ABB ABILITY™ SMART SUBSTATION CONTROL AND PROTECTION FOR ELECTRICAL SYSTEMS
MARCH 2020

OPERATION MANUAL

SSC600
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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
- 1.1 Communication................................................................. 8
  - 1.1.1 Ethernet redundancy.................................................... 8
  - 1.1.2 Process bus................................................................. 10
- 1.2 PCM600 tool........................................................................... 10
  - 1.2.1 Connectivity packages............................................... 11
  - 1.2.2 PCM600 and IED connectivity package version.......... 11
- 1.3 This manual.......................................................................... 11
  - 1.3.1 Intended audience..................................................... 11
- 1.4 Document revision history.................................................. 20
- 1.5 Related documentation..................................................... 20
- 1.6 Product documentation set.................................................. 20

### 2 Safety information

### 3 Commissioning
- 3.1 Commissioning checklist.................................................. 23
- 3.2 Checking the installation.................................................... 23
  - 3.2.1 Checking of the power supply...................................... 23
- 3.3 Authorizations...................................................................... 23
  - 3.3.1 User authorization.................................................... 23
- 3.4 Setting IED and communication.......................................... 24
  - 3.4.1 Setting the communication between IEDs and PCM600... 24
  - 3.4.2 Communication settings............................................ 25
- 3.5 Testing the IED operation................................................... 25
  - 3.5.1 Selecting the IED test mode........................................ 25
  - 3.5.2 Testing functions....................................................... 26
  - 3.5.3 Selecting the internal fault test.................................... 26
  - 3.5.4 Selecting the IED blocked or IED test and blocked mode.. 27
- 3.6 ABB Product Data Registration.......................................... 28

### 4 IED operation
- 4.1 Web HMI............................................................................. 29
  - 4.1.1 Authorization............................................................. 29
  - 4.1.2 Using the Web HMI.................................................... 30
  - 4.1.3 Identifying the device............................................... 34
  - 4.1.4 Showing parameters............................................... 34
  - 4.1.5 Editing values.......................................................... 35
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1.6</td>
<td>Committing settings</td>
<td>37</td>
</tr>
<tr>
<td>4.1.7</td>
<td>Clearing and acknowledging</td>
<td>37</td>
</tr>
<tr>
<td>4.1.8</td>
<td>Web HMI views</td>
<td>38</td>
</tr>
<tr>
<td>4.2</td>
<td>Disturbance identification</td>
<td>44</td>
</tr>
<tr>
<td>4.3</td>
<td>IED parametrization</td>
<td>45</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Settings for IED functionality</td>
<td>45</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Settings for different operating conditions</td>
<td>45</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Activating programmable virtual LEDs</td>
<td>45</td>
</tr>
<tr>
<td>4.4</td>
<td>Monitoring</td>
<td>46</td>
</tr>
<tr>
<td>4.4.1</td>
<td>Indications</td>
<td>46</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Recorded data</td>
<td>46</td>
</tr>
<tr>
<td>4.4.3</td>
<td>Monitoring fault records</td>
<td>48</td>
</tr>
<tr>
<td>4.4.4</td>
<td>Monitoring events</td>
<td>48</td>
</tr>
<tr>
<td>4.4.5</td>
<td>Remote monitoring</td>
<td>48</td>
</tr>
<tr>
<td>4.5</td>
<td>Controlling</td>
<td>49</td>
</tr>
<tr>
<td>4.5.1</td>
<td>Controlling with single-line diagram</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>Troubleshooting</td>
<td>54</td>
</tr>
<tr>
<td>5.1</td>
<td>Identifying hardware errors</td>
<td>54</td>
</tr>
<tr>
<td>5.2</td>
<td>Identifying runtime errors</td>
<td>54</td>
</tr>
<tr>
<td>5.3</td>
<td>Identifying communication errors</td>
<td>54</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Internal faults</td>
<td>54</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Warnings</td>
<td>55</td>
</tr>
<tr>
<td>5.4</td>
<td>Correction procedures</td>
<td>56</td>
</tr>
<tr>
<td>5.4.1</td>
<td>Rebooting the software</td>
<td>56</td>
</tr>
<tr>
<td>5.4.2</td>
<td>Restoring factory settings</td>
<td>56</td>
</tr>
<tr>
<td>5.4.3</td>
<td>Setting passwords</td>
<td>57</td>
</tr>
<tr>
<td>5.4.4</td>
<td>Identifying IED application problems</td>
<td>58</td>
</tr>
<tr>
<td>6</td>
<td>Environmental aspects</td>
<td>59</td>
</tr>
<tr>
<td>6.1</td>
<td>Sustainable development</td>
<td>59</td>
</tr>
<tr>
<td>6.2</td>
<td>Disposal of an IED</td>
<td>59</td>
</tr>
</tbody>
</table>
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 20 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.

Note: 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.

**Note:** 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.

**Note:** 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

Note: 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.

Document conventions

Note: 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.

**Symbols**

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

![Warning Icon]

**Caution:** 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.

![Caution Icon]

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

![Note Icon]

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

![Tip Icon]

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.

