

RELION® PROTECTION AND CONTROL

# REX640

## Engineering Manual







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## **Conformity**

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 the third party testing laboratory Intertek 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.

## Safety information



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



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



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



National and local electrical safety regulations must always be followed.



The frame of the protection relay has to be carefully earthed.



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



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

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# **1 Introduction**

## **1.1 This manual**

The engineering manual contains instructions on how to engineer the protection relays using the different tools in PCM600. The manual provides instructions on how to set up a PCM600 project and insert relays to the project structure. The manual also recommends a sequence for engineering of protection and control functions, LHMI functions as well as communication engineering for IEC 61850 and other supported protocols.

## **1.2 Intended audience**

This manual addresses system and project engineers involved in the engineering process of a project, and installation and commissioning personnel, who use technical data during engineering, installation and commissioning, and in normal service.

The system engineer must have a thorough knowledge of the application, protection and control equipment and the configured functional logic in the relays. The installation and commissioning personnel must have a basic knowledge of handling electronic equipment.



1.3 Product documentation

1.3.1 Product documentation set

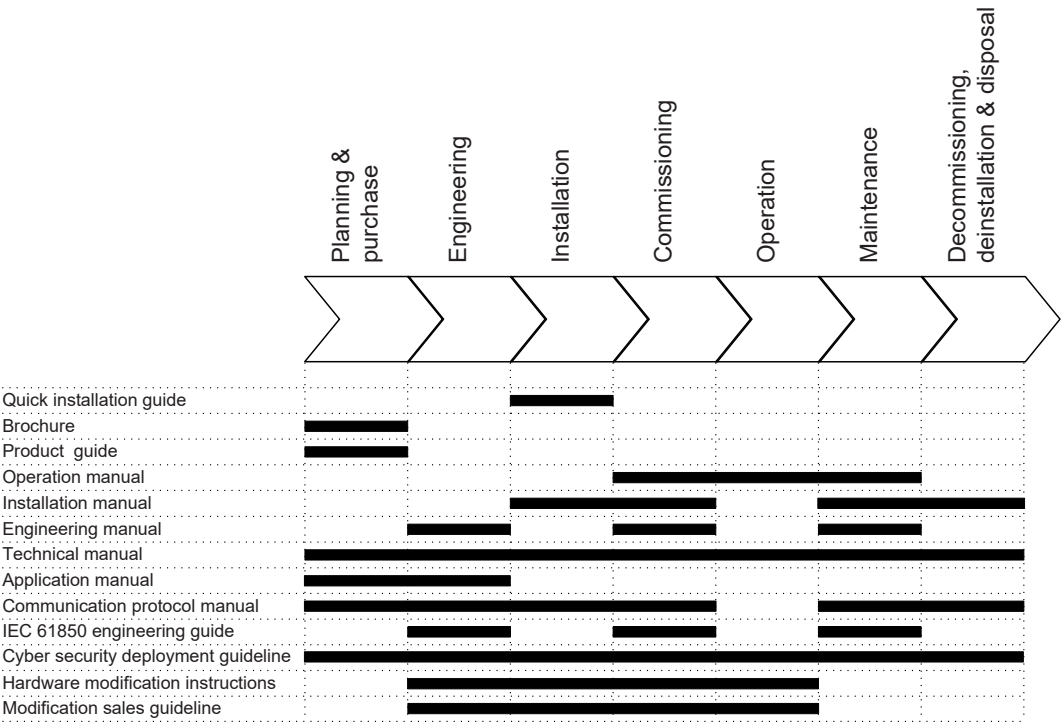


Figure 1: The intended use of documents during the product life cycle

### 1.3.2 Document revision history

Document revision/ date	Product connectivity level	History
A/2019-05-08	PCL1	First release
B/2020-02-13	PCL2	Content updated to correspond to the product connectivity level
C/2020-12-09	PCL3	Content updated to correspond to the product connectivity level
D/2023-02-13	PCL4	Content updated to correspond to the product connectivity level

### 1.3.3 Related documentation

Name of the document	Document ID
TISSUES Implementation Conformance Statement (TICS) for the IEC 61850 interface in REX640	1MRS759027
Protocol Implementation extra Information for Testing (PIX-IT) for the IEC 61850 interface in REX640	1MRS759030
Protocol Implementation extra Information for Testing (PIX-IT) for the IEC 61850 9–2LE interface in REX640	1MRS759037
Protocol Implementation Conformance Statement (PICS) for the IEC 61850 interface in REX640	1MRS759029
IEC 61850 Ed2 Model Implementation Conformance Statement (MICS) for REX640	1MRS759028



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## 1.4 Symbols and conventions

### 1.4.1 Symbols



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. Therefore, comply fully with all warning and caution notices.

## 1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Menu paths are presented in bold.

Select **Main menu > Settings**.

- 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".

- Input/output messages and monitored data names are shown in Courier font.

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

- Values of quantities are expressed with a number and an SI unit. The corresponding imperial units may be given in parentheses.
- This document assumes that the parameter setting visibility is "Advanced".

### 1.4.3 Functions, codes and symbols

**Table 1: Functions included in the relay**

Function	IEC 61850	IEC 60617	ANSI
<b>Protection</b>			
Distance protection	DSTPDIS	Z<	21P,21N
Local acceleration logic	DSTPLAL	LAL	21LAL
Scheme communication logic	DSOCPSCH	CL	85 21SCHLGC
Current reversal and weak-end infeed logic	CRWPSCH	CLCRW	85 21CREV,WEI
Communication logic for residual overcurrent	RESCPSCH	CLN	85 67G/N SCHLGC
Current reversal and weak-end infeed logic for residual overcurrent	RCRWPSCH	CLCRWN	85 67G/N CREV,WEI
Power swing detection	DSTRPSB	Zpsb	68
Line differential protection with inzone power transformer	LNPLDF	3Id/I>	87L
Binary signal transfer	BSTGAPC	BST	BST
Switch-onto-fault protection	CVPSOF	CVPSOF	SOTF
Three-phase non- directional overcurrent protection, low stage	PHLPTOC	3I>	51P-1
Three-phase non- directional overcurrent protection, high stage	PHHPTOC	3I>>	51P-2
Three-phase non- directional overcurrent protection, instantaneous stage	PHIPTOC	3I>>>	50P
Three-phase directional overcurrent protection, low stage	DPHLPDOC	3I>->	67P/51P-1
Three-phase directional overcurrent protection, high stage	DPHHPDOC	3I>>->	67P/51P-2
Non-directional earth-fault protection, low stage	EFLPTOC	Io>	51G/51N-1
Non-directional earth-fault protection, high stage	EFHPTOC	Io>>	51N-2
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	Io>>>	50G/50N
Directional earth-fault protection, low stage	DEFLPDEF	Io>->	67G/N-1 51G/N-1
Directional earth-fault protection, high stage	DEFHPDEF	Io>>->	67G/N-1 51G/N-2
Three-phase power directional element	DPSRDIR	I1 ->	67P-TC
Neutral power directional element	DNZSRDIR	I2->,Io->	67N-TC
Admittance-based earth-fault protection	EFPADM	Yo>->	21YN
Multifrequency admittance-based earth-fault protection	MFADPSDE	Io>->Y	67NYH
Wattmetric-based earth-fault protection	WPWDE	Po>->	32N
Transient/intermittent earth-fault protection	INTRPTEF	Io>->IEF	67NTEF/NIEF
Harmonics-based earth-fault protection	HAEFPTOC	Io>HA	51NH
Touch voltage based earth-fault current protection	IFPTOC	IF>/UT>	46SNQ/59N
Negative-sequence overcurrent protection	NSPTOC	I2>M	46M

*Table continues on the next page*

Function	IEC 61850	IEC 60617	ANSI
Phase discontinuity protection	PDNSPTOC	I <sub>2</sub> /I <sub>1</sub> >	46PD
Residual overvoltage protection	ROVPTOV	U <sub>0</sub> >	59G/59N
Three-phase undervoltage protection	PHPTUV	3U<	27
Three-phase overvoltage variation protection	PHVPTOV	3U <sub>rms</sub> >	59.S1
Three-phase overvoltage protection	PHPTOV	3U>	59
Positive-sequence overvoltage protection	PSPTOV	U <sub>1</sub> >	59PS
Positive-sequence undervoltage protection	PSPTUV	U <sub>1</sub> <	27PS
Negative-sequence overvoltage protection	NSPTOV	U <sub>2</sub> >	47,59NS
Frequency protection	FRPFRQ	f>/f<,df/dt	81
Three-phase voltage-dependent overcurrent protection	PHPVOC	3I(U)>	51V
Overexcitation protection	OEPVPH	U/f>	24
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	3I <sub>th</sub> >F	49F
Three-phase thermal overload protection, two time constants	T2PTTR	3I <sub>th</sub> >T/G/C	49T/G/C
Three-phase overload protection for shunt capacitor banks	COLPTOC	3I>3I<	51,37,86C
Current unbalance protection for shunt capacitor banks	CUBPTOC	dI>C	60N
Three-phase current unbalance protection for shunt capacitor banks	HCUBPTOC	3dI>C	60P
Shunt capacitor bank switching resonance protection, current based	SRCPTOC	TD>	55ITHD
Compensated neutral unbalance voltage protection	CNUPTOV	CNU>	59NU
Directional negative- sequence overcurrent protection	DNSPDO	I <sub>2</sub> >->	67Q
Low-voltage ride- through protection	LVRTPTUV	UU	27RT
Voltage vector shift protection	VVSPPAM	VS	78VS
Directional reactive power undervoltage protection	DQPTUV	Q>->,3U<	32Q,27
Reverse power/ directional overpower protection	DOPDPR	P>/Q>	32R/32O
Underpower protection	DUPDPR	P<	32U
Three-phase under impedance protection	UZPDIS	ZZ	21G
Directional negative sequence impedance protection	DNZPDIS	Z <sub>2</sub> >->	22Q
Three-phase under excitation protection	UEXPDIS	X<	40
Third harmonic-based stator earth-fault protection	H3EFPSEF	dU <sub>0</sub> >/U <sub>0</sub> 3H	64TN
Rotor earth-fault protection (injection method)	MREFPTOC	I <sub>0</sub> >R	64R
Generator shaft leakage current	GSLPTOC	I>,GS	38, 51
Thermal overload protection for rotors	RPTTR	3I <sub>th</sub> >R	49R
High-impedance or flux-balance based differential protection	MHZPDIF	3dI <sub>Hi</sub> >M	87HIM
Out-of-step protection with double blinders	OOSRPSB	OOS	78PS
Negative-sequence overcurrent protection for machines	MNSPTOC	I <sub>2</sub> >M	46M

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Loss of phase, undercurrent	PHPTUC	3I<	37
Loss of load supervision	LOFLPTUC	3I<	37
Motor load jam protection	JAMPTOC	Ist>	50TDJAM
Motor start-up supervision	STTPMSU	Is2t n<	49,66,48,50TDLR
Motor start counter	MSCPMRI	n<	66
Phase reversal protection	PREVPTOC	I2>>	46R
Thermal overload protection for motors	MPTR	3Ith>M	49M
Stabilized and instantaneous differential protection for machines	MPDIF	3dI>M/G	87M/87G
Underpower factor protection	MPUPF	PF<	55U
Stabilized and instantaneous differential protection for two- or three- winding transformers	TR3PTDF	3dI>3W	87T3
Stabilized and instantaneous differential protection for two-winding transformers	TR2PTDF	3dI>T	87T
Numerical stabilized low-impedance restricted earth-fault protection	LREFPNDF	dIoLo>	87NLI
High-impedance based restricted earth- fault protection	HREFPDIF	dIoHi>	87NHI
High-impedance differential protection for phase A	HIAPDIF	dHi_A>	87_A
High-impedance differential protection for phase B	HIBPDIF	dHi_B>	87_B
High-impedance differential protection for phase C	HICPDIF	dHi_C>	87_C
Circuit breaker failure protection	CCBRBRF	3I>/Io>BF	50BF
Three-phase inrush detector	INRPHAR	3I2f>	68HB
Master trip	TRPPTRC	Master Trip	94/86
Arc protection	ARCSARC	ARC	AFD
High-impedance fault detection	PHIZ	HIF	HIZ
Cable Fault Detection	RCFD	CFD	CFD
Fault locator	SCEFRFLO	FLOC	FLOC
Load-shedding and restoration	LSHDPFRQ	UFLS/R	81LSH
Multipurpose protection	MAPGAPC	MAP	MAP
Accidental energization protection	GAEPVOC	U<,I>	50/27
Load blinder	LBRDOB	LB	21LB
<b>Control</b>			
Circuit-breaker control	CBXCBR	I <-> O CB	52
Three-state disconnecter control	P3SXSWI	I<->O P3S	29DS/GS
Disconnecter control	DCXSWI	I <-> O DCC	29DS
Earthing switch control	ESXSWI	I <-> O ESC	29GS
Three-state disconnecter position indication	P3SSXSWI	I<->O P3SS	29DS/GS

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Disconnecter position indication	DCSXSWI	I <-> O DC	29DS
Earthing switch position indication	ESSXSWI	I <-> O ES	29GS
Motor controlled earthing switch and disconnector supervision	ESDCSSWI	ESDCCM	29CM
Emergency start-up	ESMGAPC	ESTART	EST,62
Autoreclosing	DARREC	O->I	79
Autosynchronizer for generator breaker	ASGCSYN	AUTOSYNCG	25AUTOSYNCG
Autosynchronizer for network breaker	ASNCSYN	AUTOSYNC	25AUTOSYNCBT/ T
Autosynchronizer co-ordinator	ASCGAPC	AUTOSYNC	25AUTOSYNC
Synchronism and energizing check	SECRSYN	SYNC	25
Tap changer control with voltage regulator	OL5ATCC	COLTC	90V
Transformer data combiner	OLGAPC	OLGAPC	OLGAPC
Petersen coil controller	PASANCR	ANCR	90
High speed bus transfer	HSABTC	I<->O BT	HSBT
<b>Condition monitoring and supervision</b>			
Circuit-breaker condition monitoring	SSCBR	CBCM	52CM
Hot-spot and insulation ageing rate monitoring for transformers	HSARSPTR	3lhp>T	26/49HS
Trip circuit supervision	TCSSCBR	TCS	TCM
Current circuit supervision	CCSPVC	MCS 3I	CCM
Current circuit supervision for transformers	CTSRCTF	MCS 3I, I2	CCM 3I, I2
Current transformer supervision for high- impedance protection scheme for phase A	HZCCASPVC	MCS I_A	CCM_A
Current transformer supervision for high- impedance protection scheme for phase B	HZCCBSPVC	MCS I_B	CCM_B
Current transformer supervision for high- impedance protection scheme for phase C	HZCCCSPVC	MCS I_C	CCM_C
Fuse failure supervision	SEQSPVC	FUSEF	VCM, 60
Protection communication supervision	PCSITPC	PCS	PCS
Runtime counter for machines and devices	MDSOPT	OPTS	OPTM
Three-phase remanent undervoltage supervision	MSVPR	3U<R	27R
Diesel Generator Monitoring	DGMGAPC	P><,U/f ><	32/40G
<b>Measurement</b>			
Three-phase current measurement	CMMXU	3I	IA, IB, IC
Sequence current measurement	CSMSQI	I1, I2, I0	I1, I2, I0
Residual current measurement	RESCMMXU	Io	IG
Three-phase voltage measurement	VMMXU	3U	VA, VB, VC
Single-phase voltage measurement	VAMMXU	U_A	V_A

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Phase voltage measurement	VPHMMXU	3UL	VL
Residual voltage measurement	RESVMMXU	Uo	VG/VN
Sequence voltage measurement	VSMSQI	U1, U2, U0	V1, V2, V0
Three-phase power and energy measurement	PEMMXU	P, E	P, E
Load profile recorder	LDPRLRC	LOADPROF	LOADPROF
Frequency measurement	FMMXU	f	f
Tap changer position indication	TPOSYLTC	TPOSM	84T
<b>Power quality</b>			
Current total demand, harmonic distortion, DC component (TDD, THD, DC) and individual harmonics	CHMHAI	PQM3IH	PQM ITHD,IDC
Voltage total harmonic distortion, DC component (THD, DC) and individual harmonics	VHMHAI	PQM3VH	PQM VTHD,VDC
Voltage variation	PHQVVR	PQMU	PQMV SWE,SAG,INT
Voltage unbalance	VSQVUB	PQUUB	PQMV UB
<b>Traditional LED indication</b>			
LED indication control	LEDPTRC	LEDPTRC	LEDPTRC
Individual virtual LED control	LED	LED	LED
<b>Logging functions</b>			
Disturbance recorder (common functionality)	RDRE	DR	RDRE
Disturbance recorder, analog channels 1...12	A1RADR	A1RADR	A1RADR
Disturbance recorder, analog channels 13...24	A2RADR	A2RADR	A2RADR
Disturbance recorder, binary channels 1...32	B1RBDR	B1RBDR	B1RBDR
Disturbance recorder, binary channels 33...64	B2RBDR	B2RBDR	B2RBDR
Fault recorder	FLTRFRC	FAULTREC	FR
<b>Other functionality</b>			
Parameter setting groups	PROTECTION	PROTECTION	PROTECTION
Time master supervision	GNRLTMS	TSYNC	TSYNC
Serial port supervision	SERLCCH	SERLCCH	SERLCCH
IEC 61850-1 MMS	MMSLPRT	MMS	MMS
IEC 61850-1 GOOSE	GSELPRT	GSE	GSE
IEC 60870-5-103 protocol	I3CLPRT	I3C	I3C
IEC 60870-5-104 protocol	I5CLPRT	I5C	I5C
DNP3 protocol	DNPLPRT	DNP 3.0	DNP 3.0
Modbus protocol	MBSLPRT	MBS	MBS
OR gate with two inputs	OR	OR	OR
OR gate with six inputs	OR6	OR6	OR6

Table continues on the next page



Function	IEC 61850	IEC 60617	ANSI
OR gate with twenty inputs	OR20	OR20	OR20
AND gate with two inputs	AND	AND	AND
AND gate with six inputs	AND6	AND6	AND6
AND gate with twenty inputs	AND20	AND20	AND20
XOR gate with two inputs	XOR	XOR	XOR
NOT gate	NOT	NOT	NOT
Real maximum value selector	MAX3R	MAX3R	MAX3R
Real minimum value selector	MIN3R	MIN3R	MIN3R
Rising edge detector	R_TRIG	R_TRIG	R_TRIG
Falling edge detector	F_TRIG	F_TRIG	F_TRIG
Real switch selector	SWITCHR	SWITCHR	SWITCHR
Integer 32-bit switch selector	SWITCHI32	SWITCHI32	SWITCHI32
SR flip-flop, volatile	SR	SR	SR
RS flip-flop, volatile	RS	RS	RS
Minimum pulse timer, two channels	TPGAPC	TP	62TP
Minimum pulse timer second resolution, two channels	TPSGAPC	TPS	62TPS
Minimum pulse timer minutes resolution, two channels	TPMGAPC	TPM	62TPM
Pulse counter for energy measurement	PCGAPC	PCGAPC	PCGAPC
Pulse timer, eight channels	PTGAPC	PT	62PT
Time delay off, eight channels	TOFGAPC	TOF	62TOF
Time delay on, eight channels	TONGAPC	TON	62TON
Daily timer	DTMGAPC	DTM	DTM
Calendar function	CALGAPC	CAL	CAL
SR flip-flop, eight channels, nonvolatile	SRGAPC	SR	SR
Boolean value event creation	MVGAPC	MV	MV
Integer value event creation	MVI4GAPC	MVI4	MVI4
Analog value event creation with scaling	SCA4GAPC	SCA4	SCA4
Generic control points	SPCGAPC	SPC	SPCG
Generic up-down counter	UDFCNT	UDCNT	UDCNT
Local/Remote control	CONTROL	CONTROL	CONTROL
External HMI wake-up	EIHMI	EIHMI	EIHMI
Real addition	ADDR	ADDR	ADDR
Real subtraction	SUBR	SUBR	SUBR
Real multiplication	MULR	MULR	MULR
Real division	DIVR	DIVR	DIVR

*Table continues on the next page*

Function	IEC 61850	IEC 60617	ANSI
Real equal comparator	EQR	EQR	EQR
Real not equal comparator	NER	NER	NER
Real greater than or equal comparator	GER	GER	GER
Real less than or equal comparator	LER	LER	LER
Voltage switch	VMSWI	VSWI	VSWI
Current sum	CMSUM	CSUM	CSUM
Current switch	CMSWI	CMSWI	CMSWI
Phase current preprocessing	ILTCTR	ILTCTR	ILTCTR
Residual current preprocessing	RESTCTR	RESTCTR	RESTCTR
Phase and residual voltage preprocessing	UTVTR	UTVTR	UTVTR
Residual current preprocessing, current measured as voltage	RESUTCTR	Io(U)	Io(U)
SMV stream receiver (IEC 61850-9-2LE)	SMVRCV	SMVRCV	SMVRCV
SMV stream sender (IEC 61850-9-2LE)	SMVSENDER	SMVSENDER	SMVSENDER
Redundant Ethernet channel supervision	RCHLCCH	RCHLCCH	RCHLCCH
Ethernet channel supervision	SCHLCCH	SCHLCCH	SCHLCCH
HMI Ethernet channel supervision	HMILCCH	HMILCCH	HMILCCH
Received GOOSE binary information	GOOSERCV_BIN	GOOSERCV_BIN	GOOSERCV_BIN
Received GOOSE double binary information	GOOSERCV_DP	GOOSERCV_DP	GOOSERCV_DP
Received GOOSE measured value information	GOOSERCV_MV	GOOSERCV_MV	GOOSERCV_MV
Received GOOSE 8- bit integer value information	GOOSERCV_INT8	GOOSERCV_INT8	GOOSERCV_INT8
Received GOOSE 32- bit integer value information	GOOSERCV_INT32	GOOSERCV_INT32	GOOSERCV_INT32
Received GOOSE interlocking information	GOOSERCV_INTL	GOOSERCV_INTL	GOOSERCV_INTL
Received GOOSE measured value (phasor) information	GOOSERCV_CMV	GOOSERCV_CMV	GOOSERCV_CMV
Received GOOSE enumerator value information	GOOSERCV_ENUM	GOOSERCV_ENUM	GOOSERCV_ENUM
Bad signal quality	QTY_BAD	QTY_BAD	QTY_BAD
Good signal quality	QTY_GOOD	QTY_GOOD	QTY_GOOD
Received GOOSE Test mode	QTY_GOOSE_TEST	QTY_GOOSE_TEST	QTY_GOOSE_TEST
GOOSE communication quality	QTY_GOOSE_COMM	QTY_GOOSE_COMM	QTY_GOOSE_COMM
GOOSE data health	T_HEALTH	T_HEALTH	T_HEALTH
Fault direction evaluation	T_DIR	T_DIR	T_DIR
Enumerator to boolean conversion	T_TCMD	T_TCMD	T_TCMD
32-bit integer to binary command conversion	T_TCMD_BIN	T_TCMD_BIN	T_TCMD_BIN
Binary command to 32-bit integer conversion	T_BIN_TCMD	T_BIN_TCMD	T_BIN_TCMD
Switching device status decoder - CLOSE position	T_POS_CL	T_POS_CL	T_POS_CL

Table continues on the next page

Function	IEC 61850	IEC 60617	ANSI
Switching device status decoder - OPEN position	T_POS_OP	T_POS_OP	T_POS_OP
Switching device status decoder - OK status	T_POS_OK	T_POS_OK	T_POS_OK
Controllable gate, 8 Channels	GATEGAPC	GATEGAPC	GATEGAPC
Security application	GSAL	GSAL	GSAL
Hotline tag	HLTGAPC	HLTGAPC	HLTGAPC
16 settable 32-bit integer values	SETI32GAPC	SETI32GAPC	SETI32GAPC
16 settable real values	SETRGAPC	SETRGAPC	SETRGAPC
Boolean to integer 32- bit conversion	T_B16_TO_I32	T_B16_TO_I32	T_B16_TO_I32
Integer 32-bit to boolean conversion	T_I32_TO_B16	T_I32_TO_B16	T_I32_TO_B16
Integer 32-bit to real conversion	T_I32_TO_R	T_I32_TO_R	T_I32_TO_R
Real to integer 8-bit conversion	T_R_TO_I8	T_R_TO_I8	T_R_TO_I8
Real to integer 32-bit conversion	T_R_TO_I32	T_R_TO_I32	T_R_TO_I32
Constant FALSE	FALSE	FALSE	FALSE
Constant TRUE	TRUE	TRUE	TRUE

## 2 Relay engineering process

PCM600 is used for various tasks in the protection relay engineering process.

- Relay engineering management
  - Organizing the bay protection relays in the structure of the substation by defining voltage levels and bays below the substation. PCM600 manages the project.
  - Configuring the protection relay functions (for example, protection and control functions) by using Application Configuration.
  - Configuring the parameters and setting values for the protection relay and for the process functions by using Parameter Setting.
  - Configuring LHMI pages, drawing single-line diagrams and making links to dynamic process values by using Graphical Display Editor. The single-line diagrams are displayed on the LHMI and the WHMI on the bay protection relay.
  - Configuring connections between the application configuration function blocks and physical hardware inputs and outputs by using Signal Matrix or Application Configuration.
  - Configuring the events shown on the LHMI using HMI Event Filtering.
- Communication management
  - IEC 61850 station communication engineering is done using the internal IEC 61850 Configuration tool or the separate IET600. PCM600 interacts with IET600 by importing and exporting SCL files.
  - Configuring the GOOSE receiving data connections to the protection relay's application configuration function blocks by using the Application Configuration tool and the Signal Matrix tool.
  - Configuring protocol data mapping for Modbus, DNP3, IEC 60870-5-103 or IEC 60870-5-104 with the Communication Management tool.
  - Configuring the sampled values (process bus) between the devices using Application Configuration, IEC 61850 Configuration and Signal Matrix.
  - Configuring Ethernet ports and other network settings using Ethernet Configuration.
- Record management
  - Generating overviews of the available disturbance recordings in all connected protection relays by using Disturbance Handling.
  - Manually reading the recording files (in the COMTRADE format) from the protection relays by using Disturbance Handling or automatically by using PCM600 Scheduler.
  - Managing recording files with Disturbance Handling.
  - Creating overview reports for fast evaluation of the recording file content by using Disturbance Handling.
  - Reading fault records from the protection relay, saving records to a PC and clearing old records with Fault Record.
  - Reading load profile records from the protection relay, saving records to a PC and clearing old records using Load Profile.
- Service management

- Monitoring the selected signals of a protection relay for commissioning or service purposes by using Application Configuration, Parameter Setting and Event Viewer (including security logs)

There are also additional functions for managing projects and organizing user rights.

- PCM600 user management
  - Organizing users regarding their rights, profiles and passwords to use different tools and functions in the tools.
  - Defining allowed activities for user profiles to use tools in PCM600.
- Relay user management
  - Supporting user account management and role-based access control
  - Using IED Users for local user accounts and Account Management for central account management

Once the engineering of the protection relay is finished, the results must be written to the protection relay.

The connection between the physical IED and PCM600 is established via an Ethernet link on the HMI or LAN port of the protection relay.

## 2.1 Monitoring and control system structure

The monitoring and control system can be divided into three main parts which require specific engineering and configuration.

- Bay level devices
- Station communication
- Station level devices

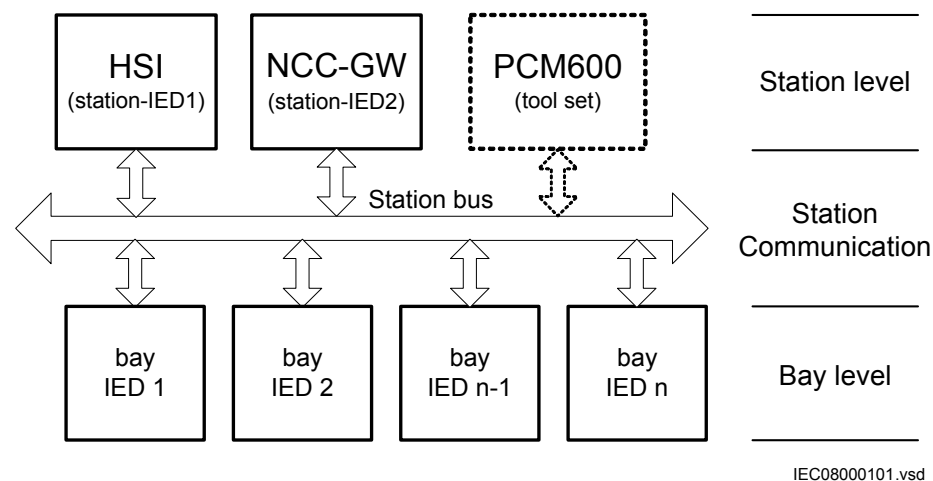


Figure 2: Principle structure of a monitoring and control system for a substation

A plant structure is used to identify each device in its location within the substation organization. The plant structure is a logical image of the substation and the bays within the substation. The device organization may differ from the structure of the primary equipment in the substation.

In PCM600 it is possible to set up a hierarchical structure of five levels for the device identification.

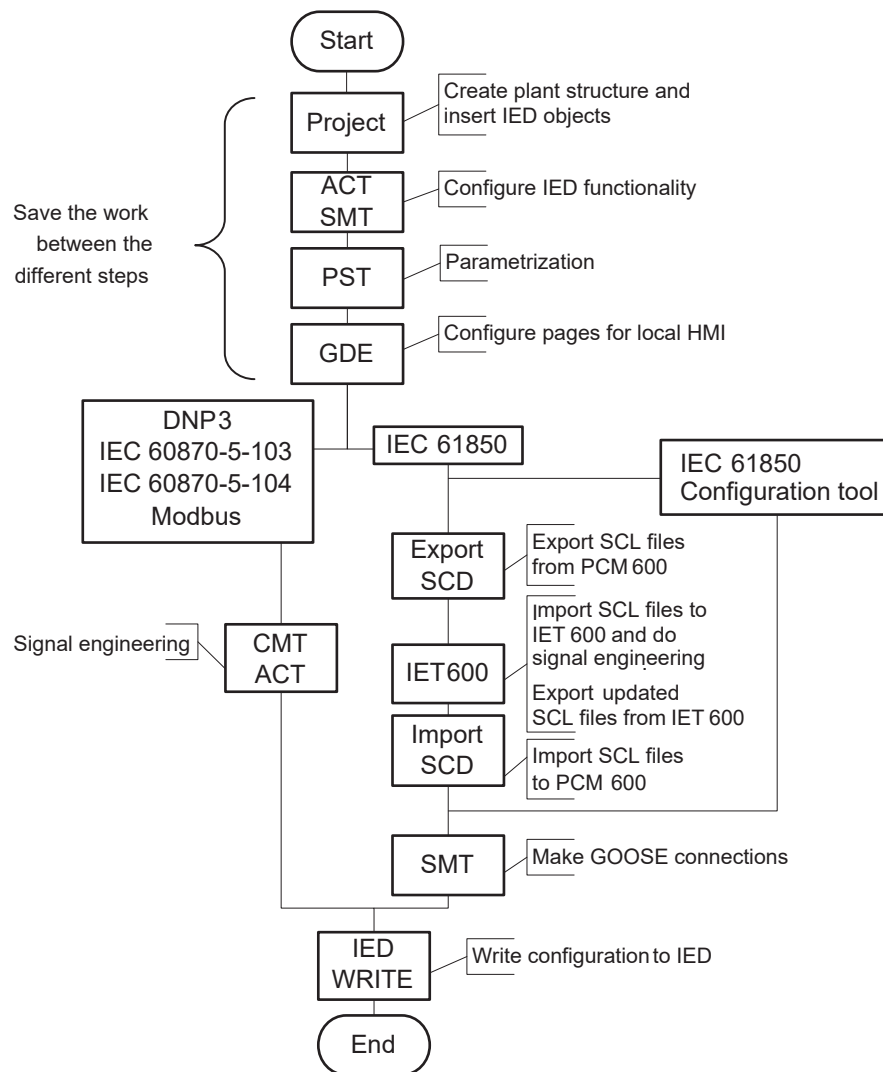
- Project
- Substation = name of the substation
- Voltage level = identifies to which grid type or part the device belongs in the substation
- Bay = bay within the voltage level
- IED = selection of the IED that is used in the bay; several IEDs can be inserted in a bay, for example, one control device and two protection relays

## 2.2 Default configuration

The protection relay contains a default configuration when delivered. The default configuration contains a simple application configuration and an LHMI configuration which can be used as a basis when the actual application configuration is created for the protection relay installation. The default configuration does not have output relays connected in the application configuration, so the relay and its configuration must not be used in installation as they are; modification of the application configuration is always required before commissioning.

The default configuration is available for IEC 61850 Edition 2 only, though the relay supports the IEC 61850 Edition 1 as well. For instructions on how to enable Edition 1 for the relay, see chapter IED insertion.

## 2.3 Workflow



*Figure 3: Protection relay engineering workflow proposal based on practical experience and dependencies of the steps*

It is possible to follow a different sequence based on the information available at the start of the project. This means that several iterations may be needed to complete the project.

### PCM600 project setup

- The plant structure is built according to the substation structure.
- To add a protection relay to a project, a suitable connectivity package is needed. Protection relays can be added either while connected or disconnected or through other means such as an IED template.
- IED objects are uniquely named within the PCM600 project.

### Application configuration in the Application Configuration tool

- Protection and control functions can be configured as needed.

- The configuration made in Application Configuration is saved to make the interfaces and signals available for other engineering tools within PCM600, for example, for Parameter Setting.

#### **Parameter setting and configuration in the Parameter Setting tool**

- The setting values are checked and adjusted with the Parameter Setting tool.

#### **HMI engineering in Graphical Display Editor**

- It is possible to create new pages, configure pages by adding widgets, set page visibility to different user categories, create single-line diagrams (shown on the LHMI and the WHMI) and symbols, and to provide language translations for the LHMI elements.

#### **Communication protocol engineering**

- The communication engineering details are protocol-dependent.
- The connectivity package creates the IEC 61850 configuration for vertical communication automatically and it is often directly suitable for IEC 61850 client configuration. Either IEC 61850 Configuration tool or IET600 is needed for configuring horizontal and vertical communication.
- The Communication Management tool is used for other protocols; for example Modbus.



The protection relay restarts automatically when writing a relay configuration where changes have been made. It is not possible to communicate with the protection relay during restart.



## 3 PCM600

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

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

The whole substation configuration 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 project needs.

PCM600 is used to conduct complete engineering and configuration activities needed for the bay-level protection relays.

Connectivity packages are separate software packages that provide type and version information to PCM600 and assist the tool with communications.

PCM600 communicates with devices over Ethernet using either IEC 61850 or the FTP/FTPS protocols. This communication allows PCM600 to configure and monitor the devices. In addition to IEC 61850, the devices have optional communication protocols and hardware to connect to station engineering tools. PCM600 provides the ability to export the configuration of the devices or an entire substation in a standard file format which enables station engineering in separate IEC 61850 system configuration tools.

A PC with PCM600 can be connected to any Relion protection relay within a station by using the Ethernet connection. The connection can also be used for service and maintenance purposes and to handle disturbance records from the protection relays.

The modern protection relays are designed using the concept of the IEC 61850 standard. This is mainly visible in how functions within the protection relay are modelled and how the protection relay is represented in the substation. The list of logical nodes available in the protection relay reflects the IEC 61850 parameter list. The logical nodes follow the structure and rules defined in part 7 of the standard.

The communication protocol engineering is a separate task and an addition to the engineering of protection and control functions.

As PCM600 can be used for different purposes throughout the protection relay life cycle, a set of tools is available for different applications.

The applications can be organized into groups.

- Relay engineering
- Communication engineering
- Record management
- Device monitoring and diagnostic
- User management



For more information, see the PCM600 documentation.

## 3.1 Connectivity packages

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

A connectivity package includes all the data which is used to describe the protection relay. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameters. In addition, it contains code which allows the software packages that use the connectivity package to properly communicate with the protection relay.

## 3.2 PCM600 and relay connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.12 or later
- REX640 Connectivity Package Ver. 1.3.0 or later



Download connectivity packages from the ABB Web site [www.abb.com/mediumvoltage](http://www.abb.com/mediumvoltage) or directly with Update Manager in PCM600.

### 3.2.1 Installing connectivity packages

- Install connectivity packages either by running the installer which can be downloaded on the ABB Web site or by using Update Manager when a network connection is available.



Download connectivity packages from the ABB Web site [www.abb.com/mediumvoltage](http://www.abb.com/mediumvoltage) or directly with Update Manager in PCM600.

#### 3.2.1.1 Installing connectivity packages by using the connectivity package installer

1. Close PCM600.
2. Run the connectivity package installer.
  - ABB IED Connectivity Package REX640 Ver. n.msi
  - ABB IED Connectivity Package REX640 Ver. n. User Documentation.msi (optional)(n = version number)

- Follow the steps in the connectivity package installation wizard.

### 3.2.1.2 Installing connectivity packages by using Update Manager

- In PCM600, click **Help** and select **Update Manager**.  
Run Update Manager with administrator rights.

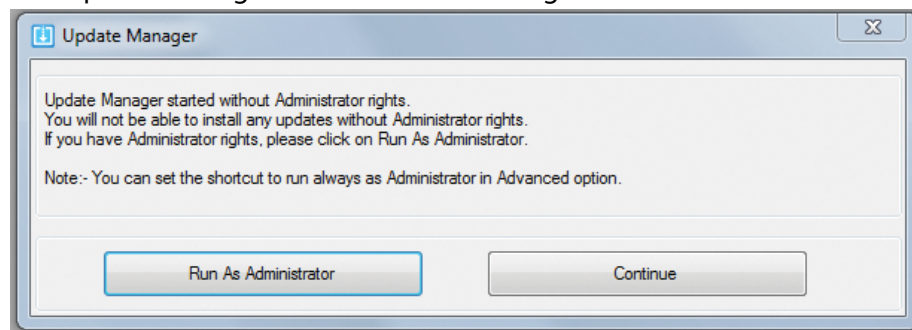


Figure 4: Running Update Manager as an administrator

- Select **Get Connectivity Packages** from the menu on the left column.
  - Select all the required connectivity packages.
  - Click **Download and Install**.
- The status bar shows the installation status.

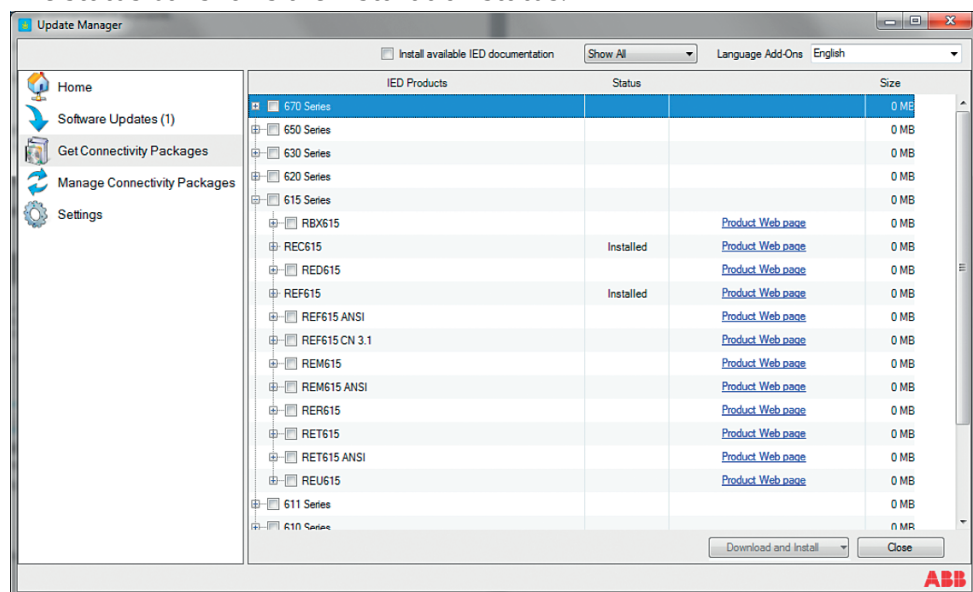


Figure 5: Selecting the connectivity packages

### 3.2.2 Activating connectivity packages

The relay connectivity package has to be installed before it can be activated in Update Manager.

1. Select **Manage Connectivity Packages** from the menu on the left column to access the installed connectivity packages.
2. Browse the tree structure to find the correct product.
3. Select the connectivity package version from the drop-down list beside the product name.



Always use the latest version of the connectivity package.

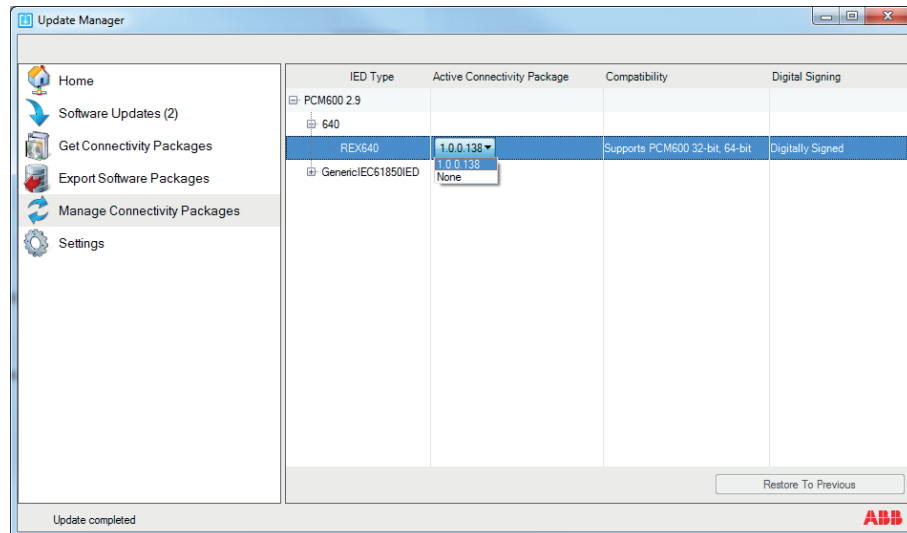


Figure 6: Selecting the connectivity package versions

PCM600 recognizes the installed connectivity packages during start-up, and the corresponding IED types are available in PCM600 when starting a new project.

### 3.3 PCM600 projects

A typical project in PCM600 contains a plant structure including one or several IED objects, where each IED object contains the engineering data created or modified using the different PCM600 tools.

Several projects can be created and managed by PCM600, but only one project can be active at a time.

Regardless of the protocol used in installation for each project, it is possible to have Edition1 and Edition2 relays configured in the same PCM600 project. The PCM600 project's SCL edition is the highest SCL edition relay in the project. If IEC 61850 is not used for station bus, either version can be applied. The protection relay's IEC 61850 version is by default Edition 2.

With PCM600, it is possible to do various tasks.

- Open existing projects
- Import projects
- Create new projects
- Export projects

- Delete projects
- Rename projects
- Copy and paste projects

The extension of the exported project file is .pcmp. The files are only used for exporting and importing projects between PCM600s.

## 3.4 Technical key

Both a physical IED and an IED object in PCM600 have a technical key. The technical key in the protection relay and PCM600 must be the same, otherwise it is not possible to download a configuration.

Each IED in a PCM600 project and in an entire substation must have a unique technical key. Therefore, it is not possible to set the same technical key for several IEDs in the same PCM600 project.



The protection relay is delivered with a factory default technical key. The validation of the technical keys between PCM600 and the protection relay does not occur if the protection relay contains the factory default technical key.



The technical key property in PCM600 corresponds to the IED name attribute in SCL files. Avoid changing the IED name attribute outside PCM600, because data in PCM600 may get lost when importing the SCL files.

When writing a configuration to the protection relay, PCM600 checks for a mismatch between the IED object and the physical IED technical key. The technical key can be read from the protection relay and updated to PCM600, or the PCM600 technical key can be written to the protection relay. Alternatively, a user-defined technical key can be defined.

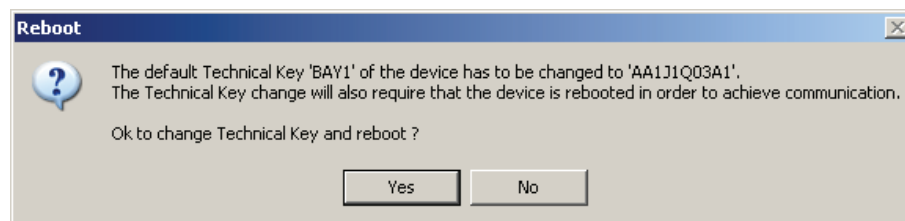


Figure 7: Reboot suggestion



Ensure that the IED object in PCM600 has the same IP address as the physical IED to be connected through the technical key.



Change the technical key for an IED object in the **Object Properties** dialog box in PCM600.

### 3.4.1 IEC 61850 naming conventions for an IED

The IEC 61850 naming conventions to identify an IED are valid only when the IEC 61850 standard is used for station bus communication. According to IEC 61850-6, the SCL model allows two kinds of project designations in the object properties: a technical key and a user-oriented textual designation.

- The technical key is used in engineering drawings and for signal identifications. This is contained in the attribute name as an identification of each object. If the value is used as a reference to an object, it is contained in an attribute name starting with a string denoting the reference target object type and ending with the string *Name*. The technical key is used within SCL for referencing other objects. The name is a relative identification within a hierarchy of objects. The maximum length of the technical key is 28 characters for Edition 1 and 60 characters for Edition 2.
- User-oriented textual designation is contained in the *desc* attribute. Attributes are not allowed to contain carriage return, line feed, tab, greater than, less than, double quotes or ampersand characters. The semantics of *desc* must also be relative within an object hierarchy. The maximum length is 100.

PCM600 supports both possibilities. The two signal designations are available per object in Object Properties for all the hierarchical levels beginning with the station as the highest level.

The technical key is automatically generated based on the rules and type specifications of IEC 61346 and the extended definitions assigned for substations by a technical committee. The technical key is shown in the Object Properties dialog box under SCL Technical Key or Technical Key.

- The station is predefined by "AA1" where 1 is the index. To get the real station name that is used, it is possible to rename the SCL Technical Key for the station as the name used by the project. To minimize the word length, a short form should be used because this name is also used in the transmitted messages to identify the events, for example.
- The voltage level. In [Figure 8](#) it is 20 kV and J1 is selected from the list below SCL Technical Key in the Object Properties dialog box.
- The bay and the IED are appended with the coding defined in the IEC 61346 standard and the substation definition lists. In the example, the bay SCL Technical Key part is Q03 and IED is A1.

The user-oriented textual designation is visible in the Plant structure view for each object. It is the name given by default or changed by with the Rename function.

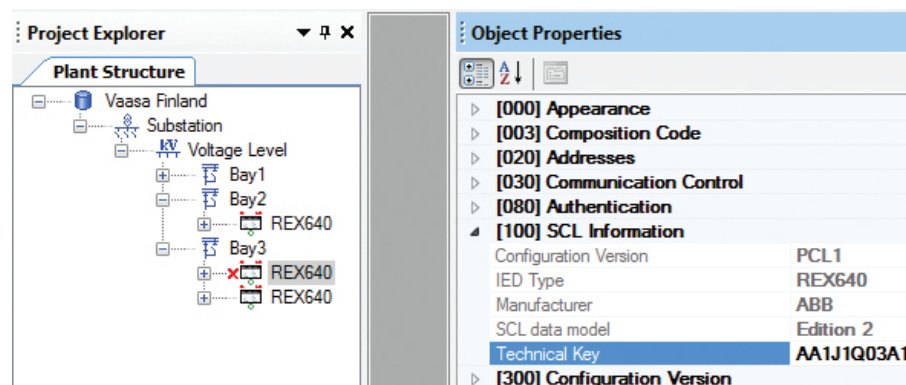


Figure 8: IEC 61850 signal designation concept in PCM600

The created technical key for the full path name of the IED would be: AA1J1Q03A1.

