RELION® PROTECTION AND CONTROL

620 series

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 ABB in accordance with the product standard EN 60255-26 for the EMC directive, and with the product standards EN 60255-1 and EN 60255-27 for the low voltage directive. The product is designed in accordance with the international standards of the IEC 60255 series.

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.

When the plug-in unit has been detached from the case, do not touch the inside of the case. The relay case internals may contain high voltage potential and touching these may cause personal injury.

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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Section 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

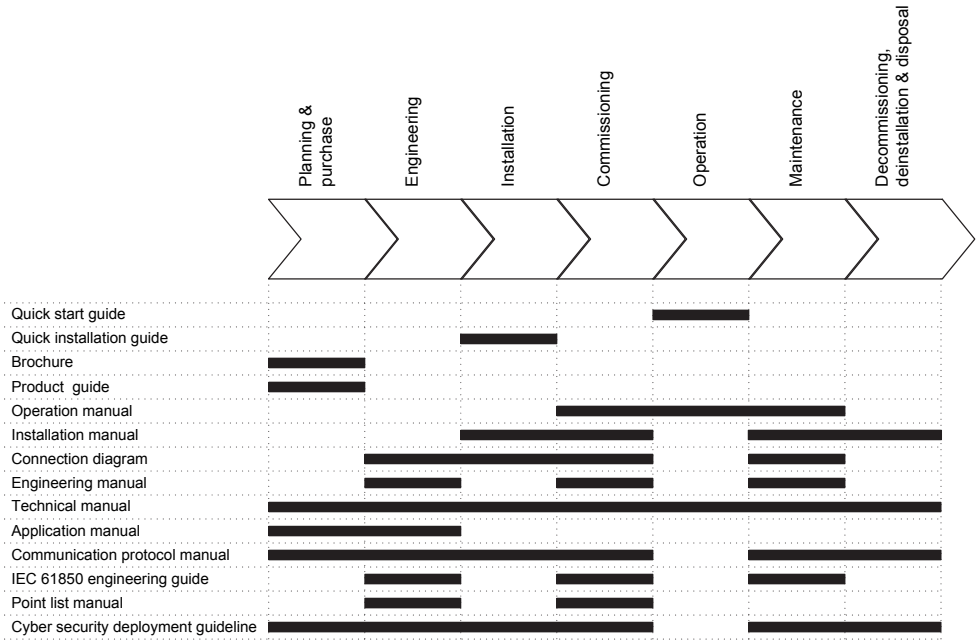

Figure 1: The intended use of documents during the product life cycle

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

1.3.2 Document revision history

Document revision/date	Product series version	History
A/2013-05-07	2.0	First release
B/2015-12-11	2.0 FP1	Content updated to correspond to the product series version
C/2019-06-19	2.0 FP1	Content updated

Download the latest documents from the ABB Web site http://www.abb.com/substationautomation.

1.3.3 Related documentation

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

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.
- Push button navigation in the LHMI menu structure is presented by using the push button icons.
  To navigate between the options, use  and  .
- Menu paths are presented in bold.
  Select **Main menu/Settings**.
- LHMI messages are shown in Courier font.
  To save the changes in nonvolatile memory, select `Yes` and press  .
- 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.

- This document assumes that the parameter setting visibility is "Advanced".

1.4.3 Functions, codes and symbols

All available functions are listed in the table. All of them may not be applicable to all products.

Table 1: Functions included in the relays

Function	IEC 61850	IEC 60617	ANSI
Protection			
Three-phase non-directional overcurrent protection, low stage	PHLPTOC1	3I> (1)	51P-1 (1)
	PHLPTOC2	3I> (2)	51P-1 (2)
Three-phase non-directional overcurrent protection, high stage	PHHPTOC1	3I>> (1)	51P-2 (1)
	PHHPTOC2	3I>> (2)	51P-2 (2)
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC1	3I>>> (1)	50P/51P (1)
	PHIPTOC2	3I>>> (2)	50P/51P (2)
Three-phase directional overcurrent protection, low stage	DPHLPDOC1	3I> -> (1)	67-1 (1)
	DPHLPDOC2	3I> -> (2)	67-1 (2)
Three-phase directional overcurrent protection, high stage	DPHHPDOC1	3I>> -> (1)	67-2 (1)
	DPHHPDOC2	3I>> -> (2)	67-2 (2)
Three-phase voltage-dependent overcurrent protection	PHPVOC1	3I(U)> (1)	51V (1)
	PHPVOC2	3I(U)> (2)	51V (2)
Non-directional earth-fault protection, low stage	EFLPTOC1	Io> (1)	51N-1 (1)
	EFLPTOC2	Io> (2)	51N-1 (2)
Non-directional earth-fault protection, high stage	EFHPTOC1	Io>> (1)	51N-2 (1)
	EFHPTOC2	Io>> (2)	51N-2 (2)
Non-directional earth-fault protection, instantaneous stage	EFIPTOC1	Io>>> (1)	50N/51N (1)
Directional earth-fault protection, low stage	DEFLPDEF1	Io> -> (1)	67N-1 (1)
	DEFLPDEF2	Io> -> (2)	67N-1 (2)
	DEFLPDEF3	Io> -> (3)	67N-1 (3)
Directional earth-fault protection, high stage	DEFHPDEF1	Io>> -> (1)	67N-2 (1)
Admittance-based earth-fault protection	EFPADM1	Yo> -> (1)	21YN (1)
	EFPADM2	Yo> -> (2)	21YN (2)
	EFPADM3	Yo> -> (3)	21YN (3)
Wattmetric-based earth-fault protection	WPWDE1	Po> -> (1)	32N (1)
	WPWDE2	Po> -> (2)	32N (2)
	WPWDE3	Po> -> (3)	32N (3)
Multifrequency admittance-based earth-fault protection	MFADPSDE1	Io> -> Y (1)	67YN (1)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI
Transient/intermittent earth-fault protection	INTRPTEF1	Io> -> IEF (1)	67NIEF (1)
Harmonics-based earth-fault protection	HAEFPTOC1	Io>HA (1)	51NHA (1)
Negative-sequence overcurrent protection	NSPTOC1	I2> (1)	46 (1)
	NSPTOC2	I2> (2)	46 (2)
Phase discontinuity protection	PDNSPTOC1	I2/I1> (1)	46PD (1)
Residual overvoltage protection	ROVPTOV1	Uo> (1)	59G (1)
	ROVPTOV2	Uo> (2)	59G (2)
	ROVPTOV3	Uo> (3)	59G (3)
Three-phase undervoltage protection	PHPTUV1	3U< (1)	27 (1)
	PHPTUV2	3U< (2)	27 (2)
	PHPTUV3	3U< (3)	27 (3)
	PHPTUV4	3U< (4)	27 (4)
Single-phase undervoltage protection, secondary side	PHAPTUV1	U_A< (1)	27_A (1)
Three-phase overvoltage protection	PHPTOV1	3U> (1)	59 (1)
	PHPTOV2	3U> (2)	59 (2)
	PHPTOV3	3U> (3)	59 (3)
Single-phase overvoltage protection, secondary side	PHAPTOV1	U_A> (1)	59_A (1)
Positive-sequence undervoltage protection	PSPTUV1	U1< (1)	47U+ (1)
	PSPTUV2	U1< (2)	47U+ (2)
Negative-sequence overvoltage protection	NSPTOV1	U2> (1)	47O- (1)
	NSPTOV2	U2> (2)	47O- (2)
Frequency protection	FRPFRQ1	f>/f<,df/dt (1)	81 (1)
	FRPFRQ2	f>/f<,df/dt (2)	81 (2)
	FRPFRQ3	f>/f<,df/dt (3)	81 (3)
	FRPFRQ4	f>/f<,df/dt (4)	81 (4)
	FRPFRQ5	f>/f<,df/dt (5)	81 (5)
	FRPFRQ6	f>/f<,df/dt (6)	81 (6)
Overexcitation protection	OEPVPH1	U/f> (1)	24 (1)
	OEPVPH2	U/f> (2)	24 (2)
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR1	3Ith>F (1)	49F (1)
Three-phase thermal overload protection, two time constants	T2PTTR1	3Ith>T/G/C (1)	49T/G/C (1)
Negative-sequence overcurrent protection for machines	MNSPTOC1	I2>M (1)	46M (1)
	MNSPTOC2	I2>M (2)	46M (2)
Loss of phase (undercurrent)	PHPTUC1	3I< (1)	37 (1)
	PHPTUC2	3I< (2)	37 (2)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI
Loss of load supervision	LOFLPTUC1	3I< (1)	37 (1)
	LOFLPTUC2	3I< (2)	37 (2)
Motor load jam protection	JAMPTOC1	Ist> (1)	51LR (1)
Motor start-up supervision	STTPMSU1	Is2t n< (1)	49,66,48,51LR (1)
Phase reversal protection	PREVPTOC1	I2>> (1)	46R (1)
Thermal overload protection for motors	MPTTR1	3Ith>M (1)	49M (1)
Stabilized and instantaneous differential protection for machines	MPDIF1	3dI>M/G (1)	87M/G (1)
High-impedance/flux-balance based differential protection for motors	MHZPDIF1	3dIHi>M (1)	87MH (1)
Stabilized and instantaneous differential protection for two-winding transformers	TR2PTDF1	3dI>T (1)	87T (1)
Numerical stabilized low-impedance restricted earth-fault protection	LREFPNDF1	dIoLo> (1)	87NL (1)
	LREFPNDF2	dIoLo> (2)	87NL (2)
High-impedance based restricted earth-fault protection	HREFPDIF1	dIoHi> (1)	87NH (1)
	HREFPDIF2	dIoHi> (2)	87NH (2)
Circuit breaker failure protection	CCBRBRF1	3I>/Io>BF (1)	51BF/51NBF (1)
	CCBRBRF2	3I>/Io>BF (2)	51BF/51NBF (2)
	CCBRBRF3	3I>/Io>BF (3)	51BF/51NBF (3)
Three-phase inrush detector	INRPHAR1	3I2f> (1)	68 (1)
Master trip	TRPPTRC1	Master Trip (1)	94/86 (1)
	TRPPTRC2	Master Trip (2)	94/86 (2)
	TRPPTRC3	Master Trip (3)	94/86 (3)
	TRPPTRC4	Master Trip (4)	94/86 (4)
Arc protection	ARCSARC1	ARC (1)	50L/50NL (1)
	ARCSARC2	ARC (2)	50L/50NL (2)
	ARCSARC3	ARC (3)	50L/50NL (3)
High-impedance fault detection	PHIZ1	HIF (1)	HIZ (1)
Load-shedding and restoration	LSHDPFRQ1	UFLS/R (1)	81LSH (1)
	LSHDPFRQ2	UFLS/R (2)	81LSH (2)
	LSHDPFRQ3	UFLS/R (3)	81LSH (3)
	LSHDPFRQ4	UFLS/R (4)	81LSH (4)
	LSHDPFRQ5	UFLS/R (5)	81LSH (5)
	LSHDPFRQ6	UFLS/R (6)	81LSH (6)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI
Multipurpose protection	MAPGAPC1	MAP (1)	MAP (1)
	MAPGAPC2	MAP (2)	MAP (2)
	MAPGAPC3	MAP (3)	MAP (3)
	MAPGAPC4	MAP (4)	MAP (4)
	MAPGAPC5	MAP (5)	MAP (5)
	MAPGAPC6	MAP (6)	MAP (6)
	MAPGAPC7	MAP (7)	MAP (7)
	MAPGAPC8	MAP (8)	MAP (8)
	MAPGAPC9	MAP (9)	MAP (9)
	MAPGAPC10	MAP (10)	MAP (10)
	MAPGAPC11	MAP (11)	MAP (11)
	MAPGAPC12	MAP (12)	MAP (12)
	MAPGAPC13	MAP (13)	MAP (13)
	MAPGAPC14	MAP (14)	MAP (14)
	MAPGAPC15	MAP (15)	MAP (15)
	MAPGAPC16	MAP (16)	MAP (16)
	MAPGAPC17	MAP (17)	MAP (17)
	MAPGAPC18	MAP (18)	MAP (18)
Automatic switch-onto-fault logic (SOF)	CVPSOF1	CVPSOF (1)	SOFT/21/50 (1)
Voltage vector shift protection	VVSPPAM1	VS (1)	78V (1)
Directional reactive power undervoltage protection	DQPTUV1	Q> -> ,3U< (1)	32Q,27 (1)
	DQPTUV2	Q> -> ,3U< (2)	32Q,27 (2)
Underpower protection	DUPPDPR1	P< (1)	32U (1)
	DUPPDPR2	P< (2)	32U (2)
Reverse power/directional overpower protection	DOPPDPR1	P>/Q> (1)	32R/32O (1)
	DOPPDPR2	P>/Q> (2)	32R/32O (2)
	DOPPDPR3	P>/Q> (3)	32R/32O (3)
Three-phase underexcitation protection	UEXPDIS1	X< (1)	40 (1)
	UEXPDIS2	X< (2)	40 (2)
Low-voltage ride-through protection	LVRTPTUV1	U<RT (1)	27RT (1)
	LVRTPTUV2	U<RT (2)	27RT (2)
	LVRTPTUV3	U<RT (3)	27RT (3)
Rotor earth-fault protection	MREFPTOC1	Io>R (1)	64R (1)
High-impedance differential protection for phase A	HIAPDIF1	dHi_A> (1)	87A (1)
High-impedance differential protection for phase B	HIBPDIF1	dHi_B> (1)	87B (1)
High-impedance differential protection for phase C	HICPDIF1	dHi_C> (1)	87C (1)

Table continues on next page

Function	IEC 61850	IEC 60617	ANSI
Circuit breaker uncorresponding position start-up	UPCALH1	CBUPS (1)	CBUPS (1)
	UPCALH2	CBUPS (2)	CBUPS (2)
	UPCALH3	CBUPS (3)	CBUPS (3)
Three-independent-phase non-directional overcurrent protection, low stage	PH3LPTOC1	3I_3> (1)	51P-1_3 (1)
	PH3LPTOC2	3I_3> (2)	51P-1_3 (2)
Three-independent-phase non-directional overcurrent protection, high stage	PH3HPTOC1	3I_3>> (1)	51P-2_3 (1)
	PH3HPTOC2	3I_3>> (2)	51P-2_3 (2)
Three-independent-phase non-directional overcurrent protection, instantaneous stage	PH3IPTOC1	3I_3>>> (1)	50P/51P_3 (1)
Directional three-independent-phase directional overcurrent protection, low stage	DPH3LPDOC1	3I_3> -> (1)	67-1_3 (1)
	DPH3LPDOC2	3I_3> -> (2)	67-1_3 (2)
Directional three-independent-phase directional overcurrent protection, high stage	DPH3HPDOC1	3I_3>> -> (1)	67-2_3 (1)
	DPH3HPDOC2	3I_3>> -> (2)	67-2_3 (2)
Three-phase overload protection for shunt capacitor banks	COLPTOC1	3I> 3I< (1)	51C/37 (1)
Current unbalance protection for shunt capacitor banks	CUBPTOC1	dI>C (1)	51NC-1 (1)
Shunt capacitor bank switching resonance protection, current based	SRCPTOC1	TD> (1)	55TD (1)
Control			
Circuit-breaker control	CBXCBR1	I <-> O CB (1)	I <-> O CB (1)
	CBXCBR2	I <-> O CB (2)	I <-> O CB (2)
	CBXCBR3	I <-> O CB (3)	I <-> O CB (3)
Disconnector control	DCXSWI1	I <-> O DCC (1)	I <-> O DCC (1)
	DCXSWI2	I <-> O DCC (2)	I <-> O DCC (2)
	DCXSWI3	I <-> O DCC (3)	I <-> O DCC (3)
	DCXSWI4	I <-> O DCC (4)	I <-> O DCC (4)
Earthing switch control	ESXSWI1	I <-> O ESC (1)	I <-> O ESC (1)
	ESXSWI2	I <-> O ESC (2)	I <-> O ESC (2)
	ESXSWI3	I <-> O ESC (3)	I <-> O ESC (3)
Disconnector position indication	DCSXSWI1	I <-> O DC (1)	I <-> O DC (1)
	DCSXSWI2	I <-> O DC (2)	I <-> O DC (2)
	DCSXSWI3	I <-> O DC (3)	I <-> O DC (3)
	DCSXSWI4	I <-> O DC (4)	I <-> O DC (4)
Earthing switch indication	ESSXSWI1	I <-> O ES (1)	I <-> O ES (1)
	ESSXSWI2	I <-> O ES (2)	I <-> O ES (2)
	ESSXSWI3	I <-> O ES (3)	I <-> O ES (3)
Emergency start-up	ESMGAPC1	ESTART (1)	ESTART (1)

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Function	IEC 61850	IEC 60617	ANSI
Autoreclosing	DARREC1	O -> I (1)	79 (1)
	DARREC2	O -> I (2)	79 (2)
Synchronism and energizing check	SECRSYN1	SYNC (1)	25 (1)
Tap changer position indication	TPOSYLTC1	TPOSM (1)	84M (1)
Tap changer control with voltage regulator	OLATCC1	COLTC (1)	90V (1)
Condition monitoring and supervision			
Circuit-breaker condition monitoring	SSCBR1	CBCM (1)	CBCM (1)
	SSCBR2	CBCM (2)	CBCM (2)
	SSCBR3	CBCM (3)	CBCM (3)
Trip circuit supervision	TCSSCBR1	TCS (1)	TCM (1)
	TCSSCBR2	TCS (2)	TCM (2)
Current circuit supervision	CCSPVC1	MCS 3I (1)	MCS 3I (1)
	CCSPVC2	MCS 3I (2)	MCS 3I (2)
Current transformer supervision for high-impedance protection scheme for phase A	HZCCASPVC1	MCS I_A (1)	MCS I_A (1)
Current transformer supervision for high-impedance protection scheme for phase B	HZCCBSPVC1	MCS I_B (1)	MCS I_B (1)
Current transformer supervision for high-impedance protection scheme for phase C	HZCCCSPVC1	MCS I_C (1)	MCS I_C (1)
Advanced current circuit supervision for transformers	CTSRCTF1	MCS 3I,I2 (1)	MCS 3I,I2 (1)
Fuse failure supervision	SEQSPVC1	FUSEF (1)	60 (1)
Runtime counter for machines and devices	MDSOPT1	OPTS (1)	OPTM (1)
	MDSOPT2	OPTS (2)	OPTM (2)
Measurement			
Three-phase current measurement	CMMXU1	3I (1)	3I (1)
	CMMXU2	3I (2)	3I (2)
Sequence current measurement	CSMSQI1	I1, I2, I0 (1)	I1, I2, I0 (1)
	CSMSQI2	I1, I2, I0 (B) (1)	I1, I2, I0 (B) (1)
Residual current measurement	RESCMMXU1	Io (1)	In (1)
	RESCMMXU2	Io (2)	In (2)
Three-phase voltage measurement	VMMXU1	3U (1)	3V (1)
Single-phase voltage measurement	VAMMXU2	U_A (2)	V_A (2)
	VAMMXU3	U_A (3)	V_A (3)
Residual voltage measurement	RESVMMXU1	Uo (1)	Vn (1)
Sequence voltage measurement	VSMSQI1	U1, U2, U0 (1)	V1, V2, V0 (1)
Three-phase power and energy measurement	PEMMXU1	P, E (1)	P, E (1)
Load profile record	LDPRLRC1	LOADPROF (1)	LOADPROF (1)

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Function	IEC 61850	IEC 60617	ANSI
Frequency measurement	FMMXU1	f (1)	f (1)
Fault location			
Fault locator	SCEFRFLO1	FLOC (1)	21FL (1)
Power quality			
Current total demand distortion	CMHAI1	PQM3I (1)	PQM3I (1)
Voltage total harmonic distortion	VMHAI1	PQM3U (1)	PQM3V (1)
Voltage variation	PHQVVR1	PQMU (1)	PQMV (1)
Voltage unbalance	VSQVUB1	PQUUB (1)	PQVUB (1)
Other			
Minimum pulse timer (2 pcs)	TPGAPC1	TP (1)	TP (1)
	TPGAPC2	TP (2)	TP (2)
	TPGAPC3	TP (3)	TP (3)
	TPGAPC4	TP (4)	TP (4)
Minimum pulse timer (2 pcs, second resolution)	TPSGAPC1	TPS (1)	TPS (1)
	TPSGAPC2	TPS (2)	TPS (2)
Minimum pulse timer (2 pcs, minute resolution)	TPMGAPC1	TPM (1)	TPM (1)
	TPMGAPC2	TPM (2)	TPM (2)
Pulse timer (8 pcs)	PTGAPC1	PT (1)	PT (1)
	PTGAPC2	PT (2)	PT (2)
Time delay off (8 pcs)	TOFGAPC1	TOF (1)	TOF (1)
	TOFGAPC2	TOF (2)	TOF (2)
	TOFGAPC3	TOF (3)	TOF (3)
	TOFGAPC4	TOF (4)	TOF (4)
Time delay on (8 pcs)	TONGAPC1	TON (1)	TON (1)
	TONGAPC2	TON (2)	TON (2)
	TONGAPC3	TON (3)	TON (3)
	TONGAPC4	TON (4)	TON (4)
Set-reset (8 pcs)	SRGAPC1	SR (1)	SR (1)
	SRGAPC2	SR (2)	SR (2)
	SRGAPC3	SR (3)	SR (3)
	SRGAPC4	SR (4)	SR (4)
Move (8 pcs)	MVGAPC1	MV (1)	MV (1)
	MVGAPC2	MV (2)	MV (2)
	MVGAPC3	MV (3)	MV (3)
	MVGAPC4	MV (4)	MV (4)
Integer value move	MVI4GAPC1	MVI4 (1)	MVI4 (1)
	MVI4GAPC2	MVI4 (2)	MVI4 (2)
	MVI4GAPC3	MVI4 (3)	MVI4 (3)
	MVI4GAPC4	MVI4 (4)	MVI4 (4)

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Function	IEC 61850	IEC 60617	ANSI
Analog value scaling	SCA4GAPC1	SCA4 (1)	SCA4 (1)
	SCA4GAPC2	SCA4 (2)	SCA4 (2)
	SCA4GAPC3	SCA4 (3)	SCA4 (3)
	SCA4GAPC4	SCA4 (4)	SCA4 (4)
Generic control point (16 pcs)	SPCGAPC1	SPC (1)	SPC (1)
	SPCGAPC2	SPC (2)	SPC (2)
	SPCGAPC3	SPC (3)	SPC (3)
Remote generic control points	SPCRGAPC1	SPCR (1)	SPCR (1)
Local generic control points	SPCLGAPC1	SPCL (1)	SPCL (1)
Generic up-down counters	UDFCNT1	UDCNT (1)	UDCNT (1)
	UDFCNT2	UDCNT (2)	UDCNT (2)
	UDFCNT3	UDCNT (3)	UDCNT (3)
	UDFCNT4	UDCNT (4)	UDCNT (4)
	UDFCNT5	UDCNT (5)	UDCNT (5)
	UDFCNT6	UDCNT (6)	UDCNT (6)
	UDFCNT7	UDCNT (7)	UDCNT (7)
	UDFCNT8	UDCNT (8)	UDCNT (8)
	UDFCNT9	UDCNT (9)	UDCNT (9)
	UDFCNT10	UDCNT (10)	UDCNT (10)
	UDFCNT11	UDCNT (11)	UDCNT (11)
	UDFCNT12	UDCNT (12)	UDCNT (12)
Programmable buttons (16 buttons)	FKEYGGIO1	FKEY (1)	FKEY (1)
Logging functions			
Disturbance recorder	RDRE1	DR (1)	DFR (1)
Fault recorder	FLTRFRC1	FAULTREC (1)	FAULTREC (1)
Sequence event recorder	SER1	SER (1)	SER (1)

Section 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 the Application Configuration tool.
  - Configuring the parameters and setting values for the protection relay itself and for the process functions by using the Parameter Setting tool.
  - Drawing single-line diagrams and making links to dynamic process values by using Graphical Display Editor. The single-line diagrams are displayed in LHMI and WHMI on the bay protection relay.
  - Configuring connections between the application configuration function blocks and physical hardware inputs and outputs by using the Signal Matrix tool or the Application Configuration tool.
  - Configuring the events shown on the LHMI using the HMI Event Filtering tool.
  - Reusing configurations from older protection relay versions using the Configuration Migration tool.

- 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 or IEC 60870-5-103 with the Communication Management tool.
  - Configuring the sampled values (process bus) between the devices using the Application Configuration tool and IEC 61850 Configuration tool.

- Record management
  - Generating overviews on the available (disturbance) recordings in all connected protection relays by using the Disturbance Handling tool.
  - Manually reading the recording files (in the COMTRADE format) from the protection relays by using the Disturbance Handling tool or automatically by using the PCM600 Scheduler.
  - Managing recording files with the Disturbance Handling tool.

- Creating recording file content overview reports for fast evaluation with assistance of the Disturbance Handling tool.
- Using the Fault Record tool to read fault records from the protection relay, save records to a PC and clear old records.
- Using the Load Profile tool to read load profile records from the protection relay, save records to a PC and clear old records.

- Service management
  - Monitoring the selected signals of a protection relay for commissioning or service purposes by using the Signal Monitoring tool and Event Viewer tool (including audit trail).

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.

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 front or rear port on the protection relay.

2.1 Monitoring and control system structure

The monitoring and control system for electrical substations contains a number of devices for various purposes.

The maximum size of a project is 180 devices. However, in order to maintain good performance and usability of the tool, it is recommended to divide one big project into multiple smaller PCM600 projects.

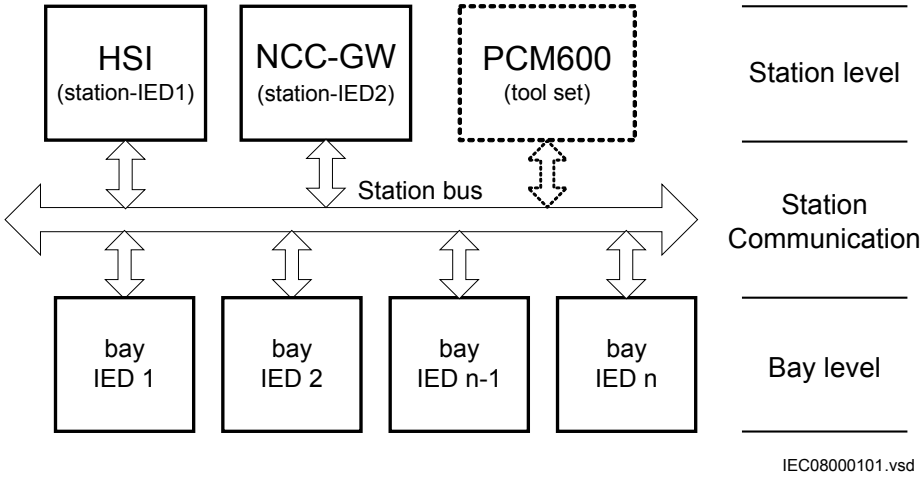

Figure 2: Principle structure of a monitoring and control system for a substation

The monitoring and control system can be divided into three main parts.

- Bay level devices
- Station communication
- Station level devices

All three parts require specific engineering and configuration.

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 organization structure for the devices 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 = the selection of the IED that is used in the bay; it is possible to insert several IEDs within a bay, for example, one control device and two protection relays

2.2 Default configuration concept

The product series covers protection relays developed for the protection of medium voltage applications. Every product has predefined application-specific software called default configuration that contains protection, control, supervision and measurement function blocks and default logical connections; for more information,

see the application manuals. The product also includes the default configuration specific default single-line diagram.

The default configuration software consists of connections between an application's functions developed according to the needs of a particular functional application. The inputs and outputs are similarly assigned to a default set of connections such as position indication and Master trip. The alarm LEDs are assigned to default connections based on the order number.

Current and voltage channels for protection and measurement functions are fixed as a part of default configuration and cannot be reassigned with Signal Matrix or Application Configuration in PCM600.

The single-line diagram consists of an application-specific general arrangement of a single-line diagram that includes position indications and the selection of controllable objects and measurements.

The content of the default configuration depends on the intended functional application. The default configurations also have selectable software options, which are selected when ordering the protection relay. Some of the software options are related to the protection relay hardware.

The default configurations can be used as is, but they can also be modified by using the PCM600. The default configuration itself can be modified or extended by using the Application Configuration tool, the Signal Matrix tool and the communication configuration tools. The single-line diagram can also be modified with Graphical Display Editor.

All functions and application logic included in a default configuration of the protection relay can be in use at the same time.

However, by removing unused function blocks from the configuration with the Application Configuration in PCM600, more resources in the protection relay become available for other purposes.

- More advanced user application logic with Application Configuration
- Extensive use of GOOSE sending and receiving
- Increasing the amount of data reported for IEC 61850 clients

2.3 Workflow

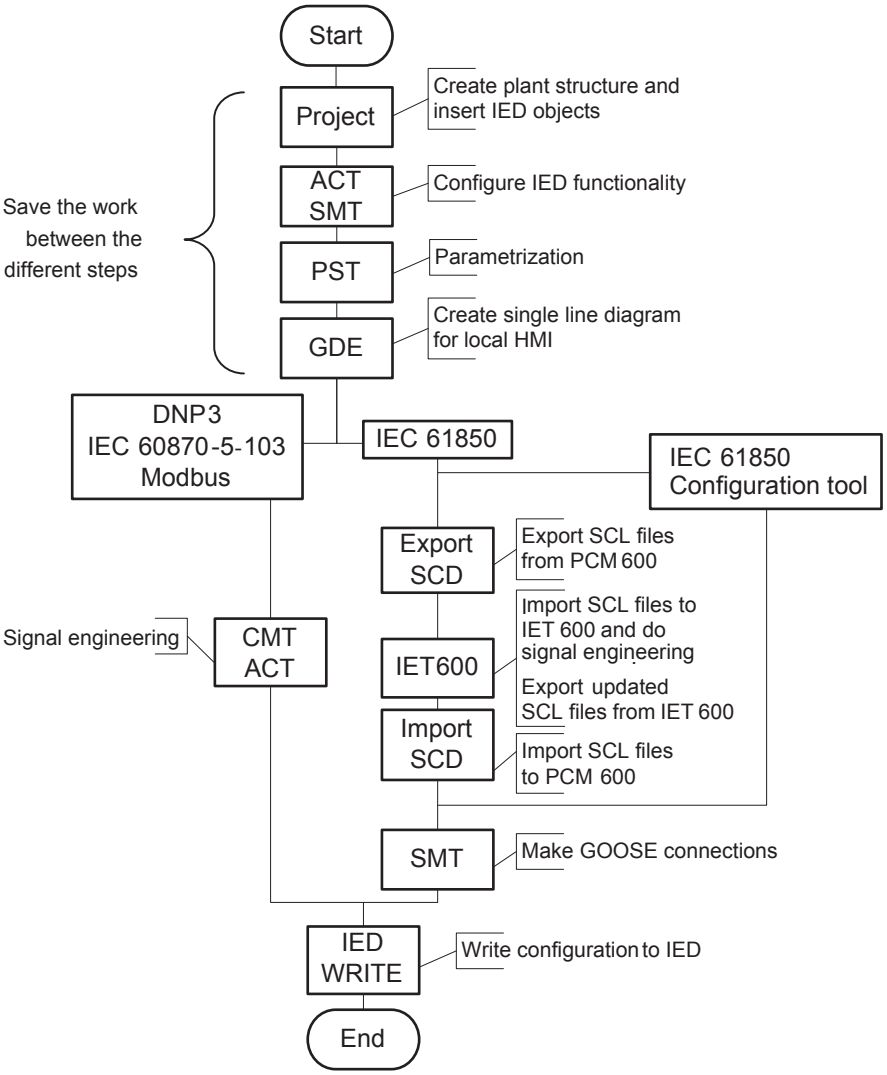

Figure 3: Protection relay engineering workflow proposal based on practical experience and dependencies of the steps

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

Setting up a PCM600 project

- The plant structure is built according to the substation structure.

The maximum size of a project is 180 IEDs. However, in order to maintain good performance and usability of the tool, it is

recommended to divide one big project into multiple smaller PCM600 projects.

- 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.
- Programmable push-buttons are configured with the Application Configuration tool.
- The configuration made in the Application Configuration tool is saved to make the interfaces and signals available for other engineering tools within PCM600, for example, for the Parameter Setting tool.

Parameter setting and configuration in the Parameter Setting tool

- Configuration parameters such as CT and VT conversion values of the transformer module are checked by the tool.
- If needed, the setting values are checked and adjusted with the Parameter Setting tool.

Single-line diagram configuration in Graphical Display Editor

- It is possible to create a single-line diagram for the switching devices in the bay.
- Measurements can be included when needed.
- The dynamic elements are linked to the functions created in the Application Configuration tool; for example, a breaker object is linked to the circuit breaker control function.

LHMI engineering

- The LEDs are configured with Application Configuration.
- The LED behavior is defined with Parameter Setting.
- The HMI Event Filtering tool can be used to configure event visibility on the LHMI event list.

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 directly suitable, in most cases, 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.

Section 3 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the protection relay 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 customer 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. Further Connectivity Packages assist the tool with communications.

PCM600 uses IEC 61850 over Ethernet to communicate with bay devices. This communication allows PCM600 to configure and monitor the devices. In addition to IEC 61850 the devices have optional communications 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 620 series protection relay within a station by using the Ethernet connection. The connection can also be used for service and maintenance purposes. In addition, the connection is used to handle disturbance records from the protection relays.

The modern-day protection relays are designed using the concept of the IEC 61850 standard. This is primarily in regards to how functions within the protection relay are modelled and how the protection relay is represented in the substation. See the IEC 61850 parameter list for the list of logical nodes available in the protection relay and observe how they follow the structure and rules as defined in part 7 of the standard.

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

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

The applications can be organized into groups.

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

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 enables 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 software packages that use the connectivity package to properly communicate with the protection relay. It also supports localization of text even when it is read from the protection relay in a standard format such as COMTRADE.

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

3.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 2.6 (Rollup 20150626) or later
- REF620 Connectivity Package Ver.2.1 or later
- REM620 Connectivity Package Ver.2.1 or later
- RET620 Connectivity Package Ver.2.1 or later

Download connectivity packages from the ABB Web site http://www.abb.com/substationautomation 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 Website or by using Update Manager when a network connection is available.

Download connectivity packages from the ABB Web site http://www.abb.com/substationautomation 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 **ABB IED Connectivity Package RE_6xx Ver. n.msi** installer. (n = version number)
3. To install the connectivity package, follow the steps in the connectivity package installation wizard.

3.2.1.2 Installing connectivity packages by using Update Manager

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

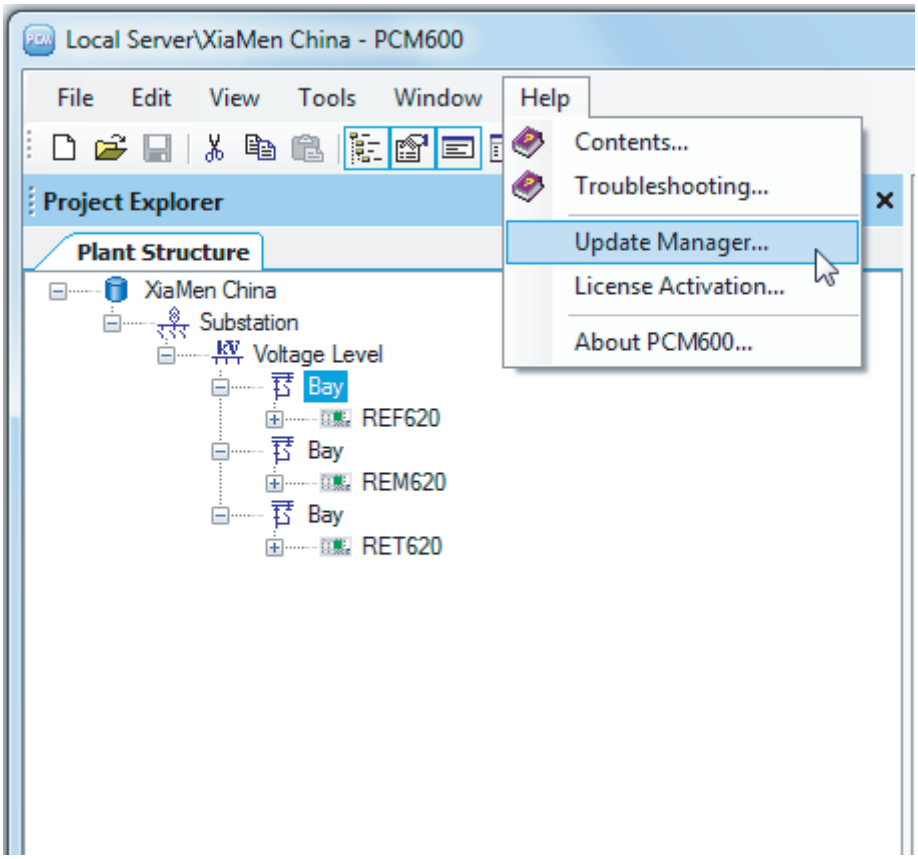

Figure 4: Help menu – Update Manager

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

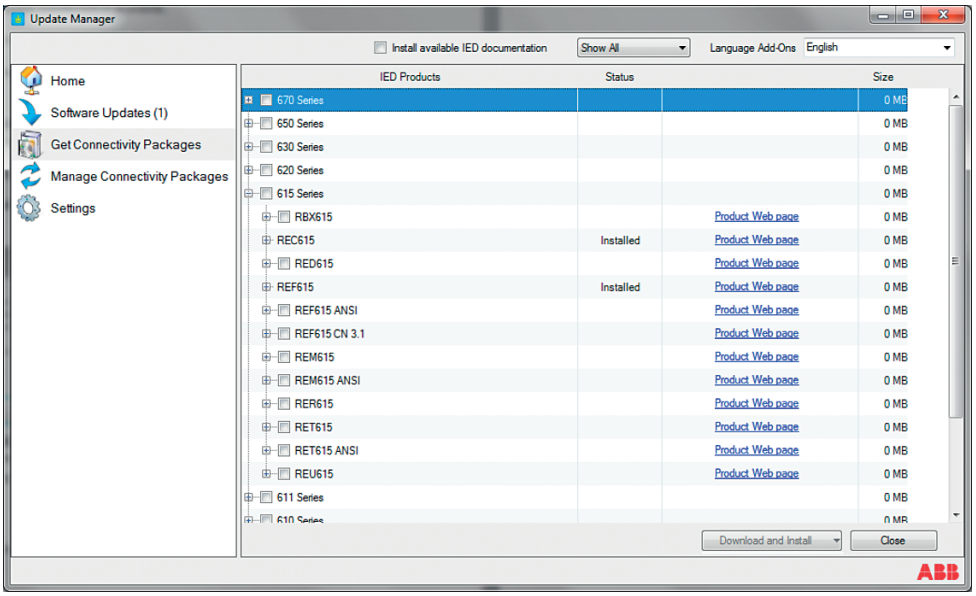

Figure 5: Selecting the connectivity packages

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.

