Relion® 620 series

Motor Protection and Control REM620 ANSI
Application Manual

Power and productivity
for a better world™

ABB

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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 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series and ANSI C37.90. This IED complies with the UL 508 certification.

Section 1 Introduction

1.1 This manual

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

1.2 Intended audience

This manual addresses the protection and control engineer responsible for planning, pre-engineering and engineering.

The protection and control engineer must be experienced in electrical power engineering and have knowledge of related technology, such as communication and protocols.

1.3 Product documentation

1.3.1 Product documentation set

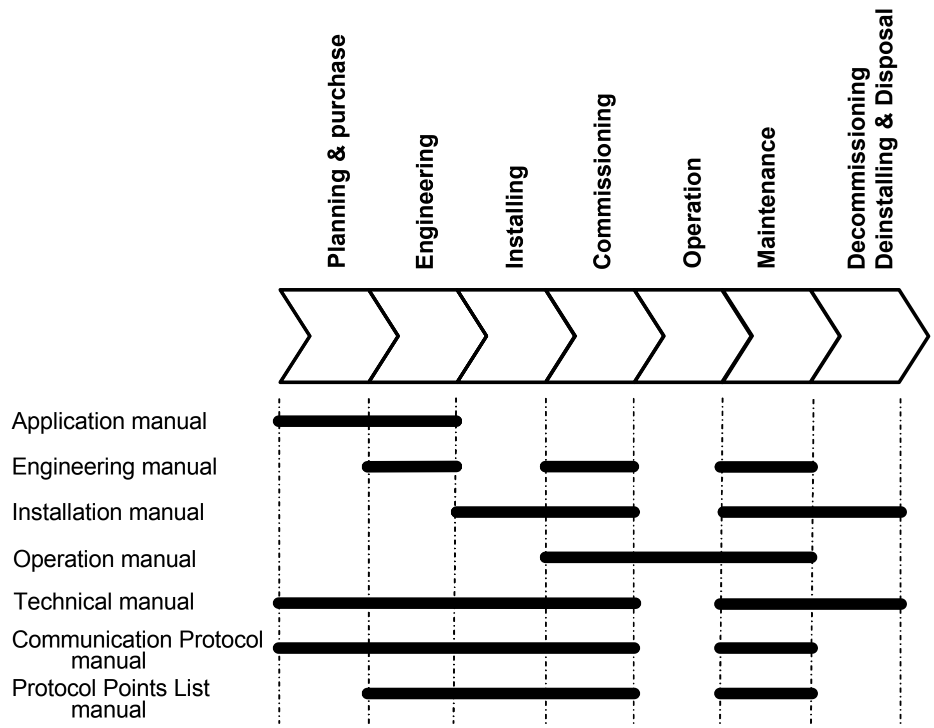


Figure 1: The intended use of manuals in different life cycles

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

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

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

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

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

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

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

1.3.2 Document revision history

Document revision/date	Product version	History
A/10/26/2012	2.0	First release

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

1.3.3 Related documentation

Name of the document	Document ID
Modbus Communication Protocol Manual	1MAC458836-IB
DNP3 Communication Protocol Manual	1MAC459571-IB
IEC 61850 Engineering Guide	1MAC454732-IB
Installation Manual	1MAC457436-IB
Operation Manual	1MAC456939-IB
Technical Manual	1MAC504801-IB

1.4 Symbols and conventions

1.4.1 Safety indication symbols

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

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

The caution 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 to 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 should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Manual conventions

Conventions used in IED manuals. A particular convention may not be used in this manual.

