devices can be linked to either a protocol or an SNTP server or a GPS reception. This selection and the associated configuration are made in the Easergy Builder configuration tool.

Refer to the *T300 Quick Start Guide* (NT00383) for more information on how to configure synchronization sources.

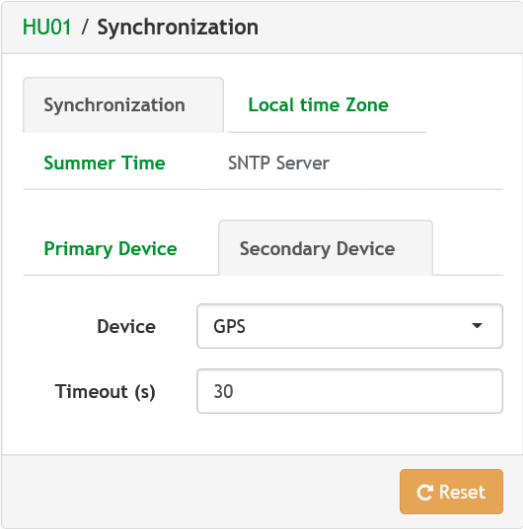
Setting the **SNTP** source parameters - **Settings > Synchronization** page:



Setting the **Protocol** source parameters - **Settings > Synchronization** page:



Setting the **GPS** source parameters - **Settings > Synchronization** page:



The T300 Web server is used to set most of the parameters. However, the settings for SNTP server can only be viewed.

Parameter	Default	Configuration range	Description
Synchronization/Primary or Secondary Device/SNTP Device			
Device	SNTP	• None • SNTP	Enabling the SNTP device as the synchronization source.
Timeout (s)	30	1 – 4294967295	Time delay before the active device is declared to be in ERROR mode and the switch is made to another device.
SNTP Server IP	–	Valid IP address	SNTP server IP address
Mode	Active	• Active • Passive	In **Active** mode, the HU250 requests a new synchronization from the SNTP server at the end of the delay set in **Period**. In **Passive** mode, the HU250 simply waits to be synchronized by the server.
Period	30	1 – 4294967295	Synchronization period, used in Active mode only. Period should be shorter than Timeout.
IPV6	No	• No • Yes	
Synchronization/Primary or Secondary Device/Protocol Device			
Device	Protocol	• None • Protocol	Enabling the Protocol device as the synchronization source.
Timeout (s)	30	1 – 4294967295	Time delay before the active device is declared to be in ERROR mode and the switch is made to another device.
Device Source Name		• Dnp3S1 • I104S1 • I101S1	Sources from which the device will receive the synchronization date and time by communicating with the SCADA system. Several protocol sources can be activated at the same time.
Synchronization/Primary or Secondary Device/GPS Device			
Device	GPS	• None • GPS	Activation of the GPS device as a source of synchronization
Timeout (s)	30	1 – 4294967295	Time delay before the active device is declared to be in ERROR mode and the switch is made to another device.
K7 SLOT	K7 GPS 1	• K7 GPS 1 • K7 GPS2	HU250 channel number (K7) on which the 4G/GPS modem used for synchronization is installed: • K7_GPS_1: modem slot number 1 • K7_GPS_2: modem slot number 2 The parameter setting is only available if a 4G/GPS modem is connected.
PPS	Yes	• Yes • No	Use of the 1 Hz PPS (Pulse Per Second) synchronization signal sent by the GPS modem. Extended setting, fixed to yes for T300.

Parameter	Default	Configuration range	Description
Local time zone			
Local time Zone - Hour	+0	—12 to +3	Difference in hours between local time and GMT
Local time Zone - Minute	+0	0 to 59	Difference in minutes between local time and GMT
Summer time			
Enabled	No	• Yes • No	If the summer time is taken into account by selecting Yes, **Start** and **End** dates and times of the period can be specified.
SNTP Server			
Enabled	Yes	• Yes • No	The SNTP server is used by the T300 to set the time on the SC150/SC160 and LV150 modules. An IED can also be connected as an SNTP client to this server if required for synchronization purposes, by configuring it as follows: Time zone inactive: No summer time management. Passive mode.
Mode	Active	• Active • Passive	The T300 is active for synchronization. It synchronizes clients at the end of the period defined below.
Destination	Eth0		Port on which the SNTP server is active (HU250 LAN)
Period (s)	30		SNTP client synchronization period
IPV6	No	• No • Yes	

NOTE: The grayed-out parameters are fixed, they cannot be modified.

Local Time and Summer Time

Internally, the system time- and date-stamping for CoreDb data is stored in GMT (seconds and nanoseconds since 1970). The SNTP server (client, server) and the GPS reception always operate in GMT. The time zone and summer time functions are used when it is necessary to change the system time from GMT to local time, which involves:

- Synchronizing the client protocols: the client protocols send a synchronization message with the local time and the server protocols assume the synchronization message as local time.
- Time-stamping the events of the server protocols: the events received are interpreted as local time before being stored and broadcast by applying the local time.

SC150 Module Settings

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Fault Current Detection Indication (FPI) on the SC150 Module 225
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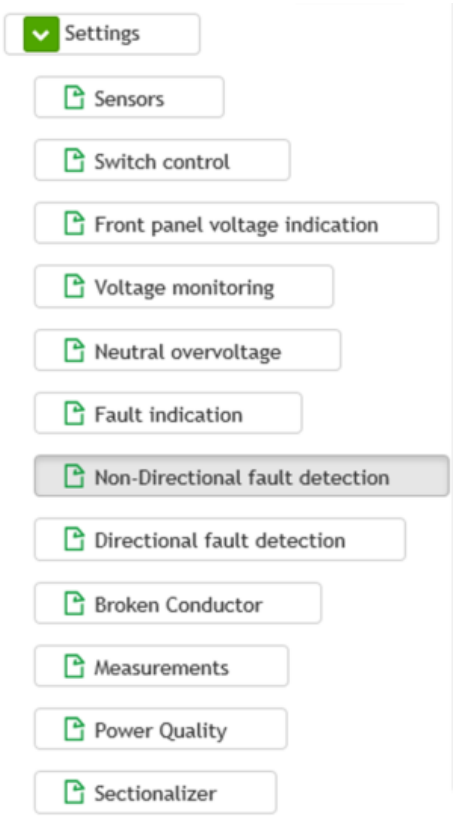
Other functionalities (common to the SC150 and LV150 modules):

- Voltage Monitoring, page 394
- Broken Phase Conductor Detection, page 401
- Port Configuration, page 141

Settings menu for the SC150 module.



All these functions are explained in detail in this manual, together with the corresponding application parameter settings.

- **Current and voltage measurements**

  The SC150 is compatible with all standard current sensors (according to IEC 61869-2).

  There are 4 possible connection configurations for acquiring the current measurement:

  - Type A: 3 phase CTs
  - Type B: 2 phase CTs + 1 core balance CT
  - Type C: 1 core balance CT
  - Type D: 3 phase CTs + 1 core balance CT
- **MV switches control and monitoring**

  Control is compatible with all existing switch types and all types of command (single or double). There is a wide range of control voltages: 12 VDC to 127 VDC, 90 VAC to 220 VAC.
- **Fault current detection and indication**

  Fault current detection is compatible with all neutral systems with or without distributed generation. Fault current detection is based on the following international ANSI code standards:

  - Phase overfault current (ANSI 50/51)
  - Ground fault (ANSI 50N/51N)
  - Directional phase overfault current (ANSI 67)
  - Directional ground fault (ANSI 67N) for detection

  Two groups of settings can be defined for each fault current type. All fault current detection algorithms function according to the methods of detection:

  - Definite time (DT)
  - Inverse definite minimum time (IDMT) with a choice of standardized inverse time curves
- **MV network voltage monitoring**
  - Undervoltage detection (ANSI 27)
  - Overvoltage detection (ANSI 59)
  - Neutral overvoltage detection (ANSI 59N)
  - Broken conductor detection (ANSI 47)
  - Active Overpower (ANSI 32P)
- **Sectionalizer automation**

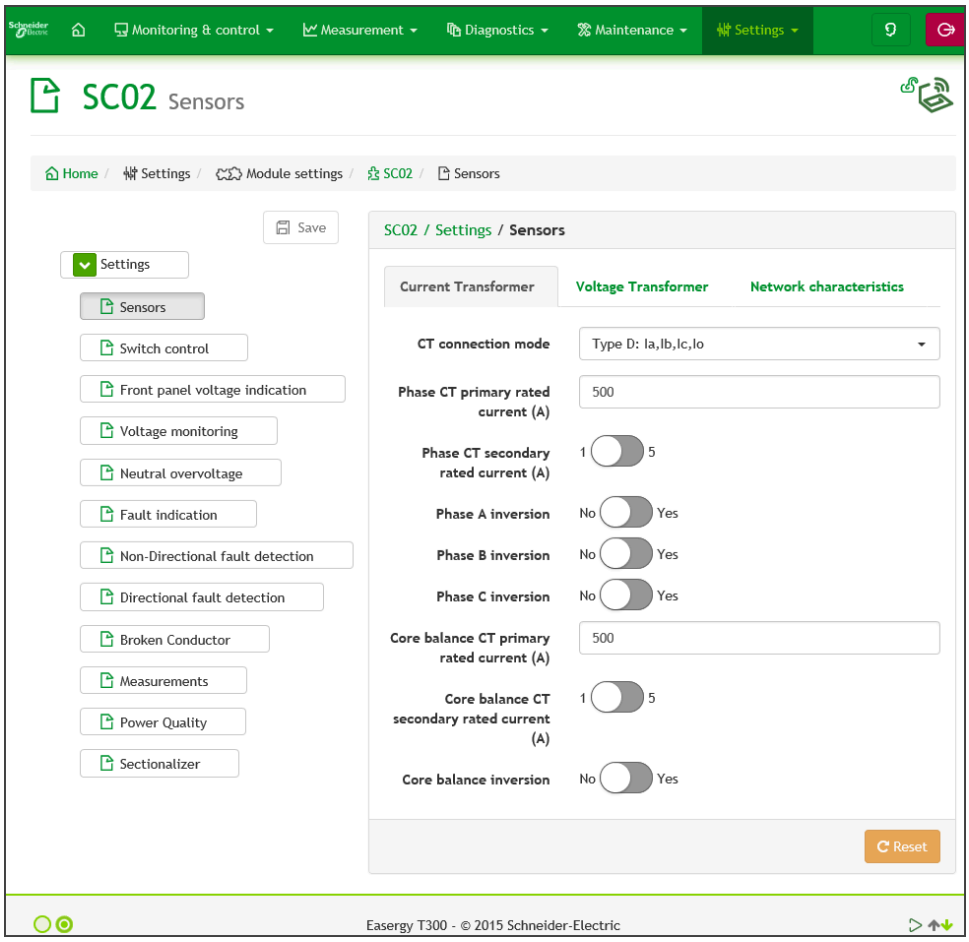
  The sectionalizer (SEC) automation function is controlled by the SC150 module. This automation function is factory-installed but configurable on-site.
- **Power measurements and power quality**
  - Power measurements (IEC 61557-12)
  - Power quality (according to the principles of IEC 61000-4-30 class S - up to harmonic 40).
- **Disturbance record**

  Record measured analog signals, digital input signals and logical states.
- **Port configuration**

  Limit access to a physical port on the SC150 module.
- **LEDs customization**

MV Current and Voltage Sensors

Accessed via **SC0x > Settings > Sensors** page



MV Current Sensors

The SC150 default configuration includes a current transformer with a ratio of 500:1.

The type of CT to be used is selected by the user.

Note that the CTs supplied by the T300 manufacturer also have a ratio of 500:1. It is possible, however, to define a different primary/secondary ratio by configuration if a CT with different characteristics is used.

Several CT connection configurations are possible on the T300:

- Type A: 3 phase CTs
- Type B: 2 phase CTs + 1 core balance CT
- Type C: 1 core balance CT
- Type D: 3 phase CTs + 1 core balance CT

NOTICE

HAZARD OF INCORRECT WIRING

- When fitting the CTs on the cables, it is essential to comply with the direction of positioning: HAUT/TOP marking facing upward, wire exit downward (see illustration beside).
- The shielding of each MV cable must be re-inserted inside the corresponding CT before being connected to ground (see diagram beside).
- The blue wire on the CT secondary (S2) is connected internally to the blue wire (blue wire including a round terminal at the end).
- The blue wire including the round terminal must be connected to the same frame ground as the cubicle.

Failure to follow these instructions can result in equipment damage.

Not following wiring instructions can lead to equipment damage and incorrect current measurements.

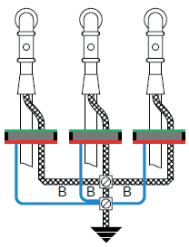
⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

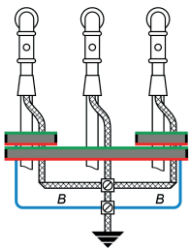
- The current sensors used for measuring must be 1 A or 5 A secondary with security factor limiting the current to 100 A secondary -1 s (according to standard IEC61869-2).
- Always use grounded external CTs for current inputs.
- The CTs must not remain disconnected while being installed and powered on.
- Put in place a short-circuit at the secondary part of the CTs if a disconnection is to be made for any reason.
- CT connectors must be IP2X.
- Cables of voltage rating greater than 1000 V must have a shield connected to ground.
- The low-voltage insulation of the PowerLogic CTs must only be used on insulated cables.
- Make sure that all electrical power on MV network is removed before working on or installing CTs on the MV cable and making CT connections.

Failure to follow these instructions will result in death or serious injury.

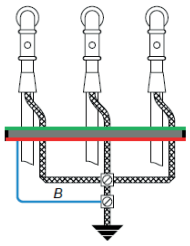
Connection type A (3 phase CTs)



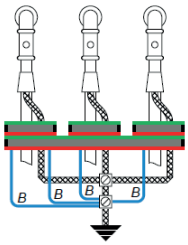
Connection type B (2 phase CTs + 1 core balance)



Connection type C (1 core balance CT)

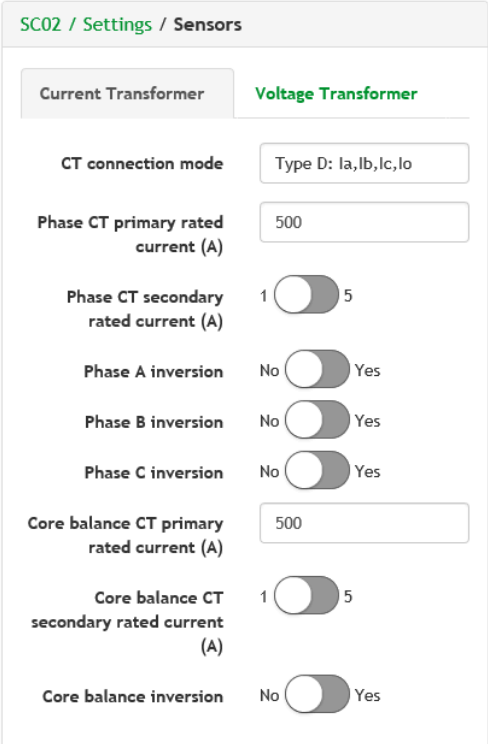


Connection type D (3 phase CTs + 1 core balance)



Current sensor parameter settings

Accessed via **SC0x > Settings > Sensors** page



Parameter	Default	Configuration range	Description
Current Transformer			
CT connection mode	D	• None • A • B • C • D	Choice of CT connection configuration options: • Type A: 3 phase CTs • Type B: 2 phase CTs + 1 core balance CT • Type C: 1 core balance CT • Type D: 3 phase CTs + 1 core balance CT
Phase CT primary rated current (A)	500	50 – 1,250 (increment = 1)	Nominal value of the current at the phase CT primary
Phase CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the phase CT secondary.
Phase A (B, C) inversion	No	• No • Yes	Used to reverse the direction of the current flowing from phase A (B, or C). This parameter is used to compensate for an inversion of the direction of connection of the CT on the MV cable via the software.
Core balance CT primary rated current (A)	500	50 – 1,250 (increment = 1)	Nominal value of the current at the core balance CT primary
Core balance CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the core balance CT secondary
Core balance inversion	No	• Yes • No	Used to reverse the direction of the residual current. This parameter is used to compensate via the software an inversion of the direction of connection of the CT on the MV cable or a reverse winding direction of core balance CT compared to phase CTs.

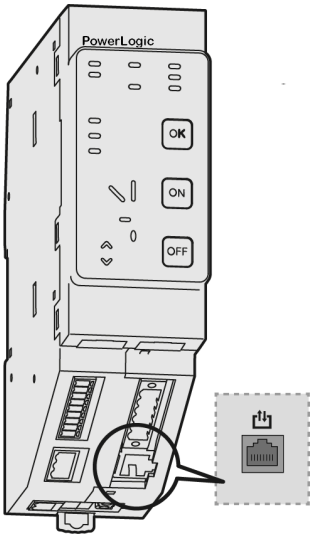
MV Voltage Sensors

The SC150 offers several sensor options for measuring and monitoring medium voltage. The accuracy of the voltage measurement depends primarily on the type of sensor used. The SC150 needs the voltage measurement for the following functions:

- Fault current detection and indication
- MV network monitoring and automation
- MV voltage measurement
- MV power measurement
- MV power quality measurement

The following table presents the voltage sources that can be used for the automation functions:

Parameter	Current presence only	Digital input	LV AC supply	Measured (any MV voltage sensor)
Sectionalizer	X	X	X	X
ATS	–	X	–	X



The link between the adapter and the voltage input on the SC150 module (RJ45 connector) is via "straight-through" Ethernet cable including RJ45 connectors.

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Do not connect VT adapter directly to the MV sensors.
- Always use fuse and disconnect switch (maximum voltage allowable on the VT adapter inputs: 600 Vac).
- Never short the secondary of a Voltage Transformer (VT).
- Do not connect items of equipment with different earth potentials with an RJ45 cable.
- Do not use RJ45 cable longer than 10 meters (32.8 feet).

Failure to follow these instructions will result in death or serious injury.

Voltage Sensors for SC150

Depending on the type of sensor used, the way in which the measurements are processed is different:

- LPVT/VT: A direct sensor measurement is taken without calibration.
- VPIS-V3 / VDS HR / VDS LRM / VDIS (with SC150 LPVT): Calibration is performed on manual demand, through the Web server. Calibration is stored in the module. Calibration is to be performed with the complete voltage measurement chain and with a known reference value used as nominal voltage. This calibration can be carried out in a controlled environment, in factory, with the equipment already installed, for better accuracy and to help avoid later deviations.

  NOTE:

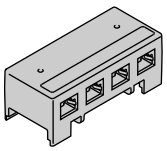
  The calibration takes the assumption that there is no phase shift between the currents and the voltages, and adds angle corrections to align voltages and currents.

  In the case of on-site calibration, disable **Angle calibration** to block the computation of new angle correction factors. Access via **SC0x > Settings > Sensors > Voltage Transformer**.
- VPIS / VDS / PPACS / VPIS-V3 / VDIS (with SC150 CAPA): Autocalibration is performed automatically in the following cases:
  - At the first power-up of the network
  - On manual command from the Web server
  - If nominal voltage is changed
  - If voltage sensor type is changed.

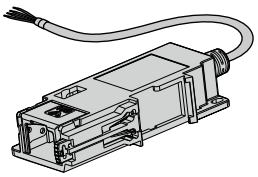
Following autocalibration, the nominal voltage is recalculated. The auto-calibration consists in defining the current voltage as the nominal voltage of the network.

The MV sensors used with the SC150 are summarized in the table below. Each type of voltage sensor requires a specific adapter (available as an option) for connection to the SC150 module.

LPVT adapter



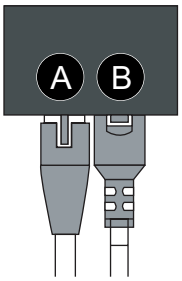
SC150/SC160 VT adapter



VPIS-V3 adapter

A. SC150 output

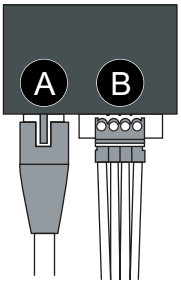
B. VPIS input



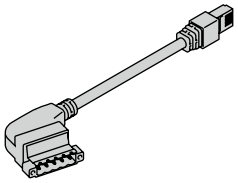
VDS adapter

A. SC150 output

B. VDS input



PPACS adapter

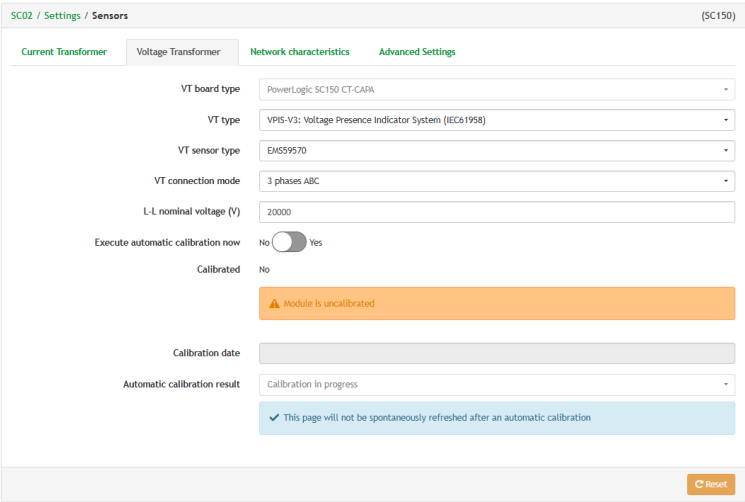


Voltage sensor	Description	Adapter Required
SC150-CAPA version: 3 phases mounting only		
VPIS-V3 VO	Official Schneider Electric voltage presence indicator with voltage output (IEC 62271-206). The VPIS-V3 VO sensor is connected to the capacitive divider installed in the MV cubicle.	VPIS-V3 VO adapter (ref: EMS59577): Voltage input (LL): 1 V to 30 VAC max. IP 30
VDS	Type LRP, LRM, and LR. Voltage detection system with voltage output (IEC 61243 5). The VDS is connected to the capacitive divider of the MV switch.	VDS adapter (ref: EMS59571): Voltage input (LL): 1 V to 30 VAC max. IP 30
PPACS	External capacitive divider connected at the head end of the MV cable in the switch cubicle. Important: the routing of PPACS cables affects the residual voltage. Install these cables in order to decrease at maximum the crosstalk (no crossover, regrouping and installation consistent for all three phases).	PPACS adapter (ref: EMS59575): Voltage input (LL): 1 V to 30 VAC max. Cable length: 54 cm IP 30
VDIS	Voltage Detecting and Indicating System (IEC 62271-213) for MV cubicles	VDIS adapter (ref: EMS59570): Voltage input (L-L): 1 V to 30 VAC max. IP30
SC150-LPVT version: 1,2 or 3 phases mounting		
VT	Standard voltage transformer according to IEC 61869-3 with 2KV/1 mn AC insulation. Note: The SC150-VT adapter accepts only 1, 2 or 3-phase transformer-primary type assemblies without neutral (phase-to-phase or phase-to-ground). For more information, refer to the SC150-VT Adapter Installation Guide. (ref: NT00394).	SC150- VT adapter (ref: EMS59572): Voltage input (LL): 50 V to 250 VAC IP 30
LPVT	Low power voltage transformer according to IEC 60044-7	LPVT adapter (ref: EMS59573): IP 30
VPIS-V3 VO	Official Schneider Electric voltage presence indicator with voltage output (IEC 62271-206). The VPIS-V3 VO sensor is connected to the capacitive divider installed in the MV cubicle.	VPIS-V3 VO adapter (ref: EMS59577): Voltage input (LL): 1 V to 30 VAC max. IP 30
VDS HR	Voltage Detector System High Resistance (IEC 61243-5)	VDS HR adapter (ref: EMS59580): Voltage input (L-L): 70 V to 90 VAC max. IP65
VDS LRM	Voltage Detector System Low Resistance Modified (IEC 61243-5)	VDS LRM adapter (ref: EMS5971): Voltage input (L-L): 1 V to 30 VAC max. IP30
VDIS	Voltage Detecting and Indicating System (IEC 62271-213) for MV cubicles	VDIS adapter (ref: EMS59570): Voltage input (L-L): 1 V to 30 VAC max. IP30

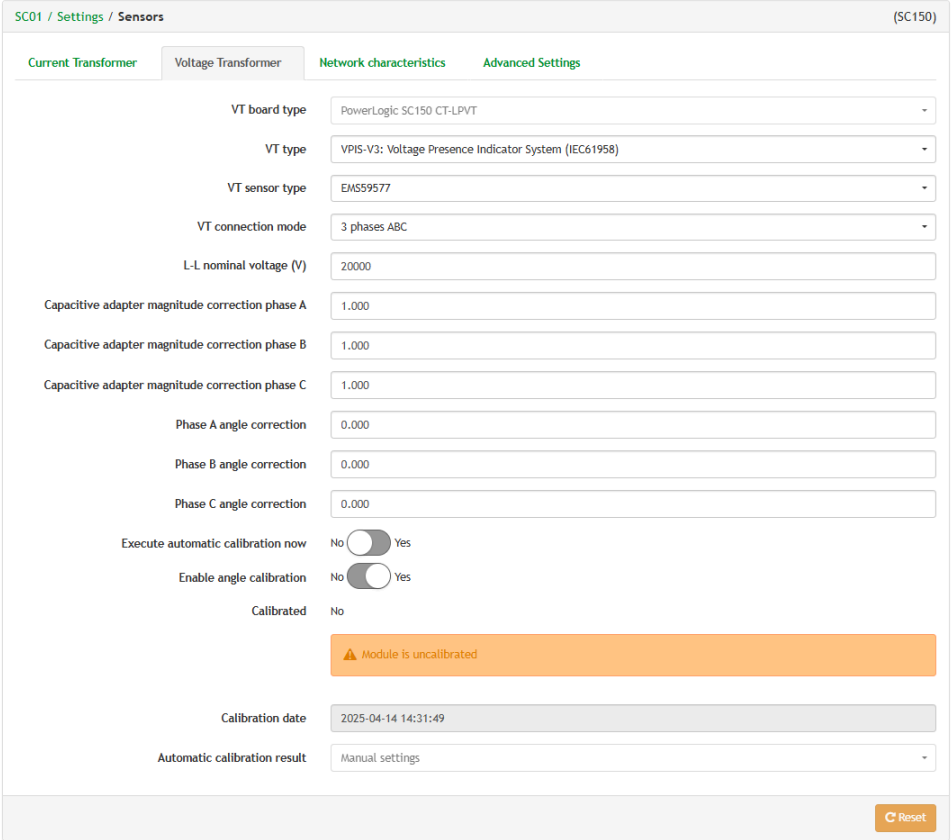
Voltage Sensor Parameter Settings for SC150

Accessed via **SC0x > Settings > Sensors** page.

Example of voltage sensor setting with a CT-CAPA VT board type



Example of voltage sensor setting with a CT-LPVT VT board type



Parameter	Default	Configuration range	Description
Voltage Transformer			
VT board type	Depends on the model supplied	• PowerLogic SC150 CT-LPVT • PowerLogic SC150 CT-CAPA	Indication of the type of SC150 module delivered. The SC150 type cannot be modified by the user. This choice is factory-set as it corresponds to the circuit board specific to each version.
Parameter Settings for VT board type = CAPA			
VT type	**None**	• None • VPIS-V3 • VDS • VDIS • PPACS	Choice of the type of voltage adapter used as the voltage measurement sensor: type of capacitive divider used (VPIS-V3, VDS, or PPACS)
VT sensor type	**None**	• None • EMS59570 • EMS59577 • PPACS C2	• VT type = VPIS-V3: Choice of the type of VPIS adapter installed in the MV cubicle. Available options: ◦ For VPIS-V3: EMS59570 or EMS59577 ◦ For VDIS: EMS59570 (EMS59577) • VT type = PPACS: Choice of PPACS model installed in the MV cubicle. This choice depends on the nominal voltage of the MV network: ◦ PPACS C2: Un = 12 to 36 kV
L-L nominal voltage (V)	**20,000**	3,000 – 36,000 (increment = 1)	Definition of the nominal voltage of the MV network (phase-to-phase voltage)
Execute automatic calibration now	**No**	• No • Yes	Immediate activation of the automatic calibration. This calibration is performed after validating this option, once the network voltage is detected present on the three phases for 3 seconds. **NOTE:** This calibration is automatically executed after every product start-up.
Parameter settings for VT board type = LPVT			

Parameter	Default	Configuration range	Description
Voltage Transformer			
VT Type	**None**	• None • VT • LPVT • VPIS–V3 • VDS HR • VDS LRM • VDIS	If VT Type is set to **none**: • Power measurements are not available. • Voltage measurements are not available. • The following FPI functions are not available: ◦ DPhPTOC ◦ DEfPTOC ◦ NeutPTOC ◦ BcPTOC • Voltage monitoring is not available. • FPI confirmation mode: when set to **Voltage**, **Measured** option is not available.
L-L nominal voltage (V)	**20,000**	3,000 – 36,000 (increment = 1) (extended to 59,000 for Single line VT connection)	Definition of the nominal voltage of the MV network (phase-to-phase voltage).
LPVT or VT Primary rated voltage (V)	**20,000**	3,000 – 36,000 (increment = 1) (extended to 78,000 for Single line VT connection)	Definition of the primary voltage of the measurement transformer. Must correspond to the characteristics of the transformer used. Parameter only available for the options VT type = VT or LPVT.
LPVT-Specific parameter settings			
VT connection mode with PQ	**3 phases ABC**	3 phases ABC	Choice of the type of connection used for the voltage sensor. The sensor can be wired on a single phase, or between 2 or 3 phases depending on the connection configuration used. The type of voltage measurement performed (with 1, 2 or 3 phases) also depends on the type of connection and mounting of the voltage sensor defined by this parameter.
VT connection mode without PQ	**3 phases ABC**	• 3 phases ABC • Single phase A • Single phase B • Single phase C • 2 phases AB • 2 phases BC • 2 phases AC	
LPVT Secondary rated voltage (V)	**3.25000**	1 – 10 (increment = 0.001)	Definition of the secondary voltage of the measurement transformer. Must correspond to the characteristics of the transformer used.
Phase A magnitude correction	**1.00000**	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase A measurement to improve accuracy.
Phase B magnitude correction	**1.00000**	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase B measurement to improve accuracy.
Phase C magnitude correction	**1.00000**	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase C measurement to improve accuracy.
Phase A angle correction	**0.000**	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase A caused by the sensor used.
Phase B angle correction	**0.000**	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase B caused by the sensor used.
Phase C angle correction	**0.000**	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase C caused by the sensor used.
VT-Specific parameter settings			

Parameter	Default	Configuration range	Description
Voltage Transformer			
VT connection mode with PQ	3 phases ABC	• 3 phases ABC • Vab-Vbc-Vb	Choice of the type of connection used for the voltage sensor. The sensor can be wired on a single phase, or between 2 or 3 phases depending on the connection configuration used. The type of voltage measurement performed (with 1, 2 or 3 phases) also depends on the type of connection and mounting of the voltage sensor defined by this parameter.
VT connection mode without PQ	3 phases ABC	• 3 phases ABC • Single phase A • Single phase B • Single C • • Line to line AB • Line to line BC • Line to line CA • Vab-Vbc-Vb • 2 phase to phase AB-BC	
VT secondary rated voltage (V)	250.000	50 – 250 (increment = 0.001)	Definition of the transformer secondary voltage. Must correspond to the characteristics of the transformer used.
VT Adapter magnitude correction phase A	50.600	30 – 60 (increment = 0.001)	Used to calibrate the phase A measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VT Adapter magnitude correction phase B	50.600	30 – 60 (increment = 0.001)	Used to calibrate the phase B measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VT Adapter magnitude correction phase C	50.600	30 – 60 (increment = 0.001)	Used to calibrate the phase C measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VPIS-V3 / VDS HR / VDS LRM / VDIS - Specific parameter settings			
VT sensor type	None	• None • EMS59577 • EMS59570 • EMS59575	Choice of the type of capacitive adapter installed in the MV cubicle. This parameter is automatically selected for the following chosen VT type : • EMS59577 for VPIS-V3 • EMS59570 for VDIS • EMS59570/EMS59575 for VDS LRM
Capacitive adapter magnitude correction phase A	1.00000	0.2 – 8 (increment = 0.001)	Used to correct the sensor phase A measurement to improve accuracy.
Capacitive adapter magnitude correction phase B	1.00000	0.2 – 8 (increment = 0.001)	Used to correct the sensor phase B measurement to improve accuracy.
Capacitive adapter magnitude correction phase C	1.00000	0.2 – 8 (increment = 0.001)	Used to correct the sensor phase C measurement to improve accuracy.
Phase A angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase A caused by the sensor used.
Phase B angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase B caused by the sensor used.
Phase C angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase C caused by the sensor used.
Execute automatic calibration now	No	• No • Yes	Immediate activation of the calibration. This calibration is executed after validating this option, using the L-L nominal voltage Un as the reference. The corrections are stored permanently in the product. The calibration is executed only with this command (no automatic calibration at start).
Enable angle calibration	Yes	• No • Yes	When enabled, the phase angle correction factors are updated when the calibration is performed.
Calibrated	No	• No • Yes	Indicates the module calibration status. This parameter is not configurable but is automatically updated after executing the calibration.

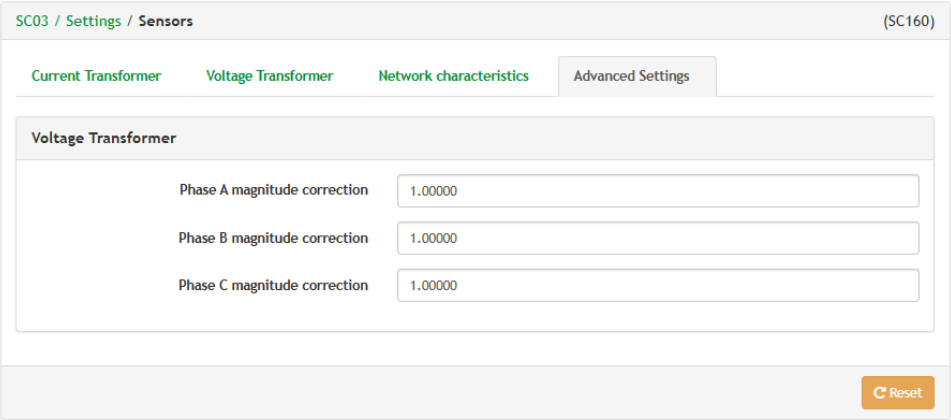
Parameter	Default	Configuration range	Description
Voltage Transformer			
Calibration date	Empty	Date in format: yyyy-mm-dd hh:mm:ss	Indicates the module last calibration date. This parameter is not configurable but is automatically updated after executing the calibration.
Automatic calibration result	Not calibrated	• Not calibrated • Calibration success • Voltage too high • Voltage too low • Timeout waiting for a valid voltage • Manual settings	Indicates the module last calibration result. This parameter is not configurable but is automatically updated after executing the calibration.

Advanced Settings

Phase magnitude correction factors applied to correct LPVT sensor measurements can also be used with capacitive sensors to extend the application range.

These factors can be defined if VPIS-V3/ VDS HR/ VDS LRM/ VDIS/ VDS adapter is selected in SC150 (LPVT or CAPA boards) or SC160 modules, in the **Advanced Settings** tab.

Accessed via **SC0x > Settings > Sensors**, **Advanced Settings** tab. Parameter settings are the same for SC150 or SC160 as shown in the following image.



Parameter	Default	Configuration range	Description
Voltage Transformer – Advanced settings			
Phase B magnitude correction	1.00000	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase B measurement to improve accuracy.
Phase A magnitude correction	1.00000	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase A measurement to improve accuracy.
Phase C magnitude correction	1.00000	0.5 – 2 (increment = 0.00001)	Used to correct the LPVT sensor phase C measurement to improve accuracy.

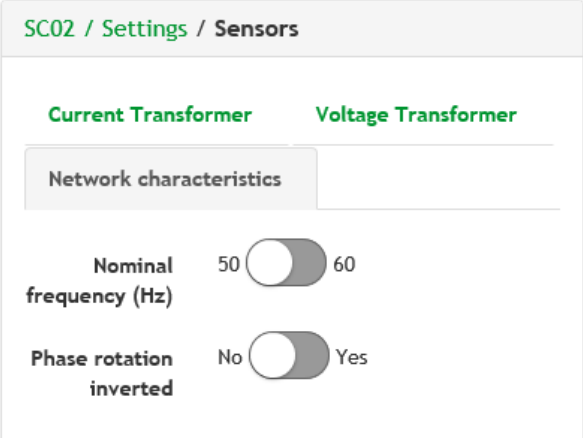
Network Characteristics

There are other parameters in addition to the sensor parameters.

- The SC150/SC160 module can take current and voltage measurements at 50 Hz or 60 Hz to correspond with the existing network frequencies.
- The sequence of phases A, B, and C can be inverted.

Measured voltages and frequency parameter settings

Accessed via **SC0x > Settings > Sensors** page.



Parameter	Default	Configuration range	Description
Network characteristics			
Nominal frequency (Hz)	50	• 50 • 60	Choice of MV network frequency
Phase rotation inverted	No	• Yes • No	Used to invert the phase sequence: • Yes = ACB (inverted) • No = ABC (normal sequence) The ACB sequence must be used when the CT wiring or connection configuration has been inverted in relation to the theoretical phase sequence or for networks with an inverted phase sequence. **NOTE:** This inversion affects current and voltage.

Switch Control

The SC module has various software interlocks to help reduce the risk of unintended switch operations.

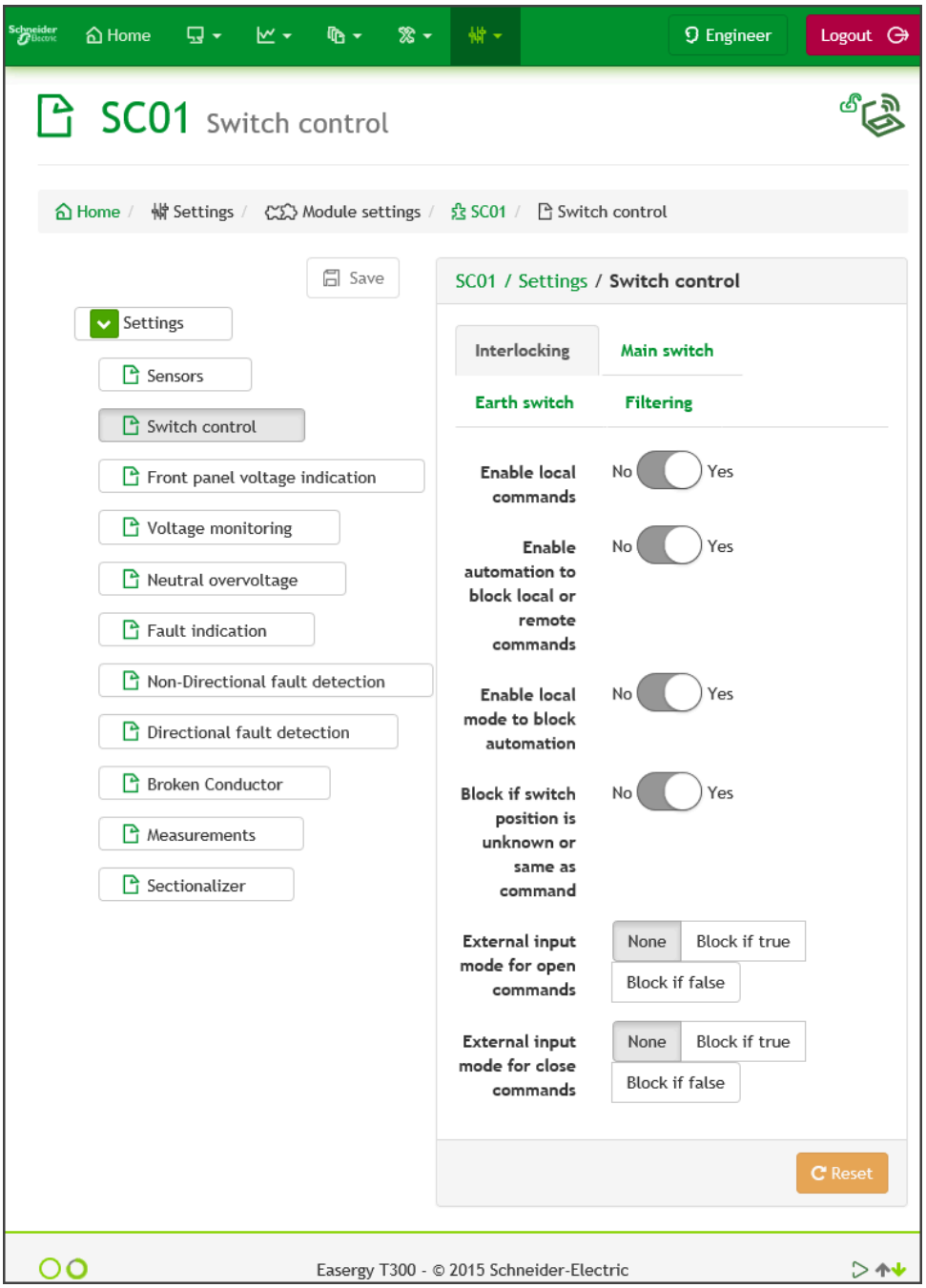
⚠ WARNING

HAZARD OF UNINTENDED EQUIPMENT OPERATION

- To help software interlocks to work as intended, both the module configuration and the wiring between the module and the equipment must be consistent and correct.
- Make sure that the main switch position indications are correctly wired.
- Make sure that the earth switch position indication(s) is/are correctly wired.
- Make sure that the disconnector position indication is correctly wired (if applicable).
- Make sure that the SC module is correctly configured to match the wiring arrangement for the earth switch and disconnector (if applicable).
- Make sure that the HMI is configured to show the correct arrangement of earth switch and disconnector (if applicable). Refer to Setting Graphical Representation of the Switch, page 55.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Accessed via **SC0x > Settings > Switch control** page.



The switch control settings are used to adapt to any type of switch. The management of switch position control and command signals is essentially specific to each switch type.

Commands can be issued from a variety of sources. Remote commands are received by the SCADA system via the HU250. Local commands are received via the buttons on the front panel of the SC150/SC160 modules or via the Web server pages. Commands can also be received via the automation functions present in the HU250 module (ATS, or other) or the SC150/SC160 module (SEC). Local commands on the front panel of the module can be disabled by configuration to help prevent unintended operation.

The T300 systematically performs a consistency check of the switch positions before executing a command.

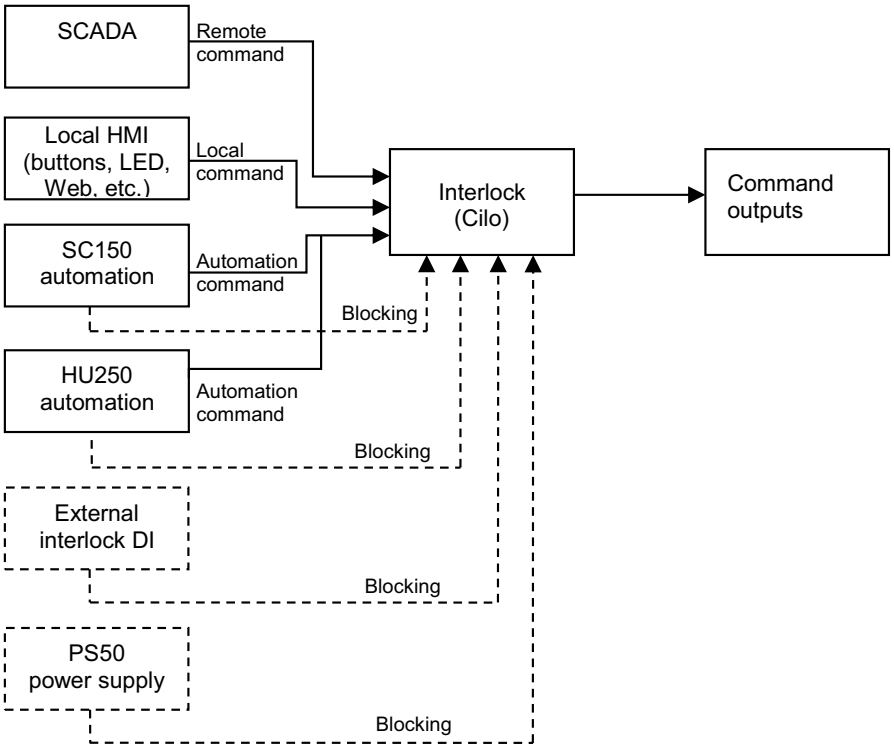
Interlock Function on SC150 Module

The interlock function is managed by the T300 "Cilo" BIN controller. The interlock function checks only the command execution conditions. It rejects a command if the execution conditions are not fulfilled. The majority of these conditions are defined by configuration via a specific parameter.

When the earth switch and disconnector wiring is selected, the earth switch interlock with the main switch command is disabled. Then, when the earth switch is closed, the main switch operations are not blocked.

The T300 power supply is only capable of managing one switch command at a time. If several commands are issued simultaneously (commands made using the buttons on the front panels of two SC150 modules at the same time, or commands via the SC150 sectionalizer automation functions that have detected a potential issue on their channel), the interlock function coordinates with the system modules to help ensure that a command will only be executed if the previous command is considered to be completed.

The diagram below summarizes the various command input options checked by the interlock function as well as the possible blocking sources:



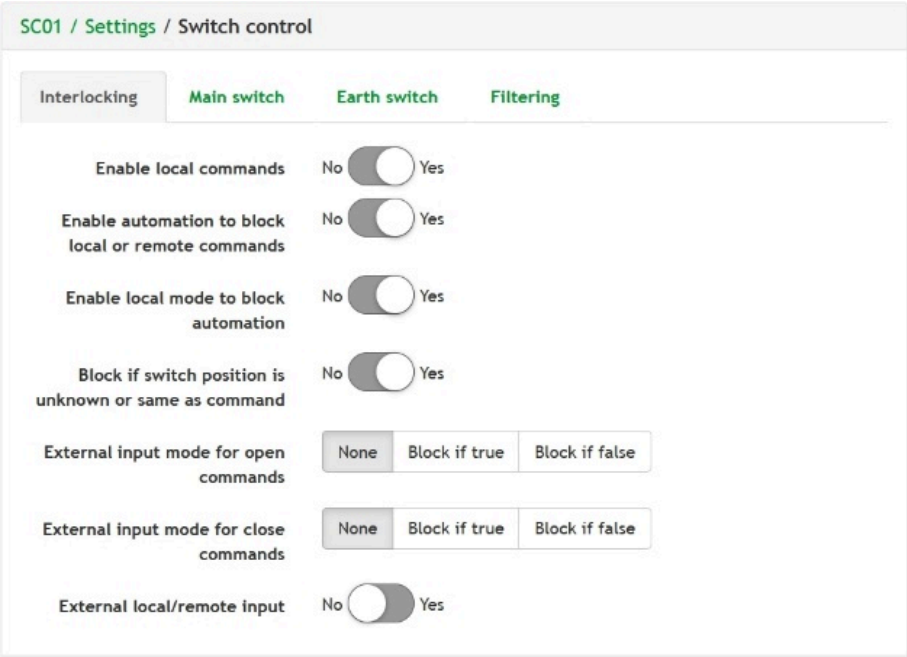
The table below summarizes the main command rejection conditions for the interlock function:

Command status	Result of the Command
Command already being executed on the same SC150/SC160 module	Rejected
Command already being executed on another SC150/SC160 module	
Manual command in local or remote mode when the automation function is active and the corresponding blocking function has been enabled by configuration	
Open command when the switch is already open or its position is unknown and the corresponding blocking function has been enabled by configuration	
Close command when the switch is already closed or its position is unknown and the corresponding blocking function has been enabled by configuration	
Ground switch closed or in unknown position	
Switch command when the external interlock digital input (DI5) is enabled and the corresponding blocking function has been enabled by configuration	

Command status	Result of the Command
Switch command when the 24/48 V motor mechanism power supply is not available or there is a problem with the battery (end of life or low charge)	

Switch control parameter settings

Access via **SC0x > Settings > Switch control** page.



Parameter	Default	Configuration range	Description
Interlocking			
Enable local commands	Yes	• No • Yes	Enables local switch commands via the buttons on the front panel of the SC150/SC160 module
Enable automation to block local or remote commands	Yes	• No • Yes	Enables the blocking of local or remote switch commands when the automation function is enabled. In this case, the automation function also manages the other command options (see the "Local/ Remote Mode" section for more information).
Enable local mode to block automation	Yes	• No • Yes	Enables the blocking of automation commands when local control mode is enabled on the HU250
Block if switch position is unknown or same as command	Yes	• Yes • No	Enables the blocking of switch commands when the position of the switch is not known or inconsistent (e.g. in the same state as the command issued)
External input mode for open commands	None	• None • Block if true • Block if false	Enables the blocking of the switch open command by external digital input (DI5 on 9-way switch state connector)
External input mode for close commands	None	• None • Block if true • Block if false	Enables the blocking of the switch close command by external digital input (DI5 on 9-way switch state connector)
External local/remote input	No	• Yes • No	Enables forcing the local mode on the SC150/SC160 by using the DI7 external input The SC150/SC160 responds to remote commands when both the HU250 and the SC150/SC160 are in remote mode. The SC150/SC160 responds to local commands when either the HU250 or the SC150/SC160 is in local mode.

Switch Positions and Commands

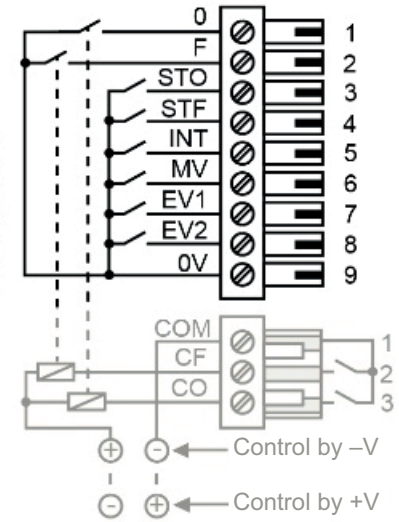
Managing Switch Positions on the SC150 Module

There are several ways of managing switch position signals. In principle on the T300, the switch position is obtained via a double status signal (open, closed). It is possible, however, to manage the switch position via a single status signal, i.e. using one of the hard-wired status indications from the switch (open or closed).

Wired switch inputs

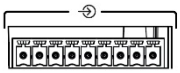
SC150/SC160 9-way connector (DI3, DI4, DI5, DI6, and DI7 can be configured)

Switch states



9–pin plug-in-screw connector

Switch states	
1	DI1–Switch open
2	DI2–Switch closed
3	DI3–Earthing switch open
4	DI4–Earthing switch closed
5	DI5–Switch interlock
6	DI6–MV voltage presence
7	DI7–SC150/SC160 local/remote input
8	DI8–Unassigned digital input
9	DI9–Common (0V)



NOTICE

HAZARD OF INCORRECT WIRING

Make sure that the digital inputs do not receive voltage because they accept only wet contact.

Failure to follow these instructions can result in equipment damage.

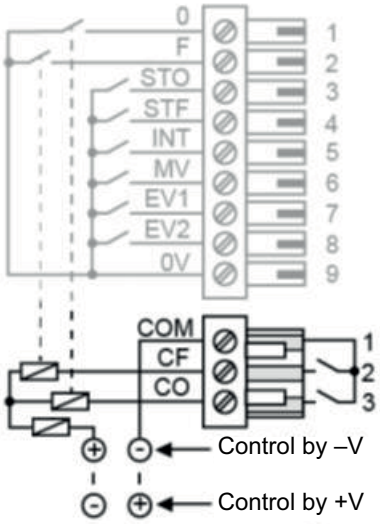
The table below summarizes the various options for managing switch position signals according to the switch wiring:

Input Wiring Parameter	Hard-Wired Digital Input Pins		Switch Status Signal
	DI1 (Switch Open)	DI2 (Switch Closed)	
Open	Active (1)		Open
	Inactive (0)		Closed
Closed		Active (1)	Closed
		Inactive (0)	Open
Open and closed	Active (1)	Inactive (0)	Open
	Inactive (0)	Active (1)	Closed
	Active (1)	Active (1)	Invalid
	Inactive (0)	Inactive (0)	Intermediate

Switch command outputs

SC150/SC160 3-way connector

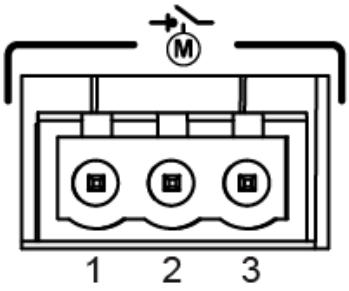
Switch controls



12Vdc < V < 127Vdc or
90Vac < V < 220Vac

3–pin plug-in-screw connector

Switch controls	
1	DO1–Motor pack power supply common
2	DO2–Closing control
3	DO3–Opening control



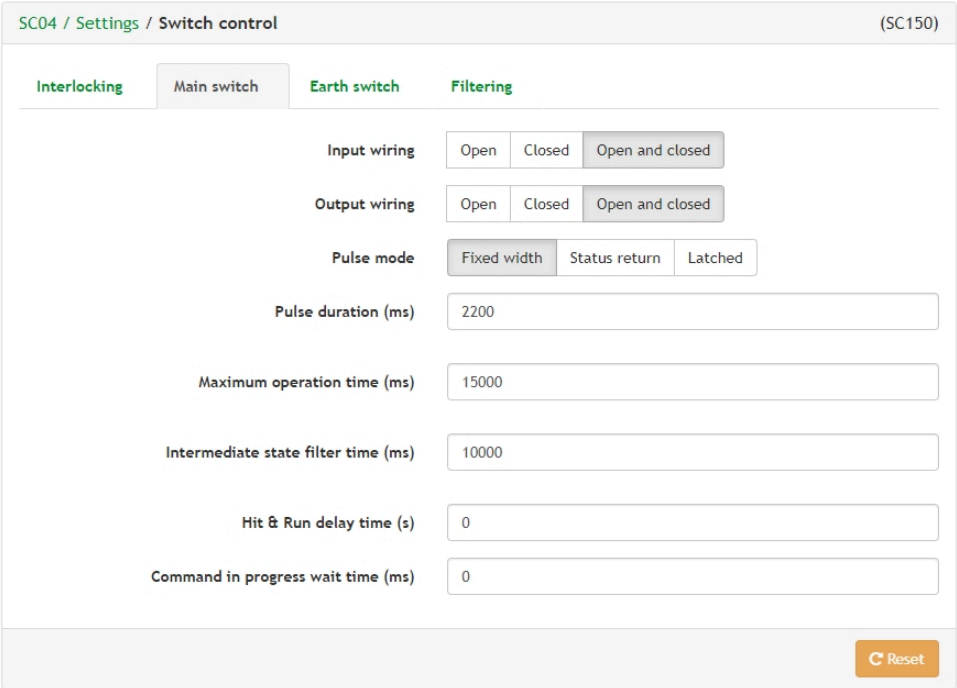
The same type of single or double command management is possible for switch control. The following table summarizes the different management modes possible and the resulting switch action:

Output Wiring Parameter	Hard-Wired Digital Output Pins		Command sent to switch
	DO2 (Closed command)	DO3 (Open command)	
Open		Active (1)	Open
		Active (1)	Close
Closed	Active (1)		Close
	Active (1)		Open
Open and closed	Active (1)	Inactive (0)	Open
	Inactive (0)	Active (1)	Close
(1): Each pulse of the output wiring activates the complementary command compared to the current state.			

In order to proceed to the command, two relays (select + open or close) must be activated at the same time. They are controlled by two different micro-controllers to help secure commands and avoid unexpected operations.

Switch control parameter settings

Accessed via **SC0x > Settings > Switch control** page.



Parameter	Default	Configuration range	Description
		Main Switch	
Input wiring	Open and closed	• **Open** • **Closed** • **Open and closed**	Choice of wiring used for the switch position inputs: • **Open** means that the open status is wired to manage the 2 switch status signals (open and closed). • **Closed** means that the closed status is wired to manage the 2 switch status signals (open and closed). • **Open and closed** means that both states (open and closed) are wired to manage the corresponding switch status signals.
Output wiring	Open and closed	• **Open** • **Closed** • **Open and closed**	Choice of wiring used for the switch command outputs: • **Open** means that only the open command is wired to control the 2 switch positions. • **Closed** means that only the close command is wired to control the 2 switch positions. • **Open and closed** means that both commands (open and close) are wired to control the 2 switch positions.
Pulse mode	Fixed width	• Fixed width • Status return. • Latched.	There are several options for managing the switch command signal: • **Fixed width**: This is a fixed period defined by the Pulse duration parameter to enable the switch command polarity. At the end of this set period, command polarity stops. • **Status return**: Variable period for enabling command polarity. This depends on the time taken by the switch to change position. Command polarity stops as soon as the change of position is detected. • **Latched**: In this mode, the control relay remains energized until the opposite command is detected. On power-up, the initial relay status will be set by the **Latched mode startup mode** parameter. If the command does not execute, the relay remains in its last position. In this mode, simultaneous multi-channel commands are possible. Note that the power supply of T300 has the power necessary only to control a single motorization at a time.
Pulse duration (ms)	2,200	• 50–60,000 (increment = 50)	Definition of the time it takes to send the switch command polarity (in **Fixed width** mode).
Latched mode startup mode	No action	• No action • Open • Closed	Choice of mode used for the initial state of the control relay on power-up. Only valid for **Pulse mode** = **Latched**.

Ground Switch (Earth Switch) and Series Disconnector

In the same way as for switch position signals, the ground (earth) switch can also be managed by a single or double status signal according to the wiring of the MV switch inputs (open or closed).

In the case of use with series disconnector, then the ground switch and disconnector are managed by single status signal only.

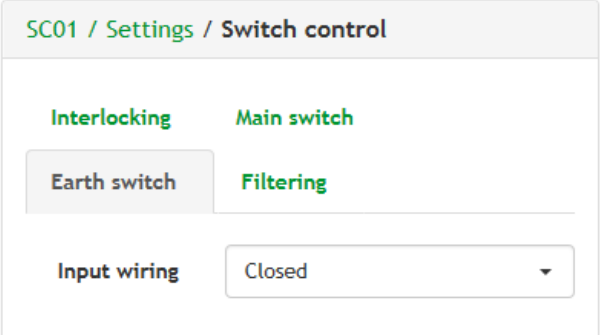
The table below summarizes the various options for managing ground (earth) switch position signals according to the switch wiring:

Input Wiring Parameter	Hard-Wired Digital Intput Pins		Ground Switch Status Signal
	DI3 (Ground Switch Open)	DI4 (Ground Switch Closed)	
None			
Open	Active (1)		Open
	Inactive (0)		Closed
Closed		Active (1)	Closed
		Inactive (0)	Open
Open and closed	Active (1)	Inactive (0)	Open
	Inactive (0)	Active (1)	Closed
	Active (1)	Active (1)	Bad
	Inactive (0)	Inactive (0)	Intermediate

	DI3 (Disconnector Open)	DI4 (Ground Switch Closed)	Ground Switch Status Signal	Disconnector Status Signal
Earth Switch and Series Disconnector	Active (1)	Inactive (0)	Open	Open
	Inactive (0)	Inactive (0)	Open	Closed
	Active (1)	Active (1)	Closed	Open
	Inactive (0)	Active (1)	Bad	Bad

Ground (earth) switch parameter setting:

Accessed via **SC0x > Settings > Switch control** page, **Earth switch** tab.



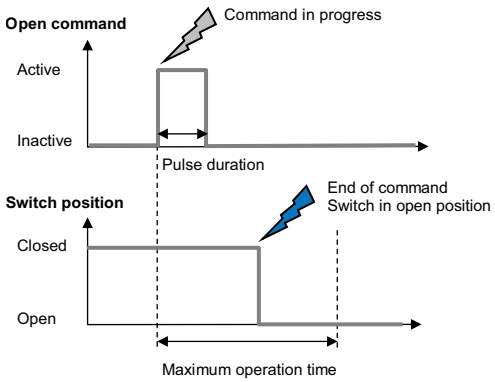
Parameter	Default	Configuration range	Description
Ground (Earth) Switch			
Input wiring	Closed	• **None** • **Open** • **Closed** • **Open and closed** • **Earth switch and series disconnector**	Choice of wiring used for the ground switch inputs: • **None** means that the interlock function does not take account of the ground switch. • **Open** means that the open status is wired to manage the 2 ground switch signals (open and closed). • **Closed** means that the closed status is wired to manage the 2 ground switch signals (open and closed). • **Open and closed** means that both states (open and closed) are wired to manage the corresponding ground switch signals • **Earth switch and series disconnector** means that the DI3 is wired to manage the disconnector state (open and closed) and DI4 is wired to manage the earth switch state (open and closed).

Managing Switch Commands

Switch commands can be managed according to several modes on the T300. The mode used generally allows adaptation to the different types of switch used, which each have their own specific mode of operation. This applies mainly to sequencing and the command polarity enabling period.

The diagrams opposite and below show the operating principle for executing an open command in each mode. The principle is the same for a close command. Explanations for each mode are also provided in the table above.

Principle of a command in **Fixed width** mode:



Command Filter Time Delays

The inputs for reading the switch position are scanned continuously during and after the command operation time, with a consistency check.

Once the control relay has de-energized, the command is considered to be complete by the T300 when the switch signals a position that corresponds to the request. The command is considered to be in ERROR mode if the position is not consistent with the command issued or if the position is unknown after the filter time delay.

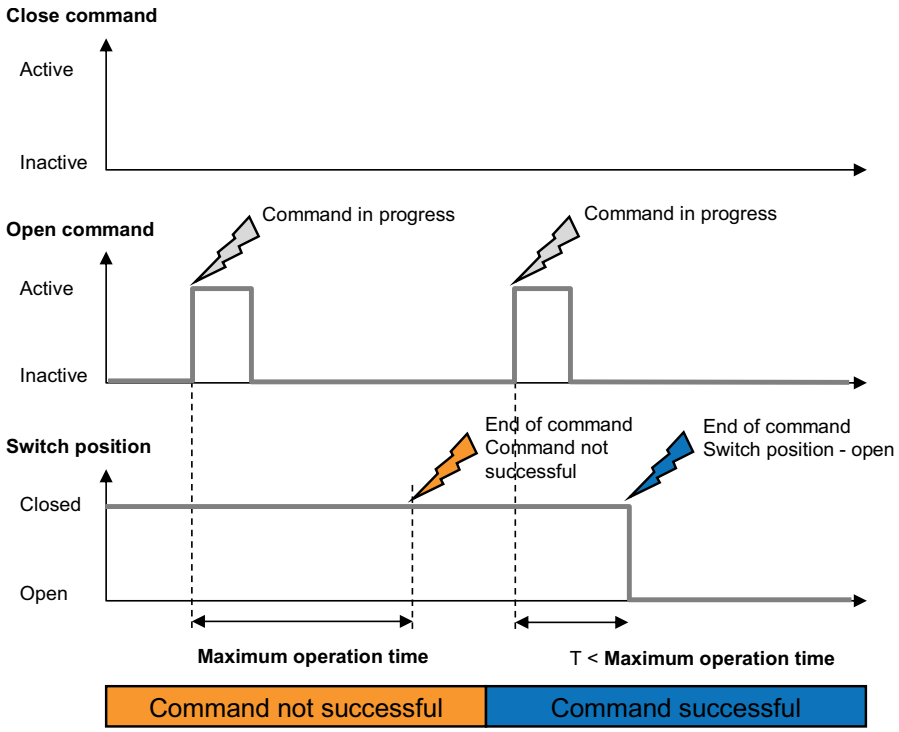
Command filter time delay parameter settings:

Accessed via **SC0x > Settings > Switch control** page, **Main switch** tab, and set up by the following parameters:

- Maximum operation time (ms)
- Intermediate state filter time (ms)

Parameter	Default	Configuration range	Description
Main Switch			
Maximum operation time (ms)	15,000	100–65,000 (increment = 100)	Maximum wait time for the switch to change position following a command before an ERROR is declared for this command. In **Pulse mode=Status return**, this also corresponds to the maximum time it takes to send the command polarity if the change of position is not detected within this time period.
Intermediate state filter time (ms)	10,000	0–30,000 (increment = 100)	Time delay for filtering the switch status before an intermediate or unknown state is declared. This delay is used to filter transient states or unintended changes. When a command is executed, it is preferable to check for a filtered and stable state before declaring an ERROR on the switch position.

Principle of switch position filtering after an open command (in **Fixed width** mode):



Hit and Run Function

The Hit and Run function is only available in local mode. It is available for all different command modes (fixed width, status return and latched).

The Hit and Run function adds an extra level of risk minimization on manual commands on MV switches. A time delay is applied after the user has pressed the buttons on the front panel of the SC150/SC160 module to issue the command to the MV switch before the command is executed. This leaves sufficient time to exit the substation before the command is executed.

Hit & Run function parameter setting:

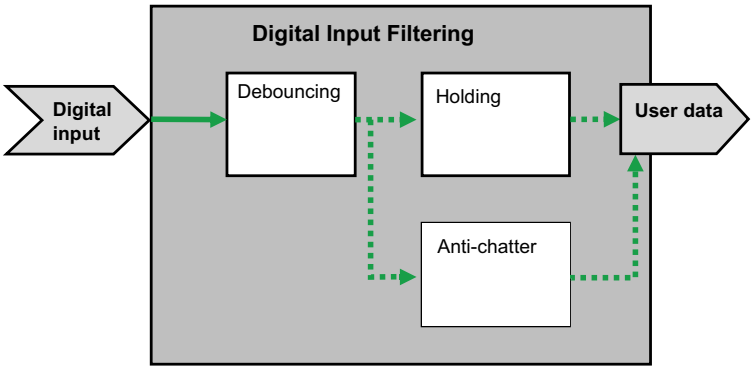
Accessed via **SC0x > Settings > Switch control** page, **Main switch** tab, and set up by the **Hit & Run delay time (seconds)** parameter.

Parameter	Default	Configuration range	Description
Main Switch			
Hit & Run delay time (seconds)	0	0–60 Increment = 1	Execution delay for the **Hit & Run** function. The delay corresponds to the time required to exit the substation before the command is executed. Only available on the T300 in Local mode. Available for all commands types (fixed width, status return and latched).

Switch Input Filters

In the same way as the filters that are applied to the digital inputs, some types of filter can also be applied to the switch inputs (states).

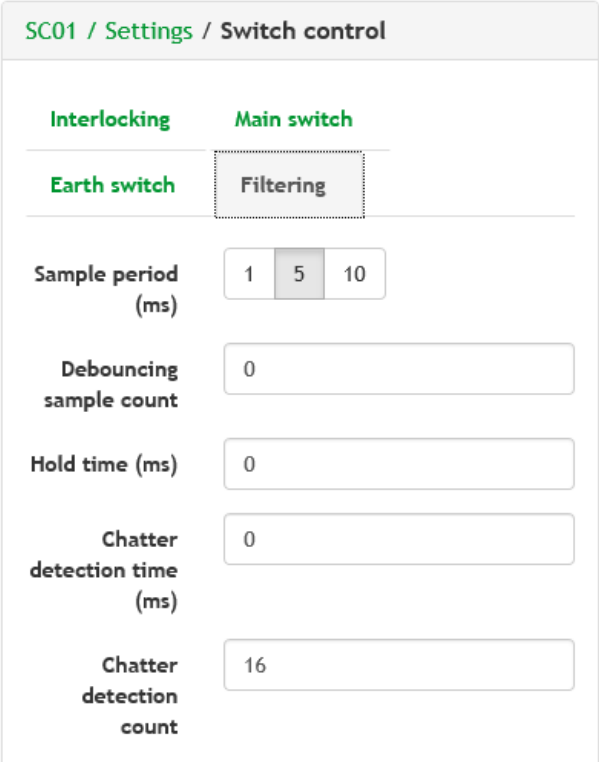
Digital Input Filtering:



NOTE: For the digital inputs (DI1 to DI4) that correspond to the switch position signals, an additional 20 ms filter (not shown in the diagram), is applied to the user data.

Digital input filter parameter setting:

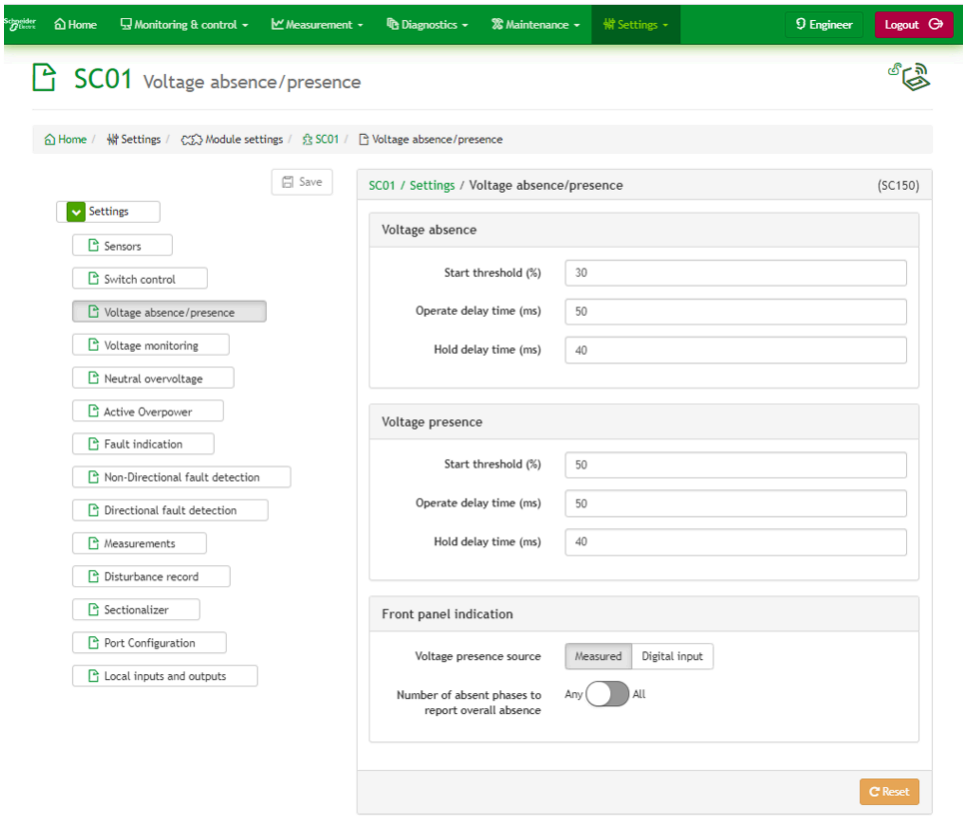
Accessed via **SC0x > Settings > Switch control** page, **Filtering** tab.



Parameter	Default	Configuration range	Description
Digital Inputs			
Sample period (ms)	5	• 1 • 5 • 10	**Sampling period** on the digital inputs for taking a state into account
Debouncing sample count	0	0 or 2–30 (increment = 1)	Filtering period for the bounce on a digital input. The value configured for the filter corresponds to a number of **Sample period** periods. The digital input must remain in the same state for a period greater than the defined debouncing period for its state to be taken into account. A value of 0 inhibits the debouncing filter.
Hold time (ms)	0	0 to disable or 5–2,000 (increment = 1 ms)	Hold time for a digital input. When a change of state (debounce-filtered) is detected on a digital input, the input is locked in its new state until the **Hold time** has elapsed. At the end of the time period, the input returns to its actual value. A value of 0 inhibits the hold filter.
Chatter detection time (ms)	0	0 to disable or 5–10,000 (increment = 1 ms)	Sliding time period corresponding to a window of observation and counting of the changes of state on a digital input. If during this period, the count becomes higher than the **Chatter detection count** value, the anti-chatter filter is activated, the state of the input is maintained at its last state. An event is signaled with the value maintained at its last state and with quality flags indicating “invalid”. The quality of the data is then signaled as bad. The anti-chatter filter becomes inactive again if, during the same period, no change of state is detected on the digital input. A value of 0 inhibits the anti-chatter filter.
Chatter detection count	16	1–255 (increment = 1)	Counts the number of changes of state on a digital input to define the anti-chatter filter action. The changes of state counted are only those filtered by the debouncing filter.

Front Panel Voltage Indication

Access via **Settings > SC0x > Voltage absence/presence** page.



A LED on the front panel of the SC150/SC160 module indicates the presence or absence of the MV network voltage.

The status is also reported to the Head Unit for display on the web pages and for use by Automation functions.

The voltage presence indication can be configured with two different sources:

- Digital input DI6 connected to an external voltage presence relay
- Measurements from the voltage sensors.

When configured to use measured values, the threshold and delay settings are displayed.

These settings are used to determine the value of two status variables for “voltage absence for three phases” or “voltage presence for three phases” (see diagrams).

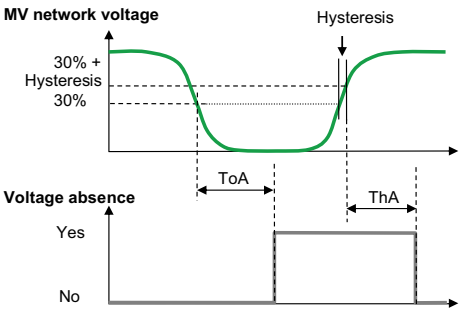
The variable “Voltage presence for HMI", that is displayed on the Head Unit web pages, is a combination of “presence OR not absence”.

For steady-state conditions, this variable is true if at least one phase is present.

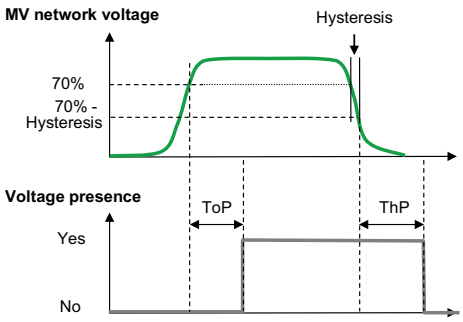
For transient conditions, the value depends on the operate delay times and hold delay times.

Note that the voltage presence thresholds are common with those configured in the **Fault indication/Voltage presence** page.

Detection of MV voltage absence from the measures



Detection of MV voltage presence from the measures



Front panel voltage indication parameter setting:

Parameter	Default	Configuration range	Description
Voltage absence (parameter available only for the case Voltage presence source = Measured)			
Start threshold (%)	30	10-100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, below which the MV network voltage will be considered to be absent. **NOTE:** Configure the threshold taking into account hysteresis (6%). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must be below the **Start threshold** level to consider the MV network voltage to be absent.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to above the **Start threshold** level to consider the MV network voltage to be not absent (to define the delay to be configured, take into account hysteresis: 6%).
Voltage presence (parameter available only for the case Voltage presence source = Measured)			
Start threshold, (%)	50	10-100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, above which the MV network voltage will be considered to be present. **NOTE:** Configure the threshold taking into account hysteresis (7%). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must remain above the **Start threshold** to validate the overvoltage detection.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to below the **Start threshold** level to consider the MV network voltage to be not present (to define the delay to be configured, take into account hysteresis: 7%).
Front panel indication			
Voltage presence source	Digital input	• Measured • Digital input	Choice of source for indicating voltage presence/absence on the front panel of the SC150/SC160 module: • Measured: voltage measurement taken by the voltage sensors. • Digital input: digital input DI6 ("MV Presence") on the SC150/SC160 9-way connector. This digital input is typically connected to an external voltage relay installed in the MV cubicle (for example. VD23).
Number of absent phases to report overall absence	All	• Any • All	• If the option is **All**, the three phase must be absent to declare an overall voltage absence. • If the option is **Any**, one single phase (any of them) voltage absence is enough to have an overall voltage absence.

NOTE: To get the voltage absence and the voltage presence at the same time, **Voltage absence operate delay time** and **Voltage presence hold delay time** parameters must be set up with the same value.

Active Overpower

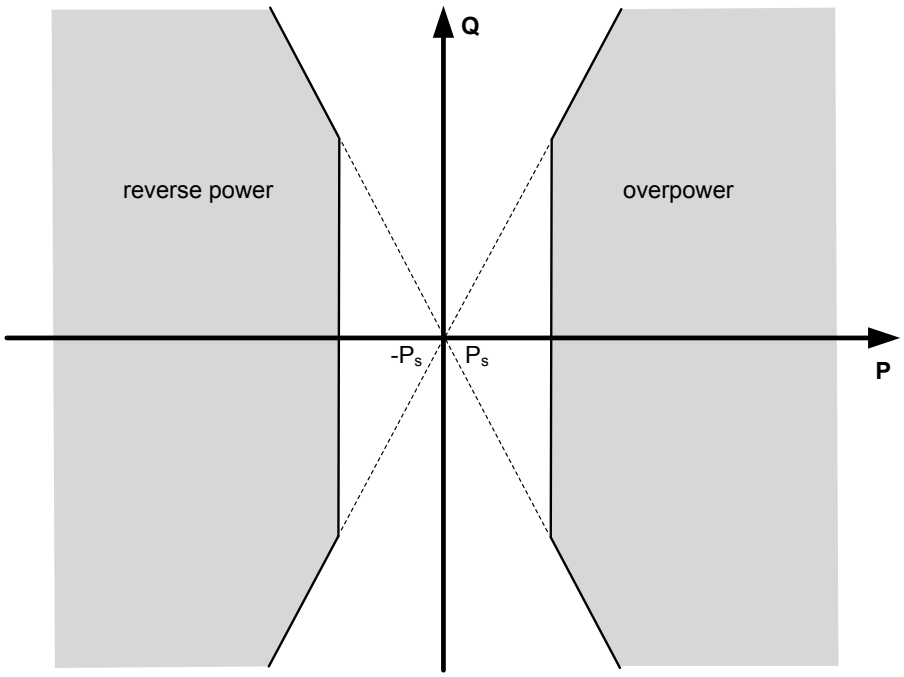
Access via **SC0x > Settings > Active Overpower** page.

The indication **Active Overpower** is based on ANSI 32P standard, “Directionnal active overpower”.

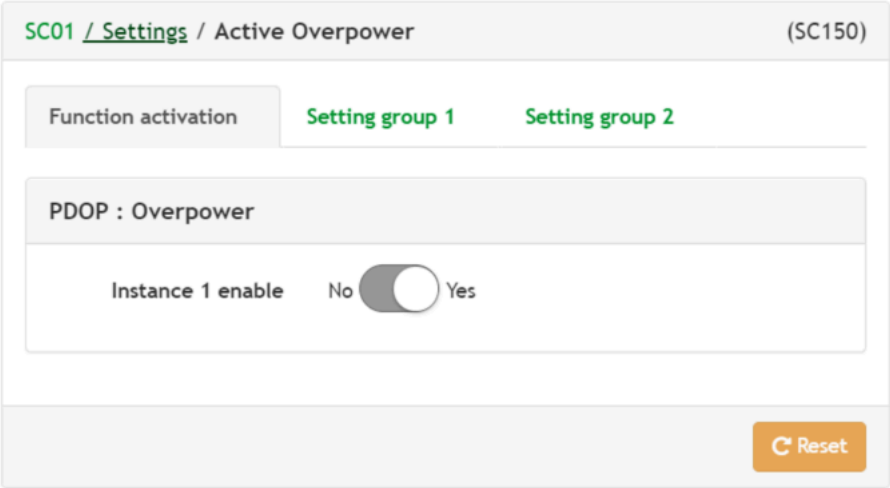
This is a two-way indication based on calculated active power, for the following applications:

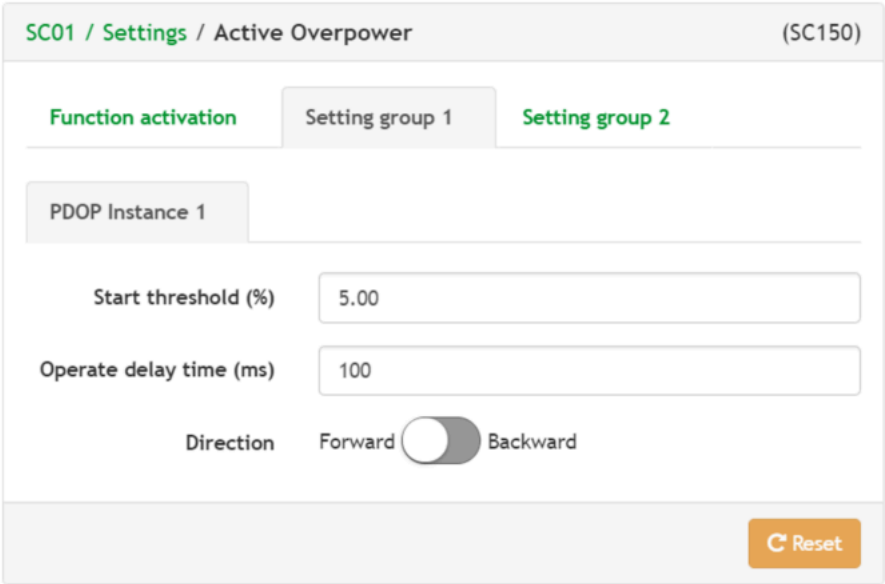
- active overpower (or maximum active power) to detect overloads and allow load shedding
- reverse active power to detect:
  - power injection from distributed production if the measure is done on transformer incomer
  - abnormal power flow if the measure is done on the feeder (MV line switchgear).

The indication 32 P is triggered if the absolute value of the active power is greater than the threshold PS if the operation mode is maximum active power (lower than the threshold -PS) and if the ratio reactive power / active power (Q / P) is less than 32.



Setting **Active Overpower** indication:





Parameter	Default	Configuration range	Description
Instance 1 enable	**No**	• Yes • No	Instance activation
Start threshold	**5 %**	1% to 120 % (increment = 0.1 %)	Percentage of the apparent power that the active power must reach to trigger the function.
Operate delay time	**100 ms**	100 ms to 300000 ms	Period (in millisecond) within which the active power must be greater than the Start threshold level to consider the Overpower to be present.
Direction	**Forward**	Forward or backward	The mode of operation of the function. Forward for maximum active power. Backward for reverse active power.

Fault Current Detection Indication (FPI) on the SC150 Module

The SC150 is capable of detecting a fault current on any type of neutral system with or without the presence of distributed power on the MV or LV network.

Fault current Detection and Protection modes available:

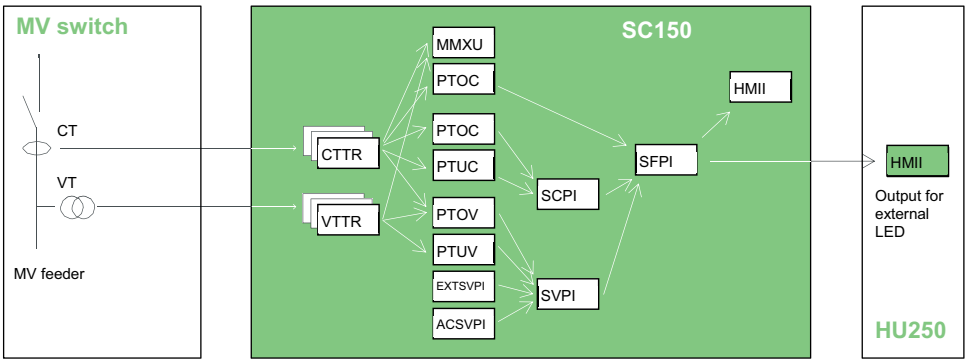
- **Indication only**
- **FPI + Sectionalizer**

Fault Current Detector Logical Nodes on the SC150 Module

The T300 fault current detection algorithms are based on the ANSI standards as well as on a certain number of logical nodes (LN, as described in standard IEC 61850) each with their own specific role. These are given for information purposes in the table below.

Logical Node (LN)	Category	Description
PhPTOC	PTOC	(ANSI 50/51) Phase overfault current detection indication
EfPTOC	PTOC	(ANSI 50N/51N) Ground (earth) fault current detection indication
SEfPTOC	PTOC	(ANSI 50N/51N) Sensitive Ground (earth) fault current detection indication
BcPTOV	POTV	(ANSI 47) Negative sequence overvoltage/broken conductor detection
DirPhPTOC	PTOC	(ANSI 67) Directional phase overfault current detection indication
DirEfPTOC	PTOC	(ANSI 67N) Directional ground (earth) fault current detection indication
AbsPTUC	PTUC	Current absence detection
PRSPTOC	PTOC	Current presence detection
PTUV	PTUV	Voltage absence detection
PrsPTOV	PTOV	Voltage presence detection
SVPI	SVPI	Indication of voltage presence based on inputs from the PTOV and PTUV logical nodes
SCPI	SCPI	Indication of current presence based on inputs from the PTOC and PTUC logical nodes
SFPI	SFPI	Fault current indication calculation based on confirmation of fault current detection (SVPI and/or SCPI)
FltMMXU	FltMMXU	H1 current and voltage at time of fault for phases A, B, C and residual.