4. Click **Apply** to activate the connectivity package.

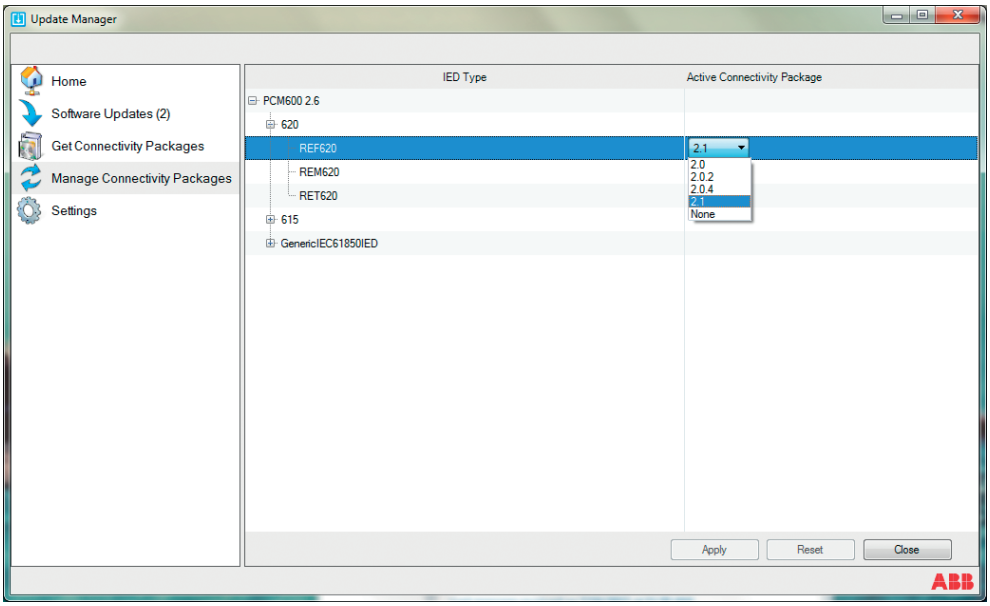

Figure 6: Selecting the connectivity package versions

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 the protocol used in installation for each project, the IEC 61850 version must be selected when adding the first IED to plant structure. After the initial selection, all IEDs in plant structure use the selected version, either Edition 1 or Edition 2. In case the IEC 61850 is not used for station bus, the default version can be applied. By default, the IEC 61850 version of PCM600 is Edition 1. 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 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.

The technical key must be the same for the communication between the protection relay and PCM600. 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.

When writing a configuration to the protection relay, PCM600 checks for a mismatch between the IED object and the physical IED technical key.

Figure 7: Reboot suggestion

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

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

3.4.1 IEC 61850 naming conventions to identify an IED

This section is only valid when the IEC 61850 standard is used for station bus communication. The IEC 61850 naming conventions to identify an IED are only valid when the IEC 61850 standard is used for station bus communication. According to the 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.

- 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 to other objects. The name is a relative identification within a hierarchy of objects. The maximum characters allowed for a technical key is 28 for IEC 61850 Edition 1 and 60 for Edition 2 projects.
- 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 takes care of these two possibilities. The two possible signal designations are available per object in the 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 used also in the transmitted messages to identify the events, for example.
- The voltage level. In the example 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 using the Rename function.

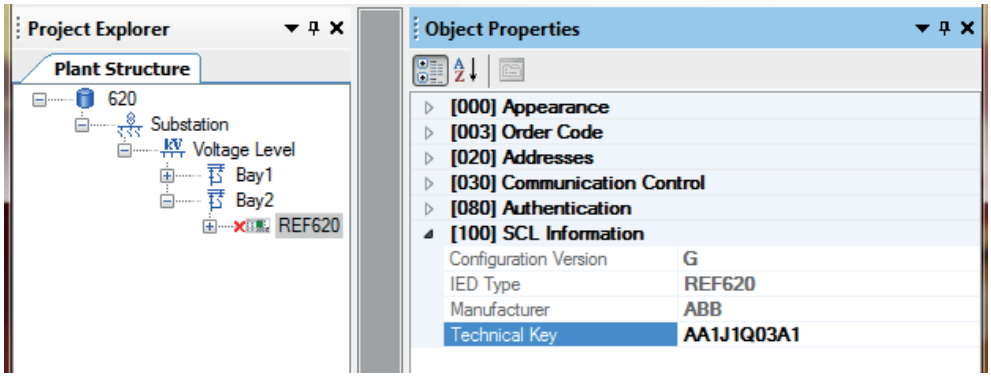

Figure 8: PCM600: IEC 61850 signal designation concept

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 = the third bay in the voltage level
- A1 = first IED in the bay Q03

3.4.2 Setting the technical key

The maximum length of 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**.

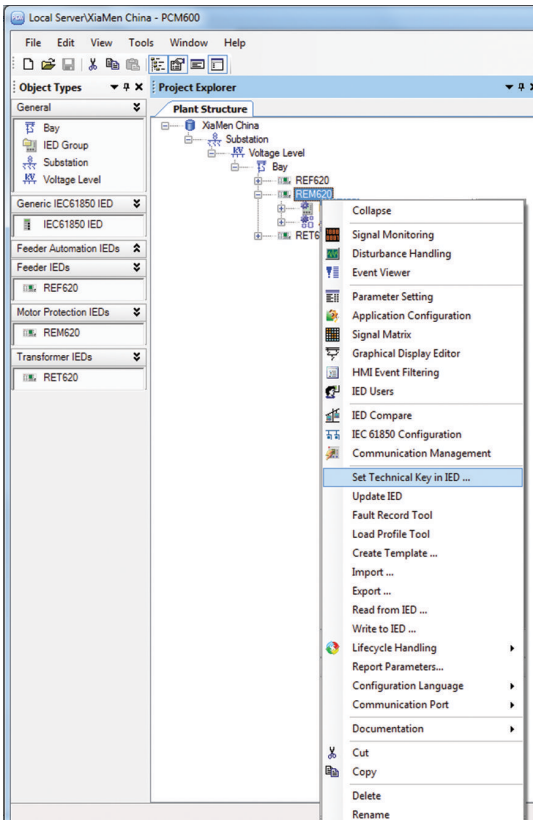

Figure 9: PCM600: Setting the technical key on the IED level

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

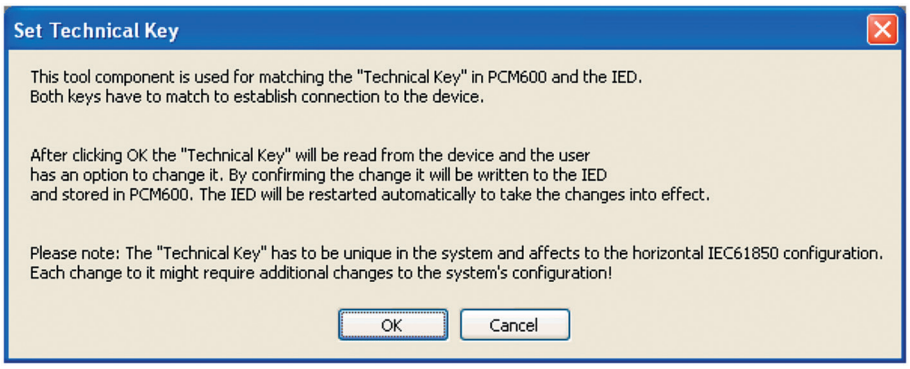

Figure 10: Technical key information

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

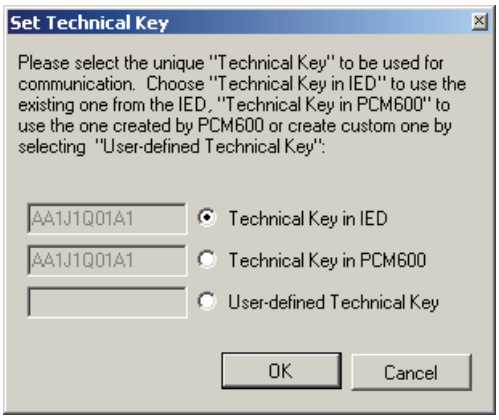

Figure 11: Setting the technical key

3. In **Set Technical Key** dialog box, select the technical key to be used. There are three alternatives.
   - Use the existing technical key in the IED
   - Use the existing 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 the **Technical key in IED** if the value is the same as 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 FTP/FTPS protocol.

Each protection relay has an Ethernet interface connector on the front and optionally on the rear side as well. The Ethernet connector can be used for communication with PCM600.

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 the protection relay's front port
- Indirect link via station LAN or from remote 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 for each protection relay to match the IP addresses of the physical IEDs.
4. Technical keys of the IEDs in PCM600 project are configured for each protection relay to match the technical keys of the physical IEDs.

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

Table 2: Ports that must be open in the firewall for different protocols

Protocol	TCP port
File Transfer Protocol (FTP and FTPS)	20, 21
IEC 61850	102
Web Server HTTP	80
Web server HTTPS	443
Simple Network Time Protocol (SNTP)	123
Modbus TCP	502
DNP TCP	20000

3.5.1 Setting up IP addresses

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

The protection relay's front port IP address is fixed to “192.168.0.254” and it cannot be modified.

1. Set the IP address for the protection relay's rear port and the corresponding subnet mask via the LHMI path **Configuration/Communication/Ethernet/ Rear port**.

Table 3: Default IP address for the rear port and the corresponding subnet mask

IP address	Subnet mask
192.168.2.10	255.255.255.0

Communication fails if the IP addresses of the front and the rear port belong to the same subnet.

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 patching the IED firmware and for adding or replacing additional languages to the IED. Update packages are provided by Customer Support. The update tool can be used either locally or remotely.

It is recommended to take a backup of the IED configuration before starting the update. This can be done by using the Read from IED function from the IED context menu in PCM600. The user needs to be authorized before using the tool. User credentials are asked if the default administrator password has been changed. Administrator or engineer credentials are needed for authorization.

3.6.1 Prerequisites for local and remote updates

Local update

- Use of the front port is recommended when updating locally. Remove the IED from the network especially with redundant network topologies (HSR/PRP).

Remote update

- Communication is recommended to be secured either by setting up a VPN connection or enabling secure communication in the IED via LHMI (**Configuration/Authorization/Remote Update**) while updating remotely.
- Remote update can be enabled in the IED either via the LHMI (**Configuration/Authorization/Security/Remote Update**) or by an administrator in the Parameter Setting tool in PCM600 (**IED Configuration/Configuration/Authorization/Remote Update** to be able to update remotely. If the IED is in local control mode, remote update proceeds only after a confirmation is received from the user.
- Remote update has to be disabled manually after the update, if wanted.
- Remote update only works when the IED is connected from the rear port with a custom IP address.

3.6.2 Updating firmware or language

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

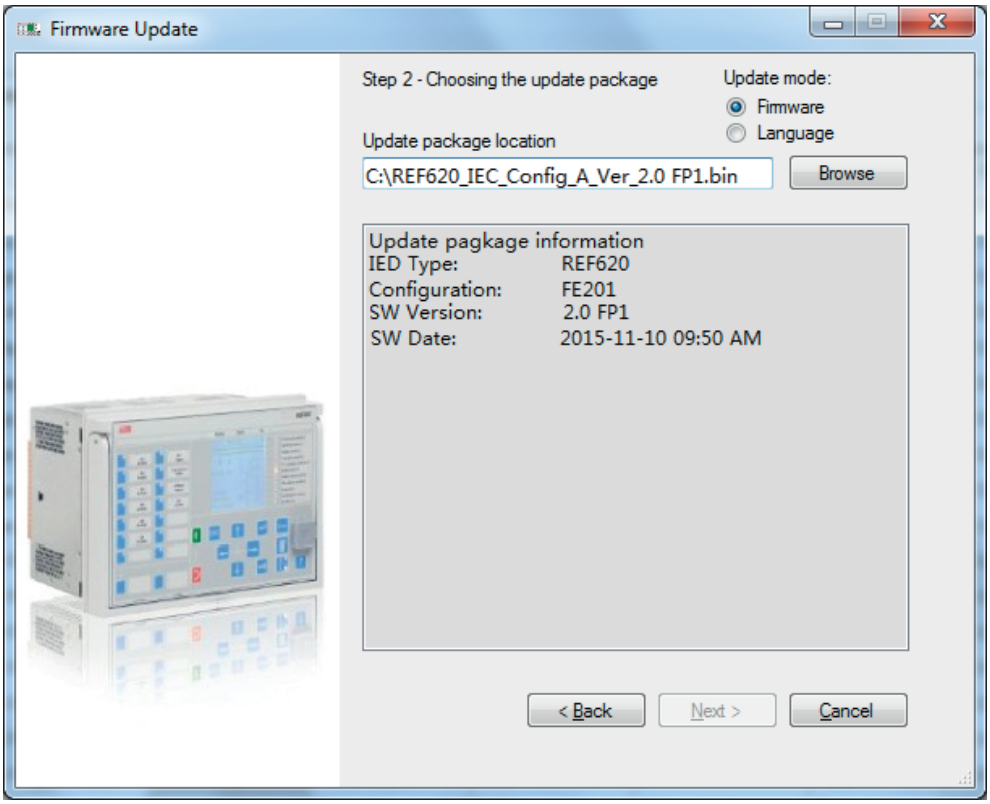

Figure 12: Choosing the update mode and package

3. Select the network interface controller, for example, the PC's integrated Ethernet communication card or an external Ethernet adapter, connected to the IED and click **OK**.

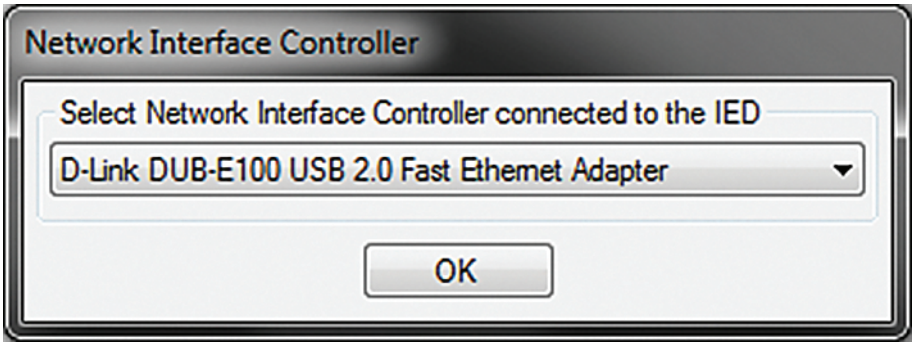

Figure 13: Selecting the network interface controller

4. 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 ESC during the 30 second window.
   - IED use is allowed after the update is completed successfully.

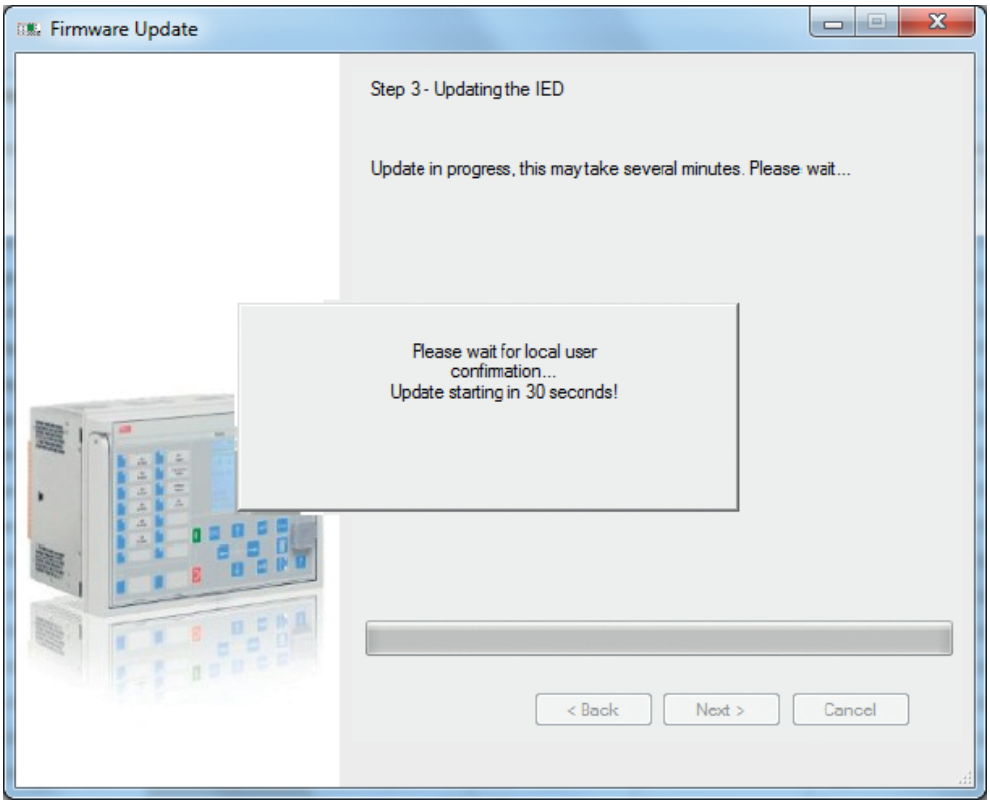

Figure 14: Waiting for local user confirmation with remote update

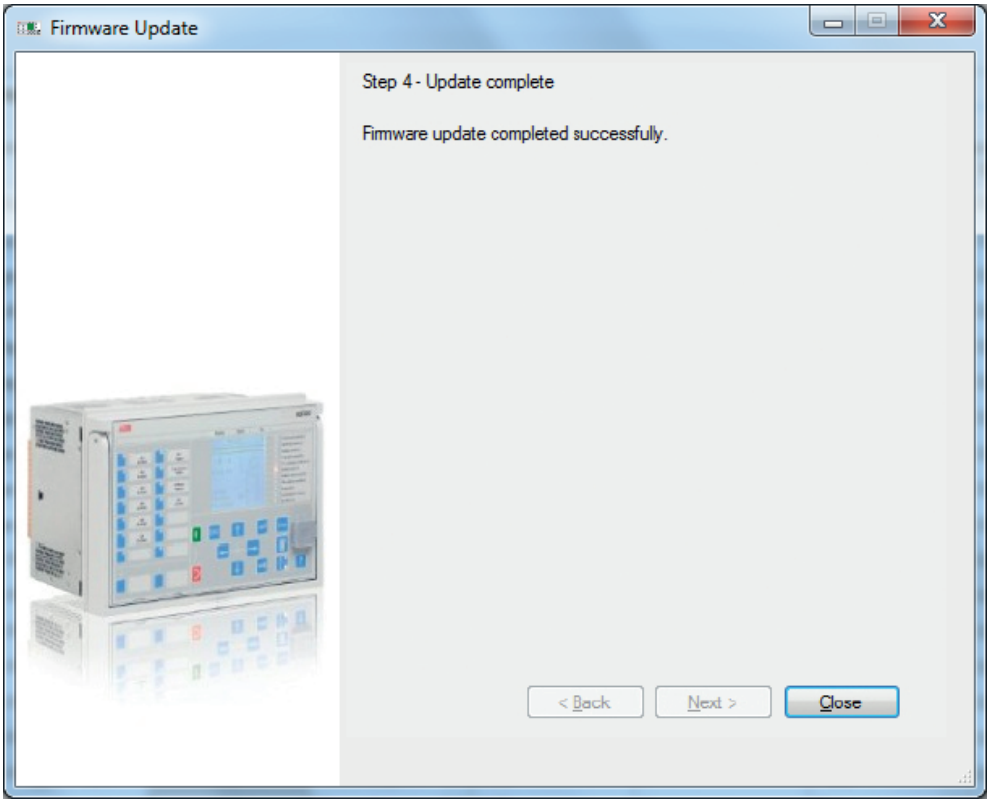

Figure 15: Completing the update

Section 4 Setting up a project

4.1 Creating a new project

1. Start PCM600.
2. To see the projects that are currently available in the PCM databases, select **File/Open/Manage Project** on the menu bar.
   The **Open/Manage Project** window is displayed.
3. Click **Projects on my computer**.
4. Click **New Project**.
5. If there are currently projects or object tools open, a confirmation dialog box opens.
   - Click **Yes** to close the open projects. A **Create New Project** dialog box opens.

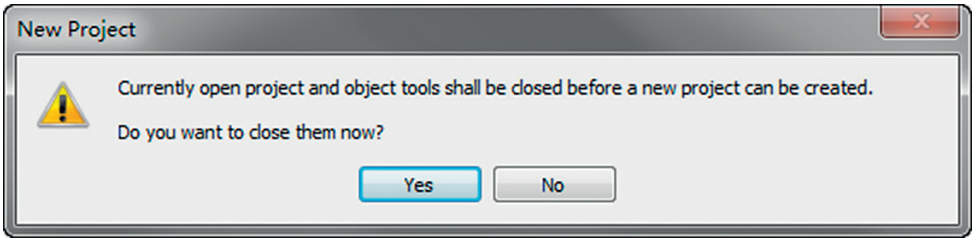

Figure 16: New Project dialog box

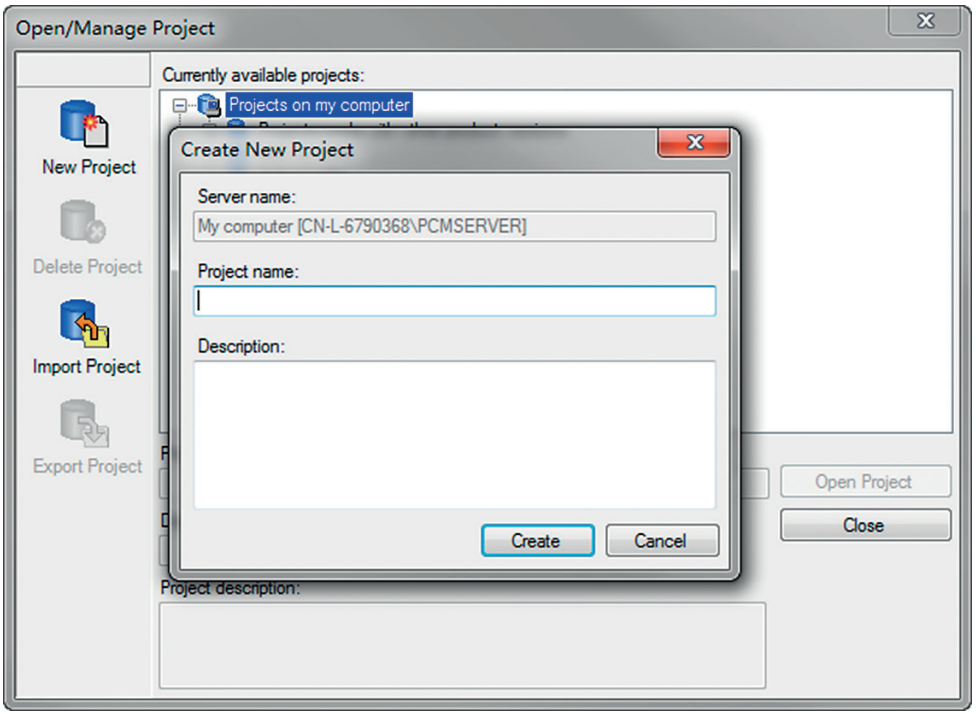

Figure 17: Creating a new project

6. In the **Project Name** box, give a name for the project.

The project name must be unique.

7. Optionally, write a description of the project in the **Description** box.
8. Click **Create**.

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

4.2 Building the plant structure

Building a plant structure is useful when a complete grid with an essential number of IEDs has to be built.

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** and select **General** and select the element 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.

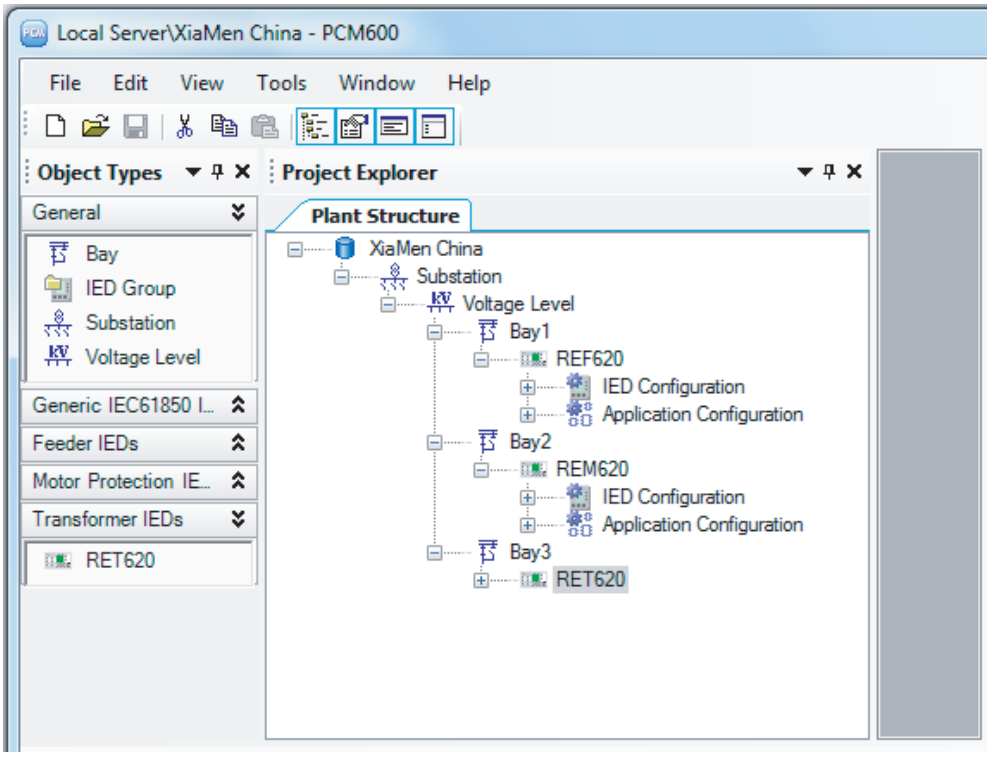

Figure 18: The start of a project with IEDs placed but not renamed

4. Rename each level in the structure by the names/identifications used in the grid.
   - Right-click the level and select **Rename**.
   - Rename the levels in the **Object Properties** view.

4.3 Inserting an IED

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

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

- Insert either offline or 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/export directly from the plant structure context menu.

IEC 61850 Edition 1 and Edition 2 IEDs cannot be used simultaneously in the same PCM600 project. The first inserted IED determines the IEC 61850 version for the whole project.

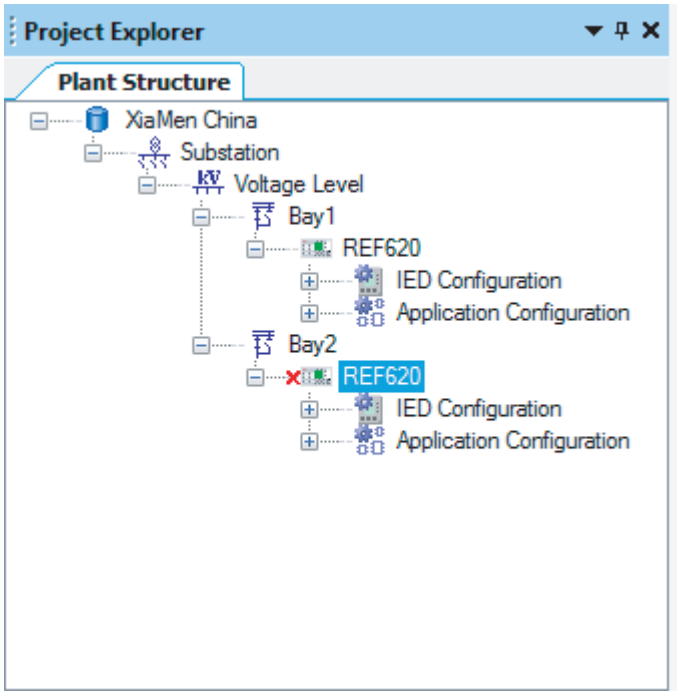

Figure 19: Plant structure showing Bay1 in the online mode and Bay2 in the offline mode

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 already connected to PCM600, PCM600 can read the order number 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 **Motor Protection IEDs** and select the protection relay type to be inserted.

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

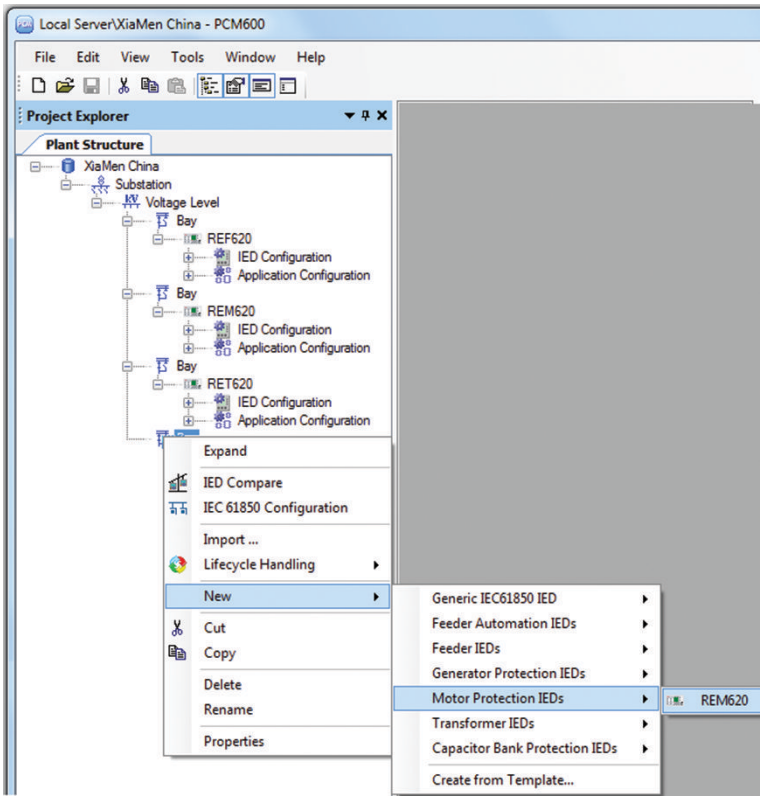

Figure 20: Selecting the protection relay type

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

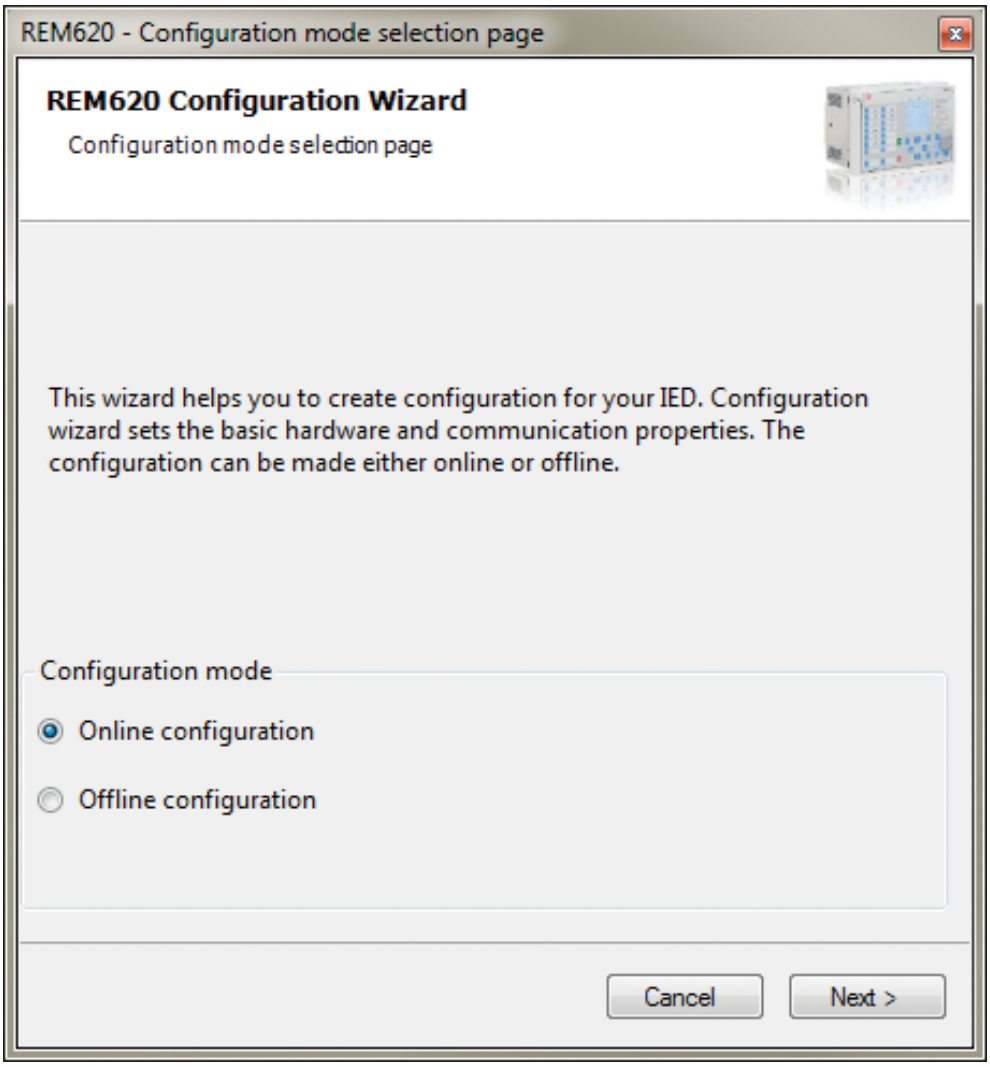

Figure 21: Configuration mode selection

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

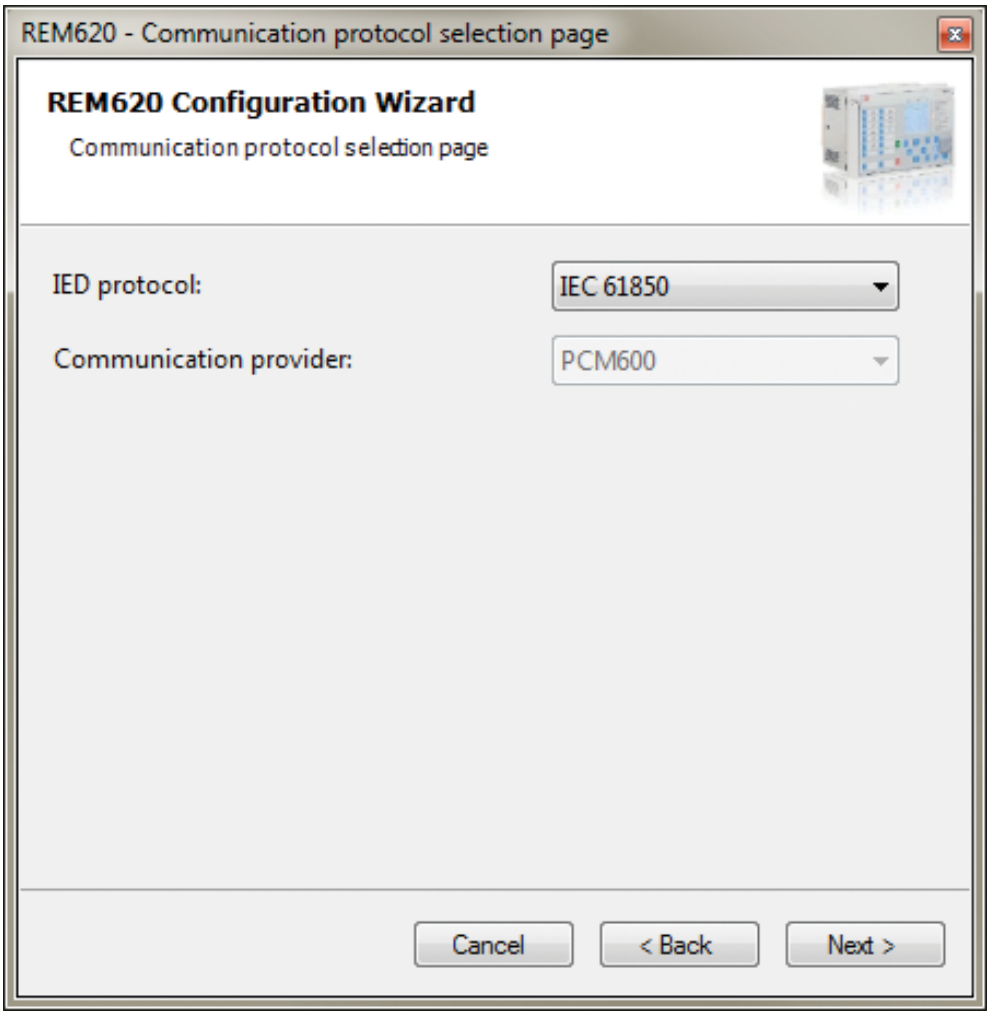

Figure 22: Communication protocol selection

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

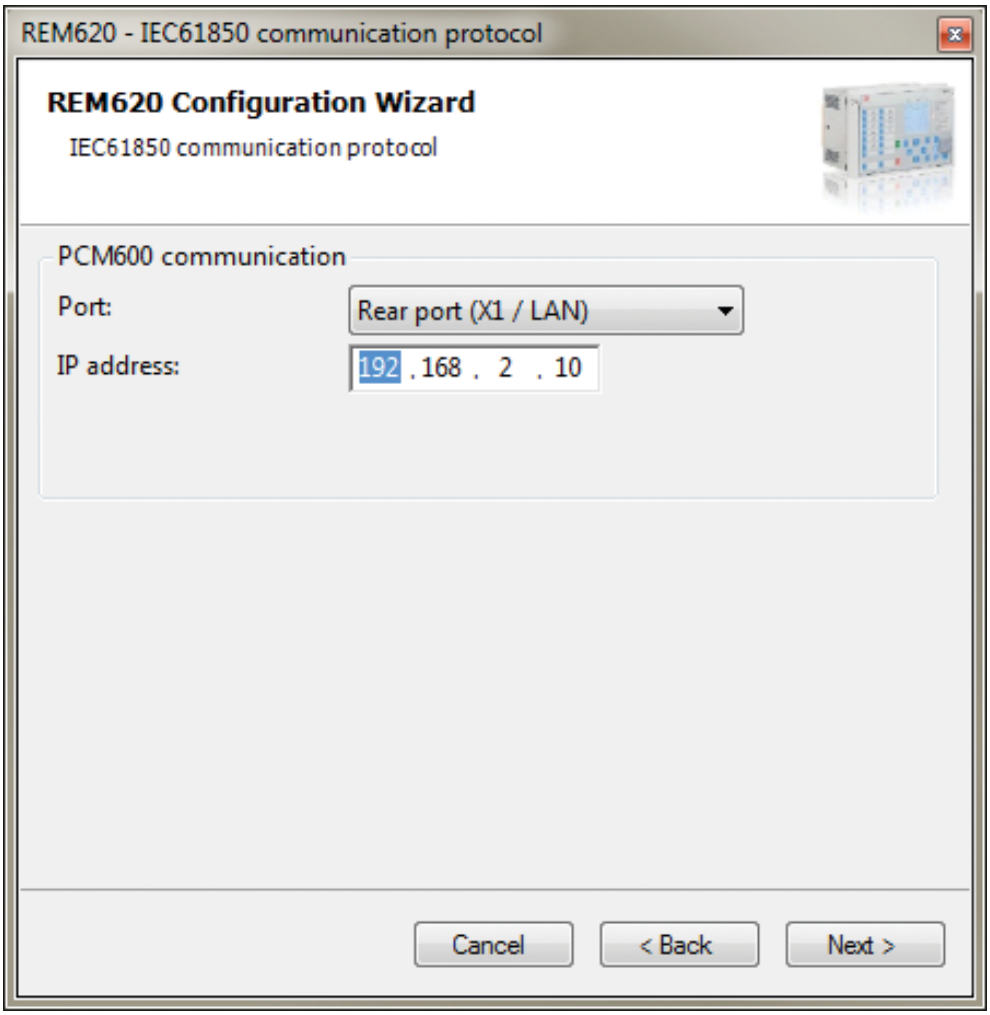

Figure 23: Communication port and IP address

Communication configuration is now defined.

