RELION® 650 SERIES

LON, 650 series
Version 2.1
Communication protocol manual

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Table of contents

Section 1 Introduction

1.1 This manual

The communication protocol manual describes the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

1.2 Intended audience

This manual addresses the communication system engineer or system integrator responsible for pre-engineering and engineering for communication setup in a substation from an IED perspective.

The system engineer or system integrator must have a basic knowledge of communication in protection and control systems and thorough knowledge of the specific communication protocol.

1.3 Product documentation

1.3.1 Product documentation set

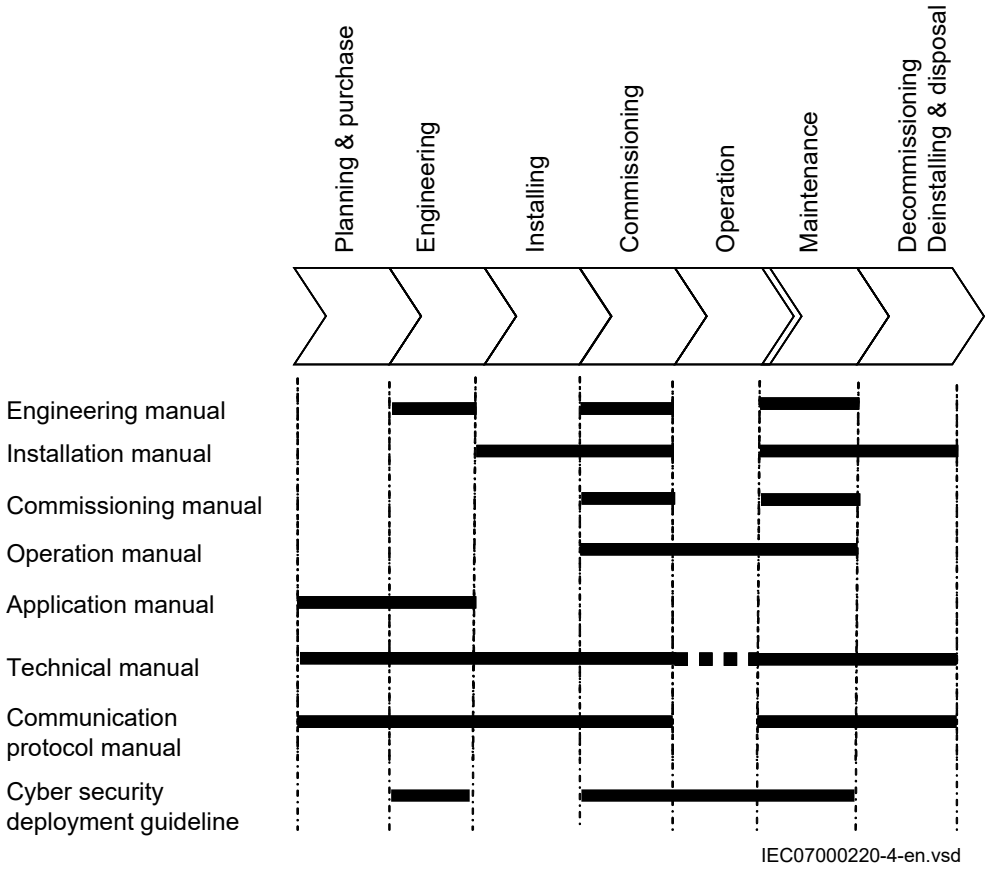


Figure 1: The intended use of manuals throughout the product lifecycle

The engineering manual contains instructions on how to engineer the IEDs using the various tools available within the PCM600 software. The manual provides instructions on how to set up a PCM600 project and insert IEDs to the project structure. The manual also recommends a sequence for the engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 60870-5-103, IEC 61850, DNP3, LON and SPA.

The installation manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in the chronological order in which the IED should be installed.

The commissioning manual contains instructions on how to commission the IED. The manual can also be used by system engineers and maintenance personnel for assistance during the testing phase. The manual provides procedures for the checking of external circuitry and energizing the IED, parameter setting and configuration as well as verifying settings by secondary injection. The manual describes the process of testing an IED in a station which is not in service. The chapters are organized in the chronological order in which the IED should be commissioned. The relevant procedures may be followed also during the service and maintenance activities.

The operation manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for the monitoring, controlling and setting of 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.

The application manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also provide assistance for calculating settings.

The technical manual contains operation principle descriptions, and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data, sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

The communication protocol manual describes the communication protocols supported by the IED. The manual concentrates on the vendor-specific implementations.

The point list manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding communication protocol manual.

The cyber security deployment guideline describes the process for handling cyber security when communicating with the IED. Certification, Authorization with role based access control, and product engineering for cyber security related events are described and sorted by function. The guideline can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

1.3.2 Document revision history

Document revision/date	History
January 2016	First Release
March 2019	Maintenance Release

1.3.3 Related documents

Documents related to REB650	Document numbers
Application manual	1MRK 505 359-UEN
Commissioning manual	1MRK 505 361-UEN
Product guide	1MRK 505 362-BEN
Technical manual	1MRK 505 360-UEN
Type test certificate	1MRK 505 362-TEN

Documents related to REC650	Document numbers
Application manual	1MRK 511 384-UEN
Commissioning manual	1MRK 511 386-UEN
Product guide	1MRK 511 387-BEN
Technical manual	1MRK 511 385-UEN
Type test certificate	1MRK 511 387-TEN

Documents related to RED650	Document numbers
Application manual	1MRK 505 363-UEN
Commissioning manual	1MRK 505 365-UEN
Product guide	1MRK 505 366-BEN
Technical manual	1MRK 505 364-UEN
Type test certificate	1MRK 505 366-TEN

Documents related to REL650	Document numbers
Application manual	1MRK 506 364-UEN
Commissioning manual	1MRK 506 366-UEN
Product guide	1MRK 506 367-BEN
Technical manual	1MRK 506 365-UEN
Type test certificate	1MRK 506 367-TEN

Documents related to REQ650	Document numbers
Application manual	1MRK 505 355-UEN
Commissioning manual	1MRK 505 357-UEN
Product guide	1MRK 505 358-BEN
Technical manual	1MRK 505 356-UEN
Type test certificate	1MRK 505 358-TEN

Documents related to RET650	Document numbers
Application manual	1MRK 504 158-UEN
Commissioning manual	1MRK 504 160-UEN
Product guide	1MRK 504 161-BEN
Technical manual	1MRK 504 159-UEN
Type test certificate	1MRK 504 161-TEN

650 series manuals	Document numbers
Operation manual	1MRK 500 125-UEN
Engineering manual	1MRK 511 381-UEN
Installation manual	1MRK 514 025-UEN
Communication protocol manual, DNP3	1MRK 511 374-UUS
Communication protocol manual, IEC 60870-5-103	1MRK 511 377-UEN
Communication protocol manual, IEC 61850 Edition 1	1MRK 511 375-UEN
Communication protocol manual, IEC 61850 Edition 2	1MRK 511 376-UEN
Communication protocol manual, LON	1MRK 511 378-UEN
Communication protocol manual, SPA	1MRK 511 379-UEN
Point list manual, DNP3	1MRK 511 380-UUS
Accessories guide	IEC: 1MRK 514 012-UEN ANSI: 1MRK 514 012-UUS
Table continues on next page	

650 series manuals	Document numbers
Cyber security deployment guideline	1MRK 511 382-UEN
Connection and Installation components	1MRK 513 003-BEN
Test system, COMBITEST	1MRK 512 001-BEN

1.4 Document symbols and conventions

1.4.1 Symbols

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

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

The caution hot surface icon indicates important information or warning about the temperature of product surfaces.

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 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. It is important that the user fully complies with all warning and cautionary notices.

1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Parameter names are shown in italics.
  For example, the function can be enabled and disabled with the *Operation* setting.
- Each function block symbol shows the available input/output signal.

- the character ^ in front of an input/output signal name indicates that the signal name may be customized using the PCM600 software.
- the character * after an input signal name indicates that the signal must be connected to another function block in the application configuration to achieve a valid application configuration.

- Dimensions are provided both in inches and millimeters. If it is not specifically mentioned then the dimension is in millimeters.