**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

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase non-directional overcurrent protection, low stage</td>
<td>PHLPTOC</td>
<td>3I&gt;</td>
<td>51P-1</td>
<td>LD0</td>
<td>PHLPTOC</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, high stage</td>
<td>PHHPTOC</td>
<td>3I&gt;&gt;</td>
<td>51P-2</td>
<td>LD0</td>
<td>PHHPTOC</td>
</tr>
<tr>
<td>Three-phase non-directional overcurrent protection, instantaneous stage</td>
<td>PHIPTOC</td>
<td>3I&gt;&gt;&gt;</td>
<td>50P</td>
<td>LD0</td>
<td>PHIPTOC</td>
</tr>
<tr>
<td>Three-phase directional overcurrent protection, low stage</td>
<td>DPHLPDOC</td>
<td>3I&gt; - &gt;</td>
<td>67P/51P-1</td>
<td>LD0</td>
<td>DPHLPDOC DPHLRDIR</td>
</tr>
<tr>
<td>Three-phase directional overcurrent protection, high stage</td>
<td>DPHHPDOC</td>
<td>3I&gt;&gt; - &gt;</td>
<td>67P/51P-2</td>
<td>LD0</td>
<td>DPHHPTOC DPHHRDIR</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, low stage</td>
<td>EFLPTOC</td>
<td>Io&gt;</td>
<td>51G/51N-1</td>
<td>LD0</td>
<td>EFLPTOC</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, high stage</td>
<td>EFHPTOC</td>
<td>Io&gt;&gt;</td>
<td>51G/51N-2</td>
<td>LD0</td>
<td>EFHPTOC</td>
</tr>
<tr>
<td>Non-directional earth-fault protection, instantaneous stage</td>
<td>EFIPTOC</td>
<td>Io&gt;&gt;&gt;</td>
<td>50G/50N</td>
<td>LD0</td>
<td>EFIPTOC</td>
</tr>
<tr>
<td>Directional earth-fault protection, low stage</td>
<td>DEFLPDEF</td>
<td>Io&gt; - &gt;</td>
<td>67G/N-1 51G/N-1</td>
<td>LD0</td>
<td>DEFLPTOC DEFLRD</td>
</tr>
<tr>
<td>Directional earth-fault protection, high stage</td>
<td>DEFHPDEF</td>
<td>Io&gt;&gt; - &gt;</td>
<td>67G/N-1 51G/N-2</td>
<td>LD0</td>
<td>DEFHPTOC DEFHRD</td>
</tr>
<tr>
<td>Admittance-based earth-fault protection</td>
<td>EFPADM</td>
<td>Yo&gt; - &gt;</td>
<td>21YN</td>
<td>LD0</td>
<td>EFPADM</td>
</tr>
<tr>
<td>Wattmetric-based earth-fault protection</td>
<td>WPWDE</td>
<td>Po&gt; - &gt;</td>
<td>32N</td>
<td>LD0</td>
<td>WRDIR WPSDE WMMXU</td>
</tr>
<tr>
<td>Function</td>
<td>IEC 61850</td>
<td>IEC 60617</td>
<td>ANSI</td>
<td>Logical device</td>
<td>Logical nodes</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-------------</td>
<td>-------------</td>
<td>-------------</td>
<td>----------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Transient/intermittent earth-fault protection</td>
<td>INTRPTEF</td>
<td>Io&gt; -&gt; IEF</td>
<td>67NTEF/NIEF</td>
<td>LD0</td>
<td>INTRPTEF</td>
</tr>
<tr>
<td>Non-directional (cross-country) earth-fault</td>
<td>EFHPTOC</td>
<td>Io&gt;&gt;</td>
<td>51G/51N-2</td>
<td>LD0</td>
<td>EFHPTOC</td>
</tr>
<tr>
<td>protection, using calculated Io</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Negative-sequence overcurrent protection</td>
<td>NSPTOC</td>
<td>I2&gt;</td>
<td>46M</td>
<td>LD0</td>
<td>NSPTOC</td>
</tr>
<tr>
<td>Phase discontinuity protection</td>
<td>PDNSPTOC</td>
<td>I2/I1&gt;</td>
<td>46PD</td>
<td>LD0</td>
<td>PDNSPTOC</td>
</tr>
<tr>
<td>Residual overvoltage protection</td>
<td>ROVPTOV</td>
<td>Uo&gt;</td>
<td>59G/59N</td>
<td>LD0</td>
<td>ROVPTOV</td>
</tr>
<tr>
<td>Three-phase undervoltage protection</td>
<td>PHPTUV</td>
<td>3U&lt;</td>
<td>27</td>
<td>LD0</td>
<td>PHPTUV</td>
</tr>
<tr>
<td>Three-phase overvoltage protection</td>
<td>PHPTOV</td>
<td>3U&gt;</td>
<td>59</td>
<td>LD0</td>
<td>PHPTOV</td>
</tr>
<tr>
<td>Positive-sequence undervoltage protection</td>
<td>PSPTUV</td>
<td>U1&lt;</td>
<td>27PS</td>
<td>LD0</td>
<td>PSPTUV</td>
</tr>
<tr>
<td>Negative-sequence overvoltage protection</td>
<td>NSPTOV</td>
<td>U2&gt;</td>
<td>59NS</td>
<td>LD0</td>
<td>NSPTOV</td>
</tr>
<tr>
<td>Frequency protection</td>
<td>FRPFREQ</td>
<td>f&gt;/f&lt;,df/dt</td>
<td>81</td>
<td>LD0</td>
<td>FRPFRC, FRPTOF, FRPTUF, FRPFRC</td>
</tr>
<tr>
<td>Distance protection</td>
<td>DSTPDIS</td>
<td>Z&lt;</td>
<td>21P, 21N</td>
<td>LD0</td>
<td>GFC1RFRC, GFC2RFRC, GFC3RFRC</td>
</tr>
</tbody>
</table>