- Abbreviations and acronyms in this manual are spelled out in the glossary. The glossary also contains definitions of important terms.
- Pushbutton navigation in the LHMI menu structure is presented by using the pushbutton icons, for example:
  To navigate between the options, use ↑ and ↓.
- HMI menu paths are presented in bold, for example:
  Select **Main menu** > **Settings**.
- LHMI messages are shown in Courier font, for example:
  To save the changes in non-volatile memory, select `Yes` and press ↵.
- Parameter names are shown in italics, for example:
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks, for example:
  The corresponding parameter values are "Enabled" and "Disabled".
- IED input/output messages and monitored data names are shown in Courier font, for example:
  When the function picks up, the `PICKUP` output is set to TRUE.
- Dimensions are provided both in inches and mm. If it is not specifically mentioned then the dimension is in mm.

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 standard configurations, REM620

Function	IEC 61850	ANSI/C37.2	IEC60617
Protection			
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P	3I> (1)
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P	3I>> (1)
Non-directional ground-fault protection, low stage, instance 1	EFLPTOC1	51G	Io> (1)
Non-directional ground-fault protection, high stage, instance 1	EFHPTOC1	50G	Io>> (1)
Directional ground-fault protection, low stage, instance 1	DEFLPDEF1	67/51N	Io> -> (1)
Residual overvoltage protection, instance 1	ROVPTOV1	59G	Uo> (1)
Residual overvoltage protection, instance 2	ROVPTOV2	59N	Uo> (2)
Three-phase under-voltage protection, instance 1	PHPTUV1	27	3U< (1)
Three-phase overvoltage protection, instance 1	PHPTOV1	59	3U> (1)
Positive-sequence undervoltage protection, instance 1	PSPTUV1	27PS	U1<(1)
Negative-sequence overvoltage protection, instance 1	NSPTOV1	47	U2>(1)
Frequency protection, instance 1	FRPFRQ1	81	f>/f<,df/dt(1)
Negative-sequence overcurrent protection for motors, instance 1	MNSPTOC1	46M-1	I2>M(1)
Negative-sequence overcurrent protection for motors, instance 2	MNSPTOC2	46M-2	I2>M(2)
Loss of load supervision, instance 1	LOFLPTUC1	37M-1	3I<(1)
Loss of load supervision, instance 2	LOFLPTUC2	37M-2	3I<(2)
Motor load jam protection	JAMPTOC1	51LR	1st>
Motor start-up supervision	STTPMSU1	66/51LRS	Is2t n<
Phase reversal protection	PREVPTOC1	46R	I2>>
Thermal overload protection for motors	MPTTR1	49M	3Ith>M
Motor differential protection	MPDIF1	87M	3dI>M
Circuit breaker failure protection, instance 1	CCBRBRF1	50BF	3I>/Io>BF(1)
Master trip, instance 1	TRPPTRC1	86/94-1	Master Trip(1)
Master trip, instance 2	TRPPTRC2	86/94-2	Master Trip (2)
Arc protection, instance 1	ARCSARC1	AFD-1	ARC (1)
Arc protection, instance 2	ARCSARC2	AFD-2	ARC (2)
Arc protection, instance 3	ARCSARC3	AFD-3	ARC (3)
RTD based thermal protection, instance 1	MAPGAPC1	38-1	MAP(1)
RTD based thermal protection, instance 2	MAPGAPC2	38-2	MAP(2)
RTD based thermal protection, instance 3	MAPGAPC3	38-3	MAP(3)
RTD based thermal protection, instance 4	MAPGAPC4	38-4	MAP(4)
RTD based thermal protection, instance 5	MAPGAPC5	38-5	MAP(5)