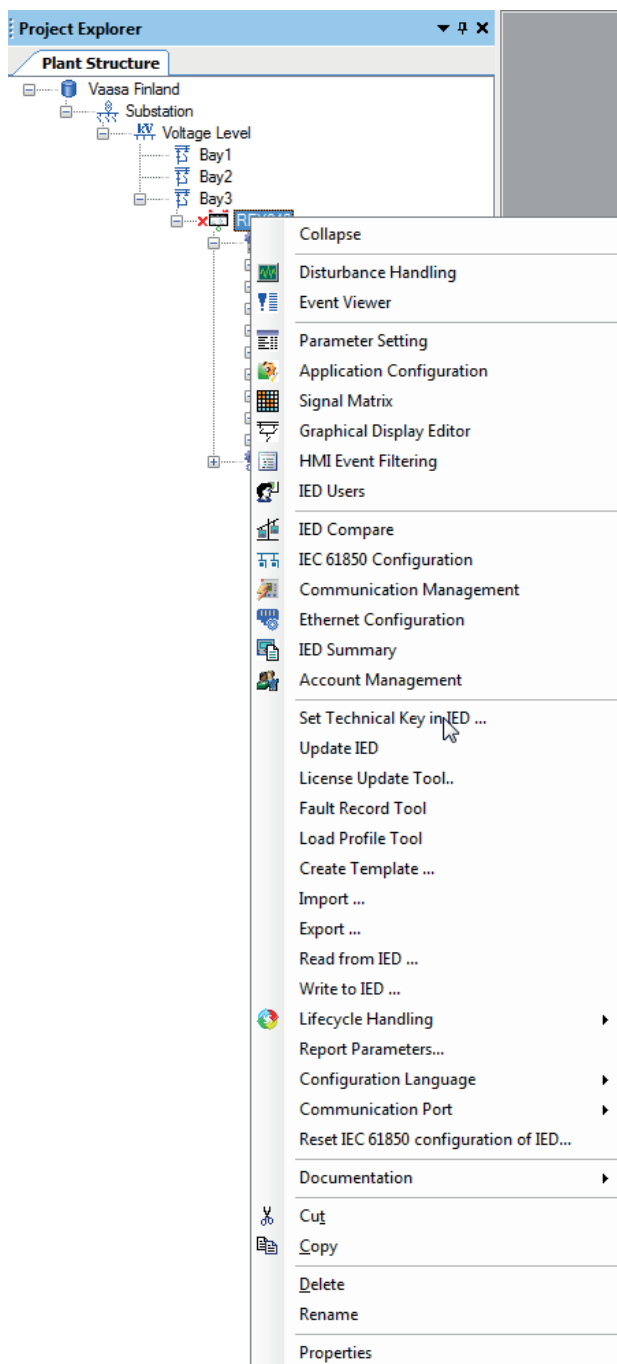
- AA1 = substation in the project
- J1 = voltage level from 20 to 30 kV
- Q03 = third bay in the voltage level
- A1 = first IED in bay Q03

### 3.4.2 Setting technical key



The maximum length of the technical key is 28 characters for Edition 1 and 60 characters for Edition 2.

1. In the **Plant Structure** view, right-click the IED and select **Set Technical Key in IED**.



*Figure 9: PCM600: Setting the technical key on the IED level*

A dialog box opens to inform about the technical key concept.



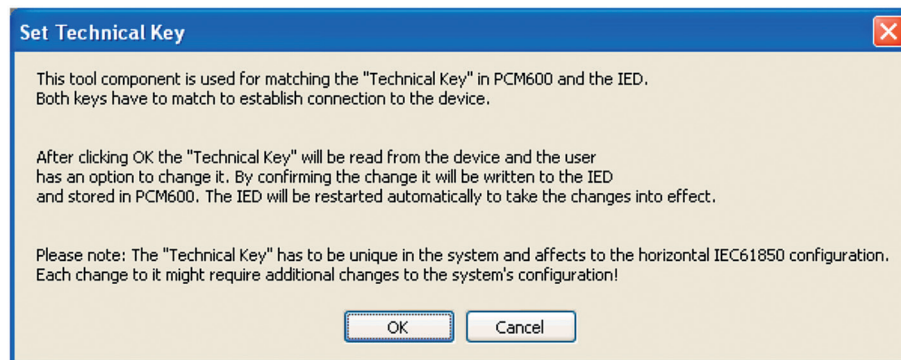


Figure 10: Technical key information

2. Click **OK**.

The technical key is read from the IED and the **Set Technical Key** dialog box opens.

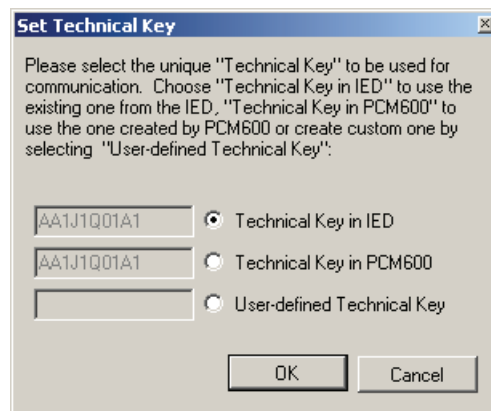


Figure 11: Setting the technical key

3. In the **Set Technical Key** dialog box, select the technical key to be used. There are three alternatives.
  - Use the technical key in the IED
  - Use the technical key defined for the IED object in PCM600
  - Set a user-defined technical key, which changes the technical key for both the physical IED and IED object in PCM600
4. Click **OK** to confirm the selection.



It is not possible to set a user-defined name or select **Technical key in IED** if the value is already given to another IED object in the PCM600 project. An error message is displayed if this happens.

## 3.5 Communication between PCM600 and the protection relay

The communication between the protection relay and PCM600 is independent of the used communication protocol within the substation or to the NCC.

All communication is done over Ethernet using either IEC 61850 or the FTP/FTPS protocol.

When an Ethernet-based station protocol is used, the same Ethernet port and IP address can be used for PCM600 communication.

Two basic variants have to be considered for the connection between PCM600 and the protection relay.

- Direct point-to-point link between PCM600 and service port X1.2 on the protection relay's LHMI or, if an LHMI is not used, the HMI port X0 of the communication module
  - Indirect link via station LAN or remotely via network
1. If needed, the IP address for the protection relay is set.
  2. A PC or workstation is set up for a direct link (point-to-point), or the PC or workstation is connected to the LAN/WAN network.
  3. The protection relays' IP addresses in the PCM600 project are configured to match the IP addresses of the physical IEDs.
  4. Technical keys of the IEDs in the PCM600 project are configured to match the technical keys of the physical IEDs.

For successful protection relay engineering and usage, the workstation firewall TCP and UDP port configurations should be checked, especially for IEC 61850 and FTP. Other protocols are not used for engineering or they are optional.

### 3.5.1 Setting up IP addresses

The IP address and the corresponding subnet mask can be set via LHMI for the Ethernet interface in the protection relay. Each Ethernet interface has a default factory IP address when the protection relay is delivered. The configured Ethernet interface IP address is preserved if the communication card is replaced.

1. Set the IP address for the protection relay's rear port and the corresponding subnet mask via the LHMI paths **Configuration > Communication > Ethernet > Network1 address** and **Configuration > Communication > Ethernet > Network2 address**.

Only the Network1 interface is enabled by default. See the cyber security deployment guideline for more information.

**Table 2: Default IP addresses for the LAN port interfaces and the corresponding subnet masks**

Interface	IP address	Subnet mask	Default mode
Network1	192.168.2.10	255.255.255.0	Enabled
Network2	192.168.3.10	255.255.255.0	Disabled



When using redundant Ethernet (HSR or PRP), configure all devices in the network before connecting cables to ports LAN A and LAN B. Avoid using the LAN A or LAN B ports on redundant communication modules while changing the *Switch mode* parameter.

## 3.6 IED Update

The firmware update tool is used for updating the following:

- IED firmware
- HW module firmware
- LHMI firmware and application
- License in case of Modifications Sales related update

The tool can also be used for adding or replacing IED languages. Update packages are provided by Customer Support.

The update tool can be used either locally or remotely.



Separate update packages are needed for updating the communication card, the LHMI and license and default configuration files. If the new communication card firmware, LHMI firmware or application need new IED firmware, it is updated at the same time, otherwise a second update with the same package is needed to update the IED firmware.

### 3.6.1 Prerequisites for local and remote updates

Local update

- It is recommended to use the LHMI's service port X1.2 or, if an LHMI is not used, the HMI port X0 of the communication module. The IED should be removed from the network especially with redundant network topologies (HSR or PRP).

Remote update

- Communication should be secured either by setting up a VPN connection or by enabling secure communication in the IED via LHMI (**Configuration > Communication > Protocols > Network1FTP** or **Configuration > Communication > Protocols > Network2 > FTP**).
- Remote update can be enabled in the IED either via the LHMI (**Configuration > Authorization > Security > Remote Update**) or by an administrator in Parameter Setting in PCM600 (**IED Configuration > Configuration > Authorization > Remote Update**). If the IED is in local control mode, remote update proceeds only after a confirmation is received from the user.
- Remote update can be disabled manually after the update.
- Remote update only works when the IED is connected from the Ethernet interface connector of the communication module with a custom IP address.
- Remote update via a network gateway can be assigned either to Network 1 or Network 2.

### 3.6.2 Updating firmware or language

1. Select the update mode.
  - Firmware
  - Language
2. Select the update package and click **Next**.

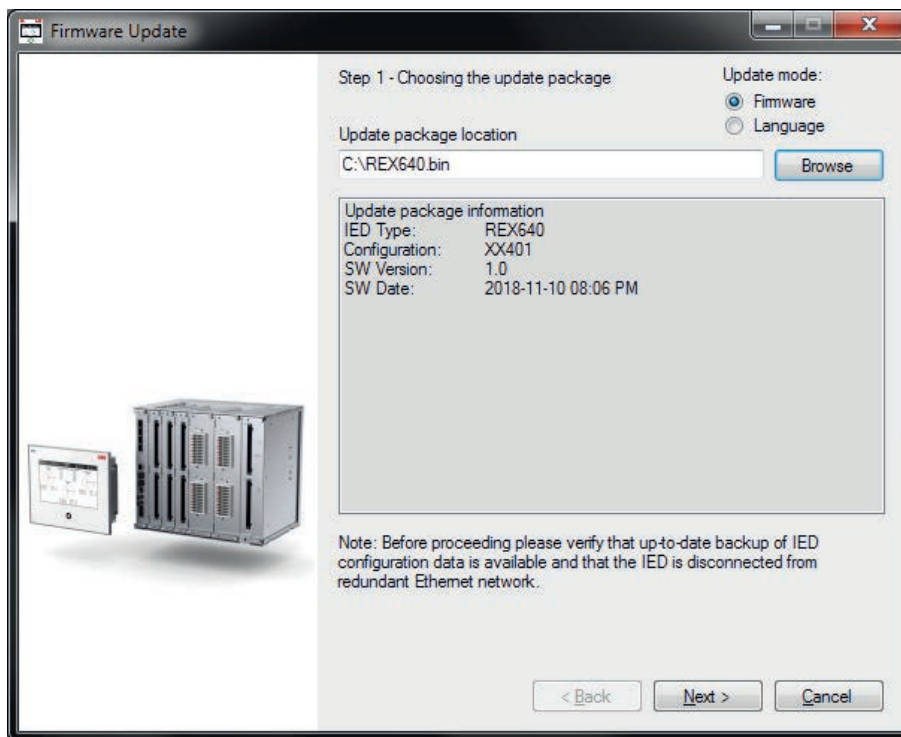


Figure 12: Choosing the update mode and package

3. Select the relay to be updated and click **Next**.  
Currently only one relay can be selected.

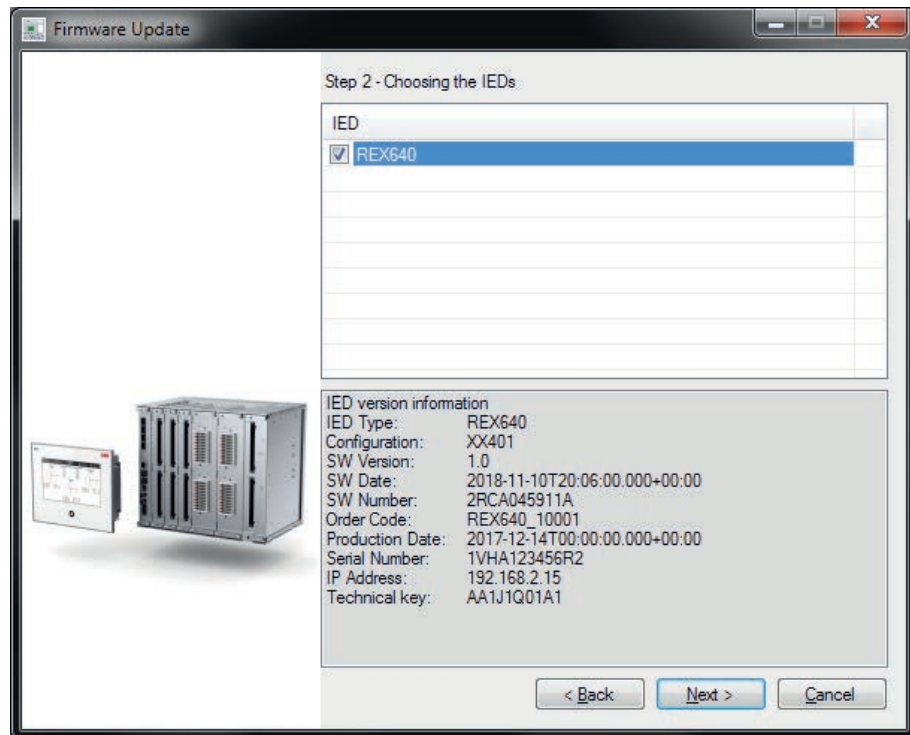
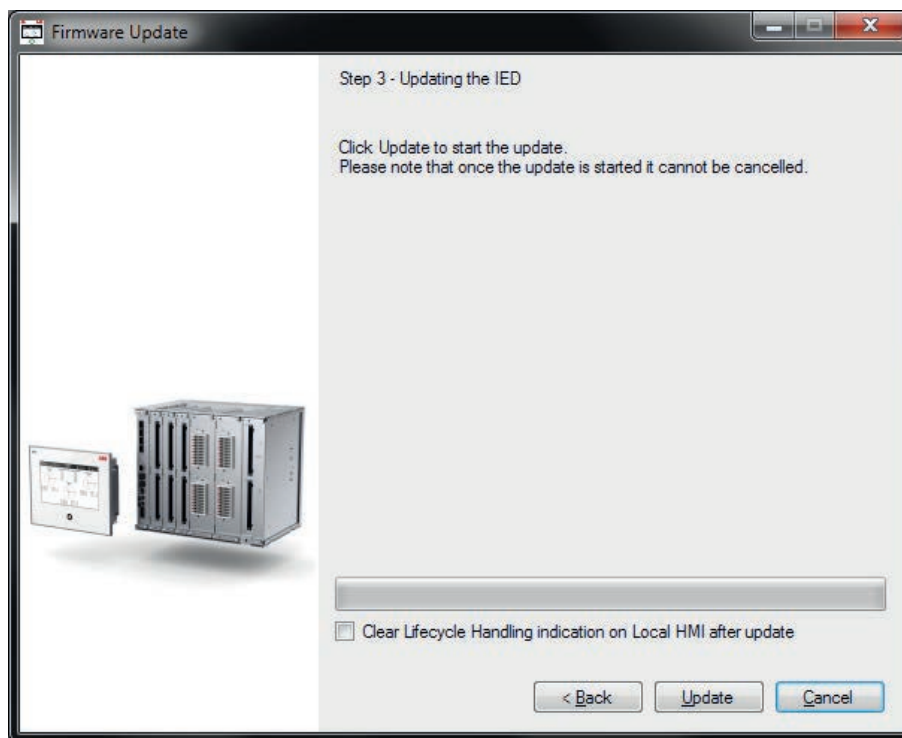


Figure 13: Choosing the relay for the update

4. If required, clear the life cycle handling indication by selecting the **Clear Lifecycle Handling indication on Local HMI after update** check box.



*Figure 14: Clearing lifecycle handling indication*

5. When updating remotely, wait for 30 seconds for the local user confirmation before proceeding with the update.
  - The local user can cancel the update via the LHMI by pressing Cancel Update during the 30-second window.
  - IED use is allowed after the update is completed successfully.

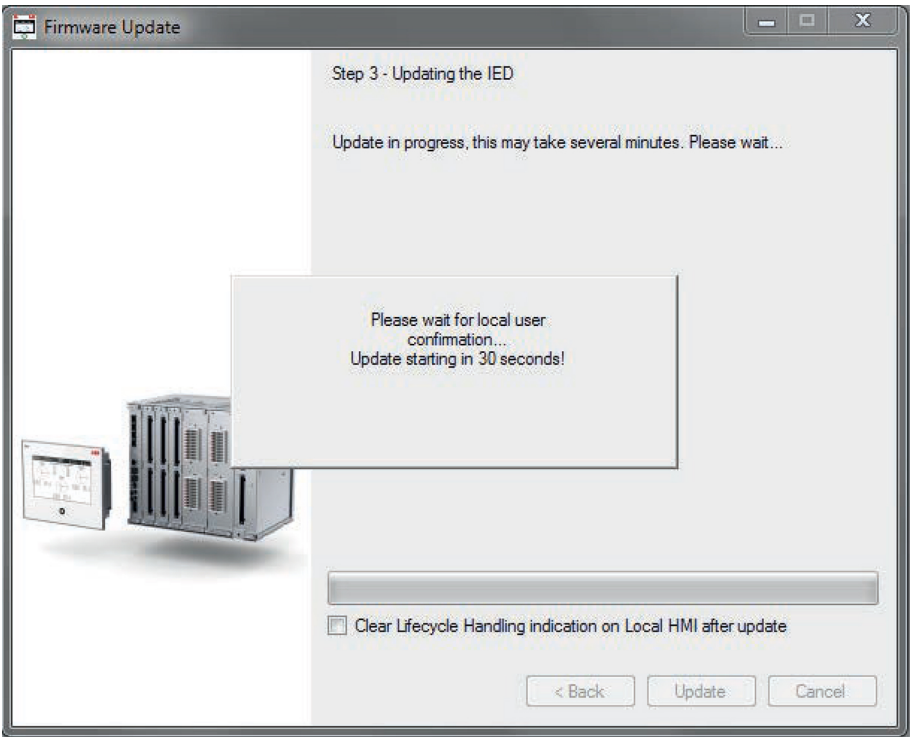


Figure 15: Waiting for local user confirmation with remote update

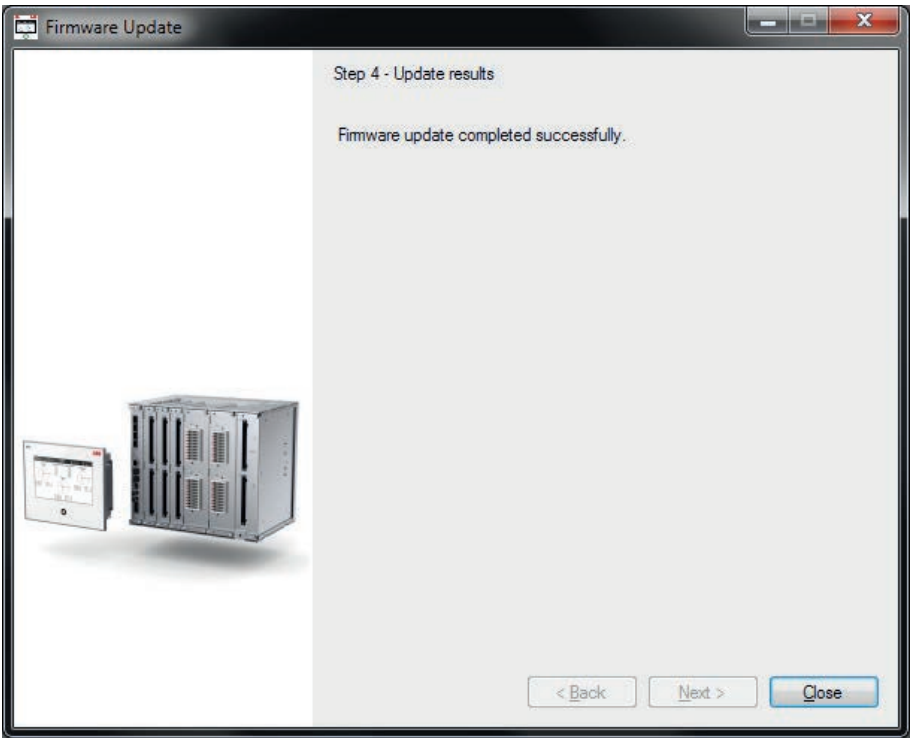
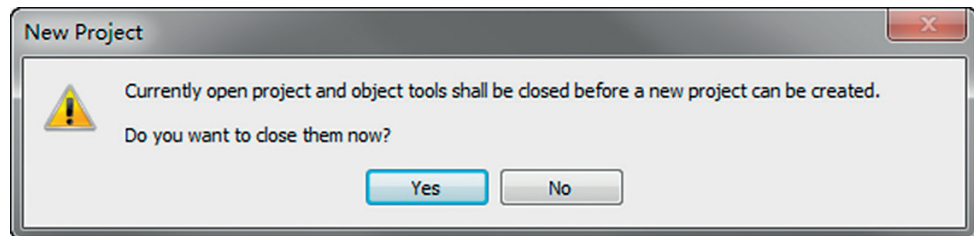


Figure 16: Completing the update

## 4 Setting up a project

### 4.1 Creating a new project

1. Start PCM600.
2. To see the projects that are available in the PCM databases, click **File** and select **Open > Manage Project** on the menu bar.
3. In the **Open > Manage Project** window, click **Projects on my computer**.
4. Click **New Project**.
5. If there are projects or object tools open, a confirmation dialog box opens.



*Figure 17: Confirming project and object tool closing*

6. In the **Create New Project** dialog box, fill in the project name and optional description.
  - In the **Project Name** box, type a unique name for the project.
  - In the **Description** box, type a description of the project.



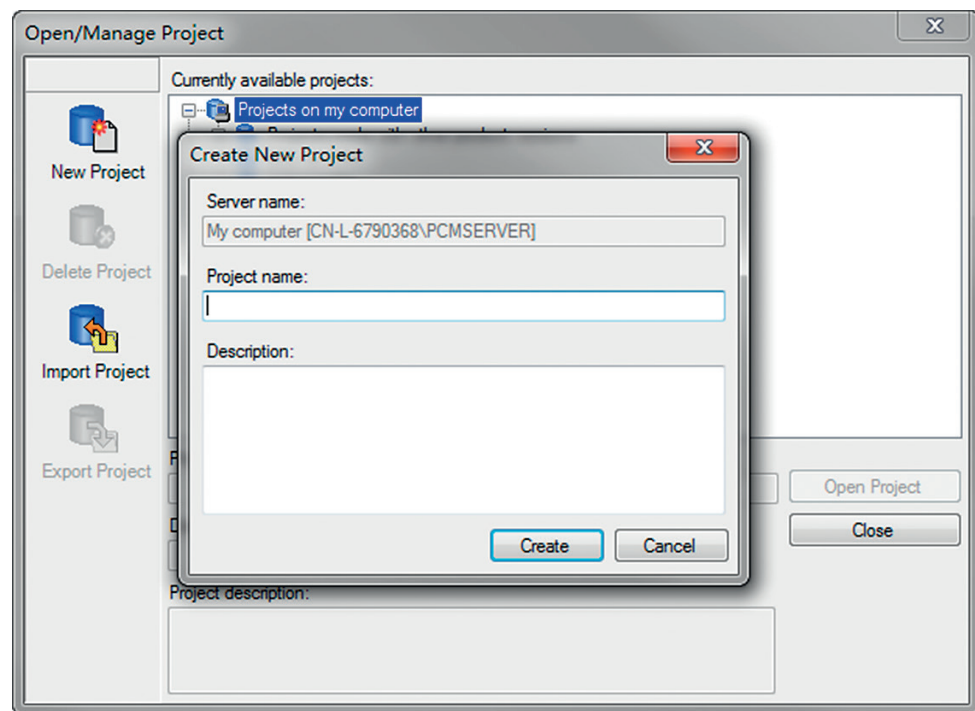


Figure 18: Creating a new project

7. Click **Create**.

PCM600 sets up a new project that is listed under **Projects on my computer**.

## 4.2 Building plant structure

1. Create a new plant structure in one of the alternative ways.
  - Right-click the **Plant Structure** view, point to **New** and select **Create from Template**.
  - Right-click the **Plant Structure** view, point to **New**, select **General** and select either **IED Group** or **Substation**.
2. On the **View** menu, select **Object Types**.

3. Select the needed elements and drag them into the plant structure.

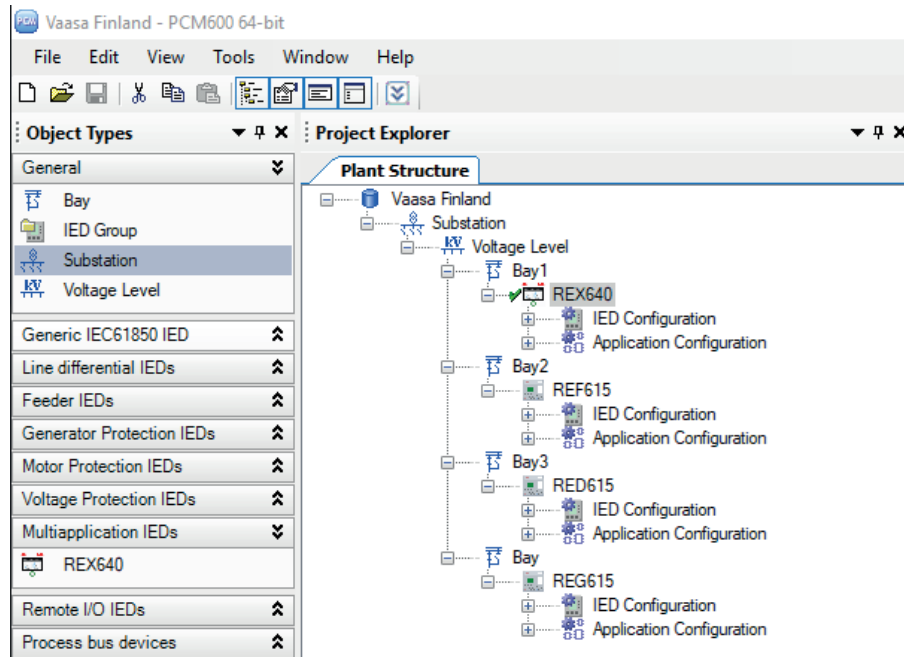


Figure 19: Project with IEDs placed but not renamed

4. Rename each level in the structure by the names or identifications used in the grid.

Use one of the alternative ways.

- Right-click the level and select **Rename**.
- Rename the levels in the **Object Properties** view.

## 4.3 IED insertion

The context menu or the **Object Types** view shows the available IEDs that can be inserted on the bay level of the plant structure according to the installed connectivity package.

It is possible to do various tasks in the plant structure.

- Insert either an offline or an online IED
- Import a template IED that is available in the template library as a .pcmt file
- Import a preconfigured IED available as a .pcmi file



PCM600 uses two kinds of IED files: .pcmt and .pcmi. Both files include the complete IED configuration but their usage differs. The .pcmt files are always accessed through the PCM600 template manager while the .pcmi files are meant for sharing the IED instances between different PCM600 users enabling quick import and export from the plant structure context menu.

### 4.3.1 Inserting an IED in online mode

To set up an IED online, the protection relay must be connected to PCM600.

When the protection relay is connected to PCM600, PCM600 can read the composition code directly from the relay. It is possible to read the full configuration from the relay by using the Read from IED function.

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the relay application area such as **Multiapplication IEDs** and select the protection relay type to be inserted.



Alternatively, drag an IED from the **Object Types** view to the bay level.

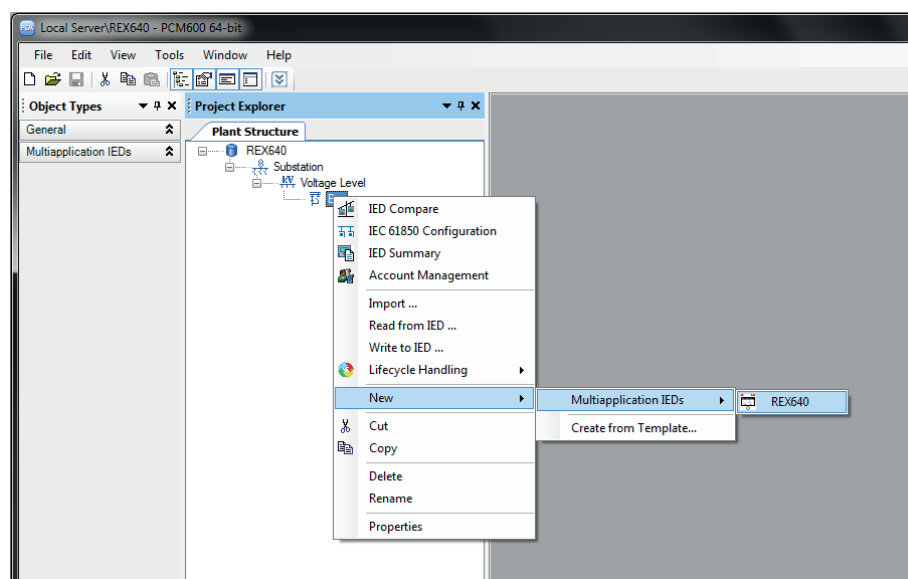
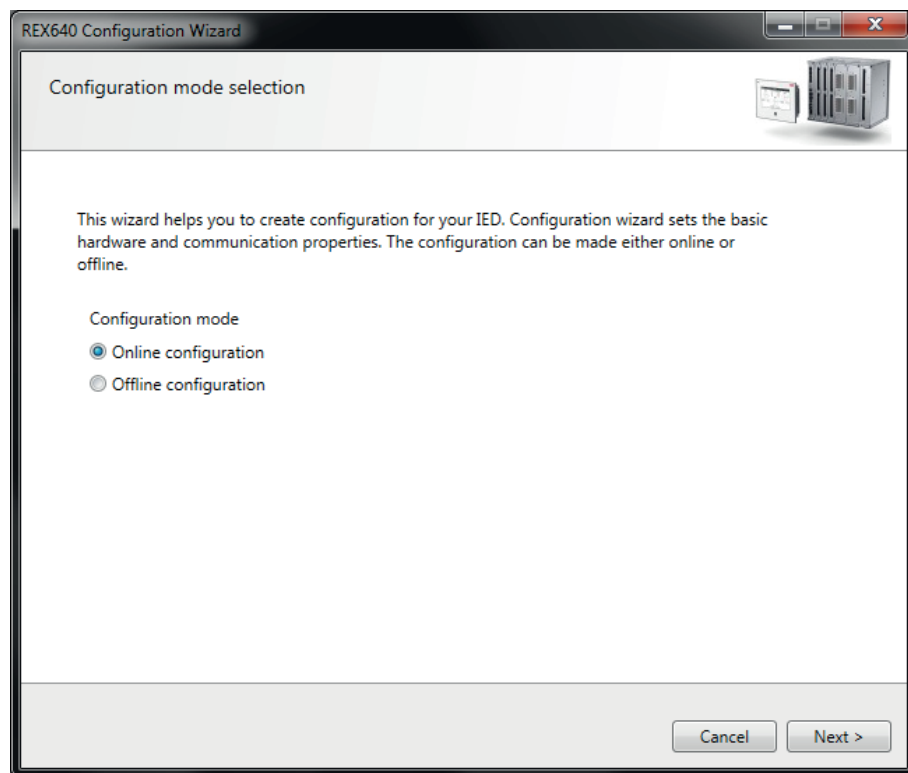


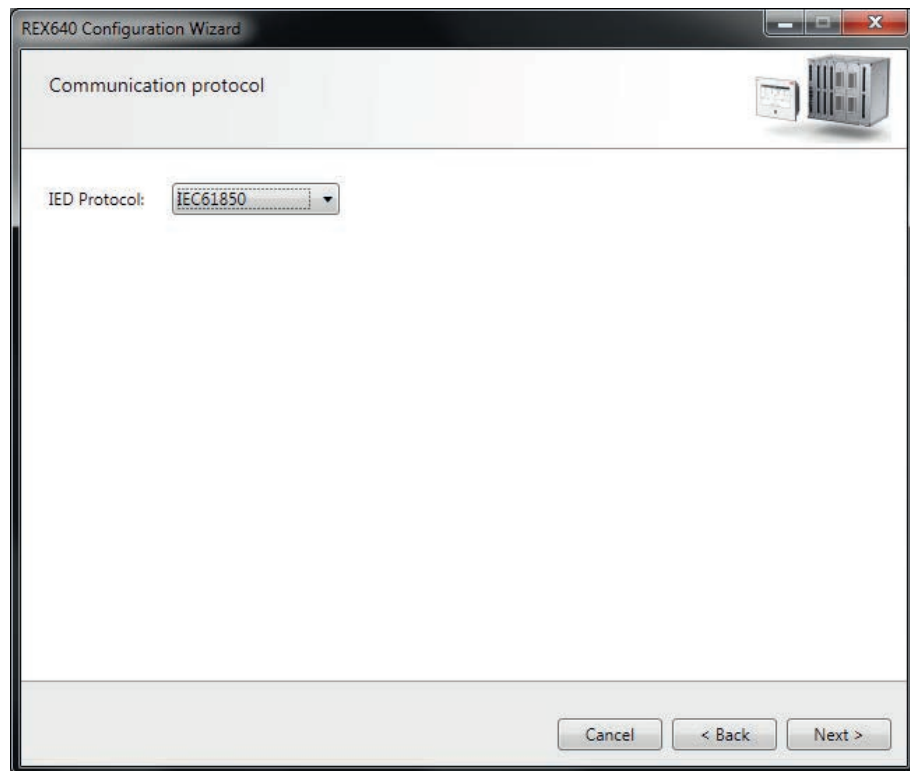
Figure 20: Selecting the protection relay type

2. On the **Configuration mode selection** page, select **Online Configuration** and click **Next**.



*Figure 21: Selecting the configuration mode*

3. On the **Communication protocol** page, select the communication protocol from the **IED Protocol** list and click **Next**.



*Figure 22: Selecting the communication protocol*

4. On the **IEC61850 communication protocol** page, select the port from the **Port** list.
  - If the LAN port is selected, type the correct IP address (of the physical protection relay to be configured) to the **IP address** box.

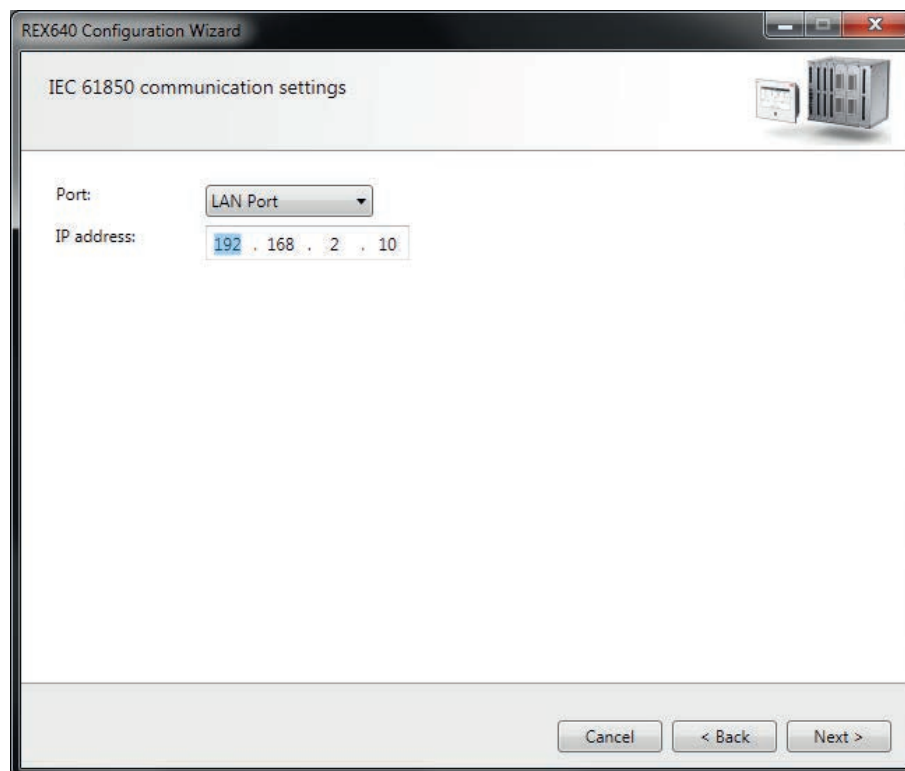


Figure 23: Selecting the communication port and IP address

Communication configuration is now defined.

5. Click **Next** to scan/read the composition code of the protection relay.
6. On the **Composition code detection** page, click **Next**.

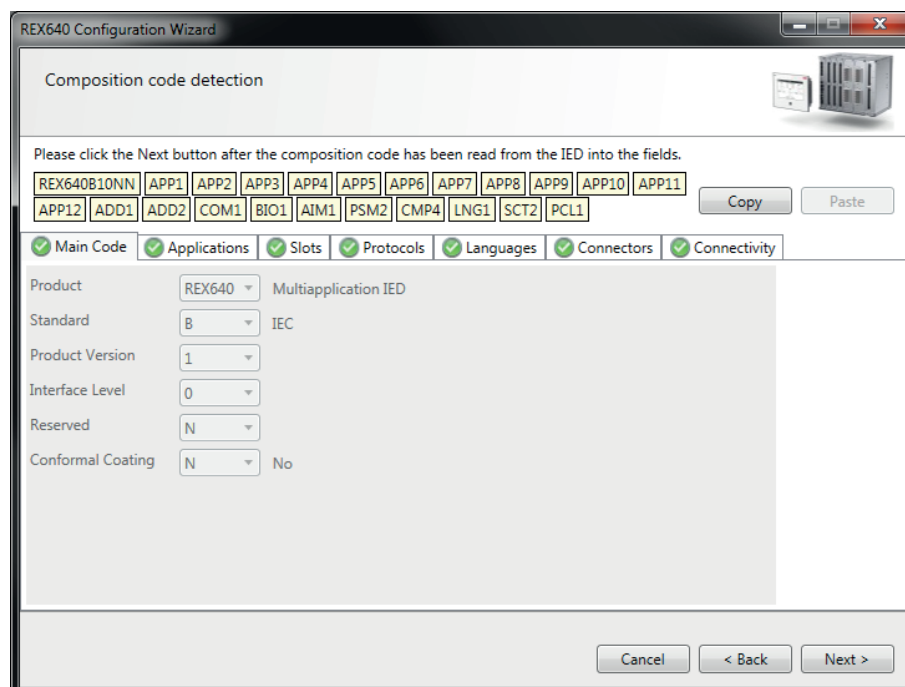


Figure 24: Detecting the composition code

7. On the **Configuration selection** page, select the configuration type and click **Next**.
  - Select **Empty Configuration** to create an empty configuration.
  - Select **Import configuration from file (PCMI/PCMT)** to import any existing example configuration.

Click **Browse** to select the .pcmi or .pcmt file that has the example configuration.
  - Select **Default configuration (available only for IEC 61850 Edition 2)** to generate a default configuration.

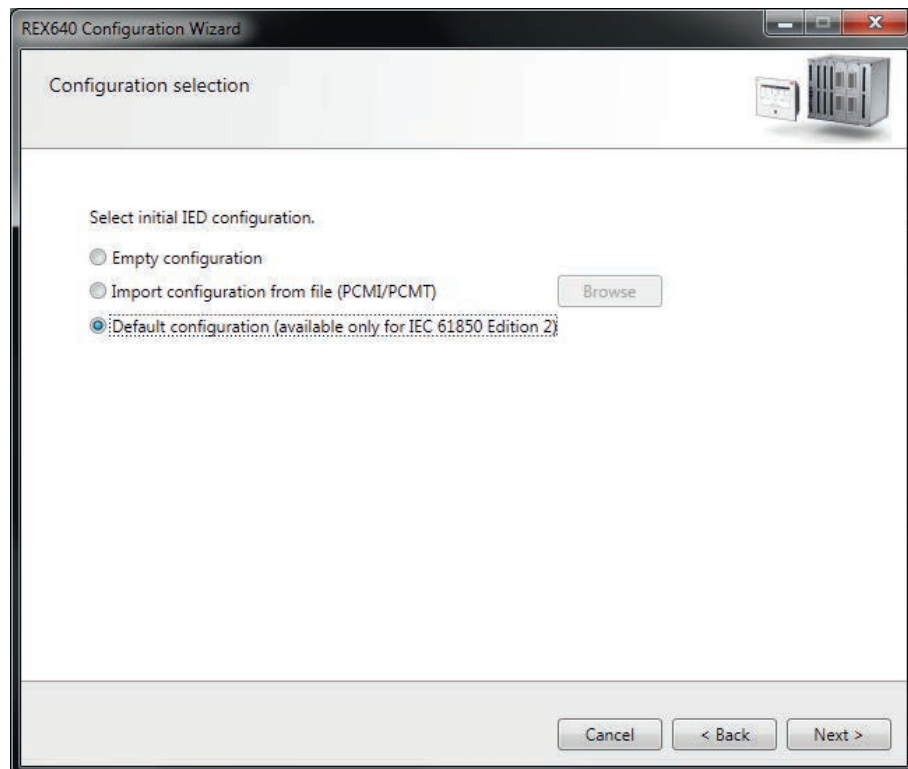
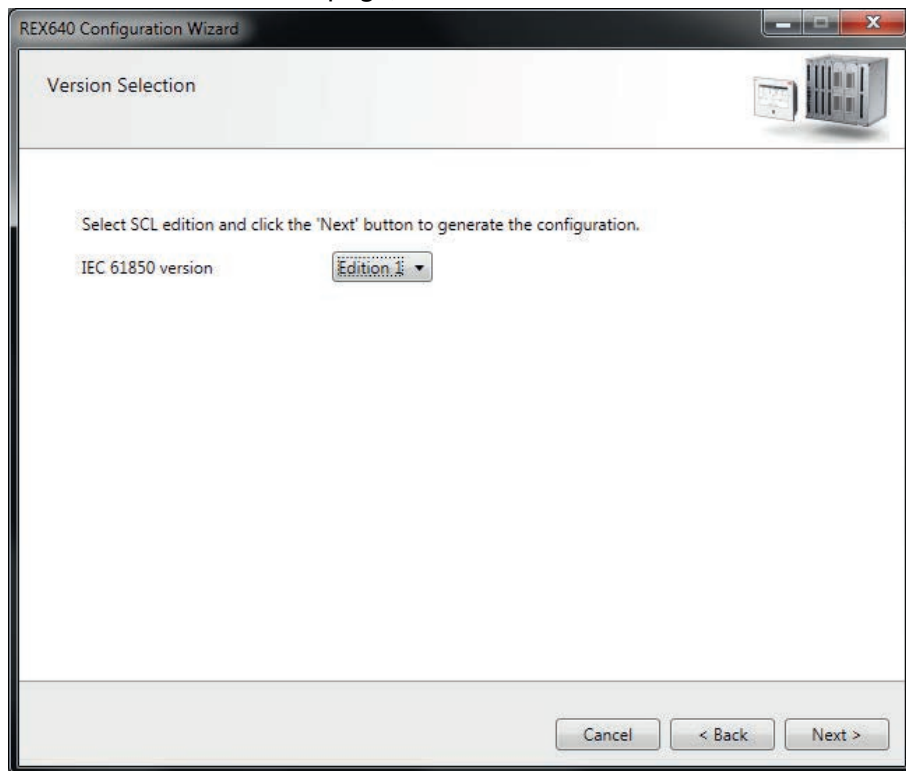


Figure 25: Selecting the configuration type



If a default configuration is selected, the next page is skipped as default configuration is only supported for the IEC 61850 Edition 2 IEDs. To configure an IEC 61850 Edition 1 IED, select empty or example configuration and make the proper selections on the next page.

8. On the **Version Selection** page, select the IEC 61850 version and click **Next**.



*Figure 26: Selecting the IEC 61850 version*



Regardless of the protocol used in the installation for each project, it is possible to have Edition1 and Edition2 relays configured in the same PCM600 project. The PCM600 project's SCL edition is the highest SCL edition relay in the project.



- On the **Summary** page, click **Finish** to confirm the configuration and insert the IED.

The **Summary** page shows the protection relay's IED type, IP address and the selected composition code.

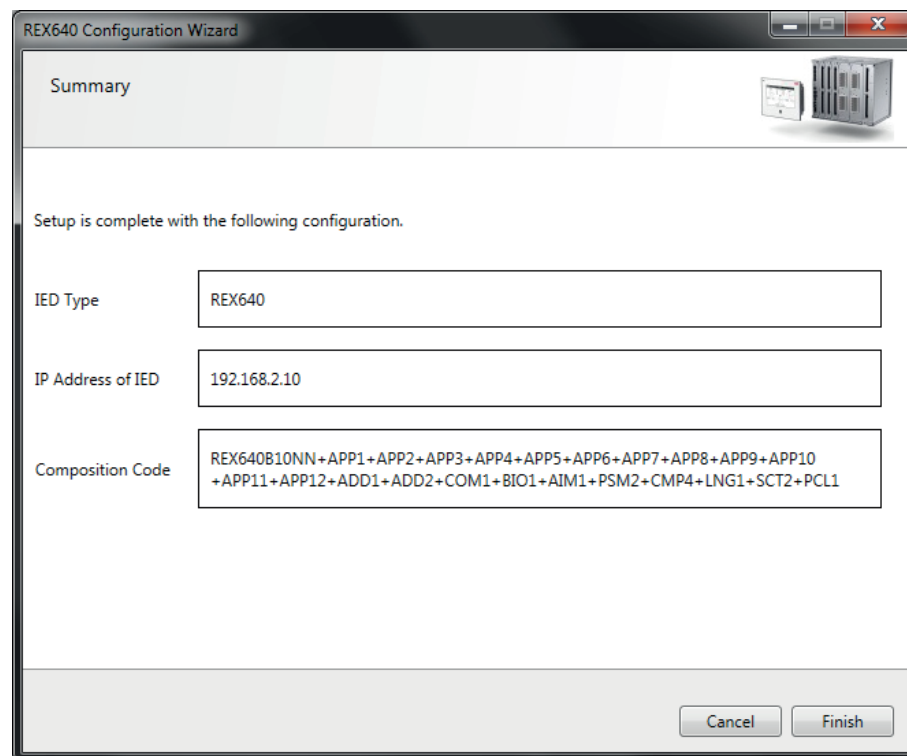


Figure 27: Confirming the configuration



If an error is shown on the **Summary** page, it is not possible to go back and make modifications. If an error is detected, cancel the insertion by clicking **Cancel** and insert the IED again.

### 4.3.2 Inserting an IED in offline mode

When the protection relay is not available or is not connected to PCM600, engineering can be done offline. The offline configuration in PCM600 can be written to the protection relay later when it is connected.

Working in the offline mode has an advantage over the online mode because the preparation for the configuration can be started even though the protection relay is not available.

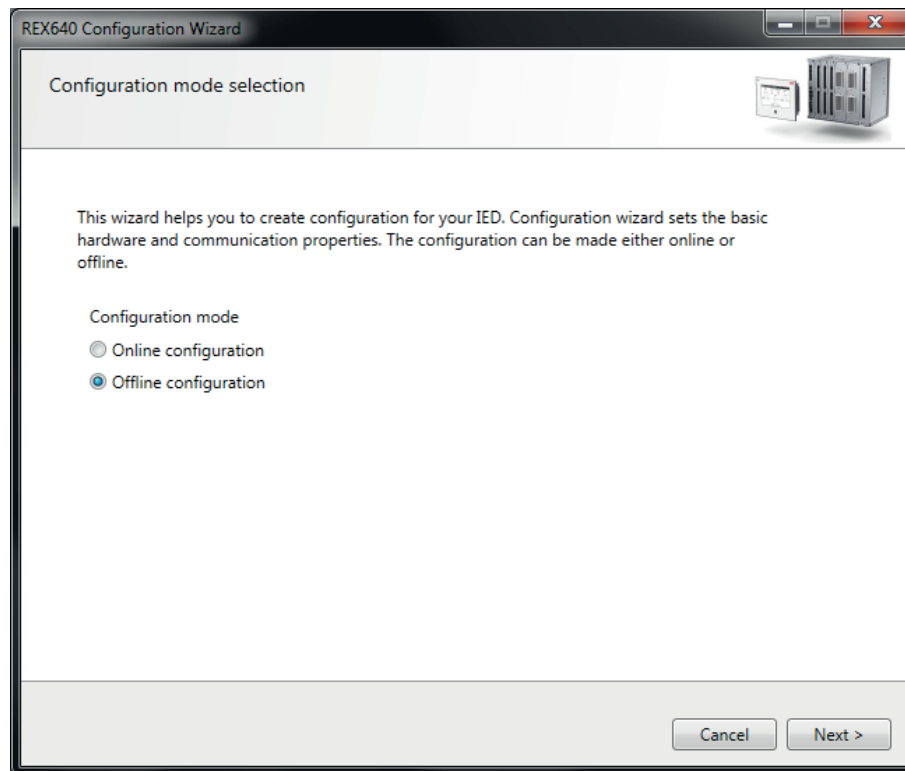
- In the **Plant Structure** view, right-click the bay, point to **New**, point to the relay application area such as **Multiapplication IEDs** and select the protection relay type to be inserted.