**Introduction**

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SSC600

Operation Manual
<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase thermal protection for feeders, cables and distribution transformers</td>
<td>T1PTTR</td>
<td>3Ith&gt;F</td>
<td>49F</td>
<td>LD0</td>
<td>T1PTTR</td>
</tr>
<tr>
<td>Three-phase thermal overload protection, two time constants</td>
<td>T2PTTR</td>
<td>3Ith&gt;T/G/C</td>
<td>49T/G/C</td>
<td>LD0</td>
<td>T2PTTR</td>
</tr>
<tr>
<td>Negative-sequence overcurrent protection for machines</td>
<td>MNSPTOC</td>
<td>12&gt;M</td>
<td>46M</td>
<td>LD0</td>
<td>MNSPTOC</td>
</tr>
<tr>
<td>Loss of load supervision</td>
<td>LOFLPTUC</td>
<td>3I&lt;</td>
<td>37</td>
<td>LD0</td>
<td>LOFLPTUC</td>
</tr>
<tr>
<td>Motor load jam protection</td>
<td>JAMPTOC</td>
<td>1st&gt;</td>
<td>50TDJAM</td>
<td>LD0</td>
<td>JAMPTOC</td>
</tr>
<tr>
<td>Motor start-up supervision</td>
<td>STTPMSU</td>
<td>Is2t n&lt;</td>
<td>49,66,48,50TD LR</td>
<td>LD0</td>
<td>STTPMSS STTPMRI</td>
</tr>
<tr>
<td>Phase reversal protection</td>
<td>PREVPTOC</td>
<td>12&gt;&gt;</td>
<td>46R</td>
<td>LD0</td>
<td>PREVPTOC</td>
</tr>
<tr>
<td>Thermal overload protection for motors</td>
<td>MPTTR</td>
<td>3Ith&gt;M</td>
<td>49M</td>
<td>LD0</td>
<td>MPTTR</td>
</tr>
<tr>
<td>Stabilized and instantaneous differential protection for two-winding transformers</td>
<td>TR2PTDF</td>
<td>3di&gt;T</td>
<td>87T</td>
<td>LD0</td>
<td>TR2PTTRC TR2LPDIF TR2H2PHAR TR2H5PHAR TR2HPDIF</td>
</tr>
<tr>
<td>Numerically stabilized low-impedance restricted earth-fault protection</td>
<td>LREFPNDF</td>
<td>dIloLo&gt;</td>
<td>87NLI</td>
<td>LD0</td>
<td>LREFPDIF LREFPHAR</td>
</tr>
<tr>
<td>Circuit breaker failure protection</td>
<td>CCBRBRF</td>
<td>3I&gt;/lo&gt;BF</td>
<td>50BF</td>
<td>LD0</td>
<td>CCBRBRF</td>
</tr>
<tr>
<td>Three-phase inrush detector</td>
<td>INRPHAR</td>
<td>3I2f&gt;</td>
<td>68HB</td>
<td>LD0</td>
<td>INRPHAR</td>
</tr>
<tr>
<td>Switch onto fault</td>
<td>CBPSOF</td>
<td>SOTF</td>
<td>SOTF</td>
<td>LD0</td>
<td>CBPSOF</td>
</tr>
<tr>
<td>Master trip</td>
<td>TRPPTRC</td>
<td>Master Trip</td>
<td>94/86</td>
<td>LD0</td>
<td>TRPPTRC</td>
</tr>
<tr>
<td>Arc protection</td>
<td>ARCSARC</td>
<td>ARC</td>
<td>AFD</td>
<td>LD0</td>
<td>ARCSARC ARC1PIOC ARC2PIOC ARCPTRC</td>
</tr>
<tr>
<td>Function</td>
<td>IEC 61850</td>
<td>IEC 60617</td>
<td>ANSI</td>
<td>Logical device</td>
<td>Logical nodes</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>-----------</td>
<td>-----------</td>
<td>-------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Multipurpose protection</td>
<td>MAPGAPC</td>
<td>MAP</td>
<td>MAP</td>
<td>LD0</td>
<td>MAPGAPC</td>
</tr>
<tr>
<td>Load-shedding and restoration</td>
<td>LSHDPFRQ</td>
<td>UFLS/R</td>
<td>81LSH</td>
<td>LD0</td>
<td>LSHDPFRQ</td>
</tr>
<tr>
<td>Fault locator</td>
<td>SCEFRFLO</td>
<td>FLOC</td>
<td>FLOC</td>
<td>LD0</td>
<td>SCEFRFLO</td>
</tr>
<tr>
<td>Reverse power/directional overpowre protection</td>
<td>DOPPDPR</td>
<td>P&gt;Q&gt;</td>
<td>32R/32O</td>
<td>LD0</td>
<td>DOPPDPR</td>
</tr>
<tr>
<td>Three-phase underimpedance protection</td>
<td>UZPDIS</td>
<td>Z&gt;G</td>
<td>21G</td>
<td>LD0</td>
<td>UZPDIS</td>
</tr>
<tr>
<td>Multifrequency admittance-based earth-fault protection</td>
<td>MFADPSDE</td>
<td>Io&gt; -&gt;Y</td>
<td>67NYH</td>
<td>LD0</td>
<td>MFADPSDE</td>
</tr>
<tr>
<td>Busbar differential protection</td>
<td>BBPBDF</td>
<td>3</td>
<td>d</td>
<td>/</td>
<td></td>
</tr>
<tr>
<td>Busbar zone selection</td>
<td>ZNRSRC</td>
<td>ZNRSRC</td>
<td>ZNRSRC</td>
<td>LD0</td>
<td>ZNRSRC</td>
</tr>
</tbody>
</table>