Section 2 LON application

2.1 Application

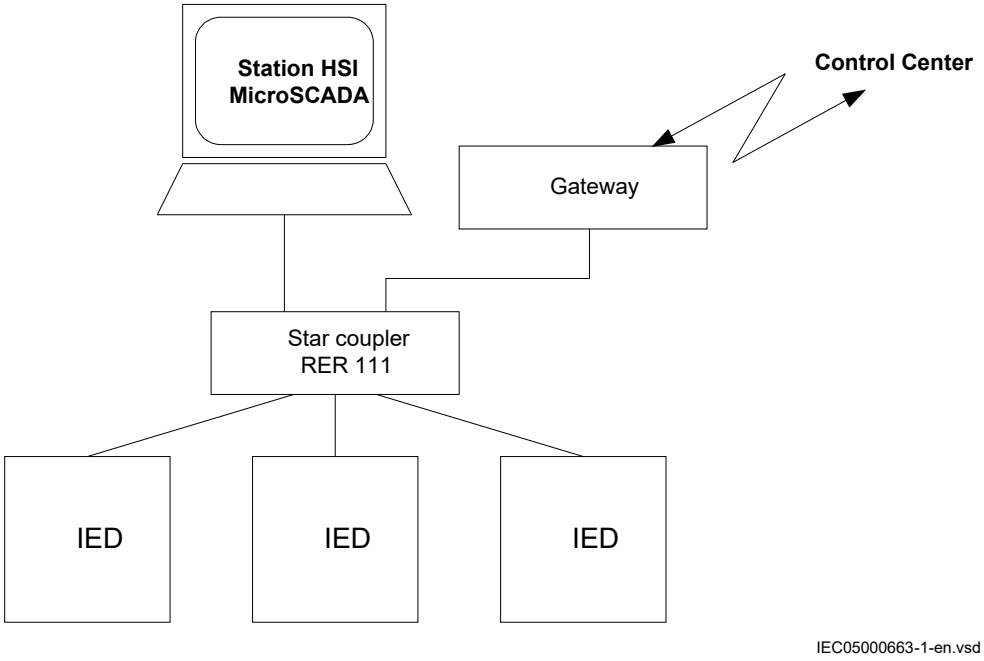


Figure 2: Example of LON communication structure for a station automation system

An optical network can be used within the station automation system. This enables communication with the IEDs through the LON bus from the operator's workplace, from the control center and also from other IEDs via bay-to-bay horizontal communication.

The fibre optic LON bus is implemented using either glass core or plastic core fibre optic cables.

Table 1: Specification of the fibre optic connectors

	Glass fibre	Plastic fibre
Cable connector	ST-connector	snap-in connector
Cable diameter	62.5/125 m	1 mm
Max. cable length	1000 m	10 m
Wavelength	820-900 nm	660 nm
Transmitted power	-13 dBm (HFBR-1414)	-13 dBm (HFBR-1521)
Receiver sensitivity	-24 dBm (HFBR-2412)	-20 dBm (HFBR-2521)

2.1.1 The LON Protocol

The LON protocol is specified in the LonTalkProtocol Specification Version 3 from Echelon Corporation. This protocol is designed for communication in control networks and is a peer-to-peer protocol where all the devices connected to the network can communicate with each

other directly. For more information of the bay-to-bay communication, refer to the section Multiple command function.

2.1.2 Hardware and software modules

The hardware needed for applying LON communication depends on the application, but one very central unit needed is the LON Star Coupler and optical fibers connecting the star coupler to the IEDs. To interface the IEDs from the MicroSCADA with Classic Monitor, application library LIB520 is required.

The HV Control 670 software module is included in the LIB520 high-voltage process package, which is a part of the Application Software Library in MicroSCADA applications.

The HV Control 670 software module is used for control functions in the IEDs. The module contains a process picture, dialogues and a tool to generate a process database for the control application in MicroSCADA.

When using MicroSCADA Monitor Pro instead of the Classic Monitor, SA LIB is used together with 670 series Object Type files.

The HV Control 670 software module and 670 series Object Type files are used with both 650 and 670 series IEDs.

Use the LON Network Tool (LNT) to set the LON communication. This is a software tool applied as one node on the LON bus. To communicate via LON, the IEDs need to know

- The node addresses of the other connected IEDs.
- The network variable selectors to be used.

This is organized by LNT.

The node address is transferred to LNT via the local HMI by setting the parameter *ServicePinMsg* = *Yes*. The node address is sent to LNT via the LON bus, or LNT can scan the network for new nodes.

The communication speed of the LON bus is set to the default of 1.25 Mbit/s. This can be changed by LNT.

Section 3 LON operation principle

3.1 Operation principle

The speed of the network depends on the medium and transceiver design. With protection and control devices, fiber optic media is used, which enables the use of the maximum speed of 1.25 Mbits/s. The protocol is a peer-to-peer protocol where all the devices connected to the network can communicate with each other. The own subnet and node number are identifying the nodes (max. 255 subnets, 127 nodes per one subnet).

The LON bus links the different parts of the protection and control system. The measured values, status information, and event information are spontaneously sent to the higher-level devices. The higher-level devices can read and write memorized values, setting values, and other parameter data when required. The LON bus also enables the bay level devices to communicate with each other to deliver, for example, interlocking information among the terminals without the need of a bus master.

The LonTalk protocol supports two types of application layer objects: network variables and explicit messages. Network variables are used to deliver short messages, such as measuring values, status information, and interlocking/blocking signals. Explicit messages are used to transfer longer pieces of information, such as events and explicit read and write messages to access device data.

The benefits achieved from using the LON bus in protection and control systems include direct communication among all terminals in the system and support for multi-master implementations. The LON bus also has an open concept, so that the terminals can communicate with external devices using the same standard of network variables.

3.1.1 LON protocol

3.1.1.1 Configuration of LON

LON network tool (LNT) is a multi-purpose tool for LonWorks network configuration. All the functions required for setting up and configuring a LonWorks network, is easily accessible on a single tool program.

3.1.1.2 Activate LON Communication

Activate LON communication in the Parameter Setting tool under **Main Menu/Configuration/ Communication/Station communication/ LON/HORZCOMM:1**, where *Operation* must be set to *ON*.

3.1.1.3 Add LON Device Types LNT

A new device is added to LON Network Tool from the Device menu or by installing the device from the ABB LON Device Types package for LNT 505 using SLDT package version 1p2 r04.

3.1.1.4 LON net address

To establish a LON connection, the IED has to be given a unique net address. The net address consists of a subnet and node number. This is accomplished with the LON Network Tool by creating one device for each IED.

3.1.2 Vertical communication

Vertical communication describes communication between the monitoring devices and protection and control IEDs. This communication includes sending of changed process data to monitoring devices as events and transfer of commands, parameter data and disturbance recorder files. This communication is implemented using explicit messages.

3.1.2.1 Events and indications

Events are sent to the monitoring devices using explicit messages (message code 44H) with unacknowledged transport service of the LonTalk protocol. When a signal is changed in the IED, one message with the value, quality and time is transmitted from terminal.

Binary events
Binary events are generated in Event function blocks EVENT:1 to EVENT:20 in the IEDs. The EVENT function blocks have predefined LON addresses. Table 2 shows the LON addresses to the first input on the EVENT function blocks. Addresses to the other inputs on the EVENT function block are consecutive after the first input. For example, input 15 on EVENT:17 function block has the address 1280 + 14 (15-1) = 1294.

For double indications, only the first eight inputs 1–8 must be used. Inputs 9–16 can be used for other types of events at the same EVENT block.

Three EVENT function blocks EVENT:1 to EVENT:3 running with a fast loop time (3 ms) are available as basic in the IEDs.. The remaining EVENT function blocks EVENT:4 to EVENT:9 run with a loop time of 8 ms and EVENT:10 to EVENT:20 run with a loop time of 100 ms. The EVENT blocks are used to send binary signals, integers, real time values like analogue data from measuring functions and mA input modules as well as pulse counter signals.

16 pulse counter value function blocks PCFCNT:1 to PCFCNT:16 are available in the IEDs.

The first LON address in every EVENT function block is found in table 2

Table 2: LON adresses for EVENT functions

Function block	First LON address in function block
EVENT:1	1024
EVENT:2	1040
EVENT:3	1056
EVENT:4	1072
EVENT:5	1088
EVENT:6	1104
EVENT:7	1120
EVENT:8	1136
EVENT:9	1152
EVENT:10	1168
EVENT:11	1184
Table continues on next page	

Function block	First LON address in function block
EVENT:12	1200
EVENT:13	1216
EVENT:14	1232
EVENT:15	1248
EVENT:16	1264
EVENT:17	1280
EVENT:18	1296
EVENT:19	1312
EVENT:20	1328

Event masks
Event mask for each input can be set individually from Parameter Setting Tool (PST) under: **Settings/IED settings/ Monitoring / Event Function** or via parameter setting tool (PST) as follows:

- No events
- OnSet, at pick-up of the signal
- OnReset, at drop-out of the signal
- OnChange, at both pick-up and drop-out of the signal
- AutoDetect, the EVENT function makes the reporting decision (reporting criteria for integers has no semantic, prefer to be set by the user)

Single indication
Directly connected binary IO signal via binary input function block (SMBI) is always reported on change, no changed detection is done in the EVENT function block. Other Boolean signals, for example a start or a trip signal from a protection function is event masked in the EVENT function block.

Double indications
Double indications can only be reported for the first 8 inputs on an EVENT function block.

- 00 generates an intermediate event with the read status 0
- 01 generates an open event with the read status 1
- 10 generates a close event with the read status 2
- 11 generates an undefined event with the read status 3

Analog value
All analog values are reported cyclic. The reporting interval is taken from the connected function if there is a limit supervised signal. Otherwise it is taken from the EVENT function block.

3.1.2.2 Command handling

Commands are transferred using transparent SPA-bus messages. The transparent SPA-bus message is an explicit LON message, which contains an ASCII character message following the coding rules of the SPA-bus protocol. The message is sent using explicit messages with message code 41H and using acknowledged transport service.

Both the SPA-bus command messages (R or W) and the reply messages (D, A or N) are sent using the same message code. It is mandatory that one device sends out only one SPA-bus message at a time to one node and waits for the reply before sending the next message.

For commands from the operator workplace to the IED for apparatus control, That is, the function blocks type SCSWI 1 to 30, SXCBR 1 to 18 and SXSWI 1 to 24; the SPA addresses are according to table 3.