Function	IEC 61850	ANSI/C37.2	IEC60617
RTD based thermal protection, instance 6	MAPGAPC6	38-6	MAP(6)
RTD based thermal protection, instance 7	MAPGAPC7	38-7	MAP(7)
Control			
Circuit-breaker control, instance 1	CBXCBR1	52	I <-> O CB (1)
Emergency startup	ESMGAPC1	62EST	ESTART
Condition Monitoring			
Circuit-breaker condition monitoring, instance 1	SSCBR1	52CM	CBCM(1)
Trip circuit supervision, instance 1	TCSSCBR1	TCM-1	TCS(1)
Trip circuit supervision, instance 2	TCSSCBR2	TCM-2	TCS(2)
Current circuit supervision	CCRDIF1	CCM	MCS 3I
Fuse Failure supervision, instance 1	SEQRFUF1	60	FUSEF(1)
Runtime counter for machines and devices, instance 1	MDSOPT1	OPTM-1	OPTS(1)
Runtime counter for machines and devices, instance 2	MDSOPT2	OPTM-2	OPTS(2)
Measurement			
Three-phase current measurement, instance 1	CMMXU1	IA, IB, IC	3I
Three-phase current measurement, instance 2	CMMXU2	IA, IB, IC (2)	3I(B)
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0	I1, I2, I0
Sequence current measurement, instance 2	CSMSQI2	I1, I2, I0 (2)	I1, I2, I0(B)
Residual current measurement, instance 1	RESCMMXU1	IG	Io
Three-phase voltage measurement, instance 1	VMMXU1	VA, VB, VC	3U
Residual voltage measurement	RESVMMXU1	VG	Uo
Sequence voltage measurement, instance 1	VSMSQI1	V1, V2, V0	U1, U2, U0
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE	SP, SE
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E
Load profile	LDPMSTA1	LoadProf	LoadProf
Frequency measurement	FMMXU1	1	1
Recorder			
Disturbance recorder	RDRE1	DFR	DR
Fault recorder	FLTMSTA1	FR	FR
Sequence event recorder	SER	SER	SER
Other Functions			
Minimum pulse timer (2 pcs), instance 1	TPGAPC1	TP-1	TP (1)
Minimum pulse timer (2 pcs), instance 2	TPGAPC2	TP-2	TP (2)
Minimum pulse timer (2 pcs), instance 3	TPGAPC3	TP-3	TP (3)
Minimum pulse timer (2 pcs), instance 4	TPGAPC4	TP-4	TP (4)
Pulse timer (8 pcs), instance 1	PTGAPC1	PT-1	PT (1)
Pulse timer (8 pcs), instance 2	PTGAPC2	PT-2	PT (2)
Time delay off (8 pcs), instance 1	TOFGAPC1	TOF-1	TOF (1)

Function	IEC 61850	ANSI/C37.2	IEC60617
Time delay off (8 pcs), instance 2	TOFGAPC2	TOF-2	TOF (2)
Time delay off (8 pcs), instance 3	TOFGAPC3	TOF-3	TOF (3)
Time delay off (8 pcs), instance 4	TOFGAPC4	TOF-4	TOF (4)
Time delay on (8 pcs), instance 1	TONGAPC1	TON -1	TON (1)
Time delay on (8 pcs), instance 2	TONGAPC2	TON -2	TON (2)
Time delay on (8 pcs), instance 3	TONGAPC3	TON -3	TON (3)
Time delay on (8 pcs), instance 4	TONGAPC4	TON -4	TON (4)
Set reset (8 pcs), instance 1	SRGAPC1	SR-1	SR (1)
Set reset (8 pcs), instance 2	SRGAPC2	SR-2	SR (2)
Set reset (8 pcs), instance 3	SRGAPC3	SR-3	SR (3)
Set reset (8 pcs), instance 4	SRGAPC4	SR-4	SR (4)
Move (8 pcs), instance 1	MVGAPC1	MV-1	MV (1)
Move (8 pcs), instance 2	MVGAPC2	MV-2	MV (2)
Move (8 pcs), instance 3	MVGAPC3	MV-3	MV (3)
Move (8 pcs), instance 4	MVGAPC4	MV-4	MV (4)
Move (8 pcs), instance 5	MVGAPC5	MV-5	MV (5)
Move (8 pcs), instance 6	MVGAPC6	MV-6	MV (6)
Move (8 pcs), instance 7	MVGAPC7	MV-7	MV (7)
Move (8 pcs), instance 8	MVGAPC8	MV-8	MV (8)
Generic control points, instance 1	SPCGGIO1	CNTRL-1	SPC(1)
Generic control points, instance 2	SPCGGIO2	CNTRL-2	SPC(2)
Generic control points, instance 3	SPCGGIO3	CNTRL-3	SPC(3)
Remote Generic control points, instance 1	SPCRGGIO1	RCNTRL-1	SPCR(1)
Local Generic control points, instance 1	SPCLGGIO1	LCNTRL-1	SPCL(1)
Generic Up-Down Counters, instance 1	UDFCNT1	CTR-1	CTR(1)
Generic Up-Down Counters, instance 2	UDFCNT2	CTR-2	CTR(2)
Generic Up-Down Counters, instance 3	UDFCNT3	CTR-3	CTR(3)
Generic Up-Down Counters, instance 4	UDFCNT4	CTR-4	CTR(4)
Generic Up-Down Counters, instance 5	UDFCNT5	CTR-5	CTR(5)
Generic Up-Down Counters, instance 6	UDFCNT6	CTR-6	CTR(6)
Generic Up-Down Counters, instance 7	UDFCNT7	CTR-7	CTR(7)
Generic Up-Down Counters, instance 8	UDFCNT8	CTR-8	CTR(8)
Generic Up-Down Counters, instance 9	UDFCNT9	CTR-9	CTR(9)
Generic Up-Down Counters, instance 10	UDFCNT10	CTR-10	CTR(10)
Generic Up-Down Counters, instance 11	UDFCNT11	CTR-11	CTR(11)
Generic Up-Down Counters, instance 12	UDFCNT12	CTR-12	CTR(12)
Programmable buttons (16 buttons), instance 1	FKEYGGIO1	FKEY	FKEY