Alternatively, drag an IED from the **Object Types** view to the bay level.

2. On the **Configuration mode selection** page, select **Offline configuration** and click **Next**.

Setting up an IED in the offline mode is similar to the online mode; however, with the offline mode it is not necessary to type the correct IP address in the **IP address** box.



*Figure 28: Selecting the configuration mode*

3. On the **Composition code selection** page, select the correct composition codes and click **Next**.



Ensure that the composition code is correct. PCM600 verifies that the composition code matches the relay. If the composition code digits related to the configuration, I/O or version do not match the relay, PCM600 does not allow writing the configuration to the relay. If other digits in the composition code do not match, PCM600 informs about the mismatch with a dialog box.

Figure 29: Selecting the composition code

4. On the **Configuration Selection Page**, select the configuration type and click **Next**.

- Select **Empty configuration** to create an empty configuration.
- Select **Import configuration from file (PCMI/PCMT)** to import an example configuration.

Click **Browse** to select the .pcmi/.pcmt file that has the example configuration.

- Select **Default configuration (available only for IEC 61850 Edition 2)** to generate a default configuration.



If a default configuration is selected, the next page is skipped as default configuration is only supported for the IEC 61850 Edition 2 IEDs. To configure an IEC 61850 Edition 1 IED, select empty or example configuration and make the proper selection on the next page.

5. On the **Version Selection page**, select the IEC 61850 version and click **Next** to generate the functions.

6. The **Summary** page shows the summary of the IED type, IP address and the selected composition code. Click **Finish** to confirm the configuration and conduct the insertion.

### 4.3.3 Inserting an IED from the template directory

IED templates can be used to replicate IEDs with the same order code in PCM600 projects. The template includes an IED application configuration, graphical display configuration (single-line diagram), communication protocol mappings and parameters. An IED in the plant structure can be exported as a template (.pcmt file). The template library can be built from all the exported IED templates.

It is also possible to insert an IED from the template library to create a new IED in the plant structure. After a template IED has been imported, *IP address* and *Caption* in IED's **Object Properties** and *Technical Key* of the physical IED have to be changed.

1. In the **Plant Structure** view, select the bay or IED group, right-click, point to **New** and select **Create from template**.
2. In the **Create New Object from Template** dialog box, select the IED under **Available Object Types**.

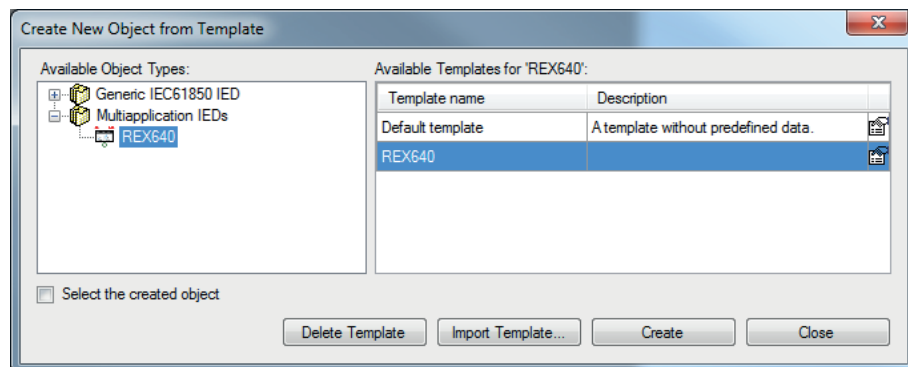
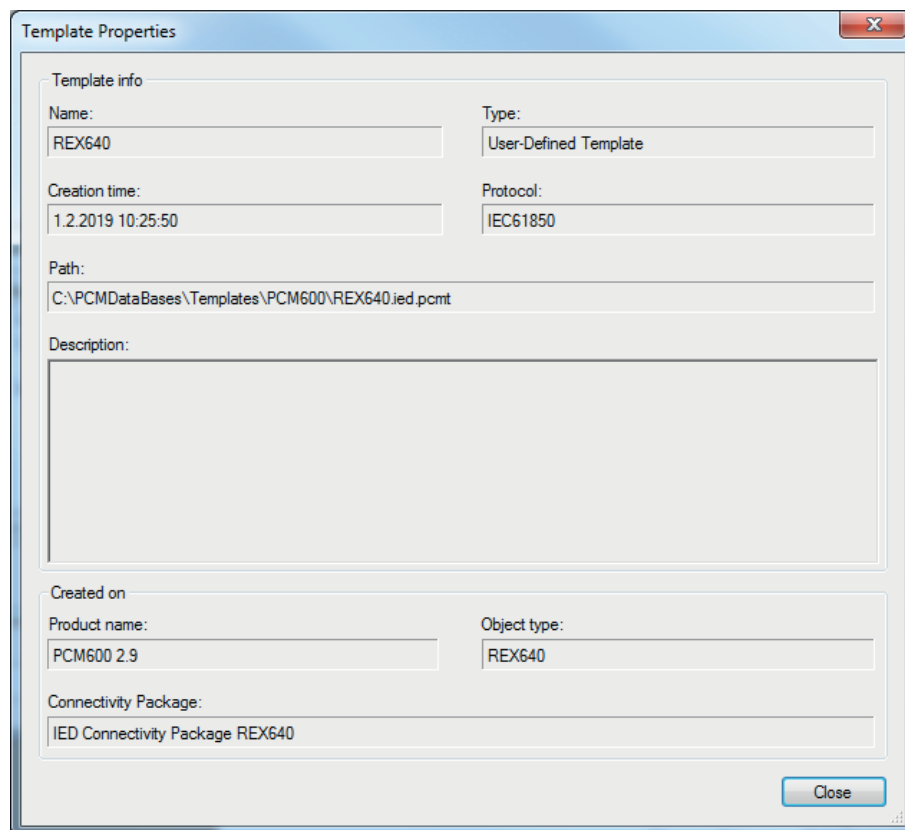


Figure 30: PCM600: Selecting an IED from the template library

3. Click the icon on the rightmost column in the list of available templates.

4. In the **Template Properties** dialog box, verify the template information and click **Close**.



The screenshot shows the 'Template Properties' dialog box with the following fields:

- Template info**
  - Name: REX640
  - Type: User-Defined Template
  - Creation time: 1.2.2019 10:25:50
  - Protocol: IEC61850
  - Path: C:\PCMDatabases\Templates\PCM600\REX640.ied.pcm
  - Description: (Empty text area)
- Created on**
  - Product name: PCM600 2.9
  - Object type: REX640
- Connectivity Package: IED Connectivity Package REX640

A 'Close' button is located at the bottom right of the dialog.

Figure 31: PCM600: Template information

5. In the **Create New Object from Template** dialog box, delete, import or create a template by clicking the corresponding button.
  - To delete the selected template, click **Delete Template**.
  - To import a template from the selection window, click **Import Template**.
  - To insert the selected IED to the bay, click **Create**.



It is possible to insert more than one IED from the **Create New Object from Template** dialog box. The dialog box remains open until **Close** is clicked.

6. Click **Close** when finished.

### 4.3.4 Inserting an IED by importing a .pcmi file

1. In the **Plant Structure** view, right-click the bay and select **Import**.



A .pcmi file can be imported only when the bay is selected in the plant structure.

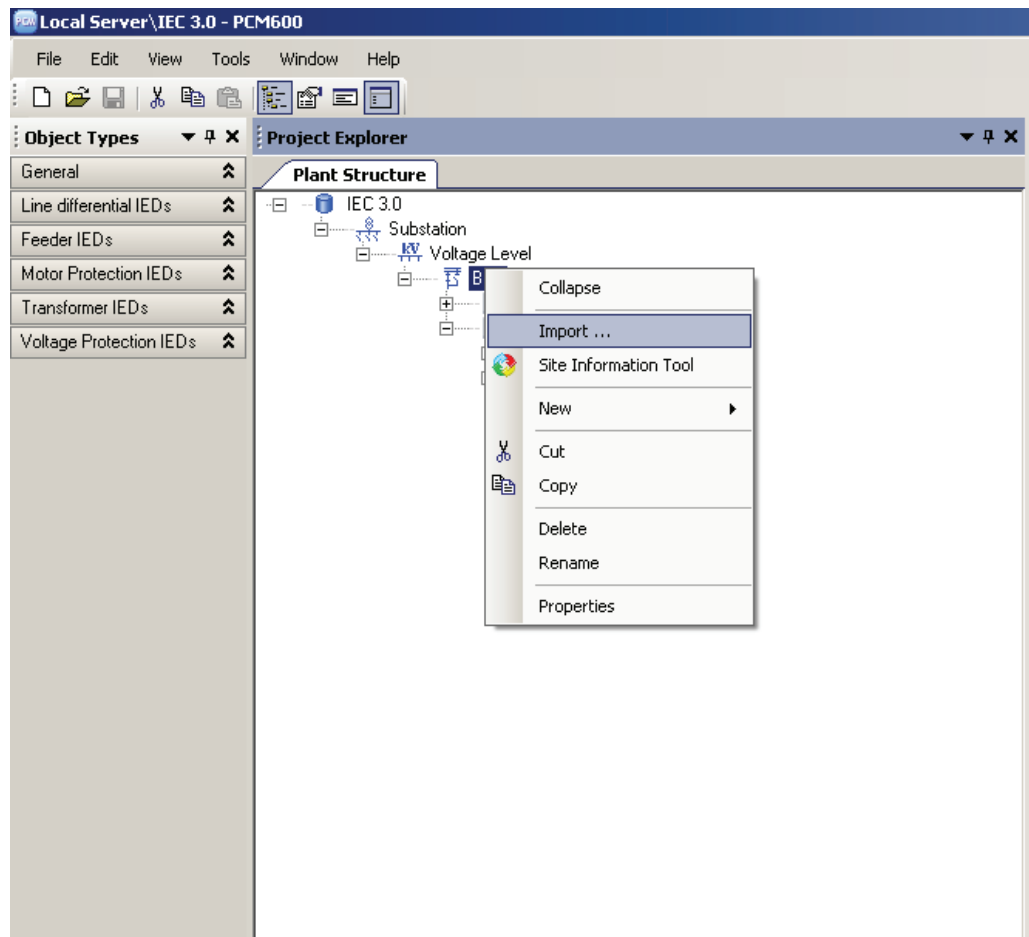


Figure 32: Importing IED configuration

2. In the **Import** dialog box, select the .pcmi file to be imported and click **Open**.  
After importing, the IED object is created in the plant structure.

After the .pcmi file has been imported, the IP address, the name and the technical key of the physical IED have to be changed.

## 4.4 Setting IED's IP address in a project

The IP address and subnet mask of the IED object in PCM600 must match the HMI and LAN ports of the protection relay (physical IED) to which the PC is connected. The IP address of the protection relay can only be set via the LHMI or Parameter Setting in PCM600. The PC and protection relay need to be on the same subnet.

There are two ways to set the IP address of an IED object in PCM600: on the first page of the wizard when including a new IED into a project or in the IP address box of the IED's Object Properties pane.

Choosing between the two ways depends on when the IP address is set. Typing the IP address via the IED's Object Properties pane is possible at any time while entering it via the configuration wizard can only be done when inserting the IED in online or offline mode.

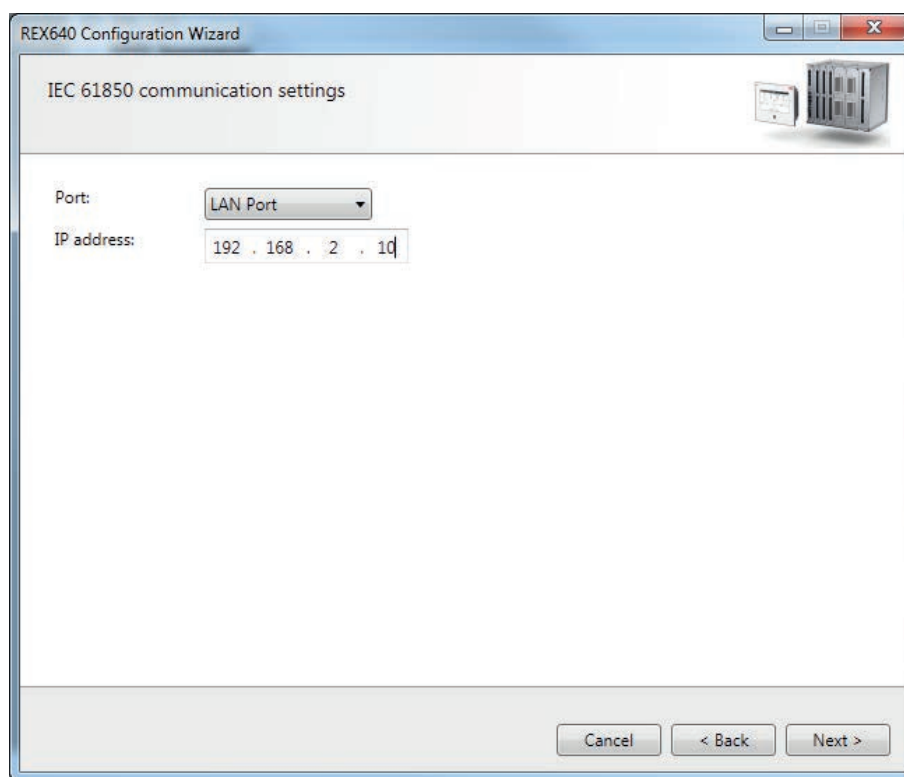


Figure 33: Alternative 1: Setting the IP address on the first wizard page

1. In the **Plant Structure** view, select the IED whose IP address must be entered.
2. On the **View** menu, select **Object Properties**.

3. In the **Object Properties** pane, type the IP address in the **IP Address** box.

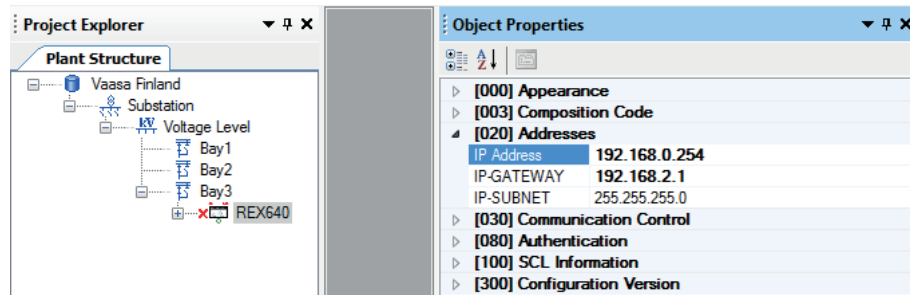


Figure 34: Alternative 2: Setting the IP address in the IED's Object Properties pane

## 4.5 Using the Web HMI

Connection to WHMI can be established using different communication card ports or the LHMI service port. WHMI is disabled by default and can be enabled with a setting parameter. As only secure communication is supported for the WHMI, it must be accessed from a Web browser using the HTTPS protocol. Three simultaneous LHMI and WHMI sessions are supported.

1. To enable the WHMI, select **Configuration > HMI > Web HMI mode** and set the parameter to "On".
2. Reboot the relay for the change to take effect.
3. Log in with the proper user rights to use the WHMI.

If the WHMI is accessed through the LHMI service port, use the corresponding IP address of the relay communication port. The IP address can be obtained via the Engineer pages. Tap the relay's name on the LHMI menu bar to open the Relay address dialog box.



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



HTTPS is enabled for all ports by default. To disable the HTTPS for station ports, select **Communication > Protocols > Network1 > HTTPS** or **Communication > Protocols > Network2 > HTTPS** and set the parameter to "Off". HTTPS is always enabled for the X0/HMI port.



The WHMI write access can be limited with the parameter HTTPS write access in **Configuration > Authorization > Network1** or **Configuration > Authorization > Network2**.



Disable the Web browser proxy settings or make an exception to the proxy rules to allow the protection relay's WHMI connection, for example, by including the relay's



IP address in **Internet Options > Connections > LAN Settings > Advanced > Exceptions.**

## 4.6 Relay user management

The user account management and role-based access control in the protection relay have been handled as specified in IEC 62351-8. The relay supports both local user account and central account management. For information on how to set up user account management, see user management in the cyber security deployment guideline.

## 4.7 PCM600 project's IEC 61850 version identification

The IEC 61850 version of a PCM600 project can be identified from the Object Properties pane of the project.

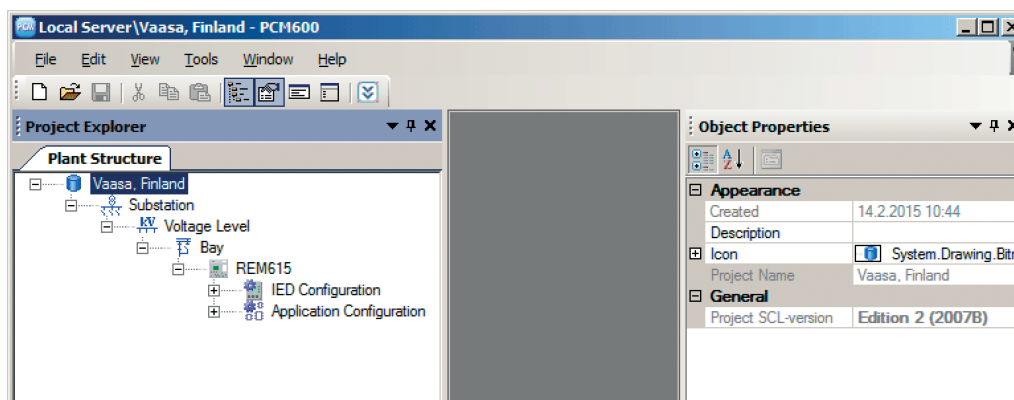


Figure 35: Project's IEC 61850 version

To change IEC 61850 version Edition 1 of an IED to Edition 2, the configuration has to be written to the IED from a PCM600 project that has IEC 61850 version Edition 2. A dialog box notifies of the version difference.

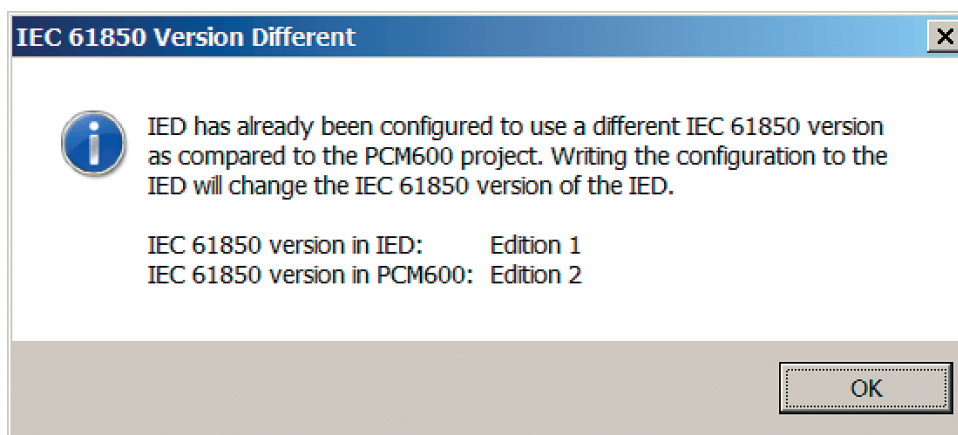


Figure 36: IEC 61850 version change

## 5 Protection and control engineering

### 5.1 Application Configuration

Application Configuration is used to modify an application configuration for a protection relay and is based on IEC 61131-3 Function Block Diagrams.

The function blocks are dedicated to different functions such as control related, protection related, monitoring or communication functions. For more information on the function blocks, see the technical manual.

Most function blocks are mapped as logical nodes according to the IEC 61850 standard. See the IEC 61850 parameter list for more information.

If a function block is removed with Application Configuration, the function-related data disappears from the menus as well as from the IEC 61850 data model, with the exception of some basic function blocks, which are mandatory and thus cannot be removed from the relay configuration by removing them from Application Configuration. The mandatory function blocks are: ETHLDEV1, ETHLDEV2, FTPLPRT1, GNRLTIM1, GNRLTMS1, GSAL1, GSELPRT1, HMILCCH1, HMILDEV1, HTTPLPRT1, LDEV1, LEDPTRC1, LINF1, LLN0, LPHD1, MMSLPRT1, RCHLCCH1, SA2LINF1, SBBIGGIO1, SBOGGIO1, SBLINF1, SCHLCCH1, SCHLCCH2, SCHLCCH3, SCHLCCH6, SFAIGGIO1, SFLINF1, SGBOGGIO1 and SGLINF1.

Some of the protocol-related LPRT function blocks contain outputs which can be used to monitor protocol status. For example, the `CHLIV` output can be used to monitor if protocol-related messages are received from the client. However, all function blocks do not have outputs as they may just be visual objects to indicate protocol support when the sheet is printed out. This applies also to the `PKIGSAL` and `LDEV` function blocks. Security related function block `GSAL` has the `DOS_ALARM` and `DOS_WARNING` outputs for indicating denial of service warning and alarm event.

Other function blocks are not mapped as logical nodes; for example, logical gates.

The basic features of Application Configuration include the ability to organize a configuration into several MainApplications as well as providing different application programming features.

- Organizing an application configuration
  - Organizing an application configuration into a number of logical parts (MainApplication)
  - Organizing a MainApplication over a number of pages
- Features for programming an application configuration
- Inserting function blocks, making connections and creating variables
- Including the hardware I/O channels directly in the application configuration
- Calculating the execution order automatically by clicking Calculate execution order on the toolbar
- Documenting the application configuration, for example, by making printouts
- Saving application configurations as templates in an application library to reuse them in other protection relays. Function blocks and the related logic can be

fully or partially reused depending on the functionality available in the other protection relay.

- Validating the application configuration during the configuration process on demand and while writing the application configuration to the protection relay



For instructions on how to perform the different tasks in PCM600, see PCM600 online help.

### 5.1.1

## Function blocks

Function blocks are the main elements of an application configuration. They are designed for a various number of functions and organized into groups according to type. The different function block types are shown in the Object Types view. Function block data can be modified with Application Configuration in PCM600.

- User-defined names can be given for function blocks and signals.



Signals that have a user-defined name created with Application Configuration are visible in Parameter Setting in PCM600 only if the relay configuration is written to the protection relay and read back to PCM600. Otherwise, only the default signal name is shown in Parameter Setting.

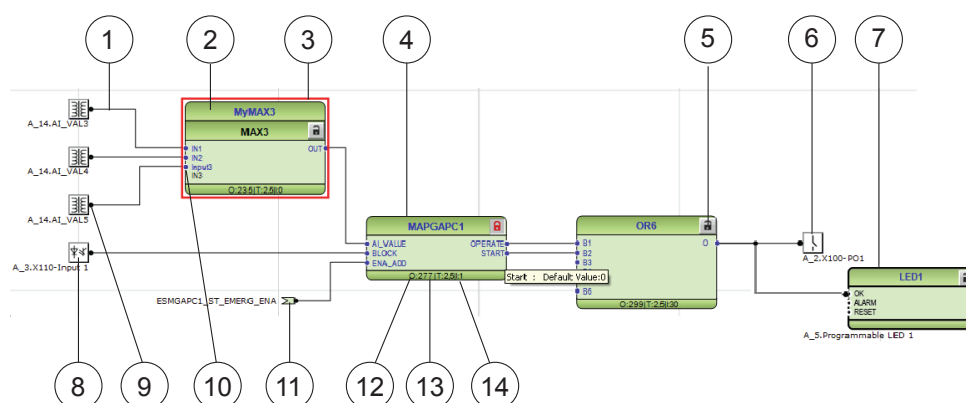


Restart the relay to ensure that all user-defined names for the disturbance recorder's Channel id texts are updated on the LHMI, WHMI and Parameter Setting menus.



If possible, set the user-defined name to a signal before connecting the signal to other function blocks.

- IEC 61850, ANSI or IEC 60617 symbol standard can be set.
- IEC or ANSI naming style can be set.
- Function blocks can be locked.
- Visibility for execution order, cycle time and instance number can be set.
- Signals can be managed.
- Boolean inputs and outputs can be inverted.



- |   |                                  |   |                                 |
|---|----------------------------------|---|---------------------------------|
| 1 | Connections                      | 6 | Hardware, binary output channel |
| 2 | User-defined function block name | 7 | Hardware, programmable LED      |
| 3 | Function block, selected (red)   |   |                                 |
| 4 | Function block name              |   |                                 |
| 5 | Function block, locked           |   |                                 |

8	Hardware, binary input channel	12	Execution order
9	Hardware, analog input channel	13	Cycle time
10	User-defined signal name	14	Instance number
11	User-defined input variable		

*Figure 37: Application Configuration: function block overview*

## 5.1.2 Signals and signal management

The function block has a set of input and output signals. The placement of function block signals is from left to right. Input signals are placed on the left and output signals on the right.

Function blocks can contain more signals than needed in an application part. Unused signals can be hidden to get a clear picture.

Signals are located up and down on both sides of the middle position. When there is space left, some signals may be moved up or down for better visibility and connection routing.

Boolean input and output signals may need to be inverted to fulfil the logic. The Application Configuration tool supports the adding of inversion logic to a binary signal.

All input signals have a default value that is used when the signals are not connected in the configuration.



The input signal on glue logic function blocks can be inverted only if a glue logic function block with lower execution order in the same cycle time is available. Similarly, the output signal can only be inverted if a glue logic function block with higher execution order in the same cycle time is available. Up to two input signals and two output signals can be inverted for glue logic blocks in the same cycle time.

## 5.1.3 Function block execution parameters

Three function block execution parameters influence the runtime execution of the function block within the application configuration.

- Execution order
- Cycle time
- Instance number

When a new function block is inserted, these parameters are shown in the Function Block Instance dialog box in Application Configuration. The three parameters are selectable or not selectable depending on the function block type. The cycle time is predefined to one value. The instance number is a counter for the total possible number of function blocks of that type used within the application configuration.

*Execution Order* and *Instance Number* are a combination that is predefined within a product. It is possible to select a pair out of the list.

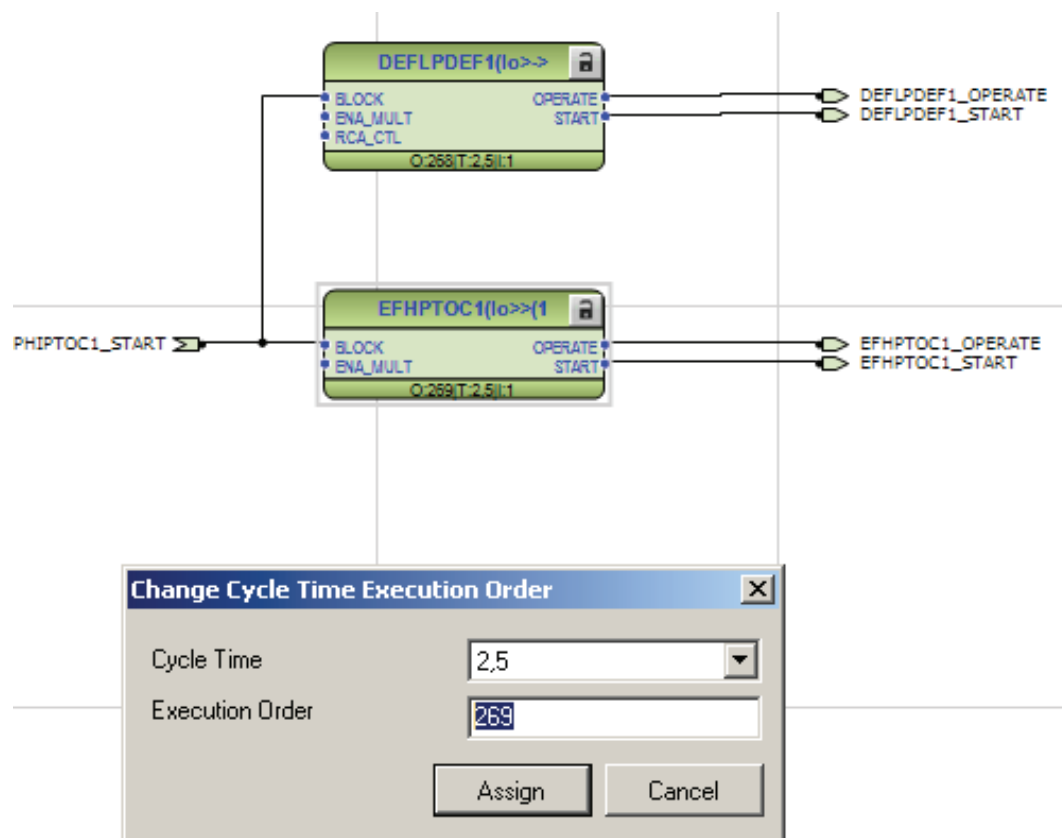


Figure 38: Application Configuration tool: an example of function block organization parameters

Cycle Time is automatically set and it cannot be modified.



To automatically calculate the execution order, click **Calculate Execution Order** on the tool bar.

#### 5.1.4 Execution order and feedback loops

It is possible to draw a multi-layer configuration logic that contains feedback loops with the Application Configuration tool. The execution order of logic functions is calculated automatically in the Application Configuration tool, but it can also be set manually. If the automatically calculated value causes the function to be executed one task cycle time after the other logic functions in the same loop, the execution order number can be set manually to prevent delays, for example, in output activation.



To perceive accurate time stamps from binary input signals to function blocks, direct logic connection should be used in the Application Configuration tool. Due to the internal execution order, time stamps may not be accurate if an additional logic is used to connect priority signals to function blocks.

Figure 39 shows a simple situation where the execution order causes one cycle time delay if the NOT gate is executed in the order determined by the automatic calculation.

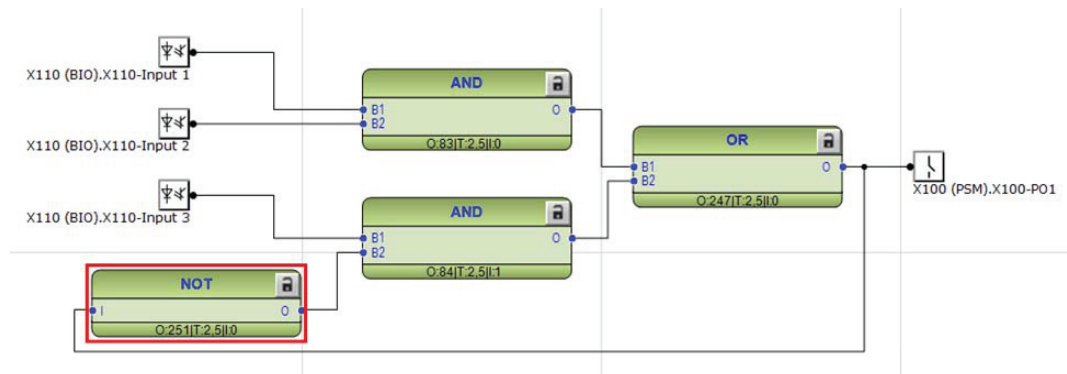


Figure 39: Feedback loop situation with automatically calculated execution orders

By setting a smaller execution number than in the AND port to where the NOT port is connected, it is possible to fix the execution order of all functions in a loop so that they are handled in the same task.

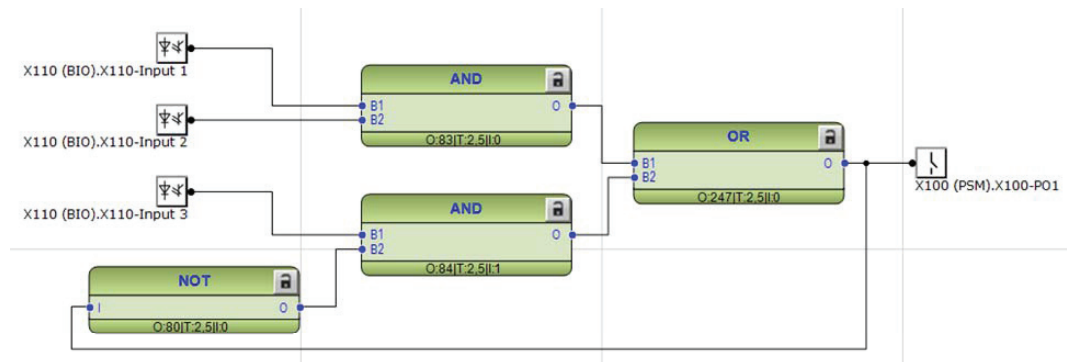


Figure 40: Feedback loop situation with manually fixed execution order for NOT port

The execution number can be changed by right-clicking the function and selecting Change CycleTime ExecOrder.

After manually defining the execution number, the function is excluded from the automatic execution order calculation. The function can be included back to the automatic calculation by right-clicking the function and selecting Include FB in calculation.

## 5.1.5 Connections and variables

A connection is the link or "wire" between function block outputs and inputs.

Connections can be made in two ways.

- Dragging a line between two signals
- Linking two signals by using variables



It is possible to search and replace variable names in Application Configuration tool.



Connect the variables to a destination, for example to a function block or a hardware output channel. The connectivity package automatically

removes the orphan variables which are not connected to any destination.



Connect at least one analog input signal from AIM or SMVRCV.

### Connection validation

A connection is only useful or even possible between two signals of the same base attribute type.

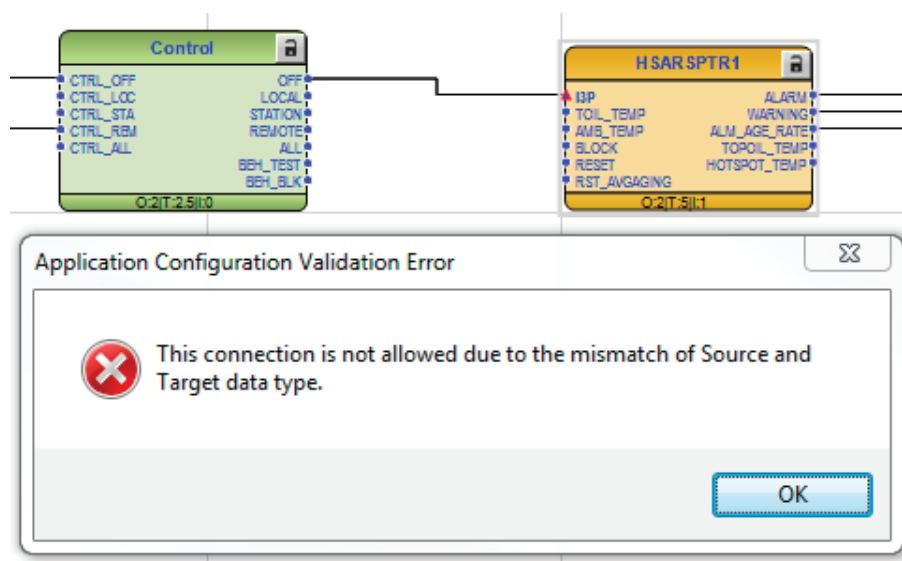


Figure 41: Application Configuration tool: an error message of a signal mismatch for a connection

## 5.1.6 Hardware channels

Hardware channels can be connected only to a function block input or output. A hardware connection can be established with Application Configuration or Signal Matrix.

When a hardware channel is connected, a graphical symbol appears in Application Configuration. The connection is also indicated in Signal Matrix with a cross mark. All hardware channels are always visible in Signal Matrix.



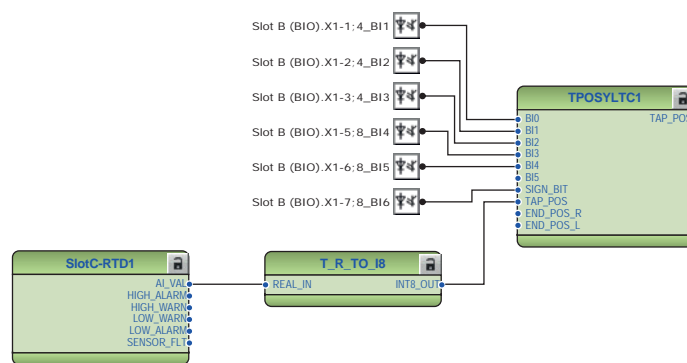


Figure 42: Application Configuration: HW signal channels

There are three types of supported hardware channels.

- Binary input channels
- Binary output channels
- Analog input channels

Hardware binary input channels may have multiple connections. A hardware binary output channel is taken from the list of available channels when a new channel is requested. This prevents using the same hardware binary output channel twice.

### 5.1.6.1

#### Hardware channel configuration

Instead of pre-configured I/O channel connections to pre-processing function blocks, user-customized configurations can be used. There are some rules which must be followed to create a working configuration. Application Configuration automatically checks if configuration is valid and results are shown in the output pane. See the technical manual for the minimum I/O requirement per application function block.

##### Example 1

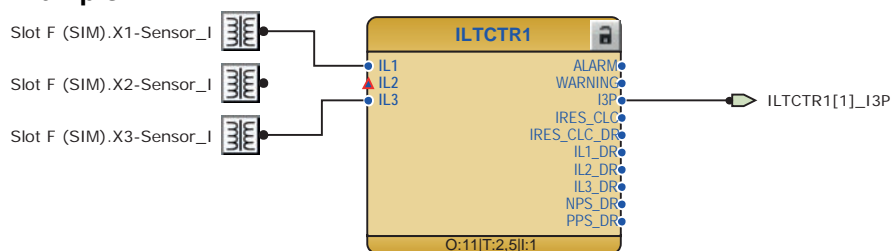


Figure 43: Missing required input connection for output

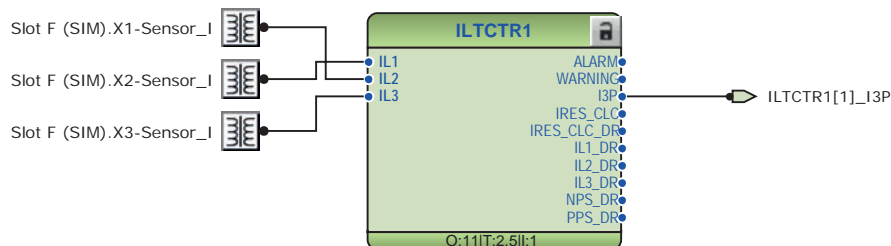


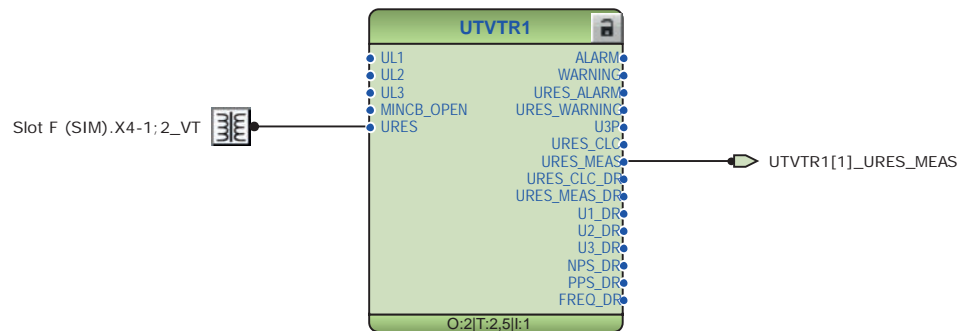
Figure 44: All required input connections configured for output

In [Figure 43](#), the output connection requires more input channels to be connected. [Figure 44](#) has correction for [Figure 43](#) where all required inputs are configured and the input order is according to installation.

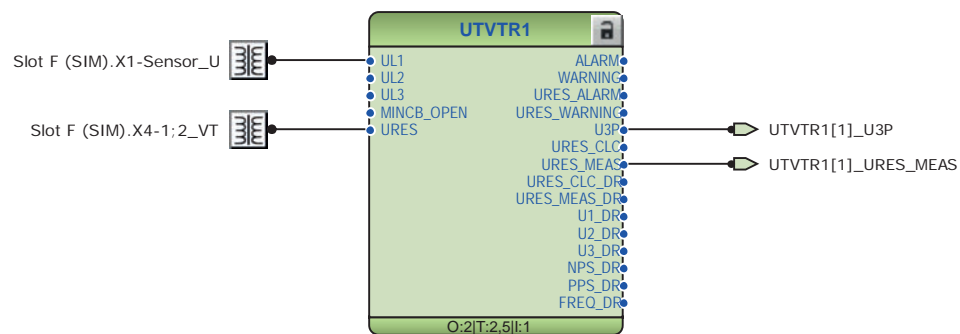


When an output is not connected to any function block, Application Configuration considers the configuration valid. Check validation warnings from the output pane for possible missing connections. Once the output is connected, the complete configuration is validated again.

### Example 2

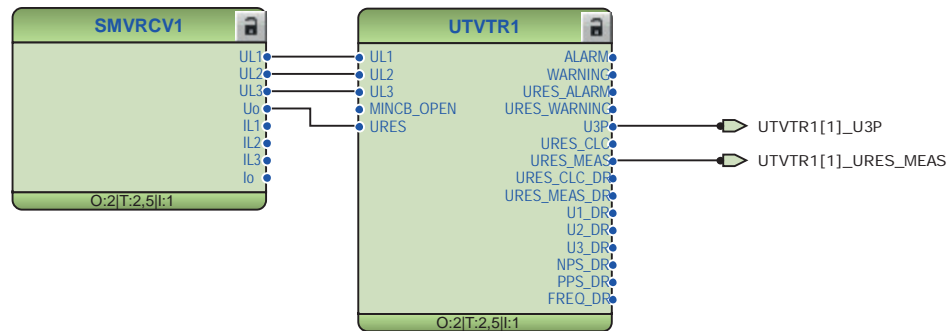
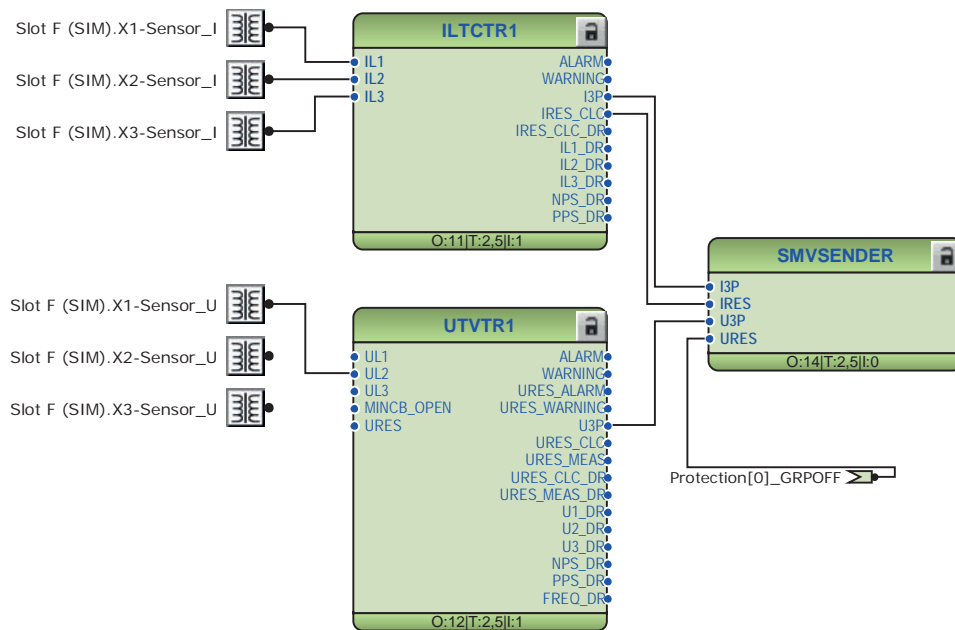


*Figure 45: Output connection requiring only one input*



*Figure 46: Two output connections requiring two inputs*

UTVTR ULx inputs can be used as one-, two- or three-phase connection. The ACT blocks connected to U3P may further demand two- or three-phase connection. URES input must be connected if URES\_MEAS output is used. [Figure 45](#) illustrates the use case of only residual voltage being used in UTVTR1. [Figure 46](#) illustrates a case where one residual voltage and one phase voltage are sufficient.

**Example 3***Figure 47: Remote samples as input connections**Figure 48: Local inputs sent out as remote samples*

Instead of local hardware inputs in [Figure 47](#), remote samples can be used by local function blocks. Remote samples sender can also be configured as described in [Figure 48](#), where GRP\_OFF is used to indicate that channel is not available locally. See the technical manual for details about GRP\_OFF.



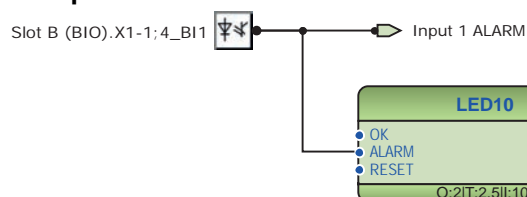
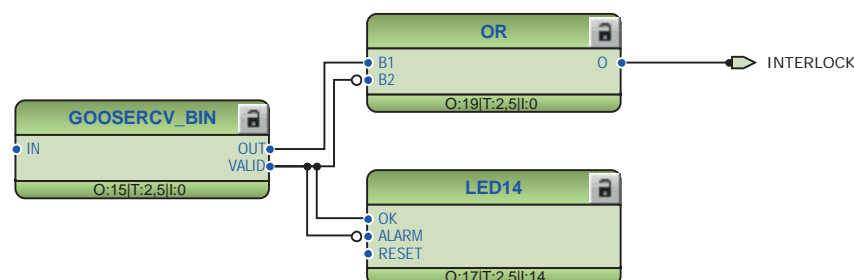
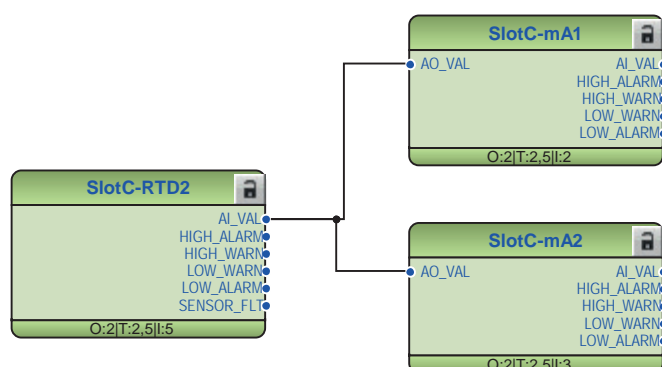
TVTR and TCTR function blocks accept analog channels connected only either from local or remote, that is, local and remote channels cannot be mixed within a TVTR/TCTR function block.



It is not possible to forward the received remote analog channels.



An analog input can only be connected to one function block. Triplets (for example, U3P and I3P) should be used instead in the application to connect analog inputs to other function blocks.

**Example 4***Figure 49: Hardware binary input channel shared by function blocks**Figure 50: GOOSE input shared by function blocks**Figure 51: RTD input shared by function blocks*

GOOSE, RTD and binary inputs can be shared by multiple function blocks.

**5.1.7****Online monitoring**

Online monitoring enables the continuous monitoring of the signal or channel values in the configuration. In the Online monitoring mode, the configuration cannot be edited in the Application Configuration tool.

Online monitoring can be started by clicking the Work online button in the toolbar. If the application configurations in the IED and PCM600 are the same, the online monitoring starts. The online monitoring ends and the tool returns to the configuration mode if the Work Offline button is clicked.



Online monitoring cannot be started if the application configurations in IED and PCM600 are different.



In some cases when the function block input is directly mapped to the function block output, the input is internally forced to the correct value

depending on the function block's settings. This function block design is present in control blocks, setting group handling and tap changer.

## 5.1.8 Validation

Validation checks the application configuration for errors based on the rules that govern the application creation at three different times.

- During the logic creation, while making a connection or placing a function block
- On demand by starting the validation
- When writing the application configuration to the protection relay

### 5.1.8.1 Validation when creating application configuration

Certain conditions require the validation to be made when creating the application configuration.

- A connection between two input or two output signals is not possible
- A connection between two different data types is not possible: for example, from a binary output to an analog input

### 5.1.8.2 Validation on demand

The validity of an application configuration can be checked by clicking **Validate Configuration** in the toolbar. The Application Configuration tool checks the application configuration for formal correctness. The found problems are divided into warnings and errors.