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

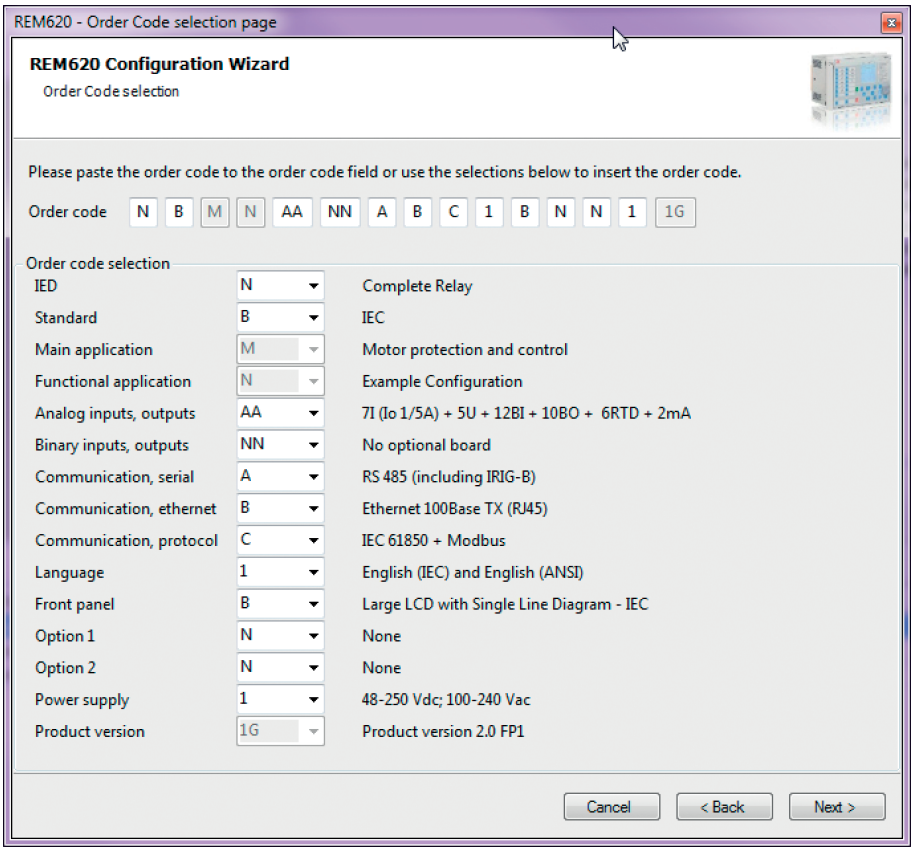

Figure 24: Order code detection

7. On the **Configuration selection** page, select the configuration type and click **Next**.
   - Select **Empty Configuration** to create an empty configuration.
   - Select **Customized Configuration** to import any existing example configuration.
     Click **Browse** to select the .pcmi/.pcmt file that has the example configuration.
   - Select **Default Configuration** to generate a default configuration.

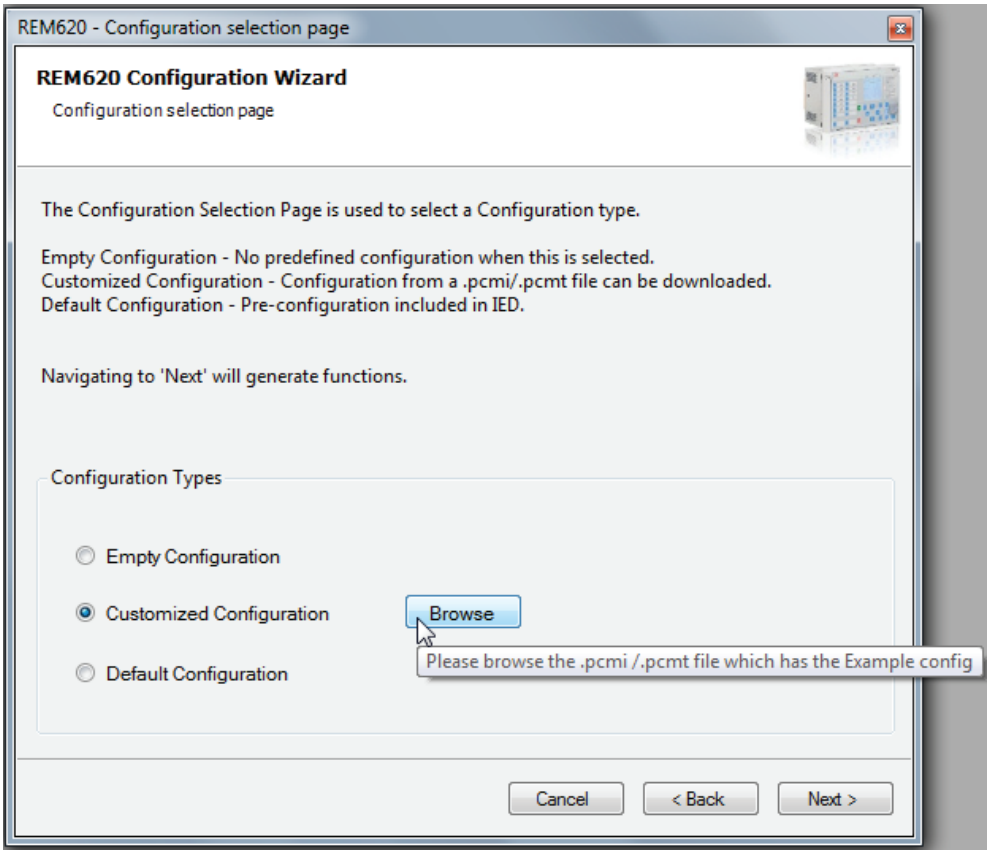

Figure 25: Configuration selection page

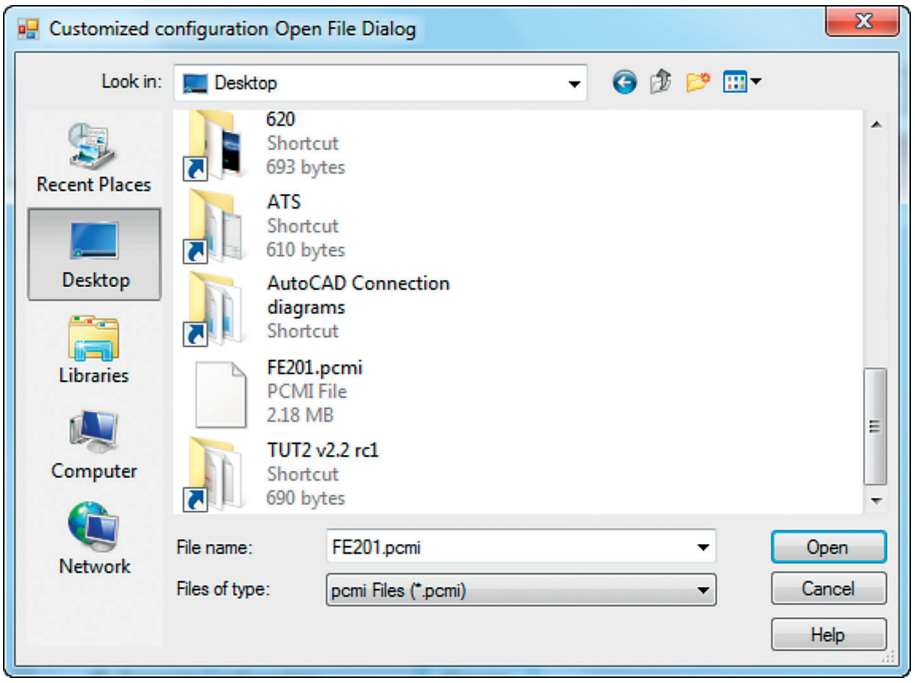

Figure 26: Importing customized configurations

The **Function generation ready** dialog box is shown. Click **Close**.

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

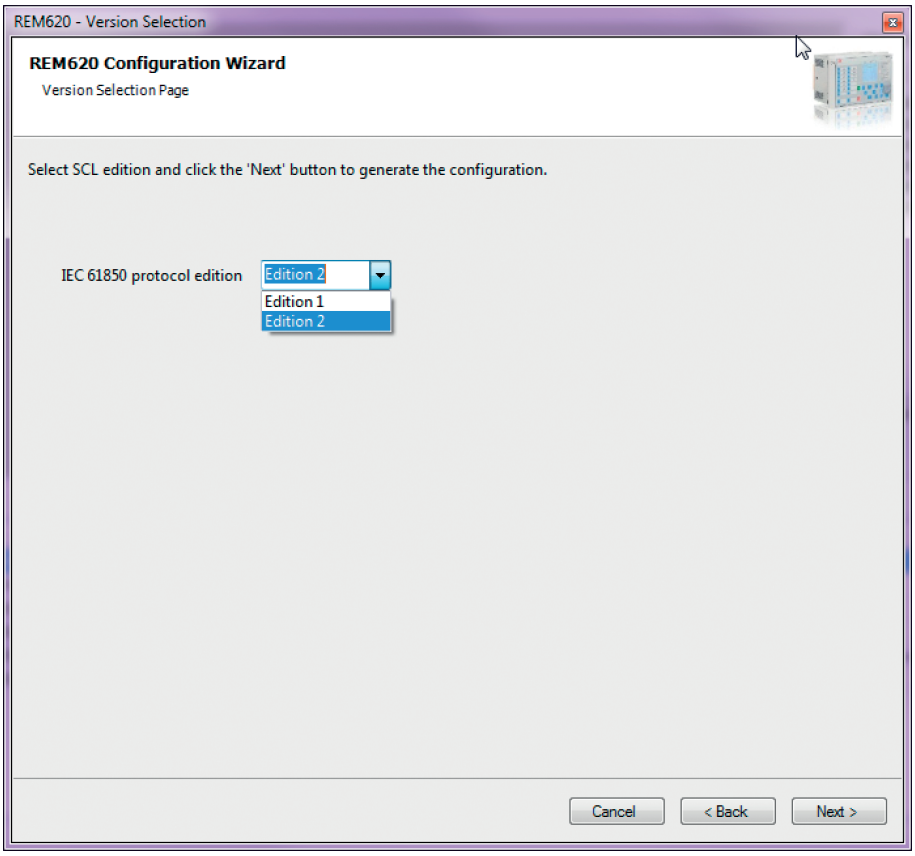

Figure 27: Version selection page

Regardless of the protocol used in the installation for each project, the IEC 61850 version must be selected when adding the first protection relay to the plant structure. After the initial selection all protection relays in the plant structure use the selected version, either Edition 1 or Edition 2.

9. The **Setup complete** page shows the summary of the protection relay's IED type, version, IP address and the selected order number. Click **Finish** to confirm the configuration and conduct the insertion.

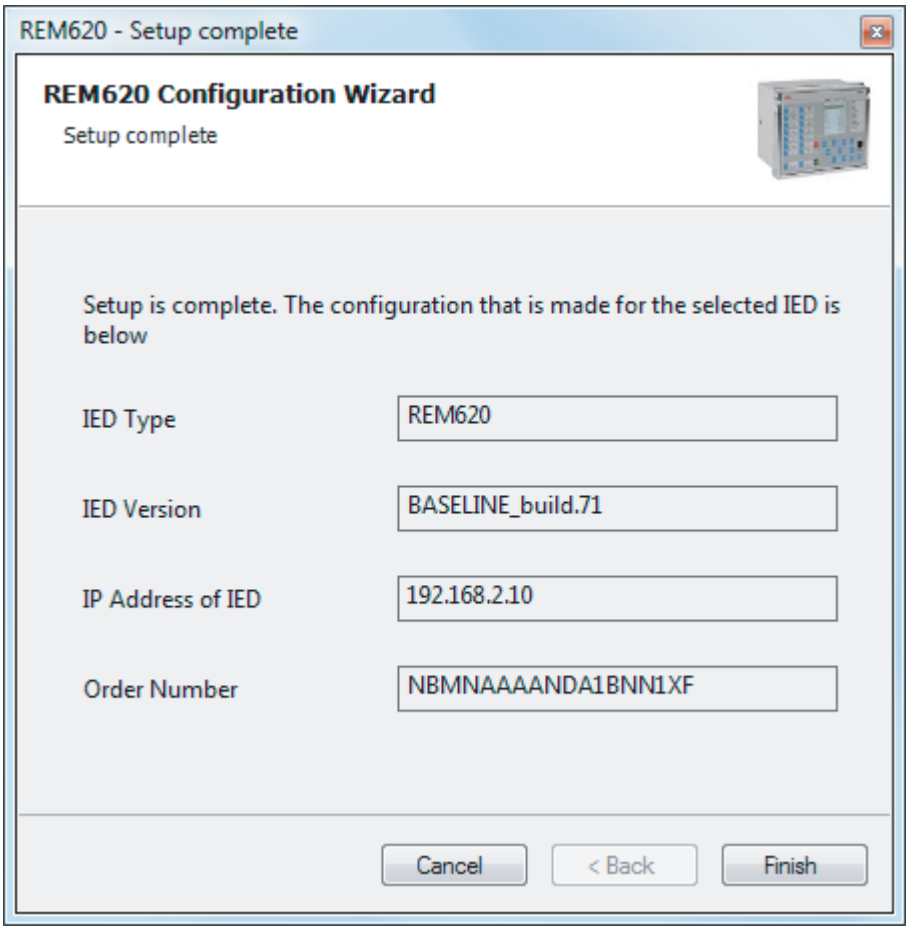

Figure 28: Setup complete

To cancel the insertion, click **Cancel**.

If an error is found on the **Setup Complete 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.

10. From the **Plant structure** view, check that PCM600 has turned online the IED that was inserted to the bay level.

Data cannot be scanned from the protection relay and proceeding is prevented if the IED is not online or if the IP address is not correct.

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 compared to online mode in that the preparation for the configuration can be started even though the protection relay is not available.

1. In the **Plant Structure** view, right-click the bay, point to **New**, point to the relay application area such as **Motor Protection 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 as in the online mode; however, with the offline mode it is not necessary to type the correct IP address in the **Communication port and IP address** dialog box.

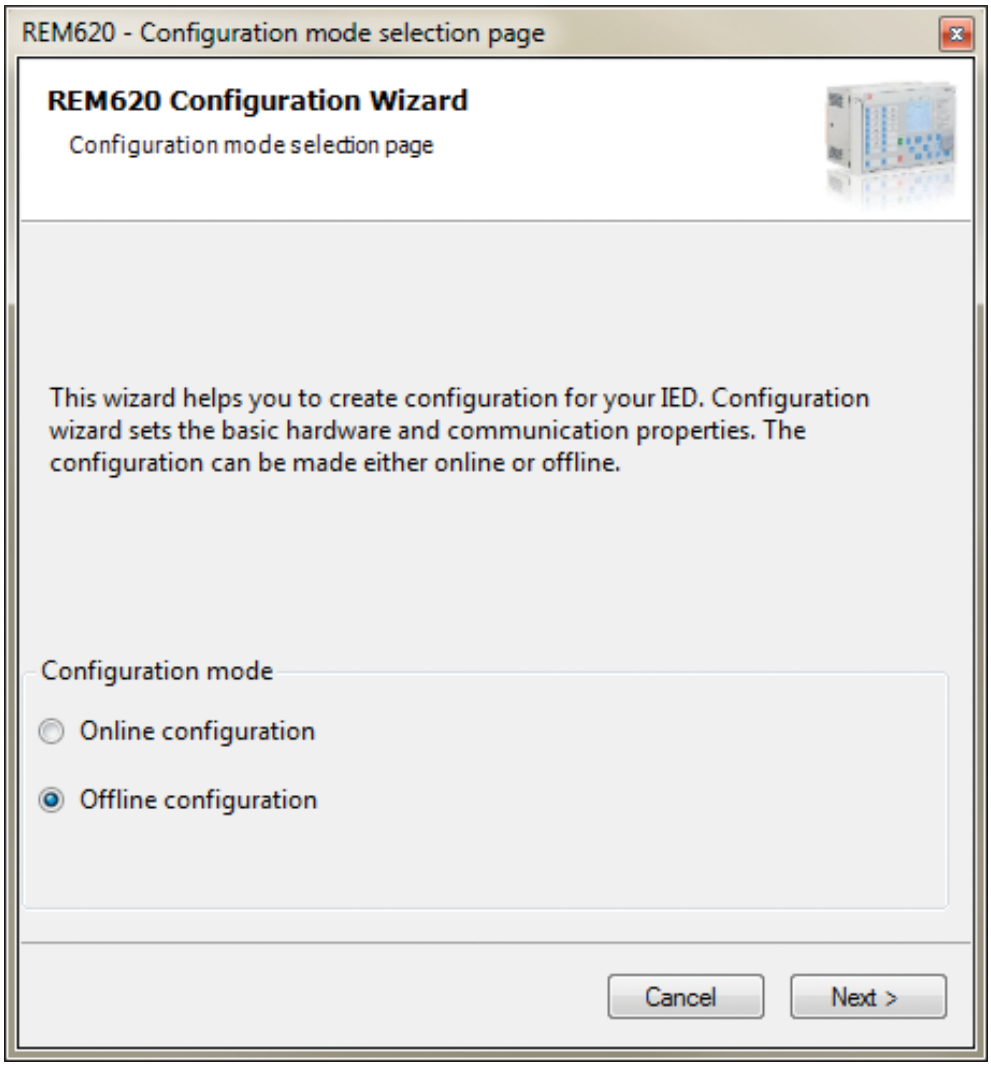

Figure 29: PCM600: Configuration Mode Selection Wizard

3. On the **Order Code selection** page, select the correct order codes and click **Next**.

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

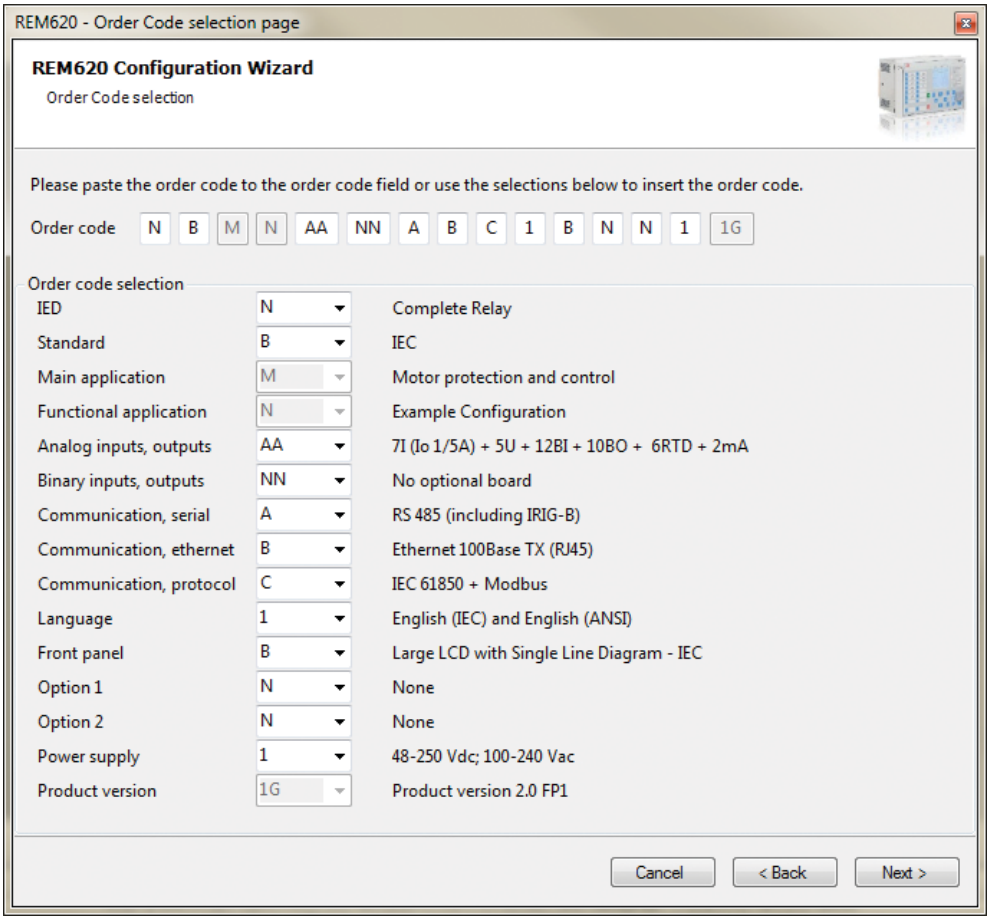

Figure 30: PCM600: IED order code selection

4. On the **Configuration Selection Page**, select the configuration type and click **Next**.
   - Select **Empty configuration** to create an empty configuration.
   - Select **Customized configuration** to import any existing example configuration.
     Click **Browse** to select the .pcmi/.pcmt file that has the example configuration.
   - Select **Default configuration** to generate a default configuration.
5. On the **Version Selection page**, select the IEC 61850 version and click **Next** to generate the functions.
6. The **Setup Complete Page** shows the summary of the IED type, version, IP address and the selected order number. 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 for replicating IEDs with same order code in PCM600 projects. Template includes 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, the *IP address*, the *Caption* in IED's **Object Properties** and the *Technical Key* that corresponds to the physical IED have to be changed.

A template IED can be inserted only when the bay is selected in the plant structure.

1. In the **Plant structure** view, select the bay, right-click, point to **New** and select **Create from template**.
   The **Create New Object from Template** dialog box opens.

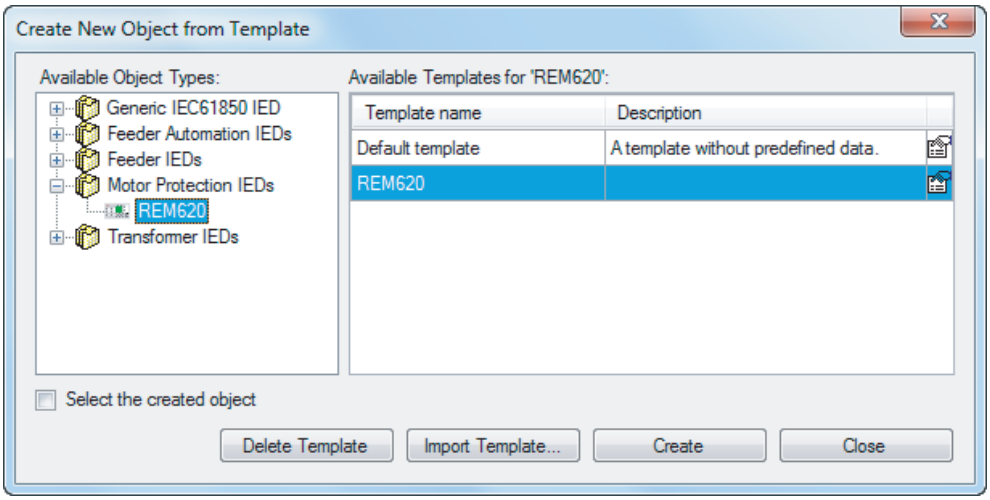

Figure 31: PCM600: Selecting an IED from the template library

2. Select the IED from the list of available IEDs.
3. Click the icon on the right column in the list of available templates.
   The **Template Properties** dialog box opens.

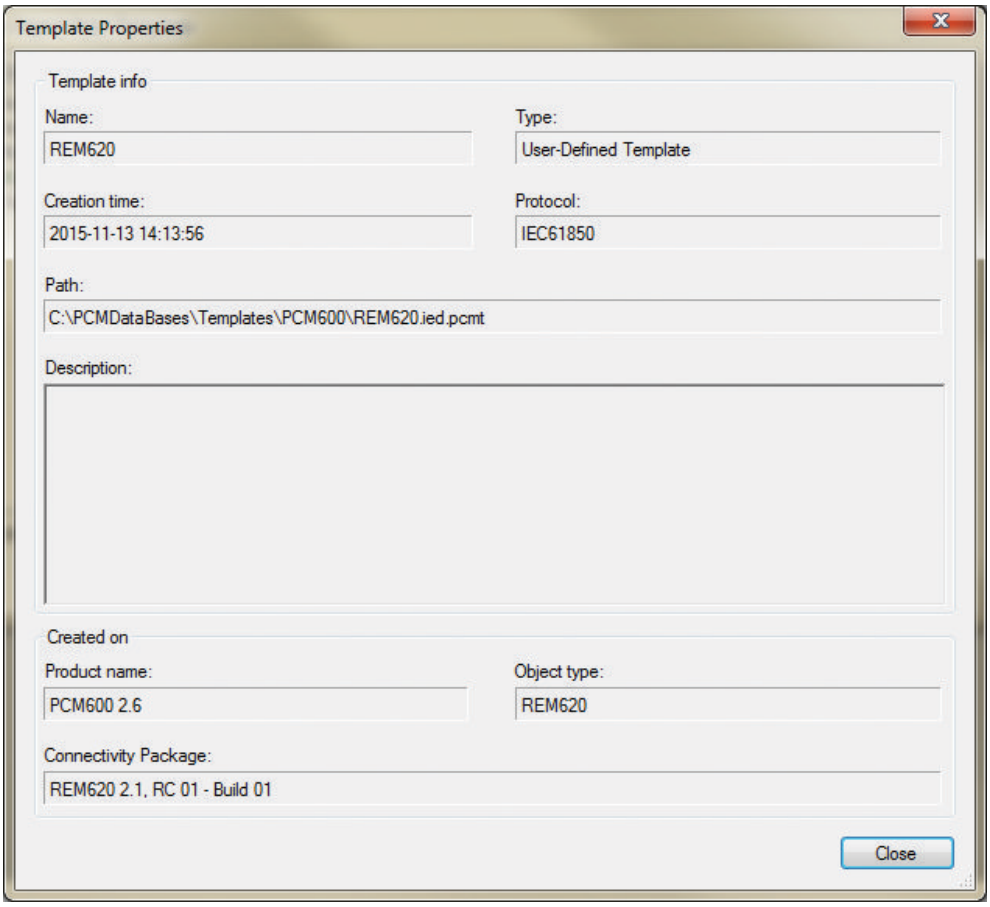

Figure 32: PCM600: Template information

4. Check and verify the template information and click **Close** to close the dialog box.
   The **Create New Object from Template** dialog box is displayed.
5. 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

It is possible to create a new IED object in the plant structure 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.

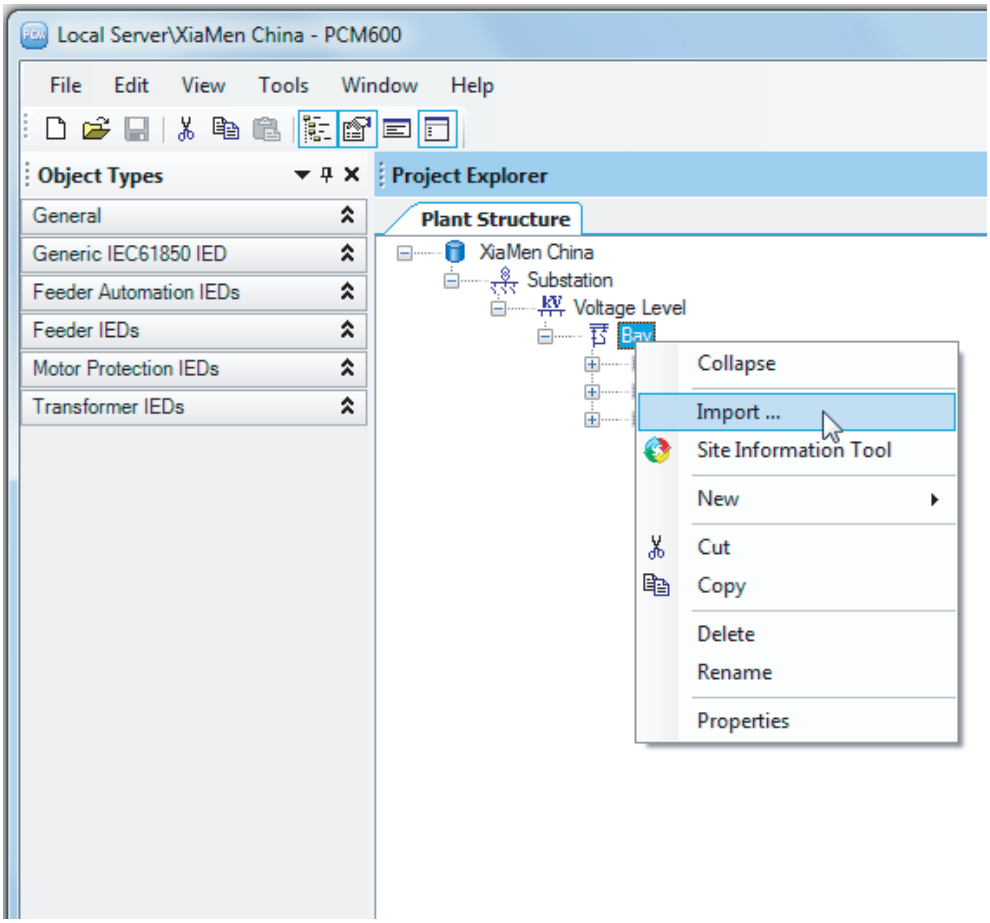

Figure 33: Importing IED configuration

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 that correspond to the physical IED have to be changed.

4.4 Setting the IED IP address in a project

The IP address and subnet mask of the IED object in PCM600 must match the front and rear port 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 tool in PCM600. The PC and protection relay need to be on the same subnet.

There are two alternatives 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.
- In the **IP address** box of the IED's **Object Properties** dialog box.

