ABB ABILITY™ SMART SUBSTATION CONTROL AND PROTECTION FOR ELECTRICAL SYSTEMS

SSC600

Operation Manual

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This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 2014/35/EU). This conformity is the result of tests conducted by ABB in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series and IEC 61805-3:2013.

Contents

1 Introduction

ABB Ability™ Smart Substation Control and Protection for electrical systems SSC600 is a Smart Substation device designed for protection, control, measurement and supervision of utility substations and industrial switchgear and equipment. The design of the device has been guided by the IEC 61850 standard for communication and interoperability of substation automation devices. It is fully integrable with Relion series IEDs for creating a complete solution. Optional functionality is available at the time of order for both software and hardware, for example, special application packages and additional communication modules.

Figure 1: SSC600

1.1 Communication

The IED supports the IEC 61850 standard and its specified GOOSE, MMS and SAV/SMV communication profiles. Operational information and controls are available through these protocols.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter settings, disturbance recordings and fault records can be accessed using the IEC 61850 protocol. Disturbance recordings are available to any Ethernet-based application in the IEC 60255-24 standard COMTRADE file format. The IED can receive binary signals from other devices (so-called horizontal communication) using the IEC 61850-8-1 GOOSE profile, where the highest performance class with a total transmission time of 3 ms is supported. Furthermore, the IED supports receiving of analog values using GOOSE messaging.

The IED meets the GOOSE performance requirements for class P1 (10 ms) tripping applications in distribution substations, as defined by the IEC 61850 standard.

The IED can support five simultaneous clients for IEC 61850 MMS reporting. The IED supports receiving sampled analogue measurements according to IEC 61850-9-2LE from up to 30 Merging Units or other IEDs.

1.1.1 Ethernet redundancy

IEC 61850 specifies a network redundancy scheme that improves the system availability for substation communication. It is based on parallel redundancy protocol PRP-1 defined in the IEC 62439-3:2012 standard. The protocol relies on the duplication of all transmitted information via two Ethernet ports for one logical network connection. Therefore, it is able to overcome the failure of a link or switch with a zero-switchover time, thus fulfilling the stringent real-time requirements for the substation automation horizontal communication and time synchronization.

PRP specifies that each device is connected in parallel to two local area networks. Thus, each device incorporates a switch element that forwards frames from port to port.

IEC 62439-3:2012 cancels and replaces the first edition published in 2010. These standard versions are also referred to as IEC 62439-3 Edition 1 and IEC 62439-3 Edition 2. The IED supports IEC 62439-3:2012 and it is not compatible with IEC 62439-3:2010.

PRP

Each PRP node, called a doubly attached node with PRP (DAN), is attached to two independent LANs operated in parallel. These parallel networks in PRP are called LAN A and LAN B. The networks are completely separated to ensure failure independence, and they can have different topologies. Both networks operate in parallel, thus providing zero-time recovery and continuous checking of redundancy to avoid communication failures. Non-PRP nodes, called single attached nodes (SANs), are either attached to one network only (and can therefore communicate only with DANs and SANs attached to the same network), or are attached through a redundancy box, a device that behaves like a DAN.

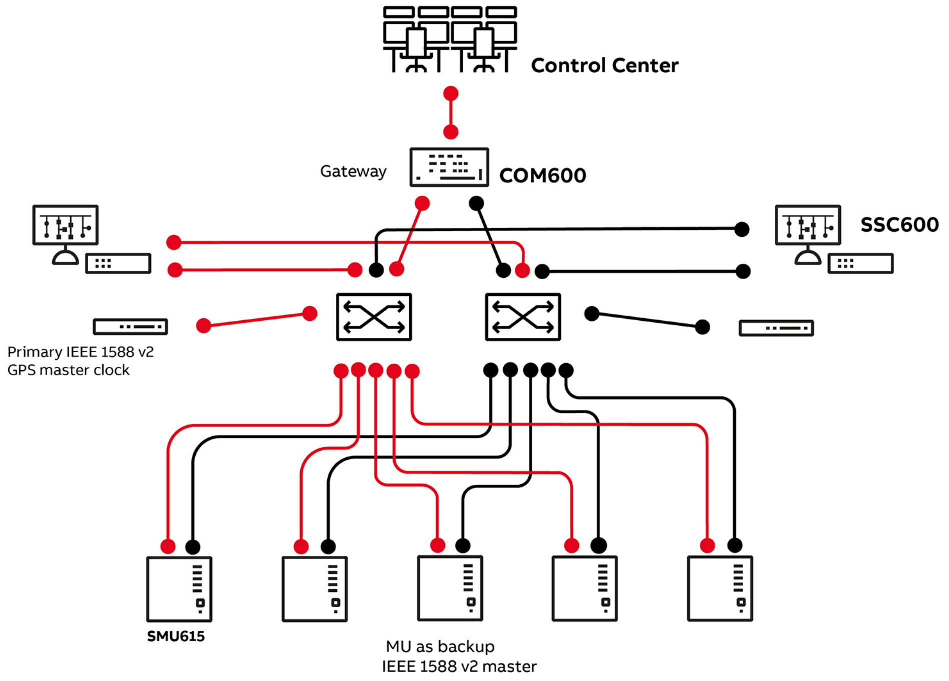


Figure 2: PRP solution

In case a laptop or a PC workstation is connected as a non-PRP node to one of the PRP networks, LAN A or LAN B, it is recommended to use a redundancy box device or an Ethernet switch with similar functionality between the PRP network and SAN to remove additional PRP information from the Ethernet frames. In some cases, default PC workstation adapters are not able to handle the maximum-length Ethernet frames with the PRP trailer.

There are different alternative ways to connect a laptop or a workstation as SAN to a PRP network.

- Via an external redundancy box (RedBox) or a switch capable of connecting to PRP and normal networks
- By connecting the node directly to LAN A or LAN B as SAN

1.1.2 Process bus

Process bus IEC 61850-9-2 defines the transmission of Sampled Measured Values within the substation automation system. UCA users' group created a guideline IEC 61850-9-2 LE that defines an application profile of IEC 61850-9-2 to facilitate implementation and enable interoperability. Process bus is used for distributing process data from the primary circuit to all process bus compatible IEDs in the local network in a real-time manner. The data can then be processed by any IED to perform different protection, automation and control functions.

Transmitting measurement samples over process bus brings also higher error detection because the signal transmission is automatically supervised. Additional contribution to the higher availability is the possibility to use redundant Ethernet network for transmitting SMV signals.

The SSC600 supports receiving of sampled values of analog currents and voltages. The measured values need to be transferred as sampled values using the IEC 61850-9-2 LE protocol.

The SSC600 IEDs with process bus based applications use IEEE 1588 v2 Precision Time Protocol (PTP) according to IEEE C37.238-2011 Power Profile for high accuracy time synchronization. With IEEE 1588 v2, the cabling infrastructure requirement is reduced by allowing time synchronization information to be transported over the same Ethernet network as the data communications.

When using PTP in redundant mode, synchronization master is primarily searched from LAN A. Synchronization master from LAN B is used only, if no master in LAN A is detected.

1.2 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the IED life cycle.

- Planning
- Engineering
- Commissioning
- Operation and disturbance handling
- Functional analysis

The whole substation can be controlled and different tasks and functions can be performed with the individual tool components. PCM600 can operate with many different topologies, depending on the customer needs.

For more information, refer to PCM600 documentation.

1.2.1 Connectivity packages

A connectivity package is a software component that consists of executable code and data which enables system tools to communicate with an IED. Connectivity packages are used to create configuration structures in PCM600. The latest PCM600 and connectivity packages are backward compatible with older IED versions.

A connectivity package includes all of the data which is used to describe the IED. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameter. In addition, it contains code which allows software packages that consume the connectivity package to properly communicate with the IED. It also allows for localization of text even when its read from the IED in a standard format such as COMTRADE.

Update Manager is a tool that helps in defining the right connectivity package versions for different system products and tools. Update Manager is included with products that use connectivity packages.

1.2.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 2.9 or later
- SSC600 Connectivity Package Ver.1.0 or later

Download connectivity packages from the ABB Web site *www.abb.com/mediumvoltage* or directly with the Update Manager in PCM600.

1.3 This manual

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured power grid data to determine the cause of a fault.

1.3.1 Intended audience

This manual addresses the operator, who operates the IED on a daily basis.

The operator must be trained in and have a basic knowledge of how to operate protection equipment. The manual contains terms and expressions commonly used to describe this kind of equipment.

1.3.1.1 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- whmi menu paths are presented in **bold** typeface.

  Select **Main menu** > **Settings**.
- whmi menu names are presented in **bold** typeface.

  Click **Information** in the whmi menu structure.
- Parameter names are shown in *italics*.

  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.

  The corresponding parameter values are "On" and "Off".
- ied input/output messages and monitored data names are shown in Courier font.

  When the function starts, the `START` output is set to TRUE.

1.3.1.2 Symbols

The warning icon indicates the presence of a hazard which could result in electrical shock or other personal injury.

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader of important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although the warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.3.1.3 Functions, codes and symbols

All available functions included in the IED are listed in the tables below. Available functions depend on the chosen product options.

Table 1: Protection functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	3I>	51P-1	LD0	PHLPTOC
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	3I>>	51P-2	LD0	PHHPTOC
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	3I>>>	50P	LD0	PHIPTOC
Three-phase directional overcurrent protection, low stage	DPHLPDOC	3I> ->	67P/51P-1	LD0	DPHLPTOC DPHLRDIR
Three-phase directional overcurrent protection, high stage	DPHHPDOC	3I>> ->	67P/51P-2	LD0	DPHHPTOC DPHHRDIR
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51G/51N-1	LD0	EFLPTOC
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51G/51N-2	LD0	EFHPTOC
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50G/50N	LD0	EFIPTOC
Directional earth-fault protection, low stage	DEFLPDEF	Io> ->	67G/N-1 51G/N-1	LD0	DEFLPTOC DEFLRDIR
Directional earth-fault protection, high stage	DEFHPDEF	Io>> ->	67G/N-1 51G/N-2	LD0	DEFHPTOC DEFHRDIR
Admittance-based earth-fault protection	EFPADM	Yo> ->	21YN	LD0	EFPADM
Wattmetric-based earth-fault protection	WPWDE	Po> ->	32N	LD0	WRDIR WPSDE WMMXU
Transient/intermittent earth-fault protection	INTRPTEF	Io> -> IEF	67NTEF/NIEF	LD0	INTRPTEF
Non-directional (cross-country) earth-fault protection, using calculated Io	EFHPTOC	Io>>	51G/51N-2	LD0	EFHPTOC
Negative-sequence overcurrent protection	NSPTOC	I2>	46M	LD0	NSPTOC
Phase discontinuity protection	PDNSPTOC	I2/I1>	46PD	LD0	PDNSPTOC
Residual overvoltage protection	ROVPTOV	Uo>	59G/59N	LD0	ROVPTOV
Three-phase undervoltage protection	PHPTUV	3U<	27	LD0	PHPTUV
Three-phase overvoltage protection	PHPTOV	3U>	59	LD0	PHPTOV
Positive-sequence undervoltage protection	PSPTUV	U1<	27PS	LD0	PSPTUV
Negative-sequence overvoltage protection	NSPTOV	U2>	59NS	LD0	NSPTOV
Frequency protection	FRPFRQ	f>/f<,df/dt	81	LD0	FRPTRC FRPTOF FRPTUF FRPFRC
Distance protection	DSTPDIS	Z<	21P, 21N	LD0	GFCPDIS GFCRDIR DST1PDIS DST2PDIS DST3PDIS DST4PDIS DST5PDIS DSTRDIR GFC1RFRC

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
					GFC2RFRC GFC3RFRC
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	3Ith>F	49F	LD0	T1PTTR
Three-phase thermal overload protection, two time constants	T2PTTR	3Ith>T/G/C	49T/G/C	LD0	T2PTTR
Negative-sequence overcurrent protection for ma- chines	MNSPTOC	I2>M	46M	LD0	MNSPTOC
Loss of load supervision	LOFLPTUC	3I<	37	LD0	LOFLPTUC
Motor load jam protection	JAMPTOC	Ist>	50TDJAM	LD0	JAMPTOC
Motor start-up supervision	STTPMSU	Is2t n<	49,66,48,50TDLR	LD0	STTPMSS STTPMRI
Phase reversal protection	PREVPTOC	I2>>	46R	LD0	PREVPTOC
Thermal overload protection for motors	MPTTR	3Ith>M	49M	LD0	MPTTR
Stabilized and instantaneous differential protection for two-winding transformers	TR2PTDF	3dI>T	87T	LD0	TR2PTRC TR2LPDIF TR2H2PHAR TR2H5PHAR TR2HPDIF
Numerically stabilized low-impedance restricted earth-fault protection	LREFPNDF	dIoLo>	87NLI	LD0	LREFPDIF LREFPHAR
Circuit breaker failure protection	CCBRBRF	3I>/Io>BF	50BF	LD0	CCBRBRF
Three-phase inrush detector	INRPHAR	3I2f>	68HB	LD0	INRPHAR
Switch onto fault	CBPSOF	SOTF	SOTF	LD0	CBPSOF
Master trip	TRPPTRC	Master Trip	94/86	LD0	TRPPTRC
Arc protection	ARCSARC	ARC	AFD	LD0	ARCSARC ARC1PIOC ARC2PIOC ARCPTRC
Multipurpose protection	MAPGAPC	MAP	MAP	LD0	MAPGAPC
Load-shedding and restoration	LSHDPFRQ	UFLS/R	81LSH	LD0	LSHDPTRC LSHDPTOF LSHDPTUF LSHDPFRC
Fault locator	SCEFRFLO	FLOC	FLOC	LD0	SCEFRFLO SCEFZLIN SCEF2ZLIN SCEF3ZLIN FLORFRC
Reverse power/directional overpower protection	DOPPDPR	P>/Q>	32R/32O	LD0	DPPDOP DOPMMXU
Three-phase underimpedance protection	UZPDIS	Z>G	21G	LD0	UZPDIS UZMMXU
Multifrequency admittance-based earth-fault protection	MFADPSDE	Io> ->Y	67NYH	LD0	MFADPSDE MFADRDIR
Busbar differential protection	BBPBDF	3Id/I	87BL	LD0	BBPTRC ZNAPDIF ZNBPDIF ZNCZPDIF SFAPDIF SFBPDIF BBCCSPVC
Busbar zone selection	ZNRSRC	ZNRSRC	ZNRSRC	LD0	ZNRSRC
Load blinder	LBRDOB	LB	21LB	LD0	LBRDOB LBMMXU

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Three-phase overload protection for shunt capacitor banks	COLPTOC	3I> 3I<	51,37,86C	LD0	COL1PTOC COLPTUC COL2PTOC
Current unbalance protection for shunt capacitor banks	CUBPTOC	dI>C	60N	LD0	CUB1PTOC CUB2PTOC
Three-phase current unbalance protection for shunt capacitor banks	HCUBPTOC	3dI>C	60P	LD0	HCUB1PTOC HCUB2PTOC
Shunt capacitor bank switching resonance protection,current based	SRCPTOC	TD>	55ITHD	LD0	SRC1PTOC SRC2PTOC
Anomaly detector	ANOGAPC	ANOGAPC	ANOGAPC	LD0	ANOGAPC

Table 2: Interconnection functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Directional reactive power undervoltage protection	DQPTUV	Q> ->,3U<	32Q,27	LD0	DQPTUV DQPDOP DQMMXU
Low-voltage ride-through protection	LVRTPTUV	U<RT	27RT	LD0	LVRTPTUV

Table 3: Power quality functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Current total demand distortion	CMHAI	PQM3I	PQM3I	CMHAI	CMHAI
Voltage total harmonic distortion	VMHAI	PQM3U	PQM3V	VMHAI	VMHAIVMHAI
Voltage variation	PHQVVR	PQMU	PQMV	PHQVVR PH2QVVR PH3QVVR QVVRQRC QVV2RQRC QVV3RQRC	PHQVVR PH2QVVR PH3QVVR QVVMSTA QVV2MSTA QVV3MSTA
Voltage unbalance	VSQVUB	PQUUB	PQVUB	-	-

Table 4: Control functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Circuit-breaker control	CBXCBR	I <-> O CB	I <-> O CB	CTRL	CBCSWI CBCILO CBXCBR
Disconnector control	DCXSWI	I <-> O DCC	I <-> O DCC	CTRL	DCCSWI DCCILO DCXSWI
Earthing switch control	ESXSWI	I <-> O ESC	I <-> O ESC	CTRL	ESCSWI ESCILO ESXSWI

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Disconnector position indication	DCSXSWI	I <-> O DC	I <-> O DC	CTRL	DCSXSWI
Earthing switch indication	ESSXSWI	I <-> O ES	I <-> O ES	CTRL	ESSXSWI
Emergency start-up	ESMGAPC	ESTART	ESTART	LD0	ESMGAPC
Autoreclosing	DARREC	O -> I	79	LD0	DARREC
Tap changer position indication	TPOSYLTC	TPOSM	84M	LD0	TPOSYLTC
Tap changer control with voltage regulator	OLATCC	COLTC	90V	LD0	OLATCC
Synchronism and energizing check	SECRSYN	SYNC	25	LD0	SECRSYN

Table 5: Condition monitoring and supervision functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Circuit-breaker condition monitoring	SSCBR	CBCM	CBCM	LD0	SSCBR1 SPH1SCBR SPH2SCBR SPH3SCBR SSOPM SSIMG
Runtime counter for machines and devices	MDSOPT	OPTS	OPTM	LD0	MDSOPT
Fuse failure supervision	SEQSPVC	FUSEF	VCM, 60	LD0	SEQSPVC

Table 6: Measurement functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Disturbance recorder	RDRE	DR	DFR	LD0	DR_LLN0 DR_LPHD RDRE RBDR
Fault record	FLTRFRC	FAULTREC	FAULTREC	LD0	FLTRFRC
Three-phase current measurement	CMMXU	3I	3I	LD0	CMMXU CAVMMXU CMAMMXU CMIMMXU
Sequence current measurement	CSMSQI	I1, I2, I0	I1, I2, I0	LD0	CSMSQI
Residual current measurement	RESCMMXU	Io	In	LD0	RESCMMXU RCAVMMXU RCMAMMXU RCMIMMXU
Three-phase voltage measurement	VMMXU	3U	3V	LD0	VMMXU VAVMMXU
Residual voltage measurement	RESVMMXU	Uo	Vn	LD0	RESVMMXU RVAVMMXU RVMAMMXU

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
					RVMIMMXU
Sequence voltage measurement	VSMSQI	U1, U2, U0	V1, V2, V0	LD0	VSMSQI
Three-phase power and energy measurement	PEMMXU	P, E	P, E	LD0	PEMMXU PEMMTR PEAVMMXU PEMAMMXU PEMIMMXU
Frequency measurement	FMMXU	f	f	LD0	FMMXU
IEC 61850-9-2 LE sampled value receiving	SMVRECEIVE	SMVRECEIVE	SMVRECEIVE		SVIL1TCTR SVIL2TCTR SVIL3TCTR SVRESTCTR SVUL1TVTR SVUL2TVTR SVUL3TVTR SVRESTVTR

Table 7: Other functions

Function	IEC 61850	IEC 60617	ANSI	Logical device	Logical nodes
Minimum pulse timer	TPGAPC	TP	TP		TPGAPC
Minimum pulse timer (second resolution)	TPSGAPC	TPS	TPS		TPSGAPC
Minimum pulse timer minute resolution)	TPMGAPC	TPM	TPM		TPMGAPC
Pulse timer	PTGAPC	PT	PT		PTGAPC
Time delay off	TOFGAPC	TOF	TOF		TOFGAPC
Time delay on	TONGAPC	TON	TON		TONGAPC
Set-reset	SRGAPC	SR	SR		SRGAPC
Move	MVGAPC	MV	MV		MVGAPC
Generic control point	SPCGAPC	SPC	SPC		SPCGAPC
Analog value scaling	SCA4GAPC	SCA4	SCA4		SCA4GAPC
Integer value move	MVI4GAPC	MVI4	MVI4		MVI4GAPC
Voltage switch	VMSWI	VSWI	VSWI		VMSWI
Current switch	CMSWI	CMSWI	CMSWI		CMSWI
Current sum	CMSUM	CSUM	CSUM		SIL1TCTR SIL2TCTR SIL3TCTR SRESTCTR

1.4 Document revision history

Document revision/ date	Product series version	History
A/2019-05-10	1.0	First release
B/2020-03-23	1.0 FP1	Content updated
C/2021-11-26	1.0 FP3	Content updated
D/2022-12-05	1.0 FP4	Content updated

Download the latest documents from the ABB Web site *www.abb.com/mediumvoltage*.