3.1.3 Horizontal communication

Network variables are used for communication between 500 and 650 series IEDs The supported network variable type is SNVT_state (NV type 83). SNVT_state is used to communicate the state of a set of 1 to 16 Boolean values.

Multiple command send function block (MULTICMDSND) is used to pack the information to one value. This value is transmitted to the receiving node and presented for the application by a multiple command receive function block (MULTICMDRCV). With horizontal communication, the input BOUND on MULTICMDSND must be set to 1. There are 10 MULTICMDSND and 60 MULTICMDRCV function blocks available. These function blocks are connected using the LON network tool (LNT). The tool also defines the service and addressing on LON.

This is an overview for configuring the network variables for the IEDs.

3.1.3.1 Configuration of LON network variables

Configure the Network variables according to the specific application using the LON network tool (LNT). The following is an example of how to configure network variables concerning, for example, interlocking between two IEDs.

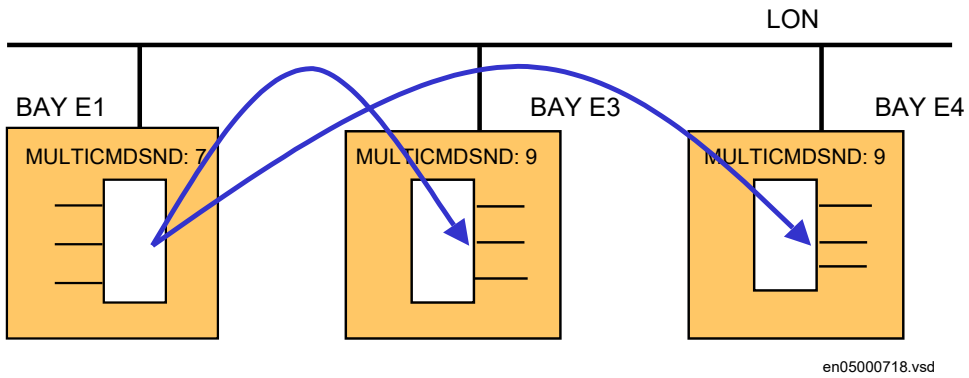
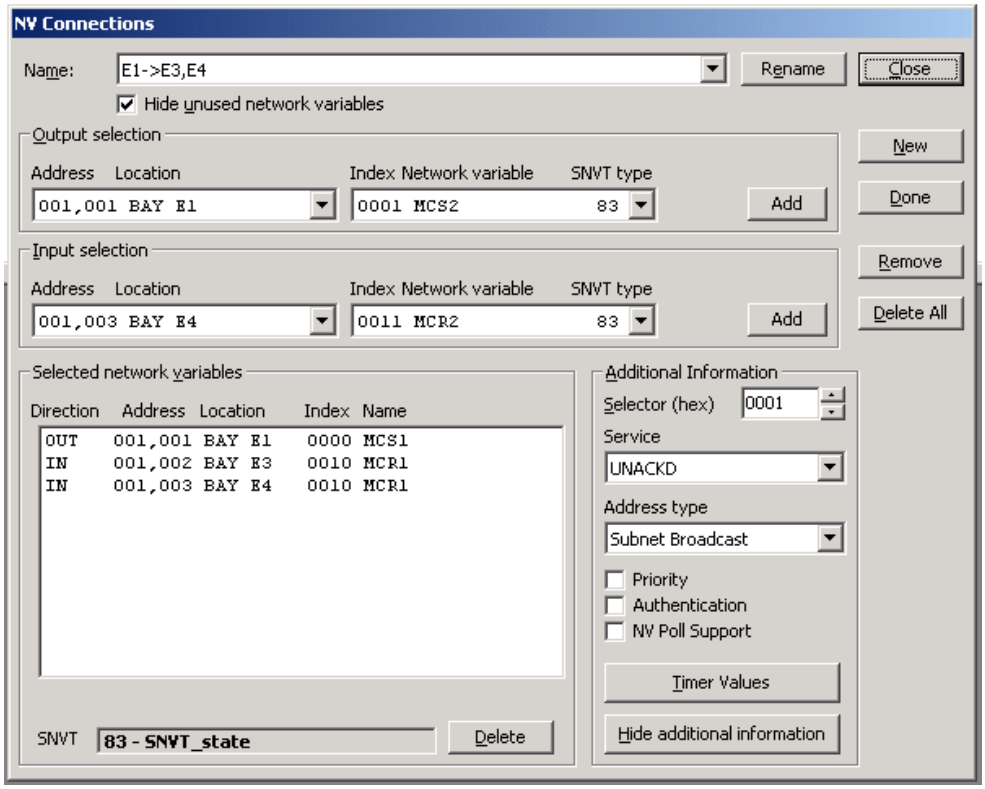


Figure 3: Examples connections between MULTICMDSND and MULTICMDRCV function blocks in three IEDs

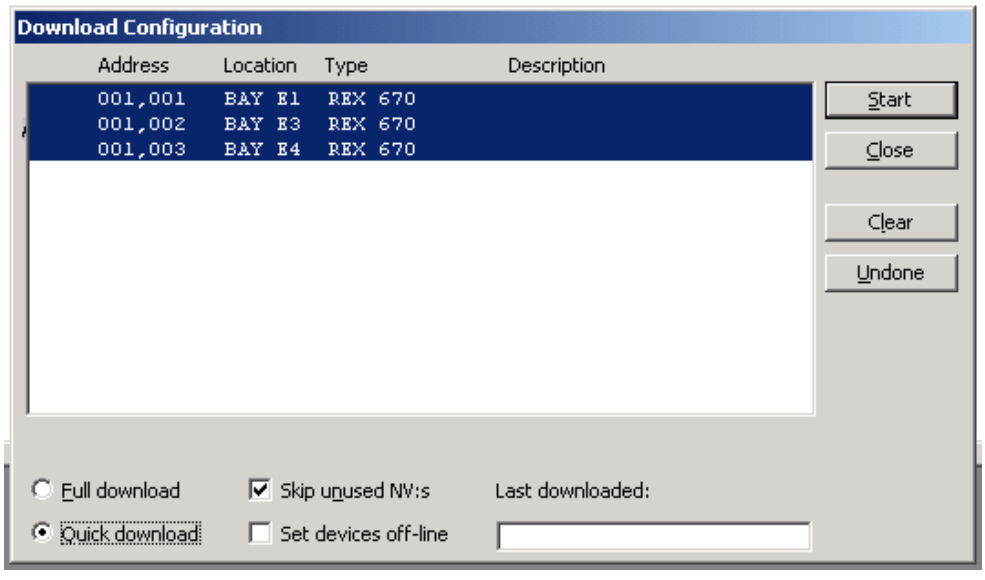
The network variable connections are done from the NV Connection window. From LNT window select **Connections/ NVConnections/ New**.



en05000719.vsd

Figure 4: The network variables window in LNT

There are two ways of downloading NV connections. Either the users can use the drag-and-drop method where they can select all nodes in the device window, drag them to the Download area in the bottom of the program window and drop them there; or, they can perform it by selecting the traditional menu, **Configuration/ Download**.



en05000720.vsd

Figure 5: The download configuration window in LNT

3.1.4 Communication ports

The serial communication module (SLM) is a mezzanine module placed on the Main Processing Module (NUM) and is used for LON, SPA, IEC 60870-5-103 and DNP communication.

There are two types of IO connectors: snap-in connectors for plastic fibre cables and ST/ bayonet connectors for glass fibre cables. The SLM can be equipped with either type of connector or a combination of both connectors. This is identified by a tag.

Connect the incoming optical fibre to the RX receiver input, and the outgoing optical fibre to the TX transmitter output. Pay special attention to the instructions concerning handling and connection of fibre cables.

Table 3: SPA addresses for commands from the operator workplace to the IED for apparatus control

Name	Function block	SPA address	Description
BL_CMD	SCSWI01	1 I 5115	SPA parameters for block command
BL_CMD	SCSWI02	1 I 5139	SPA parameters for block command
BL_CMD	SCSWI02	1 I 5161	SPA parameters for block command
BL_CMD	SCSWI04	1 I 5186	SPA parameters for block command
BL_CMD	SCSWI05	1 I 5210	SPA parameters for block command
BL_CMD	SCSWI06	1 I 5234	SPA parameters for block command
BL_CMD	SCSWI07	1 I 5258	SPA parameters for block command
BL_CMD	SCSWI08	1 I 5283	SPA parameters for block command
BL_CMD	SCSWI09	1 I 5307	SPA parameters for block command
BL_CMD	SCSWI10	1 I 5331	SPA parameters for block command
BL_CMD	SCSWI11	1 I 5355	SPA parameters for block command
BL_CMD	SCSWI12	1 I 5379	SPA parameters for block command
BL_CMD	SCSWI13	1 I 5403	SPA parameters for block command
BL_CMD	SCSWI14	1 I 5427	SPA parameters for block command
BL_CMD	SCSWI15	1 I 5451	SPA parameters for block command
BL_CMD	SCSWI16	1 I 5475	SPA parameters for block command
BL_CMD	SCSWI17	1 I 5499	SPA parameters for block command
BL_CMD	SCSWI18	1 I 5523	SPA parameters for block command
BL_CMD	SCSWI19	1 I 5545	SPA parameters for block command
Table continues on next page			