Section 2 REM620 overview

2.1 Overview

REM620 is a dedicated motor IED (intelligent electronic device) designed for the protection, control, measurement and supervision of medium and large motors. REM620 is a member of ABB's Relion® product family and part of its 620 protection and control product series. The 620 series IEDs are characterized by their compactness and withdrawable design.

Re-engineered from the ground up, the 620 series has been designed to unleash the full potential of the IEC 61850 standard for communication and interoperability between substation automation devices.

Once the standard configuration IED has been given the application-specific settings, it can directly be put into service.

The 620 series IEDs support a range of communication protocols including IEC 61850 with GOOSE messaging, Modbus® and DNP3.

2.1.1 Product version history

Product version	Product history
2.0	• Product released

2.1.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.4.1
- IED Connectivity Package REM620 Ver. 2.0 ANSI or later
  - Parameter Setting
  - Application configuration
  - Firmware Update
  - Disturbance Handling
  - Signal Monitoring
  - Life Cycle Traceability
  - Signal Matrix
  - Communication Management
  - Configuration Wizard
  - Label Printing
  - IED User Management
  - IED Users

Download connectivity packages from the ABB web site http://www.abb.com/substationautomation

2.2 Physical hardware

The IED consists of two main parts: plug-in unit and case. The plug-in unit content depends on the ordered functionality.