1.5 Related documentation

Product series- and product-specific manuals can be downloaded from the ABB Web site *www.abb.com/mediumvoltage*.

1.6 Product documentation set

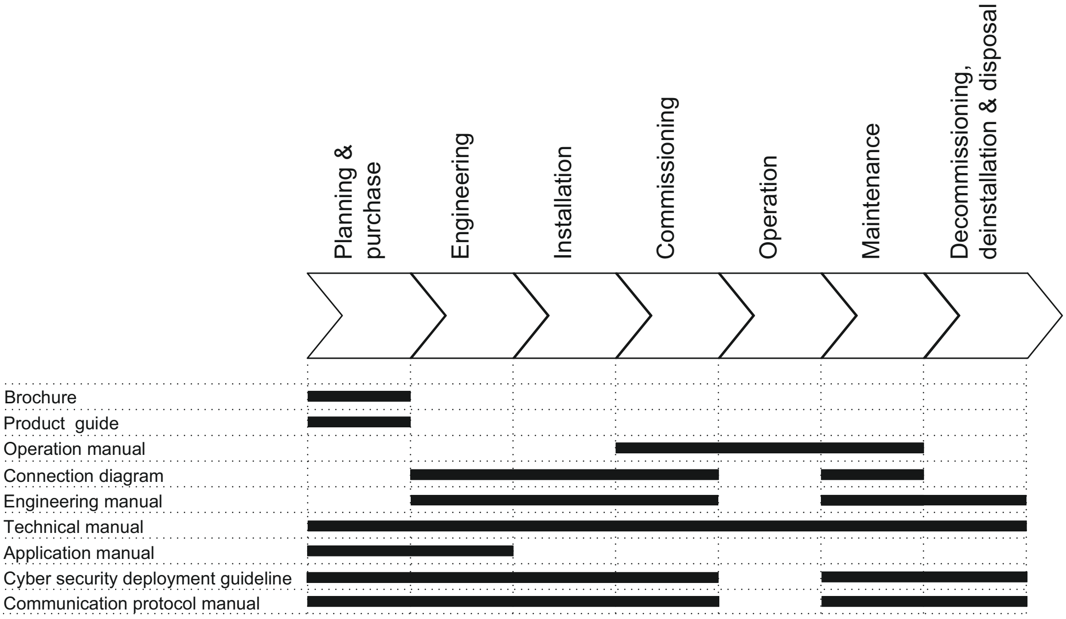


Figure 3: The intended use of documents during the product life cycle

Product series- and product-specific manuals can be downloaded from the ABB Web site.

2 Safety information

Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.

The frame of the device has to be carefully earthed.

The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

Whenever changes are made in the device, measures should be taken to avoid inadvertent tripping.

3 Commissioning

3.1 Commissioning checklist

Familiarize yourself with the IED and its functionality before you start the commissioning work.

- Ensure that you have all the needed station drawings.
- Ensure that your version of the technical manual applies to the IED version you test.
- Ensure that your setting software and connectivity packages work with the IED version you test.
- Find out if you need any additional software.
- Ensure that you have the IED settings either on paper or in electronic format. The settings and logic should be well documented.
- Inspect the settings to ensure that they are correct.
- Ensure that you have the correct cable to connect your PC to the IED's communication port. The RJ-45 port supports any CAT 5Ethernet cable but the recommendation is STP.
- Test your PC's communication port before you go to the site.
- Find out who to contact if you have trouble and make sure you have a means to contact them.
- Find out who is responsible for the settings.
- Ensure that you have with you the proper test equipment and all needed connection cables.
- Ensure that the owner of the switchgear familiarizes you with the work site and any special aspects of it.
- Ensure that you know how to operate in emergency situations. Find out where the first aid and safety materials and exit routes are.

3.2 Checking the installation

3.2.1 Checking of the power supply

Check that the auxiliary supply voltage remains within the permissible input voltage range under all operating conditions. Check that the polarity is correct before powering the IED.

3.3 Authorizations

3.3.1 User authorization

Four users have been predefined for WHMI, each with different rights and default passwords (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline). Local connection is allowed only from the Ethernet port called 'Local port'. Via the local connection user is allowed to perform local control operations such as opening or closing circuit breaker. From all other Ethernet ports only remote connections are allowed.

Passwords are settable for all predefined users. The password must contain at least nine characters. The maximum number of characters is 20. Only the following characters are accepted.

- Numbers 0-9
- Letters a-z, A-Z
- Space
- Special characters !"#%&'()*+´-./:;<=>?@[\]^_`{|}~

Table 8: Predefined users and default passwords

Username	Password	User rights
VIEWER	remote0001	Only view access
OPERATOR	remote0002	Authorized to make operations
ENGINEER	remote0003	Allowed to change IED parameters, but no operation rights
ADMINISTRATOR	remote0004	Full access

For user authorization for PCM600, see PCM600 documentation.

3.4 Setting IED and communication

3.4.1 Setting the communication between IEDs and PCM600

The communication between the IED and PCM600 is independent of the used communication protocol within the substation or to the NCC. It can be seen as a second channel for communication.

The media is always Ethernet and communication is based on TCP/IP.

Each IED has multiple Ethernet connectors, and all Ethernet interfaces can be used to connect PCM600.

When an Ethernet based station protocol is used, the PCM600 communication can use the same Ethernet port and IP address. The IED is able to separate the information belonging to the PCM600 dialog.

To configure the physical connection and the IP addresses:

1. Set up or get the IP addresses of the IEDs.
2. Set up the PC for a direct link or connect the PC or workstation to the network.
3. Configure the IP addresses in the PCM600 project for each IED.

   The addresses are used for communication between IEDs and PCM600.

3.4.2 Communication settings

The local and remote ports use fixed IP addresses, 192.168.0.254 and 192.168.1.254 respectively, and they also provide DHCP servers to assign an IP address for the connected computer. The main communication port Ethernet interface has a factory default IP address 192.168.2.10 when the complete IED is delivered. The service communication port Ethernet interface has a factory default IP address 192.168.4.10 when the complete IED is delivered.

Different communication ports are available via optional communication modules. Ethernet RJ-45 and optical Ethernet LC are the two station communication port Ethernet communication options. Station communication port Ethernet is intended for station bus communication. Communication protocols used via Ethernet ports are IEC 61850-8-1 and IEC 61850-9-2 LE.

Use the correct Ethernet connectors in the IED with redundant communication protocols like PRP. IEDs with PRP support have two Ethernet connectors and redundant Ethernet ports are marked as LAN A and LAN B.

The redundant communication module has two operation modes: “Normal” and “PRP”. The operation mode can be changed from communication settings.

For more information, see the communication protocol manuals and the technical manual.

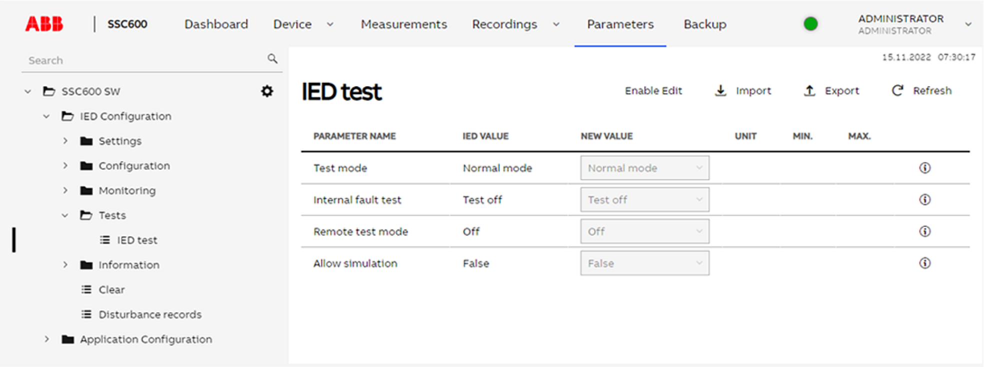
3.5 Testing the IED operation

The IED has to be in the test mode before the digital outputs and certain output signals of protection and other functions can be activated.

3.5.1 Selecting the IED test mode

The test mode can be activated by activating the IED test view. The test mode is useful for simulated testing of functions and outputs without providing current inputs.

1. Select **IED test** from the main menu structure to activate the IED test view.



PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Test mode	Normal mode	Normal mode			
Internal fault test	Test off	Test off			
Remote test mode	Off	Off			
Allow simulation	False	False			

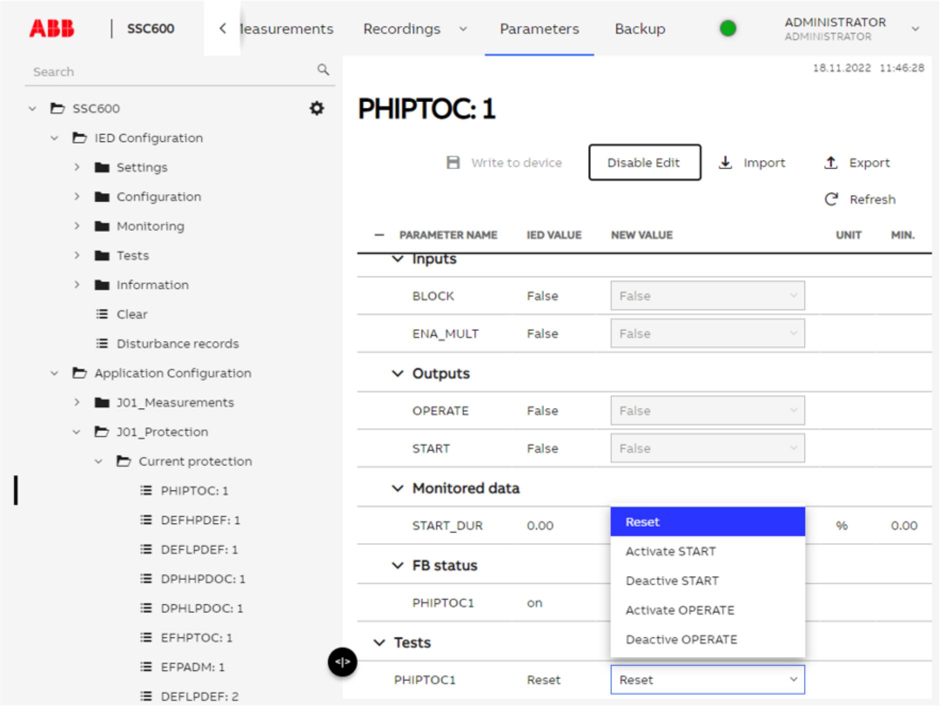
Figure 4: IED test view

2. Enable parameter editing by selecting **Enable Edit**.
3. Select the test mode to be activated by changing the New Value field selection.
4. Select **Write to device** to save changes into the IED's memory.
   The selected test mode is now activated.

3.5.2 Testing functions

Activate or deactivate an output signal for protection, or other function, to test the function.

1. Select the protection function from the main menu structure and find the test activation parameter from the bottom.



PHIPTOC: 1

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.
Inputs				
BLOCK	False	False		
ENA_MULT	False	False		
Outputs				
OPERATE	False	False		
START	False	False		
Monitored data				
START_DUR	0.00		%	0.00
FB status				
PHIPTOC1	on			
Tests				
PHIPTOC1	Reset	Reset		

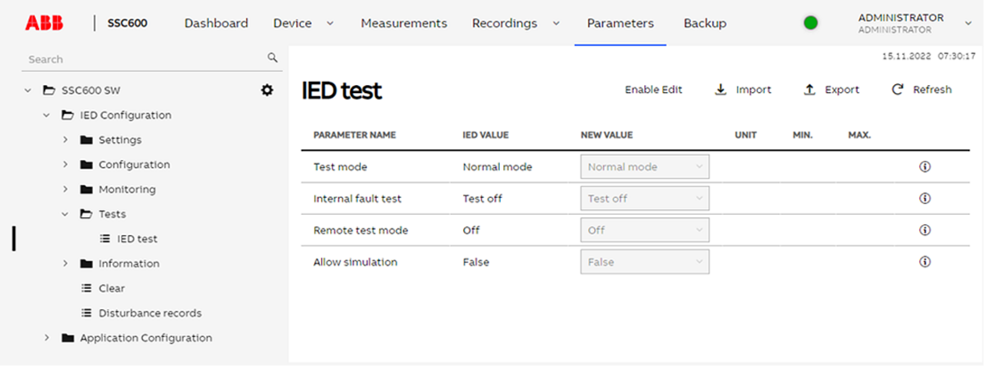
Figure 5: Test activation parameter

2. Enable parameter editing by selecting **Enable edit**.
3. Select the test to be activated by changing the New Value field selection.
4. Select **Write to device** to save changes into the IED's memory.
   The selected test is now activated.

3.5.3 Selecting the internal fault test

The internal fault test can be activated from the IED test view.

1. Select **IED test** from the main menu structure to activate the IED test view.



IED test

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Test mode	Normal mode	Normal mode			
Internal fault test	Test off	Test off			
Remote test mode	Off	Off			
Allow simulation	False	False			

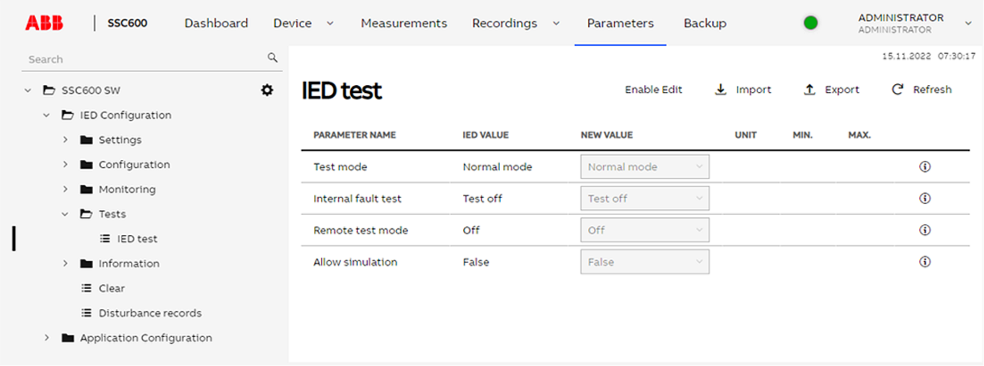
Figure 6: IED test view

2. Enable parameter editing by selecting **Enable Edit**.
3. Select the test mode to be activated by changing the New Value field selection.
4. Select **Write to device** to save changes into the IED's memory.
   The selected test mode is now activated.

3.5.4 Selecting the IED blocked or IED test and blocked mode

The IED blocked mode and the IED test and blocked mode can be activated from the IED test view. The test mode can be used for simulated testing of functions and outputs without providing current inputs. The IED blocked mode can be used to block the physical outputs to the process.

1. Select **IED test** from the main menu structure to activate the IED test view.



IED test

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Test mode	Normal mode	Normal mode			
Internal fault test	Test off	Test off			
Remote test mode	Off	Off			
Allow simulation	False	False			

Figure 7: IED test view

2. Enable parameter editing by selecting **Enable Edit**.
3. Select the test mode to be activated by changing the New Value field selection.
4. Select **Write to device** to save changes into the IED's memory.
   The selected test mode is now activated.

If the IED blocked or IED test and blocked mode is not cancelled, it remains on and the Start and/or Ready LEDs remain flashing.

3.6 ABB Product Data Registration

The ABB Product Data Registration feature traces composition changes in the IED's SW or HW. Traceability allows better support and maintenance possibilities.

After a composition change, an LCT indication is seen on the WHMI at the IED startup. The PCM600 reads the changed data from the IED. Therefore, a connection to the IED must be established first. Composition data can be read with PCM600 by enabling LCT during PCM600 installation and activating collection in PCM600 from 'Lifecycle Handling' menu. For detailed information, see PCM600 online help.

The number of composition changes can be seen from the Composition changes parameter in **IED Configuration** > **Monitoring** > **IED status**.

4 IED operation

In a normal IED use situation, the basic operation includes monitoring and checking procedures.