Table 2: Interconnection functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Directional reactive power undervoltage protection</td>
<td>DQPTUV</td>
<td>Q&gt; -&gt;,3U&lt;</td>
<td>32Q,27</td>
<td>LD0</td>
<td>DQPTUV</td>
</tr>
<tr>
<td>Low-voltage ride-through protection</td>
<td>LVRTPTUV</td>
<td>U&lt;RT</td>
<td>27RT</td>
<td>LD0</td>
<td>LVRTPTUV</td>
</tr>
</tbody>
</table>
### Table 3: Power quality functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current total demand distortion</td>
<td>CMHAI</td>
<td>PQM3I</td>
<td>PQM3I</td>
<td>CMHAI</td>
<td>CMHAI</td>
</tr>
<tr>
<td>Voltage total harmonic distortion</td>
<td>VMHAI</td>
<td>PQM3U</td>
<td>PQM3V</td>
<td>VMHAI</td>
<td>VMHAI/VMHAI</td>
</tr>
<tr>
<td>Voltage variation</td>
<td>PHQVVR</td>
<td>PQMU</td>
<td>PQMV</td>
<td>PHQVVR/PH2QVVR/PH3QVVR/QVVRQRC/QVVR2RQRC/QVVR3RQRC</td>
<td>PHQVVR/PH2QVVR/PH3QVVR/QVVMSTA/QVV2MSTA/QVV3MSTA</td>
</tr>
<tr>
<td>Voltage unbalance</td>
<td>VSQVUB</td>
<td>PQUUB</td>
<td>PQVUB</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

### Table 4: Control functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit-breaker control</td>
<td>CBXCBR</td>
<td>I &lt;-&gt; O CB</td>
<td>I &lt;-&gt; O CB</td>
<td>CTRL</td>
<td>CBCSWI/CBCILO/CBXCBR</td>
</tr>
<tr>
<td>Disconnector control</td>
<td>DCXSWI</td>
<td>I &lt;-&gt; O DCC</td>
<td>I &lt;-&gt; O DCC</td>
<td>CTRL</td>
<td>DCCSWI/DCCILO/DCXSWI</td>
</tr>
<tr>
<td>Earthing switch control</td>
<td>ESXSWI</td>
<td>I &lt;-&gt; O ESC</td>
<td>I &lt;-&gt; O ESC</td>
<td>CTRL</td>
<td>ESCSWI/ESCILO/ESXSWI</td>
</tr>
<tr>
<td>Disconnector position indication</td>
<td>DCSXSWI</td>
<td>I &lt;-&gt; O DC</td>
<td>I &lt;-&gt; O DC</td>
<td>CTRL</td>
<td>DCSXSWI</td>
</tr>
<tr>
<td>Earthing switch indication</td>
<td>ESXSWI</td>
<td>I &lt;-&gt; O ES</td>
<td>I &lt;-&gt; O ES</td>
<td>CTRL</td>
<td>ESXSWI</td>
</tr>
<tr>
<td>Emergency start-up</td>
<td>ESMGAPC</td>
<td>ESTART</td>
<td>ESTART</td>
<td>LD0</td>
<td>ESMGAPC</td>
</tr>
<tr>
<td>Autoreclosing</td>
<td>DARREC</td>
<td>O -&gt; I</td>
<td>79</td>
<td>LD0</td>
<td>DARREC</td>
</tr>
<tr>
<td>Tap changer position indication</td>
<td>TPOSYLTC</td>
<td>TPOSM</td>
<td>84M</td>
<td>LD0</td>
<td>TPOSYLTC</td>
</tr>
</tbody>
</table>
### Table 5: Condition monitoring and supervision functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tap changer control with voltage regulator</td>
<td>OLATCC</td>
<td>COLTC</td>
<td>90V</td>
<td>LD0</td>
<td>OLATCC</td>
</tr>
<tr>
<td>Synchronism and energizing check</td>
<td>SECRSYN</td>
<td>SYNC</td>
<td>25</td>
<td>LD0</td>
<td>SECRSYN</td>
</tr>
</tbody>
</table>

### Table 6: Measurement functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit-breaker condition monitoring</td>
<td>SSCBR</td>
<td>CBCM</td>
<td>CBCM</td>
<td>LD0</td>
<td>SSCBR1</td>
</tr>
<tr>
<td>Runime counter for machines and devices</td>
<td>MDSOPT</td>
<td>OPTS</td>
<td>OPTM</td>
<td>LD0</td>
<td>MDSOPT</td>
</tr>
<tr>
<td>Disturbance recorder</td>
<td>RDRE</td>
<td>DR</td>
<td>DFR</td>
<td>LD0</td>
<td>DR_LLN0</td>
</tr>
<tr>
<td>Fault record</td>
<td>FLTRFRC</td>
<td>FAULTREC</td>
<td>FAULTREC</td>
<td>LD0</td>
<td>FLTRFRC</td>
</tr>
<tr>
<td>Three-phase current measurement</td>
<td>CMMXU</td>
<td>3I</td>
<td>3I</td>
<td>LD0</td>
<td>CMMXU</td>
</tr>
<tr>
<td>Sequence current measurement</td>
<td>CSMSQI</td>
<td>I1, I2, I0</td>
<td>I1, I2, I0</td>
<td>LD0</td>
<td>CSMSQI</td>
</tr>
<tr>
<td>Residual current measurement</td>
<td>RESCMXMU</td>
<td>Io</td>
<td>In</td>
<td>LD0</td>
<td>RESCMXMU</td>
</tr>
<tr>
<td>Three-phase voltage measurement</td>
<td>VMMXU</td>
<td>3U</td>
<td>3V</td>
<td>LD0</td>
<td>VMMXU</td>
</tr>
</tbody>
</table>
### Function Table