Name	Function block	SPA address	Description
BL_CMD	SCSWI20	1 I 5571	SPA parameters for block command
BL_CMD	SCSWI21	1 I 5594	SPA parameters for block command
BL_CMD	SCSWI22	1 I 5619	SPA parameters for block command
BL_CMD	SCSWI23	1 I 5643	SPA parameters for block command
BL_CMD	SCSWI24	1 I 5667	SPA parameters for block command
BL_CMD	SCSWI25	1 I 5691	SPA parameters for block command
BL_CMD	SCSWI26	1 I 5715	SPA parameters for block command
BL_CMD	SCSWI27	1 I 5739	SPA parameters for block command
BL_CMD	SCSWI28	1 I 5763	SPA parameters for block command
BL_CMD	SCSWI29	1 I 5787	SPA parameters for block command
BL_CMD	SCSWI30	1 I 5811	SPA parameters for block command
BL_CMD	SCSWI31	1 I 5835	SPA parameters for block command
BL_CMD	SCSWI32	1 I 5859	SPA parameters for block command
CANCEL	SCSWI01	1 I 5107	SPA parameters for cancel command
CANCEL	SCSWI02	1 I 5131	SPA parameters for cancel command
CANCEL	SCSWI03	1 I 5153	SPA parameters for cancel command
CANCEL	SCSWI04	1 I 5178	SPA parameters for cancel command
CANCEL	SCSWI05	1 I 5202	SPA parameters for cancel command
CANCEL	SCSWI06	1 I 5226	SPA parameters for cancel command
CANCEL	SCSWI07	1 I 5250	SPA parameters for cancel command
CANCEL	SCSWI08	1 I 5275	SPA parameters for cancel command
CANCEL	SCSWI09	1 I 5299	SPA parameters for cancel command
CANCEL	SCSWI10	1 I 5323	SPA parameters for cancel command
CANCEL	SCSWI11	1 I 5347	SPA parameters for cancel command
CANCEL	SCSWI12	1 I 5371	SPA parameters for cancel command
CANCEL	SCSWI13	1 I 5395	SPA parameters for cancel command

Table continues on next page

Name	Function block	SPA address	Description
CANCEL	SCSWI14	1 I 5419	SPA parameters for cancel command
CANCEL	SCSWI15	1 I 5443	SPA parameters for cancel command
CANCEL	SCSWI16	1 I 5467	SPA parameters for cancel command
CANCEL	SCSWI17	1 I 5491	SPA parameters for cancel command
CANCEL	SCSWI18	1 I 5515	SPA parameters for cancel command
CANCEL	SCSWI19	1 I 5537	SPA parameters for cancel command
CANCEL	SCSWI20	1 I 5563	SPA parameters for cancel command
CANCEL	SCSWI21	1 I 5586	SPA parameters for cancel command
CANCEL	SCSWI22	1 I 5611	SPA parameters for cancel command
CANCEL	SCSWI23	1 I 5635	SPA parameters for cancel command
CANCEL	SCSWI24	1 I 5659	SPA parameters for cancel command
CANCEL	SCSWI25	1 I 5683	SPA parameters for cancel command
CANCEL	SCSWI26	1 I 5707	SPA parameters for cancel command
CANCEL	SCSWI27	1 I 5731	SPA parameters for cancel command
CANCEL	SCSWI28	1 I 5755	SPA parameters for cancel command
CANCEL	SCSWI29	1 I 5779	SPA parameters for cancel command
CANCEL	SCSWI30	1 I 5803	SPA parameters for cancel command
CANCEL	SCSWI31	1 I 5827	SPA parameters for cancel command
CANCEL	SCSWI32	1 I 5851	SPA parameters for cancel command
SELECTOpen=00, SELECTClose=01, SELOpen+ILO=10, SELClose+ILO=11, SELOpen+SCO=20, SELClose+SCO=21, SELOpen+ILO+SCO=30, SELClose+ILO+SCO=31	SCSWI01	1 I 5105	SPA parameters for select (Open/Close) command Note: Send select command before operate command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI02	1 I 5129	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI03	1 I 5151	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI04	1 I 5176	SPA parameters for select (Open/Close) command

Table continues on next page

Name	Function block	SPA address	Description
SELECTOpen=00, SELECTClose=01, so on.	SCSWI05	1 I 5200	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI06	1 I 5224	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI07	1 I 5248	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI08	1 I 5273	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI09	1 I 5297	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI10	1 I 5321	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI11	1 I 5345	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI12	1 I 5369	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI13	1 I 5393	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI14	1 I 5417	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI15	1 I 5441	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI16	1 I 5465	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI17	1 I 5489	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI18	1 I 5513	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI19	1 I 5535	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI20	1 I 5561	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI21	1 I 5584	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI22	1 I 5609	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI23	1 I 5633	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI24	1 I 5657	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI25	1 I 5681	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI26	1 I 5705	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI27	1 I 5729	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI28	1 I 5753	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI29	1 I 5777	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI30	1 I 5801	SPA parameters for select (Open/Close) command

Table continues on next page

Name	Function block	SPA address	Description
SELECTOpen=00, SELECTClose=01, so on.	SCSWI31	1 I 5825	SPA parameters for select (Open/Close) command
SELECTOpen=00, SELECTClose=01, so on.	SCSWI32	1 I 5849	SPA parameters for select (Open/Close) command
ExcOpen=00, ExcClose=01, ExcOpen+ILO=10, ExcClose+ILO=11, ExcOpen+SCO=20, ExcClose+SCO=21, ExcOpen+ILO+SCO=30, ExcClose+ILO+SCO=31	SCSWI01	1 I 5106	SPA parameters for operate (Open/Close) command Note: Send select command before operate command
ExcOpen=00, ExcClose=01, so on.	SCSWI02	1 I 5130	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI02	1 I 5152	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI04	1 I 5177	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI05	1 I 5201	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI06	1 I 5225	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI07	1 I 5249	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI08	1 I 5274	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI09	1 I 5298	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI10	1 I 5322	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI11	1 I 5346	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI12	1 I 5370	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI13	1 I 5394	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI14	1 I 5418	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI15	1 I 5442	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI16	1 I 5466	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI17	1 I 5490	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI18	1 I 5514	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI19	1 I 5536	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI20	1 I 5562	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI21	1 I 5585	SPA parameters for operate (Open/Close) command
Table continues on next page			

Name	Function block	SPA address	Description
ExcOpen=00, ExcClose=01, so on.	SCSWI22	1 I 5610	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI23	1 I 5634	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI24	1 I 5658	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI25	1 I 5682	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI26	1 I 5706	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI27	1 I 5730	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI28	1 I 5754	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI29	1 I 5778	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI30	1 I 5802	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI31	1 I 5826	SPA parameters for operate (Open/Close) command
ExcOpen=00, ExcClose=01, so on.	SCSWI32	1 I 5850	SPA parameters for operate (Open/Close) command
Sub Value	SXCBR01	2 I 7854	SPA parameter for position to be substituted Note: Send the value before Enable
Sub Value	SXCBR02	2 I 7866	SPA parameter for position to be substituted
Sub Value	SXCBR03	2 I 7884	SPA parameter for position to be substituted
Sub Value	SXCBR04	2 I 7904	SPA parameter for position to be substituted
Sub Value	SXCBR05	2 I 7923	SPA parameter for position to be substituted
Sub Value	SXCBR06	2 I 7942	SPA parameter for position to be substituted
Sub Value	SXCBR07	2 I 7961	SPA parameter for position to be substituted
Sub Value	SXCBR08	2 I 7980	SPA parameter for position to be substituted
Sub Value	SXCBR09	3 I 7	SPA parameter for position to be substituted
Sub Value	SXCBR10	3 I 26	SPA parameter for position to be substituted
Sub Value	SXCBR11	3 I 45	SPA parameter for position to be substituted
Sub Value	SXCBR12	3 I 56	SPA parameter for position to be substituted
Sub Value	SXCBR13	3 I 74	SPA parameter for position to be substituted
Sub Value	SXCBR14	3 I 94	SPA parameter for position to be substituted

Table continues on next page

Name	Function block	SPA address	Description
Sub Value	SXCBR15	3 I 120	SPA parameter for position to be substituted
Sub Value	SXCBR16	3 I 133	SPA parameter for position to be substituted
Sub Value	SXCBR17	3 I 158	SPA parameter for position to be substituted
Sub Value	SXCBR18	3 I 179	SPA parameter for position to be substituted
Sub Value	SXSWI01	3 I 196	SPA parameter for position to be substituted
Sub Value	SXSWI02	3 I 216	SPA parameter for position to be substituted
Sub Value	SXSWI03	3 I 235	SPA parameter for position to be substituted
Sub Value	SXSWI04	3 I 254	SPA parameter for position to be substituted
Sub Value	SXSWI05	3 I 272	SPA parameter for position to be substituted
Sub Value	SXSWI06	3 I 292	SPA parameter for position to be substituted
Sub Value	SXSWI07	3 I 310	SPA parameter for position to be substituted
Sub Value	SXSWI08	3 I 330	SPA parameter for position to be substituted
Sub Value	SXSWI09	3 I 348	SPA parameter for position to be substituted
Sub Value	SXSWI10	3 I 359	SPA parameter for position to be substituted
Sub Value	SXSWI11	3 I 378	SPA parameter for position to be substituted
Sub Value	SXSWI12	3 I 397	SPA parameter for position to be substituted
Sub Value	SXSWI13	3 I 416	SPA parameter for position to be substituted
Sub Value	SXSWI14	3 I 435	SPA parameter for position to be substituted
Sub Value	SXSWI15	3 I 454	SPA parameter for position to be substituted
Sub Value	SXSWI16	3 I 473	SPA parameter for position to be substituted
Sub Value	SXSWI17	3 I 492	SPA parameter for position to be substituted
Sub Value	SXSWI18	3 I 511	SPA parameter for position to be substituted
Sub Value	SXSWI19	3 I 530	SPA parameter for position to be substituted
Sub Value	SXSWI20	3 I 549	SPA parameter for position to be substituted
Sub Value	SXSWI21	3 I 568	SPA parameter for position to be substituted
Sub Value	SXSWI22	3 I 587	SPA parameter for position to be substituted