- Monitoring measured values
- Checking object states
- Checking function setting parameters
- Checking events and alarms

All basic operations can be performed via the WHMI or with PCM600.

For more information, see PCM600 documentation.

4.1 Web HMI

The WHMI is the only user access service in the protection device. To provide encryption and secure identification in the communication to the WHMI, the device supports HTTPS protocol. In this case, plain HTTP connection request is automatically changed to HTTPS. The WHMI requires a modern web browser, with support for HTML5 and ECMAScript 6. Note that Internet Explorer is not supported. Secure communication is required, with TLS v1.2 or v1.3. The WHMI is verified with latest versions of Microsoft Edge, Firefox and Google Chrome."

WHMI offers several functions:

- Programmable virtual LEDs and event lists
- System supervision
- Parameter settings
- Measurement display
- Disturbance records
- Fault records
- Phasor diagram
- Single line diagram
- Switch control operations
- Report summary
- Configuration back up and restore for merging units

The WHMI can be accessed locally and remotely.

- Locally by connecting the laptop to the IED via the local communication port
- Remotely over LAN/ WAN

4.1.1 Authorization

Four users have been predefined for the WHMI, each with different rights and default passwords.

The default passwords in the IED delivered from the factory can be changed using an user account with User Management right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline).

Table 9: Predefined users

Username	User rights
VIEWER	Read only access
OPERATOR	• Changing setting groups • Controlling • Clearing indications
ENGINEER	• Changing settings • Changing system settings such as IP address • Setting the IED to test mode • Selecting language
ADMINISTRATOR	• All listed above • Changing password • Factory default activation

For user authorization for PCM600, see PCM600 documentation.

Controlling operations with Web HMI are only allowed with local mode for user with Control Operation Right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline).

4.1.2 Using the Web HMI

As secure communication is enabled by default, the WHMI must be accessed from a Web browser using the HTTPS protocol. Log in with the proper user rights to use the WHMI.

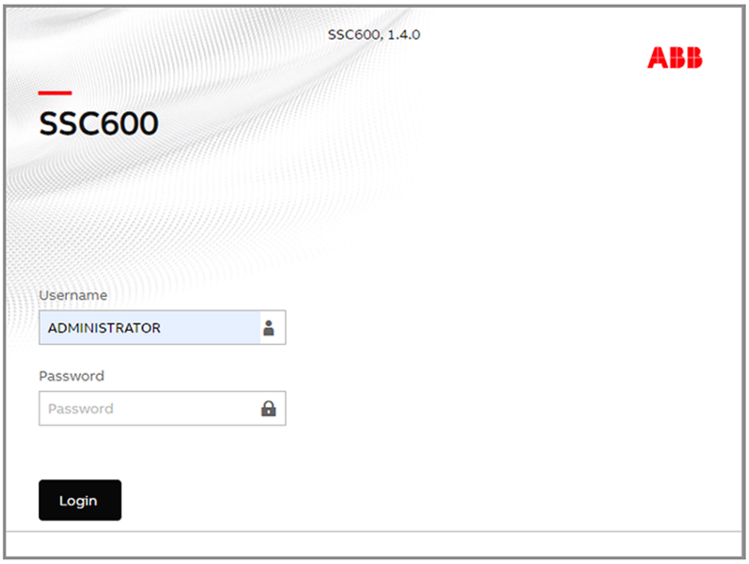
To establish a remote WHMI connection to the IED, contact the network administrator to check the company rules for IP and remote connections.

Disable the Web browser proxy settings or make an exception to the proxy rules to allow the IED's WHMI connection, for example, by including the IED's IP address in **Internet Options** > **Connections** > **LAN Settings** > **Advanced** > **Exceptions**.

4.1.2.1 Logging in

1. Open a supported web browser.
2. Type the IED's IP address in the Address bar and press ENTER.
3. Type the username with capital letters.

4. Type the password.



SSC600, 1.4.0

SSC600

Username

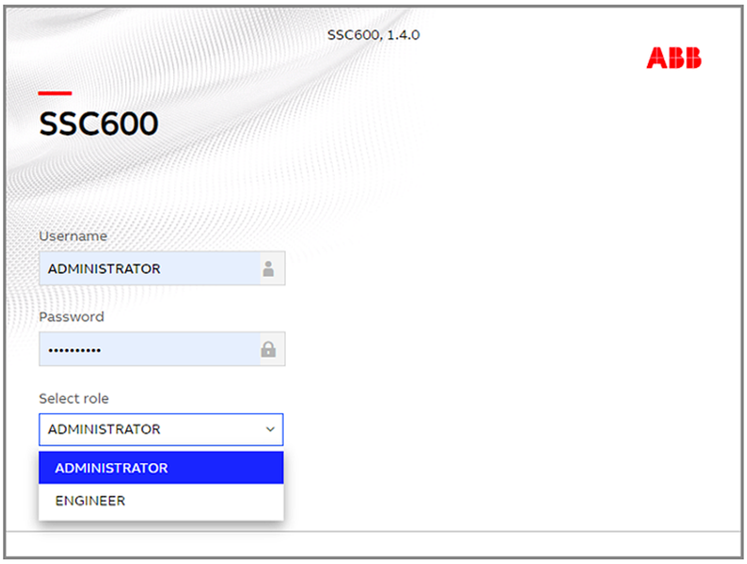
ADMINISTRATOR

Password

Password

Figure 8: Entering username and password to use the WHMI

5. Click **OK**.
6. Select a role for WHMI.



SSC600, 1.4.0

SSC600

Username

ADMINISTRATOR

Password

••••••••••

Select role

ADMINISTRATOR

ADMINISTRATOR

ENGINEER

Figure 9: Selecting role for WHMI

The language file starts loading and the progress bar is displayed.

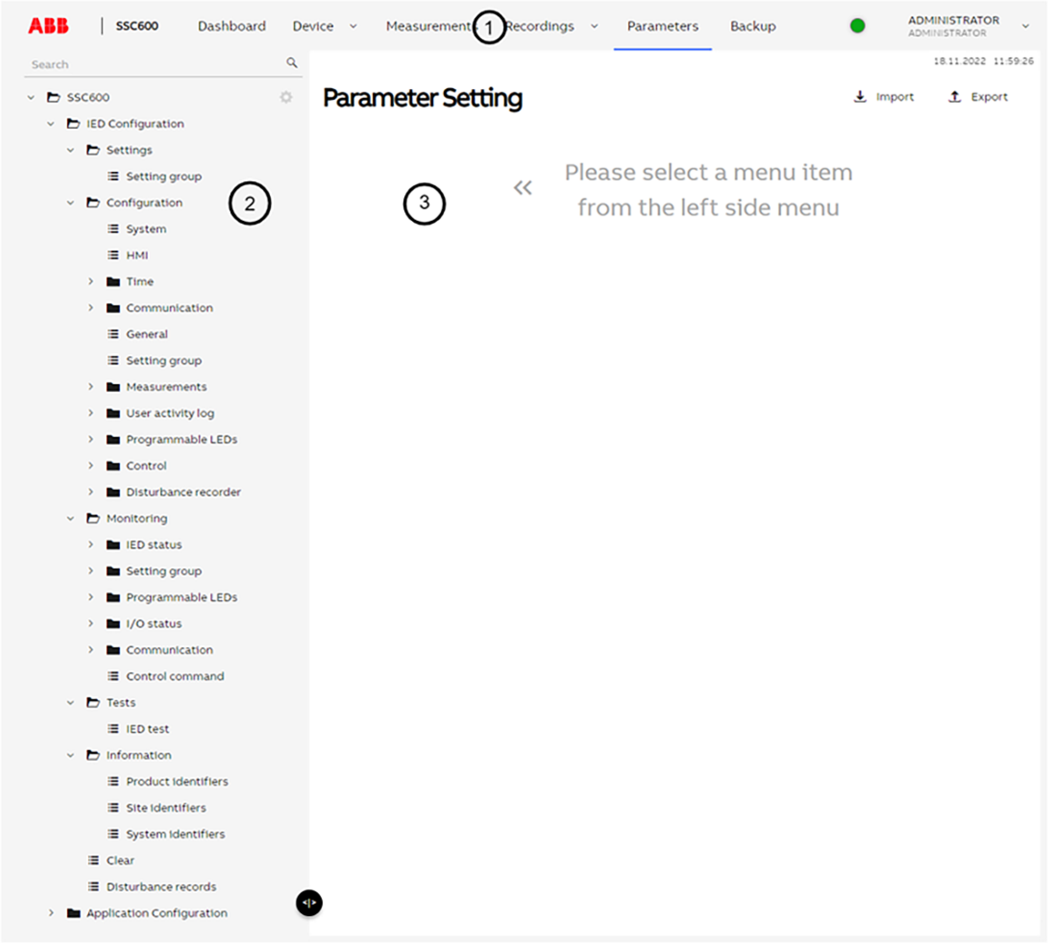
4.1.2.2 Logging out

The user is logged out after session timeout. The timeout can be set in **IED Configuration** > **HMI** > **Web HMI timeout**.

- To log out manually, select **Logout** in the View bar.

4.1.2.3 User interface

The user interface contains the **View bar** and a content area. Additionally, in Parameters view a left pane is shown, containing the **Parameter menu**.



Please select a menu item from the left side menu

Figure 10: User interface

1. **View bar** for accessing different WHMI views.
2. **Parameter menu** containing main menu groups which are divided further into more detailed submenus.
3. **Information area** for displaying data.

4.1.2.4 Menu structure

The **Parameter menu** contains two groups which are divided further into more detailed submenus:

- IED Configuration
  - Built-in to the product and can be seen in the above figure.
- Application Configuration
  - Always depend on the application configuration.

A specific item in the menu structure can be found by using the search field above the menu structure.

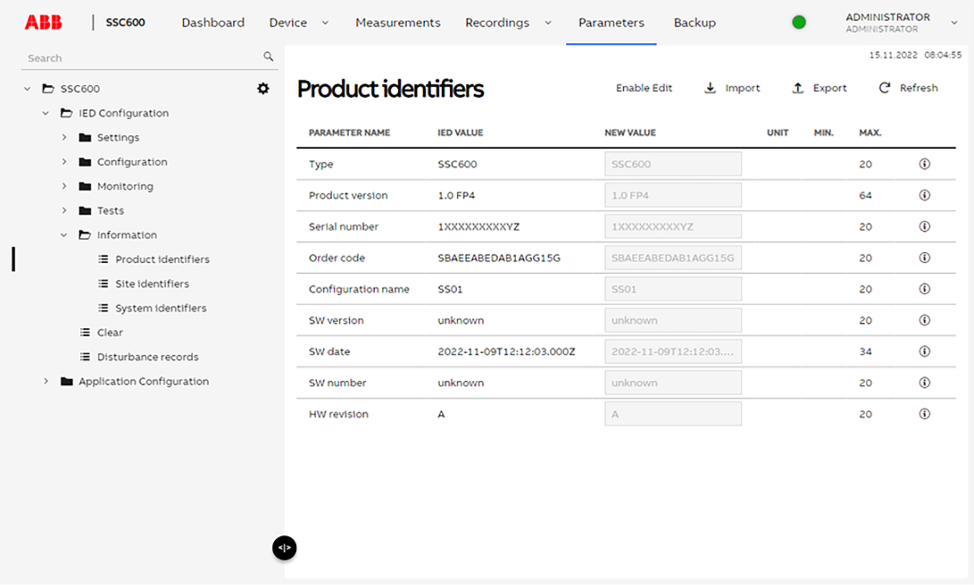
4.1.2.5 Using the Web HMI help

The context-sensitive WHMI help provides information on a single parameter, for example. Click on the information-icon on the right side of the parameter (see *Figure 11* below).

4.1.3 Identifying the device

The Information menu includes detailed information about the device, for example, revision and serial number.

1. Select **IED Configuration** > **Information** > **Product identifiers** from the main menu structure.



Product identifiers

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.	
Type	SSC600	SSC600			20	ⓘ
Product version	1.0 FP4	1.0 FP4			64	ⓘ
Serial number	1XXXXXXXXXYZ	1XXXXXXXXXYZ			20	ⓘ
Order code	SBAEEABEDAB1AGG15G	SBAEEABEDAB1AGG15G			20	ⓘ
Configuration name	SS01	SS01			20	ⓘ
SW version	unknown	unknown			20	ⓘ
SW date	2022-11-09T12:12:03.000Z	2022-11-09T12:12:03....			34	ⓘ
SW number	unknown	unknown			20	ⓘ
HW revision	A	A			20	ⓘ

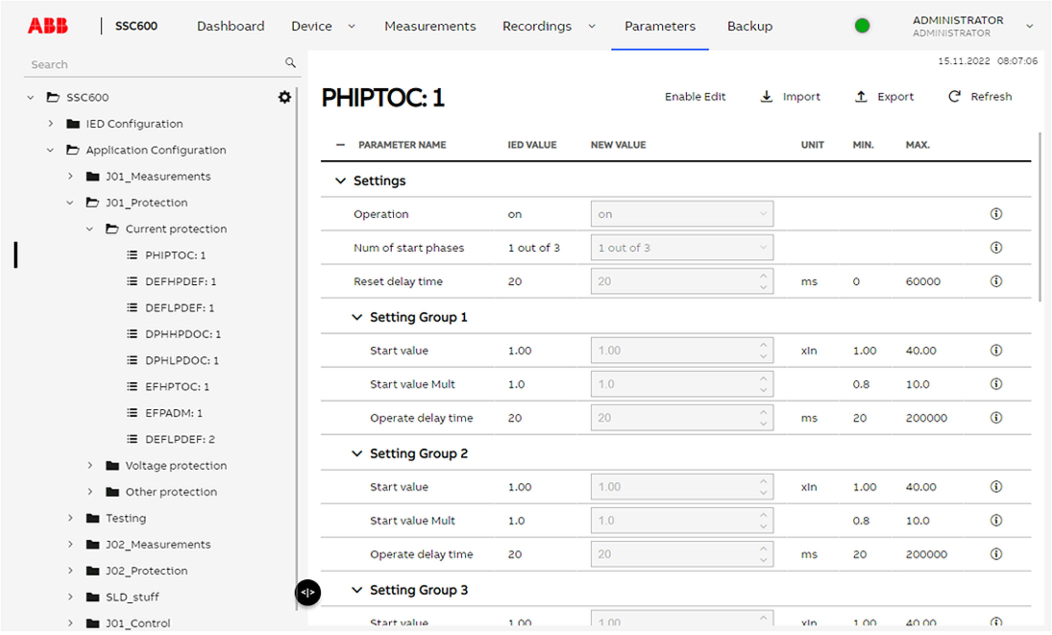
Figure 11: Device information view

2. Select **Site identifiers** to view site information or **System identifiers** to view system-level information.

4.1.4 Showing parameters

Some function blocks have a function-specific On/Off setting. When the function setting is “Off”, all settings are hidden. When the function setting is “On”, all settings are visible based on other visibility and hiding rules.

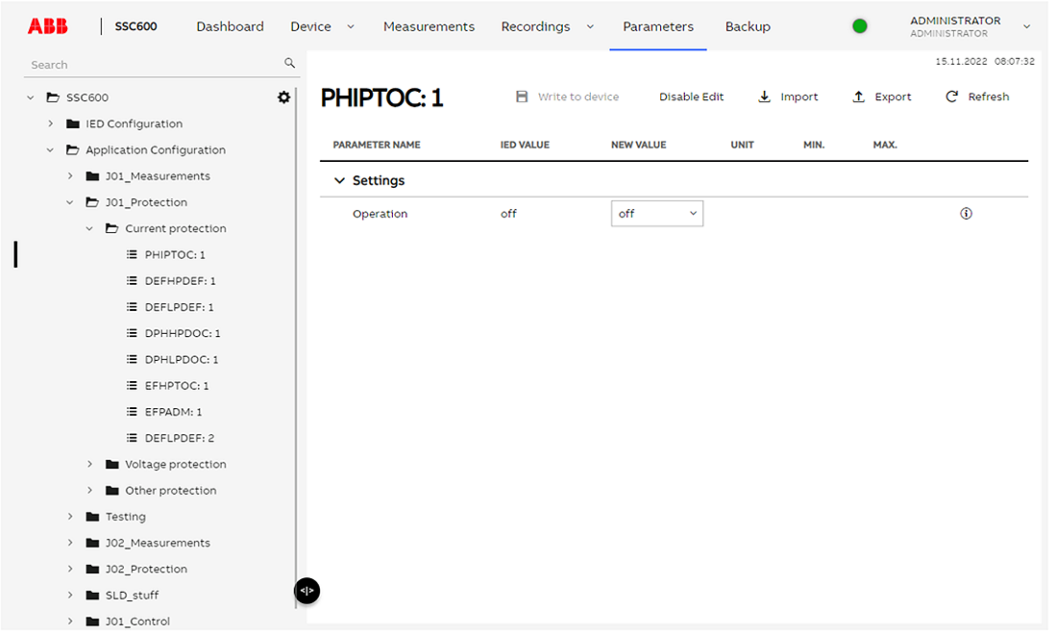
Switch the function setting by changing the value of the **Operation** parameter ON or OFF.



PHIPTOC: 1

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Settings					
Operation	on	on			
Num of start phases	1 out of 3	1 out of 3			
Reset delay time	20	20	ms	0	60000
Setting Group 1					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 2					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 3					
Start value	1.00	1.00	xIn	1.00	40.00

Figure 12: Function block On



PHIPTOC: 1

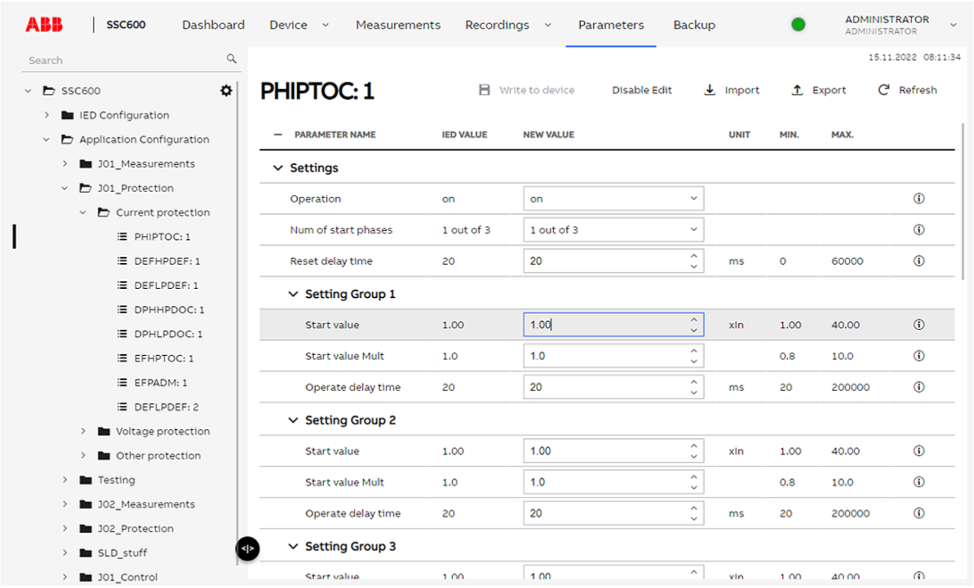
PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Settings					
Operation	off	off			

Figure 13: Function block Off

4.1.5 Editing values

1. Select a menu in the menu navigation bar.
2. Click a submenu to see the function blocks.
3. Click a function block to see the setting values.
4. Click **Enable Edit**.
5. Edit the value.