Figure 2: Front view of REM620 with plug-in unit partly drawn out

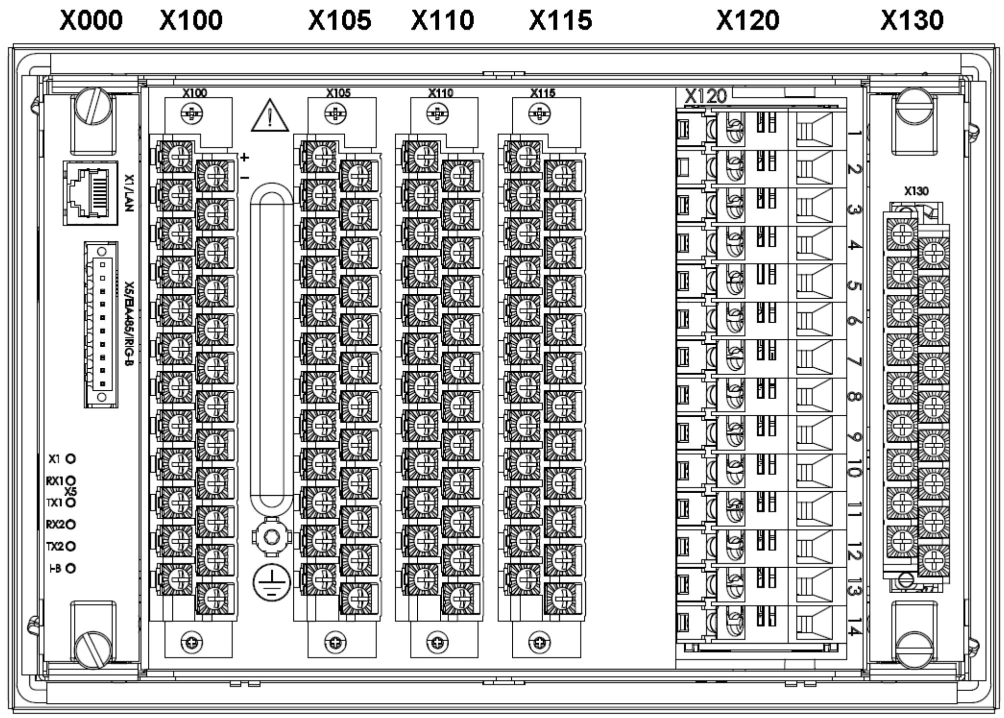


Figure 3: Rear view of REM620 with all slots equipped, with slot ID's indicated on top

Table 2: Plug-in unit and case (REM620)

<table>
<tr><th>Main unit</th><th>Slot ID</th><th>Module ID</th><th colspan="2">Content options</th></tr>
<tr><td rowspan="9">Plug-in unit</td><td>-</td><td>DIS0008</td><td>HMI</td><td>128/128 LCD large display with text and graphics</td></tr>
<tr><td>X100</td><td>PSM0004
Or
PSM0003</td><td>Auxiliary power/BO module</td><td>48-250V DC/ 80-240V AC; or 24-60V DC
2 normally-open PO contacts
2 normally-open SO contacts
2 double-pole PO contacts with TCS
1 dedicated internal fault output contact</td></tr>
<tr><td>X105</td><td>RTD0003</td><td>RTD/mA Input module</td><td>Equipped as standard:
6 RTD inputs
2 low current (0.1ma-20mA) inputs</td></tr>
<tr><td>X110</td><td>RTD0003</td><td>RTD/mA Input module</td><td>Equipped as standard:
6 RTD inputs
2 low current (0.1ma-20mA) inputs</td></tr>
<tr><td rowspan="2">X115</td><td>BIO0005</td><td rowspan="2">BI/O module</td><td>Default minimum, equipped with
8 Binary Inputs
4 Binary Outputs</td></tr>
<tr><td>BIO0007</td><td>May be alternatively equipped with high-speed BIO module
8 Binary Inputs
3 High speed PO contacts</td></tr>
<tr><td rowspan="2">X120</td><td>AIM0004</td><td rowspan="2">AI module</td><td>With Configuration A
3 phase current Inputs (1/5A)
1 phase current input (1/5A)
3 Voltage Inputs</td></tr>
<tr><td>AIM0005</td><td>With Configuration B and C
3 phase current Inputs (1/5A)
3 phase current Inputs (1/5A)
1 phase current input (1/5A)</td></tr>
<tr><td rowspan="5">Case</td><td rowspan="4">X130</td><td colspan="2">Blank Module</td><td>Not equipped with Configuration A as default, may alternatively be equipped as below</td></tr>
<tr><td>BIO0006</td><td>BI/O Module</td><td>Alternatively with Config A, may be equipped with BIO module, detailed below:
6 Binary Inputs
3 Binary outputs</td></tr>
<tr><td>AIM0006</td><td>AI/BI Module (Voltage Sensor)</td><td>With Configuration B
3 Phase Voltage Inputs
1 Phase Voltage Input
1 Phase Voltage Input
4 Binary inputs</td></tr>
<tr><td>AIM0003</td><td>AI/BI/RTD/mA Input Module (Voltage sensor)</td><td>With Configuration C
3 Phase Voltage Inputs
1Phase Voltage Input
1 Phase Voltage Input
2 RTD inputs
1 low current (0.1ma-20mA) inputs</td></tr>
<tr><td>X000</td><td></td><td>Optional communicat ion module</td><td>See technical manual for details about different type of communication modules.
IEC61850
DNP3
Modbus</td></tr>
</table>