Interconnection between the logical nodes used on the SC150 module:



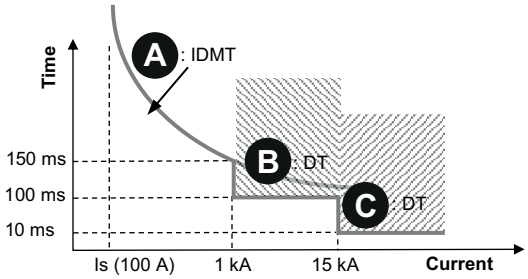
Fault Current Detection Indication (FPI) Principle

Counters are used for storing the type and number of fault currents on the MV network to provide statistical and analytical data on the quality of the network.

Internal variables, which can be consulted on the **Monitoring & Control > Data > Analog** page, allow you to save the latest current and voltage values before the fault current occurs on the network (values stored up to 3 seconds before the fault current appears).

NOTE: In case of type B connection (2 phase CTs + 1 core balance CT), the only mean to detect a fault on phase B is to use a core balance current transformer and activate the earth fault detection.
Monitoring phase B is done through I0 detection (2 or 3 instances available).
To activate the earth fault detection in the EfPTOC and DefPTOC functions, set parameters in **SC0x > Settings > Non-Directional fault detection** Web server and/or **SC0x > Settings > Directional fault detection** Web server page.

Fault current detection curve with three instances:



Instance A: IDMT curve (overload)
Instance B: DT curve (short-circuit)
Instance C: DT curve (instantaneous short-circuit)

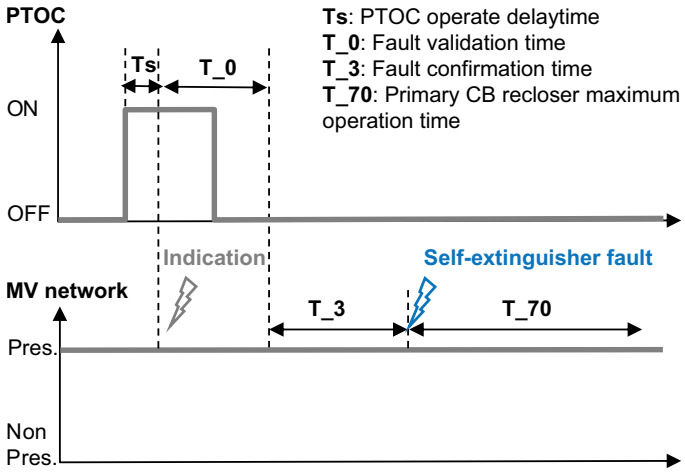
Different Fault Current Types Detected

The T300 can detect and indicate several types of fault current:

- **Self-extinguishing fault currents:**

  Detected fault currents that appear and disappear on the MV network, without tripping the upstream circuit breaker. This type of fault current is stored in the event log but not indicated by the LEDs on the T300.

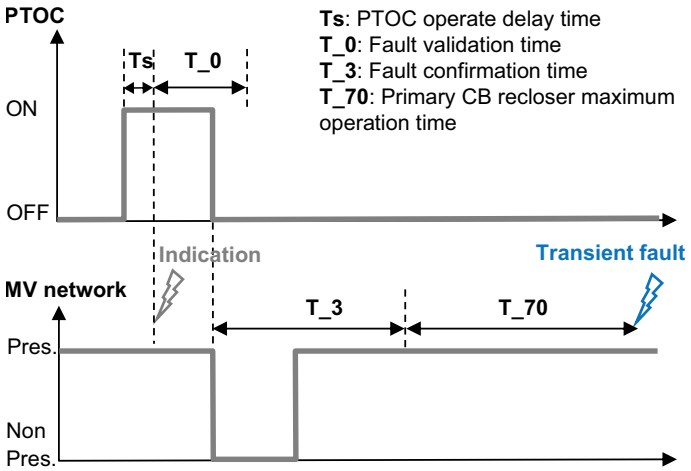
  Example of self-extinguisher fault current (the MV network power is not cut: the fault current is not validated. The delay T_70 is ignored).



- **Transient fault currents**

  Detected and validated fault currents on the MV network that are self-cleared in the first reclose cycle of the upstream circuit breaker or by a manual reset action.

  Example of transient fault current (the fault current is validated but network power is restored at the end of the T_3 or T_70 time delay).

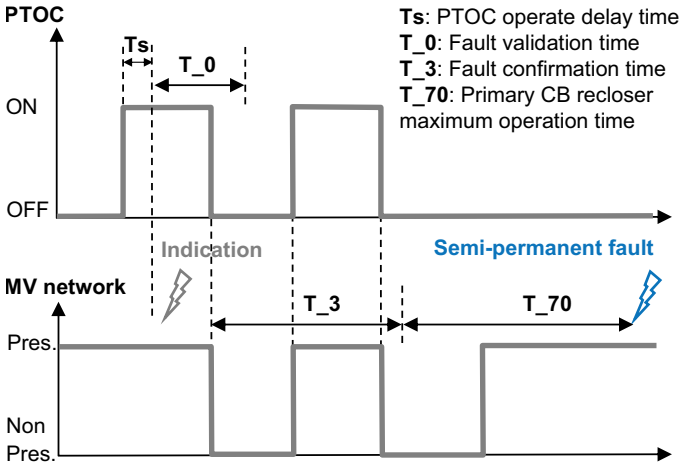


  NOTE: Self-extinguishing and transient fault currents are combined in a single transient fault current counter.

- **Semi-permanent fault currents:**

  Detected and validated fault currents that trip the upstream protection on the MV network, but that are self-cleared by the reclose cycles of the upstream circuit breaker (cycle 2 or cycle 3).

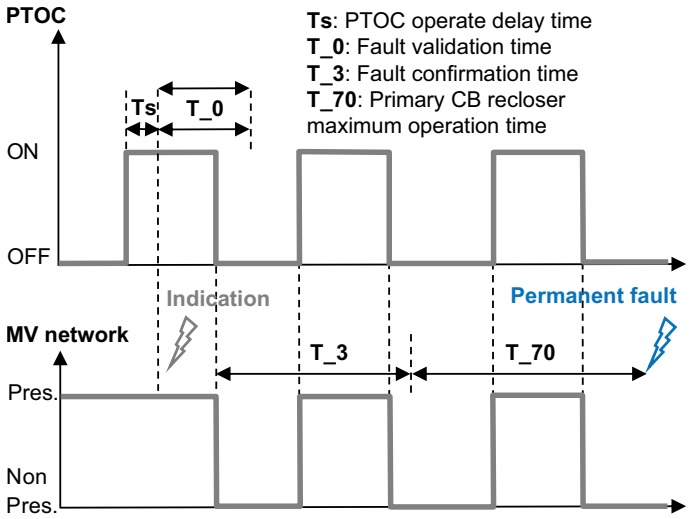
  Example of semi-permanent fault current, with reclose cycle (the validated fault current disappears before the end of the T_70 delay and network power is restored)



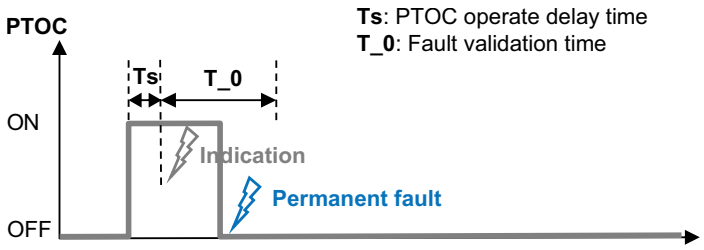
- **Permanent fault currents:**

  Detected and validated fault currents that trip the upstream protection permanently on the MV network (with or without reclose cycles). This means that the upstream circuit breaker remains open at the end of the reclose cycle time delay (T_70).

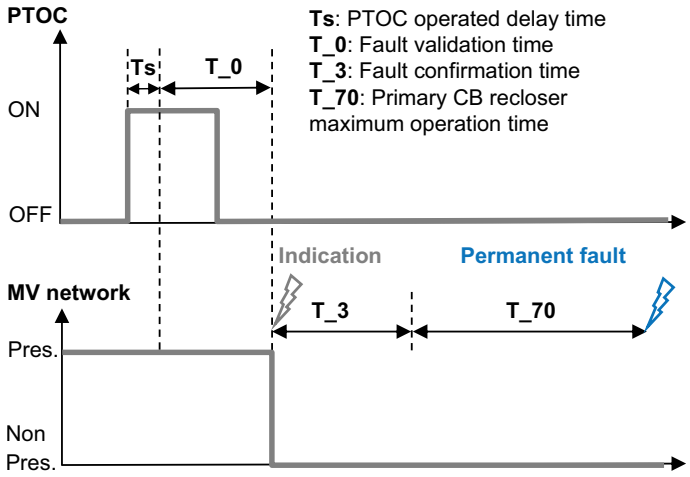
  Example of permanent fault current, with reclose cycle (the validated fault current has not been eliminated by the end of the cycle and the T_70 delay and network power is not restored)



  Example of a permanent fault current when there is no confirmation of network non présence (FPI network presence and confirmation mode=None). In this mode, the fault current is not validated by the non presence of the MV network, but only by detection and disappearance of the fault current during the time delay T_Valid.



  Example of a permanent fault current, without reclose cycle (the validated fault current has not been eliminated by the end of the T_70 delay and network power is not restored)



NOTE: When the fault current confirmed by the non presence of the MV network is not enabled by configuration (**FPI network presence and confirmation mode =None**), any detected fault current is only confirmed by the disappearance of the fault current, if this occurs during the confirmation time delay (T_Valid). In this mode, any confirmed fault current is considered to be a permanent fault current.

See the parameter settings table in the *Fault Current Indication* section for a detailed explanation of the time delays mentioned in these diagrams (T_0, T_3, T_70).

Fault current Acknowledgment Principle

The diagram below illustrates the principle for taking account of a detected fault current according to the current threshold (**Threshold value**) and configurable time delay (**Reset delay time** and **Operation delay time**) settings.

The time counter mentioned in the diagram is incremented whenever the current is greater than the fault current threshold and it remains at its most recent value if the current falls back below the threshold. The counter is then reset if the time for which the current remains below the detection threshold reaches the **Reset delay time** setting.

The following scenarios are possible based on the different phases in the diagram:

- Scenario **A**

  The measured current is not validated as a fault current since the duration for which the current is present above the fault current threshold (**Is**) is less than time **Ts**. The counter is reset at the end of time **Rdt** because the current remains below the threshold **Is** for a time longer than this delay

- Scenario **B**

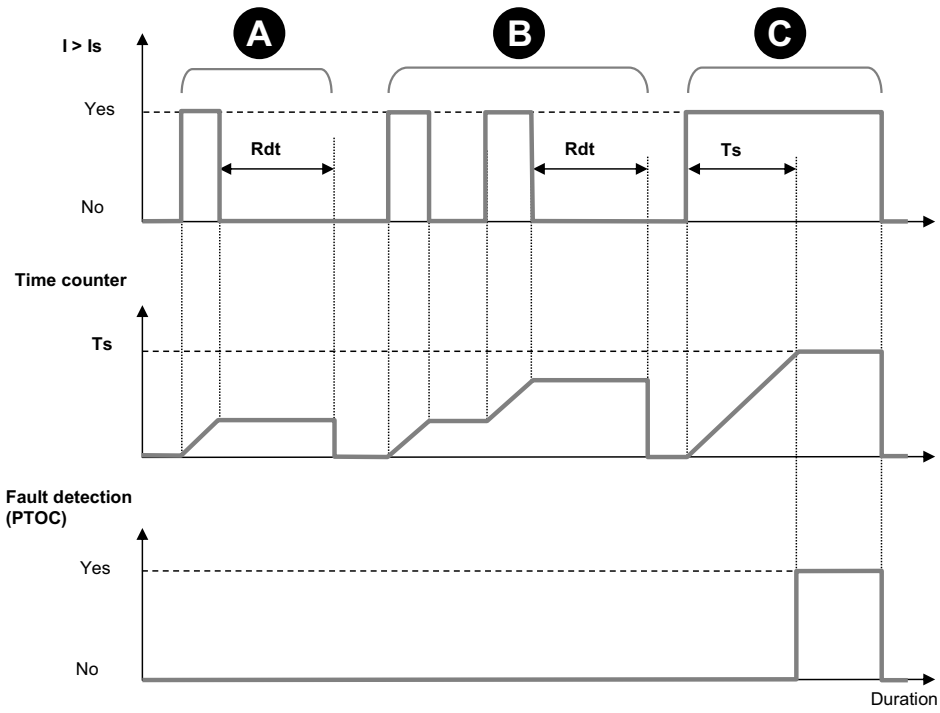
  The current greater than threshold **Is** appears twice in succession above threshold **Is** and increments the counter in stages. Time **Ts** is not reached, consequently the fault current is not validated. The counter is reset at the end of time **Rdt** because the current remains below the threshold **Is** for a time longer than this delay.

  NOTE: CT saturation phenomena may cause transient conditions for the current to fall below the threshold. The counting system described in scenario 2 allows this type of behavior to be filtered.

- Scenario **C**

  The current remains above the threshold **Is** long enough for the counter to be incremented until time **Ts** is reached. The current is validated as a fault current. As soon as the current falls below the threshold **Is**, time **Rdt** is no longer applicable once the fault current has been validated.

  NOTE: For definite time (DT) detection, time **Ts** remains the same, regardless of the value of the current Is. In contrast to this, in terms of the principle of inverse definite minimum time (IDMT) detection, time **Ts** varies according to the value of **Is**.



Rdt: Reset delay time

Is: Threshold value (fault current)

Ts: Operation delay time (for taking account of fault current)

General Configuration Rule

The general rules for configuring the settings thresholds on the T300 are as follows: The fault current detection settings used by the T300 must be configured on the T300 to correspond to those configured on the upstream circuit breaker on the MV network. The detection curves and the instances used must also be the same as those on the protection device for fault current behavior to be identical.

In theory, the fault current detection thresholds and time delays to be configured on the T300 must be slightly lower (e.g. by 20%) in relation to those of the upstream circuit breaker for the T300 to be able to detect the presence of the fault current before tripping the circuit breaker.
Additionally, for an ammetric fault current, the current configured on the T300 must be greater than the downstream capacitive current.

Fault current detector configuration example:

Circuit Breaker End	T300 End
I Max threshold = 350 A	Phase fault current threshold = 300 A
I0 threshold = 45 A	Ground fault threshold = 40 A
ACK I max. = 250 ms	ACK = 225 ms
ACK I0 = 250 ms	ACK = 225 ms

Fault Current Detection Curves on SC150 Module

Two main types of fault current detection are used on the T300:

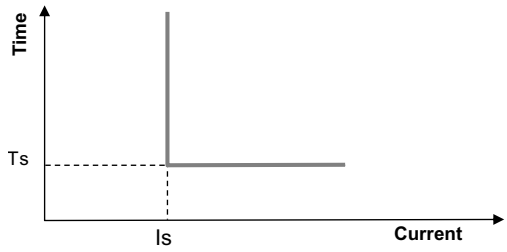
- Definite time (DT) detection
- Inverse definite minimum time (IDMT) detection

Different detection curves can be derived from these 2 types of fault current detection.

Definite Time (DT) Detection Curve

The basic principle behind this type of detection is summarized as follows:

- For a current less than or equal to the configurable fault current threshold Is (**Threshold value**), there is no fault current detection.
- For a current greater than **Is**, fault current detection takes place, but only if the current remains above this threshold for a time greater than or equal to the configurable acknowledge time **Ts** (**Operate delay time**).



Definite time (DT) detection curve

Inverse Definite Minimum Time (IDMT) Detection Curve on the SC150 Module

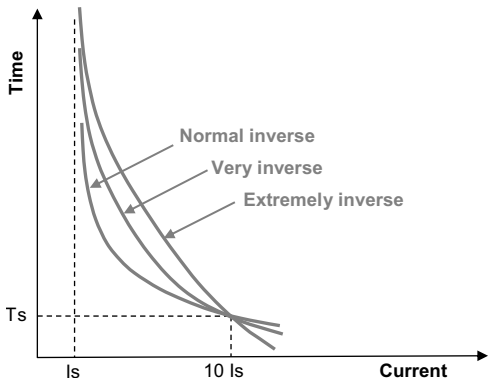
The basic principle behind this type of detection is essentially the same except for one difference in that the time taken to acknowledge the fault current depends on the value of the fault current:

- For a current less than or equal to the configurable fault current threshold **Is** (**Threshold value**), there is no fault current detection.
- For a current greater than **Is**, the fault current acknowledge time depends on the value of the current. The higher the current, the shorter the acknowledge time and vice versa. This type of curve allows the fault current detector to react more swiftly to high currents.
- The acknowledge time is infinite for a current equal to **Is**.

The Is (Threshold value) parameter is set by configuration.

Time Ts (Operate delay time) is also a configurable parameter set by the user. It corresponds to the acknowledge time for a current value of 10 Is.

Both these values are common to all selected curve types. The equation of the curve is constructed on the basis of these 2 values. It corresponds to the vertical asymptote of the curves.



Several types of IDMT curve, defined on the basis of this principle and the IEC and IEEE standards, are used by the fault current detector.

3 IDMT curves are defined based on the IEC standard:

- IEC normal inverse time/A (SIT)
- IEC very inverse time/B (VIT)

- IEC extremely inverse time/C (EIT)

3 IDMT curves are defined based on the IEEE standard:

- IEEE moderately inverse time (MI) o o
- IEEE very inverse time (VI)
- IEEE extremely inverse time (EI)

See the Appendix for more information about these IDMT curves.

Conversion of Time Multiplier settings to Operating Time

The fault current detection function settings must be set up to be consistent with the settings for the circuit breaker protection at the feeder source.

Sometimes protection device settings are defined using a Time Multiplier setting and not an Operating Delay setting.

To convert a time multiplier setting (TMS) to Operating Time, use the following formula
Ts = TMS x β
Where β depends on the selected curve (see tables of equations for IEC and IEEE here after).

- Equation for IEC-Type IDMT Curves

  The equation is similar for each IEC IDMT curve except for the parameters:

$$t_d(I) = \frac{A}{\left(\frac{I}{I_S}\right)^P - 1} \times \frac{T}{\beta}$$

  Where:

  - $t_d(I)$ = Fault current detection time according to the current value (in seconds). Equivalent to Ts
  - I = Measured current value
  - A, p, ß = Parameters defined by the IEC standard (see table below)
  - Is = Fault current detection threshold value (configurable **Threshold value**)
  - T = Time delay value at 10 Is.

Curve Parameters	A	p	ß
Normal inverse time/A	0.14	0.02	2.9709
Very inverse time/B	13.5	1	1.5
Extremely inverse time/C	80	2	0.8081

NOTE: The letters A, B, and C associated with the IEC curves define the category of a curve. The power "p" defined in the equation is used to classify a curve into 1 of 3 the categories according to the following criteria:

Category	p
A	p ≤ 0.5
B	0.5 ≤ p ≤ 1.5
C	p ≥ 1.5

- Equation for IEEE-Type IDMT Curves

  The equation is similar for each IEEE IDMT curve except for the parameters:

$$t_d(I) = \left(\frac{A}{\left(\frac{I}{I_S}\right)^P - 1} + B\right) \times \frac{T}{\beta}$$

  Where:

  - $t_d(I)$ = Fault current detection time according to the current value (in seconds). Equivalent to Ts
  - I = Measured current value
  - A, B, p, ß = Parameters defined by the IEEE standard (see table below)
  - Is = Fault current detection threshold value (configurable **Threshold value**)
  - T = Time delay value 10 Is.

Curve Parameters	A	B	p	ß
IEEE moderately inverse time	0.0515	0.114	0.02	1.20676
IEEE very inverse time	19.61	0.491	2	0.68908
EE extremely inverse time	28.2	0.1217	2	0.40548

Inrush Filter

A filter for detecting transformer inrush current can be enabled on the T300 to help prevent spurious fault currents being detected on the MV network.

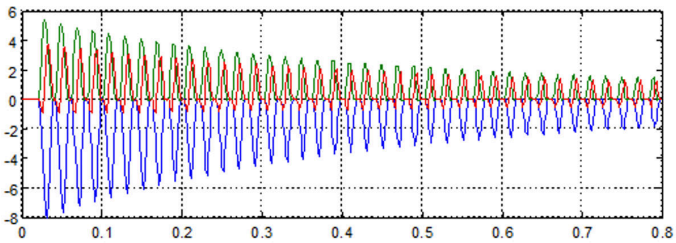
A current peak may occur on power-up of the MV network due to energization of the transformers and saturation of the phase CTs installed on the network. These current peaks may activate the fault current detectors falsely by tripping the configured thresholds.

To avoid this phenomenon, an algorithm is used to discriminate fault currents from transformer inrush currents on network power-up.

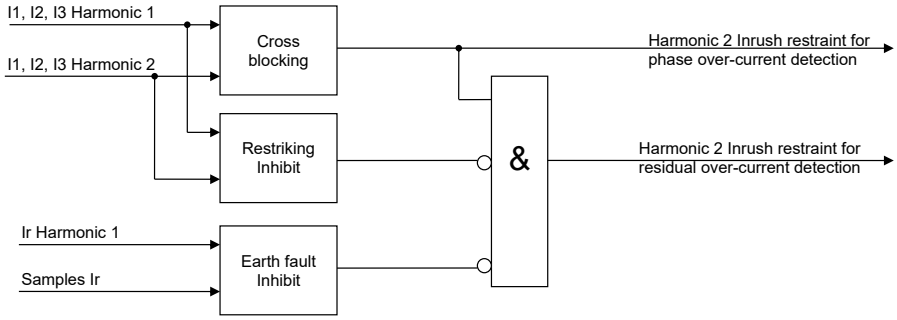
The algorithm for detecting the transformer inrush phenomenon is based on an analysis of the ratio between the second harmonic distortion and the fundamental current on the 3 network phase currents. The inrush filter becomes active when a high proportion of second harmonics are detected.

The inrush filter is only possible for ANSI 50/51, ANSI 50N/51N, and ANSI 67 type detection, and for instances 1 and 2 only.

Example of inrush current with 2nd harmonic content on transformer magnetization:



Block Diagram



Cross Blocking

The quadratic harmonic 2 is used to do a cross blocking on inrush currents when a feeder is energized.

$$If \quad I1_{h1}^2 + I2_{h1}^2 + I3_{h1}^2 > 3 \bullet (0.008)^2 In^2$$

$$then \quad T_Q = \frac{I1_{h2}^2 + I2_{h2}^2 + I3_{h2}^2}{I1_{h1}^2 + I2_{h1}^2 + I3_{h1}^2}$$

$$else \quad T_Q = 0$$

$$End$$

When TQ is higher than 0.03 (harmonic 2 ratio > 17.3%), the output Inrush restraint for phase over-current is set.

Restriking Earth Fault Inhibit

On restriking earth fault, the harmonic 2 ratio is high only on one phase.

So to discriminate inrush currents from restriking earth fault we use the harmonic ratio on each phase, to inhibit the cross blocking inrush restraint.

$$If \quad Ix_{h1}^2 > (0.008)^2 In^2 \qquad for\ x = 1\ to\ 3$$

$$then \quad T_x = \frac{Ix_{h2}^2}{Ix_{h1}^2}$$

$$else \quad T_x = 0$$

$$End$$

Restriking_Inhibit = (T1 > 0.04) AND (T2 < 0.01) AND (T3 < 0.01)

Restriking_Inhibit = Restriking_Inhibit OR [(T2 > 0.04) AND (T1 < 0.01) AND (T3 < 0.01)]

Restriking_Inhibit = Restriking_Inhibit OR [(T3 > 0.04) AND (T1 < 0.01) AND (T2 < 0.01)]

Earth Fault Inhibit

If an earth fault is present when the feeder is energized, we compare the form factor of the residual current to discriminate inrush currents from earth fault.

$$If\ \max\left(|x_i|_{i=1}^{36}\right)^2 < 4 \cdot \mathrm{mod}^2(I_r)$$

then

Earth_fault_inhibit=1

else

Earth_fault_inhibit=0

End

The function

$$\max\left(|x_i|_{i=1}^{36}\right)$$

calculates the maximum value of absolute samples of residual current on one cycle.

Fault Event

The magnitudes of the values of the first harmonic (H1) currents FltMMXU1.A and voltages FltMMXU1.phsV during the fault are saved and are reported to the Head Unit for logging or reporting to SCADA.

The phase currents at time of fault are the magnitudes of the H1 values (or the filtered crest if it is greater) used by the phase over-current PTOCs (ANSI 50/51 or 67 functions) in the cycle that changes the operate status (delayed bit).

The residual current at time of fault is the magnitude of the H1 values (or the filtered crest if it is greater) used by the earth fault PTOCs (ANSI 50N/51N or 67N functions) in the cycle that changes the operate status (delayed bit).

If current values (for phase) exceeds the measurement range for the phase currents, then the over-range quality flag is set.

- Phase current maximum: 20 In (when CT = 1A)
- Phase current maximum: 7 In (when CT = 5A)

If current value of I0 (calculated or measured) exceeds the measurement range, then the over-range quality flag is set.

- Residual current maximum: 7 In (when I0 is calculated)
- Residual current maximum: 7 In0 (when I0 is measured)

The phase voltages at time of fault are the magnitudes of the H1 values of the phase voltages during the cycle where the first PTOC operates.

The residual voltage at time of fault is the magnitude of the H1 value of the residual voltage during the cycle where the first PTOC operates.

If voltage values exceed the measurement range, then the over-range quality flag is set.

- Phase voltage maximum: 4 Un
- Residual voltage maximum: 4 Un

If one channel is not available, because of the configuration of CT sensors, its value is fixed to 0.

Voltage channels (line to neutral) are always saved. When the VT sensor is not wired (single phase) or is wired to measure a line to line voltage, the calculated line to neutral voltage is used.

An additional variable FltMMXU.ClcExp is needed to signal to the Head Unit that the other data (voltages and currents harmonic 1) is ready. This variable is published in the same execution cycle than the publication of the current and voltage values.

Setting Groups

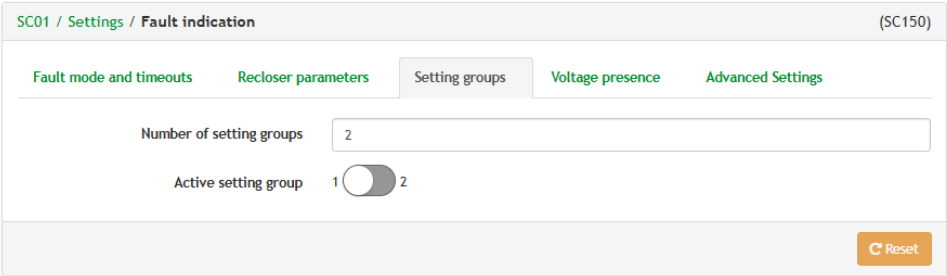
In the **Setting Groups** tab, you can select the parameter setting group to apply for the fault detection type. Up to 8 groups of parameter settings can be defined by the user to control the operation of the protection equipment, adjusting the behavior to different conditions or network configurations. Each instance has its own specific parameters for each group of settings.

There are 7 protection functions in the SC150 module that use **Setting Groups**:

- Voltage monitoring (ANSI 27, ANSI 59)
- Neutral overvoltage (ANSI 59N)
- Active overpower (ANSI 32P)
- No Directional Fault Detection (ANSI 50/51, ANSI 50N/51N)
- Directional Fautl Detection (ANSI 67, ANSI 67N)
- Broken Conductor (ANSI 47)
- Sectionalizer

Only one setting group can be active at a time. It is possible to change over from one group of settings to another by the **Active setting group** parameter, remotely via the SCADA system or manually in the **Substation** page of the Web server.

Access via **SC0x > Settings > Global fault settings > Setting group** tab.



Fault Current Detection Indication Setting on the SC150 Module

The Tripping protection mode is not available on the SC150.

ANSI 50/51 Phase (PhPTOC) Overcurrent Description for SC150 Module

This fault current detection is based on the fundamental component of the rms current on the 3 phases (types A and D CT connection configurations) and on the 2 phases (type B CT connection configuration). Detection is activated if 1, 2, or all 3 phases reach the operating threshold. Fault current detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the table below.

Up to 8 groups of settings are available. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the **Substation** page in the Web server
- Remotely via the SCADA system

The table below describes the ANSI 50/51 characteristics.

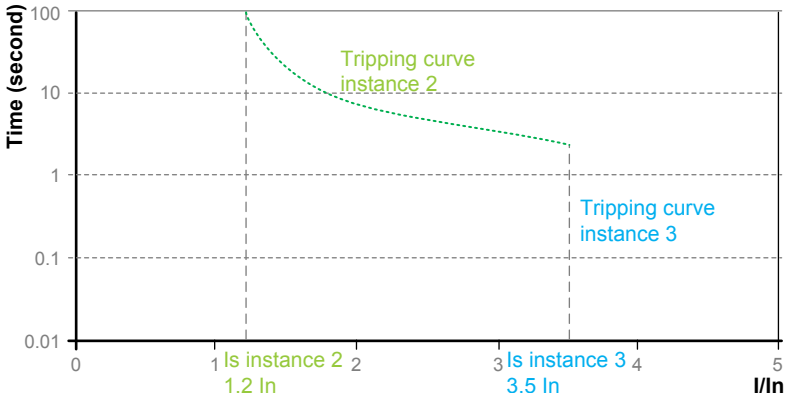
Each instance has its own specific parameters for each group of settings. The 3 instances can operate simultaneously with different settings.

ANSI 50/51 Characteristics	
Number of instances	3
Groups of settings	From 1 to 8

ANSI 50/51 Characteristics		
Logical node name		**PhPTOCx** (x = instance number)
Indication only		Indication of faulted phases A, B, C (*) Phase fault detected: instance 1, 2, or 3 • No • Indication only : the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer
FPI + Sectionalizer		
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	• No • Indication only : the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer
	Instance 2	
	Instance 3	
Detection mode (curve type)	IEC definite time (DT)	Instance 1, 2, and 3
	Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	Instance 1 and 2 only
Overcurrent threshold	DT	See parameter settings table, page 240.
	IDMT	
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Inrush filter	Instance 1 and 2 only (**)	Active or inactive
(*): Phase B fault indication is not available with type B CT connection. (**): Instance 3 is dedicated to detecting high fault currents. There is no value in using the inrush filter in this case, since inrush currents can only be detected for lower fault currents.		

Example detection curve with several instances:

- Instance 1: Inactive:
- Instance 2: Active/IEC inverse time/A (IDMT)
- Instance 3: Active/IEC definite time (DT)



ANSI 50N/51N Earth Fault (EfPTOC) and Sensitive Earth Fault (SEfPTOC) Description for SC150 Module

Ground fault detection is based on residual current values measured by a core balance CT (type B, C or D connection configuration) or calculated from the currents of all 3 phases (types A and D connection configuration).
Type D connection configuration allows 2 ways of detecting ground fault currents:

- By measuring the current from the 3 phase CTs
- By measuring the current from 1 core balance CT (for greater accuracy)

NOTE: It is still possible to define by configuration a ground fault measurement obtained by adding the 3 phase CTs together, even if a core balance CT is available, knowing that this does not really make sense, as this configuration does not provide the most accurate results.
Detection is activated if the residual current reaches the threshold defined by configuration.
This is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the table below.

ANSI 50N/51N Characteristics		
Number of instances		3 available instances for EfPTOC (capable of operating simultaneously with different settings) Only one instance available for SEfPTOC
Groups of settings		From 1 to 8
Logical node name		• **EfPTOC** (x = instance number) • **SEfPTOC**
Fault current indication only		Earth fault detected Cross-country fault detected: instance 3 Generic phase fault indication Indication of faulted phases A, B, C (*) Phase fault detected: instance 1, 2, or 3 • No • Indication only : the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer
FPI + Sectionalizer		
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Activation of the instance for detecting phase-to-phase fault currents • No • Indication only : the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer
	Instance 2	
	Instance 3	
Residual current acquisition		Ires (sum of all 3 phases)
		I0 (directly from the core balance CT)
Detection mode (curve type)	IEC definite time (DT)	Instance 1, 2, and 3
	Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	

ANSI 50N/51N Characteristics		
Ground fault threshold	DT	See parameter settings table, page 240.
	IDMT	
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Inrush filter	Instance 1 and 2 only (*) and in 3 phase CTs connection configuration only	Active or inactive
(*): Instance 3 is dedicated to detecting high fault currents. There is no value in using the inrush filter in this case, since inrush currents can only be detected for lower fault currents.		

ANSI 50/51 and ANSI 50N/51N Non-Directional Fault Current Detection Indication Settings on SC150

- Configuring an ANSI 50/51 instance
  Accessed via **SC0x > Settings > Non-directional fault detection**, **PhPTOC** tab.
- Configuring an ANSI 50N/51N instance
  Accessed via **SC0x > Settings > Non-directional fault detection** , **EfPTOC** tab.

Up to 8 groups of settings are available. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the Substation page in the Web server
- Remotely via the SCADA system

Each instance has its own specific parameters for each group of settings. The 3 instances can operate simultaneously with different settings.

Parameter	Default	Configuration range	Description
Function Activation – PhPTOC (ANSI 50/50): Phase Over-current			
Instance 1 enabled	No	• None • Indication only • FPI + sectionalizer	Activation of the instance for detecting phase-to-phase fault currents: • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer **NOTE:** To enable instances 1 and 2, first enable instance 3.
Instance 2 enabled	No	• None • Indication only • FPI + sectionalizer	
Instance 3 enabled	Yes	• None • Indication only • FPI + sectionalizer	
Function Activation – EfPTOC (ANSI 50N/51N): Earth Fault			
Instance 1 enabled	No	• None • Indication only • FPI + sectionalizer	Activation of the instance for detecting earth fault currents: • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer
Instance 2 enabled	No	• None • Indication only • FPI + sectionalizer	
Instance 3 enabled	Yes	• None • Indication only • FPI + sectionalizer	

Parameter	Default	Configuration range	Description
Function Activation – SEfPTOC: Sensitive Earth Fault			
Instance 1 enabled	No	• None • Indication only • FPI + sectionalizer	Activation of the instance for detecting earth fault currents: • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer

Parameter	Default	Configuration range	Description
PhPTOC Instance 1, 2, or 3			
Operating curve type	IEC definite time	• IEC definite time • IEC normal inverse • IEC very inverse • IEC extremely invers • IEEE extremely inverse • IEEE very inverse • IEEE moderately inverse	Choice of the type of standardized IEC or IEEE curve to apply to the selected instance for detecting phase-to-phase fault currents. **NOTE:** Instance 3 only uses the **IEC definite time** curve.
Threshold value (A)	100	• DT ◦ 0.02-10 In (1 A minimum) for CT = 1 A (*) ◦ 0.02-4 In (1 A minimum) for CT = 5 A (*) • IDMT 0.02-1 In (1 A minimum) (**) (increment = 1)	Minimum threshold for detecting phase-to-phase fault currents. The current must be detected above this threshold for a longer time than the **Operate delay time** to validate the presence of a fault.
Operate delay time (ms)	100	• Instance 1 and 2 ◦ DT: 50-300,000 ◦ IDMT: 20-12,500 • Instance 3 ◦ DT: 0-300,000 (increment = 1)	Minimum time for which the detected current must be greater than the phase-to-phase Threshold value to validate the fault current.
Reset delay time (ms)	0	0-300,000 (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the **Operate delay time**. For the period when the current is below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This time is incremented again if the current exceeds the threshold. This reset time is inactive once the fault current has been validated.
Inrush filter enabled	No	• Instance 1 and 2: ◦ No ◦ Yes	Activation of the algorithm for detecting transformer inrush.

Parameter	Default	Configuration range	Description
EfPTOC Instance 1, 2, or 3 — SEfPTOC Instance 1			
Io measured	No	• No • Yes	Activation of the I0 current measurement by core balance CT for ground fault detection. If this option is not enabled, the residual current is calculated by adding together the currents from the 3 phase CTs. **NOTE:** This parameter is only configurable for a type D connection configuration with core balance CT.
Operating curve type	IEC definite time	• IEC definite time • IEC normal inverse • IEC very inverse • IEC extremely invers • IEEE extremely inverse • IEEE very inverse • IEEE moderately inverse	Choice of the type of standardized IEC or IEEE curve to apply to the selected instance for detecting earth fault currents. Note that instance 3 only uses the **IEC definite time** algorithm.

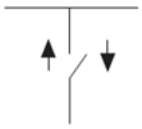
Parameter	Default	Configuration range	Description
Threshold value (A)	100	• DT ◦ 0.008-3.5 In (1 A minimum) for CT = 1 A (*) ◦ 0.008-1.6 In (1 A minimum) for CT = 5 A (*) and for SEfPTOC Instance 1 • IDMT ◦ 0.008-1 In (1 A minimum) (**) (increment = 1)	Minimum threshold for detecting zero sequence fault currents. The current must be detected above this threshold for a longer time than the **Operate delay time** to validate the presence of a fault current.
Operate delay time (ms)	100	• Instance 1 and 2: ◦ DT: 50-300,000 ◦ IDMT: 20-12,500 • Instance 3: 0–300,000 (increment = 1)	Minimum time for which the detected current must be greater than the zero sequence **Threshold value** to validate the fault current.
Reset delay time (ms)	0	0-3 00,000 (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the **Operate delay time**. For the period when the current is below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This time is incremented again if the current exceeds the threshold. This reset time is inactive once the fault current has been validated.
Inrush filter enabled	No	• Instance 1 and 2: ◦ No ◦ Yes	Activation of the algorithm for detecting transformer inrush.
(*): Setting value of Phase CT secondary rated current or Core Balance CT secondary rated current (if Io measured is selected) in **SC0x > Settings > Sensors > Current Transformer** parameter. (**): In corresponds to the nominal current at the CT primary (by default In = 500 A) or to the nominal current at the core balance CT primary (by default In = 500 A) for earth faults if Io measured option is selected.			

ANSI 67 Directional Phase Overcurrent Description for SC150 Module

In a looped network where a fault current is supplied with power at both ends, but also in a network with several power sources, a method of detection that is sensitive to the direction of the fault current flow is required to be able to locate and indicate the fault current direction selectively: this is the role of directional phase overcurrent detectors.

Fault current detection operates if the phase overcurrent function is enabled for at least 2 of the 3 phases. The fault current direction (network or busbar) is also determined and associated with this detection. The detector indicates the phases in which the fault current has occurred and the direction of the fault current.

Direction convention for a directional fault current:



Busbar direction Network direction

- Busbar direction: from the busbar to the network (=Backward)
- Network direction: from the network to the busbar (=Forward)

To enable detection, the phase current must reach the threshold defined by configuration. Detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67 characteristics table.

Up to 8 groups of settings are available. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the Substation page in the Web server

- Remotely via the SCADA system

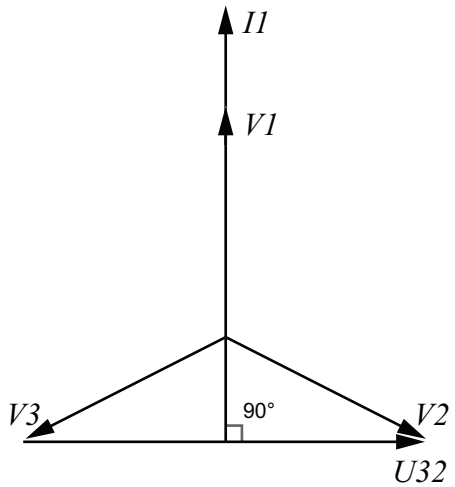
Direction of Fault Current

The direction of the fault current is determined by the comparison between the phase current and the polarization voltage. The detector therefore requires both current and voltage data. The direction is classed as either busbar or network according to the direction convention. Polarization voltage is the phase-to-phase voltage in quadrature with the current for cos φ= 1 (phase-to-phase voltage creating a 90° angle in relation to the current).

The table below indicates the polarization voltage used to determine the direction as a function of the current on each phase (only phases 1 and 3 are used in the case of type B CT connection):

Measured current	I1	I2	I3
Polarization voltage	U23	U31	U12

Example with 1 phase: current and polarization voltage (U32 in this case)



The current vector plane on 1 phase is divided into 2 semi-planes separated by a boundary line. These 2 semi-planes correspond to 2 zones: the direct zone and the reverse zone.

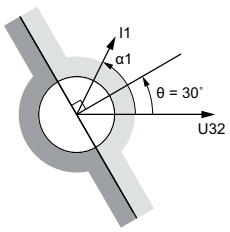
The characteristic angle φ is the angle between the perpendicular to the boundary line between these 2 zones and the polarization voltage. The value of this angle (which is configurable) determines the position of this boundary line in the vector plane.

The direction of the fault current is determined by the presence of current in the zone in which this vector plane is located:

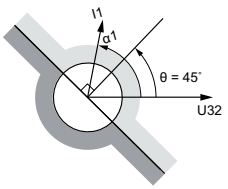
- Fault current on the direct zone: fault current is from the busbar to the network (forward fault); the fault is detected on the network side of the switch.
- Fault current on the reverse zone: fault current is from the network to the busbar (backward fault); the fault is detected on the busbar side of the switch.

This rule of positioning of current in the vector plane depends on the value of the angle α between the current and the polarization voltage.

Example of fault current on phase 1, in the direct zone, with characteristic angle φ = 30°:



Example of fault current on phase 1, in the direct zone, with characteristic angle φ = 45°:



Voltage Memory

In the event of a 3-phase fault current close to the busbar, the level of each polarization voltage may not be sufficient (close to zero) to detect the fault current correctly. The fault current detector therefore uses a voltage memory to detect the fault current reliably.

To help ensure that the voltage memory is only used for a 3-phase fault current, the detector verifies that at least 2 phase-to-phase voltages are close to zero.

NOTE: If a fault current occurs just after the MV network is energized, the direction of the fault current cannot be indicated by the voltage memory. In this case, where the voltage is zero just before the fault current, the voltage memory is not reliable for determining the direction. The fault current will still be detected and indicated by the detector, however.

ANSI 67 Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		From 1 to 8
Logical node name		**DPhPTOCx** (x = instance number)
Fault current indication		Type of fault current detected
		Phase with fault current condition: instance 1, 2 with indication of direction
FPI + Sectionalizer		Generic phase fault indication Indication of faulted phases A, B, C (*)
		Phase fault detected: instance 1, 2, or 3
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Detection mode (curve type)	IEC definite time (DT)	Instance 1, 2, and 3
	Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	
Overcurrent threshold	DT	See parameter setting table, page 245
	IDMT	
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Inrush filter		Active or inactive
Characteristic angle		30, 45, or 60° (default: 45°)

ANSI 67 Directional Phase Fault Current Detection Indication Parameter Setting on SC150 Module

Access via **SC0x > Settings > Directional fault detection** page.

Parameter	Default	Configuration range	Description
Function Activation – DPhPTOC: Phase Over-current			
Instance 1 or 2	No	• No • Indication only • FPI + Sectionalizer	Activation of the instance for detecting phase-to-phase fault currents • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer

Parameter	Default	Configuration range	Description
PhPTOC Instance 1 or 2			
Operating curve type	IEC definite time	• IEC definite time • IEC normal inverse • IEC very inverse • IEC extremely invers • IEEE extremely inverse • IEEE very inverse • IEEE moderately inverse	Choice of the type of standardized IEC or IEEE algorithm to apply to the selected instance for detecting phase-to-phase fault currents .
Threshold value (A)	100	• DT ◦ 0.02–10 In (1 A minimum) for CT = 1 A (*) ◦ 0.02–4 In (1 A minimum) for CT = 5 A (*) • IDMT: 0.02–1In (1 A minimum) (**) (increment = 1)	Minimum threshold for detecting phase-to-phase fault currents. The current must be detected above this threshold for a longer time than the **Operate delay time** to validate the presence of a fault current.
Operate delay time (ms)	20	• DT: 50–300,000 ms • IDMT: 20–12,500 ms	Minimum time for which the detected current must be greater than the phase-to-phase **Threshold value** to validate the fault current.
Reset delay time (ms)	0	0–300,000 (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the **Operate delay time**. For the period when the current is below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This time is incremented again if the current exceeds the threshold. This reset time is inactive once the fault current has been validated. Constraint: if you choose a reset time equal to 0, a reset time equal to 35 ms fixed is used internally to limit the impact of the CT saturation.
Inrush filter enabled	No	• No • Yes	Activation of the inrush current filter function.
Characteristic angle (degrees)	45	• 30 ° • 45 ° • 60 °	Choice of characteristic angle value. The characteristic angle is the angle between the perpendicular to the boundary line and the magnitude of polarization (phase-to-phase voltage in quadrature with the current for Cos φ=1). The value of the characteristic angle determines the position of the boundary line defining the separation between the reverse zone and the direct zone (see the description of the ANSI 67 function).
(*): Setting value of Phase CT secondary rated current in **SC0x > Settings > Sensors > Current Transformer** parameter. (**): In corresponds to the nominal current at the CT primary (by default In = 500 A).			

ANSI 67N Directional Earth (DEfPTOC) Fault Detection Indication Description for the SC150 Module

Introduction

The directional fault current detection combines a ground function based on residual voltage with a fault current direction indication.

The residual current I0 measured on this detection can be determined in 2 different ways (configurable option: **Io measured**):

- By adding the values of the 3 phase CTs together (A or D type connection configurations)
- By measuring the residual current directly using the core balance CT (B, C or D type connection configurations)

To enable detection, the residual current must reach the threshold defined by configuration. Detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67N characteristics table.

There are three steps to enable the detection of a directional ground (earth) fault current:

1. The fault current is taken into account if the following conditions are met:
   - the residual voltage and the residual current exceed the thresholds defined by configuration (**Minimum residual voltage threshold** and threshold value, respectively)
   - both remain above these thresholds for a longer time than the configurable time period (**Operate delay time**).
2. The direction of the fault current is determined during the transient phase of the fault by examining the sign of the residual sequence current with respect to the residual voltage. This can be achieved by comparing either the projection of the residual current onto the residual voltage (types 1 and 2), or the residual current phasor with respect to the defined sector (type 3). This depends on the calculation mode selected.

   NOTE: It is also possible to only validate fault currents with a high current peak during this transient phase by using specific thresholds on the residual current and voltage measurements (see parameter setting table, page 250).
3. The presence of the fault current detected in step 1 is then validated by the absence of residual voltage.

Up to eight groups of settings are available for this type of detection. It is possible to change over from one group of settings to the other during operation as follows:

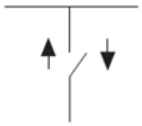
- Manually in the **Substation** page in the Web server
- Remotely via the SCADA system

Direction of Fault Current

The direction of the fault current can then be determined using the following convention:

- Fault current on the direct zone: fault current is from the busbar to the network (forward fault); the fault is detected on the network side of the switch.
- Fault current on the reverse zone: fault current is from the network to the busbar (backward fault); the fault is detected on the busbar side of the switch.

Direction convention for a directional fault current:



Busbar direction Network direction

Detection Modes for Different Network Types

There are three types of detection modes available:

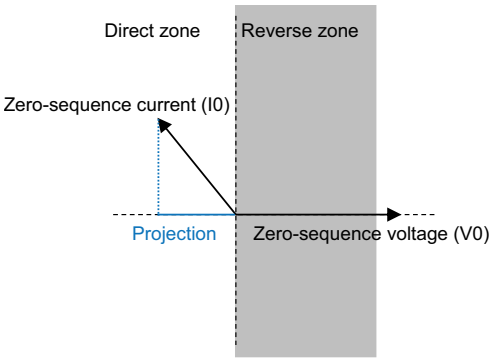
- Detection based on the projection of the residual current onto the residual voltage (Types 1 and 2)
- Detection based on the active sector configuration (Type 3)

Detection based on the projection of the residual current onto the residual voltage (Types 1 and 2)

This protection function is suitable for radial feeders in impedant, isolated or compensated neutral systems. The direction of the fault current is determined by projecting the residual current onto the residual voltage during the transient phase. This projection can be detected in 2 distinct zones (see diagram below):

- in the direct zone, if the integral of the projection of I0 on V0 is negative
- in the reverse zone, if the integral of the projection of I0 on V0 is positive

Principle of projecting the residual current onto the residual voltage to determine the direction of the fault current:



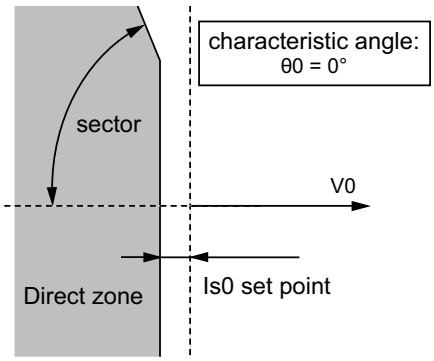
To enable the detection, this projection must reach the threshold defined by configuration, while the residual voltage remains above its configured threshold for the **Operate delay time**. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67N characteristics table.

> **NOTE:** For Type 1 algorithm, only Definite Time (DT) operating curve is available.

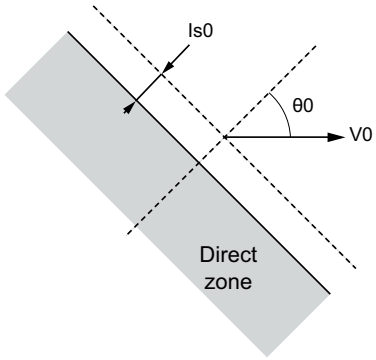
The distinction between these types depends on the available parameters:

- **Type 1**: the function determines the projection of the residual current on the characteristic line, the position of which is determined by the setting of the characteristic angle θ0 in relation to the residual voltage.
  When θ0 = 0º, the **Desensitization area** parameter is used to reduce the detection zone to stabilize it on fault-free feeders.
  Additionally for Type 1, a memory algorithm is also implemented to extend the transient pick-up information. Detection is extended throughout the duration of the fault based on the criterion V0 u V0mem, within the limit of T0mem. Refer to ANSI 67N Directional Earth (DEfPTOC) Fault Detection Indication and Tripping Protection Description, page 342 (Tripping enabled/Memory) for more information.

  ANSI 67N type 1 operation characteristics for angle Θ = 0):



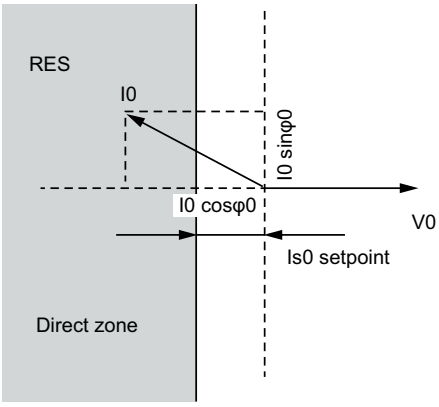
  ANSI 67N type 1 operation characteristics for angle Θ ≠ 0):



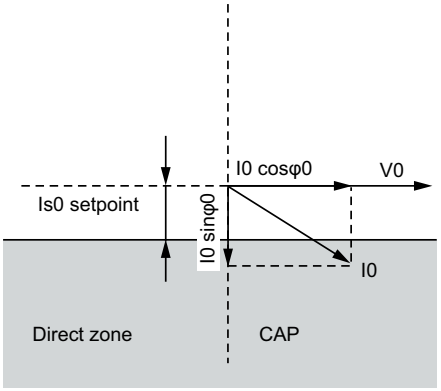
- **Type 2**: the characteristic angle can switch between two values, 0º (Res mode) and 90º (Cap mode), changing the configuration of the **Polarization quantity** parameter.
  When selecting Res mode, the instance becomes sensitive to the resistive component of the residual current. This submode is suitable for compensated neutral systems and grounded networks with a high resistance.
  When the Cap mode is selected, the instance becomes sensitive to the capacitive component of the residual current. This submode is suitable for unearthed/ungrounded networks.
  Additionally for Type 2, the validation of electrical faults with a high current peak during the transient phase is enabled by the **Enable validation checks** parameter (see parameter setting table, page 250).

  ANSI 67N Type 2 operation characteristic for Res mode or Cap mode:

ANSI 67N Type 2 operation characteristic for Res mode



ANSI 67N Type 2 operation characteristic for Cap mode

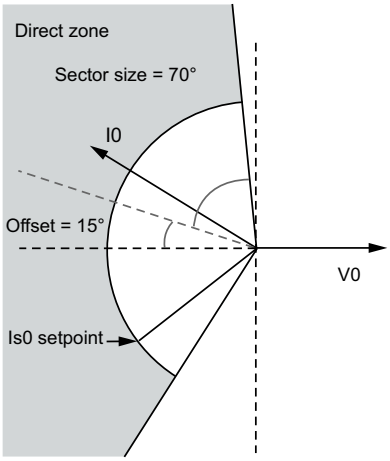


Detection based on the active sector configuration (Type 3)

The function operates like an earth fault detection function with an added angular direction criterion: the detection area has the shape of a sector (see diagram below) that can be configured by selecting the angle offset and a sector size with respect to the residual voltage.
The residual current measured or calculated value is compared to the residual current threshold defined in the configuration. The protection function is inhibited for residual voltages below the residual voltage.
This mode is suitable for closed ring distribution networks with directly earthed/grounded neutral and with a small resistance.

To enable the detection, residual voltage and residual current must remain above the configured thresholds for the **Operate delay time**. This time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67N characteristics table.

ANSI 67N Type 3 operation characteristic:



ANSI 67N Characteristics

Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		From 1 to 8
Logical node name		**DEfPTOCx** (x = instance number)
Direction of fault current		Busbar / Network
Parameter Setting (For Each Instance)		
Instance activation	Instance 1 or 2	Active or inactive
Residual current acquisition		Ires (sum of all 3 phases)
		I0 (directly from the core balance CT)
Detection mode (curve type)	IEC definite time (DT)	Type 1: both instances
	IEC definite time (DT) Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	Type 2 and 3: both instances
Minimum residual voltage threshold	DT	See parameter setting table, page 251.
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Validation by residual current and voltage peaks		Active or inactive
Residual voltage peak threshold	DT	See parameter setting table, page 251.
Residual current peak threshold	DT	
Directional earth fault algorithm		Type 1, Type 2 or Type 3
Polarization quantity	Type 2	Resistive or capacitive
Characteristic angle	Type 1	-45º, 0 -45º, 0º, 15º, 30º, 45º, 60º, 90º Default = 0º
Desensitization area	Type 1	76º, 83º or 86º Default = 83º
Angle offset	Type 3	-180º – 179º
Sector size	Type 3	10º– 170º
Maximum time of memorization	Type 1	See parameter setting table, page 251.
Minimum residual voltage threshold for memorization	Type 1	See parameter setting table, page 251.

ANSI 67N Directional Earth (DEfPTOC) Fault Indication Parameter Setting on the SC150 Module

Accessed via **SC0x > Settings > Directional fault detection** page

Each instance has its own specific parameters for each group of settings. The 2 instances can operate simultaneously with different settings.

Parameter	Default	Configuration range	Description
Function Activation – DEfPTOC Indication: Earth Fault Currrent			
Instance 1 or 2	No	• No • Indication only • FPI + Sectionalizer	Activation of 1 or 2 for detecting zero sequence fault currents.

DEfPTOC Common

Parameter	Default	Configuration range	Description
DEfPTOC Indication Instance 1 or 2			
Io measured	No	• No • Yes	Activation of the I0 current measurement by core balance CT for directional ground fault detection. If this option is not enabled, the residual current is calculated by adding the currents from the 3 phase CTs together. **NOTE:** This parameter is only configurable for a type D connection configuration with core balance CT.
Directional earth fault algorithm	Type 2	• Type 1 • Type 2 • Type 3	Selection of the directional earth fault algorithm.
Threshold value (A)	100	• DT ◦ 0.008 In – 3.5 In for CT = 1 A (*) ◦ 0.008 In – 1.6 In for CT 0 5 A (*) • IDMT ◦ 0.008 In – 1 In (**) (increment = 0.1)	Minimum threshold for detecting residual fault currents. The current must be detected above this threshold for a longer time than the **Operate delay time** to validate the presence of a fault current.
Operate delay time (ms)	100	50 – 300,000 (increment = 1)	Minimum time for which the detected voltage must be greater than the **Threshold value Minimum residual voltage threshold** to validate the presence of a fault current.
Reset delay time (ms)	0	50 – 300,000 (increment = 1)	Minimum time for which the voltage must pass and remain below the fault current detection threshold to reset the **Operate delay time**. For the period when the magnitudes are below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This time is incremented again if the voltage exceeds the threshold. This reset time is inactive once the fault current has been validated.
Minimum residual voltage threshold (% nominal line voltage)	Instance 1: 10% Instance 2: 20%	2% – 80% (increment = 1)	Minimum value, as a percentage of the nominal voltage, above which the residual voltage activates fault current detection. The residual voltage must be detected above this threshold (excluding during the transient phase) for a longer time than the **Operate delay time** to validate the presence of a zero sequence fault current.
(*): Setting value of Phase CT secondary rated current or Core Balance CT secondary rated current (if Io measured is selected) in **SC0x** > **Settings** > **Sensors** > **Current Transformer** parameter. (**): In corresponds to the nominal current at the CT primary (by default In = 500 A) or to the nominal current at the core balance CT primary (by default In = 500 A) if Io measured option is selected.			

DEfPTOC Type 1

Parameter	Default	Configuration range	Description
Type 1 DEfPTOC Indication Instance 1 or 2 - Specific parameters			
Operating curve type	IEC definite time	IEC definite time	This type of detection only uses the **IEC definite time** algorithm.
Characteristic angle (degrees)	0°	• -45° • 0° • 15° • 30° • 45° • 60°	Define the orientation of the operaation angle.

Parameter	Default	Configuration range	Description
		• 90º	
Desensitization area (degrees)	86º	• 76º • 83º • 86º	Define the desensitization area of the protection. Only if **Characteristic angle** θo=0°.
Maximum time for memorization (ms)	0	• 0 – Instantaneous • 50 – 300000 (increment = 1)	Maximum time during which the instantaneous bit is memorized.
Minimum residual voltage threshold for memorization (% nominal line voltage)	0	• 0% – Disable • 2% – 80% (increment = 1)	Minimum value of the residual voltage for which the instantaneous bit is memorized.

DEfPTOC Type 2

Parameter	Default	Configuration range	Description
Type 2 DEfPTOC Indication Instance 1 or 2 - Specific parameters			
Operating curve type	IEC definite time	• IEC definite time • IDMT ◦ IEC normal inverse time/A ◦ IEC very inverse time/B ◦ IEC extremely inverse/C ◦ IEEE moderately inverse time ◦ IEEE very inverse time ◦ IEEE extremely inverse time	Choice of the type of standardized IEC or IEEE algorithm to apply to the selected instance for detecting directional earth fault currents.
Enable validation checks	Yes	• No • Yes	Activation of the option to add an extra level of validation to fault current acknowledgment. This filter validates the fault current through the presence of minimum current and voltage peaks during the transient phase of the fault current, according to the values defined by the **Minimum (blocking) operating peak voltage (% nominal line voltage)** and **Minimum (blocking) operating peak current (A)**parameters below.
Minimum (blocking) operating peak voltage (% nominal line voltage)	Instance 1: 25% Instance 2: 55%	6% – 60% (increment = 1)	Minimum peak value, as a percentage of the nominal voltage, above which the residual voltage peak (during the transient phase of the fault current) enables the optional fault current detection validation function (if the **Enable validation checks** option is selected).
Minimum (blocking) operating peak current (A)	Instance 1: 15A Instance 2: 70A	Io calculated: 0.015 In – 2.3 In Io measured: 0.01 In0 – 2.3 In0 (increment = 0.1) Minimum: 0.5 A	Minimum peak value of the residual current peak during the transient phase of the fault current used to enable the optional fault current detection validation function (if the **Enable validation checks** option is selected).

DEfPTOC Type 3

Parameter	Default	Configuration range	Description
Type 3 DEfPTOC Indication Instance 1 or 2 - Specific parameters			
Operating curve type	IEC definite time	• IEC definite time • IDMT ◦ IEC normal inverse time/A ◦ IEC very inverse time/B ◦ IEC extremely inverse/C ◦ IEEE moderately inverse time ◦ IEEE very inverse time ◦ IEEE extremely inverse time	This type of detection only uses the **IEC definite time** algorithm.

Parameter	Default	Configuration range	Description
Angle offset (degrees)	0º	-180º – 179º (increment = 1)	Angular displacement, measured clockwise from the residual voltage phasor, which determines the center of the detection sector.
Sector size (degrees)	90º	10º – 170º (increment = 1)	Angular width of the directional detection zone, centered on the offset angle. A directional fault is detected when the residual current phasor lies within this angular sector, relative to the residual voltage.

Fault Current Validation and Indication

Access via **SC0x > Settings > Fault indication** page.

The T300 offers several ways of indicating fault currents detected on the MV network:

- Via the LEDs on the front panel of the SC150/SC160 module: 2 "arrow" LEDs are lit orange, red, or green depending on the indication phase or the type of detection.
- Via an external LED.
- In the Substation Web server page: A red "flash" symbol is displayed for all fault current types, accompanied by a red or green arrow to indicate the direction of the fault current (for a directional fault current).

On the LEDs (front panel and external), fault currents (validated and confirmed) can be indicated in different ways depending on the type of detection and the fault current type:

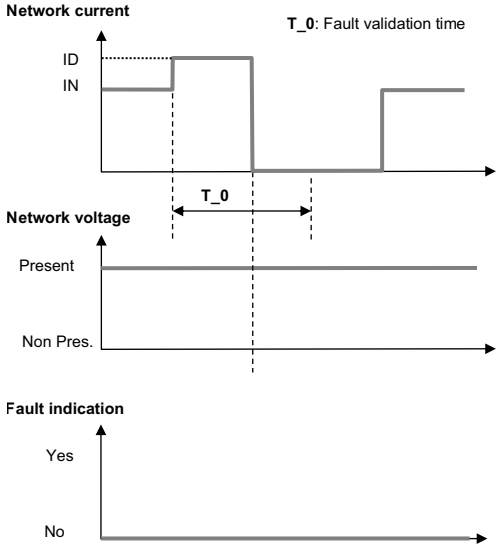
- Ammetric detection: Flashing red for earth fault, Steady for cross-country or phase-to-phase faults.
- Directional detection: Flashing red or green for earth faults, steady red or green for other types of fault.

  NOTE: On the LEDs on the front panel only, an orange indication phase precedes the green or red indication. This phase corresponds to the fault current confirmation wait time within which the fault current type is analyzed (transient, or semi-permanent/permanent).

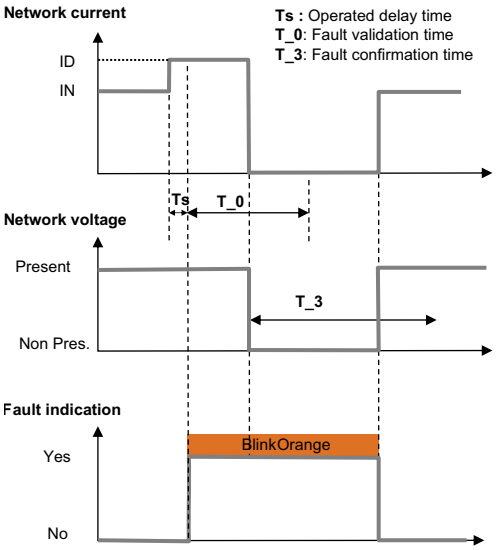
Fault Current Indication

The diagrams below illustrate the different indication phases for a potential fault current. Note that these diagrams correspond to indication via LEDs on the front panel, which is the most comprehensive method in terms of number of colors represented, as it includes the orange indication phase that does not exist with the other types of indication (via external LED or the Web server).

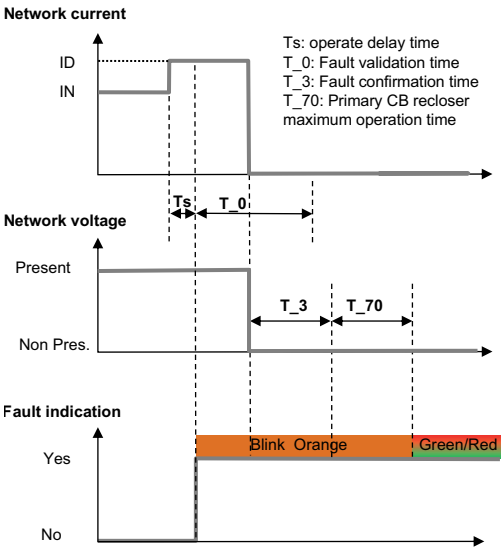
No indication of a non-validated (and therefore unconfirmed) transient fault current on the front panel:



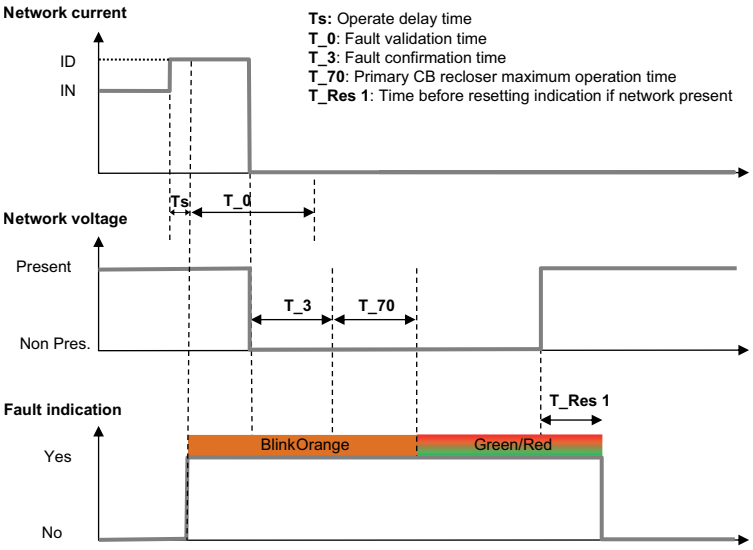
Indication of a validated but not confirmed transient fault current on the front panel:



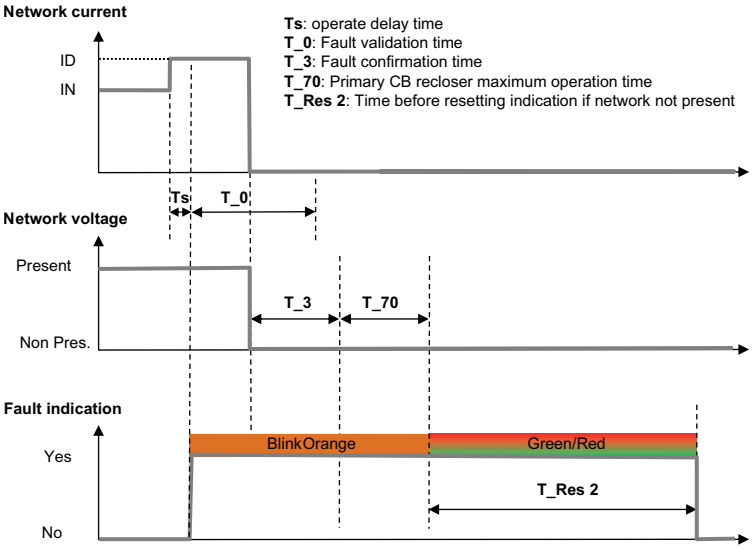
Indication of a permanent or semi-permanent validated and confirmed fault current on the front panel:



Indication of a permanent or semi-permanent validated and confirmed fault current on the front panel, reset by a power return:



Indication of a permanent validated and confirmed fault current on the front panel, reset by the network non presence delay time:



The principle for these diagrams remains the same for indication via external LED, except for the fact that there is no orange phase and the red (or green) indication is therefore given at the start of the confirmation phase.

Instructions on how to configure external LED are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

In the Web page, the indication principle is the same as for the external LED.

See the parameter settings table for a detailed explanation of the time delays mentioned in these diagrams (T_0, T_3, T_70, etc.).

Resetting a Fault Current

A fault current indication is reset as follows:

- Automatically when power is restored (if the corresponding option is enabled)
- Automatically at the end of the reset delay time, if the voltage remains absent for the duration of this time delay
- Manually by pressing the button on the front panel of the HU250 module (general reset for all channels where a fault current has been detected)

- Manually from the Web server, using the **Reset** button on the **Substation** page
- Remotely from the SCADA system, via the communication protocol.

Fault Current Validation (and Indication)

A detected fault current is generally validated by the non-presence detection of the MV network, if the T300 configured for this purpose.

The MV network absence/presence detection is also used by the T300 to indicate the fault current passage, by various means (for example LEDs on the front panel, or indications on the **Monitoring > Substation** page).

Absence/presence detection of the MV network can be done by monitoring current or the voltage (parameter FPI network presence and confirmation mode). You can also choose not to monitor current or voltage of the MV network for fault confirmation. In this case, the fault is indicated if the threshold is exceeded, without any further validation.

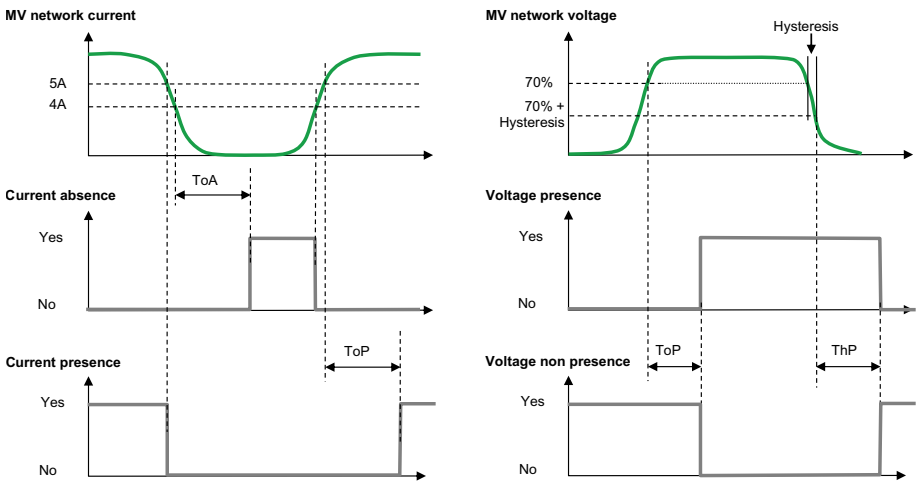
Some automation functions might also use the MV presence/absence detection as a start condition for a reclose cycle or a fault current isolation (for example ATS, if present in the unit).

This table summarizes the signaling/indication possibilities proposed by the T300 for indicating the MV network absence/presence, depending whether current or voltage is used for detection.

	FPI	IHM	Web server	Data pages
Network Absence/Presence				
By current	Yes	No	No	Yes
By voltage	Yes	Yes	Yes	Yes

Detection of MV current absence/presence
ToA: Operate delay time – current absence (by default: 50 ms)
ToP: Operate delay time – current presence (by default: 50 ms)

Detection of MV voltage presence/non-presence by the measures
ToP: Operate delay time – voltage presence (by default: 65 ms)
ThP: Hold delay time – voltage presence (fixed at 40 ms)



Detection of Network Absence/Presence by the Current

The detection of MV network absence/presence by the observation of the current is carried out only by the measurement of the MV currents from CTs. Configurable thresholds based on these measurements are used to determine the level at

which the current is detected to be present or absent and for how long, and the level at which these detections were canceled out and for how long.

The current is considered to be present if the 3 phases meet the presence criteria defined by the configured thresholds and time delays. The current is considered to be absent if at least 1 phase meets the absence criteria defined by the configured thresholds and time delays. The current is considered to be non-present if at least one of the phases no longer meets the presence criteria defined by the configured thresholds and time delays. The current is considered to be non-absent if the 3 phases no longer meets the absence criteria defined by the configured thresholds and time delays.

Network current absence detection for validation of a fault current uses the following standardized ANSI standard: ANSI 37 (undercurrent detection).

NOTE: If current is chosen as the source for validating a fault current, a detected fault current is validated by the non-presence of the MV current and not by the absence of the MV current.

ANSI 37 Characteristics	
Number of instances	1 (presence/absence)
Groups of settings	1
Detection mode	Definite time (DT)
Logical node name	AbsPTUC x (x = instance number)
Hysteresis reset detection	0,2 % x In
Parameter Setting (For Each Instance)	
Operation mode	On all 3 phases
Detection threshold	See parameter table, page 258.
Time delays	

Detection of Network Presence/Absence by the Voltage

Detection of MV network presence/absence by the observation of the voltage can be carried out in several ways:

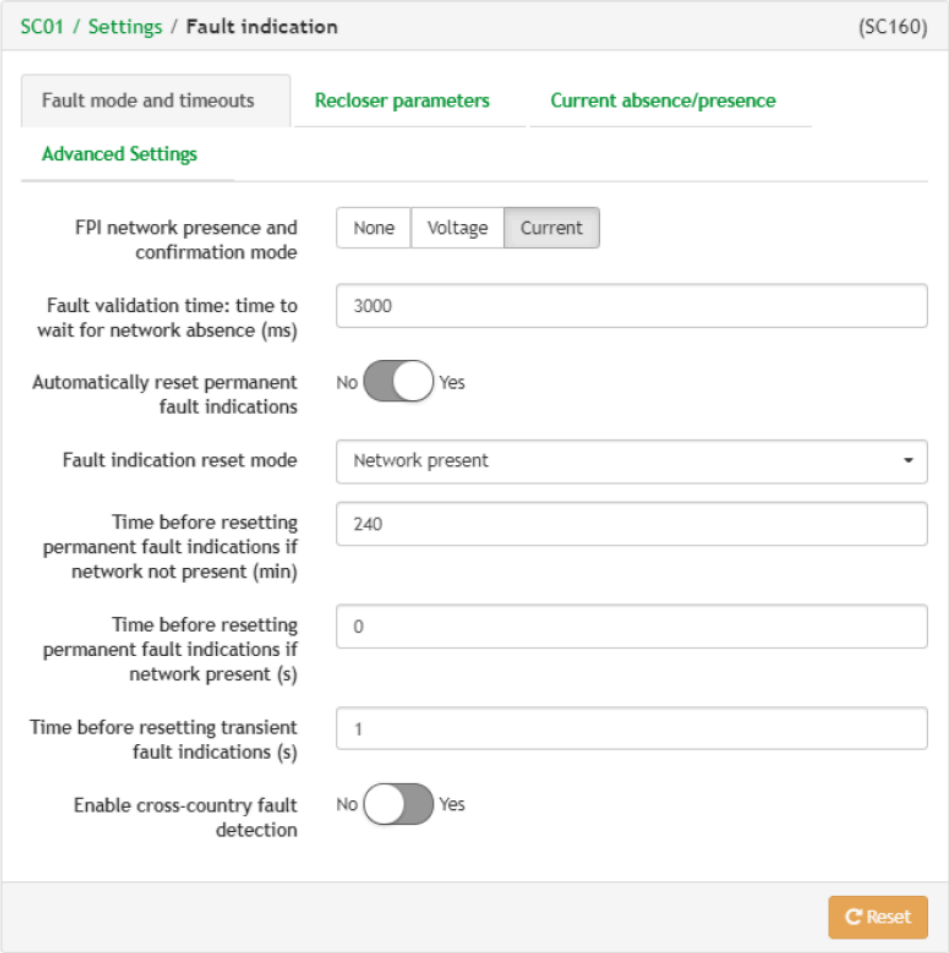
- By the information from the digital input DI6 of the SC150 module (MV network presence via an external voltage presence relay, e.g. VD23)
- By the information from the digital input DI5 of the HU250 module (main supply presence/absence information via the PS50 power supply)
- By the measurement resulting from the voltage sensors. Configurable thresholds related to these measurements define whether the MV voltage is considered to be present and for what duration this detection is considered to be not present (see diagram attached). The voltage is considered as present (or absent) if all the measured phases (1, 2 or 3 phases according to configuration) satisfy the criteria of presence (or absence) defined by the thresholds and time delays. The voltage is considered as not present (or not absent) if at least one phase no longer checks the presence (or-absence) criteria defined by the thresholds and time delays.

  NOTE: If voltage is chosen as the source for validating a fault current, a fault current detected is validated by the non-presence of the MV network voltage and not by the absence of the MV network voltage. Note that these voltage presence thresholds are for the most common with those configured in the **Voltage presence/absence** page.

Fault Current Validation and Indication Parameter Setting

Setting Fault Mode and Timeouts

Access via **SC0x > Settings > Fault indication** page, **Fault mode and timeouts** tab.

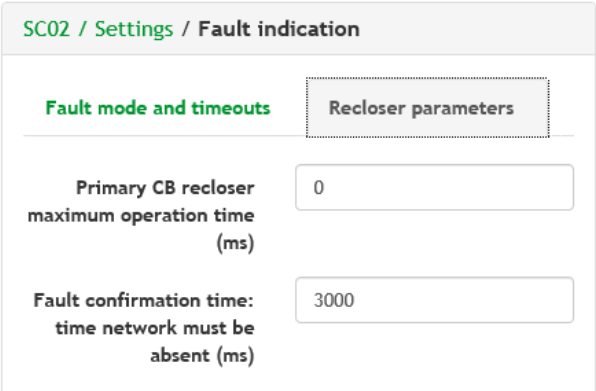


Parameter	Default	Configuration range	Description
Fault current Mode and Timeouts tab			
FPI network presence and confirmation mode	Current	• None • Voltage • Current	Choice of source to define presence of the MV network and to enable a fault current detection confirmation (confirmation by absence of current and non-presence of voltage). None disables fault current confirmation. In this case, detection of a fault current only is sufficient to validate and indicate it. **It is advisable to enable fault current detection confirmation by either current or voltage to help ensure that only fault currents detected by the upstream protection device are confirmed.**
Voltage presence source	AC power supply	• Measured • Digital input • AC power supply	The voltage source can be acquired in several ways for the fault current indication: • **Measured**: Using the measurement from the voltage sensors • **Digital input**: Using the information from the digital input DI6 of the SC150 module (via external voltage relay) • **AC power supply**: Using the information from the digital input DI5 of the HU250 module (via the PS50 module). Parameter only available for the options **FPI network presence and confirmation mode = Voltage**.
Fault validation time: time to wait for network absence (ms) (T_0)	3,000	0 – 300,000 (increment = 1)	Observation window within which the MV network (via observation of the current or voltage) must be non present to validate a fault current that has just been detected. This validation is used to filter self-extinguishing type faults and only validate those fault that have caused the upstream circuit breaker or recloser to trip. Fault current indication starts the moment the fault current is validated.

Parameter	Default	Configuration range	Description
Fault current Mode and Timeouts tab			
Automatically reset permanent fault indications if network present	Yes	• Yes • No	If enabled, this option is used to clear the permanent fault current indication, once the MV network power has been restored, at the end of the **Time before resetting permanent fault indications if network present** delay. On networks with "non-sustained" fault currents, the fact that the upstream circuit breaker or recloser has reclosed means that the fault current has disappeared. It is therefore generally no longer necessary to indicate it.
Fault indication reset mode	Network present	• Network present • Network present AND switch closed • Network present And switch closed, OR current present	• **Network present**: The permanent fault can be reset with an indication of “Network present”, once the MV network power has been restored. • **Network present AND switch closed**: This condition can be completed by a “switch closed” condition, to cover cases where automation system (such as sectionalizer) has opened the switch. Therefore, even if the MV network has been restored, the fault can be still present downstream and must be still indicated. • **Network present And switch closed, OR current present**: The third case is to add a security, for the case the network present indication would fail: a current present indication normally corresponds to network present and switch closed
Time before resetting permanent fault indications if network not present (mn) (T_Res 2)	240	1 – 1440 (increment = 1)	This time delay corresponds to a maximum delay (timeout) for indicating a permanent fault current if the MV network is still non present. It is important to leave the indication active for a certain length of time to be able to locate the fault on the MV network. However, indication stops at the end of this timeout, primarily to save battery power.
Time before resetting permanent fault indications if network present (s) (T_Res 1)	0	0 – 300 (increment = 1)	Filter time before clearing indication of a permanent fault current, when MV network presence is detected again. This time delay is used to help ensure that the MV network is in a stable state and that no other fault current has occurred, before being able to clear the fault current indication.
Time before resetting transient fault indications (s)	1	0 – 300 (increment = 1)	This time delay corresponds to a maximum delay (timeout) for indicating a transient fault current. Indication stops at the end of this timeout.
Enable cross-country fault detection	No	• Yes • No	This option is used to enable detection of "double" fault, i.e. 2 simultaneous phase-to-ground fault on 2 phases and at 2 different locations on the network. **NOTE:** Double fault are only available on instance 3 of a zero sequence fault (in ammetric fault current detection).

Setting Recloser Parameters

Access via **SC0x > Settings > Fault indication** page, **Recloser Parameters** tab.

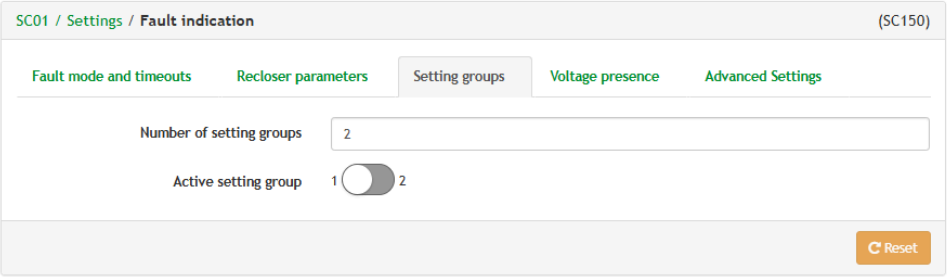


Parameter	Default	Configuration range	Description
Recloser Parameters			
Primary CB recloser maximum operation time (ms) (T_70)	0	0 – 300 (increment = 1)	After a fault current has been detected on the MV network, this time delay corresponds to the maximum wait time for the reclose cycle of the upstream protection device. This time delay is used to categorize the detected fault current as a permanent or semi-permanent fault current depending on whether it occurs during the delay period or not (see the "Fault current Detection" section). Setting a value of "0" disables this time delay. In this case, the fault current is categorized as a permanent fault current at the end of the **Fault confirmation time**. **NOTE:** This time delay must be set to a value other than "0" to be able to use the Sectionalizer automation function.
Fault confirmation time: delay before re-checking for network absence (ms) (T_3)	3,000	0 – 10,000	Confirmation time corresponding to an observation window within which power must not be restored on the MV network after a fault current has been validated. The fault is indicated by the color orange on the LEDs on the front panel during this confirmation phase. This stops if the fault current is not confirmed during this confirmation window. Once the time delay expires, confirmation is enabled and the fault remains indicated (although now either red or green) until the reset time becomes active.

Selecting the Active Setting Group

In the **Setting Group** tab you can select the parameter setting group to apply for the fault detection type as well as the number of available sets of groups (see Setting groups, page 237).

Access via **SC0x > Settings > Global fault settings** page, **Setting group** tab.



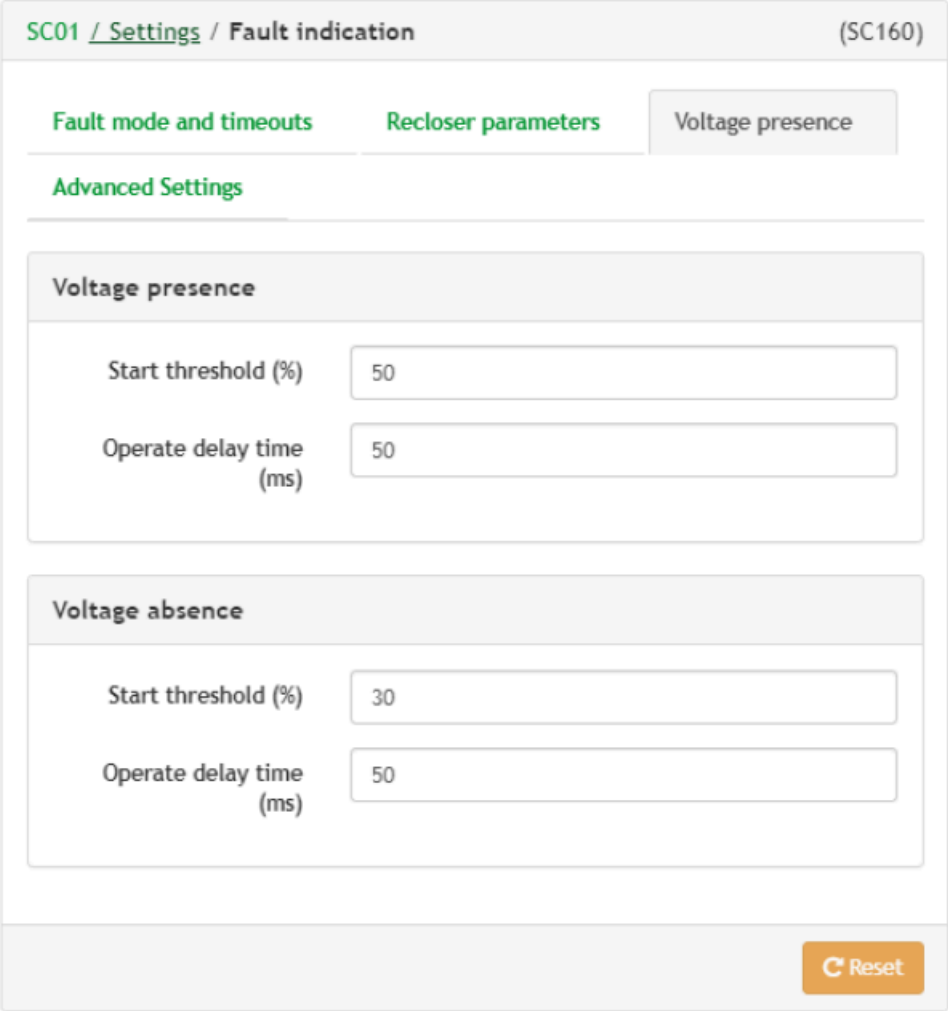
Select the **Active setting group** to apply for the fault detection type.