Table continues on next page

Name	Function block	SPA address	Description
Sub Value	SXSWI23	3 I 606	SPA parameter for position to be substituted
Sub Value	SXSWI24	3 I 625	SPA parameter for position to be substituted
Sub Value	SXSWI25	3 I 644	SPA parameter for position to be substituted
Sub Value	SXSWI26	3 I 663	SPA parameter for position to be substituted
Sub Value	SXSWI27	3 I 682	SPA parameter for position to be substituted
Sub Value	SXSWI28	3 I 701	SPA parameter for position to be substituted
Sub Enable	SXCBR01	2 I 7855	SPA parameter for substitute enable command Note: Send the Value before Enable
Sub Enable	SXCBR02	2 I 7865	SPA parameter for substitute enable command
Sub Enable	SXCBR03	2 I 7885	SPA parameter for substitute enable command
Sub Enable	SXCBR04	2 I 7903	SPA parameter for substitute enable command
Sub Enable	SXCBR05	2 I 7924	SPA parameter for substitute enable command
Sub Enable	SXCBR06	2 I 7941	SPA parameter for substitute enable command
Sub Enable	SXCBR07	2 I 7962	SPA parameter for substitute enable command
Sub Enable	SXCBR08	2 I 7979	SPA parameter for substitute enable command
Sub Enable	SXCBR09	3 I 8	SPA parameter for substitute enable command
Sub Enable	SXCBR10	3 I 25	SPA parameter for substitute enable command
Sub Enable	SXCBR11	3 I 46	SPA parameter for substitute enable command
Sub Enable	SXCBR12	3 I 55	SPA parameter for substitute enable command
Sub Enable	SXCBR13	3 I 75	SPA parameter for substitute enable command
Sub Enable	SXCBR14	3 I 93	SPA parameter for substitute enable command
Sub Enable	SXCBR15	3 I 121	SPA parameter for substitute enable command
Sub Enable	SXCBR16	3 I 132	SPA parameter for substitute enable command
Sub Enable	SXCBR17	3 I 159	SPA parameter for substitute enable command
Sub Enable	SXCBR18	3 I 178	SPA parameter for substitute enable command
Sub Enable	SXSWI01	3 I 197	SPA parameter for substitute enable command

Table continues on next page

Name	Function block	SPA address	Description
Sub Enable	SXSWI02	3 I 215	SPA parameter for substitute enable command
Sub Enable	SXSWI03	3 I 234	SPA parameter for substitute enable command
Sub Enable	SXSWI04	3 I 252	SPA parameter for substitute enable command
Sub Enable	SXSWI05	3 I 271	SPA parameter for substitute enable command
Sub Enable	SXSWI06	3 I 290	SPA parameter for substitute enable command
Sub Enable	SXSWI07	3 I 309	SPA parameter for substitute enable command
Sub Enable	SXSWI08	3 I 328	SPA parameter for substitute enable command
Sub Enable	SXSWI09	3 I 347	SPA parameter for substitute enable command
Sub Enable	SXSWI10	3 I 360	SPA parameter for substitute enable command
Sub Enable	SXSWI11	3I 379	SPA parameter for substitute enable command
Sub Enable	SXSWI12	3 I 398	SPA parameter for substitute enable command
Sub Enable	SXSWI13	3 I 417	SPA parameter for substitute enable command
Sub Enable	SXSWI14	3 I 436	SPA parameter for substitute enable command
Sub Enable	SXSWI15	3 I 455	SPA parameter for substitute enable command
Sub Enable	SXSWI16	3 I 474	SPA parameter for substitute enable command
Sub Enable	SXSWI17	3 I 493	SPA parameter for substitute enable command
Sub Enable	SXSWI18	3 I 512	SPA parameter for substitute enable command
Sub Enable	SXSWI19	3 I 531	SPA parameter for substitute enable command
Sub Enable	SXSWI20	3 I 550	SPA parameter for substitute enable command
Sub Enable	SXSWI21	3 I 569	SPA parameter for substitute enable command
Sub Enable	SXSWI22	3 I 588	SPA parameter for substitute enable command
Sub Enable	SXSWI23	3 I 607	SPA parameter for substitute enable command
Sub Enable	SXSWI24	3 I 626	SPA parameter for substitute enable command
Sub Enable	SXSWI25	3 I 645	SPA parameter for substitute enable command
Sub Enable	SXSWI26	3 I 664	SPA parameter for substitute enable command
Sub Enable	SXSWI27	3 I 683	SPA parameter for substitute enable command

Table continues on next page

Name	Function block	SPA address	Description
Sub Enable	SXSWI28	3 I 702	SPA parameter for substitute enable command
Update Block	SXCBR01	2 I 7853	SPA parameter for update block command
Update Block	SXCBR02	2 I 7864	SPA parameter for update block command
Update Block	SXCBR03	2 I 7883	SPA parameter for update block command
Update Block	SXCBR04	2 I 7905	SPA parameter for update block command
Update Block	SXCBR05	2 I 7922	SPA parameter for update block command
Update Block	SXCBR06	2 I 7943	SPA parameter for update block command
Update Block	SXCBR07	2 I 7960	SPA parameter for update block command
Update Block	SXCBR08	2 I 7981	SPA parameter for update block command
Update Block	SXCBR09	3 I 6	SPA parameter for update block command
Update Block	SXCBR10	3 I 27	SPA parameter for update block command
Update Block	SXCBR11	3 I 44	SPA parameter for update block command
Update Block	SXCBR12	3 I 57	SPA parameter for update block command
Update Block	SXCBR13	3 I 73	SPA parameter for update block command
Update Block	SXCBR14	3 I 92	SPA parameter for update block command
Update Block	SXCBR15	3 I 122	SPA parameter for update block command
Update Block	SXCBR16	3 I 131	SPA parameter for update block command
Update Block	SXCBR17	3 I 160	SPA parameter for update block command
Update Block	SXCBR18	3 I 177	SPA parameter for update block command
Update Block	SXSWI01	3 I 198	SPA parameter for update block command
Update Block	SXSWI02	3 I 214	SPA parameter for update block command
Update Block	SXSWI03	3 I 236	SPA parameter for update block command
Update Block	SXSWI04	3 I 253	SPA parameter for update block command
Update Block	SXSWI05	3 I 273	SPA parameter for update block command
Update Block	SXSWI06	3 I 291	SPA parameter for update block command
Update Block	SXSWI07	3 I 311	SPA parameter for update block command

Table continues on next page

Name	Function block	SPA address	Description
Update Block	SXSWI08	3 I 329	SPA parameter for update block command
Update Block	SXSWI09	3 I 349	SPA parameter for update block command
Update Block	SXSWI10	3 I 358	SPA parameter for update block command
Update Block	SXSWI11	3 I 377	SPA parameter for update block command
Update Block	SXSWI12	3 I 396	SPA parameter for update block command
Update Block	SXSWI13	3 I 415	SPA parameter for update block command
Update Block	SXSWI14	3 I 434	SPA parameter for update block command
Update Block	SXSWI15	3 I 453	SPA parameter for update block command
Update Block	SXSWI16	3 I 472	SPA parameter for update block command
Update Block	SXSWI17	3 I 491	SPA parameter for update block command
Update Block	SXSWI18	3 I 510	SPA parameter for update block command
Update Block	SXSWI19	3 I 529	SPA parameter for update block command
Update Block	SXSWI20	3 I 548	SPA parameter for update block command
Update Block	SXSWI21	3 I 567	SPA parameter for update block command
Update Block	SXSWI22	3 I 586	SPA parameter for update block command
Update Block	SXSWI23	3 I 605	SPA parameter for update block command
Update Block	SXSWI24	3 I 624	SPA parameter for update block command
Update Block	SXSWI25	3 I 643	SPA parameter for update block command
Update Block	SXSWI26	3 I 662	SPA parameter for update block command
Update Block	SXSWI27	3 I 681	SPA parameter for update block command
Update Block	SXSWI28	3 I 700	SPA parameter for update block command

Section 4 LON settings

4.1 Settings

Table 4: HORZCOMM Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation

Table 5: ADE Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation
TimerClass	Slow Normal Fast	-	-	Slow	Timer class
TimeDomain	Local without DST Local with DST	-	-	Local with DST	Time domain

Section 5 LON technical data

5.1 Technical data

Table 6: LON communication protocol

Function	Value
Protocol	LON
Communication speed	1.25 Mbit/s

Section 6 Establishing connection and verifying theLONcommunication

6.1 Establishing connection and verifying the LON communication

About this chapter

This chapter explains how to set up LON communication and how to verify that LON communication is up and running.