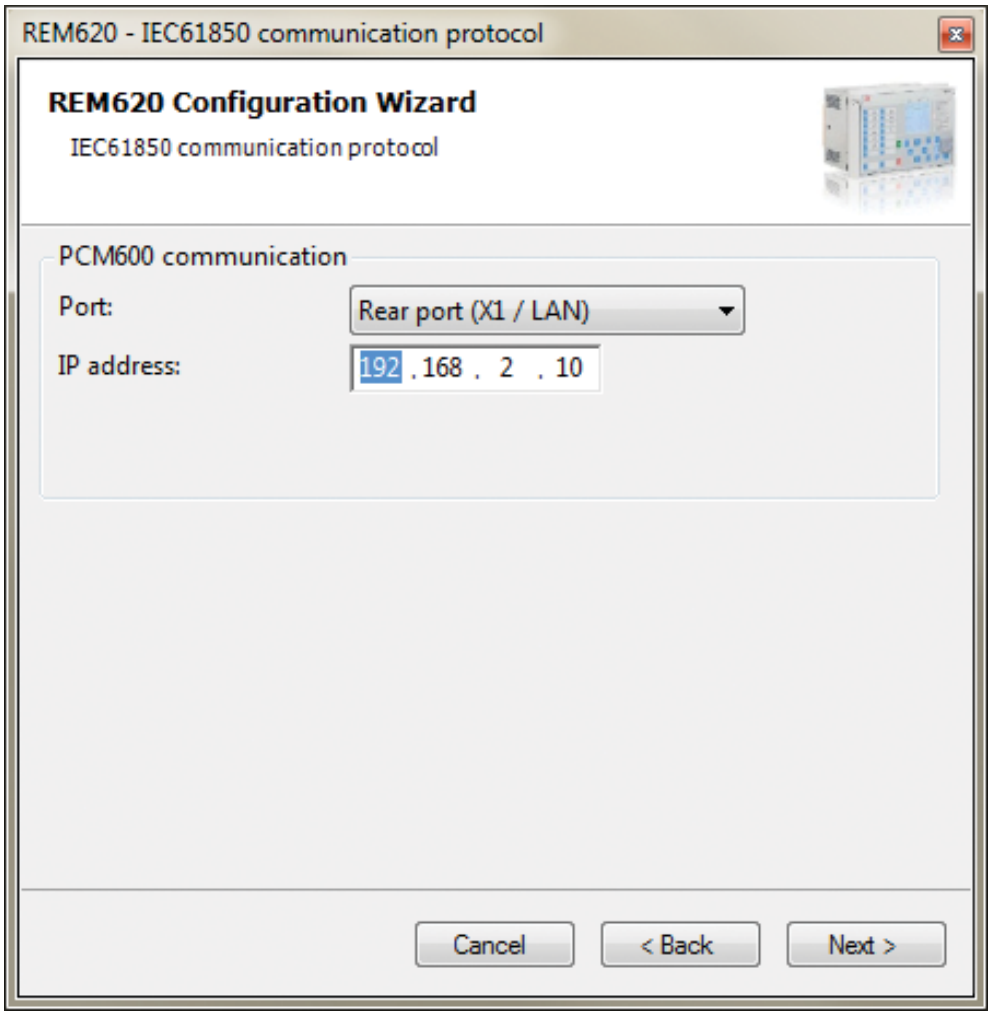

Figure 34: Alternative 1: Setting the IP address on the first wizard page

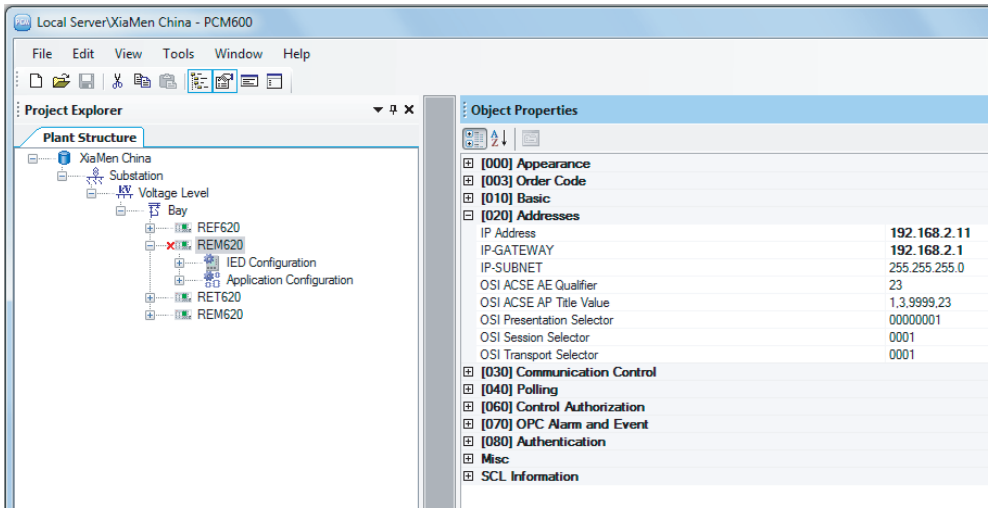

Figure 35: Alternative 2: Setting the IP address in IED's Object Properties dialog box

Choosing between the two ways depends on when the IP address is set. Typing the IP address via the IED's **Object Properties** dialog box is possible at any time while entering it via the configuration wizard can only be done when adding the IED object.

1. In the **Plant Structure** view, select the IED to which the IP address is to be entered.
2. On the **View** menu, select **Object Properties**.
   Object Properties dialog box is opened.
3. Type in the IP address to the **IP Address** row.

4.5 COM600S project

The 620 series connectivity package supports SAB600. A 620 series IED is imported as a 620 series device. It is also possible to import a full PCM600 project including several 620 series devices to SAB600. In this case, PCM600 project information is imported to SAB600 using a SCD file.

The 620 series device supports several functions in COM600S.

- Controlling the switchgear
- Monitoring the measured values
- Reading disturbance recordings
- Setting parameters

4.5.1 Selecting communication port for configuration

When a relay is configured to a PCM600 project, the connection between the relay and the tool can be established using a point-to-point link between the relay front port and the computer or by connecting the computer to the relay rear port over an Ethernet station bus. In PCM600, the front or rear communication port can be selected from the project structure.

When using the front port, DHCP server functionality must be activated in the computer network adapter settings to get the IP address from the relay. Alternatively, the computer network adapter IP address can be set manually to the same subnet range as the front port.

Figure 36: Communication port options

- Check that the settings are correct to ensure successful configuration access to the relay.
  - Computer port settings must match relay settings (IP address, subnet mask, DHCP).
  - Any firewall in the computer or in the network must pass required communication services.
  - When using the front port and switching the connection from the computer to another relay, it takes some time before the computer refreshes the relay's MAC address for front port IP address automatically. The MAC address can also be reset manually by clearing the computer ARP table.

4.5.2 Importing a 620 series protection relay in a COM600S project

1. Create a PCM600 project including several IEDs.

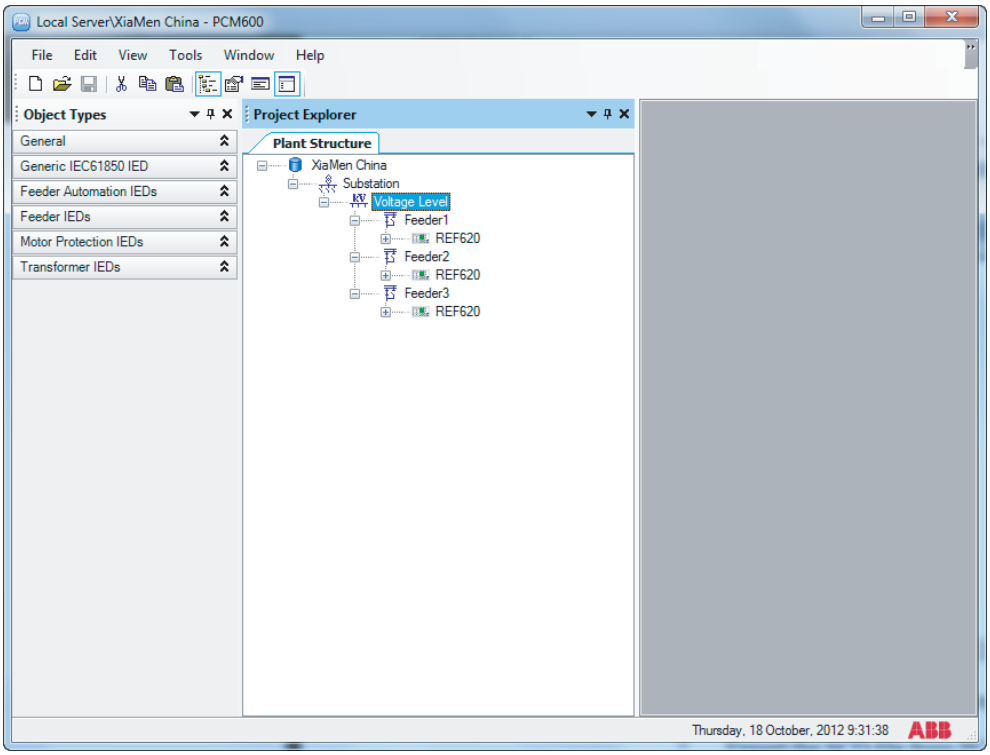

Figure 37: Creating a PCM600 project including several IEDs

2. Export the SCD file from PCM600.
   In the **Plant structure** view, select the substation, right-click and select **Export**.

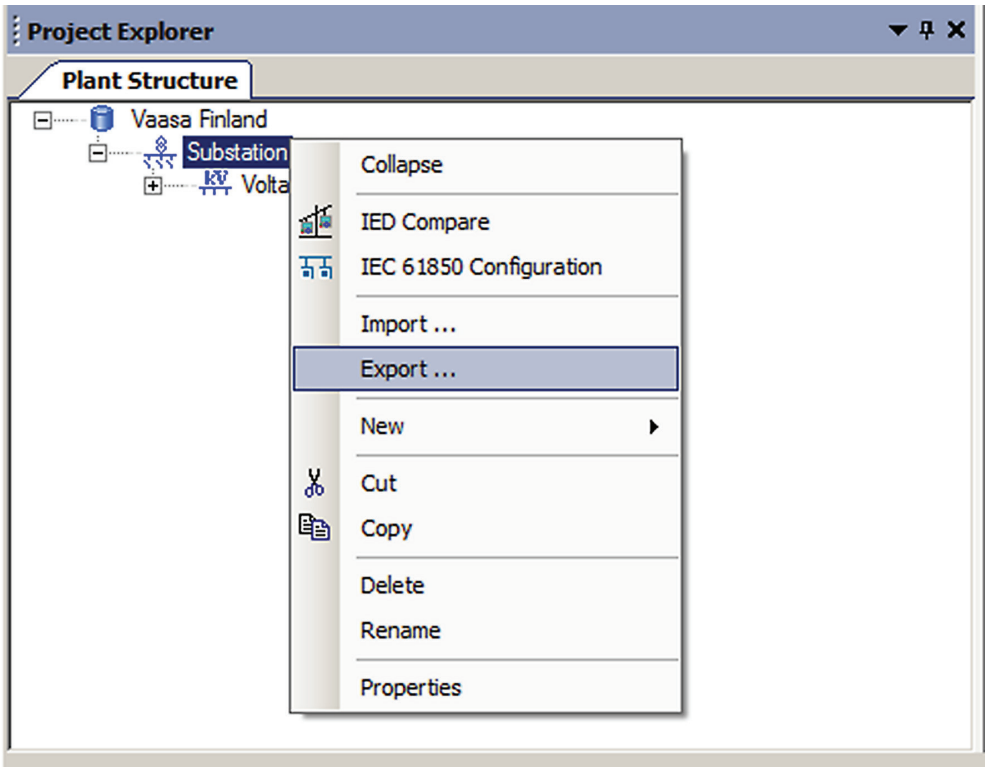

Figure 38: Exporting SCD file from PCM600 and importing it to SAB600

3. Import the SCD configuration into the SAB600 project.
In the **Project Explorer** view, right-click the IEC61850 OPC Server object and select **SCL Import**.

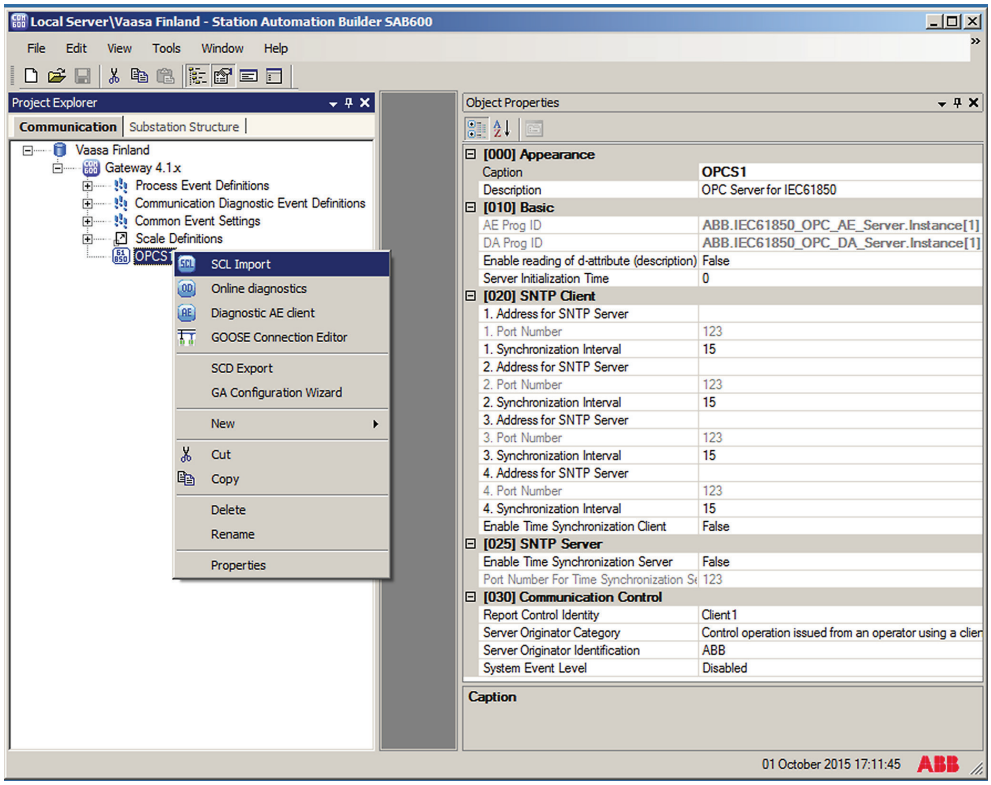

Figure 39: Importing the SCD configuration into the SAB600 project

4. In the **SCL Import** view, click **Select File** to select the SCD file exported from PCM600.

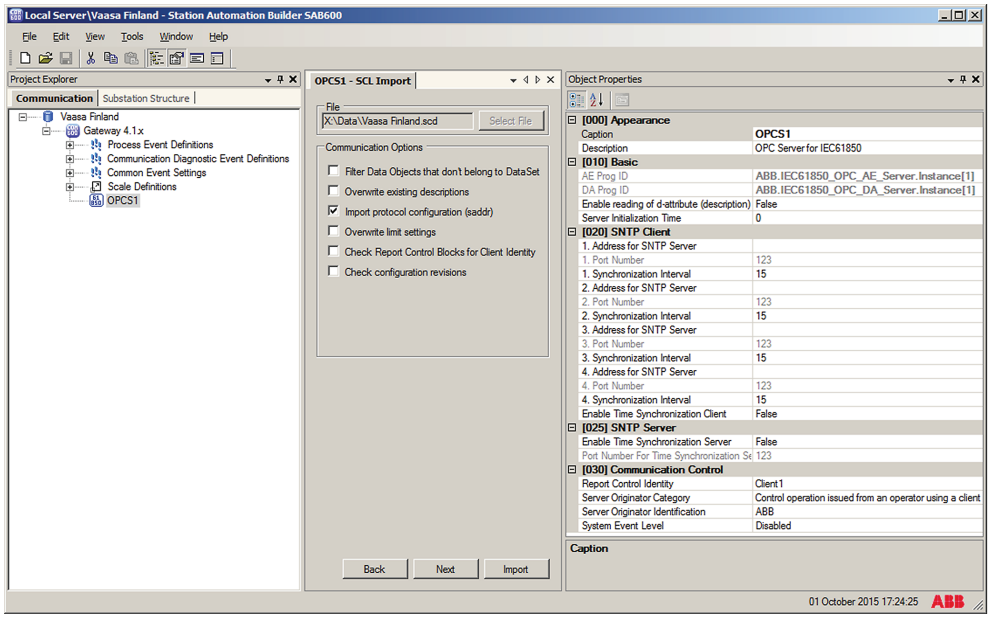

Figure 40: Creating a new IED into SAB600 project

5. Check the default settings in the **SCL Import** view and change the settings if they are not suitable.
   The default settings in the **SCL Import** dialog should be correct in most cases.
6. Click **Import** to import the SCD file.
7. Check the IP address on the IEC 61850 subnetwork and change it if needed.
   When the SCD file is directly exported from PCM600, it uses the IP address of the PCM600 computer, not the COM600S.

The communication towards the protection relays is now ready. For information on how to finalize the single-line diagram and enable parameter setting through COM600S HMI, see COM600S documentation.

4.6 Using the Web HMI

WHMI is disabled by default, and has to be activated in the protection relay configuration. As secure communication is enabled by default, the WHMI must be accessed from a Web browser using the HTTPS protocol.

1. To enable the WHMI, select **Main menu/Configuration/HMI/Web HMI mode** via the LHMI.
2. Reboot the relay for the change to take effect.
3. Log in with the proper user rights to use the WHMI.

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

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

For more information on the WHMI, see the operation manual.

4.7 Managing IED users

IED user authorization is disabled by default. IED user passwords can be changed in LHMI, WHMI and using the IED Users tool in PCM600.

Local passwords can be changed only via the LHMI. Remote passwords can be changed via the LHMI or WHMI or with PCM600.

If the IED-specific Administrator password is forgotten, ABB can provide a onetime reliable key to access the IED. For support, contact ABB. The recovery of the Administrator password takes a few days.

1. Enable IED user authorization at **Main Menu/Configuration/Authorization/Passwords** in LHMI or WHMI.
2. Use the IED Users tool in PCM600 to change the passwords.
   This tool cannot be used to add or change users.

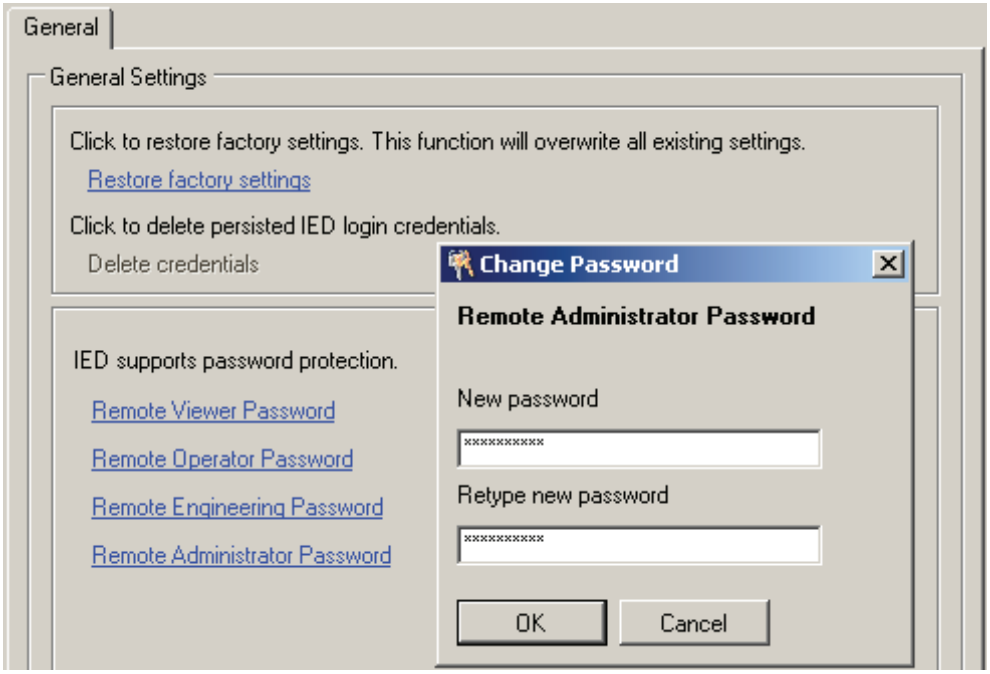

Figure 41: Changing the password using the IED User Management tool

3. Set the object property values in PCM600 to make the communication between the IED and PCM600 work, if the remote authentication has been enabled.

Table 4: Object properties to change

Object Properties field	Value
Is Authentication Disabled	False
Is Password used	True
Password	Write the correct password

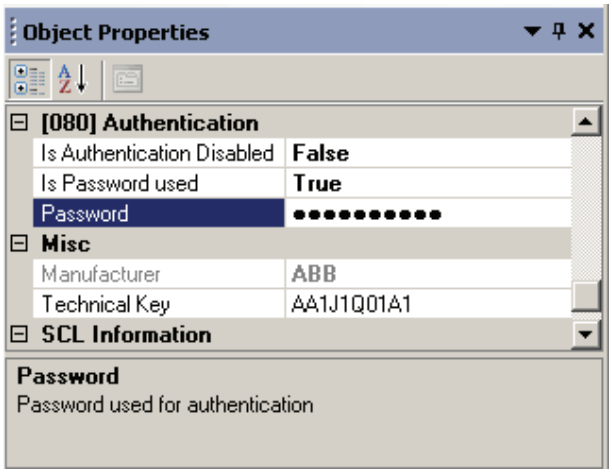

Figure 42: Object properties

When communicating with the protection relay with PCM600 tools and with the relay authentication enabled, the relay username and password must be given when prompted. When setting the technical key, the username and password must be given twice.

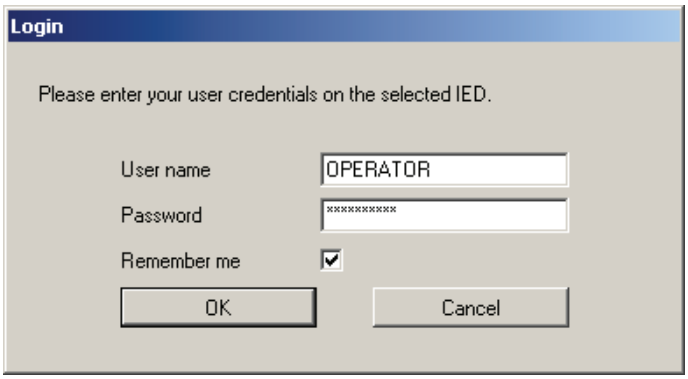

Figure 43: User login

If the PCM600 authentication has been enabled in PCM600 System Settings, a relay user can be linked to the current PCM600 user by selecting the Remember me check box in the Login dialog. After that, the user credentials are no longer asked at tool communication as logging in PCM600 also provides the authentication credentials to the protection relay.

4.8 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.

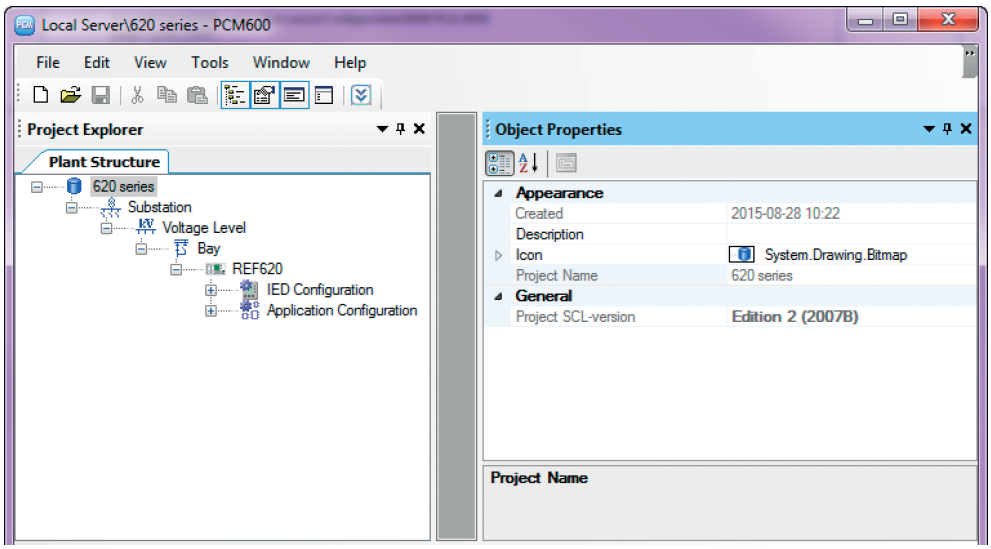

Figure 44: Project's IEC 61850 version

To change the 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 the IEC 61850 version Edition 2. A dialog box notifies on the difference of the versions.

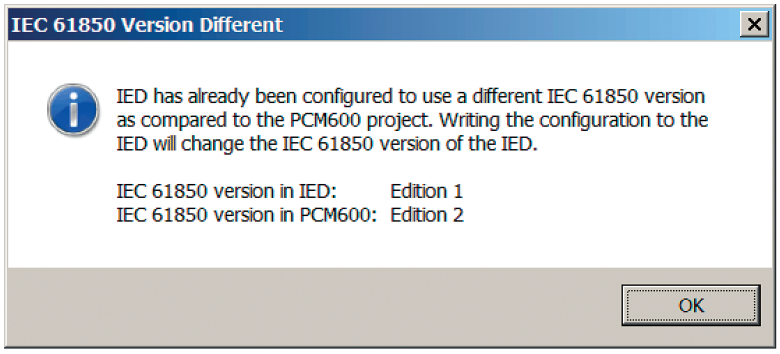

Figure 45: IEC 61850 version change

Section 5 Protection and control engineering

5.1 Application Configuration tool

Application Configuration tool 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.

- Control related functions
- Protection related functions
- Monitoring functions
- Communication

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 the Application Configuration.

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

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

- Organize an application configuration
  - Organize an application configuration into a number of logical parts (MainApplication)
  - Organize a MainApplication over a number of pages
- Features for programming an application configuration
  - Insert function blocks, make connections and create variables
  - Include the hardware I/O channels directly to the application configuration
  - Calculate the execution order automatically by clicking **Calculate execution order** on the toolbar.

- Document the application configuration: such as, make printouts
- Save application configurations as templates in an application library to reuse them in other protection relays (Function blocks and related logic can be fully or partially reused depending on the functionality available in the other protection relay)
- Validate 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 the Application Configuration tool.

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

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

  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.

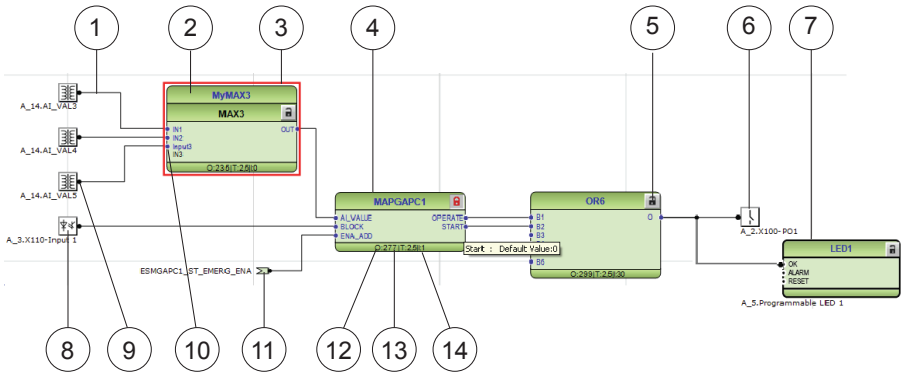

Figure 46: Application Configuration tool: function block overview

1 Connection(s)
2 User-defined function block name
3 Function block, selected (red)
4 Function block name
5 Function block, locked
6 Hardware, binary output channel
7 Hardware, programmable LED
8 Hardware, binary input channel
9 Hardware, analog input channel
10 User-defined signal name
11 User-defined input variable
12 Execution order
13 Cycle time
14 Instance number

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 that 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.

5.1.3 Function block execution parameters

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

- Execution order
- Cycle time
- Instance number

Each time a new function block is inserted, these parameters are shown in the Function Block Instance dialog box in the Application Configuration tool. The three parameters are selectable and 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.

The *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.

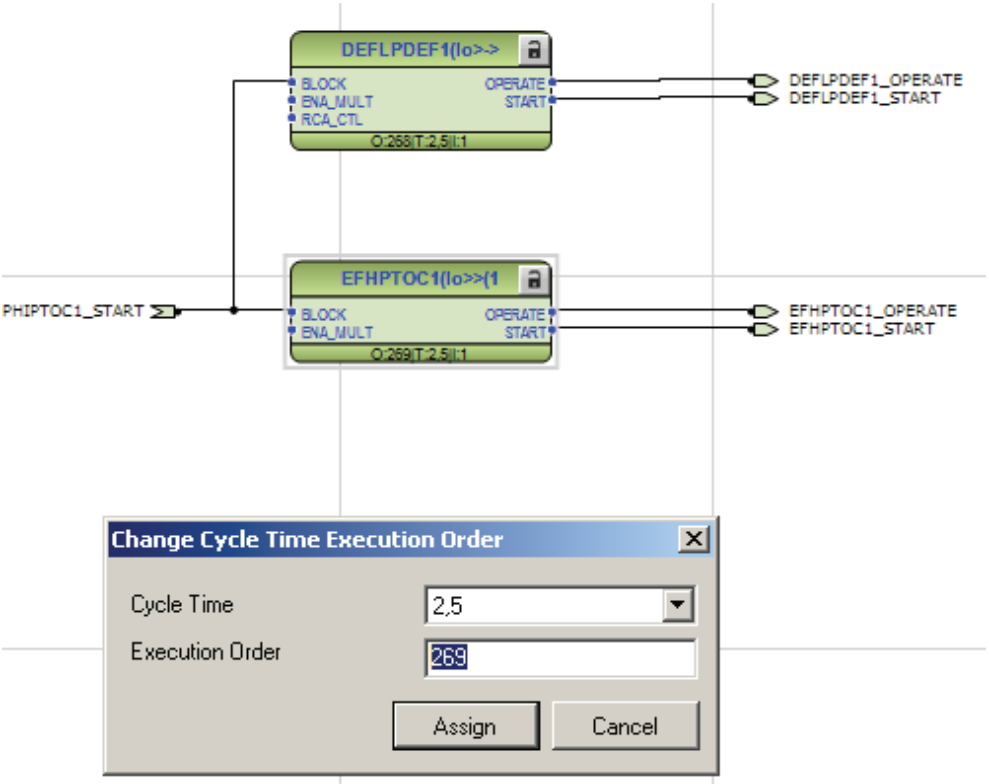

Figure 47: Application Configuration tool: an example of function block organization parameters

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 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 the execution order 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 internal execution order, time stamps may not be accurate if additional logic is used to connect priority signals to function blocks.

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

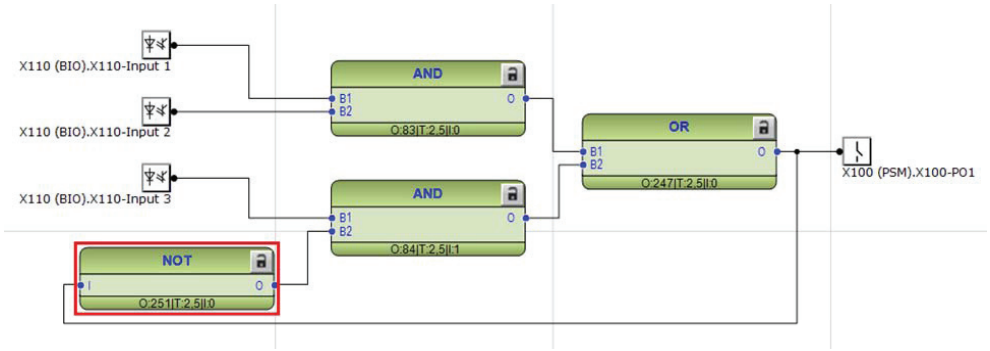

Figure 48: Feedback loop situation with automatically calculated execution orders

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.

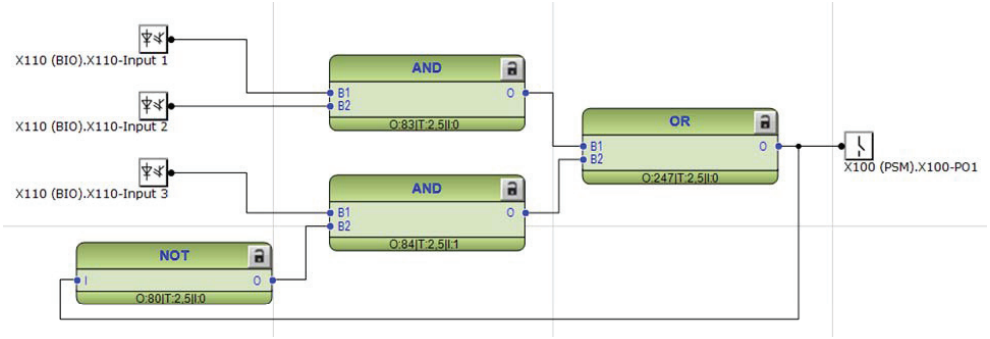

Figure 49: Feedback loop situation with manually fixed execution order for NOT port

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

After manually defining the execution number, the function is no longer part of 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 Configuration parameters

Configuration parameters can be viewed and set with the Parameter Setting tool.

5.1.6 Connections and variables

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

There are rules and methods for making connections.

- Drag a line between two signals
- Link 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.

Connection validation

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

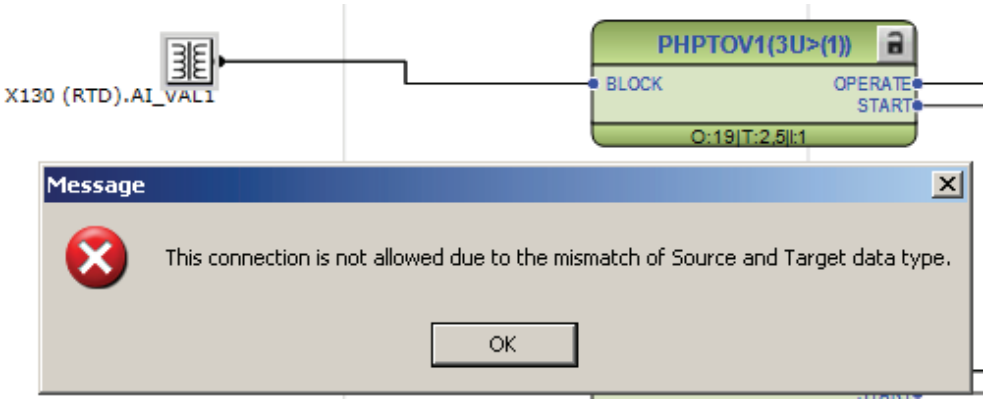

Figure 50: Application Configuration tool: an error message of a signal mismatch for a connection

5.1.7 Hardware channels

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

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

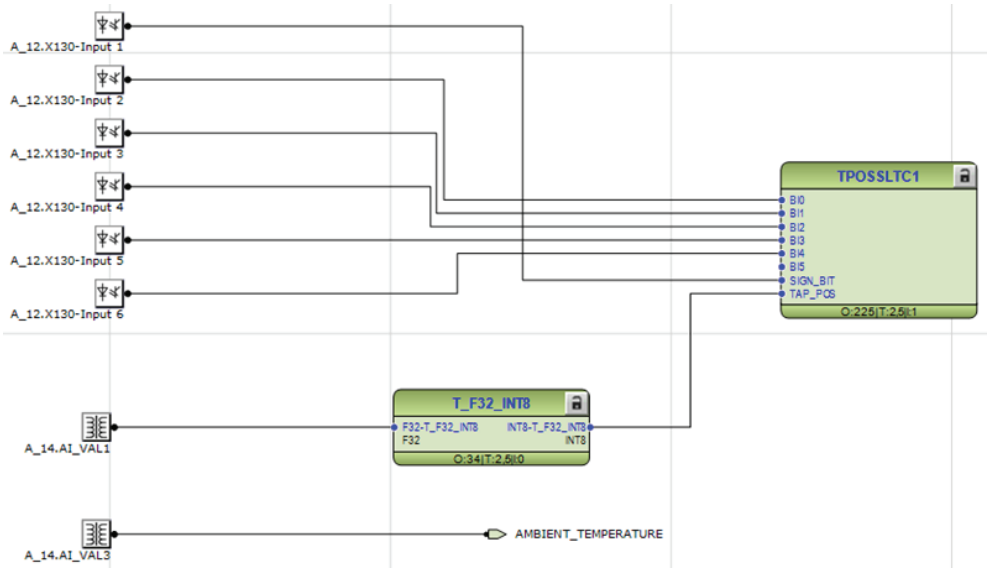

Figure 51: Application Configuration tool: HW signal channels

There are three types of supported hardware channels.

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

Hardware input channel can be used as often as needed. 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.

5.1.8 Online monitoring

The 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 configuration 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 of the function block's settings. This kind of function block design is present in control blocks, setting group handling and tap changer.

5.1.9 Validation

Validation checks the application configuration for errors based on the rules that govern the creation of the application 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

5.1.9.1 Validation when creating an application configuration

Validation is 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

5.1.9.2 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 inputs of 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.