Select also the number of **Groups of setting** in the **Substation**, page 237 page.

Parameter	Default	Configuration range	Description
Active setting group			
Number of setting groups	2	1 to 8	Number of groups of parameter settings available to configure fault detection functions.
Active setting group	1	From 1 to 8	Choice of group of parameter settings to apply to fault detection. Each group includes specific thresholds, time delays, and parameters.

Setting Voltage Presence / Absence Parameters

Access via **SC0x > Settings > Fault indication** page, **Voltage presence** tab.

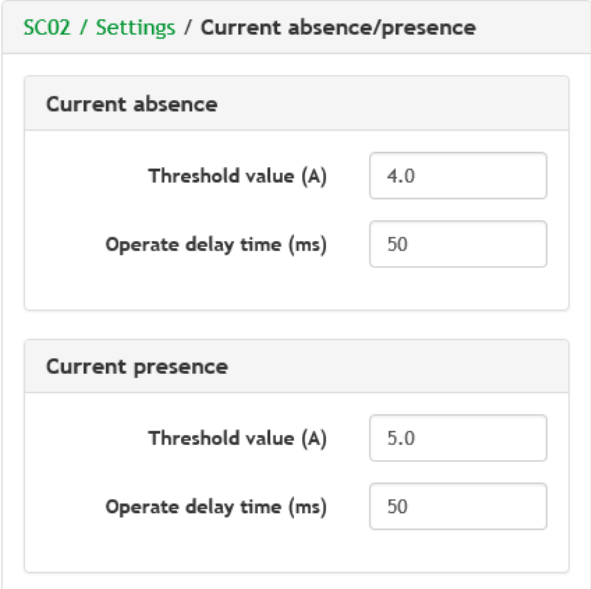


Parameter	Default	Configuration range	Description
Voltage presence			
Start threshold (%)	50	10 – 100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, above which the MV network voltage is considered to be present. **NOTE:** Configure the threshold taking into account hysteresis (7 %). Consult the glossary for the definition of hysteresis. Parameter available only for the case **Voltage presence source = Measured**.
Operate delay time (ms)	50	0 – 300000 (increment = 1)	Period within which the voltage must be above the **Start threshold** level to consider the MV network voltage to be present. Parameter available only for the case **Voltage presence source = Measured**.
Voltage absence			
Start threshold (%)	30	10 – 100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, below which the MV network voltage is considered to be absent. **NOTE:** Configure the threshold taking into account hysteresis (6 %). Consult the glossary for the definition of hysteresis. Parameter available only for the case **Voltage presence source = Measured**.
Operate delay time (ms)	50	0 – 300000 (increment = 1)	Period within which the voltage must be below the **Start threshold** level to consider the MV network voltage to be absent. Parameter available only for the case **Voltage presence source = Measured**.

NOTE: To configure the **Hold delay time** for Voltage presence refer to Front Panel Voltage Indication, page 384.

Setting Current Absence / Presence Parameters

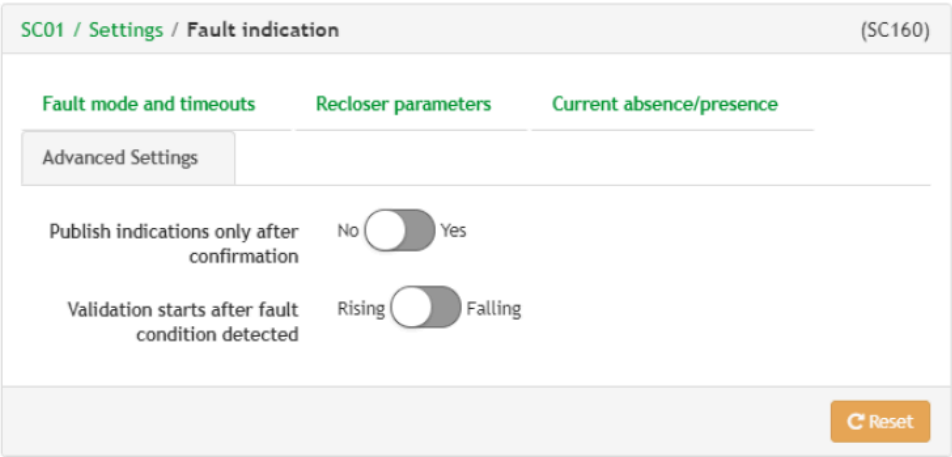
Access via **SC0x > Settings > Fault indication** page, **Current absence/ presence** tab.



Parameter	Default	Configuration range	Description
Current absence			
Threshold value (A)	0.008 In	0.002 In – 0.02 In (*) (increment = 0.1)	Definition of the measured current threshold below which the MV network current is considered to be absent.
Operate delay time (ms)	50	0 – 300,000 (increment = 1)	Period within which the current must remain below the **Threshold value** to validate detection of the absence of the MV network current.
Current presence			
Threshold value (A)	0.01 In	0.002 In – 0.02 In (*) (increment = 0.1)	Definition of the measured current threshold below which the MV network current is considered to be present.
Operate delay time (ms)	50	0 – 300,000 (increment = 1)	Period within which the current must remain above the **Threshold value** to validate detection of the presence of the MV network current. **NOTE:** It is the non-presence of the MV network current that allows to validate and indicate a fault current.
(*): In corresponds to the nominal current at the CT primary (by default In = 500 A).			

Advanced Settings

Access via **SC0x > Settings > Fault indication** page, **Advanced settings** tab.



Parameter	Default	Configuration range	Description
Advanced settings			
Publish indication only after confirmation	No	• No • Yes	This option is used to wait for the fault confirmation (network absence) to indicate the fault. By default, the fault is indicated as soon as the detection element is triggered.
Validation starts after fault condition detected	Rising	• Rising • Falling	This option is used to start the validation timer when the fault condition becomes untrue (falling edge of the detection element). By default, the validation timer starts on the rising edge of the detection element.

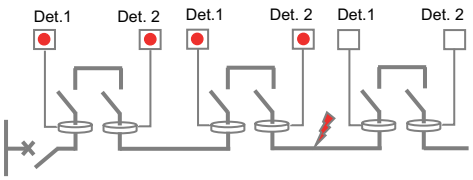
Locating Fault Currents on the MV Network

The LEDs on the T300 are used to help locate the fault current on the MV network according to the following rules:

- Ammetric detection

  The fault current is only signaled by fault current detectors located on the section of the MV network upstream of the fault current: i.e. the fault current will be located between the last detector indicating the fault current and the first detector not indicating the fault current. The fault current is indicated by a red flashing LED regardless of type (zero sequence, double, or phase-to-phase).

  Example of colors indicating a fault current in ammetric detection

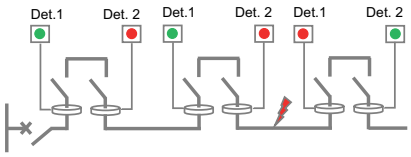


- Directional detection

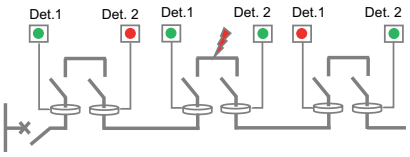
  Fault current detection is directional. All the T300 RTUs located on the section of MV network where the fault current has been signaled flash the same color. The direction of the fault current is indicated by the color of the LED. The following rules apply when the LED on the front panel of the detector in the substation indicates the color green or red:

  - **Green**: The fault current impacts the section of the network in the direction of the busbar in the substation.
  - **Red**: The fault current impacts the section of cable outside the substation.

  Example of colors indicating a fault current in directional detection:



  Second example of colors indicating a fault current in directional detection:



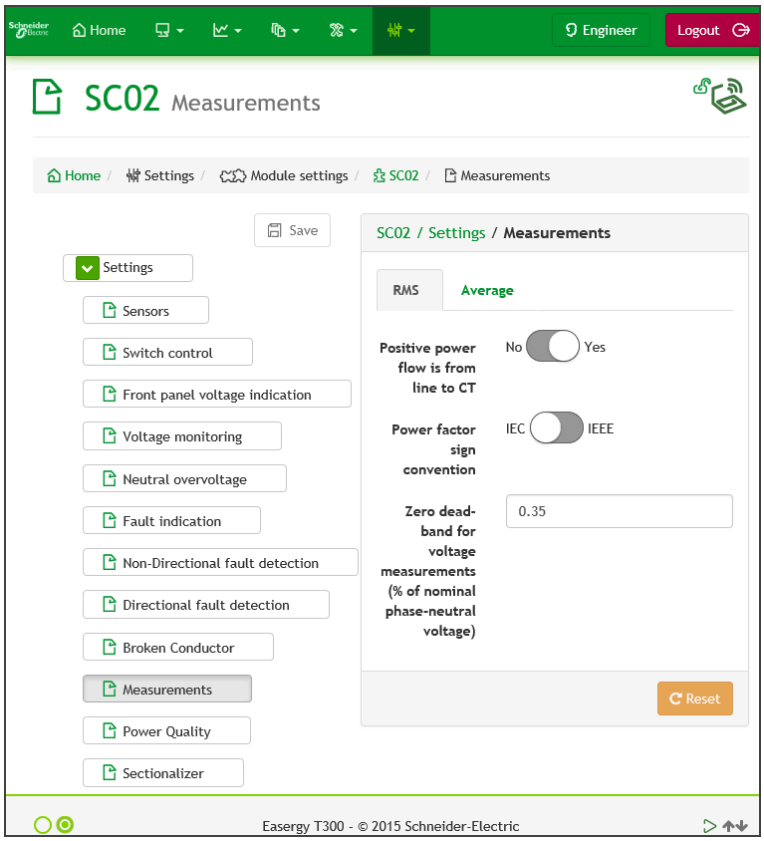
  NOTE: This theory is only valid if there is sufficient capacitive current in the network for a downstream detector to indicate the fault current (via flashing LED).

The section in which the fault current condition exists will therefore be identified in the conventional manner:

- Either in the section between the last detector to indicate the fault current (flashing) and the first detector that is not flashing
- Or by 2 consecutive detectors that are flashing the same color, indicating 2 opposite directions.

MV Power Measurement Settings

Access via **SC0x > Settings > Measurements** page.



These power measurements are optional on the SC150/SC160. If this option is not present in the equipment, the corresponding parameter settings page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the MV Measurement/PM – Power, and PM – Energy pages. See the relevant section for more information on displaying these measurements.

The SC150/SC160 is used to take power measurements for the purposes of monitoring the MV network. These power measurements comply with standard IEC 61557-12.

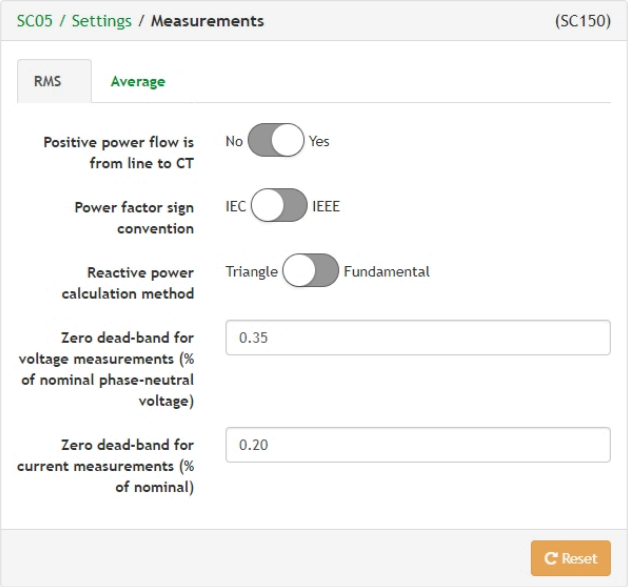
The SC150/SC160 takes these MV measurements using the same current and voltage sensors as those used to detect fault currents.

The SC150/SC160 stores the power measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

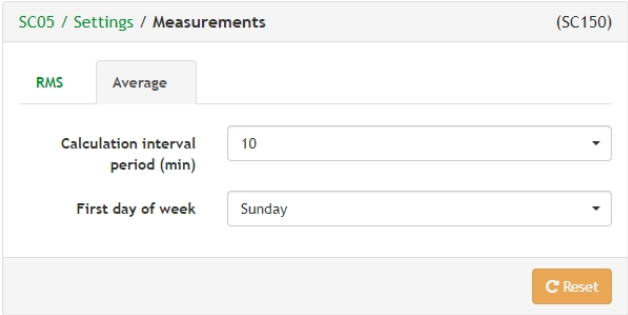
Parameters

MV Power measurements require certain options to be configured.

Setting the **RMS** values



Setting the **Average** values



Measurement parameter settings

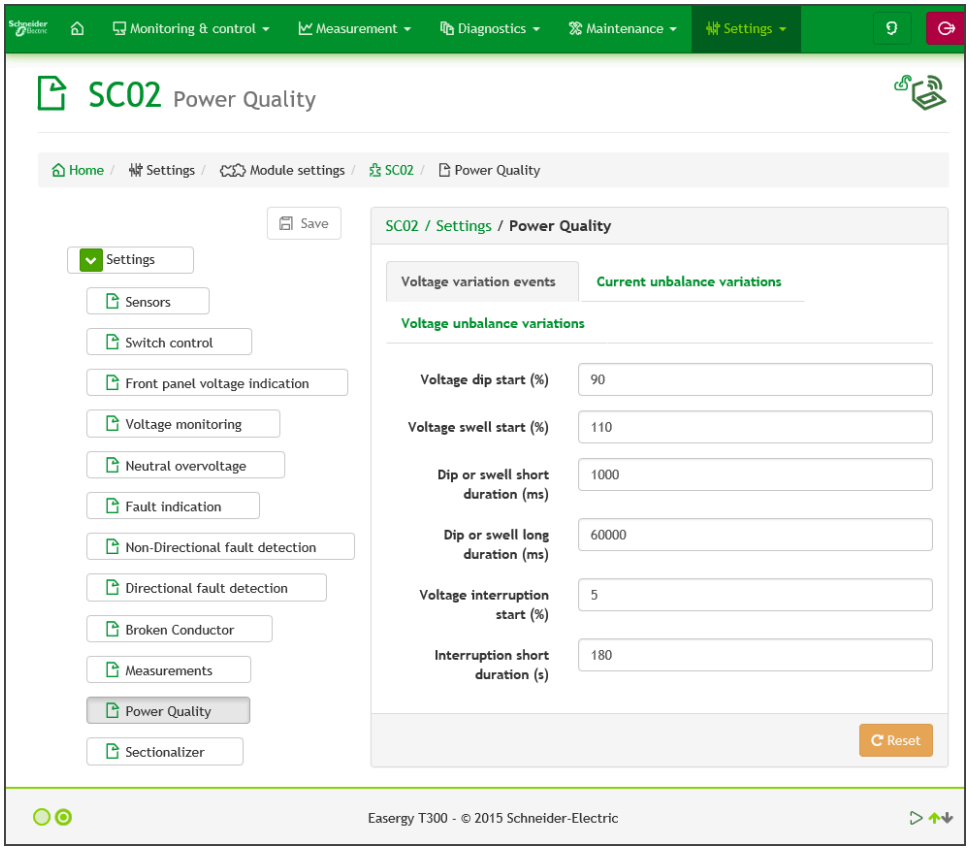
The same parameters specify the Power Measurement for MV or LV network.

Parameter	Default	Configuration range	Description
RMS			
Positive power flow is from line to CT	**Yes**	• No • Yes	Definition of the direction of the power flow on the channel. By default, a positive direction corresponds to a flow of power from the line to the CTs. This parameter depends on the location of the channel (channel = feeder or incomer). The choice assigns the sign for the power measurements calculated by the module (SC150/SC160 or LV150).
Power factor sign convention	**IEC**	• IEC • IEEE	Choice of sign convention for the power factor calculation: • **IEC:** International Electrotechnical Commission • **IEEE:** Institute of Electrical and Electronics Engineers
Reactive power calculation method	**Triangle**	• Triangle • Fundamental	Approaches used to determine the reactive power.
Zero dead-band for voltage measurements (% of nominal)	**0.35**	• 0.01–10	Filtering of low values on measured voltages. Values below this percentage will be filtered and displayed at zero value to avoid inaccurate measurement.
Zero dead-band for current measurements	**0.20**	0.01–10	Filtering of low values on measured currents. Values below this percentage are filtered and displayed at zero value to avoid inaccurate measurement.

Parameter	Default	Configuration range	Description
Average			
Calculation interval period (min)	**10**	• 1 • 5 • 10 • 15 • 20 • 30 • 60	Definition of the period for calculation interval of the averages on the measurements.
First day of week	**Sunday**	• Monday • Tuesday • Wednesday • Thursday • Friday • Saturday • Sunday	Definition of the first day of the week for the calculation of averages and min/max including a period based on the weeks.

MV Power Quality Parameter Setting

Access via **SC0x > Settings > Power Quality** page.



Parameters are displayed in the **Voltage variation events**, **Current unbalance variations** and **Voltage unbalance variations** tabs.

These power quality measurements are optional on the SC150. If this option is not present in the equipment, the corresponding parameter setting page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the **MV Measurement/Power – Quality** page. See the relevant section for more information on displaying these measurements.

Voltage measurement of power quality is performed with the 3-phase voltages. Therefore, if power quality option is activated, parameter VT connection mode is 3 phase ABC.

In addition to power measurements, the T300 can also take measurements to check the quality of the power supply on the MV network.

These measurements are completed according to the principles of IEC 61000-4-30 class S (up to harmonic 40).

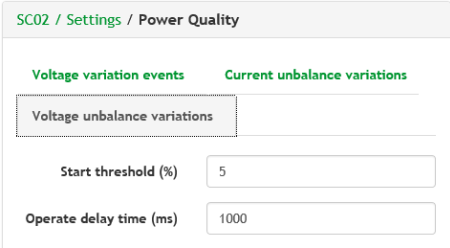
They are used in particular to monitor the number and duration of voltage interruptions, sags (dips), or swells, as well as the current and voltage unbalance and the harmonics.

The T300 takes these measurements using the same current and voltage sensors as those used to detect fault currents.

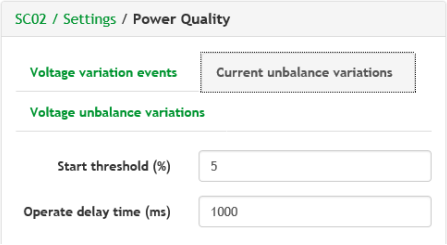
The T300 stores the measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

Power quality measurements require certain options to be configured.

Setting the voltage unbalance parameters



Setting the current unbalance parameters



These are summarized in the table below:

Parameter	Default	Configuration range	Description
Voltage variation events tab			
Voltage dip start (%)	90	5-100	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage sag (dip) by the power quality measurement.
Voltage swell start (%)	110	100–150	Threshold, as a percentage of the nominal voltage, above which the detected voltage rise is considered to be a voltage swell by the power quality measurement.
Dip or swell short duration (ms)	1000	10-60,000	Duration below which the presence of a voltage sag (dip) or swell is considered to be short duration.
Dip or swell long duration (ms)	60,000	10-60,000	Duration above which the presence of a voltage sag (dip) or swell is considered to be long duration. Similarly, the average duration corresponds to the time interval between the short and long duration.
Voltage interruption start (%)	5	1-90	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage interruption by the power quality measurement.
Interruption short duration (s)	180	60-900	Duration below which the voltage interruption is considered to be short duration. Similarly, a long duration corresponds to an interruption lasting longer than the time set for the short duration. There is no notion of average duration for voltage interruptions.
Current unbalance variations tab			
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal current, above which the current variation is considered to be a current unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200–60,000	Time delay above which the current variation is taken into account and considered to be a current unbalance by the power quality measurement.
Voltage unbalance variationstab			

Parameter	Default	Configuration range	Description
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal voltage, above which the voltage variation is considered to be a voltage unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200-60,000	Time delay above which the voltage variation is taken into account and considered to be a voltage unbalance by the power quality measurement.

Disturbance Record Settings

Access via **SC0x > Settings > Disturbance Record** page.

Disturbance Records

Operation

The disturbance record function is used to record measured analog signals, digital input signals and logical states.

The storage of records is activated by one or more events set in the **Disturbance records** page in the Web server, for each SC150/SC160 module.

Depending on the trigger position setting, the stored event can begin before the event and continues afterwards.

Records comprise the following information:

- Values sampled from the different signals
- Date

The disturbance records can log the following elements:

- Actual samples at a rate of 4,800 samples per second for:
  - Ia, Ib, Ic, I0 (measured) according to CT connection mode setting for SC150/SC160 module (in SC0x/Settings/Sensors page)
  - Va, Vb, Vc or Uab, Ubc, Uca according to VT board type and VT connection mode setting for SC150/SC160 module (in SC0x/Settings/Sensors page)
- Any change of state of the main switch (digital inputs DI1 and DI2)
- Any change of state of digital input (digital inputs DI3 to DI8)
- Any change of active Instantaneous PTOC (ANSI 50/51, 50N/51N, 67/67N and 47)
- Any change of active Instantaneous (ANSI 59, 59N)
- Any change of PQ event indications (dip, swell, and interruption)
- Any change of network presence as defined by fault confirmation

Files can be transferred locally using a PC which is connected on the HU250 front panel and includes the T300 Web server access. The record files can be downloaded from the T300 Web server (see the Disturbance Records Page, page 92).

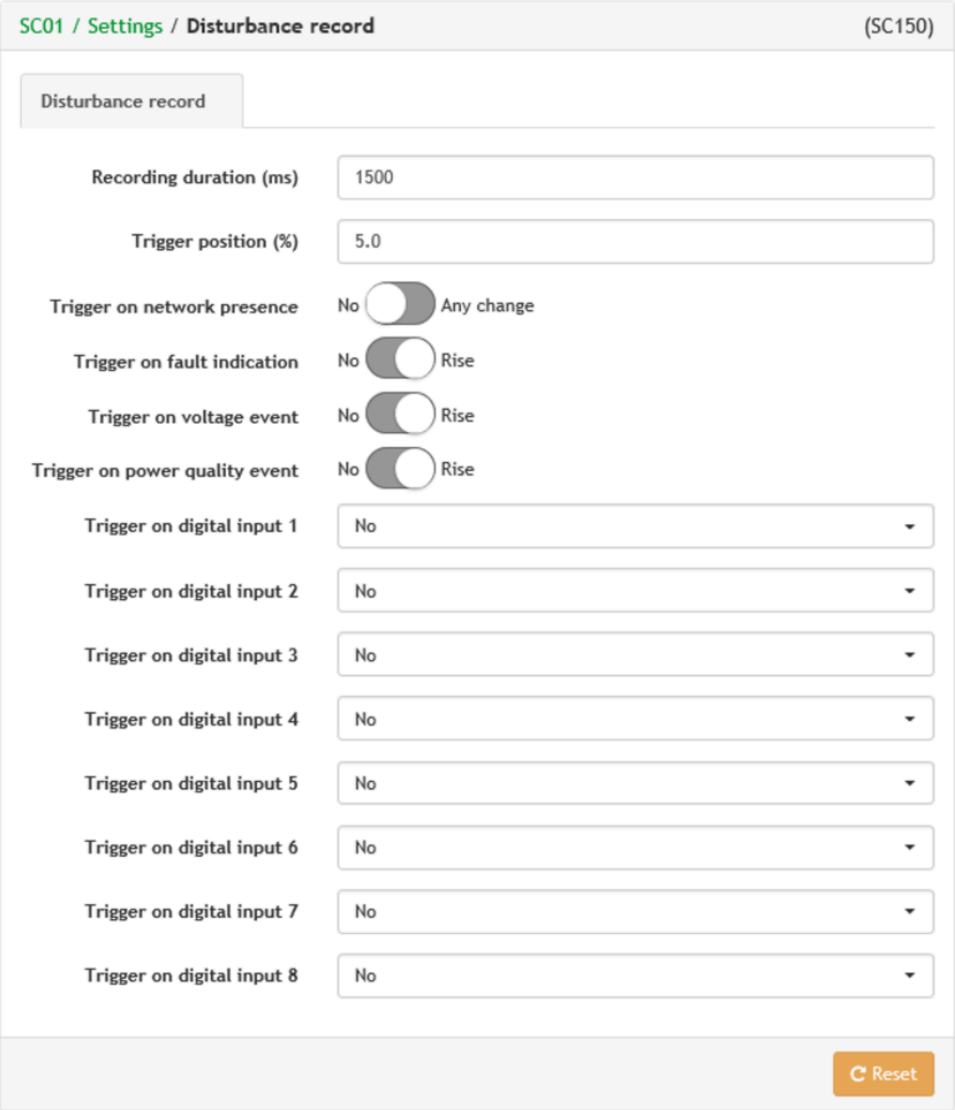
Files can also be transferred by protocol. Refer to the protocol user manual and the Easergy Builder manual for more information on file transfer by protocol.

Characteristics

Characteristics	Values
Recording content	• Set-up file: date, channel characteristics, sampling rate • Sample file: recorded signals
Sampling frequency	4,800 samples per second
Analog signals recorded (2)	• Ia, Ib, Ic, I0 (measured) current channels • Va, Vb, Vc or Uab, Ubc, Uca voltage channels
Logical states recorded (1) (3)	Digital input signals and logical states
Number of recordings stored	Up to 50 (recorded in FIFO (First In First Out) type shift storage: when the maximum number of records is reached, the oldest record is erased when a new record is triggered.)
Total duration of a recording (1)	100 to 70,000 ms
Maximum recording capacity	140 s maximum with 70 s maximum per record
File format	COMTRADE - IEC 60255-24 Ed. 1 - 2001
(1) To be set in the SC0x Disturbance Records Page, page 92 in the T300 Web server. (2) According to type and connection of sensors. (3) According to T300 system configuration.	

Disturbance Records Parameter Setting on SC150

Accessed via **Settings > SC0x > Disturbance records** page.



Parameter	Default	Configuration range	Description
Recording duration (ms)	1,500	100-70,000	Total duration of a recording
Trigger position (%)	33.3	0-100	Sets the trigger point as a percentage of the recording duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3 % of this, taking into consideration the following recording times: 0.5 s before trigger and 1 s after trigger.
Trigger on network presence	No	• No • Any change	Disturbance record triggered on any change on network presence
Trigger on fault indication	No	• No • Rise	Disturbance record triggered on instantaneous detection of a protection event (ANSI 50/51, 50N/51N, 67, 67N, 47)
Trigger on voltage event	No	• No • Rise	Disturbance record triggered on instantaneous detection of a protection event (ANSI 59 or 59N)
Trigger on power quality event	No	• No • Rise	If power quality available, disturbance record triggered on the occurrence of a power quality event (voltage dip or swell or interruption)
Trigger on digital input 1 to Trigger on digital input 8	No	• No • Rise • Fall • Any change	Digital channel selected to trigger the disturbance record on either a rising (low to high) or a falling (high to low) transition or any change

Any configuration change on this function or on sensors and network characteristics stops the record in progress. It is saved but may not comply with

the expected duration. Previous records are kept as they were recorded. In case of voltage absence during disturbance recording in progress, the record is lost.

Disturbance Record Triggers

Depending on the T300 system configuration, a disturbance record can be triggered on either one or several of the following conditions:

- Network presence and absence
- Combination of instantaneous bits of fault detection protections (ANSI 50/51, 50N/51N, 67,67N, 47)
- Combination of instantaneous bits of ANSI 59 and 59N voltage
- PQ event (dip, swell, interruption)
- Digital input and switch change of state
- Dedicated command

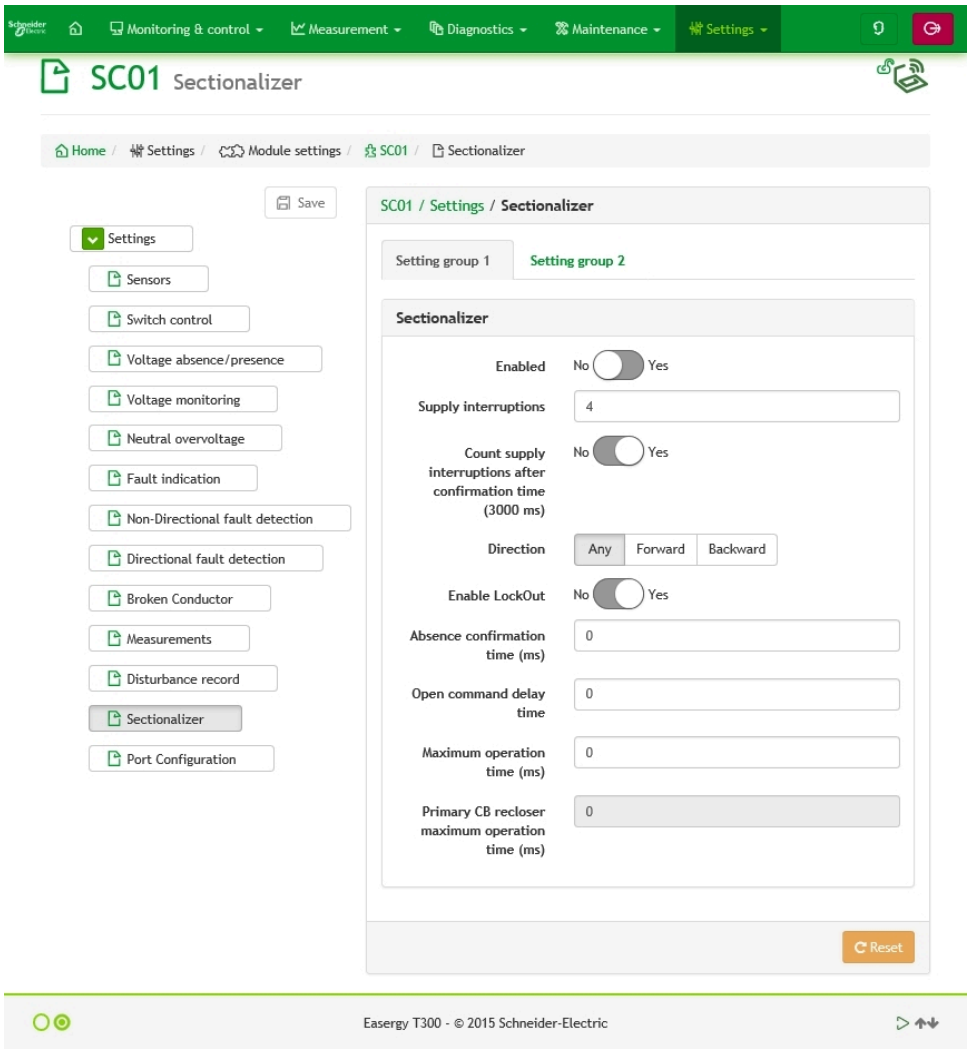
Disturbance record can be triggered on communication via remote control or a dedicated command sent from the T300 Web server. Triggering on dedicated command is always active.

There is no effect on a record if a new trigger happens while the record is already on-going.

Use WaveWin software to analyse disturbance record file.

Automation Settings

Access via **Settings > SC0x > Sectionalizer** page.



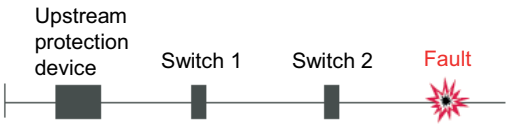
Sectionalizer Automation

Sectionalizer automation is used to disconnect a section of feeder that has a permanent electrical fault. It is used in conjunction with an upstream circuit breaker or recloser. This type of automation is applicable for feeders with sections of overhead line.

The general principle is that the automation function counts the number of supply interruptions. When the configured number of interruptions is reached, the controller opens the MV load break switch during the recloser "dead time", that is, whilst the voltage is absent. This isolates the downstream fault, allowing the recloser to restore supply to the upstream sections.

A feeder may have several sectionalizer switches, each with a different configuration, such that upstream devices are set to open at a higher number of supply interruptions than the downstream devices.

A supply interruption is defined as a fault current followed by network absence. The sectionalizer automation uses the same network absence state as the FPI functions.



NOTE: On the SC160 module, the sectionalizer is not available if the **Tripping** mode is enabled. It is available when the **Tripping** mode is disabled.

Operation

In normal operating conditions, the MV network is energized and the switch is closed.

The automation function sends an open command to the MV switch if:

- The module sectionalizer setting is enabled for the active setting group.
- The T300 automation status is ON.
- The switch is closed.
- The number of supply interruptions counted reaches the number configured.
- The MV network is absent.
- There is no fault current.

Automation enable/disable

Each SC150/SC160 module has parameter settings to enable or disable sectionalizer automation for the MV switch controlled by that module.

In addition, automation functions are enabled or disabled globally on the T300 (for all SC150/SC160 modules) either remotely from the SCADA system or locally:

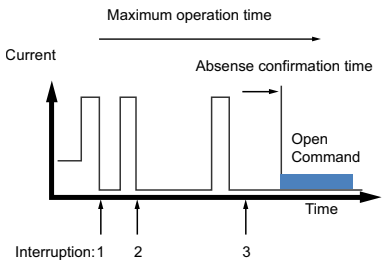
- By pressing simultaneously the (automation state button) and **OK** buttons on the front of the HU250 module.
- Via the Web server (on the **Monitoring & control > Substation** page).

Automation and FPI settings

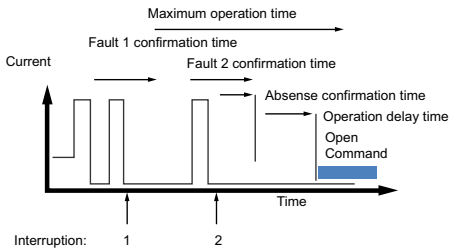
The sectionalizer automation works in conjunction with the fault passage indication function. To use the sectionalizer automation, certain FPI parameters must have compatible values:

- The **FPI network presence and confirmation mode** setting must be either **Voltage** or **Current**.
- **The Primary CB recloser maximum operation time** must be at least 1,000 ms and greater than the time required to detect the required number of supply interruptions.
- If it is required to ignore the first rapid reclose cycle, then the recloser **Fault confirmation time** should be greater than the first rapid cycle time.

Example 1:
Count after confirmation mode = No
Open after 3 interruptions



Example 2:
Count after confirmation mode = Yes
Rapid cycle ignored Open after 2 interruptions, plus operation delay time



Network absence can be detected:

- By measurement sensors (current or voltage). If the voltage measuring sensor is used, refer to the chapter Front panel voltage indication, page 384 to set the corresponding MV voltage absence settings.
- By digital input DI6.
- By the AC power supply (in this case, the T300 must be powered by a low voltage source from the MV line on which the switch is installed).

For details, see the *Fault Current validation and indication* section.

Automation Lock Out

Certain conditions can block the automation function. When this occurs, the “automation locked” LED lights up orange on the front panel of the SC150/SC160 (and the HU250). It is possible to reset the automation lock out as follows:

- By pressing the **Reset** (fault current indication reset) button on the front of the HU250 module
- On the **Substation** page, by clicking the **Reset** button associated with the automation function.

The automation lock out conditions are active only if the **Enable LockOut** option is activated by configuration. These conditions are associated with any action that makes it impossible to operate the MV switch, namely:

- If the T300 is in local mode and the **Enable local mode to block automation** option is enabled by configuration.
- If the switch interlock digital input (DI5) is enabled and the **External input mode for open commands** blocking option is enabled by configuration.
- If the switch position is unknown at the time of the command and the **Block if switch position is unknown or same as command** option is enabled by configuration

  NOTE: The three blocking options above can be configured in the **Switch control** page (see the **Interlock Function** section).

Sectionalizer automation parameter setting

Access via **SC0x > Settings > Sectionalizer** page.

The setting includes two groups of settings. These two groups define two sets of preset parameters.

The settings group can easily be changed by a command to select the active group (from 1 to 8 depending on the number of groups configured, page 258) from the preset thresholds, without needing to reconfigure the T300. This is done in the **Monitoring & Control > Substation** page (see the corresponding section) or remotely from the SCADA system.

Sectionalizer automation requires certain options to be configured. These are summarized in the table below.

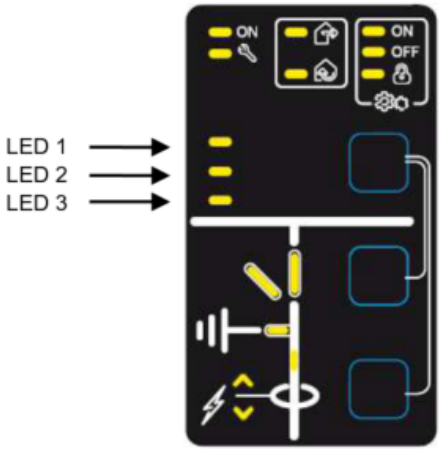
Parameter	De-fault	Configuration range	Description
Sectionalizer			
Enabled	No	• No • Yes	Activation of the sectionalizer automation function on the SC150/SC160. **NOTE:** On the SC160 module, if the tripping protection is enabled, the sectionalizer function is not available. **NOTE:** At least one protection instance must be configured as **FPI + sectionalizer**.
Supply interruptions	4	1-4	Number of confirmed faults to detect during the sectionalizer **Maximum operation time (ms)** to trigger the sectionalizer automation action
Count supply interruptions after confirmation time (3000 ms)	Yes	• No • Yes	Counting supply interruptions condition: • When the setting value is **No**, supply interruptions are counted as soon as a fault has been validated by a supply interruption. • When the setting value is **Yes**, the function waits for the confirmation time before counting supply interruptions. **Fault confirmation time** is the delay before re-checking for network absence (ms). **Fault confirmation time** is set in **Settings > SC0x > Fault indication > Recloser parameters**, page 259 page.
Direction	Any	• Any • Forward • Backward	Choice of the fault current direction taken into account to activate sectionalizer automation
Enable LockOut	Yes	• No • Yes	This setting applies if the switch does not open when commanded. • When the setting value is **No** then the automation function attempts to open the switch on the next interruption. • When the setting value is **Yes** then the automation function is locked out and is not activated for new fault interruptions until it is reset by the user. When lock out is active, the “automation locked” LED is lit on the front of both the SC150/SC160 and HU250 modules.
Absence confirmation time (ms)	0	0–10,000 increment = 1	The time network must be absent before the sectionalizer automation takes the decision to send the switch open command.
Open command delay time (ms)	0	0–30,000 increment = 1	Additional delay after confirmation of network absence before executing the switch open command
Maximum operation time (ms)	0	0–30,000 increment = 1	Sectionalizer maximum operation time. If the **Enabled** setting value is **Yes**, this setting must be greater than 1,000 ms and less than or equal to the value of **Primary CB recloser maximum operation time (ms)**.
Primary CB recloser maximum operation time (ms)	0	0–300,000 increment = 1	Read only (copy of the value set in the **Settings > SC0x > Fault indication > Recloser parameters**, page 259). After a fault current has been detected on the MV network, this time delay corresponds to the total operation time for all the reclose cycles of the upstream protection device.

Local I/O on SC150/SC160 module

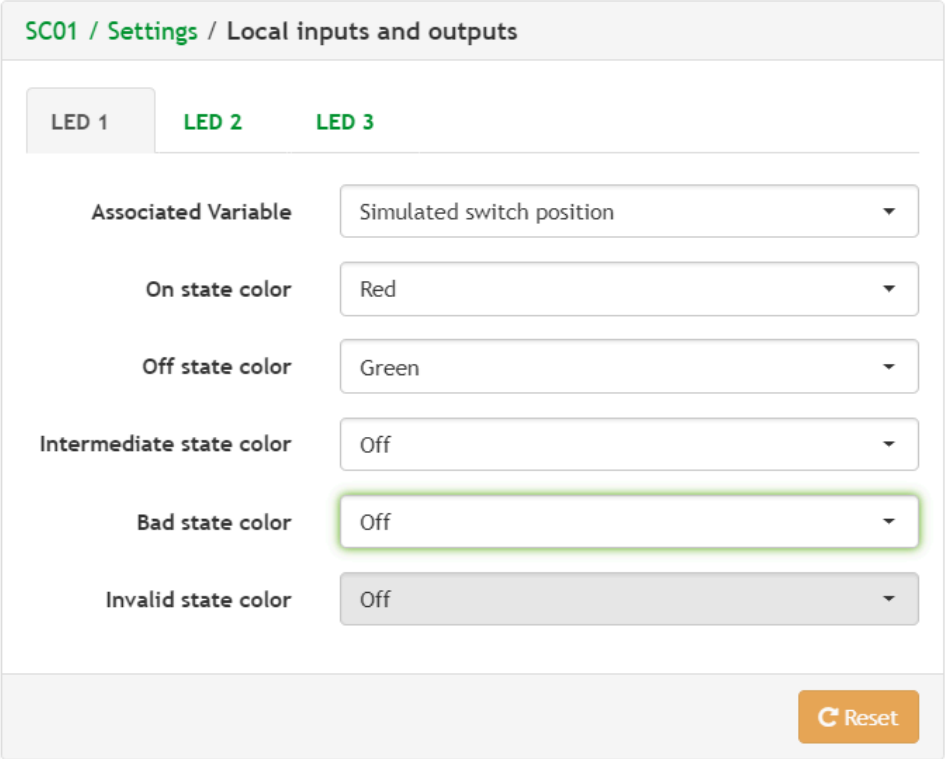
Customizing LEDs on the SC150/SC160 module

The color of 3 user LEDs on the front of the SC150/SC160 or LV150 modules can be customized.

LEDs 1 to 3 can be assigned to different variables/functions. The colors and behavior can be customized for each state.



Access via **Settings > SCx > Local inputs and outputs** page.



Variables/functions that can be associated with each LED (1, 2, 3)

Associated variables	Comment	Type	Proposed Color / Behavior
None	Default for LED 2	SPS	• 0 Intermediate: Off • 1 Off = Off • 2 On = Off
Dummy switch			
Simulated switch position	Default for LED 1 (dummy circuit breaker)	DPS	• 0 Intermediate: Off • 1 Off = Open: Green • 2 On = Closed: Red
Physical inputs			
Digital input 5	(Switch interlock input)	SPS	• 0 = Off • 1 On = Orange • Invalid: Red-blink
Digital input 6	(Voltage presence)	SPS	
Digital input 7		SPS	
Digital input 8		SPS	
Physical outputs			
Open command output status		SPS	• 0 Off = Off • 1 On = Orange
Close command output status		SPS	
Switch controller blocking conditions			
External lock active	Default for LED 3. Logical OR of {MainXSWI_BlkOpn_stVal, MainXSWI_BlkCls_stVal}	SPS	• 0 Off = Off • 1 On = Orange • Invalid: Red-blink
Switch open commands blocked	Function of variables {Switch position, Digital input 5} and setting {“External input mode for Open commands”}	SPS	
Switch close commands blocked	Function of variables {Switch position, Digital input 5} and setting {“External input mode for Close commands”}	SPS	
Sectionalizer state			
Sectionalizer enabled	for active setting group	SPS	• 0 Off = Off • 1 On = Green
Sectionalizer automation started	(in progress)	SPS	• 0 Off = Off • 1 On = Orange
Automation operated	(sectionalizer opened the switch)	SPS	
FPI Phases			
Fault indication on phase A / B / C		SPS	• 0 Off = Off • 1 On = Red
FPI Faults			
Phase fault		SPS	• 0 Off = Off • 1 On = Red
Earth fault		SPS	
Sensitive Earth fault		SPS	

Setting LED colors

Parameter	Default	Configuration range	Description
LEDs 1 to 3			
On state color	Red	• Off • Red • Green • Orange • Red blink • Green blink • Orange blink	Choice of color for LEDs 1 to 3 for the active state of the data.
Off state color	Green		Choice of color for LEDs 1 to 3 for the inactive state of the data.
Intermediate state color	Off		Choice of color for LEDs 1 to 3 for the intermediate state of the data. The intermediate state can be, for instance, the transitional phase of a change of state. For DPS only.
Bad state color	Off		Choice of color for LEDs 1 to 3 for a bad state of the data. A bad state may be an unexpected state for the data. For DPS only
Invalid state color	Green blink		Choice of color for LEDs 1 to 3 for an invalid state of the data. An invalid state corresponds to a missing known state for the data.

SC160 Module Settings

What's in This Chapter

MV Current and Voltage Sensors 281
Switch Control 290
Front Panel Voltage Indication 302
Active Overpower 305
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Other functionalities (common to the SC150, SC160 and LV150 modules):

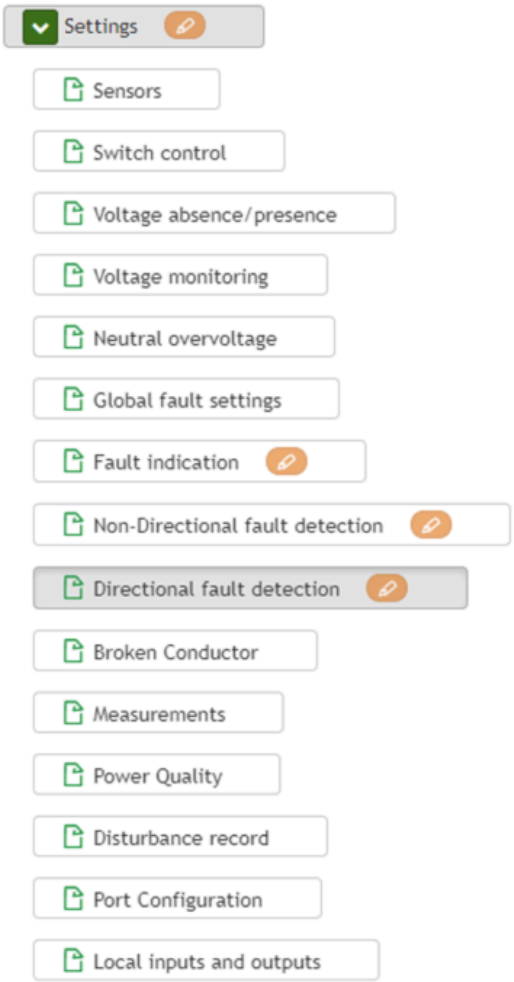
Voltage Monitoring, page 394

Broken Phase Conductor Detection, page 401

Port Configuration, page 404

Functions of SC150 and SC160modules are described in this manual.

Settings menu for SC160 module



All these functions are explained in detail in this manual, together with the corresponding application parameter settings.

- **Current and voltage measurements**

  LPVT, VT and VPIS-V3 sensors can be used with SC160 module for voltage measurement.

  The SC160 is compatible with all standard current sensors (according to IEC 61869-2).

  There are 4 possible connection configurations for acquiring the current measurement:

  - Type A: 3 phase CTs
  - Type B: 2 phase CTs + 1 core balance CT
  - Type C: 1 core balance CT
  - Type D: 3 phase CTs + 1 core balance CT
- **Fault current detection indication and tripping protection**

  Fault current detection is compatible with all neutral systems with or without distributed generation. Fault current detection is based on the following international ANSI code standards:

  - Phase overfault current (ANSI 50/51)
  - Ground fault (ANSI 50N/51N)
  - Neutral Voltage Displacement (ANSI 59N)
  - Directional phase overfault current (ANSI 67)
  - Directional ground fault (ANSI 67N) for detection
  - Directional ground fault (ANSI 67N) for tripping protection

  Two groups of settings can be defined for each fault current type. All fault current detection algorithms function according to the methods of detection:

  - Instantaneous (SC160 only)
  - Definite time (DT)
  - Inverse definite minimum time (IDMT) with a choice of standardized inverse time curves

    NOTE: Directional fault protection (Tripping) cannot be configured for the following VT types: VPIS-V3, VDS-HR, VDS-LRM and VDIS.
- **MV network voltage monitoring**
  - Undervoltage detection (ANSI 27)
  - Overvoltage detection (ANSI 59)
  - Neutral overvoltage detection (ANSI 59N)
  - Broken conductor detection (ANSI 47)
  - Active Overpower (ANSI 32P)
- **Sectionalizer automation**

  The sectionalizer (SEC) automation function is controlled by the SC150/SC160 module. This automation function is factory-installed but configurable on-site.

  The Sectionalizer automation function is deactivated if the tripping protection mode is enabled on the SC160 module.
- **Power measurements and power quality**
  - Power measurements (IEC 61557-12)
  - Power quality (according to the principles of IEC 61000-4-30 class S - up to harmonic 40).
- **Control and monitoring of MV switches**

  Control is compatible with all existing switch types and all types of command (single or double). There is a wide range of control voltages: 12 VDC to 127 VDC, 90 VAC to 220 VAC.
- **Disturbance record**

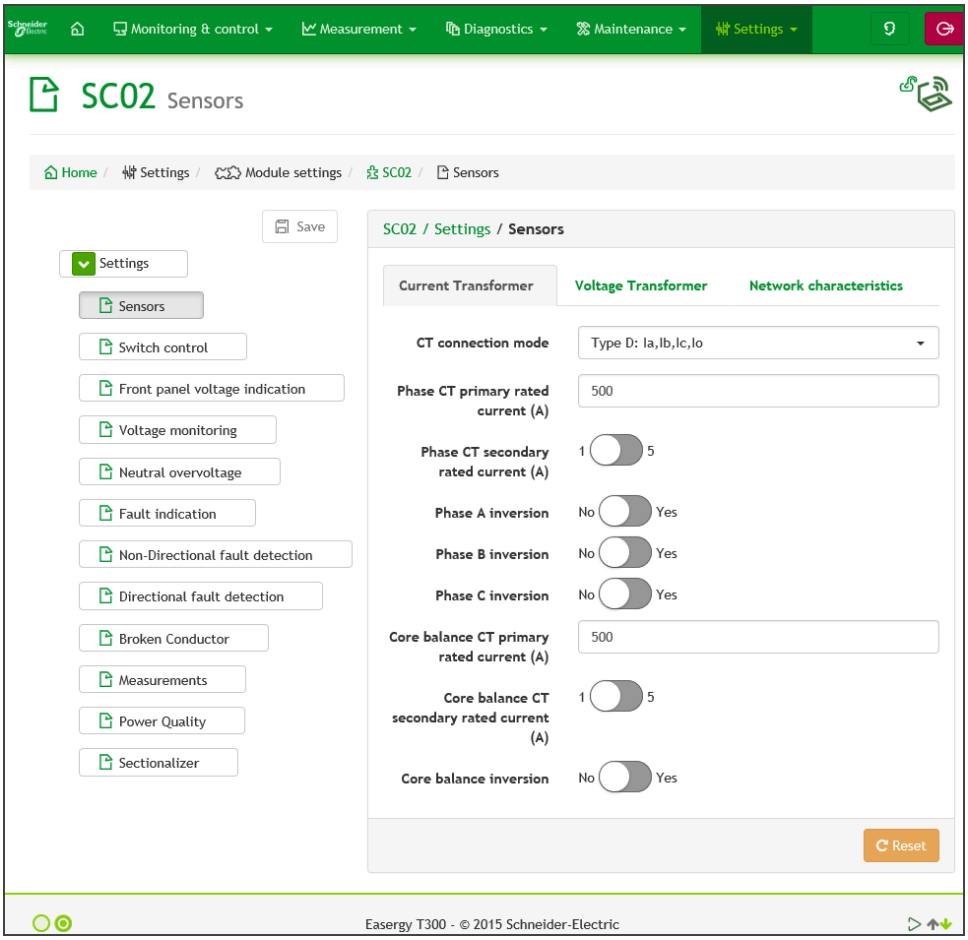
  Record measured analog signals, digital input signals and logical states.

- **Port configuration**

  Limit access to a physical port on the SC150/SC160 module.
- **LEDs customization**

MV Current and Voltage Sensors

Accessed via **SC0x > Settings > Sensors** page



MV Current Sensors

The SC150/SC160 default configuration includes a current transformer with a ratio of 500:1.

The type of CT to be used is selected by the user.

Note that the CTs supplied by the T300 manufacturer also have a ratio of 500:1. It is possible, however, to define a different primary/secondary ratio by configuration if a CT with different characteristics is used.

Several CT connection configurations are possible on the T300:

- Type A: 3 phase CTs
- Type B: 2 phase CTs + 1 core balance CT
- Type C: 1 core balance CT
- Type D: 3 phase CTs + 1 core balance CT

For the SC160, the tripping protection function is available with current transformer 1 A and 5 A at secondary according to IEC 61869-2.

NOTICE

HAZARD OF INCORRECT WIRING

- When fitting the CTs on the cables, it is mandatory to comply with the direction of positioning: HAUT/TOP marking facing upward, wire exit downward (see illustration beside).
- The shielding of each MV cable must be re-inserted inside the corresponding CT before being connected to ground (see diagram beside).
- The blue wire on the CT secondary (S2) must be connected internally to the blue wire (blue wire including a round terminal at the end).
- The blue wire including the round terminal must be connected to the same frame ground as the cubicle.

Failure to follow these instructions can result in equipment damage.

Not following wiring instructions can lead to equipment damage and incorrect current measurements.

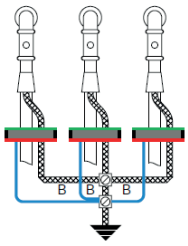
⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

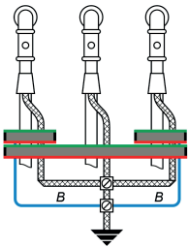
- The current sensors used for measuring must be 1 A or 5 A (only for FPI) secondary with security factor limiting the current to 100 A secondary -1 s (according to standard IEC61869-2).
- Always use grounded external CTs for current inputs.
- The CTs should not remain disconnected, while being installed and power on. If a disconnection is to be made, for any reason whatsoever, a short circuit is required at the secondary part of the CTs. CTs connectors are IP2X.
- Cables of voltage rating greater than 1000 V must have a shield connected to ground.
- The low-voltage insulation of the PowerLogic CTs means they can only be used on insulated cables.
- Make sure that all electrical power on MV network is removed before working on or installing CTs on the MV cable and making CT connections.

Failure to follow these instructions will result in death or serious injury.

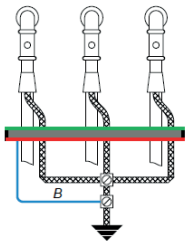
Connection type A (3 phase CTs)



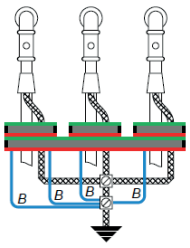
Connection type B (2 phase CTs + 1 core balance)



Connection type C (1 core balance CT)

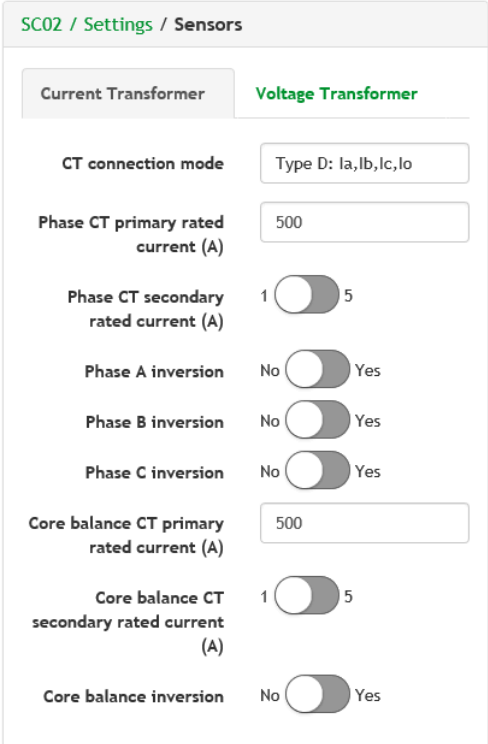


Connection type D (3 phase CTs + 1 core balance)



Current sensor parameter settings

Accessed via **SC0x > Settings > Sensors** page



Parameter	Default	Configuration range	Description
Current Transformer			
CT connection mode	D	• None • A • B • C • D	Choice of CT connection configuration options: • Type A: 3 phase CTs • Type B: 2 phase CTs + 1 core balance CT • Type C: 1 core balance CT • Type D: 3 phase CTs + 1 core balance CT
Phase CT primary rated current (A)	500	50 – 1,250 (increment = 1)	Nominal value of the current at the phase CT primary
Phase CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the phase CT secondary according to IEC 61869-2
Phase A (B, C) inversion	No	• No • Yes	Used to reverse the direction of the current flowing from phase A (B, or C). This parameter is used to compensate for an inversion of the direction of connection of the CT on the MV cable via the software.
Core balance CT primary rated current (A)	500	10 – 1,250 (increment = 1)	Nominal value of the current at the core balance CT primary
Core balance CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the core balance CT secondary
Core balance inversion	No	• Yes • No	Used to reverse the direction of the residual current. This parameter is used to compensate via the software an inversion of the direction of connection of the CT on the MV cable or a reverse winding direction of core balance CT compared to phase CTs.

MV Voltage Sensors

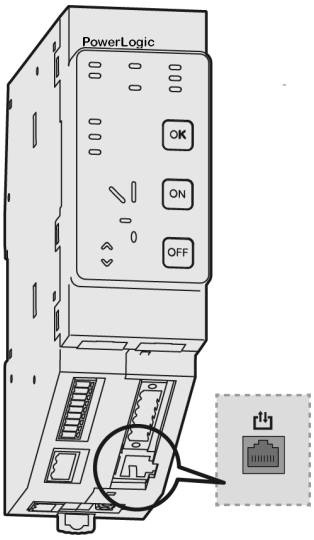
The SC160 offers several sensor options for measuring and monitoring medium voltage. The accuracy of the voltage measurement depends primarily on the type

of sensor used. The SC160 needs the voltage measurement for the following functions:

- Fault current detection and indication
- Fault current detection and tripping protection (SC160 only)
- MV network monitoring and automation
- MV voltage measurement
- MV power measurement
- MV power quality measurement

The following table presents the voltage sources that can be used for the automation functions:

Parameter	Current presence only	Digital input	LV AC supply	Measured (any MV voltage sensor)
Sectionalizer	X	X	X	X
ATS	–	X	–	X



The link between the adapter and the voltage input on the SC150/SC160 module (RJ45 connector) is via "straight-through" Ethernet cable including RJ45 connectors.

⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Do not connect VT adapter directly to the MV sensors. Always use fuse and disconnect switch (maximum voltage allowable on the VT adapter inputs: 600 VAC).
- Never short the secondary of a Voltage Transformer (VT).
- Do not connect items of equipment with different earth potentials with an RJ45 cable.
- Do not use RJ45 cable longer than 10 meters (32.8 feet).

Failure to follow these instructions will result in death or serious injury.

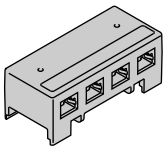
Voltage Sensors for SC160

Depending on the type of sensor used, the way in which the measurements are processed is different:

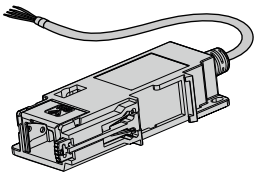
- LPVT/VT: A direct sensor measurement is taken without calibration.
- VPIS-V3 / VDS HR / VDS LRM / VDIS: Calibration is performed on manual demand, through the Web server. Calibration is stored in the module. Calibration is to be performed with the complete voltage measurement chain and with a known reference value used as nominal voltage. For better accuracy, perform calibration in factory with a controlled voltage source, once for all.

The different MV sensor types used with the SC160, and the possible connections are summarized in the table below. Each type of voltage sensor requires a specific adapter (available as an option) for connection to the SC160 module.

LPVT adapter



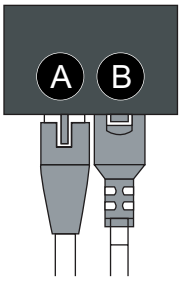
VT adapter



VPIS-V3 adapter

A. SC150/SC160 output

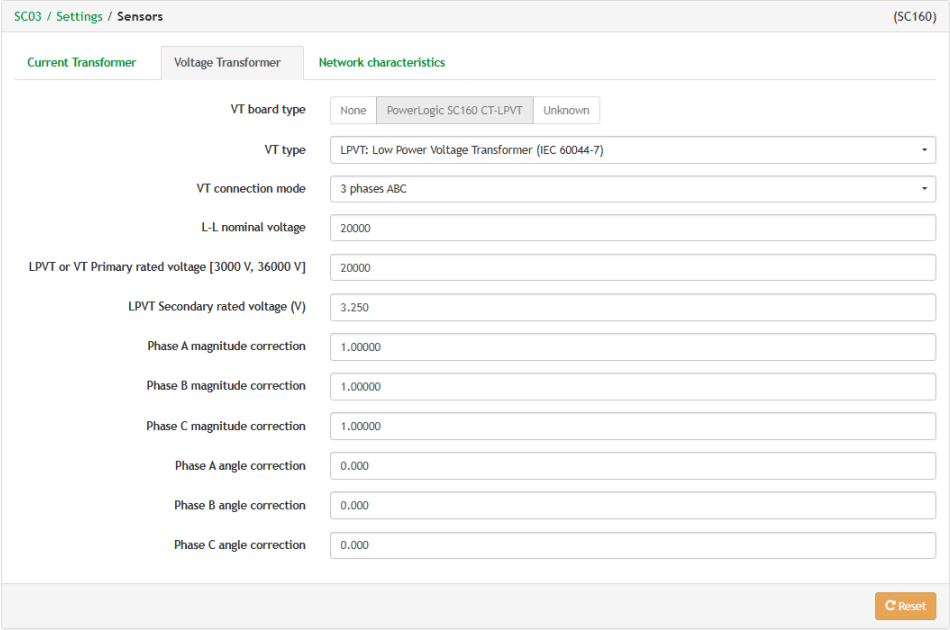
B. VPIS input



Voltage sensor	Description	Adapter Required
SC160-LPVT version: 1,2 or 3 phases mounting		
VT	Standard voltage transformer according to IEC 61869-3 with 2KV/1 mn AC insulation. **NOTE:** The SC160-VT adapter accepts only 1, 2 or 3-phase transformer-primary type assemblies without neutral (phase-to-phase or phase-to-ground).	SC160- VT adapter (ref: EMS59572): Voltage input (LL): 50 V to 250 VAC IP 30
LPVT	Low power voltage transformer according to IEC 60044-7	LPVT adapter (ref: EMS59573): IP 30
VPIS-V3 VO	Official Schneider Electric voltage presence indicator with voltage output (IEC 62271-206). The VPIS-V3 VO sensor is connected to the capacitive divider installed in the MV cubicle.	VPIS-V3 VO adapter (ref: EMS59577): Voltage input (LL): 1 V to 30 VAC max. IP 30
VDS HR	Voltage Detector System High Resistance (IEC 61243-5)	VDS HR adapter (ref: EMS59580): Voltage input (L-L): 70 V to 90 VAC max. IP65
VDS LRM	Voltage Detector System Low Resistance Modified (IEC 61243-5)	VDS LRM adapter (ref: EMS59571): Voltage input (L-L): 1 V to 30 VAC max. IP30
VDIS	Voltage Detecting and Indicating System (IEC 62271-213) for MV cubicles	VDIS adapter (ref: EMS59570): Voltage input (L-L): 1 V to 30 VAC max. IP30

Voltage Sensor Parameter Settings for SC160

Access via **SC0x > Settings > Sensors** page with a CT-LPVT VT board type.



Parameter	Default	Configuration range	Description
Voltage Transformer			
VT board type	Depends on the model supplied	PowerLogic SC160 CT-LPVT	This choice is factory-set as it corresponds to the circuit board specific to each version.
Parameter settings for VT board type = LPVT			
VT Type	None	• None • VT • LPVT • VPIS-V3 • VDS HR • VDS LRM • VDIS	If VT Type is set to none: • Power measurements are not available • Voltage measurements are not available • The following FPI functions are not available: ◦ DPhPTOC ◦ DEfPTOC ◦ NeutPTOC ◦ BcPTOC • Voltage monitoring is not available • FPI confirmation mode: when set to Voltage, Measured option is not available
L-L nominal voltage (V)	20,000	3,000-36,000 (increment = 1)	Definition of the nominal voltage of the MV network (phase-to-phase voltage)
LPVT or VT Primary rated voltage (V)	20,000	3,000-36,000 (increment = 1)	Definition of the primary voltage of the measurement transformer. Must correspond to the characteristics of the transformer used. Parameter only available for the options VT type = VT or LPVT.
LPVT-Specific parameter settings			
VT connection mode with PQ	3 phases ABC	3 phases ABC	Choice of the type of connection used for the voltage sensor. The sensor can be wired on a single phase, or between 2 or 3 phases depending on the connection configuration used. The type of voltage measurement performed (with 1, 2 or 3 phases) also depends on the type of connection and mounting of the voltage sensor defined by this parameter.
VT connection mode without PQ	3 phases ABC	• 3 phases ABC • Single phase A • Single phase B • Single phase C	
LPVT Secondary rated voltage (V)	3.25000	1-10 (increment = 0.001)	Definition of the secondary voltage of the measurement transformer. Must correspond to the characteristics of the transformer used.

Parameter	Default	Configuration range	Description
Voltage Transformer			
Phase A magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase A measurement to improve accuracy
Phase B magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase B measurement to improve accuracy
Phase C magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase C measurement to improve accuracy
Phase A angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase A caused by the sensor used
Phase B angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase B caused by the sensor used
Phase C angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase C caused by the sensor used
VT- Specific parameter settings			
VT connection mode with PQ	3 phases ABC	• 3 phases ABC • Vab-Vbc-Vb	Choice of the type of connection used for the voltage sensor. The sensor can be wired on a single phase, or between 2 or 3 phases depending on the connection configuration used. The type of voltage measurement performed (with 1, 2 or 3 phases) also depends on the type of connection and mounting of the voltage sensor defined by this parameter.
VT connection mode without PQ	• 3 phases ABC • Vab-Vbc-Vb	• 3 phases ABC • Single phase A • Single phase B • Single phase C • Line to line AB • Line to line BC • Line to line CA • Vab-Vbc-Vb	
VT secondary rated voltage (V)	250.000	50-250 (increment = 0.001)	Definition of the transformer secondary voltage. Must correspond to the characteristics of the transformer used.
VT Adapter magnitude correction phase A	50.600	30-60 (increment = 0.001)	Used to calibrate the phase A measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VT Adapter magnitude correction phase B	50.600	30-60 (increment = 0.001)	Used to calibrate the phase B measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VT Adapter magnitude correction phase C	50.600	30-60 (increment = 0.001)	Used to calibrate the phase C measurement taken by the VT adapter to improve accuracy. The corresponding calibration value is indicated on the VT adapter.
VPIS-V3 / VDS HR / VDS LRM / VDIS - Specific parameter settings			
VT sensor type	None	• None • EMS59577 • EMS59570 • EMS59575	Choice of the type of capacitive adapter installed in the MV cubicle. This parameter is automatically selected for the following chosen VT type: • EMS59577 for VPIS-V3 • EMS59570 for VDIS • EMS59570/EMS59575 for VDS LRM
Capacitive adapter magnitude correction phase A	1.00000	0.2-8 (increment = 0.001)	Used to correct the sensor phase A measurement to improve accuracy.
Capacitive adapter magnitude correction phase B	1.00000	0.2-8 (increment = 0.001)	Used to correct the sensor phase B measurement to improve accuracy.
Capacitive adapter magnitude correction phase C	1.00000	0.2-8 (increment = 0.001)	Used to correct the sensor phase C measurement to improve accuracy.
Phase A angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase A caused by the sensor used.
Phase B angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase B caused by the sensor used.
Phase C angle correction	0.000	-180 to 180 (increment = 0.001)	Used to correct the induced phase shift on phase C caused by the sensor used.

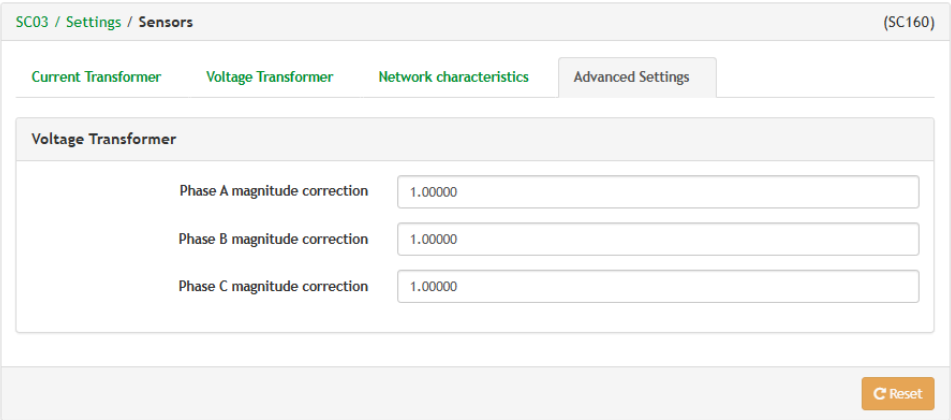
Parameter	Default	Configuration range	Description
Voltage Transformer			
Execute automatic calibration now	No	• No • Yes	Immediate activation of the calibration. The calibration is executed after validating this option, using the L-L nominal voltage Un as the reference. The corrections are stored permanently in the product. The calibration is executed only with this command (no automatic calibration at start).
Enable angle calibration	Yes	• No • Yes	When enabled, the phase angle correction factors are updated when the calibration is performed.
Calibrated	No	• No • Yes	Indicates the module calibration status. This parameter is not configurable but is automatically updated after executing the calibration.
Calibration date	Empty	Date in format: yyyy-mm-dd hh:mm:ss	Indicates the module last calibration date. This parameter is not configurable but is automatically updated after executing the calibration.
Automatic calibration result	Not calibrated	• Not calibrated • Calibration success • Voltage too high • Voltage too low • Timeout waiting for a valid voltage • Manual settings	Indicates the module last calibration result. This parameter is not configurable but is automatically updated after executing the calibration.

Advanced Settings

Phase magnitude correction factors applied to correct LPVT sensor measurements can also be used with capacitive sensors to extend the application range.

These factors can be defined if VPIS-V3/ VDS HR/ VDS LRM/ VDIS/ VDS adapter is selected in SC150 (LPVT or CAPA boards) or SC160 modules, in the **Advanced Settings** tab.

Accessed via **SC0x > Settings > Sensors**, **Advanced Settings** tab. Parameter settings are the same for SC150 or SC160 as shown in the following image.



Parameter	Default	Configuration range	Description
Voltage Transformer — Advanced settings			
Phase B magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase B measurement to improve accuracy.
Phase A magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase A measurement to improve accuracy.
Phase C magnitude correction	1.00000	0.5-2 (increment = 0.00001)	Used to correct the LPVT sensor phase C measurement to improve accuracy.

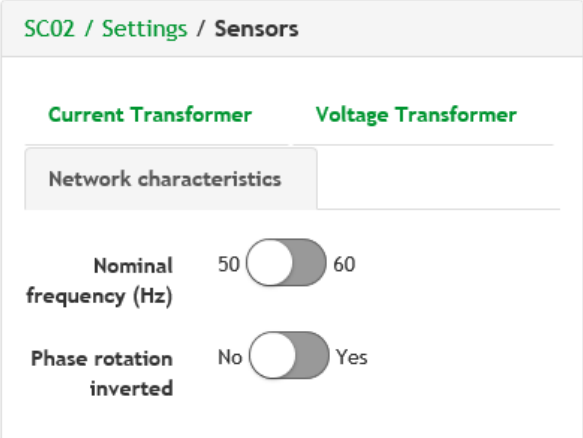
Network Characteristics

There are other parameters in addition to the sensor parameters.

- The SC150/SC160 module can take current and voltage measurements at 50 Hz or 60 Hz to correspond with the existing network frequencies.
- The sequence of phases A, B, and C can be inverted.

Measured voltages and frequency parameter settings

Accessed via **SC0x > Settings > Sensors** page.



Parameter	Default	Configuration range	Description
Network characteristics			
Nominal frequency (Hz)	50	• 50 • 60	Choice of MV network frequency
Phase rotation inverted	No	• Yes • No	Used to invert the phase sequence: • Yes = ACB (inverted) • No = ABC (normal sequence) The ACB sequence must be used when the CT wiring or connection configuration has been inverted in relation to the theoretical phase sequence or for networks with an inverted phase sequence. **NOTE:** This inversion affects current and voltage.

Switch Control

The SC module has various software interlocks to help reduce the risk of unintended switch operations.

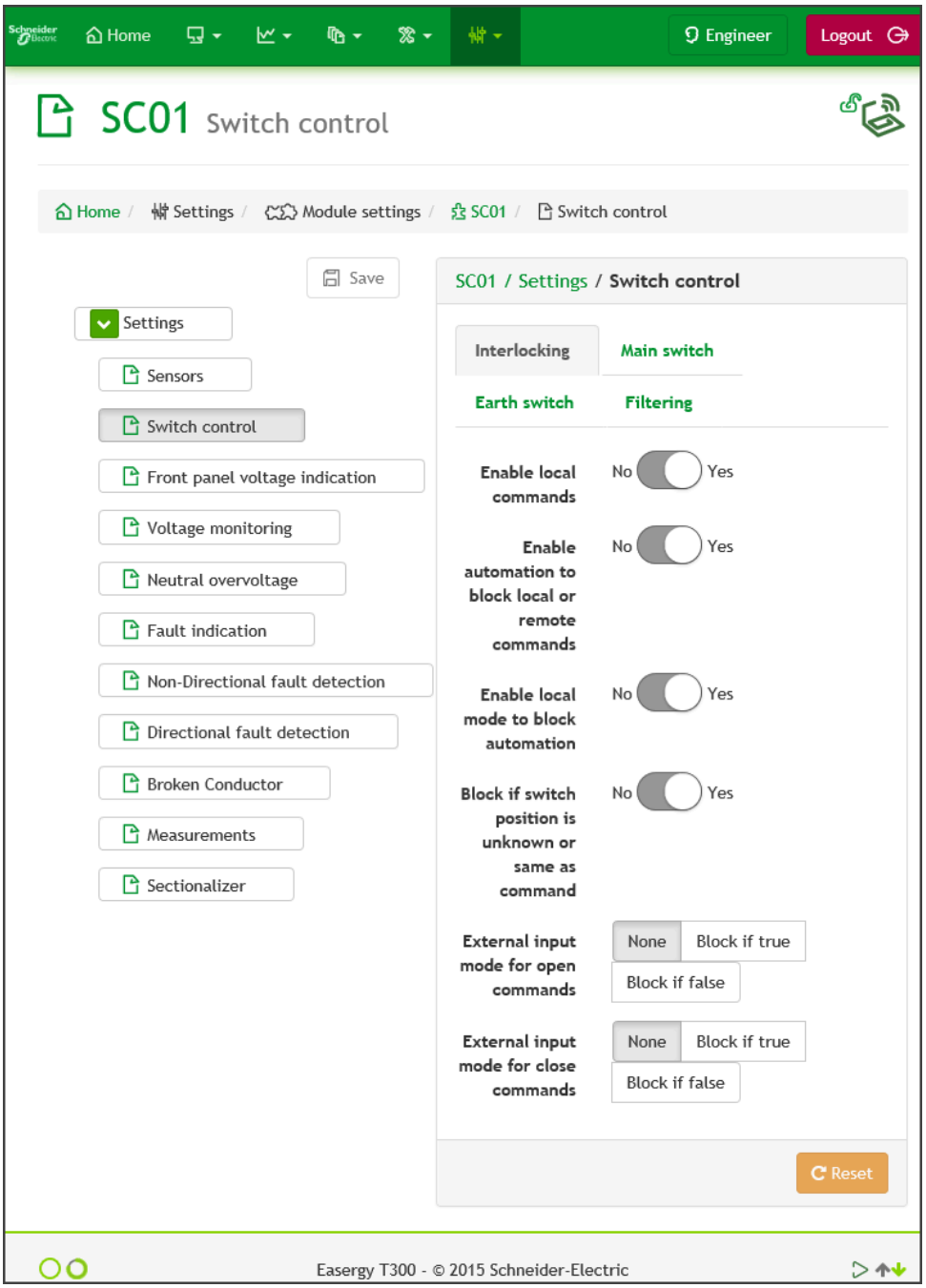
⚠ WARNING

HAZARD OF UNINTENDED EQUIPMENT OPERATION

- To help software interlocks to work as intended, both the module configuration and the wiring between the module and the equipment must be consistent and correct.
- Make sure that the main switch position indications are correctly wired.
- Make sure that the earth switch position indication(s) is/are correctly wired.
- Make sure that the disconnector position indication is correctly wired (if applicable).
- Make sure that the SC module is correctly configured to match the wiring arrangement for the earth switch and disconnector (if applicable).
- Make sure that the HMI is configured to show the correct arrangement of earth switch and disconnector (if applicable). Refer to Setting Graphical Representation of the Switch, page 55.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Accessed via **SC0x > Settings > Switch control** page.



The switch control settings are used to adapt to any type of switch. The management of switch position control and command signals is essentially specific to each switch type.

Commands can be issued from a variety of sources. Remote commands are received by the SCADA system via the HU250. Local commands are received via the buttons on the front panel of the SC150/SC160 modules or via the Web server pages. Commands can also be received via the automation functions present in the HU250 module (ATS, or other) or the SC150/SC160 module (SEC). Local commands on the front panel of the module can be disabled by configuration to help prevent unintended operation.

The T300 systematically performs a consistency check of the switch positions before executing a command.

Interlock Function

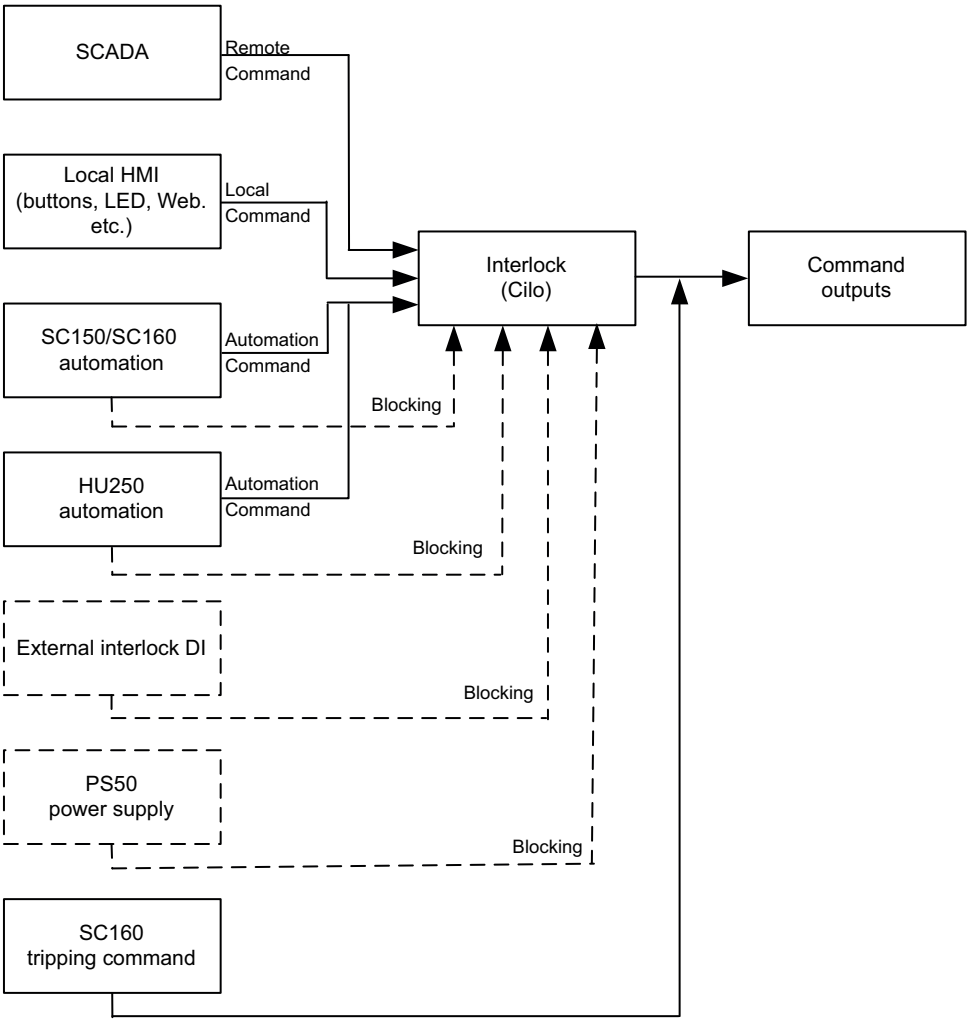
The interlock function is managed by the T300 "Cilo" BIN controller. The interlock function checks only the command execution conditions. It rejects a command if the execution conditions are not fulfilled. The majority of these conditions are defined by configuration via a specific parameter.

When the earth switch and disconnector wiring is selected, the earth switch interlock with the main switch command is disabled. Then, when the earth switch is closed, the main switch operations are not blocked.

On the SC160 module, the tripping protection cannot be blocked by the interlock function.

The T300 power supply is only capable of managing one switch command at a time. If several commands are issued simultaneously (commands made using the buttons on the front panels of two SC150/SC160 modules at the same time, or commands via the SC150/SC160 sectionalizer automation functions that have detected a potential issue on their channel), the interlock function coordinates with the system modules to help ensure that a command will only be executed if the previous command is considered to be complete.

The diagram below summarizes the various command input options checked by the interlock function as well as the possible blocking sources:



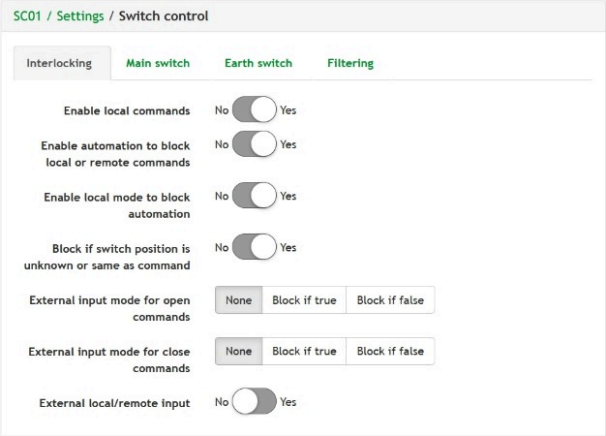
The table below summarizes the main command rejection conditions for the interlock function:

Command status	Result of the Command
Command already being executed on the same SC150/SC160 module	Rejected
Command already being executed on another SC150/SC160 module	

Command status	Result of the Command
Manual command in local or remote mode when the automation function is active and the corresponding blocking function has been enabled by configuration	
Open command when the switch is already open or its position is unknown and the corresponding blocking function has been enabled by configuration	
Close command when the switch is already closed or its position is unknown and the corresponding blocking function has been enabled by configuration	
Ground switch closed or in unknown position	
Switch command when the external interlock digital input (DI5) is enabled and the corresponding blocking function has been enabled by configuration	
Switch command when the 24/48 V motor mechanism power supply is not available or there is a problem with the battery (end of life or low charge)	

Switch control parameter settings

Access via **SC0x > Settings > Switch control** page.



Parameter	Default	Configuration range	Description
Interlocking			
Enable local commands	Yes	• No • Yes	Enables local switch commands via the buttons on the front panel of the SC150/SC160 module
Enable automation to block local or remote commands	Yes	• No • Yes	Enables the blocking of local or remote switch commands when the automation function is enabled. In this case, the automation function also manages the other command options (see the "Local/ Remote Mode" section for more information).
Enable local mode to block automation	Yes	• No • Yes	Enables the blocking of automation commands when local control mode is enabled on the HU250
Block if switch position is unknown or same as command	Yes	• Yes • No	Enables the blocking of switch commands when the position of the switch is not known or inconsistent (e.g. in the same state as the command issued)
External input mode for open commands	None	• None • Block if true • Block if false	Enables the blocking of the switch open command by external digital input (DI5 on 9-way switch state connector)
External input mode for close commands	None	• None • Block if true • Block if false	Enables the blocking of the switch close command by external digital input (DI5 on 9-way switch state connector)
External local/remote input	No	• Yes • No	Enables forcing the local mode on the SC150/SC160 by using the DI7 external input The SC150/SC160 responds to remote commands when both the HU250 and the SC150/SC160 are in remote mode. The SC150/SC160 responds to local commands when either the HU250 or the SC150/SC160 is in local mode.