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual voltage measurement</td>
<td>RESVMMXU</td>
<td>Uo</td>
<td>Vn</td>
<td>LD0</td>
<td>RESVMMXU, RVAVMMXU, RVMAMMXU, RVMIMMXU</td>
</tr>
<tr>
<td>Sequence voltage measurement</td>
<td>VSMSQI</td>
<td>U1, U2, U0</td>
<td>V1, V2, V0</td>
<td>LD0</td>
<td>VSMSQI</td>
</tr>
<tr>
<td>Three-phase power and energy measurement</td>
<td>PEMMXU</td>
<td>P, E</td>
<td>P, E</td>
<td>LD0</td>
<td>PEMMXU, PEMMTR, PEAVMMXU, PEMAAMMXU, PEMIMMXU</td>
</tr>
<tr>
<td>Frequency measurement</td>
<td>FMMXU</td>
<td>f</td>
<td>f</td>
<td>LD0</td>
<td>FMMXU</td>
</tr>
<tr>
<td>IEC 61850-9-2 LE sampled value receiving</td>
<td>SMVRECEIVE</td>
<td>SMVRECEIVE</td>
<td>SMVRECEIVE</td>
<td>SVIL1TCTR, SVIL2TCTR, SVIL3TCTR, SVRESTCTR, SVUL1TVTR, SVUL2TVTR, SVUL3TVTR, SVRESTVTR</td>
<td></td>
</tr>
</tbody>
</table>

### Table 7: Other functions

<table>
<thead>
<tr>
<th>Function</th>
<th>IEC 61850</th>
<th>IEC 60617</th>
<th>ANSI</th>
<th>Logical device</th>
<th>Logical nodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum pulse timer</td>
<td>TPGAPC</td>
<td>TP</td>
<td>TP</td>
<td>TPGAPC</td>
<td>TPGAPC</td>
</tr>
<tr>
<td>Minimum pulse timer (second resolution)</td>
<td>TPSGAPC</td>
<td>TPS</td>
<td>TPS</td>
<td>TPSGAPC</td>
<td>TPSGAPC</td>
</tr>
<tr>
<td>Minimum pulse timer minute resolution)</td>
<td>TPMGAPC</td>
<td>TPM</td>
<td>TPM</td>
<td>TPMGAPC</td>
<td>TPMGAPC</td>
</tr>
<tr>
<td>Pulse timer</td>
<td>PTGAPC</td>
<td>PT</td>
<td>PT</td>
<td>PTGAPC</td>
<td>PTGAPC</td>
</tr>
<tr>
<td>Time delay off</td>
<td>TOFGAPC</td>
<td>TOF</td>
<td>TOF</td>
<td>TOFGAPC</td>
<td>TOFGAPC</td>
</tr>
<tr>
<td>Time delay on</td>
<td>TONGAPC</td>
<td>TON</td>
<td>TON</td>
<td>TONGAPC</td>
<td>TONGAPC</td>
</tr>
<tr>
<td>Set-reset</td>
<td>SRGAPC</td>
<td>SR</td>
<td>SR</td>
<td>SRGAPC</td>
<td>SRGAPC</td>
</tr>
<tr>
<td>Move</td>
<td>MVGAPC</td>
<td>MV</td>
<td>MV</td>
<td>MVGAPC</td>
<td>MVGAPC</td>
</tr>
<tr>
<td>Generic control point</td>
<td>SPCGAPC</td>
<td>SPC</td>
<td>SPC</td>
<td>SPCGAPC</td>
<td>SPCGAPC</td>
</tr>
<tr>
<td>Analog value scaling</td>
<td>SCA4GAPC</td>
<td>SCA4</td>
<td>SCA4</td>
<td>SCA4GAPC</td>
<td>SCA4GAPC</td>
</tr>
</tbody>
</table>
### Function | IEC 61850 | IEC 60617 | ANSI | Logical device | Logical nodes |
--- | --- | --- | --- | --- | --- |
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, SRESTTCTR |

### 1.4 Document revision history

| Document revision/date | Product series version | History |
--- | --- | --- |
A/2019-05-10 | 1.0 | First release |
B/2020-03-20 | 1.1 | FP1 added |

**Note:** Download the latest documents from the ABB Web site [www.abb.com/mediumvoltage](http://www.abb.com/mediumvoltage).

### 1.5 Related documentation

1.6 Product documentation set

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

Note: Product series- and product-specific manuals can be downloaded from the ABB Web site www.abb.com/relion
2 Safety information

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

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

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

Warning: National and local electrical safety regulations must always be followed.

Warning: The frame of the device has to be carefully earthed.

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

Caution: 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

<table>
<thead>
<tr>
<th>Username</th>
<th>Password</th>
<th>WHMI local password</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIEWER</td>
<td>remote0001</td>
<td>0001</td>
<td>Only view access</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>remote0002</td>
<td>0002</td>
<td>Authorized to make operations</td>
</tr>
<tr>
<td>ENGINEER</td>
<td>remote0003</td>
<td>0003</td>
<td>Allowed to change IED parameters, but no operation rights</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>remote0004</td>
<td>0004</td>
<td>Full access</td>
</tr>
</tbody>
</table>

Note: 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.

**Note:** 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.

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

**Note:** 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.

2. Enable parameter editing by selecting Enable Write.

3. Select the test mode to be activated by changing the New Value field selection.

4. Select Write to IED to save changes into the IED's memory. The selected test mode is now activated.

3.5.2 Testing functions

Before you begin

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

1. Select Tests > Function tests from the main menu structure.

2. Select the function test type from the main menu structure.

3. Enable parameter editing by selecting Enable Write.

4. Select the test to be activated by changing the New Value field selection.

5. Select Write to IED 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 by from the IED test view.
1. Select IED test from the main menu structure to activate the IED test view.

2. Enable parameter editing by selecting Enable Write.

3. Select the internal fault test by changing the New Value field selection.

4. Select Write to IED to save changes into the IED’s memory. The internal fault test 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 by 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.