6.1.1 Communication via the rear ports

6.1.1.1 LON communication

LON communication is normally used in station automation systems. Optical fiber is used within the substation as the physical communication link.

The test can only be carried out when the whole communication system is installed. Thus, the test is a system test and is not dealt with here.

6.1.2 Settings

The setting parameters for the LON communication are set via the local HMI. Refer to the technical manual for setting parameters specifications.

The path to LON settings in the local HMI is **Main menu/Configuration/Communication/SLM configuration/Rear optical LON port**

If the LON communication from the IED stops, caused by setting of illegal communication parameters (outside the setting range) or by another disturbance, it is possible to reset the LON port of the IED.

Path in the local HMI under **Main menu/Configuration/Communication/SLM configuration/ Rear optical LON port**

These parameters can only be set with the LON Network Tool (LNT).

Table 7: Setting parameters for the LON communication

Parameter	Range	Default	Unit	Parameter description
DomainID	0	0	-	Domain identification number
SubnetID*	0 - 255 Step: 1	0	-	Subnet identification number
NodeID*	0 - 127 Step: 1	0	-	Node identification number
*Can be viewed in the local HMI				

Path in the local HMI under **Main menu/Congifuration/Communication/SLM configuration/ Rear optical LON port**

These parameters can only be set with the LON Network Tool (LNT).

Table 8: LON node information parameters

Parameter	Range	Default	Unit	Parameter description
NeuronID*	0 - 12	Not loaded	-	Neuron hardware identification number in hexadecimal code
Location	0 - 6	No value	-	Location of the node
*Can be viewed in the local HMI				

Path in the local HMI under **Main menu/Configuration/Communication/SLM configuration/ Rear optical LON port**

Table 9: ADE Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
Operation	Off On	-	-	Off	Operation
TimerClass	Slow Normal Fast	-	-	Slow	Timer class

Path in the local HMI under **Main menu/Configuration/Communication/SLM configuration/ Rear optical LON port**

Table 10: LON commands

Command	Command description
ServicePinMsg	Command with confirmation. Transfers the node address to the LON Network Tool.

6.1.2.1 Optical budget calculation for serial communication with LON

Table 11: Example

	Distance 1 km Glass	Distance10 m Plastic
Maximum attenuation	-11 dB	- 7 dB
4 dB/km multi mode: 820 nm - 62.5/125 um	4 dB	-
0.3 dB/m plastic: 620 nm - 1mm	-	3 dB
Margins for installation, aging, and so on	5 dB	2 dB
Losses in connection box, two contacts (0.75 dB/contact)	1.5 dB	-
Losses in connection box, two contacts (1dB/contact)	-	2 dB
Margin for repair splices (0.5 dB/splice)	0.5 dB	-
Maximum total attenuation	11 dB	7 dB

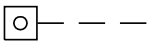
6.1.2.2 Reference

We refer to document: LNT 505 Operator’s Manual 1MRS751706-MUM, Issued: 31.10.99, Program rev: 1.1.1 Doc. version: B.

Section 7 LON Functions

7.1 Event function EVENT

7.1.1 Identification

Function description	IEC 61850 identification	IEC 60617 identification	ANSI/IEEE C37.2 device number
Event function	EVENT		-

When using a Substation Automation system with LON or SPA communication, time-tagged events can be sent at change or cyclically from the IED to the station level. These events are created from any available signal in the IED that is connected to the Event function (EVENT). The EVENT function block is used for LON and SPA communication.

Analog and double indication values are also transferred through the EVENT function.

7.1.2 Function block

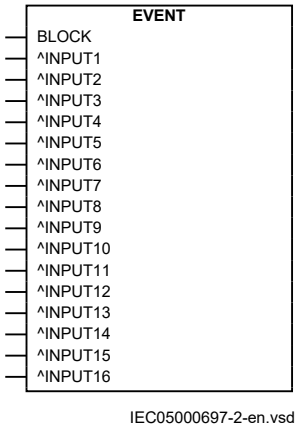


Figure 6: EVENT function block

7.1.3 Signals

Table 12: EVENT Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of function
INPUT1	GROUP SIGNAL	0	Input 1
INPUT2	GROUP SIGNAL	0	Input 2
INPUT3	GROUP SIGNAL	0	Input 3
INPUT4	GROUP SIGNAL	0	Input 4
INPUT5	GROUP SIGNAL	0	Input 5
INPUT6	GROUP SIGNAL	0	Input 6
INPUT7	GROUP SIGNAL	0	Input 7
INPUT8	GROUP SIGNAL	0	Input 8
INPUT9	GROUP SIGNAL	0	Input 9
INPUT10	GROUP SIGNAL	0	Input 10
INPUT11	GROUP SIGNAL	0	Input 11
INPUT12	GROUP SIGNAL	0	Input 12
INPUT13	GROUP SIGNAL	0	Input 13
INPUT14	GROUP SIGNAL	0	Input 14
INPUT15	GROUP SIGNAL	0	Input 15
INPUT16	GROUP SIGNAL	0	Input 16

7.1.4 Settings

Table 13: EVENT Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
SPAChannelMask	Off Channel 1-8 Channel 9-16 Channel 1-16	-	-	Off	SPA channel mask
LONChannelMask	Off Channel 1-8 Channel 9-16 Channel 1-16	-	-	Off	LON channel mask
EventMask1	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 1
EventMask2	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 2
EventMask3	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 3
EventMask4	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 4
EventMask5	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 5
EventMask6	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 6
EventMask7	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 7
EventMask8	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 8
EventMask9	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 9

Table continues on next page

Name	Values (Range)	Unit	Step	Default	Description
EventMask10	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 10
EventMask11	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 11
EventMask12	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 12
EventMask13	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 13
EventMask14	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 14
EventMask15	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 15
EventMask16	NoEvents OnSet OnReset OnChange AutoDetect	-	-	AutoDetect	Reporting criteria for input 16
MinRepIntVal1	0 - 3600	s	1	2	Minimum reporting interval input 1
MinRepIntVal2	0 - 3600	s	1	2	Minimum reporting interval input 2
MinRepIntVal3	0 - 3600	s	1	2	Minimum reporting interval input 3
MinRepIntVal4	0 - 3600	s	1	2	Minimum reporting interval input 4
MinRepIntVal5	0 - 3600	s	1	2	Minimum reporting interval input 5
MinRepIntVal6	0 - 3600	s	1	2	Minimum reporting interval input 6
MinRepIntVal7	0 - 3600	s	1	2	Minimum reporting interval input 7
MinRepIntVal8	0 - 3600	s	1	2	Minimum reporting interval input 8
MinRepIntVal9	0 - 3600	s	1	2	Minimum reporting interval input 9
MinRepIntVal10	0 - 3600	s	1	2	Minimum reporting interval input 10
MinRepIntVal11	0 - 3600	s	1	2	Minimum reporting interval input 11
MinRepIntVal12	0 - 3600	s	1	2	Minimum reporting interval input 12
MinRepIntVal13	0 - 3600	s	1	2	Minimum reporting interval input 13
MinRepIntVal14	0 - 3600	s	1	2	Minimum reporting interval input 14
MinRepIntVal15	0 - 3600	s	1	2	Minimum reporting interval input 15
MinRepIntVal16	0 - 3600	s	1	2	Minimum reporting interval input 16

7.1.5 Operation principle

The main purpose of the Event function (EVENT) is to generate events when the state or value of any of the connected input signals is in a state, or is undergoing a state transition, for which event generation is enabled.

Each EVENT function has 16 inputs INPUT1 - INPUT16. Each input can be given a name from the Application Configuration tool. The inputs are normally used to create single events, but are also intended for double indication events.

The EVENT function also has an input BLOCK to block the generation of events.

Events that are sent from the IED can originate from both internal logical signals and binary input channels. The internal signals are time-tagged in the main processing module, while the binary input channels are time-tagged directly on the input module. Time-tagging of the events that are originated from internal logical signals have a resolution corresponding to the execution cycle-time of the source application. Time-tagging of the events that are originated from binary input signals have a resolution of 1 ms.

The outputs from the EVENT function are formed by the reading of status, events and alarms by the station level on every single input. The user-defined name for each input is intended to be used by the station level.

All events according to the event mask are stored in a buffer, which contains up to 1000 events. If new events appear before the oldest event in the buffer is read, the oldest event is overwritten and an overflow alarm appears.

Events are produced according to set event masks. The event masks are treated commonly for both the LON and SPA communication. An *EventMask* can be set individually for each input channel. These settings are available:

- *NoEvents*
- *OnSet*
- *OnReset*
- *OnChange*
- *AutoDetect*

It is possible to define which part of the EVENT function generates the events. This can be performed individually for communication types *SPAChannelMask* and *LONChannelMask*. For each communication type these settings are available:

- *Off*
- *Channel 1-8*
- *Channel 9-16*
- *Channel 1-16*

For LON communication, events are normally sent to station level at change. It is also possible to set a time for cyclic sending of the events individually for each input channel.