Switch Positions and Commands

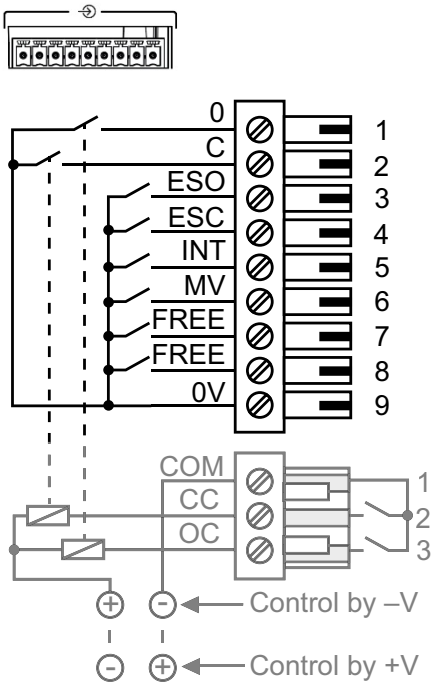
Managing Switch Positions

There are several ways of managing switch position signals. In principle on the T300, the switch position is obtained via a double status signal (open, closed). It is possible, however, to manage the switch position via a single status signal, i.e. using one of the hard-wired status indications from the switch (open or closed).

Wired switch inputs

SC150/SC160 9-way connector (DI3, DI4, DI5, DI6, and DI7 can be configured).

Switch or breaker states



9–pin plug-in-screw connector

Switch or breaker states	
1	DI1–Switch or breaker open
2	DI2–Switch or breaker closed
3	DI3–Earthing switch open
4	DI4–Earthing switch closed
5	DI5–Switch interlock
6	DI6–MV voltage presence
7	DI7–SC150/SC160 local/remote input
8	DI8–Unassigned digital input
9	DI9–Common (0V)

NOTICE

HAZARD OF INCORRECT WIRING

Make sure that the digital inputs do not receive voltage because they accept only wet contact.

Failure to follow these instructions can result in equipment damage.

The table below summarizes the various options for managing switch position signals according to the switch wiring:

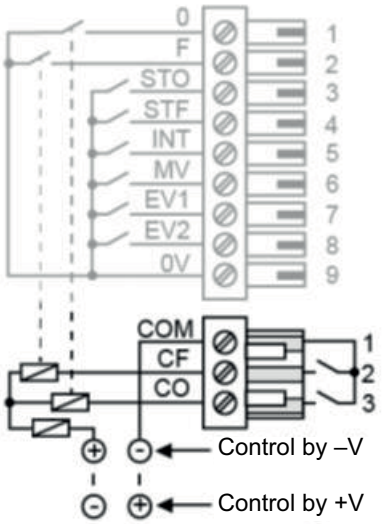
Input Wiring Parameter	Hard-Wired Digital Input Pins		Switch Status Signal
	DI1 (Switch or breaker Open)	DI2 (Switch or breaker Closed)	
Open	Active (1)		Open
	Inactive (0)		Closed
Closed		Active (1)	Closed
		Inactive (0)	Open
Open and closed	Active (1)	Inactive (0)	Open

	Inactive (0)	Active (1)	Closed
	Active (1)	Active (1)	Invalid
	Inactive (0)	Inactive (0)	Intermediate

Switch command outputs

SC150/SC160 3-way connector

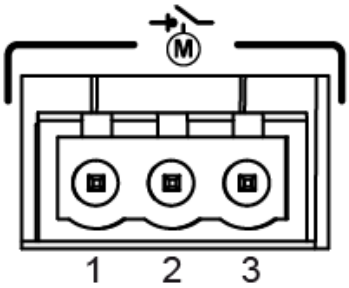
Switch or breaker controls



12Vdc < V < 127Vdc or
90Vac < V < 220Vac

3–pin plug-in-screw connector

Switch or breaker controls	
1	DO1–Motor pack power supply common
2	DO2–Closing control or breaker close
3	DO3–Opening control or breaker tripping



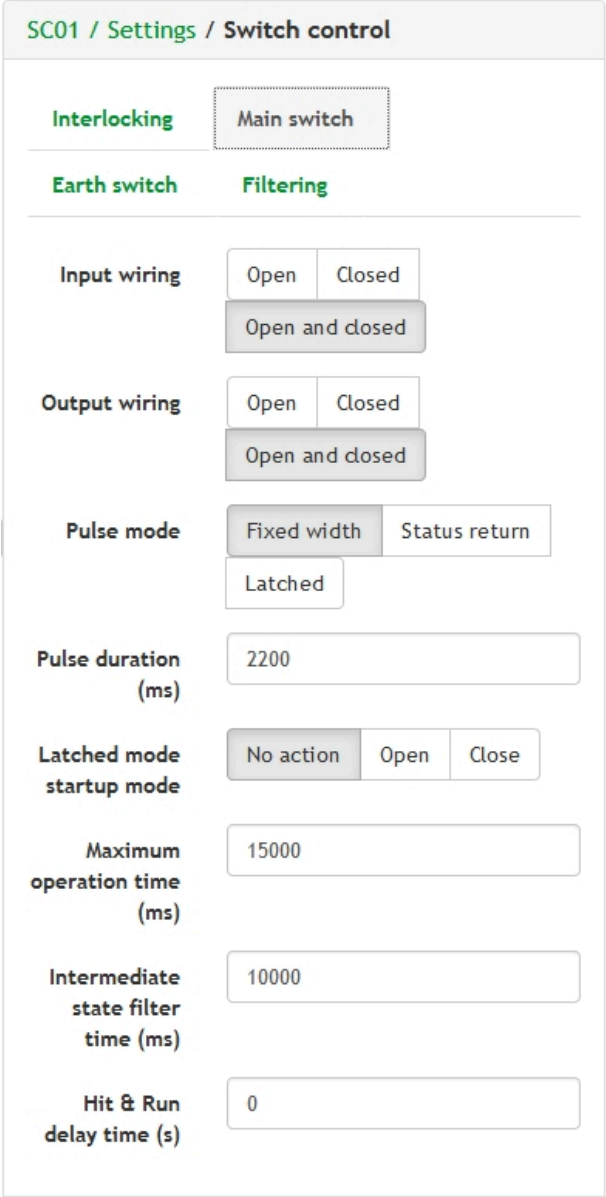
The same type of single or double command management is possible for switch control. The following table summarizes the different management modes possible and the resulting switch action:

Output Wiring Parameter	Hard-Wired Digital Output Pins		Command sent to switch
	DO2 (Closed command)	DO3 (Open command)	
Open		Active (1)	Open
		Active (1)	Close
Closed	Active (1)		Close
	Active (1)		Open
Open and closed	Active (1)	Inactive (0)	Open
	Inactive (0)	Active (1)	Close
(1): Each pulse of the output wiring activates the complementary command compared to the current state			

In order to proceed to the command, two relays (select + open or close) must be activated at the same time. They are controlled by two different micro-controllers to help secure commands and avoid unexpected operations.

Switch control parameter settings

Accessed via **SC0x > Settings > Switch control** page



Parameter	Default	Configuration range	Description
Main Switch			
Input wiring	Open and closed	• **Open** • **Closed** • **Open and closed**	Choice of wiring used for the switch position inputs: • **Open** means that the open status is wired to manage the 2 switch status signals (open and closed). • **Closed** means that the closed status is wired to manage the 2 switch status signals (open and closed). • **Open and closed** means that both states (open and closed) are wired to manage the corresponding switch status signals.
Output wiring	Open and closed	• **Open** • **Closed** • **Open and closed**	Choice of wiring used for the switch command outputs: • **Open** means that only the open command is wired to control the 2 switch positions. • **Closed** means that only the close command is wired to control the 2 switch positions. • **Open and closed** means that both commands (open and close) are wired to control the 2 switch positions.
Pulse mode	Fixed width	• Fixed width • Status return. Not available for SC160 in **Tripping** protection mode. • Latched. Not available for SC160 in **Tripping** protection mode.	• **Fixed width**: This is a fixed period defined by the Pulse duration parameter to enable the switch command polarity. At the end of this set period, command polarity stops. • **Status return**: Variable period for enabling command polarity. This depends on the time taken by the switch to change position. Command polarity stops as soon as the change of position is detected. Not available for SC160 in **Tripping** protection mode. • **Latched**: In this mode, the control relay remains energized until the opposite command is detected. On power-up, the initial relay status will be set by the **Latched mode startup mode** parameter. If the command does not execute, the relay remains in its last position. Not available for SC160 in **Tripping** protection mode.In this mode, simultaneous multi-channel commands are possible. Note that the power supply of T300 has the power necessary only to control a single motorization at a time.
Pulse duration (ms)	2,200	• 50–60,000 • From 200 in **Tripping** protection mode, for a SC160 module. (increment = 50)	Definition of the time it takes to send the switch command polarity (in **Fixed width** mode)
Latched mode startup mode	No action	• No action • Open • Closed	Choice of mode used for the initial state of the control relay on power-up. Only valid for **Pulse mode** = **Latched**.

Ground Switch (Earth Switch) and Series Disconnector

In the same way as for switch position signals, the ground (earth) switch can also be managed by a single or double status signal according to the wiring of the MV switch inputs (open or closed).

In the case of use with series disconnector, then the ground switch and disconnector are managed by single status signal only.

The table below summarizes the various options for managing ground (earth) switch position signals according to the switch wiring:

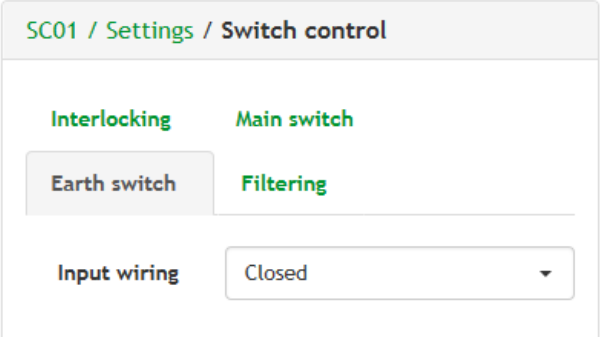
Input Wiring Parameter	Hard-Wired Digital Intput Pins		Ground Switch Status Signal
	DI3 (Ground Switch Open)	DI4 (Ground Switch Closed)	
None			
Open	Active (1)		Open
	Inactive (0)		Closed
Closed		Active (1)	Closed

		Inactive (0)	Open
Open and closed	Active (1)	Inactive (0)	Open
	Inactive (0)	Active (1)	Closed
	Active (1)	Active (1)	Bad
	Inactive (0)	Inactive (0)	Intermediate

	DI3 (Disconnector Open)	**DI4 (Ground Switch Closed)**	**Ground Switch Status Signal**	**Disconnector Status Signal**
Earth Switch and Series Disconnector	Active (1)	Inactive (0)	Open	Open
	Inactive (0)	Inactive (0)	Open	Closed
	Active (1)	Active (1)	Closed	Open
	Inactive (0)	Active (1)	Bad	Bad

Ground (earth) switch parameter setting:

Accessed via **SC0x > Settings > Switch control** page, **Earth switch** tab.



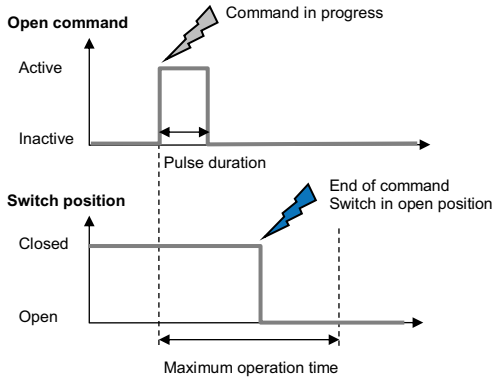
Parameter	**Default**	**Configuration range**	**Description**
Ground (Earth) Switch			
Input wiring	Closed	• **None** • **Open** • **Closed** • **Open and closed** • **Earth switch and series disconnector**	Choice of wiring used for the ground switch inputs: • **None** means that the interlock function does not take account of the ground switch. • **Open** means that the open status is wired to manage the 2 ground switch signals (open and closed). • **Closed** means that the closed status is wired to manage the 2 ground switch signals (open and closed). • **Open and closed** means that both states (open and closed) are wired to manage the corresponding ground switch signals • **Earth switch and series disconnector** means that the DI3 is wired to manage the disconnector state (open and closed) and DI4 is wired to manage the earth switch state (open and closed).

Managing Switch Commands

Switch commands can be managed according to several modes on the T300. The mode used generally allows adaptation to the different types of switch used, which each have their own specific mode of operation. This applies mainly to sequencing and the command polarity enabling period.

The diagrams opposite and below show the operating principle for executing an open command in each mode. The principle is the same for a close command. Explanations for each mode are also provided in the table above.

Principle of a command in **Fixed width** mode:



Command Filter Time Delays

The inputs for reading the switch position are scanned continuously during and after the command operation time, with a consistency check.

Once the control relay has de-energized, the command is considered to be complete by the T300 when the switch signals a position that corresponds to the request. The command is considered to be in ERROR mode if the position is not consistent with the command issued or if the position is unknown after the filter time delay.

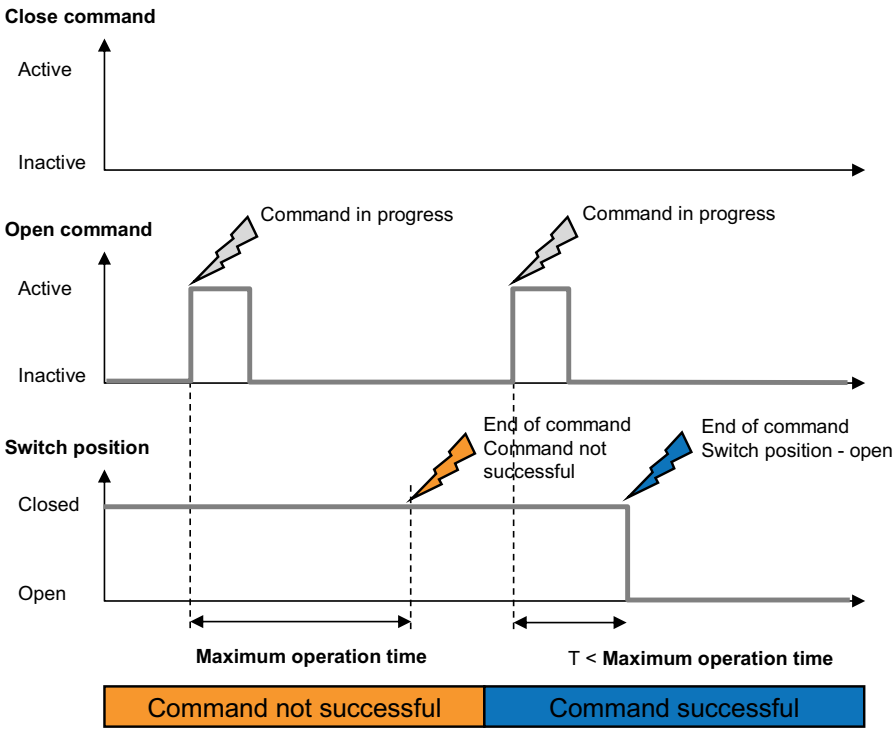
Command filter time delay parameter settings:

Accessed via **SC0x > Settings > Switch control** page, **Main switch** tab, and set up by the following parameters:

- Maximum operation time (ms)
- Intermediate state filter time (ms)

Parameter	Default	Configuration range	Description
Main Switch			
Maximum operation time (ms)	15,000	100–65,000 (increment = 100)	Maximum wait time for the switch to change position following a command before an ERROR is declared for this command. In **Pulse mode=Status return**, this also corresponds to the maximum time it takes to send the command polarity if the change of position is not detected within this time period.
Intermediate state filter time (ms)	10,000	0–30,000 (increment = 100)	Time delay for filtering the switch status before an intermediate or unknown state is declared. This delay is used to filter transient states or unintended changes. When a command is executed, it is preferable to check for a filtered and stable state before declaring an ERROR on the switch position.

Principle of switch position filtering after an open command (in **Fixed width** mode):



Hit and Run Function

The Hit and Run function is only available in local mode. It is available for all different command modes (fixed width, status return and latched).

The Hit and Run function adds an extra level of risk minimization on manual commands on MV switches. A time delay is applied after the user has pressed the buttons on the front panel of the SC150/SC160 module to issue the command to the MV switch before the command is executed. This leaves sufficient time to exit the substation before the command is executed.

Hit & Run function parameter setting:

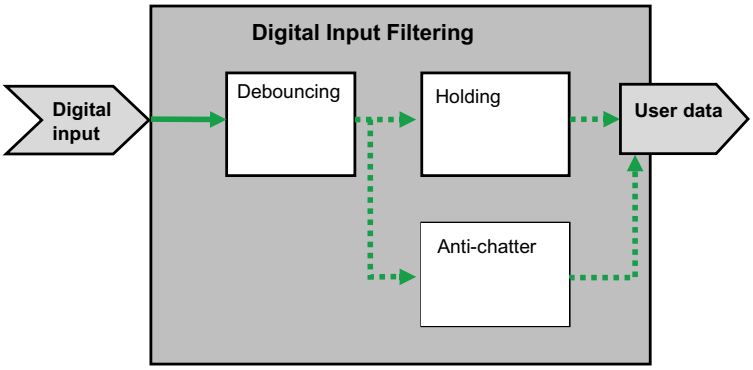
Accessed via **SC0x > Settings > Switch control** page, **Main switch** tab, and set up by the **Hit & Run delay time (seconds)** parameter.

Parameter	Default	Configuration range	Description
		Main Switch	
Hit & Run delay time (seconds)	0	0–60 Increment = 1	Execution delay for the **Hit & Run** function. The delay corresponds to the time required to exit the substation before the command is executed. Only available on the T300 in Local mode. Available for all commands types (fixed width, status return and latched).

Switch Input Filters

In the same way as the filters that are applied to the digital inputs, some types of filter can also be applied to the switch inputs (states).

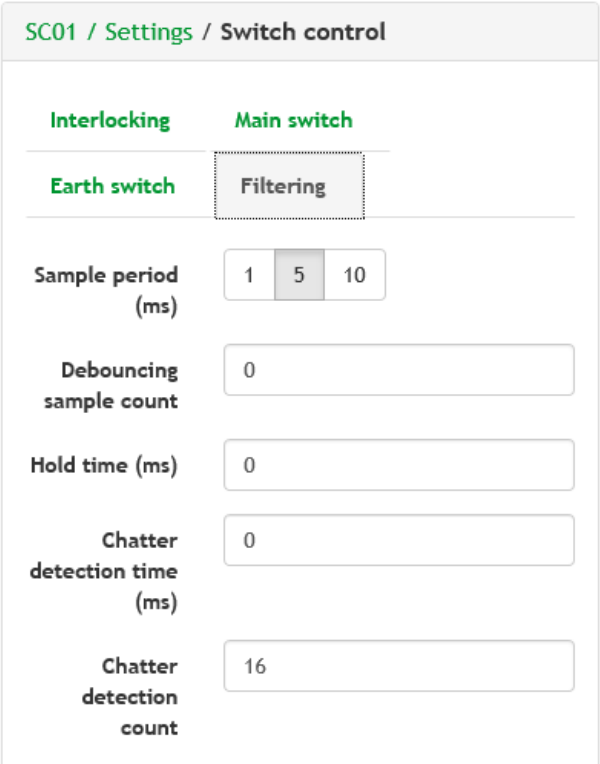
Digital Input Filtering:



NOTE: For the digital inputs (DI1 to DI4) that correspond to the switch position signals, an additional 20 ms filter (not shown in the diagram), is applied to the user data.

Digital input filter parameter setting:

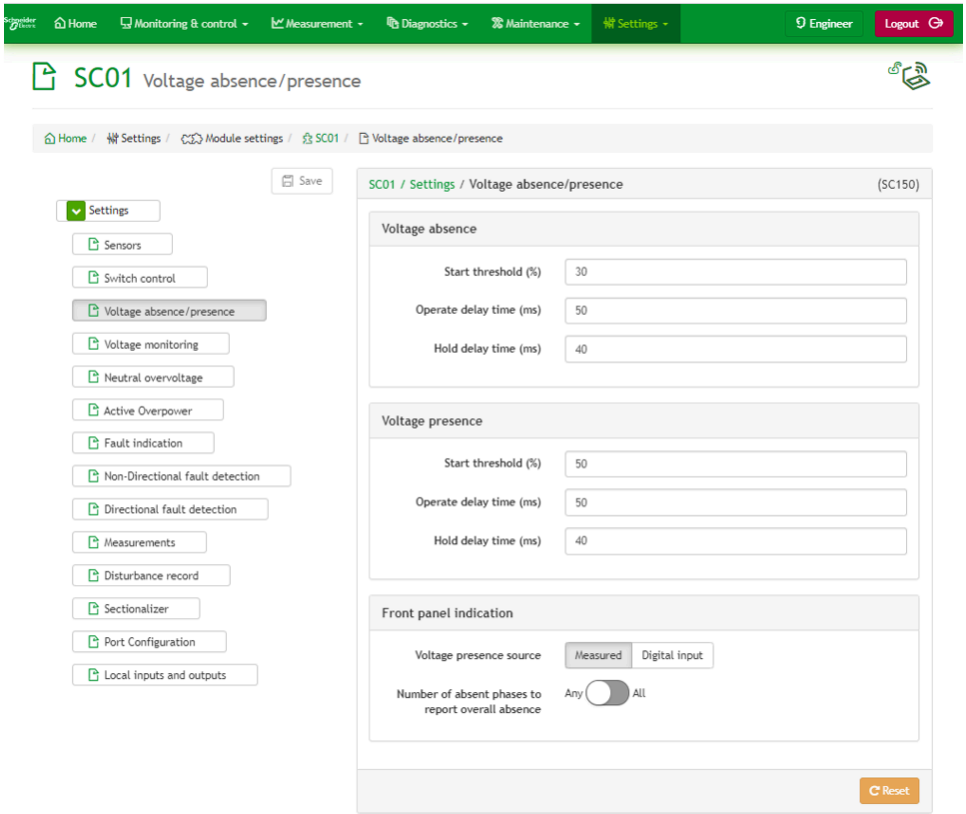
Accessed via **SC0x > Settings > Switch control** page, **Filtering** tab.



Parameter	Default	Configuration range	Description
Digital Inputs			
Sample period (ms)	5	• 1 • 5 • 10	**Sampling period** on the digital inputs for taking a state into account
Debouncing sample count	0	0–100 (increment = 1)	Filtering period for the bounce on a digital input. The value configured for the filter corresponds to a number of **Sample period** periods. The digital input must remain in the same state for a period greater than the defined debouncing period for its state to be taken into account. A value of 0 inhibits the debouncing filter.
Hold time (ms)	0	0–2,000 (increment = 1 ms)	Hold time for a digital input. When a change of state (debounce-filtered) is detected on a digital input, the input is locked in its new state until the **Hold time** has elapsed. At the end of the time period, the input returns to its actual value. A value of 0 inhibits the hold filter.
Chatter detection time (ms)	0	• 0 • 5–10,000 (increment = 1 ms)	Sliding time period corresponding to a window of observation and counting of the changes of state on a digital input. If during this period, the count becomes higher than the **Chatter detection count** value, the anti-chatter filter is activated, the state of the input is maintained at its last state. An event is signaled with the value maintained at its last state and with quality flags indicating “invalid”. The quality of the data is then signaled as bad. The anti-chatter filter becomes inactive again if, during the same period, no change of state is detected on the digital input. A value of 0 inhibits the anti-chatter filter.
Chatter detection count	16	1–255 (increment = 1 ms)	Counts the number of changes of state on a digital input to define the anti-chatter filter action. The changes of state counted are only those filtered by the debouncing filter.

Front Panel Voltage Indication

Access via **Settings > SC0x > Voltage absence/presence** page.



A LED on the front panel of the SC150/SC160 module indicates the presence or absence of the MV network voltage.

The status is also reported to the Head Unit for display on the web pages and for use by Automation functions.

The voltage presence indication can be configured with two different sources:

- Digital input DI6 connected to an external voltage presence relay
- Measurements from the voltage sensors.

When configured to use measured values, the threshold and delay settings are displayed.

These settings are used to determine the value of two status variables for “voltage absence for three phases” or “voltage presence for three phases” (see diagrams).

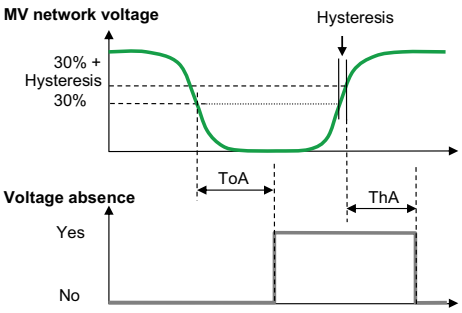
The variable “Voltage presence for HMI", that is displayed on the Head Unit web pages, is a combination of “presence OR not absence”.

For steady-state conditions, this variable is true if at least one phase is present.

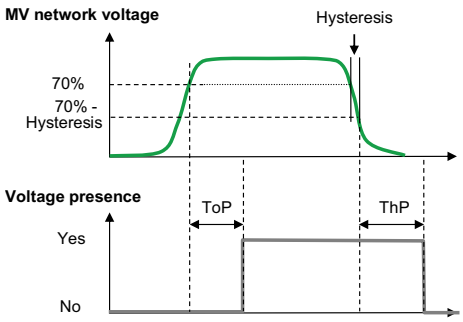
For transient conditions, the value depends on the operate delay times and hold delay times.

Note that the voltage presence thresholds are common with those configured in the **Fault indication/Voltage presence** page.

Detection of MV voltage absence from the measures



Detection of MV voltage presence from the measures



Front panel voltage indication parameter setting:

Parameter	Default	Configuration range	Description
Voltage absence (parameter available only for the case Voltage presence source = Measured)			
Start threshold (%)	30	10-100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, below which the MV network voltage will be considered to be absent. **NOTE:** Configure the threshold taking into account hysteresis (6%). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must be below the **Start threshold** level to consider the MV network voltage to be absent.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to above the **Start threshold** level to consider the MV network voltage to be not absent (to define the delay to be configured, take into account hysteresis: 6%).
Voltage presence (parameter available only for the case Voltage presence source = Measured)			
Start threshold, (%)	50	10-100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, above which the MV network voltage will be considered to be present. **NOTE:** Configure the threshold taking into account hysteresis (7%). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must remain above the **Start threshold** to validate the overvoltage detection.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to below the **Start threshold** level to consider the MV network voltage to be not present (to define the delay to be configured, take into account hysteresis: 7%).
Front panel indication			
Voltage presence source	Digital input	• Measured • Digital input	Choice of source for indicating voltage presence/absence on the front panel of the SC150/SC160 module: • Measured: voltage measurement taken by the voltage sensors. • Digital input: digital input DI6 ("MV Presence") on the SC150/SC160 9-way connector. This digital input is typically connected to an external voltage relay installed in the MV cubicle (for example. VD23).
Number of absent phases to report overall absence	All	• Any • All	• If the option is **All**, the three phase must be absent to declare an overall voltage absence. • If the option is **Any**, one single phase (any of them) voltage absence is enough to have an overall voltage absence.

NOTE: To get the voltage absence and the voltage presence at the same time, **Voltage absence operate delay time** and **Voltage presence hold delay time** parameters must be set up with the same value.

Active Overpower

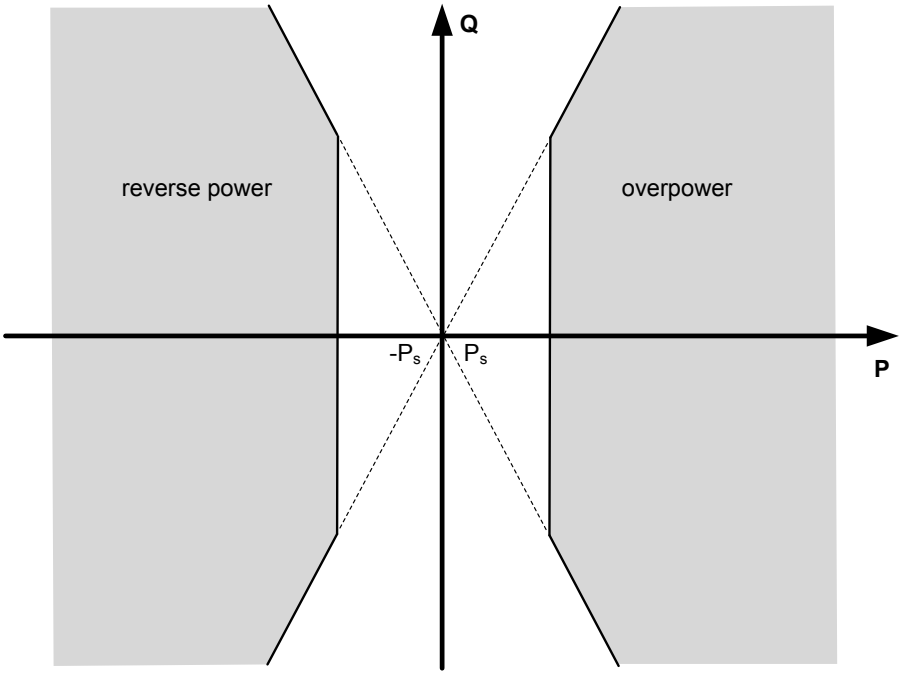
Access via **SC0x > Settings > Active Overpower** page.

The indication **Active Overpower** is based on ANSI 32P standard, “Directionnal active overpower”.

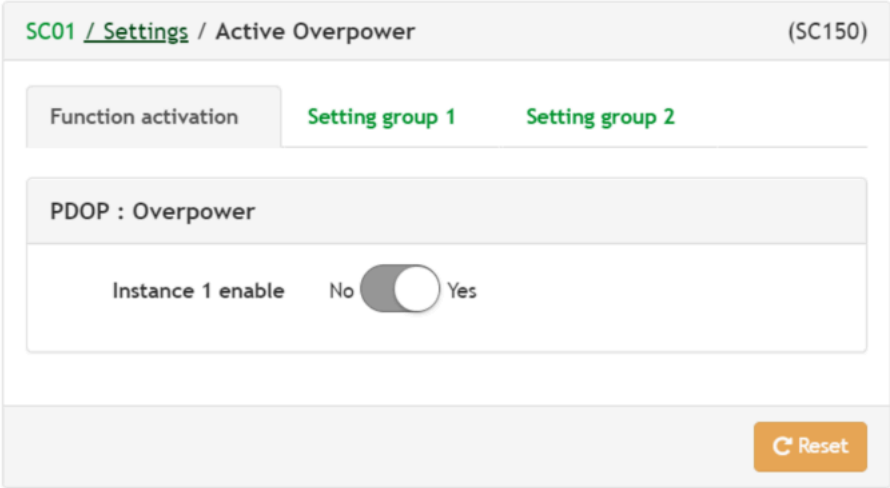
This is a two-way indication based on calculated active power, for the following applications:

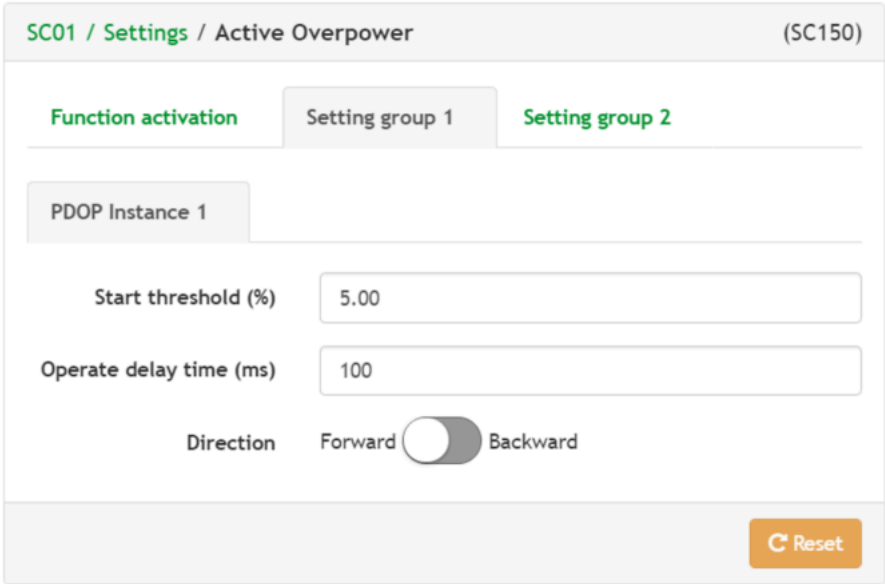
- active overpower (or maximum active power) to detect overloads and allow load shedding
- reverse active power to detect:
  - power injection from distributed production if the measure is done on transformer incomer
  - abnormal power flow if the measure is done on the feeder (MV line switchgear).

The indication 32 P is triggered if the absolute value of the active power is greater than the threshold PS if the operation mode is maximum active power (lower than the threshold -PS) and if the ratio reactive power / active power (Q / P) is less than 32.



Setting **Active Overpower** indication:





Parameter	Default	Configuration range	Description
Instance 1 enable	**No**	• Yes • No	Instance activation
Start threshold	**5 %**	1% to 120 % (increment = 0.1 %)	Percentage of the apparent power that the active power must reach to trigger the function.
Operate delay time	**100 ms**	100 ms to 300000 ms	Period (in millisecond) within which the active power must be greater than the Start threshold level to consider the Overpower to be present.
Direction	**Forward**	Forward or backward	The mode of operation of the function. Forward for maximum active power. Backward for reverse active power.

Fault Current Detection Indication (FPI) and Tripping Protection on the SC160 Module

General

The SC150/SC160 is capable of detecting a fault current on any type of neutral system with or without the presence of distributed power on the MV or LV network.

Fault current Detection and Protection modes available:

- If **Tripping Protection** disabled (in **Global setting** menu), available modes:
  - **Indication only**
  - **FPI+Sectionalizer**
- If **Tripping Protection** enabled (in **Global setting** menu), available modes:
  - **Indication only**
  - FPI +**Tripping protection**

Fault current detection is based on the following international ANSI code standards:

- Phase overfault current detection or, detection and tripping protection (ANSI 50/51)
- Ground (earth) fault current detection or, detection and tripping protection (ANSI 50N/51N)
- Negative sequence overvoltage/broken conductor detection (ANSI 47)
- Neutral overvoltage detection, or detection and tripping protection (ANSI 59N)
- Directional phase overfault current detection or, detection and tripping protection (ANSI 67)
- Directional ground (earth) fault current detection or, detection and tripping protection (ANSI 67N)

Three ammetric fault current instances and two directional fault current instances, each with their specific settings and detection mode, can operate separately or simultaneously on the fault current detector and for each SC150/SC160 channel. The first instance that checks the fault current condition activates the detector and the corresponding indicator on the T300.

The ability to combine instances allows the T300 to adapt to the characteristics and type of protection used upstream in line with the MV network characteristics. This also enables adjustment based on the fault current values measured by the measurement sensors.
For example, one instance can be defined for overload detection (typically an IDMT curve) and another instance can be defined for short-circuit detection (typically a DT curve). See the resulting detection curve example opposite.

Each instance includes two groups of settings. These two groups correspond to two sets of thresholds and time delays that are typically linked to two upstream protection settings.
These two sets of thresholds can be useful for managing power supply source changeover, for example, in an MV loop with a dual power supply (e.g. changing over from a line supply to a generator or vice versa).
The settings group can easily be changed by a command to select group 1 or group 2 from the preset thresholds, without needing to reconfigure the T300. This is done in the **Monitoring & Control > Substation** page (see the corresponding section) or remotely from the SCADA system.

Fault Current Detector and Protection Tripping Logical Nodes on the SC160 Module

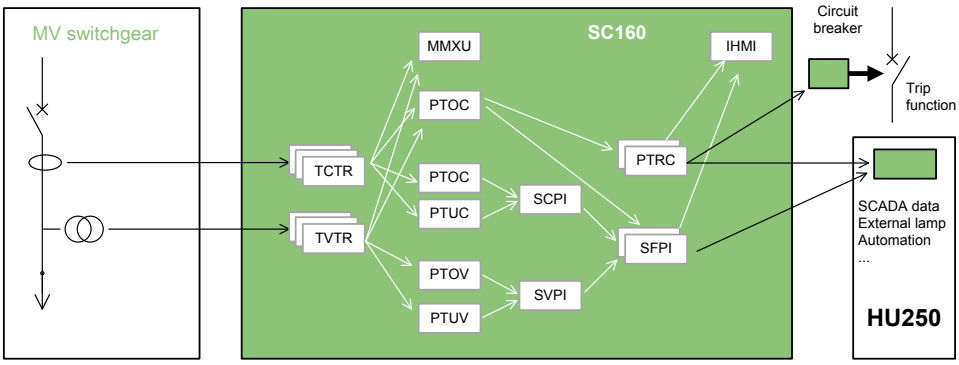
The T300 fault current detection algorithms are based on the ANSI standards as well as on a certain number of logical nodes (LN, as described in standard

IEC 61850) each with their own specific role. These are given for information purposes in the table below.

Logical Node (LN)	Category	Description
PhPTOC	PTOC	(ANSI 50/51) Phase overfault current detection indication and tripping protection
EfPTOC	PTOC	(ANSI 50N/51N) Ground (earth) fault current detection indication and tripping protection
SEfPTOC	PTOC	(ANSI 50N/51N) Sensitive Ground (earth) fault current detection indication
BcPTOV	PTOV	(ANSI 47) Negative sequence overvoltage / broken conductor detection
DirPhPTOC	PTOC	(ANSI 67) Directional phase overfault current detection indication and Directional phase overfault current detection indication and tripping protection
DirEfPTOC	PTOC	(ANSI 67N) Directional ground (earth) fault current detection indication and Directional ground (earth) fault current detection indication and tripping protection
AbsPTUC	PTUC	Current absence detection
PRSPTOC	PTOC	Current presence detection
AbsPTUV	PTUV	Voltage absence detection
PrsPTOV	PTOV	Voltage presence detection
SVPI	SVPI	Indication of voltage presence based on inputs from the PTOV and PTUV logical nodes
SCPI	SCPI	Indication of current presence based on inputs from the PTOC and PTUC logical nodes
SFPI	SFPI	Fault current indication calculation based on confirmation of fault current detection (SVPI and/or SCPI)
EfPTRC	PTRC	Protection trip conditioning. Combines the output for the earth fault PTOC instances (ANSI 50N51N and 67N)
PhPTRC	PTRC	Protection trip conditioning. Combines the output for the phase-overcurrent fault PTOC instances instances (ANSI 5051 and 67)
ClpPTUC	PTUC	Cold load pickup absence detection
ClpPTOC	PTOC	Cold load pickup presence detection
EfPCLP	PCLP	Cold load pickup for earth faults
PhPCLP	PCLP	Cold load pickup for phase faults
DPhPCLP	PCLP	Cold load pickup for directional phase faults
DEfPCLP	PCLP	Cold load pickup for directional earth faults
FltMMXU	FltMMXU	H1 current and voltage at time of fault for phases A, B, C and residual.

NOTE: PCLP is a non-standard extension to the logical nodes defined in IEC 61850-7-4.

Interconnection between the logical nodes used on the SC160 module



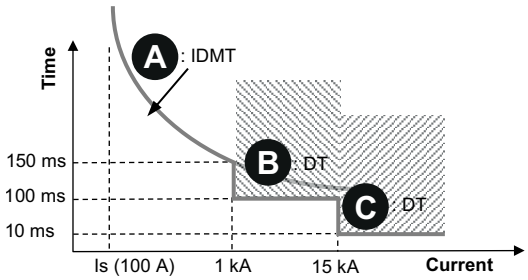
Fault Current Detection Indication (FPI) Principle

Counters are used for storing the type and number of fault currents on the MV network to provide statistical and analytical data on the quality of the network.

Internal variables, which can be consulted on the **Monitoring & Control > Data > Analog** page, allow you to save the latest current and voltage values before the fault current occurs on the network (values stored up to 3 seconds before the fault current appears).

> **NOTE:** In case of type B connection (2 phase CTs + 1 core balance CT), the only mean to detect a fault on phase B is to use a core balance current transformer and activate the earth fault detection.
> Monitoring phase B is done through I0 detection (2 or 3 instances available).
> To activate the earth fault detection in the EfPTOC and DefPTOC functions, set parameters in **SC0x > Settings > Non-Directional fault detection** Web server and/or **SC0x > Settings > Directional fault detection** Web server page.

Fault current detection curve with three instances:



Instance A: IDMT curve (overload)
Instance B: DT curve (short-circuit)
Instance C: DT curve (instantaneous short-circuit)

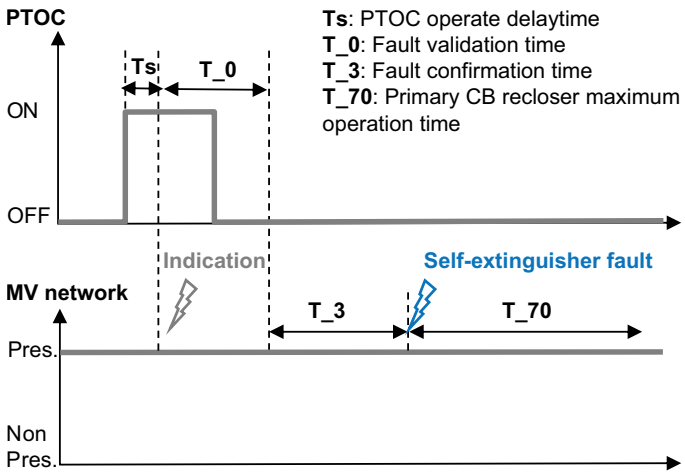
Different Fault Current Types Detected

The T300 can detect and indicate several types of fault current:

- **Self-extinguishing fault currents:**

  Detected fault currents that appear and disappear on the MV network, without tripping the upstream circuit breaker. This type of fault current is stored in the event log but not indicated by the LEDs on the T300.

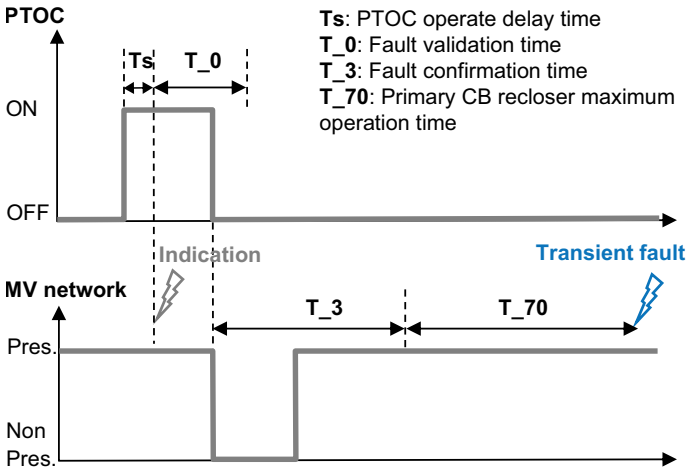
  Example of self-extinguisher fault current (the MV network power is not cut: the fault current is not validated. The delay T_70 is ignored).



- **Transient fault currents**

  Detected and validated fault currents on the MV network that are self-cleared in the first reclose cycle of the upstream circuit breaker or by a manual reset action.

  Example of transient fault current (the fault current is validated but network power is restored at the end of the T_3 or T_70 time delay).

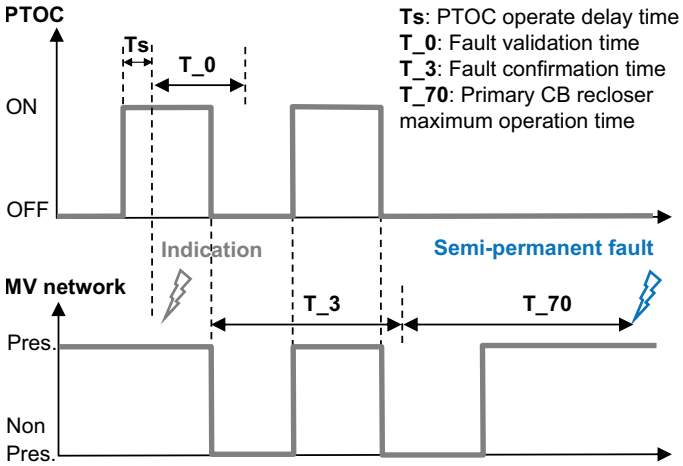


  NOTE: Self-extinguishing and transient fault currents are combined in a single transient fault current counter.

- **Semi-permanent fault currents:**

  Detected and validated fault currents that trip the upstream protection on the MV network, but that are self-cleared by the reclose cycles of the upstream circuit breaker (cycle 2 or cycle 3).

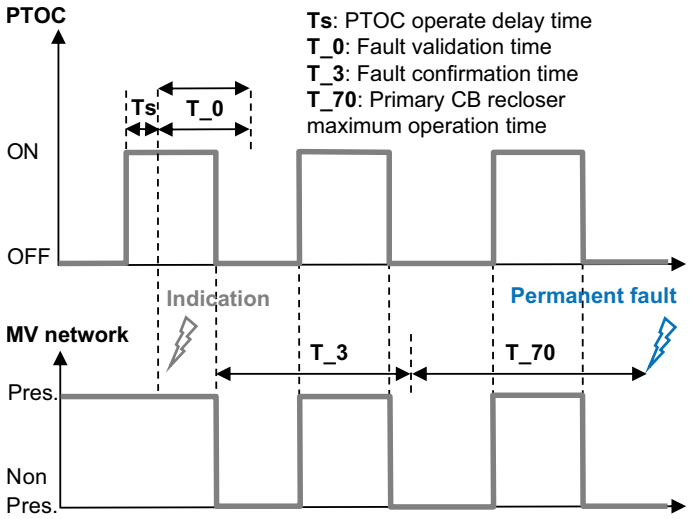
  Example of semi-permanent fault current, with reclose cycle (the validated fault current disappears before the end of the T_70 delay and network power is restored)



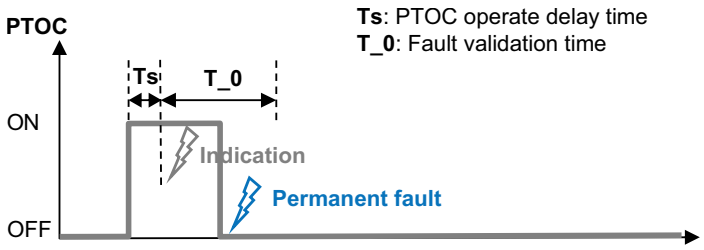
- **Permanent fault currents:**

  Detected and validated fault currents that trip the upstream protection permanently on the MV network (with or without reclose cycles). This means that the upstream circuit breaker remains open at the end of the reclose cycle time delay (T_70).

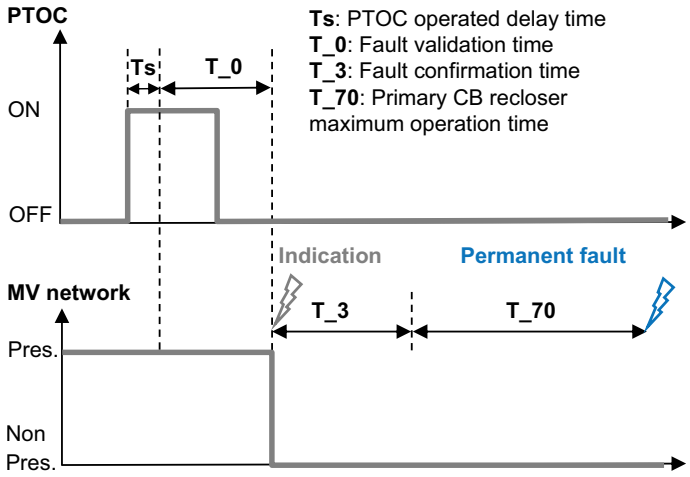
  Example of permanent fault current, with reclose cycle (the validated fault current has not been eliminated by the end of the cycle and the T_70 delay and network power is not restored)



  Example of a permanent fault current when there is no confirmation of network non présence (FPI network presence and confirmation mode=None). In this mode, the fault current is not validated by the non presence of the MV network, but only by detection and disappearance of the fault current during the time delay T_Valid.



  Example of a permanent fault current, without reclose cycle (the validated fault current has not been eliminated by the end of the T_70 delay and network power is not restored)



NOTE: When the fault current confirmed by the non presence of the MV network is not enabled by configuration (**FPI network presence and confirmation mode =None**), any detected fault current is only confirmed by the disappearance of the fault current, if this occurs during the confirmation time delay (T_Valid). In this mode, any confirmed fault current is considered to be a permanent fault current.

See the parameter settings table in the *Fault Current Indication* section for a detailed explanation of the time delays mentioned in these diagrams (T_0, T_3, T_70).

Fault current Acknowledgment Principle

The diagram below illustrates the principle for taking account of a detected fault current according to the current threshold (**Threshold value**) and configurable time delay (**Reset delay time** and **Operation delay time**) settings.

The time counter mentioned in the diagram is incremented whenever the current is greater than the fault current threshold and it remains at its most recent value if the current falls back below the threshold. The counter is then reset if the time for which the current remains below the detection threshold reaches the **Reset delay time** setting.

The following scenarios are possible based on the different phases in the diagram:

- Scenario **A**

  The measured current is not validated as a fault current since the duration for which the current is present above the fault current threshold (**Is**) is less than time **Ts**. The counter is reset at the end of time **Rdt** because the current remains below the threshold **Is** for a time longer than this delay

- Scenario **B**

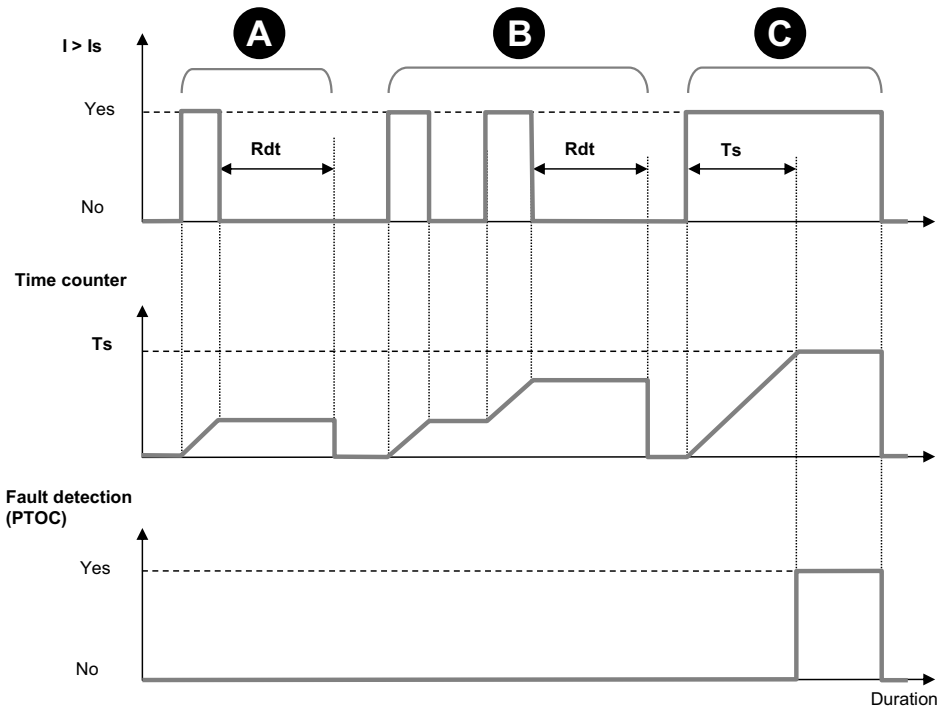
  The current greater than threshold **Is** appears twice in succession above threshold **Is** and increments the counter in stages. Time **Ts** is not reached, consequently the fault current is not validated. The counter is reset at the end of time **Rdt** because the current remains below the threshold **Is** for a time longer than this delay.

  NOTE: CT saturation phenomena may cause transient conditions for the current to fall below the threshold. The counting system described in scenario 2 allows this type of behavior to be filtered.

- Scenario **C**

  The current remains above the threshold **Is** long enough for the counter to be incremented until time **Ts** is reached. The current is validated as a fault current. As soon as the current falls below the threshold **Is**, time **Rdt** is no longer applicable once the fault current has been validated.

  NOTE: For definite time (DT) detection, time **Ts** remains the same, regardless of the value of the current Is. In contrast to this, in terms of the principle of inverse definite minimum time (IDMT) detection, time **Ts** varies according to the value of **Is**.



Rdt: Reset delay time

Is: Threshold value (fault current)

Ts: Operation delay time (for taking account of fault current)

General Configuration Rule

The general rules for configuring the settings thresholds on the T300 are as follows: The fault current detection settings used by the T300 must be configured on the T300 to correspond to those configured on the upstream circuit breaker on the MV network. The detection curves and the instances used must also be the same as those on the protection device for fault current behavior to be identical.

In theory, the fault current detection thresholds and time delays to be configured on the T300 must be slightly lower (e.g. by 20%) in relation to those of the upstream circuit breaker for the T300 to be able to detect the presence of the fault current before tripping the circuit breaker.
Additionally, for an ammetric fault current, the current configured on the T300 must be greater than the downstream capacitive current.

Fault current detector configuration example:

Circuit Breaker End	T300 End
I Max threshold = 350 A	Phase fault current threshold = 300 A
I0 threshold = 45 A	Ground fault threshold = 40 A
ACK I max. = 250 ms	ACK = 225 ms
ACK I0 = 250 ms	ACK = 225 ms

Fault Current Tripping Protection Principle

If the module is no longer supplied with power, the protection functions are no longer active and all the output relays are inactive.

NOTICE

HAZARD OF UNINTENTED EQUIPMENT OPERATION

- Check that the protection functions such as the operating mode and the watchdog relay wiring are compatible with your installation.
- Follow these instructions to help prevent from unwanted shutdown of the electrical installation.

Failure to follow these instructions can result in equipment damage.

Tripping Logic

The SC160 module provides a fault tripping protection function control logic dedicated to public network distribution protection. The trip event is issued according to selected protection functions.

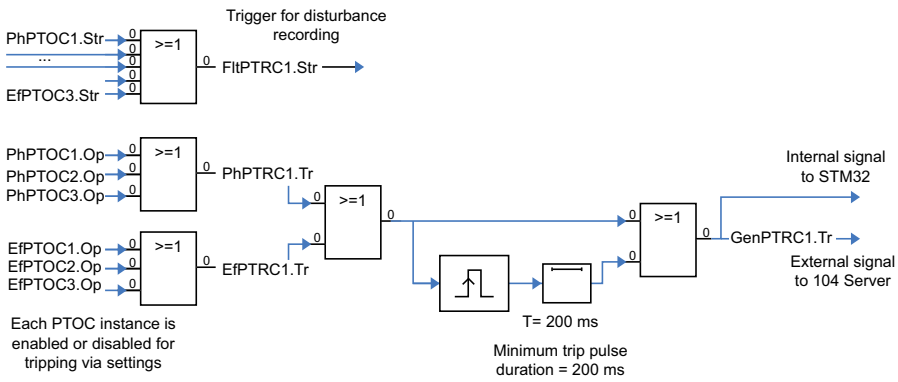
When the switch gear is closed it is possible that a fault condition exists that can cause an immediate trip. In this case, the trip event must take precedence over completing the “close” relay pulse. This requirement can be generalized so that regardless of whether a close operation was in progress or not, a Trip event must always deactivate the “close” relay at the same time as activating the “open” relay.

Tripping Description

The protection control logic does not use a CILO (interlocking) request for processing, since energy to trip in stored by the circuit breaker function itself. The Tr signal is set (activates the output relays) when at least one enabled PTOC operate bit is set. In the case of directional PTOCs, the Tr bit is set only if the direction is consistent with the direction configuration setting. The Tr is reset (releases the output relays) when all the enabled PTOC operate bits are reset, subject to a minimum pulse width.

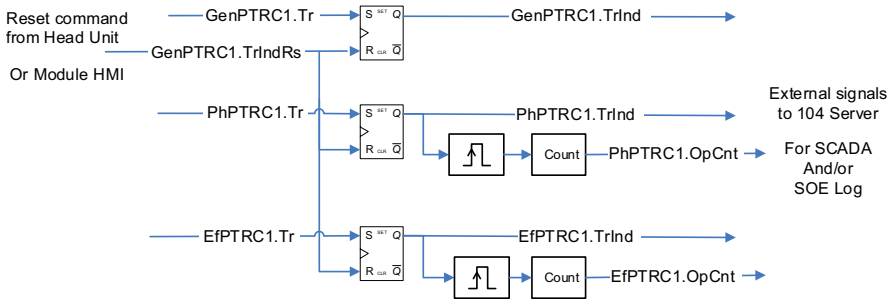
Internal tripping logic

The diagram below shows the internal tripping logic. Note that the trigger for disturbance recording is a logical OR of all the over-current pick-up detection elements regardless of whether they are enabled for tripping.



Latched trip indications and counters

The logic for the latched trip indications is implemented in the same process as the switch control and HMI (RTP Application).

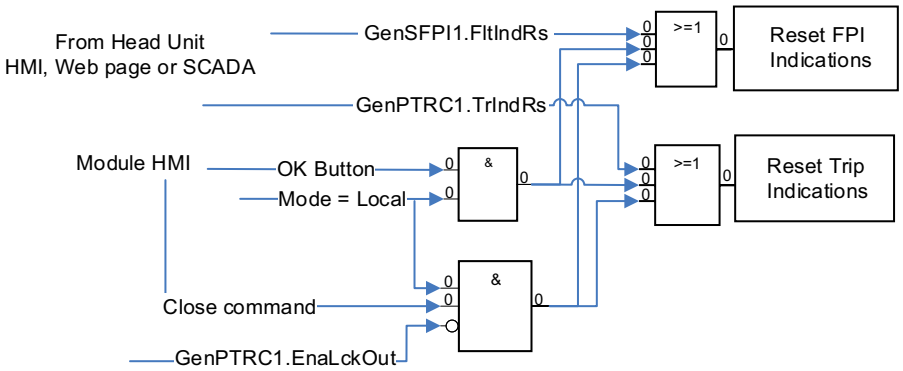


The latched trip indications are reset by any of the following signals:

- a command received from the Head Unit
- the module HMI (OK button), if the module is in local mode
- the module HMI Close command, if the module is in local mode and lockout is disabled.

Local reset of trip and FPI indications

Whether the protection mode is enabled or not, the last two signals also reset the FPI indications, in addition to the FPI indication reset command.

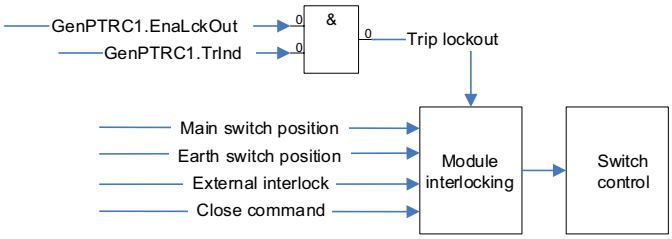


The "module reset latched trip indications" command (GenPTRC1.TrIndRs) resets the values of all the latched trip indications (xxxPTRC1.TrInd). Trip operation counts can be reset.

Latched trip indications, trip operation counts and trip direction are saved persistently. If the SC160 module reboots with a tripping lockout enabled, then tripping is set again at the start of the module.

Tripping Lockout Management

The SC160 general tripping function enables tripping lockout by latching the trip output contact and indication until a user reset occurs. This leads to the blocking of the switch closing and related control functions until a user reset occurs. This feature is configured by parameter setting.



When the lockout is enabled and a fault pickup occurs, all buttons remain enabled. Once the tripping is complete, the **ON** and **OFF** buttons are disabled. The **OK** button remains enabled to allow the lockout condition to be acknowledged.
The tripping lockout and tripping state determine whether remote commands received from the head unit are accepted or rejected. This is done using the same rules as for the manual commands from the buttons.

Lockout setting behaviour

Lockout enabled	Trip state	Switch state	LED User 2 Internal trip	Remote commands	Open/Close + OK buttons
No	Off	Any	Off	Open accepted Close accepted	Enable all buttons
No	Fault pickup - tripping imminent	(initial) Closed (final) Open	Orange / blink	Open accepted Close accepted	Enable all buttons
No	Trip latched	Any (expected) Open	Red / blink	Open accepted Close accepted	Enable all buttons
Yes	Off	Any	Off	Open accepted Close accepted	Enable all buttons
Yes	Fault pickup - tripping imminent	(initial) Closed (final) Open	Orange / blink	Open accepted Close accepted	Enable all buttons
Yes	Trip latched	Any (expected) Open	Red / blink	Open rejected Close rejected	Open/Close buttons disabled OK button action enabled
Yes	Acknowledged	Any	Off	Open accepted Close accepted	Enable all buttons

Tripping Acknowledgement (Reset)

In case of fault protection trip, if lockout is not enabled, the fault and trip indications is acknowledged when the CB is closed with a local command.

In case of fault protection trip, the tripping SC160 module can be acknowledged by the following actions:

- a remote reset from the SCADA via protocol (with T300 Generator configuration)
- the HU250 HMI **Reset** button (via Easergy Builder configuration)
- a long push on the **OK** button of the SC160 during 3 s in local mode. The fault detection indication is also reseted by the same way
- locally by closing the CB if tripping lockout is disabled. The fault detection indication is also reseted by the same way.
- by a reset from the HU250 Web server application

Fault Current Detection and Tripping Protection Curves on the SC160 module

Two main types of fault current detection are used on the T300:

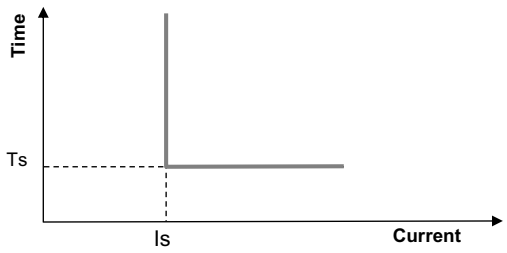
- Definite time (DT) detection
- Inverse definite minimum time (IDMT) detection

Different detection curves can be derived from these 2 types of fault current detection.

Definite Time (DT) Detection Curve

The basic principle behind this type of detection is summarized as follows:

- For a current less than or equal to the configurable fault current threshold Is (**Threshold value**), there is no fault current detection.
- For a current greater than **Is**, fault current detection takes place, but only if the current remains above this threshold for a time greater than or equal to the configurable acknowledge time **Ts** (**Operate delay time**).



Definite time (DT) detection curve

Inverse Definite Minimum Time (IDMT) Detection Curve on the SC160 Module

The basic principle behind this type of detection is essentially the same except for one difference in that the time taken to acknowledge the fault current depends on the value of the fault current:

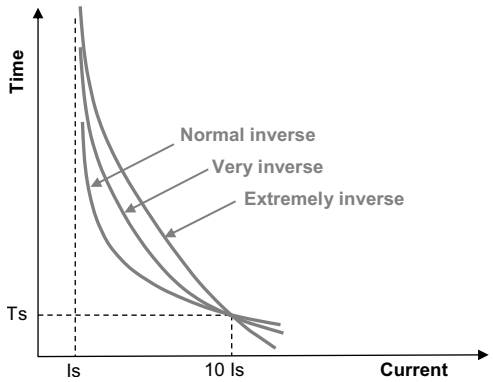
- For a current less than or equal to the configurable fault current threshold **Is** (**Threshold value**), there is no fault current detection.
- For a current greater than **Is**, the fault current acknowledge time depends on the value of the current. The higher the current, the shorter the acknowledge time and vice versa. This type of curve allows the fault current detector to react more swiftly to high currents.
- The acknowledge time is infinite for a current equal to **Is**.

The Is (Threshold value) parameter is set by configuration.

Time Ts (Operate delay time) is also a configurable parameter set by the user. It corresponds to the acknowledge time for a current value of 10 Is.

If the monitored value exceeds 20 times the set point of the measurement capacity of the SC160 module, the tripping time is limited to the value corresponding to the minimum value between the largest measurable value of SC160 (7In for CT=5A and 15,6In for CT=1A) and the 20 Is value defined in the IEC standard.

Both these values are common to all selected curve types. The equation of the curve is constructed on the basis of these 2 values. It corresponds to the vertical asymptote of the curves.



Several types of IDMT curve, defined on the basis of this principle and the IEC and IEEE standards, are used by the fault current detector.

3 IDMT curves are defined based on the IEC standard:

- IEC normal inverse time/A (SIT)
- IEC very inverse time/B (VIT)
- IEC extremely inverse time/C (EIT)

3 IDMT curves are defined based on the IEEE standard:

- IEEE moderately inverse time (MI) o o
- IEEE very inverse time (VI)
- IEEE extremely inverse time (EI)

See the Appendix for more information about these IDMT curves.

Conversion of Time Multiplier settings to Operating Time

The fault current detection function settings must be set up to be consistent with the settings for the circuit breaker protection at the feeder source.

Sometimes protection device settings are defined using a Time Multiplier setting and not an Operating Delay setting.

To convert a time multiplier setting (TMS) to Operating Time, use the following formula
Ts = TMS x β
Where β depends on the selected curve (see tables of equations for IEC and IEEE here after).

- Equation for IEC-Type IDMT Curves

  The equation is similar for each IEC IDMT curve except for the parameters:

$$t_d(I) = \frac{A}{\left(\frac{I}{I_S}\right)^P - 1} \times \frac{T}{\beta}$$

  Where:

  - $t_d(I)$ = Fault current detection time according to the current value (in seconds). Equivalent to Ts
  - I = Measured current value
  - A, p, ß = Parameters defined by the IEC standard (see table below)
  - Is = Fault current detection threshold value (configurable **Threshold value**)
  - T = Time delay value at 10 Is.

Curve Parameters	A	p	ß
Normal inverse time/A	0.14	0.02	2.9709
Very inverse time/B	13.5	1	1.5
Extremely inverse time/C	80	2	0.8081

NOTE: The letters A, B, and C associated with the IEC curves define the category of a curve. The power "p" defined in the equation is used to classify a curve into 1 of 3 the categories according to the following criteria:

Category	p
A	p ≤ 0.5
B	0.5 ≤ p ≤ 1.5
C	p ≥ 1.5

- Equation for IEEE-Type IDMT Curves

  The equation is similar for each IEEE IDMT curve except for the parameters:

$$t_d(I) = \left(\frac{A}{\left(\frac{I}{I_S}\right)^P - 1} + B\right) \times \frac{T}{\beta}$$

  Where:

  - $t_d(I)$ = Fault current detection time according to the current value (in seconds). Equivalent to Ts
  - I = Measured current value
  - A, B, p, ß = Parameters defined by the IEEE standard (see table below)
  - Is = Fault current detection threshold value (configurable **Threshold value**)
  - T = Time delay value at 10 Is.

Curve Parameters	A	B	p	ß
IEEE moderately inverse time	0.0515	0.114	0.02	1.20676
IEEE very inverse time	19.61	0.491	2	0.68908
EE extremely inverse time	28.2	0.1217	2	0.40548

Inrush Filter

A filter for detecting transformer inrush current can be enabled on the T300 to help prevent spurious fault currents being detected on the MV network.

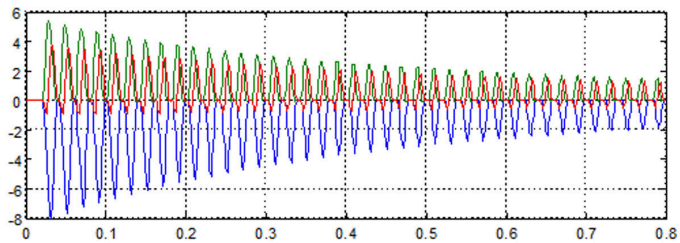
A current peak may occur on power-up of the MV network due to energization of the transformers and saturation of the phase CTs installed on the network. These current peaks may activate the fault current detectors falsely by tripping the configured thresholds.

To avoid this phenomenon, an algorithm is used to discriminate fault currents from transformer inrush currents on network power-up.

The algorithm for detecting the transformer inrush phenomenon is based on an analysis of the ratio between the second harmonic distortion and the fundamental current on the 3 network phase currents. The inrush filter becomes active when a high proportion of second harmonics are detected.

The inrush filter is only possible for ANSI 50/51, ANSI 50N/51N, and ANSI 67 type detection, and for all instances.

Example of inrush current with 2nd harmonic content on transformer magnetization:



Harmonic Restraint Tab

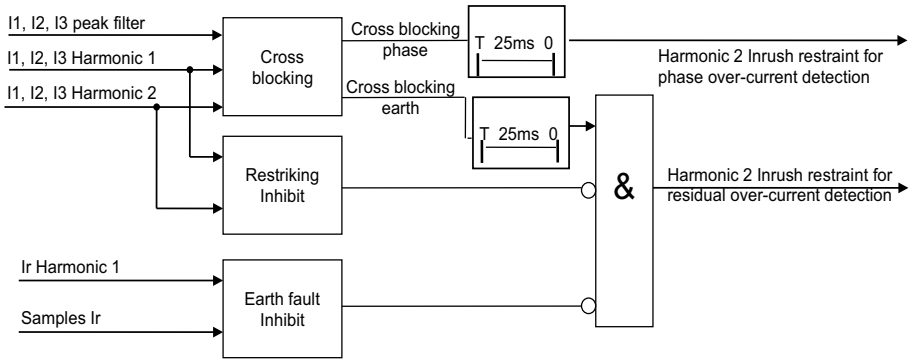
When a feeder is energized after a long outage, most connected devices draw a significant inrush current. The inrush current may be greater than the overcurrent or earth fault overcurrent settings. To reduce the risk of unwanted tripping, the

function identifies an inrush current and provides a signal which can be used for blocking low stage of protections.

There are two inrush restraint outputs:

- one for blocking the wrong residual current on inrush current when a feeder is energized
- one for blocking the over-current on inrush current when a feeder is energized.

Block Diagram



The 25ms time delay aims to avoid unwanted activation of the inrush restraint at the fault occurrence: when a fault occurs (single phase-to-ground, phase-to-phase or 3 phases short-circuit) the inrush restraint might rise up transiently and could delay the overcurrent protection functions when they are set to instantaneous.

Cross Blocking

The quadratic harmonic 2 is used to do a cross blocking on inrush currents when a feeder is energized.

Inrush restraint for phase overcurrent:

The Inrush restraint for phase overcurrent protection is inhibited in the following conditions:

- Current is lower than the minimum setting of ANSI 50/51 protection
- Current is higher than min(Iscmin/2,10In) or min(Iscmin/2,4In). In case of short-circuit current, current transformers might saturate. This saturation creates high Harmonic 2 rate which can activate the H2 inrush restraint and block unexpectedly the overcurrent protection tripping. In order to avoid this blocking, H2 restraint is inhibited when current is higher than 0.5 Iscmin of the installation (customer setting).

  When 0.5 x Iscmin is higher than 10 In or 4 In (maximum settings of ANSI 50/51 protection), the current seen by the protection might be lower than 0.5 Iscmin (because of CT saturation) and the H2 restraint could not be inhibited. In order to help insure the correct inhibition, the H2 inrush restraint is inhibited when the measured current is higher than 10 In or 4 In. This value of 10 In or 4 In helps ensure a correct detection of short-circuit current up to 25 kA with CT saturation.

$$If \;\; I1_{H1}^2 + I2_{H1}^2 + I3_{H1}^2 > 3 \bullet (0.006)^2 In^2$$

$$and\ if$$

$$\max(I1_{H1}, I1_{peak\ filter}, I2_{H1}, I2_{peak\ filter}, I3_{H1}, I3_{peak\ filter}) < \min(\frac{Isc_{\min}}{2}, 10In\ or\ 4In)$$

$$then$$

$$T_Q = \frac{I1_{h2}^2 + I2_{h2}^2 + I3_{h2}^2}{I1_{h1}^2 + I2_{h1}^2 + I3_{h1}^2}$$

$$else$$

$$TQ_{Phase} = 0$$

$$End$$

When TQphase is higher than (Phase H2 threshold)², the phase cross blocking is set.

NOTE:

- For type B acquisition, I2 is considered as equal to 0.
- For type B acquisition, I1²+I3² is compared to 2x0.006²In².

Inrush restraint for earth overcurrent:

The Inrush restraint for earth overcurrent protection is inhibited if current is lower than the minimum setting of ANSI 50N/51N protection.

$$If \;\; I1_{H1}^2 + I2_{H1}^2 + I3_{H1}^2 > 3 \bullet (0.006)^2 In^2$$

$$then$$

$$T_Q = \frac{I1_{h2}^2 + I2_{h2}^2 + I3_{h2}^2}{I1_{h1}^2 + I2_{h1}^2 + I3_{h1}^2}$$

$$else$$

$$TQ_{earth} = 0$$

$$End$$

When TQearth is higher than (Earth H2 threshold)², the earth cross blocking is set.

NOTE: The H2 restraint for earth protection must not be inhibited when the current is higher than min(Iscmin/2,10In) or min(Iscmin/2,4In). In case of phase-to-phase fault, the three phases CT can saturate differently and create false zero sequence current. As a result, it is necessary to keep the H2 restraint dedicated for earth protection activated. Cases of phase-to-earth fault:

- Either the fault current is low (it is generally the case in MV depending on the neutral earthing system): in this case the phases CT will not saturate and the H2 restraint will not be activated.
- Or the fault current is high but on one phase only. In this case, there is a potential CT saturation for the faulty phase. The computation of the H2 rate per phase will avoid the activation of the H2 restraint.

Restriking Earth Fault Inhibit

On restriking earth fault, the harmonic 2 ratio is high only on one phase.

So to discriminate inrush currents from restriking earth fault we use the harmonic ratio on each phase, to inhibit the cross blocking inrush restraint.

$$If \quad Ix_{h1}^2 > (0.006)^2 In^2 \qquad for\ x = 1\ to\ 3$$

$$then \quad T_x = \frac{Ix_{h2}^2}{Ix_{h1}^2}$$

$$else \quad T_x = 0$$

$$End$$

Restriking_Inhibit = (T1 > 0.04) AND (T2 < 0.01) AND (T3 < 0.01)

Restriking_Inhibit = Restriking_Inhibit OR [(T2 > 0.04) AND (T1 < 0.01) AND (T3 < 0.01)]

Restriking_Inhibit = Restriking_Inhibit OR [(T3 > 0.04) AND (T1 < 0.01) AND (T2 < 0.01)]

Earth Fault Inhibit

When an earth fault is present when the feeder is energized, we compare the form factor of the residual current to discriminate inrush currents from earth fault.

$$If\ \max\left(|x_i|_{i=1}^{36}\right)^2 < 4 \cdot \mathrm{mod}^2(I_r)$$

$$then$$

$$Earth_fault_inhibit=1$$

$$else$$

$$Earth_fault_inhibit=0$$

$$End$$

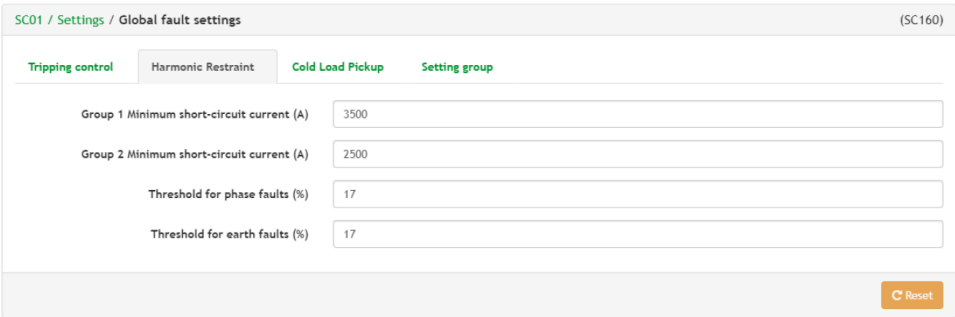
The function

$$\max\left(|x_i|_{i=1}^{36}\right)$$

calculates the maximum value of absolute samples of residual current on one cycle.

Parameter Settings

Access via **SC0x > Settings > Global fault settings** page, **Harmonic Restraint** tab.



Parameter	Default	Configuration range	Description
Group 1 Minimum short-circuit current (A)	3500	From In to 999 kA	Define the value of the minimum short-circuit current of the installation for the setting group 1
Group 2 Minimum short-circuit current (A)	2500	From In to 999 kA	Define the value of the minimum short-circuit current of the installation for the setting group 2

Parameter	Default	Configuration range	Description
Threshold for phase (%)	17	From 5% to 50%	Define the H2 rate for which the phase inrush restraint is activated
Threshold for earth (%)	17	From 5% to 50%	Define the H2 rate for which the earth inrush restraint is activated

Cold Load PickUp Function

The Cold Load PickUp Function avoids nuisance tripping of the overcurrent protection (ANSI 50-51/ ANSI 50-51N/ ANSI 67/ ANSI 67N) during energization after a long outage. It is used to increase the protection set point temporarily. The Cold Load PickUp function is only available on the SC160 module

Depending on the installation characteristics, these operations can generate transient inrush currents likely to exceed the protection set points.

These transient currents may be due to:

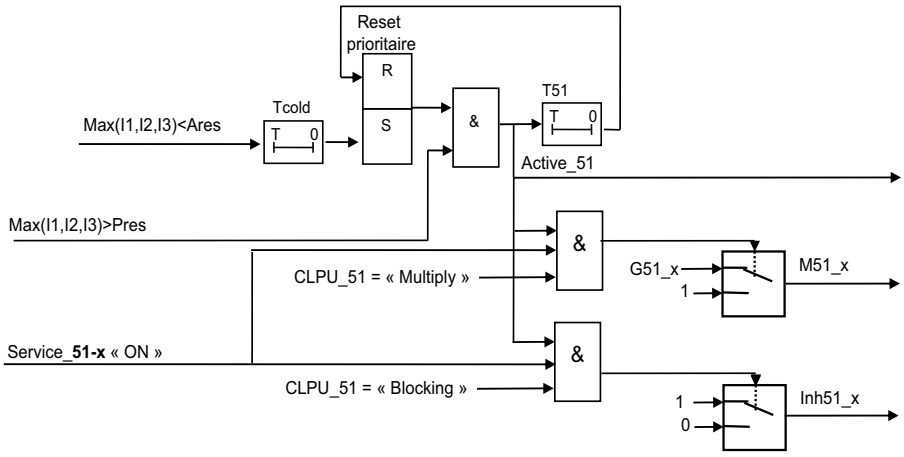
- simultaneous resetting of all the loads in an installation (air conditioning, heating, etc.)
- the power transformer magnetizing currents
- the motor starting currents

In normal circumstances, the protection settings are defined so as to avoid tripping due to these transient currents. However, if this rule results in inadequate sensitivity levels or delays that are too long, this function can be used to increase or inhibit set points temporarily after energization. This function helps to keep a good level of protection sensitivity, regardless of the constraints affecting energization.

NOTE: In the rest of this manual, this function is referred to by its abbreviation CLPU.

Block diagram for CLPU function dedicated for ANSI 50/51 protection – instance x, setting group 1

This block diagram is executed each half cycle (10 ms at 50 Hz - this value is likely to evolve).



The same logic is applied for setting group 2 and for ANSI 67 protection, ANSI 67N protection and detection and ANSI 50N/51N protections.

The action of the CLPU for Instance x, setting group 1 is considered if the following conditions are true:

- CLPU function in service for instance x – setting group 1
- Current absence during more than **Tcold** followed by current presence.

The CLPU action is reset at the end of **T51_x** time delay.

The CLPU modifies the current threshold of the protection if CLPU_51 = “Multiply”

The CLPU inhibits the protection if CLPU_51 = “blocking”.

NOTE: The CLPU must not be activated during a recloser cycle in order to keep the correct sensitivity of the protections in presence of fault. To do so, a **Tcold** time delay higher than the longer time delay used for the recloser slow cycle must be specified.

Setting Cold Load PickUp (CLPU) function

The **Cold Load Pickup** function avoids unwanted trip in case of electrical network reenergizing creating transient inrush current.

When a feeder is energized after a long outage, most connected devices draw a significant inrush current. The inrush current may be greater than the overcurrent or earth fault settings, thus causing mal-operation. To help prevent unwanted tripping, the CLPU function automatically increases the settings for a selectable time.

The **Cold Load Pickup** function is configured for the following protections:

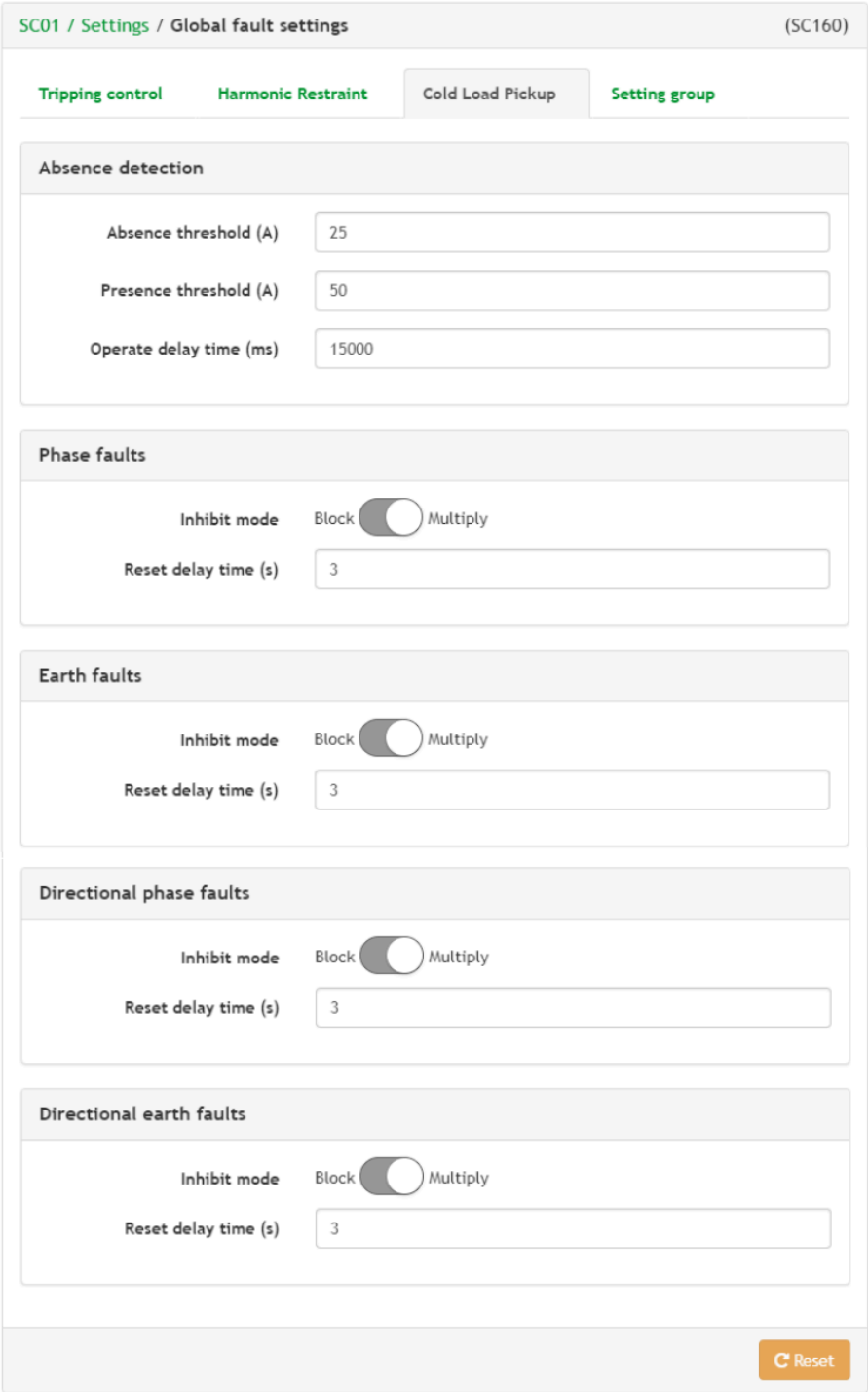
- Phase Fault Protection (ANSI 50/51)
- Earth Fault Protection (ANSI 50/51 N)
- Directional Phase Fault Protection (ANSI 67)
- Directional Earth Fault Protection (ANSI 67N)

The **Cold Load Pickup** function is enabled for each fault detection and setting group with **Cold load pickup enabled** parameter, described in later sections.