- The minimum, maximum and step values for a parameter are shown in the Min., Max. and Step columns.

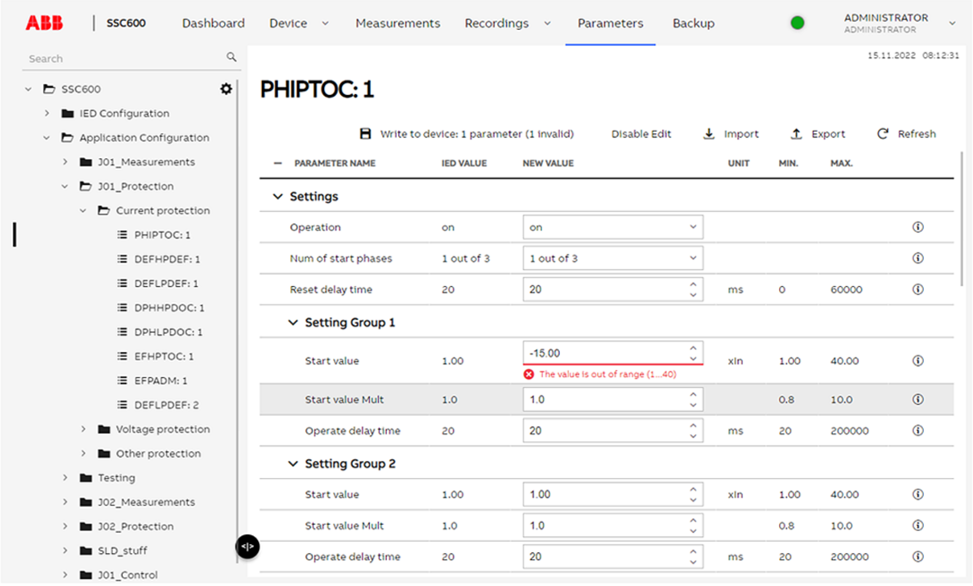


PHIPTOC: 1

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Settings					
Operation	on	on			
Num of start phases	1 out of 3	1 out of 3			
Reset delay time	20	20	ms	0	60000
Setting Group 1					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 2					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 3					
Start value	1.00	1.00	xIn	1.00	40.00

Figure 14: Editing a value

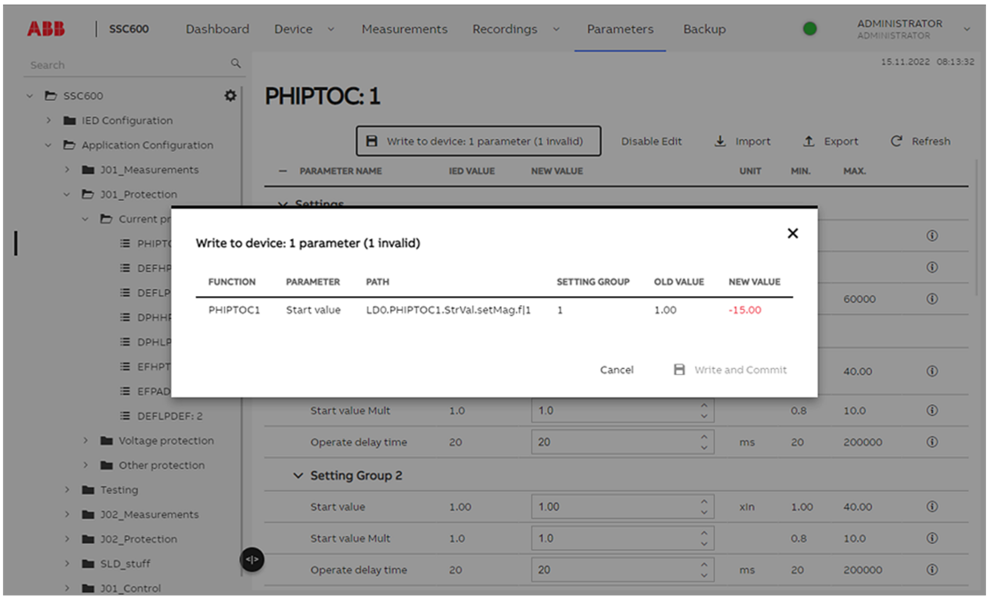
- If the entered value is out of range, the row is highlighted in red and a warning messages displayed. **Write to device** is available, but the write and commit confirmation is not allowed.



PHIPTOC: 1

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Settings					
Operation	on	on			
Num of start phases	1 out of 3	1 out of 3			
Reset delay time	20	20	ms	0	60000
Setting Group 1					
Start value	1.00	-15.00 The value is out of range (1...40)	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 2					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000

Figure 15: Warning indicating that the entered value is incorrect



PHIPTOC: 1

Write to device: 1 parameter (1 invalid)

FUNCTION	PARAMETER	PATH	SETTING GROUP	OLD VALUE	NEW VALUE
PHIPTOC1	Start value	LD0.PHIPTOC1.StrVal.setMag.f[1	1	1.00	-15.00

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Settings					
					60000
					40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000
Setting Group 2					
Start value	1.00	1.00	xIn	1.00	40.00
Start value Mult	1.0	1.0		0.8	10.0
Operate delay time	20	20	ms	20	200000

Figure 16: Writing invalid value is prevented

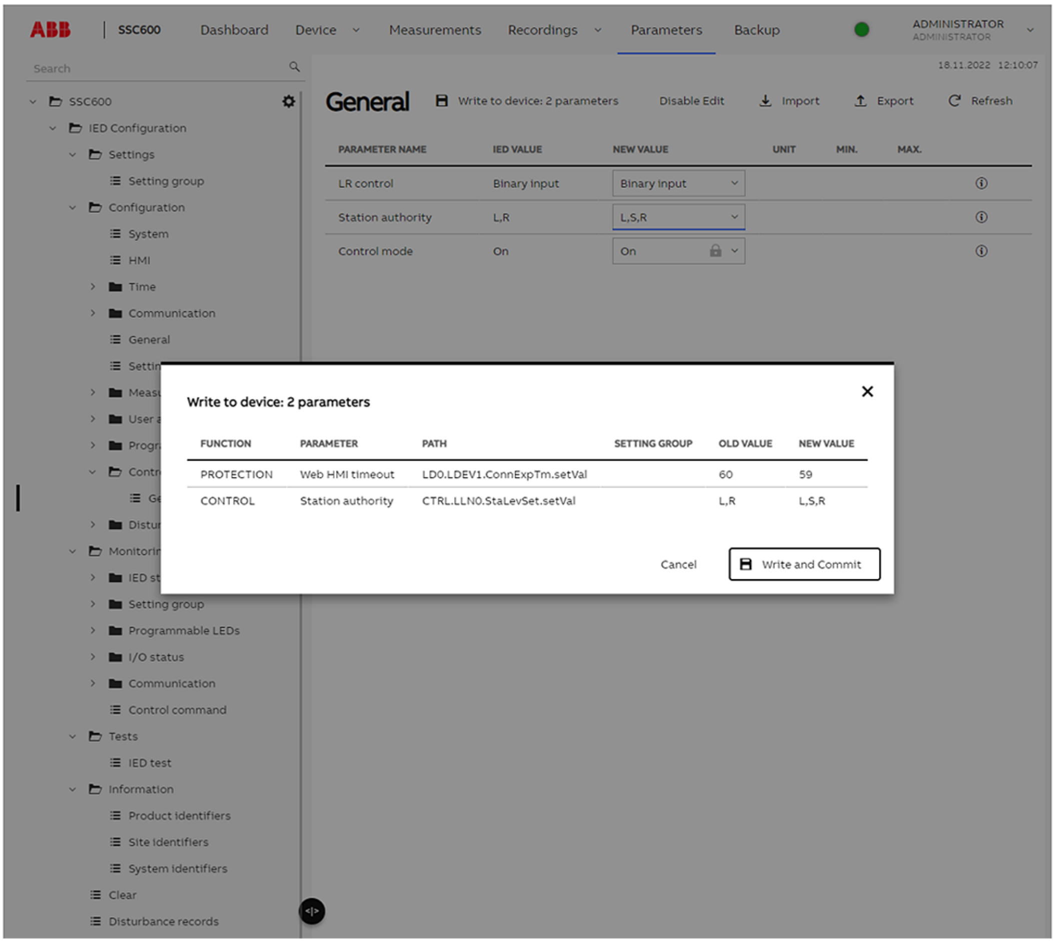
- If writing fails, a warning dialog box is displayed.

If writing is enabled accidentally, click **Disable Edit**.

4.1.6 Committing settings

Editable values are stored either in RAM or in nonvolatile flash memory. Values stored in the flash memory are also in effect after a reboot.

While editing, parameter value changes are only stored within browser memory. Refreshing the browser page will destroy any pending changes. All changes are written and committed to the device atomically.



PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
LR control	Binary input	Binary input			
Station authority	L,R	L,S,R			
Control mode	On	On			

Write to device: 2 parameters

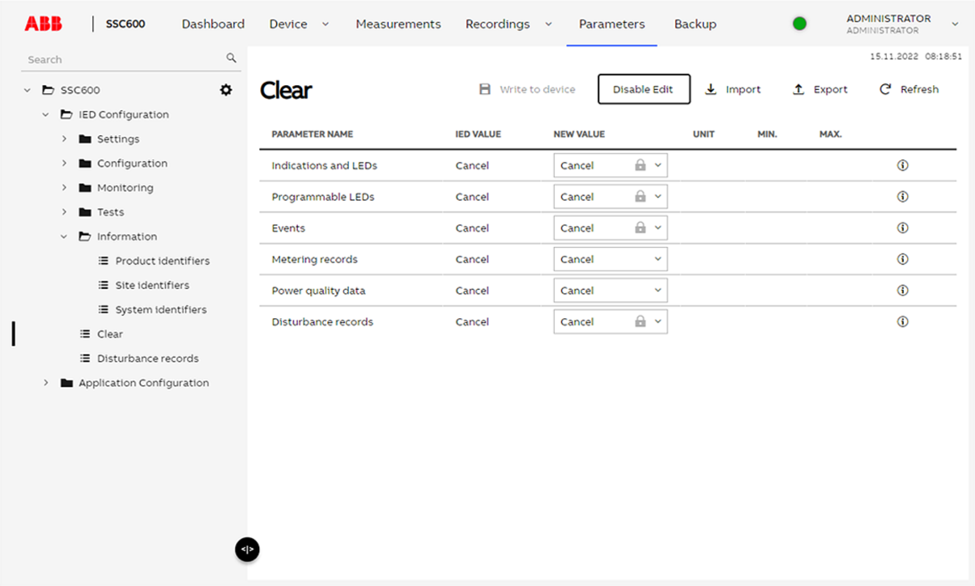
FUNCTION	PARAMETER	PATH	SETTING GROUP	OLD VALUE	NEW VALUE
PROTECTION	Web HMI timeout	LD0.LDEV1.ConnExpTm.setVal		60	59
CONTROL	Station authority	CTRL.LLN0.StaLevSet.setVal		L,R	L,S,R

- If editing is cancelled, the changed values within browser memory are replaced with the values from the device.

4.1.7 Clearing and acknowledging

Reset, acknowledge, or clear all messages and indications, including LEDs and latched outputs as well as registers and recordings, in the **Clear** menu.

1. Select **Clear** from the main menu structure.



Clear

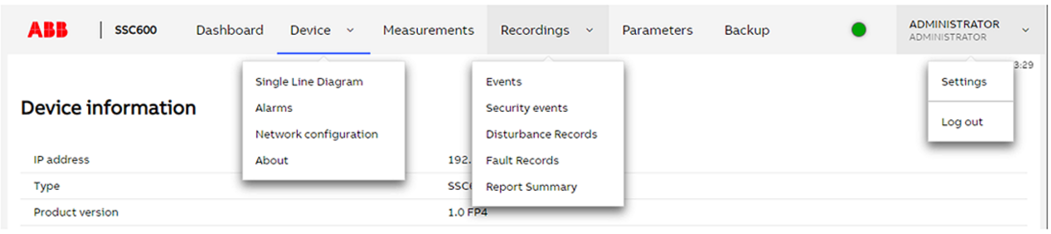
PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Indications and LEDs	Cancel	Cancel			
Programmable LEDs	Cancel	Cancel			
Events	Cancel	Cancel			
Metering records	Cancel	Cancel			
Power quality data	Cancel	Cancel			
Disturbance records	Cancel	Cancel			

Figure 17: Selecting clear menu

2. Set the New Value to Clear for those items to be cleared.
3. Select **Write to device** to save the changes.

4.1.8 Web HMI views

The different views available in the WHMI are illustrated below. Use the **View bar** to access different views.



Device information

IP address	192.
Type	SSC
Product version	1.0 FP4

Figure 18: View bar

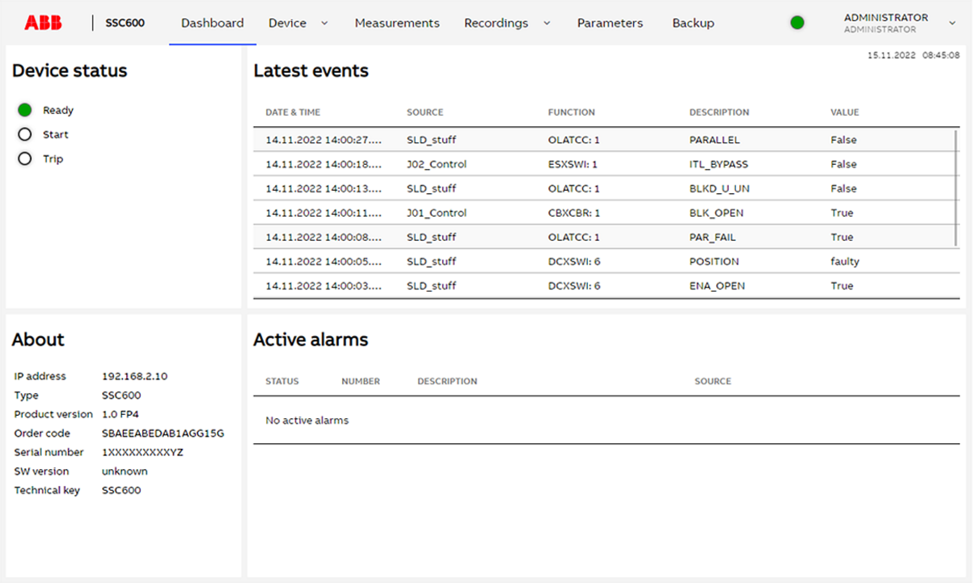
- **Dashboard** contains a quick snapshot of the system state.
- **Single Line Diagram** view shows the single-line diagram.
- **Alarms** view shows the status of the programmable virtual LEDs.
- **Network configuration** (only available in the SSC600 SW) shows an editable list of device network interfaces.
- **About** page shows brief information about the device.
- **Measurements** page shows phasor diagrams.

- **Events** view contains a list of events produced by the application configuration.
- **Security events** view contains a list of security events (i.e. audits) produced by the application.
- **Disturbance records** view shows the list of disturbance records.
- **Fault records** view shows the list of fault records.
- **Report summary** page allows the user to save events, fault records, disturbance records and the parameter list.
- **Parameters** page shows all device parameter menus and values.
- **Backup** page allows to store backups of relay and merging unit configurations.
- **Settings** view allows the user to change password, and system language.
- **Logout** ends the session.

4.1.8.1 Dashboard view

The **Dashboard** view shows the IED version and current operating status, with latest events and alarms.

1. Select **Dashboard** in the View bar.



Device status

● Ready
○ Start
○ Trip

Latest events

DATE & TIME	SOURCE	FUNCTION	DESCRIPTION	VALUE
14.11.2022 14:00:27....	SLD_stuff	OLATCC: 1	PARALLEL	False
14.11.2022 14:00:18....	J02_Control	ESXSWI: 1	ITL_BYPASS	False
14.11.2022 14:00:13....	SLD_stuff	OLATCC: 1	BLKD_U_UN	False
14.11.2022 14:00:11....	J01_Control	CBXCBR: 1	BLK_OPEN	True
14.11.2022 14:00:08....	SLD_stuff	OLATCC: 1	PAR_FAIL	True
14.11.2022 14:00:05....	SLD_stuff	DCXSWI: 6	POSITION	faulty
14.11.2022 14:00:03....	SLD_stuff	DCXSWI: 6	ENA_OPEN	True

About

IP address	192.168.2.10
Type	SSC600
Product version	1.0 FP4
Order code	SBAEEABEDAB1AGG15G
Serial number	1XXXXXXXXXYZ
SW version	unknown
Technical key	SSC600

Active alarms

STATUS	NUMBER	DESCRIPTION	SOURCE

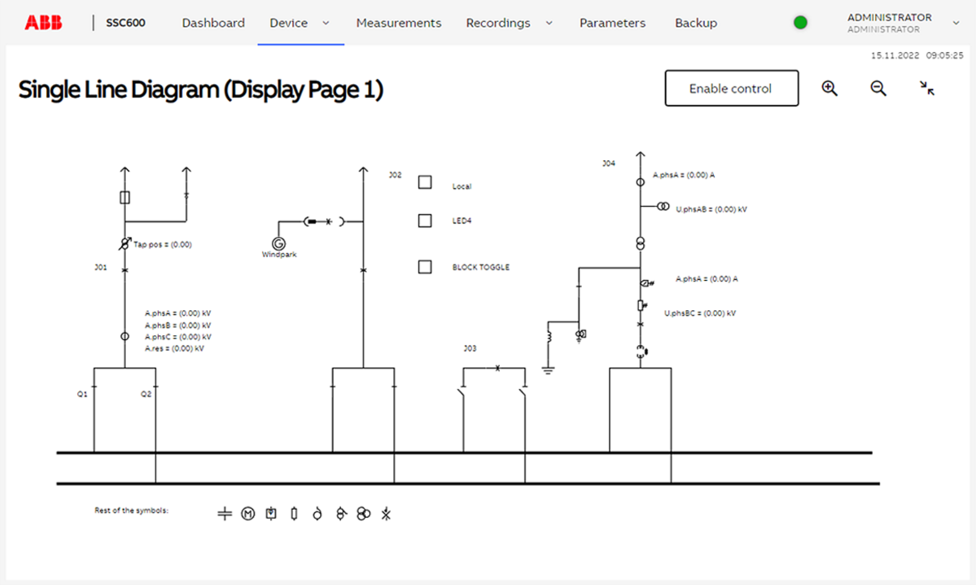
No active alarms

Figure 19: Dashboard view

The IED version, current operating status, latest events and alarms are shown.