To protect the SA system from signals with a high change rate that can easily saturate the EVENT function or the communication subsystems behind it, a quota limiter is implemented. If an input creates events at a rate that completely consume the granted quota then further events from the channel will be blocked. This block will be removed when the input calms down and the accumulated quota reach 66% of the maximum burst quota. The maximum burst quota per input channel is 45 events per second.

7.2 MULTICMDRCV and MULTICMDSND

Function description	IEC 61850 identification	IEC 60617 identification	ANSI/IEEE C37.2 device number
Multiple command and receive	MULTICMDRCV	-	-
Multiple command and send	MULTICMDSND	-	-

7.2.1 Application

The IED provides two function blocks enabling several IEDs to send and receive signals via the interbay bus. The sending function block, MULTICMDSND, takes 16 binary inputs. LON enables these to be transmitted to the equivalent receiving function block, MULTICMDRCV, which has 16 binary outputs.

7.2.2 Design

7.2.2.1 General

The common behavior for all 16 outputs of the MULTICMDRCV is set to either of two modes: Steady or Pulse.

- 1 = Steady: This mode simply forwards the received signals to the binary outputs.
- 2 = Pulse: When a received signal transitions from 0 (zero) to 1 (one), a pulse with a duration of exactly one execution cycle is triggered on the corresponding binary output. This means that no connected function block may have a cycle time that is higher than the execution cycle time of the particular MULTICMDRCV instance.

7.2.3 Function block

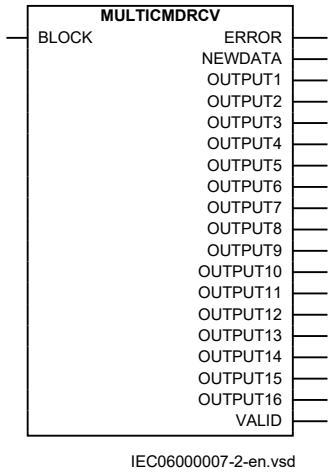


Figure 7: MULTICMDRCV function block

Table 14: MULTICMDRCV Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of function

Table 15: MULTICMDRCV Output signals

Name	Type	Description
ERROR	BOOLEAN	MultiReceive error
NEWDATA	BOOLEAN	New data is received
OUTPUT1	BOOLEAN	Output 1
OUTPUT2	BOOLEAN	Output 2
OUTPUT3	BOOLEAN	Output 3
OUTPUT4	BOOLEAN	Output 4
OUTPUT5	BOOLEAN	Output 5
OUTPUT6	BOOLEAN	Output 6
OUTPUT7	BOOLEAN	Output 7
OUTPUT8	BOOLEAN	Output 8
OUTPUT9	BOOLEAN	Output 9
OUTPUT10	BOOLEAN	Output 10
OUTPUT11	BOOLEAN	Output 11
OUTPUT12	BOOLEAN	Output 12
OUTPUT13	BOOLEAN	Output 13
OUTPUT14	BOOLEAN	Output 14
OUTPUT15	BOOLEAN	Output 15
OUTPUT16	BOOLEAN	Output 16
VALID	BOOLEAN	Output data is valid

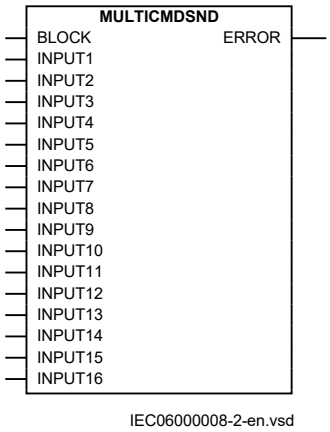


Figure 8: MULTICMDSND function block

7.2.4 Signals

Table 16: MULTICMDSND Input signals

Name	Type	Default	Description
BLOCK	BOOLEAN	0	Block of function
INPUT1	BOOLEAN	0	Input 1
INPUT2	BOOLEAN	0	Input 2
INPUT3	BOOLEAN	0	Input 3
INPUT4	BOOLEAN	0	Input 4
INPUT5	BOOLEAN	0	Input 5
INPUT6	BOOLEAN	0	Input 6
INPUT7	BOOLEAN	0	Input 7
INPUT8	BOOLEAN	0	Input 8
INPUT9	BOOLEAN	0	Input 9
INPUT10	BOOLEAN	0	Input 10
INPUT11	BOOLEAN	0	Input 11
INPUT12	BOOLEAN	0	Input 12
INPUT13	BOOLEAN	0	Input 13
INPUT14	BOOLEAN	0	Input 14
INPUT15	BOOLEAN	0	Input 15
INPUT16	BOOLEAN	0	Input 16

Table 17: MULTICMDSND Output signals

Name	Type	Description
ERROR	BOOLEAN	MultiSend error

7.2.5 Settings

Table 18: MULTICMDRCV Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
tMaxCycleTime	0.050 - 200.000	s	0.001	11.000	Maximum cycle time between receptions of input data
tMinCycleTime	0.000 - 200.000	s	0.001	0.000	Minimum cycle time between receptions of input data
Mode	Steady Pulsed	-	-	Steady	Mode for output signals
tPulseTime	0.000 - 60.000	s	0.001	0.200	Pulse length for multi command outputs

Table 19: MULTICMDSND Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
tMaxCycleTime	0.000 - 200.000	s	0.001	5.000	Maximum time interval between transmission of output data
tMinCycleTime	0.000 - 200.000	s	0.001	0.000	Minimum time interval between transmission of output data

7.2.6 Operation principle

There are 10 instances of the MULTICMDSND function block. The first two are fast (8 ms cycle time) while the others are slow (100 ms cycle time). Each instance has 16 binary inputs, to which 16 independent signals can be connected. Connected signals are sent through MULTICMDSND to the receiving equivalent, MULTICMDRCV, located on a different IED.

The MULTICMDRCV function block has 16 binary outputs, all controlled through the command block of one or many MULTICMDSND function blocks. There are 60 instances of the MULTICMDRCV where the first 12 are fast (8 ms), and the others are slow (100 ms). Additionally, the MULTICMDRCV has a supervision function, which sets the output connector "VALID" to 0 (zero) if its block does not receive any data within the time defined by tMaxCycleTime.

LON connections are established using LON network tool (LNT).

7.3 Synchronization alternatives

7.3.1 Synchronization via Serial Communication Module (SLM)

On the serial buses (both LON and SPA) two types of synchronization messages are sent.

- Coarse message is sent every minute and comprises complete date and time, that is, year, month, day, hours, minutes, seconds and milliseconds.
- Fine message is sent every second and comprises only seconds and milliseconds.

The SLM module is located on the Numeric processing module (NUM).

7.4 Settings

Table 20: TIMESYNCHGEN Non group settings (basic)

Name	Values (Range)	Unit	Step	Default	Description
CoarseSyncSrc	Off SPA LON SNTP DNP IEC103	-	-	Off	Coarse time synchronization source
FineSyncSource	Off SPA LON BIN GPS GPS+SPA GPS+LON GPS+BIN SNTP GPS+SNTP IRIG-B GPS+IRIG-B PPS	-	-	Off	Fine time synchronization source
SyncMaster	Off SNTP-Server	-	-	Off	Activate IEDas synchronization master
TimeAdjustRate	Slow Fast	-	-	Fast	Adjust rate for time synchronization
HWSyncSrc	Off GPS IRIG-B PPS	-	-	Off	Hardware time synchronization source
AppSynch	NoSynch Synch	-	-	NoSynch	Time synchronization mode for application
SyncAccLevel	Class T5 (1us) Class T4 (4us) Unspecified	-	-	Unspecified	Wanted time synchronization accuracy

Section 8 Glossary

8.1 Glossary

AC	Alternating current
ACC	Actual channel
ACT	Application configuration tool within PCM600
A/D converter	Analog-to-digital converter
ADBS	Amplitude deadband supervision
ADM	Analog digital conversion module, with time synchronization
AI	Analog input
ANSI	American National Standards Institute
AR	Autoreclosing
ASCT	Auxiliary summation current transformer
ASD	Adaptive signal detection
ASDU	Application service data unit
AWG	American Wire Gauge standard
BBP	Busbar protection
BFOC/2,5	Bayonet fiber optic connector
BFP	Breaker failure protection
BI	Binary input
BIM	Binary input module
BOM	Binary output module
BOS	Binary outputs status
BR	External bistable relay
BS	British Standards
BSR	Binary signal transfer function, receiver blocks
BST	Binary signal transfer function, transmit blocks
C37.94	IEEE/ANSI protocol used when sending binary signals between IEDs
CAN	Controller Area Network. ISO standard (ISO 11898) for serial communication
CB	Circuit breaker
CBM	Combined backplane module
CCITT	Consultative Committee for International Telegraph and Telephony. A United Nations-sponsored standards body within the International Telecommunications Union.
CCM	CAN carrier module
CCVT	Capacitive Coupled Voltage Transformer
Class C	Protection Current Transformer class as per IEEE/ ANSI