- Warnings, marked with a yellow warning icon
  - Example: a variable connected to an output signal that is not connected
  - Example: if an output from a higher execution order function is connected to the inputs of a lower execution order function
- Errors, marked with a red circle with a cross
  - Example: unconnected hardware output

Warnings do not prevent writing to the protection relay. However, errors must be corrected before writing the application configuration to the protection relay. The application configuration can be saved and the Application Configuration tool can be closed with open errors, but the application configuration cannot be written to the protection relay.

These problems are listed in the **Output** view under the **Application Configuration** tab. Double-clicking the error or warning row navigates to the **MainApplication > Page > Area**, where the problem was identified.

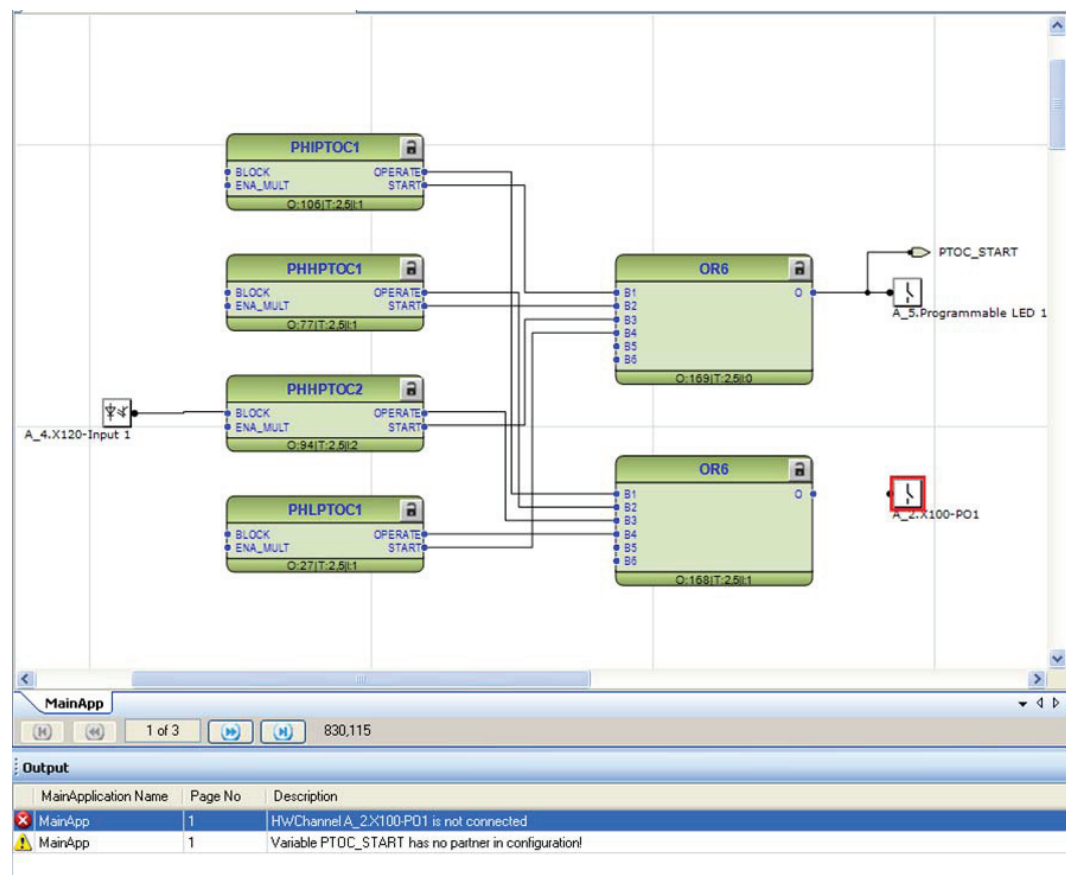


Figure 52: Application Configuration tool: validation on demand

### 5.1.8.3 Validation when writing to protection relay

When writing the application configuration to the protection relay, an automatic validation is performed. Errors abort the writing.

## 5.1.9 Configuration load calculation

The connectivity package calculates an estimated application configuration load every time it is saved in Application Configuration or written to the IED. This functionality prevents too complex configurations from being used and possibly risking IED protection functionality.

Calculation results are divided into two different sections: OK and Error. At 100 percent, PCM600 can give either an OK or an error message because the connectivity package rounds the actual limit to the closest percentage. If the calculation result is above 100 percent, PCM600 always gives an error message and prevents writing the configuration to the IED as the configuration is too large for the IED to handle. The configuration is written to the IED if the result is below the error range.



The calculation result is visible only in PCM600 output window on the Logging tab.

Output				
Date and Time	Category	User	Object	Message
27.10.2018 1...	Message	[local]	REX640	Estimated configuration load is 93 %
27.10.2018 1...	Fatal error	[local]	REX640	Estimated configuration load is 103 %. This is not allowed. Estimated load can be decreased by removing some functionality with Application Configuration.
Logging   Application Configuration				

Figure 53: Configuration load result: an example of different messages shown in PCM600

## 5.2 Parameter Setting

Configuration and setting parameters can be changed with LHMI, WHMI or with the Parameter Setting tool in PCM600.



Some parameters are only visible in the Parameter Setting tool and some only on the LHMI.



The Write to IED command from PCM600 to the protection relay overwrites any parameter changes made with the HMI.

All parameters displayed in the parameter list can be sorted into two groups.

- Configuration parameters
- Setting parameters

### 5.2.1 Configuration parameter

The configuration parameter specifies the operation mode of an application function or of the protection relay. These are basic configurations that are normally configured only once and then not modified again. The protection relay configures itself during start-up according to the given configuration parameter values.

### 5.2.2 Setting parameter

Setting parameter (short form: “setting”) is a parameter that can be changed in the protection relay at runtime.

### 5.2.3 Setting group

Nearly all settings used by the protection relay for protection application functions are organized into a group of settings. Up to six setting groups can be configured with different values.

The protection relay supports the selection of a setting group at runtime.

### 5.2.4 Parameter import and export

The parameter export and import function can be used, for example, when the protection relay's parameters are set using the WHMI instead of PCM600. The relay

settings engineered with PCM600 can be exported to XRIO files and imported to the WHMI, which can be used to write the settings to the protection relays. The WHMI can also be used to read the relay setting parameters and to export those to files, which can be used by PCM600.



The setting export and import are sensitive to the protection relay's content. Settings are exported and imported for one protection relay at a time. The export files of a protection relay can be exchanged between PCM600, WHMI and the actual physical IED. To avoid errors and to efficiently manage the setting export and import, for example, in a substation with several protection relays, ensure that the names of the export files identify the protection relay to which the file should be imported.

The parameter import and export functionality is available via the File menu when the Parameter Setting tool is open.

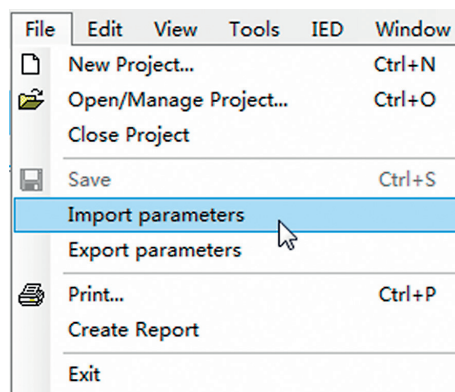


Figure 54: Parameter import and export

### 5.2.5 Parameter organization

The organization of parameters into a tree structure can be seen in the **Plant Structure** by expanding the setting tree.

## 5.3 Configure Autosynchronization

Manual configuration of the autosynchronization scheme in PCM600 is time-consuming and complex in case the system contains both generator circuit breakers and non-generator circuit breakers, that is, non-source circuit breakers. Configure Autosynchronization in PCM600 can be used to simplify the configuration process. The autosynchronization scheme for a given project can be configured via user-understandable terminologies regarding the system to understand the network topology.

The relay supports synchronizing of GCBs and NSCBs, such as grid connection or bus coupler circuit breakers, by providing dedicated function blocks to perform the synchronization process.

- ASGCSYN is used for GCB synchronization.
- ASNSCSYN is used for NSCB synchronization.



- ASCGAPC is a coordination function that handles the control request and allows communication among the relays connected to the autosynchronization system.

Configure Autosynchronization generates a configuration with IEC61850-8-1 GOOSE engineering, function block parameters in Parameter Setting and relevant connections in Application Configuration for ASGCSYN, ASNSCSYN and ASCGAPC. Further, the tool displays the configured network topology as an SLD preview.

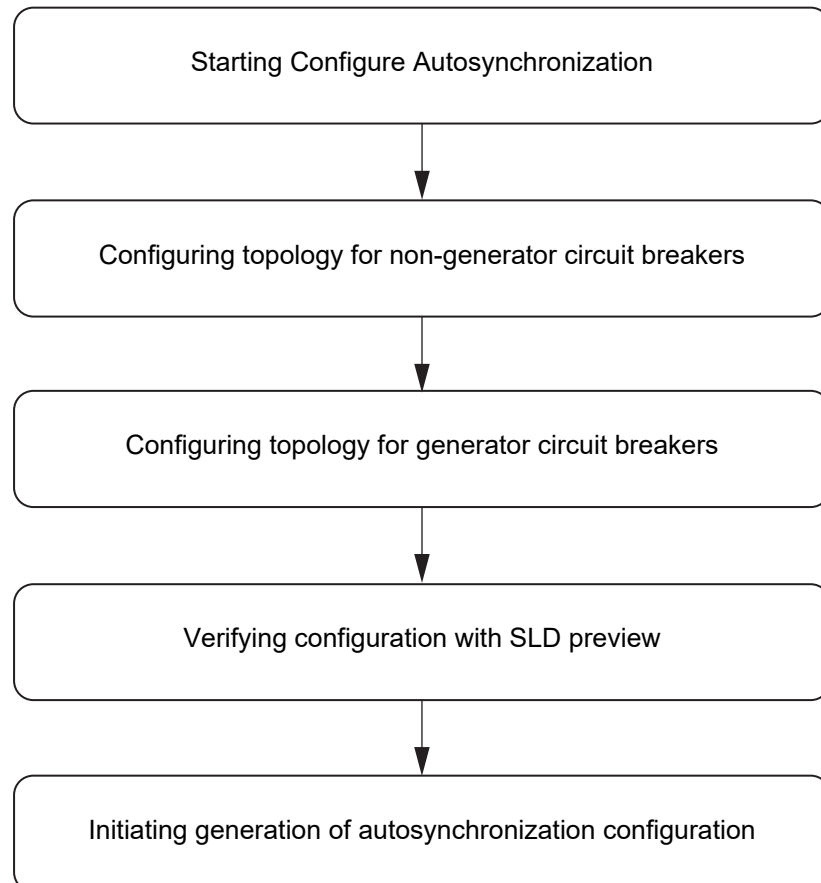


Figure 55: Simple engineering flow for Configure Autosynchronization



After using Configure Autosynchronization, manually handle the connections for voltage measurements, inputs and outputs to ASGCSYN, ASNSCSYN and ASCGAPC in Application Configuration. For functional details, see the technical and application manuals.

### 5.3.1

### Example case

[Figure 56](#) presents a 11 kV network with a generator, grid connection, bus sectionalizers, local power generation and two feeder loads to illustrate a more realistic application. The target is to create a complete autosynchronization system where each of the breakers, except for CB1 and CB2, are capable of performing synchronized closing. The system is continuously aware of the relevant primary objects' switching status as well as the availability of the generator. Depending on which circuit breaker is selected for synchronization, the system checks the conditions and proceeds only if the selected circuit breaker is viable. As the feeder relays do not have any dependency on the autosynchronization system, they are not

explained further in this example. This example case is used in the selections made in the following chapters.

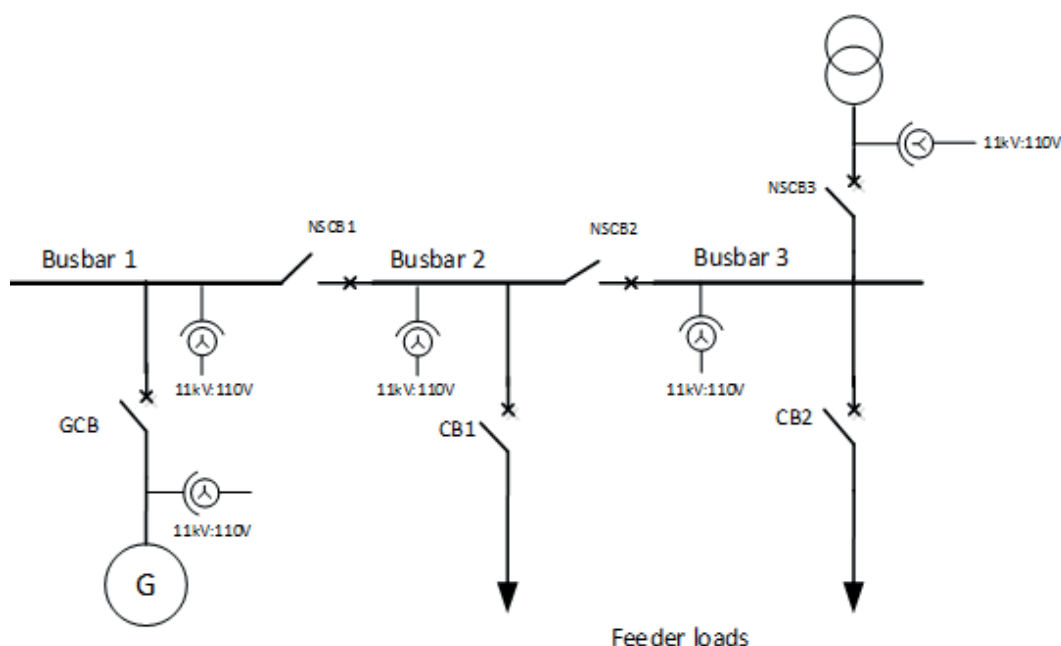


Figure 56: Example case for the autosynchronization scheme

Figure 57 presents the terminology used in a typical topology for different busbar arrangements containing an NSCB. It only depicts the logical connections and does not represent any primary network.

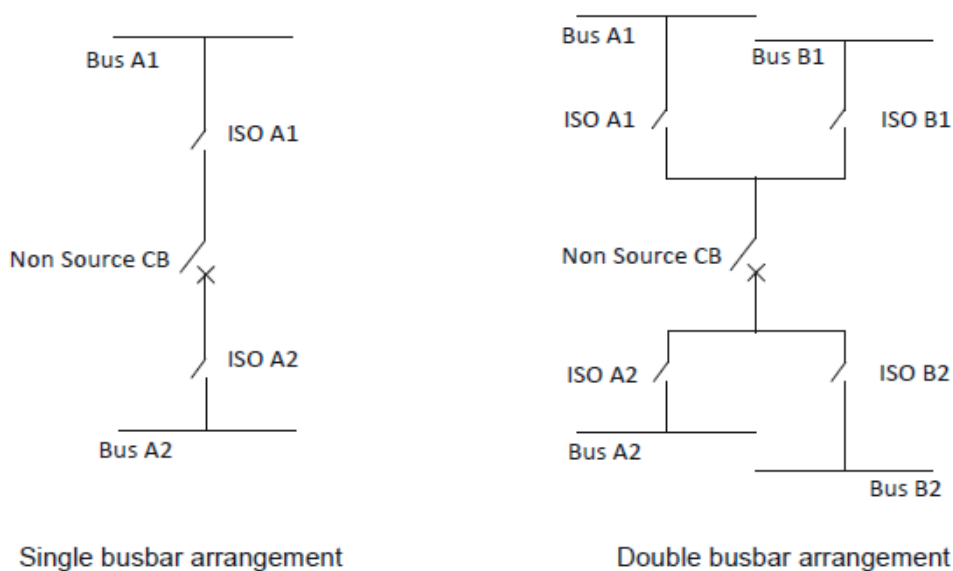


Figure 57: Terminology used in a typical topology containing a non-generator circuit breaker

Figure 58 presents the terminology used in a typical topology for different busbar arrangements containing a GCB. It only depicts the logical connections and does not represent any primary network.

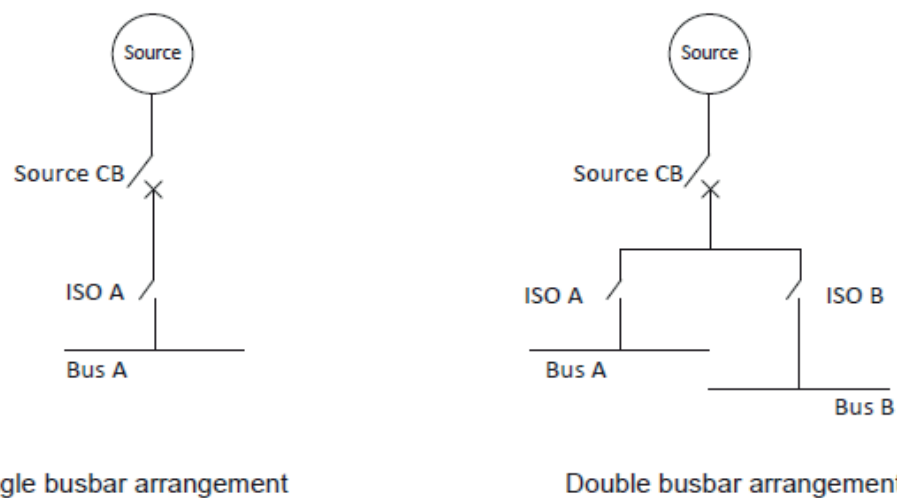


Figure 58: Terminology used in a topology containing a generator circuit breaker

### 5.3.2 Configuring autosynchronization scheme

If Autosynchronization Configuration has already been used to successfully generate an autosynchronization configuration, relaunching the tool loads the previously made configuration to the respective pages. Any existing connections in Application Configuration or settings in Parameter Setting made to ASGCSYN, ASNSCSYN or ASCGAPC must be reconfigured as they are removed from the configurations of the respective relays after relaunching Autosynchronization Configuration.

1. In the **Plant Structure**, right-click **Substation** or **IED Group** and select **Configure Autosynchronization**.



Configure Autosynchronization can be opened only if there are at least two relays in the PCM600 project: one with the Generator autosynchronizer application package and the other with the Network autosynchronizer application package. No other tools should be open in PCM600.

2. On **Welcome Page**, click **Next** to configure first the topology for NSCBs and then for GCBs.
3. On the **Non-generator Configuration** page, configure the topology by adding, removing or clearing NSCBs.

The page displays the relays from the PCM600 project setup that support the Network autosynchronizer application package. It is possible to synchronize up to 17 NSCBs in the configuration.

- **IED Name:** Shows a list of relays with non-generator capabilities that can be selected and added to the configuration
- **IP Address:** Shows the IP address of the selected non-generator (read only)
- **Non-generator CB ID:** Shows an autogenerated non-generator circuit breaker ID to identify the breaker in the SLD preview controlled by the relay (read only)
- **Breakers:** Used to specify the number of breakers a relay can control

- **Bus A1:** Used to specify the Bus A1 value for a non-generator in a single bus system
- **Bus A2:** Used to specify the Bus A2 value for a non-generator in a single bus system
- **Bus B1:** Used to specify the Bus B1 value for a non-generator in a double bus system
- **Bus B2:** Used to specify the Bus B2 value for a non-generator in a double bus system



Bus A1 and Bus A2 are mandatory to configure for non-generators. Use unique values in Bus A1, Bus A2, Bus B1 and Bus B2 for a given non-generator.

Autosynchronization configuration Page 2 of 5

Non-generator Configuration

Add Non-generators

+ Add    - Remove    ✖ Clear All

IED Name	IP Address	Non-generator CB ID	Breakers	Bus A1	Bus A2	Bus B1	Bus B2
AA1/IQ01A2-NSCB1	192.168.2.11	NonGeneratorCB1	1	BUS1	BUS2	Not Configured	Not Configured
AA1/IQ01A3-NSCB2	192.168.2.12	NonGeneratorCB2	1	BUS2	BUS3	Not Configured	Not Configured
AA1/IQ01A4-NSCB3	192.168.2.13	NonGeneratorCB3	1	Grid	BUS3	Not Configured	Not Configured

Cancel    < Back    Next >

Figure 59: Configuring the topology for non-generator circuit breakers

4. Correct any invalid selections highlighted in yellow to be able to proceed and click **Next**.

Autosynchronization configuration Page 2 of 5

Non-generator Configuration

Add Non-generators

+ Add - Remove ✖ Clear All

IED Name	IP Address	Non-generator CB ID	Breakers	Bus A1	Bus A2	Bus B1	Bus B2
AA1J1Q01A2-NSCB1	192.168.2.11	NonGeneratorCB1	2	BUS1	BUS2	Not Configured	Not Configured
AA1J1Q01A2-NSCB1	192.168.2.11	NonGeneratorCB2	2	BUS2	BUS2	Not Configured	Not Configured
AA1J1Q01A3-NSCB2	192.168.2.12	NonGeneratorCB3	1	BUS2	BUS2	Not Configured	Not Configured
AA1J1Q01A4-NSCB3	192.168.2.13	NonGeneratorCB4	1	Grid	BUS3	Not Configured	Not Configured

Cancel < Back Next >

Figure 60: Correcting invalid non-generator circuit breaker selections

5. On the **Generator Configuration** page, configure the topology by adding, removing or clearing GCBs.

The page displays the relays from the PCM600 project setup that support the Generator autosynchronizer application package. It is possible to synchronize up to eight GCBs to the configuration.

- **IED Name:** Shows a list of relays with generator capabilities that can be selected and added to the configuration
- **IP Address:** Shows the IP address of the selected generator (read only)
- **Generator Name:** Used to specify a user-defined name for the generator
- **Bus A:** Used to specify the Bus A value for a generator in a single bus system
- **Bus B:** Used to specify the Bus B value for a generator in a double bus system



Bus A and Generator Name are mandatory to configure for generators. Use unique values in Bus A and Bus B for a given generator.



The value in Generator Name is later shown in the SLD preview and the REX640 LHMI dialog where the synchronization for NSCBs is initiated. The generator name can be modified in this field only.

IED Name	IP Address	Generator Name	Bus A	Bus B
AA1/JQ01A1-GC81	192.168.2.10	Steam Generator 1	BUS1	Not Configured

Figure 61: Configuring the topology for generator circuit breakers

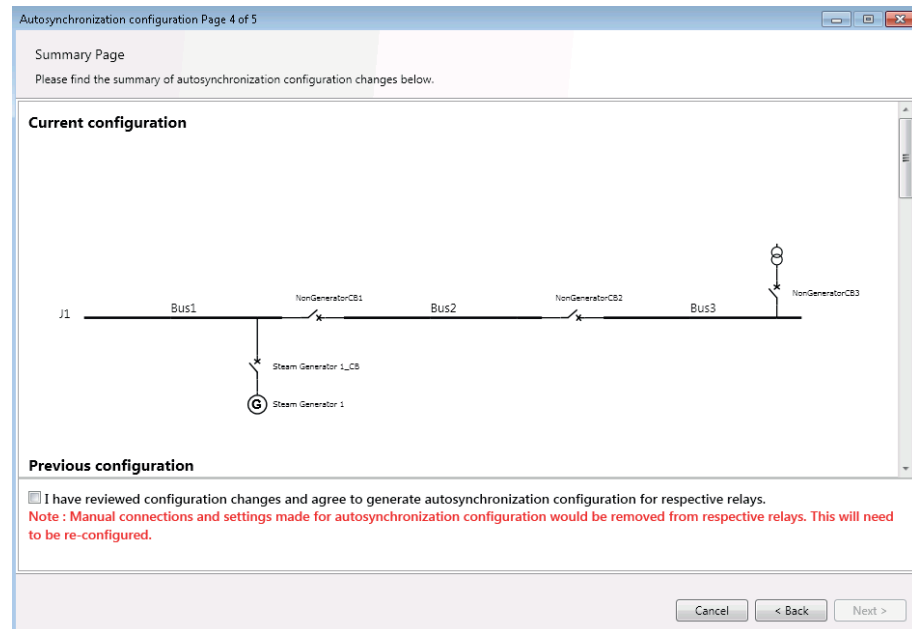
6. Correct any invalid selections highlighted in yellow to be able to proceed and click **Next**.

IED Name	IP Address	Generator Name	Bus A	Bus B
AA1/JQ01A1-GC81	192.168.2.10	Generator name is empty or more than 64 characters.	Not Configured	Not Configured

Figure 62: Correcting invalid generator circuit breaker selections

7. On **Summary Page**, verify the configuration with the SLD preview and click **Next**.

The page shows an SLD based on the network topology entered in the previous pages and a report regarding the configuration changes made along with their impact on the relays. [Figure 63](#) shows a part of the page which displays the SLD generated based on the case presented in the [Chapter 5.3.1 Example case](#).



*Figure 63: SLD preview for the example case*



If the SLD preview is compressed and not properly visible, double-click the SLD to open the preview in a separate dialog with zoom buttons and scroll bars.



The autosynchronization configuration for ASGCSYN, ASNSCSYN and ASCGAPC is modified in Application Configuration, Parameter Setting and GOOSE engineering.

8. Verify the configuration made against the SLD preview and click **Next** to initiate the generation of autosynchronization configuration for the respective relays.



In case Autosynchronization Configuration has already been used to complete the configuration, the impact of configuration changes for each relay is shown on Summary Page. Review the configuration changes by comparing the SLDs of the current and previous configurations before initiating the configuration generation.

Autosynchronization configuration Page 4 of 5

Summary Page

Please find the summary of autosynchronization configuration changes below.

**Please find below the impact of configuration changes for each relay**

**Relays modified**

AA1J1Q01A2\_39(NG1)

Config property	Current value	Saved value
Number of Breakers	3	1
AutoSyncItem Type	Non-generator	Non-generator
Breaker Number1	NonsourceCB1	NonsourceCB1
Breaker Number2	NonsourceCB2	NotPresent
Breaker Number3	NonsourceCB3	NotPresent
NonGeneratorBusA1-1	Bus1	Bus1
NonGeneratorBusA2-1	Bus2	Bus2
NonGeneratorBusB1-1	Notconfigured	Notconfigured
NonGeneratorBusB2-1	Notconfigured	Notconfigured
NonGeneratorBusA1-2	Bus2	NotPresent
NonGeneratorBusA2-2	Bus3	NotPresent
NonGeneratorBusB1-2	Notconfigured	NotPresent

☒ I have reviewed configuration changes and agree to generate autosynchronization configuration for respective relays.

Note : Manual connections and settings made for autosynchronization configuration would be removed from respective relays. This will need to be re-configured.

Cancel < Back Next >

Figure 64: Reviewing configuration changes

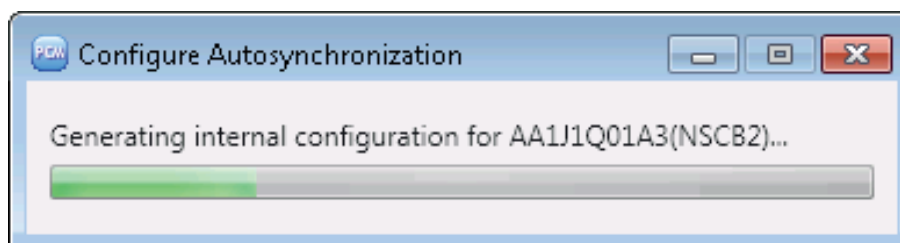


Figure 65: Generating configuration

9. On **Finish Page**, click **Finish** to close the tool.

The page displays the configuration created as an SLD and the status of the autosynchronization configuration generation.

Figure 66: Finish Page

### 5.3.3

## Finalizing of generated autosynchronization configuration

Configure Autosynchronization generates a partial configuration in Application Configuration and Parameter Setting and a complete GOOSE engineering for the



function blocks ASGCSYN, ASNSCSYN and ASCGAPC. The remaining connections for voltage measurements and other inputs and outputs need to be handled manually in PCM600.



For functional details, see the technical and application manuals.

With reference to the example given in the [Chapter 5.3.1 Example case](#) chapter, the following figures show the partial configuration generated by the tool in PCM600.

[Figure 67](#) shows the Application Configuration view of the relay controlling NSCB1. Similar connections are also generated for the other relays. The connections for the function blocks shown in the figure should be completed next.

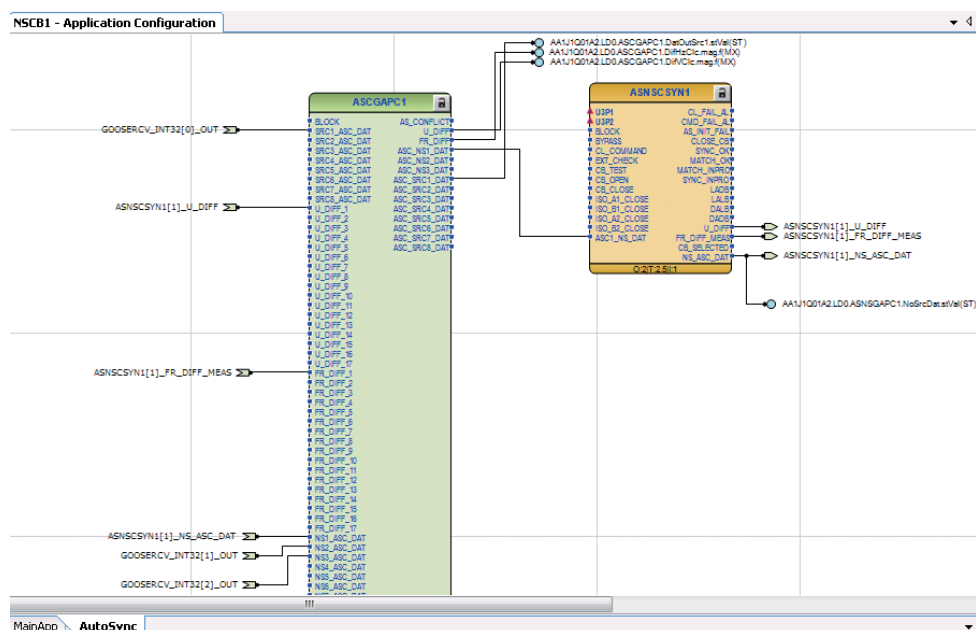


Figure 67: Application Configuration view of relay controlling NSCB1

[Figure 68](#) shows part of the Parameter Setting view of ASCGAPC of the relay controlling NSCB1. Similar settings are also made for ASCGAPC in other relays. The other settings for ASGCSYN, ASNSCSYN and ASCGAPC should be checked and modified, if needed.

NSCB1 - Parameter Setting					
Group / Parameter Name	IED Value	PC Value	Unit	Min	Max
✓ Operation		on			
✓ ASC CB Num1		Non source CB 1			
✓ ASC CB Num2		Not Configured			
✓ ASC CB Num3		Not Configured			
✓ Max matching time		60000	ms	100	6000000
✓ Central PMS present		No			
✓ Double busbar		False			
✓ Setting Group 1					
✓ Number of sources		1		1	8
✓ Number of NonSrc CB		3		1	17
✓ Src1 bus A Num		Bus 1			
✓ Src1 bus B Num		Not Configured			
✓ NonSrc1 bus A1 Num		Bus 1			
✓ NonSrc1 bus A2 Num		Bus 2			
✓ NonSrc1 bus B1 Num		Not Configured			
✓ NonSrc1 bus B2 Num		Not Configured			
✓ NonSrc2 bus A1 Num		Bus 2			
✓ NonSrc2 bus A2 Num		Bus 3			
✓ NonSrc2 bus B1 Num		Not Configured			
✓ NonSrc2 bus B2 Num		Not Configured			
✓ NonSrc3 bus A1 Num		Grid			
✓ NonSrc3 bus A2 Num		Bus 3			

Figure 68: Partial Parameter Setting view of ASCGAPC in the relay controlling NSCB1

Figure 69 shows the GOOSE data sets generated by the tool containing all the entries required to be exchanged among the relays for the autosynchronization process. No further user actions are required regarding the GOOSE engineering for the autosynchronization process. However, GOOSE data exchange for any other logic or scheme may be handled manually.

Project Explorer		GOOSE Communication - IEC 61850 Configuration			
Plant Structure			AA1J1Q01A1 (AP1)	AA1J1Q01A2 (AP1)	AA1J1Q01A3 (AP1)
AS Wizard					
Substation					
Voltage Level					
Bay					
GCB1					
NSCB1					
NSCB2					
NSCB3					
		AA1J1Q01A1LD0/LLN0.GooseDS	✓	✓	✓
		AA1J1Q01A2LD0/LLN0.GooseDS	✓		✓
		AA1J1Q01A3LD0/LLN0.GooseDS	✓	✓	
		AA1J1Q01A4LD0/LLN0.GooseDS	✓	✓	

Figure 69: GOOSE data sets in IEC 61850 Configuration

## 5.4 Signal Matrix

Signal Matrix is used to make cross-references between the physical I/O signals, function blocks and SMV and for the GOOSE signal input engineering.



Application Configuration is used for adding or removing function blocks, for example, GOOSE receiving function blocks.

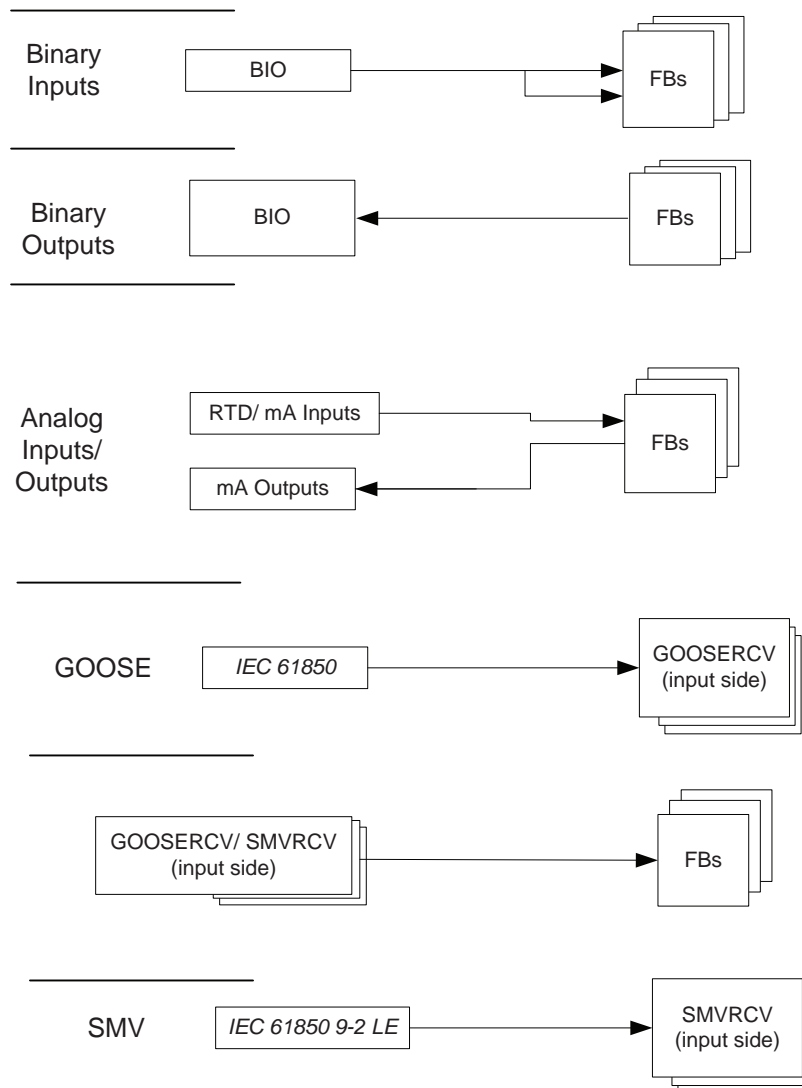


Figure 70: Signal Matrix: operation principles

A binary input channel can be connected to one or more function block inputs. If a binary input channel is connected to several different function blocks in the Application Configuration tool, the connection appears as glue logic in Signal Matrix.

A binary output channel can only be activated from one function block output. If it is activated from more than one function block output, the glue logic has to be used.

Glue logic means inserting a logical gate (OR and AND blocks) between the binary input and the function blocks or between the function blocks and the binary output channel. This can be engineered with the Signal Matrix.



Connections made with Signal Matrix are automatically shown in Application Configuration.

		Slot B (BIO)													
		Input 1	Input 2	Input 3	Input 4	Input 5	Input 6	Input 7	Input 8	Input 9	Input 10	Input 11	Input 12	Input 13	Input 14
- CBXCBR1:1 CBXCBR1:1	POSOPEN			X											
	POSCLOSE		X												
	ENA_OPEN														
	ENA_CLOSE														
	BLK_OPEN														
	BLK_CLOSE														
	AU_OPEN														
	AU_CLOSE														
	TRIP														
	SYNC_OK														
	SYNC_ITL_BYP														

		Slot B (BIO)							
		Output 1	Output 2	Output 3	Output 4	Output 5	Output 6	Output 7	Output 8
		OR							
- CBXCBR1:1 CBXCBR1:1	SELECTED								
	EXE_OP		X						
	EXE_CL	X							
	OP_REQ								
	CL_REQ								
	OPENPOS								
	CLOSEPOS								
	OKPOS								
	OPEN_ENAD								
	CLOSE_ENAD								

Figure 71: Signal Matrix: a connection between binary input channels to binary input signals

Each SMVRCV block used in Application Configuration needs to be connected to the desired SMV stream in Signal Matrix. Connections need to be one-to-one and unconnected SMVRCV blocks are not allowed.

Signal Matrix has a separate sheet for each possible combination.

- Binary inputs
- Binary outputs
- Analog inputs
- GOOSE
- SMV

## 5.5 Load Profile tool

Load Profile tool is used for reading load profile records of COMTRADE format from a protection relay, clearing old records and viewing records via an external COMTRADE viewer. The default viewer included with PCM600 is Wavewin, but a third-party viewer can be used.

### 5.5.1 Opening and closing Load Profile tool

- To open the Load Profile tool, right-click an IED in the PCM600 project tree and select **Load Profile Tool**.
- To close the Load Profile tool, click Close in the tool. The Load Profile tool runs in the same process as PCM600 but in a separate window. Multiple instances of the tool can be run at the same time. Any open tool instances are closed without confirmation when PCM600 is closed.

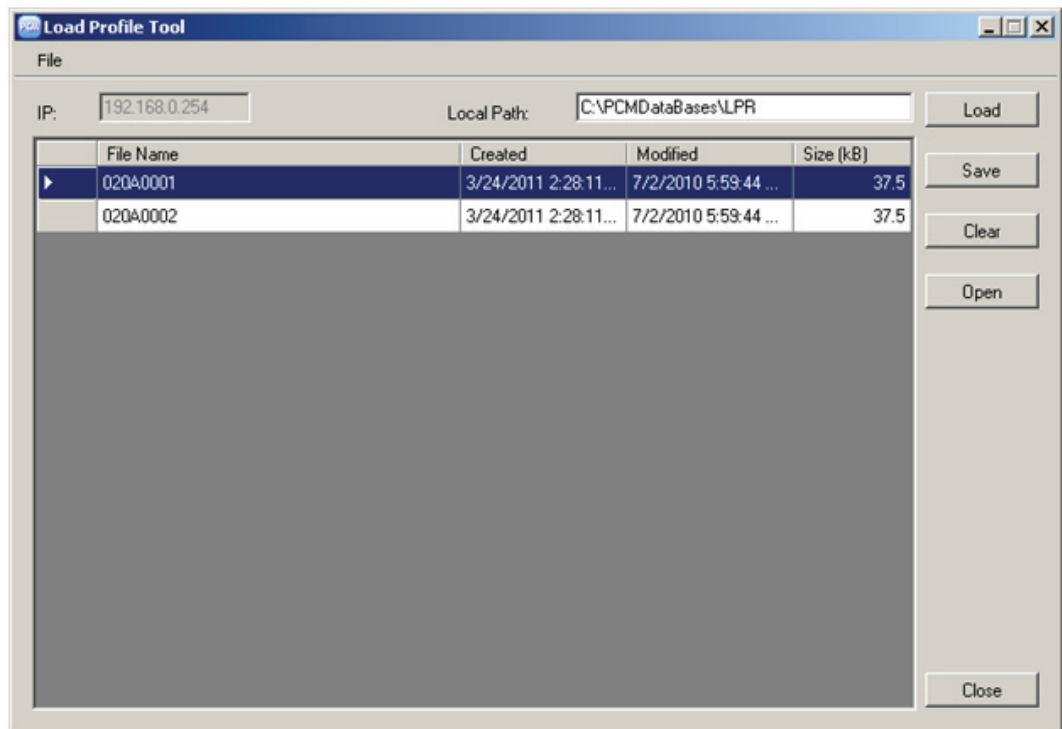


Figure 72: Load Profile tool

By default, the Load Profile tool uses the \PCMDatabases\LPR directory as a saving target directory.

## 5.5.2 Load Profile tool user interface

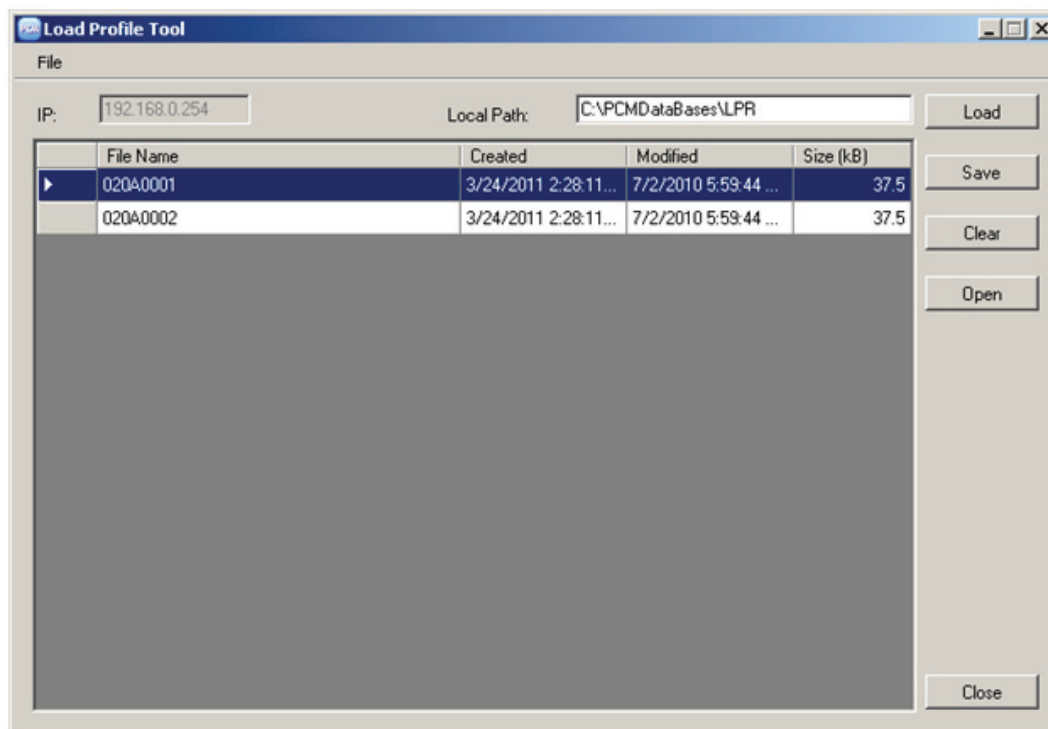


Figure 73: Load Profile tool interface

Table 3: Available actions on the user interface

Action	Description
Local Path	Default local path (C : \PCMDatabases\LPR) is the location from which the records are shown on the Load Profile tool. It is also the default path for saving records. The location where the records are saved can be changed in the Local Path field. The grid of the Load Profile tool shows only the records in the default local path including any unsaved records in C : \Temp\Load\Profile Tool. Therefore records can be saved at a user-specified location on the local machine but those records are not visible in the grid of the Load Profile tool.
Load	Clicking Load downloads all available records from C : \LDP\COMTRADE directory in the protection relay to a temporary folder C : \Temp\Load-ProfileTool on the local machine. In this temporary folder, the target file name is constant, and loading again overwrites the file. An unsaved record is deleted when the tool is closed.
Save	Clicking <b>Save</b> moves the records to the default or specified local path, <b>Load</b> transfers the records to a temporary folder. Each load profile record comprises two files with file extensions .dat and .cfg.  Clicking <b>Save</b> adds a time stamp to the file names and moves the two files pertaining to the record to the default or specified folder. Saving another record creates a new record in addition to the old ones.
Clear	Clicking <b>Clear</b> clears the record from either the Load Profile tool or protection relay or both. Before deleting the records, a confirmation dialog box is shown.

Table continues on the next page

Action	Description
Open	Clicking <b>Open</b> opens any selected record to be viewed in Wavewin, provided that this external software is installed. Additionally, any record row can be double-clicked to view that record.
Sort	Record rows can be sorted by any column by clicking the column header.
Close	Clicking <b>Close</b> closes the tool instance. All open tool instances are closed when PCM600 is closed.
File	All the actions are also available on the <b>File</b> menu.

### 5.5.3 Information fields

The **IP** box shows the IP address of the selected IED and the **Local Path** box shows the selected location for reading or viewing records.

The record grid shows the name, creation time, modification time and size of each record. The times and dates shown in the grid are the times when the files have been read rather than the original date stamps in the device.

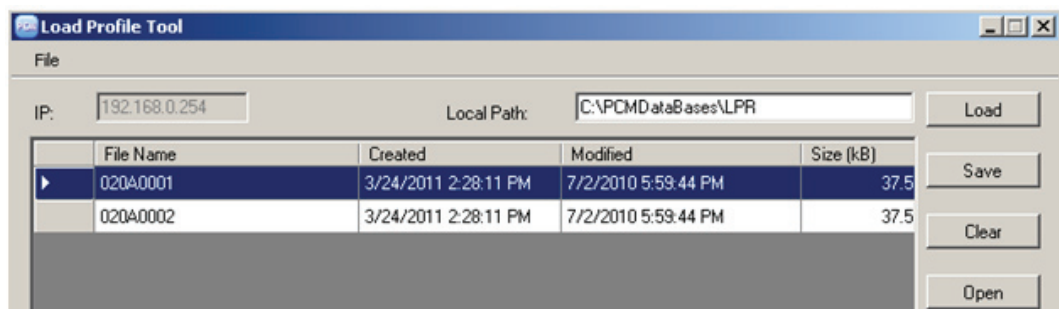


Figure 74: Information fields

## 5.6 Fault Record tool

The Fault Record tool is used for reading the fault records from the protection relay. The tool makes analyzing the fault records easier by showing them separately in their own user control components. It also includes save, copy and clear functions where all the fault records are saved or copied in text format for later viewing or cleared from the protection relay or the tool.



The fault record is saved to a local PC with the default name `FaultRecords.txt`. Rename the file before saving it to avoid overriding the old record.

### 5.6.1 Opening and closing Fault Record tool

- To open the Fault Record tool, right-click an IED node in the PCM600 project tree and select **Fault Record Tool**.

- To close the Fault Record tool, click the **Close** button in the tool.

The Fault Record tool runs in the same process as PCM600 but in a separate window. Multiple instances of the tool can be run at the same time. Any open tool instances are closed without confirmation when PCM600 is closed.

The main functionality is divided into three parts: reading the fault record parameters from the protection relay, displaying their names, values and units on the user interface and saving them to a text file. It is also possible to clear all the fault records from both the tool and the protection relay and copy the fault records either individually or all at once to a word processor.