Setting the Cold Load Pickup function

1. In **Setting group** tab, specify the following parameters for each Phase fault current or Earth fault current protection:
   - **Cold Load Pickup enabled**, **Yes** or **No** button
   - **Cold Load Pickup Multiplier**

2. Set parameters in **SC0x > Settings > Global Fault settings** page, **Cold Load Pickup** tab:



Absence detection global parameters			
Parameter	**Default**	**Configuration range**	**Description**
Absence threshold (A)	**0.05 In**	From 0.01 In to In	Define the maximum current value below which the current is considered as absent. This value must be lower than the **Presence threshold** value.
Presence threshold (A)	**0.1 In**	From 0.01 In to In	Define the minimum current value to consider the current as present.
Operate delay time (ms)	**15,000**	100–300,000 (increment = 1)	Define the minimum time of current absence before activating the CLPU.

Parameters for each fault current protection type (ANSI 50/51, ANSI 50/51V, ANSI 67, ANSI 67N)			
Parameter	**Default**	**Configuration range**	**Description**
Inhibit mode	**Multiply**	• Block • Multiply	Define the action of the CLPU for protection.
Reset delay time (s)	**3 s**	1–7,200 (increment = 1)	Define the activation time of the CLPU for all instances and all setting groups of a protection.

Fault Event

The magnitudes of the values of the first harmonic (H1) currents FltMMXU1.A and voltages FltMMXU1.phsV during the fault are saved and are reported to the Head Unit for logging or reporting to SCADA.

The phase currents at time of fault are the magnitudes of the H1 values (or the filtered crest if it is greater) used by the phase over-current PTOCs (ANSI 50/51 or 67 functions) in the cycle that changes the operate status (delayed bit).

The residual current at time of fault is the magnitude of the H1 values (or the filtered crest if it is greater) used by the earth fault PTOCs (ANSI 50N/51N or 67N functions) in the cycle that changes the operate status (delayed bit).

If current values (for phase) exceeds the measurement range for the phase currents, then the over-range quality flag is set.

- Phase current maximum: 20 In (when CT = 1A)
- Phase current maximum: 7 In (when CT = 5A)

If current value of I0 (calculated or measured) exceeds the measurement range, then the over-range quality flag is set.

- Residual current maximum: 7 In (when I0 is calculated)
- Residual current maximum: 7 In0 (when I0 is measured)

The phase voltages at time of fault are the magnitudes of the H1 values of the phase voltages during the cycle where the first PTOC operates.

The residual voltage at time of fault is the magnitude of the H1 value of the residual voltage during the cycle where the first PTOC operates.

If voltage values exceed the measurement range, then the over-range quality flag is set.

- Phase voltage maximum: 4 Un
- Residual voltage maximum: 4 Un

If one channel is not available, because of the configuration of CT sensors, its value is fixed to 0.

Voltage channels (line to neutral) are always saved. When the VT sensor is not wired (single phase) or is wired to measure a line to line voltage, the calculated line to neutral voltage is used.

An additional variable FltMMXU.ClcExp is needed to signal to the Head Unit that the other data (voltages and currents harmonic 1) is ready. This variable is published in the same execution cycle than the publication of the current and voltage values.

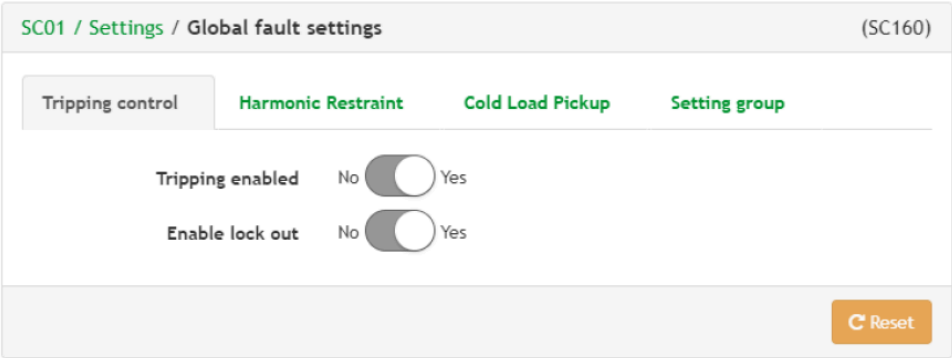
Fault Current Detection Indication and Tripping Settings on the SC160 module

Here is an overview of the possible settings for fault current detection and protection:

Menus in Settings page	Fault current type detection menus	Available protection instances	Process mode selected for each protection instance in Function activation tab	2 parameter setting groups in the ND fault detection / Dir. Fault protection pages possible for each instance
Global setting >>**Tripping control** tab >>**Tripping disabled** button(1)	Non directional Fault current	PhPTOC (50/51)	**None**	Setting group 1 or Setting group 2
			Indication only	
			FPI + Sectionalizer	
		EfPTOC (50N/51N)	**None**	
			Indication only	
			FPI + Sectionalizer	
	Directional Fault current	DPhPTOC (67)	**None**	
			Indication only	
			FPI + Sectionalizer	
		DEfPTOC (67N) Indication	None	
			Indication only	
			FPI + Sectionalizer	
Global setting >>**Tripping control** tab >>**Tripping enabled** button	Non directional Fault current	PhPTOC (50/51)	**None**	Setting group 1 or Setting group 2
			Indication only	
			Tripping	
		EfPTOC (50N/51N)	**None**	
			Indication only	
			Tripping	
	Directional Fault Current	DPhPTOC (67)	**None**	
			Indication only	
			Tripping	
		DEfPTOC (67N) Tripping	**None**	
			Indication only	
			Tripping	
(1) In gray rows, functions available when tripping is disabled.				

Tripping Control Tab

Accessed via **SC0x > Settings > Global Fault settings** page.



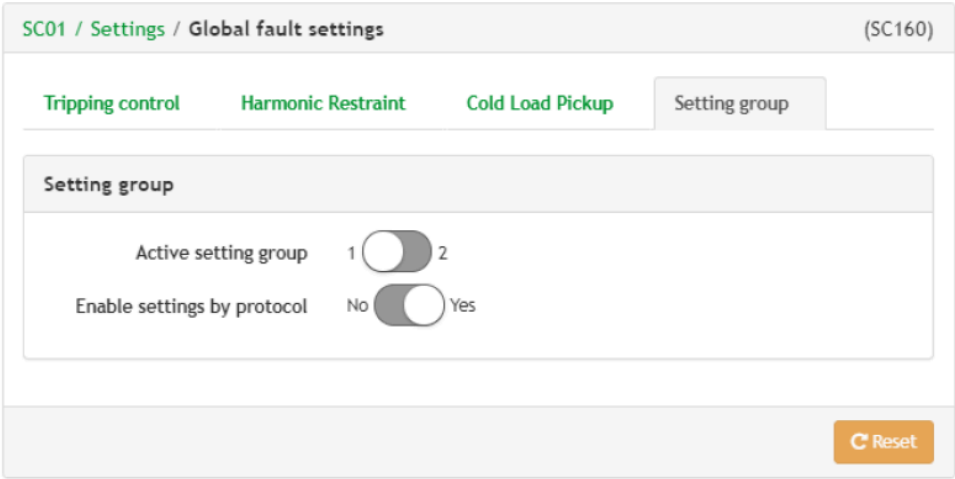
Parameter	Default	Configuration range	Description
			Voltage absence
Tripping enabled	**Yes**	• Yes • No	Defines whether tripping protection mode is enabled or not for all fault protections. “Yes” to enable tripping protection.
Enable lock out	**Yes**	• Yes • No	Defines if tripping lockout function is enabled. "Yes" to enable Tripping lock out. Refer to Tripping Lock Out Management, page 315

Setting Group Tab

In the **Setting Group** tab you can select the parameter setting group to apply for the fault detection type. Two groups of parameter setting can be defined, and you can switch from Setting 1 to Setting 2 as necessary.

In this tab you can also choose if settings can be changed by protocol or not.

Accessed via **SC0x > Settings > Global Fault settings** page, **Setting group** tab



Non-Directional Fault Current Detection and Tripping Protection Description

In this section:

- ANSI 50/51 Phase (PhPTOC) Overcurrent Description, page 329
- ANSI 50N/51N Earth Fault (EfPTOC) and Sensitive Earth Fault (SEfPTOC) Description, page 330
- Non-Directional Fault Current Detection and Tripping Protection Parameter Setting, page 332

ANSI 50/51 Phase (PhPTOC) Overcurrent Description for SC160 Module

This fault current detection is based on the fundamental component of the rms current on the 3 phases (types A and D CT connection configurations) and on the 2 phases (type B CT connection configuration). Detection is activated if 1, 2, or all 3 phases reach the operating threshold. Fault current detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the table below.

2 groups of settings are available. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the **Substation** page in the Web server
- Remotely via the SCADA system

The table below describes the ANSI 50/51 characteristics for both uses on SC150 and SC160 modules. Specificities for each module are indicated.

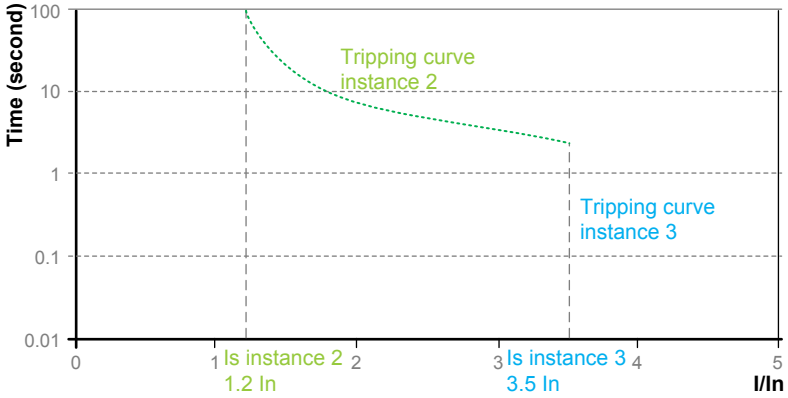
Each instance has its own specific parameters for each group of settings. The 3 instances can operate simultaneously with different settings.

<table>
<tr><th colspan="3">ANSI 50/51 Characteristics</th></tr>
<tr><td colspan="2">Number of instances</td><td>3</td></tr>
<tr><td colspan="2">Groups of settings</td><td>2</td></tr>
<tr><td colspan="2">Logical node name</td><td>PhPTOCx (x = instance number)</td></tr>
<tr><td colspan="2">Indication only</td><td rowspan="2">Indication of faulted phases A, B, C (*)
Phase fault detected: instance 1, 2, or 3
• No
• Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer.
• FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer.</td></tr>
<tr><td colspan="2">FPI + Sectionalizer</td></tr>
<tr><td colspan="2">Fault current tripping (only available on the SC160 module when Tripping protection is “enabled”).</td><td>Tripping on phase fault: instance 1, 2 and 3</td></tr>
<tr><th colspan="3">Parameter Setting (For Each Instance)</th></tr>
<tr><td rowspan="3">Instance activation</td><td>Instance 1</td><td rowspan="3">• No
• Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer.
• FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer.
• Fault current tripping (only available on the SC160 module when Tripping protection is “enabled”).</td></tr>
<tr><td>Instance 2</td></tr>
<tr><td>Instance 3</td></tr>
<tr><td rowspan="3">Detection mode (curve type)</td><td>Instantaneous (on SC160 module)</td><td rowspan="2">Instance 1, 2, and 3</td></tr>
<tr><td>IEC definite time (DT)</td></tr>
<tr><td>Inverse definite minimum time (IDMT):
• IEC normal inverse time/A
• IEC very inverse time/B
• IEC extremely inverse/C
• IEEE moderately inverse time
• IEEE very inverse time
• IEEE extremely inverse time</td><td>Instance 1, 2, and 3</td></tr>
</table>

Parameter Setting (For Each Instance)		
Overcurrent threshold	DT or Instantaneous	See parameter settings table, page 332 .
	IDMT	
Acknowledge time	DT or Instantaneous	
	IDMT	
Reset time	DT or Instantaneous	
Inrush filter	All instances	Active or inactive
Cold load pickup	All instances	See parameter settings table, page 332 .
(*): Phase B fault indication is not available with type B CT connection.		

Example detection curve with several instances:

- Instance 1: Inactive:
- Instance 2: Active/IEC inverse time/A (IDMT)
- Instance 3: Active/IEC definite time (DT)



ANSI 50N/51N Earth Fault (EfPTOC) and Sensitive Earth Fault (SEfPTOC) Description for SC160 Module

Ground fault detection is based on residual current values measured by a core balance CT (type B, C or D connection configuration) or calculated from the currents of all 3 phases (types A and D connection configuration).
Type D connection configuration allows 2 ways of detecting ground fault currents:

- By measuring the current from the 3 p hase CTs
- By measuring the current from 1 core balance CT (for greater accuracy)

  NOTE: It is still possible to define by configuration a ground fault measurement obtained by adding the 3 phase CTs together, even if a core balance CT is available, knowing that this does not really make sense, as this configuration does not provide the most accurate results.
  Detection is activated if the residual current reaches the threshold defined by configuration.
  This is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the table below.

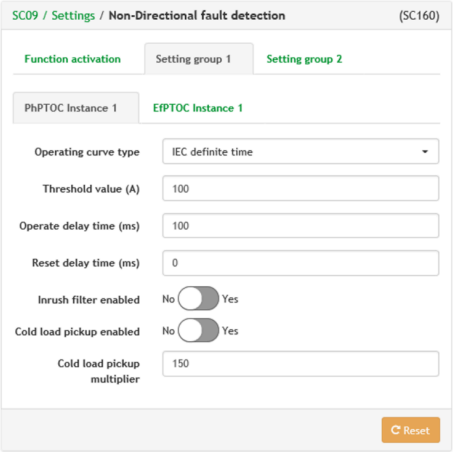
ANSI 50N/51N Characteristics	
Number of instances	3 available instances for EfPTOC (capable of operating simultaneously with different settings) Only one instance available for SEfPTOC
Groups of settings	2
Logical node name	• **EfPTOC** (x = instance number) • **SEfPTOC**

ANSI 50N/51N Characteristics	
Fault current indication only	Earth fault detected Cross-country fault detected: instance 3 Generic phase fault indication Indication of faulted phases A, B, C (*) Phase fault detected: instance 1, 2, or 3 • No • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ingnored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer.
FPI + Sectionalizer	
Fault current tripping protection (only available on SC160 when Tripping protection is set Enabled)	Tripping on Phase fault: instance 1, 2 and 3
(*): Instance 3 is dedicated to detect high fault currents. There is no value in using the inrush filter in this case, since inrush currents can only be detected for lower fault currents.	

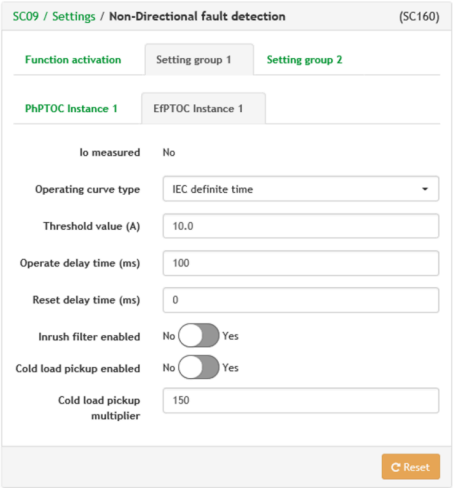
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Activation of the instance for detecting phase-to-phase fault currents • No • Indication only: the instance is used for fault detection, but not in the sectionalizer. A fault detected by the instance will be indicated, but ignored by the sectionalizer. • FPI + sectionalizer: the instance is used both by the FPI and the sectionalizer. • Fault current tripping (only available on the SC160 module when Tripping protection is “enabled”).
	Instance 2	
	Instance 3	
Residual current acquisition		Ires (sum of all 3 phases)
		I0 (directly from the core balance CT)
Detection mode (curve type)	Instantaneous	Instance 1, 2, and 3
	IEC definite time (DT)	
	Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	
Ground fault threshold	DT	See parameter settings table, page 332.
	IDMT	
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Inrush filter	All instances	Active or inactive
Cold load pickup	All instances	See parameter settings table, page 332.

Non-Directional Fault Current Detection and Tripping Protection Parameter Setting

Configuring a PhPTOC instance
Accessed via **SC0x > Settings > Non-directional fault detection**page ANSI 50/51



Configuring a EfPTOC instance
Accessed via **SC0x > Settings > Non-directional fault detection** page, ANSI 50N/51N



Parameters are the same in both **Indication only** or **Tripping** modes.

2 groups of settings can be defined. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the **Substation** page in the Web server
- Remotely via the SCADA system

Each instance has its own parameters for each group of settings. The 3 instances can operate simultaneously with different settings.

Parameter	Default	Configuration range	Description
Function Activation – PhPTOC: Phase Over-current			
Instance 1, 2 or 3 enabled	None	• None • Indication only • Tripping	• Indication only: Activation of instance 1, 2 or 3 for detecting phase-to-phase fault currents • Tripping: Activation of instance 1, 2 or 3 for detecting phase-to-phase fault currents and tripping protection **NOTE:** If Tripping is disabled, the option FPI+Sectionalizer is available instead.
Function Activation – EfPTOC: Earth Fault / SEfPTOC: Sensitive Earth Fault			
Instance 1, 2 or 3 enabled	None	• None • Indication only • Tripping	• Indication only: Activation of instance 1, 2 or 3 for detecting phase-to-phase fault currents • Tripping: Activation of instance 1, 2 or 3 for detecting phase-to-phase fault currents and tripping protection

Parameter	Default	Configuration range	Description
Setting Group 1 or 2 – PhPTOC Instance 1, 2, or 3			
Operating curve type	IEC definite time	• Instantaneous • IEC definite time • IEC normal inverse • IEC very inverse • IEC extremely inverse • IEEE extremely inverse • IEEE very inverse • IEEE moderately inverse	Choice of the type of standardized IEC or IEEE curve to apply to the selected instance for: • detecting (Indication only) phase-to-phase fault currents • and tripping protection (Tripping), for settings group 1 or 2.

Parameter	Default	Configuration range	Description
Threshold value (A)	100	• DT ◦ for Detection only from 0.02 In (or 2 A – highest value to be used) to 10 In ◦ for Tripping from 0.1 In (or 2 A – highest value to be used) to 10 In • IDMT ◦ for Detection only from 0.02 In (or 2 A – highest value to be used) to 2.4 In ◦ for Tripping from 0.1 In (or 2 A – highest value to be used) to 2.4 In (increment = 1)	Minimum threshold for detecting phase-to-phase fault currents, and tripping protection. The current must be detected above this threshold for a longer time than the Operate delay time to validate the presence of a fault.
Operate delay time (ms)	100	• DT: 0-300,000 ms for all instances • IDMT: 20-12,500 ms (increment = 1)	Minimum time for which the detected current must be greater than the phase-to-phase Threshold value to validate the fault current. Constraint: Depending Time curves are truncated at the minimum between the dynamic of acquisition (1) and 20 Is, and replaced by a DT curve. Depending Time curves are truncated for a delay lower than 20 ms and replaced by a DT curve.
Reset delay time (ms)	0	0-300000 ms (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the Operate delay time. For the period when the current is below the threshold, the Operate delay time maintains its value, as long as there is no reset. This time is incremented again if the current exceeds the threshold. This reset time is inactive once the fault current has been validated. Constraint: When reset time equal to 0, a Tmini reset time equal to 35 ms is used whatever the power frequency cycle, in order to limit the impact of the CT saturation
Inrush filter enabled	No	• Instance 1, 2 and 3: ◦ No ◦ Yes	Activation of the algorithm for detecting transformer inrush
Cold load pickup enabled	No	• Instance 1, 2 and 3: ◦ No ◦ Yes	Define if CLPU is enabled for ANSI50/51.
Cold load pickup multiplier	150 %	From 100 % to 999 %	Define the value of the multiplying factor applied on Is threshold for ANSI50/51.

Parameter	Default	Configuration range	Description
Setting Group 1 or 2 – EfPTOC / SEfPTOC Instance 1, 2, or 3			
Io measured	No	• Instance 1, 2 and 3: ◦ No ◦ Yes	Activation of the I0 current measurement by core balance CT for ground fault detection. If this option is not enabled, the residual current is calculated by adding together the currents from the 3 phase CTs. Note: This parameter is only configurable for a type D connection configuration with core balance CT.
Operating curve type	IEC definite time	• Instantaneous • IEC definite time • IEC normal inverse • IEC very inverse • IEC extremely inverse • IEEE extremely inverse • IEEE very inverse • IEEE moderately inverse	Choice of the type of standardized IEC or IEEE curve to apply to the selected instance for detecting zero sequence fault currents for settings group 1 or 2.

Parameter	Default	Configuration range	Description
Threshold value (A)	100	• DT ◦ 0.02 In - 10 In for I0 sum ◦ 0.008 In0 - 10 In0 for Io measured • IDMT ◦ 0.02 In - 1 In for I0 sum ◦ 0.008 In0 - 1 In0 for Io measured (*) (increment = 0.1)	Minimum threshold for detecting zero sequence fault currents. The current must be detected above this threshold for a longer time than the Operate delay time to validate the presence of a fault current.
Operate delay time (ms)	100	• DT: 0-300,000 ms for all instances • IDMT: 20-12,500 ms	Minimum time for which the detected current must be greater than the zero sequence Threshold value to validate the fault current.
Reset delay time (ms)	0	0-300,000 ms (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the Operate delay time. For the period when the current is below the threshold, the Operate delay time maintains its value, as long as there is no reset. This time is incremented again if the current exceeds the threshold. This reset time is inactive once the fault has been validated. Constraint: When reset time equal to 0, a Tmini reset time equal to 35 ms is used whatever the power frequency cycle, in order to limit the impact of the CT saturation.
Inrush filter enabled	No	• Instance 1, 2 and 3: ◦ No ◦ Yes	Activation of the inrush current filter function. **NOTE:** The inrush filter is only valid for an I0 current calculated using the sum of the 3 phase CTs.
Cold load pickup enabled	No	• Instance 1, 2 and 3: ◦ No ◦ Yes	Define if CLPU is enabled for ANSI50N/51N.
Cold load pickup multiplier	150-%	From 100 % to 999 %	Define the value of the multiplying factor applied on Is threshold for ANSI50N/51N.
(*) In corresponds to the nominal current at the CT primary (by default In = 500 A). In0 corresponds to the nominal current at the core balance CT primary (by default In = 500 A) if Io measured option is selected.			

Directional Fault Current Detection and Tripping Protection on the SC160

ANSI Detection Standards

Directional fault current detection uses the following ANSI detection standards:

- (ANSI 67) Directional phase overfault current detection
- (ANSI 67N) Directional ground (earth) fault current detection

Used Algorithms

According to the global tripping capability configuration (enabled/disabled), the SC160 uses the following algorithms:

- the same ANSI 67 algorithm for managing:
  - directional phase fault indication or
  - circuit breaker tripping capability

- different ANSI 67N algorithms for managing:
  - directional earth/ground fault indication or
  - circuit breaker tripping capability

  Both functions (ANSI 67N Detection and ANSI 67N Tripping) operate with the residual current measured with core balanced CT or computed from the three phases currents.

  With the current acquisition type D (3 phases CT and core balance CT) both residual current measured or computed can be selected.

  - Tripping capability enabled:

    The protection function (TRIP) and fault indication (FPI) use I0 vector projection. This projection method is suitable for radial feeders in resistive, isolated or compensated neutral systems.

    This method combines a transient criteria with a permanent criteria according to the settings, depending on the neutral system type.

    If **Tripping** Protection is enabled, the available modes are **Indication only** or **Tripping** protection.

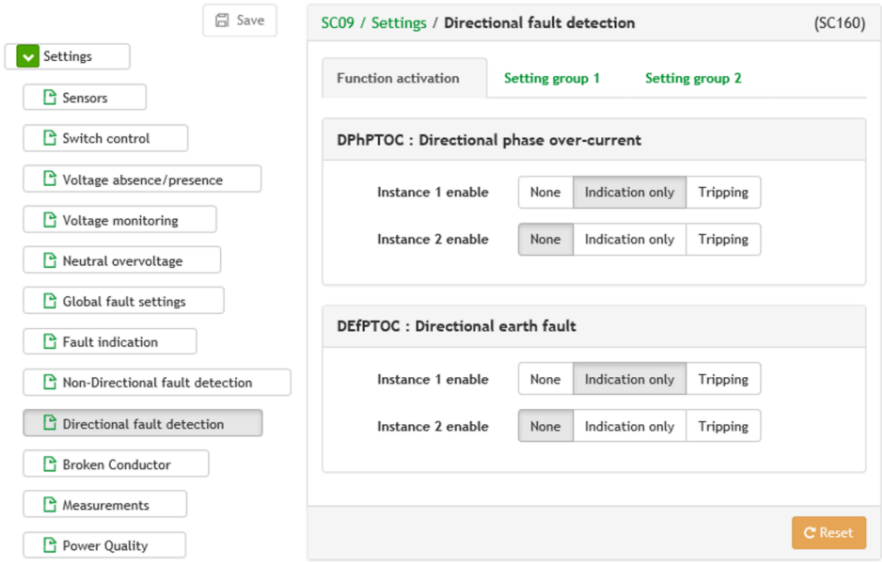
    Directional fault current detection uses the following ANSI detection standards:

    – Directional phase overfault current detection indication (**Indication only**) or, detection and tripping protection (**Tripping**) (ANSI 67)

    – Directional ground fault current detection indication **(Indication only**) or, detection and tripping protection (**Tripping**) (ANSI 67N)

    The characteristics for each ANSI code are given below.

    Accessed via **SC0x > Settings > Directional fault detection** page.



    This page allows you to define:

    – Which process mode (**Detection only** or **Tripping** Protection) is activated on each protection, and on which instance. Protections/Function:

      ◊ Phase over-current

      ◊ Earth fault

    – Process applied:

      ◊ **None**

      ◊ **Indication only**

      ◊ **Tripping**

    Refer to:

    – ANSI 67 Directional Phase (DPhPTOC) Fault Current Parameter Setting on SC160 module, page 339

– ANSI 67N Directional Earth (DEfPTOC) Fault Current Parameter Setting for Detection and Tripping Protection, page 344

◦ Tripping capability disabled:

The fault current detection (FPI) combines a ground fault detection with a fault current direction indication. The fault current is taken into account if the residual voltage exceeds the threshold defined by configuration and the direction of the fault current is determined by projecting the residual current onto the residual voltage during the transient phase.

If Tripping Protection disabled (in **Global setting** menu), available modes: **Indication only** or **FPI+Sectionalizer**

Parameters are identical in both **Indication only** and **FPI+Sectionalizer** modes.

ANSI 67 Directional Phase Overcurrent Description for SC160 Module (Tripping enabled or disabled)

On the SC160 module, the ANSI 67 protection function has directional phase overcurrent fault detection indication and tripping capability.

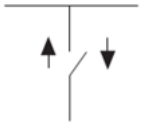
The contribution of the ANSI 67 function to the protection control logic or detection logic is set via configuration.

ANSI 67 protection function for detection indication and tripping is activated only when the VT connection mode settings is “3 phase ABC”.

In a looped network where a fault current is supplied with power at both ends, but also in a network with several power sources, a method of detection that is sensitive to the direction of the fault current flow is required to be able to locate and indicate the fault current direction selectively: this is the role of directional phase overcurrent detectors.

Fault current detection operates if at least two phases (or one phase is case of acquisition with only 2 phases CT) current are higher than the defined threshold (Is) during the tripping time (Ts).

Direction convention for a directional fault current:



Busbar direction Network direction

The fault current direction (network or busbar) is also determined and associated with this detection. The detector indicates the phases in which the fault current has occurred and the direction of the fault current.

To enable detection, the fault current must reach the threshold defined by configuration. Detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67 characteristics table.

2 groups of settings are available. It is possible to change over from one group of settings to the other during operation as follows:

- Manually in the Substation page in the Web server
- Remotely via the SCADA system

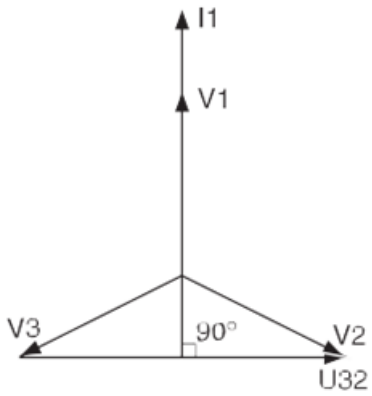
Direction of Fault Current

The direction of the fault current is determined by the comparison between the phase current and the polarization voltage. The detector therefore requires both current and voltage data. The direction is classed as either busbar or network according to the direction convention. Polarization voltage is the phase-to-phase voltage in quadrature with the current for cos φ= 1 (phase-to-phase voltage creating a 90° angle in relation to the current).

The table below indicates the polarization voltage used to determine the direction as a function of the current on each phase (only phases 1 and 3 are used in the case of type B CT connection):

Measured current	I1	I2	I3
Polarization voltage	U23	U31	U12

Example with 1 phase: current and polarization voltage (U32 in this case)



The current vector plane on 1 phase is divided into 2 semi-planes separated by a boundary line. These 2 semi-planes correspond to 2 zones: the direct zone and the reverse zone.

The characteristic angle φ is the angle between the perpendicular to the boundary line between these 2 zones and the polarization voltage. The value of this angle (which is configurable) determines the position of this boundary line in the vector plane.

Fault current direction:

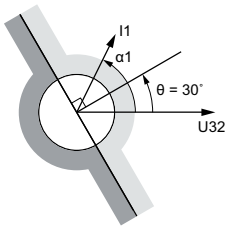
- Busbar direction (reverse zone): the fault current is from the network to the busbar (backward, green light).
- Network direction (direct zone): the fault current is from the busbar to the network (forward, red light).

CT are always wired in the same manner for all SC160: backward fault on the busbar side and forward fault on the network side. If customer the CT wiring is not correct, it is still possible to reverse the current measurement by the dedicated setting for phase inversion.

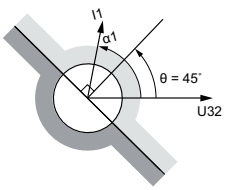
In function of the number of phase current transformers connected - 2 or 3 CTs connected - the simplified diagram of the directional phase overcurrent function is different:

- In case of three phases CTs connected, the fault direction is validated by two phases current on the same direction and higher than the current threshold. This method is more robust than the method using the validation by only one phase.
- In case of two phases CTs connected, the fault direction is only validated with one phase. This method is less robust than the first one. That is why it is only used when only two phases CTs are connected.

Example of fault current on phase 1, in the direct zone, with characteristic angle φ = 30°:



Example of fault current on phase 1, in the direct zone, with characteristic angle φ = 45°:



Voltage Memory

In the event of a 3-phase fault current close to the busbar, the level of each polarization voltage may not be sufficient (close to zero) to detect the fault current correctly. The fault current detector therefore uses a voltage memory to detect the fault current reliably.

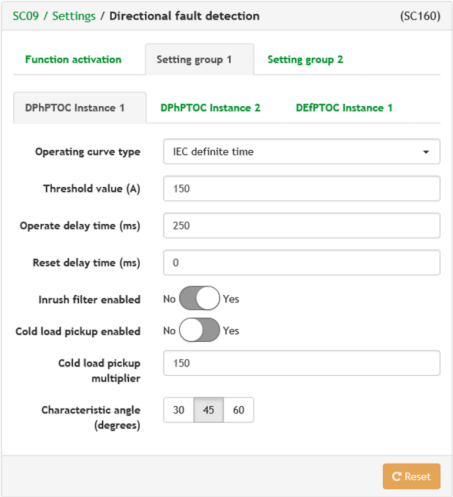
To help ensure that the voltage memory is only used for a 3-phase fault current, the detector verifies that at least 2 phase-to-phase voltages are close to zero.

NOTE: If a fault current occurs just after the MV network is energized, the direction of the fault current cannot be indicated by the voltage memory. In this case, where the voltage is zero just before the fault current, the voltage memory is not reliable for determining the direction. The fault current will still be detected and indicated by the detector, however.

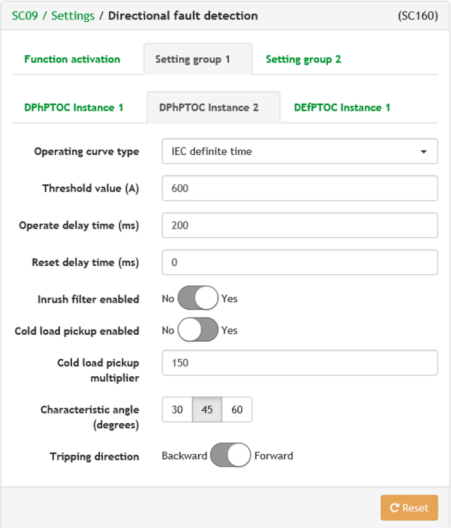
ANSI 67 Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		2
Logical node name		**DPhPTOCx** (x = instance number)
Fault current indication		Type of fault current detected
		Phase with fault current condition: instance 1, 2 with indication of direction
FPI + Sectionalizer		Generic phase fault indication Indication of faulted phases A, B, C (*)
		Phase fault detected: instance 1 or 2
Fault current tripping protection (only available on the SC160 module when Tripping protection is enabled)		Tripping on phase fault: instance 1 and 2
Cold Load Pickup		Enabled (Yes / No)
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Detection mode (curve type)	IEC definite time (DT)	Instance 1, 2, and 3
	Inverse definite minimum time (IDMT): • IEC normal inverse time/A • IEC very inverse time/B • IEC extremely inverse/C • IEEE moderately inverse time • IEEE very inverse time • IEEE extremely inverse time	Instance 1 and 2
Overcurrent threshold	DT	See parameter setting table, page 339.
	IDMT	
Acknowledge time	DT	
	IDMT	
Reset time	DT	
Inrush filter		Active or inactive
Characteristic angle		30, 45, or 60° (default: 45°)

ANSI 67 Directional Phase (DPhPTOC) Fault Current Parameter Setting on SC160 module

Configuring a Phase fault current (DPhPTOC instance) **Detection only**



Configuring a Phase fault current (DPhPTOC instance) **Tripping**



The following table describes ANSI 67 Directional Phase Fault Current parameters when Tripping is enabled or disabled in **Global settings**. Refer to Fault Current Detection Indication and Tripping Settings on the SC160 module, page 327.

Parameter	Default	Configuration range	Description
Function activation – DPhPTOC: Directional Phase Overcurrent – Tripping disabled			
Instance 1 or 2	None	• None • Indication only • FPI + Sectionalizer	Activation of instance 1 or 2 for detecting phase-to-phase fault currents
Function activation – DPhPTOC: Directional Phase Overcurrent – Tripping enabled			
Instance 1 or 2	None	• None • Indication only • Tripping	Activation of instance 1 or 2 for detecting phase-to-phase fault currents and tripping protection

Parameter	Default	Configuration range	Description
DPhPTOC Indication Instance 1 or 2 – Tripping disabled			
Operating curve type	IEC definite time	• IEC definite time (DT) • IDMT: ◦ IEC normal inverse ◦ IEC very inverse ◦ IEC extremely invers ◦ IEEE extremely inverse ◦ IEEE very inverse ◦ IEEE moderately inverse	Choice of the type of standardized IEC or IEEE algorithm to apply to the selected instance for detecting phase-to-phase fault currents.

Parameter	Default	Configuration range	Description
Threshold value (A)	100	• DT: 0.02 In – 10 In • IDMT: 0.02 In – 2.4 In (increment = 1)	Minimum threshold for detecting phase-to-phase fault currents. The current must be detected above this threshold for a time longer than the **Operate delay time** to validate the presence of a fault current.
Operate delay time (ms)	100	• DT: 0-300,000 ms • IDMT: 20-12,500 ms (increment = 1)	Minimum time for which the detected current must be greater than the phase-to-phase **Threshold value** to validate the fault current. Constraint: depending whether time curves are truncated at the minimum between the dynamic of acquisition (1) and 20 Is, and replaced by a DT curve. Depending whether time curves are truncated for a delay lower than 20 ms and replaced by a DT curve.
Reset delay time (ms)	0	• 0 • 0-300000 ms (increment = 1)	Minimum time for which the current must pass and remain below the fault current detection threshold to reset the **Operate delay time**. For the period when the current is below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This time is incremented again if the voltage exceeds the threshold. This reset time is inactive once the fault current has been validated. **NOTE:** When a reset time equal to 0 ms is chosen, a delay equal to 35 ms fixed is added internally to limit the impact of the CT saturation.
Inrush filter enabled	No	• No • Yes	Activation of the inrush current filter function See Inrush filter, page 319 function description for more information.
Cold load pickup enabled	No	• No • Yes	Define if CLPU is enabled for ANSI 67.
Cold load pickup multiplier	150 %	From 100 % to 999 % (increment = 1)	Define the value of the multiplying factor applied on Is threshold for ANSI 67.
Characteristic angle (degrees)	45	• 30° • 45° • 60°	Choice of characteristic angle value. The characteristic angle is the angle between the perpendicular to the boundary line and the magnitude of polarization (phase-to-phase voltage in quadrature with the current for Cos φ=1). The value of the characteristic angle determines the position of the boundary line defining the separation between the reverse zone and the direct zone. See the description of the ANSI 67 function, page 336.

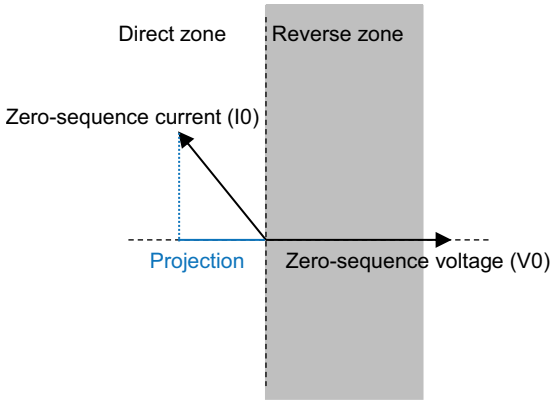
Parameter	Default	Configuration range	Description
DPhPTOC Indication Instance 1 or 2 – Tripping enabled – Specific parameters			
Threshold value (A)	100	• DT: 0.1 In – 10 In • IDMT: 0.1 In – 2.4 In (increment = 1)	Minimum threshold for detecting phase-to-phase fault currents. The current must be detected above this threshold for a time longer than the **Operate delay time** to validate the presence of a fault current.
Tripping direction	Forward	• Backward • Forward	Define the direction of the tripping zone. Only available if the protection instance is configured in Tripping mode.

ANSI 67N Directional Earth Overcurrent Description for SC160 module (Tripping disabled)

The directional fault current detection combines a ground function based on residual voltage with a fault current direction indication.

The residual current I0 measured on this detection can be determined in 2 different ways (configurable option: **Io measured**):

- By adding the values of the 3 phase CTs together (A or D type connection configurations)
- By measuring the residual current directly using the core balance CT (B, C or D type connection configurations)



To enable detection, the residual current must reach the threshold defined by configuration. Detection is delayed. The time delay can be definite time (DT) or inverse time (IDMT) according to the curves indicated in the ANSI 67N characteristics table.

There are three steps to enable the directional ground (earth) fault current detection:

1. The fault current is taken into account if the residual voltage exceeds the thresholds defined by configuration (**Minimum residual voltage threshold** and if it remains above this threshold for a time longer than the configurable time period (**Operate delay time**)

   NOTE: The time delay is definite time only (DT).

2. The direction of the fault current is determined during the transient phase of the fault by examining the sign of the residual sequence current projected onto the residual voltage. Depending on the parameters used for this type of detection, it is possible to only validate fault currents with a high current peak during this transient phase by using specific thresholds on the residual current and voltage measurements (see parameter settings table below).
3. The presence of the fault current detected in step 1 is then validated by the absence of residual voltage.

Up to eight groups of settings are available for this type of detection. It is possible to change over from one group of settings to the another during operation as follows:

- Manually in the **Substation** page in the Web server
- Remotely via the SCADA system

Direction of Fault Current

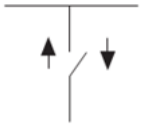
The direction of the fault current is determined by projecting the residual current onto the residual voltage during the transient phase. This projection can be detected in 2 distinct zones (see diagram above):

- In the direct zone, if the integral of the projection of I0 on V0 is negative
- In the reverse zone, if the integral of the projection of I0 on V0 is positive

The direction of the fault current can then be determined using the following convention:

- Fault current on the direct zone: fault current is from the busbar to the network (forward fault); the fault is detected on the network side of the switch.
- Fault current on the reverse zone: fault current is from the network to the busbar (backward fault); the fault is detected on the busbar side of the switch.

Direction convention for a directional fault current:



Busbar direction Network direction

ANSI 67N Directional Earth (DEfPTOC) Fault Detection indication and Tripping Protection Description (Tripping enabled)

The SC160 module can provide ANSI 67N protection function for earth overcurrent directional fault protection and tripping capability. The contribution of the ANSI 67N function to the protection control logic or detection logic is set via configuration.

Protection tripping is activated according to the direction setting **Forward** or **Backward** by instance.

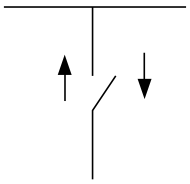
ANSI 67 N protection function for detection and tripping is activated only when the VT connection mode settings is “3 phase ABC”.

Earth fault protection is with selective tripping according to fault current direction.

The protection function uses I0 vector projection. This projection method is suitable for radial feeders in resistive, isolated or compensated neutral systems.

Tripping direction

The direction of the residual current is qualified as busbar direction or line direction according to the following convention:



Busbar direction Network direction

Busbar direction (reverse zone): fault current is from the network to the busbar (Backward, green light)

Network direction (direct zone): fault current is from the busbar to the network (Forward, red light)

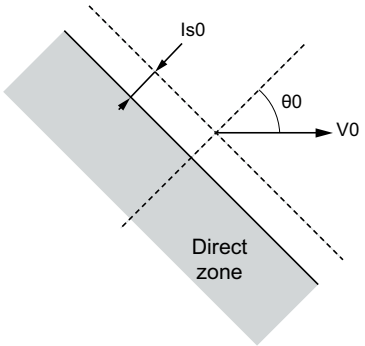
The tripping zone can be set for tripping in direct zone (forward fault) or reverse zone (backward fault) by changing the value of the **Tripping direction** parameter. By default, the reverse zone is where the protection function does not trip, being used only for indication.

The function determines the projection of the residual current I0 on the characteristic line, the position of which is determined by the setting of characteristic angle θ0 in relation to the residual voltage. The projection value is compared to the Is0 set point.
This protection function is suitable for radial feeders in resistive, isolated or compensated neutral systems.
With compensated neutral systems, it is characterized by its capacity to detect very brief, repetitive faults (recurrent faults). In the case of Petersen coils with no additional resistance, fault detection under steady state conditions is not possible due to the absence of active zero sequence current. The protection function uses the transient current at the beginning of the fault to help ensure tripping.
The θ0 = 0° setting is suitable for compensated or impedant neutral systems. When this setting is selected, the parameter setting of the sector is used to reduce the protection tripping zone to help ensure its stability on fault-free feeders.
The protection function operates with the residual current measured at one of the relay I0 inputs (operation with sum of three currents impossible). The protection function is inhibited for residual voltages below the Vs0 set point. It implements a definite time (DT) delay.
The tripping direction may be set at the busbar end or line end.
Each of the two units has two groups of settings. Switching to setting group 1 or 2 can be carried out by a logic input or a remote control order, depending on the settings.

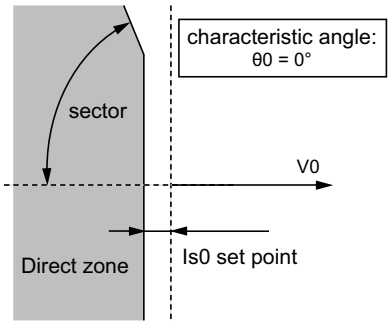
Memory

The detection of recurrent faults is controlled by the time delay T0mem which extends the transient pick-up information, thereby enabling the operation of the definite time delay even with faults that are rapidly extinguished (≈ 2 ms) and restrike periodically. Even when a Petersen coil with no additional resistance is used, the device trips due to fault detection during the transient fault appearance. Detection is extended throughout the duration of the fault based on the criterion V0 u V0mem, within the limit of T0mem.

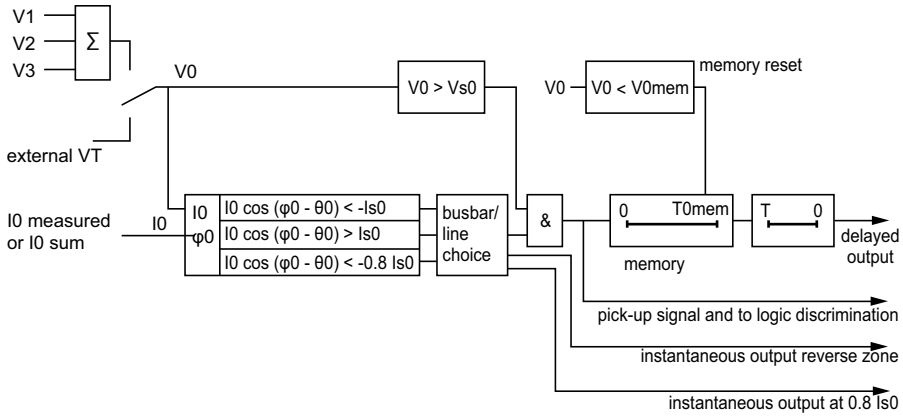
Tripping characteristic of ANSI 67N type 1 protection (characteristic angle Θ ≠ 0):



Tripping characteristic of ANSI 67N type 1 protection (characteristic angle Θ = 0°):



Block diagram



ANSI 67N tripping Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		From 1 to 8
Logical node name		**DEfPTOCx** (x = instance number)
Cold Load Pickup		Enabled (Yes/No)
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Residual current acquisition		Ires (sum of all 3 phases)
		I0 (directly from the core balance CT)
Detection mode (curve type)	IEC definite time (DT)	Instance 1 and 2
Minimum residual voltage threshold	DT	See parameter setting table, page 344.
Acknowledge time	DT	
Reset time	DT	
Residual voltage peak threshold		See parameter setting table, page 344.
Residual current peak threshold		
Voltage memory		See parameter setting table, page 344.
Characteristic angle		-45º, 0º, 15º, 30º, 45º, 60º, 90º (default is 0º)

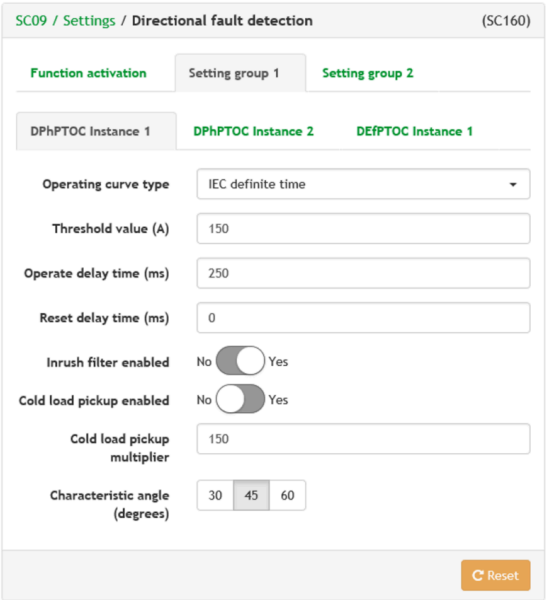
ANSI 67N Directional Earth (DEfPTOC) Fault Parameter Setting for Detection Indication and Tripping Protection

ANSI 67N parameters vary according to the protection activation:

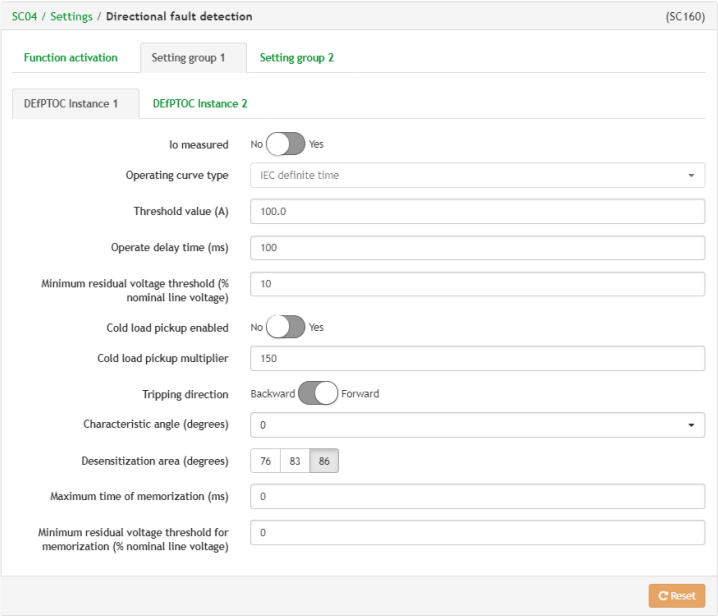
- For **Tripping disabled** (**Indication only or FPI+Sectionalizer**): the fault current threshold is not configurable (a minimum setting of 2 A is taken into account for the detection). Additionally, it is possible to only validate fault currents with a high peak during this transient phase by using specific thresholds.
- For **Tripping enabled** (**Indication only or Tripping**): the characteristic angle that defines the tripping zone is configurable along with the tripping direction and the residual current threshold value. Additionally, a voltage memory algorithm can also be configured.

Refer to the possible settings for fault current detection and protection, page 327.

Tripping disabled



Tripping enabled



ANSI 67N Directional Earth (DEfPTOC) Fault Indication Parameter Setting on the SC160 Module (Tripping enabled)

Description of parameters when Tripping enabled is selected in **Global setting** and **Tripping** is selected in **Function activation**.

Accessed via **SC0x > Settings > Directional fault detection** page.

Parameter	De-fault	Configuration range	Description
Function Activation – DEfPTOC: Earth Overcurrent - Tripping enabled			
Instance 1 or 2	Non-e	• None • Indication only • Tripping	Activation of instance 1 or 2 for detecting earth fault currents and tripping protection

Parameter	Default	Configuration range	Description
DEfPTOC Indication Instance 1 or 2 – Tripping enabled			
Io measured	No	• No • Yes	Activation of the I0 current measurement by core balance CT for directional ground fault detection. If this option is not enabled, the residual current is calculated by adding the currents from the 3 phase CTs together. **NOTE:** This parameter is only configurable for a type of connection configuration with core balance CT.
Operating curve type	IEC definite time	IEC definite time	This type of detection only uses the **IEC definite time** algorithm.
Threshold value (A)	100	I0 calculated: 0.02 In - 3.5 In I0 measured: 0.008 In - 3.5 In (increment = 1)	Minimum threshold for detecting zero sequence fault currents. The current must be detected above this threshold for a time longer than the **Operate delay time** to validate the presence of a fault current.
Operate delay time (ms)	100	0 - 300,000 (increment = 1)	Minimum time for which the detected voltage must be greater than the **Minimum residual voltage threshold** to validate the presence of a fault current.
Minimum residual voltage threshold (% nominal line voltage)	Instance 1: 10% Instance 2: 20%	2% - 80% (increment = 1)	Minimum value, as a percentage of the nominal voltage, above which the residual voltage activates fault current detection. The residual voltage must be detected above this threshold (excluding during the transient phase) for a time longer than the **Operate delay time** to validate the presence of a zero sequence fault current.

Parameter	Default	Configuration range	Description
Cold load pickup enabled	No	• No • Yes	Define if CLPU is enabled for DEfPTOC (ANSI 67N) fault detection.
Cold load pickup multiplier	150 %	From 100 % to 999 %	Define the value of the multiplying factor applied on Is threshold for ANSI 67N.
Tripping direction	Forward	• Forward • Backward	Define the direction of the tripping zone. Only available if protection instance is configured in Tripping mode.
Characteristic angle (degrees)	0°	• -45° • 0° • 15° • 30° • 45° • 60° • 90°	Define the orientation of the tripping angle.
Desensitization area (degrees)	86°	• 76° • 83° • 86°	Define the desensitization area of the protection. Only applied / accessible if Characteristic angle θo=0°.
Maximum time of memorization	0	• 0 – Instantaneous • 50 – 300000 m s (increment = 1)	Maximum time during which the instantaneous bit is memorized.
Minimum residual voltage threshold for memorization (% nominal line voltage)	0	• 0% – Disable • 2% – 80% (increment = 1)	Minimum value of the residual voltage for which the instantaneous bit is memorized.

ANSI 67N Directional Earth (DEfPTOC) Fault Indication Parameter Setting on the SC160 Module (Tripping disabled)

Description of parameters when Tripping enabled is selected in **Global setting** and **Tripping** is selected in **Function activation**.

Accessed via **SC0x > Settings > Directional fault detection** page.

Parameter	Default	Configuration range	Description
Function Activation – DEfPTOC: Earth Overcurrent - Tripping disabled			
Instance 1 or 2	None	• None • Indication only • FPI +Sectionalizer	Activation of instance 1 or 2 for detecting earth fault currents

Parameter	Default	Configuration range	Description
DEfPTOC Indication Instance 1 or 2 – Tripping disabled			
Io measured	No	• No • Yes	Activation of the I0 current measurement by core balance CT for directional ground fault detection. If this option is not enabled, the residual current is calculated by adding the currents from the 3 phase CTs together. **NOTE:** This parameter is only configurable for a type D connection configuration with core balance CT.
Operating curve type	IEC definite time	IEC definite time	This type of detection only uses the **IEC definite time** algorithm.
Operate delay time (ms)	100	0 – 300000 ms (increment = 1)	Minimum time for which the detected voltage must be greater than the **Minimum residual voltage threshold** to validate the presence of a fault current.
Reset delay time (ms)	0	0 – 300000 ms (increment = 1)	Minimum time for which the voltage must pass and remain below the fault detection threshold to reset the **Operate delay time**. For the period when the voltage is below the threshold, the **Operate delay time** maintains its value, as long as there is no reset. This

Parameter	Default	Configuration range	Description
			time is incremented again if the voltage exceeds the threshold. This reset time is inactive once the fault current has been validated. **NOTE:** When a reset time equal to 0 ms is chosen, a delay equal to 35 ms fixed is added internally to limit the impact of the CT saturation.
Minimum residual voltage threshold (% nominal line voltage)	Instance 1: 10% Instance 2: 20%	6% – 30% (increment = 1)	Minimum value, as a percentage of the nominal voltage, above which the residual voltage activates fault current detection. The residual voltage must be detected above this threshold (excluding during the transient phase) for a time longer than the **Operate delay time** to validate the presence of residual fault current.
Enable validation checks	Yes	• No • Yes	Activation of the option to add an extra level of validation to fault current acknowledgment. This filter validates the fault current through the presence of minimum current and voltage peaks during the transient phase of the fault current, according to the values defined by the next 2 parameters below.
Minimum (blocking) operating peak voltage (% nominal line voltage)	Instance 1: 25% Instance 2: 55%	6% – 60% (increment = 1)	Minimum peak value, as a percentage of the nominal voltage, above which the residual voltage peak (during the transient phase of the fault current) enables the optional fault current detection validation function (if the **Enable validation checks** option is selected).
Minimum (blocking) operating peak current (A)	Instance 1: 15 A Instance 2: 70 A	• Io calculated: 0.015 In - 2.3 In Io measured: 0.01 In0 - 2.3 In0 (increment = 1) Minimum: 0.5 A	Minimum peak value of the residual current peak during the transient phase of the fault current used to enable the optional fault current detection validation function (if the **Enable validation checks** option is selected).
Cold load pickup enabled	No	• No • Yes	Define if CLPU is enabled for ANSI 67N.
Cold load pickup multiplier	150 %	From 100 % to 999 % (increment = 1)	Define the value of the multiplying factor applied on Is threshold for ANSI 67N.

Fault Current Validation and Indication

Access via **SC0x > Settings > Fault indication** page.

The T300 offers several ways of indicating fault currents detected on the MV network:

- Via the LEDs on the front panel of the SC150/SC160 module: 2 "arrow" LEDs are lit orange, red, or green depending on the indication phase or the type of detection.
- Via an external LED.
- In the Substation Web server page: A red "flash" symbol is displayed for all fault current types, accompanied by a red or green arrow to indicate the direction of the fault current (for a directional fault current).

On the LEDs (front panel and external), fault currents (validated and confirmed) can be indicated in different ways depending on the type of detection and the fault current type:

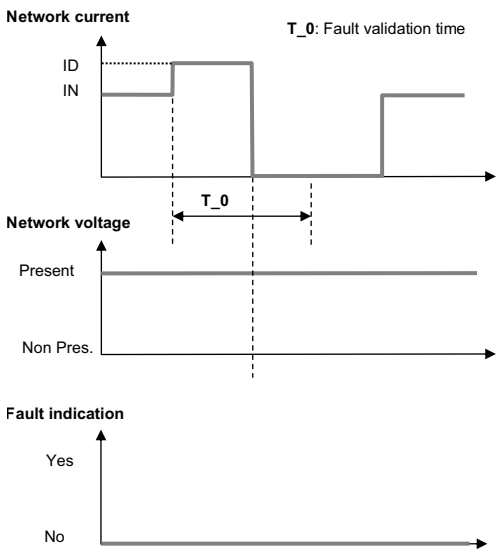
- Ammetric detection: Flashing red for earth fault, Steady for cross-country or phase-to-phase faults.
- Directional detection: Flashing red or green for earth faults, steady red or green for other types of fault.

  NOTE: On the LEDs on the front panel only, an orange indication phase precedes the green or red indication. This phase corresponds to the fault current confirmation wait time within which the fault current type is analyzed (transient, or semi-permanent/permanent).

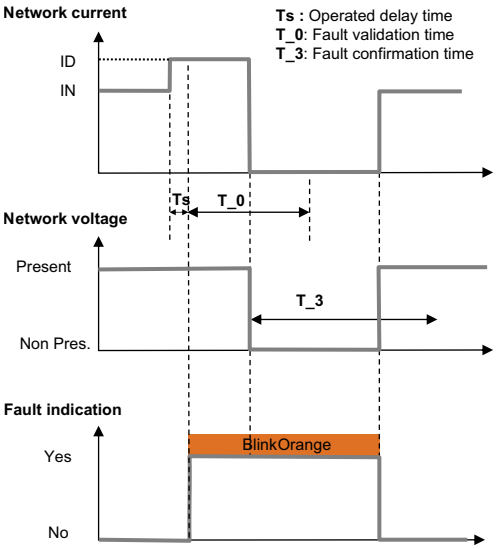
Fault Current Indication

The diagrams below illustrate the different indication phases for a potential fault current. Note that these diagrams correspond to indication via LEDs on the front panel, which is the most comprehensive method in terms of number of colors represented, as it includes the orange indication phase that does not exist with the other types of indication (via external LED or the Web server).

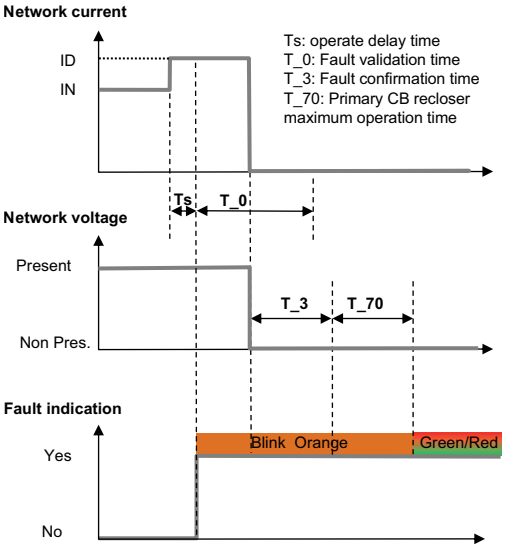
No indication of a non-validated (and therefore unconfirmed) transient fault current on the front panel:



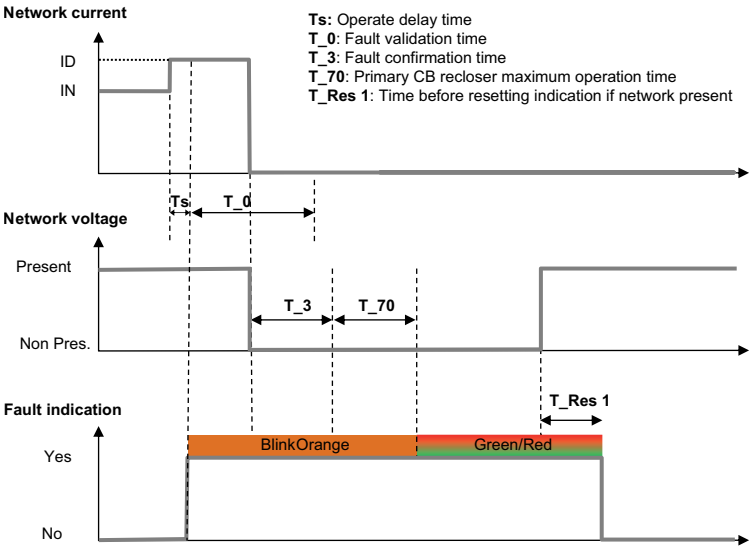
Indication of a validated but not confirmed transient fault current on the front panel:



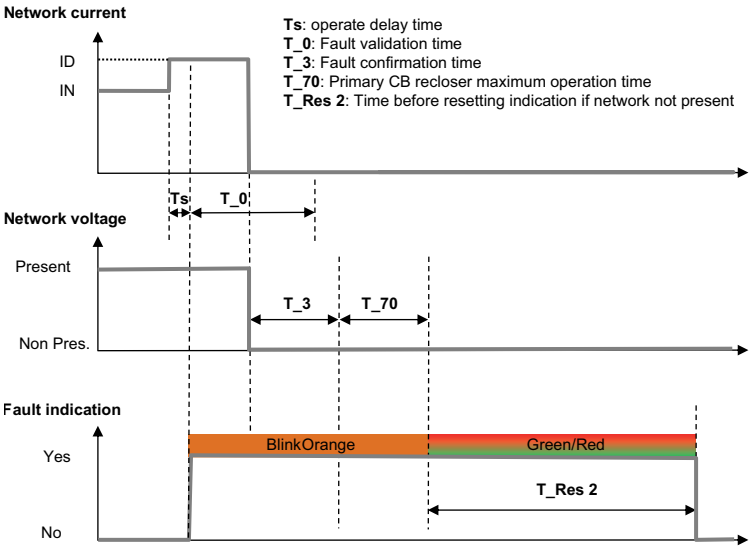
Indication of a permanent or semi-permanent validated and confirmed fault current on the front panel:



Indication of a permanent or semi-permanent validated and confirmed fault current on the front panel, reset by a power return:



Indication of a permanent validated and confirmed fault current on the front panel, reset by the network non presence delay time:



The principle for these diagrams remains the same for indication via external LED, except for the fact that there is no orange phase and the red (or green) indication is therefore given at the start of the confirmation phase.

Instructions on how to configure external LED are given in the T300 Quick Start Guide (NT00383). Refer to this document for more information.

In the Web page, the indication principle is the same as for the external LED.

See the parameter settings table for a detailed explanation of the time delays mentioned in these diagrams (T_0, T_3, T_70, etc.).

Resetting a Fault Current

A fault current indication is reset as follows:

- Automatically when power is restored (if the corresponding option is enabled)
- Automatically at the end of the reset delay time, if the voltage remains absent for the duration of this time delay
- Manually by pressing the button on the front panel of the HU250 module (general reset for all channels where a fault current has been detected)
- Manually from the Web server, using the **Reset** button on the **Substation** page
- Remotely from the SCADA system, via the communication protocol.

Fault Current Validation (and Indication)

A detected fault current is generally validated by the non-presence detection of the MV network, if the T300 configured for this purpose.

The MV network absence/presence detection is also used by the T300 to indicate the fault current passage, by various means (for example LEDs on the front panel, or indications on the **Monitoring > Substation** page).

Absence/presence detection of the MV network can be done by monitoring current or the voltage (parameter FPI network presence and confirmation mode). You can also choose not to monitor current or voltage of the MV network for fault confirmation. In this case, the fault is indicated if the threshold is exceeded, without any further validation.

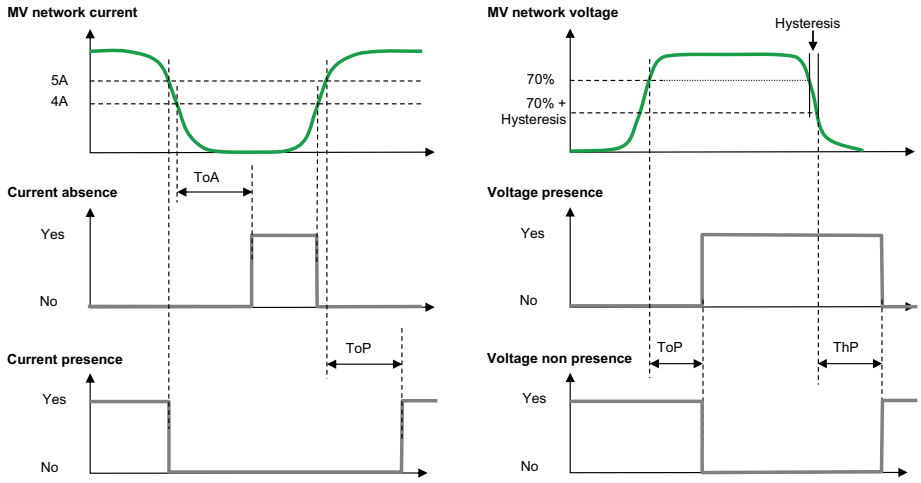
Some automation functions might also use the MV presence/absence detection as a start condition for a reclose cycle or a fault current isolation (for example ATS, if present in the unit).

This table summarizes the signaling/indication possibilities proposed by the T300 for indicating the MV network absence/presence, depending whether current or voltage is used for detection.

	FPI	IHM	Web server	Data pages
Network Absence/Presence				
By current	Yes	No	No	Yes
By voltage	Yes	Yes	Yes	Yes

Detection of MV current absence/ presence
ToA: Operate delay time – current absence (by default: 50 ms)
ToP: Operate delay time – current presence (by default: 50 ms)

Detection of MV voltage presence/ non-presence by the measures
ToP: Operate delay time – voltage presence (by default: 65 ms)
ThP: Hold delay time – voltage presence (fixed at 40 ms)



Detection of Network Absence/Presence by the Current

The detection of MV network absence/presence by the observation of the current is carried out only by the measurement of the MV currents from CTs. Configurable thresholds based on these measurements are used to determine the level at which the current is detected to be present or absent and for how long, and the level at which these detections were canceled out and for how long.

The current is considered to be present if the 3 phases meet the presence criteria defined by the configured thresholds and time delays. The current is considered to be absent if at least 1 phase meets the absence criteria defined by the configured thresholds and time delays. The current is considered to be non-present if at least one of the phases no longer meets the presence criteria defined by the configured thresholds and time delays. The current is considered to be non-absent if the 3 phases no longer meets the absence criteria defined by the configured thresholds and time delays.

Network current absence detection for validation of a fault current uses the following standardized ANSI standard: ANSI 37 (undercurrent detection).

NOTE: If current is chosen as the source for validating a fault current, a detected fault current is validated by the non-presence of the MV current and not by the absence of the MV current.

ANSI 37 Characteristics	
Number of instances	1 (presence/absence)
Groups of settings	1
Detection mode	Definite time (DT)

ANSI 37 Characteristics	
Logical node name	AbsPTUC x (x = instance number)
Hysteresis reset detection	0,2 % x In
Parameter Setting (For Each Instance)	
Operation mode	On all 3 phases
Detection threshold	See parameter table, page 353.
Time delays	

Detection of Network Presence/Absence by the Voltage

Detection of MV network presence/absence by the observation of the voltage can be carried out in several ways:

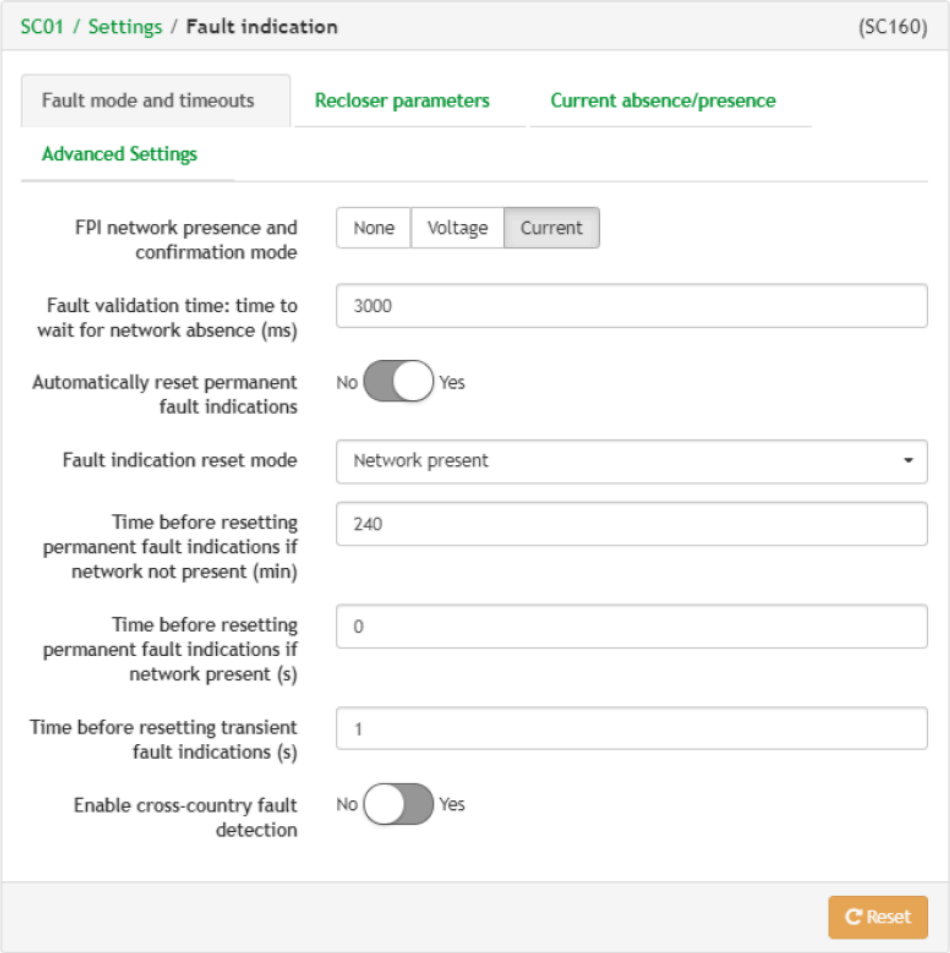
- By the information from the digital input DI6 of the SC150 module (MV network presence via an external voltage presence relay, e.g. VD23)
- By the information from the digital input DI5 of the HU250 module (main supply presence/absence information via the PS50 power supply)
- By the measurement resulting from the voltage sensors. Configurable thresholds related to these measurements define whether the MV voltage is considered to be present and for what duration this detection is considered to be not present (see diagram attached). The voltage is considered as present (or absent) if all the measured phases (1, 2 or 3 phases according to configuration) satisfy the criteria of presence (or absence) defined by the thresholds and time delays. The voltage is considered as not present (or not absent) if at least one phase no longer checks the presence (or-absence) criteria defined by the thresholds and time delays.

  NOTE: If voltage is chosen as the source for validating a fault current, a fault current detected is validated by the non-presence of the MV network voltage and not by the absence of the MV network voltage. Note that these voltage presence thresholds are for the most common with those configured in the **Voltage presence/absence** page.

Fault Current Validation and Indication Parameter Setting

Setting Fault Mode and Timeouts

Access via **SC0x > Settings > Fault indication** page, **Fault mode and timeouts** tab.

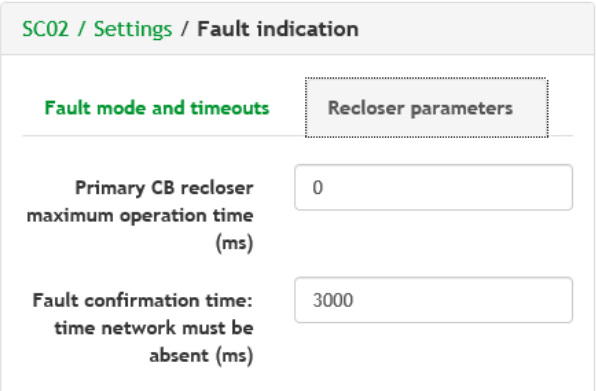


Parameter	Default	Configuration range	Description
Fault current Mode and Timeouts tab			
FPI network presence and confirmation mode	Current	• None • Voltage • Current	Choice of source to define presence of the MV network and to enable a fault current detection confirmation (confirmation by absence of current and non-presence of voltage). None disables fault current confirmation. In this case, detection of a fault current only is sufficient to validate and indicate it. **It is advisable to enable fault current detection confirmation by either current or voltage to help ensure that only fault currents detected by the upstream protection device are confirmed.**
Voltage presence source	AC power supply	• Measured • Digital input • AC power supply	The voltage source can be acquired in several ways for the fault current indication: • **Measured**: Using the measurement from the voltage sensors • **Digital input**: Using the information from the digital input DI6 of the SC150 module (via external voltage relay) • **AC power supply**: Using the information from the digital input DI5 of the HU250 module (via the PS50 module). Parameter only available for the options **FPI network presence and confirmation mode = Voltage**.
Fault validation time: time to wait for network absence (ms) (T_0)	3,000	0 – 300,000 (increment = 1)	Observation window within which the MV network (via observation of the current or voltage) must be non present to validate a fault current that has just been detected. This validation is used to filter self-extinguishing type faults and only validate those fault that have caused the upstream circuit breaker or recloser to trip. Fault current indication starts the moment the fault current is validated.

Parameter	Default	Configuration range	Description
Fault current Mode and Timeouts tab			
Automatically reset permanent fault indications if network present	Yes	• Yes • No	If enabled, this option is used to clear the permanent fault current indication, once the MV network power has been restored, at the end of the **Time before resetting permanent fault indications if network present** delay. On networks with "non-sustained" fault currents, the fact that the upstream circuit breaker or recloser has reclosed means that the fault current has disappeared. It is therefore generally no longer necessary to indicate it.
Fault indication reset mode	Network present	• Network present • Network present AND switch closed • Network present And switch closed, OR current present	• **Network present**: The permanent fault can be reset with an indication of “Network present”, once the MV network power has been restored. • **Network present AND switch closed**: This condition can be completed by a “switch closed” condition, to cover cases where automation system (such as sectionalizer) has opened the switch. Therefore, even if the MV network has been restored, the fault can be still present downstream and must be still indicated. • **Network present And switch closed, OR current present**: The third case is to add a security, for the case the network present indication would fail: a current present indication normally corresponds to network present and switch closed
Time before resetting permanent fault indications if network not present (mn) (T_Res 2)	240	1 – 1440 (increment = 1)	This time delay corresponds to a maximum delay (timeout) for indicating a permanent fault current if the MV network is still non present. It is important to leave the indication active for a certain length of time to be able to locate the fault on the MV network. However, indication stops at the end of this timeout, primarily to save battery power.
Time before resetting permanent fault indications if network present (s) (T_Res 1)	0	0 – 300 (increment = 1)	Filter time before clearing indication of a permanent fault current, when MV network presence is detected again. This time delay is used to help ensure that the MV network is in a stable state and that no other fault current has occurred, before being able to clear the fault current indication.
Time before resetting transient fault indications (s)	1	0 – 300 (increment = 1)	This time delay corresponds to a maximum delay (timeout) for indicating a transient fault current. Indication stops at the end of this timeout.
Enable cross-country fault detection	No	• Yes • No	This option is used to enable detection of "double" fault, i.e. 2 simultaneous phase-to-ground fault on 2 phases and at 2 different locations on the network. **NOTE:** Double fault are only available on instance 3 of a zero sequence fault (in ammetric fault current detection).

Setting Recloser Parameters

Access via **SC0x > Settings > Fault indication** page, **Recloser Parameters** tab.

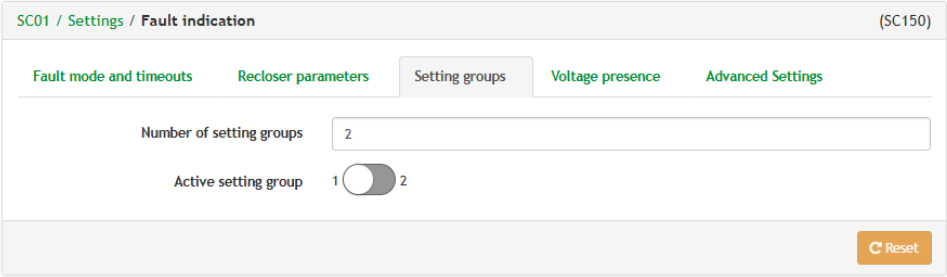


Parameter	Default	Configuration range	Description
Recloser Parameters			
Primary CB recloser maximum operation time (ms) (T_70)	0	0 – 300 (increment = 1)	After a fault current has been detected on the MV network, this time delay corresponds to the maximum wait time for the reclose cycle of the upstream protection device. This time delay is used to categorize the detected fault current as a permanent or semi-permanent fault current depending on whether it occurs during the delay period or not (see the "Fault current Detection" section). Setting a value of "0" disables this time delay. In this case, the fault current is categorized as a permanent fault current at the end of the **Fault confirmation time**. **NOTE:** This time delay must be set to a value other than "0" to be able to use the Sectionalizer automation function.
Fault confirmation time: delay before re-checking for network absence (ms) (T_3)	3,000	0 – 10,000	Confirmation time corresponding to an observation window within which power must not be restored on the MV network after a fault current has been validated. The fault is indicated by the color orange on the LEDs on the front panel during this confirmation phase. This stops if the fault current is not confirmed during this confirmation window. Once the time delay expires, confirmation is enabled and the fault remains indicated (although now either red or green) until the reset time becomes active.

Selecting the Active Setting Group

In the **Setting Group** tab you can select the parameter setting group to apply for the fault detection type as well as the number of available sets of groups (see Setting groups, page 237).

Access via **SC0x > Settings > Global fault settings** page, **Setting group** tab.



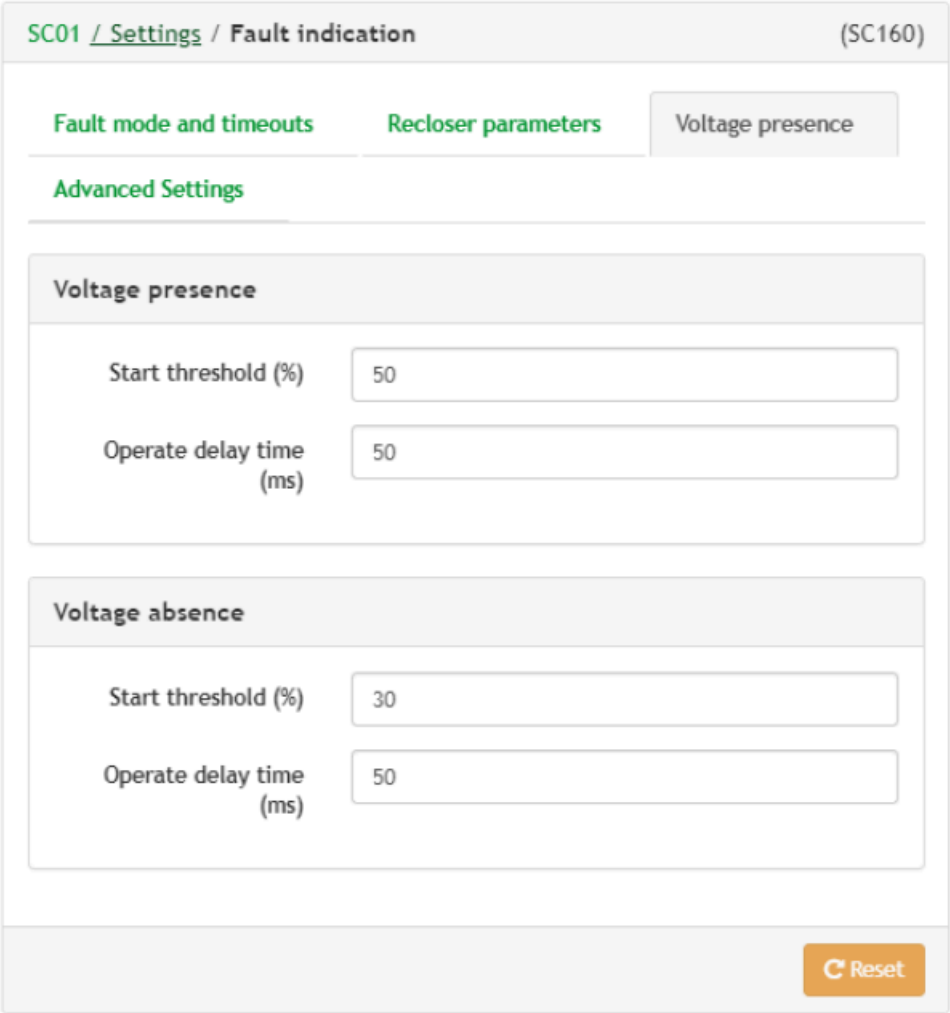
Select the **Active setting group** to apply for the fault detection type.

Select also the number of **Groups of setting** in the **Substation**, page 237 page.

Parameter	Default	Configuration range	Description
Active setting group			
Number of setting groups	2	1 to 8	Number of groups of parameter settings available to configure fault detection functions.
Active setting group	1	From 1 to 8	Choice of group of parameter settings to apply to fault detection. Each group includes specific thresholds, time delays, and parameters.

Setting Voltage Presence / Absence Parameters

Access via **SC0x > Settings > Fault indication** page, **Voltage presence** tab.

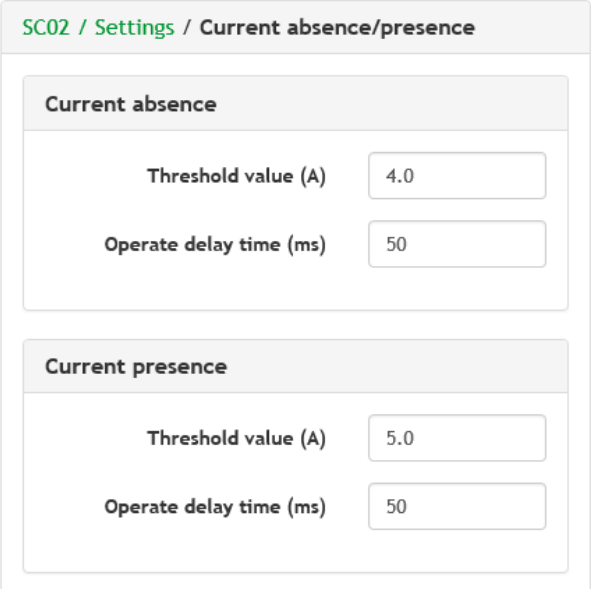


Parameter	Default	Configuration range	Description
Voltage presence			
Start threshold (%)	50	10 – 100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, above which the MV network voltage is considered to be present. **NOTE:** Configure the threshold taking into account hysteresis (7 %). Consult the glossary for the definition of hysteresis. Parameter available only for the case **Voltage presence source = Measured**.
Operate delay time (ms)	50	0 – 300000 (increment = 1)	Period within which the voltage must be above the **Start threshold** level to consider the MV network voltage to be present. Parameter available only for the case **Voltage presence source = Measured**.
Voltage absence			
Start threshold (%)	30	10 – 100 (increment = 1)	Definition of the measured MV network voltage threshold, as a percentage of the nominal voltage, below which the MV network voltage is considered to be absent. **NOTE:** Configure the threshold taking into account hysteresis (6 %). Consult the glossary for the definition of hysteresis. Parameter available only for the case **Voltage presence source = Measured**.
Operate delay time (ms)	50	0 – 300000 (increment = 1)	Period within which the voltage must be below the **Start threshold** level to consider the MV network voltage to be absent. Parameter available only for the case **Voltage presence source = Measured**.

NOTE: To configure the **Hold delay time** for Voltage presence refer to Front Panel Voltage Indication, page 384.