2. Enable parameter editing by selecting Enable Write.

3. Select the IED blocked mode and the IED test and blocked mode by changing the New Value field selection.

4. Select Write to IED to save changes into the IED’s memory. The selected test mode is now activated.

Note: 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 Main Menu > 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.

**Note:** 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. In case of HTTPS access the Web client must support HTTPS via TLS 1.0 or TLS 1.1/1.2. The WHMI is verified with Internet Explorer 11.0.

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
- Report summary

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

<table>
<thead>
<tr>
<th>Username</th>
<th>User rights</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIEWER</td>
<td>Read only access</td>
</tr>
<tr>
<td>OPERATOR</td>
<td>• Changing setting groups&lt;br&gt;• Controlling&lt;br&gt;• Clearing indications</td>
</tr>
<tr>
<td>ENGINEER</td>
<td>• Changing settings&lt;br&gt;• Clearing event list&lt;br&gt;• Clearing disturbance records&lt;br&gt;• Changing system settings such as IP ADDRESS, serial baud rate or disturbance recorder settings&lt;br&gt;• Setting the IED to test mode&lt;br&gt;• Selecting language</td>
</tr>
<tr>
<td>ADMINISTRATOR</td>
<td>• All listed above&lt;br&gt;• Changing password&lt;br&gt;• Factory default activation</td>
</tr>
</tbody>
</table>

**Note:** For user authorization for PCM600, see PCM600 documentation.

**Note:** Controlling operations are only allowed via local connection for user with Control Operation Right (refer to table Default roles-to-rights in the Cyber Security Deployment Guideline), and never via remote connection.

### 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.

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

**Note:** 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.

#### Logging in
1. Open Internet Explorer.
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.

![Password input](image)

*Figure 7 Entering username and password to use the WHMI*

5. Click **OK**.

6. Role Selection from WHMI.

![Role selection](image)

*Figure 8 Selecting Role from WHMI*

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

**Logging out**

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

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

**User interface**

The user interface contains three main areas for navigation and displaying information.
Figure 9 User interface

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

**Menu structure**

The **Main menu** contains main groups which are divided further into more detailed submenus.

Figure 10 Main menu

- Control
- Events
- Measurements
- Disturbance records
- Settings
- Configuration
- Monitoring
• Tests
• Information
• Clear
• Language
• WHMI settings

You can find a specific item in the menu structure by using the Search: field.

Command buttons
Command buttons can be used to edit parameters and control information via the WHMI.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Show help</td>
<td>Show context sensitive help messages</td>
</tr>
<tr>
<td>Error icon</td>
<td>Error icon</td>
</tr>
<tr>
<td>Alarm icon</td>
<td>Alarm icon</td>
</tr>
<tr>
<td>Enable Write</td>
<td>Enable parameter editing</td>
</tr>
<tr>
<td>Disable Write</td>
<td>Disable parameter editing</td>
</tr>
<tr>
<td>Write to IED</td>
<td>Write parameters to the IED</td>
</tr>
<tr>
<td>Refresh Values</td>
<td>Refresh parameter values</td>
</tr>
<tr>
<td>Print</td>
<td>Print out parameters</td>
</tr>
<tr>
<td>Commit</td>
<td>Commit changes to IED's non-volatile flash memory</td>
</tr>
<tr>
<td>Reject</td>
<td>Reject changes</td>
</tr>
<tr>
<td>Clear events</td>
<td>Clear events</td>
</tr>
<tr>
<td>Manual trigger</td>
<td>Trigger the disturbance recorder manually</td>
</tr>
<tr>
<td>Save</td>
<td>Save values to TXT or CSV file format</td>
</tr>
<tr>
<td>Freeze</td>
<td>Freeze the values so that updates are not displayed</td>
</tr>
<tr>
<td>Continue</td>
<td>Receive continuous updates to the monitoring view</td>
</tr>
<tr>
<td>Delete</td>
<td>Delete the selection</td>
</tr>
<tr>
<td>Delete all</td>
<td>Delete all selections</td>
</tr>
<tr>
<td>Download files</td>
<td>Download files</td>
</tr>
<tr>
<td>View all</td>
<td>View all records</td>
</tr>
<tr>
<td>Select all</td>
<td>Select all</td>
</tr>
<tr>
<td>Name</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Clear all</td>
<td>Clear all selections</td>
</tr>
<tr>
<td>Enable Control</td>
<td>Enable controlling Circuit Breakers and Disconnectors in SLD</td>
</tr>
</tbody>
</table>

Using the Web HMI help

The context-sensitive WHMI help provides information on a single parameter, for example.

- Move the mouse over the ☰️ to display the context-sensitive help dialog box.

4.1.3 Identifying the device

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

1. Select SSC600 > Information > Product identifiers from the main menu structure.

   ![Figure 11 Device information view](image)

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 and when the function setting is “On”, all settings are visible based on the other visibility and hiding rules.

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

4.1.5 Editing values

1. Select a menu in the menu navigation bar.
2. Click a submenu to see function blocks.
3. Click a function block to see the setting values.
4. Click Enable Write.
   The selected setting group is shown in the Setting Group drop-down list. The active setting group is indicated with an asterisk *.
5. Edit the value.
• The minimum, maximum and step values for a parameter are shown in the Min., Max. and Step columns.

• Setting group values are indicated with .

Figure 14 Editing a value

• If the entered value is within the accepted value range, the selection is highlighted in green. If the value is out of range, the row is highlighted in red and a warning dialog box is displayed. Write to IED is unavailable.

Figure 15 Warning indicating that the entered value is incorrect

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

Tip: If writing is enabled accidentally, click Disable Write. Disable Write cannot be selected when a value has already been written to the IED. After clicking Write to IED, click either Commit or Reject.
4.1.6 Committing settings

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

Some parameters have an edit-copy. If editing is cancelled, the values with an edit-copy are immediately restored to the original value. The values without an edit-copy, such as string values, are restored to the original value only after a reboot even though the edited value is not stored in the flash memory.