## 5.6.2 Fault Record tool interface

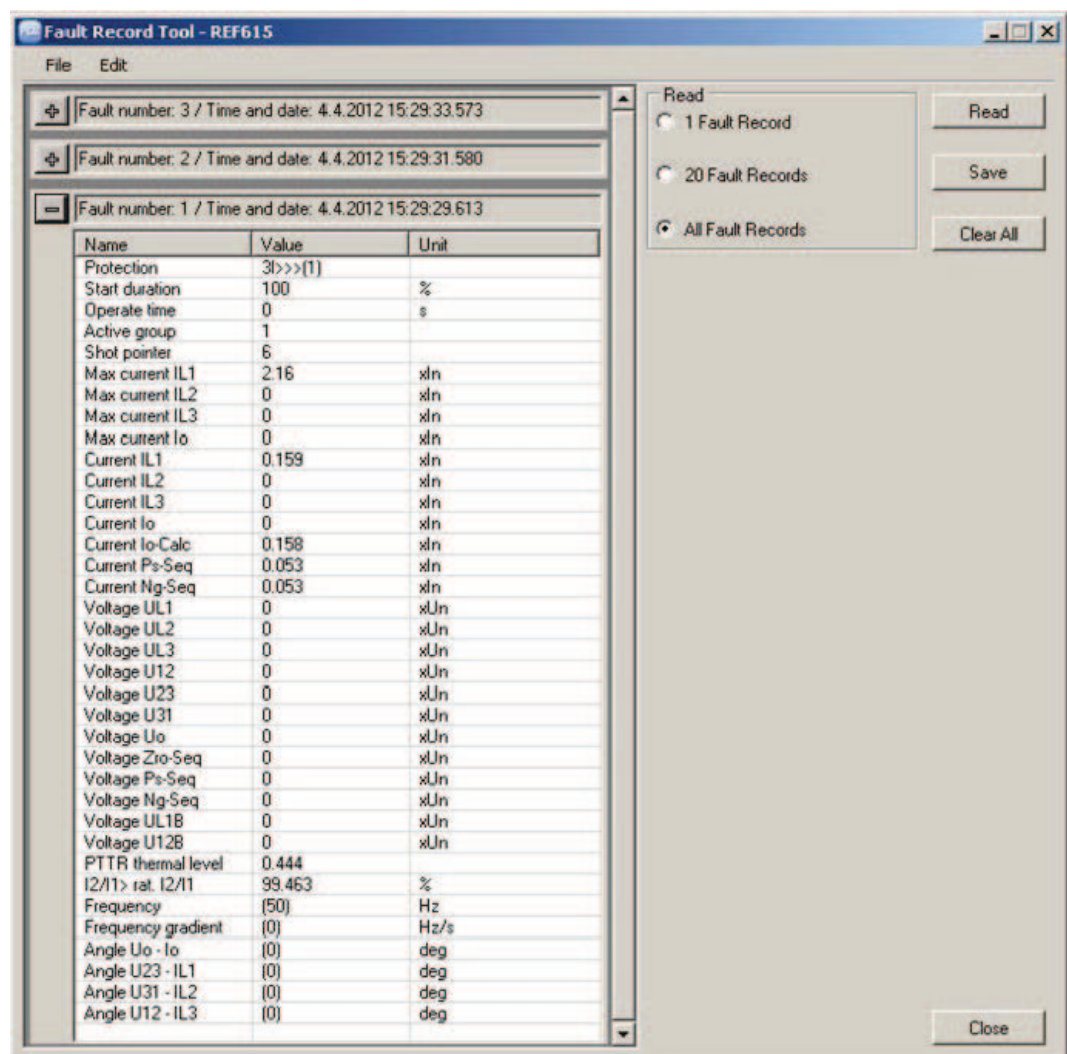


Figure 75: Fault record tool



**Table 4: Available actions on the user interface**

Action	Description
Read	<p>Clicking <b>Read</b> reads all available fault records from the protection relay into the tool. One fault record, 20 fault records or all fault records can be read. The <b>Read</b> button opens up a progress bar to indicate an ongoing read operation.</p> <p>Clicking <b>Cancel</b> on the Read progress bar cancels the read operation. On operation completion, the available fault records are shown in the record grid.</p> <p>Click the + icon to expand and view record details.</p> <p>Clicking the + icon expands the record details for viewing.</p>
Save	Clicking <b>Save</b> saves the fault records on the local machine as .txt file.
Clear	A record can be cleared from the Fault Record tool, the protection relay or both. Before deleting the records, a confirmation dialog box is shown.
Close	Clicking <b>Close</b> closes this instance of the Fault Record tool. All open instances are closed when PCM600 is closed.
File	<b>File</b> menu for <b>Save</b> and <b>Exit</b> actions.
Edit	<p><b>Copy All</b> in the <b>Edit</b> menu allows to copy all the fault records which can then be pasted to a word processor and saved on the local machine without having to save the records as a .txt file.</p> <p>Additionally the user can select any particular fault record and right-click to copy the selected record.</p>

## 5.7

### IED Compare

IED Compare is used to compare the IED configurations of two IEDs of the same type. It generates a text report which lists the differences between the IED configurations. IED Compare provides an option to compare an IED configuration stored in PCM600, IED or .pcmi file. IED Compare can compare certain types of IED configurations and parameters.

- Application configuration
- Display configuration
- GOOSE receive configuration
- Parameters



Application comparison also compares the system function blocks.



Display comparison compares the LHMI page configurations.



Detailed instructions are shown in PCM600 documentation.

### 5.7.1 Starting IED Compare

- Start **IED Compare** in the shortcut menu in plant structure.
  - a) In the PCM600 plant structure, right-click **Substation**, **Voltage level**, **Bay** or **IED**.
  - b) Select **IED Compare**.
- Start **IED Compare** from the PCM600 main menu.
  - a) Select **Substation**, **Voltage level**, **Bay** or **IED** in the PCM600 plant structure.
  - b) On the PCM600 menu bar, point to **Tools** and select **IED Compare**.

### 5.7.2 IED Compare tool interface

The comparison report shows differences in the configuration of two IEDs. Hardware, application, display, GOOSE and parameter configuration differences are grouped and listed under the corresponding headings.

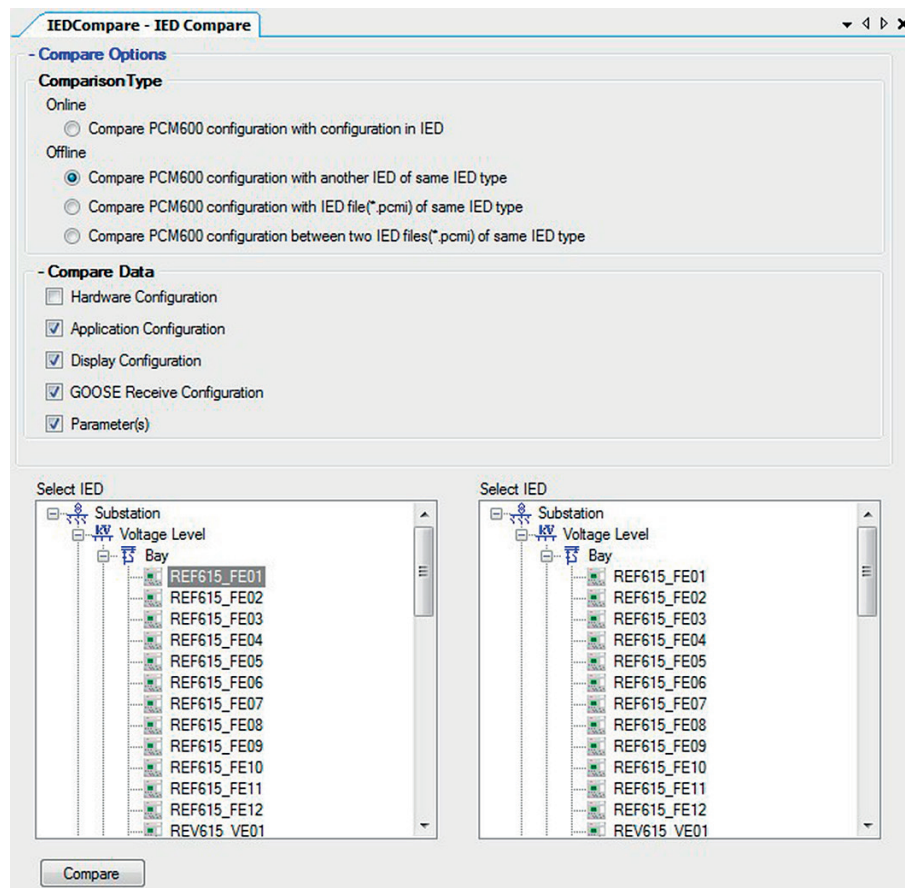


Figure 76: Compare options

Each configuration group can be expanded or collapsed by clicking the plus (+) or minus (-) button next to it in the result grid.

The reports must be read from left to right row-wise.

Compare PCM600 configuration with another IED of same IED type

Configuration Group	REF615_FE01 (AA1J1Q01A4)	REF615_FE02 (AA1J1Q01A2)
Application Configuration		
Display Configuration		
GOOSE Receive Configuration		
Parameter(s)	No differences found	
Parameter	[Setting Group ] Product identifiers:0:C...	FE01
	[Setting Group ] Product identifiers:0:S...	2RCA031416A
		FE02
		2RCA031417A

Find Save Close

Figure 77: Compare report

Table 5: Acronyms used in a report

Acronym	Description
DA	Data attribute
DO	Data object
IED	Intelligent electronic device
LN	Logical node
SIG	Signal

## 5.8 Protection and control blocking examples

*Test mode* is selected through one common parameter via the HMI path **Tests > IED test**. By default, *Test mode* can only be set locally through LHMI. *Test mode* is also available via IEC 61850 communication (LD0.LLN0.Mod).

Table 6: Test mode

Test mode	Description	Protection BEH_BLK
Normal mode	Normal operation	FALSE
IED blocked	Protection working as in Normal mode but ACT configuration can be used to block physical outputs to process. Control function commands are blocked.	TRUE
IED test	Protection working as in Normal mode but protection functions work in parallel with test parameters.	FALSE
IED test and blocked	Protection working as in Normal mode but protection functions work in parallel with test parameters. ACT configuration can be used to block physical outputs to process. Control function commands are blocked.	TRUE

The mode of all logical nodes located under the CTRL logical device is set with *Control mode*. *Control mode* is selected via the HMI or PCM600 path **Configuration > Control > General**. By default, *Control mode* can only be set

locally through LHMI. *Control mode* inherits its value from *Test mode* but *Control mode* "On", "Blocked" and "Off" can also be independently set. *Control mode* is also available via IEC 61850 communication (CTRL.LLN0.Mod).

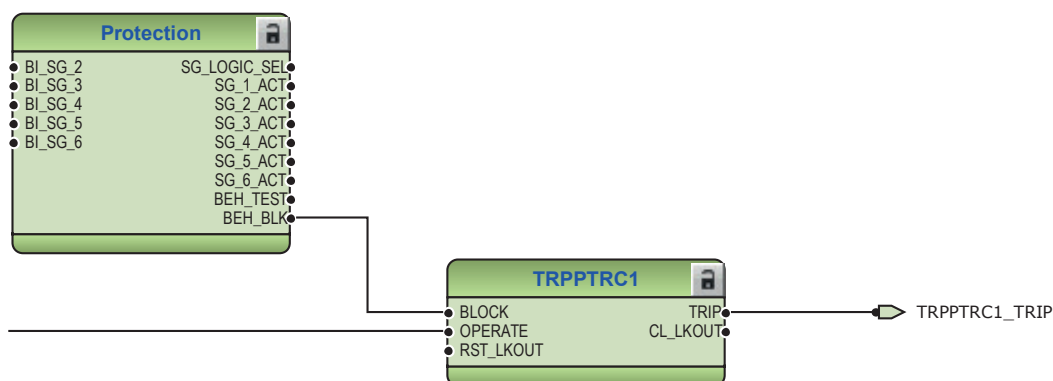
**Table 7: Control mode**

Control mode	Description	Control BEH_BLK
On	Normal operation	FALSE
Blocked	Control function commands blocked	TRUE
Off	Control functions disabled	FALSE

According to IEC 61850, the physical outputs to process should be blocked when the device is set to blocked or test blocked mode. The blocking logic must be implemented in the ACT configuration. In the protection blocking example the main trip from TRPPTRC1 is blocked, and in the control blocking example CBXCBR1 is blocked. Both comply with IEC 61850. In real applications some PTRCs might also be used for signalling purposes (GOOSE) and blocking and interlocking via I/O.

### 5.8.1 Protection blocking example

The physical outputs to process can be blocked with "IED blocked" and "IED test and blocked" modes. If physical outputs need to be blocked, the application configuration must block the signals or the function blocks that affect primary apparatuses. The blocking scheme needs to use the BEH\_BLK output of the PROTECTION function block.



*Figure 78: Master trip TRPPTRC blocked using Protection function block BEH\_BLK output*

### 5.8.2 Control blocking example

The physical outputs to process can be blocked with "Blocked" mode. If physical outputs need to be blocked, the application configuration must block signals or function blocks that affect primary apparatuses. Blocking scheme needs to use BEH\_BLK output of CONTROL function block.

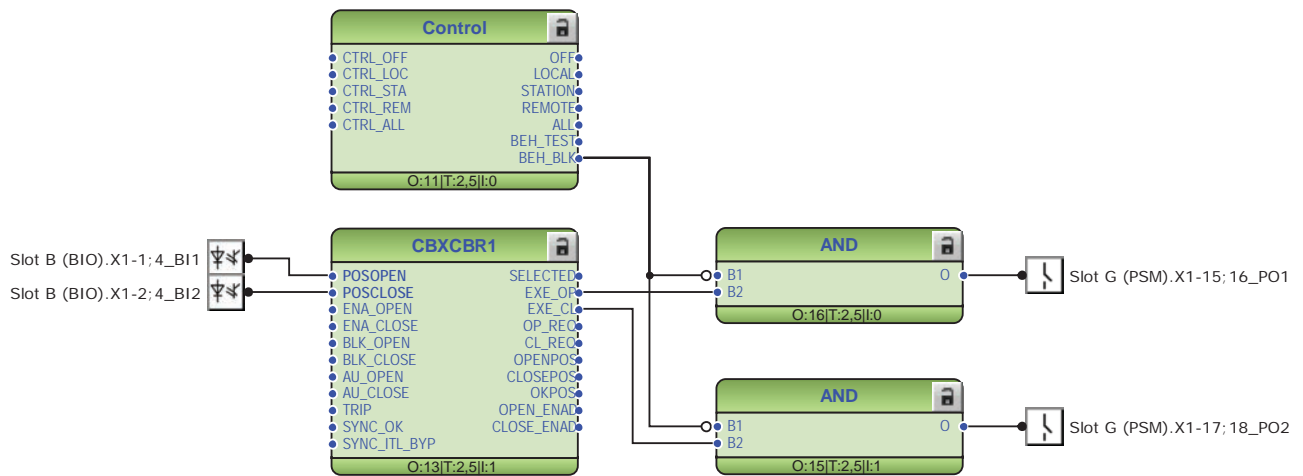


Figure 79: Circuit breaker control CBXCBR1 blocked using Protection function block BEH\_BLK output

## 6 HMI engineering

### 6.1 Graphical Display Editor

Graphical Display Editor is used to configure the protection relay's HMI pages.

Graphical Display Editor can be used to create new pages, configure pages by adding widgets, set page visibility to different user categories, create single-line diagrams and symbols and provide language translations.

#### 6.1.1 Creating complete local HMI page configuration

- Configure the protection relay functions such as protection, measurements and control functions with Application Configuration. The configuration made in Application Configuration can be saved to make the interfaces and signals available for other engineering tools within PCM600 such as Parameter Setting or Graphical Display Editor.
- Make connections between the application configuration function blocks and physical hardware inputs and outputs by using Signal Matrix or Application Configuration.
- Configure HMI pages by using Graphical Display Editor. Create new pages, configure the pages by adding widgets, set page visibility to different user categories, create single-line diagrams shown on the LHMI and WHMI and symbols, and provide language translations for the added LHMI elements.
  1. To configure the single-line diagram, check if any new symbols are required in addition to the default symbols in SLD Editor. Use Symbol Editor to create the missing symbols.
  2. Use SLD Editor to create a single-line diagram. Add bus bars, symbols and texts and create links between the symbols. Link the dynamic symbols to the corresponding function blocks in the application configuration. The function blocks control the objects represented by symbols on the HMI. Add 10 SLD pages at the maximum.
  3. Use Page Organizer to configure the main screen of HMI and to create main pages and linked pages by using the predefined ABB built-in pages and template pages. Set also the page visibility to Basic or Advanced access rights and define unique page names.
  4. Use Page Editor to configure the main and linked pages and, for example, to add widgets.
  5. Use Language Translation to translate the configuration data text into different languages. Configuration data includes widget properties, page properties and symbol captions. If needed, add a new language from the list of languages supported by the relay and set the translated text for the language for available configuration.
  6. Save the configuration.
  7. Preview the configuration before writing it to the relay.
  8. Write the configuration to the relay.

## 6.1.2 Creating complete switchgear HMI configuration

- Configure HMI pages for all the relays that are intended to be connected to the SHMI. These steps are described separately.
- Configure bay overview for each relay by using Graphical Display Editor. Create SHMI pages, configure SLDViewPort or Image widgets, and create single-line diagrams shown on the SHMI navigation page.
  1. To configure a single-line diagram for the bay overview, create a single-line diagram in Switchgear HMI SLD Editor. Create an SHMI page in Page Organizer, add an SLDViewPort widget to the SHMI page, and select the previously drawn SHMI SLD to be shown.
  2. To configure an image for the bay overview, create an SHMI page in Page Organizer. Add an Image widget to the SHMI page, and select the image to be shown in the bay overview.
  3. Save the configuration and write the bay overview configuration to the relay.
  4. Close Graphical Display Editor.
- Create an SHMI object in the plant structure.
- Start Switchgear HMI Configuration from the SHMI object to configure the navigation page for the SHMI.
  1. Set the substation name, voltage level and switchgear name according to the project requirements.
  2. Ensure that all bay overviews under the Switchgear HMI Navigation Page Configuration section are presented as intended in the SHMI navigation page. The order of bays can be changed and any bay overviews unintended for the SHMI can be moved to the Unallocated bays overview section.
  3. Preview the navigation page to ensure that the result is correct.
- Set up a connection to the relays through a station network so that all the relays are reachable.
- Write the SHMI configuration to all allocated relays.

## 6.1.3 ABB built-in pages

The ABB built-in pages contain information and functionality which are common to most of the applications. Widget properties are usually fixed on these pages but some, such as measurement page and phasors page contents, can be modified.

### 6.1.3.1 Measurements page

The Measurements page contains two configurable measurement lists. The buttons at the bottom of the page are used to navigate to other measurement-related pages: **Phasors**, **Load Profile**, **Harmonics** and **Temperatures**.

Only the **Measurements** and **Phasors** pages are user-configurable.

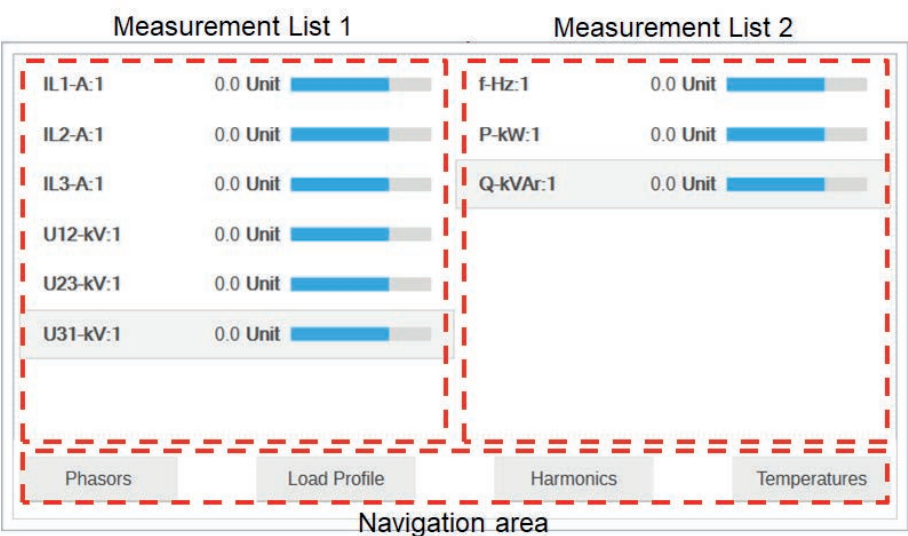


Figure 80: Measurements page



The **Measurements** page configuration data is also used by the WHMI, that is, even if the LHMI is not used with the relay, if the measurements need to be seen on the WHMI, the **Measurements** page configuration must be created in Graphical Display Editor.

**Adding and removing measurements**

1. In Page Editor, select the **Measurements** page and then select a measurement list by clicking it.
2. In the **Object Properties** pane, click ... on the **listId** row to browse the available signals.

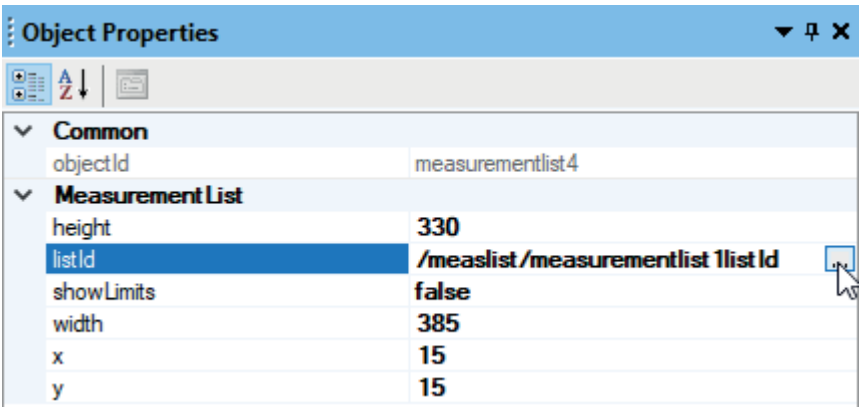


Figure 81: Accessing the signals



3. In the **Signal Group Selection** dialog, select check boxes to add the required signals or clear them to remove any unused signals.

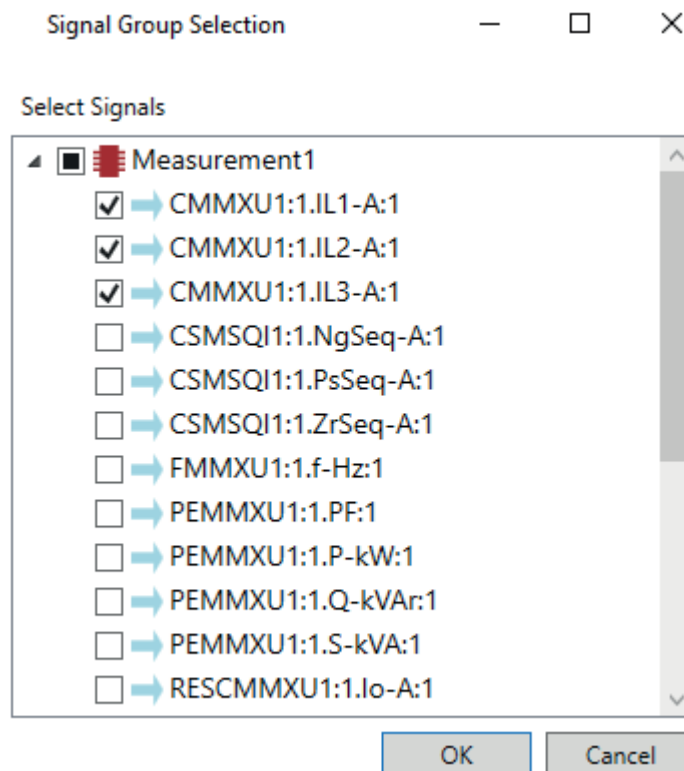


Figure 82: Selecting signals

4. Click **OK**.

### Configuring measurement items

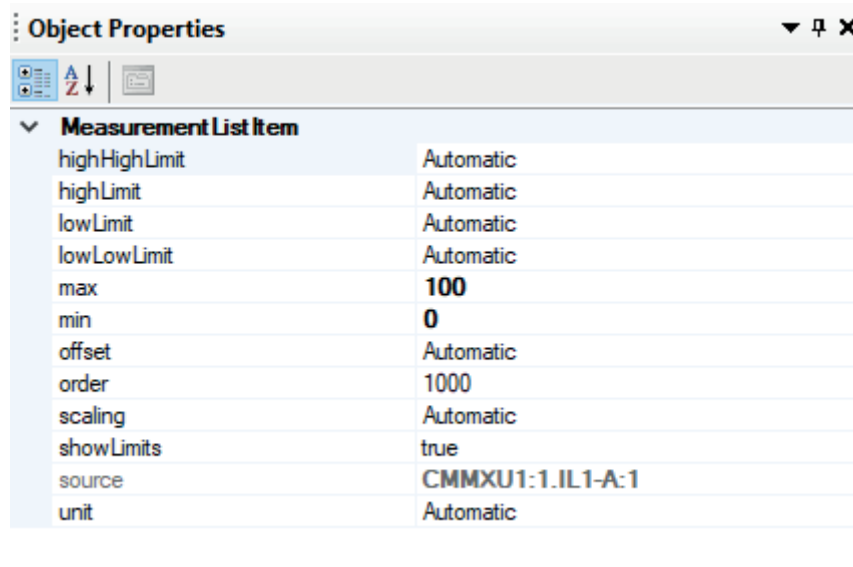
The measurement limits, scaling and order can be independently configured in the Object Properties pane.



Click a measurement to select the measurement item. Then click the same item again to select the measurement list.

- Set the measurement properties.

If the property value is set to "Automatic", the LHMI uses the value defined by the data model.



Object Properties	
▼ Measurement List Item	
highHighLimit	Automatic
highLimit	Automatic
lowLimit	Automatic
lowLowLimit	Automatic
max	100
min	0
offset	Automatic
order	1000
scaling	Automatic
showLimits	true
source	CMMXU1:1.IL1-A:1
unit	Automatic

Figure 83: Configuring measurement items


- Apply custom scaling, if needed.
  1. In the **scaling** box, define the correct value which is a coefficient applied to the measurement value. The supported scaling is linear:  $\text{new\_value} = \text{read\_measurement\_value} \times \text{scaling\_property} + \text{offset\_property}$ .
  2. In the **offset** box, define the offset value.
  3. In the **unit** box, define the unit (string).
  4. Adjust the other limit properties to better fit the scaled measurement value.
- In the **order** box, define custom order for the measurements, if needed. The smaller the order property, the higher the measurement's position in the measurement list.

By default, all measurement list items are arranged in alphabetical order. Modifying the order property overrides the default behavior.

### 6.1.3.2 Phasors page

By default, the Phasors page template available in Page Organizer contains an empty Custom signal group. Measurements can be added to the Custom signal group or new signal groups can be added and removed by opening the **Phasors** page in Page Editor.

#### Opening Signal Grouping Editor

1. In Page Editor, open the **Phasors** page.
2. Click  in the lower-right corner of the Phasors page.

The **Signal Grouping Editor** dialog opens.

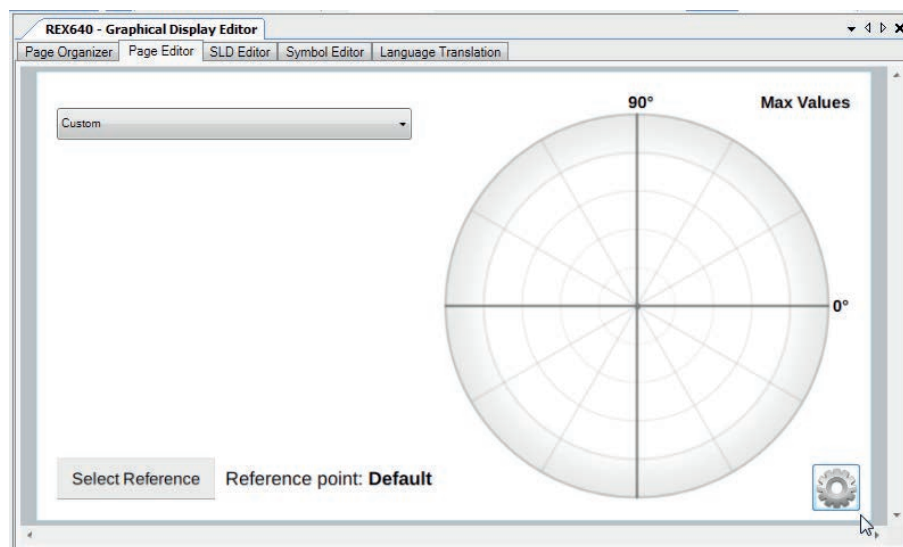


Figure 84: Opening Signal Grouping Editor

### Adding and removing signal groups

- Add a new signal group.
  1. In **Signal Grouping Editor** dialog, click **Add**.
  2. In **Enter Group Name** dialog, type the signal group name.
  3. Click **OK**.

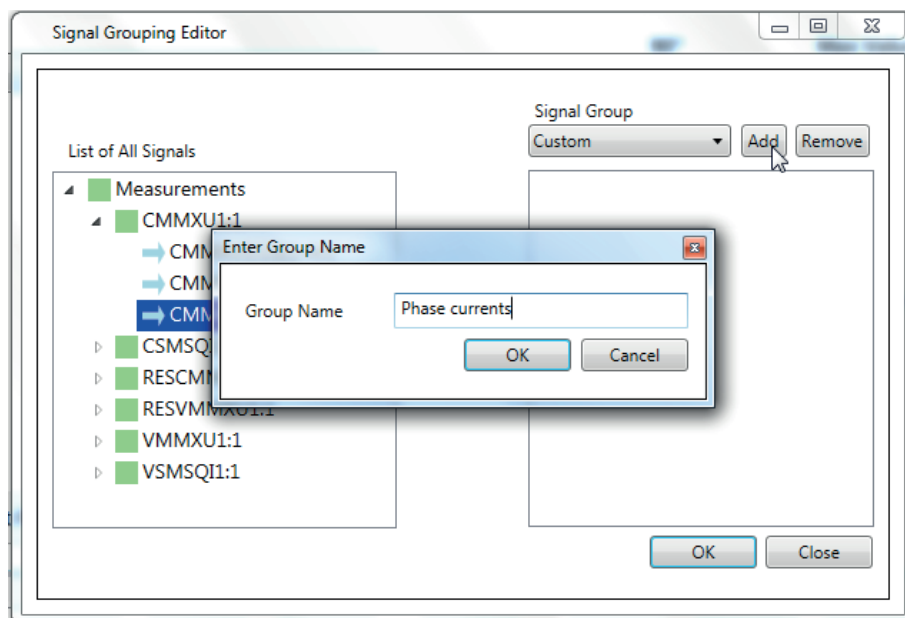


Figure 85: Adding a signal group

- Remove an existing signal group.
  1. In **Signal Grouping Editor** dialog, select a group from the **Signal Group** drop-down list.
  2. Click **Remove**.

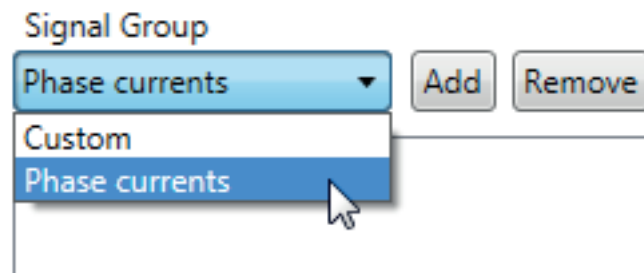



Figure 86: Removing a signal group

### Adding and removing signals

- Add new signals.
  1. In **Signal Grouping Editor** dialog, select a group from the **Signal Group** drop-down list.
  2. In List of All Signals list, select the required signals and click . Add seven signals at the maximum to a single group.
  3. Click **OK**.

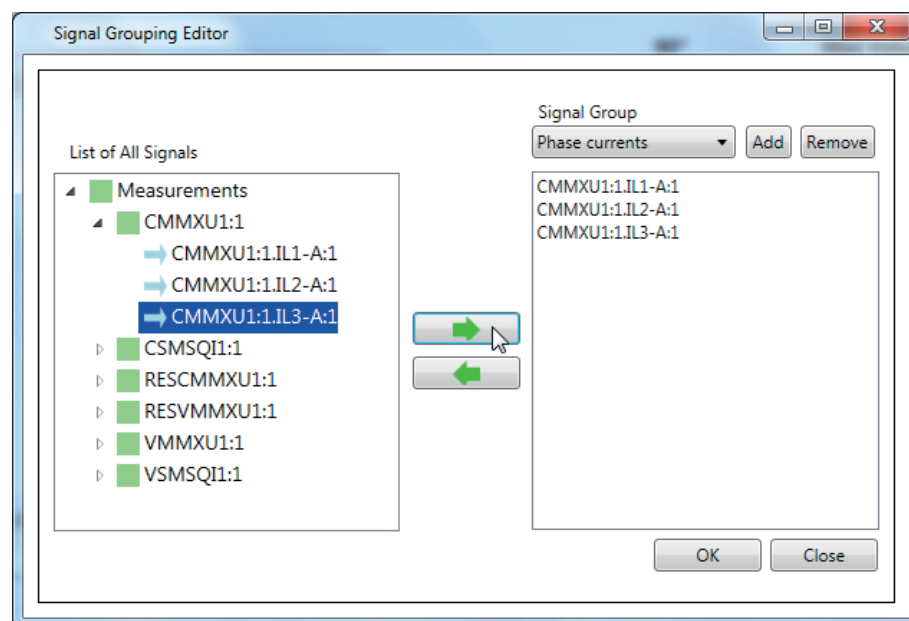



Figure 87: Adding a signal

- Remove existing signals.
  1. In **Signal Grouping Editor** dialog, select a group from the **Signal Group** drop-down list.
  2. Select the required signals and click .
  3. Click **OK**.

## 6.1.4 Page Organizer

Page Organizer is used for configuring the main screen of LHMI by creating main pages, linked pages and switchgear HMI pages. Pages can be added, removed or reordered in Page Organizer and, for example, their visibility can be set to "Basic" or "Advanced". These access rights are mapped to user roles with User Management in PCM600 and the pages are filtered based on the mapping. The selection "Basic" or "Advanced" is not applicable to the WHMI. SHMI pages are used on the navigation page of the SHMI.



In the Add Page dialog, some of the pages in the ABB Built-in Pages category are marked with a padlock symbol. They are locked and cannot be modified in Page Editor. If such a page should be modified, it can be enabled by first saving it as a template.

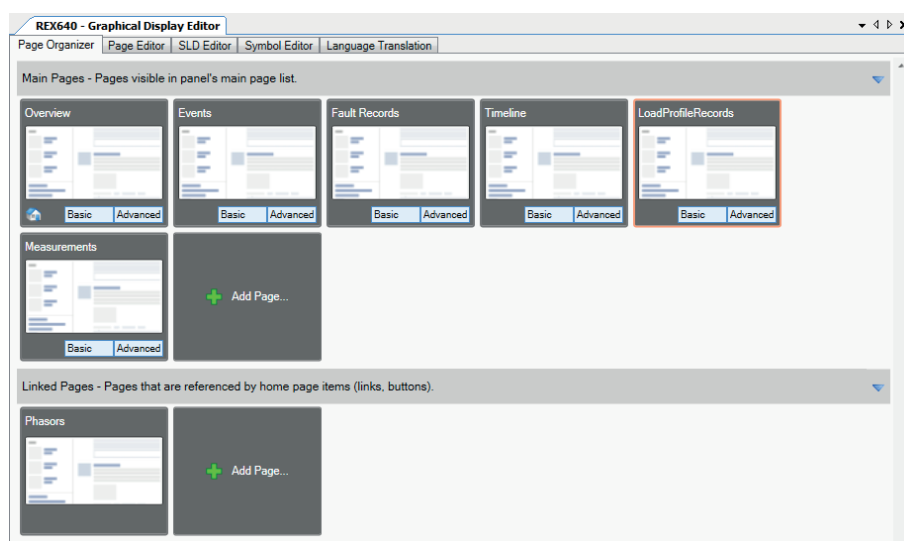


Figure 88: Page Organizer

### 6.1.4.1 Main pages and linked pages

Main pages can be navigated using the Home button on the LHMI. The main page visibility is bound to access rights. Linked pages are pages which are linked from other pages; they can be opened from a main page when a button is tapped. Depending on the selected role, linked pages are shown under the main page area.

Both the main pages and the linked pages are defined in Page Organizer.

### 6.1.4.2 Templates

Templates allow replicating the same configuration with less effort. New pages can be created by selecting a template page so that the new page becomes a new instance of the template page. Templates also contain empty pages.

In Page Organizer, the ABB built-in pages are seen as page templates. Both ABB built-in pages and template pages require unique names.

### 6.1.4.3 Creating pages

The relay supports 10 main pages, 20 linked pages and 2 SHMI pages at the maximum.

1. In Page Organizer, create new pages in one of the alternative ways.

- Under **Main Pages**, click **Add Page** to create a main page.
- Under **Linked Pages**, click **Add Page** to create a linked page.



Change the page type (main or linked) by dragging the page from one area to the other.

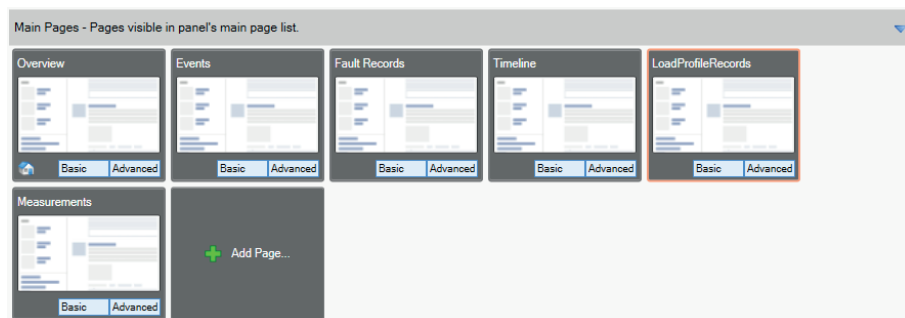


Figure 89: Adding pages

2. In the **Add Page** dialog, select a predefined ABB built-in page or a template page and click **Add**.



Define unique names for all main, linked and SHMI pages regardless of their type.

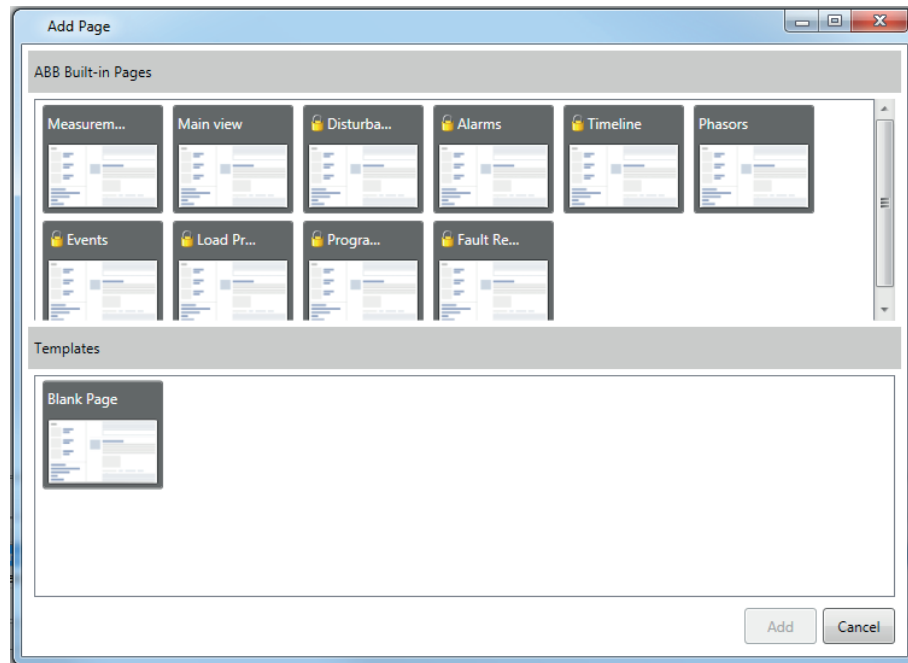


Figure 90: Using ABB built-in pages or templates

#### 6.1.4.4 Changing page order

- In Page Organizer, change the order of the pages by dragging a page to the required place.
- Pages can also be dragged from **Main Pages** to **Linked Pages** and vice versa.

#### 6.1.4.5 Creating templates

When a template is created out of an existing page, it becomes available under the Templates section in the Add Page dialog. Templates allow replicating the same configuration with less effort.

Save pages as templates in one of the alternative ways.

- Click **Options** in the upper-right corner of the page and select **Save as Template** from the shortcut menu.
- Right-click the page and click **Save as Template**.

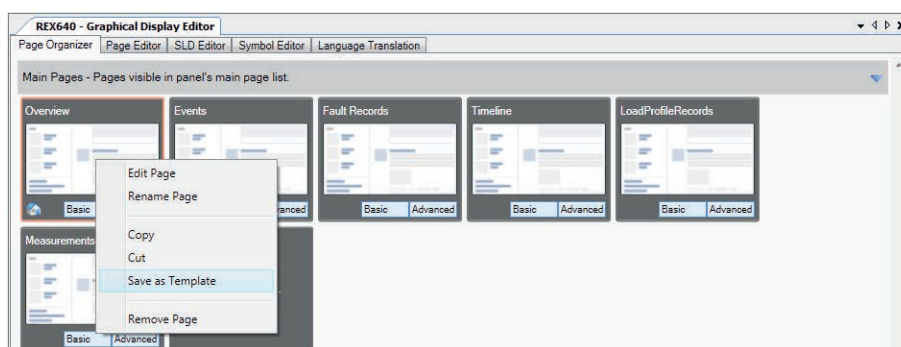


Figure 91: Saving templates

## 6.1.5 Switchgear HMI Page Editor

Switchgear HMI Page Editor is used to configure the bay overview shown on the SHMI navigation page. SHMI pages can be configured by adding widgets that are the building blocks for configuring the bay overview. All the supported widgets are populated in the Object Types pane.

Page Browser is shown at the bottom of Switchgear HMI Page Editor. It displays all editable SHMI pages that are available in the Page Organizer. When a page is clicked, it opens in Page Editor. Page templates are not shown in Page Browser.

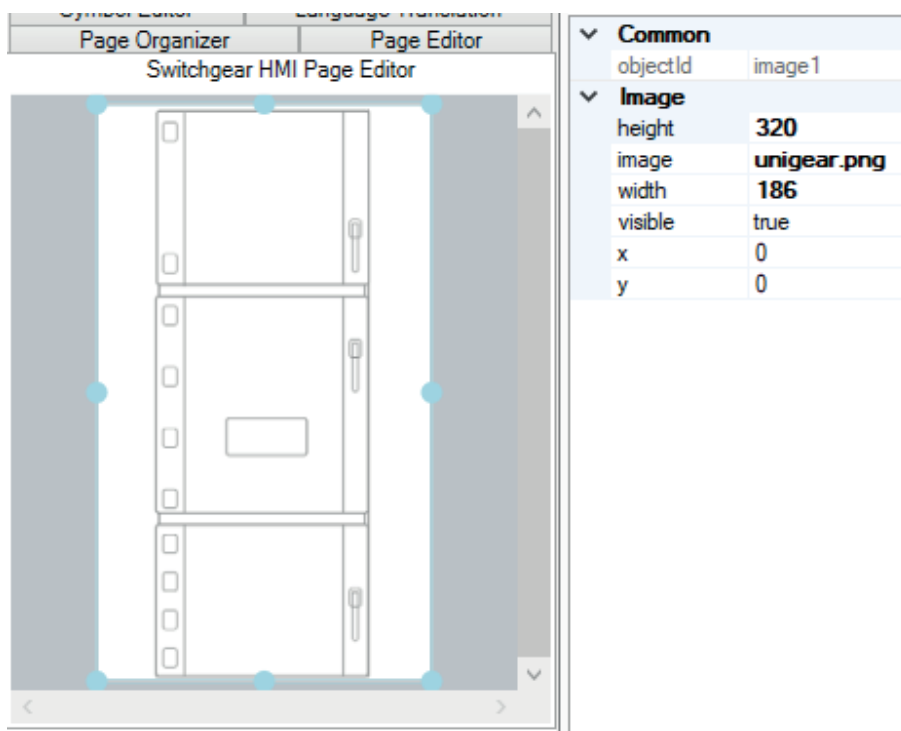


Figure 92: Page with Image widget

### 6.1.5.1 Adding widgets

- Add a widget to the page by dragging it from the **Object Types** pane.



- Set the widget properties.

### Adding SLDViewPort

The SLDViewPort widget displays the single-line diagram configured in Switchgear HMI SLD Editor. The single-line diagram is shown on the bay overview area of the SHMI navigation page.

1. Drag the **SLDViewPort** widget from the **Object Types** pane to the page.
2. In **Object Properties**, select the required page from the **page** drop-down list.

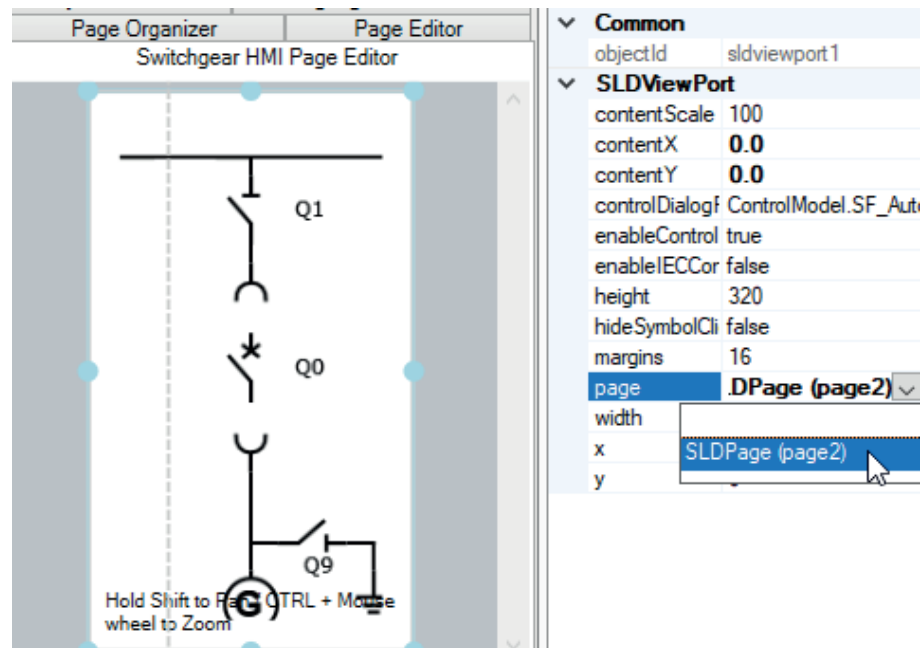


Figure 93: Configuring the SLDViewPort widget

### Adding Image

The Image widget displays a custom image on the bay overview area of the SHMI navigation page.

1. Drag the **Image** widget from the **Object Types** pane to the page.
2. In **Object Properties**, select the required image from the file selection dialog.



Slicing of a photo or a static SLD picture for multiple bays should be done in a separate editor application. Maximum size of the picture is 186 × 320 pixels.

## 6.1.6 Page Editor

Page Editor is used for configuring pages. Pages can be configured, for example, by adding widgets that are the building blocks of the LHMI configuration or by creating a single-line diagram.

Any graphical object drawn on the LHMI page is a widget. All the supported widgets are populated in the Object Types pane.

Page Browser is shown at the bottom of Page Editor. It displays all editable pages selected for the Main Pages and Linked Pages categories in Page Organizer. When a page is clicked, it opens in Page Editor. Page templates are not shown in Page Browser.

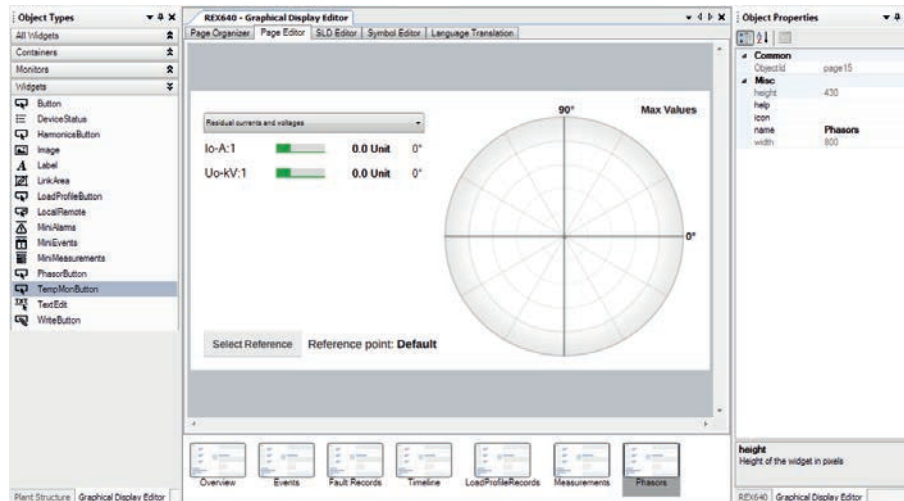


Figure 94: Page with phasors

### 6.1.6.1

## Adding widgets

- Add a widget to the page by dragging it from the **Object Types** pane.
- Set the widget properties.