Setting Current Absence / Presence Parameters

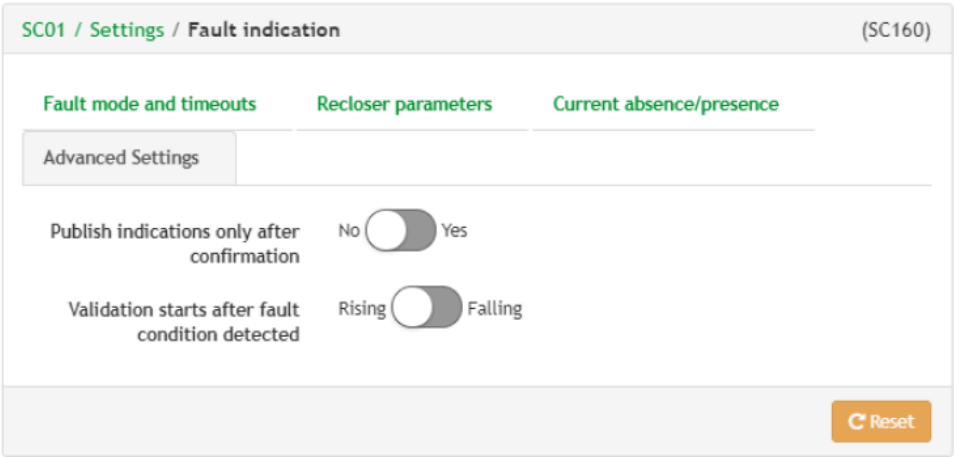
Access via **SC0x > Settings > Fault indication** page, **Current absence/ presence** tab.



Parameter	Default	Configuration range	Description
Current absence			
Threshold value (A)	0.008 In	0.002 In – 0.02 In (*) (increment = 0.1)	Definition of the measured current threshold below which the MV network current is considered to be absent.
Operate delay time (ms)	50	0 – 300,000 (increment = 1)	Period within which the current must remain below the **Threshold value** to validate detection of the absence of the MV network current.
Current presence			
Threshold value (A)	0.01 In	0.002 In – 0.02 In (*) (increment = 0.1)	Definition of the measured current threshold below which the MV network current is considered to be present.
Operate delay time (ms)	50	0 – 300,000 (increment = 1)	Period within which the current must remain above the **Threshold value** to validate detection of the presence of the MV network current. **NOTE:** It is the non-presence of the MV network current that allows to validate and indicate a fault current.
(*): In corresponds to the nominal current at the CT primary (by default In = 500 A).			

Advanced Settings

Access via **SC0x > Settings > Fault indication** page, **Advanced settings** tab.



Parameter	Default	Configuration range	Description
Advanced settings			
Publish indication only after confirmation	No	• No • Yes	This option is used to wait for the fault confirmation (network absence) to indicate the fault. By default, the fault is indicated as soon as the detection element is triggered.
Validation starts after fault condition detected	Rising	• Rising • Falling	This option is used to start the validation timer when the fault condition becomes untrue (falling edge of the detection element). By default, the validation timer starts on the rising edge of the detection element.

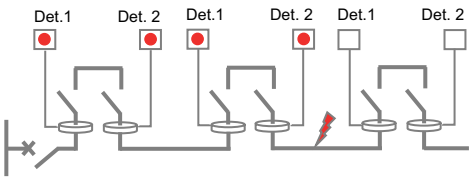
Locating Fault Currents on the MV Network

The LEDs on the T300 are used to help locate the fault current on the MV network according to the following rules:

- Ammetric detection

  The fault current is only signaled by fault current detectors located on the section of the MV network upstream of the fault current: i.e. the fault current will be located between the last detector indicating the fault current and the first detector not indicating the fault current. The fault current is indicated by a red flashing LED regardless of type (zero sequence, double, or phase-to-phase).

  Example of colors indicating a fault current in ammetric detection

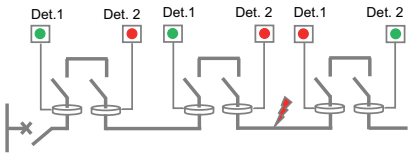


- Directional detection

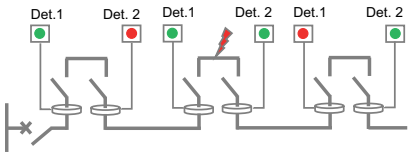
  Fault current detection is directional. All the T300 RTUs located on the section of MV network where the fault current has been signaled flash the same color. The direction of the fault current is indicated by the color of the LED. The following rules apply when the LED on the front panel of the detector in the substation indicates the color green or red:

  - **Green**: The fault current impacts the section of the network in the direction of the busbar in the substation.
  - **Red**: The fault current impacts the section of cable outside the substation.

  Example of colors indicating a fault current in directional detection:



  Second example of colors indicating a fault current in directional detection:



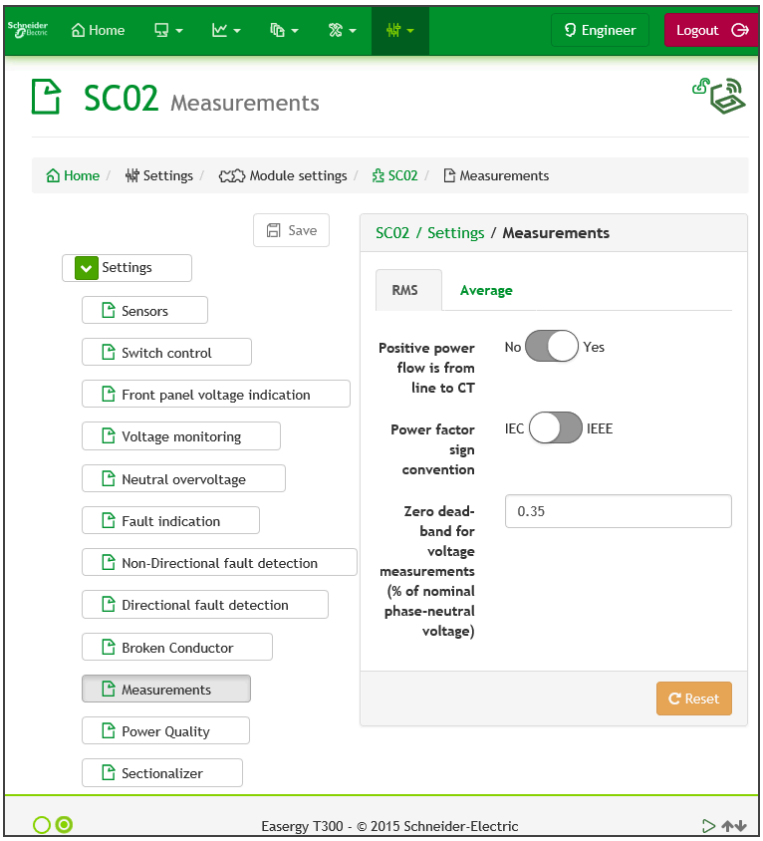
  NOTE: This theory is only valid if there is sufficient capacitive current in the network for a downstream detector to indicate the fault current (via flashing LED).

The section in which the fault current condition exists will therefore be identified in the conventional manner:

- Either in the section between the last detector to indicate the fault current (flashing) and the first detector that is not flashing
- Or by 2 consecutive detectors that are flashing the same color, indicating 2 opposite directions.

MV Power Measurement Settings

Access via **SC0x > Settings > Measurements** page.



These power measurements are optional on the SC150/SC160. If this option is not present in the equipment, the corresponding parameter settings page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the MV Measurement/PM – Power, and PM – Energy pages. See the relevant section for more information on displaying these measurements.

The SC150/SC160 is used to take power measurements for the purposes of monitoring the MV network. These power measurements comply with standard IEC 61557-12.

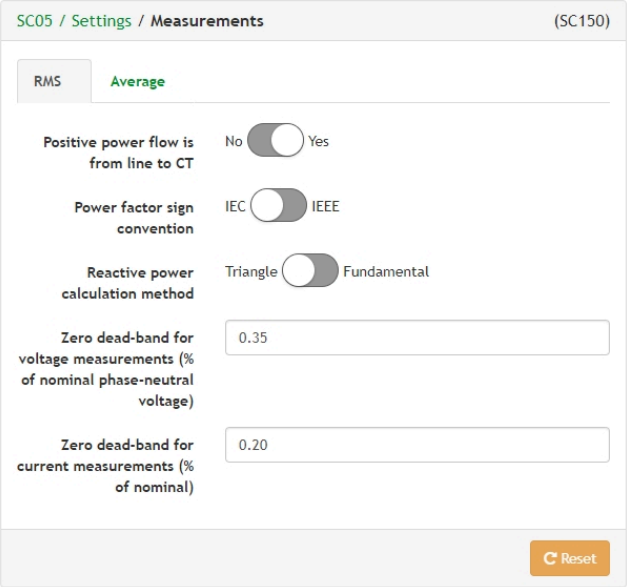
The SC150/SC160 takes these MV measurements using the same current and voltage sensors as those used to detect fault currents.

The SC150/SC160 stores the power measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

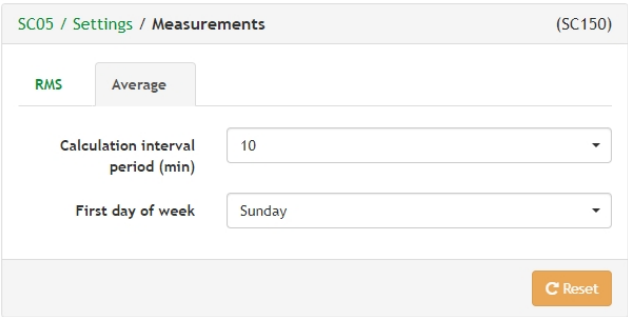
Parameters

MV Power measurements require certain options to be configured.

Setting the **RMS** values



Setting the **Average** values



Measurement parameter settings

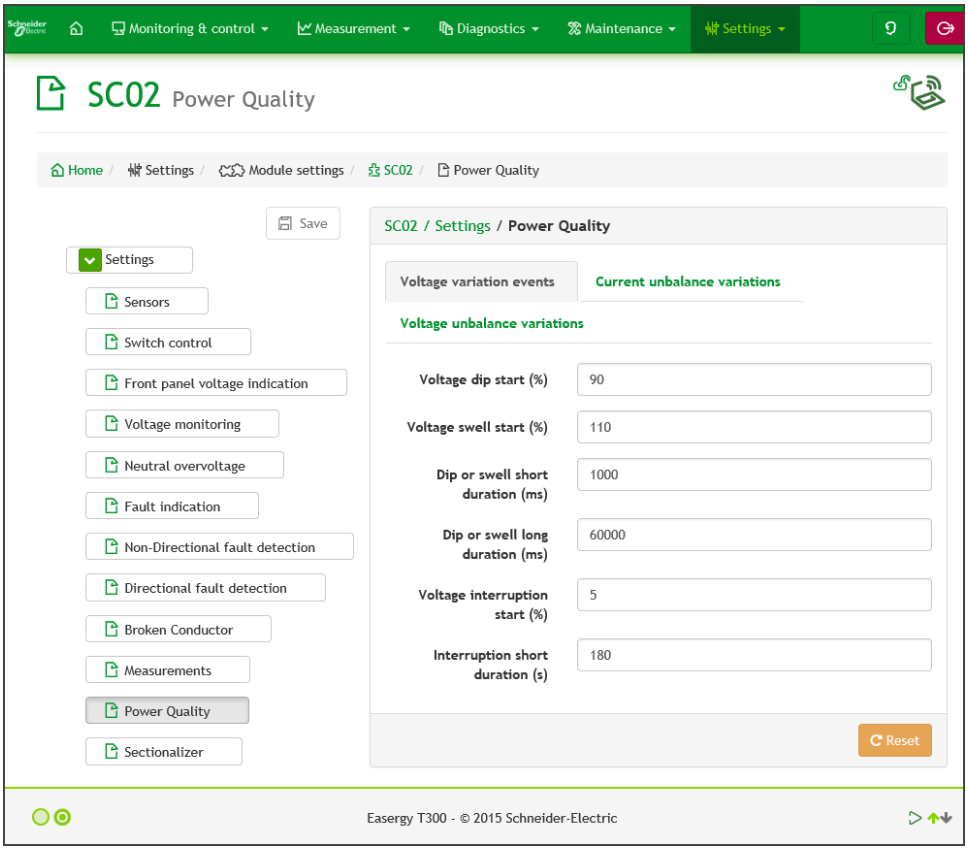
The same parameters specify the Power Measurement for MV or LV network.

Parameter	Default	Configuration range	Description
RMS			
Positive power flow is from line to CT	**Yes**	• No • Yes	Definition of the direction of the power flow on the channel. By default, a positive direction corresponds to a flow of power from the line to the CTs. This parameter depends on the location of the channel (channel = feeder or incomer). The choice assigns the sign for the power measurements calculated by the module (SC150/SC160 or LV150).
Power factor sign convention	**IEC**	• IEC • IEEE	Choice of sign convention for the power factor calculation: • **IEC:** International Electrotechnical Commission • **IEEE:** Institute of Electrical and Electronics Engineers
Reactive power calculation method	**Triangle**	• Triangle • Fundamental	Approaches used to determine the reactive power.
Zero dead-band for voltage measurements (% of nominal)	**0.35**	• 0.01–10	Filtering of low values on measured voltages. Values below this percentage will be filtered and displayed at zero value to avoid inaccurate measurement.
Zero dead-band for current measurements	**0.20**	0.01–10	Filtering of low values on measured currents. Values below this percentage are filtered and displayed at zero value to avoid inaccurate measurement.

Parameter	Default	Configuration range	Description
Average			
Calculation interval period (min)	**10**	• 1 • 5 • 10 • 15 • 20 • 30 • 60	Definition of the period for calculation interval of the averages on the measurements.
First day of week	**Sunday**	• Monday • Tuesday • Wednesday • Thursday • Friday • Saturday • Sunday	Definition of the first day of the week for the calculation of averages and min/max including a period based on the weeks.

MV Power Quality Parameter Setting

Access via **SC0x > Settings > Power Quality** page.



Parameters are displayed in the **Voltage variation events**, **Current unbalance variations** and **Voltage unbalance variations** tabs.

These power quality measurements are optional on the SC150. If this option is not present in the equipment, the corresponding parameter setting page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the **MV Measurement/Power – Quality** page. See the relevant section for more information on displaying these measurements.

Voltage measurement of power quality is performed with the 3-phase voltages. Therefore, if power quality option is activated, parameter VT connection mode is 3 phase ABC.

In addition to power measurements, the T300 can also take measurements to check the quality of the power supply on the MV network.

These measurements are completed according to the principles of IEC 61000-4-30 class S (up to harmonic 40).

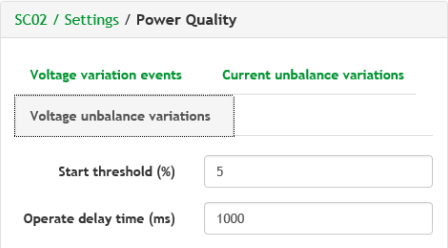
They are used in particular to monitor the number and duration of voltage interruptions, sags (dips), or swells, as well as the current and voltage unbalance and the harmonics.

The T300 takes these measurements using the same current and voltage sensors as those used to detect fault currents.

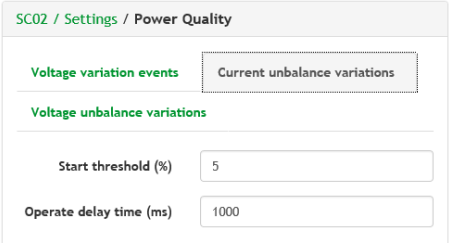
The T300 stores the measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

Power quality measurements require certain options to be configured.

Setting the voltage unbalance parameters



Setting the current unbalance parameters



These are summarized in the table below:

Parameter	Default	Configuration range	Description
Voltage variation events tab			
Voltage dip start (%)	90	5-100	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage sag (dip) by the power quality measurement.
Voltage swell start (%)	110	100–150	Threshold, as a percentage of the nominal voltage, above which the detected voltage rise is considered to be a voltage swell by the power quality measurement.
Dip or swell short duration (ms)	1000	10-60,000	Duration below which the presence of a voltage sag (dip) or swell is considered to be short duration.
Dip or swell long duration (ms)	60,000	10-60,000	Duration above which the presence of a voltage sag (dip) or swell is considered to be long duration. Similarly, the average duration corresponds to the time interval between the short and long duration.
Voltage interruption start (%)	5	1-90	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage interruption by the power quality measurement.
Interruption short duration (s)	180	60-900	Duration below which the voltage interruption is considered to be short duration. Similarly, a long duration corresponds to an interruption lasting longer than the time set for the short duration. There is no notion of average duration for voltage interruptions.
Current unbalance variations tab			
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal current, above which the current variation is considered to be a current unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200–60,000	Time delay above which the current variation is taken into account and considered to be a current unbalance by the power quality measurement.
Voltage unbalance variationstab			

Parameter	Default	Configuration range	Description
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal voltage, above which the voltage variation is considered to be a voltage unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200-60,000	Time delay above which the voltage variation is taken into account and considered to be a voltage unbalance by the power quality measurement.

Disturbance Record Settings

Access via **SC0x > Settings > Disturbance Record** page.

Disturbance Records

Operation

The disturbance record function is used to record measured analog signals, digital input signals and logical states.

The storage of records is activated by one or more events set in the **Disturbance records** page in the Web server, for each SC150/SC160 module.

Depending on the trigger position setting, the stored event can begin before the event and continues afterwards.

Records comprise the following information:

- Values sampled from the different signals
- Date

The disturbance records can log the following elements:

- Actual samples at a rate of 4,800 samples per second for:
  - Ia, Ib, Ic, I0 (measured) according to CT connection mode setting for SC150/SC160 module (in SC0x/Settings/Sensors page)
  - Va, Vb, Vc or Uab, Ubc, Uca according to VT board type and VT connection mode setting for SC150/SC160 module (in SC0x/Settings/Sensors page)
- Any change of state of the main switch (digital inputs DI1 and DI2)
- Any change of state of digital input (digital inputs DI3 to DI8)
- Any change of active Instantaneous PTOC (ANSI 50/51, 50N/51N, 67/67N and 47)
- Any change of active Instantaneous (ANSI 59, 59N)
- Any change of PQ event indications (dip, swell, and interruption)
- Any change of network presence as defined by fault confirmation

Files can be transferred locally using a PC which is connected on the HU250 front panel and includes the T300 Web server access. The record files can be downloaded from the T300 Web server (see the Disturbance Records Page, page 92).

Files can also be transferred by protocol. Refer to the protocol user manual and the Easergy Builder manual for more information on file transfer by protocol.

Characteristics

Characteristics	Values
Recording content	• Set-up file: date, channel characteristics, sampling rate • Sample file: recorded signals
Sampling frequency	4,800 samples per second
Analog signals recorded (2)	• Ia, Ib, Ic, I0 (measured) current channels • Va, Vb, Vc or Uab, Ubc, Uca voltage channels
Logical states recorded (1) (3)	Digital input signals and logical states
Number of recordings stored	Up to 50 (recorded in FIFO (First In First Out) type shift storage: when the maximum number of records is reached, the oldest record is erased when a new record is triggered.)
Total duration of a recording (1)	100 to 70,000 ms
Maximum recording capacity	140 s maximum with 70 s maximum per record
File format	COMTRADE - IEC 60255-24 Ed. 1 - 2001

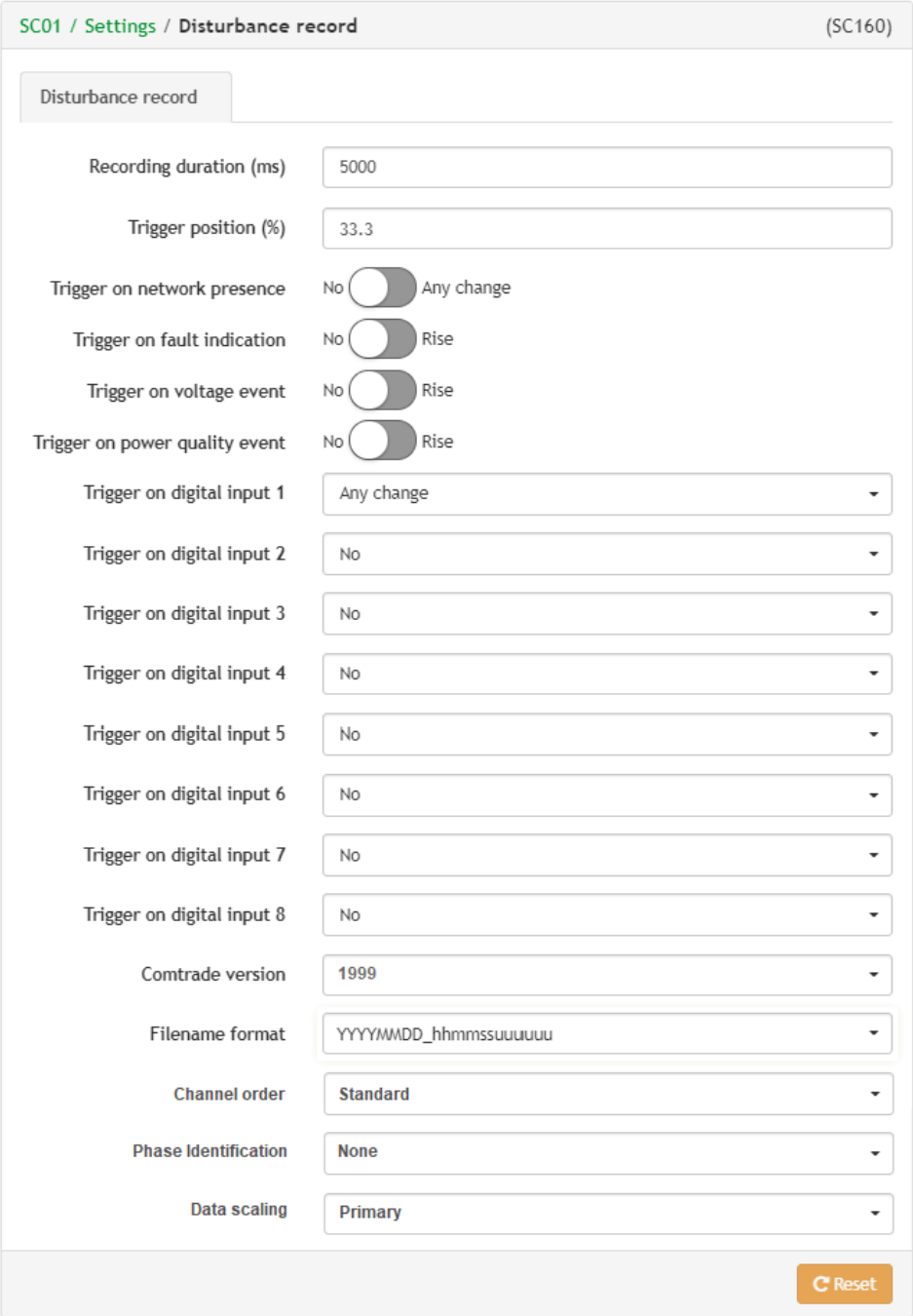
(1) To be set in the SC0x Disturbance Records Page, page 92 in the T300 Web server.

(2) According to type and connection of sensors.

(3) According to T300 system configuration.

Disturbance Records Parameter Setting on SC160

Accessed via **Settings > SC0x > Disturbance records** page.



Parameter	Default	Configuration range	Description
Recording duration (ms)	1,500	100-70,000	Total duration of a recording
Trigger position (%)	33.3	0-100	Sets the trigger point as a percentage of the recording duration. For example, the default settings show that the overall recording time is set to 1.5 s with the trigger point being at 33.3 % of this, taking into consideration the following recording times: 0.5 s before trigger and 1 s after trigger.
Trigger on network presence	No	• No • Any change	Disturbance record triggered on any change on network presence
Trigger on fault indication	No	• No • Rise	Disturbance record triggered on instantaneous detection of a protection event (ANSI 50/51, 50N/51N, 67, 67N, 47)

Parameter	Default	Configuration range	Description
Trigger on voltage event	No	• No • Rise	Disturbance record triggered on instantaneous detection of a protection event (ANSI 59 or 59N)
Trigger on power quality event	No	• No • Rise	If power quality available, disturbance record triggered on the occurrence of a power quality event (voltage dip or swell or interruption)
Trigger on digital input 1 to Trigger on digital input 8	No	• No • Rise • Fall • Any change	Digital channel selected to trigger the disturbance record on either a rising (low to high) or a falling (high to low) transition or any change

Parameter	Default	Configuration range	Description
Comtrade revision	2013	• 2013 • 1999	Version of the comtrade. If **1999** is selected, the following parameters are displayed further down: • Channel order • Phase identification • Data scaling
Filename	YYYYMMDD_ hhmmssuuuuuu	• YYYYMMDD_hhmmssuuuuuu • NNNN_YYYYMMDD_ hhmmssuuuuuu • NNNN_YYYYMMDD_hhmmss_ nnn	Format of the comtrade file name: NNNN is the comtrade number YYYYMMDD_hhmmssuuuuuu and YYYYMMDD_ hhmmss_nnn are the comtrade date with: • YYYY = year • MM = month • DD = day • hh = hour • mm = minute • ss = second • uuuuuu = microsecond • nnn= millisecond
Channel order	Standard	• Standard • Specific	Only displayed if **Comtrade revision** = 1999. If **Standard** is selected, the channel order is similar to SC150. If **Specific** is selected, the channel order is: • Voltage channel (U instead of V and Vz for neutral) • Current channel (Iz for neutral instead of I0) • and only two digital channels: ◦ FW1 (Switch open) ◦ HW1 (Switch closed)

Parameter	Default	Configuration range	Description
Phase identification	None	• None • Specific	Only displayed if **Comtrade revision** = 1999. The channel identification is the 3rd element in analog channel information (ph) in the configuration file (*.cfg). Analog channel information: An,ch_id,**ph**,ccbm,uu,a,b, skew,min,max,primary,secondary,PS. If **None** is selected, the channel phase identification is empty. If **Specific** is selected, the channel phase identification is A or B or C or Z.
Data scaling	Primary	• Primary • Secondary	Only displayed if **Comtrade revision** = 1999. The disturbance recording data scaling is the last element in analog channel information (PS) in the configuration file (*.cfg). Analog channel information: An,ch_id,ph,ccbm,uu,a,b, skew,min,max,primary,secondary,**PS**. If **Primary** is selected, the converted data is in primary (PS = P). If **Secondary** is selected, the converted data is in secondary (PS = S).

Any configuration change on this function or on sensors and network characteristics stops the record in progress. It is saved but may not comply with the expected duration. Previous records are kept as they were recorded. In case of voltage absence during disturbance recording in progress, the record is lost.

Disturbance Record Triggers

Depending on the T300 system configuration, a disturbance record can be triggered on either one or several of the following conditions:

- Network presence and absence
- Combination of instantaneous bits of fault detection protections (ANSI 50/51, 50N/51N, 67,67N, 47)
- Combination of instantaneous bits of ANSI 59 and 59N voltage
- PQ event (dip, swell, interruption)
- Digital input and switch change of state
- Dedicated command

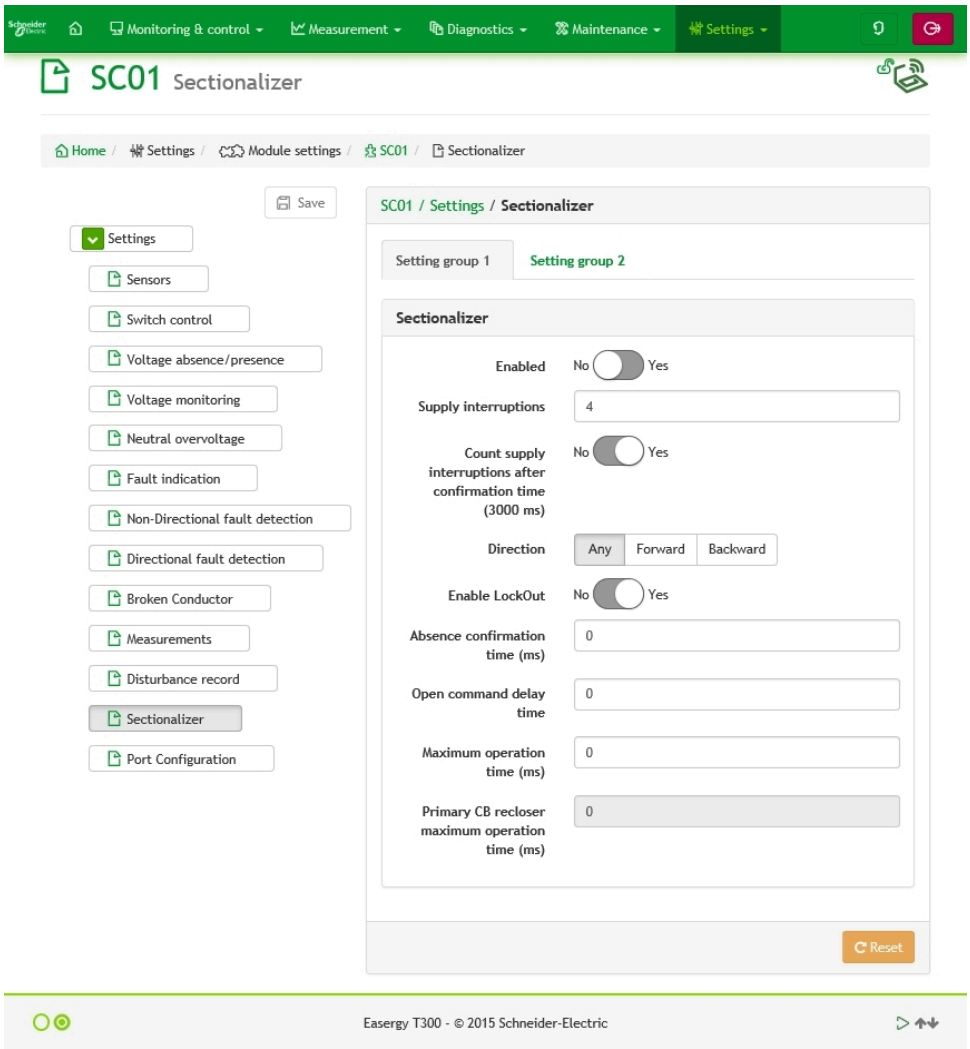
Disturbance record can be triggered on communication via remote control or a dedicated command sent from the T300 Web server. Triggering on dedicated command is always active.

There is no effect on a record if a new trigger happens while the record is already on-going.

Use WaveWin software to analyse disturbance record file.

Automation Settings

Access via **Settings > SC0x > Sectionalizer** page.



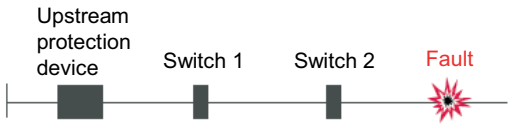
Sectionalizer Automation

Sectionalizer automation is used to disconnect a section of feeder that has a permanent electrical fault. It is used in conjunction with an upstream circuit breaker or recloser. This type of automation is applicable for feeders with sections of overhead line.

The general principle is that the automation function counts the number of supply interruptions. When the configured number of interruptions is reached, the controller opens the MV load break switch during the recloser "dead time", that is, whilst the voltage is absent. This isolates the downstream fault, allowing the recloser to restore supply to the upstream sections.

A feeder may have several sectionalizer switches, each with a different configuration, such that upstream devices are set to open at a higher number of supply interruptions than the downstream devices.

A supply interruption is defined as a fault current followed by network absence. The sectionalizer automation uses the same network absence state as the FPI functions.



NOTE: On the SC160 module, the sectionalizer is not available if the **Tripping** mode is enabled. It is available when the **Tripping** mode is disabled.

Operation

In normal operating conditions, the MV network is energized and the switch is closed.

The automation function sends an open command to the MV switch if:

- The module sectionalizer setting is enabled for the active setting group.
- The T300 automation status is ON.
- The switch is closed.
- The number of supply interruptions counted reaches the number configured.
- The MV network is absent.
- There is no fault current.

Automation enable/disable

Each SC150/SC160 module has parameter settings to enable or disable sectionalizer automation for the MV switch controlled by that module.

In addition, automation functions are enabled or disabled globally on the T300 (for all SC150/SC160 modules) either remotely from the SCADA system or locally:

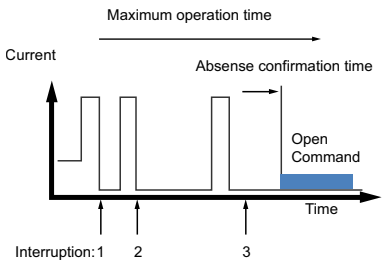
- By pressing simultaneously the (automation state button) and **OK** buttons on the front of the HU250 module.
- Via the Web server (on the **Monitoring & control > Substation** page).

Automation and FPI settings

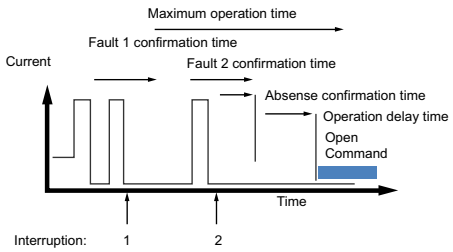
The sectionalizer automation works in conjunction with the fault passage indication function. To use the sectionalizer automation, certain FPI parameters must have compatible values:

- The **FPI network presence and confirmation mode** setting must be either **Voltage** or **Current**.
- **The Primary CB recloser maximum operation time** must be at least 1,000 ms and greater than the time required to detect the required number of supply interruptions.
- If it is required to ignore the first rapid reclose cycle, then the recloser **Fault confirmation time** should be greater than the first rapid cycle time.

Example 1:
Count after confirmation mode = No
Open after 3 interruptions



Example 2:
Count after confirmation mode = Yes
Rapid cycle ignored Open after 2 interruptions, plus operation delay time



Network absence can be detected:

- By measurement sensors (current or voltage). If the voltage measuring sensor is used, refer to the chapter Front panel voltage indication, page 384 to set the corresponding MV voltage absence settings.
- By digital input DI6.
- By the AC power supply (in this case, the T300 must be powered by a low voltage source from the MV line on which the switch is installed).

For details, see the *Fault Current validation and indication* section.

Automation Lock Out

Certain conditions can block the automation function. When this occurs, the “automation locked” LED lights up orange on the front panel of the SC150/SC160 (and the HU250). It is possible to reset the automation lock out as follows:

- By pressing the **Reset** (fault current indication reset) button on the front of the HU250 module
- On the **Substation** page, by clicking the **Reset** button associated with the automation function.

The automation lock out conditions are active only if the **Enable LockOut** option is activated by configuration. These conditions are associated with any action that makes it impossible to operate the MV switch, namely:

- If the T300 is in local mode and the **Enable local mode to block automation** option is enabled by configuration.
- If the switch interlock digital input (DI5) is enabled and the **External input mode for open commands** blocking option is enabled by configuration.
- If the switch position is unknown at the time of the command and the **Block if switch position is unknown or same as command** option is enabled by configuration

  NOTE: The three blocking options above can be configured in the **Switch control** page (see the **Interlock Function** section).

Sectionalizer automation parameter setting

Access via **SC0x > Settings > Sectionalizer** page.

The setting includes two groups of settings. These two groups define two sets of preset parameters.

The settings group can easily be changed by a command to select the active group (from 1 to 8 depending on the number of groups configured, page 353) from the preset thresholds, without needing to reconfigure the T300. This is done in the **Monitoring & Control > Substation** page (see the corresponding section) or remotely from the SCADA system.

Sectionalizer automation requires certain options to be configured. These are summarized in the table below.

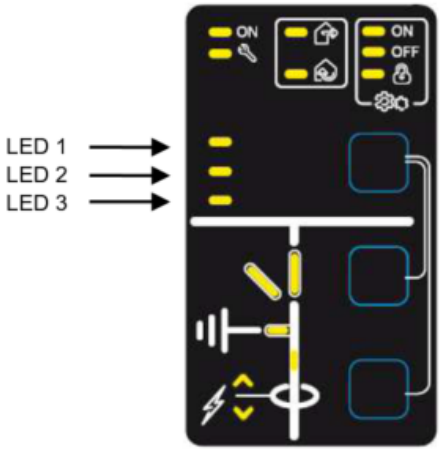
Parameter	De-fault	Configuration range	Description
Sectionalizer			
Enabled	No	• No • Yes	Activation of the sectionalizer automation function on the SC150/SC160. **NOTE:** On the SC160 module, if the tripping protection is enabled, the sectionalizer function is not available. **NOTE:** At least one protection instance must be configured as **FPI + sectionalizer**.
Supply interruptions	4	1-4	Number of confirmed faults to detect during the sectionalizer **Maximum operation time (ms)** to trigger the sectionalizer automation action
Count supply interruptions after confirmation time (3000 ms)	Yes	• No • Yes	Counting supply interruptions condition: • When the setting value is **No**, supply interruptions are counted as soon as a fault has been validated by a supply interruption. • When the setting value is **Yes**, the function waits for the confirmation time before counting supply interruptions. **Fault confirmation time** is the delay before re-checking for network absence (ms). **Fault confirmation time** is set in **Settings > SC0x > Fault indication > Recloser parameters**, page 354 page.
Direction	Any	• Any • Forward • Backward	Choice of the fault current direction taken into account to activate sectionalizer automation
Enable LockOut	Yes	• No • Yes	This setting applies if the switch does not open when commanded. • When the setting value is **No** then the automation function attempts to open the switch on the next interruption. • When the setting value is **Yes** then the automation function is locked out and is not activated for new fault interruptions until it is reset by the user. When lock out is active, the “automation locked” LED is lit on the front of both the SC150/SC160 and HU250 modules.
Absence confirmation time (ms)	0	0–10,000 increment = 1	The time network must be absent before the sectionalizer automation takes the decision to send the switch open command.
Open command delay time (ms)	0	0–30,000 increment = 1	Additional delay after confirmation of network absence before executing the switch open command
Maximum operation time (ms)	0	0–30,000 increment = 1	Sectionalizer maximum operation time. If the **Enabled** setting value is **Yes**, this setting must be greater than 1,000 ms and less than or equal to the value of **Primary CB recloser maximum operation time (ms)**.
Primary CB recloser maximum operation time (ms)	0	0–300,000 increment = 1	Read only (copy of the value set in the **Settings > SC0x > Fault indication > Recloser parameters**, page 354). After a fault current has been detected on the MV network, this time delay corresponds to the total operation time for all the reclose cycles of the upstream protection device.

Local I/O on SC150/SC160 module

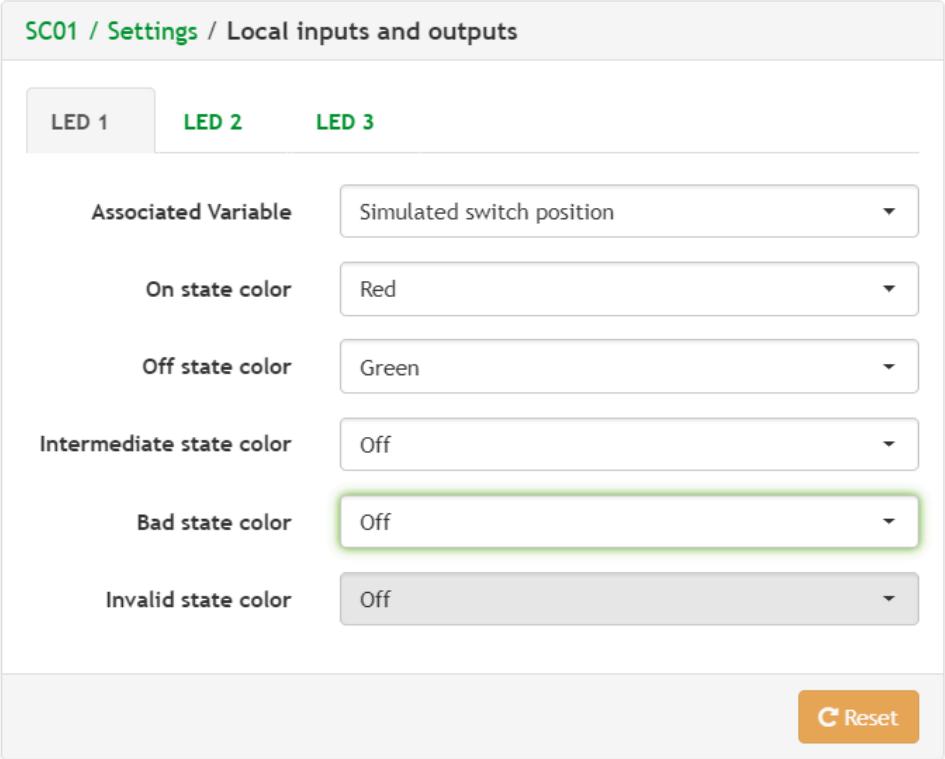
Customizing LEDs on the SC150/SC160 module

The color of 3 user LEDs on the front of the SC150/SC160 or LV150 modules can be customized.

LEDs 1 to 3 can be assigned to different variables/functions. The colors and behavior can be customized for each state.



Access via **Settings > SCx > Local inputs and outputs** page.



Variables/functions that can be associated with each LED (1, 2, 3)

Associated variables	Comment	Type	Proposed Color / Behavior
None	Default for LED 2	SPS	• 0 Intermediate: Off • 1 Off = Off • 2 On = Off
Dummy switch			
Simulated switch position	Default for LED 1 (dummy circuit breaker)	DPS	• 0 Intermediate: Off • 1 Off = Open: Green • 2 On = Closed: Red
Physical inputs			
Digital input 5	(Switch interlock input)	SPS	• 0 = Off • 1 On = Orange • Invalid: Red-blink
Digital input 6	(Voltage presence)	SPS	
Digital input 7		SPS	
Digital input 8		SPS	
Physical outputs			
Open command output status		SPS	• 0 Off = Off • 1 On = Orange
Close command output status		SPS	
Switch controller blocking conditions			
External lock active	Default for LED 3. Logical OR of {MainXSWI_BlkOpn_stVal, MainXSWI_BlkCls_stVal}	SPS	• 0 Off = Off • 1 On = Orange • Invalid: Red-blink
Switch open commands blocked	Function of variables {Switch position, Digital input 5} and setting {“External input mode for Open commands”}	SPS	
Switch closed commands blocked	Function of variables {Switch position, Digital input 5} and setting {“External input mode for Close commands”}	SPS	
Sectionalizer state			
Sectionalizer enabled	for active setting group	SPS	• 0 Off = Off • 1 On = Green
Sectionalizer automation started	(in progress)	SPS	• 0 Off = Off • 1 On = Orange
Automation operated	(sectionalizer opened the switch)	SPS	
FPI Phases			
Fault indication on phase A / B / C		SPS	• 0 Off = Off • 1 On = Red
FPI Faults			
Phase fault		SPS	• 0 Off = Off • 1 On = Red
Earth fault		SPS	
Sensitive Earth fault		SPS	

Setting LED colors

Parameter	Default	Configuration range	Description
LEDs 1 to 3			
On state color	Red	• Off • Red • Green • Orange • Red blink • Green blink • Orange blink	Choice of color for LEDs 1 to 3 for the active state of the data.
Off state color	Green		Choice of color for LEDs 1 to 3 for the inactive state of the data.
Intermediate state color	Off		Choice of color for LEDs 1 to 3 for the intermediate state of the data. The intermediate state can be, for instance, the transitional phase of a change of state. For DPS only.
Bad state color	Off		Choice of color for LEDs 1 to 3 for a bad state of the data. A bad state may be an unexpected state for the data. For DPS only
Invalid state color	Green blink		Choice of color for LEDs 1 to 3 for an invalid state of the data. An invalid state corresponds to a missing known state for the data.

Settings by Protocol

A part of the SC160 module settings can be read and changed by protocols in using advanced configuration and specific commands and sequence:

1. select the setting group to edit (edition phase)
2. send the setting values
3. wait for 5s
4. confirm application of new settings
5. wait for 5s
6. read the applied settings and check them.

   NOTE: If the same setting is edited several times during the edition phase, only the first value is saved.

Refer to the protocol user manual and the Easergy Builder manual for more information on settings by protocol **DLT634.5101-2002** and **DLT634.5104-2009**.

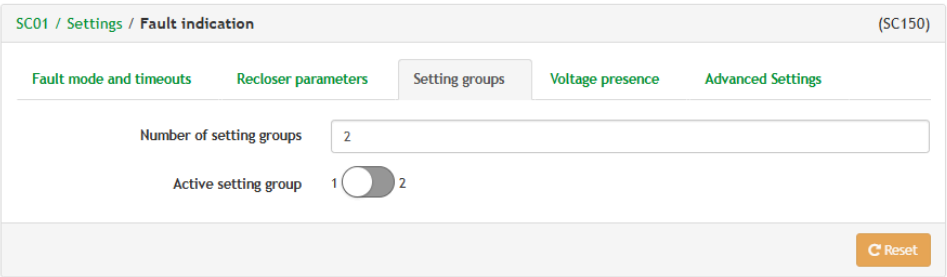
The following settings are accessible by protocol:

Name	Description	Type	Unit
AbsPTUV1_LnEna_setVal	Voltage absence 1 enabled	Bool	
AbsPTUV1_OpDlTmms_setVal	Voltage absence 1 validation time setting	Unsigned int	ms
AbsPTUV1_StrValPct_setMag	Voltage absence 1 threshold setting as percentage of rating	Float	%
AbsPTUV2_LnEna_setVal	Voltage absence 2 enabled	Bool	
AbsPTUV2_OpDlTmms_setVal	Voltage absence 2 validation time setting	Unsigned int	ms
AbsPTUV2_StrValPct_setMag	Voltage absence 2 threshold setting as percentage of rating	Float	%
DEfPTOC1_LnEna_setVal	Directional earth fault detection instance 1 enabled	Bool	
DEfPTOC1_OpDlTmms_setVal	Directional earth fault detection instance 1 validation time setting	Unsigned int	ms
DEfPTOC1_StrVal_setMag	Directional earth fault detection instance 1 current threshold setting	Float	A
DEfPTOC2_LnEna_setVal	Directional earth fault detection instance 2 enabled	Bool	
DEfPTOC2_OpDlTmms_setVal	Directional earth fault detection instance 2 validation time setting	Unsigned int	ms
DEfPTOC2_StrVal_setMag	Directional earth fault detection instance 2 current threshold setting	Float	A
DPhPTOC1_LnEna_setVal	Directional phase fault detection instance 1 enabled	Bool	
DPhPTOC1_OpDlTmms_setVal	Directional phase fault detection instance 1 validation time setting	Unsigned int	ms
DPhPTOC1_StrVal_setMag	Directional phase fault detection instance 1 threshold setting	Float	A
DPhPTOC2_LnEna_setVal	Directional phase fault detection instance 2 enabled	Bool	
DPhPTOC2_OpDlTmms_setVal	Directional phase fault detection instance 2 validation time setting	Unsigned int	ms
DPhPTOC2_StrVal_setMag	Directional phase fault detection instance 2 threshold setting	Float	A
EfPTOC1_LnEna_setVal	Earth fault detection instance 1 enabled	Bool	
EfPTOC1_OpDlTmms_setVal	Earth fault detection instance 1 validation time setting	Unsigned int	ms
EfPTOC1_StrVal_setMag	Earth fault detection instance 1 threshold setting	Float	A
EfPTOC2_LnEna_setVal	Earth fault detection instance 2 enabled	Bool	
EfPTOC2_OpDlTmms_setVal	Earth fault detection instance 2 validation time setting	Unsigned int	ms
EfPTOC2_StrVal_setMag	Earth fault detection instance 2 threshold setting	Float	A
EfPTOC3_LnEna_setVal	Earth fault detection instance 3 enabled	Bool	
EfPTOC3_OpDlTmms_setVal	Earth fault detection instance 3 validation time setting	Unsigned int	ms
EfPTOC3_StrVal_setMag	Earth fault detection instance 3 threshold setting	Float	A
EfPTRC1_RefDEfPTOC1_setVal	Directional Earth Fault 1 enabled for tripping	Bool	
EfPTRC1_RefDEfPTOC2_setVal	Directional Earth Fault 2 enabled for tripping	Bool	
EfPTRC1_RefEfPTOC1_setVal	Earth Fault 1 enabled for tripping	Bool	
EfPTRC1_RefEfPTOC2_setVal	Earth Fault 2 enabled for tripping	Bool	
EfPTRC1_RefEfPTOC3_setVal	Earth Fault 3 enabled for tripping	Bool	
EfPTRC1_RefSEfPTOC1_setVal	Sensitive Earth Fault 1 enabled for tripping	Bool	
FeaDGIO1_DebTmms_setVal	Digital input debouncing sample time (corresponding to Debouncing sample count * Sample period (ms))	Unsigned int	ms
MainXSWI1_PlsOnTmms_setVal	Main switch control pulse duration	Unsigned int	ms
PhPTOC1_LnEna_setVal	Phase fault detection instance 1 enabled	Bool	
PhPTOC1_OpDlTmms_setVal	Phase fault detection instance 1 validation time setting	Unsigned int	ms

Name	Description	Type	Unit
PhPTOC1_StrVal_setMag	Phase fault detection instance 1 threshold setting	Float	A
PhPTOC2_LnEna_setVal	Phase fault detection instance 2 enabled	Bool	
PhPTOC2_OpDlTmms_setVal	Phase fault detection instance 2 validation time setting	Unsigned int	ms
PhPTOC2_StrVal_setMag	Phase fault detection instance 2 threshold setting	Float	A
PhPTOC3_LnEna_setVal	Phase fault detection instance 3 enabled	Bool	
PhPTOC3_OpDlTmms_setVal	Phase fault detection instance 3 validation time setting	Unsigned int	ms
PhPTOC3_StrVal_setMag	Phase fault detection instance 3 threshold setting	Float	A
PhPTRC1_RefDPhPTOC1_setVal	Directional Phase Fault 1 enabled for tripping	Bool	
PhPTRC1_RefDPhPTOC2_setVal	Directional Phase Fault 2 enabled for tripping	Bool	
PhPTRC1_RefPhPTOC1_setVal	Phase Fault 1 enabled for tripping	Bool	
PhPTRC1_RefPhPTOC2_setVal	Phase Fault 2 enabled for tripping	Bool	
PhPTRC1_RefPhPTOC3_setVal	Phase Fault 3 enabled for tripping	Bool	
PrsPTOV1_LnEna_setVal	Voltage presence 1 enabled	Bool	
PrsPTOV1_OpDlTmms_setVal	Voltage presence 1 validation time setting	Unsigned int	ms
PrsPTOV1_StrValPct_setMag	Voltage presence 1 threshold setting as percentage of rating	Float	%
PrsPTOV2_LnEna_setVal	Voltage presence 2 enabled	Bool	
PrsPTOV2_OpDlTmms_setVal	Voltage presence 2 validation time setting	Unsigned int	ms
PrsPTOV2_StrValPct_setMag	Voltage presence 2 threshold setting as percentage of rating	Float	%
SEfPTOC1_LnEna_setVal	Sensitive earth fault detection enabled	Bool	
SEfPTOC1_OpDlTmms_setVal	Sensitive earth fault detection validation time setting	Unsigned int	ms
SEfPTOC1_StrVal_setMag	Sensitive earth fault detection threshold setting	Float	A
TCTR1_IoPriARtg_setMag	CT Core balance primary rated current	Float	A
TCTR1_IoSecARtg_setMag	CT Core balance secondary rated current	Float	A
TCTR1_PhPriARtg_setMag	CT Phase primary rated current	Float	A
TCTR1_PhSecARtg_setMag	CT Phase secondary rated current	Float	A
TVTR1_PriVRtg_setMag	Primary rated voltage (phase-to-phase)	Float	V
TVTR1_SecVRtg_setMag	Secondary rated voltage (phase-to-phase)	Float	V

Parameter Setting

Access via **SC0x > Settings > Global fault indication** page, **Setting group** tab.



Parameter	De-fault	Configuration range	Description
Enable settings by protocol	Yes	• No • Yes	This option specifies whether edition of settings by protocol is enabled or disabled.

LV150 Module Settings

What's in This Chapter

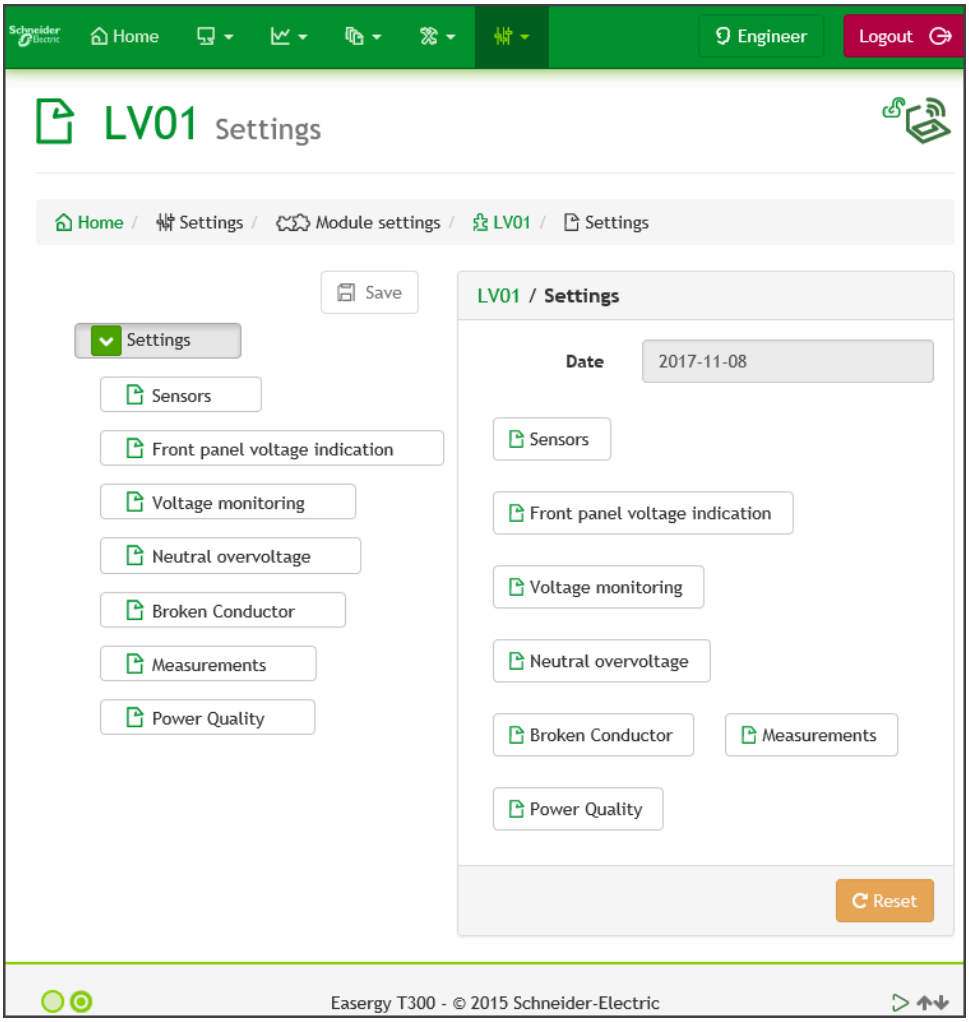
LV Current and Voltage Sensors 378
Front Panel Voltage Indication 384
LV Power Measurement Settings 387
LV Power Quality Settings 390
Local I/O on LV150 module 392

Other functionalities (common to the SC150 and LV150 modules):

Voltage Monitoring, page 394

Broken Phase Conductor Detection, page 401

Port Configuration, page 404



Each LV150 module supports the following T300 functions:

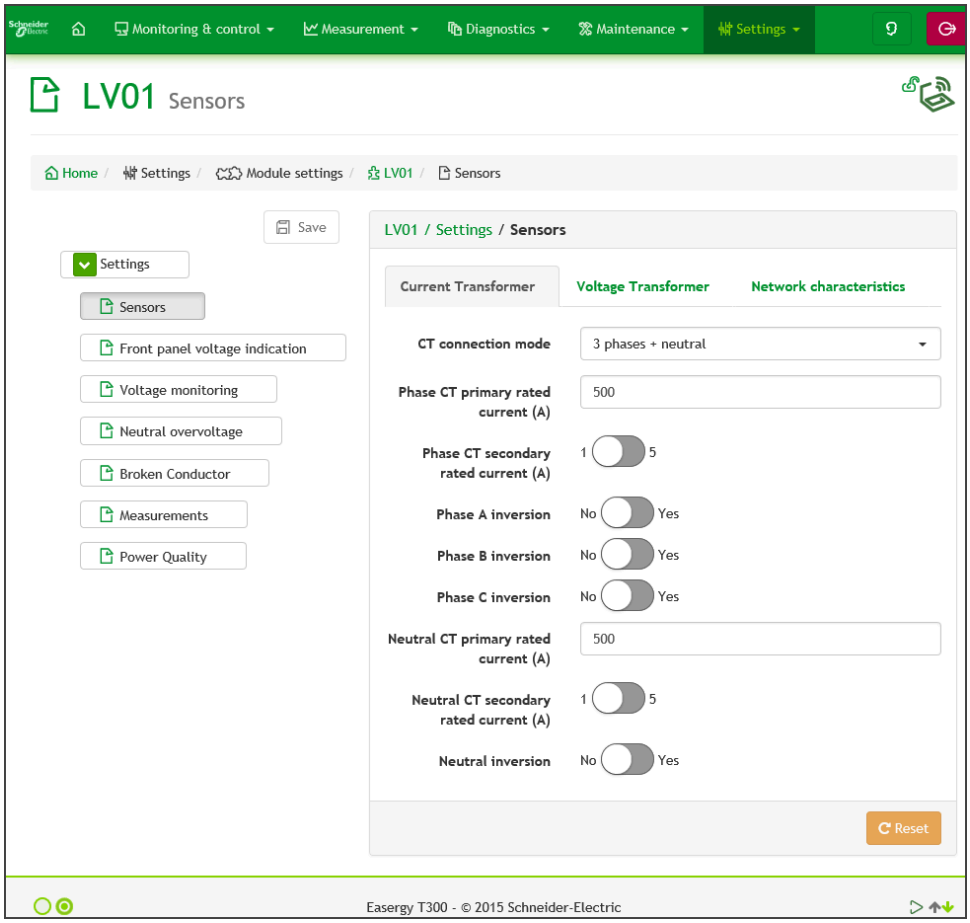
- **LV Current and voltage measurements**
  The LV150 is compatible with all standard current sensors (according to IEC 61869-2).
  There are 2 possible connection configurations for acquiring the current measurement:
  - 3 phase CTs
  - 3 phase CTs + 1 neutral measurement CT

- **LV network voltage monitoring**
  - Undervoltage detection (ANSI 27)
  - Overvoltage detection (ANSI 59)
  - Neutral overvoltage detection (ANSI 59N)
  - Broken conductor detection (ANSI 47)
- **Broken conductor detection**
- **Power measurements and power quality**
  - Power measurements (IEC 61557-12)
  - Power quality (according to the principles of IEC 61000-4-30 Class S)
- **Transformer monitoring**
  - Temperature monitoring with threshold alarm
  - Measurement of current peaks
- **Port configuration**
  - Limit access to a physical port on the LV150 module
- **Local I/O**

All these functions are explained in detail in this manual, together with the corresponding application parameter settings.

LV Current and Voltage Sensors

Access via **Settings > LV0x > Sensors** page.



LV Current Sensors

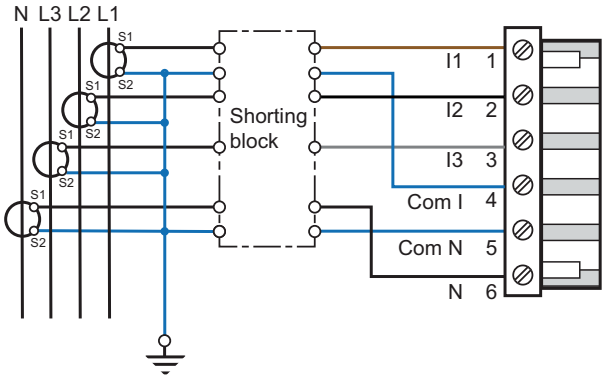
The LV150 default configuration includes a current transformer with a ratio of 500:1. The type of CT to be used is selected by the user.
It is possible, however, to define a different primary/secondary ratio by configuration if a CT with different characteristics is used.

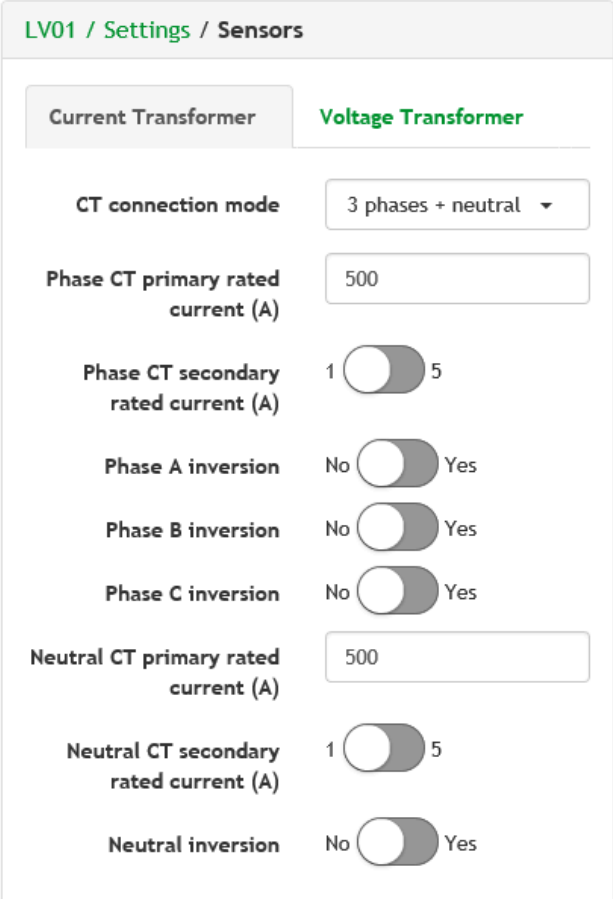
Several CT connection configurations are possible on the LV150:

- 3 phase CTs
- 3 phase CTs + 1 neutral measurement CT

  NOTE: In 3 phase CTs mounting, the neutral is calculated by summing the measurements on the 3 phase sensors. In 3 phase CTS + neutral mounting, the neutral is measured directly on the neutral sensors.

Current sensor parameter settings:





Parameter	Default	Configuration range	Description
Current Transformer			
CT connection mode	D	• None • A • D	Choice of CT connection configuration options: • 3 phase CTs • 3 phase CTs + neutral.
Phase CT primary rated current (A)	500	50 –3000 (increment = 1)	Nominal value of the current at the phase CT primary
Phase CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the phase CT secondary
Phase A (B, C) inversion	No	• No • Yes	Used to reverse the direction of the current flowing from phase A (B, or C). This parameter is used to compensate for an inversion of the direction of connection of the CT on the LV cable via the software.
Neutral CT primary rated current (A)	500	50 –3000 (increment = 1)	Nominal value of the current at the neutral CT primary
Neutral CT secondary rated current (A)	1	• 1 • 5	Nominal value of the current at the neutral CT secondary
Neutral inversion	No	• No • Yes	Used to reverse the direction of the residual current. This parameter is used to compensate via the software an inversion of the direction of connection of the CT on the LV cable or a reverse winding direction of neutral CT compared to phase CTs.

NOTICE

HAZARD OF INAPPROPRIATE ASSEMBLY

Make sure that the CTs are mounted in the correct direction not to impact the current measurements.

Failure to follow these instructions can result in equipment damage.

DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- The current sensors used for measuring must be 1 A or 5 A secondary with security factor limiting the current to 100 A secondary -1 s (according to standard 61869-2).
- The toroids must be short-circuited at the secondary when they are disconnected from the T300 (e.g. during a maintenance operation). To do this, use a shorting block.
- The low-voltage insulation of the PowerLogic CTs must only be used on insulated cables.
- Always use grounded external CTs for current inputs.
- Make sure that the LV Network is turned off before installing the CTs on the LV cable and making the CT connections to the LV150.

Failure to follow these instructions will result in death or serious injury.

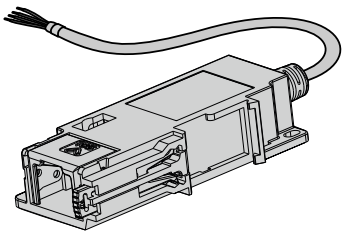
LV Voltage Sensors

The LV150 uses a single sensor (Voltage adapter) for measuring and monitoring Low Voltage. The LV150 requires LV measurement for the following functions:

- LV network monitoring
- LV voltage measurement
- LV power measurement
- LV power quality measurement

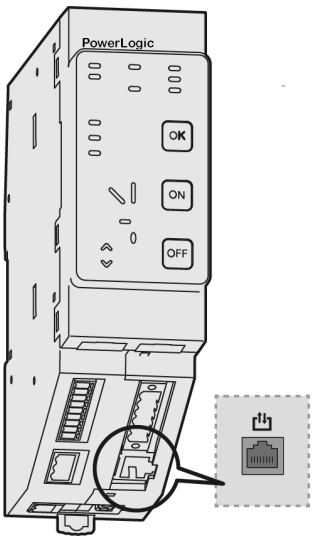
The measurement is carried out directly from the sensor without any calibration. The LV sensor used with LV150 is shown in the table below. This type of voltage sensor (available as an option) including a specific adapter allows the connection interface to the LV150 module:

LV150-Voltage adapter (VT)



VT adapter

Voltage input on the LV150

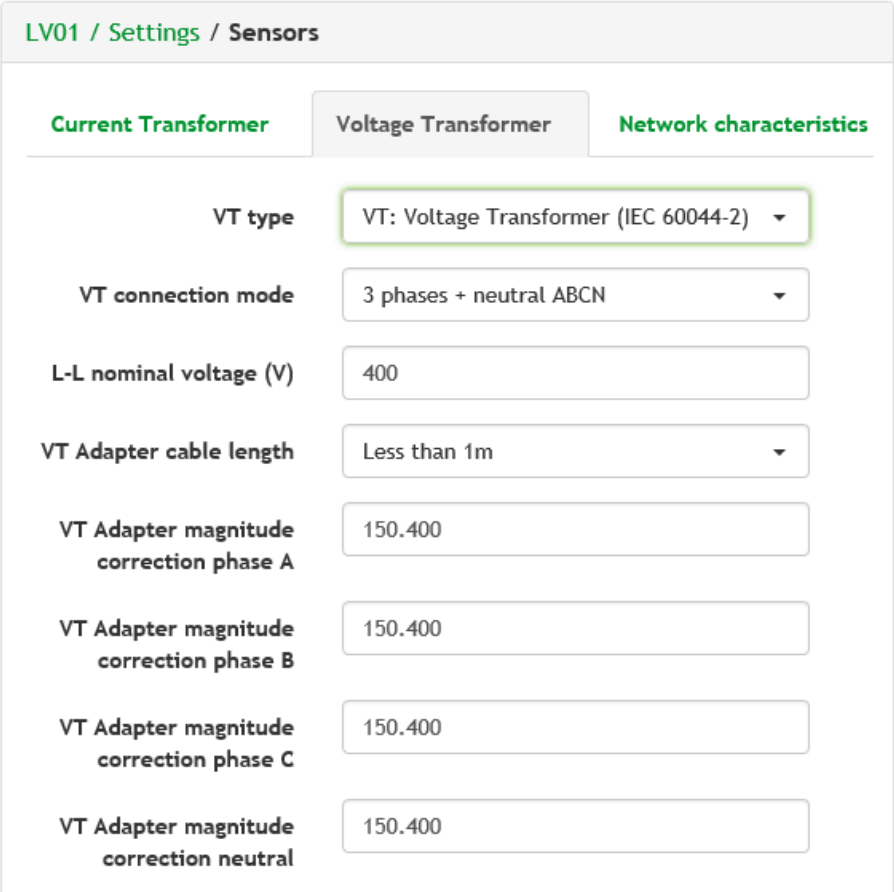


Voltage Sensor	Description	Adapter Required
VT	Resistive voltage adapter/divider with 10 KV/1 sec (6 KV/1 mn) insulation. **NOTE:** The LV150 Voltage adapter accepts 3 phase + neutral LV connections. For more information about the mounting of the adapter, refer to the LV150 Voltage adapter Installation guide (ref: NT00393).	**LV150-Voltage adapter (ref: EMS59574):** Voltage input (LL): 190 V to 415 VAC IP 30

The link between the adapter and the voltage input on the LV150 module (RJ45 connector) is via "straigth-through" Ethernet cable including RJ45 connectors.

Voltage sensor parameter settings:

Access via **LV0x > Settings > Sensors** page.



Parameter	Default	Configuration range	Description
Voltage Transformer			
VT type	VT	• None • VT	Choice of the type of voltage adapter used as the voltage measurement sensor. The dedicated adapter for the LV150 is the voltage adapter (VT).
VT connection mode	3 phases + neutral ABCN	3 phases + neutral ABCN	Choice of the type of connection used for the voltage sensor. The LV sensor requires the wiring of the three phases plus the neutral.
L-L nominal voltage (V)	400	190-415 (increment = 1)	Definition of the nominal voltage of the LV network (phase-to-phase voltage).
VT adapter cable length	Less than 1 m	• Less than 1 m • 1 m to 2 m • More than 2 m	Definition of the length of the Ethernet cable used for the voltage adapter-LV150 adapter link. The length of the cable affects the accuracy of the measurement.
VT adapter magnitude correction phase A	150.400	140-160 (increment =0,001)	Used to calibrate the phase A measurement taken by the voltage adapter to improve accuracy. The corresponding calibration value is indicated on the voltage adapter.
VT adapter magnitude correction phase B	150.400	140-160 (increment =0,001)	Used to calibrate the phase B measurement taken by the Voltage adapter to improve accuracy. The corresponding calibration value is indicated on the voltage adapter.
VT adapter magnitude correction phase C	150.400	140-160 (increment =0,001)	Used to calibrate the phase C measurement taken by the Voltage adapter to improve accuracy. The corresponding calibration value is indicated on the voltage adapter.
VT adapter magnitude correction neutral	150.400	140-160 (increment =0,001)	Used to calibrate the neutral measurement taken by the Voltage adapter to improve accuracy. The corresponding calibration value is indicated on the voltage adapter.

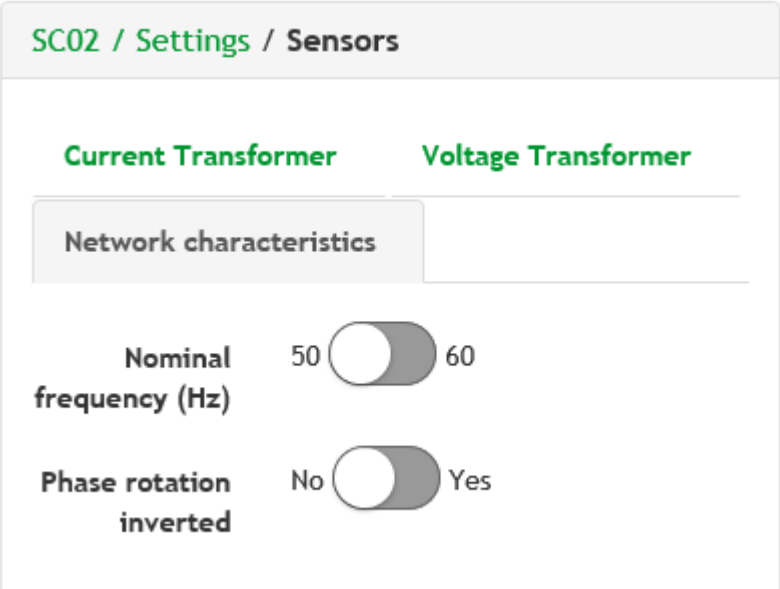
⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Do not connect the voltage adapter directly to the MV sensors.
- Always use fuse and disconnect switch (maximum voltage allowable on the voltage adapter inputs: 10 Vac).
- Never short the secondary of a voltage transformer (VT).
- Do not connect items of equipment with different earth potentials with an RJ45 cable.
- Do not use RJ45 cable longer than 10 meters (32.8 feet).

Failure to follow these instructions will result in death or serious injury.

Network Characteristics



There are other parameters in addition to the sensor parameters.

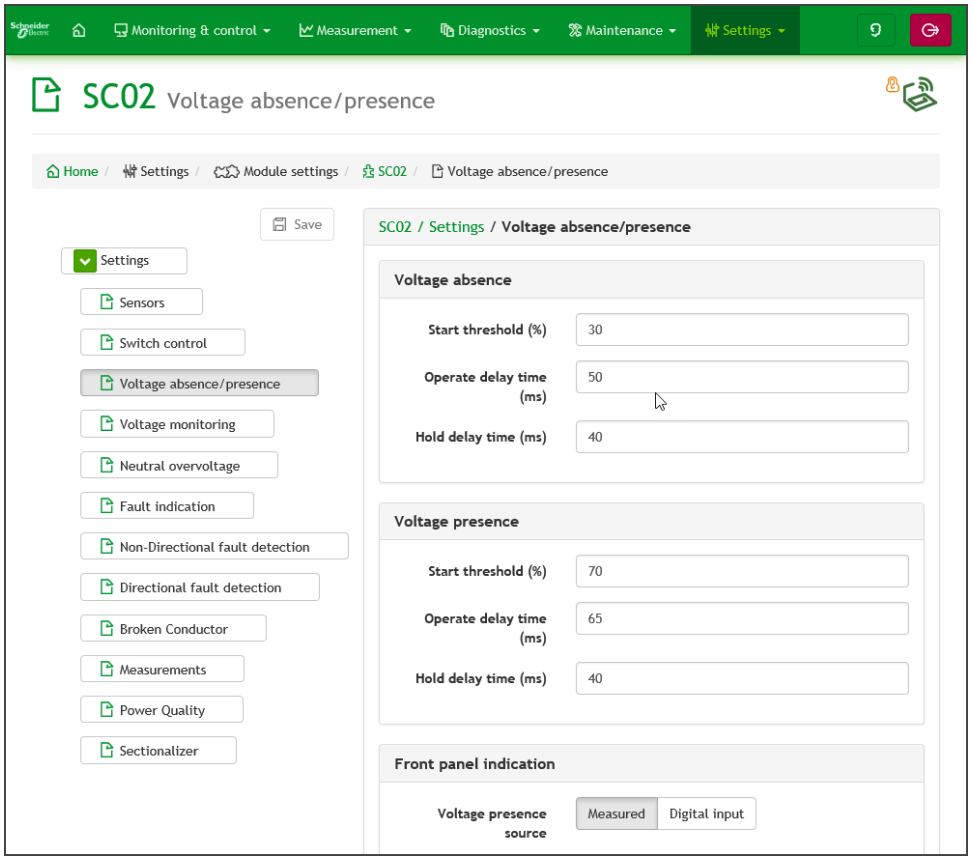
- The LV150 module can take current and voltage measurements at 50 Hz or 60 Hz to correspond with the existing network frequencies.
- The sequence of phases A, B, and C can be inverted.

Measured voltages and frequency parameter settings:

Parameter	Default	Configuration range	Description
Network Characteristics			
Nominal frequency (Hz)	50	• 50 • 60	Choice of LV network frequency
Phase rotation inverted	No	• Yes • No	Used to invert the phase sequence: • **Yes** = ACBN (inverted) • **No** = ABCN (normal sequence) The ACBN sequence must be used when the CT wiring or connection configuration has been inverted in relation to the theoretical phase sequence or for networks with an inverted phase sequence. **NOTE:** This inversion affects current and voltage.

Front Panel Voltage Indication

Access via **Settings > LV0x > Voltage absence/presence** page.



A LED on the front panel of the LV150 module indicates the presence or absence of the LV network voltage.

The voltage presence indication source are the measurements from the voltage sensors.

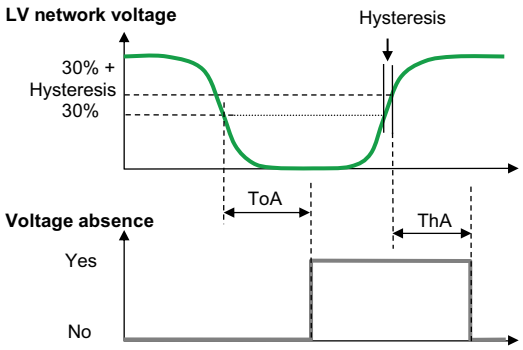
The LED uses colors to show how many phases are present. Off means 3 phases absent Red means 3 phases present Orange means 1 or 2 phases present.

The threshold and delay settings are used to determine the value of two status variables for “voltage absence for three phases” or “voltage presence for three phases” (see diagrams).

Front panel voltage indication settings:

Parameter	Default	Configuration range	Description
Voltage absence			
Start threshold (%)	30	10-100 (increment = 1)	Definition of the measured LV network voltage threshold, as a percentage of the nominal voltage, below which the LV network voltage will be considered to be absent. **NOTE:** Configure the threshold taking into account hysteresis (6 %). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must be below the **Start threshold** level to consider the LV network voltage to be absent.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to above the **Start threshold** level to consider the LV network voltage to be not absent (to define the delay to be configured, take into account hysteresis: 6 %).
Voltage presence			
Start threshold (%)	70	10-100 (increment = 1)	Definition of the measured LV network voltage threshold, as a percentage of the nominal voltage, above which the LV network voltage will be considered to be present. **NOTE:** Configure the threshold taking into account hysteresis (7 %). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Period within which the voltage must be above the **Start threshold** level to consider the LV network voltage to be present.
Hold delay time (ms)	40	40-300000 (increment = 1)	Period within which the voltage must return to below the **Start threshold** level to consider the LV network voltage to be not present (to define the delay to be configured, take into account hysteresis: 7 %).
Front panel indication			
Voltage presence source	Digital input	• Measured • Digital input	Choice of source for indicating voltage presence/absence on the front panel of the SC150/SC160 module: • Measured: voltage measurement taken by the voltage sensors. • Digital input: digital input DI6 ("MV Presence") on the SC150/SC160 9-way connector. This digital input is typically connected to an external voltage relay installed in the MV cubicle (for example. VD23).

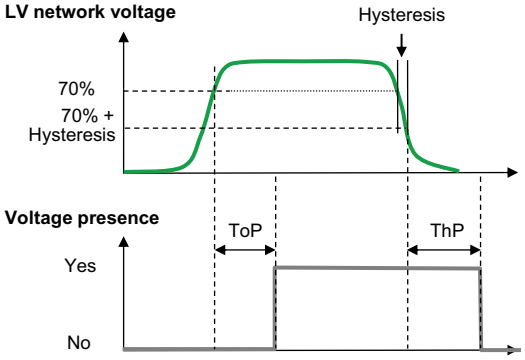
Detection of LV voltage absence from the measures



ToA: **Operate delay time** – voltage absence (by default: 50 ms)

ThA: **Hold delay time** – voltage absence (by default: 40 ms)

Detection of LV voltage presence from the measures

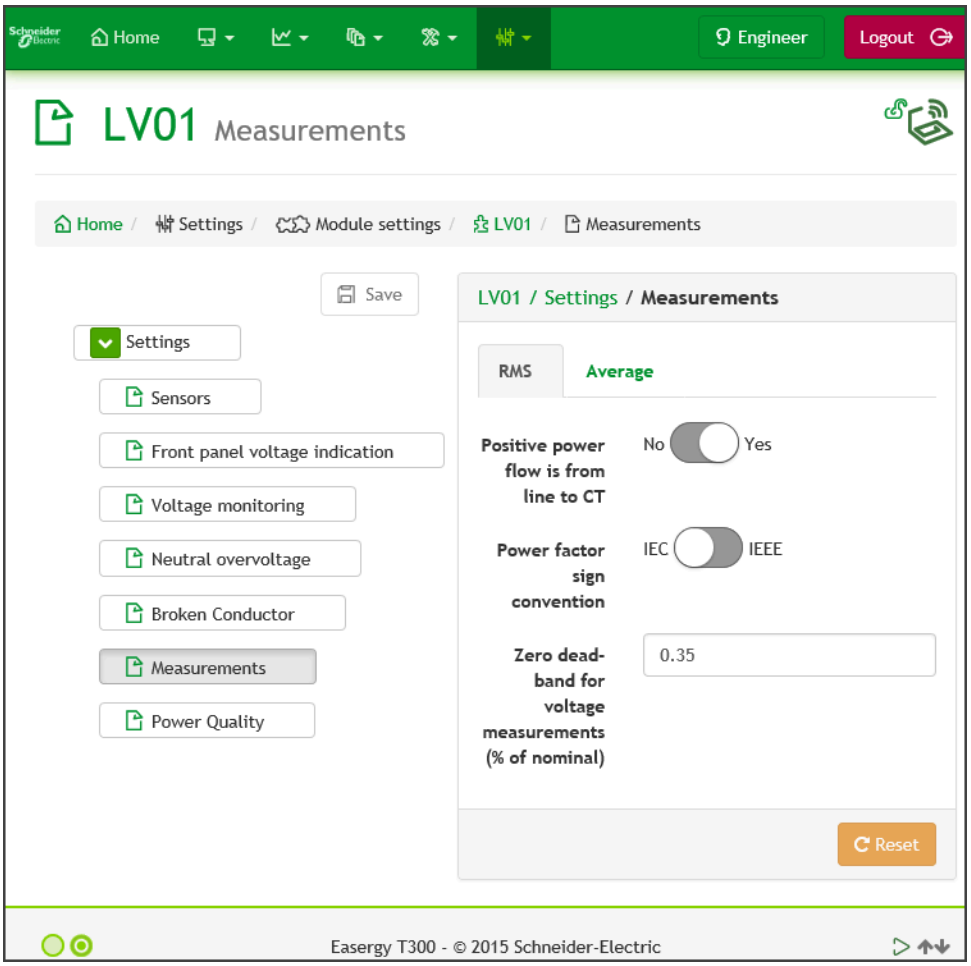


ToP: **Operate delay time** – voltage presence (by default: 50 ms)

ThP: **Hold delay time** – voltage presence (by default: 40 ms)

LV Power Measurement Settings

Access via **LV0x > Settings > Measurements** page.



The LV150 module is used to take power measurements for the purposes of monitoring the LV network. These power measurements are implemented according to standard IEC 61557-12.

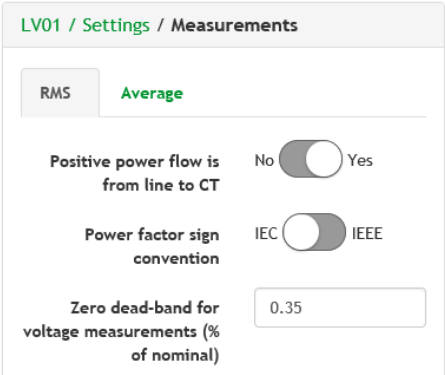
Unlike the SC150 module, these power measurements are not optional. These are included as standard in the LV150 module.

LV power measurements are displayed locally in the Web server in the **LV Measurement > PM - Power and PM – energy** pages. See the relevant section for more information on displaying these measurements.

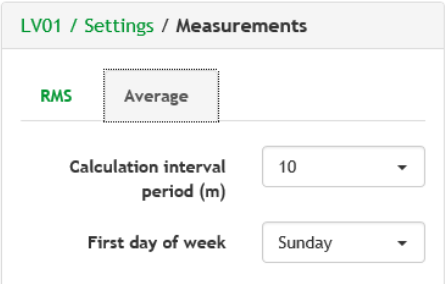
The LV150 stores the power measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

Parameters

Setting the RMS values



Setting the Average values



LV Power measurements require certain options to be configured. These are summarized in the table below:

Measurement parameter settings

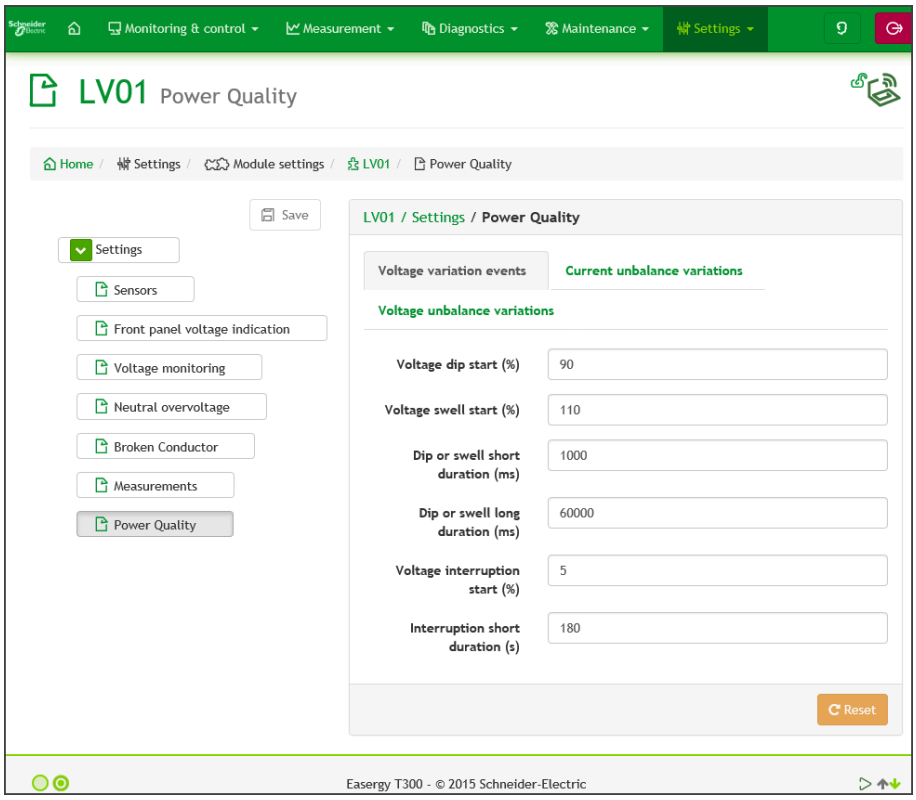
The same parameters specify the Power Measurement for MV or LV network.