CMPPS	Combined megapulses per second
CMT	Communication Management tool in PCM600
CO cycle	Close-open cycle
Codirectional	Way of transmitting G.703 over a balanced line. Involves two twisted pairs making it possible to transmit information in both directions
COM	Command
COMTRADE	Standard Common Format for Transient Data Exchange format for Disturbance recorder according to IEEE/ANSI C37.111, 1999 / IEC 60255-24
Contra-directional	Way of transmitting G.703 over a balanced line. Involves four twisted pairs, two of which are used for transmitting data in both directions and two for transmitting clock signals
COT	Cause of transmission
CPU	Central processing unit
CR	Carrier receive
CRC	Cyclic redundancy check
CROB	Control relay output block
CS	Carrier send
CT	Current transformer
CU	Communication unit
CVT or CCVT	Capacitive voltage transformer
DAR	Delayed autoreclosing
DARPA	Defense Advanced Research Projects Agency (The US developer of the TCP/IP protocol etc.)
DBDL	Dead bus dead line
DBLL	Dead bus live line
DC	Direct current
DFC	Data flow control
DFT	Discrete Fourier transform
DHCP	Dynamic Host Configuration Protocol
DIP-switch	Small switch mounted on a printed circuit board
DI	Digital input
DLLB	Dead line live bus
DNP	Distributed Network Protocol as per IEEE Std 1815-2012
DR	Disturbance recorder
DRAM	Dynamic random access memory
DRH	Disturbance report handler
DSP	Digital signal processor
DTT	Direct transfer trip scheme
EHV network	Extra high voltage network
EIA	Electronic Industries Association
EMC	Electromagnetic compatibility

EMF	Electromotive force
EMI	Electromagnetic interference
EnFP	End fault protection
EPA	Enhanced performance architecture
ESD	Electrostatic discharge
F-SMA	Type of optical fiber connector
FAN	Fault number
FCB	Flow control bit; Frame count bit
FOX 20	Modular 20 channel telecommunication system for speech, data and protection signals
FOX 512/515	Access multiplexer
FOX 6Plus	Compact time-division multiplexer for the transmission of up to seven duplex channels of digital data over optical fibers
FTP	File Transfer Protocol
FUN	Function type
G.703	Electrical and functional description for digital lines used by local telephone companies. Can be transported over balanced and unbalanced lines
GCM	Communication interface module with carrier of GPS receiver module
GDE	Graphical display editor within PCM600
GI	General interrogation command
GIS	Gas-insulated switchgear
GOOSE	Generic object-oriented substation event
GPS	Global positioning system
GSAL	Generic security application
GSE	Generic substation event
HDLC protocol	High-level data link control, protocol based on the HDLC standard
HFBR connector type	Plastic fiber connector
HMI	Human-machine interface
HSAR	High speed autoreclosing
HV	High-voltage
HVDC	High-voltage direct current
IDBS	Integrating deadband supervision
IEC	International Electrical Committee
IEC 60044-6	IEC Standard, Instrument transformers – Part 6: Requirements for protective current transformers for transient performance
IEC 60870-5-103	Communication standard for protection equipment. A serial master/slave protocol for point-to-point communication
IEC 61850	Substation automation communication standard
IEC 61850–8–1	Communication protocol standard
IEEE	Institute of Electrical and Electronics Engineers
IEEE 802.12	A network technology standard that provides 100 Mbits/s on twisted-pair or optical fiber cable

IEEE P1386.1	PCI Mezzanine Card (PMC) standard for local bus modules. References the CMC (IEEE P1386, also known as Common Mezzanine Card) standard for the mechanics and the PCI specifications from the PCI SIG (Special Interest Group) for the electrical EMF (Electromotive force).
IEEE 1686	Standard for Substation Intelligent Electronic Devices (IEDs) Cyber Security Capabilities
IED	Intelligent electronic device
I-GIS	Intelligent gas-insulated switchgear
IOM	Binary input/output module
Instance	When several occurrences of the same function are available in the IED, they are referred to as instances of that function. One instance of a function is identical to another of the same kind but has a different number in the IED user interfaces. The word "instance" is sometimes defined as an item of information that is representative of a type. In the same way an instance of a function in the IED is representative of a type of function.
IP	1. Internet protocol. The network layer for the TCP/IP protocol suite widely used on Ethernet networks. IP is a connectionless, best-effort packet-switching protocol. It provides packet routing, fragmentation and reassembly through the data link layer. 2. Ingression protection, according to IEC 60529
IP 20	Ingression protection, according to IEC 60529, level 20
IP 40	Ingression protection, according to IEC 60529, level 40
IP 54	Ingression protection, according to IEC 60529, level 54
IRF	Internal failure signal
IRIG-B:	InterRange Instrumentation Group Time code format B, standard 200
ITU	International Telecommunications Union
LAN	Local area network
LIB 520	High-voltage software module
LCD	Liquid crystal display
LDCM	Line differential communication module
LDD	Local detection device
LED	Light-emitting diode
LNT	LON network tool
LON	Local operating network
MCB	Miniature circuit breaker
MCM	Mezzanine carrier module
MPM	Main processing module
MVAL	Value of measurement
MVB	Multifunction vehicle bus. Standardized serial bus originally developed for use in trains.
NCC	National Control Centre
NOF	Number of grid faults
NUM	Numerical module
OCO cycle	Open-close-open cycle

OCP	Overcurrent protection
OEM	Optical Ethernet module
OLTC	On-load tap changer
OTEV	Disturbance data recording initiated by other event than start/pick-up
OV	Overvoltage
Overreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is overreaching when the impedance presented to it is smaller than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay “sees” the fault but perhaps it should not have seen it.
PCI	Peripheral component interconnect, a local data bus
PCM	Pulse code modulation
PCM600	Protection and control IED manager
PC-MIP	Mezzanine card standard
PMC	PCI Mezzanine card
POR	Permissive overreach
POTT	Permissive overreach transfer trip
Process bus	Bus or LAN used at the process level, that is, in near proximity to the measured and/or controlled components
PSM	Power supply module
PST	Parameter setting tool within PCM600
PT ratio	Potential transformer or voltage transformer ratio
PUTT	Permissive underreach transfer trip
RASC	Synchrocheck relay, COMBIFLEX
RCA	Relay characteristic angle
RISC	Reduced instruction set computer
RMS value	Root mean square value
RS422	A balanced serial interface for the transmission of digital data in point-to-point connections
RS485	Serial link according to EIA standard RS485
RTC	Real-time clock
RTU	Remote terminal unit
SA	Substation Automation
SBO	Select-before-operate
SC	Switch or push button to close
SCL	Short circuit location
SCS	Station control system
SCADA	Supervision, control and data acquisition
SCT	System configuration tool according to standard IEC 61850
SDU	Service data unit
SLM	Serial communication module.
SMA connector	Subminiature version A, A threaded connector with constant impedance.

SMT	Signal matrix tool within PCM600
SMS	Station monitoring system
SNTP	Simple network time protocol – is used to synchronize computer clocks on local area networks. This reduces the requirement to have accurate hardware clocks in every embedded system in a network. Each embedded node can instead synchronize with a remote clock, providing the required accuracy.
SOF	Status of fault
SPA	Strömberg Protection Acquisition (SPA), a serial master/slave protocol for point-to-point and ring communication.
SRY	Switch for CB ready condition
ST	Switch or push button to trip
Starpoint	Neutral point of transformer or generator
SVC	Static VAr compensation
TC	Trip coil
TCS	Trip circuit supervision
TCP	Transmission control protocol. The most common transport layer protocol used on Ethernet and the Internet.
TCP/IP	Transmission control protocol over Internet Protocol. The de facto standard Ethernet protocols incorporated into 4.2BSD Unix. TCP/IP was developed by DARPA for Internet working and encompasses both network layer and transport layer protocols. While TCP and IP specify two protocols at specific protocol layers, TCP/IP is often used to refer to the entire US Department of Defense protocol suite based upon these, including Telnet, FTP, UDP and RDP.
TEF	Time delayed earth-fault protection function
TLS	Transport Layer Security
TM	Transmit (disturbance data)
TNC connector	Threaded Neill-Concelman, a threaded constant impedance version of a BNC connector
TP	Trip (recorded fault)
TPZ, TPY, TPX, TPS	Current transformer class according to IEC
TRM	Transformer Module. This module transforms currents and voltages taken from the process into levels suitable for further signal processing.
TYP	Type identification
UMT	User management tool
Underreach	A term used to describe how the relay behaves during a fault condition. For example, a distance relay is underreaching when the impedance presented to it is greater than the apparent impedance to the fault applied to the balance point, that is, the set reach. The relay does not “see” the fault but perhaps it should have seen it. See also Overreach.
UTC	Coordinated Universal Time. A coordinated time scale, maintained by the Bureau International des Poids et Mesures (BIPM), which forms the basis of a coordinated dissemination of standard frequencies and time signals. UTC is derived from International Atomic Time (TAI) by the addition of a whole number of "leap seconds" to synchronize it with Universal Time 1 (UT1), thus allowing for the eccentricity of the Earth's orbit, the rotational axis tilt (23.5 degrees), but still showing the Earth's

	irregular rotation, on which UT1 is based. The Coordinated Universal Time is expressed using a 24-hour clock, and uses the Gregorian calendar. It is used for aeroplane and ship navigation, where it is also sometimes known by the military name, "Zulu time." "Zulu" in the phonetic alphabet stands for "Z", which stands for longitude zero.
UV	Undervoltage
WEI	Weak end infeed logic
VT	Voltage transformer
$3I_O$	Three times zero-sequence current.Often referred to as the residual or the earth-fault current
$3U_O$	Three times the zero sequence voltage. Often referred to as the residual voltage or the neutral point voltage

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