4.1.8.2 Single Line Diagram view

1. Select **Single Line Diagram** in the View bar to view the single-line diagram.



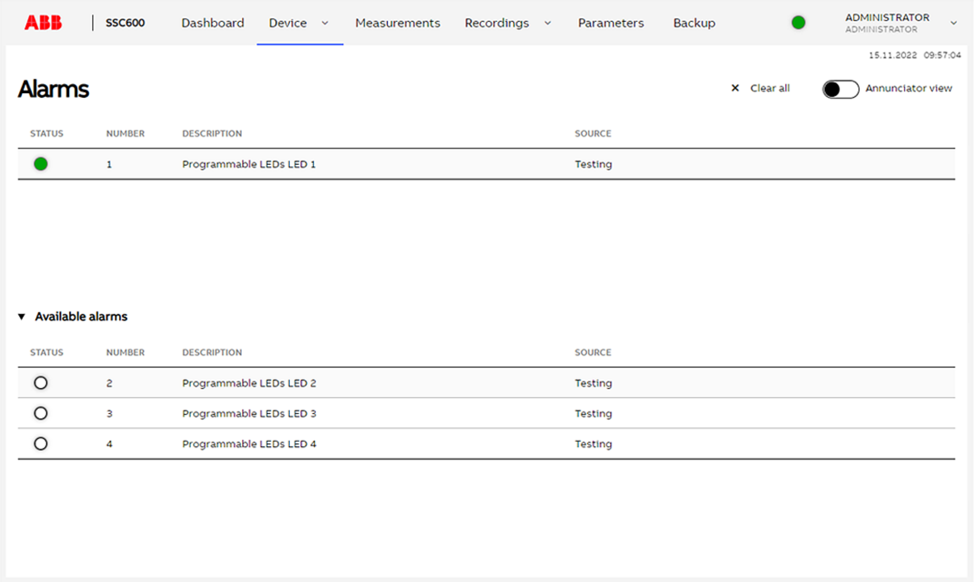
Single Line Diagram (Display Page 1)

Figure 20: Viewing the single-line diagram

4.1.8.3 Alarms view

The **Alarms** view shows the status of the programmable virtual LEDs.

- Click **Device** > **Alarms** in the View bar.



Alarms

STATUS	NUMBER	DESCRIPTION	SOURCE
●	1	Programmable LEDs LED 1	Testing

▼ Available alarms

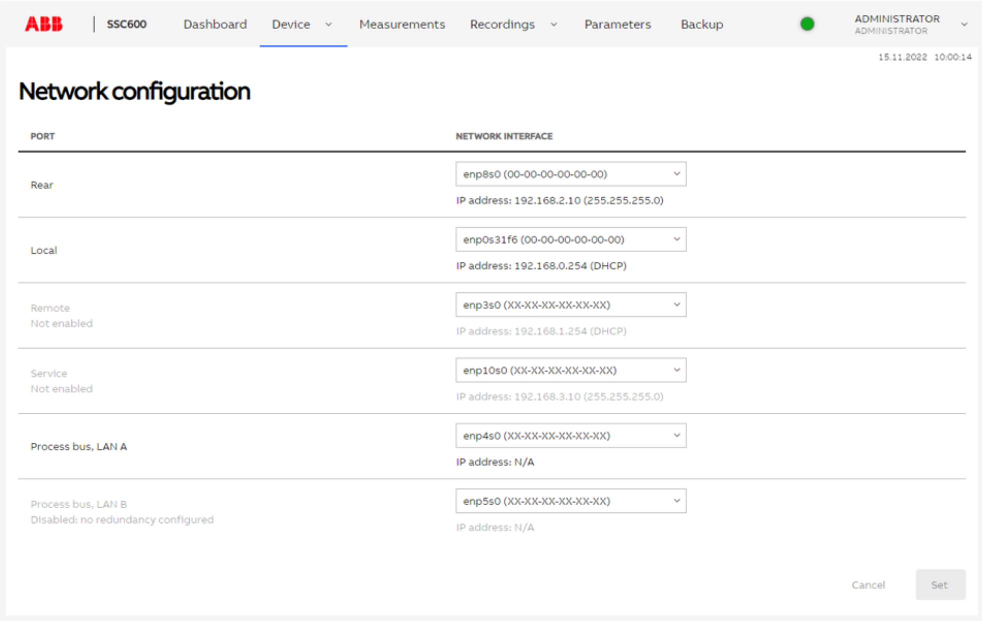
STATUS	NUMBER	DESCRIPTION	SOURCE
○	2	Programmable LEDs LED 2	Testing
○	3	Programmable LEDs LED 3	Testing
○	4	Programmable LEDs LED 4	Testing

Figure 21: Monitoring programmable LEDs

The status of each programmable virtual LED is displayed.

4.1.8.4 Network configuration view

Network configuration view shows an editable view of device network interfaces. This functionality is only available in virtualized environments, when using SSC600 SW.



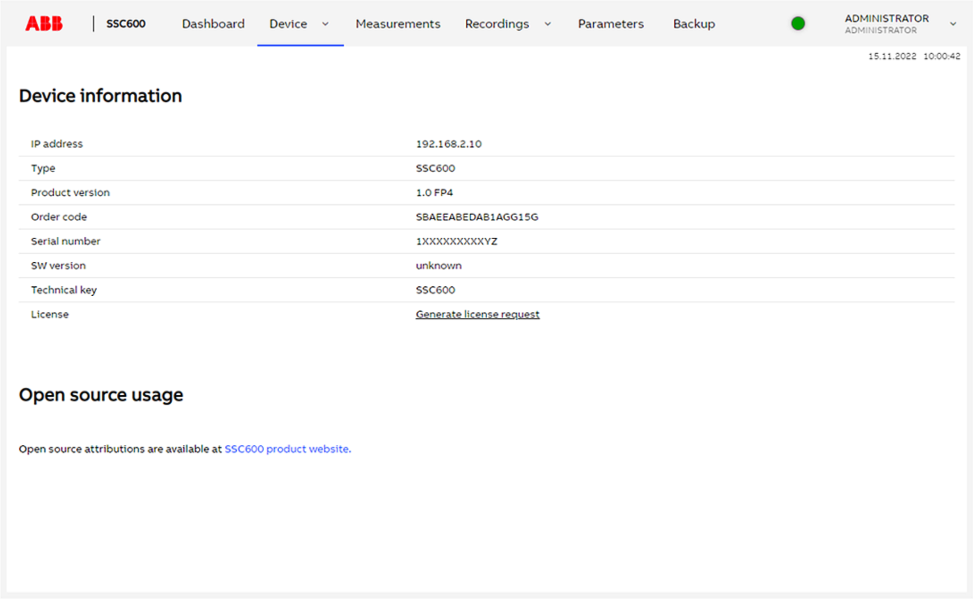
Network configuration

PORT	NETWORK INTERFACE
Rear	enp8s0 (00-00-00-00-00-00) IP address: 192.168.2.10 (255.255.255.0)
Local	enp0s31f6 (00-00-00-00-00-00) IP address: 192.168.0.254 (DHCP)
Remote Not enabled	enp3s0 (XX-XX-XX-XX-XX-XX) IP address: 192.168.1.254 (DHCP)
Service Not enabled	enp10s0 (XX-XX-XX-XX-XX-XX) IP address: 192.168.3.10 (255.255.255.0)
Process bus, LAN A	enp4s0 (XX-XX-XX-XX-XX-XX) IP address: N/A
Process bus, LAN B Disabled: no redundancy configured	enp5s0 (XX-XX-XX-XX-XX-XX) IP address: N/A

Figure 22: Network configuration view

4.1.8.5 About view

About view shows basic device information and a link to open source components usage declaration. Through this view, it is also possible to generate a license request file.



Device information

IP address	192.168.2.10
Type	SSC600
Product version	1.0 FP4
Order code	SBAEEABEDAB1AGG15G
Serial number	1XXXXXXXXXYZ
SW version	unknown
Technical key	SSC600
License	Generate license request

Open source usage

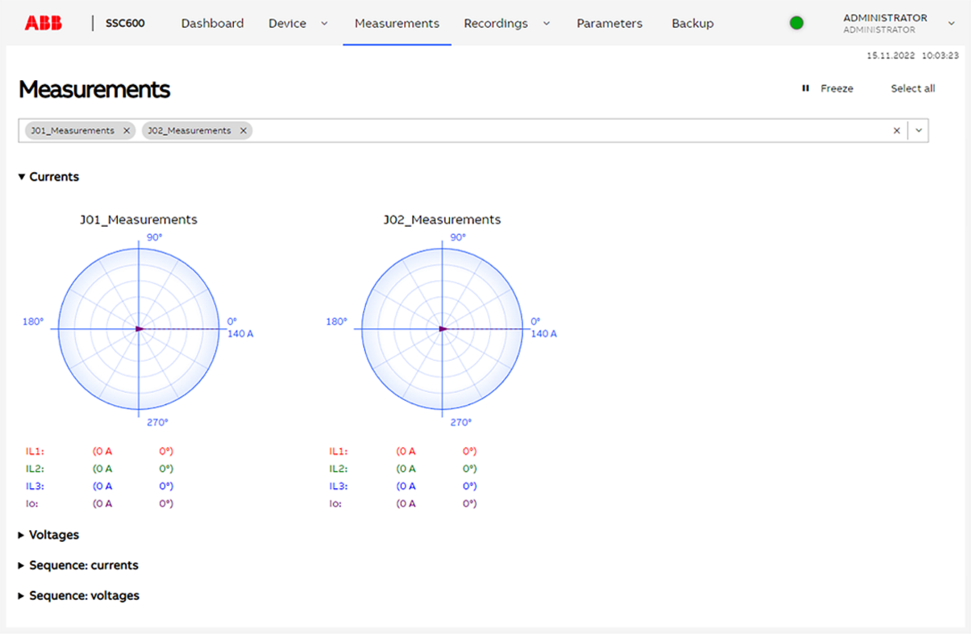
Open source attributions are available at SSC600 product website.

Figure 23: About view

4.1.8.6 Measurements view

The **Measurements** view shows phasor diagrams.

1. Select **Measurements** in the View bar.



Measurements

▾ Currents

J01_Measurements

IL1:	(0 A	0°)
IL2:	(0 A	0°)
IL3:	(0 A	0°)
Io:	(0 A	0°)

J02_Measurements

IL1:	(0 A	0°)
IL2:	(0 A	0°)
IL3:	(0 A	0°)
Io:	(0 A	0°)

Figure 24: Monitoring phasors

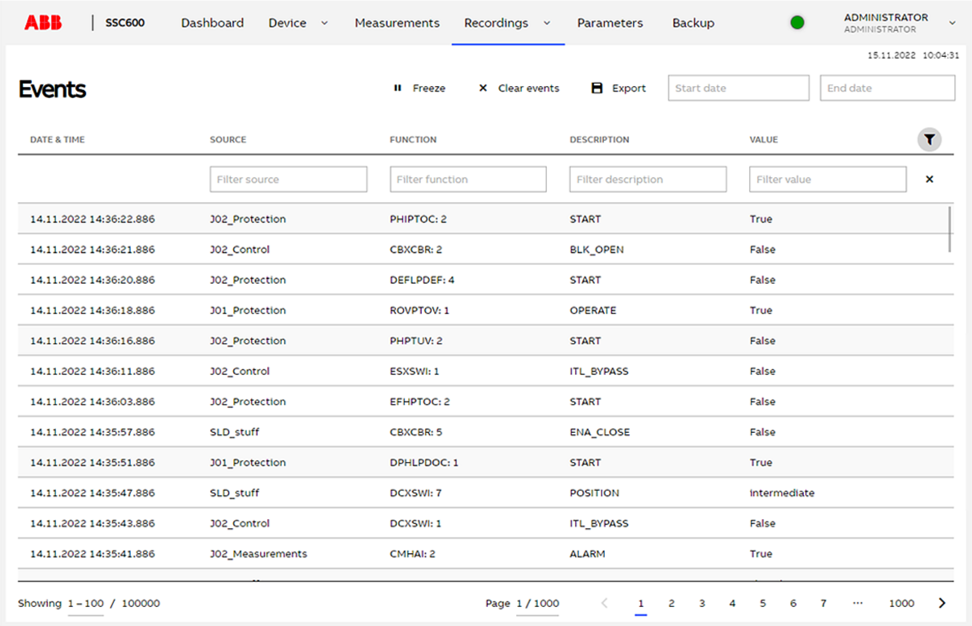
2. Toggle the diagram visibility by selecting the diagrams from the drop-down menu.
3. Click **Freeze** to stop updating the phasor diagram.

   No updates are displayed in the diagram.

4.1.8.7 Events and security events views

The **Events** view contains a list of all events produced by the application configuration, and **Security events** list contains all audit events produced by the device. Both lists are updated automatically.

1. Select **Recordings** > **Events** in the **View** bar.



DATE & TIME	SOURCE	FUNCTION	DESCRIPTION	VALUE
14.11.2022 14:36:22.886	J02_Protection	PHIPTOC: 2	START	True
14.11.2022 14:36:21.886	J02_Control	CBXCBR: 2	BLK_OPEN	False
14.11.2022 14:36:20.886	J02_Protection	DEFLPDEF: 4	START	False
14.11.2022 14:36:18.886	J01_Protection	ROVPTOV: 1	OPERATE	True
14.11.2022 14:36:16.886	J02_Protection	PHPTUV: 2	START	False
14.11.2022 14:36:11.886	J02_Control	ESXSWI: 1	ITL_BYPASS	False
14.11.2022 14:36:03.886	J02_Protection	EFHPTOC: 2	START	False
14.11.2022 14:35:57.886	SLD_stuff	CBXCBR: 5	ENA_CLOSE	False
14.11.2022 14:35:51.886	J01_Protection	DPHLPDOC: 1	START	True
14.11.2022 14:35:47.886	SLD_stuff	DCXSWI: 7	POSITION	intermediate
14.11.2022 14:35:43.886	J02_Control	DCXSWI: 1	ITL_BYPASS	False
14.11.2022 14:35:41.886	J02_Measurements	CMHAI: 2	ALARM	True

Figure 25: Monitoring events

2. Click **Freeze** to stop updating the event list.
3. Select a page from the bottom to view older events.

   Events can be exported in CSV and text formats.

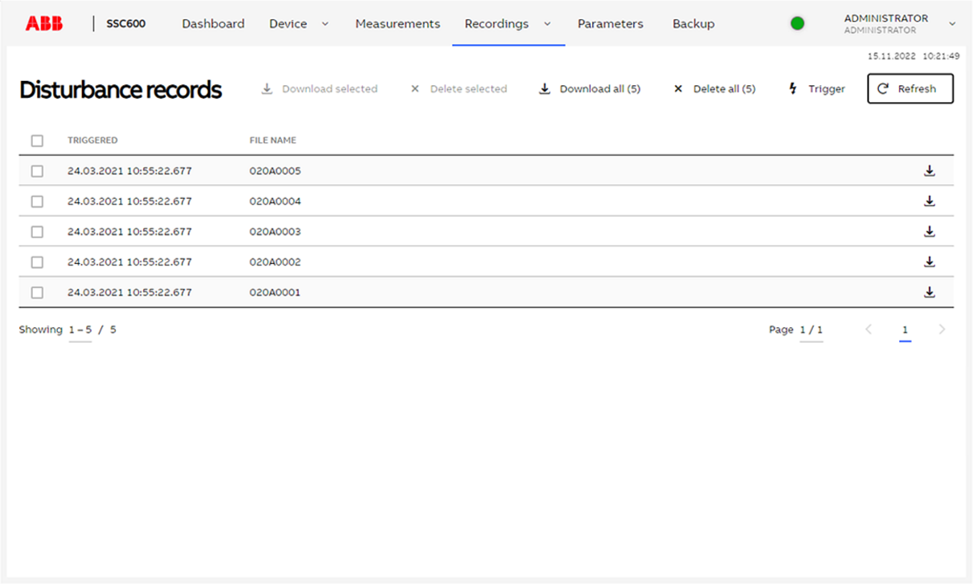
   The CSV file can be opened with a spreadsheet program such as OpenOffice.org Calc or Microsoft Excel.

4. Click **Clear events** to clear all events from the IED.

4.1.8.8 Disturbance records view

The **Disturbance records** view shows the list of disturbance records.

1. Select **Disturbance records** in the View bar.



☐	TRIGGERED	FILE NAME	
☐	24.03.2021 10:55:22.677	020A0005	⤓
☐	24.03.2021 10:55:22.677	020A0004	⤓
☐	24.03.2021 10:55:22.677	020A0003	⤓
☐	24.03.2021 10:55:22.677	020A0002	⤓
☐	24.03.2021 10:55:22.677	020A0001	⤓

Figure 26: Disturbance record view

The list of disturbance records is displayed.

Saving disturbance records

1. Select **Disturbance records** in the View bar.
2. Either click the ⤓ icon on the record row to download a single record, or select multiple rows via checkboxes on the left, and click **Download selected** to download all selected records.

   Both the disturbance record files (CFG and DAT) are then downloaded as a zip file.
3. Open the disturbance record files with a suitable program.