Parameter	Default	Configuration range	Description
RMS			
Positive power flow is from line to CT	**Yes**	• No • Yes	Definition of the direction of the power flow on the channel. By default, a positive direction corresponds to a flow of power from the line to the CTs. This parameter depends on the location of the channel (channel = feeder or incomer). The choice assigns the sign for the power measurements calculated by the module (SC150/SC160 or LV150).
Power factor sign convention	**IEC**	• IEC • IEEE	Choice of sign convention for the power factor calculation: • **IEC:** International Electrotechnical Commission • **IEEE:** Institute of Electrical and Electronics Engineers
Reactive power calculation method	**Triangle**	• Triangle • Fundamental	Approaches used to determine the reactive power.
Zero dead-band for voltage measurements (% of nominal)	**0.35**	• 0.01–10	Filtering of low values on measured voltages. Values below this percentage will be filtered and displayed at zero value to avoid inaccurate measurement.
Zero dead-band for current measurements	**0.20**	0.01–10	Filtering of low values on measured currents. Values below this percentage are filtered and displayed at zero value to avoid inaccurate measurement.

Parameter	Default	Configuration range	Description
Average			
Calculation interval period (min)	**10**	• 1 • 5 • 10 • 15 • 20 • 30 • 60	Definition of the period for calculation interval of the averages on the measurements.
First day of week	**Sunday**	• Monday • Tuesday • Wednesday • Thursday • Friday • Saturday • Sunday	Definition of the first day of the week for the calculation of averages and min/max including a period based on the weeks.

LV Power Quality Settings

Access via **LV0x > Settings > Power Quality** page.



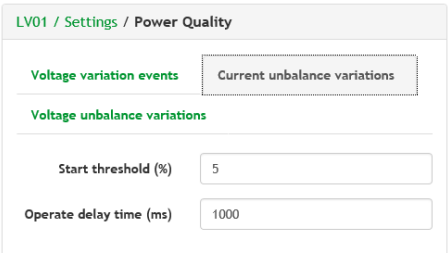
In addition to power measurements, the T300 can also take measurements to check the quality of the power supply on the LV network. These measurements are implemented according to standard IEC62586-PQI-S. They are used in particular to monitor the number and duration of voltage interruptions, sags (dips), or swells, as well as the current and voltage unbalance and the harmonics.

These power quality measurements are optional on the LV150. If this option is not present in the equipment, the corresponding parameter setting page is not displayed in the Web server. This is also true for the values of these optional measurements displayed on the **LV Measurement/Power – Quality** page. See the relevant section for more information on displaying these measurements.

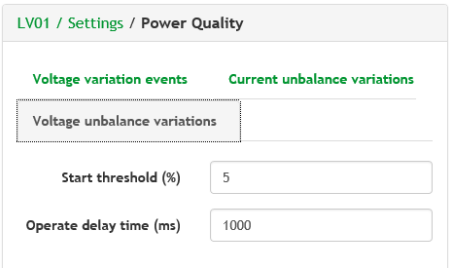
The T300 stores the measurements taken. These can be viewed locally via the Web server or remotely via the SCADA system.

Power quality measurements require certain options to be configured. These are summarized in the table below:

Setting the current unbalance parameters



Setting the voltage unbalance parameters



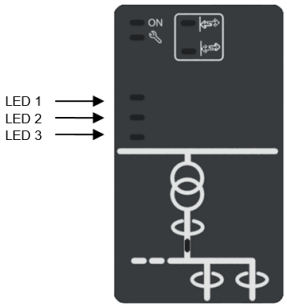
Power quality parameter settings:

Parameter	Default	Configuration range	Description
Voltage variation events tab			
Voltage dip start (%)	90	5-100	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage sag (dip) by the power quality measurement.
Voltage swell start (%)	110	100–150	Threshold, as a percentage of the nominal voltage, above which the detected voltage rise is considered to be a voltage swell by the power quality measurement.
Dip or swell short duration (ms)	1000	10-60,000	Duration below which the presence of a voltage sag (dip) or swell is considered to be short duration.
Dip or swell long duration (ms)	60,000	10-60,000	Duration above which the presence of a voltage sag (dip) or swell is considered to be long duration. Similarly, the average duration corresponds to the time interval between the short and long duration.
Voltage interruption start (%)	5	1-90	Threshold, as a percentage of the nominal voltage, below which the detected drop in voltage is considered to be a voltage interruption by the power quality measurement.
Interruption short duration (s)	180	60-900	Duration below which the voltage interruption is considered to be short duration. Similarly, a long duration corresponds to an interruption lasting longer than the time set for the short duration. **NOTE:** There is no notion of average duration for voltage interruptions.
Current unbalance variations tab			
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal current, above which the current variation is considered to be a current unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200–60,000	Time delay above which the current variation is taken into account and considered to be a current unbalance by the power quality measurement.
Voltage unbalance variationstab			
Start threshold (%)	5	1–100	Threshold, as a percentage of the nominal voltage, above which the voltage variation is considered to be a voltage unbalance by the power quality measurement, provided that this variation lasts longer than the configured **Operate delay time**.
Operate delay time (ms)	1,000	200-60,000	Time delay above which the voltage variation is taken into account and considered to be a voltage unbalance by the power quality measurement.

Local I/O on LV150 module

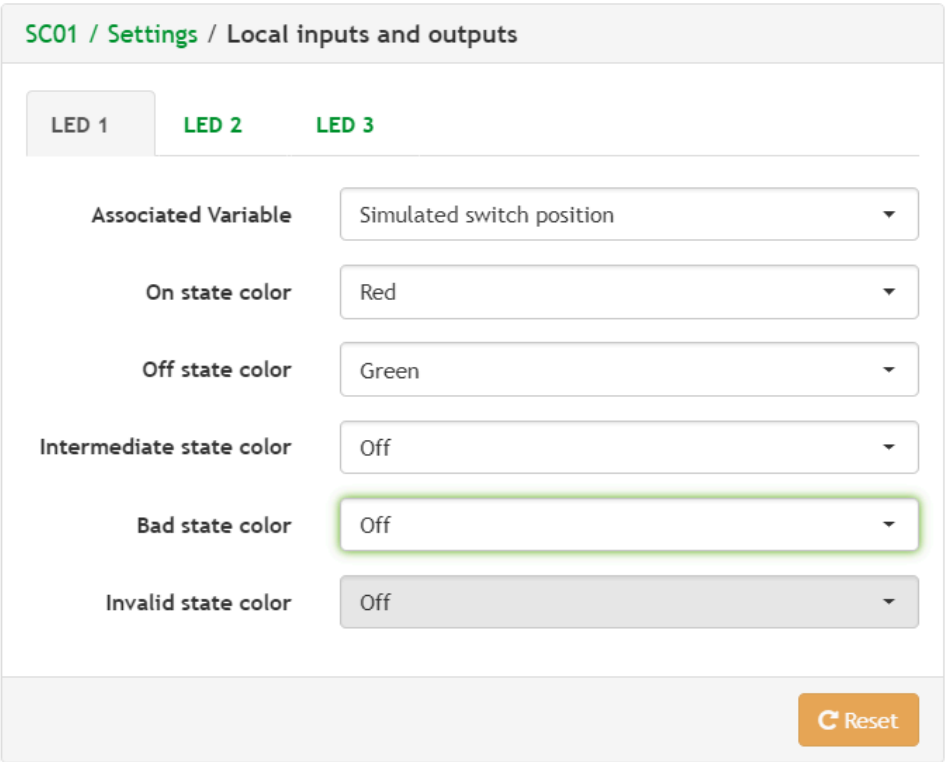
Customizing LEDs on the LV150 module

The color of 3 user LEDs on the front of the LV150 modules can be customized.



LEDs 1 to 3 can be assigned to different variables/functions. The colors and behaviour can be customized for each state.

Access via **Settings > LVx > Local inputs and outputs** page.



Variables/functions that can be associated with each LED (1, 2, 3):

Associated variables	Comment	Typ-e	Proposed Color / Behavior
None	Default for LEDs1, 2, 3	SPS	• 0 Intermediate: Off • 1 Off = Off • 2 On = Off
Voltage indication			
Voltage absence indication instance 1 / 2		SPS	• 0 Off = Off • 1 On = Orange

Voltage presence indication instance 1 / 2		SPS	• 0 Off = Off • 1 On = Red
Voltage neutral displacement indication 1 / 2 /3		SPS	• 0 Off = Off • 1 On = Orange

Setting LED colors:

Parameter	Default	Configuration range	Description
LEDs 1 to 3			
On state color	Red	• Off • Red • Green • Orange • Red blink • Green blink • Orange blink	Choice of color for LEDs 1 to 3 for the active state of the data.
Off state color	Green		Choice of color for LEDs 1 to 3 for the intive state of the data.
Intermediate state color	Off		Choice of color for LEDs 1 to 3 for the intermediate state of the data. The intermediate state can be, for instance, the transitional phase of a change of state. For DPS only.
Bad state color	Off		Choice of color for LEDs 1 to 3 for a bad state of the data. A bad state may be an unexpected state for the data. For DPS only
Invalid state color	Green blink		Choice of color for LEDs 1 to 3 for an invalid state of the data. An invalid state corresponds to a missing known state for the data.

Settings Common to LV150, SC150 Modules

What's in This Chapter

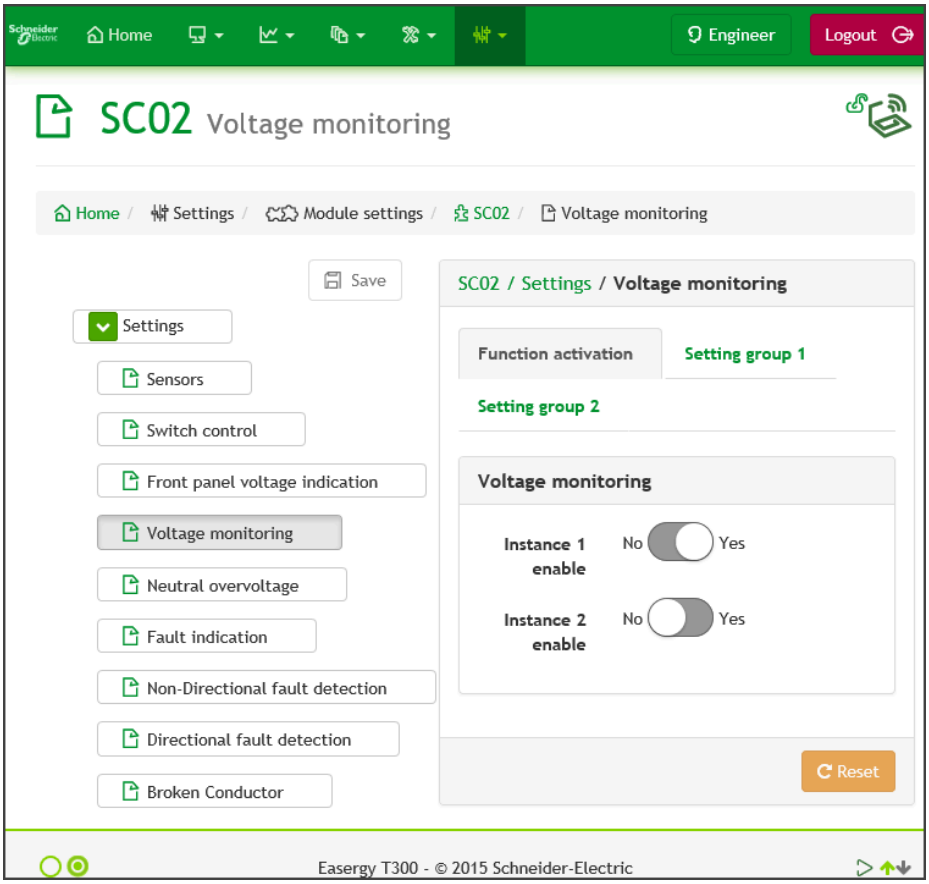
Voltage Monitoring 394
Broken Phase Conductor Detection 401
Port Configuration 404

Voltage Monitoring

- MV Voltage is monitored on the SC150/SC160 modules
  Accessed via **Settings > SC150/SC160 > Voltage monitoring** page
- LV Voltage is monitored on the LV150 modules
  Accessed via **Settings > LV150 > Voltage monitoring** page

Undervoltage and Overvoltage

- For LV: Accessed via **Settings > LV0x > Voltage monitoring** page.
- For MV: Accessed via **Settings > SC150/SC160 > Voltage monitoring** page.



Voltage monitoring enables the T300 to detect voltage anomalies on the MV or LV network. For example, an abnormally low voltage or high voltage on one or more phases can have consequences on the status of the electrical network, so it is important that the T300 detects and reports it.
Note that the T300 only detects, reports and records voltage anomalies. No action or order is produced by the T300 following the detection of an anomaly.

The T300 implements some standard detections to monitor network voltage anomalies. These are summarized below:

- **ANSI 27 (Undervoltage detection):** detects a voltage drop or an abnormally low voltage (for example due to an unbalance) on each phase.
- **ANSI 59 (Overvoltage detection):** detects overvoltages on each phase.

Voltage monitoring is performed by voltage measurements from the voltage sensors.

Configurable thresholds and delays define the detection sensitivity (see parameter table).

For each SC150/SC160 or LV150 module, you can operate two voltage monitoring instances. Each instance can operate independently and simultaneously with different detection modes. Each instance includes two groups of configuration settings. These two groups define two sets thresholds and time delays. Each voltage monitoring instance applies one of these groups of configuration settings. Cooperating instances have the same detection mode and the same group of configuration settings. The first instance that checks the condition enables minimum and maximum voltage detection and the corresponding signaling on the SC150/SC160 or LV150 module.

The settings group can easily be changed by a command, to select group 1 or group 2 from the preset thresholds, without needing to reconfigure the T300. This is done in the **Monitoring & Control > Substation** page (see the corresponding section) or remotely from the SCADA system.

NOTE: The module SC150 allows the configuration up to 8 different groups, page 237 of protection settings.

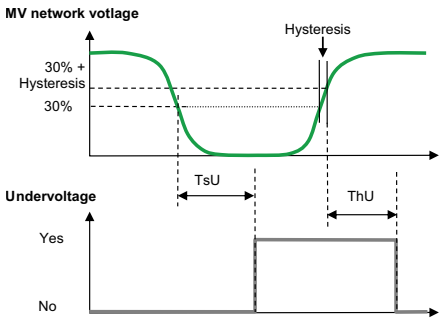
ANSI 27 Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		• SC150: from 1 to 8 • SC160 and LV150: 2
Detection mode		Definite time (DT)
Logical node name		**AbsPTUV** x (x = instance number)
Hysteresis reset detection		6 %
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Measured voltage		Phase-to-phase voltage or phase-to-neutral voltage
Operation mode		On any phase
Detection threshold		See parameter table below.
Time delays		
Reset time delay		

ANSI 59 Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		• SC150: from 1 to 8 • SC160 and LV150: 2
Detection mode		Definite time (DT)
Logical node name		**PrsPTOV** x (x = instance number)
Hysteresis reset detection		7 %
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Measured voltage		Phase-to-phase voltage or phase-to-neutral voltage
Operation mode		On any phase or on all 3 phases

Detection threshold	See parameter table below.
Time delays	
Reset time delay	

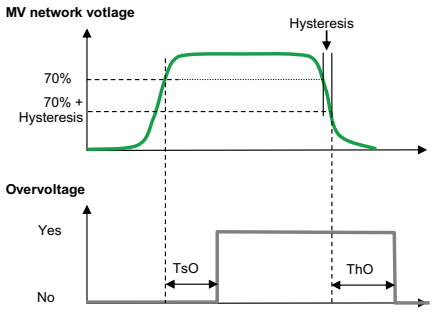
Detection of MV Undervoltage from the measures

TsU: Operate delay time –undervoltage (by default: 50 ms)
ThU: Hold delay time – undervoltage (by default: 40 ms)

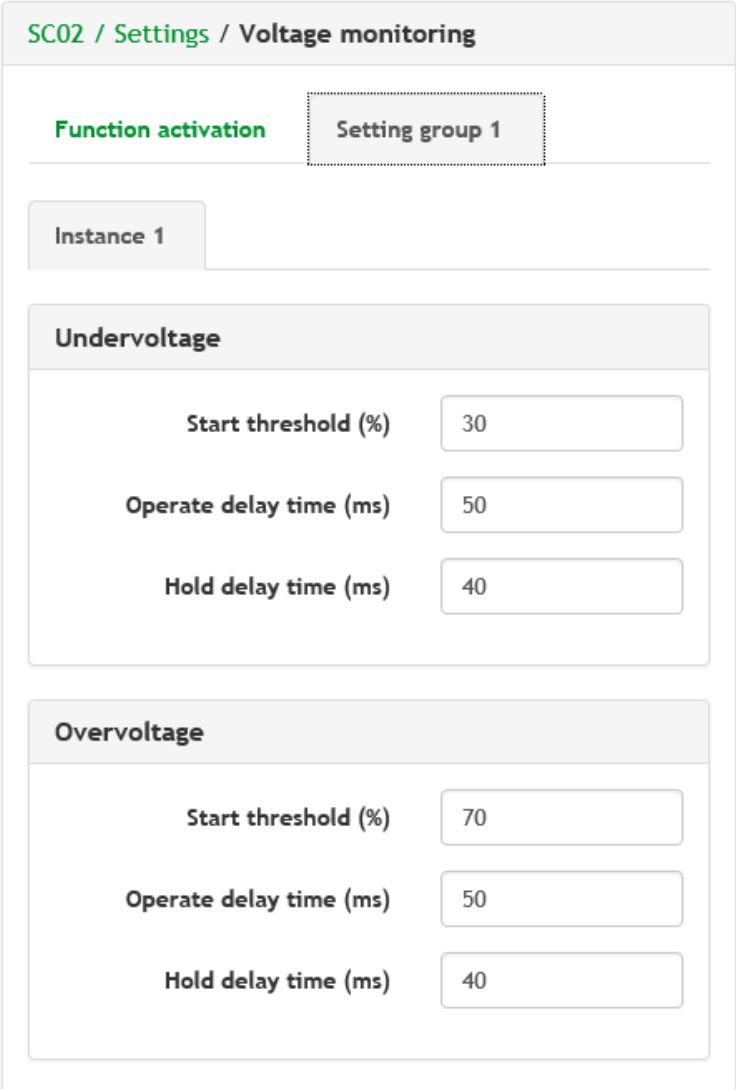


Detection of MV Undervoltage from the measures

TsO: Operate delay time – overvoltage (by default: 50 ms)
ThO: Hold delay time – overvoltage (by default: 40 ms)



MV or LV undervoltage and overvoltage parameter setting:

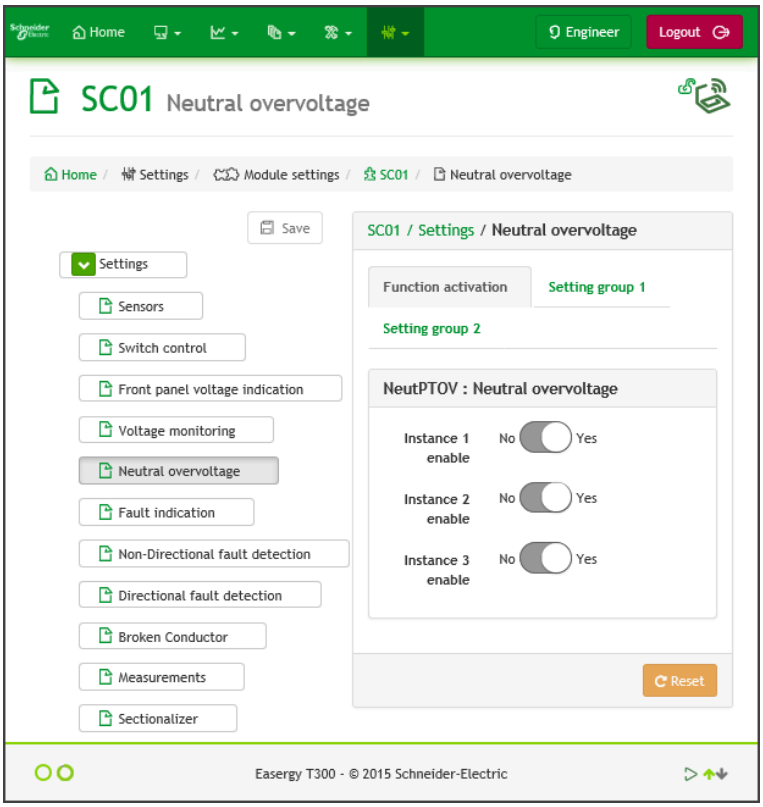


Parameter	Default	Configuration range	Description
Function activation – Voltage monitoring			
Instance 1 enable	No	• No • Yes	Activation of instance 1 for voltage monitoring
Instance 2 enable	No	• No • Yes	Activation of instance 2 for voltage monitoring
Undervoltage - Instance 1 and 2			
Start threshold, (%)	30	10-200 (increment = 1)	Definition of the measured voltage threshold below which the undevoltage will be detected. **NOTE:** Configure the threshold taking into account hysteresis (6 %). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Time within which the voltage must remain below the **Start threshold** to validate the undervotlage detection.
Hold delay time (ms)	40	0-300000 (increment = 1)	Time within which the voltage must return above the **Start threshold** to cancel undervoltage detection (to define the delay to be configured, take into account hysteresis: 6 %).
Overvoltage - Instance 1 and 2			
Start threshold, (%)	70	10-200 (increment = 1)	Definition of the measured voltage threshold above which the overvoltage will be detected. **NOTE:** Configure the threshold taking into account hysteresis (7 %). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	50	0-300000 (increment = 1)	Time within which the voltage must remain above the **Start threshold** to validate the overvoltage detection.
Hold delay time (ms)	40	0-300000 (increment = 1)	Time within which the voltage must return below the **Start threshold** to cancel overvoltage detection (to define the delay to be configured, take into account hysteresis: 7 %).

Neutral Overvoltage

- For LV: Accessed via **Settings > LV0x > Voltage monitoring** page.

- For MV: Accessed via **Settings > SC0x > Voltage monitoring** page.



The voltage monitoring also enables the T300 to observe Neutral voltage anomalies, reflecting whether the network is unbalanced.
Note that the T300 only detects, reports and records neutral voltage anomalies. No action or order is produced by the T300 following the detection of an anomaly.

The Neutral voltage anomaly is managed by the following standard detection:

- **ANSI 59N (Neutral overvoltage detection):** detection of abnormal voltages or insulation faults by measuring the residual voltage.

Neutral overvoltage monitoring is performed by voltage measurements from the voltage sensors.

This monitoring can also be performed by calculation and summation of the three phase voltages (in the absence of residual voltage direct measurement).

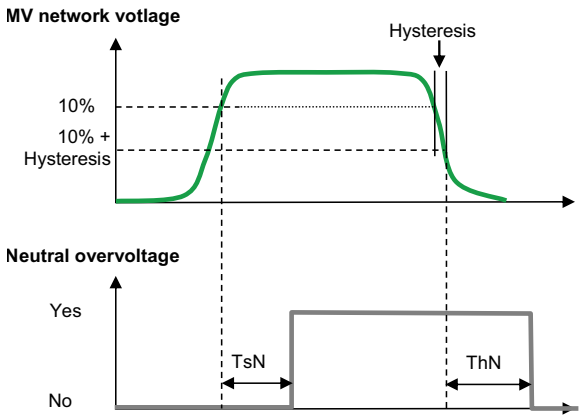
Configurable thresholds and delays define the detection sensitivity (see parameter table below).

NOTE: The SC160 module has the capability to enable the circuit breaker tripping for the Neutral Overvoltage (ANSI 59N) function if Tripping is enabled (**SC0x > Settings > Global fault settings> Advanced Settings** page, Tripping enabled).

ANSI 59N Characteristics		
Number of instances		3 (capable of operating simultaneously with different settings)
Groups of settings		• SC150: From 1 to 8 • SC160 and LV150: 2
Detection mode		Definite time (DT)
Logical node name		**FPTOV x** (x = instance number)
Hysteresis reset detection		7%
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
	Instance 3	Active or inactive

ANSI 59N Characteristics		
Measured voltage		Phase-to-phase voltage or phase-to-neutral voltage
Operation mode		On neutral or 3 phases
Detection threshold		See parameter table below.
Time delays		
Reset time delay		

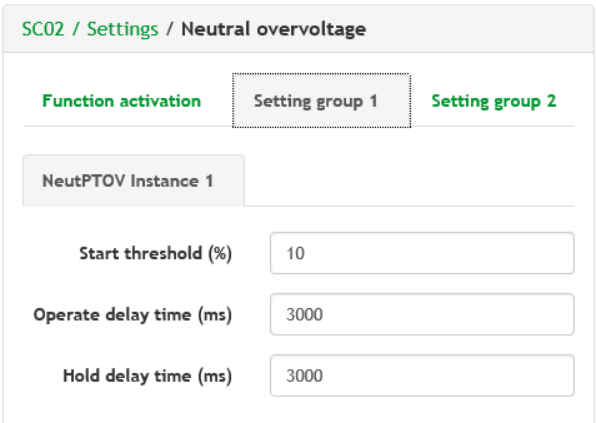
Detection of MV Neutral overvoltage



TsN: Operate delay time – neutral overvoltage
ThN: Hold delay time – neutral overvoltage

Neutral overvoltage settings

Access via **SC0x > Settings > Neutral overvoltage** page.

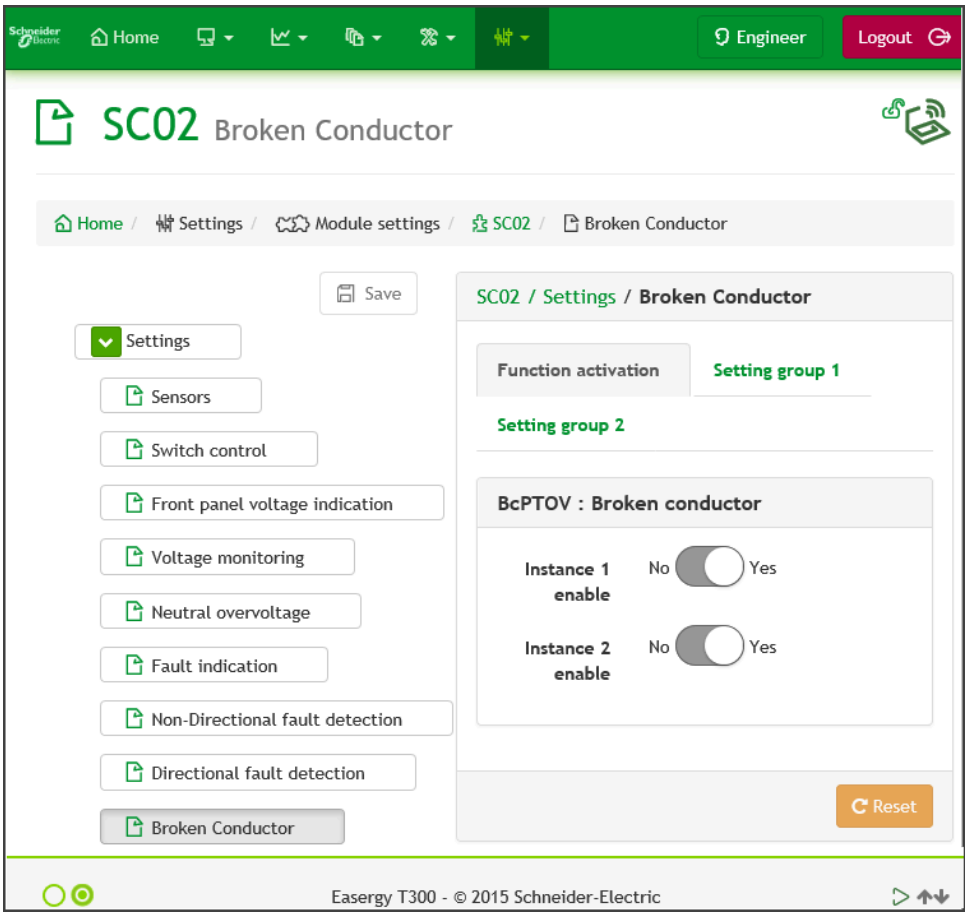


Parameter	Default	Configuration range	Description
Function activation – NeutPTOV- Neutral overvoltage			
Instance 1 enable	Yes	• No • Yes	Activation of instance 1 for neutral overvoltage monitoring
Instance 2 enable	Yes	• No • Yes	Activation of instance 2 for neutral overvoltage monitoring
Instance 3 enable	No	• No • Yes	Activation of instance 3 for neutral overvoltage monitoring
NeutPTOV - Instance 1, 2 and 3			
Start threshold, (%)	• Instance 1: ◦ 10	10-200 (increment = 1)	Definition of the measured neutral voltage threshold above which a neutral overvoltage will be detected.

Parameter	Default	Configuration range	Description
Function activation – NeutPTOV- Neutral overvoltage			
	• Instance 2: ◦ 30 • Instance 3: ◦ 60		**NOTE:** configure the threshold taking into account hysteresis (7%). Consult the glossary for the definition of hysteresis.
Operate delay time (ms)	• Instance 1: ◦ 3000 • Instance 2: ◦ 1000 • Instance 3: ◦ 300	0-300000 (increment = 1)	Time within which the neutral voltage must remain above the **Start threshold** to validate the neutral overvotlage detection.
Hold delay time (ms)	• Instance 1: ◦ 3000 • Instance 2: ◦ 1000 • Instance 3: ◦ 300	0-300000 (increment = 1)	Time within which the neutral voltage must return below the **Start threshold** to cancel neutral overvoltage detection (to define the delay to be configured, take into account hysteresis: 7%).

Broken Phase Conductor Detection

- For SC150/SC160 module: Accessed via **SC0x > Settings > Broken Conductor** page
- For LV150 module: Accessed via **LV0x > Settings > Broken Conductor** page



Detecting a broken phase conductor is an optional function on the SC150/SC160 or LV150 module. If this option is not present in the equipment, the corresponding parameter setting page is not displayed in the Web server.

Broken conductor detection uses the following ANSI detection standard: Negative sequence overvoltage detection (ANSI 47).

The characteristics of this ANSI code are given below.

ANSI 47: Negative Sequence Overvoltage Detection

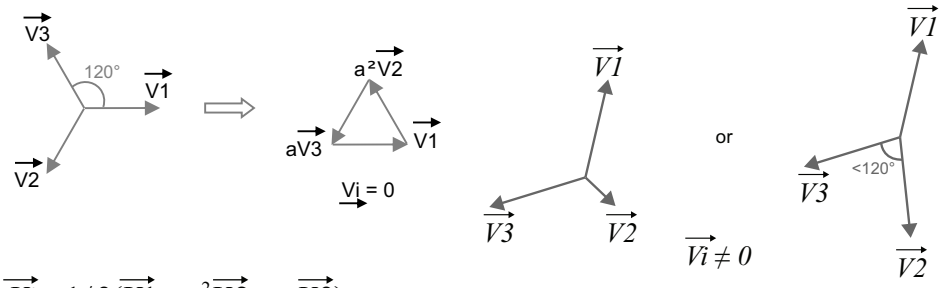
The loss of a phase resulting from a broken phase conductor creates an unbalance on the network. The negative sequence voltage component becomes significant. The T300 uses this negative sequence voltage component to detect a break in a conductor.

Broken conductor detection is therefore enabled on the module (SC150/SC160 or LV150) if the negative sequence voltage component detected is greater than the configurable **Start threshold** for a longer time than the **Operate delay time**. Broken conductor detection is canceled if the negative sequence voltage component falls below the configurable **Reset Threshold** for a longer time than the **Hold delay time**.

ANSI 47 Characteristics		
Number of instances		2 (capable of operating simultaneously with different settings)
Groups of settings		• SC150: From 1 to 8 • SC160 and LV150: 2
Logical node name		**BcPTOV x** (x = instance number)
Fault current indication		Fault current detected
Parameter Setting (For Each Instance)		
Instance activation	Instance 1	Active or inactive
	Instance 2	Active or inactive
Minimum negative sequence voltage component threshold	DT	See parameter settings table
Acknowledge time	DT	
Reset threshold	DT	
Reset time	DT	

Balanced line supply. The negative sequence component (Vi) of the 3-phase voltages is zero.

Examples of unbalanced line supplies with a significant negative sequence voltage component (Vi ≠ 0).



$$\vec{Vi} = 1/3(\vec{V1} + a^2\vec{V2} + a\vec{V3})$$

$$where\ a = {}^{j2\pi/3}$$

$$\vec{Vi} \neq 0$$

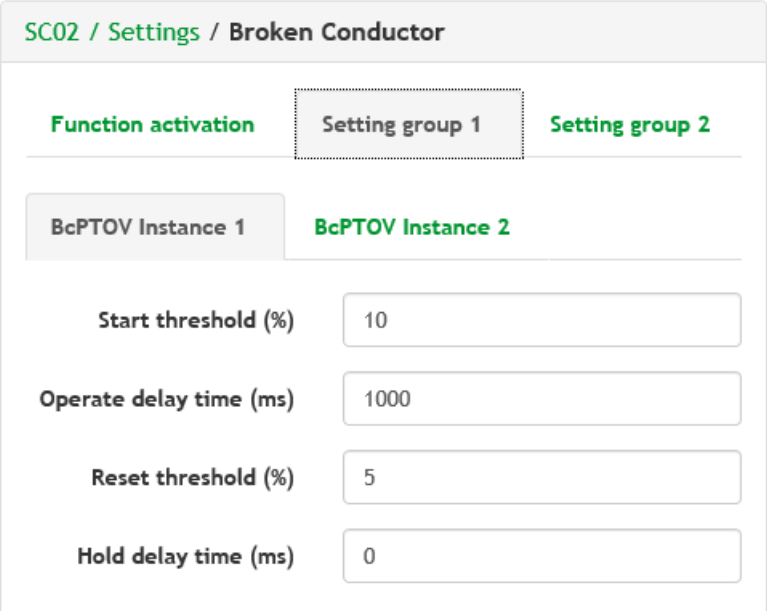
Parameters

Two broken phase conductor instances, with their detection mode and their specific settings can operate individually or simultaneously and for each module (SC150/SC160 or LV150). The first instance that checks the condition enables broken phase conductor detection and the corresponding signaling on the T300. Each instance includes two groups of settings. These two groups enable two sets of preset thresholds.

The settings group can easily be changed by a command, without needing to reconfigure the T300. This is done in the **Monitoring & Control/Substation** page, page 56 or remotely from the SCADA system.

Broken conductor detection parameter settings:

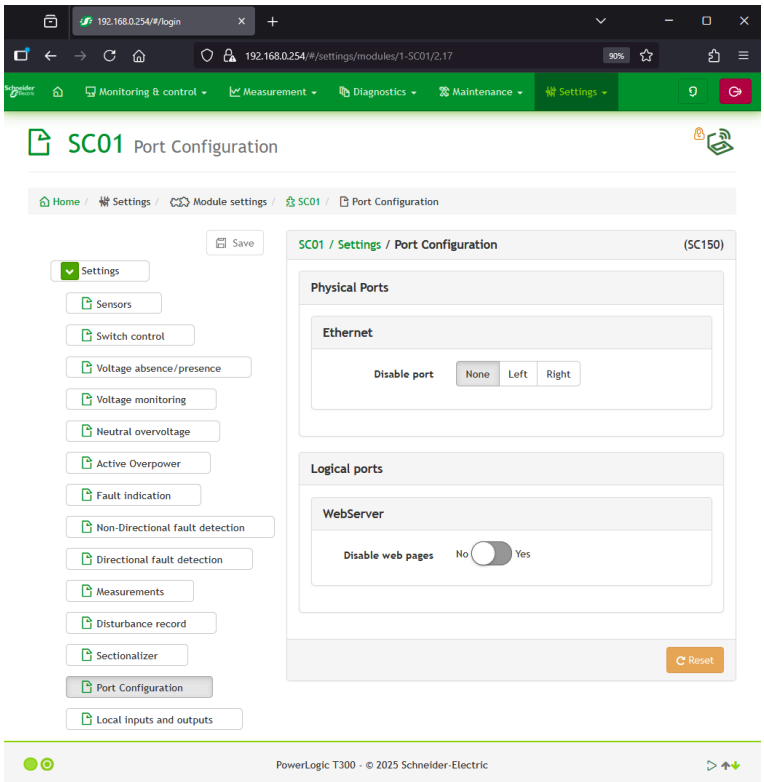
Access via **SC0x / LV0x > Settings > Broken Conductor** page.



Parameter	Default	Configuration range	Description
Function activation – Broken conductor			
Instance 1 enable	No	• No • Yes	Activation of instance 1 for detecting broken phase conductor
Instance 2 enable	No	• No • Yes	Activation of instance 2 for detecting broken phase conductor
BcPTOV Instance 1, 2			
Start threshold (%)	Inst. 1: 10 Inst. 2: 20	2-30 (increment = 1)	Value, as a percentage of the nominal voltage, above which the negative sequence voltage component activates broken conductor detection. The negative sequence voltage component must be detected above this threshold for a longer time than the **Operate delay time** to validate detection.
Operate delay time (ms)	1000	0-300,000 (increment = 1)	Minimum time for which the detected negative sequence voltage component must be above the **Start threshold** to validate broken conductor detection.
Reset threshold (%)	Inst. 1: 5 Inst. 2: 15	2-30 (increment = 0.1)	Value, as a percentage of the nominal voltage, below which the negative sequence voltage component cancels broken conductor detection, provided that it remains below this threshold for the **Hold delay time**. This value must be configured below the value of the **Start threshold**.
Hold delay time (ms)	0	0-300,000 (increment = 1)	Minimum time for which the negative sequence voltage component must remain below the **Reset threshold** to cancel broken conductor detection.

Port Configuration

Access via **Settings > LV0x/SC0x > Port Configuration** page.



T300 manages port configuration to limit access to the minimal subset of required physical ports.

See also Port hardening on T300, page 141.

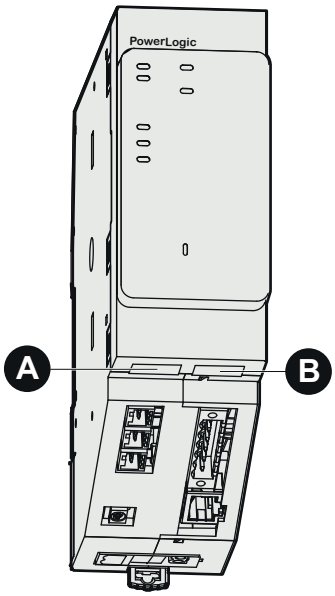
Configuration of Physical Ports

To limit access to a physical port on the T300 equipment, you can deactivate ports from the Web server.

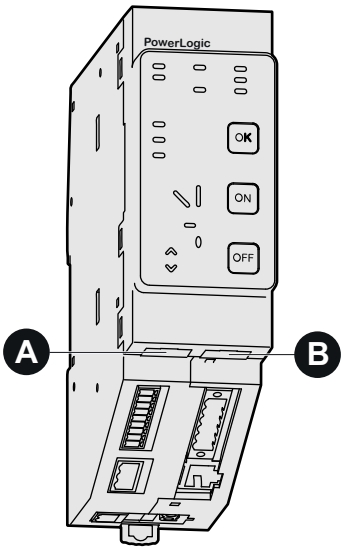
For physical port configuration on:

- HU250, refer to Port configuration on HU250, page 147
- LV150, see below
- SC150/SC160, see below

Physical port on LV0x



Physical port on SC0x



- A: LAN left
- B: LAN right

In the T300 Web server:

- By default, both SC0x/LV0x Ethernet ports are enabled (parameter set to **None**).
- At least one of the SC0x/LV0x Ethernet ports must be enabled to access the T300 equipment. Otherwise, the communication with the T300 equipment is lost.

NOTICE
HAZARD OF INAPPROPRIATE USE CONDITIONS Use the LAN network for internal communication between T300 modules. **Failure to follow these instructions can result in equipment damage.**

The T300 LAN network is designed for internal communication between T300 modules.

Other use of the LAN network can create an unexpected functioning of the system.

The T300 LAN network features ring topology. This setup requires that the right port (LAN right) of the last module is connected to the left port (LAN left) of the HU250. This creates a continuous ring. One key feature of this configuration is the resilience: if you disconnect or break the communication cable between two consecutive modules, the system continues to operate without being affected.

The parameter settings of SC0x/LV0x Ethernet physical ports are as follows:

Parameter	Default	Configuration range	Description
Physical ports			
Ethernet			
Disable port	None	• None • Left • Right	Ethernet LAN port dedicated to internal communication between T300 modules or for connecting a PC.

For physical port configuration on a T300 system, see the example in the section HU250 **Port Configuration**, page 149.

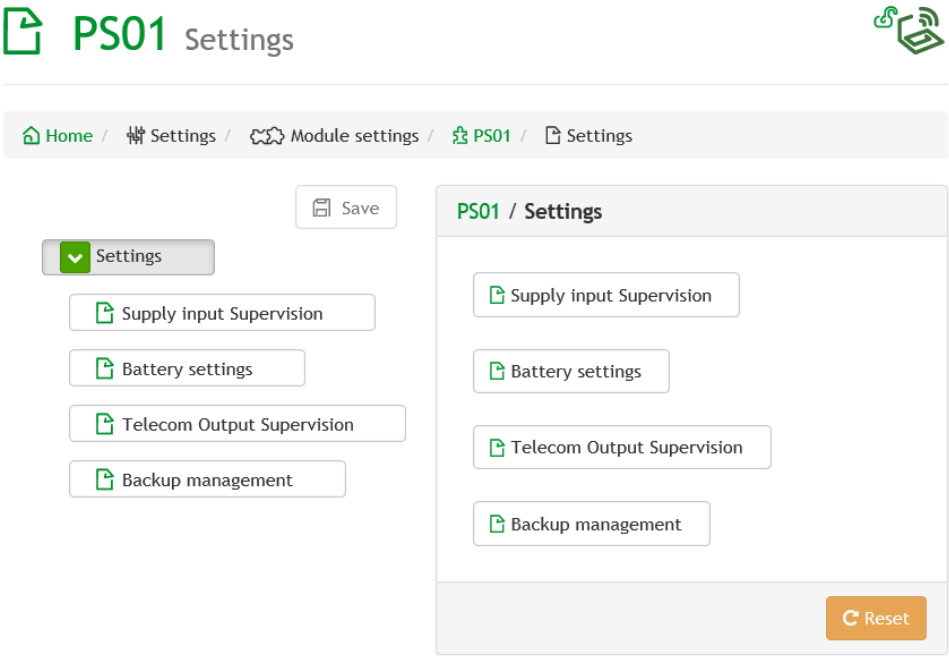
Configuration of Logical Ports

Under **Logical ports/WebServer**, set the **Disable web** pages to **Yes** to not access the HTML pages for SC0x/LV0x Module Maintenance. These HTML pages are configured during commissioning.

Refer to the Quick Start Guide (NT00383) for more information on commissioning operations, in particular changing the IP address of SC0x/LV0x modules.

PS50 Module Settings

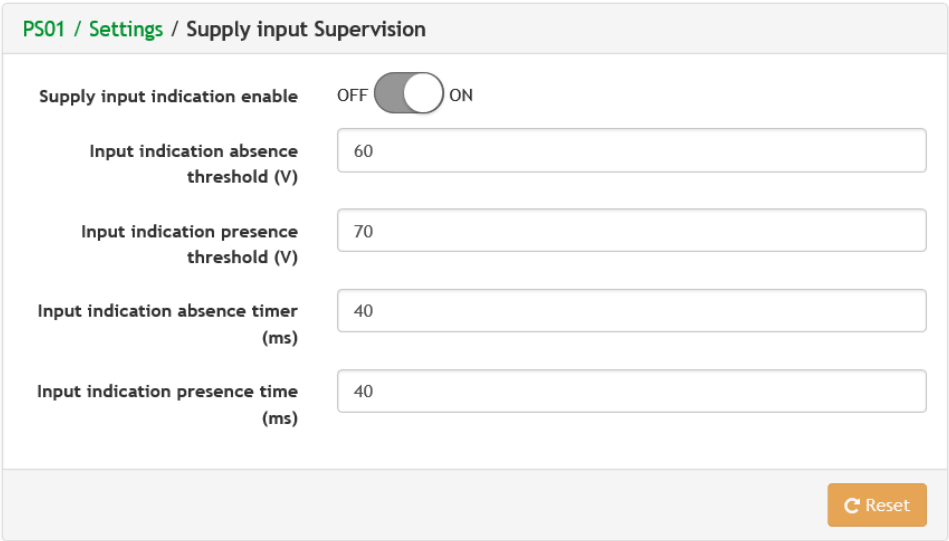
Access via **Settings > PS01** pages.



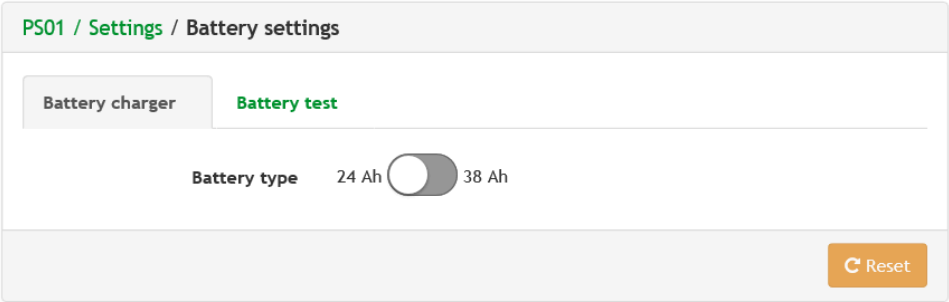
The T300 Web server is also used to define the PS50 power supply module settings.
The module is delivered with the default factory settings. These settings can be customized via **PS01** page.

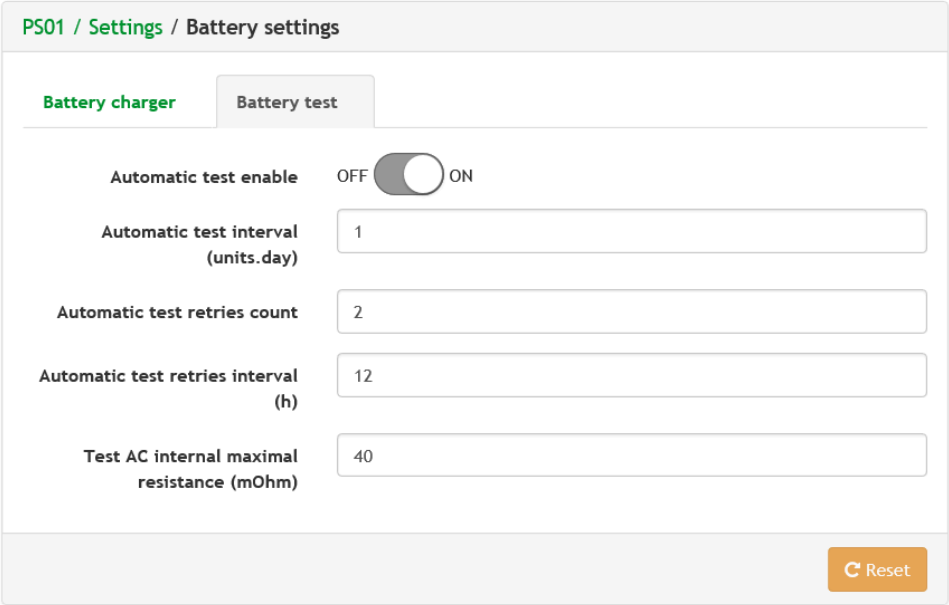
The PS50 module communicates with the HU250 module via an RS485 Modbus link. It is via this communication that the settings defined in the Web page are sent to the PS50 module.
These settings are saved in the PS50 module and in the T300 configuration.

Setting the supply input supervision parameters:

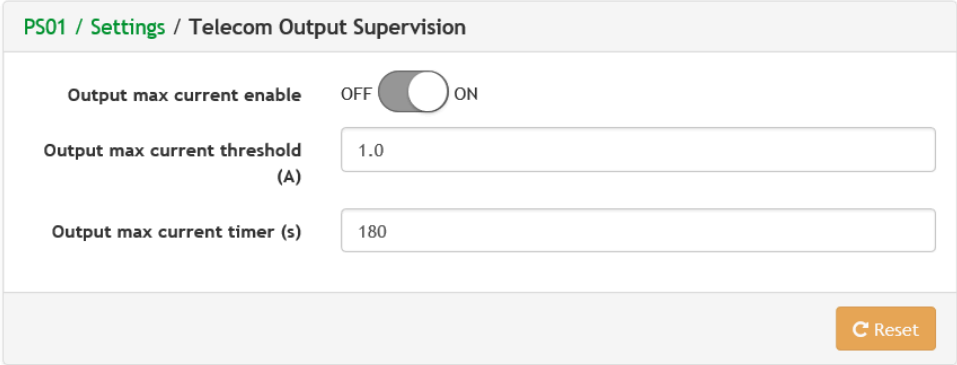


Setting the battery test parameters:

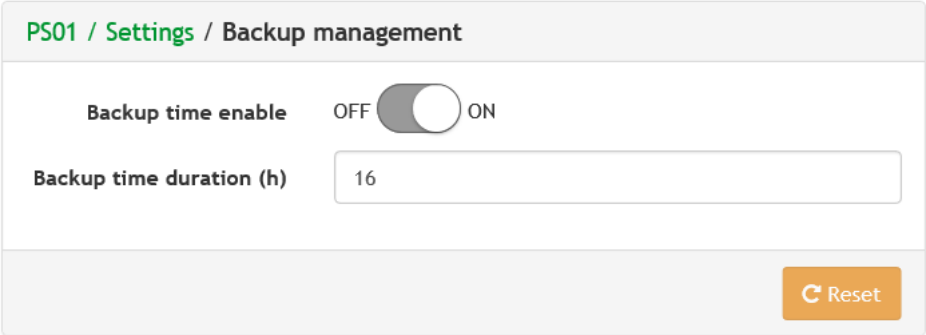




Setting the telecom output supervision parameters:



Setting the backup management parameters:



The table below lists the settings that can be modified:

Parameter	Default	Configuration range	Description
Supply Input Supervision			
Input indication enable	ON	• OFF • ON	Activation of the AC line supply monitoring input for the corresponding signal.
Input indication absence threshold	60 V	50-240	Definition of the threshold for enabling the voltage absence signal on the AC line supply input.
Input indication presence threshold	70 V	50–240	Definition of the threshold for enabling the voltage presence signal on the AC line supply input.
Input indication absence timer	40 ms	20–2,000	Time delay for the absence of voltage for the AC line supply input signal. The voltage must be below the defined threshold for the duration of this time period to activate the signal.
Input indication presence time	40 ms	20–2,000	Time delay for the presence of voltage for the AC line supply input signal. The voltage must be above the defined threshold for the duration of this time period to activate the signal.
Battery Charger			
Battery type	24 Ah	• 24 Ah • 38 Ah	Definition of the type of battery used with the PS50
Nominal capacity	24.0 Ah		Indication of the nominal capacity of the battery according to the type of battery selected. This is an advanced setting available on the set points list, and used if the battery type is forced to 0 (=manual) in the same list.
Battery Test			
Automatic test enable	ON	• OFF • ON	Activation of the automatic battery test
Automatic test interval	1 d	1–100	Time interval for the automatic battery test
Automatic test retries count	2	1–9	Definition of the maximum number of unsuccessful attempts to carry out the battery test. If the counter total is reached, the battery test is abandoned.
Automatic test retries interval	12 h	1–24	Time interval between each unsuccessful attempt to test the battery
Test AC internal maximal resistance	40 mO-hm	30–300	Internal maximum resistance for the battery test (AC measurement)
Telecom Output Supervision			
Output max current enable	ON	• OFF • ON	Activation of monitoring of maximum current delivered at the telecommunication power supply output
Output max current threshold	1.0 A	0.2–4	Maximum current threshold for the telecommunication power supply output. If the current reaches this value during the Output max current timer period, the corresponding power supply is automatically cut.
Output max current timer	180 s	1–300	Duration for which the current must exceed the Output max current threshold before the telecommunication power supply output is cut.
Backup Management			
Backup time enable	ON	• OFF • ON	Activation of the battery backup power supply
Backup time duration	16 h	1–16	Definition of the battery backup duration in the event of loss of the AC line supply At the end of this period, the power is automatically cut to conserve the battery.

Commissioning Tests

The SC modules have various software interlocks to reduce the risk of unintended switch operations.

⚠ CAUTION

HAZARD OF UNINTENDED EQUIPMENT OPERATION

For these to work as intended, both the module configuration and the wiring between the module and the equipment must be correct. Make sure that the following are checked:

- Main switch position status
- Earth switch disconnector position status
- Disconnector position status (if applicable).

Failure to follow these instructions can result in injury or equipment damage.

Some instructions are given here by way of example in terms of how to commission the equipment and help ensure that it is operating correctly with all the associated connections and devices operational.
The PC used to configure the T300 can remain connected to the HU250 module during the tests. This allows users to observe the different equipment states and the time-stamped events.

Local/Remote Button in “Local” Position

- Verify that the PC has taken account of the local mode option.
- Verify that the MV cubicle motor mechanisms function correctly: opening and closing of each channel, switch position information corresponding to the status of the LEDs.
- Verify “locked” information (ground switch): check that the “locked” inputs are taken into account by the equipment.

Local/Remote Button in “Remote” Position

- Verify that the MV cubicles status is correctly displayed on the control station.
- Verify that the cubicle connection cables are correctly identified. Disconnect the cubicle connection cables from the T300: the loss of position must be signaled on the front panel of the corresponding SC150/SC160 module.
- If equipped with Harting connectors, check that the HA10 connectors for linking the cubicles have a locating device.
  If you have dummy devices, install them on the HA10 connectors so as not to overload the battery or the MV cubicle.
- Verify the remote controls:
  - Check that each command taken into account by the SCADA system is correctly transmitted and executed by the equipment: opening and closing of each channel.
  - Check that the switch position information received by the SCADA system corresponds to the status indicated by the LEDs.
- Verify the digital inputs:
  - Check that the digital inputs are taken into account by the equipment and that the signals are retransmitted to the SCADA system.

- Verify the fault current detection function:
  - Use a current simulator available as an option to generate a fault current to check the fault current conditions configured in the T300 and help ensure that the T300 detects and indicates the fault current and retransmits the signals to the SCADA system.
  - Remove the dummy devices and reconnect the cubicle connection cables to their corresponding HA10 connector (with locating device).
- Verify “locked” information (ground switch):
  - Check that the “locked” inputs are taken into account by the equipment and that the signals are retransmitted to the SCADA system.
- Verify voltage presence information:
  - Simulate the absence/presence of voltage on the voltage acquisition device (DI6 or voltage sensor) and check that the voltage absence/presence is taken into account by the equipment and that the signals are retransmitted to the SCADA system.
- Verify the “loss of AC voltage” alarm:
  - Open the AC voltage fuse unit and check that the equipment takes account of the loss of line supply and that this signal is retransmitted to the SCADA system.

  NOTE: These tests can store time-stamped events. Do not forget to clear them from the PC used for configuration.

LED Test Button on Front Panel

- Check that all LEDs on front panel of HU250, SC150/SC160 and LV150 are blinking by pressing the **Test LED** button on the front panel of the HU250 module. This test also checks the internal communication between the modules. Refer to the chapter Testing the LEDs on the front panel, page 427 for more information about this test.

  NOTE: See the Operation, page 414 section for more information on how the commands and the local/remote modes work on the T300.

Check-list to be Used During Commissioning or After Firmware Upgrade

⚠ WARNING

HAZARD OF UNINTENDED EQUIPMENT OPERATION

Check that the configuration of the earth switch and disconnector matches the switchgear and wiring.

Failure to follow these instructions can result in death, serious injury, or equipment damage.

Checks to be performed during commissioning

During a commissioning phase, it is recommended to check all the inputs/outputs connected to the T300:

- Check consistency between physical status and corresponding status in T300.
- Check effectiveness of commands.

Checks to be performed after a firmware upgrade and an import of a new configuration

After a firmware upgrade and the import of a new configuration, it is recommended to check that the main variables of the system have a value and a quality which are consistent with the reality. Example of a list of variables that should be checked:

- For HU250:
  - General health error
  - General health warning
- For SC150/SC160:
  - Module health error
  - Main switch position status
  - Earth switch disconnector position status
  - Disconnector position status (if configured)
  - Voltage absence for all phases
  - Voltage presence for all phases
  - RMS current phase A, B, C
  - RMS voltage phase A, B, C
- For LV150:
  - Module health error
  - Voltage absence for all phases
  - Voltage presence for all phases
  - RMS current phase A, B, C
  - RMS voltage phase A, B, C

Operation

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Indications and Actions on the Front Panel

What's in This Chapter

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LED Status on LV150 Module - Meaning of Colors 425
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⚠⚠DANGER

HAZARD OF ELECTRIC S HOCK, EXPLOSION, OR ARC FLASH

- Wear your personal protective equipment (PPE) and comply with the safe electrical work practices. See NFPA 70E in the USA or applicable local standards.
- This unit must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this unit before working on or inside the unit.
- Always use a properly rated volt age sensing device to confirm that the power is off.
- A live current transformer secondary circuit must not be opened without turning off the primary side of the transformer and short circuiting transformer secondary circuit first.
- Replace all devices, door s and covers before turning on power to this unit.

Failure to follow these instructions will result in death or serious injury.

⚠WARNING

HAZARD OF LOSS OF CONTROL

- The designer of any control scheme must consider the potential failure modes of control paths.
- For certain critical control functions, provide a means to achieve a safe state during and after a path failure. Example: Emergency Stop.
- Separate or redundant control paths must be provided for critical control functions.
- System control paths must include communication links.
- Consideration must be given to the implications of anticipated transmission delays or failures of the link.

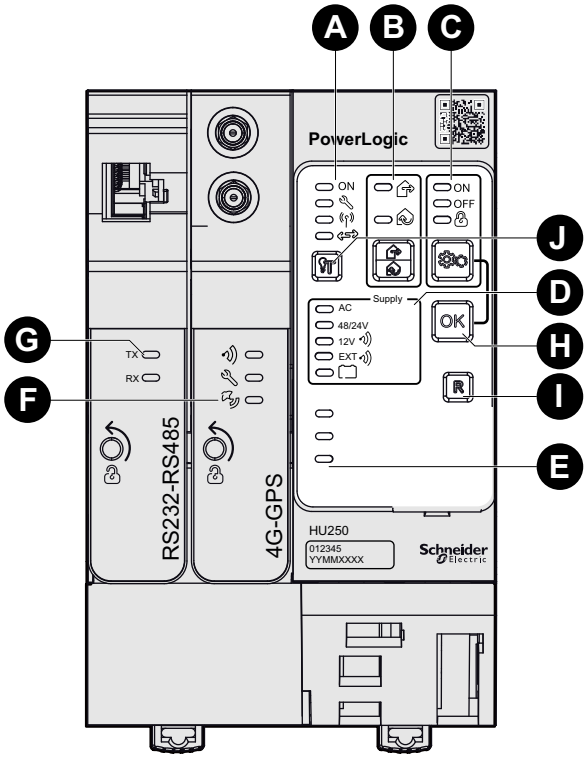
Failure to follow these instructions can result in death, serious injury, or equipment damage.

During operation the T300 indicates a certain number of signals via the LEDs on the front panel of the modules.
There are also pushbuttons allowing manual user actions. These indications and actions are summarized in the tables below for each module type.
For a more detailed description of the cause of each potential issue, refer to the section entitled Diagnostic LEDs on the Front Panel, page 437.

Indications and Actions on the Front Panel of the HU250 Module

The following image shows the HU250 LEDs.

A. HU250 states
B. Local/remote mode
C. Automation function states and checks
D. Power supply
E. Customizable LEDs
F. 4G modem box or IEEE 802.15.4 protocol (T300 option) LEDs
G. RS-232-RS-485 modem LEDs
H. Change of state confirmation
I. Reset
J. LED test

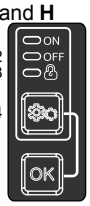


Once the T300 is energized, the LEDs on the front panel can be lit to indicate operating states.

The buttons allow actions from the user.

The information and actions are summarized in the following table.

Description of HU250 module

Part	Description
A A.1 A.2 A.3 A.4 	**HU250 states** **A.1** HU250 operating **A.2** Equipment status **A.3** Wi-Fi access during operation (activated by local mode) **A.4** Communication status with modules (SC150/SC160, LV150, PS50…).
B B.1 B.2 B.3 	**Local/remote mode** **B.1** Remote mode position: All local switch commands (via the front panel and Wi-Fi) via the SC150/SC160 module are blocked. **B.2** Local mode position: All remote commands are blocked. **B.3** Pushbutton for selecting local or remote mode. The changeover to local mode enables Wi-Fi access for WiFi modules.
C and **H** C.1 C.2 C.3 C.4 H.1  	**Automation function states and checks** **C.1** Automation active **C.2** Automation inactive **C.3** Automation locked **C.4** Button to change state of automation function (ON/OFF) **H.1** Button to confirm change of state. Both buttons (change of state and OK button) need to be pressed simultaneously to implement the change of state. This changeover occurs simultaneously on all T300 modules using the automation functions. It is only possible to change the state of the automation function using the buttons in local mode.

Part	Description
D D.1 D.2 D.3 D.4 D.5	**Power supply** **D.1** AC line supply operating **D.2** 48 V/24 V motor mechanism power supply operating **D.3** Transmission equipment power supply operating **D.4** Overconsumption on transmission equipment power supply **D.5** Battery status These states correspond to the information retransmitted by the PS50 module via Modbus communication between modules. If another type of power supply module is used, these LEDs can be customized using the Easergy Builder advanced configuration tool.
E E.1 E.2 E.3	**Customizable LEDs** **E.1; E.2; E.3** Freely configurable LEDs for customized status indication. These LEDs can be customized using the Easergy Builder advanced configuration tool. Refer to the *T300 Quick Start*.
F F.1 F.2 F.3	**4G modem box or IEEE 802.15.4 protocol (T300 option) LEDs** **F.1** LED indicating activity on the mobile (GPRS/4G) or IEEE 802.15.4 networks. Flashes when searching for a network or transferring data, and, for IEEE 802.15.4 protocol, when commissioning the device. **F.2** LED indicating a modem status: lights for a SIM card status or to indicate a network connection problem (at receive level, etc.). **F.3** GPS signal reception status LED (modem box only)
G G.1 G.2	**RS-232-RS-485 modem LEDs** **G.1** TX: LED indicating transmission of RS-232/RS-485 data. **G.2** RX: LED indicating reception of RS-232/RS-485 data.
I I.1	**Reset** **I.1** Button for resetting all fault current indications on all SC150/SC160 modules as well as automation locking.
J J.1	**LED test** **J.1** LED test button forcing all LEDs on the front panel of all SC150/SC160 modules and the external LED to light up. Used to detect any potential anomaly on the LEDs.

NOTE: See the table on the next page for the meaning of the different flashing and color combinations for each of the LEDs. Some LEDs can be customized by configuration.

HU250 LED Status

Meaning of the color indications for each LED

LED status	LED legend	Flashing		Steady			OFF
		Red	Green	Red	Green	Orange	
A A.1 A.2 A.3 A.4	A.1	Boot	-	Fault	**OK**	COM fault	-
	A.2	-	-	Major fault	-	Minor Fault	**OK**
	A.3	-	-	Fault	**ON**	In progress	OFF
	A.4	-	-	Fault	-	-	**OK**
B B.1 B.2	B.1	-	-	-	Remote	-	**Local**
	B.2	-	-	**Local**	-	-	Remote
C C.1 C.2 C.3	C.1	-	-	-	ON	-	**OFF**
	C.2	-	-	**OFF**	-	-	ON
	C.3	-	-	-	-	Locked	**Unlocked**
D D.1 D.2 D.3 D.4 D.5	D.1	-	-	**AC OFF**	**AC ON**	-	-
	D.2	-	-	**Fault**	**OK**	-	-
	D.3	-	-	**Fault**	**OK**	-	-
	D.4	-	-	**Fault**	**OK**	-	-
	D.5	-	-	**Fault**	**OK**	-	-

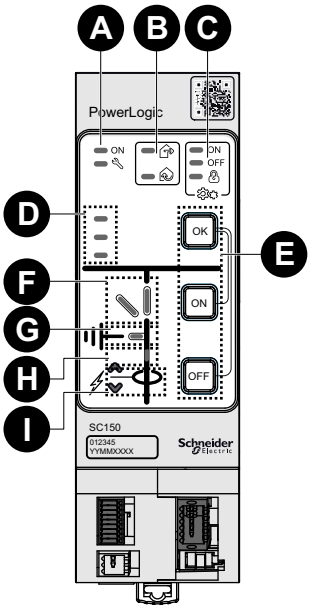
LED status	LED legend	Flashing		Steady			OFF
		Red	Green	Red	Green	Orange	
E(1) E.1 E.2 E.3	E.1	-	-	-	-	ON	**OFF**
	E.2	-	-	-	-	ON	**OFF**
	E.3	-	-	-	-	ON	**OFF**
4G modem **F** F.1 F.2 F.3	F.1	-	Active	-	-	-	**Inactive**
	F.2	-	-	Fault	-	-	**OK**
	F.3	-	Active and synchro	-	No synchro	-	**Disabled**
IEEE 802.15.4 receiver **F** F.1 F.2	F.1	-	Commission-ing	-	OK	-	**Inactive**
	F.2	-	-	Fault	-	-	**OK**
G G.1 G.2 TX RX	G.1	-	Transmission	-	-	-	**Inactive**
	G.2	-	Reception	-	-	-	**Inactive**

(1) LEDs customizable by configuration. Default values only indicated.

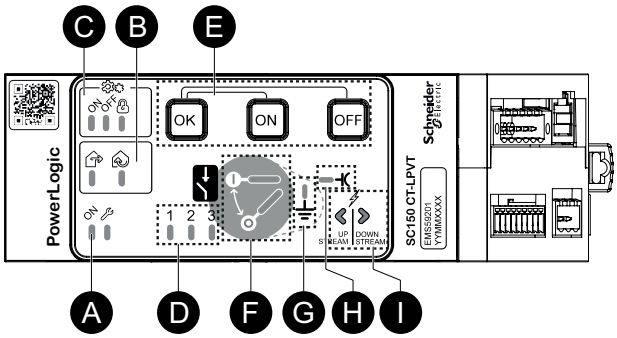
NOTE: Indications in **bold** correspond to normal operation (first power up without existence of a potential issue indication).

Indications and Actions on the Front Panel of the SC150 Module

SC150



SC150H



Part	Description of indications and actions
A A.1 A.2	**SC150 Status** **A.1**SC150 operating, communication status with the HU250 **A.2** Equipment status (potential software issue, potential hardware issue, potential configuration issue)
B B.1 B.2	**Local/Remote** **B.1** Local mode: Commands via the front panel (or Wi-Fi) are possible. Commands from the control center are locked. **B.2** Remote mode: Local commands via the front panel of the SC150 module (or Wi-Fi) are locked. Commands from the control center are possible The Local/Remote position displayed on the SC150 is a copy of the display managed on the HU250 module.
C C.1 C.2 C.3	**Automation function states and checks** **C.1** Automation active **C.2** Automation inactive **C.3** Automation locked The automatic control enabled and disabled states on SC150 modules are copied from the HU250 module. The automation locked state on an SC150/SC160 module reflects the state of the SC150 module and is copied to the HU250 module.
D D.1 D.2 D.3	**Special function LEDs** Default assignment: **D.1** Simulated switch position (green = open, red = closed) **D.2** Unassigned **D.3** External lock (orange = external lock configured and input active) These LEDs can be customized. Refer to Indications and Actions on the Front Panel of the SC150 Module, page 418 (T300 User Manual).
E E.1 E.2 E.3	**Local switch commands** Local switch commands are only possible in local mode. **E.1**Command confirmation button. This button must be pressed simultaneously with the change of state (OK or OFF) button for the command to be considered. **E.2** Button to close switch (ON) **E.3** Button to open switch (OFF)

Part	Description of indications and actions
F F.2 F.1	**Switch state** Switch position symbolized by a representation in 2 colors: **F.1** Vertical/red: closed position **F.2** Oblique/green: open position
G G.1	**Ground (earth) switch state** Position of the ground (earth) switch symbolized by 2 states and 1 color: **G.1** Off: Ground (earth) switch in open position Green: Ground (earth) switch in closed position
H H.1	**Voltage presence** If DI6 used: **H.1** Red: Voltage present (DI active) Off: Voltage absent (DI inactive) If voltage sensor used: **H.1** Red: Voltage present on 3 phases, or invalid measures Off: Voltage absent on 3 phases Orange: Intermediate, which means Presence on at least one phase, and Absence on at least one phase.
I I.1 I.2	**Fault current detection** Fault current detection is symbolized by two arrows that can indicate the direction of the fault current (for directional fault current type only): **I.1** Arrow pointing backward, flashing orange means fault detection in progress, flashing green means permanent earth fault, steady green means permanent phase fault, flowing in the direction indicated by the arrow (toward the busbar). **I.2** Arrow pointing forward, flashing orange means fault detection in progress, flashing red means permanent earth fault, steady red means permanent phase fault, flowing in the direction indicated by the arrow (toward the network). Also, serves to indicate the presence of an ammetric type fault current.

SC150 LED Status

Meaning of the color indications for each LED

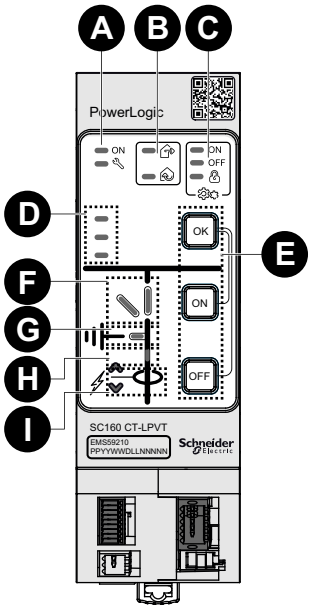
LED status	LED legend	Flashing			Steady			OFF
		Red	Green	Orange	Red	Green	Orange	
A A.1 A.2	A.1	Start-up	-	-	Fault	**OK**	COM OFF	-
	A.2	-	-	-	Major fault	-	Minor fault	**OK**
B B.1 B.2	B.1	-	-	-	-	Remote	-	**Local**
	B.2	-	-	-	**Local**	-	-	Remote
C C.1 C.2 C.3	C.1	-	-	-	-	ON	-	**OFF**
	C.2	-	-	-	**OFF**	-	-	ON
	C.3	-	-	-	-	-	Locked	**Unlocked**
D(1) D.1 D.2 D.3	D.1	-	-	-	Simulated closed	Simulated open	-	Unknown
	D.2	-	-	-	-	-	-	-
	D.3	-	-	-	-	-	External lock	No lock
F F.2 F.1	F.1	Invalid	-	Intermediate state	Closed	-	-	Open
	F.2	Invalid	-	Intermediate state	Closed	Open	-	Closed
G G.1	G.1	Invalid	-	Intermediate state	-	Closed	-	Open
H H.1	H.1	-	-	-	ON (3 phases or DI6) or Invalid	-	ON (1 or 2 phases)	OFF (3 phases or DI6)
I I.1 I.2	I.1	-	Earth fault towards busbar	Fault detection in progress	-	Phase fault towards busbar	-	**No fault**
	I.2	Earth fault towards network or ammetric fault	-	Fault detection in progress	Phase fault towards network or ammetric fault	-	-	**No fault**

(1) LEDs customizable by configuration. Default values only indicated.

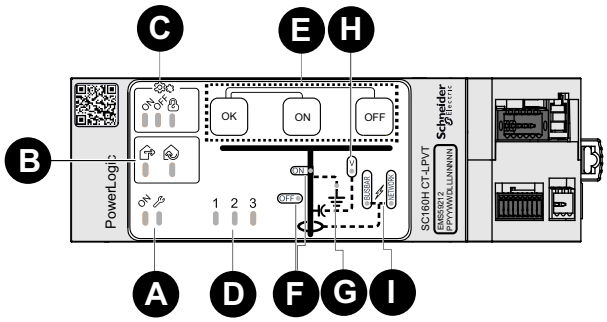
NOTE: Indications in **bold** correspond to normal operation (first power up without existence of a potential issue indication).The switchgear and voltage presence states cannot be determined during normal operation as they depend on the network status and the position of the breaking

Indications and Actions on the Front Panel of the SC160 Module

SC160



SC160H



Part	Description of indications and actions
A A.1 A.2	**SC160 Status** **A.1** SC160 operating, communication status with the HU250 **A.2** Equipment status (potential software issue, potential hardware issue, potential configuration issue)
B B.1 B.2	**Local/Remote** **B.1** Local mode: Commands via the front panel (or Wi-Fi) are possible. Commands from the control center are locked. **B.2** Remote mode: Local commands via the front panel of the SC160 module (or Wi-Fi) are locked. Commands from the control center are possible The Local/Remote position displayed on the SC160 is a copy of the display managed on the HU250 module.
C C.1 C.2 C.3	**Automation function states and checks** **C.1** Automation active **C.2** Automation inactive **C.3** Automation locked The automatic control enabled and disabled states on SC150/SC160 modules are copied from the HU250 module. The automation locked state on an SC160 module reflects the state of the SC160 module and is copied to the HU250 module.
D D.1 D.2 D.3	**Special function LEDs** Default assignment: **D.1** Tripping mode (green = enabled, unlit = disabled) **D.2** Tripping indication (orange flashing quickly = fault pick up/tripping imminent, red flashing slowly = trip latched) **D.3** Unassigned These LEDs can be customized. Refer to Customizing the LEDs on the SC150/SC160, page 372.
E E.1 E.2 E.3	**Local switch commands** Local switch commands are only possible in local mode. **E.1**Trip acknowledgment button: this button must be pressed during 3 s for resetting trip indication. Control enabling button: this button must be pressed simultaneously with the change-of-state button (ON or OFF) for control to be accepted. **E.2** Button to close switch (ON) **E.3** Button to open switch (OFF)

Part	Description of indications and actions
F	**Switch state** Switch position symbolized by a representation in 2 colors: **ON** Red: closed position **OFF** Green: open position
G	**Ground (earth) switch state** Position of the ground (earth) switch symbolized by 2 states and 1 color: **G.1** Off: Ground (earth) switch in open position Green: Ground (earth) switch in closed position
H	**Voltage presence** If DI6 used: Red: Voltage present (DI active) Off: Voltage absent (DI inactive) If voltage sensor used: Red: Voltage present on 3 phases or invalid measure Off: Voltage absent on 3 phases Orange: Intermediate which means presence on at least one phase, and Absence on at least one phase
I	**Fault current detection and tripping** Fault current detection or tripping is symbolized by two leds that can indicate the direction of the fault current (for directional fault current type only): Busbar LED pointing backward fault, flashing orange means fault detection in progress, flashing green means permanent earth fault, steady green means permanent phase fault or tripped on earth fault, steady green means permanent phase fault or tripped on phase fault, flowing in the direction indicated toward the busbar). Network LED pointing forward fault, flashing orange means fault detection in progress, flashing red means permanent earth fault or tripped on earth fault, steady red means permanent phase fault or tripped on phase fault, flowing in the direction indicated (toward the network). Also, serves to indicate the presence of an ammetric type fault current.

SC160 LED Status

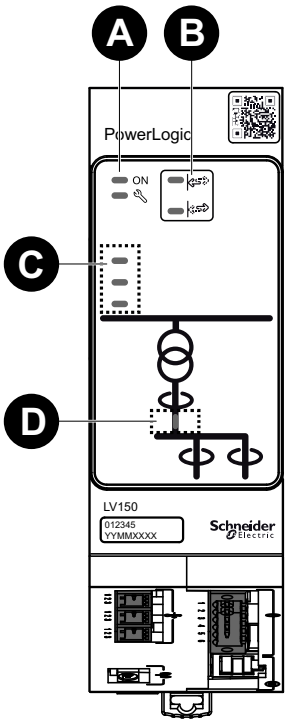
Meaning of the color indications for each LED

LED status	LED legend	Flashing			Steady			OFF
		Red	Green	Orange	Red	Green	Orange	
A A.1 A.2	A.1	Start-up	-	-	Fault	**OK**	COM OFF	-
	A.2	Module is going to restart	-	-	Major fault	-	Minor or transcient fault or Not yet configured	**OK**
B B.1 B.2	B.1	-	-	-	-	Remote	-	**Local**
	B.2	-	-	-	**Local**	-	-	Remote
C C.1 C.2 C.3	C.1	-	-	-	-	ON	-	**OFF**
	C.2	-	-	-	**OFF**	-	-	ON
	C.3	-	-	-	-	-	Locked	**Unlocked**
D(1) D.1 D.2 D.3	D.1	-	-	-	-	**Tripping mode enabled**	-	Tripping mode disabled
	D.2	Trip latched	-	Tripping imminent	-	-	-	**No fault**
	D.3	-	-	-	-	-	-	-
F F.2 F.1	F.1	Invalid	-	Intermediate state or Earth switch closed (with earth switch only)	Closed	-	-	Open
	F.2	Invalid	-	Intermediate state	-	Open	-	Closed
G G.1	G.1	Invalid	-	Intermediate state	-	Closed	-	Open
H H.1	H.1	-	-	-	ON (3 phases or DI6) or invalid	-	ON (1 or 2 phases)	OFF (3 phases or DI6)
I I.1 I.2	I.1	-	Earth fault towards busbar	Fault detection in progress	-	Phase fault towards busbar	-	**No fault**
	I.2	Earth fault towards network or ammetric fault	-	Fault detection in progress	Phase fault towards network or ammetric fault	-	-	**No fault**

(1) LEDs customizable by configuration. Default values only indicated.

NOTE: Indications in **bold** correspond to normal operation (first power up without existence of a potential issue indication).The switchgear and voltage presence states cannot be determined during normal operation as they depend on the network status and the position of the breaking.

Indications and Actions in the Front Panel of the LV150 Module



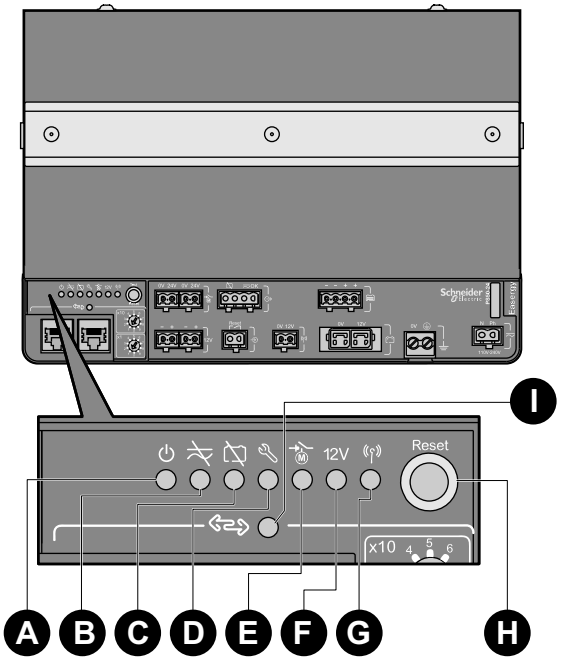
Part	Description of indications and actions
A A.1 A.2	**LV150 states** **A.1** LV150 operating, communication status with the HU250 **A.2** Equipment status (potential software issue, potential hardware issue, potential configuration issue).
B B.1 B.2	Not used.
C C.1 C.2 C.3	Not used These LEDs can be customized. Refer to Customizing the LEDs on the LV150 module, page 392.
D D.1	**Voltage presence** **D.1** Red: power on 3 phases or invalid measure Off: Power off on 3 phases Orange: Power on on at least one phase, and power off on at least one phase

LED Status on LV150 Module - Meaning of Colors

Indicator state	LED legend	Flashing			Steady			OFF
		Red	Green	Orange	Red	Green	Orange	
A A.1 A.2	A.1	Start-up	-	-	Fault	**OK**	Com OFF	-
	A.2	-	-	-	Major fault	-	Minor fault	**OK**
B B.1 B.2	B.1	Not used						
C C.1 C.2 C.3	C.1	Not used						
D D.1	D.1	-	-	-	ON (3 phases) or Invalid	-	ON (1 or 2 phases)	OFF (3 phases)

NOTE: The indications in bold letters correspond to normal operation (first power up without existence of a potential issue indication). The voltage presence states cannot be determined for normal operation, because that depends on the state of the network.

Indications and Actions on the Front Panel of the PS50 Module

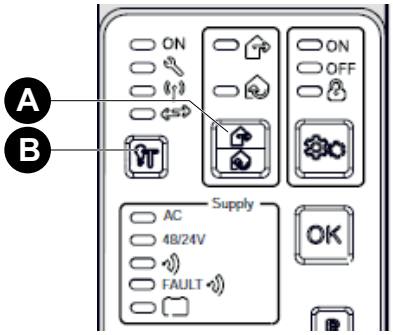


Part	Description of the states and actions
A	**PS50 Module Status** **A.1** If the LED flashes green once a second, this indicates that the PS50 module is operating **A.2** If the LED flashes green every 100 ms, this indicates the startup sequence **A.3** If the LED flashes green every 4 seconds, this indicates that the PS50 is in standby mode.
B	**Network voltage status** **B.1** If the LED is red, this indicates that the network voltage is absent.
C	**Battery status LED** **C.1** Red LED indicates that the battery has a potential issue or at end of life (replacement needed).
D	**Equipment status LED** **D.1** If the LED is red, this indicates a potential issue on the PS50 module.
E	**48 V/24 V power supply status** **E.1** If the LED is green, the 48 V/24 V is operating.
F 12V	**12 V IED power supply status** **F.1** If the LED is green, the 12 V IED power supply is operating.
G	**12 V transmission power supply status** **G.1** If the LED is green, the 12 V transmission power supply is operating.
H Reset	**Reset button** This button has 2 functions: **H.1** To restart outputs **H.2** To restart the reserve power supply (12 V and 24 V/48 V) after a long power outage.
I	**Modbus communication status** **9.1** If the LED flashes yellow, this indicates that the internal Modbus communication between the PS50 and the HU250 modules is operating. **NOTE:** During the startup sequence, the LED is lit when there is no communication then is off when receiving and transmitting frames.

NOTE: All the LEDs mentioned above only include single color indication.

Testing the LEDs on the Front Panel

Location of the local/remote and LED test buttons on the front of HU250 module



A. Local/Remote button

B. LED test button

The LED test button on the front of the HU250 module is used to:

- **Verify LED operation:** Once the pushbutton has been pressed, all the LEDs on the front panel of the HU250, SC150 and LV150 modules flash for 10 s, lighting up alternately in orange, red, and green. The external LEDs are also activated during this period. This test is also used to verify module synchronization, by checking that all LEDs are flashing on all modules at the same time.
- **Verify communication on the SC150 and LV150 modules:** The LED test is also a way of checking communication between the HU250 and various SC150 modules. This test, initiated by the HU250, is then sent to the various modules via the internal IP communication using IEC 60870-5-104 protocol. Those SC150 and LV150 modules with flashing LEDs indicate that the link with the HU250 is operational.

Local/Remote Mode

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Automation Enabled 429

The local/remote pushbutton on the front of the HU250 module is used to select the T300 operating mode. This mode on the HU250 module is copied to all the SC150 modules. Each time the pushbutton is pressed, the mode switches between local and remote mode and vice versa.
It is also possible to use an external local/remote selector switch by connecting it to digital inputs 7 and 8 on the HU250 module to replace the pushbutton on the front panel (see the "External Local/Remote" section for more information).
By default, the local/remote mode is managed by the pushbutton on the front of the HU250. Remote mode can be forced by setting **External local/remote** key to **Yes** in the **HU01/Settings/Local inputs and outputs/Miscellaneous** page.

In addition, each SC150 module can be configured to use a digital input to provide the local/remote mode for the individual module (see section Switch Control, page 97). The SC150 responds to remote commands when both the HU250 and the SC150 are in remote mode.
The SC150 responds to local commands when either the HU250 or the SC150 is in local mode.