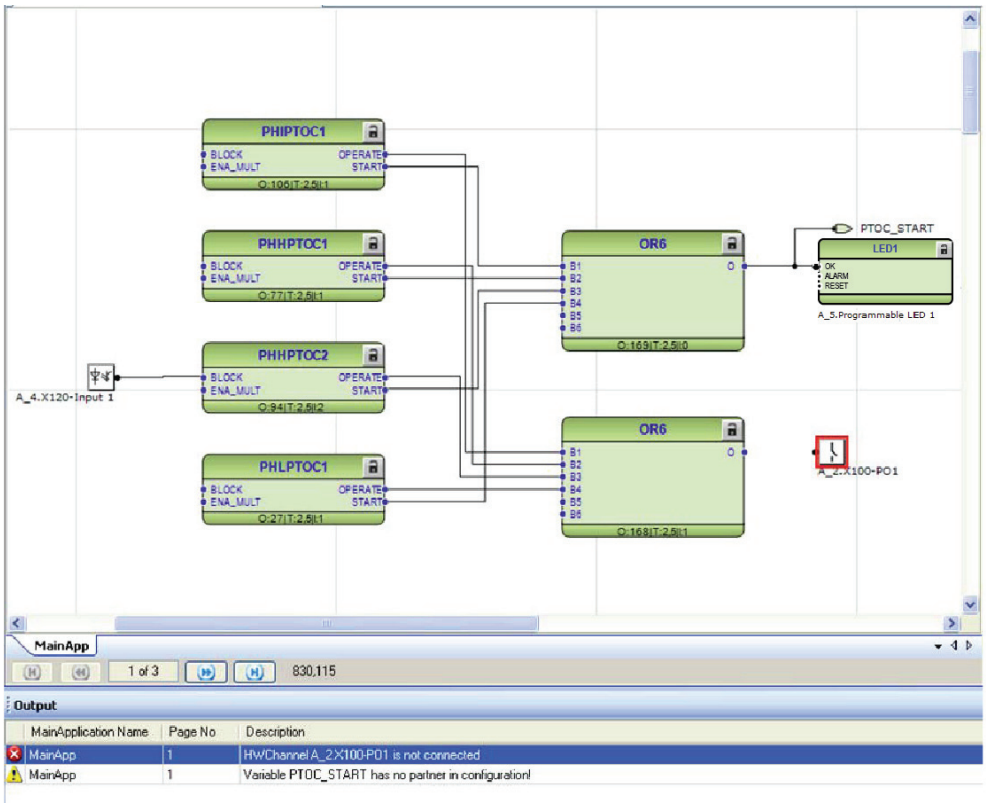

Figure 52: Application Configuration tool: validation on demand

5.1.9.3 Validation when writing to the protection relay

When writing the application configuration to the protection relay, an automatic validation is performed. The validation is the same as the manually demanded validation. Errors abort the writing.

5.1.10 Configuration load calculation

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

Calculation results are divided into three different sections which are OK, Warning and Error. If the calculation result is 105% or more, the configuration is too large for the IED to handle and PCM600 prevents writing the configuration to the IED. If the configuration load is more than 100%, PCM600 gives a warning not to add

functionality to the configuration. The configuration is written to the IED if the result is inside or below the warning range.

Some inaccuracy exists between the calculated load estimate and the actual load of an IED when considering all parameters. This is why PCM600 does not prevent the writing immediately when the estimated load exceeds 100%. The IED supervises its performance continuously and indicates with self-supervision warning code 2 if an actual performance risk is detected. It is recommended to verify the configuration load also with an actual IED and actual settings when exceeding the calculation result of 90% or when using GOOSE on a larger scale.

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

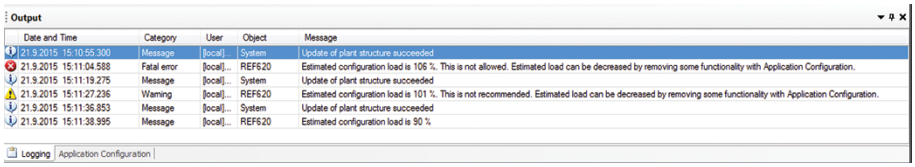

Figure 53: Configuration load result: an example of nearby maximum capacity

5.2 Parameter Setting tool

Configuration parameters and settings 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 in LHMI.

A common writing from PCM600 to the protection relay, where parameters are changed in the Parameter Setting tool, overwrites any parameter changes made locally with LHMI.

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

- Configuration parameters
- Setting parameters

5.2.1 Configuration parameter

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 utilized, 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. The WHMI 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 exporting and importing of settings is sensitive to the protection relay's content. Settings are exported and imported for one protection relay at a time. The export files of a specific protection relay can be exchanged between PCM600, WHMI and the actual physical IED. To avoid errors and to efficiently manage the exporting and importing of settings, 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/export functionality is available via the File menu when the Parameter Setting tool is open.

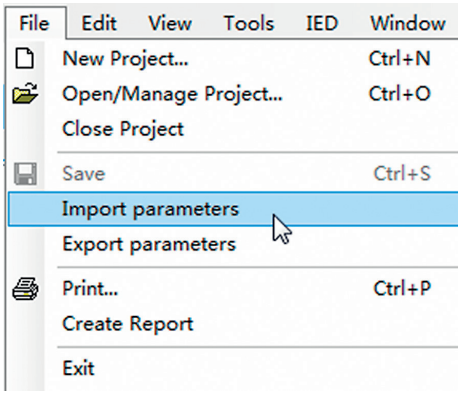

Figure 54: Parameter import/export

5.2.5 Parameter organization

The organization of parameters into a tree structure becomes visible in the **Plant Structure** by expanding the setting tree.

5.3 Signal Matrix tool

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

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

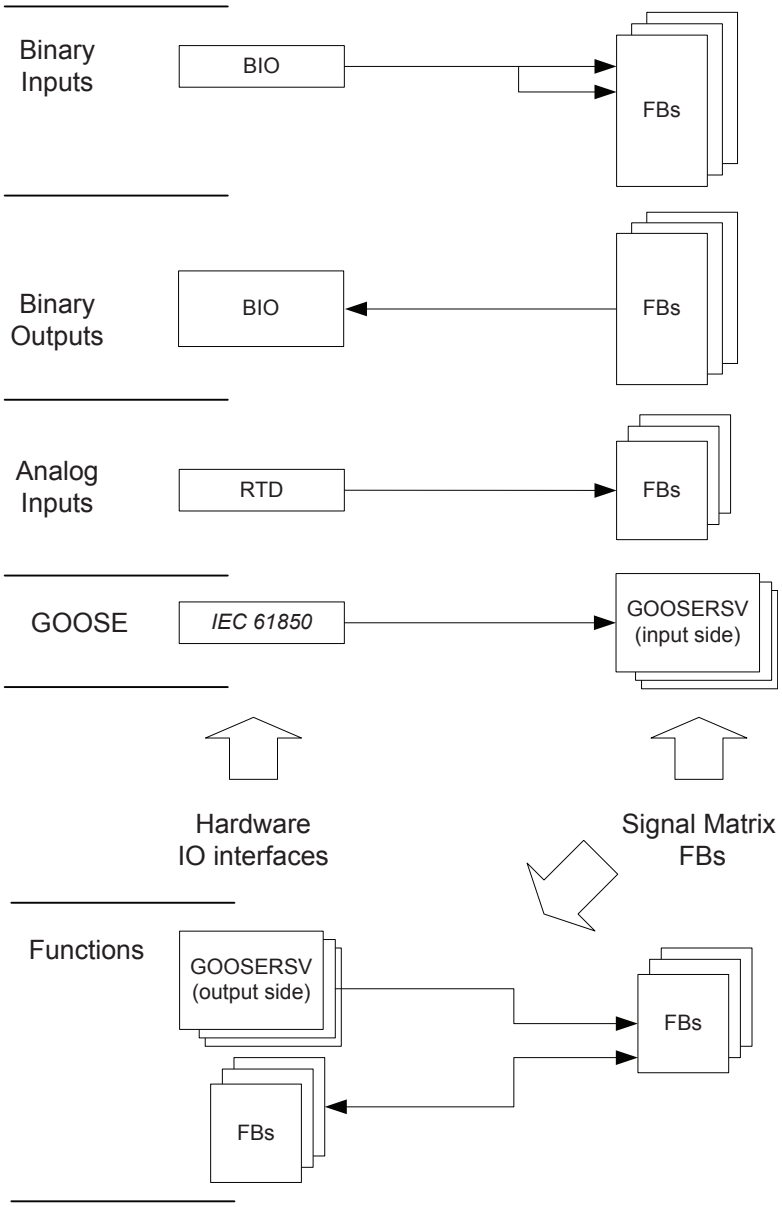

Figure 55: Signal Matrix: operation principles

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 tool.

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

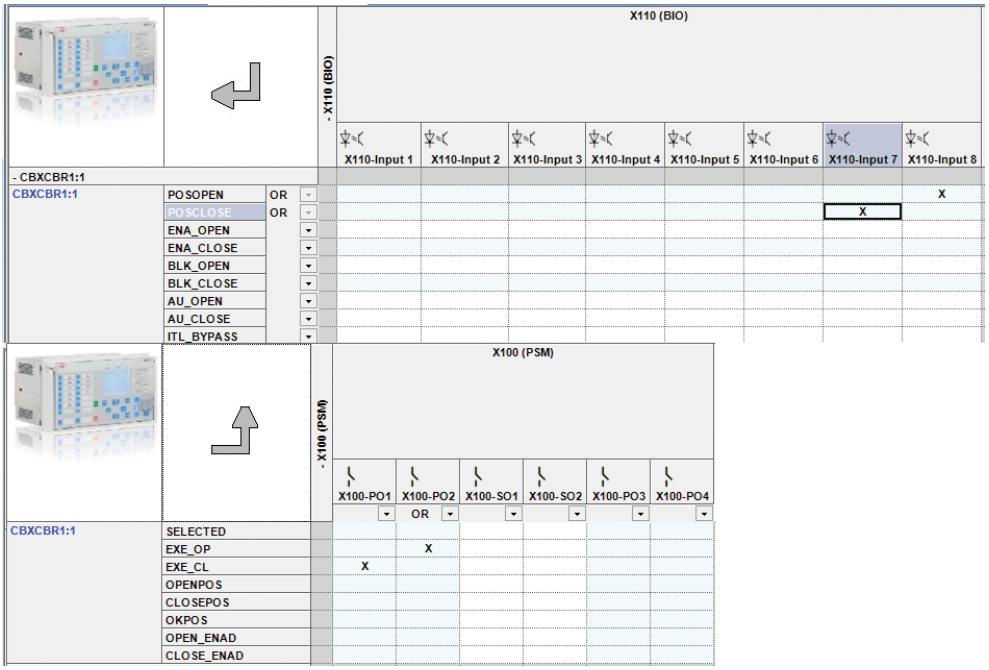

Figure 56: Signal Matrix: a connection between binary input channels to binary input signals

The Signal Matrix tool has a separate sheet for each possible combination.

- Binary inputs
- Binary outputs
- Analog inputs
- Functions
- GOOSE

5.4 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.

5.4.1 Opening and closing Load Profile tool

- To open the Load Profile tool, click **Load Profile Tool** on the context menu of an IED node inside the PCM600 project tree.

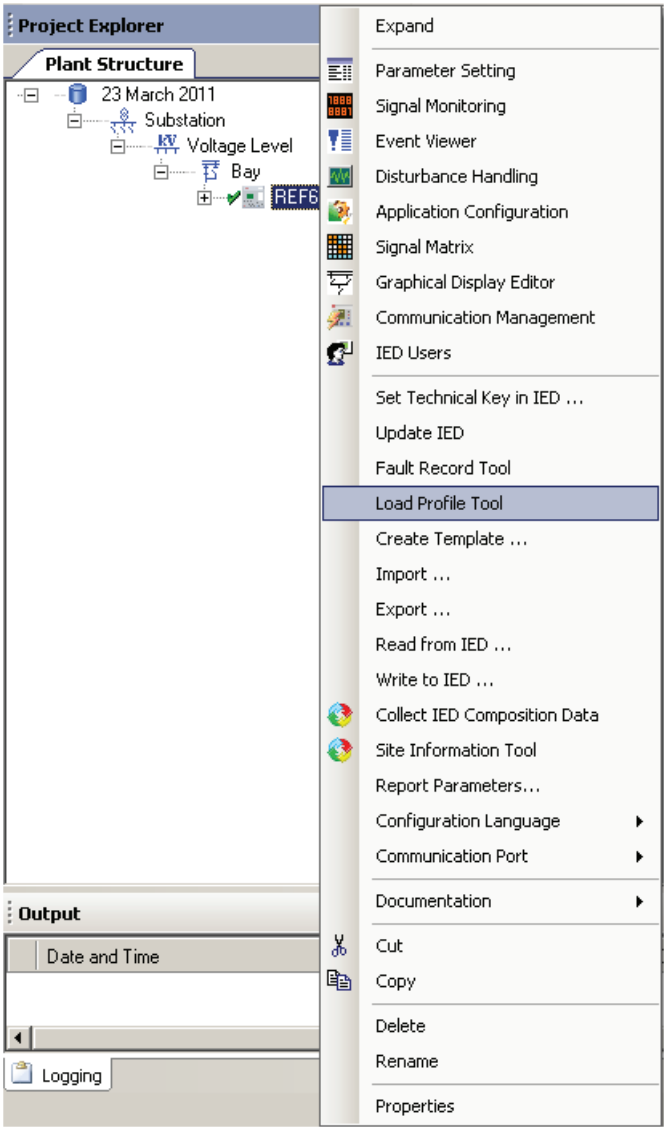

Figure 57: Opening the Load Profile tool

- To close the Load Profile tool, click the **Close** button 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.

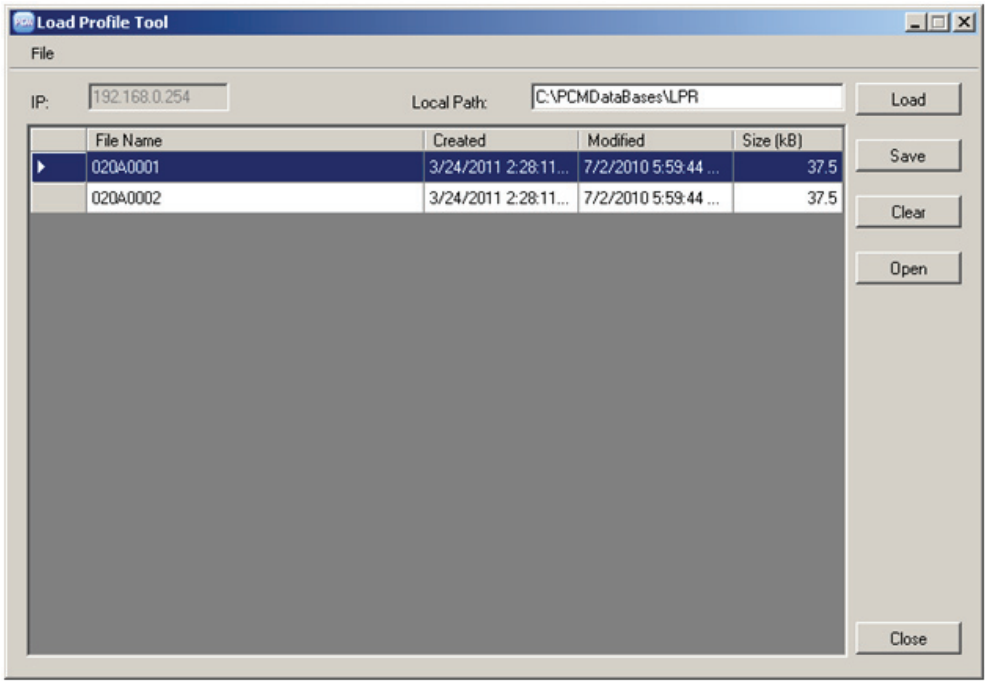

Figure 58: Load Profile tool

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

5.4.2 Load Profile tool user interface

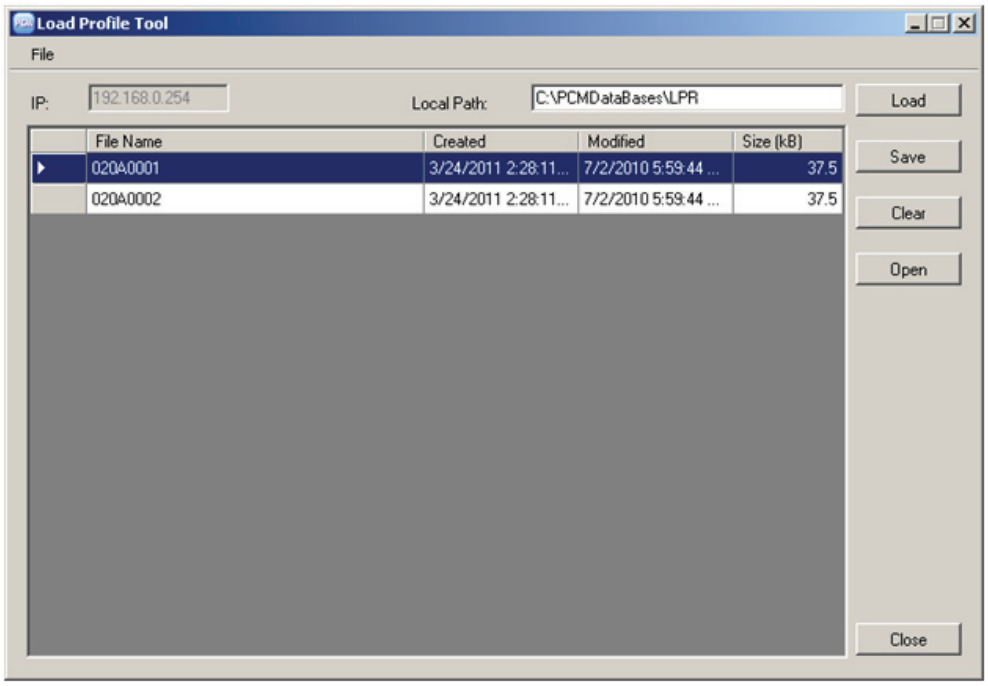

Figure 59: Load Profile tool interface

Table 5: 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. **Local Path** field also allows the user to change the target location where the records are saved. The grid of the Load Profile tool shows only the records in the default local path including unsaved records in the temp path (`C:\Temp\Load\Profile Tool`) if there are any. Therefore changing the default local path allows the user to save records at the specified location on the local machine but the user is not be able to see those records in the grid of the Load Profile tool.
Load	Clicking the **Load** button downloads all available records from `C:\LDP\COMTRADE` directory in the protection relay to a temporary folder `C:\Temp\LoadProfileTool` 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 the **Save** button moves the records to the default or specified local path, **Load** transfers the records to a temporary folder. Each load profile record comprises two files with file extensions .dat and .cfg. Clicking **Save** 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 the **Clear** button clears record from either the Load Profile tool or protection relay or both. Before deleting the records, a confirmation dialog box is shown.
Open	Select any record and click **Open** to view the record in Wavewin, provided that this external software is installed. Additionally, any record row can be double-clicked to view that record.

Table continues on next page

Action	Description
Sort	To sort the record rows by any column click a column header.
Close	Clicking the **Close** button closes this instance of the tool. Any open instance is finally closed when the whole PCM600 is closed.
File	All the actions are also available on the tool through **File** drop-down menu.

5.4.3 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.

In the record grid, the name, creation time, modification time and size of each record are shown. 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.

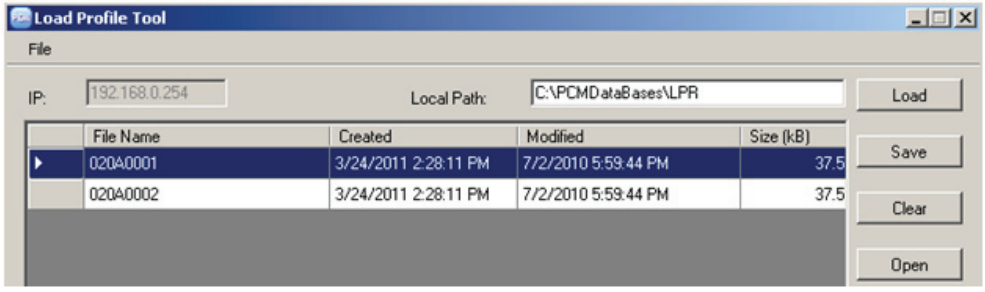

Figure 60: Information fields

5.5 Fault Record tool

The Fault Record tool is used for reading the fault records from the protection relay and it is included in the connectivity packages. 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`. Revise the file name before saving to avoid overriding the old record.

5.5.1 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**.

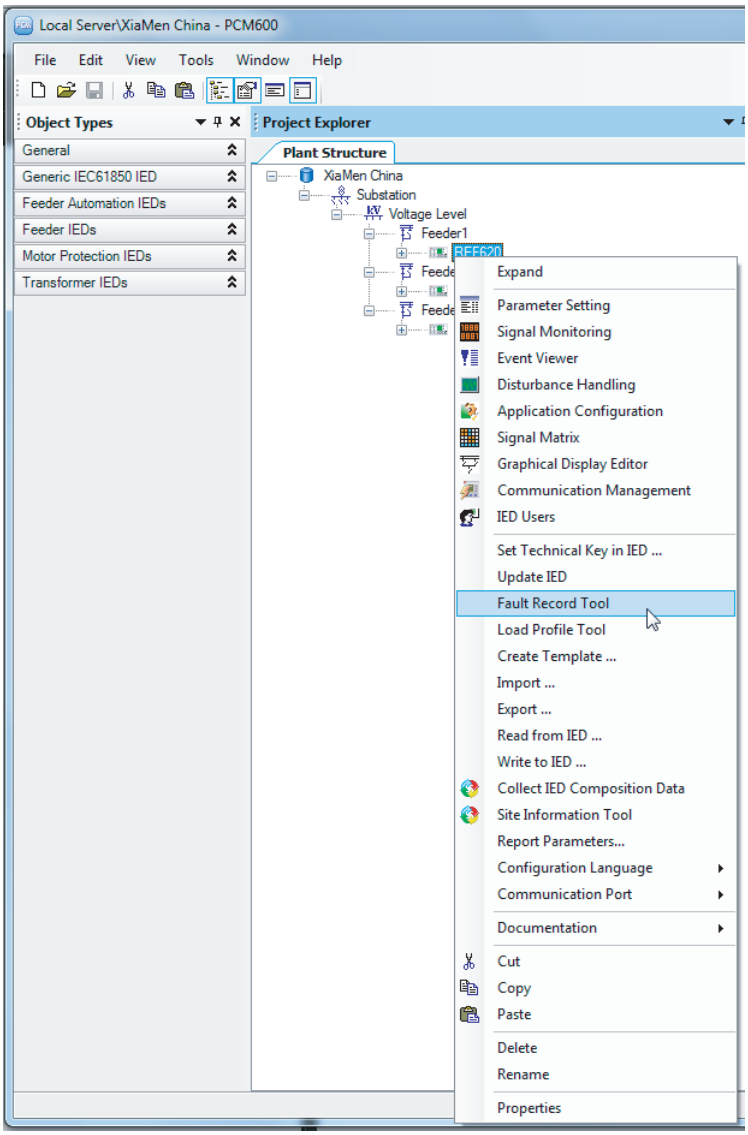

Figure 61: Opening the Fault Record tool

- 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 Fault Record tool is a connectivity package tool. 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.

5.5.2 Fault Record tool interface

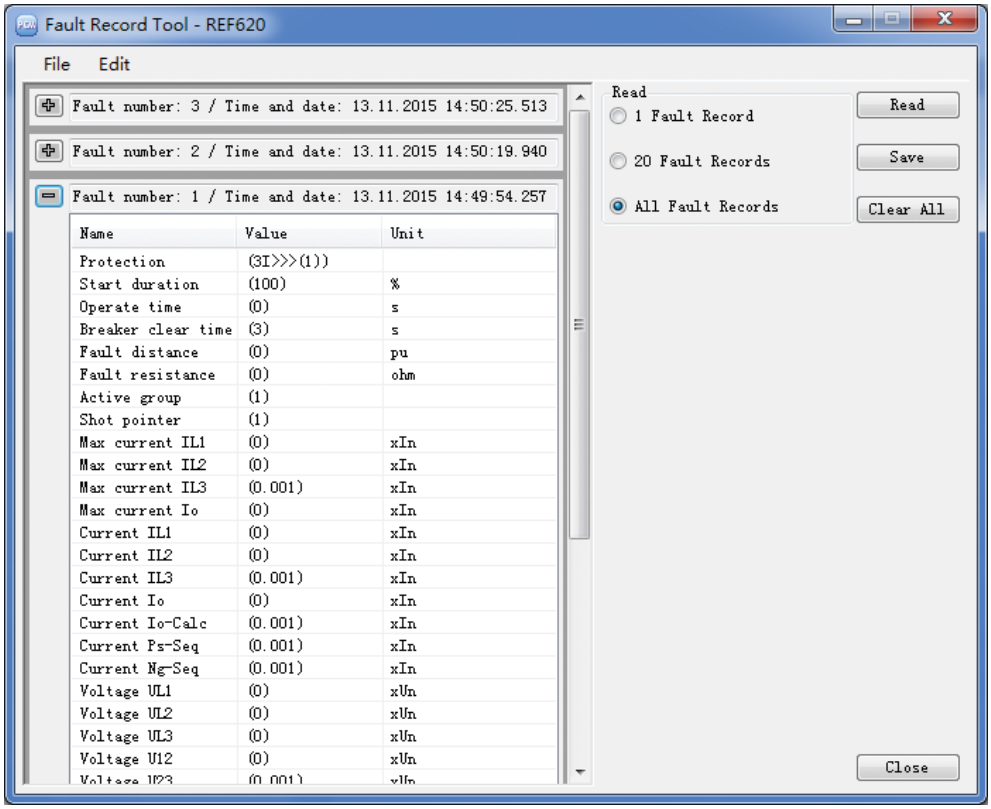

Figure 62: Fault record tool

Table 6: Available actions on the user interface

Action	Description
Read	Clicking the **Read** button reads all available fault records from the protection relay into the tool. User has the option to read 1 fault record, 20 fault records or all fault records. The **Read** button opens up a progress bar to indicate an ongoing read operation. Click the **Cancel** button on the Read progress bar to cancel the read operation. On operation completion, the available fault records are shown in the record grid. Click the **+** icon to expand and view record details.
Save	Click **Save** to save the fault records on the local machine as .txt file.
Clear	Record can be cleared from either the Fault record tool or the protection relay or both. Before deleting the records, a confirmation dialog box is shown.
Close	Clicking the **Close** button closes this instance of the Fault Record tool. Any open instance is finally closed when the whole PCM600 is closed.
File	**File** menu for **Save** and **Exit** actions.
Edit	**Copy All** in the **Edit** 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. Additionally the user can select any particular fault record and right-click to copy the selected record.

5.6 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 two display pages with a delta of two pixels.

Detailed instructions are shown in PCM600 documentation.

5.6.1 Starting IED Compare

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

5.6.2 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.

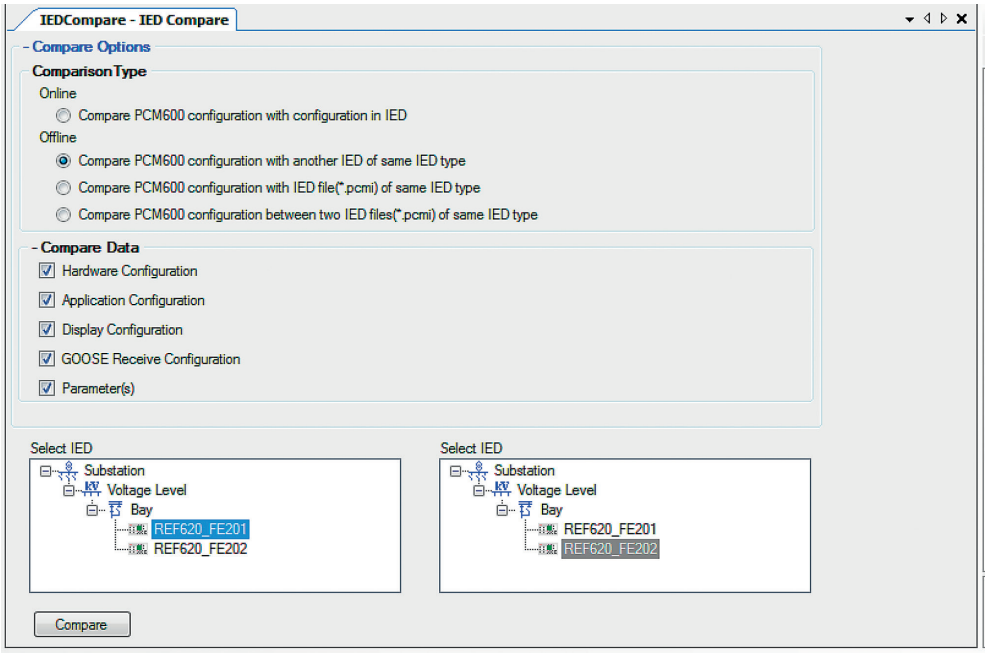

Figure 63: Compare options

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.

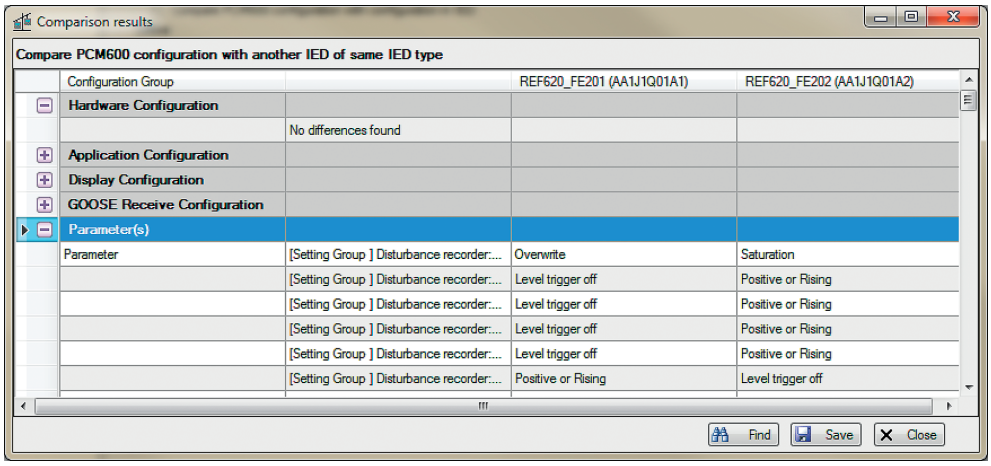

Figure 64: Compare report

Table 7: Acronyms used in a report

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

5.7 Protection and control blocking examples

All of the relay's logical nodes are set with *Test mode*. *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 8: 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 blocked.	TRUE
IED test	Protection working as in "Normal mode" but protection functions are working in parallel with test parameters.	FALSE
IED test and blocked	Protection working as in "Normal mode" but protection functions are working in parallel with test parameters. ACT configuration can be used to block physical outputs to process. Control function commands blocked.	TRUE

The mode of all logical nodes located under CTRL logical device are 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.To set it from WHMI, the *Remote test mode* parameter under **Tests/IED test/Test mode** should be set as "All Levels". *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 9: 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 device is set to blocked or test blocked mode. The usage depends heavily on the actual ACT configuration. In the protection blocking example the main trip from TRPPTRC1 is blocked, and in the control blocking example the CBXCBR1 is blocked. Both comply to the IEC 61850. In real applications some of PTRC's might also be used for signalling purposes (GOOSE) and blocking and interlocking via IO.

5.7.1 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 signals or function blocks that affect primary apparatuses. Blocking scheme needs to use the BEH_BLK output of the PROTECTION function block.

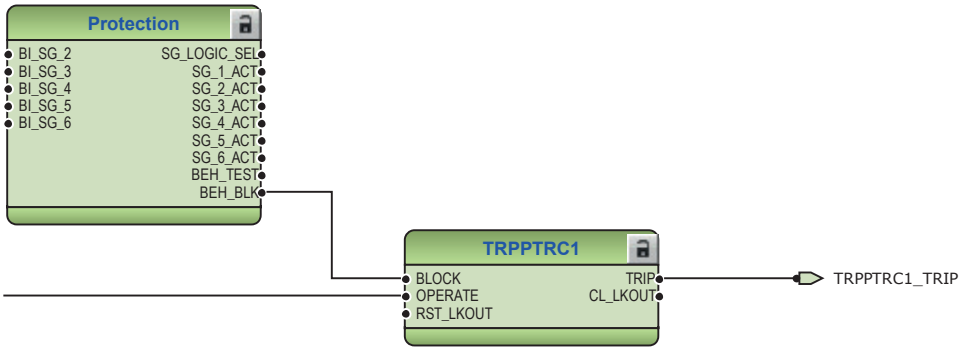

Figure 65: Master trip TRPPTRC blocked using Protection function block BEH_BLK output

5.7.2 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.

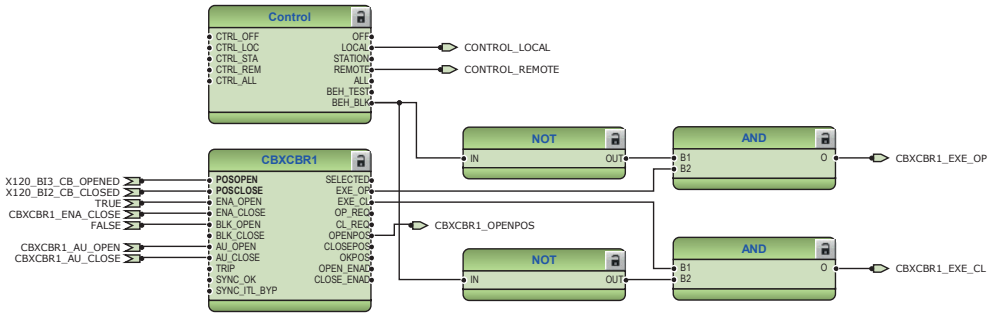

Figure 66: Circuit breaker control CBXCBR1 blocked using Protection function block BEH_BLK output

Section 6 LHMI engineering

For information on LED operation modes supported by the protection relay, see the technical manual.

6.1 Single-line diagram engineering

A single-line diagram of the protection relay can be designed by using the Graphical Display Editor tool of PCM600. The single-line diagram is modelled according to the IEC 61850 standard in the Graphical Display Editor.

6.1.1 Diagrams in Graphical Display Editor

The Graphical Display Editor is used for various tasks.

- Creating HMI display raster layouts
- Adding static text
- Adding measurands
- Adding busbars
- Adding symbols onto display page
- Drawing lines (creating a link)
- Adding buttons to control ACT application with SPCGGIO

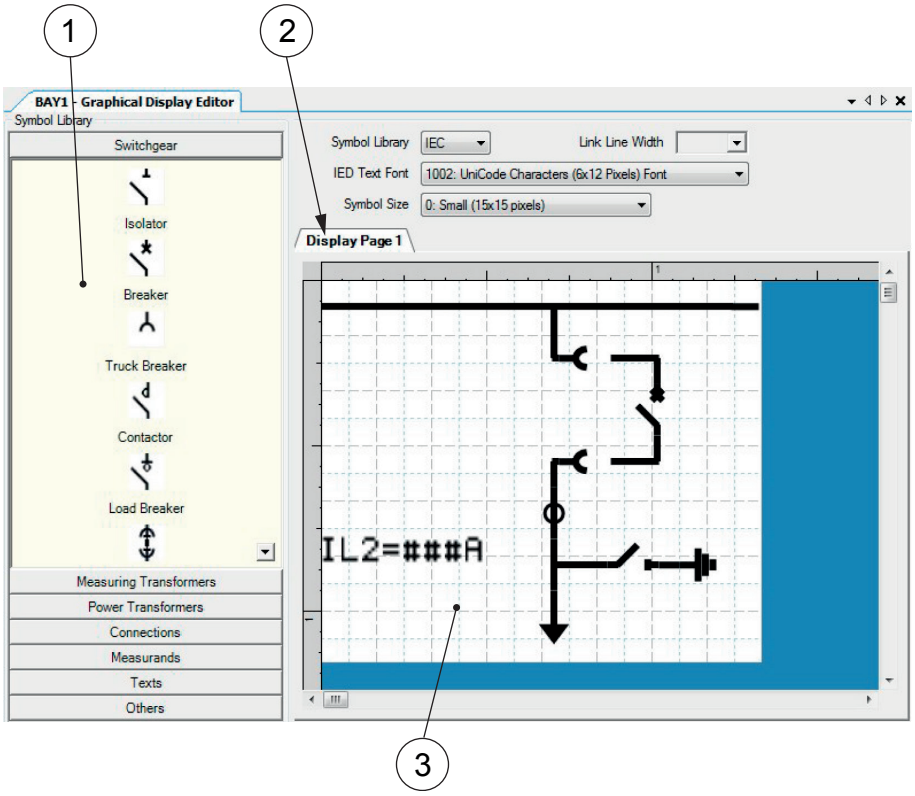

Figure 67: Graphical Display Editor: active view

1 Symbol library window
2 HMI display page
3 Protection relay's HMI display window

The Graphical Display Editor has a stationary symbol library window on the left side of the view. The window is empty when no page exists for the protection relay. A default single-line diagram presentation is displayed if standard configurations are used.

Additional single-line diagram HMI display pages can be added or removed with the **Add Display Page** or **Remove Display Page** commands in the Graphical Display Editor menu.

6.1.1.1 Display window and sequence order

The HMI pages are handled according to rules.

- The protection relay supports one bay with up to ten single-line diagram HMI pages.
- Measurements and the single-line diagram can be displayed on the page in any possible order and placement.
- All symbol objects, for example apparatus and measurement, on the HMI page must be linked to the correct function block in the application configuration to present the correct process values.

6.1.1.2 Symbol library

The **Symbol Library** view contains panes that include drawing symbols or elements for creating a single-line diagram, measurements and texts onto a page. Panes can be opened by clicking the name bar of the selected element.