Triggering the disturbance recorder manually

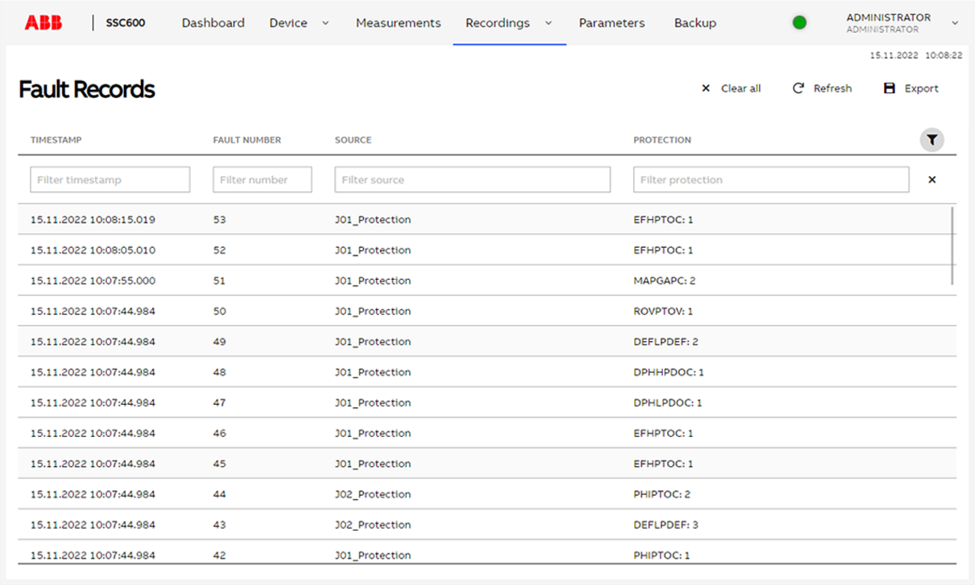
1. Select **Disturbance records** in the View bar.
2. Click **Trigger**.

Deleting disturbance records

1. Select **Disturbance records** in the View bar.
   - Select one or more recordings and click **Delete** to delete selected records.

4.1.8.9 Fault records view

1. Select **Recordings** > **Fault records** from the View bar to view a list of all available fault records.

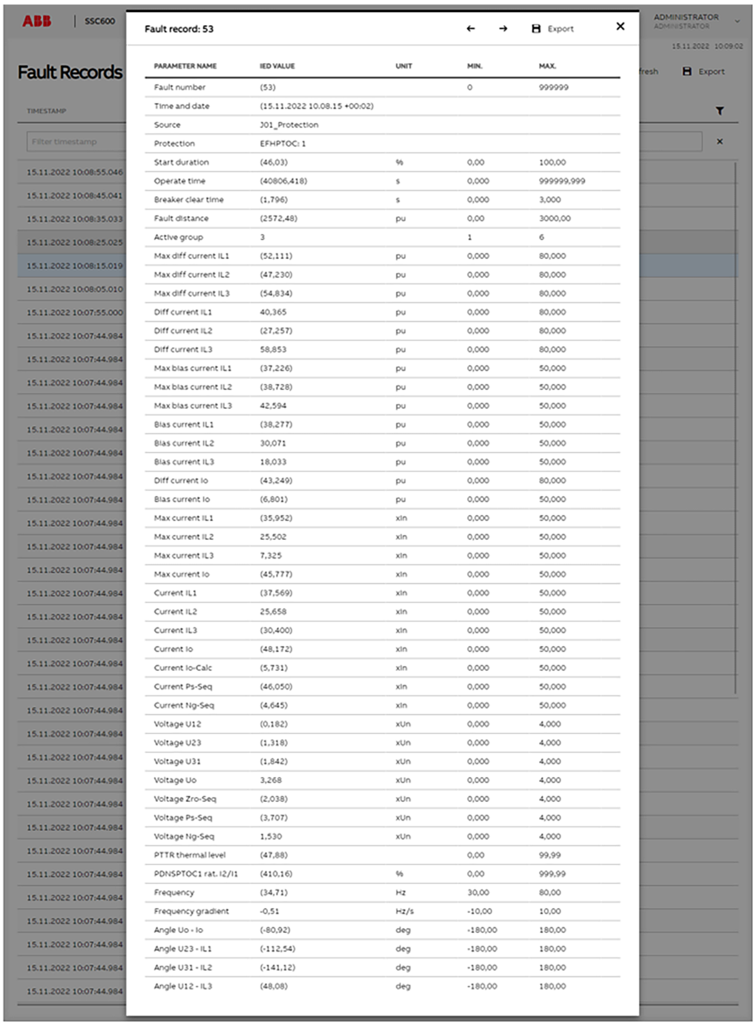


Fault Records

TIMESTAMP	FAULT NUMBER	SOURCE	PROTECTION
Filter timestamp	Filter number	Filter source	Filter protection
15.11.2022 10:08:15.019	53	J01_Protection	EFHPTOC: 1
15.11.2022 10:08:05.010	52	J01_Protection	EFHPTOC: 1
15.11.2022 10:07:55.000	51	J01_Protection	MAPGAPC: 2
15.11.2022 10:07:44.984	50	J01_Protection	ROVPTOV: 1
15.11.2022 10:07:44.984	49	J01_Protection	DEFLPDEF: 2
15.11.2022 10:07:44.984	48	J01_Protection	DPHHPDOC: 1
15.11.2022 10:07:44.984	47	J01_Protection	DPHLPDOC: 1
15.11.2022 10:07:44.984	46	J01_Protection	EFHPTOC: 1
15.11.2022 10:07:44.984	45	J01_Protection	EFHPTOC: 1
15.11.2022 10:07:44.984	44	J02_Protection	PHIPTOC: 2
15.11.2022 10:07:44.984	43	J02_Protection	DEFLPDEF: 3
15.11.2022 10:07:44.984	42	J01_Protection	PHIPTOC: 1

Figure 27: Fault record list view

2. Click a record from the list to open the fault record details view.



PARAMETER NAME	IED VALUE	UNIT	MIN.	MAX.
Fault number	(53)		0	999999
Time and date	(15.11.2022 10.08.15 +00:02)			
Source	J01_Protection			
Protection	EFHPTOC: 1			
Start duration	(46,03)	%	0,00	100,00
Operate time	(40806,418)	s	0,000	999999,999
Breaker clear time	(1,796)	s	0,000	3,000
Fault distance	(2572,48)	pu	0,00	3000,00
Active group	3		1	6
Max diff current IL1	(52,111)	pu	0,000	80,000
Max diff current IL2	(47,230)	pu	0,000	80,000
Max diff current IL3	(54,834)	pu	0,000	80,000
Diff current IL1	40,365	pu	0,000	80,000
Diff current IL2	(27,257)	pu	0,000	80,000
Diff current IL3	58,853	pu	0,000	80,000
Max bias current IL1	(37,226)	pu	0,000	50,000
Max bias current IL2	(38,728)	pu	0,000	50,000
Max bias current IL3	42,594	pu	0,000	50,000
Bias current IL1	(38,277)	pu	0,000	50,000
Bias current IL2	30,071	pu	0,000	50,000
Bias current IL3	18,033	pu	0,000	50,000
Diff current Io	(43,249)	pu	0,000	80,000
Bias current Io	(6,801)	pu	0,000	50,000
Max current IL1	(35,952)	xIn	0,000	50,000
Max current IL2	25,502	xIn	0,000	50,000
Max current IL3	7,325	xIn	0,000	50,000
Max current Io	(45,777)	xIn	0,000	50,000
Current IL1	(37,569)	xIn	0,000	50,000
Current IL2	25,658	xIn	0,000	50,000
Current IL3	(30,400)	xIn	0,000	50,000
Current Io	(48,172)	xIn	0,000	50,000
Current Io-Calc	(5,731)	xIn	0,000	50,000
Current Ps-Seq	(46,050)	xIn	0,000	50,000
Current Ng-Seq	(4,645)	xIn	0,000	50,000
Voltage U12	(0,182)	xUn	0,000	4,000
Voltage U23	(1,318)	xUn	0,000	4,000
Voltage U31	(1,842)	xUn	0,000	4,000
Voltage Uo	3,268	xUn	0,000	4,000
Voltage Zro-Seq	(2,038)	xUn	0,000	4,000
Voltage Ps-Seq	(3,707)	xUn	0,000	4,000
Voltage Ng-Seq	1,530	xUn	0,000	4,000
PTTR thermal level	(47,88)		0,00	99,99
PDNSPTOC1 rat. I2/I1	(410,16)	%	0,00	999,99
Frequency	(34,71)	Hz	30,00	80,00
Frequency gradient	-0,51	Hz/s	-10,00	10,00
Angle Uo - Io	(-80,92)	deg	-180,00	180,00
Angle U23 - IL1	(-112,54)	deg	-180,00	180,00
Angle U31 - IL2	(-141,12)	deg	-180,00	180,00
Angle U12 - IL3	(48,08)	deg	-180,00	180,00

Figure 28: Fault record details view

3. To save the records in TXT or CSV file formats, select **Export**, then select the file format and confirm from the export dialog.
    - When the fault record details view is shown, only the shown fault record is saved.
    - When fault record list view is shown, all fault records are saved.
4. To clear all fault records from the IED, click **Clear all**.

    This can be done only when the fault record list view is shown.

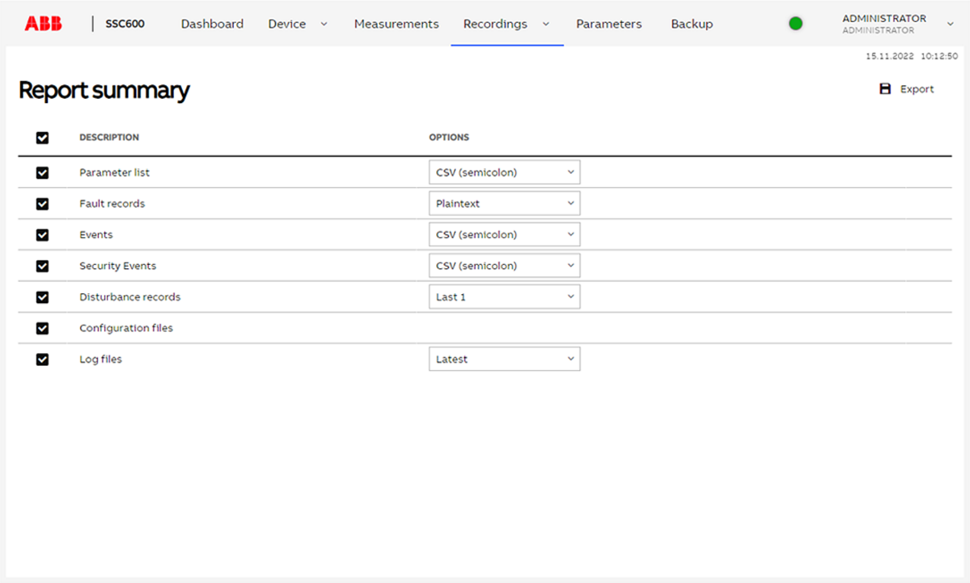
4.1.8.10 Report summary

The **Report summary** view allows to save events, fault records, disturbance records, parameter list, configuration files and log files. File formats can be chosen separately for each content type, with available options being CSV and text. Parameters can also be saved in JSON format. This is the only format that can be used to import parameters back to the device.

Disturbance records files are saved in CFG and DAT formats.

When log files are exported, two of the latest core dumps are also included in the package, if there are any. Additionally, a text file with a list of all found core dumps is included. These files can be very large, and therefore not all of them are automatically included.

1. Select **Report summary** in the View bar.



15.11.2022 10:12:50

Report summary

☑	DESCRIPTION	OPTIONS
☑	Parameter list	CSV (semicolon)
☑	Fault records	Plaintext
☑	Events	CSV (semicolon)
☑	Security Events	CSV (semicolon)
☑	Disturbance records	Last 1
☑	Configuration files	
☑	Log files	Latest

Figure 29: Report summary view

2. Select the items to be exported.
3. Select the amount of records to be saved from the **Disturbance records** drop-down list.
   - All
   - Last 1
   - Last 10
4. Click **Export** to export the ZIP file with the selected files.

4.1.8.11 Backups view

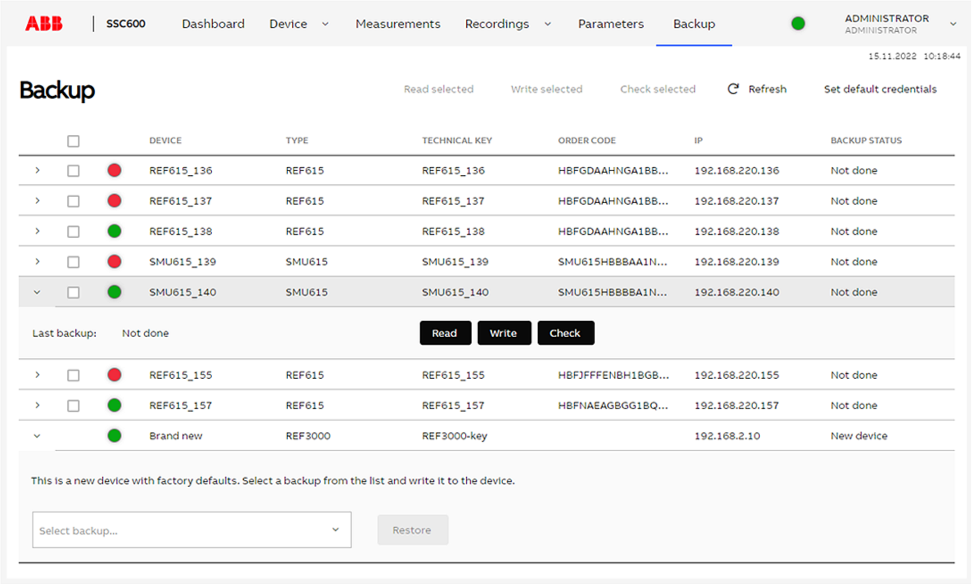
Select **Backup** view in the View bar. In this view all connected devices are shown, with possibilities to take and restore backups. Device connection state is shown with green (online) or red (offline) indicator.

Available operations for existing devices:

- Read: take full backup of the device
- Write: overwrite the device configuration with one from the backup

- Check: compare the contents of the backup and current device state. Check fails if the contents do not match, and passes if they match.

This view also shows the newly added, factory-reset devices, with IP address 192.168.2.10 (see bottom-most device in *Figure 30*). Any of the existing backups can be deployed to this device. There can only be one factory-reset device visible at a time, otherwise IP address conflict would occur.



Backup

	☐		DEVICE	TYPE	TECHNICAL KEY	ORDER CODE	IP	BACKUP STATUS
›	☐	🔴	REF615_136	REF615	REF615_136	HBFGDAAHNGA1BB...	192.168.220.136	Not done
›	☐	🔴	REF615_137	REF615	REF615_137	HBFGDAAHNGA1BB...	192.168.220.137	Not done
›	☐	🟢	REF615_138	REF615	REF615_138	HBFGDAAHNGA1BB...	192.168.220.138	Not done
›	☐	🔴	SMU615_139	SMU615	SMU615_139	SMU615HBBBAA1N...	192.168.220.139	Not done
⌄	☐	🟢	SMU615_140	SMU615	SMU615_140	SMU615HBBBBA1N...	192.168.220.140	Not done
›	☐	🔴	REF615_155	REF615	REF615_155	HBFJFFFENBH1BGB...	192.168.220.155	Not done
›	☐	🟢	REF615_157	REF615	REF615_157	HBFNAEAGBGG1BQ...	192.168.220.157	Not done
⌄		🟢	Brand new	REF3000	REF3000-key		192.168.2.10	New device

Last backup: Not done

This is a new device with factory defaults. Select a backup from the list and write it to the device.

Figure 30: Backup view

4.2 Disturbance identification

Disturbances and their causes can be identified by physical or WEB HMI indicator LEDs: Ready, Start and Trip. During normal operation, the Ready LED is steady green.

Table 10: Physical LED indications

LED	State	Description
Start LED	Green, steady	Protection started
Start LED	Green, flashing	Protection function blocked
Trip LED	Green, steady	Protection operated
Ready LED	Green, flashing	Internal fault
Alarm LED	Green, steady	Programmable LED in alarm state

Table 11: Web HMI LED indications

LED	State	Description
Start LED	Yellow, steady	Protection started
Start LED	Yellow, flashing	Protection function blocked
Trip LED	Red, steady	Protection operated
Ready LED	Green, flashing	Internal fault

Further actions to be taken to identify the disturbance:

- Checking programmable virtual LEDs
- Reading event history
- Checking fault records
- Analyzing disturbance recordings

Document the disturbance before clearing the information from the IED.

Only authorized and skilled personnel should analyze possible errors and decide on further actions. Otherwise, stored disturbance data can be lost.

4.3 IED parametrization

IED parameters are set via the WHMI or PCM600.

Setting parameters need to be calculated according to the electrical network conditions and the electrical characteristics of the protected equipment. The settings need to be verified before the IED is connected to a system.

Document all changes to parameter settings.

For more information, see PCM600 documentation.

4.3.1 Settings for IED functionality

Function settings can be edited one by one by navigating to the individual setting values. The values in other setting groups should be known before editing a certain setting value.

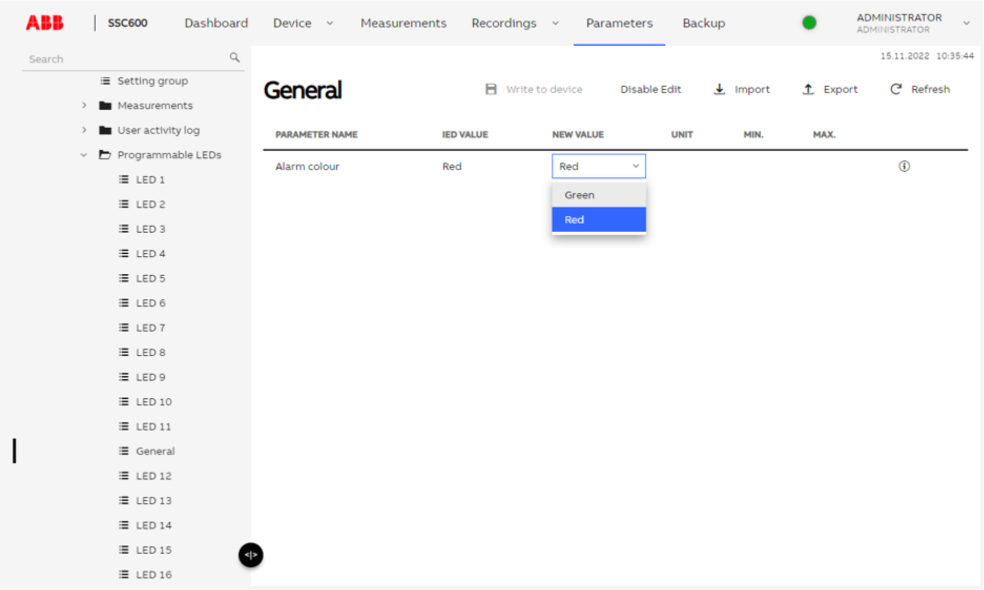
After completing the editing of setting group values, the new values are activated. The user can either commit the edited values or discard them. Setting values can also be copied from one setting group to another.