### Adding SLDViewPort

The SLDViewPort widget displays the single-line diagram configured in SLD Editor.

1. Drag the **SLDViewPort** widget from the **Object Types** pane to the page.
2. In **Object Properties**, select the required page from the **page** drop-down list.

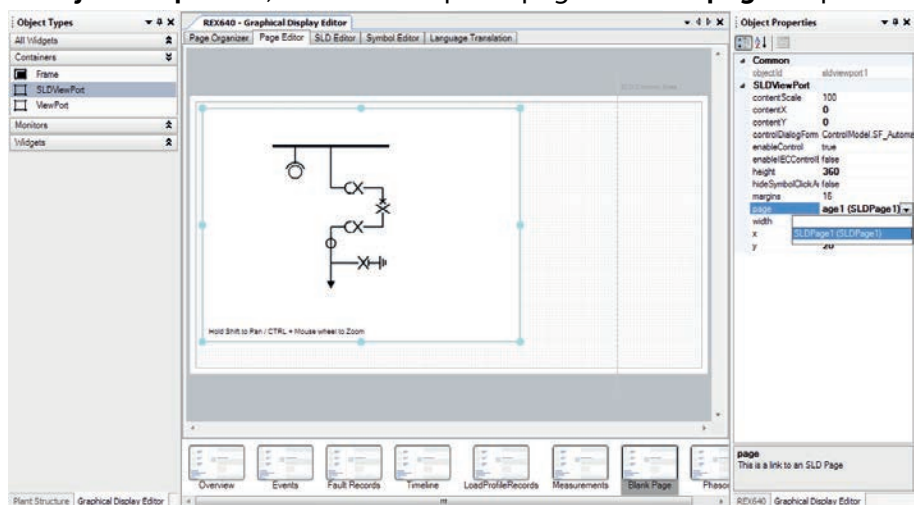


Figure 95: Configuring the SLDViewPort widget

### Adding ViewPort

The ViewPort widget displays the contents of a page.

1. Drag the **ViewPort** widget from the **Object Types** pane to the page.
2. In **Object Properties**, select the required page from the **page** drop-down list.

### 6.1.6.2

### Configuring pages

- Add new widgets by dragging them from **Object Types** to the page.
- Resize the selected widgets in one of the alternative ways.
  - Click and hold any resize point on the edge or corner of the widget and drag the mouse to resize the widget.
  - Change the width and height properties of the widget in the **Object Properties** pane.
- Set the properties of the selected widget by modifying the values in the **Object properties** pane.

Once widgets are placed on the HMI page, some of them (Monitors) can be linked to the corresponding function block in the application configuration by using the source property. The values are updated by the protection relay either periodically (measurement) or in case of an event.

Some of the widget properties can be in an automatic mode. When the property is in the automatic mode, the values are set automatically by the protection relay's LHMI. If a value is specified for an automatic property, the LHMI displays the specified value.



Some of the widget properties cannot be edited as they are read-only values.

- Group or ungroup multiple widgets regardless of their type.

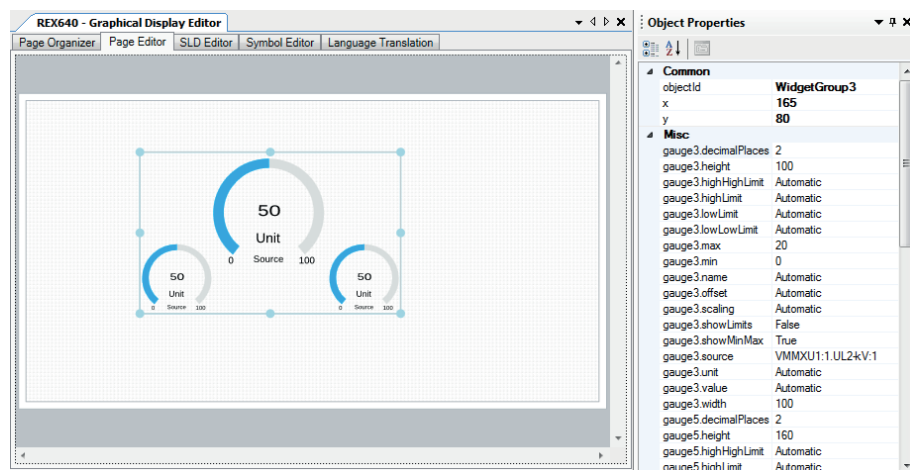


Figure 96: Grouping widgets

When a group is created, all the individual widget properties such as the widget name followed by the dot and the property name, are shown in the Object Properties pane. Only properties x and y are common for all the widgets in the group.

The widget group property naming (aliases), visibility and read-only can be modified.

The grouped widgets can be ungrouped by right-clicking the group and selecting **Ungroup**.

- Bind the widget property values to the same or to another widget property values or to signal values from the application configuration function.

It is possible to specify simple if...else conditions. The property values are then changed based on those conditions.

For example, the LED color can be changed to red if the signal value is high or to green if button2 is checked. Otherwise the LED color is yellow.

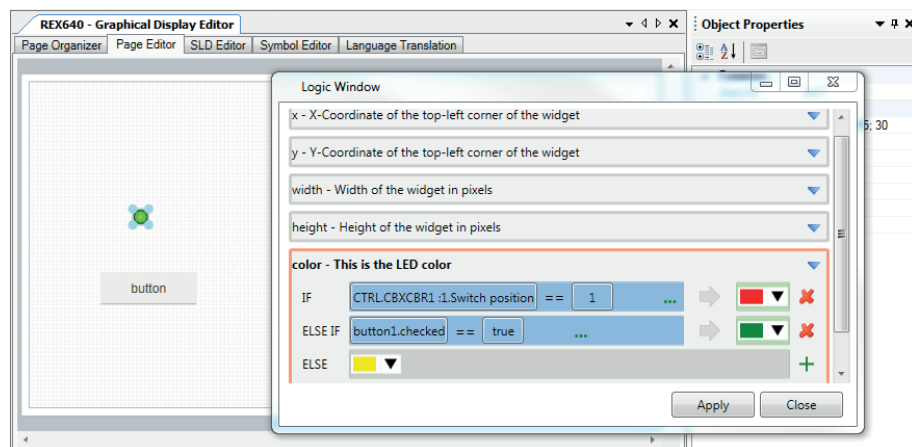


Figure 97: Binding property data

## 6.1.7 Symbol Editor

Symbol Editor is used to create symbols for a single-line diagram. It has different drawing tools available such as line, rectangle and ellipse to draw the symbols.

### 6.1.7.1 Symbols

Symbols are used in the single-line diagram. Each symbol has at least one state that represents the graphics of a symbol at different positions.

Symbol Editor supports three types of symbol standards. New symbols can only be created under the custom standard.

- ANSI
- IEC
- Custom

Symbol Editor can be used to create dynamic symbols that have different states corresponding to the different signal values supported by the symbol. For example, the symbol states of a breaker (open, close, intermediate and faulty) can be illustrated in Symbol Editor with the help of drawing tools such as line, rectangle, ellipse, curve or polyline. The symbol State value should match the signal Enum value. On the LHMI the symbols are displayed according to the signal value and the matching symbol state value. One of the states is always the default state. Symbols used in SLD Editor show the default state graphics.

There are several options for the symbol size: 1x1 (normal size), 1x2 (height is doubled), 2x1 (width is doubled) and 2x2 (both the height and width are doubled).

Custom symbols can be exported from the Graphical Display Editor and reused in other projects.

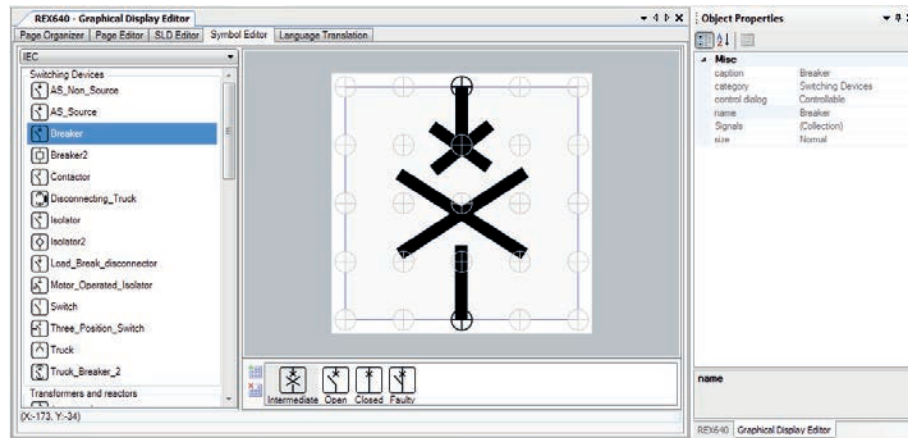


Figure 98: Symbol Editor


### 6.1.7.2

#### Creating custom symbols

New symbols can only be created under the custom standard. The available options are the category, size and states. At least one state should be selected when creating any symbol.



Before creating a new custom symbol, check that the states and category required for the new symbol are available by default. Otherwise, it may be necessary to create new states or categories.

1. Create a new symbol in one of the alternative ways.
  - On the menu bar, point to **Graphical Display Editor**, point to **Symbol Editor** and select **Create Symbol**.
  - Right-click the symbol library and click **Create Symbol**.
  - On the toolbar, click .

2. In the **Create Symbol** dialog, specify a name, category, size and states and click **Create**.

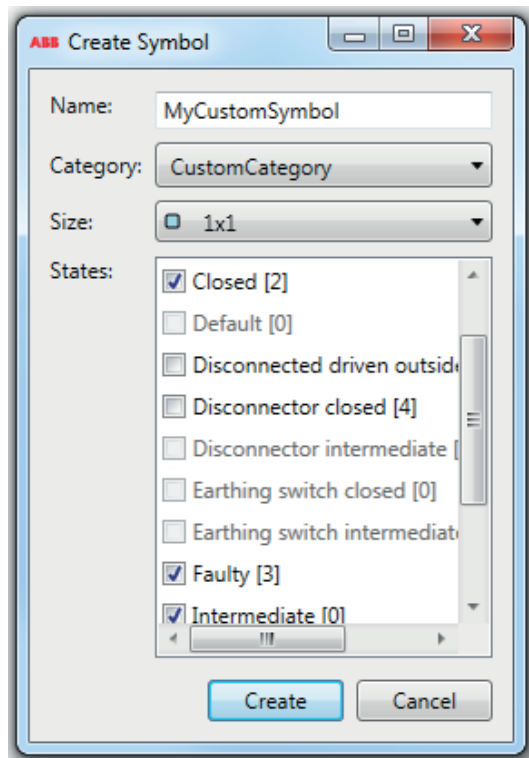


Figure 99: Creating a new symbol

The new symbol becomes available in Symbol Editor with the states selected for drawing. Different drawing tools such as line, rectangle and ellipse can be used to draw the graphics for the different states.

3. Select the symbol state to be used as the default and set **is default** to **True** in the **Object Properties** pane.

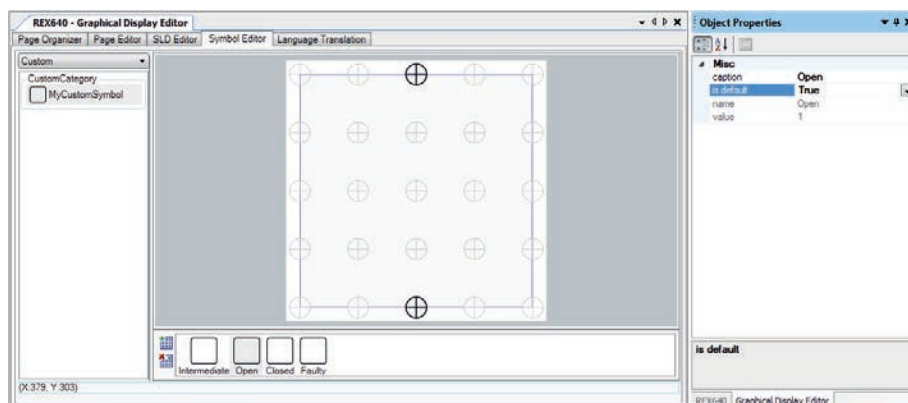


Figure 100: Setting the default state

4. Select the signals that should be connectable in SLD Editor via the symbol's Signals property.

- a) On the menu bar, point to **Graphical Display Editor**, point to **Symbol Editor**, point to **Symbol** and select **Object Properties**.
- b) Select **Signals property** and click ....
- c) In the **Signals Selection** dialog, use  and  to add or remove signals and click **OK**.

The connectable signal types for symbols are shown on the left side of the Signal Selection dialog. Any signal type can be moved from the left side to the right side and vice versa. These signal types are used to connect to the symbol if the instance is available in the configuration.

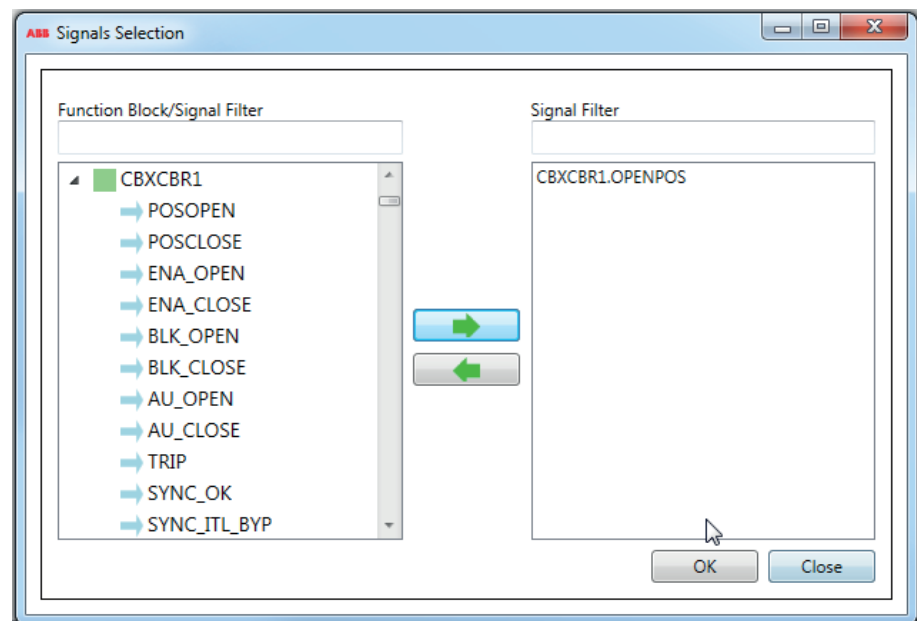


Figure 101: Selecting the signals for a symbol

- d) If the symbol is of control type, select the correct value in the **control dialog** drop-down list.

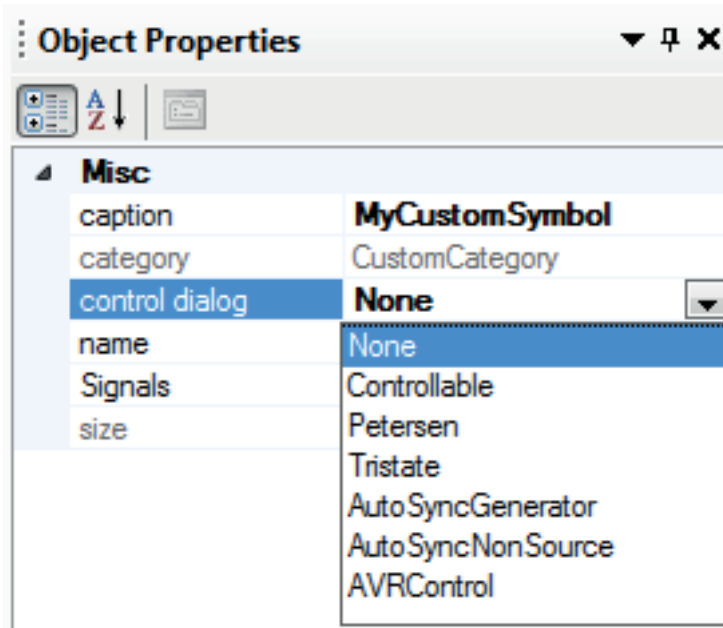



Figure 102: Selecting the control dialog type

5. Save the symbol to make it available in SLD Editor.



### 6.1.7.3 Creating categories

1. Create a new category in one of the alternative ways.
  - On the menu bar, point to **Graphical Display Editor**, point to **Symbol Editor** and select **Create Category**.
  - Right-click the symbol library and click **Create Category**.
  - On the toolbar, click .

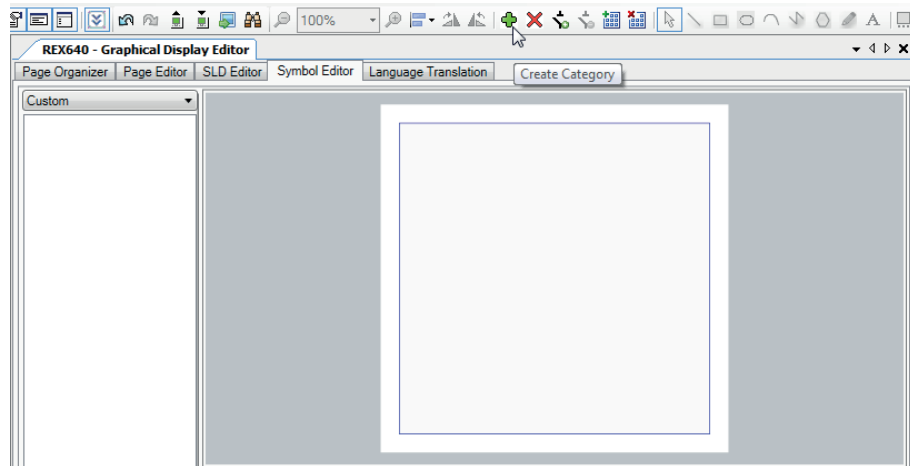



Figure 103: Creating a category

2. In the **Create Category** dialog, specify a name and click **Create**.

### 6.1.7.4 Creating states

The symbol can have different states that represent the graphics for the symbol. The symbol graphics are different for each state. The state is selected when creating a new symbol.

1. Create a new state in one of the alternative ways.
  - On the menu bar, point to **Graphical Display Editor**, point to **Symbol Editor** and select **Create State**.
  - On the toolbar, click .
2. In the **Create State** dialog, select **Create new state**.

3. Specify a name and numeric value and click **Create**.

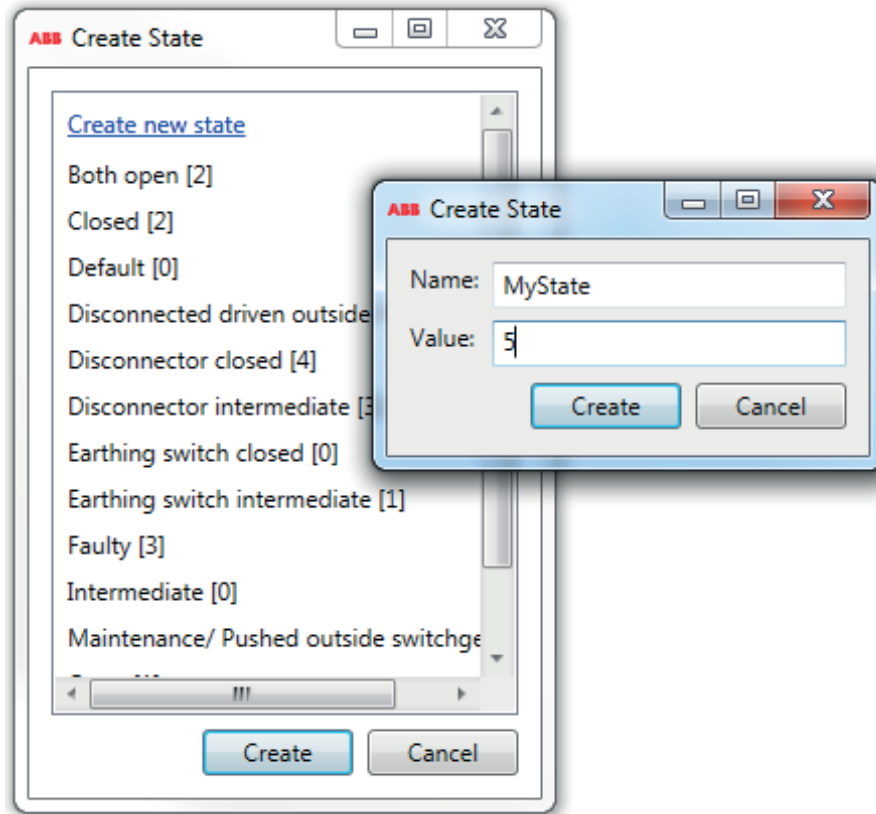


Figure 104: Creating a state

### 6.1.8 SLD Editors

SLD editors are used to create single-line diagrams. In SLD editors, bus bars, symbols and text can be added from the object type window and links can be created between symbols. Graphical Display Editor has two separate editors.

- SLD Editor is used to draw single-line diagrams that are used on the normal HMI pages.
- Switchgear HMI SLD Editor is used to draw a single-line diagram that is used on the bay overview area of the SHMI.

Once the symbols are placed on the SLD page, they must be linked in Application Configuration to the corresponding function block that protects or controls the object represented by the symbol. The values are updated by the protection relay either periodically (measurement) or in case of an event.

Single-line diagrams support both ANSI and IEC standards. Single-line diagrams created in ANSI can be changed to IEC and vice versa by changing the symbol standard in PCM600. Custom symbols can be used in both ANSI and IEC standards. In the object type window, symbols are grouped by their category.

The single-line diagram created in SLD Editor can be used on the main pages with a special widget called SLDViewPort. The widget is available under the Container group and its page property populates the list of SLD pages. The single-line

diagram size can be selected from the Object Properties pane. In ViewPort the single-line diagram can be zoomed and panned on the LHMI.

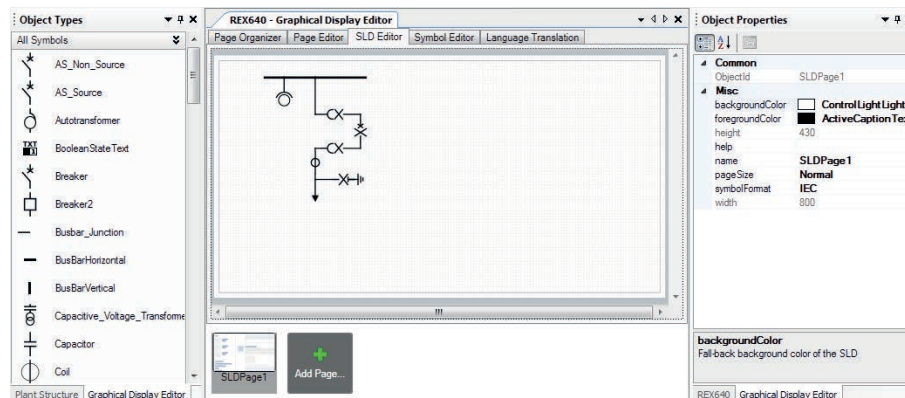


Figure 105: SLD Editor

All SLD pages are shown at the bottom of SLD Editor. When a page is clicked, it opens in SLD Editor. New SLD pages can be added by clicking the Add Page button. To remove an SLD page, right-click the SLD page and select the Remove Page option in the context menu.



The relay supports a maximum of 10 SLD pages.

SLD Page Editor is used for various tasks.

- Adding static text
- Adding measurands
- Adding bus bars
- Adding symbols to the display page
- Drawing lines (creating links)

### 6.1.8.1 Adding bus bars

1. In SLD Editor, drag a **BusBarHorizontal** or **BusBarVertical** object from the **Object Types** pane to the page view.

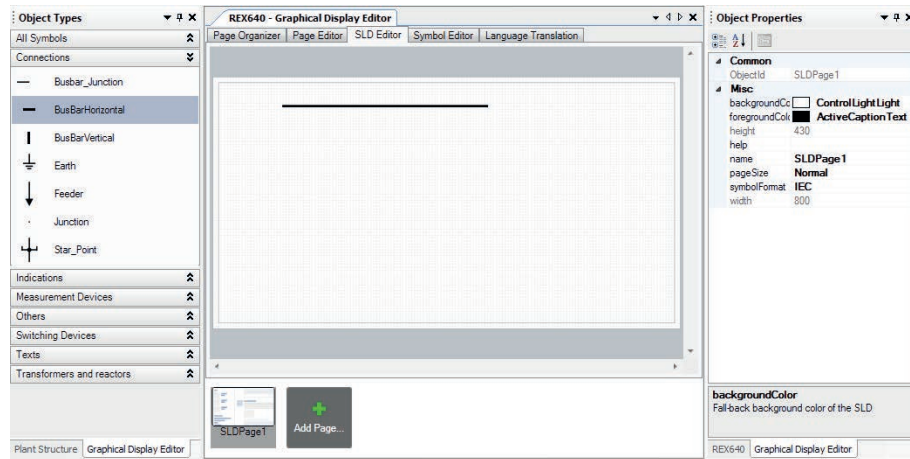


Figure 106: Adding a bus bar

2. Select the left or right connection point and drag it to increase the size of the bus bar.

### 6.1.8.2 Managing bus bar coloring

Bus bar coloring is used to assign a color to a bus bar or links. New bus bar color groups can be created and each color group can have one or more logic conditions; each logic condition is associated with one color.

#### Apply the bus bar coloring

1. Right-click anywhere on the page and select **Show Bus Bar Coloring**.
2. In the **SLD Logic Window** dialog, click **+** to add a new color group or **x** to remove an existing color group.
3. Expand any color group and click **+** to add **IF** and **ELSE** conditions and **x** to remove them.
4. Click **...** to add another **And** condition inline. Click **And** to change or remove the condition.
5. To add a value for a condition, click **Value Button**, select any signal value or widget property value and press ENTER.
6. Select any color from the drop-down list.
7. Select **Color Group** and click on any bus bar to apply the coloring.

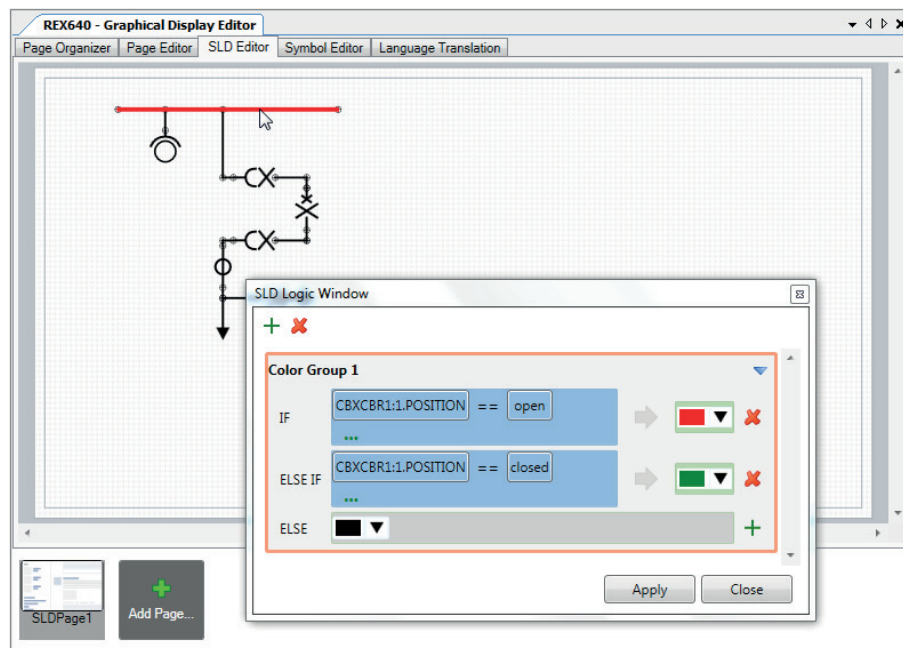


Figure 107: Managing bus bar coloring

#### Remove the bus bar coloring

1. Right-click anywhere on the page and select **Show Bus Bar Coloring**.
2. Select any color group and click the bus bar to remove the bus bar coloring.

#### Bus bar coloring example based on the CBXCBR position value

If the CBXCBR position is open, all the bus bars and links associated with the “Color Group1” group should be displayed in red color. If the CBXCBR position is closed, it should be indicated in green color. Otherwise the color is black.

```
IF CBXCBR1:1. POSITION== open THEN Line Color is Red ELSE
CBXCBR1:1. POSITION== closed THEN Line Color is Green ELSE Line
Color is black.
```



Right-click anywhere on the page and select **Highlight Conditional Bus Bar** to show bus bars that have the coloring applied.

### 6.1.8.3

#### Adding symbols to an SLD page

1. In SLD Editor, prepare the body of the single-line diagram by placing symbols to the wanted positions on the page view.
2. Drag the apparatus or transformer symbols to the SLD Editor view.
3. Drag the connection symbols.
4. Place the junction points.

5. Connect the symbols where necessary by drawing lines between the symbols' source and destination ports.

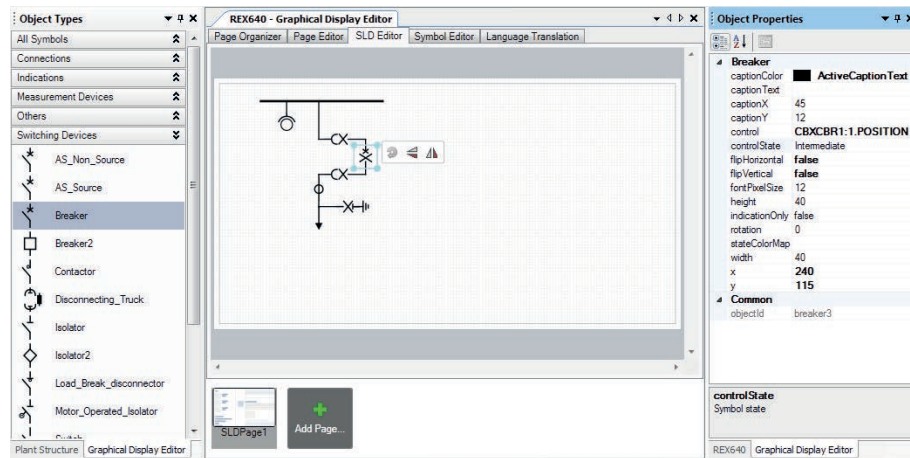


Figure 108: Adding symbols to an SLD page

6. In the **Object Properties** pane, set the symbol properties.
  - Use the **x** and **y** coordinates to adjust the placement of symbols in the single-line diagram.
  - Use **controlState** to define the default state of the symbol to be displayed in the view.
  - Use **indicationOnly** to define if the symbol is controllable (true = status only; false = controllable).
  - Use **control** to link the symbol to the function block in the application configuration that protects or controls the object.
  - Use **stateColorMap** to specify colors for the different states of the symbol.

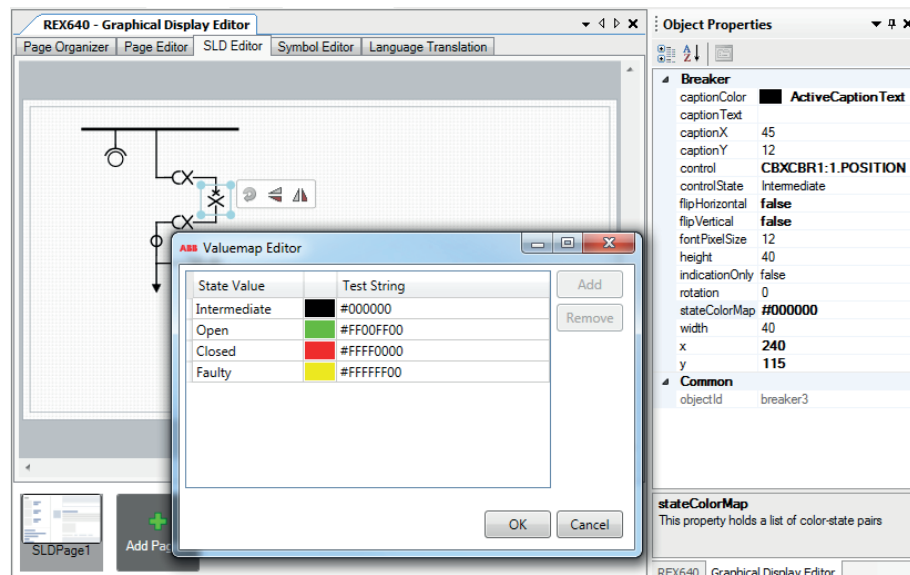


Figure 109: Setting colors for the different symbol states

If custom symbols have been used in the SLD configuration and then deleted, the symbol graphics show an error and all the related connections are removed from the configuration.

#### 6.1.8.4 Creating SLD pages

1. On the Graphical Display Editor toolbar, select the symbol standard from the drop-down list.
  - IEC
  - ANSI
2. Ensure that the **Snap to grid** and **Show grid** functions are available. These are the default and recommended settings when designing a single-line diagram.
3. Place the primary equipment on the single-line diagram approximately in the wanted position.

If required, rotate the symbols using the Rotate Left or Rotate Right functions.

4. Consider the necessary symbol connections, that is, links.
  - a) Click on the source port and click on the desired position to add a connection point.
  - b) Draw a perpendicular line by moving the mouse while pressing SHIFT and clicking on the target port.

5. Connect the symbols where necessary.

- a) Move the mouse pointer over the symbol's connection ports.

The connection ports of all symbols are activated.

- b) Drag the connection from the source connection port and drop it in the target connection port.

A connection line between the source and target connection ports is drawn.

Alternatively, click on the source port and then click once at the target port to create the connection. Move the mouse pointer on the nearest connection port to ensure the target port. A "+" sign appears.

- c) Right-click or press ESC to cancel the connection creation.

Once a link has been used to connect the symbols, the link follows the symbol when it is moved to a new position or when it is rotated.

6. Move the mouse pointer away from the symbol's port for all the connection ports of the symbols to become deactivated.
7. Select a symbol and modify its properties in the **Object Properties** pane.

The symbol name can also be changed by double-clicking the symbol.

8. In the **Object Properties** pane, use control to relate dynamic symbols to their source data.

#### 6.1.9 Language Translation

Language Translation is used to translate widget properties, page properties and symbol captions into different languages. All the translatable properties, that is, text properties, are displayed on the language translation tab.

With Language Translation the users can add a new language from the list of languages supported by the IED and set the translated text for the language. Once the translations are written to the IED they can be displayed on the LHMI based on the language selected.

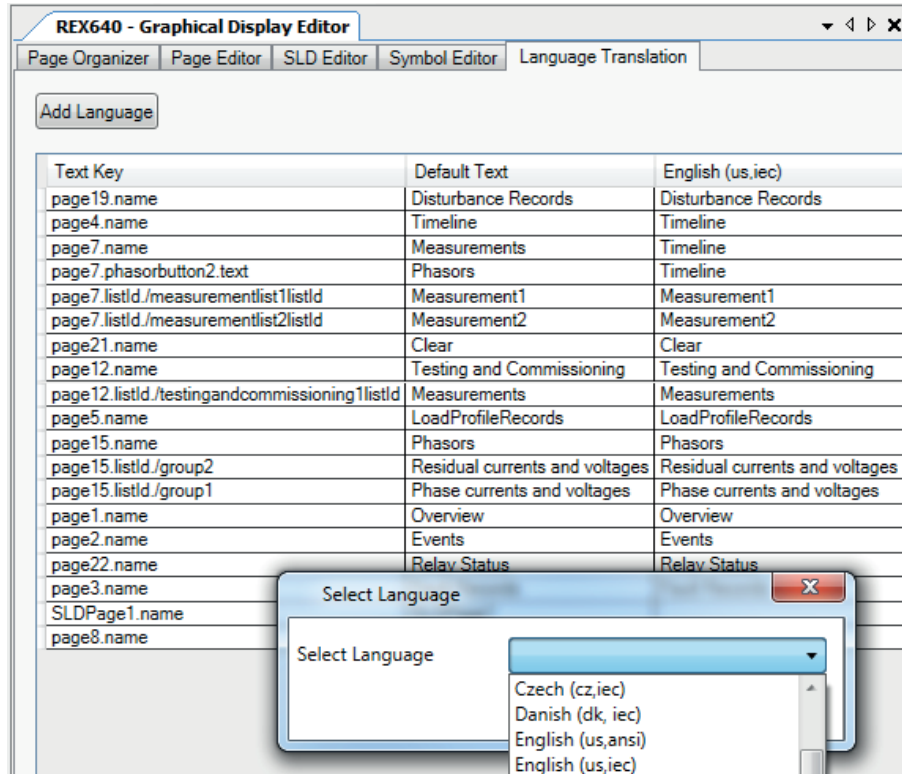


Figure 110: Language selection

New languages can be added by clicking the **Add Language** button, selecting any available language and clicking the **OK** button. The options Language 1...10 can be used to specify a custom language.

PCM600 shows all the languages supported by the IED. When adding a new language and writing it to the IED, it must be ensured that the corresponding language binary is loaded in the IED and that the corresponding language pack for the connectivity package is installed in the PC.



A warning message is displayed by the tool if the language binary is not loaded in the IED.

## 6.1.10

### Saving, reading and writing configuration to IED

1. Save the LHMI configuration in one of the alternative ways.
  - On the **File** menu, select **Save**.
  - Click the **Save** button on the toolbar.
  - Press CTRL+S.



2. To write the configuration to the IED, click the **Write to IED** button on the toolbar.

This action must be confirmed before it is carried out, because it overwrites the IED's existing display configuration. The writing operation can take a few seconds or minutes to complete.

3. To read the configuration from the IED, click the **Read from IED** button on the toolbar.

### 6.1.11 Previewing configuration

After the pages have been configured, the configuration can be previewed with a soft LHMI before it is written to the IED. The soft LHMI is a Windows version of the actual LHMI.

To launch the soft LHMI and to preview the configuration, click the **Show Preview** button.

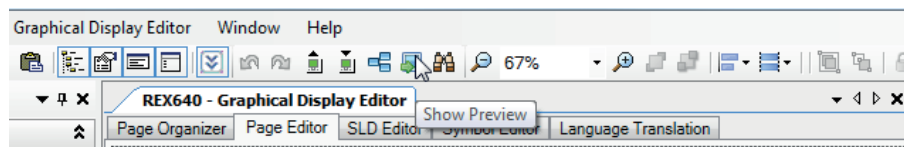


Figure 111: Launching the LHMI preview

### 6.1.12 Using HMI Client

REX640 HMI Client can be launched from PCM600. It connects to REX640 via selected Communication Port and shows HMI view that is identical to actual physical HMI.

HMI client can't be paired with the REX640 and control operations are not possible.

1. Select context menu on the top of REX640 in plant structure using right click.
2. Select **Browse with HMI > HMI Client**. When connection is established "No pages configured for the current user" is shown.
3. Click **LOGIN** on and enter credentials.

4. HMI Client is showing the configured HMI pages.

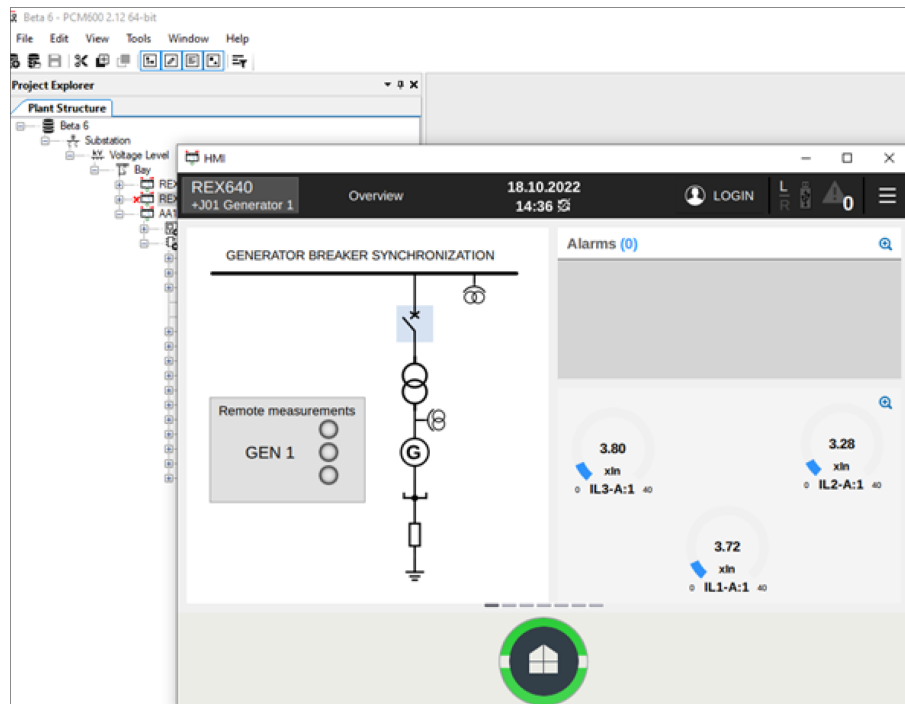


Figure 112: HMI Client

## 6.1.13 GDE configuration export and import

The GDE configuration can be exported and then imported to any other IED.

### 6.1.13.1 Exporting GDE configuration

1. On the **File** menu, point to **Display Editor Template** and select **Export**.

2. In the **GDE Export** dialog, select the pages, SLD pages, custom symbols and translations to be exported.

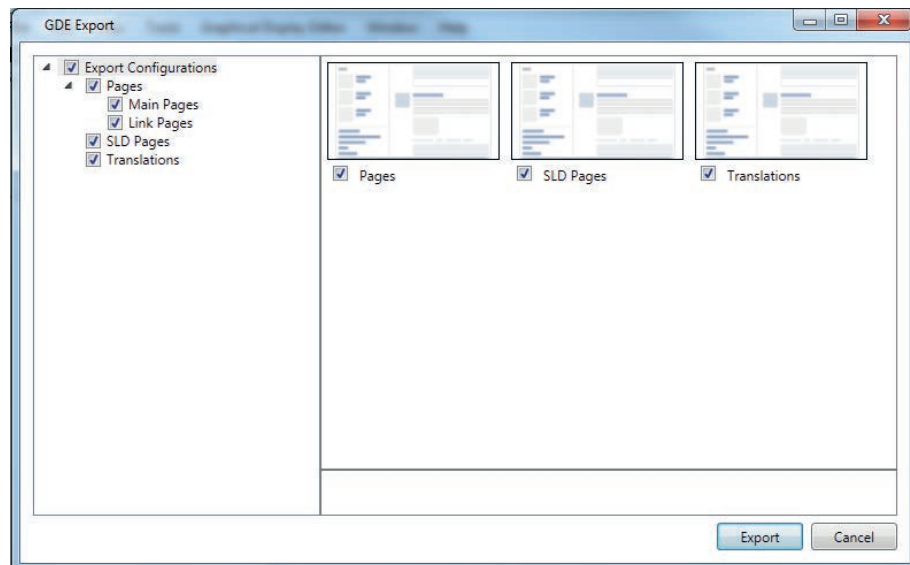


Figure 113: Selecting objects for export

3. Click **Export**.

The selected items are exported in .pgdep format.

If the configuration contains custom symbols that are not selected, a warning dialog is displayed.

4. Select the location to save the template and click **Save**.

### 6.1.13.2 Importing GDE configuration

1. On the **File** menu, point to **Display Editor Template** and select **Import**.
2. Click **Browse** to select any previously exported template file in .pgdep format and click **Open**.
3. In the **GDE Import** dialog, select the pages, SLD pages, custom symbols and translations to be imported.
  - Items present in the current configuration have a green border.
  - Items present in the current configuration with differences have a red border.
  - Items not present in the current configuration (new items) have a blue border.

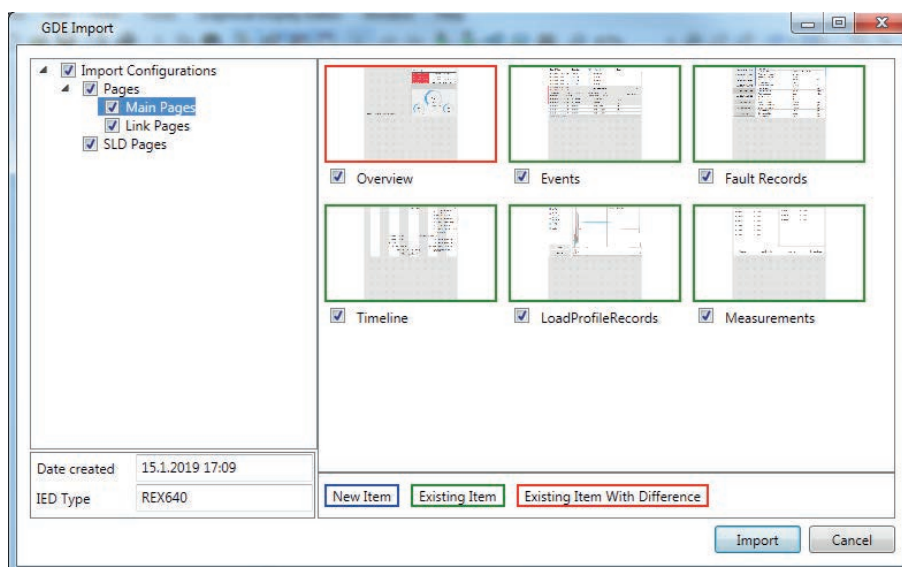


Figure 114: Selecting objects for import

4. Click **Import**.

All page names must be unique. If a page is imported with a name that is used by an existing page, a confirmation dialog is displayed. The options are to overwrite the existing page, to create a new page with a different name or to cancel the import.

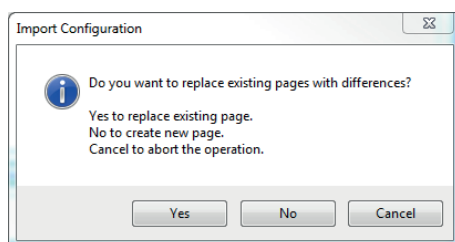


Figure 115: Confirming action after name conflict

## 6.2 Switchgear HMI Configuration

Switchgear HMI Configuration is used to configure the SHMI navigation page after the bay overview area has been configured for each relay using Graphical Display Editor.

### 6.2.1 Configuring switchgear HMI navigation page



A maximum of 20 REX640 relays can be connected to one SHMI.

1. In the Plant Structure, right-click a substation, a voltage level or a bay and point to **New**, point to **General** and select **SHMI** to create an SHMI object.

Each SHMI object represents one SHMI in the installation.

2. Right-click the SHMI object and select **Switchgear HMI Configuration**.
3. Define **Substation Name**, **Voltage Level** and **Switchgear Name** to be shown on the SHMI navigation page.
4. Drag the bay overviews to change their order, to allocate them for the SHMI or to remove them from the SHMI.

All relays that support the SHMI are visible in the tool, and 20 relays are automatically assigned to the SHMI. The unallocated bay overviews are available to be assigned for other SHMIs in the project.

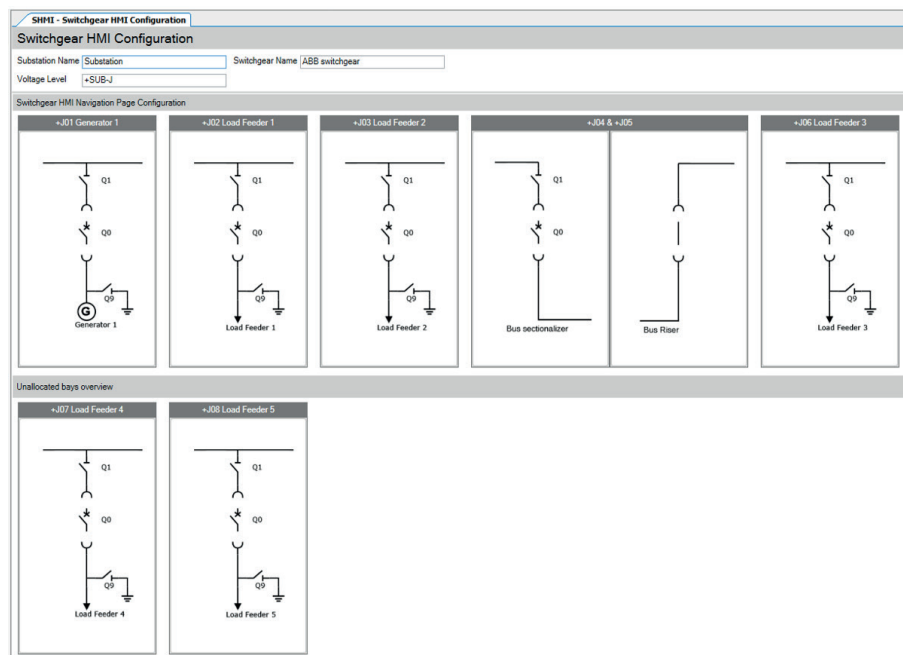


Figure 116: Allocating bay overviews to the switchgear HMI

5. Click **Preview** to test the result on the SHMI.
6. Click **Write** to write the SHMI configuration to all allocated relays.