The library shows the symbols either in the ANSI standard or IEC standard. The standard is selected from the list located on top of the window.

When changing to another library standard, Graphical Display Editor changes the symbols according to the selected new standard and redraws the single-line diagram in the window.

To change the symbol format used in the protection relay, select **Main menu/Configuration/HMI/SLD symbol format** and choose IEC or ANSI.

To become familiar with the available symbols, select the different panes and their symbols.

6.1.1.3 Supported single-line diagram symbols

Table 10: Single-line diagram symbols

Description	IEC representation	ANSI representation
Disconnector – Intermediate position		
Disconnector – Open position		
Disconnector – Closed position		
Disconnector – Bad (faulty) position		

Table continues on next page

Description	IEC representation	ANSI representation
Circuit breaker – Intermediate position		
Circuit breaker – Open position		
Circuit breaker – Closed position		
Circuit breaker – Bad (faulty) position		
Truck – Intermediate position		
Truck – Open position		
Truck – Closed position		
Truck – Bad (faulty) position		
Contactor – Intermediate position		
Contactor – Open position		
Contactor – Closed position		
Contactor – Bad (faulty) position		
Load Breaker – Intermediate position		
Load Breaker – Open position		
Load Breaker – Closed position		
Load Breaker – Bad (faulty) position		

Table continues on next page

Description	IEC representation	ANSI representation
Disconnecting truck – Intermediate position		
Disconnecting truck – Open position		
Disconnecting truck – Closed position		
Disconnecting truck – Bad (faulty) position		
Current transformer		
Voltage transformer 2 windings		
Voltage measurement truck – Intermediate position		
Voltage measurement truck – Open position		
Voltage measurement truck – Closed position		
Voltage measurement truck – Bad (faulty) position		
Current sensor		
Voltage sensor		
Transformer 2 windings		
Transformer 3 windings		
Autotransformer		
Tap changer		

Table continues on next page

Description	IEC representation	ANSI representation
Transformer 2 windings with earth		
In-feeder		
Out-feeder		
Earth symbol		
Button		
Capacitor		
Motor		
Generator		
Fuse		
Resistor		
Earthing transformer		
Petersen coil		
Power factor controller		

6.1.1.4 HMI display raster layout and text font selection

The raster on the page changes from symbol presentation to text presentation when a text object is selected and vice versa.

The text can be presented in UniCode characters (6 x 12 pixels). The total size of the presented white area (page) represents the visible part of the LHMI display without the header line.

The visible display for a single-line diagram is organized in a raster of 9 x 7 (columns x rows). Each symbol (presented in 15 x 15 pixels) included in the drag-and-drop method must be dropped into a raster box.

The description text for an apparatus object can be placed in all four directions around the symbol. The description is part of the apparatus object. It is possible to place the symbols without the assistance of **Snap to Grid** and manually change the position coordinates.

6.1.1.5 Text handling

The display switches when text is selected in a display of 22 x 9 (columns x rows). One display box holds one character. A text element must be placed in the position of the display.

The name and the unit of a measurement or text symbol can be changed by double-clicking the symbol or via the **Object Properties** view.

Selecting and toggling **Show Texts using the IED fonts** can be used to preview the single-line diagram to see how it is presented in the real HMI display.

6.1.1.6 Adding static text

1. Place a **Static Text** object into a raster box by dragging-and-dropping.

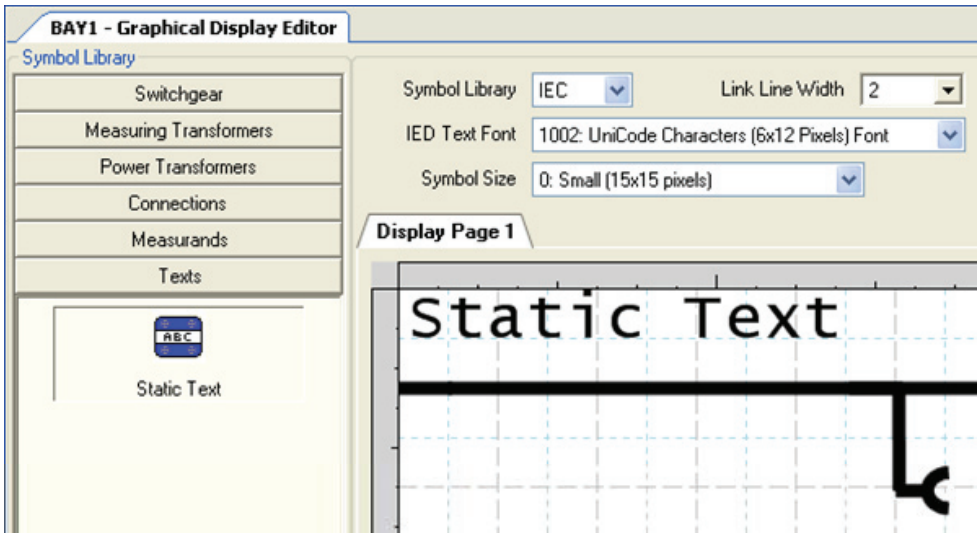

Figure 68: Adding a static text field into a LHMI view

2. Edit the text in the **Name** field in the **Object Properties** view, or alternatively double-click the text to edit it.

6.1.1.7 Adding select buttons

1. Drag a **Select Button** object into a raster box.

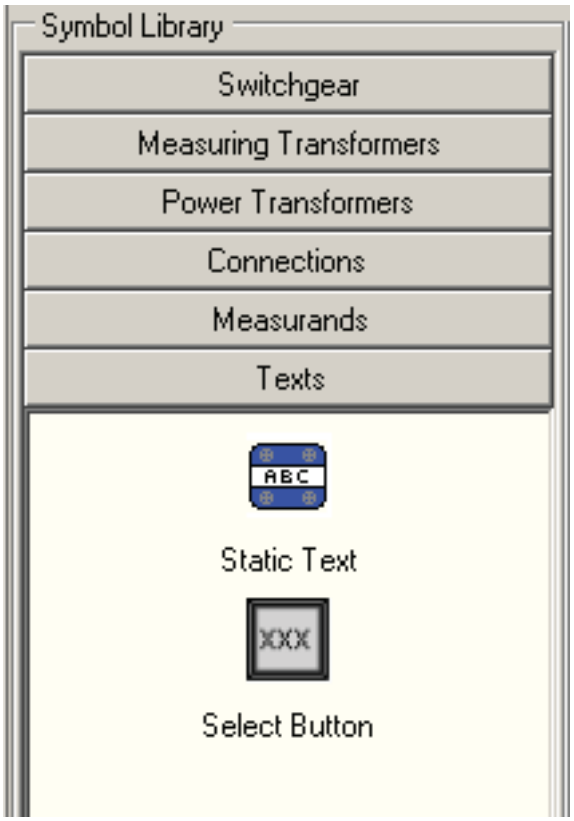

Figure 69: Select button

2. Right-click the select button symbol, point to **Select Input Signal** and select the input signal from the list.

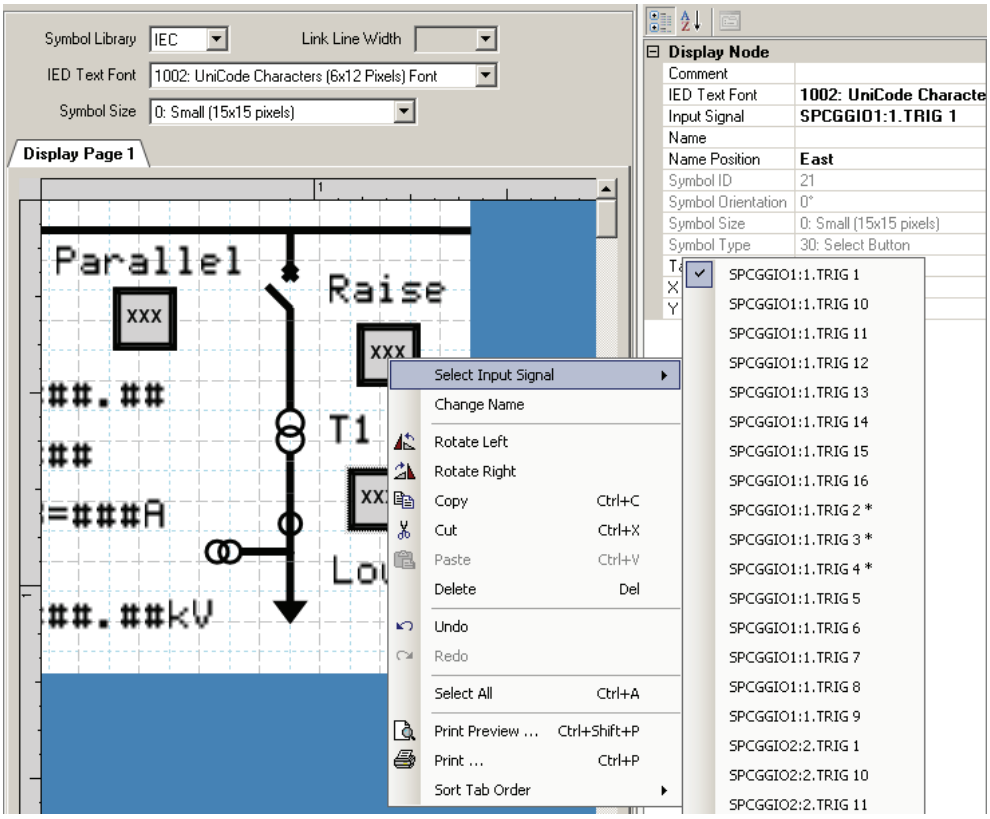

Figure 70: Selecting input signal

6.1.1.8 Adding measurands

1. Drag a **Measurand** object into a raster box.

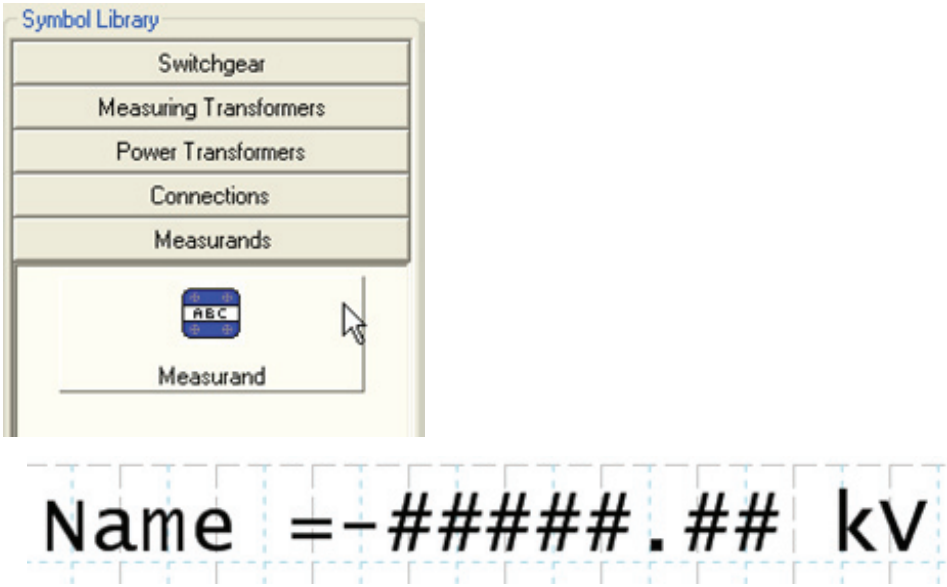

Figure 71: Adding a measurand object to an LHMI view

2. In the **Objects Properties** view, edit the name, unit and the number of decimals. **Unit text** specifies the default text used for the measurement's unit. If the **Unit text** is empty in the Graphical Display Editor, no unit is shown. If the **Unit text** is not empty, the unit in the protection relay is updated dynamically based on the signal it is connected to. The *Scale factor* parameter is not used.

Uncheck the option **Place Symbol at available space** in the Graphical Display Editor menu to allocate more space for symbols near measurands.

6.1.1.9 Adding a busbar

1. Add at least two **Busbar Junction** elements from the **Symbol Library** to the display page.
2. Select the **Busbar Junction** and use the rotate command from the toolbar to ensure that the busbar ends to the margin.
3. Add links between the busbar junctions.

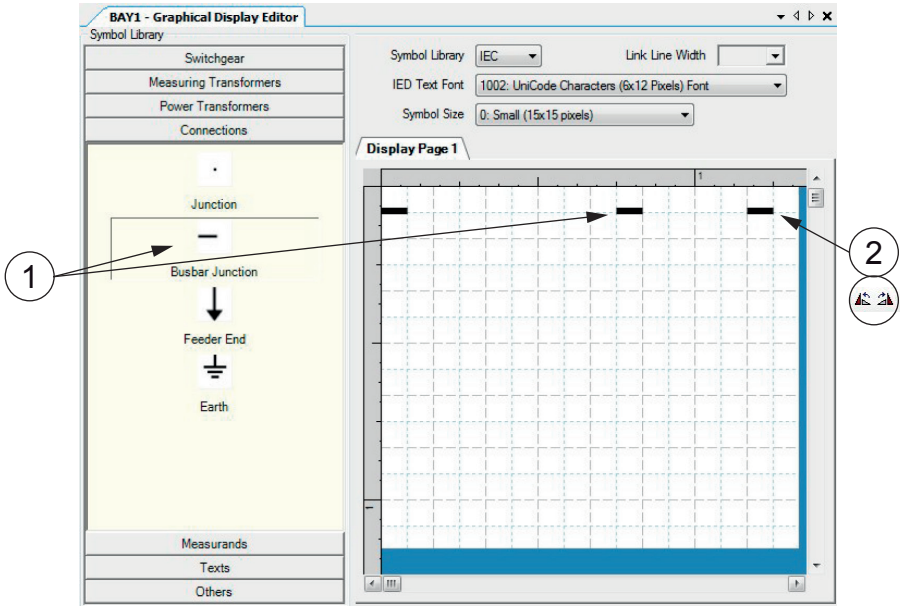

Figure 72: Graphical Display Editor: drawing a busbar and placing busbar junctions

1 Busbar junction
2 Rotate command

4. Add a link between one busbar junction point and the corresponding symbol or junction point.

6.1.1.10 Adding symbols into a display page

1. Prepare the body of the single-line diagram by locating symbols to the wanted positions on the display.
2. Drag the apparatus or transformer symbols into a raster box.
3. Drag the connection symbols into a raster box.
4. Place the junction points.
   Do not connect two symbols directly to each other. Instead, add a junction between them.
5. Use the X and Y coordinates in the **Object Properties** window to adjust the placement of symbols in the single-line diagram.

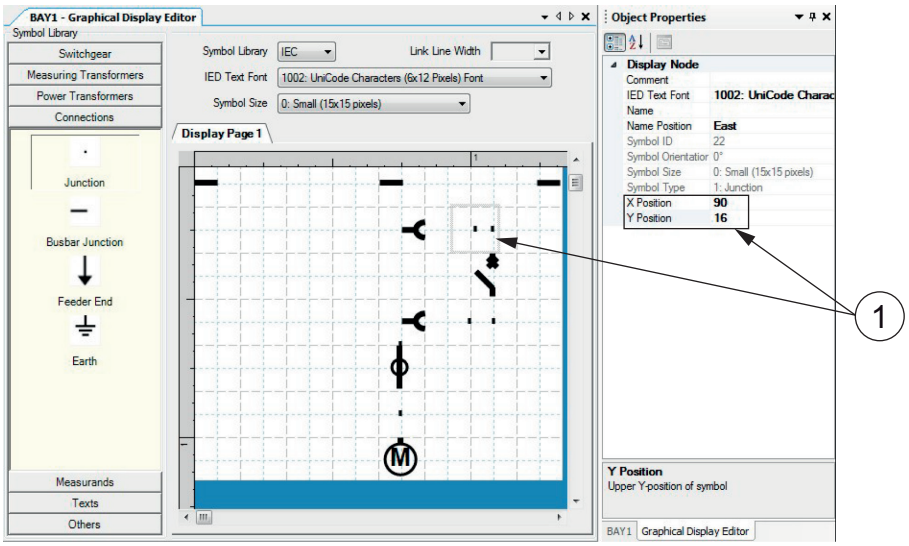

Figure 73: Graphical Display Editor: adding single-line diagram symbols into a display page

1 X and Y coordinates

6.1.1.11 Drawing lines to create links

After the apparatus symbols are placed, lines can be drawn to create links.

1. To draw a line, point to the center of the connection point which is visible in two circles at the end points of a line.
2. Drag the pointer to the destination connection point. Center the pointer again and release to draw the line.
3. Draw all the necessary line elements.

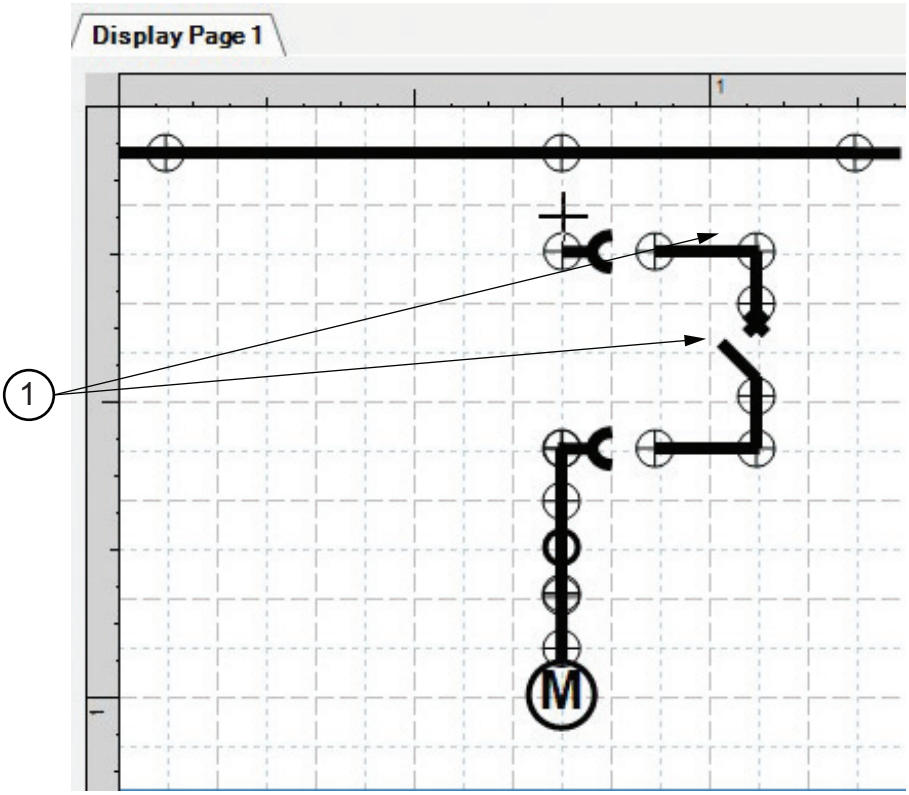

Figure 74: Graphical Display Editor: drawing a line between symbols

1 Line draw icon used for drawing lines between symbols

6.1.2 Bay configuration engineering

A view with a single-line diagram and measurements contains active living objects. The object values are updated by the protection relay periodically (measurement) or in case of an event.

Once the symbols are placed on the HMI page, they must be linked to the corresponding function block in the application configuration, which protects or controls the object that the symbol on the HMI page represents.

6.1.2.1 Linking process objects

To describe a process object within an IED, it needs to be established in the application configuration, configured when given the parameters by the Parameter Setting tool and linked to be displayed in the HMI.

Three tools are involved in the described steps.

- Application Configuration tool for programming the application function block for the apparatus and measurements
- Parameter Setting tool for adapting the settings and configuration parameters of the application function block
- Graphical Display Editor for establishing the link to update the selected data attribute in the HMI of the application function block

The needed information is delivered with switch controller (of type CSWI) for an apparatus and all the configured function blocks with measurements (of type MMXU) for the measurements

1. Right-click the apparatus symbol and select **Select Input Signal**.
   A list of engineered switch control application function blocks opens.
2. Select the switch control application function block that corresponds to the selected apparatus.
3. Right-click the measurement symbol and select **Select Input Signal**.
   A list of the engineered measurement application function blocks opens.
4. Select the measurement application function block that corresponds to the selected symbol.

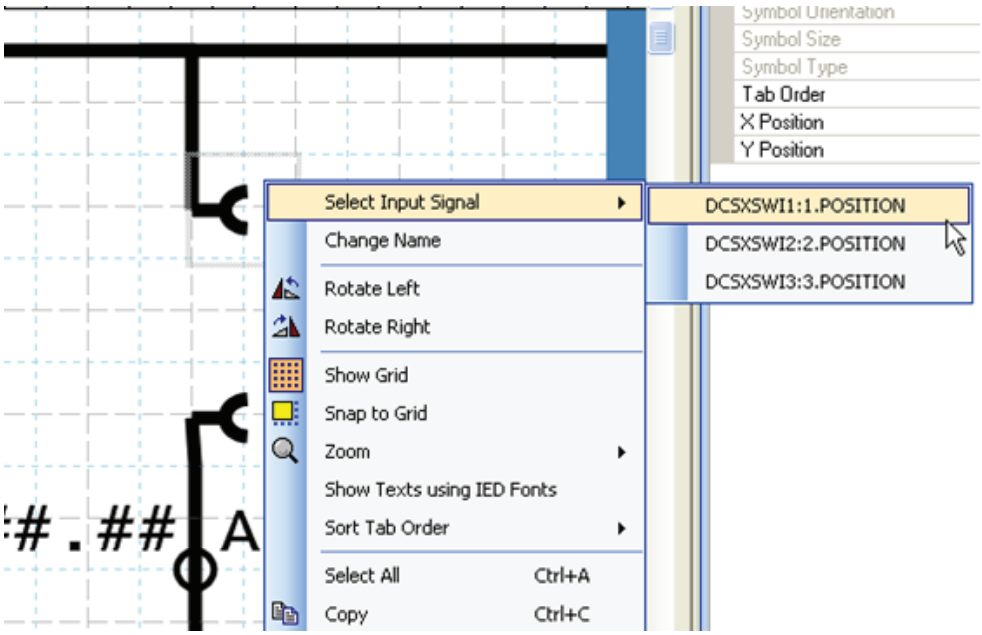

Figure 75: Graphical Display Editor: input signal selection

The ordering number in the selection window of the process objects corresponds to the number given in the Parameter Setting tool tree and to the application function block in the Application Configuration tool.
Only the apparatus and measurements that are configured in the application configuration program are displayed.

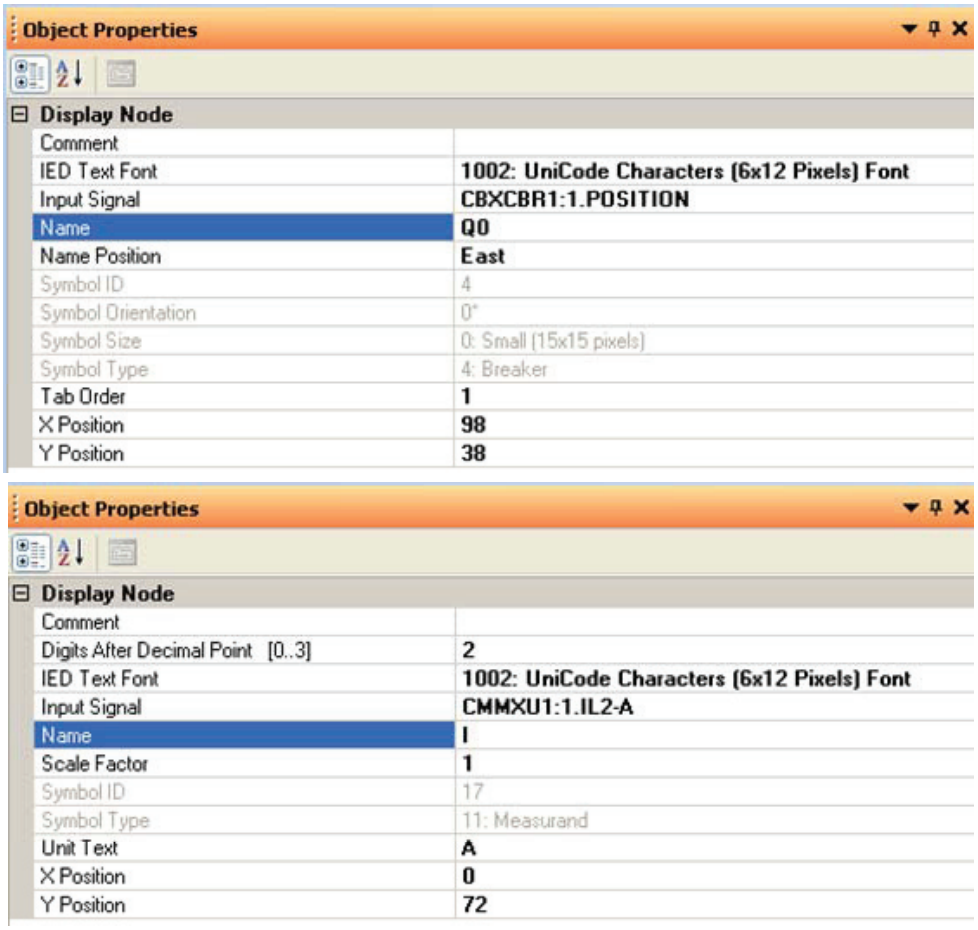

Figure 76: Graphical Display Editor: object properties view for text insertion

6.1.2.2 Creating a complete HMI display page

1. Make a sketch of how to present the single-line diagram.
2. Place the apparatus, transformer and other symbols that are needed for the single-line diagram into the raster boxes.
3. Add **Junction points** where needed.
4. Link the apparatus symbols with line elements.
5. In the **Object Properties** view, adjust the text symbols while writing to north, east, south or west.
6. Place measurements when needed.
7. Edit the name, unit and the number of the measurements' decimals.
8. Select each object that has a dynamic link and make the link to the corresponding process object.
9. Check that the correct function block is selected.
   Function blocks of the same type can have different instance numbers.

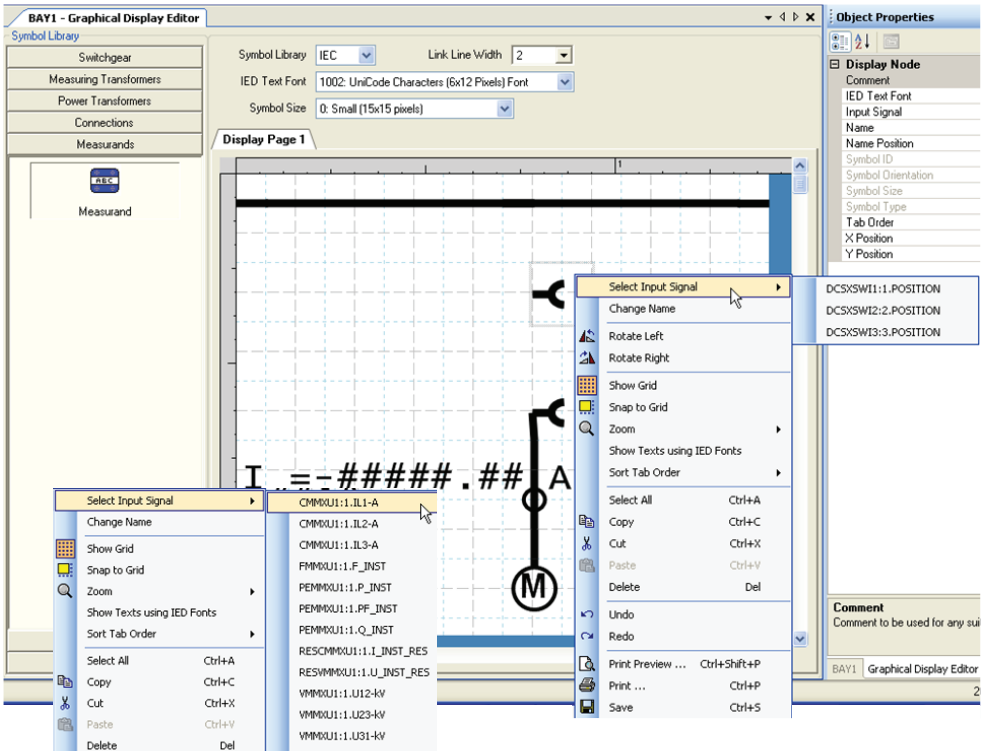

Figure 77: Graphical Display Editor: establishing a dynamic object link

10. Ensure that all links are done.
11. Save the complete picture.
12. Write to the IED.
13. Validate the single-line diagram on the protection relay.

6.1.2.3 Adding new process objects to Application Configuration and Graphical Display Editor

If new process objects need to be added to both Application Configuration and Graphical Display Editor, follow the given steps.

1. Add the object to Application Configuration.
2. Right-click the object and select **Write to IED**.
3. Add the object to Graphical Display Editor.
4. Right-click the object and select **Write to IED** or click the corresponding button on the Graphical Display Editor toolbar.

6.2 Programmable push-button engineering

LHMI comprises 16 programmable push-buttons. The push-buttons are aligned in two columns. Push-buttons 1...8 are on the left and push-buttons 9…16 are on the right.

There are 16 corresponding controllable LEDs also, each close to a push-button.

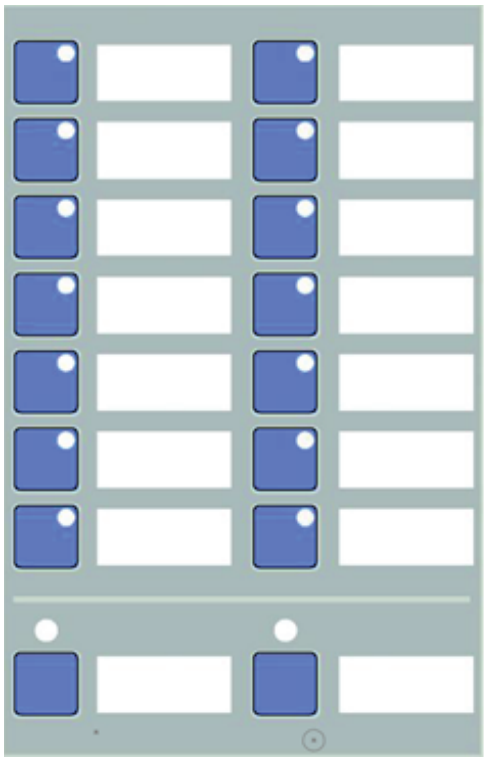

Figure 78: Programmable push-buttons

The status of the LEDs is not related to the status of the push-buttons but separately controlled.

Although the location of L8 and L16 looks different from the other 14 LEDs on LHMI, all these LEDs works the similar way.

6.2.1 Programmable interface FKEYGGIO

Function block FKEYGGIO is the interface provided to configure the 16 programmable buttons and controllable LEDs.

FKEYGGIO has 16 inputs, L1…L16 and 16 outputs, K1…K16. L1…L16 represent the 16 LEDs and K1…K16 represent the buttons.

When an input is set to TRUE, the corresponding LED is lit. When a button is pressed, the corresponding output K1...K16 is set to TRUE.

6.2.2 Configuration of programmable buttons and controllable LEDs

The Application Configuration tool or Signal Monitoring tool configures the programmable buttons and controllable LEDs.

FKEYGGIO is a simple interface, as the L1…L16 just follow the status of the inputs (True or false) and K1…16 just follow the status of the buttons (pushed or un-pushed).

However, with a combined configuration with other functions, like SPCGGIO, it is possible to enhance the functionality of the programmable buttons and controllable LEDs.

SPCGGIO offers the capability to activate its outputs through a local or remote control. The local control is provided through the LHMI menu and the remote control is provided through communication. SPCGGIO also has two modes of operation. In the Toggle mode, the block toggles the output signal for every input pulse received. In the Pulsed mode, the block generates an output pulse of a preset duration.

By connecting the outputs of FKEYGGIO through SPCGGIO, it is possible to have toggled or pulsed functionality for the push-buttons and the control through button can be controlled by local/remote mode of the IED.

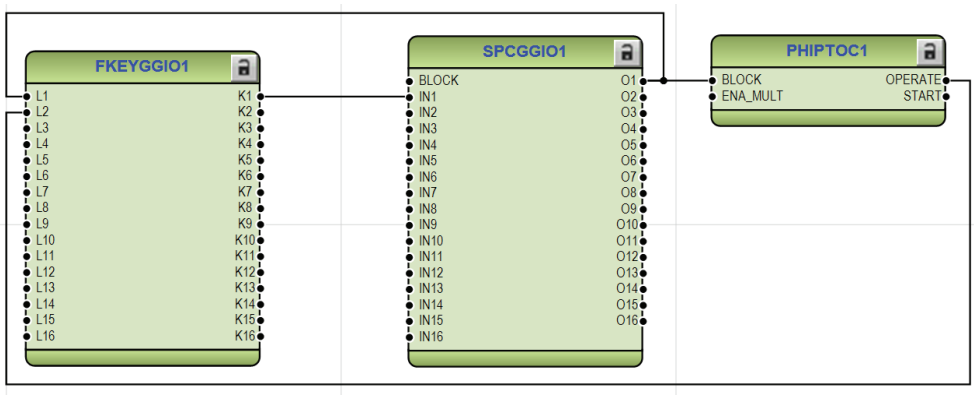

Figure 79: Function key configuration

Button 1 is configured to block PHIPTOC1 through `O1` of SPCGGIO1 and the output status of `O1` is also routed to `L1` of FKEYGGIO. Thus, the LED on button 1 indicates the block status of PHIPTOC1.

OPERATE of PHIPTOC is connected to L2 of FKEYGGIO1. Thus, the LED on button 2 indicates if PHIPTOC has operated. As K2 is not connected anywhere, button 2 is not in use.

6.3 Template export and import

The single-line diagram templates enable the reuse of the single-line diagram created in the Graphical Display Editor tool. The single-line diagram can be exported as a template and the same template can be imported to another IED. The file extension of the single-line diagram template file is .psld.

6.3.1 Exporting a template

1. Create a single-line diagram in the **Graphical Display Editor** tool.
2. On the menu bar, point to **Graphical Display Editor** and select **Export Display Pages as a Template**, or on the **File** menu, point to **Display Editor Template** and click **Export**.
3. Once the display page is selected, click **Export**.
   The **File save** dialog box appears.
4. Browse the location to export the template and provide the file name.
   The default file name is the bay name+date.

By default, single-line diagram templates are saved in the drive where PCM600 is installed <Drive:> \PCMDataBases\GDE\Templates \<IED type folder>.

6.3.2 Importing a template

1. On the menu bar, point to **Graphical Display Editor** and select **Import Display Pages from Template** or on the **File** menu, point to **Display Editor Template** and click **Import**.
   The **Import GDE Template** window appears with two sections, **List of Templates** and **Display Pages Preview**.
2. Click **Browse** to select the template files.
   The templates available in the folder appear in the **List of Templates** section.
3. Select a template file to preview the display pages available in the template file.
4. Once the display pages are selected, click **Import** to import the display page.

Multiple pages can be selected for the **Import** function.

6.4 HMI event filtering

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

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 in the same way as functions in the PCM600 plant structure.

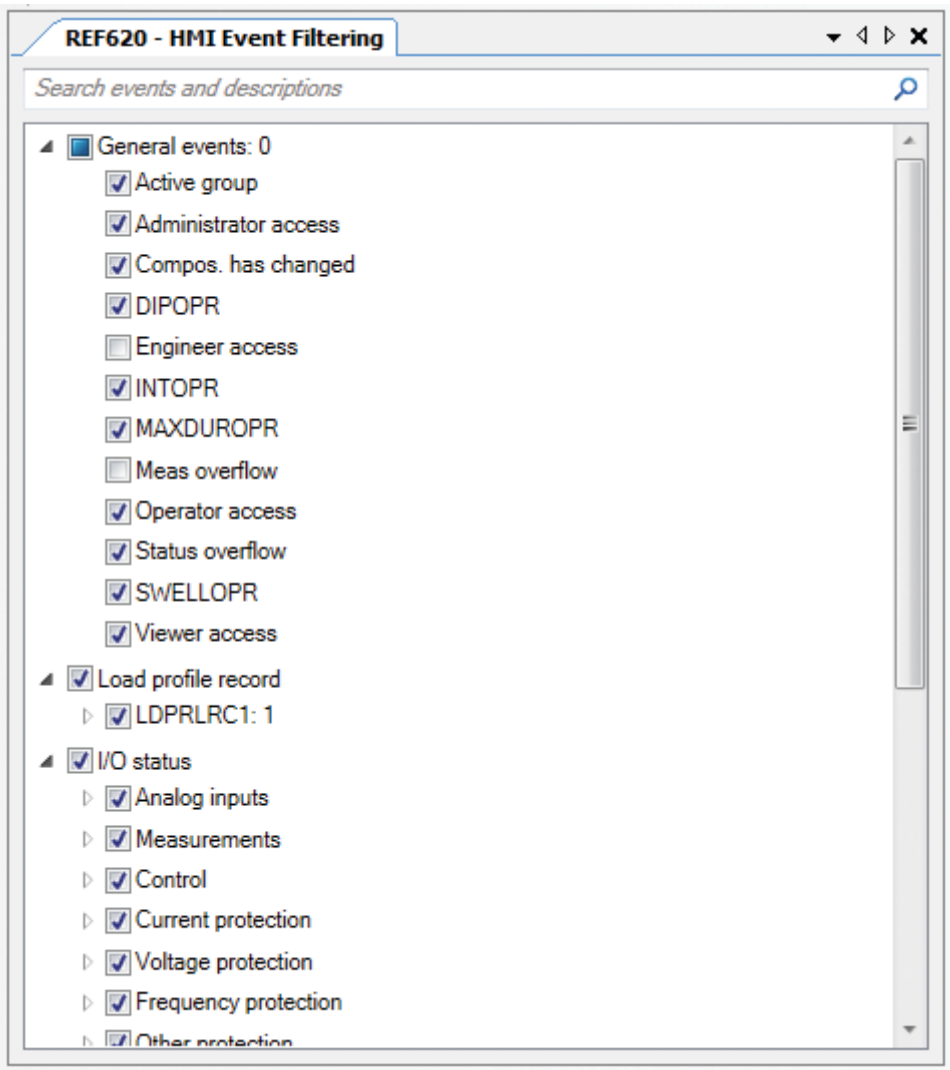

Figure 80: HMI event filtering interface

6.4.1 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**.