4.3.2 Settings for different operating conditions

IED settings can be designed for various operation conditions by defining different setting values to different setting groups. The active setting group can be changed by the IED application or manually via the WHMI or PCM600.

4.3.3 Activating programmable virtual LEDs

1. Select **IED Configuration** > **Configuration** > **Programmable LEDs**.
2. Select **General** to set the alarm color for the programmable LEDs.
3. Enable parameter editing by selecting **Enable edit**.

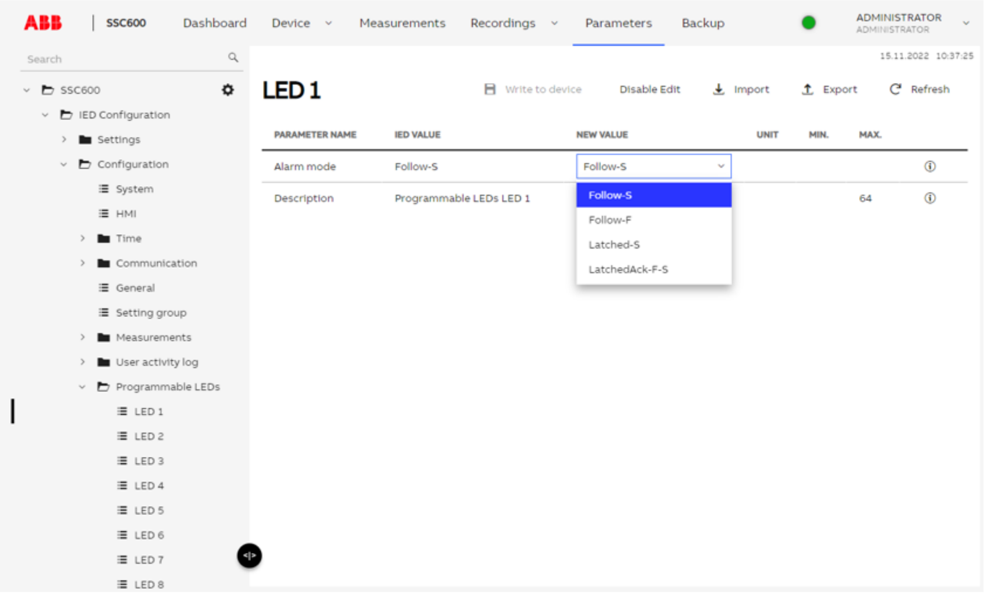


General

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Alarm colour	Red	Red			

Figure 31: Enabling parameter editing

4. Select **Write to device** to save changes into the IED's memory.
5. Select **LED 1 ... LED 100** to define the alarm mode and description for each programmable LED.
6. Enable parameter editing by selecting **Enable edit**.



LED 1

PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Alarm mode	Follow-S	Follow-S			
Description	Programmable LEDs LED 1				64

Figure 32: Alarm modes

The available alarm modes are:

- Follow-S
- Follow-F
- Latched-S
- LatchedAck-F-S.

7. Select **Write to device** to save changes into the IED's memory.

See the Technical manual for details on LED configuration.

4.4 Monitoring

4.4.1 Indications

The operation of the IED can be monitored via three different indications:

1. Four indicator LEDs with fixed functionality: Ready, Start, Trip and Alarm
2. Programmable virtual LEDs on the WHMI
3. Information on the **Events** view.

4.4.2 Recorded data

The IED is provided with intelligent and flexible functionality that collects different kinds of data. The recorded data gives substantial information for post fault analysis.

- Disturbance records
- Fault records
- Events

4.4.2.1 Creating disturbance recordings

The disturbance recordings are triggered by the IED applications normally, but the recording can also be triggered manually.

1. Click **Disturbance records** in the View bar.
2. Click **Trigger** to create disturbance recordings manually.

4.4.2.2 Monitoring disturbance recorder data

You can view the disturbance recordings from the IED.

1. Select **Disturbance records** in the View bar.

   The following items are listed in the view:

   - Number of recordings currently in the IED's memory
   - Remaining amount of recordings that fit into the available recording memory
   - Recording memory used in percentage
   - If the periodic triggering function is used, the time to trigger which indicates the remaining time to the next periodic triggering of the disturbance recorder.
2. An individual disturbance record can be deleted by selecting **Delete**. All disturbance records can be deleted from the IED's memory by selecting **Delete All**.

4.4.2.3 Controlling and reading of disturbance recorder data

Disturbance recorder data can be controlled and read with PCM600. It can also be read via WHMI.

For more information, see PCM600 documentation.

4.4.2.4 IED self-supervision

The IED self-supervision handles internal run-time fault situations. The main indication of an internal fault is a flashing green Ready LED.

Internal faults can be divided to hardware errors, run-time errors in the application or operating system and communication errors. Further actions always depend on the cause of the error.

Only authorized and skilled personnel should analyze the errors and decide on further actions.

The IED records system registrations, IED status data and events.

Document all the recorded data from the IED before resetting the tripping and lockout functions.

4.4.3 Monitoring fault records

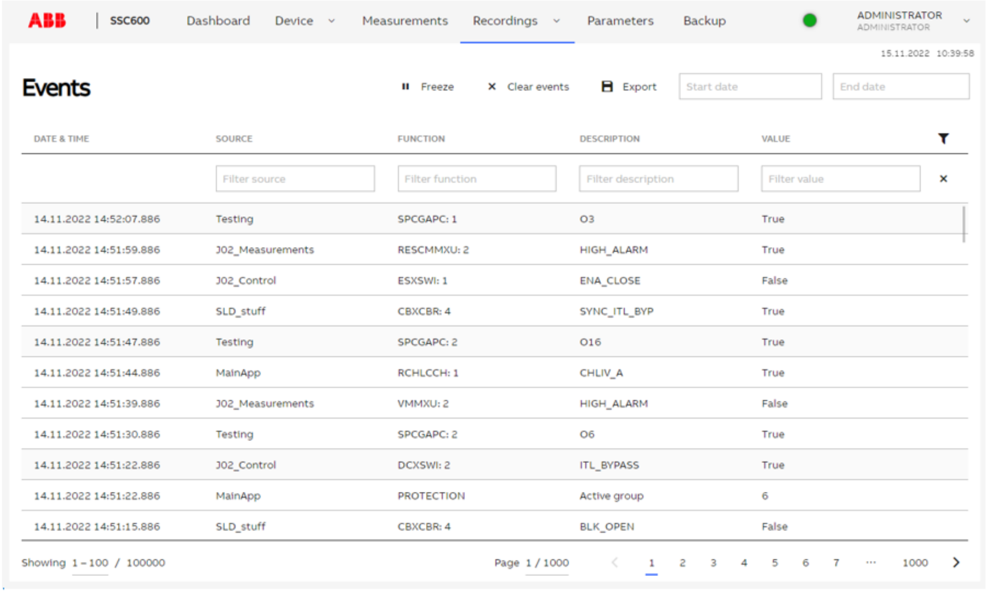
Timestamps of the fault records are shown as a list.

1. Select **Fault records** in the View bar.
   The fault records stored in the IED's memory are listed. The first fault record is the newest. Select **View all** to view all fault records.
2. You save the fault records either as a text (.txt) or comma separated value (.csv) file.
3. You can clear all fault records from the IED's memory by selecting **Clear records**.

4.4.4 Monitoring events

Event view contains a list of events produced by the application configuration. Each event takes one view area. The header area shows the currently viewed event index and the total amount of the events. The most recent event is always first.

1. Select **Events** in the View bar.



DATE & TIME	SOURCE	FUNCTION	DESCRIPTION	VALUE
14.11.2022 14:52:07.886	Testing	SPCGAPC: 1	O3	True
14.11.2022 14:51:59.886	J02_Measurements	RESCMMXU: 2	HIGH_ALARM	True
14.11.2022 14:51:57.886	J02_Control	ESXSWI: 1	ENA_CLOSE	False
14.11.2022 14:51:49.886	SLD_stuff	CBXCBR: 4	SYNC_ITL_BYP	True
14.11.2022 14:51:47.886	Testing	SPCGAPC: 2	O16	True
14.11.2022 14:51:44.886	MainApp	RCHLCCH: 1	CHLIV_A	True
14.11.2022 14:51:39.886	J02_Measurements	VMMXU: 2	HIGH_ALARM	False
14.11.2022 14:51:30.886	Testing	SPCGAPC: 2	O6	True
14.11.2022 14:51:22.886	J02_Control	DCXSWI: 2	ITL_BYPASS	True
14.11.2022 14:51:22.886	MainApp	PROTECTION	Active group	6
14.11.2022 14:51:15.886	SLD_stuff	CBXCBR: 4	BLK_OPEN	False

Showing 1 – 100 / 100000

Figure 33: Events view

Number of events displayed can be selected. Gathering of event data can be stopped temporarily by selecting **Freeze**.

2. Save the event data as a text (.txt) or comma separated value (.csv) file. Select **Export** to save event information.
3. Clear all event data from the IED's memory by selecting **Clear events**.

4.4.5 Remote monitoring

Use the PCM600 tool and WHMI to operate the IED remotely.

- Read maintenance record and version log.
- Analyze disturbance record data.
- Create disturbance records.
- Monitor IED values.

For more information, see PCM600 documentation.

4.5 Controlling

4.5.1 Controlling with single-line diagram

In the single-line diagram view, controllable objects can be opened and closed.

To control the IED, logging in and authorization are required.

4.5.1.1 Controlling circuit breaker, disconnectors and earthing switch

1. Select **Enable control**.

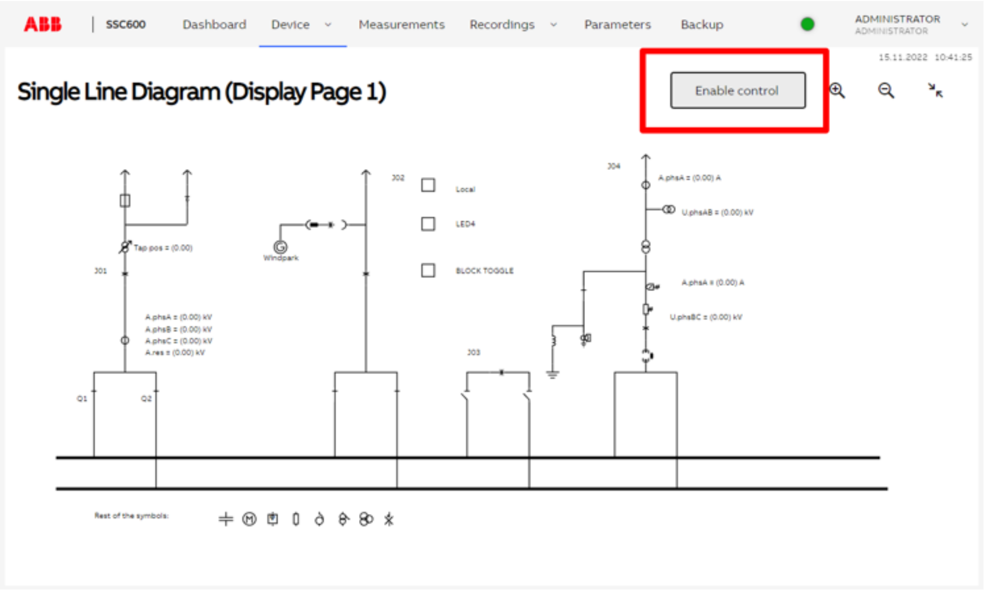


Figure 34: Single-line diagram with Enable control button

This is only possible in local mode when logging in as a user with Control Operations right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline).

2. Select the object from the Single Line Diagram.

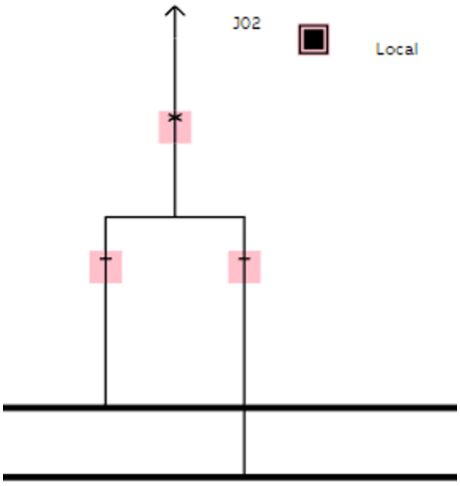


Figure 35: Single-line diagram with a breaker and IEC symbols

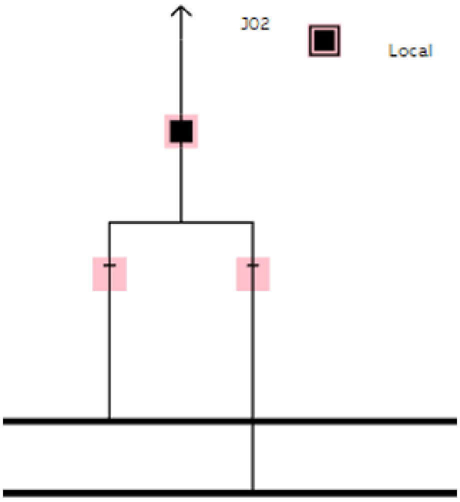
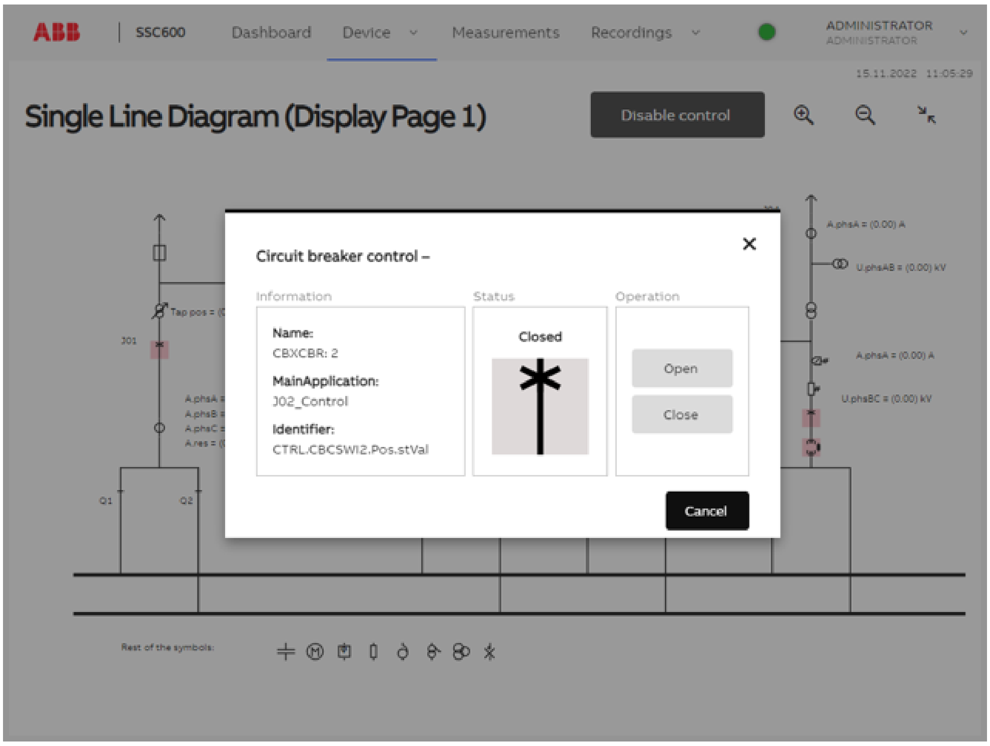


Figure 36: Single-line diagram with one breaker and ANSI symbols

Control dialog for selected object is opened.



Circuit breaker control –

Information

Name:
CBXCBR: 2

MainApplication:
J02_Control

Identifier:
CTRL.CBCSWI2.Pos.stVal

Status

Closed

Operation

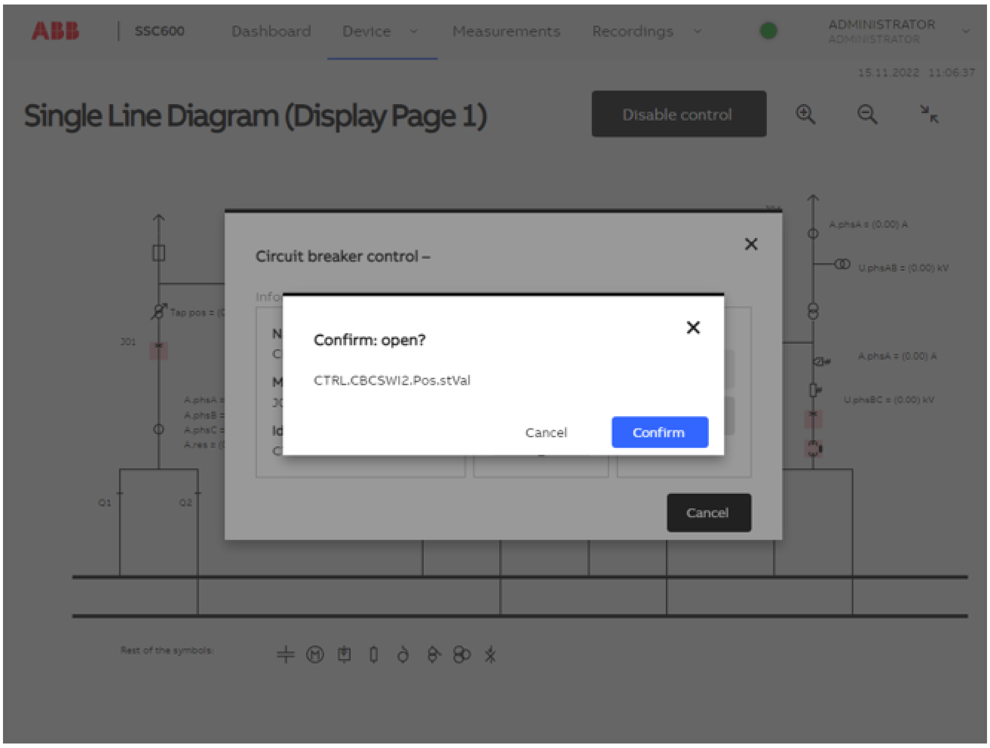
Open

Close

Cancel

Figure 37: Control dialog

3. Click either **Open** or **Close**.
4. Select **Confirm**.



Confirm: open?