1. Click Write to IED after editing parameter values to put the values into IED’s database for use.
   The values are not stored to the flash memory.
2. Click Commit to write the values to the flash memory.
   • Click Reject to cancel saving settings.
     - If the parameter has an edit-copy, the original parameter value is restored.
     - If the parameter does not have an edit-copy, the edited parameter value remains visible until the IED is rebooted. However, the edited value is not stored in the nonvolatile memory and thus the reboot restores the original value.

Figure 16 Committing changes

Note: Committing values takes a few seconds.

Note: If the values are not committed, they are not taken into use and they are lost after a reboot.

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.

![Selecting clear menu](image.png)

*Figure 17 Selecting clear menu*

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

![View bar](image.png)

*Figure 18 View bar*

- The **General** view shows the IED version and status.
- The **Events** view contains a list of events produced by the application configuration.
- The **Programmable LEDs** view shows the status of the programmable virtual LEDs.
- The **Phasor diagrams** view shows phasor diagrams.
- The **Disturbance records** view shows the list of disturbance records.
- The **Fault records** view shows the list of fault records.
- The **Single Line Diagram** view shows the SINGLE-LINE DIAGRAM.
- The **Report summary** page shows the load profile record and the parameter list.
- The **Maintenance** page allows to store backups of relay and merging unit configurations.
- **Logout** ends the session.

**General view**

The **General** view shows the IED version and current operating status.
1. Select **General** in the View bar.

![General view](image)

**Figure 19 General view**

The IED version and current operating status are displayed.

**Events view**

The Events view contains a list of events produced by the application configuration. When the Events view is selected, it displays up to 100 latest events. The event list is updated automatically.

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

![Monitoring events](image)

**Figure 20 Monitoring events**

2. Click **Freeze** to stop updating the event list.

3. Select a page from the drop-down list to view older events or select **View all** to show all events on the same page.

4. To save the events in text (*.txt) or comma separated value (*.csv) file formats, select the file format from the drop-down list and click **Save**.

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

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

6. Click **Print** to print all the selected events.
Programmable LEDs view

The Programmable LEDs view shows the status of the programmable virtual LEDs.

- Click Programmable LEDs in the View bar.

![Figure 21 Monitoring programmable LEDs](image)

The status of each programmable virtual LED is displayed.

Phasor diagrams view

The Phasor diagrams view shows phasor diagrams.

Tip: Install or enable the SVG plugin to view the phasor diagrams, if needed.

1. Select Phasor diagrams in the View bar.

![Figure 22 Monitoring phasors](image)

Note: The arrow extends outside the circle if the current value is too high.

2. Toggle the diagram visibility by selecting the diagram from the drop-down menu. Visible diagrams are indicated with an asterisk *.

3. Change the size of the diagram by changing the zoom value.

4. Click Freeze to stop updating the phasor diagram. No updates are displayed in the diagram.
Disturbance records view

The Disturbance records view shows the list of disturbance records.

1. Select Disturbance records in the View bar.

The list of disturbance records is displayed.

Saving disturbance records

1. Select Disturbance records in the View bar.
2. Click the icon ![Download Files](image) in the Download Files column of the record.
   Both the disturbance record files CFG and DAT are saved at once.
3. Open the disturbance record files with a suitable program.

Triggering the disturbance recorder manually

1. Select Disturbance records in the View bar.

Deleting disturbance records

1. Select Disturbance records in the View bar.
   • Select one or more recordings and click Delete ⚠️ to delete selected records.
   • Click Delete all ⚠️ to delete all records.
2. Click OK to confirm or Cancel to cancel the operation.
Fault records view

1. Select Monitoring > Recorded data > Fault record from the Main menu or select Fault records in the View bar to view a list of all available fault records.

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

3. To go back to the list view, click Fault records in the View bar or click the View all button.

4. To save the records in TXT or CSV file formats, select the format from the File format drop-down list and click Save.

   - 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.

5. To clear all fault records from the IED, click Clear records.

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

6. To print all fault records, click Print when the fault record list view is shown.

7. To print only one record, open it in the details view and click Print.
Single Line Diagram view

1. Select Control > SLD in the Main menu or select Single Line Diagram in the View bar to view the SINGLE-LINE DIAGRAM.

![Image of Single Line Diagram](image)

**Figure 25 Viewing the single-line diagram**

**Note:** SLD control is only available when the connection is via Local WHMI connection. With Remote WHMI connection SLD is view-only.

Report summary view

The **Report summary** view allows to save events, fault records, disturbance records and the parameter list.

Events, fault records and the parameter list are saved in TXT format. Saved files contain all events, fault records and settings.

Disturbance records and load profile record files are saved in CFG and DAT formats.


![Image of Report Summary](image)

**Figure 26 Report summary view**

2. Select the items to be exported.

   Click **Select all** to select all items and click **Clear all** to clear all selections.

3. From the Disturbance records drop-down list, select the amount of records to be saved.
   - All
4. Click **Save** to export the ZIP file with the selected files.

**Maintenance view**
1. Select **Maintenance view** in the View bar.

4.2 **Disturbance identification**

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

**Table 10: Disturbance Indications**

<table>
<thead>
<tr>
<th>LED</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start LED</td>
<td>Yellow, steady</td>
<td>Protection started</td>
</tr>
<tr>
<td>Start LED</td>
<td>Yellow, flashing</td>
<td>Protection function blocked</td>
</tr>
<tr>
<td>Trip LED</td>
<td>Red, steady</td>
<td>Protection operated</td>
</tr>
<tr>
<td>Ready LED</td>
<td>Green, flashing</td>
<td>Internal fault</td>
</tr>
</tbody>
</table>

Further actions to be taken to identify the disturbance:

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

**Note:** Document the disturbance before clearing the information from the IED.

**Note:** 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.

**Note:** Document all changes to parameter settings.

**Note:** 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 Main menu > Configuration > Programmable LEDs.
2. Select General to set the alarm color for the programmable LEDs.
3. Enable parameter editing by selecting Enable Write.
4. Select **Write to IED** 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 Write**.