6.4.2 Setting visibility of HMI events

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 it's visibility.
   - When the check box is cleared, the event is not visible on either LHMI or WHMI.
   - When the check box is selected, the event is visible on both LHMI and WHMI.

The HMI visibility can also be modified for multiple events by selecting the check box of the parent node in the event tree view.

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

6.4.3 Searching events

HMI Event Filtering has search capabilities to quickly find wanted event from the event tree view. Use predefined search strings or type a search string manually. The event tree view is filtered using the search string.

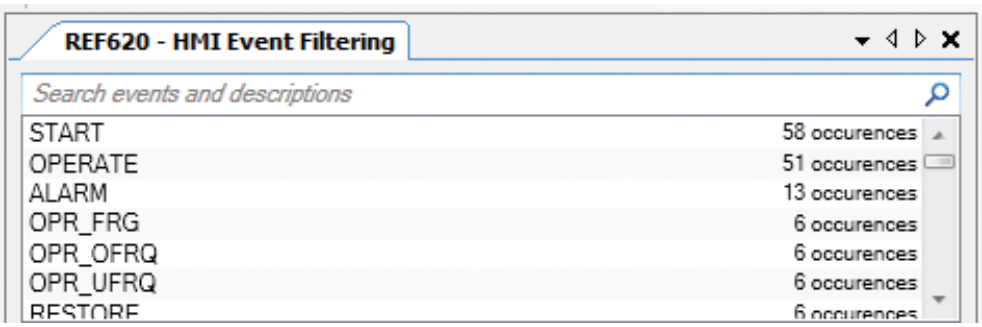

Figure 81: Searching events

- Search events using predefined search strings.
  1. Click the search text box shown on top of the event tree view.
     A drop-down list is shown with predefined search strings.
  2. Select the event name to be shown in the event tree.
     Event tree is filtered to show only events with the specified name.
- Search using custom search strings.
  1. Click the search text box shown on top of the event tree view.
  2. Type a custom search string in the search text box.

The event tree is filtered to all matching events. Search functionality tries to match the given custom search string to the event name and description. Partial matches are also shown in the results view.

- To clear the search results, click the Clear button on the right side of the search text box or erase the search string.

6.4.4 Saving event filter configuration

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

- In the event tree view, select **File/Save**.
- Click the Save button on the toolbar.

Section 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
- The IEC 61850 engineering guide
- The IEC 61850 conformance documents for the protection relay to be engineered
- The 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.

Table 11: Function blocks and IEC 61850 Edition 1 and Edition 2 Logical Nodes

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Protection				
Protection LLN0	Protection	LD0	LLN0 LPHD LINF LDEV	LLN0 LPHD IHMI GSAL
Three-phase non-directional overcurrent protection, low stage	PHLPTOC	LD0	PHLPTOC	PHLPTOC
Three-phase non-directional overcurrent protection, high stage	PHHPTOC	LD0	PHHPTOC	PHHPTOC
Three-phase non-directional overcurrent protection, instantaneous stage	PHIPTOC	LD0	PHIPTOC	PHIPTOC
Three-phase directional overcurrent protection, low stage	DPHLPDOC	LD0	DPHLPTOC DPHLRDIR	DPHLPTOC DPHLRDIR
Three-phase directional overcurrent protection, high stage	DPHHPDOC	LD0	DPHHPTOC DPHHRDIR	DPHHPTOC DPHHRDIR
Three-phase voltage-dependent overcurrent protection	PHPVOC	LD0	PHPVOC	

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Non-directional earth-fault protection, low stage	EFLPTOC	LD0	EFLPTOC	EFLPTOC
Non-directional earth-fault protection, high stage	EFHPTOC	LD0	EFHPTOC	EFHPTOC
Non-directional earth-fault protection, instantaneous stage	EFIPTOC	LD0	EFIPTOC	EFIPTOC
Directional earth-fault protection, low stage	DEFLPDEF	LD0	DEFLPTOC DEFLRDIR	DEFLPTOC DEFLRDIR
Directional earth-fault protection, high stage	DEFHPDEF	LD0	DEFHPTOC DEFHRDIR	DEFHPTOC DEFHRDIR
Admittance-based earth-fault protection	EFPADM	LD0	EFPADM	EFPADM
Wattmetric-based earth-fault protection	WPWDE	LD0	WRDIR WPSDE WMMXU	WRDIR WPSDE WMMXU
Transient/intermittent earth-fault protection	INTRPTEF	LD0	INTRPTEF	INTRPTEF
Harmonics-based earth-fault protection	HAEFPTOC	LD0	HAEFPTOC HAEFMHAI	HAEFPTOC HAEFMHAI
Negative-sequence overcurrent protection	NSPTOC	LD0	NSPTOC	NSPTOC
Phase discontinuity protection	PDNSPTOC	LD0	PDNSPTOC	PDNSPTOC
Residual overvoltage protection	ROVPTOV	LD0	ROVPTOV	ROVPTOV
Three-phase undervoltage protection	PHPTUV	LD0	PHPTUV	PHPTUV
Single-phase undervoltage protection, secondary side	PHAPTUV	LD0	PHAPTUV	
Three-phase overvoltage protection	PHPTOV	LD0	PHPTOV	PHPTOV
Single-phase overvoltage protection, secondary side	PHAPTOV	LD0	PHAPTOV	
Positive-sequence undervoltage protection	PSPTUV	LD0	PSPTUV	PSPTUV
Negative-sequence overvoltage protection	NSPTOV	LD0	NSPTOV	NSPTOV
Frequency protection	FRPFRQ	LD0	FRPTRC FRPTOF FRPTUF FRPFRC	FRPTRC FRPTOF FRPTUF FRPFRC
Overexcitation protection	OEPVPH	LD0	OEPVPH	OEPVPH
Three-phase thermal protection for feeders, cables and distribution transformers	T1PTTR	LD0	T1PTTR	T1PTTR
Three-phase thermal overload protection, two time constants	T2PTTR	LD0	T2PTTR	T2PTTR
Negative-sequence overcurrent protection for machines	MNSPTOC	LD0	MNSPTOC	MNSPTOC
Loss of phase (undercurrent)	PHPTUC	LD0	PHPTUC	
Loss of load supervision	LOFLPTUC	LD0	LOFLPTUC	LOFLPTUC
Motor load jam protection	JAMPTOC	LD0	JAMPTOC	JAMPTOC
Motor start-up supervision	STTPMSU	LD0	STTPMSS STTPMRI	STTPMSS STTPMRI
Phase reversal protection	PREVPTOC	LD0	PREVPTOC	PREVPTOC
Thermal overload protection for motors	MPTTR	LD0	MPTTR	MPTTR

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Stabilized and instantaneous differential protection for two-winding transformers	TR2PTDF	LD0	TR2LPDIF TR2HPDIF TR2PTRC TR2HPHAR TR5HPHAR	TR2PDIF TR2HPHAR TR5HPHAR
Numerical stabilized low-impedance restricted earth-fault protection	LREFPNDF	LD0	LREFPDIF LREFPHAR	LREFPDIF LREFPHAR
High-impedance based restricted earth-fault protection	HREFPDIF	LD0	HREFPDIF	HREFPDIF
High-impedance differential protection for phase A	HIAPDIF	LD0	HIAPDIF	
High-impedance differential protection for phase B	HIBPDIF	LD0	HIBPDIF	
High-impedance differential protection for phase C	HICPDIF	LD0	HICPDIF	
Circuit breaker uncorresponding position start-up	UPCALH	LD0	UPCALH	
Three-independent-phase non-directional overcurrent protection, low stage	PH3LPTOC	LD0	PH3LPTOC	
Three-independent-phase non-directional overcurrent protection, high stage	PH3HPTOC	LD0	PH3HPTOC	
Three-independent-phase non-directional overcurrent protection, instantaneous stage	PH3IPTOC	LD0	PH3IPTOC	
Directional three-independent-phase directional overcurrent protection, low stage	DPH3LPDOC	LD0	DPH3LPTOC DPH3LRDIR	
Directional three-independent-phase directional overcurrent protection, high stage	DPH3HPDOC	LD0	DPH3HPTOC DPH3HRDIR	
Circuit breaker failure protection	CCBRBRF	LD0	CCBRBRF	CCBRBRF
Three-phase inrush detector	INRPHAR	LD0	INRPHAR	INRPHAR
Automatic switch-onto-fault logic (SOF)	CVPSOF	LD0	CVPSOF	
Master trip	TRPPTRC	LD0	TRPPTRC	TRPPTRC
Arc protection	ARCSARC	LD0	ARCSARC ARCPIOC ARCPIOC2 ARCPTRC	ARCSARC ARCPIOC ARCPIOC2 ARCPTRC
Multipurpose protection	MAPGAPC	LD0	MAPGAPC	MAPGAPC
Load-shedding and restoration	LSHDPFRQ	LD0	LSHDPTRC LSHDPTOF LSHDPTUF LSHDPFRC	LSHDPTRC LSHDPTUF LSHDPFRC
Fault locator	SCEFRFLO	LD0	SCEFRFLO SCEFZLIN SCEF2ZLIN SCEF3ZLIN FLORFRC	SCEFRFLO FLOMSTA
Three-phase overload protection for shunt capacitor banks	COLPTOC	LD0	COLPTOC COL2PTOC COLPTUC	COLPTOC COL2PTOC COLPTUC
Current unbalance protection for shunt capacitor banks	CUBPTOC	LD0	CUBPTOC CUB2PTOC	CUBPTOC CUB2PTOC
Shunt capacitor bank switching resonance protection, current based	SRCPTOC	LD0	SRCPTOC SRC2PTOC	SRCPTOC SRC2PTOC
High-impedance fault detection	PHIZ	LD0	PHIZ	PHIZ

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Stabilized and instantaneous differential protection for machines	MPDIF	LD0	MLPDIF MHPDIF MPTRC	
High-impedance/flux-balance based differential protection for motors	MHZPDIF	LD0	MHZPDIF	
Underpower protection	DUPPDPR	LD0	DPPDUP DPMMXU	
Reverse power/directional overpower protection	DOPPDPR	LD0	DPPDOP DOPMMXU	
Three-phase under excitation protection	UEXPDIS	LD0	UEXPDIS UEXMMXU	
Multifrequency admittance-based earth-fault protection	MFADPSDE	LD0	MFADPSDE MFADRDIR	
Interconnection functions				
Directional reactive power undervoltage protection	DQPTUV	LD0	DQPTUV DQPDOP DQMMXU	
Low-voltage ride-through protection	LVRTPTUV	LD0	LVRTPTUV	
Rotor earth-fault protection	MREFPTOC	LD0	MRE1PTOC MRE2PTOC	
Voltage vector shift protection	VVSPPAM	LD0	VVSPPAM	
Power quality				
Current total demand distortion	CMHAI	LD0	CMHAI	CMHAI
Voltage total harmonic distortion	VMHAI	LD0	VMHAI	VMHAI
Voltage variation	PHQVVR	LD0	PHQVVR PH2QVVR PH3QVVR QVVRQRC QVV2RQRC QVV3RQRC	PHQVVR PH2QVVR PH3QVVR QVVMSTA QVV2MSTA QVV3MSTA
Voltage unbalance	VSQVUB	LD0	VSQVUB QVU1RQRC QVU2RQRC QVU3RQRC	
Control				
Local/remote control function block	Control	CTRL	LLN0 LPHD1	LLN0 LPHD1
Circuit-breaker control	CBXCBR	CTRL	CBCSWI CBCILO CBXCBR	CBCSWI CBCILO CBXCBR
Disconnector control	DCXSWI	CTRL	DCCSWI DCCILO DCXSWI	DCCSWI DCCILO DCXSWI
Earthing switch control	ESXSWI	CTRL	ESCSWI ESCILO ESXSWI	ESCSWI ESCILO ESXSWI
Disconnector position indication	DCSXSWI	CTRL	DCSXSWI	DCSXSWI
Earthing switch indication	ESSXSWI	CTRL	ESSXSWI	ESSXSWI
Emergency start-up	ESMGAPC	LD0	ESMGAPC	ESMGAPC

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Autoreclosing	DARREC	LD0	DARREC	DARREC
Tap changer position indication	TPOSYLTC	LD0	TPOSYLTC	TPOSSLTC
Tap changer control with voltage regulator	OLATCC	LD0	OLATCC	OLATCC
Synchronism and energizing check	SECRSYN	LD0	SECRSYN	SECRSYN
Condition monitoring				
Circuit-breaker condition monitoring	SSCBR	LD0	SSCBR SPH1SCBR SPH2SCBR SPH3SCBR SSOPM SSIMG	SSCBR
Trip circuit supervision	TCSSCBR	LD0	TCSSCBR	TCSSCBR
Current circuit supervision	CCSPVC	LD0	CCSPVC	CCRDIF
Current transformer supervision for high-impedance protection scheme for phase A	HZCCASPVC	LD0	HZCCASPVC	
Current transformer supervision for high-impedance protection scheme for phase B	HZCCBSPVC	LD0	HZCCBSPVC	
Current transformer supervision for high-impedance protection scheme for phase C	HZCCCSPVC	LD0	HZCCCSPVC	
Advanced current circuit supervision for transformers	CTSRCTF	LD0	CTSRCTF	
Fuse failure supervision	SEQSPVC	LD0	SEQSPVC	SEQRFUF
Runtime counter for machines and devices	MDSOPT	LD0	MDSOPT	MDSOPT
Measurement				
Disturbance recorder	RDRE	LD0	DR_LLN0 RDRE_type RADR_type RBDR_type LPHD_M	DR_LLN0 RDRE_type RADR_type RBDR_type LPHD_M
Load profile record	LDPRLRC	LD0	LDPRLRC	LDPMSTA
Three-phase current measurement	CMMXU	LD0	CMMXU CAVMMXU CMAMMXU CMIMMXU	CMMXU CMSTA
Sequence current measurement	CSMSQI	LD0	CSMSQI	CSMSQI
Residual current measurement	RESCMMXU	LD0	RESCMMXU RCAVMMXU RCMAMMXU RCMIMMXU	RESCMMXU RESCMSTA
Three-phase voltage measurement	VMMXU	LD0	VMMXU VAVMMXU	VMMXU VMSTA
Single-phase voltage measurement	VAMMXU	LD0	VAMMXU VAAVMMXU	
Residual voltage measurement	RESVMMXU	LD0	RESVMMXU RVAVMMXU RVMAMMXU RVMIMMXU	RESVMMXU RESVMSTA
Sequence voltage measurement	VSMSQI	LD0	VSMSQI	VSMSQI

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Three-phase power and energy measurement	PEMMXU	LD0	PEMMXU PEMMTR PEAVMMXU PEMAMMXU PEMIMMXU	PEMMXU PEMMTR PEMSTA
Frequency measurement	FMMXU	LD0	FMMXU	FMMXU
RTD/mA measurement X130 (RTD)	XRGGIO130	LD0	XRGGIO130	XRGGIO130
RTD/mA measurement X130 (AIM+RTD)	XARGGIO130	LD0	XARGGIO130	XARGGIO130
Instrument transformers and sensors				
Three-phase current transformer	ILTCTR	LD0	IL1TCTR IL2TCTR IL3TCTR	IL1TCTR IL2TCTR IL3TCTR
Three-phase voltage transformer	ULTVTR	LD0	UL1TVTR UL2TVTR UL3TVTR	UL1TVTR UL2TVTR UL3TVTR
Residual current transformer	RESTCTR	LD0	RESTCTR	RESTCTR
Residual voltage transformer	RESTVTR	LD0	RESTVTR	RESTVTR
Communication				
IEC 61850-9-2 LE, sampled value sender	SMVSENDER	MU01	LLN0 LPHD1 I01ATCTR1 I01BTCTR2 I01CTCTR3 I01NTCTR4 U01ATVTR1 U01BTVTR2 U01CTVTR3 U01NTVTR4	LLN0 LPHD1 I01ATCTR1 I01BTCTR2 I01CTCTR3 I01NTCTR4 U01ATVTR1 U01BTVTR2 U01CTVTR3 U01NTVTR4
IEC 61850-9-2 LE, sampled value subscription	SMVRCV	MU01	SMVLSVS	
Redundant Ethernet channel supervision	RCHLCCH	LD0	RCHLCCH	
Ethernet channel supervision	SCHLCCH	LD0	SCHLCCH	
Serial port supervision	SERLCCH	LD0	SERLCCH	
Human machine interface	IHMI	LD0	IHMI	IHMI
General security application	GSAL	LD0	GSAL	GSAL
Time synchronization and local time	GNRLLTMS	LD0	GNRLLTMS[1)] GNRLLTIM	GNRLLTMS
Controllable logic				
Minimum pulse timer	TPGAPC		TPGAPC	TPGAPC
Minimum pulse timer	TPSGAPC		TPSGAPC	TPSGAPC
Minimum pulse timer	TPMGAPC		TPMGAPC	TPMGAPC
Pulse timer	PTGAPC		PTGAPC	PTGAPC
Time delay off	TOFGAPC		TOFGAPC	TOFGAPC
Time delay on	TONGAPC		TONGAPC	TONGAPC
Set-reset	SRGAPC		SRGAPC	SRGAPC
Move	MVGAPC		MVGAPC	MVGAPC
Generic control point	SPCGAPC		SPCGAPC	SPCGGIO

Table continues on next page

Function	IEC 61850	Logical device	Logical nodes in product version 2.0 FP1	Logical nodes in product version 2.0
Analog value scaling	SCA4GAPC		SCA4GAPC	SCA4GAPC
Integer value move	MVI4GAPC		MVI4GAPC	MVI4GAPC
Protocols				
IEC 61850	MMSLPRT	LD0	MMSLPRT	MMSGGIO
GOOSE	GSELPRT	LD0	GSELPRT	GSEGGIO
MODBUS	MBSLPRT	LD0	MBSLPRT	MBSLPRT
DNP3	DNPLPRT	LD0	DNPLPRT	DNPLPRT
IEC 103	I3CLPRT	LD0	I3CLPRT	I3CLPRT
Hardware				
PSM (X100) card	X100 (PSM)	LD0	XGGIO100	XGGIO100
BIO (X105) card	X105 (BIO)	LD0	XGGIO105	XGGIO105
BIO (X105) high speed output	X105 (BIO-H)	LD0	XBGGIO105	XBGGIO105
RTD (X105) 6 RTD and 2 mA	X105 (RTD)	LD0	XRGGIO105	XRGGIO105
BIO (X110) card	X110 (BIO)	LD0	XGGIO110	XGGIO110
RTD (X110) 6 RTD and 2 mA	X110 (RTD)	LD0	XRGGIO110	XRGGIO110
BIO (X115) card	X115 (BIO)	LD0	XGGIO115	XGGIO115
AIM (X115) 4CT_3VT with Io	X115 (AIM2)	LD0	XAGGIO115	XAGGIO115
AIM (X115) 4CT_3VT with sensitive Io	X115 (AIM2)	LD0	XAGGIO115	XAGGIO115
AIM (X120) 7CT with Io	X120 (AIM2)	LD0	XAGGIO120	XAGGIO120
AIM (X120) 7CT with sensitive Io	X120 (AIM2)	LD0	XAGGIO120	XAGGIO120
AIM (X120) 4CT_3VT with Io	X120 (AIM2)	LD0	XAGGIO120	XAGGIO120
AIM (X120) 4CT_3VT with sensitive Io	X120 (AIM2)	LD0	XAGGIO120	XAGGIO120
AIM (X130) 5 VT	X130 (AIM)	LD0	XAGGIO130	XAGGIO130
SIM (X130) 3Is_3Us with sensitive Io	X130 (SIM)	LD0	XSGGIO130	XSGGIO130
RTD (X130) 2RTD and 1 mA	X130 (RTD)	LD0	XRGGIO130	XRGGIO130
COM (X000) LDM card	XGGIO90	LD0	XGGIO90	XGGIO90
COM (X000) card	XGGIO90	LD0	XGGIO90	XGGIO90
LED indication control	LEDPTRC	LD0	LEDPTRC	LEDPTRC
Programmable LEDs	LED	LD0	LEDGGIO	LEDGGIO

1) IEC 61850 Edition1 logical node is GNRLLTMM.

7.2.1 IEC 61850 interface in the protection relay

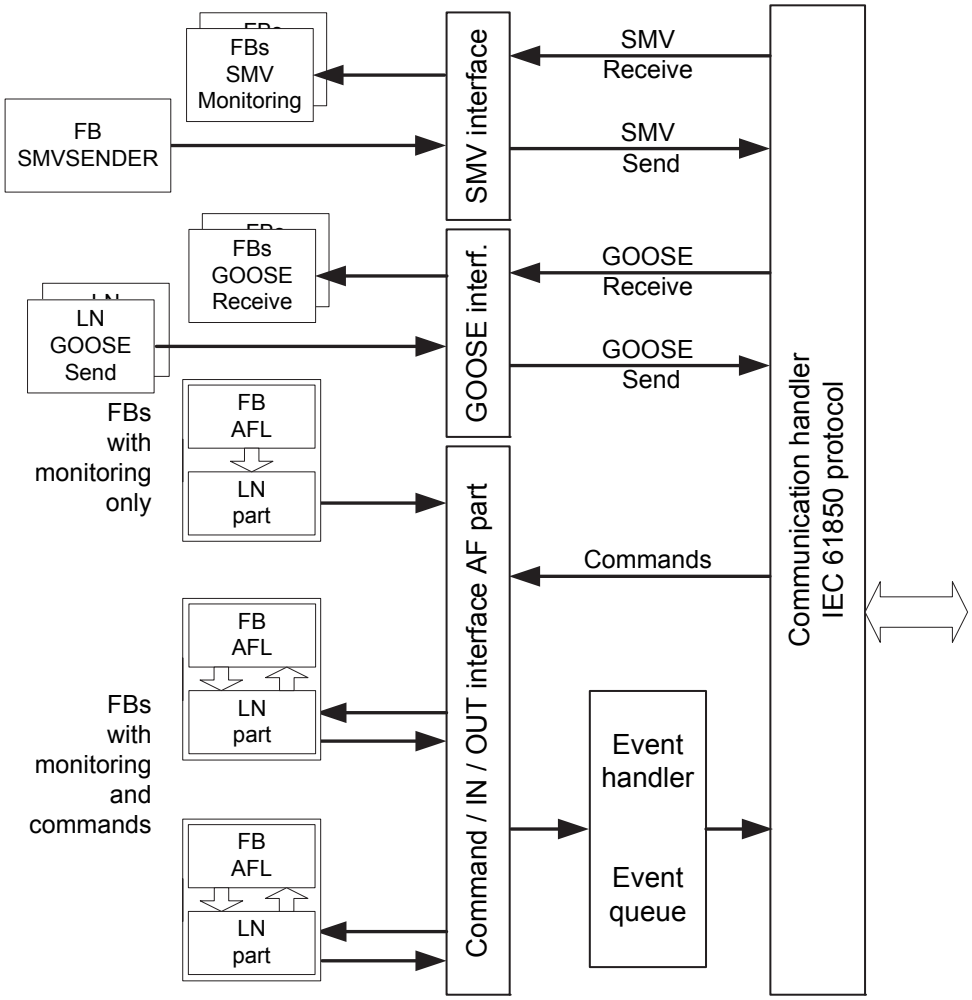

Figure 82: IEC 61850 communication interface principle

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 commands and monitoring are available in logical nodes.

Whenever a function block is instantiated in the Application Configuration tool, 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 the Ethernet. Whoever needs the information, detects the telegram by its source address, reads the telegram and handles it. The telegrams are multicast sent and not acknowledged by the receiver.

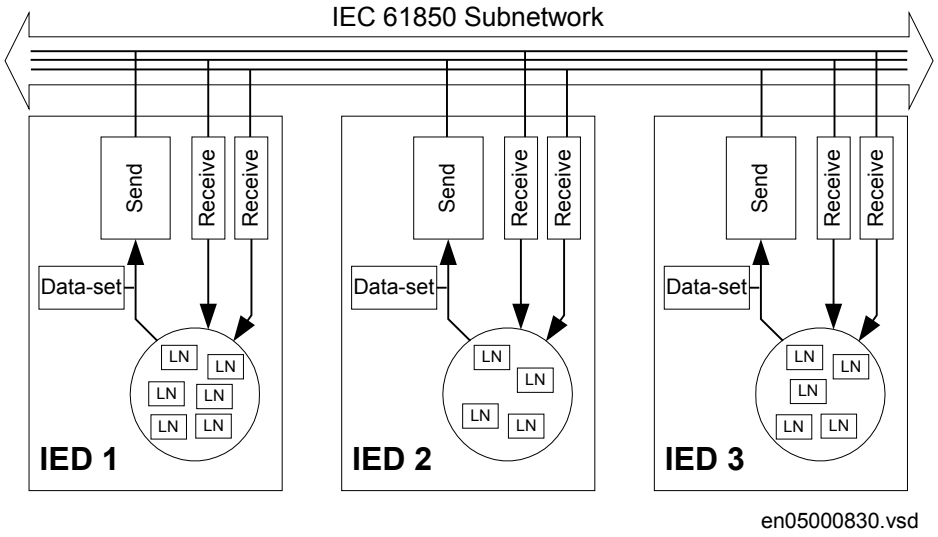

Figure 83: IEC 61850: Horizontal communication principle, an example of three IEDs where each IED communicates with all others

When a GOOSE message is to be 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.

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 tool use IEC 61850 logical node naming for function blocks. This relation is automatically handled by the PCM600 tools.

The concept in the IED is such that 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 sequence of engineering. These files have a different definition, which is explained in IEC 61850-6. Three of the file types are used in the engineering process for an IED.

- 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, have to be done 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 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 one specific IED. This includes 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 IED configuration tool to a system configuration tool.

The uploading of IEC 61850 communication configuration is not supported when reading a configuration from an online IED. The PCM600 project works as a repository for the IEC 61850 configuration.

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 the IEC 61850 Configuration tool inside PCM600. In that case the SCL file export and import operations (steps 1 and 3) are not needed.

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.

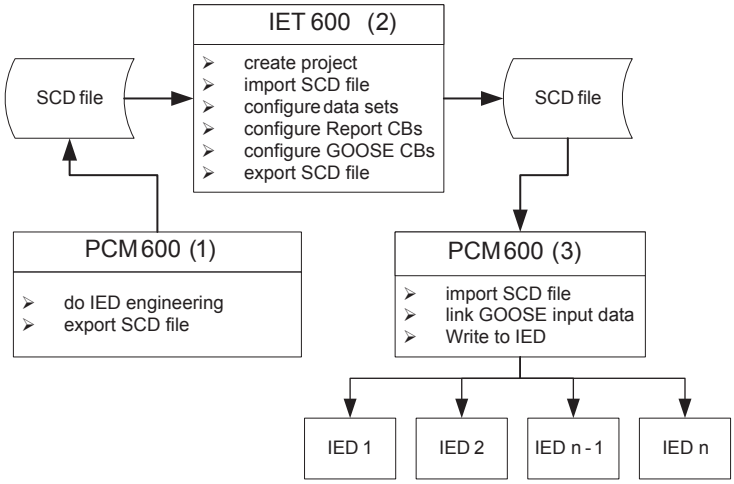

Figure 84: IEC 61850: signal engineering procedure flow when a complete station is exported as a SCD file

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 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. Select the station in the **Plant Structure** view.

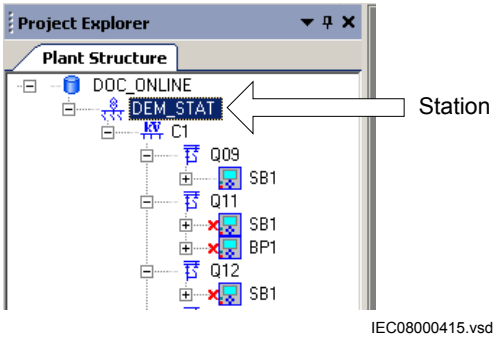

Figure 85: IEC 61850: selecting the station

2. Right-click the station and select **Export**.
3. From the open standard Windows dialog box, select the location to store the file and name it.
4. Click **Save**.
   The **SCL Export Options** dialog box opens.

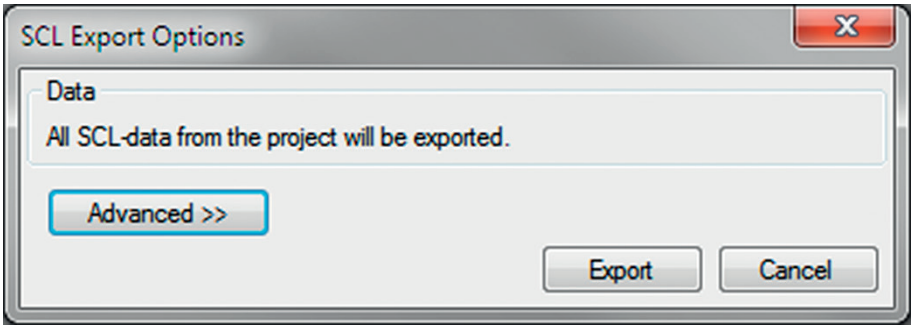

Figure 86: IEC 61850: selecting the SCL export option

5. Change the SCL file version by clicking the **Advanced** button, if required by the receiving configuration tool.

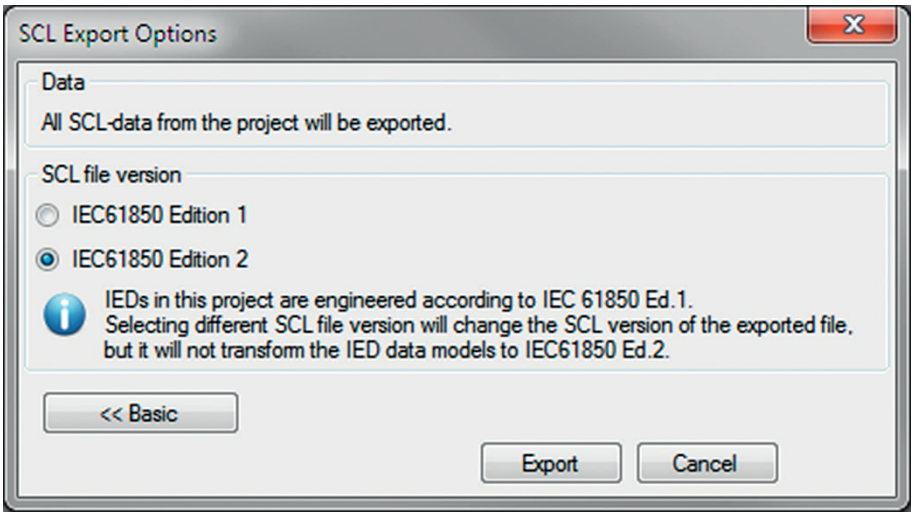

Figure 87: Export options of SCL

6. 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...**
   The **Export** dialog box opens.
3. 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

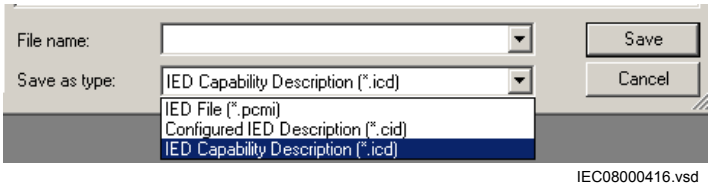

Figure 88: IEC 61850: export IED file type selection

4. Click **Save**.
   The **SCL Export Options** dialog box opens.
5. Select the export options.

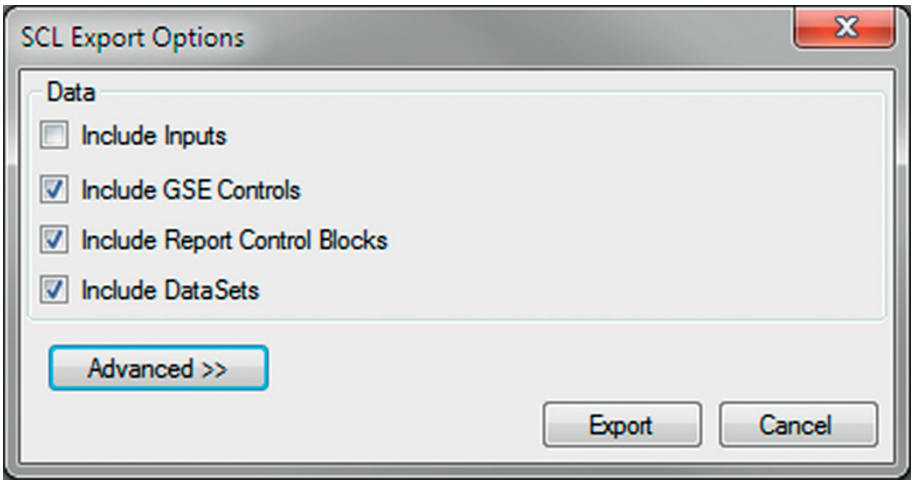

Figure 89: IEC 61850: export options for ICD files

6. Change the SCL file version by clicking the **Advanced** button, if required by the receiving configuration tool.

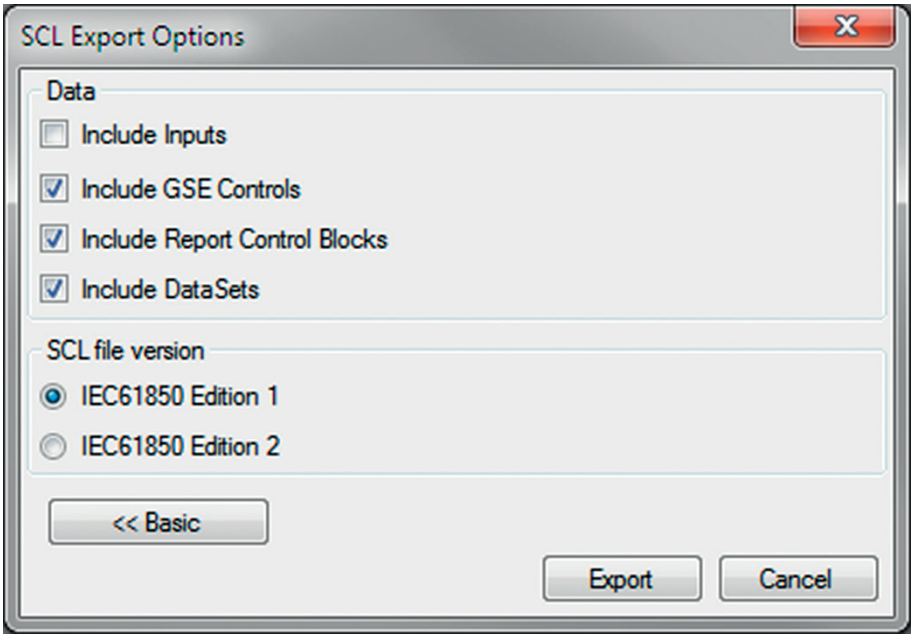

Figure 90: SCL export options

7. Click **Export**.

7.3.2 Engineering vertical and horizontal communication

For IEC 61850 engineering a separate system configuration tool is needed to be used with PCM600. In PCM600 Ver.2.5 or later 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. [1]
2. Import the SCD file created by PCM600. [1]
3. Conduct vertical communication engineering (monitoring direction).
   3.1. Check the default data sets.
   3.2. Configure and/or reconfigure 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.

   3.3. Configure additional **Report Control Blocks** when needed for each data set used for vertical communication.
   3.4. Link the IED clients to the **Report Control Blocks**.

Up to five report clients can be configured.