Local and remote modes imply differences in terms of the actions and command options available on the equipment. Some interfaces/access levels are considered to be active in local mode and allow control and actions in local mode and others do the same in remote mode. The table below summarizes these differences. Note that the user control options will depend not only on the T300 operating mode, but also the access level used:

Interface/Access	Control in Local Mode	Control in Remote Mode
Local human machine interface (HMI)	x	
Web server via Wi-Fi access for WiFi modules only	x	
Web server via LAN access		x
Web server via WAN access		x
SCADA protocols		x

The table below gives a more precise summary of the actions that are possible or inhibited on each interface in local or remote mode:

Interface/Access	Functions	Local	Remote
Human Machine Interface (HMI)			
HU250	Fault current reset button	Enabled	Enabled
	LED test button	Enabled	Enabled
	Automation ON/OFF button	Enabled	Disabled
	Local/remote button	Enabled	Enabled
SC150	Switch control button	Enabled	Disabled
Web Server			
Web server via Wi-Fi access for WiFi modules only	Writing command variables	Enabled	Disabled
	Other actions on CoreDB variables	Enabled	Enabled
Web server via LAN/WAN access	Writing command variables	Disabled	Enabled
	Other actions on CoreDB variables	Enabled	Enabled
Protocols			
IEC 60870-5-101 and IEC 60870-5-104	Single (CSC) and double (CDC) commands	Disabled	Enabled
	Other object type	Enabled	Enabled

Interface/Access	Functions	Local	Remote
Human Machine Interface (HMI)			
DNP3	Binary output commands (object group 12)	Disabled	Enabled
	Other object type	Enabled	Enabled
Modbus	Write functions (FC=5, 6, 15, 16)	Disabled	Enabled
	Read functions (FC=1, 2, 3, 4)	Enabled	Enabled
IEC 61850	MMS Controls services	Disabled	Enabled
	Other MMS services (Read, Write, Reports, Data access)	Enabled	Enabled

Automation Enabled

When the automation function is used and enabled on the T300 for the purposes of controlling an MV switch, it may be advisable to block manual commands, regardless of whether they are issued locally or remotely, to help ensure control is left purely to the automation function.
Commands are therefore blocked on the SC150 by default when the automation function is active. This can be modified by configuration (see the "Switch Control" section for more information).

The table below summarizes the command inhibit and activation options according to the state of the automation function and depending on the source of the command and the mode used:

Source of Command Action	Local Mode		Remote Mode	
	Automation OFF	**Automation ON**	**Automation OFF**	**Automation ON**
Via SC150 front panel	Command OK	Command blocked (configurable)	Command rejected by SC150	
Via Web server	Command OK	Command blocked (configurable)	Command rejected by HU250	
Via SCADA system	Command rejected by HU250		Command OK	Command blocked (configurable)
Via automation functions (SEC, ATS, etc.)	N/A	Command blocked (configurable)	N/A	Command OK

Switch Commands

Switches can only be controlled if:

- The battery is connected to the equipment at the correct level.
- The “Local/Remote” selector switch is in the correct position to allow control according to the access method used (see the "Local/Remote Mode" section).
- The motor mechanism power supply (24 V or 48 V) is present.
- No other command is in progress

A command taken into account moves the switch into the corresponding position:

- A command on a closed switch opens it.
- A command on an open switch closes it.

Other Commands

The power supply module can be used to reset the power supply:

- To restore the "Telecom power supply” when this output has been disconnected following overconsumption.
- To reactivate the backup power source (battery) in the event of an extended power outage.
- To reactivate the power supply outputs following a detected overload or short-circuit.

Maintenance

What's in This Part

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Diagnostic LEDs on the Front Panel 437
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Battery Maintenance 443
Replacing the HU250, SC150/SC160 or LV150 Module 445
Replacing a Modem Box 447
Replacing the PS50 Module 448
Zigbee Network Maintenance 450

General

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Menu Overview 433

⚠⚠DANGER

HAZARD OF ELECTRIC S HOCK, EXPLOSION, OR ARC FLASH

- Wear your personal protective equipment (PPE) and comply with the safe electrical work practices. See NFPA 70E in the USA or applicable local standards.
- This unit must be installed and serviced only by qualified electrical personnel.
- Turn off all power supplying this unit before working on or inside the unit.
- Always use a properly rated voltage sensing device to confirm that the power is off.
- A live current transformer secondary circuit must not be opened without turning off the primary side of the transformer and short circuiting transformer s econdary circuit first.
- Replace all devices, doors and covers before turning on power to this unit.

Failure to follow these instructions will result in death or serious injury.

The equipment does not require regular maintenance. The integrated battery test informs the user of its availability.

NOTE: There is no fuse in the T300. Electronic protection devices help protect all the power supplies by cutting out automatically in the event of overconsumption or short-circuit. They can be reactivated manually by using the **Reset** button on the PS50 module (via the Web server).

Fix the issue before reactivating. Reactivating repeatedly on fault may damage the equipment.

The T300 features several diagnostic tools for troubleshooting. These require a PC equipped with a Web browser. It is then possible to read the internal states of the equipment and the events stored by the T300 (see also "Commissioning").

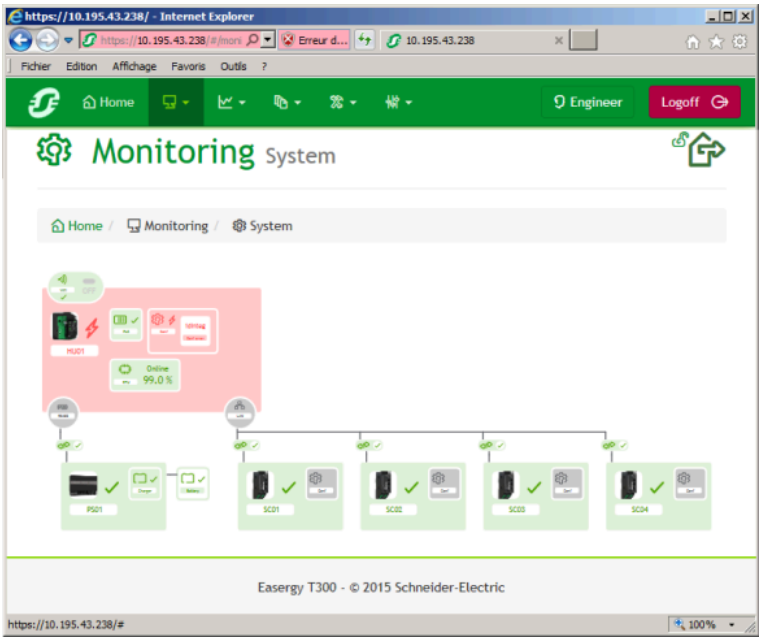
The following tools are available for maintenance and diagnostics.

Menu Overview

Substation and System Pages

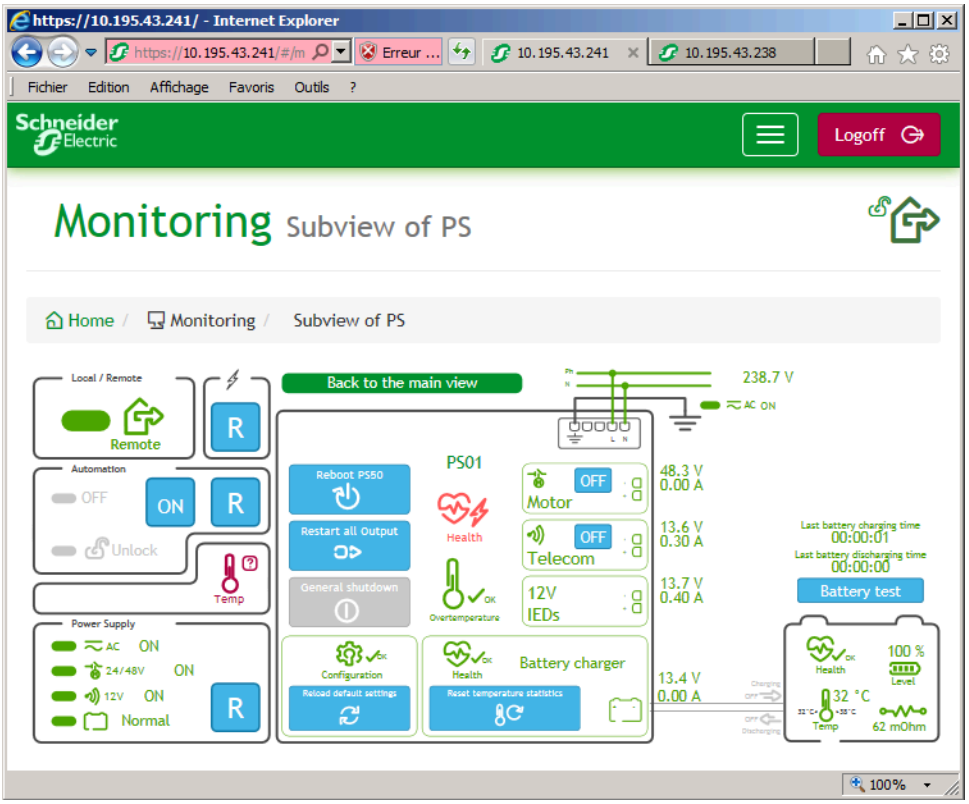
These Web server pages display all the T300 states and measurements as well as any internal potential issues to help perform diagnostics. Each potential issue detected is indicated by a red symbol. The information displayed in these pages that can indicate the presence of a potential issue is summarized below:

Substation page – Web server (showing PS50 general health status)



- **Substation** Page
  - The general health of the PS50 power supply module with indication of the associated temperature,
  - The health of all the power supplies with an indication of the associated measured voltages and consumption levels,
  - The health of the battery charger,
  - The health of the battery with its associated temperature measurement,
  - The automation blocking state (locked).

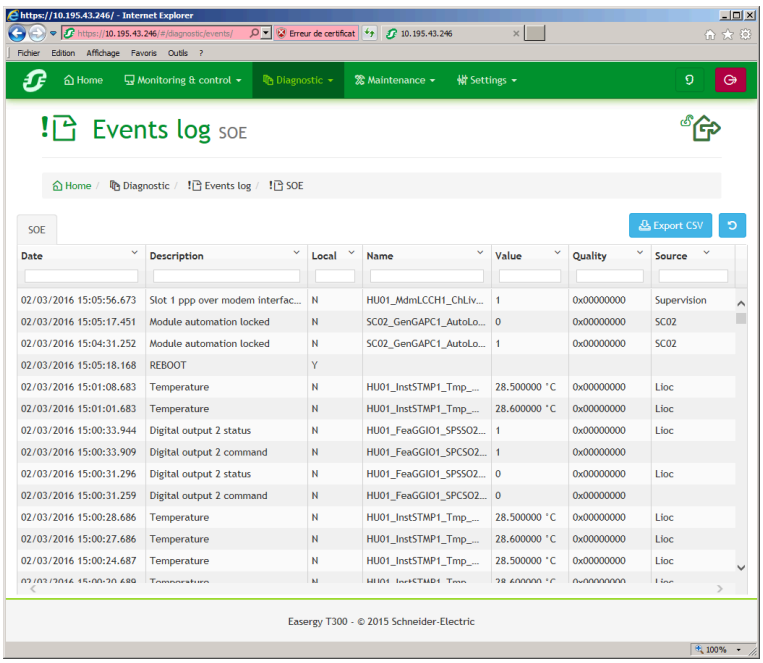
Substation page – Web server (showing PS50 general health status)



- **System** Page
  - The general health of the HU250 module with indication of any configuration or PLC potential issues,
  - The health of each SC150 and LV150 module with indication of any potential configuration issue,
  - The health of the PS50 module with indication of a battery or charger status,
  - The health of the communication on the internal LAN between the SC150/LV150 and HU250 modules,
  - The health of the internal RS485 communication between the HU250 and the PS50,
  - The cellular communication signal strength, as well as modem current IP@.

Viewing Events

Diagnostics/Events page – Web server



The diagnostic log files available (e.g. the **Events** and **System** files) are used to view the history of events that have occurred on the T300. This can help determine the cause of a potential issue.

- All events displayed in the diagnostic log files are time- and date-stamped.
- A large number of time- and date-stamped events are stored to help ensure that sufficient information is fed back over time to identify the source of a problem.
- These files can be saved to PC in a format supported by Excel to be able to run diagnostics, reports, or statistics at a later date.
- Files can be transferred by email to advise a maintenance service or engineer of the potential issue or, if necessary, to seek advice from the T300 manufacturer.

  It is then recommended to send it with a backed-up configuration file.

LED Indications

The T300 provides a certain amount of diagnostic information via the LEDs on the front panels of the T300 modules (see the "Operation - Commands and Indications" section).
These LEDs provide information about the operating state of the T300 and indicate the presence of a potential issue. See the table on the next page for more information about the diagnostics offered by the LEDs.

NOTE: In addition to the information indicated by the LEDs, it is often necessary to view the diagnostic log files or the Substation and Physical View pages in the Web server to determine the source of the potential issue more accurately.

Diagnostic LEDs on the Front Panel

It is advisable to use a PC connected to the T300 to determine the cause of an issue.

The events corresponding to these issues can be viewed in the following diagnostic logs:

- **Events** log
- **System** log

NOTE: The following diagnostic tables consider the use of the default T300 power supply (PS50).

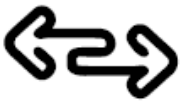
LED	LED color	Possible causes	Solutions
On the HU250 module			
All LEDs	Off	Cabinet power supply interrupted automatically after an extended power outage.	Check the cause of the loss of AC voltage. If the AC voltage remains absent, there is an option to reboot the power cycle by pressing the **Reset** button on the PS50 module. If the power supply does not restart, change the PS50 module and/or the battery.
ON LED ON	Orange (steady)	No dialog on the internal link between the HU250 module and one of the other modules.	Check that the Ethernet bridges between the modules are present and correctly connected. The **ON LED** ON must also be lit orange on the corresponding SC150/SC160 or LV150 module exhibiting the potential communication issue to enable it to be identified. Replace the module if all the connections are correct.
	Red (steady)	T300 equipment status: Indicates an issue on the HU250, or one of the SC150/ SC160, LV150 or PS50 modules.	A **FAULT LED** must also be lit on the module. Refer to the possible causes as to why this LED might be lit to determine a solution.
	Red (flashing)	The HU250 is starting up.	Wait until the HU250 module startup phase is complete. If the flashing persists, replace the HU250.
HU250 FAULT LED	Red (steady)	MAJOR FAULT on the T300	MAJOR FAULT on the HU250 include potential configuration issues, potential modem box issues, and potential PLC issues. For major FAULT on SC150/SC160, LV150 or PS50 modules, refer to the description of the specific LED that is lit on the module. The **Physical View** page is used to determine the module and the cause of the issue. It is also possible to find the description by consulting the potential issues in the **System** log file.
	Orange (steady)	MINOR FAULT on the T300	MINOR FAULT on the HU250 may relate to PLC variables that are not correlated with the HU250 database. Review the PLC program configuration. Consult the potential issues in the **System** log file to find the description of the incorrect PLC variables.

LED	LED color	Possible causes	Solutions
On the HU250 module			
Wi-Fi LED	Red	Potential Wi-Fi issue	Reboot the T300 by cycling the AC supply and battery off and on again. If the problem persists, replace the HU250 module.
	Off	Wi-Fi inactive	By default, the **Local/Remote** button enables or disables the Wi-Fi connection. If Wi-Fi is not enabled in local mode, check that it is configured to be active in the IP interface parameters in the T300 Web server.
Internal COM LED	Red (steady)	No dialog on the internal link between the HU250 module and one of the other modules.	Check that the Ethernet bridges between the modules are present and correctly connected. Refer to the **Physical View** page in the Web server to determine which module is exhibiting the issue. The **ON LED** ON must also be lit orange on the module exhibiting the potential communication issue to enable it to be identified. Replace the module if all the connections are correct.
AC supply LED	Red (steady)	AC power supply circuit breaker tripped	Reset the circuit breaker to restore power to the equipment. If the circuit breaker trips again, cut the power to each module in turn to determine where the potential issue lies and replace the module.
		The AC power supply circuit breaker output connector is disconnected	Replace the connector on the PS50 module.
		No power supply to the cabinet	Reconnect the AC voltage input.
		Momentary absence of AC voltage	Wait for the AC voltage to be restored (the cabinet running on battery).
Motor mechanism power LED	Red (steady)	Automatic disconnection of the 24/48 V power supply output after an issue is detected (short-circuit, overload, overvoltage on this output) or abnormal operation of power supply.	Determine the type of issue using the indications given in the PS50 module view in the System page: • MAJOR PS50 FAULT: See possible actions in the corresponding description of the PS50 error LED. • MINOR PS50 FAULT: See possible actions in the corresponding description of the PS50 error LED.
		Potential issue regarding the Power supply module	Replace the PS50 module.
Transmission power LED	Red (steady)	Automatic disconnection of the transmission power supply output after an issue is detected (short-circuit, overload, overvoltage on this output) or abnormal operation of power supply.	Determine the type of issue using the indications given in the PS50 module view in the **System** page: • MAJOR PS50 FAULT: See possible actions in the corresponding description of the PS50 error LED. • MINOR PS50 FAULT: See possible actions in the corresponding description of the PS50 error LED.
		Potential issue regarding the Power supply module	Replace the PS50 module.

LED	LED color	Possible causes	Solutions
On the HU250 module			
Transmission power FAULT LED EXT	Red (steady)	Overconsumption on the 12 V transmission output (> 1 A for 3 min by default)	Check the transmission equipment. Restore power by pressing the Reset button on the PS50 module or reset the power supplies from the **Substation** page in the T300 Web server. If the potential issue recurs 3 minutes later, replace the transmission interface or the PS50 module.
Battery status LED	Red (steady)	Battery status	The health of the battery can be checked on the **Substation** page in the Web server. If the battery is declared to have potential issue, check the wiring (corrosion, connection, etc.). If the wiring is OK, replace the battery by a new charged battery.
		Battery disconnected	Check the battery connection and wiring. You can check the disconnected indication on the **Substation** page in the Web server. Reconnect the battery to the PS50 module and wait several minutes to see if the indication disappears (the time period depends on the level of charge of the battery).

LED	LED color	Possible causes	Solutions
On the SC150/SC160 or LV150 module			
ON LED ON	Orange (steady)	No internal dialog between the SC150/SC160 or LV150 module and the HU250 module.	Check that the Ethernet bridges between the modules are present and correctly connected. The **ON LED** ON must also be lit orange on the HU250 module. Check the address of the SC150/SC160 or LV150 module (refer to the Quick Start Guide for instructions on how to do this). Replace the SC150/SC160 or LV150 module if the connections and address are correct.
	Red (steady)	Potential SC150/SC160 or LV150 issue	Refer to the possible causes for an **SC150/LV150 FAULT LED**.
	Red (flashing)	The SC150/SC160 or LV150 is starting up	Wait until the SC150/SC160 or LV150 module startup phase is complete. If the flashing persists, replace the SC150/SC160 or LV150.
SC150/SC160 or LV150 FAULT LED	Red (steady)	Major SC150/SC160 or LV150 potential issue	MAJOR FAULT on the SC150/SC160 or LV150 include hardware or firmware potential issue. Reboot the T300 or try to reload the latest firmware version. If the problem persists, replace the SC150/SC160 or LV150 module.
	Orange (steady)	Minor SC150/SC160 or LV150 potential issue	A MINOR FAULT on the SC150/SC160 or LV150 is due to a potential configuration issue. Reload a valid configuration file. Also check the HU250 configuration.

LED	LED color	Possible causes	Solutions
On the PS50 Module			
AC voltage absent LED	Red (steady)	See the description for a red **AC supply LED** on the HU250 (identical symptoms and solutions).	
Battery status LED	Red (steady)	See the description for a red **battery error LED** on the HU250 (identical symptoms and solutions).	
PS50 FAULT LED	Red (steady)	MAJOR PS50 FAULT	The presence of a MAJOR FAULT is symbolized by a red flash in the detailed view of the PS50 module in the **System** Web server page. Disconnect the T300 power supply and the battery then turn the power on again. If the problem persists after the reboot, replace the PS50 module.
		MINOR PS50 FAULT	The presence of a MINOR FAULT is symbolized by an orange warning in the detailed view of the PS50 module in the **System** page. The possible causes include: • Potential issue on one of the power supply outputs (short-circuit, overload): identify the origin of the short-circuit (wiring or connected device) or the overload (potential device power supply issue). • Thermal protection device tripped: leave it to cool and reset via the **Reset** button on the PS50. If the problem persists, check that there is sufficient cooling in the cabinet to help ensure correct operation. • Permanent overvoltage on the AC supply input: check that the supply voltage is not greater than the specified acceptable input range for the power supply. This may be caused by the increased voltage associated with the loss of a phase, for example.
24/48 V supply FAULT LED	Off	See the description for a red **motor mechanism power LED** on the HU250 (identical symptoms and solutions).	
12 V IED power FAULT LED	Off	Automatic disconnection of the transmission power supply output after a potential issue is detected (short-circuit, overload, overvoltage on this output) or abnormal operation of power supply.	Press the **Reset** button on the PS50 module to reboot the power supplies. If the potential issue persists, disconnect the equipment connected to this output. Reset the equipment. If the potential issue is still present, replace the PS50 module. Otherwise, check the wiring and the devices powered by this output. Note that this **Reset** can also be actuated from the **Substation** page in the T300 Web server.
		If the **AC supply LED** is also off, the Cabinet power supply has been automatically disconnected following an extended AC voltage outage.	Check the cause of the loss of AC voltage. If the AC voltage remains absent, there is an option to reboot the power supply by pressing the **Reset** button on the PS50 module. If the power supply does not restart, change the PS50 module.

LED	LED color	Possible causes	Solutions
On the PS50 Module			
12 V transmission power LED	Off	See the description for a red **transmission power LED** on the HU250 (identical symptoms and solutions).	
Modbus communication LED 	Off	Potential internal link issue between the HU250 and PS50 modules	Check that the RS485 cable is correctly connected between the 2 modules. Check the Modbus address on the PS50 module (thumbwheels) and that the communication speed and parameters are the same as those of the link.

Other Diagnostics

Events	Possible causes	Solutions
Unexecuted commands	Switch command is not executed	Check: • the battery connection (commands cannot be executed without a battery) • the position of the local/remote selector switch • the validity of the command issued • the T300 connection with the switches • for deeper diagnosis check main switchgear control failure code in Event Log on the Web server and refer to appendix SC150/SC160 Potential Issue Codes on Switch/Breaker Control, page 464 for failure code explanation.

Powering Down the Equipment

⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- The CTs must not remain disconnected, while being installed and power on.
- If a disconnection is to be made for any reason, a short-circuit is required at the secondary part of the CTs. CTs connectors are IP2X.
- No cable modifications are required to connect the CT and voltage cables to the cabinet.
- Do not modify cables under any circumstances.

Failure to follow these instructions will result in death or serious injury.

- **Cut the AC power supply**, either externally or via the circuit breaker inside the cabinet.
- **Break the battery circuit:**
  Disconnect the battery from the power supply module. Once both these actions have been implemented, all LEDs on the T300 front panel will be off. This indicates that the PowerLogic T300 cabinet is therefore powered down (off).

Battery Maintenance

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Replacing the Battery 443
Battery Care and Storage..... 443
Equipment Disposal 444

Replacing the Battery

⚠⚠DANGER

HAZARD OF ELECTRIC SHOCK, EXPLOSION, OR ARC FLASH

- Before replacing the battery, make sure first of all that it is disconnected from the power supply module (battery cable must be disconnected).
- Do not make a short-circuit between the battery terminals + and - and any metallic part of the T300, when removing it.
- Protect the + and - terminals of the battery contact, during storage period.

Failure to follow these instructions will result in death or serious injury.

NOTICE

HAZARD OF UNINTENTED EQUIPMENT OPERATION

- Use batteries with recent manufacturing dates (less than 3 months old).
- Do not store batteries for longer than 6 months without charging them.
- Dispose of batteries correctly.

Failure to follow these instructions can result in equipment damage.

Before carrying out any operations on the battery, disconnect it from the equipment.
Remove the battery by sliding it out, remove the terminal protectors, and unscrew the 2 nuts, then disconnect the Faston connectors from the connection cable.
Follow these instructions in reverse to insert a new battery.

Battery Care and Storage

The batteries used are sealed lead acid type. This technology offers several advantages, including reducing risk or explosion or acid leakage, and no special care is required.

However, this type of battery does have limitations:

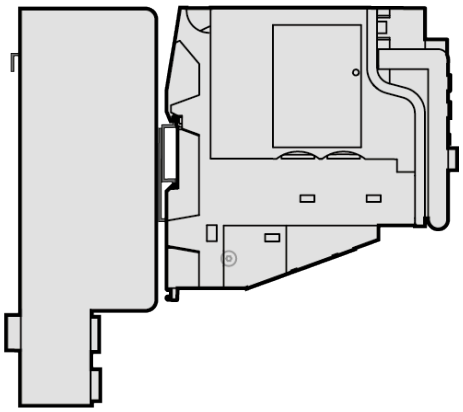
- Limited number of charge cycles
- Average 10-year lifetime, with aging accelerated by high temperatures
- Ages in storage (do not store for longer than 6 months without recharging as this type of battery does not tolerate deep discharge)
- Difficult to forecast battery life

The power supply module is designed to optimize the battery characteristics. A battery status alarm informs the remote control system of a battery-related problem.

NOTE: The battery is an important component as the switch commands cannot be executed if the battery is not connected and charged.

Equipment Disposal

Example of module installed on the PS50 power supply unit



The equipment should be disposed of in a safe manner. Any equipment containing batteries should have them removed before disposal, taking precautions to avoid short-circuits. Particular regulations within the country of operation may apply to the disposal of the equipment.

⚠ WARNING

HAZARD OF LOSS OF CONFIGURATION OR INCORRECT OPERATION

- Before replacing a module, it is important to back up the T300 configuration to help ensure no parameter settings are lost, including the Zigbee commissioning information. Part of the parameter settings are effectively saved in each module.
- The configuration therefore needs to be reloaded to the T300 once a new module has been installed.
- See the "Managing the configuration" section for more information on how to save and restore configuration settings.

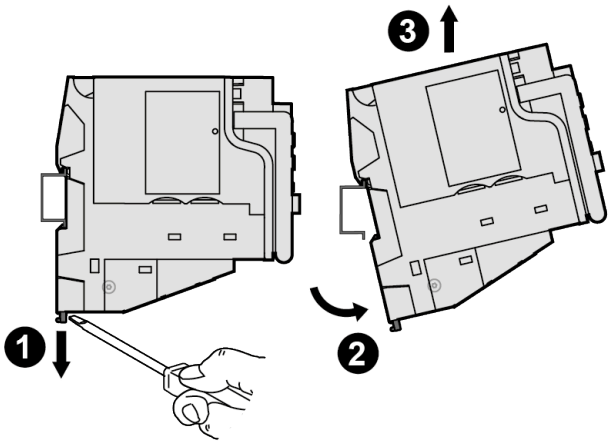
Failure to follow these instructions can result in death, serious injury, or equipment damage.

Replacing the HU250, SC150/SC160 or LV150 Module

What's in This Chapter

Addressing the SC150/SC160 and LV150 Modules 445
Checking the Firmware Version 446
Importing a Stored Configuration 446
Checks To Be Performed After Module Replacement 446

How to remove the T300 module from the DIN mounting rail:



The module removal-installation principle is the same for all T300 modules (HU250, SC150/SC160, LV150). The module is clipped onto a DIN rail.

Before removing a module, you must first:

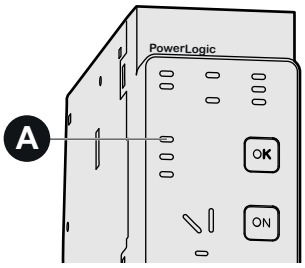
- Power down the cabinet, refer to Powering Down the Equipment, page 442.
- Disconnect all cables, connectors, and Ethernet bridges from the modules.

The module can then be removed as follows:

1. Using a flat-blade screwdriver (< 6 mm, 0,236 in), pull down the tab that holds the module in place on the DIN rail.
2. Tilt the module forwards to free it from the rail.
3. Pull the top of the module upwards to remove it from the rail.

To insert a new module, follow the instructions above in reverse and restore the cabinet power. Refer to the module Installation Manual for more installation instructions.

Addressing the SC150/SC160 and LV150 Modules



A. Dummy switch position LED – front panel of SC150/SC160 module

After an SC150/SC160 or LV150 has been replaced, its IP address needs to be configured. Refer to the T300 Quick Start Guide for detailed instructions on how to proceed.

It is then necessary to check (if possible) that the address has been taken into account. This check is possible for the SC150/SC160, by performing the following operations:

- In the **Substation** page in the Web server, click the symbol corresponding to the SC150/SC160 to be checked.
- In the **Simulation** section displayed on screen, open or close the dummy switch and check that the first customizable LED on the front of the corresponding SC150/SC160 is lit red or green depending on the command sent. This test can be used to check the SC150/SC160 address and dialog with the HU250.

Dummy switch control – **Monitoring > Subview of SC** – page

See the Substation page, page 49 section for more information on simulation.

Checking the Firmware Version

After a module has been replaced, it is necessary to check that it includes the most up-to-date version of the firmware.

To do this, connect to the T300 Web server and check the current version indicated in the **Maintenance/Firmware** page.

If this is not up-to-date, refer to the Updating the Firmware, page 152 for instructions on how to update the firmware.

> **NOTE:** On a T300, all modules have to be upgraded with the firmware provided in the same T300 firmware package (firmware versions must be part of the same T300 release).

Importing a Stored Configuration

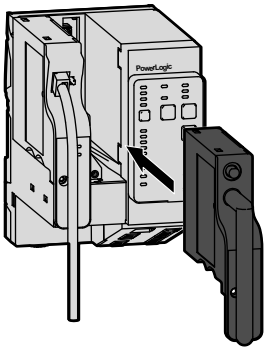
Once the firmware has been updated, it is necessary to load the configuration that was present in the previous module to help ensure that the new module has the same configuration. This configuration should have been saved before the module was replaced.

To load the stored configuration, refer to the Managing the Configuration, page 157/Uploading the configuration, page 161.

Checks To Be Performed After Module Replacement

After a module replacement, it is recommended to check that the main variables of the system have a value which is consistent with the reality. Refer to Commissioning tests, page 410 chapter.

Replacing a Modem Box



Each modem box can be interchanged quickly and easily in the HU250 module.

The modem box is factory-installed but can be removed and replaced with another type of modem if necessary. To install a modem box:

- Unscrew the screw on the front of the modem box using a flat-blade or cross-head screwdriver.
- Pull the modem box to free the connector on the rear from the HU250 module. To install a modem box in its slot, carry out the procedure in reverse.

  NOTE: Replacing a modem box with one of the same kind does not require any configuration. Changing the modem for one of a different kind requires the configuration to be modified using Easergy Builder (refer to the *Easergy Builder User Guide*). Adding a new modem requires the use of T300 Generator.

Replacing the PS50 Module

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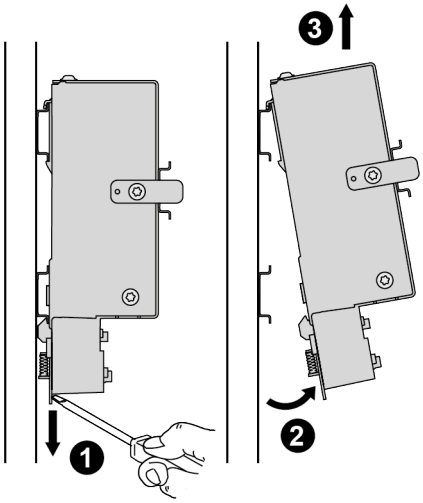
Commissioning 449



To remove the PS50 module, proceed as follows:

- Power down the cabinet, refer to Powering Down the Equipment, page 442.
- Disconnect all cables and connectors from the PS50 module.

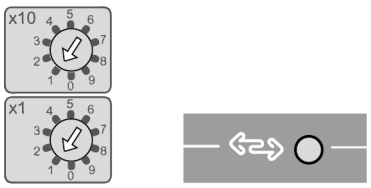
The module can then be removed as follows:

1. Using a flat-blade screwdriver (< 6 mm, 0,236 in), pull down the tab that holds the module in place on the cabinet DIN rails.
2. Tilt the module forwards to free it from the rails.
3. Pull the top of the module upwards to remove it from the rails.

To insert a new module, follow the instructions above in reverse and restore the cabinet power. Refer to the PS50 Installation Manual for more installation instructions.

Addressing the PS50 Module

Thumbwheels and Modbus link status LED – PS50



After a PS50 has been replaced, its Modbus address needs to be configured.

- Configure the thumbwheels on the PS50 module to correspond to the module that has just been replaced to help ensure the Modbus address is the same.
- Once powered up, check that no potential module link issues are indicated on the HU250 and that the Modbus link status LED is flashing regularly on the PS50 module.

Commissioning

The PS50 module is delivered with the factory default settings. If these are not suitable, they can be customized via the **Settings > PS01** page in the Web server. To set the PS50 module parameters, refer to PS50 Module Settings, page 407.

Zigbee Network Maintenance

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Zigbee Network Management

Accessed via **Maintenance > Zigbee Network Management** page.

Overview

The **Zigbee Network Management** page displays the status of the Zigbee network used to monitor the environmental conditions and thermal conditions in the substation and cubicles.

A Zigbee network is operational when all the following conditions are met:

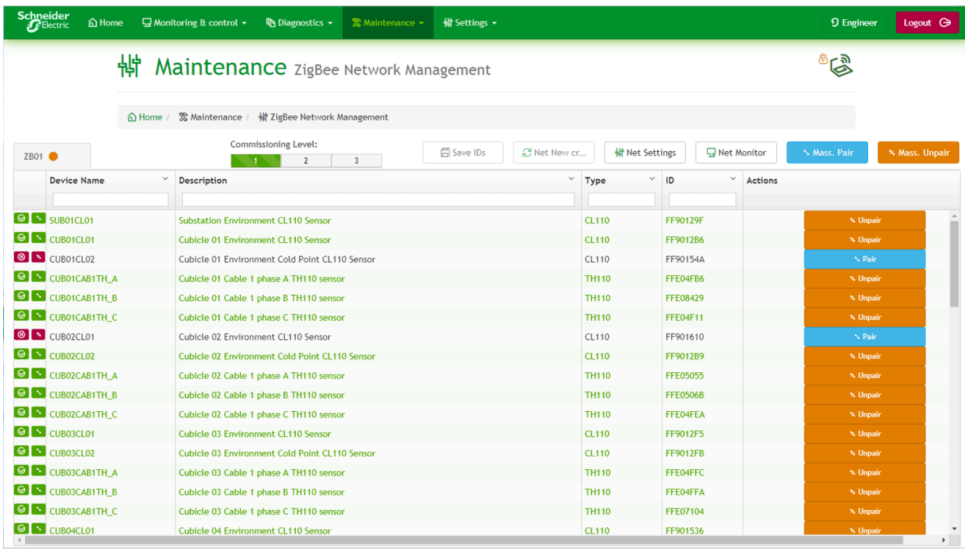
- Sensors installed in the substation are physically enabled.
- Sensors are paired with the network.
- Network configuration is saved. It is automatically saved 20 seconds after the sensors have been paired.

This page displays a general status of the network commissioning **(Commissioning Level)**.
It displays the commissioning status of the sensors installed in the substation and cubicles, and used to monitor the environmental conditions and thermal conditions on the cables.

The sensors displayed in this window have been declared using Easergy Builder.

Use the **Zigbee Network Management** page for the following actions:

- **Pair** the installed and declared sensors to associate them with the Zigbee network,
  or
- **Unpair** the paired sensors to remove them from the Zigbee network. Click the corresponding button in the **Actions** columns.
- Replace sensors.



Network Commissioning Level

There are three commissioning levels:

- Level 1: Some devices need to be paired.
- Level 2: All installed devices are paired.
- Level 3: Network processor information internally saved*.

*“Network processor information internally saved”, means that a copy of the internal memory of the Zigbee box (K7) is saved in the HU250. This copy is used when replacing a Zigbee box (K7), to set up the same network configuration, without any other action than the physical K7 replacement.

New Network Creation

Before creating a new network, remove the existing network as follows:

1. Unpair all sensors (required condition).
2. Click the **Net New creation** button in the **Zigbee Network Management** window.

Pairing Sensors

To pair sensors means to associate them with the Zigbee network.

Sensor status	Description
	Offline and Not paired
	Online and Paired
	Online and Unpairing (previously paired, has been unpaired)
	Offline and Paired

A sensor is Offline when data is no longer received from the sensor, for example, due to an incident on the sensor, or absence of current to supply TH110 sensors.

Pairing Single Sensors

In the **Actions** column, click the **Pair** button

corresponding to the sensor you want to enable and associate with the Zigbee network.

You can also pair a sensor that is not yet configured (with unknown ID). The selected sensor is the first one that responds to the pairing request. In such a case, check that the selected sensor to pair is the expected one.
Prerequisites before pairing a sensor:

- TH110 sensor: it must be powered with the required current.
- CL110 sensor: you must press the sensor button.

When clicking the **Pair** button, the parameter dialog box is displayed to allow you to set up the timeout. Refer to Zigbee devices parameters, page 185.

Pairing All Configured Sensors

This action pairs all the configured sensors (with known IDs) in one click.

Click the **Mass. Pair** button

. The timeout dialog is displayed to allow you to set up the maximum time, in minutes, for this massive pairing action. Keep the recommended default timeout, which depends on the number of devices.

Saving IDs

The IDS are automatically saved in a file independently from the configuration.

This action allows to additionally save them in the configuration file (for export/ import purpose).

This action is optional and only concerns discovered IDs, that is, sensor IDs that have not been configured using Easergy Builder.

After sensors have been paired, the configuration can be updated with the discovered IDs.

Unpairing Sensors

To unpair sensors means to remove them from the Zigbee network.
There are two ways to unpair a sensor:

- Press the **Unpair** button corresponding to the sensor you want to remove from the Zigbee network.
- Disable the sensor physically.
  For example, to disable a CL110 sensor, press 5 seconds on the **CL110** button. To disable sensor physically, refer to the sensor user manual.

During the unpairing process, the sensor pairing status is displayed in orange. When the sensor is unpaired, it is displayed in red.

Sensors are then displayed with the **Pair** button available and with an unkown ID.

Replacing Sensors

1. Unpair the sensor to replace.
2. Pair the new sensor displayed with unknown ID
   or
   set up the new sensor ID in the Zigbee devices parameters window, then pair the new sensor.

Zigbee Box (K7) Replacement

Replace the Zigbee box (K7).
Check that the Network commissioning level is 3.

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Appendix A: General characteristics

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SC160 456
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HU250

Technical Characteristics - Modem Box and Interfaces	
RS modem box	• RJ45 connector • Insulation: 2 kVACrms/5 kV overvoltage The RS modem box can be configured as follows: • RS-232 ◦ With all the control signals to manage an external modem, such as a radio modem, or connection to a PC ◦ Maximum data rate: 115,200 bps • RS-422/RS485 ◦ Maximum distance: 1,500 m ◦ Maximum data rate: 38,400 bps ◦ Polarization and line impedance resistors adaptation: configurable for 2-wire mode ◦ 2-wire or 4-wire mode: configurable via the HU250
4G modem or Zigbee protocol	• 4G modem box, standard EU version ◦ 6 LTE bands: 700/800/900/1800/2100/2600 MHz; 5 FDD bands (28, 20, 8, 3, 1, 7) ◦ 2 GSM/GPRS/EDGE bands: 900/1800 MHz; FDD bands (8, 3) ◦ GPS synchronization option (requires additional antenna) • Zigbee protocol (K7Z) ◦ Operating frequency range (standard IEEE 802.15.4): 2405 – 2480 MHZ
Ethernet ports	• RJ45 10/100 base T connector • Auto-negotiation • DHCP client • Isolation (Port 4: 4 kVAC rms/8 kV overvoltage) • Isolation (Port 3 and 5: 2 kVAC rms/5 kV overvoltage)
Wi-Fi for WiFi modules only	This option is not compatible with the EMS59009 HU250 Without Wireless Unit. • 2.4 GHz IEEE 802.11n. band backward-compatible with standard IEEE 802.11b/g • WPA CCMP security • DHCP server
Power Supply	
Power consumption	< 3 VA

SC150

Output Characteristics		
Motor mechanism nominal voltage		12 VDC to 127 VDC/90 VAC to 220 VAC
AC supply nominal voltage		250 VAC
Maximum interrupt voltage		440 VAC
Nominal current		8 A
DC current limiting		8 A
Current limiting supplied, 4 s max.		15 A
Maximum breaking capacity		2,000 VA
Typical motor control current	15 s	16 A for 50 ms and 6 A for 15 s
Digital Input Characteristics		
8 single or double inputs	(0 V common)	IEC 61131-2 compatible
Voltage Measurement inputs Characteristics (LPVT/VT version)		
Measurement range		0.1 Un to 4 Un
Accuracy (without sensors)	Standard	IEC 61557-12
	Voltage	• 0.5% - from 20% of Un to 120% of Un • 5% - < 20% of Un and > 120% of Un
Voltage accuracy with sensors	Schneider LPVT	0.5% with calibration
MV voltage range	Nominal voltage (Un)	3 to 36 kV
	Frequency	45 to 67 Hz
Voltage input impedance		• SC150 for capacitive adapter interface: 4 MΩ • SC150 for LPVT-VT adapter interface: 10 MΩ
Current Measurement CT inputs Characteristics		
Measurement range	Phase CT input	• 0.02 to 20 In (1 A minimum) for CT = 1 A* • 0.02 to 7 In (1 A minimum) for CT = 5 A* * Setting value of Phase CT secondary rated current in the **SC0x > Settings > Sensors** page
	Zero sequence CT input	0.01 In to 3.5 In (1 A min)
Accuracy (without sensors)	Standard	IEC 61557-12
	Current	0.5%: 0.1 In to 2 In (1% outside of this range)
Permissible overload		10 A continuous operation 50 A – 10 s per hour 120 A – 1 s
Impedance		1 milli Ohm
Burden		0.025 VA
Power Measurement Characteristics (LPVT/VT version)		
Standards	Power and energy	IEC 61557-12/PMD/SD/K70/1
Accuracy (without sensors)	Active power	1%
	Active energy	1%
Number of samples per cycle		• IEC 61557-12 • According to the principles of IEC 61000-4-30 class S (up to harmonic 40)
Frequency range		45 to 67 Hz
Power Supply		
Power consumption		< 2 VA

SC160

Output Characteristics		
Motor mechanism nominal voltage		12 VDC to 127 VDC/90 VAC to 220 VAC
AC supply nominal voltage		250 VAC
Maximum interrupt voltage		440 VAC
Nominal current		8 A
DC current limiting		8 A
Current limiting supplied, 4 s max.		15 A
Maximum breaking capacity		2,000 VA
Typical motor control current	15 s	16 A for 50 ms and 6 A for 15 s
Digital Input Characteristics		
8 single or double inputs	(0 V common)	IEC 61131-2 compatible
Voltage Measurement inputs Characteristics (LPVT/VT version)		
Measurement range		0.1 Un to 4 Un
Accuracy (without sensors)	Standard	IEC 61557-12
	Voltage	• 0.5% - from 20% of Un to 120% of Un • 5% - < 20% of Un and > 120% of Un
Voltage accuracy with sensors	Schneider LPVT	0.5% with calibration
MV voltage range	Nominal voltage (Un)	3 to 36 kV
	Frequency	45 to 67 Hz
Voltage input impedance		• SC150 for capacitive adapter interface: 4 MΩ • SC150 for LPVT-VT adapter interface: 10 MΩ
Current Measurement CT inputs Characteristics		
Measurement range	Phase CT input	• 0.008 to 20 In (1 A minimum) for CT = 1 A* • 0.008 to 7 In (1 A minimum) for CT = 5 A* * Setting value of Phase CT secondary rated current in the **SC0x > Settings > Sensors** page
	Zero sequence CT input	0.01 In to 7 In (1 A min)
Accuracy (without sensors)	Standard	IEC 61557-12
	Current	0.5%: from 0.1 In to 2 In (1% outside of this range) 3%: <0.1 In and >1.2 In up to 20 In
Permissible overload		10 A continuous operation 50 A – 10 s per hour 120 A – 1 s
Impedance		1 milli Ohm
Burden		0.025 VA
Power Measurement Characteristics (LPVT/VT version)		
Standards	Power and energy	IEC 61557-12/PMD/SD/K70/1
Accuracy (without sensors)	Active power	1%
	Active energy	1%
Number of samples per cycle		• IEC 61557-12 • According to the principles of IEC 61000-4-30 class S (up to harmonic 40)
Frequency range		45 to 67 Hz
Tripping protection perfomances		

Phase fault protection (50N/51)	Precision of the threshold	± 5% or ± 0.01 I_N when influences quantities are at rated values
	Tripping delay definite time	±2% or from -15 to +30 ms (1)
	Tripping delay depending time (IDMT)	±5% or from -15 to +30 ms at 10 Is (1)
	Operation time	Instantaneous (Pickup) < 40 ms at 1.2 Is
	Overshoot time	< 30 ms at 2 Is
	Return time	< 50 ms at 2 Is
Earth fault protection (50N/51N)	Precision of the threshold	± 5% or ± 0.004 I_{NO}/ $I_{SO}$when influences quantities are at rated values
	Tripping delay definite time	±2% or from -15 to +30 ms (1)
	Tripping delay depending time (IDMT)	±5% or from -15 to +30 at 10 Is
	Operation time	Instantaneous (Pickup) < 40 ms at 1.2 Is
	Overshoot time	< 30 ms at 2 Is
	Return time	< 50 ms at 2 Is
Directional phase fault protection (ANSI 67)	Precision of the threshold	± 5% or ± 0.02 I_N when influences quantities are at rated values
	Tripping delay definite time for tripping time ≥ 100 ms	±2% or from -15 to +30 ms (1)
	Tripping delay depending time (IDMT) for tripping time ≥ 100 ms	±5% or from -15 o +30 ms
	Operation time	Instantaneous (Pickup) < 80 ms at 2 Is (it takes into account the 40 ms confirmation time)
	Overshoot time	< 30 ms at 2 Is
	Return time	< 55 ms at 2 Is (for a reset time equal to 0)
Directional earth fault protection (ANSI 67N)	Precision of the threshold	± 5% or ± 0.02 I_N when influences quantities are at rated values
	Tripping delay definite time	±2% or from -15 to +30 ms when influences quantities are at rated values
	Operation time	Instantaneous (Pickup) < 50 ms at 2 Is
	Overshoot time	< 50 ms at 2 Is
	Return time	< 55 ms at 2 Is (for a reset time equal to 0)
(1) If H2 restraint is enabled, the tripping time is delayed by 12 ms.		
Power Supply		
Power consumption		< 2 VA

LV150

Voltage Measurement inputs Characteristics (LPVT/VT version)		
Measurement range		0.1 Un to 4 Un
Accuracy (without sensors)	Standard	IEC 61557-12
	Voltage	0.5% from 20% Un to 120% Un
MV voltage range	Nominal voltage (Un)	190 to 400 VAC
	Frequency	45 to 67 Hz
Voltage input impedance		With Voltage adapter interface: 10 MΩ
Current Measurement CT inputs Characteristics		
Measurement range	Phase CT input	0.01 In to 7 In (1 A min)
	Sensors	3 phases + neutral (1 A min)
	Zero sequence CT input	0.01 In to 3.5 In (1 A min)
Accuracy (without sensors)	Standard	IEC 61557-12
	Current	0.5%: 0.1 In to 2 In (1% outside of this range)
Permissible overload		10 A continuous operation 50 A – 10 s per hour 120 A – 1 s
Impedance		1 milli Ohm
Burden		0.025 VA
Power Measurement Characteristics (LPVT/VT version)		
Standards	Power and energy	IEC 61557-12/PMD/SD/K70/1
Accuracy (without sensors)	Active power	1%
	Active energy	1%
Number of samples per cycle		• IEC 61557-12 • According to the principles of IEC 61000-4-30 class S (up to harmonic 40)
Frequency range		45 to 67 Hz
Temperature Measurements Characteristics		
Sensors	Type	3 measures by PT100 sensor
Measurement range	Temperature	-55°C to 250°C (-67°F to 482°F)
	Resolution	1°C (1°F)
Power Supply		
Power consumption		< 2 VA

HU250, SC150/SC160 and LV150

Harmonized standard			
EN 61000-6-2	Electromagnetic compatibility (EMC) - Part 6-2: generic standards - Immunity for industrial environments		
EN 61000-6-4	Electromagnetic compatibility (EMC) - Part 6-4: generic standards - Emission standard for industrial environments		
Dielectric Compatibility			
Dielectric	IEC 60255-27	Common mode (CM)	• Isolation (50 Hz/1 min.): 2 kV • Overvoltage (1.2/50 µs): 5 kV
		Differential mode (DM)	• Isolation (50 Hz/1 min.): 1 kV • Overvoltage (1.2/50 µs): 3 kV
Electromagnetic Compatibility/Immunity			
Electrostatic discharge	IEC 61000-4-2 Level 4/Criteria B	15 kV in air 8 kV on contact	
Radiated, radio-frequency, electromagnetic field immunity	IEC 61000-4-3 Level 4/Criteria A	30 V/m – 27 MHz to 6 GHz AM 80% - 1 kHz	
Immunity to fast transients	IEC 61000-4-4 Level 4/Criteria A	Power supply, Ethernet, voltage and current inputs	CM: ±4 kV 5 kHz – 100 kHz
		Digital inputs and outputs	CM: ±2 kV 5 kHz – 100 kHz
Surge immunity	IEC 61000-4-5 Level 3/Criteria A	Common mode: 2 kV - 1.2/50 µs wave	
		Differential mode: 1 kV - 1.2/50 µs wave	
Immunity to conducted disturbances induced by radio-frequency fields	IEC 61000-4-6 Level 3/Criteria A	10 Vrms - 0.15 MHz to 80 MHz AM 80% - 1 kHz	
Immunity to radiated magnetic fields	IEC 61000-4-8 Level 5/Criteria B	100 A/m – 50 Hz persistent 1,000 A/m 1 to 3 s	
Immunity to pulse magnetic fields	IEC 61000-4-9 Level 5/Criteria A	1,000 A/m	
Conducted disturbances in common mode	IEC 61000-4-16 Level 4/Criteria A	CM: 30 V for 15 Hz to 150 kHz, 300 V (DC/50/60 Hz) for 1 s	
Conducted disturbances in common mode	IEC 61000-4-18 (including IEC 61000-4-12) Level 3/Criteria A	CM: 100 kHz, 1 MHz, 3 MHz, 10 MHz, 30 MHz - 2.5 kV DM: 100 kHz, 1 MHz -1 kV	
Immunity to voltage sags (dips) and short interruptions	IEC 61000-4-29 Criteria A	Voltage sags (dips)	• 24 VDC: 100 ms • 48 VDC: 500 ms
		Short interruptions	• 24 VDC: 100 ms • 48 VDC: 500 ms
Emission Test			
Radio disturbance	CISPR 22	Class A (EN 55022)	
Starting equipment			
Maximum start-up time	IEC 61557-12	1 min 30 sec	
Environmental Conditions			
Operating temperature	IEC 60068-2-1 IEC 60068-2-2	-40°C to +70°C	
Storage temperature	IEC 60068-2-1 IEC 60068-2-2	-40°C to +85°C	
Humidity, steady state	IEC 60068-2-78	93% RH, 40°C, RH without condensation, 56 days	
Change of temperature	IEC 60068-2-14	-40°C to +70°C, 5°C/min, 10 cycles, 27 hrs without condensation	
Humidity	IEC 60068-2-30	144 hours: 6 cycles of 24 hours (+55°C, 93% RH for 9 hours; +25° C, 95% RH for 6 hours)	

Salt mist test	IEC 60068-2-11	168 hours
Safety		
Protection of people and property	IEC 60255-27	Insulation resistance (CM & DM : 500 V, R > 100 Mohm) Protective bounding continuity (12 V, < 12 ohm, 60 s)
Fire resistance	IEC 60695-2-11	850°C
Mechanical Characteristics		
Degree of protection	IEC 60529	• Front panel: IP4x • Body of module: IP2x
Ruggedness	IEC 62262	IK7 2J (front face)
Vibration	IEC 60068-2-6	10 to 2,000 Hz/1 g (peak value) 10 cycles
Bumps	IEC 60068-2-29	10 g/16 ms/1,000 bumps non-operating
Shock	IEC 60068-2-27	10 gn/11 ms/3 pulses during operation

PS50

Capacity			
Number of modules		Up to 16 modules	
Voltage Input Characteristics			
AC voltage input		90 to 264 VAC - 50/60 Hz single-phase	
DC voltage input		110 to 220 VDC	
Overvoltage		440 VAC max.	
Voltage Output Characteristics			
12 V IEDs	Nominal output power	36 W	
	Nominal output voltage	12 V (10.5 V to 15 V)	
	DC current	3 A	
	Overload limit	8 A	
	Current peak on short-circuit	13 A – 50 ms	
	Overvoltage protection on output	15.5 V	
12 V Telecom	Nominal output power	18 W	
	Nominal output voltage	12 V (10.5 V to 15 V)	
	DC current	1.5 A	
	Overload limit	8 A	
	Current peak on short-circuit	13 A – 50 ms	
	Overvoltage protection on output	15.5 V	
48 V and 24 V motor mechanism and IEDs		24 V	48 V
	Nominal output power	10 W	10 W
	Nominal output power	300 W (60 s)	300 W (60 s)
	Nominal output voltage	24 V ± 10%	48 V ± 10%
	DC current	0.4 A	0.2 A
	Overload limit	3 A	1.5 A
	Current peak on short-circuit	40 A	40 A
	Nominal output current	30 A for 50 ms then 12 A for 15 s	15 A for 50 ms then 6 A for 15 s
	Overvoltage protection on output	27 V	55 V
Battery Management			
Number of batteries		1	
Charger capacity		Up to 38 Ah	
Battery type		No-maintenance, lead-acid type	
Charge management	Nominal voltage	10.5 V to 15 V	
	Battery type	Configurable: 38 Ah, 24 Ah, or other	
	Compensated temperature	By measuring internal temperature	
	Charge time	10 to 24 hours	
Battery protection		• Against deep discharge • Against short-circuits • Against reverse polarity	
Battery test		• Automatic periodic tests • On internal charge • Can be activated by communication	
Battery monitoring		• End of life detection	

		• Connection/disconnection detection	
Battery			
Brand		Yuasa	
Voltage/Amps		12 V/24 Ah 12 V/38 Ah	
Model		24 Ah: SWL750 38 Ah: SWL1100	
Type		Lead acid	
Battery life		10 years	
Temperatures		• Storage: -20°C to +60°C • Charge: -15°C to +50°C • Discharge: -20°C to +60°C	
Weight		• SWL1100: 14 kg • SWL750: 9 kg	
Contact Outputs			
Auxiliary contacts	Breaking capacity	60 VDC – 2 A	
	Contact outputs	• Battery status • AC supply present	
Temperature			
Operating temperature		-40°C to +70°C	
Storage temperature		-40°C to +70°C	
Dielectric Compatibility			
Dielectric	IEC 60255-27	AC supply input	• CM: Isolation (50 Hz/1 min.): 10 kV • CM: Overvoltage (1.2/50 µs): 20 kV • DM: Overvoltage (1.2/50 µs): 8 kV
		RS485	• CM: Isolation (50 Hz/1 min.): 1.5 kV • CM: Overvoltage (1.2/50 µs): 2.5 kV
		Other	• CM: Isolation (50 Hz/1 min.): 2 kV • CM: Overvoltage (1.2/50 µs): 5 kV • DM: Isolation (50 Hz/1 min.): 1 kV • DM: Overvoltage (1.2/50 µs): 3 kV
Electromagnetic Compatibility/Immunity			
Electrostatic discharge	IEC 61000-4-2 Level 4/Criteria B	15 kV in air 8 kV on contact	
Radiated, radio-frequency, electromagnetic field immunity	IEC 61000-4-3 Level 4/Criteria A	30 V/m – 27 MHz to 6 GHz	
Immunity to fast transients	IEC 61000-4-4 Level 3, 4/Criteria A	Power supply, voltage outputs, RS485	CM: ±4 kV (N4) 5 kHz – 100 kHz
		Other circuits	CM: ±2 kV (N3) 5 kHz – 100 kHz
Surge immunity	IEC 61000-4-5 µLevel 3, 4/Criteria A	AC supply input	CM: 4 kV (N4) - 1.2/50 s wave DM: 2 kV (N4) - 1.2/50 µs wave
		Other	CM: 2 kV (N4) - 1.2/50 µs wave DM: 1 kV (N4) - 1.2/50 µs wave
Immunity to conducted disturbances induced by radio-frequency fields	IEC 61000-4-6 Level 3/Criteria A	10 Vrms - 0.15 MHz to 80 MHz	

Immunity to radiated magnetic fields	IEC 61000-4-8 Level 5/Criteria B	100 A/m – 50 Hz persistent 1,000 A/m 1 to 3 s
Immunity to pulse magnetic fields	IEC 61000-4-9 Level 5/Criteria A	1,000 A/m
Conducted disturbances in common mode	IEC 61000-4-16 Level 4/Criteria A	CM: 30 V for 15 Hz to 150 kHz, 300 V (DC/50/60 Hz) for 1 s
Conducted disturbances in common mode	IEC 61000-4-18 (including IEC 61000-4-12) Level 3/Criteria A	CM: 3 MHz, 10 MHz, 30 MHz - 2 kV
Emission Test		
Radio disturbance	CISPR 22	Class A (EN 55022)
Conducted disturbance	CISPR 22	Class A (EN 55022)
Environmental Conditions		
Operating temperature	IEC 60068-2-1 IEC 60068-2-2	-40°C to +70°C
Storage temperature	IEC 60068-2-1 IEC 60068-2-2	-40°C to +70°C
Humidity, steady state	IEC 60068-2-78	93% RH, 40°C, RH without condensation, 56 days
Change of temperature	IEC 60068-2-14	-40°C to +70°C, 1°C/min, 10 cycles, 27 hrs without condensation
Humidity	IEC 60068-2-30	144 hours: 6 cycles of 24 hours (+55°C, 93% RH for 9 hours; +25°C, 95% RH for 6 hours)
Salt mist test	IEC 60068-2-11	168 hours in cubicle
Safety		
Protection of people and property	IEC 60255-27	
IEC 60255-27	IEC 60255-27	• 500 V CM & DM • R > 100 MΩ
Fire resistance	IEC 60695-2-11	850°C
Flame retardancy	IEC 60255-11-5	• Application of flames: 5 times for 15 s at a time • Interval between each application: 15 s or 30 s (once)
Continuity of protection link	IEC 60255-27	12 V, < 0.1 Ω, 60 s
Mechanical Characteristics		
Degree of protection	IEC 60529	IP20
Ruggedness	IEC 62262	IK7 2J
Vibration	IEC 60068-2-6	10 to 2,000 Hz/1 g (peak value) 10 cycles
Bumps	IEC 60068-2-29	10 g/16 ms/1,000 bumps non-operating
Shock	IEC 60068-2-27	10 gn/11 ms/3 pulses during operation

Appendix B: List of Potential Issue Codes

What's in This Chapter

SC150/SC160 Potential Issue Codes on Switch/Breaker Control 464

SC150/SC160 Potential Issue Codes on Switch/Breaker Control

During an opening or closing command to a switch via one of the SC150/SC160 modules, a code representing the status of the control is displayed on the **Monitoring & Control > Status** page. This status can be a potential issue code or simply an indication of the command result.

The **Main switchgear control** failure variable displayed in this page takes the value of this code. Referring to the table below, you can see the code's correspondence and its meaning, depending on the value displayed for the variable.

Main switchgear control failure variable	
Value (potential issue code)	**Description**
0	Command completed successfully
1	Local command blocked because switch position is intermediate or unknown
2	Local command blocked because switch position is already in correct state
3	Local command canceled by user
4	Switch position did not change within configured maximum operation time
5	Command blocked by Head Unit interlocks, e.g. potential motor supply issue or battery low
6	Command did not execute due to timeout waiting for enable from Head Unit
7	Local command blocked because disabled by configuration
8	Local command blocked because local/remote status is unknown
9	Local command blocked because local/remote status is remote
10	Local command blocked because automation is on
11	Remote command blocked because automation is on
12	Sectionalizer command blocked because automation is off
13	Sectionalizer command blocked because local/remote status is unknown
14	Sectionalizer command blocked because local/remote status is local
15	Unexpected command source (firmware potential issue)
16	Remote command blocked because requested position is not a valid value
17	Command blocked because a command is already in progress for this module
18	Command blocked because the power shutdown signal is active
19	Command blocked because a command is already in progress for another module
20	Command blocked because measured switch position is intermediate or unknown
21	Command blocked because measured switch position is the same as the requested position
22	Command blocked because ground (earth) switch position is not open
23	Open command blocked because external input is false
24	Open command blocked because external input is true
25	Close command blocked because external input is false
26	Close command blocked because external input is true

Main switchgear control failure variable	
Value (potential issue code)	**Description**
27	Commands blocked because module behaviour mode is off
28	Command blocked because switch controller is in local mode
29	Command blocked because switch controller local/remote input is undefined
30	Command blocked because protection trip lockout is active
31	Command blocked because the OPEN/CLOSE command is in progress
32	Command blocked because a self-test is in progress

Appendix C: Inverse Definite Minimum Time (IDMT)

What's in This Chapter

Inverse Definite Minimum Time (IDMT) Curves 466

Inverse Definite Minimum Time (IDMT) Curves

The table below gives the values and data for each inverse definite minimum time curve.
It can be used to calculate the detection time for a specific current value for each curve type.

Example: A motor has an SIT type detection curve including the following settings:

- Is = 1,000 A
- T (10 Is) = 4 s

You wish to determine the detection time for a current I of 3,500 A.

Solution: You have an SIT curve and an I/Is ratio of 3,500/1,000 = 3.5.
You therefore need to search for the corresponding k value (I/Is) in the table.
Then calculate t=T x k:
i.e.: t = 4 x 1.858 = 7.43 s

The detection time for a current of 3,500 A will therefore be 7.43 seconds.

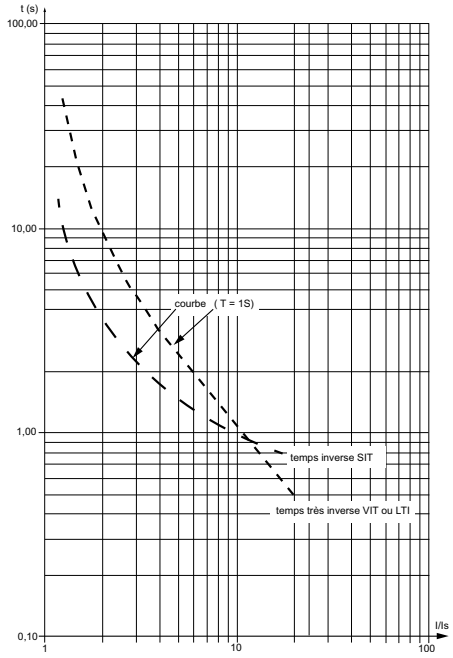
Table of values of K

I/Is	SIT and IEC/A	VIT, LTI and IEC/B	EIT and IEC/C	UIT	RI	IEEE MI (IEC/D)	IEEE VI (IEC/E)	IEEE EI (IEC/F)	IAC I	IAC VI	IAC EI
1.0	—	—	—	—	3.062	—	—	—	62.005	62.272	200.226
1.1	24.700 (1)	90.000 (1)	471.429 (1)	—	2.534	22.461	136.228	330.606	19.033	45.678	122.172
1.2	12.901	45.000	225.000	545.905	2.216	11.777	65.390	157.946	9.413	34.628	82.899
1.5	5.788	18.000	79.200	179.548	1.736	5.336	23.479	55.791	3.891	17.539	36.687
2.0	3.376	9.000	33.000	67.691	1.427	3.152	10.199	23.421	2.524	7.932	16.178
2.5	2.548	6.000	18.857	35.490	1.290	2.402	6.133	13.512	2.056	4.676	9.566
3.0	2.121	4.500	12.375	21.608	1.212	2.016	4.270	8.970	1.792	3.249	6.541
3.5	1.858	3.600	8.800	14.382	1.161	1.777	3.242	6.465	1.617	2.509	4.872
4.0	1.676	3.000	6.600	10.169	1.126	1.613	2.610	4.924	1.491	2.076	3.839
4.5	1.543	2.571	5.143	7.513	1.101	1.492	2.191	3.903	1.396	1.800	3.146
5.0	1.441	2.250	4.125	5.742	1.081	1.399	1.898	3.190	1.321	1.610	2.653
5.5	1.359	2.000	3.385	4.507	1.065	1.325	1.686	2.671	1.261	1.473	2.288
6.0	1.292	1.800	2.829	3.616	1.053	1.264	1.526	2.281	1.211	1.370	2.007
6.5	1.236	1.636	2.400	2.954	1.042	1.213	1.402	1.981	1.170	1.289	1.786
7.0	1.188	1.500	2.063	2.450	1.033	1.170	1.305	1.744	1.135	1.224	1.607
7.5	1.146	1.385	1.792	2.060	1.026	1.132	1.228	1.555	1.105	1.171	1.460
8.0	1.110	1.286	1.571	1.751	1.019	1.099	1.164	1.400	1.078	1.126	1.337
8.5	1.078	1.200	1.390	1.504	1.013	1.070	1.112	1.273	1.055	1.087	1.233
9.0	1.049	1.125	1.238	1.303	1.008	1.044	1.068	1.166	1.035	1.054	1.144
9.5	1.023	1.059	1.109	1.137	1.004	1.021	1.031	1.077	1.016	1.026	1.067
10.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
10.5	0.979	0.947	0.906	0.885	0.996	0.981	0.973	0.934	0.985	0.977	0.941
11.0	0.959	0.900	0.825	0.787	0.993	0.963	0.950	0.877	0.972	0.957	0.888
11.5	0.941	0.857	0.754	0.704	0.990	0.947	0.929	0.828	0.960	0.939	0.841
12.0	0.925	0.818	0.692	0.633	0.988	0.932	0.912	0.784	0.949	0.922	0.799
12.5	0.910	0.783	0.638	0.572	0.985	0.918	0.896	0.746	0.938	0.907	0.761
13.0	0.895	0.750	0.589	0.518	0.983	0.905	0.882	0.712	0.929	0.893	0.727
13.5	0.882	0.720	0.546	0.471	0.981	0.893	0.870	0.682	0.920	0.880	0.695
14.0	0.870	0.692	0.508	0.430	0.979	0.882	0.858	0.655	0.912	0.868	0.667
14.5	0.858	0.667	0.473	0.394	0.977	0.871	0.849	0.631	0.905	0.857	0.641
15.0	0.847	0.643	0.442	0.362	0.976	0.861	0.840	0.609	0.898	0.846	0.616
15.5	0.836	0.621	0.414	0.334	0.974	0.852	0.831	0.589	0.891	0.837	0.594
16.0	0.827	0.600	0.388	0.308	0.973	0.843	0.824	0.571	0.885	0.828	0.573
16.5	0.817	0.581	0.365	0.285	0.971	0.834	0.817	0.555	0.879	0.819	0.554

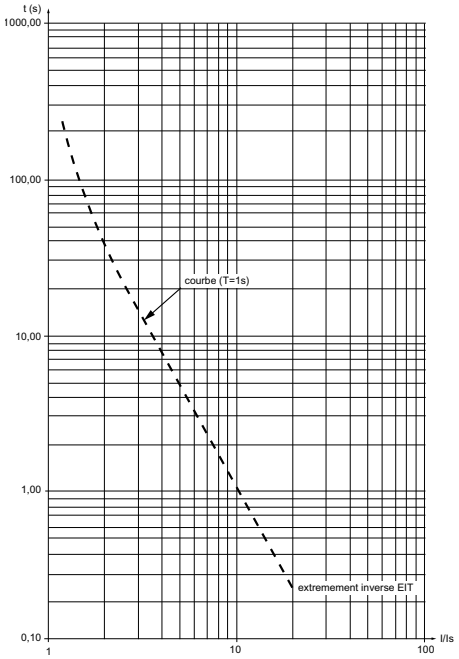
The different IDMT curves are represented for information purposes on the next page using the values from this table.

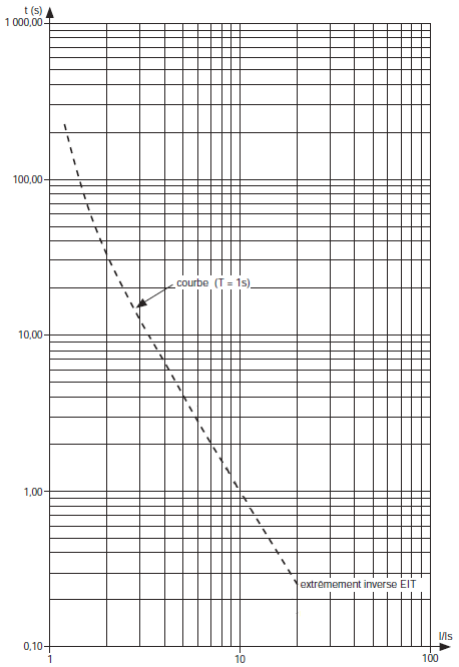
Refer to the Inverse Definite Minimum Time (IDMT) Detection Curve, page 317 chapter for the correspondence between the denominations of the IDMT curves listed in the column title of this table and the names of the IDMT curves cited in this document.

Normal inverse time curve (SIT)
Very inverse time curve (VIT)

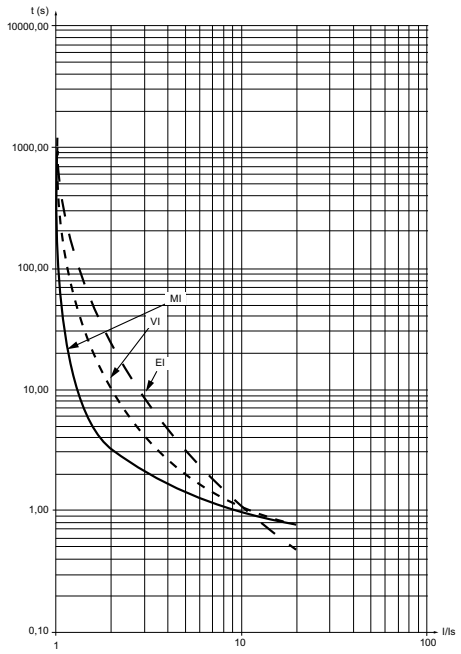


Extremely inverse time curve (EIT)





IEEE inverse time curve


t (s)
10000,00
1000,00
100,00
10,00
1,00
0,10
1
10
100
I/Is
MI
VI
EI

Appendix D: Wi-Fi Access

What's in This Chapter

Activation of Local Wi-Fi Access 470
Connection to T300 Web Server via Wi-Fi Access 472

Activation of Local Wi-Fi Access

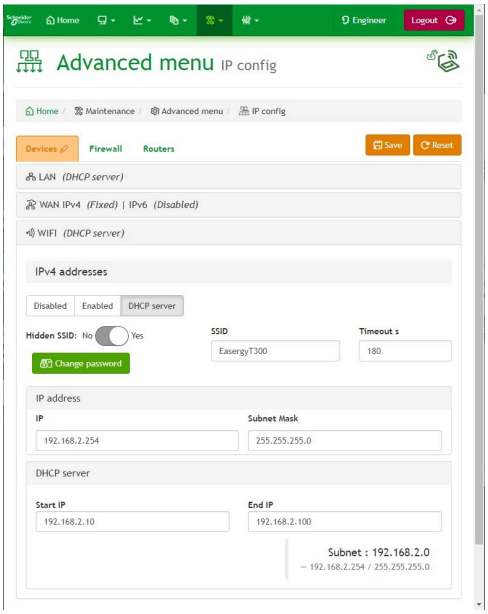
NOTE: Wi-Fi and other wireless protocols are only available on the HU250 with part number EMS59000.

NOTE: Wi-Fi access is disabled by configuration on the T300 RTU when received from the factory.

To get a wireless connection with the unit, the first step is to activate Wi-Fi access via the T300 Web server.

To do this, an Ethernet connection to the unit is required.

1. Power on the unit.
2. Wait until the HU250 operating LED is flashing. When the LED lights steadily, connect the Ethernet cable between the PC and the local LAN Ethernet port of the HU250.
3. Once connected and logged in, go to the **Maintenance > IP configuration** page.
4. In the Wi-Fi section, configure the following settings to activate Wi-Fi access:



Setting	By default	To be configured	Description
Wi-Fi	Disabled	DHCP Server	**Enabled** means Wi-Fi activation
Hidden SSID	No	No	
SSID	PowerLogic T300	To customize	Enter a unique SSID for each T300.
IP	192.168.2.254	192.168.2.254	The default settings can be changed according to the properties of your LAN network if required.
Subnet mask	255.255.255.0	255.255.255.0	
DHCP Server	Enabled	Enabled	
Sart IP	192.168.2.10	192.168.2.10	
End IP	192.168.2.100	192.168.2.100	

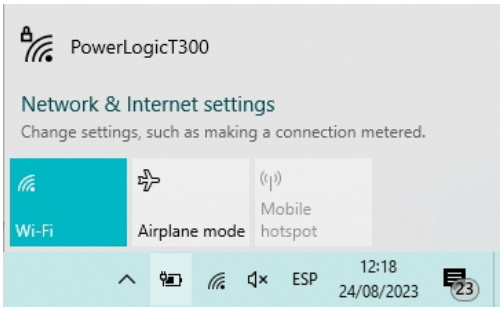
5. Click the **Save** button to apply the changes.
6. Click the **Change password** button. Define a new personal password.

   NOTE: For security reasons, it is important to change default passwords so they are unique on each T300 RTU.

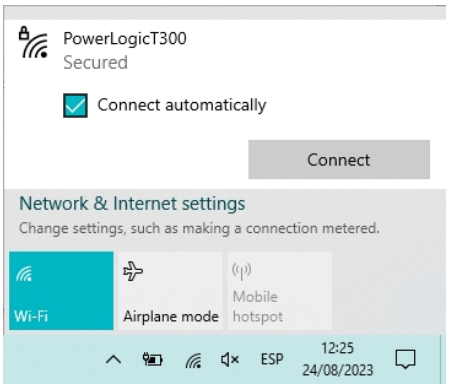
7. Put the unit in **Local mode** using button on the front panel of the HU250.

   NOTE: By default, Wi-Fi access is activated on the unit only in Local mode.

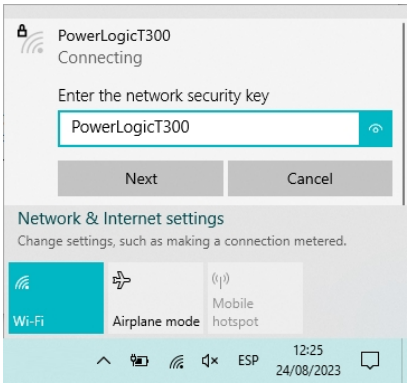
8. Click the Wireless icon on the Windows task bar of your computer desktop.



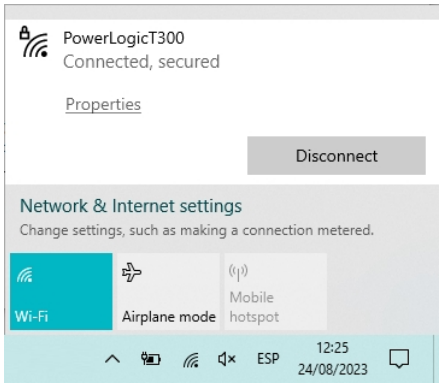
9. Check that the wireless connection (with SSID defined previously) appears in the Windows task bar and click it.
10. Click the **Connect** button.



11. Enter the Wi-Fi security key (password defined previously).



12. Windows automatically connects to this Wi-Fi network and the T300 SSID appears as connected in the task bar. You can now disconnect the Ethernet cable from the unit.

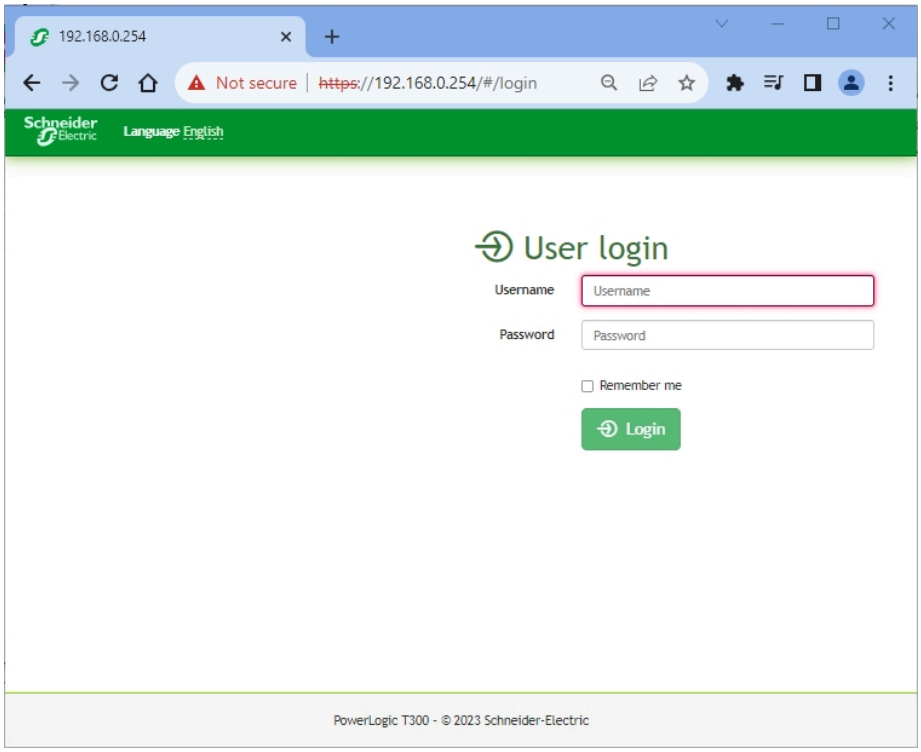


Connection to T300 Web Server via Wi-Fi Access

1. Start an Internet browser. Access to the HTML pages is activated according to the rights related to the user type. Refer to Rights Defined For Each Role/User, page 98.
2. In the **Address** field, enter the following IP address: **https://192.168.2.254**. Click **Ok**.

   A message appears regarding the Security Certificate.
3. Follow the instructions to override and continue to access the T300 Website.

   The startup page of the embedded server appears on screen.
4. Select the language to be used and click **Ok**.
5. Enter a **User name** and a **Password**. The following default users are defined on the unit:



NOTE: By default, there is only one SecurityAdmin user with AAAAAAAA password. Other users/roles need to be created manually.
For security requirements, the default password must be changed during commissioning.

6. Access to the HTML pages is activated according to the rights relating to the user type.

Glossary

A

ANSI: American National Standards Institute. Private and non-profit organization headquartered in Washington that oversees the development of standards for products, services, processes, systems, and personnel in the United States.

AT: AT is the abbreviation for ATtention. These 2 characters are used to start and send a command line in the form of text (ASCII codes) to a modem. The modem responds with OK or gives the response to the request.

B

BIN controller: This relates to the different system data acquisition and processing application software that has access to the CoreDB database. Each BIN controller acts as a producer and/or consumer of data managed by CoreDB.

BIN: This is a set of Input/Output (I/O) signals with a common source. They may relate, for example, to the representation of an IED that communicates with the T300 RTU, or the representation of a SCADA system that receives or generates information acquired or generated on the platform.

BIMon: Base Line Monitoring tool is a shell dedicated to monitoring the various application program components of the firmware. The various communication channels can be monitored, for example, for diagnostic purposes.

C

CAE: Cybersecurity Administrator Expert. The CAE is a tool for organizing the T300 security policy and defining system access restrictions and user rights.

CILO: Command InterLOcking. This is the system BIN controller that controls the switch output commands.

CM: Common Mode

CoreDB: CoreDB is a real-time RTU database that helps ensure the RTU signals are managed in real-time.

CPU: Central Processing Unit.

D

DHCP: Dynamic Host Configuration Protocol. A network protocol for helping ensure that station IP parameters are automatically configured via automatic IP address allocation.

DI: Digital Input.

DM: Differential Mode.

DO: Digital Output.

DT: Definite time. Designation for definite time fault current detection curves.

E

Easergy Builder: Easergy Builder is the official configuration tool for T300 equipment. This tool can be used to configure all the advanced RTU functions (for example, database, protocol addressing, events) and to carry out maintenance tasks on the equipment.

F

FPI: Fault Passage Indicator. Designation of the fault current detection function.

G

GMT: Greenwich Mean Time. Mean solar time at the Royal Observatory in Greenwich, London, England, used as the universal time standard.

H

HMI: Human Machine Interface.

HTTP: Hyper Text Transfer Protocol. Client-server communication protocol developed for the World Wide Web. HTTPS (where S = Secure) is the secure variant of HTTP using SSL or TLS protocols.

HU250: Head Unit 250. Control and communication module for the T300.

Hysteresis: Delay of the effect on the cause in the behavior of a signal subjected to an increasing and then decreasing action (see diagram below). Hysteresis creates a zone of uncertainty signal detection in which the state is not clearly identified. Outside this area, the state is known.

I

IDMT: Inverse Definite Minimum Time. Designation for inverse definite minimum time fault current detection curves.

IEC: International Electrotechnical Commission. The international standards organization for the fields of electricity, electronics, electromagnetic compatibility, nanotechnology, and related technologies. It complements the International Organization for Standardization (ISO), which is responsible for other fields.

IED: Intelligent Electronic Device.

IEEE: Institute of Electrical and Electronics Engineers. The IEEE is a professional association comprising members from the fields of electrical engineering, information technology, telecommunications, etc. The organization's mission is to advance knowledge in the field of electrical engineering and publish associated standards and other texts written by its members.

IP: Internet Protocol.

Is: Maximum fault current threshold

K

K7: Another name for a mode box installed in the modem slots on the HU250.

L

LAN: Local Area Network.

LDAP: Lightweight Directory Access Protocol

LDAPS: Lightweight Directory Access Protocol over TLS

LED: Light Emitting Diode.

Linux: Operating system running in realtime on the software platform. This is the element in charge of extracting the various software components from the hardware.

LIOC: Local Input Output Controller. This is the system BIN controller that manages the HMI and the digital I/O.

LV150: Low Voltage 150. Low Voltage measurement management module for T300 equipment.

LV: Low Voltage.

M

Module: Hardware device comprising a functional component of the T300 (for example, SC150, HU250, and PS50 are modules on the T300).

MQTT: Message Queuing Telemetry Transport

MV: Medium Voltage.

O

OS: Operating System.

P

PC: Personal Computer.

PLC: Programmable Logic Controller.

PPP: Point to Point Protocol. Internet transmission protocol for establishing a link-type connection between 2 hosts on a point-to-point link.

PS50: Power Supply 50. Standard power supply module for the T300 equipment.

PTOC: Protection Time OverCurrent

PTOV: Protection Time OverVoltage

PTUC: Protection Time UnderCurrent

PTUV: Protection Time UnderVoltage

R

RADIUS: Remote Authentication Dial-In User Service

RMS: Root Mean Square.

RS: Serial link.

RTU: Remote Terminal Unit.

S

SC150: Switch Control 150. Switch control and MV measurement management module for the T300.

SCADA: Supervisory Control And Data Acquisition.

SEC: Sectionalizer automation function

SFTP: Secure File Transfer Protocol.

SHELL: The shell is a command interpreter. It is the interface between the user and the operating system. The shell uses command lines entered by the user to act as the intermediary between the operating system and the user. The role of the shell is to read the command line, interpret its meaning, run the command, then return the result to the outputs.

SLOT: Slot reserved in the HU250 for a K7 modem.

SNTP: Simple Network Time Protocol.

SOE: Sequence Of Events. This relates to saving and storing events and signal changes in the RTU that manages the data in real-time.

SSH: Secure SHell. SSH is both a program and a secure communication protocol. It is the equivalent of the Telnet program and is used in the same way to run certain operations remotely (mainly server administration or file transfer operations). SSH is more secure than Telnet protocol.

SSID: Service Set IDentifier. Name used to identify a Wi-Fi network according to standard IEEE 802.11.

T

TCP or TCP/IP: Transmission Control Protocol/Internet Protocol. Set of protocols used to transfer data on the Internet.

Ts: Fault current acknowledge time

U

UDP: User Datagram Protocol. Connectionless transport layer communication protocol for the TCP/IP model.

V

VAC: Voltage of Alternate Current.

VDC: Voltage of Direct Current.

W

WAN: Wide Area Network.

Wi-Fi: Wireless network

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