   The available alarm modes are:
   - Follow-S
   - Follow-F
   - Latched-S
   - LatchedAck-F-S.

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

   **Note:** 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. Three indicator LEDs with fixed functionality: Ready, Start and Trip
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

Creating disturbance recordings
Normally disturbance recordings are triggered by the IED applications but the recording can also be triggered manually.
1. Click Disturbance records in the View bar.
2. Click Manual trigger to create disturbance recordings manually.

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. You can delete an individual disturbance record by selecting Delete. You can delete all disturbance records from the IED’s memory by selecting Delete All.

Controlling and reading of disturbance recorder data
Disturbance recorder data can be controlled and read with PCM600. It can also be read via WHMI.

Note: For more information, see PCM600 documentation.

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.

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

The IED records system registrations, IED status data and events.
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.
   - You can select the number of events displayed. You can also stop the gathering of event data temporarily by selecting **Freeze**.
2. You save the event data as a text (.txt) or comma separated value (.csv) file. Select **Save** to save event information.
3. You can clear all event data from the IED’s memory by selecting **Clear events**. You can also print event data by selecting **Print**.

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.

**Note:** 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.

**Note:** To control the IED, logging in and authorization are required.
Controlling circuit breaker, disconnectors and earthing switch

1. Select 'Enable Control'.

![Figure 28 Single-line diagram with Enable Control button](image)

**Note:** This is only possible if logging in from the Local port 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 29 Single-line diagram with one breaker and IEC symbols](image)
3. Select value 'Open' or 'Close'.

4. Select 'Execute'.

Controlling SLD buttons
Before you begin
Buttons are controlled via WHMI SLD like any other controllable single-line diagram objects.
1. Select ‘Enable control’.

![Figure 31 Single-line diagram with Enable Control button]

2. Select the button from Single Line Diagram.

![Figure 32 Single-line diagram with one button. The Local button is in “True” state.]

The selected button has a square around it.
3. Select value 'True' or 'False'.

4. Select 'Execute'.

**Note:** 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.

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

### 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.

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

#### Table 11: Warning indications and codes

<table>
<thead>
<tr>
<th>Warning indication</th>
<th>Warning code</th>
<th>Additional information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warning IEC61850 error</td>
<td>20</td>
<td>Error when building the IEC 61850 data model.</td>
</tr>
<tr>
<td>Warning Dataset error</td>
<td>24</td>
<td>Error in the Data set(s).</td>
</tr>
<tr>
<td>Warning Report cont. error</td>
<td>25</td>
<td>Error in the Report control block(s).</td>
</tr>
<tr>
<td>Warning GOOSE contr. error</td>
<td>26</td>
<td>Error in the GOOSE control block(s).</td>
</tr>
<tr>
<td>Warning SCL config error</td>
<td>27</td>
<td>Error in the SCL configuration file or the file is missing.</td>
</tr>
<tr>
<td>Warning Logic error</td>
<td>28</td>
<td>Too many connections in the configuration.</td>
</tr>
<tr>
<td>Warning SMT logic error</td>
<td>29</td>
<td>Error in the SMT connections.</td>
</tr>
<tr>
<td>Warning GOOSE input error</td>
<td>30</td>
<td>Error in the GOOSE connections.</td>
</tr>
<tr>
<td>ACT error</td>
<td>31</td>
<td>Error in the ACT connections.</td>
</tr>
<tr>
<td>Warning GOOSE Rx. error</td>
<td>32</td>
<td>Error in the GOOSE message receiving.</td>
</tr>
</tbody>
</table>
### 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.

**Note:** 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 **Configuration > General** from the main menu structure.

2. Enable parameter editing by selecting **Enable Write**.

3. Reboot the software by changing the New Value field from Cancel into Activate.

4. Select **Write to IED** to save changes into the IED's memory. The software is now rebooted.
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.

**Note:** 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 **Configuration > General** from the main menu structure.

2. Enable parameter editing by selecting **Enable Write**.

3. Restore the factory settings by changing the New Value field from Cancel into **Activate**.

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

The file system is now restored to the original factory state.

**Results**
The IED restores the factory settings and restarts. Restoring takes 1...3 minutes. Confirmation of restoring the factory settings is shown on the display a few seconds, after which the IED restarts.

**Note:** Avoid the unnecessary restoring of factory settings, because all the parameter settings that are written earlier to the IED will be overwritten with the default values. During normal use, a sudden change of the settings can cause a protection function to trip.

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 Write**.

3. Set the new password in the respective New Value field.

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

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.

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.

Note: 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 12: Maximum concentration values by weight per homogeneous material

<table>
<thead>
<tr>
<th>Substance</th>
<th>Proposed maximum concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead - Pb</td>
<td>0.1%</td>
</tr>
<tr>
<td>Mercury - Hg</td>
<td>0.1%</td>
</tr>
<tr>
<td>Cadmium - Cd</td>
<td>0.01%</td>
</tr>
<tr>
<td>Hexavalent Chromium Cr (VI)</td>
<td>0.1%</td>
</tr>
<tr>
<td>Polybrominated biphenyls - PBB</td>
<td>0.1%</td>
</tr>
<tr>
<td>Polybrominated diphenyl ethers - PBDE</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

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.