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

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

   4.2. Define the client IEDs for each GOOSE control block.
   4.3. Link the IEDs to the GOOSE control block that is to receive the GOOSE control block.
5. Export the updated SCD file. [1]

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

[1] Applicable when using IET600

7.3.3 Importing SCL files to PCM600

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

7.3.3.1 Importing SCD files

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. Select the station in the **Plant Structure** view.
2. Right-click the station and select **Import**.
3. From the open standard Windows menu, select the file to be imported and start the reading.
   The **SCL Import Options** dialog box opens, querying how the file should be handled during the import.

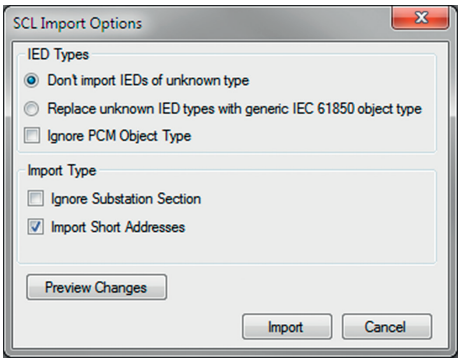

Figure 91: SCL Import Options

4. In the **SCL Import Options** dialog box, select how to handle the file during the import.
   - 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 it is known that the file includes additional IEDs that are needed. The IED of type “Generic IEC 61850 IED” is used to integrate these kinds 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.
5. Click **Import** when the file definition has been completed.

A progress view displays the importing procedure.

6. Make connections from the sending IEDs to the receiving function blocks with the Signal Matrix tool.
   Make connections between the signals that the server is sending and the function blocks on the receiver's side.
7. Write the configuration to the IED.
   In the **Plant Structure** view, select the IED, right-click and select **Write to IED**.

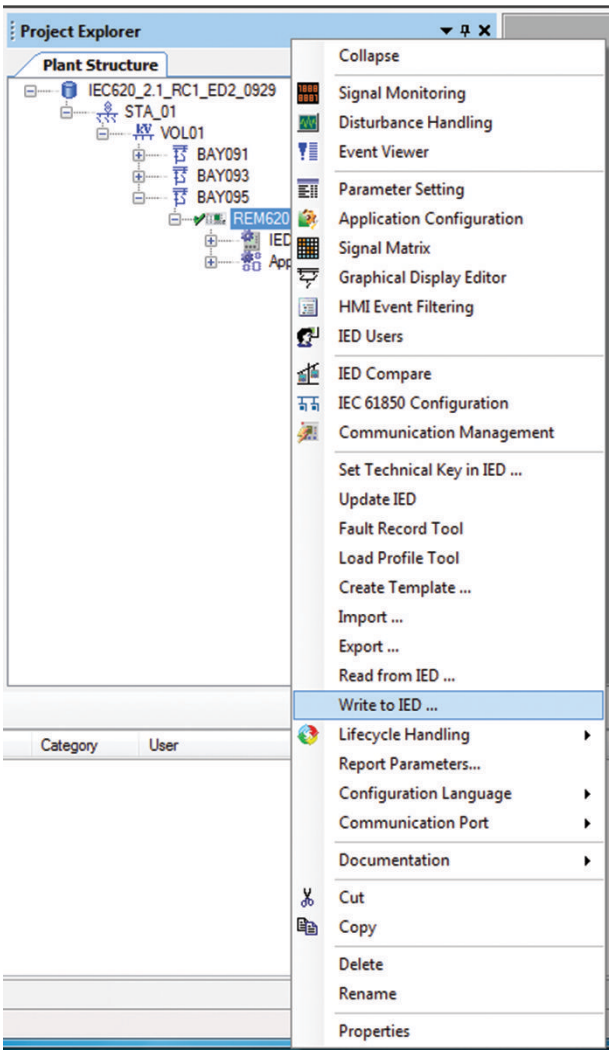

Figure 92: Common write menu

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

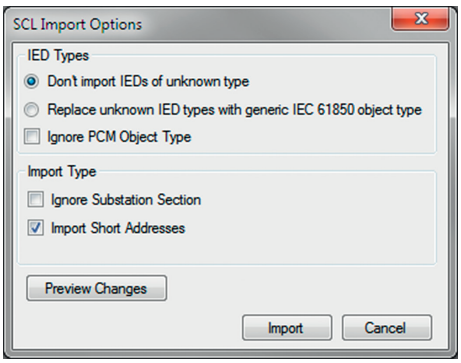

Figure 93: SCL Import Options

- **Don't import** protects the existing IEDs in case the SCD file does not match the original configuration in PCM600.
- **Replace unknown** can be used when it is known that the file includes additional IEDs that are needed. The IED of type “Generic IEC 61850 IED” is used to integrate these kinds of IEDs into, for example, the plant structure.
- **Ignore PCM Object Type** updates the IED object(s) in PCM600 from the IED type(s) in the SCD file, discarding whether or not the IED type(s) in the SCD file matches the IED object(s) 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 the 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 protection relay, the horizontal communication configuration needs to be updated.

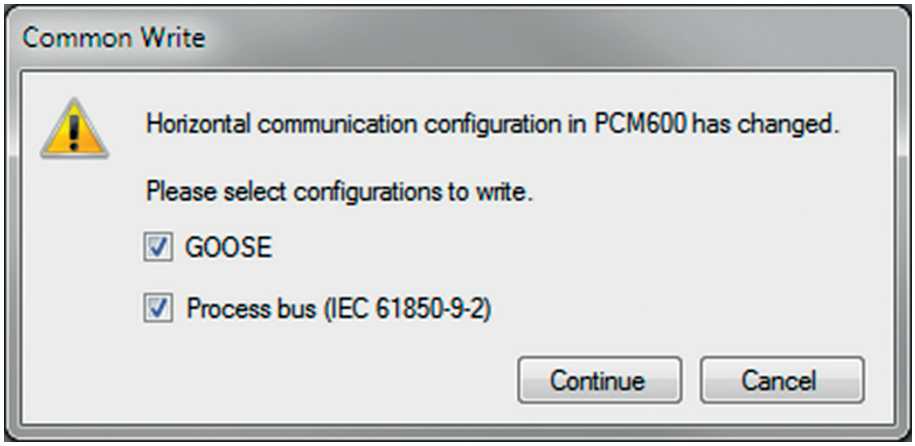

Figure 94: Updating the communication configuration in the IED with the configuration made in PCM600

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

Section 8 Configuration migration

8.1 Configuration migration workflow

IED Configuration Migration (ICM) migrates the configuration from an old relay product version into the latest product version with the corresponding functionality. The configuration migration is done by the Migrate Configuration functionality in PCM600. IED Configuration Migration retains the contents of an existing IED configuration and enables using it with the latest product version.

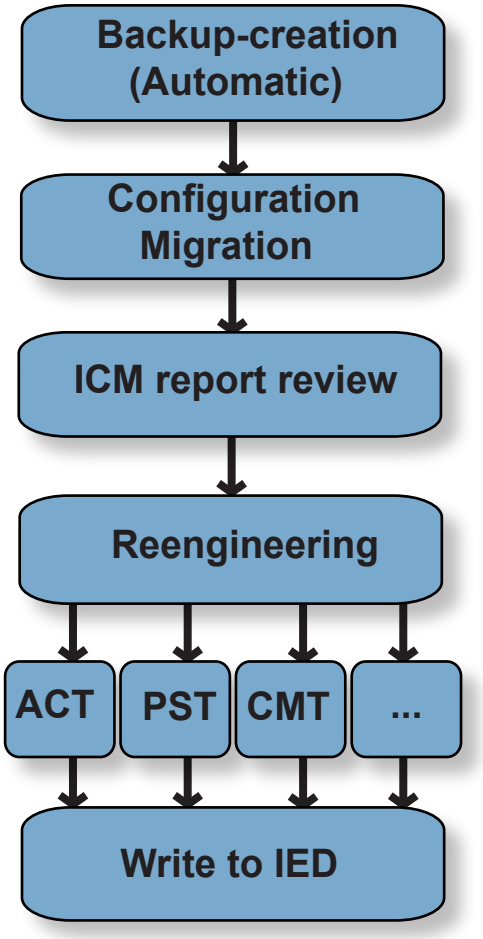

Figure 95: IED configuration migration workflow

The newer product versions and the function revisions have been designed to be backward compatible. No functionality is removed in newer function revisions apart from some exceptions.

8.2 Preconditions for configuration migration

The source IED configuration can be migrated to the target version using the latest versions of PCM600 and the connectivity package.

Manual reengineering may also be required as some interface changes can exist between the functions in different product versions.

The order code of the target IED must match the order code of the source IED. However, the language options and product version can differ.

Table 12: Versions supporting migration

PCM600 version	Connectivity package version	Source version	Target version
PCM600 2.6 (Rollup 20150626)	Ver.2.1	Ver.2.0	Ver.2.0 FP1

8.3 Backup creation

While starting IED Configuration Migration, a backup is created automatically. The backup project is available in the PCMBackup folder under PCMdatabases. The default location is C:\PCMdatabases\PCMBackup.

8.4 Migrating the IED configuration

Ensure that the latest connectivity package is activated in PCM600 in **Help/Update Manager/Manage connectivity packages**. Restart PCM600 for the changes to take place in the active connectivity package.

1. Right-click the IED to be migrated and select **Migrate Configuration**.

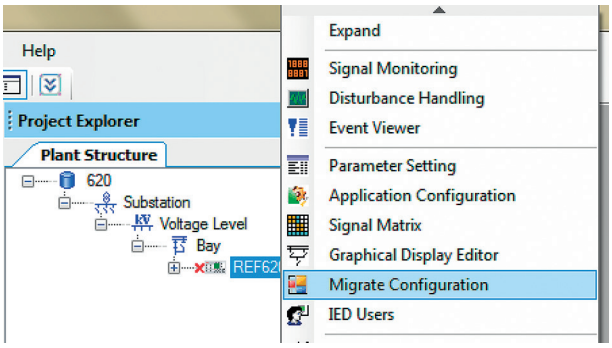

Figure 96: Selecting the IED to be migrated

2. Select the target version in the dialog box and click **Continue**.

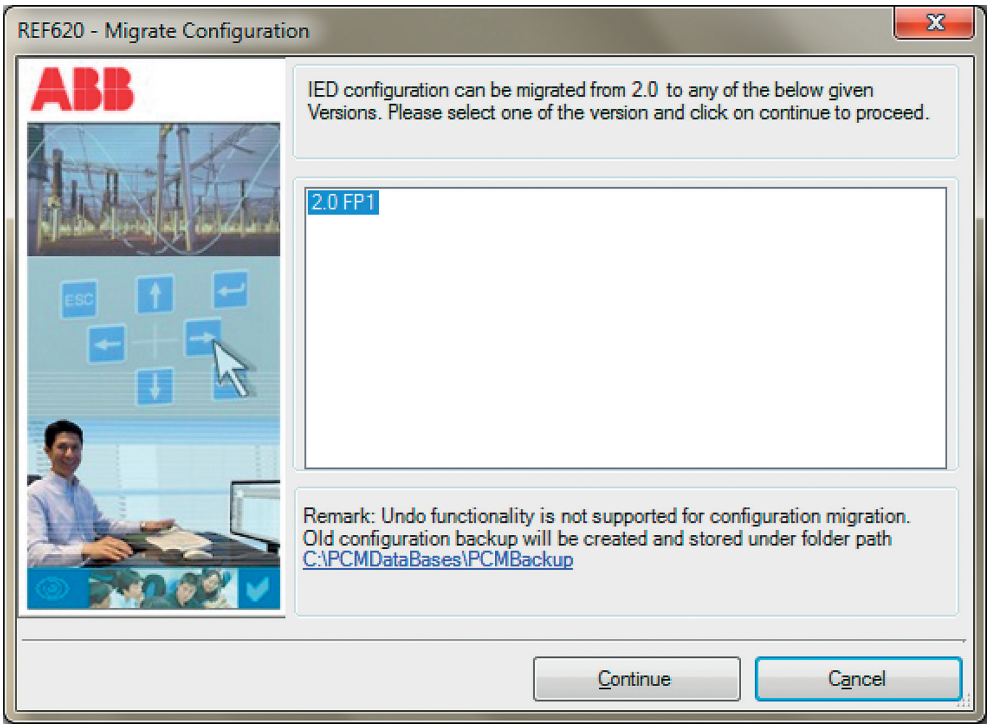

Figure 97: Target version selection

The Configuration Migration Details dialog box is displayed giving the summary of the migration process.

3. Click **Next** to start the migration process.

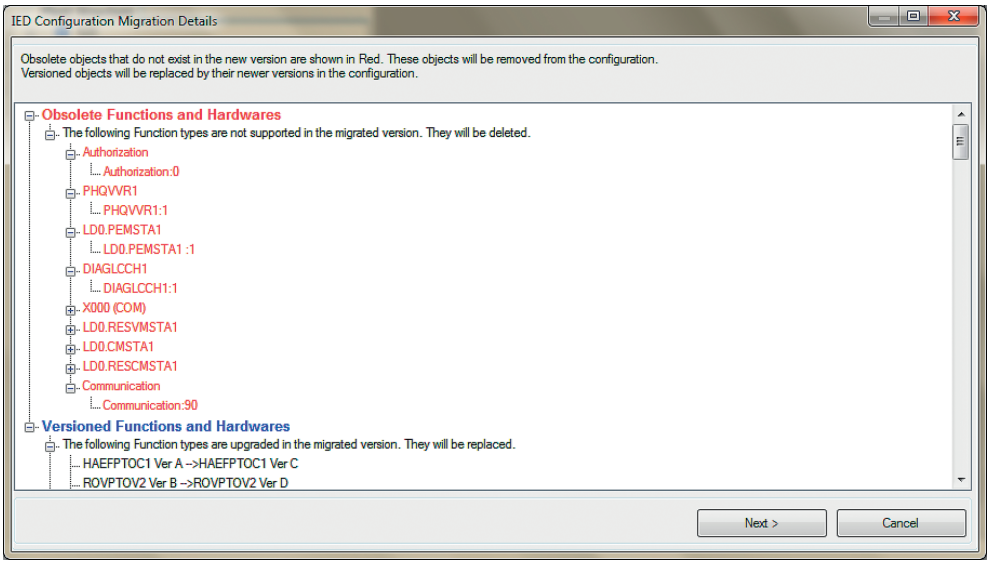

Figure 98: IED configuration Migration Details

Obsolete Functions and Hardware	Functions that cannot be migrated. The corresponding function blocks are removed from the configuration. Some of these functions are part of the fixed instances found under the IED configuration in the plant structure, and these functions are instantiated automatically but their parameters are set to default values. Some functions may require reengineering, for example LED connections.
Versioned Functions and Hardware	Functions that have been replaced in the configuration and are migrated to a new function version.

Table 13: IEC 61850 names changed from Ver.2.0 to Ver.2.0 FP1 shown in Versioned Functions and Hardware

Function	IEC 61850 name in product version 2.0 FP1	IEC 61850 name in product version 2.0
Generic control point (16 pcs)	SPCGAPC	SPCGGIO
Remote generic control points	SPCRGAPC	SPCRGGIO
Local generic control points	SPCLGAPC	SPCLGGIO
Fuse failure	SEQSPVC	SEQRFUF
Current circuit supervision	CCSPVC	CCRDIF
Tap changer position indication	TPOSYLTC	TPOSSLTC
Fault recorder	FLTRFRC	FLTMSTA
Load profile	LDPRLRC	LDPMSTA

The functions that cannot be not found in any of the lists have the same source and the target versions and do not need to be reengineered.

The migration takes a few minutes. The PCM600 output window contains valuable information from different parts of the migration, such as successfully imported parameter details and the location of the newly created template. The migration process also creates a report.

4. Wait until the migration process is completed.
5. Select the **Show IED Configuration Migration Report** check box to view, print or save the report and click **Finish**.
   The report is useful later when updating the configuration.

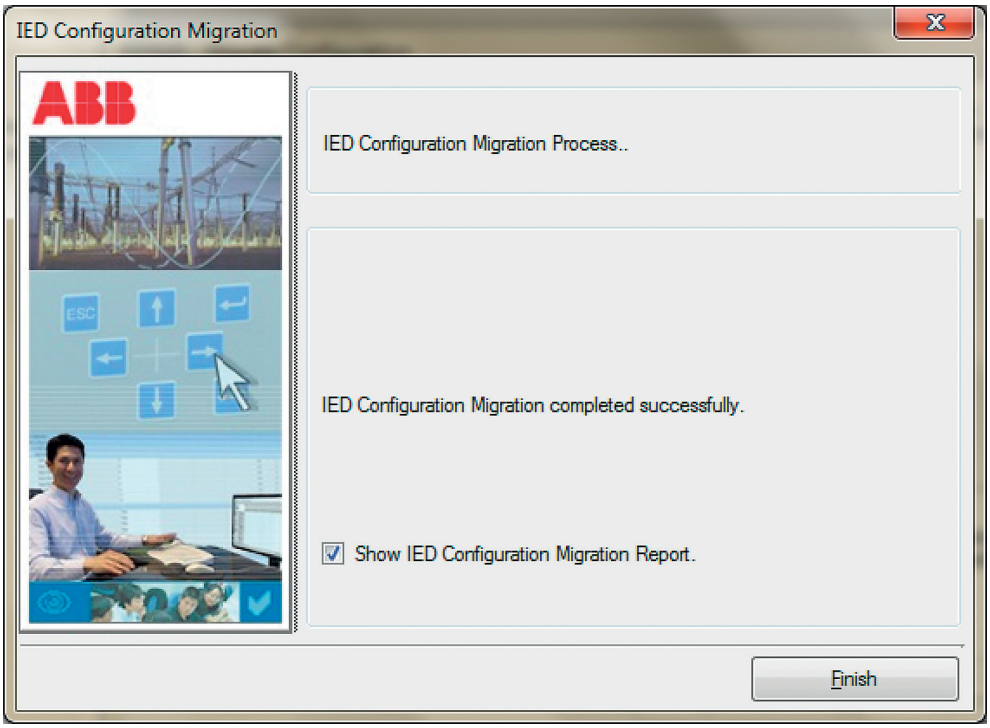

Figure 99: IED Configuration Migration window

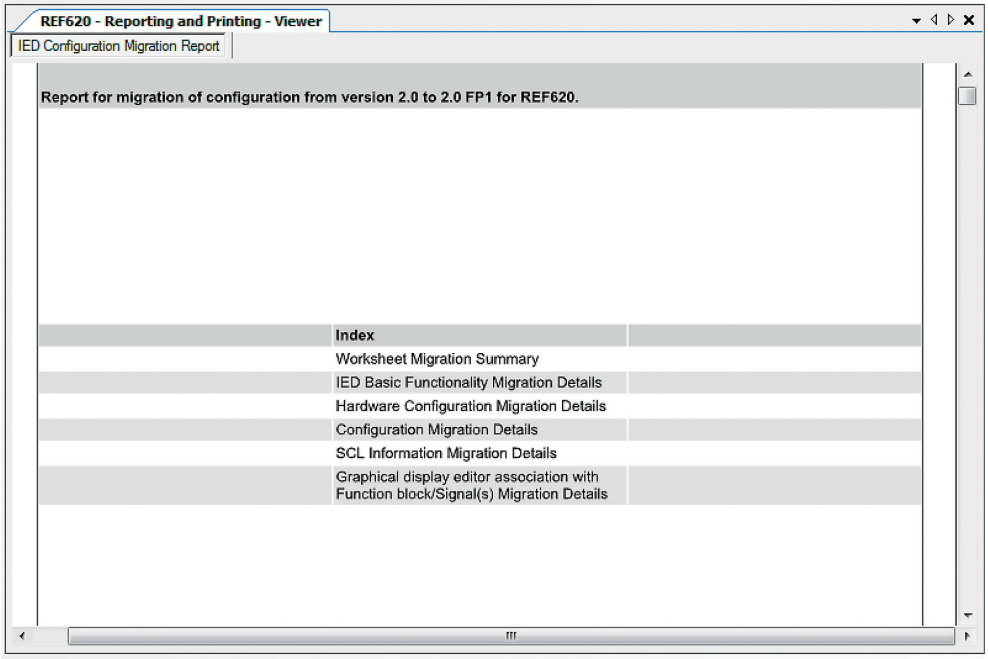

Figure 100: IED Configuration Migration Report pane in PCM600

While open, the migration report can be saved or printed from the PCM600 tool bar.

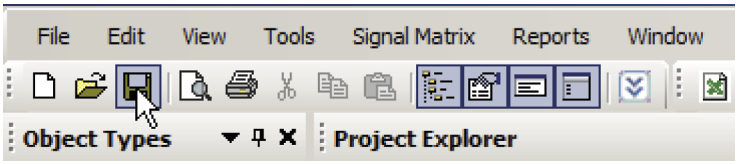

Figure 101: Saving and printing from the tool bar

Save the IED configuration migration report for later use as PCM600 does not save it automatically.

8.5 Reengineering the migrated configuration

8.5.1 Reengineering in the Application Configuration tool

1. Review the configuration migration report and update the application configuration accordingly.

- If a function has been removed, it has been replaced by another function or the migration has not been possible for other reasons.
- If a signal has been removed, it has a new functional meaning. See the technical manual to ensure how the functions are used correctly. Even if the function has a new version number, the actual change in the function itself might be very minor.

2. Save the Application Configuration tool configuration again and exit.

See the technical manual for version history of the functions and Table 11 for the IEC 61850 Edition 1 vs. Edition 2 mapping.

8.5.1.1 Example of reengineering LED connections

LED functionality has changed in Ver.2.0 FP1. For example, the color of the LEDs when an alarm is triggered can be changed. Therefore LED connections must be reengineered to achieve the desired IED LED panel functionality. In older versions they can be found under hardware but in Ver.2.0 FP1 and later versions under configuration as programmable LEDs.

1. Right-click an IED to be configured and select **Application Configuration**. Locate the LED connections page in Application Configuration. Missing output blocks are represented in red.

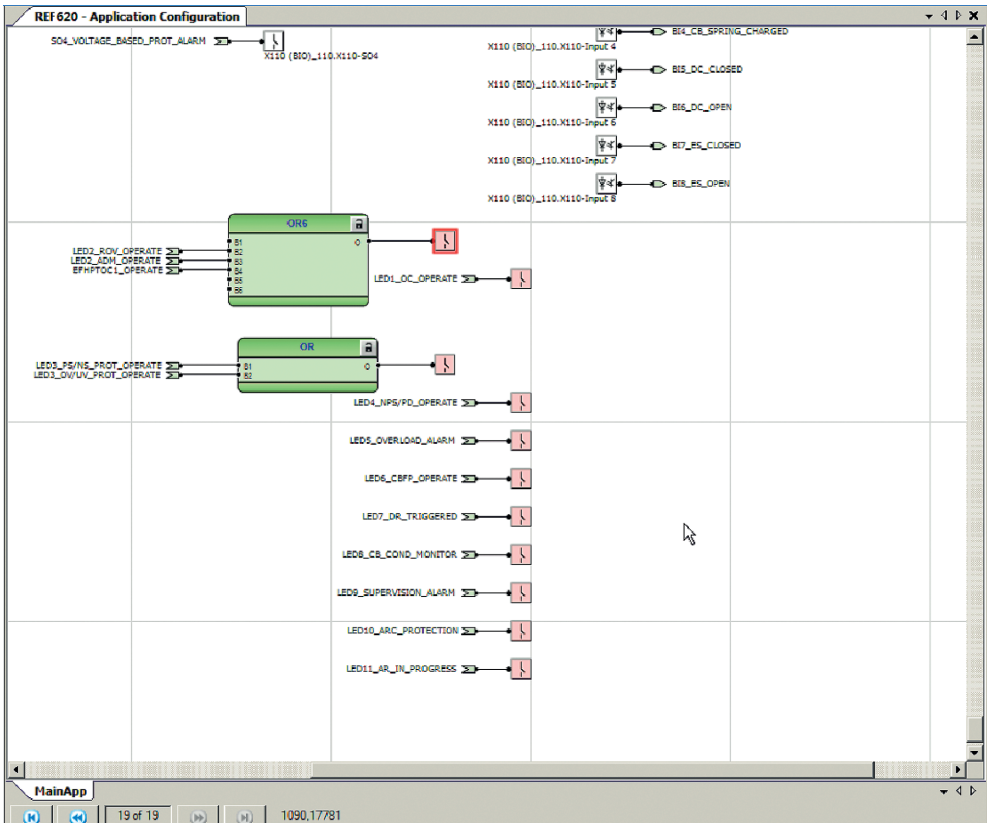

Figure 102: LED connection blocks after migration

2. Delete old output blocks shown in red.
3. Drag new LED blocks from the **Object Types** pane on the left to the **Application Configuration** pane.
   LED function blocks can be found under **Local HMI**.

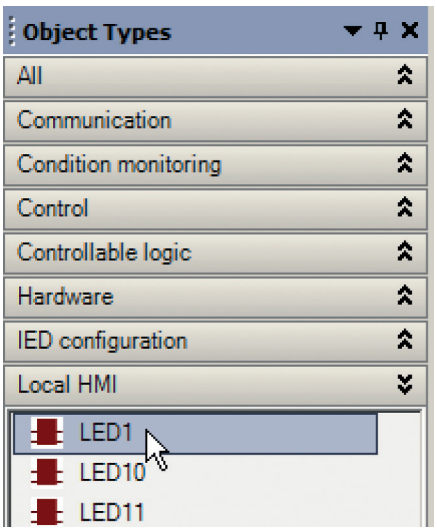

Figure 103: Locating LED blocks in the Object Types pane

4. In the **Function Block Instance** dialog, change the names and execution orders of the function blocks and click **Assign**.
The names and execution orders can be edited later by right-clicking the desired function block.

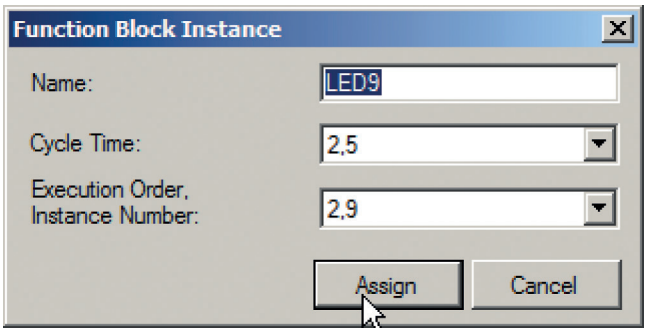

Figure 104: Changing LED name and execution order

5. Connect the inputs to the correct LED function blocks by dragging from the variable or OR function block output to the input of the LED function block. Rearranging may be required to fit everything on the page.

Connect to the right input of the LED function block to achieve correct functionality of the LED panel. Typically, LED function blocks are connected to variables or OR function blocks that should already be present; just connect the LED function block inputs to the corresponding variables or outputs of the OR function block.

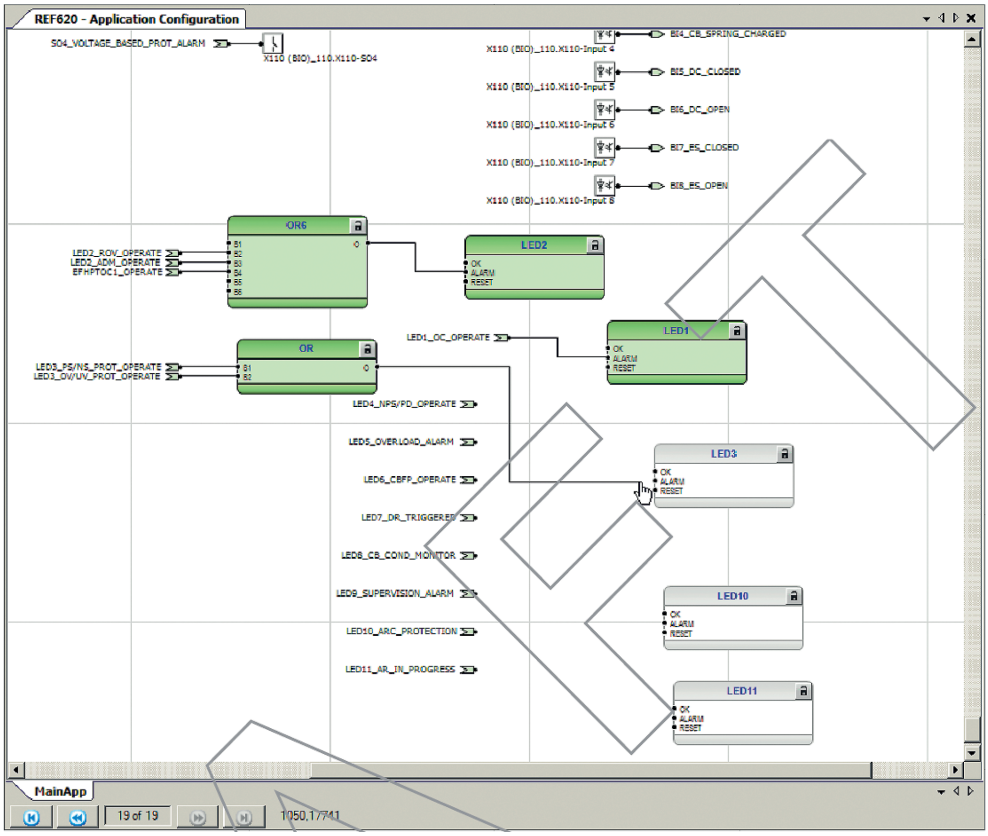

Figure 105: Connecting LED inputs to correct LED blocks

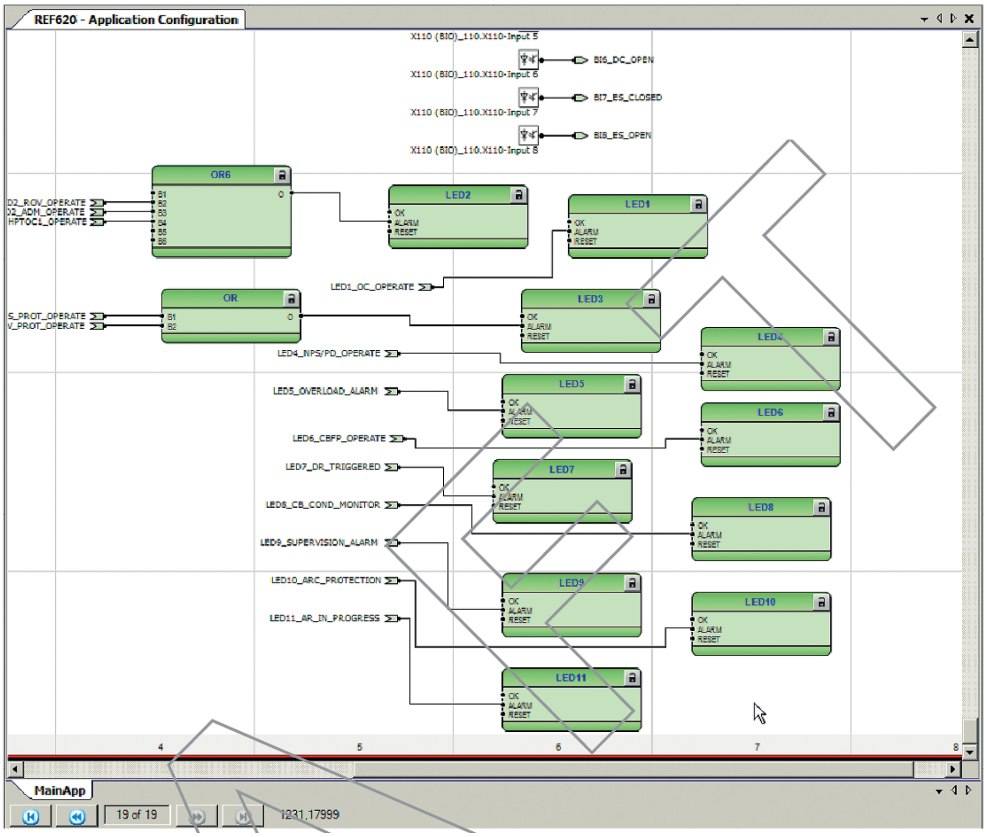

Figure 106: Every LED input is connected to the corresponding LED block

6. Save the configuration and click the **Validate configuration** button from the PCM600 toolbar.

Figure 107: Validating configuration

8.5.2 Reengineering in the Parameter Setting tool

Parameter values remain unchanged for all the functions listed in Versioned Functions and Hardwares list. Parameter values remain unchanged also for the functions not listed in the migration report, that is, the functions that have the same version in both the product versions.

- Set the parameter values again for all the needed functions.

- All functions listed in **Obsolete Functions and Hardwares**.
- All parameters for which the migration failed. See the migration report for failed parameters.
- Parameters of the DNP3 and Profibus related functions that are reset to default values in migration. Restore the original parameters.

Note that some functions may have new settings.

8.5.3 Reengineering in the IEC 61850 Configuration tool

IEC 61850 data names have been changed in 2.0 FP1 compared to older product versions. I CM automatically updates the names according to the new version names. Migration report describes the details of the changes in dataset entries.

For the function block names in IEC 61850 Edition 1 and Edition 2, see Table 11.

8.5.4 Reengineering in the Communication Management tool

After migration, check the protocol mapping related to programmable LEDs, setting groups, power measurement and control objects for circuit breakers, disconnectors and earth switches.

8.5.4.1 Checking and updating DNP3 points

If DNP3 is used, the migrated DNP3 point list should for most part correspond to the configuration made in the old IED.

1. Check the point list and verify that all the point types correspond to the old configuration and DNP3 master.
   - Analog input objects
   - Binary input objects
   - Binary output objects

- Counter objects
- Double bit indication objects
- Analog output objects

2. If some points have different point addresses or other mapping attributes, adjust them in the Communication Management tool.
3. Add the possible missing points in the migrated configuration by taking them back to use in the Communication Management tool.

8.5.4.2 Checking and updating Modbus points

If Modbus is used, the migrated Modbus point list should for most part correspond to the configuration made in the old IED.

1. Check the point list and verify that all the point types correspond to the old configuration and Modbus master.
   - 0X – Readable coils
   - 1X – Discrete inputs
   - 3X – Input registers
   - 4X - Readable holding registers
   - Fault record data

   If some points have different attributes, adjust them in the Communication Management tool.
2. Adjust possible missing points or changed point addresses in Modbus master configuration.

8.5.4.3 Checking and updating IEC 60870-5-103 points

If IEC 60870-5-103 is used, the migrated IEC 60870-5-103 point list should for most part correspond to the configuration made in the old IED.

1. Check the point list and verify that all the point types correspond to the old configuration and IEC 60870-5-103 master.
   - Indications
   - Measurands
2. If some points have different attributes, adjust them in the Communication Management tool.
3. Change the possible changed point addresses to match the master address by using a user-defined address instead of the default address.
4. Adjust possible missing points points in IEC 60870-5-103 master configuration.

8.5.5 Reengineering in the HMI event filtering tool

If HMI event filtering is used, the migrated event filter should for most part correspond to the configuration made in the old IED.

1. Check the HMI event filter tree view and verify that the event filter corresponds to the old configuration.
2. Add or remove the possible missing events in the migrated configuration by selecting or clearing the check box in the HMI event filtering tool.

8.5.6 Reengineering in Graphical Display Editor

- Check and modify the single-line diagram in Graphical Display Editor for the desired appearance and needed functionalities for the HMI.
- Write the migrated configuration into the IED.

Section 9 Glossary

620 series	Series of numerical protection and control relays for high-end protection and supervision applications of utility substations, and industrial switchgear and equipment
ACT	1. Application Configuration tool in PCM600 2. Trip status in IEC 61850
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
CT	Current transformer
DA	Data attribute
DHCP	Dynamic Host Configuration Protocol
DHT	Disturbance Handling tool in PCM600
DNP3	A distributed network protocol originally developed by Westronic. The DNP3 Users Group has the ownership of the protocol and assumes responsibility for its evolution.
DO	Data object
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
EVT	Event Viewer tool in PCM600
FTP	File transfer protocol
FTPS	FTP Secure

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
ICM	IED configuration migration
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modeling
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
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
MON	Signal Monitoring tool in PCM600
NCC	Network control center
PC	1. Personal computer 2. Polycarbonate

PCM600	Protection and Control IED Manager
PRP	Parallel redundancy protocol
PST	1. Parameter Setting tool in PCM600 2. Product Selection Tool
SAB600	Substation automation builder tool
SCD	Substation configuration description
SCL	XML-based substation description configuration language defined by IEC 61850
SMT	Signal Matrix tool in PCM600
SNTP	Simple Network Time Protocol
Subnet mask	A set of four numbers used to create IP address numbers that are used only within a particular network, subnet
TCP	Transmission Control Protocol
UDP	User datagram protocol
VPN	Virtual Private Network
VT	Voltage transformer
WAN	Wide area network
WHMI	Web human-machine interface
XRIO	eXtended Relay Interface by OMICRON

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