CTRL.CBCSWI2.Pos.stVal

Cancel Confirm

Figure 38: Confirm screen

4.5.1.2 Controlling SLD buttons

Buttons are controlled via WHMI SLD like any other controllable single-line diagram objects.

1. Select **Enable control**.
2. Clickable buttons are highlighted in the SLD.

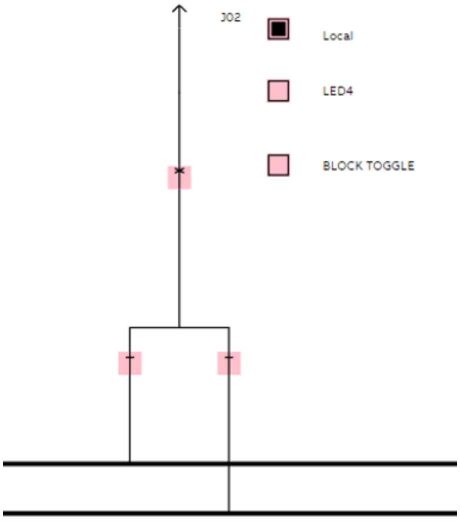
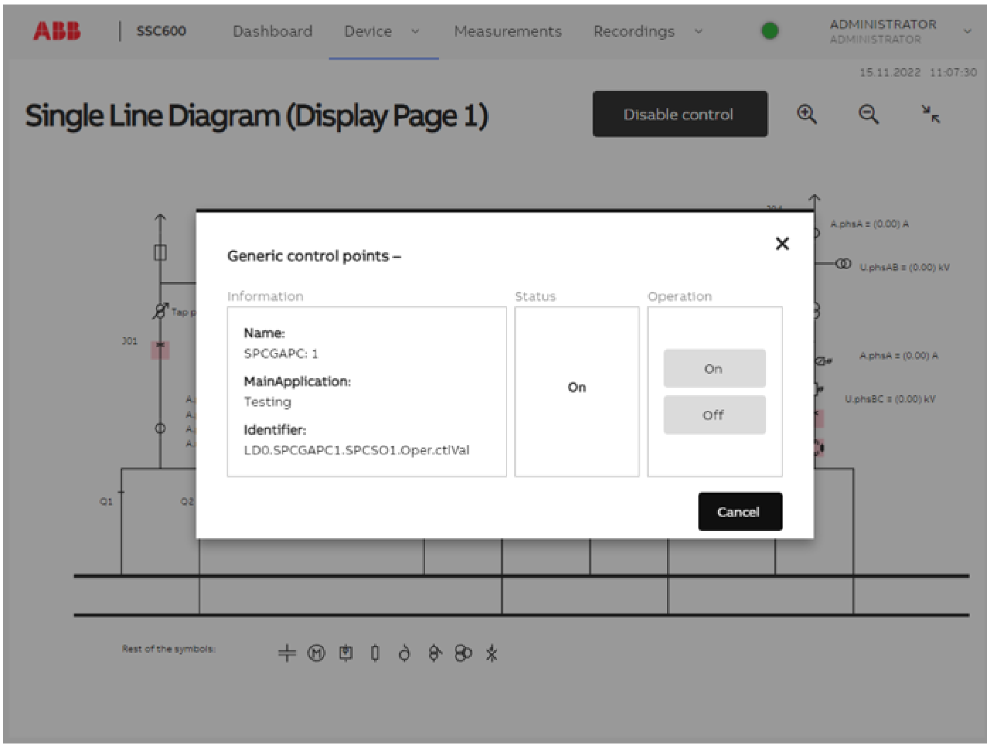


Figure 39: Single-line diagram with some buttons. The Local button is in “True” state, whereas “LED4” and “BLOCK TOGGLE” buttons are in “False” state

3. Click any button in the SLD.

   Control dialog is shown.



Single Line Diagram (Display Page 1)

Generic control points –

Information

Name:
SPCGAPC: 1

MainApplication:
Testing

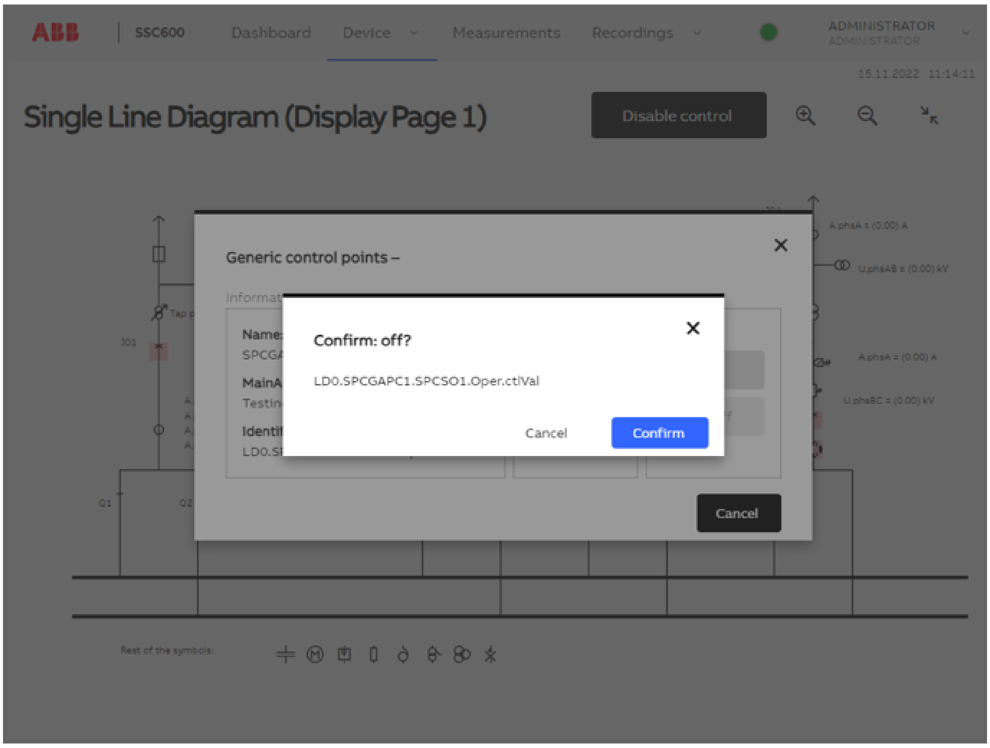
Identifier:
LD0.SPCGAPC1.SPCSO1.Oper.ctlVal

Status: On

Figure 40: Button control dialog

4. Click either **On** or **Off**.

   Confirmation dialog is shown.



Confirm: off?

LD0.SPCGAPC1.SPCSO1.Oper.ctlVal

Figure 41: Button control dialog confirmation

5. From confirmation dialog, click **Confirm**.

The control position of the IED affects the controlling SLD buttons. Depending on the parameter settings, the IED may have to be in local state for the control to succeed.

5 Troubleshooting

5.1 Identifying hardware errors

1. Check the module with an error.

   Check the IED supervision events in **Main menu** > **Monitoring** > **IED status** > **Self-supervision** for a faulty hardware module.
2. Inspect the IED visually.
   - Inspect the IED visually to find any physical error causes.
   - If you can find some obvious physical damage, contact ABB for repair or replacement actions.
3. Check whether the error is external or internal.
   - Check that the error is not caused by external origins.
   - Remove the wiring from the IED and test the input and output operation with an external test device.
   - If the problem remains, contact ABB for repair or replacement actions.

5.2 Identifying runtime errors

1. Check the error origin from the IED's supervision events **Main menu** > **Monitoring** > **IED status** > **Self-supervision**.
2. Reboot the IED and recheck the supervision events to see if the fault has cleared.
3. In case of persistent faults, contact ABB for corrective actions.

5.3 Identifying communication errors

Communication errors are normally communication interruptions or synchronization message errors due to communication link breakdown.

- In case of persistent faults originating from IED's internal faults such as component breakdown, contact ABB for repair or replacement actions.

5.3.1 Internal faults

An indication about the fault is shown in the event list of the WHMI. The text Internal Fault with an additional text message, a code, date and time, is shown to indicate the fault type.

Different actions are taken depending on the severity of the fault. The IED tries to eliminate the fault by restarting. After the fault is found to be permanent, the IED stays in the internal fault mode. All other output contacts are released and locked for the internal fault. The IED continues to perform internal tests during the fault situation.

The internal fault code indicates the type of internal IED fault. When a fault appears, the code must be recorded so that it can be reported to ABB customer service.

Fault indication	Fault code	Additional information
Internal Fault System error	2	An internal system error has occurred.
Internal Fault File system error	7	A file system error has occurred.
Internal Fault Test	8	Internal fault test activated manually by the user.
Internal Fault SW watchdog error	10	Watchdog reset has occurred too many times within an hour.
Internal Fault License check fail	117	The devices is equipped with invalid license.

5.3.2 Warnings

Warnings are shown in the event list of the WHMI. The text Warning additionally provided with the name of the warning, a numeric code as well as the date and time is shown on the WHMI. The warning indication message can be manually cleared.

If a warning appears, record the name and code so that it can be provided to ABB customer service.

Table 12: Warning indications and codes

Warning indication	Warning code	Additional information
Warning IEC61850 error	20	Error when building the IEC 61850 data model.
Warning Dataset error	24	Error in the Data set(s).
Warning Report cont. error	25	Error in the Report control block(s).
Warning GOOSE contr. error	26	Error in the GOOSE control block(s).
Warning SCL config error	27	Error in the SCL configuration file or the file is missing.
Warning Logic error	28	Too many connections in the configuration.
Warning SMT logic error	29	Error in the SMT connections.

Table continues on the next page

Warning indication	Warning code	Additional information
Warning GOOSE input error	30	Error in the GOOSE connections.
ACT error	31	Error in the ACT connections.
Warning GOOSE Rx. error	32	Error in the GOOSE message receiving.
Warning AFL error	33	Analog channel configuration error.
Warning SMV config error	34	Error in the SMV configuration.
Warning Real-time task's latency exceeded	117	Real-time task execution is delayed.
Warning Redundant PSU fail	118	One of the power supply is faulty, maintenance recommended.

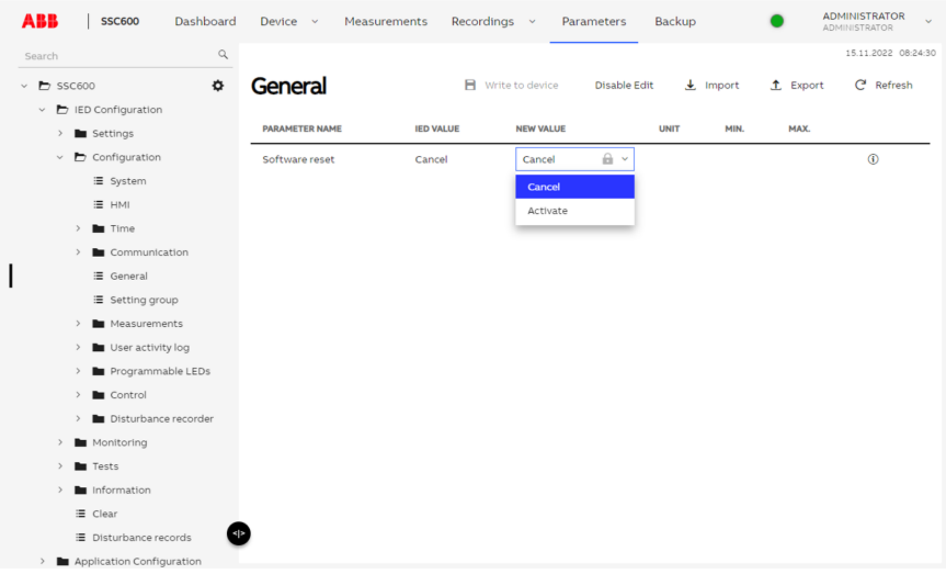
5.4 Correction procedures

5.4.1 Rebooting the software

In case of configuration data loss or any other file system error that prevents the IED from working properly, the software can be rebooted. All default settings and configuration files stored in the factory are restored.

Only a user with System Update right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline) can reboot the software.

1. Select **IED Configuration** > **Configuration** > **General** from the main menu structure.



PARAMETER NAME	IED VALUE	NEW VALUE	UNIT	MIN.	MAX.
Software reset	Cancel	Cancel			

Figure 42: General menu

2. Enable parameter editing by selecting **Enable Edit**.
3. Reboot the software by changing the New Value field from Cancel to Activate.
4. Select **Write to device** to save changes to the IED's memory.

5.4.2 Restoring factory settings

In case of configuration data loss or any other file system error that prevents the IED from working properly, the whole file system can be restored to the original factory state. All default settings and configuration files stored in the factory are restored.

Restoring factory settings is possible with PCM600.

For more information, refer to SSC600 Device Management section in the Engineering Manual.

5.4.3 Setting passwords

User password can be set via the WHMI or with PCM600.

1. Select **Configuration** > **Authorization** > **Passwords** from the main menu structure.
2. Enable parameter editing by selecting **Enable edit**.
3. Set the new password in the respective New Value field.
4. Select **Write to device** to save changes into the IED.

If the password of the last user with User Management right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline) is lost, contact ABB technical customer support.

5.4.4 Identifying IED application problems

- Check that the function is on.
- Check the blocking.
- Check the mode.
- Check the measurement value.
- Check the connection to trip and disturbance recorder functions.
- Check the channel settings.

5.4.4.1 Checking of the power supply

Check that the auxiliary supply voltage remains within the permissible input voltage range under all operating conditions. Check that the polarity is correct before powering the IED.

5.4.4.2 Sample data interruptions

Occasionally IEDs can receive corrupted or faulty measurement data during runtime. In these cases the operation system halts the corresponding application execution until correct data is received. In case of permanent faults, the measurement chain should be checked to remove the origin of the faulty measurement data.

In case of persistent faults originating from IED's internal faults, contact ABB for repair or replacement actions.

6 Environmental aspects

6.1 Sustainable development

Sustainability has been taken into account from the beginning of the product design including the pro-environmental manufacturing process, long life time, operation reliability and disposing of the device.

The choice of materials and the suppliers have been made according to the EU RoHS directive (2011/65/EU). This directive limits the use of hazardous substances which are the following:

Table 13: Maximum concentration values by weight per homogeneous material

Substance	Proposed maximum concentration
Lead - Pb	0.1%
Mercury - Hg	0.1%
Cadmium - Cd	0.01%
Hexavalent Chromium Cr (VI)	0.1%
Polybrominated biphenyls - PBB	0.1%
Polybrominated diphenyl ethers - PBDE	0.1%

Operational reliability and long life time have been assured with extensive testing during the design and manufacturing processes. Moreover, long life time is supported by maintenance and repair services as well as by the availability of spare parts.

Design and manufacturing have been done under a certified environmental system. The effectiveness of the environmental system is constantly evaluated by an external auditing body. We follow environmental rules and regulations systematically to evaluate their effect on our products and processes.

6.2 Disposal of an IED

Definitions and regulations of hazardous materials are country-specific and change when the knowledge of materials increases. The materials used in this product are typical for electric and electronic devices.

All parts used in this product are recyclable. When disposing of an IED or its parts contact a local waste handler who is authorized and specialized in disposing of electronic waste. These handlers can sort the material by using dedicated sorting processes and dispose of the product according to the local requirements.

7 Glossary

ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
CB	Circuit breaker
CFG	Configuration file
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
DAN	Doubly attached node
DAT	1. Data attribute type 2. Data file
Data set	The content basis for reporting and logging containing references to the data and data attribute values
DC	1. Direct current 2. Disconnector 3. Double command
DHCP	Dynamic Host Configuration Protocol
DT	Definite time
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
GOOSE	Generic Object-Oriented Substation Event
GPS	Global Positioning System
HMI	Human-machine interface
HTTPS	Hypertext Transfer Protocol Secure
HW	Hardware
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series
IEC 61850-9-2	A communication protocol based on the IEC 61850 standard series
IEC 61850-9-2 LE	Lite Edition of IEC 61850-9-2 offering process bus interface
IED	Intelligent electronic device
IEEE	Institute of Electrical and Electronics Engineers, Inc.
IEEE 1588 v2	Standard for a Precision Clock Synchronization Protocol for networked measurement and control systems
IP	Internet Protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/ IP protocol.
LAN	Local area network

LC	Connector type for glass fiber cable, IEC 61754-20
LCT	Life cycle traceability
LE	Light Edition
LED	Light-emitting diode
LOG	Loss of grid
LV	Low voltage
MAC	Media access control
MM	1. Multimode 2. Multimode optical fiber
MMS	1. Manufacturing message specification 2. Metering management system
MV	Medium voltage
NCC	Network control center
NRP	Negative reactance principle
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and Control IED Manager
PO	Power output
PRP	Parallel redundancy protocol
PTP	Precision Time Protocol
RAM	Random access memory
RCA	Also known as MTA or base angle. Characteristic angle.
RJ-45	Galvanic connector type
RMS	Root-mean-square (value)
RoHS	Restriction of hazardous substances
Rx	Receive/Received
SAN	Single attached node
SCL	XML-based substation description configuration language defined by IEC 61850
Single-line diagram	Simplified notation for representing a three-phase power system. Instead of representing each of three phases with a separate line or terminal, only one conductor is represented.
SLD	Single-line diagram
SMT	Signal Matrix tool in PCM600
SMV	Sampled measured values
SOTF	Switch onto fault
ST	Connector type for glass fiber cable
STP	Shielded twisted-pair
SW	Software
TCP	Transmission Control Protocol
TCP/IP	Transmission Control Protocol/Internet Protocol
TLS	Transport layer security
TP	Disturbance data recorded with or without trip bit

VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface

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