Order Code	Ex: NAMAAAAB….	1	2	3	4	5	6	7	8
		N	A	M	A	A	A	A	B
Digit	Description								
1) Product Series	620 series (Includes case)								
2) Standard	ANSI								
3) Main Appl	Motor protection and control								
4) Configuration	A: Overcurrent, load loss, phase and neutral voltage, frequency and RTD protection and power system metering for medium to large motors				A				
	B: Differential, overcurrent, load loss, phase and neutral voltage, frequency and RTD protection and power system metering for medium to large motors				B				
	C: Differential, overcurrent, load loss, phase and neutral voltage, frequency and extended RTD protection and power system metering for medium to large motors				C				

Digit	Description	Slot X130		Slot X120		Slot X110		Slot X105		5	6
		Type		Type		Type		Type			
5-6) Analog Inputs	3 CT + Ground CT + 3 VT + 12 RTD			AIM 0004	4 CT + 3 VT	RTD 0003	RTD (6*RTD / 2 mA)	RTD 0003	RTD (6*RTD / 2 mA)	A	A
	6 CT + Ground CT + 4 VT + 12 RTD	AIM 0006	5 VT + 4 BI	AIM 0005	7 CT	RTD 0003	RTD (6*RTD / 2 mA)	RTD 0003	RTD (6*RTD / 2 mA)	B	A
	6 CT + Ground CT + 4 VT + 14 RTD	AIM 0003	5VT + 2RTD + 1mA	AIM 0005	7 CT	RTD 0003	RTD (6*RTD / 2 mA)	RTD 0003	RTD (6*RTD / 2 mA)	C	A

Digit	1)	Slot X130		Slot X115		7	8
		Type		Type			
7-8) Binary I/O	8 BI + 6 BO + 3 HSO			BIO 0007	8 BI + 3 HSO	A	1
	8 BI + 10 BO			BIO 0005	8 BI + 4 BO	A	A
	14 BI + 9 BO + 3 HSO	BIO 0006	6 BI + 3 BO	BIO 0007	8 BI + 3 HSO	A	2
	14 BI + 13 BO	BIO 0006	6 BI + 3 BO	BIO 0005	8 BI + 4 BO	A	B
	12 BI + 6 BO + 3 HSO			BIO 0007	8 BI + 3 HSO	B	1
	12 BI + 10 BO			BIO 0005	8 BI + 4 BO	B	A
	8 BI + 6 BO + 3 HSO			BIO 0007	8 BI + 3 HSO	C	1
	8 BI + 10 BO			BIO 0005	8 BI + 4 BO	C	A

Notes: **1)** Total Binary I/O includes those provided in Power Supply card (Slot X100) and Analog input cards (Slot X130) in addition to IO card (Slot X115) as applicable

Figure 4: *Ordering codes and corresponding equipment in various slot ID's*

The rated input levels are selected in the IED software for phase current and ground current. The binary input thresholds 18...176 V DC are selected by adjusting the IED's parameter settings.

The connection diagrams of different hardware modules are presented in this manual.

See the installation manual for more information about the case and the plug-in unit.