Ensure that a connection is made to the relays through a station network. All relays should be reachable in the network when the SHMI configuration is written to the relays.

## 6.3 HMI Event Filtering

HMI Event Filtering is a tool that helps in configuring the visibility of the events shown on the IED's LHMI and WHMI. This tool does not modify the actual events on the protocol level.

The event visibility is modified in the event tree view. The events in the tree view are structured in the same way as the functions in the PCM600 plant structure.

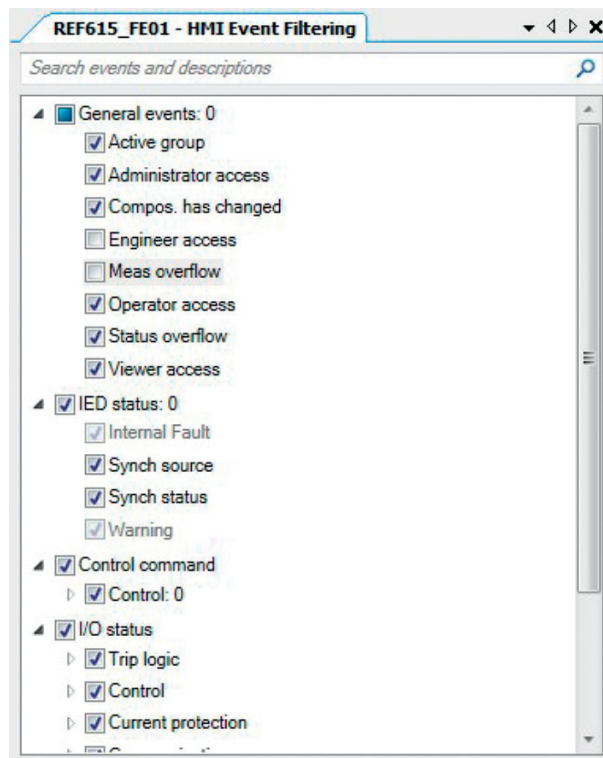


Figure 117: HMI Event Filtering interface

### 6.3.1 Starting HMI Event Filtering

Start HMI Event Filtering in one of the alternative ways.

- Right-click an IED and select **HMI Event Filtering**.
- On the **Tools** menu, click **HMI Event Filtering**.

### 6.3.2 Setting visibility of HMI events

The event tree view is used to modify the visibility of the events shown on the LHMI and WHMI. Events in the tree view are structured similarly to the functions in the PCM600 plant structure.

1. Browse the event tree for the event.  
Event nodes in the tree have more detailed description in the tool tip.

2. Select or clear the check box next to the event name to specify its visibility.

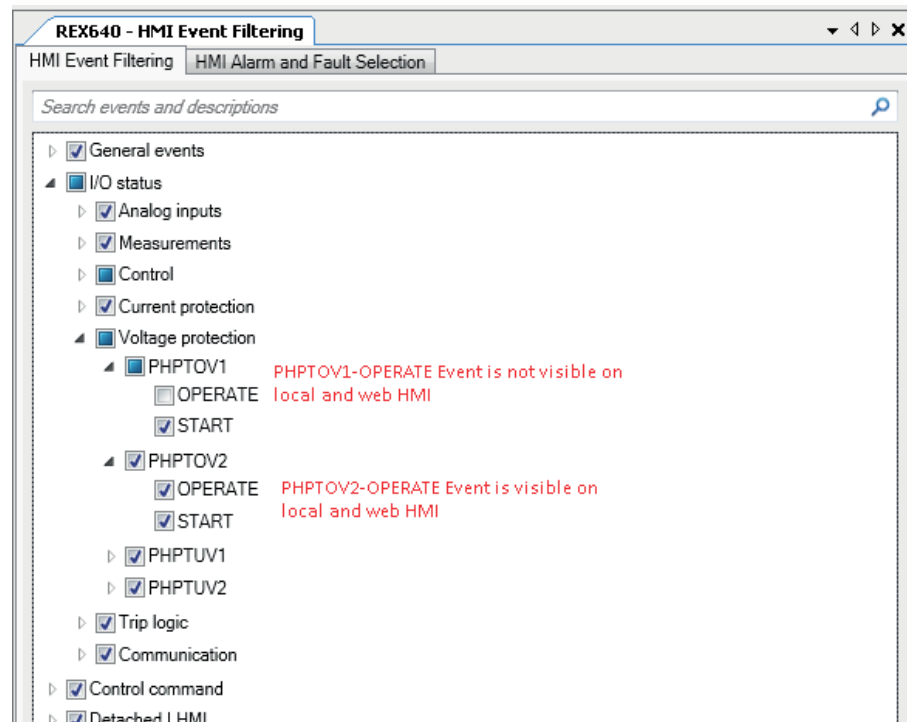


Figure 118: Setting visibility of the HMI events

The event is visible on both LHMI and WHMI only when the check box is selected.



Select the check box of the parent node in the event tree view to modify the HMI visibility for multiple events.

Some events in the event tree are read-only and cannot be modified. The read-only events appear dimmed on the user interface.

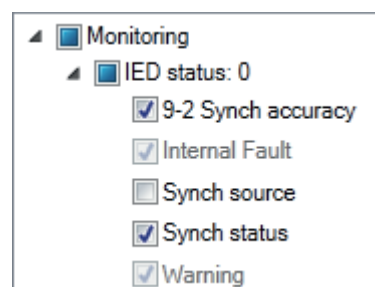


Figure 119: Read-only events are dimmed

### 6.3.3 Saving event filter configuration

Save the event filter configuration in one of the alternative ways.

- On the **File** menu, select **Save**.

- Click **Save** on the toolbar.

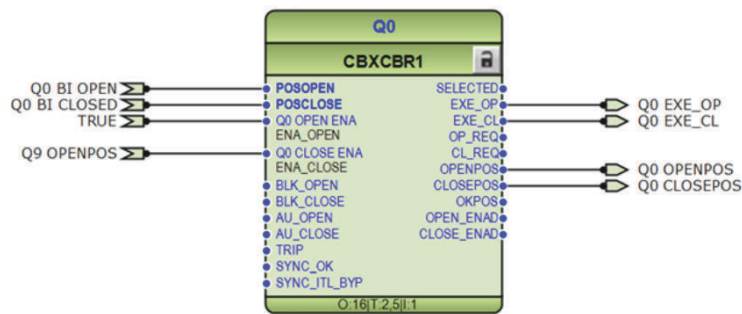
The **Save** button on the toolbar is activated when the configuration is modified.

## 6.4 User defined names

PCM600 has a feature to set user defined names for signals, function blocks and hardware channels. Functions and signals where setting user defined name is supported are having blue color in application configuration tool. These user defined names are used in different PCM600 tool components and on HMI to ease identification of function or signal usage.

In PCM600 Application Configuration tool user defined name can be set by selecting *Set User Defined Name* from context menu, or by editing *User Defined Name* property in *Object Properties* pane.

User defined names are not shown on REX640 HMI and Web HMI by default. User must enable them by setting parameter **Configuration > HMI > User defined name**.





REX640 REX640		Events	15.11.2018 13:06	?	L R 2	≡
Date & Time	Function	Filter OFF	Description	Event		
15.11.2018 11:56:43.488	Q0		Q0 CLOSE ENA	False		
15.11.2018 11:56:43.488	Q9		ESSXSW1 switch position	closed		
15.11.2018 11:56:42.286	Q0		CBXCBR1 switch position	open		
15.11.2018 10:51:37.319	Q1		Q1 OPEN ENA	True		
15.11.2018 10:51:37.319	Q1		Q1 CLOSE ENA	True		
15.11.2018 10:51:37.319	Q2		Q2 OPEN ENA	True		
15.11.2018 10:51:37.319	Q2		Q2 CLOSE ENA	True		

REX640 REX640		Parameters	15.11.2018 13:07	?	L R 2	≡
Setting group	General					
Settings	LHMI					
Configuration	Q0	Circuit breaker control				
Control	Q1	Disconnecter control				
Control	Q2	Disconnecter control				
Information	Q9	Earth switch status				

Figure 120: Example how user defined names are shown in events view and menu structure

## 6.5 Alarm configuration

The HMI supports two alarm handling approaches.

- Alarm list
- Programmable LEDs

The alarm list approach uses event configuration to elevate an event to an alarm. The programmable LEDs approach is similar to the traditional programmable LEDs where instead of a physical LED, a virtual LED user interface element is used.

Programmable LEDs have three different presentation methods in the user interface.

- Programmable LEDs page
- Virtual Alarm LED widget
- Alarm Annunciator full-page widget

Programmable LEDs page is available in ABB Built-in Pages category in the Page Organizer. Programmable LEDs page automatically shows configured LEDs and alarm texts. Page has buttons for clearing LEDs and resetting trips.

Virtual Alarm LED widget is single programmable LED. It can be added on any operator page on HMI and it shows status and alarm text for configured LED. There are also button widgets available for clearing LEDs and resetting trips.

Alarm annunciator is full page widget where user configures up to 64 alarms. Alarms are presented in groups containing up to 16 alarms each.

## 6.5.1 Alarm list

HMI Event Filtering in PCM600 is used to configure the event visibility on the LHMI and WHMI. Any visible event can be configured as an alarm. See [Chapter 6.3.2 Setting visibility of HMI events](#).

### 6.5.1.1 Elevating events to alarms

Alarm configuration is done in the HMI Alarm and Fault Selection view. Any visible events can be elevated to an alarm or priority alarm. An alarm configuration text can also be added to describe the alarm context.

Events can be grouped into a fault (group of selected events) on the LHMI and WHMI event list. Grouping of events as a fault starts when any of the events selected in the Fault column is activated and ends when all the events selected in the Fault column are deactivated.

The group of selected events is shown as a Fault Events row on the event list. Each event is visible by expanding this row.

1. Browse the **HMI Alarm and Fault Selection** view to find the event to be configured as an alarm.

The event rows in the data grid view have more detailed description in the tool tip.

2. Select or clear the check box in the **Alarm** column to elevate an event to an alarm.

The event is visible as an alarm on both LHMI and WHMI only when the check box is selected.

3. Select or clear the check box in the **Priority** column to elevate an event to a priority alarm.

When the check box is selected, the event is visible as a priority alarm on both LHMI and WHMI. The priority alarm is always the topmost in the alarm list. If the check box is cleared, the event is visible as a normal alarm on both LHMI and WHMI if the alarm check box is selected.

4. Select or clear the check box in the **Fault** column to create an event group on the HMI event list.

When the check box is selected, the event in question (if activated) is included in a fault.

5. In the **Alarm Configuration Text** column, write some text to describe an alarm context.

Event Container	Event	Alarm	Priority	Fault	Alarm Configuration Text
PARAMETERS_	Device state	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
General events	Active group	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
General events	Status overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
General events	Meas overflow	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
General events	Compos. has changed	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
IED status	Warning	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	IED status as Warning
IED status	Internal Fault	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
IED status	Boot up reason	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
IED status	SMV Synch accuracy	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
IED status	Synch status	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
IED status	Synch source	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Normal alarm
EHM1	CONNECTION	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure 121: Elevating events to alarms



The alarm configuration text can be specified only if an event is elevated to an alarm.



Select the check box in the column header of a column in the data grid view to modify the alarm configuration, priority or fault selection of all events.

### 6.5.1.2 Searching for events and alarms

In HMI Event Filtering, locate an event or alarm in the event filtering or alarm selection views in one of the alternative ways.

- Use the predefined search strings.
- Type a search string manually.

### 6.5.1.3 Saving HMI alarm and fault selection

Save the HMI alarm and fault selection in one of the alternative ways.

- On the **File** menu, select **Save**.
- Click **Save** on the toolbar.

The **Save** button on the toolbar is activated when the configuration is modified.

## 6.5.2 Virtual programmable LEDs

### 6.5.2.1 Configuring LEDs in application configuration

Three steps must be completed to enable programmable LEDs in the relay's HMI.

1. Instantiate LED functions in application configuration and connect the **OK** and **ALARM** signals in application configuration.

2. Configure LED description texts in **Parameter Setting**. Parameters are in **IED Configuration > Configuration > Programmable LEDs**.
3. Clear all events elevated as alarms in **HMI Event Filtering** so that the HMI Home button LED can follow the programmable LED state instead of the alarm list.


#### 6.5.2.2 Configuring Programmable LEDs page


1. Open **Page Organizer** in Graphical Display Editor.
2. Select **Add Page...** on **Main Pages** section.
3. Select **Programmable LEDs** from **ABB Built-in Pages** section.
4. Select **Add** to insert programmable LED page to operator pages.

#### 6.5.2.3 Configuring Virtual Alarm LED widget

1. Open **Page Editor** in Graphical Display Editor.
2. Drag and drop **VirtualAlarmLed** widget on the page.
3. Keep LED widget active and select **LED1...LED66** in Object Properties pane's source property.

#### 6.5.2.4 Configuring Alarm Annunciator page

1. Open **Page Organizer** in Graphical Display Editor.
2. Select **Add Page...** on **Main Pages** section.
3. Select **Blank Page** from **Templates** section.
4. Open **Page Editor**, and drag and drop **Alarm Annunciator** widget on the empty page.
5. Select  in the lower-right corner of the alarm annunciator page to open function grouping editor.
6. Select **Add** to create new group.
7. Activate one of the created groups and select **Local HMI/LEDx** in the list of available functions.

8. Select  to add LED to alarm group.

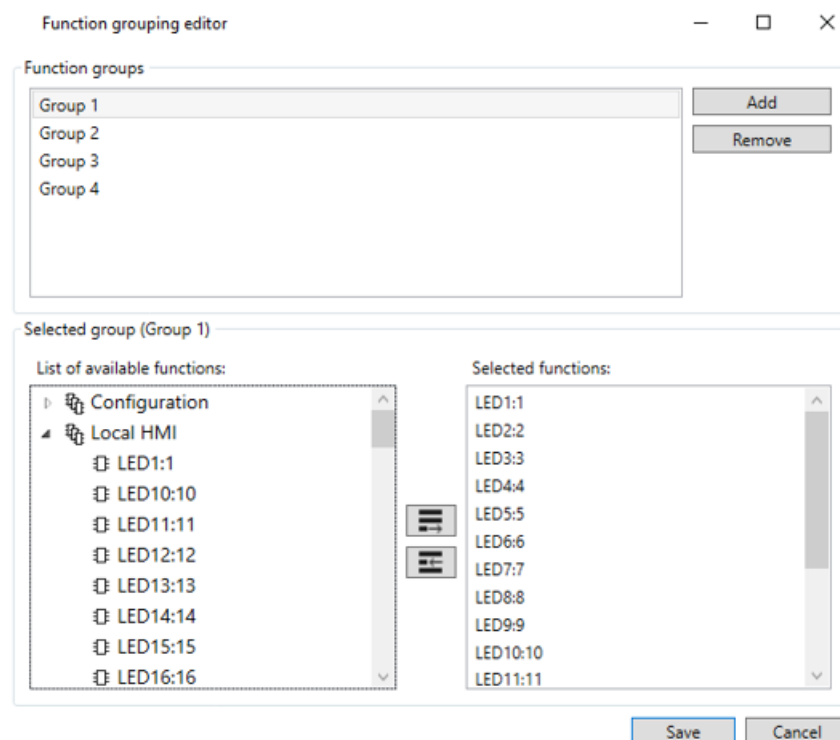


Figure 122: Function grouping editor and 4 configured groups

9. Select **Save** to close the editor.
10. Activate **Short description** area for one of the LEDs and type description that is always visible on the annunciator page.

Description can be split on three lines.

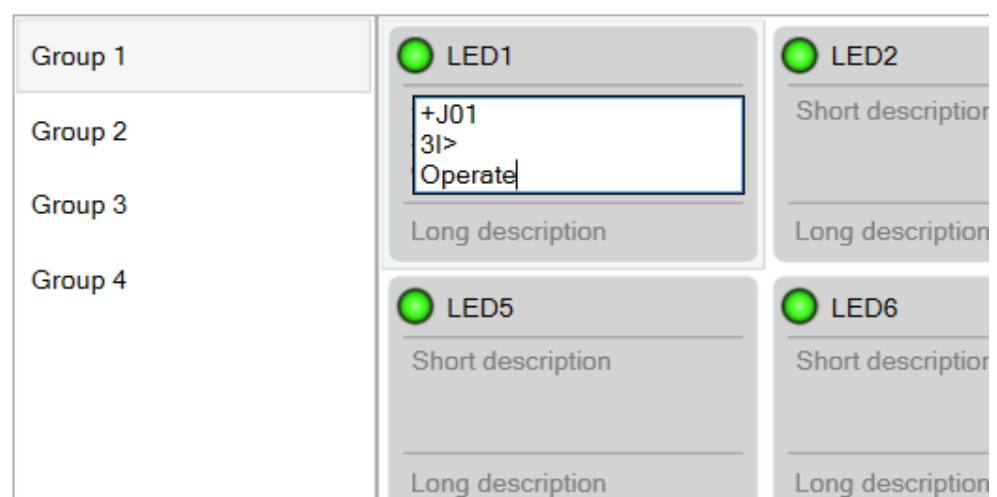


Figure 123: Editor for short description in the alarm annunciator page

- 11. Activate **Long description** for one of the LEDs and type description that becomes visible when alarm is tapped on HMI page.

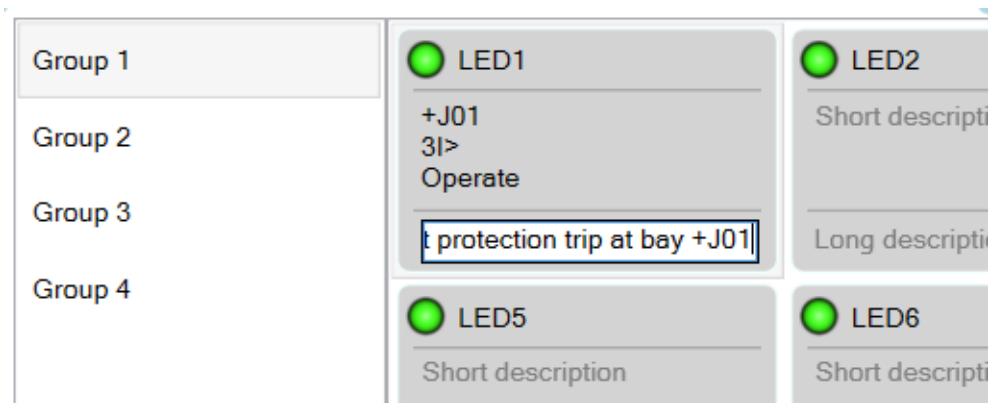


Figure 124: Editor for long description in the alarm annunciator page

## 7 IEC 61850 communication engineering

### 7.1 IEC 61850 protocol references and pre-conditions

To engineer the IEC 61850 protocol interface for the protection relay, the following additional manuals or knowledge of their contents is required.

- Knowledge of the IEC 61850 engineering process as described in the IEC 61850 standard
- The technical manual describes the function blocks defined as logical nodes
- IEC 61850 engineering guide
- IEC 61850 conformance documents for the protection relay to be engineered
- IEC 61850 parameter list

### 7.2 IEC 61850 interface



For more information on the implementation of IEC 61850 in protection relays, see IEC 61850 engineering guide and conformance documents.

## 7.2.1 IEC 61850 interface in the protection relay

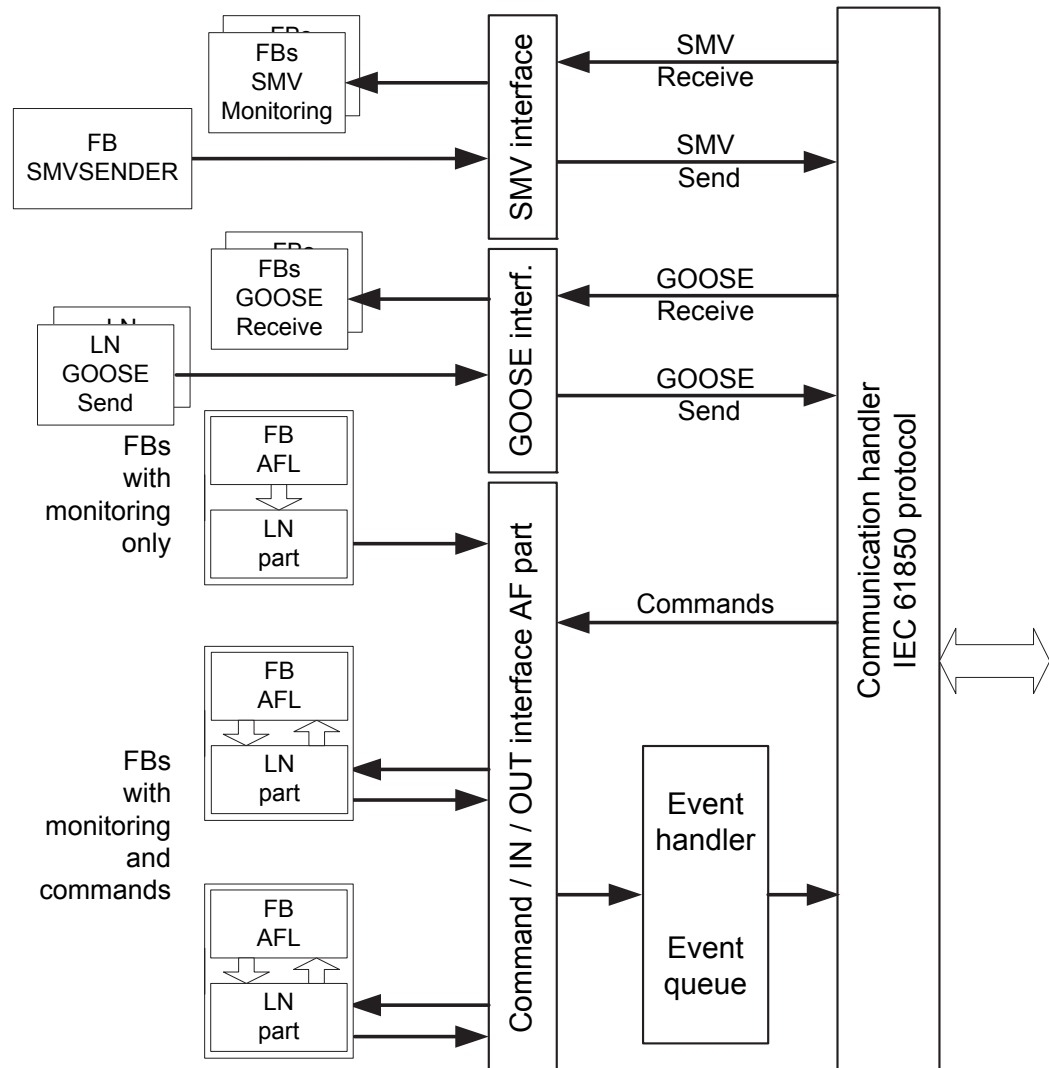


Figure 125: IEC 61850 communication interface principle

IEC 61850 provides a method for identifying all signals that belong to a function. These signals are identified through the logical nodes representing the functions. All signal information for relay parameters, settings, control and monitoring are available in logical nodes.

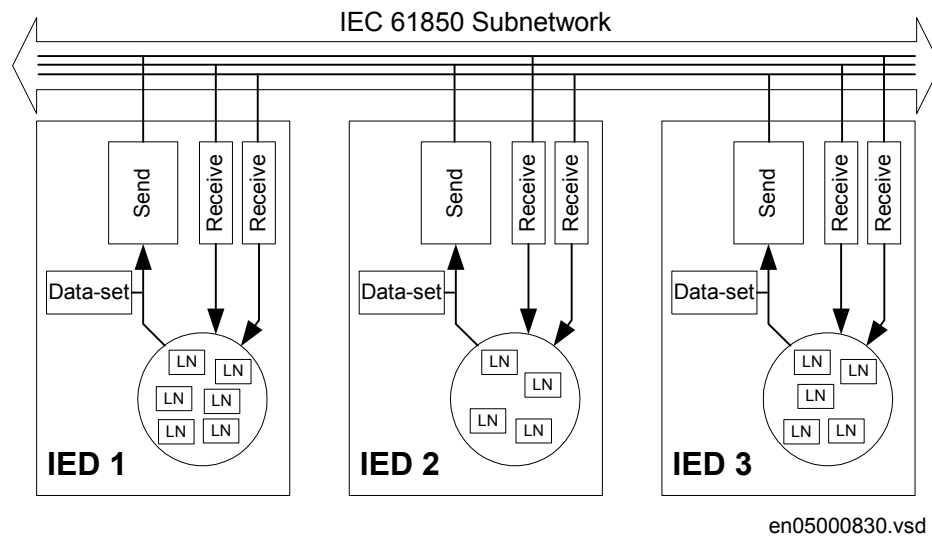
Whenever a function block is instantiated in Application Configuration, PCM600 automatically generates the corresponding logical node data.

### 7.2.1.1 GOOSE data exchange

The IEC 61850 protocol supports a method to directly exchange data between two or more devices (IEDs). This method is described in the IEC 61850-7-2 clause 15.

The concept is based on sending a multicast over Ethernet. The receiver detects the telegram by its multicast destination address and application identifier, and decodes the telegram for further processing by the application.





*Figure 126: IEC 61850: Horizontal communication principle, an example of three IEDs where each IED communicates with all others*

When a GOOSE message is to sent, it is defined by configuring the data set with the defined trigger option and GoCB. This engineering process is done in a station configuration tool, for example, IEC 61850 Configuration tool or IET600. The task involves configuring lists with the signal, value and quality (data attributes or data objects) that belong to the GOOSE message data set.

In the opposite direction, the standard only defines the IED as a receiver of a GOOSE message. How the GOOSE input signals are handled must be defined in the device's application configuration. The SCL data generated by the IEC 61850 Configuration tool or IET600 (or any other station configuration tool) contains the GOOSE data sets as input data. The input data must be connected to a GOOSE receive function blocks in the Signal Matrix tool.

In the opposite direction, the standard only defines the IED as a receiver of a GOOSE message. How the GOOSE input signals are handled must be defined in the device's application configuration. The SCL data generated by the IEC 61850 Configuration tool or IET600 (or any other station configuration tool) contains the GOOSE data sets as input data. The input data must be connected to a GOOSE receive function block in Signal Matrix.

## 7.2.2 Function view for IEC 61850 in PCM600

The IED design is directly based on IEC 61850. Thus, the function blocks in PCM600 use IEC 61850 logical node naming for function blocks. This relation is automatically handled by the PCM600 tools.

In the IED, the IEC 61850 data for each function instance is available in the data model, even when the function is not used in the application. This means that it is not necessary to handle any instance information for the functions regarding IEC 61850.

### 7.2.3 Station configuration description file types

The IEC 61850 standard defines SCL file types in the engineering sequence. These files have a different definition, which is explained in IEC 61850-6. Three of the file types are used in the IED's engineering process.

- ICD = IED capability description

Capability description of the IED in logical nodes and their data. No information about, for example, the communication configuration is included.

An IED is already extended by default data sets and report control blocks. They are predefined by ABB. Changes or additional data sets, for example, are handled with IEC 61850 Configuration tool or IET600.

- SCD = Station configuration description

A complete configuration description of all IEDs in a station and the full engineering of the process signals and communication structure is included. This includes all the needed data sets and control blocks.

- CID = Configured IED description

The CID file contains the information needed for configuring one specific IED. The CID file contains the complete configuration description of the IED: the configured IED name, communication part, data sets and all control blocks.

- IID = Instantiated IED description

The IID file contains a complete IED configuration, like the CID file. The IID file can include references to other devices which are not present in the file. The IID file is meant for transferring configuration data from the IED configuration tool to a system configuration tool.

## 7.3 IEC 61850 engineering process

The IEC 61850 standard defines how information is communicated in a substation. The information communication can be divided into different parts.

- Description of the substation part, including the used logical nodes
- Description of the IEDs with their logical nodes
- Description of the communication network
- Description of the engineering process

When exporting an SCL file from PCM600, the tool builds a default substation structure and creates default data sets and control blocks for vertical communication between the substation client and IEDs. For more information, see the IEC 61850 standards.

In the following example, it is assumed that PCM600 and IET600 are used as the system configuration tools. Another option is to use IEC 61850 Configuration tool or Application Configuration in PCM600. In that case, the SCL file export and import (steps 1 and 3) are not needed. For more information on the GOOSE engineering

in IEC 61850 Configuration tool and Application Configuration, see the IEC 61850 engineering guide.

1. SCL files are exported from PCM600. In this case, a SCD file. It is also possible to export other SCL file types.
2. Horizontal and vertical communication is configured using the station configuration tool, for example, IEC 61850 Configuration tool or IET600.
3. SCL files are imported to a PCM600 project. In this case, it is the updated SCD file.

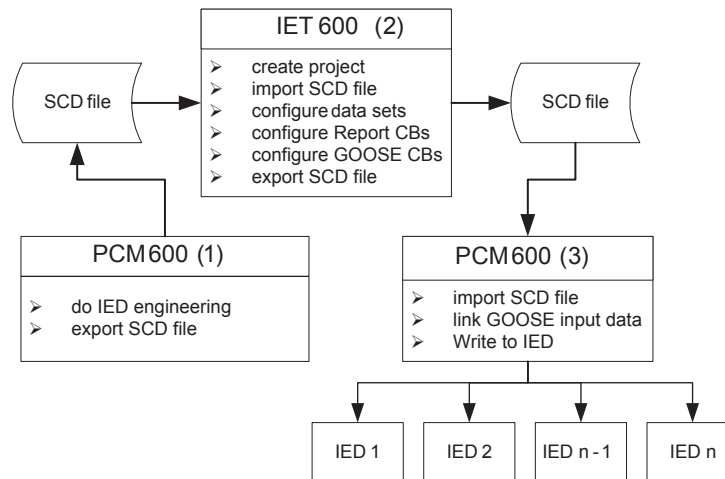


Figure 127: IEC 61850: signal engineering procedure flow when a complete station is exported as a SCD file

## 7.3.1 Exporting SCL files from PCM600

A pre-condition for exporting SCL files from PCM600 is that all IEDs in the project must be engineered in PCM600. The IEDs require a unique name and IP addresses and they must be set according to the project definitions. IED configurations must be finalized as far as possible before starting the IEC 61850 configuration part.

### 7.3.1.1 Exporting SCD files

1. In the **Plant Structure** view, right-click the substation and select **Export**.

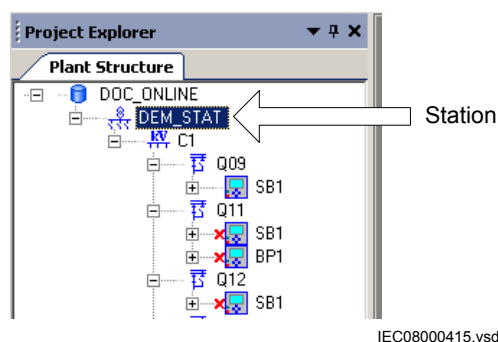


Figure 128: IEC 61850: selecting the substation

2. In the **Export** dialog box, select the location to store the file and name it.

3. Click **Save**.
4. In the **SCL Export Options** dialog box, click **Advanced** to change the SCL file version if required by the receiving configuration tool.

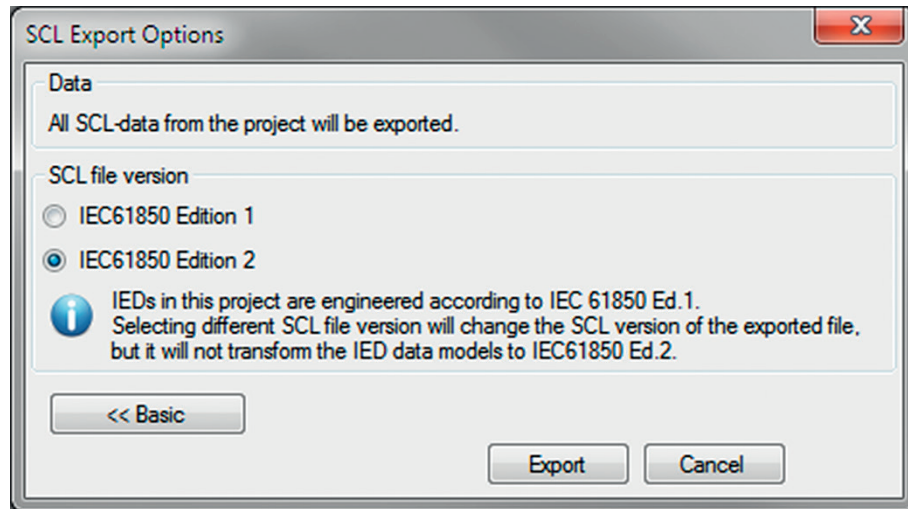


Figure 129: Selecting the SCL file version

5. Click **Export** to generate the SCD file.
- A progress window shows the ongoing export of the station.

### 7.3.1.2

#### Exporting ICD or CID files

1. Select the IED in the **Plant Structure** view.
2. Right-click the IED and select **Export**.
3. In the **Export** dialog box, from the **Save as type** list, select the type of file to export.
  - Configured IED description (.cid) for the IEC 61850 structure as needed for the IED at runtime
  - IED capability description (.icd) for the IEC 61850 structure

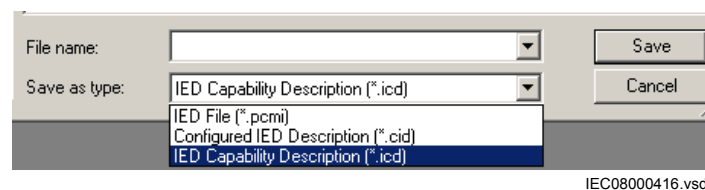


Figure 130: IEC 61850: Selecting the IED file type for export

4. Click **Save**.

5. In the **SCL Export Options** dialog box, select the export options.

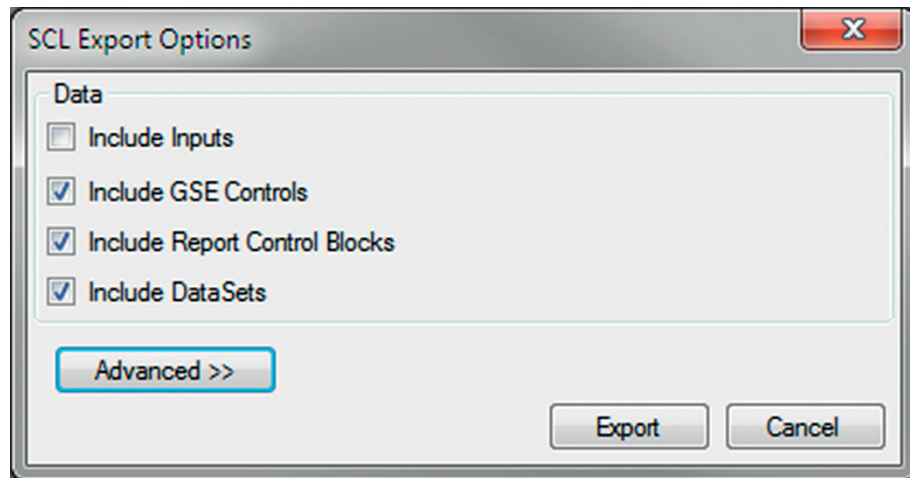


Figure 131: IEC 61850: Selecting the export options

6. Click **Advanced** to change the SCL file version if required by the receiving configuration tool.

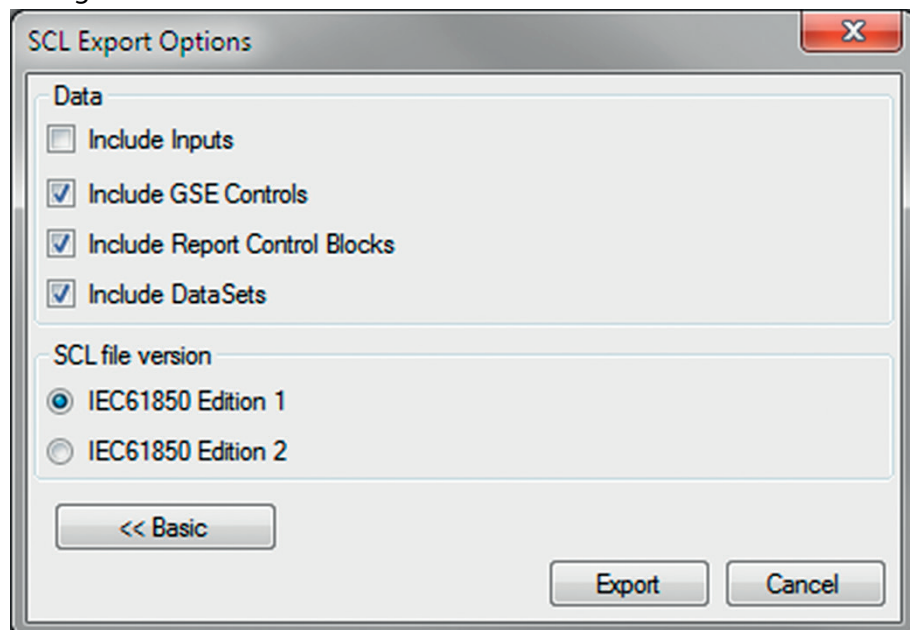


Figure 132: Selecting the SCL file version

7. Click **Export**.

## 7.3.2 Engineering vertical and horizontal communication

For IEC 61850 engineering a separate system configuration tool needs to be used with PCM600. The recommended tool for smaller projects is the IEC 61850 Configuration tool. For larger projects it is recommended to use IET600, which is available as a standalone tool.

1. Create a project in IET600.<sup>1</sup>

2. Import the SCD file created by PCM600.<sup>1</sup>
3. Conduct vertical communication engineering (monitoring direction).
  - a) Check the default data sets.
  - b) Configure the default data sets.



Data sets meant for vertical reporting can only contain data on the data object level, not on the data attribute level.



The data set for GOOSE can contain signals on the data attribute or data object level. Data object level GOOSE entries can only be received of the following CDC types: SPS, SPC, ACD, ACT, DPS, DPC, INC, INS, ENC and ENS.

- c) Configure additional **Report Control Blocks** when needed for each data set used for vertical communication.
- d) Link the IED clients to the **Report Control Blocks**.



Up to five report clients can be configured.

4. Conduct horizontal communication engineering.
  - a) Configure GOOSE control blocks for each data set configured for GOOSE messages.



One data can be included in the GOOSE data set only once.

- b) Define the client IEDs for each GOOSE control block.
- c) Link the IEDs to the GOOSE control block that must receive the GOOSE control block.

5. Export the updated SCD file.<sup>1</sup>



All data sets, **Report Control Blocks** and GOOSE control blocks must be located in LLN0.

### 7.3.3 Importing SCL files to PCM600

The IED engineering tool must be able to receive an SCD file or an ICD file as an import to receive the engineered communication extensions, for example, for the different IEDs.

To be able to import an SCD file at station level, the option IED 61850 configuration engineering mode enabled has to be cleared in PCM600.

1. On the **Tools** menu, select **Options** and click **IEC 61850 Configuration**.

<sup>1</sup> Applicable when using IET600

2. On the **Engineering** tab, clear the option **IED 61850 configuration engineering mode enabled** and click **OK**.

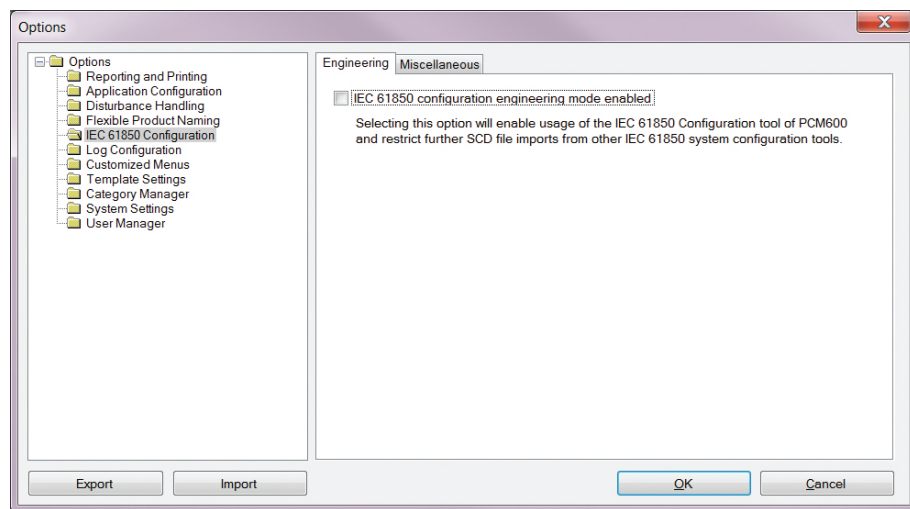


Figure 133: Enabling SCD file import at station level

If the IED 61850 configuration engineering mode is enabled, SCD files cannot be imported and an error message is shown.

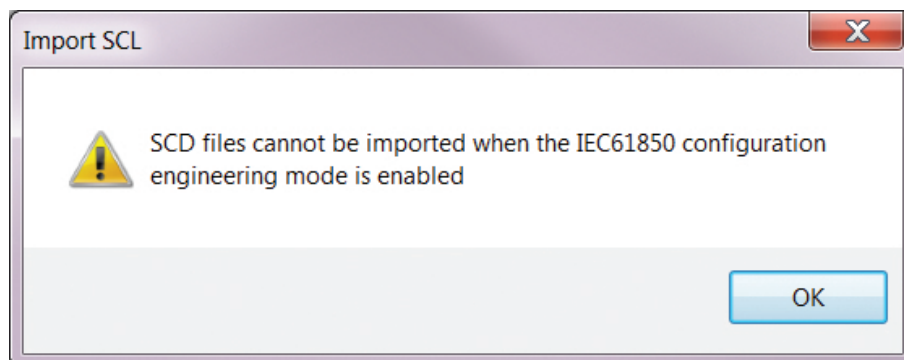


Figure 134: Error message when SCD files cannot be imported

### 7.3.3.1 Importing SCD files

To be able to import an SCD file at substation level, the option IED 61850 configuration engineering mode enabled has to be cleared in PCM600.

1. In the **Plant Structure** view, right-click the substation and select **Import**.
2. On the **Import** dialog box, select the file to be imported.
3. In the **SCL Import Options** dialog box, select how to handle the file during the import.

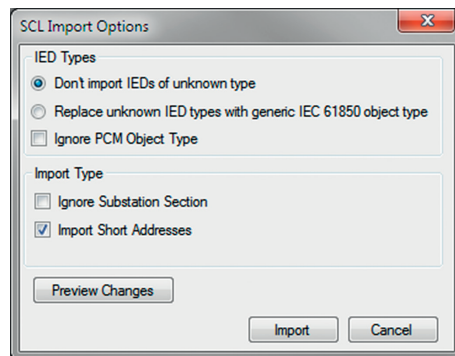


Figure 135: SCL Import Options

- Click **Don't import IEDs of unknown type** to protect the existing IEDs in case the SCD file does not match the original configuration in PCM600.
  - Click **Replace unknown** if the file includes additional IEDs that are needed. The IED of type “Generic IEC 61850 IED” is used to integrate this kind of IEDs into the plant structure, for example.
  - Click **Ignore PCM Object Type** to update the IED object(s) in PCM600 from the IED type(s) in the SCD file, whether or not the IED type(s) in the SCD file matches the IED object(s) in PCM600. This option can be used, for example, when third party IEDs are included in the system and the SCD file sends GOOSE messages to ABB IEDs included in the project.
  - Click **Ignore Substation Section** to not import the SSD file part of the SCD file.
4. Click **Import** when the file definition has been completed. A progress view displays the importing procedure.
  5. Make connections from the sending IEDs to the receiving function blocks with the Signal Matrix.  
Make connections between the signals that the server is send and the function blocks on the receiver's side.



6. Write the configuration to the IED.

In the **Plant Structure** view, select the IED, right-click and select **Write to IED**.

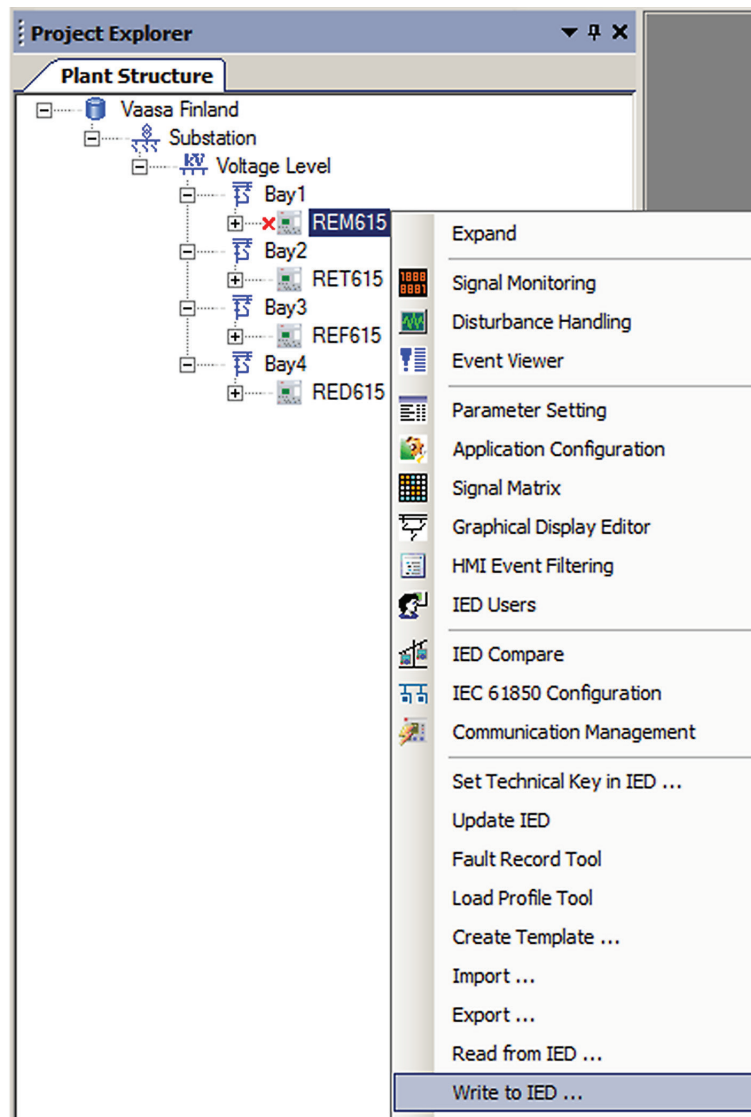


Figure 136: Write to IED menu



The engineered data is written to the IED when executing a common *Write to IED* operation.

### 7.3.3.2 Importing ICD or CID files

1. Select an existing IED.
2. From the **Files of type** list, select the IEC 61850 file type to be imported (ICD or CID).
3. In the **SCL Import Option** dialog box, select how the file is to be handled during the import.

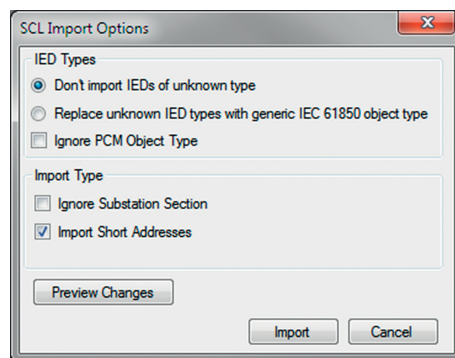


Figure 137: SCL Import Options

- **Don't import** protects the existing IEDs if the SCD file does not match the original configuration in PCM600.
  - **Replace unknown** can be used when the file includes additional IEDs that are needed. The IED of type “Generic IEC 61850 IED” is used to integrate this kind of IEDs into, for example, the plant structure.
  - **Ignore PCM Object Type** updates the IED objects in PCM600 from the IED types in the SCD file, whether or not the IED types in the SCD file match the IED objects in PM600.
  - **Ignore Substation Section** does not import the SSD file part of the SCD file.
4. Click **Import** when the definition has been completed.  
A progress view displays the importing procedure.

### 7.3.4 Writing communication configuration to IED

IEC 61850 communication depends on the proper communication configuration in all IEDs that communicate via IEC 61850.