2.3 Local HMI

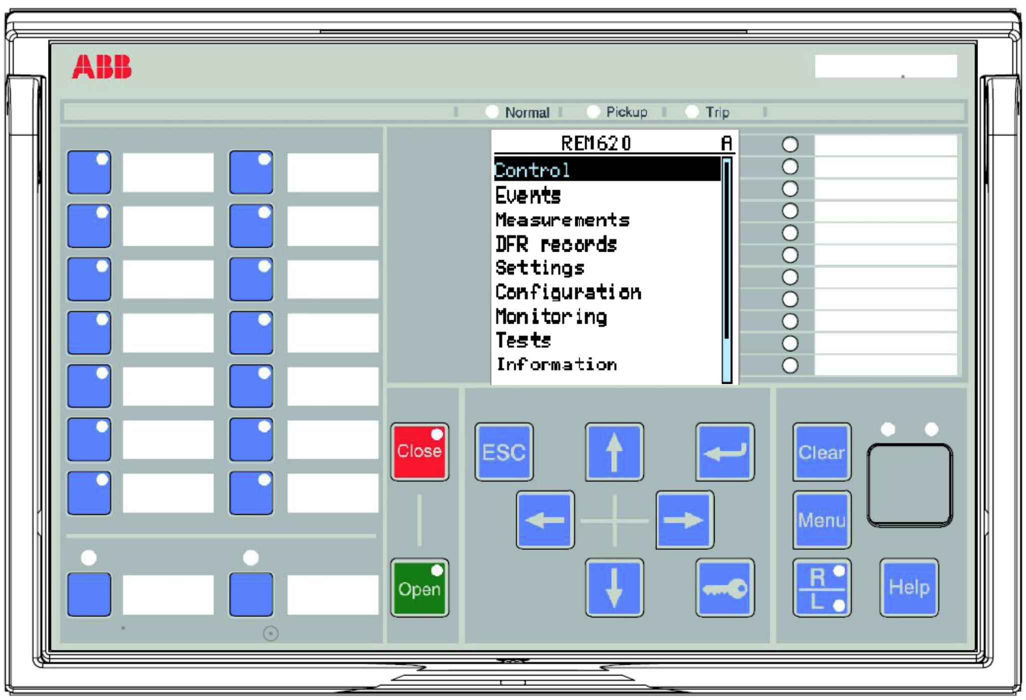


Figure 5: LHMI

The LHMI of the IED contains the following elements:

- Display
- Buttons
- LED indicators
- Communication port

The LHMI is used for setting, monitoring and controlling.

2.3.1 LCD

The LHMI includes a graphical LCD that supports two character sizes. The character size depends on the selected language.

Table 3: Characters and rows on the view

Character size	Rows in view	Characters on row
Large, variable width (13 x 14 pixels)	10 rows 8 rows with large screen	min 8

The display view is divided into four basic areas.

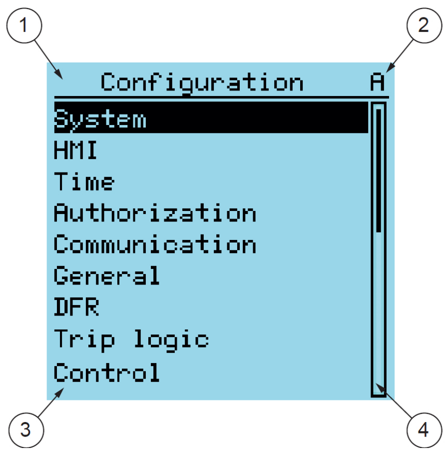


Figure 6: Display layout

1 Header

2 Icon

3 Content

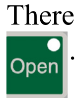
4 Scroll bar (displayed when needed)

2.3.2 LEDs

The LHMI includes three protection indicators above the display: Normal, Pickup and Trip.

There are also 11 matrix programmable alarm LEDs on front of the LHMI. The LEDs can be configured with PCM600 and the operation mode can be selected with the LHMI, WHMI or PCM600.