It is possible to make a configuration change in one IED, without affecting the horizontal communication (GOOSE or IEC 61850-9-2 LE) engineering between IEDs. For example, when the Application Configuration tool configuration is changed, but no changes are done to the instantiation or deletion of functions that represent a logical node.

When a changed configuration is written to the IED, the horizontal communication configuration needs to be updated.

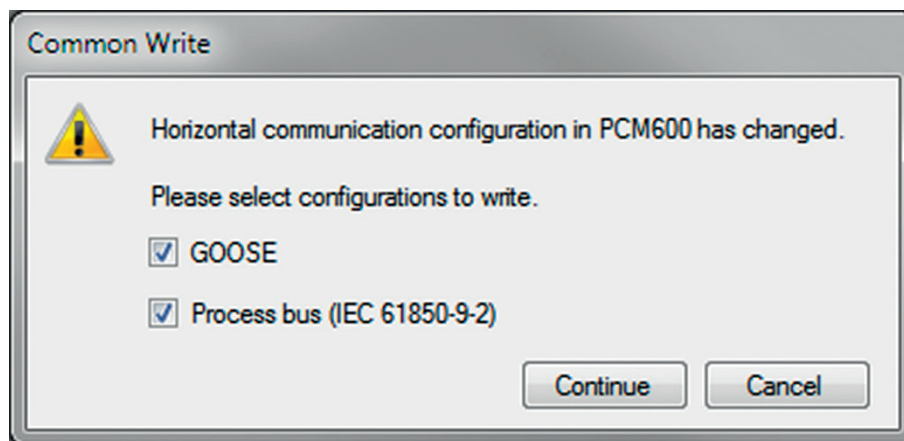


Figure 138: Updating the communication configuration in the IED with the configuration made in PCM600

1. Select which configuration part to include in writing.
  - Select **GOOSE** to update the GOOSE configuration part in the IED.
  - Select **Process bus (IEC 61850-9-2)** to update the IEC 61850-9-2 configuration part in the IED.

The options can be left unselected. In this case, other parts of the configuration are updated.
2. Select whether or not to update the configuration.
  - Click **Continue** to update the selected communication configuration parts in the IED.
  - Click **Cancel** to cancel the writing operation.

## 8 Flexible product naming

## 8.1 IEC 61850 Structure Mapping

IEC 61850 Structure Mapping is used to manage the IED's data model as required. This is done by mapping the data model to the customer-specific data model. IEC 61850 Structure Mapping is available only in FPN projects in PCM600. A PCM600 project can be converted into an FPN project by importing an FPN SCD file into it. FPN is supported for both IEC 61850 Edition 1 and IEC 61850 Edition 2.

FPN allows the use of standardized, predefined and IED vendor independent templates for building and maintaining substations. See the PCM600 documentation for more information about FPN.

### 8.1.1 User interface

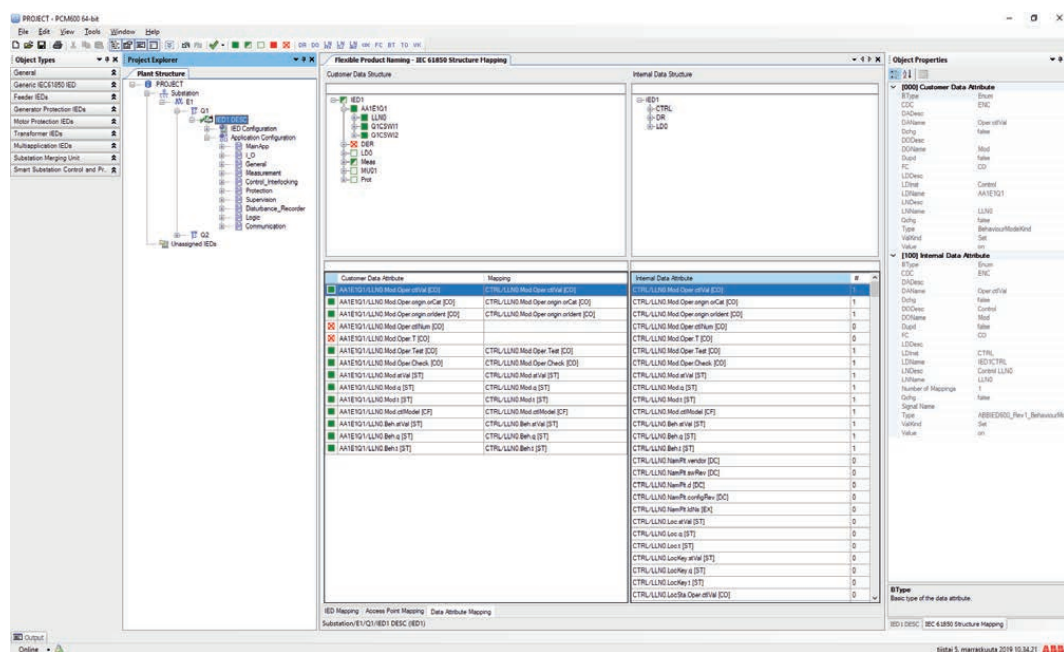


Figure 139: IEC 61850 Structure Mapping

## Plant structure

The data tree displays the FPN IEDs under substation and internal IEDs under unassigned IEDs.

## IEC 61850 structure mapping

The IEC 61850 structure mapping list displays the FPN objects based on the current selection in the plant structure. The list may display either IEDs or data attributes.

The FPN object's name is displayed in the column on the left and the mapped PCM600 internal object name is displayed in the column on the right. The customer data structure and attributes are on the left, and the internal data structure and attributes are on the right.

### **Object properties**

The Object Properties pane displays the properties of the objects selected in the FPN mappings and Internal Data Attribute lists.

## **8.1.2 IED and signal naming convention**

The names used for the internal objects can be defined to be either the names used in PCM600 or the names in the internal IEC 61850 model.



To change the naming convention, select the PCM600 naming style in use from **Options**.

## 8.2 Importing substation configuration description file

The SCD file can be imported only at the substation level.

1. On the **Tools** menu, click **Options**.
  - a) Select **Flexible Product Naming**. In the **General** tab, select **Import as Flexible Product Naming SCD option enabled**.
  - b) Select **IEC 61850 Configuration**. In the **Engineering** tab, clear the **IEC 61850 configuration engineering model enabled** check box.
  - c) Click **OK**.

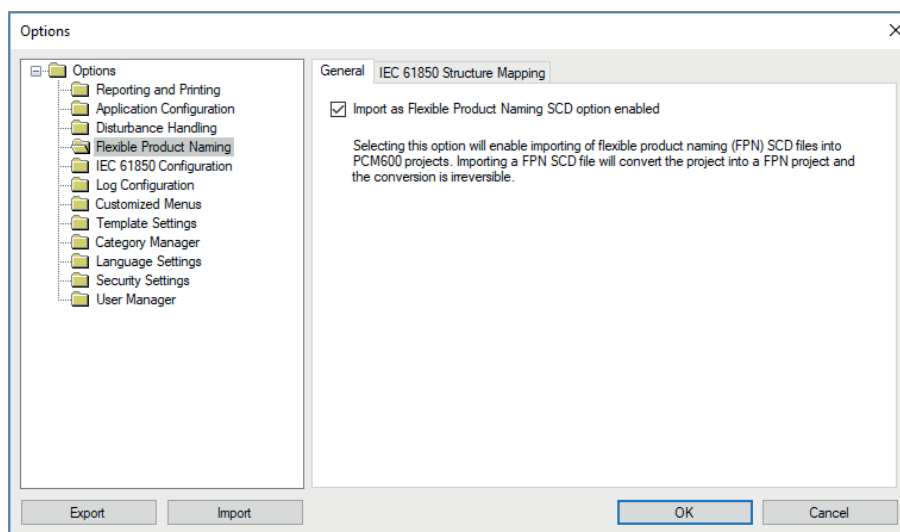


Figure 140: Enabling the FPN option

2. Right-click a substation level, and then click **Import**.
3. Browse and select the SCD file.
4. Click **Open** to open the file.

5. Select **Import as Flexible Product Naming SCD**.

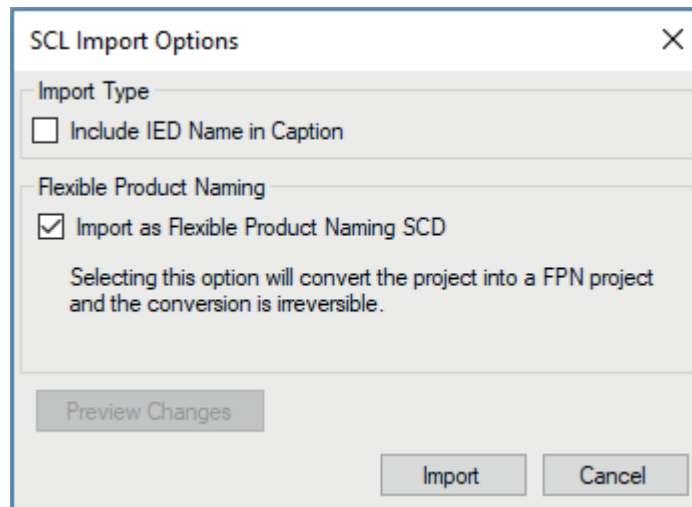


Figure 141: Importing as Flexible Product Naming SCD

The imported SCD file changes the substation structure. The internal IED from the original substation structure is replaced and pushed to the unassigned IEDs folder.

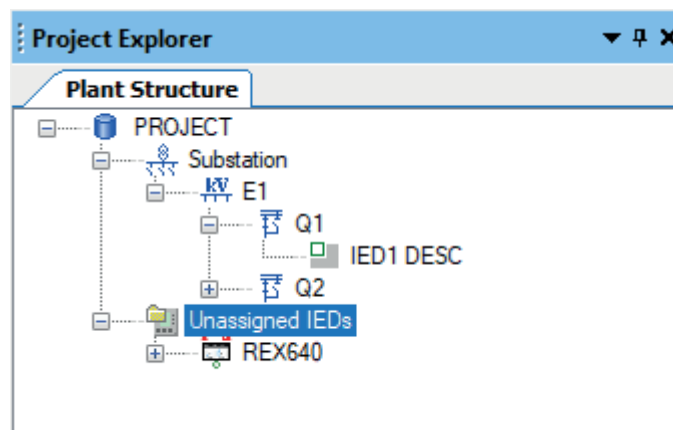


Figure 142: Unassigned IEDs

6. Drag the unassigned IED over the internal IED.

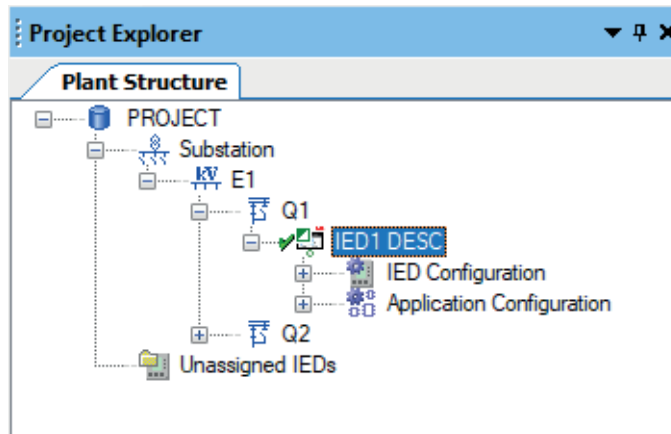


Figure 143: Assigned IED



Importing the FPN SCD file converts the project into an FPN project. The conversion is irreversible.



FPN projects do not support configuring GOOSE with Application Configuration.

## 8.3 Starting IEC 61850 Structure Mapping

The tool can be started from any node from the substation to IED level.

1. Right-click one of the IEDs and point to **Flexible Product Naming**.



2. Click **IEC 61850 Structure Mapping**.

The FPN object's name is displayed in the column on the left and the name of the mapped PCM600 internal object is displayed in the column on the right.

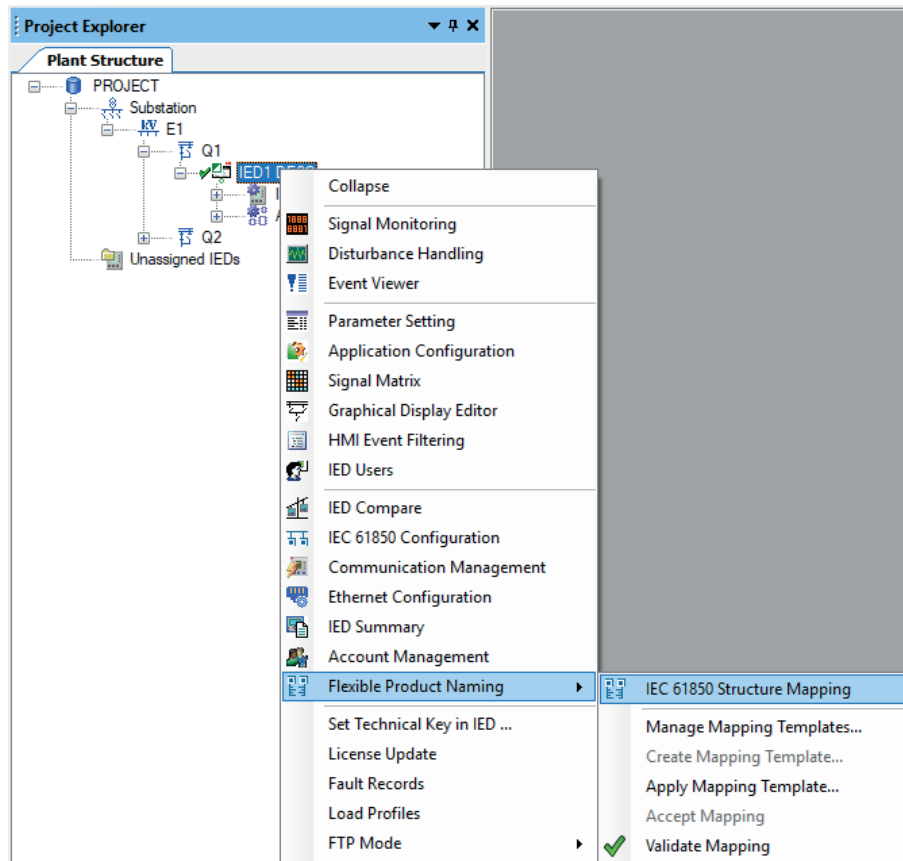


Figure 144: Flexible product naming tool

## 8.4 IEC 61850 structure mapping

### 8.4.1 IED mapping

The first step in the IEC 61850 structure mapping is to map the real IEDs to the customer-specific IEDs. IED mapping means that each server IED in the FPN model is mapped with a corresponding IED in the internal PCM600 model, that is, the real device in the substation. A server IED is an IED that has an access point containing a server. IED mapping does not map the data attributes between the IEDs unless the data attribute mapping is complete. IED mapping can be done in the PCM600 plant structure and in IEC 61850 Structure Mapping.

### 8.4.1.1 Mapping IED in PCM600 plant structure

- To map the IED in the plant structure, drag a PCM600 IED from the Unassigned IEDs group onto an FPN IED in the substation.

IED mapping status is indicated visually in the plant structure.

- To remove an IED mapping from the plant structure, drag a mapped FPN IED onto the Unassigned IEDs group.

The removed mapping is indicated visually in the plant structure. The PCM600 internal IED, with which the FPN IED was mapped, appears back in the Unassigned IEDs group if it is not mapped with any FPN IEDs.

### 8.4.1.2 IED mapping in IEC 61850 Structure Mapping

#### IED mapping

The tool displays all FPN IEDs and all PCM600 IEDs in separate lists. Mapping is done by dragging the PCM600 IED on the right-hand side to an FPN IED on the lefthand side. The tool indicates the mapping status visually. The mapping needs to be saved to apply it.

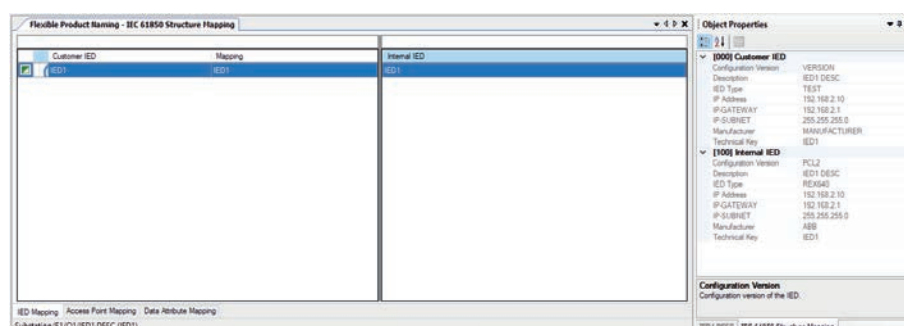


Figure 145: Mapping of IEDs in IEC 61850 Structure Mapping

#### Removing IED mapping

Removing IED mapping is done in IEC 61850 Structure Mapping by right-clicking the mapping and selecting the context menu option or pressing the DELETE key. The tool indicates the mapping status visually. The change must be saved.

#### Access point mapping

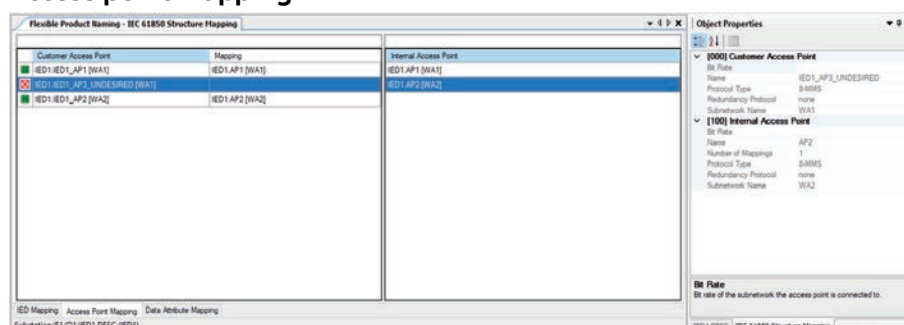


Figure 146: Access point mapping

Access point mapping defines the relations between REX640 internal access points and customer access points.

In the above example, REX640 access point AP1 is in subnetwork WA1, while access point AP2 is in subnetwork WA2. The configuration is created using Ethernet configuration.



The network configuration must be correct before the flexible product mapping is started.



REX640 supports one access point for data model. Second access point AP2 is based on the ServerAt concept and has the same data model in different IP addresses.

The REX640 access points are mapped to FPN project's access points IED1\_AP1 and IED\_AP2. The third access point IED1\_AP2\_UNDESIRED is excluded from the mapping since it does not have a network interface.

### Data tree view

The data tree view consists of customer data structure in the column on the left and the name of the mapped PCM600 internal data structure in the column on the right.

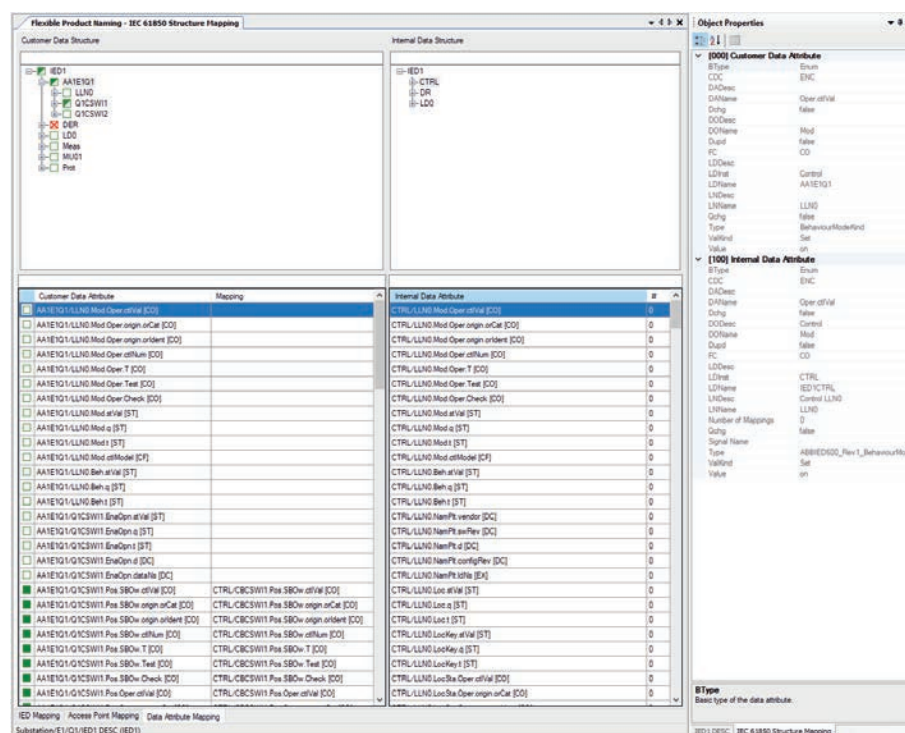


Figure 147: Data tree view

### Data attribute list view

The data attribute list view consists of customer data attributes in the column on the left and the PCM600 internal data attributes in the column on the right.

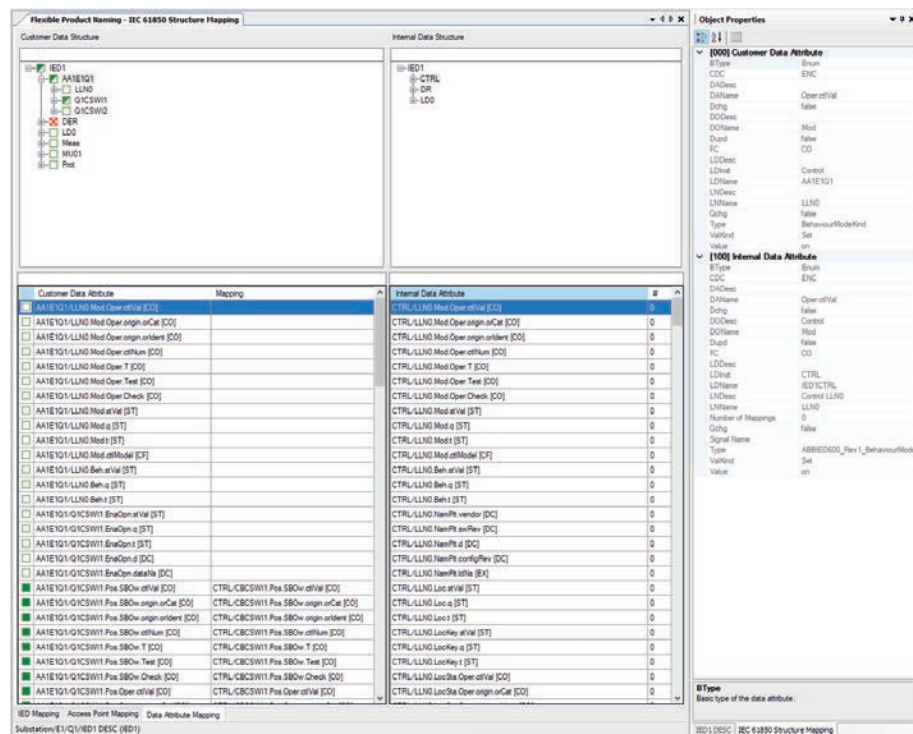


Figure 148: Data attribute list view

## Filters

The displayed objects can be filtered using the filtering options on the quick access toolbar.



*Figure 149: Filters*

### Free text filter

The objects are filtered by free text, showing all the objects with a certain name in both Data Structure level and Data Attribute level.

### Show/hide objects by status

The objects are filtered by status, showing only the selected objects in Data Structure level and Data Attribute level.

## Enable and disable type filters

Objects in the FPN can be filtered using additional filtering options available in the quick access menu.

### 8.4.2 Data attribute mapping






Data attribute mapping means that each FPN data attribute in the FPN model is mapped to a corresponding data attribute in the internal PCM600 model, that is, the real device in the substation.

The mapping status is indicated visually. It can be seen what FPN data attribute is mapped to what PCM600 internal data attribute and how many FPN data attributes are mapped to a PCM600 internal data attribute.

Data attribute mapping is complete when all data attributes of the FPN IED, which are not excluded from the mappings, are mapped to a PCM600 internal data attribute. Data attribute mapping must be complete to be able to write to IED.

Data attribute mapping is broken if any of the mapped data attributes - FPN or PCM600 internal - does not exist in the SCL database.

**Table 8: Visual indication of the mapping status**

Icon	Description
	Completely mapped
	Not mapped
	Broken mapping
	Partially mapped
	Excluded from mappings



All data attributes in the FPN model must be mapped or excluded, otherwise write to IED fails.

#### 8.4.2.1

#### Mapping data attribute level

IEC 61850 Structure Mapping displays the FPN data attributes and PCM600 internal data attributes in separate lists.

- To map data attributes, drag the FPN data attribute onto a PCM600 internal data attribute.
- Remove a data attribute mapping in one of the alternative ways.
  - Right-click the mapping and select the remove option.
  - Select the mapping and press the DELETE key.

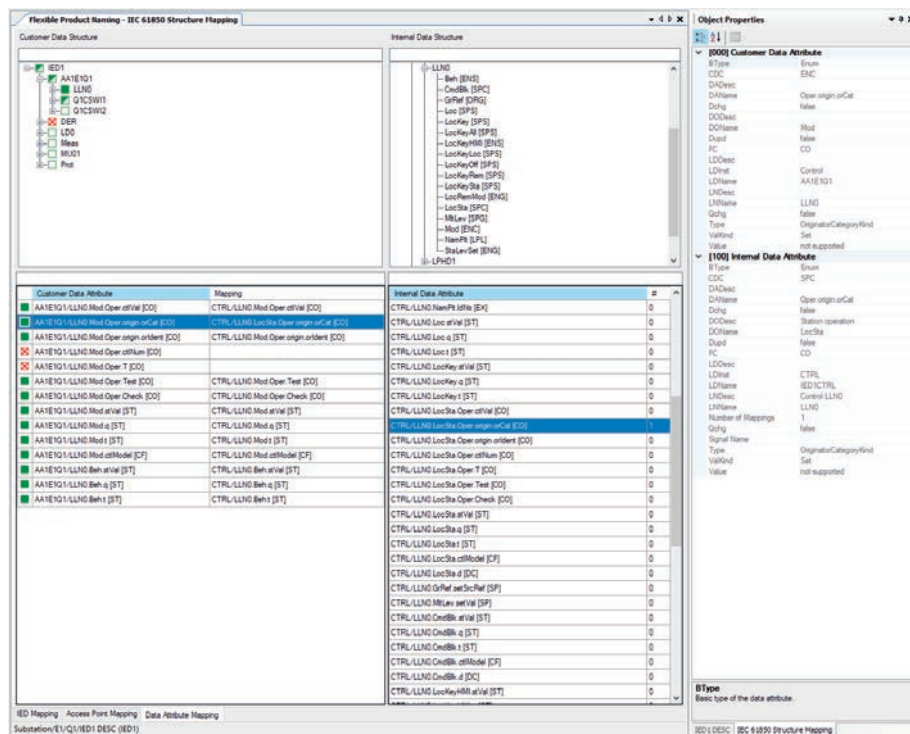


Figure 150: Data attribute level mapping

### 8.4.2.2

### Mapping data object level

Create data attribute mapping on the data object level in one of the alternative ways.

- Drag a data object from the customer data structure onto a data object in the internal data structure.
- Drag a data object from the internal data structure onto a data object in the customer data structure.

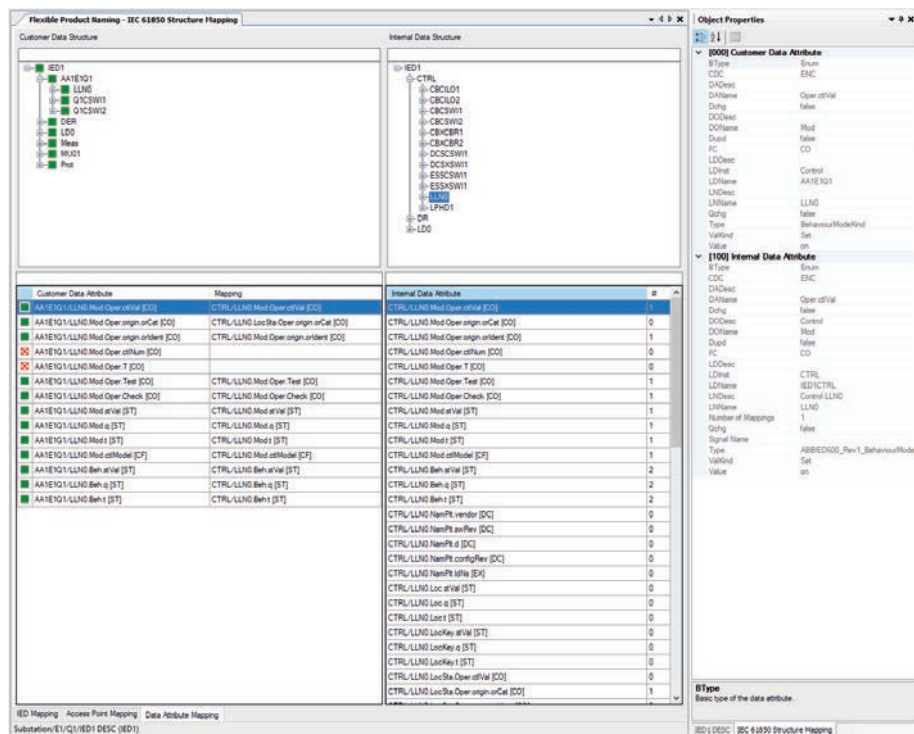


Figure 151: Completed data object mapping

### 8.4.2.3

### Mapping logical node level

Create data attribute mapping on the logical node level in one of the alternative ways.

- Drag a logical node from the customer data structure onto a logical node in the internal data structure.
- Drag a logical node from the internal data structure onto a logical node in the customer data structure.



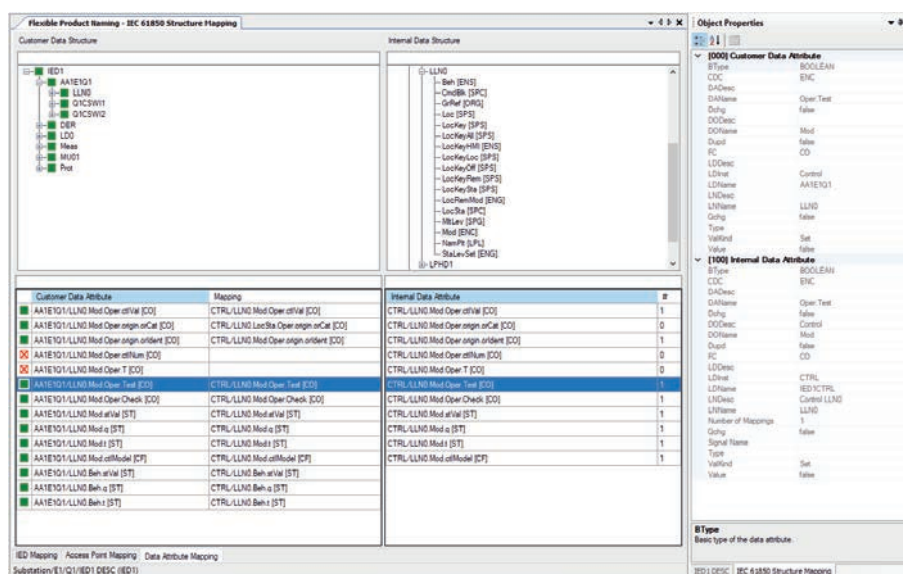


Figure 152: Logical node level mapping

#### 8.4.2.4 Excluding data attributes from mapping

Exclude the data attributes in one of the alternative ways.

- Select the data attributes to exclude, right-click and select **Exclude Items**.

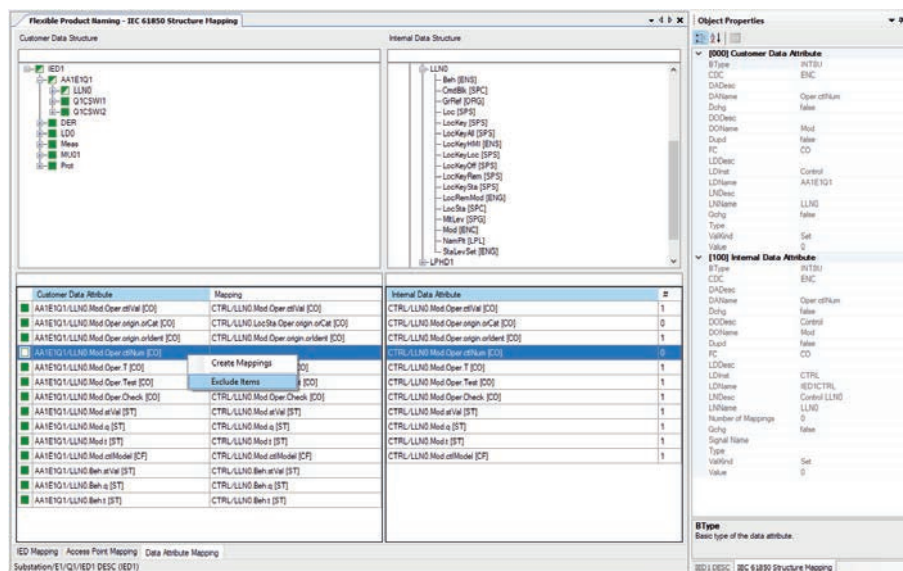
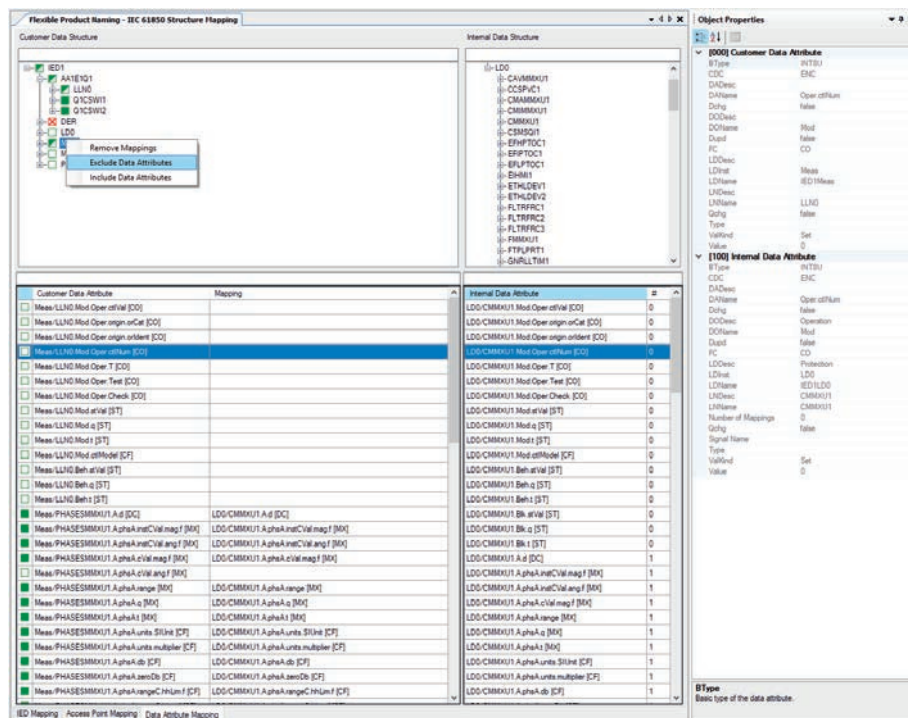


Figure 153: Excluding data attributes from mapping

- Exclude all unmapped data attributes from the data object at once by right-clicking the data object and selecting **Exclude Data Attributes**.





*Figure 154: Excluding data attributes from mapping*

The data attributes that are excluded from the mapping are not excluded from the model. Excluded mappings are ignored when determining if an IED mapping is complete.



It is crucial to set a value to the excluded data attributes before initiating the mapping.

## 8.5 Setting data attribute value

Edit the **Value** field in the **Object Properties** pane.

- For enum type of data attributes, select the value from the list of available values.
- For numeric and string type of data attributes, type the value in the **Value** field.

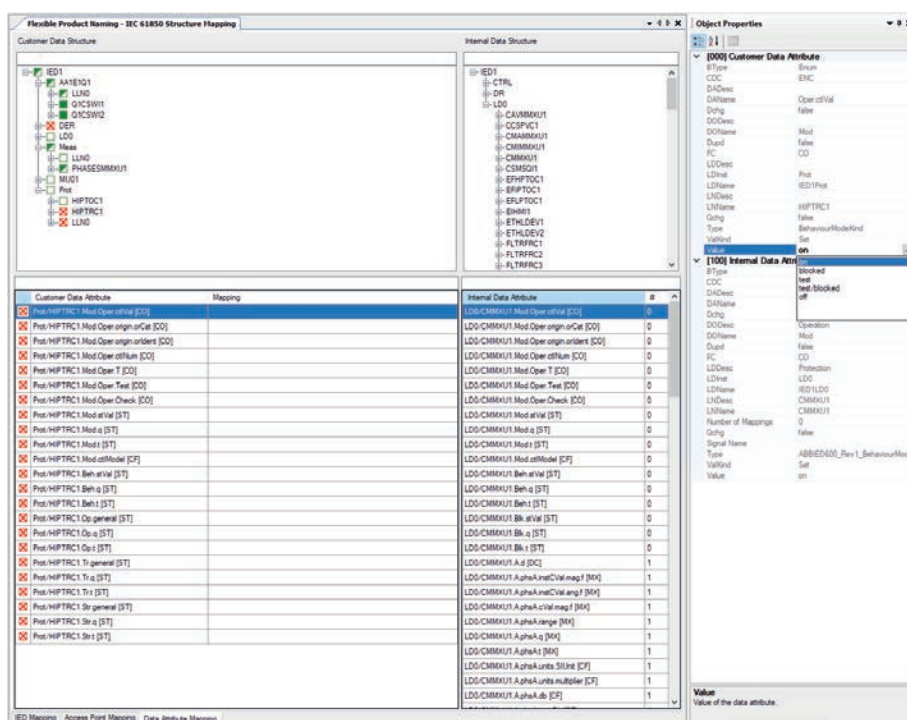


Figure 155: Setting the data attribute value



A value cannot be set for all data attributes types. For example, quality and timestamp values cannot be edited.

## 8.6

## Validation

Once the FPN mapping is complete, all mapping can be validated in three ways using the validate options available on the toolbar.

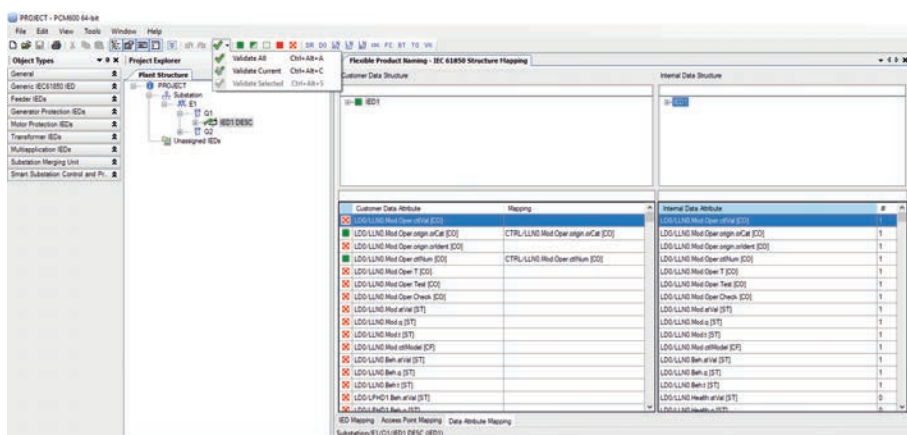


Figure 156: Validate mapping

## 8.7 Template creation

It is possible to create a template of an IED's data attribute mapping and store it for reuse. The template contains the description of the data attribute mapping of two IED SCL models.

All mapping templates created in PCM600 are stored in a template library. The template library is not specific to a certain PCM600 project, but it is common for all projects. Templates in the library can be managed in several ways.

- Delete selected templates
- Export templates: One or multiple template files can be exported.
- Import templates: One or multiple template files can be imported. If a template being imported already exists in the library, the user is asked whether to overwrite the existing one.
- Export project's templates: When a PCM600 project is exported, all templates used in the project are automatically included in the exported .pcmp file.
- Import project's templates: When a PCM600 project is imported, all templates included in the imported .pcmp file are automatically imported into the template library. If a template being imported already exists in the library, it overwrites the template in the library.

The mapping templates are also used by IET600 to translate the internal data references in the signal library to the FPN references, because IET600 needs to know what template to use to resolve the internal data references.



Create a template for each IED mapping.

### 8.7.1 Mapping template creation

Data attribute mapping templates can be created from mapped IEDs. If the template is created from an incompletely mapped IED, a dialog box is shown. The user can select an option to not show the dialog box again. The dialog box can be activated afterwards from the PCM600's Options menu.

The template can be created either from IEC 61850 Structure Mapping or from the PCM600 plant structure. The required template information must be filled in before it can be created.

### 8.7.2 Applying of a mapping template to IED

The template can be selected from a list of available templates. The FPN IED must be mapped with a PCM600 internal IED before the template can be applied.

The template can be applied either in IEC 61850 Structure Mapping or in the PCM600 plant structure. In IEC 61850 Structure Mapping, the template can be applied to one or several IEDs at once. In the plant structure, the template can be applied on one IED at a time by right-clicking an IED, or on all IEDs under a bay by right-clicking the bay.

### 8.7.3 Exporting FPN templates

1. Right-click the PCM600 plant structure.
2. Point to **Flexible Product Naming** and select **Manage Mapping Templates**.
3. Select the templates to export and click **Export**.

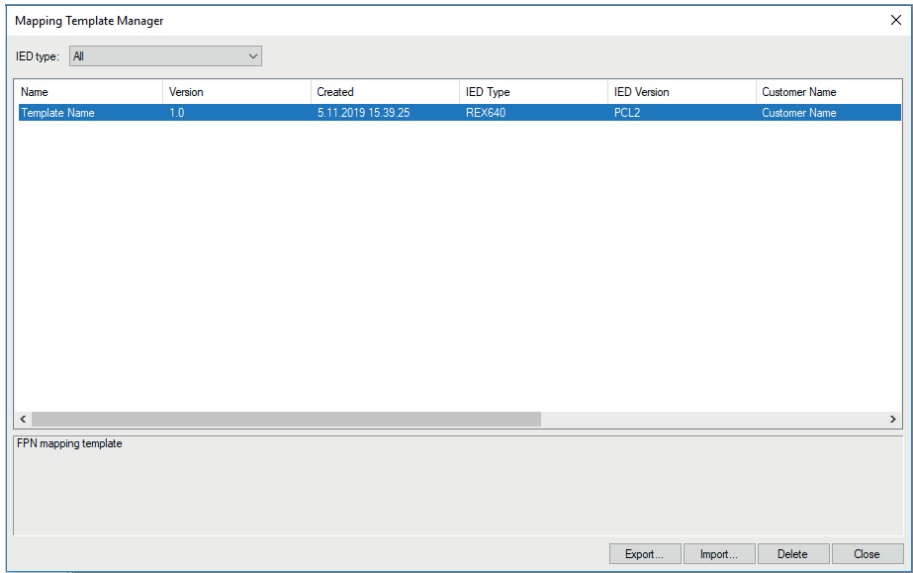


Figure 157: Exporting FPN templates

4. Select the folder where to export the templates and click **OK**.

### 8.7.4 Reporting and printing

The report consists of a cross-reference list of the IED and data attribute mappings, that is, a table of all FPN objects together with the PCM600 internal objects they are mapped with.

Parameter	Customer IED	Internal IED
Technical Key	IED1	IED1
Description	IED1 DESC	IED1 DESC
IED Type	TEST	TEST
Configuration Version	VERSION	VERSION
Manufacturer	MANUFACTURER	MANUFACTURER
IP Address	192.168.2.10	192.168.2.10
IP-GATEWAY	192.168.2.1	192.168.2.1
IP-SUBNET	255.255.255.0	255.255.255.0
Voltage Level	E1 (E1)	E1 (E1)
Bay	Q1 (Q1)	Q1 (Q1)

Figure 158: IED mappings

Customer Access Point	Internal Access Point
IED1.IED1_AP1 [WA1]	IED1.AP1 [WA1]
IED1.IED1_AP3_SERVERAT [WA2]	IED1.AP2 [WA2]

Figure 159: Access point mappings

Customer Data Attribute	Internal Data Attribute	Signal Name
AA1E1Q1/LLN0.Beh.q [ST]	CTRL/LLN0.Beh.q [ST]	
AA1E1Q1/LLN0.Beh.stVal [ST]	CTRL/LLN0.Beh.stVal [ST]	
AA1E1Q1/LLN0.Beh.t [ST]	CTRL/LLN0.Beh.t [ST]	
AA1E1Q1/LLN0.Mod.ctllModel [CF]	CTRL/LLN0.Mod.ctllModel [CF]	
AA1E1Q1/LLN0.Mod.Oper.Check [CO]	CTRL/LLN0.Mod.Oper.Check [CO]	
AA1E1Q1/LLN0.Mod.Oper.ctlVal [CO]	CTRL/LLN0.Mod.Oper.ctlVal [CO]	
AA1E1Q1/LLN0.Mod.Oper.origin.orCat [CO]	CTRL/LLN0.LocSta.Oper.origin.orCat [CO]	
AA1E1Q1/LLN0.Mod.Oper.origin.orIdent [CO]	CTRL/LLN0.Mod.Oper.origin.orIdent [CO]	
AA1E1Q1/LLN0.Mod.Oper.Test [CO]	CTRL/LLN0.Mod.Oper.Test [CO]	
AA1E1Q1/LLN0.Mod.q [ST]	CTRL/LLN0.Mod.q [ST]	
AA1E1Q1/LLN0.Mod.stVal [ST]	CTRL/LLN0.Mod.stVal [ST]	

*Figure 160: Data attribute mappings*

## 9 Glossary

ACT	1. Application configuration tool in PCM600 2. Trip status in IEC 61850
AIM	Analog input module
ANSI	American national standards institute
ARP	Address resolution protocol
CID	Configured IED description
CMT	Communication management tool in PCM600
COM600S	Substation management unit. An all-in-one communication gateway, automation platform and user interface solution for utility and industrial distribution substations.
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE standard.
Connectivity package	A collection of software and information related to a specific protection and control IED, providing system products and tools to connect and interact with the IED.
DA	Data attribute
Data attribute	Defines the name, format, range of possible values and representation of values while being communicated
DHCP	Dynamic host configuration protocol
DO	Data object
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN.
FPN	Flexible product naming
FTP	File transfer protocol
FTPS	FTP Secure
GCB	1. GOOSE control block 2. Generator circuit breaker
GDE	Graphical display editor in PCM600
GoCB	GOOSE control block
GOOSE	Generic object-oriented substation event
HMI	Human-machine interface
HSR	High-availability seamless redundancy
HTTPS	Hypertext transfer protocol secure
HW	Hardware
I/O	Input/output
ICD	IED capability description

*Table continues on the next page*

IEC	International electrotechnical commission
IEC 61850	International standard for substation communication and modeling
IEC 61850-9-2	A communication protocol based on the IEC 61850 standard series
IED	Intelligent electronic device
IET600	Integrated engineering toolbox
IID	Instantiated IED description
Instance	Identical protection function blocks available in a standard configuration. By setting the application-specific parameters of an instance, a protection function stage can be established.
IP	Internet protocol
IP address	A set of four numbers between 0 and 255, separated by periods. Each server connected to the Internet is assigned a unique IP address that specifies the location for the TCP/IP protocol.
LAN	Local area network
LED	Light-emitting diode
LHMI	Local human-machine interface
LN	Logical node
MAC	Media access control
NCC	Network control center
PC	1. Personal computer 2. Polycarbonate
PCM600	Protection and control IED manager
PRP	Parallel redundancy protocol
PST	Parameter setting tool in PCM600
RTD	Resistance temperature detector
SAB600	Substation automation builder tool
SCD	Substation configuration description
SCL	XML-based system configuration description language defined by IEC 61850
SLD	Single-line diagram
SMT	Signal matrix tool in PCM600
SMV	Sampled measured values
Subnet mask	A set of four numbers used to create IP address numbers that are used only within a particular network, subnet
VPN	Virtual private network
WAN	Wide area network
WHMI	Web human-machine interface
Widget	Any graphical object drawn on the LHMI page with Page Editor in PCM600
XRIO	eXtended relay interface by OMICRON



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