There are two additional LEDs which are embedded into the control buttons 

and 

. They represent the status of the circuit breaker.

2.3.3 Keypad

The LHMI keypad contains push-buttons which are used to navigate in different views or menus. With the push-buttons you can give open or close commands to one primary object, for example, a circuit breaker, disconnector or switch. The push-buttons are also used to acknowledge alarms, reset indications, provide help and switch between local and remote control mode.

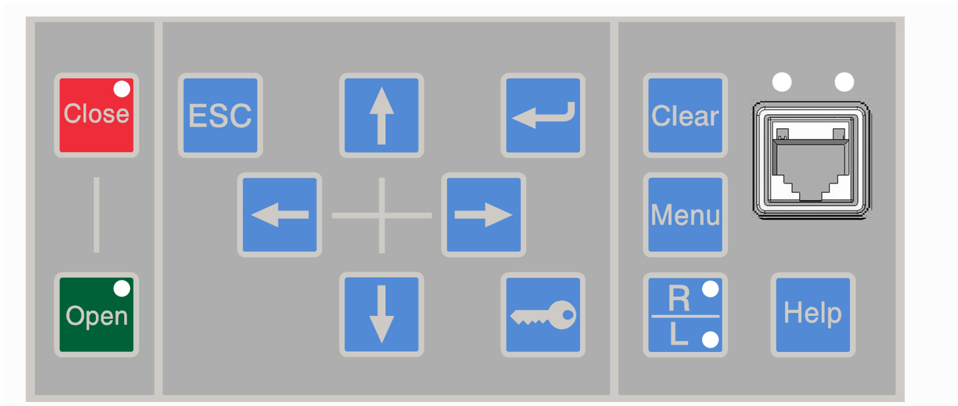


Figure 7: *LHMI keypad with object control, navigation and command push-buttons and RJ-45 communication port*

2.3.4 Programmable pushbuttons and LEDs

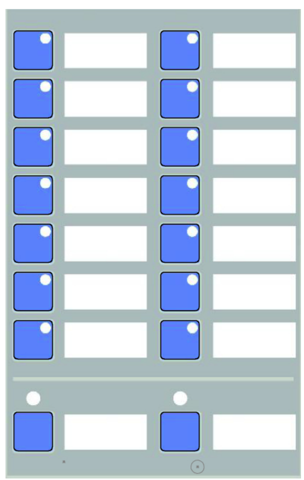


Figure 8: *Programmable pushbuttons with LEDs*

On the left portion of the IED, the LHMI keypad has totally sixteen programmable pushbuttons with 'Red' LEDs. Two of these pushbuttons, located at the bottom portion, have the LEDs located on top of the buttons, while the remaining fourteen buttons have the LEDs embedded on top right corners within the pushbuttons.

The pushbuttons and the lamps are freely programmable and can be configured to not only select an operation but also get acknowledgement back from the internal logic that the action has been executed through the LEDs associated with the pushbuttons. The combination is very useful, typically for quickly selecting or changing setting groups, selection and operation of equipment, indicating field contact status, indication and acknowledging of individual alarms etc. Independent of the pushbuttons, the LEDs may also be independently configured for general indication or important alarms to draw operator's attention

The bottom two buttons with lamps are typically used for Hotline Tag and emergency operation of the circuit which is controlled by the IED.

The space to the right side of the buttons is meant for providing a description of the functionality of each button. One can insert a sheet of paper with appropriate text behind a transparent film provided on the LHMI for this purpose.

2.4 Web HMI

The WHMI enables the user to access the IED via a web browser. The supported web browser version is Internet Explorer 7.0 or later.

WHMI is enabled by default.

WHMI offers several functions.

- Alarm indications and event lists
- System supervision
- Parameter settings
- Measurement display
- Oscillographic records
- Phasor diagram

The menu tree structure on the WHMI is almost identical to the one on the LHMI.

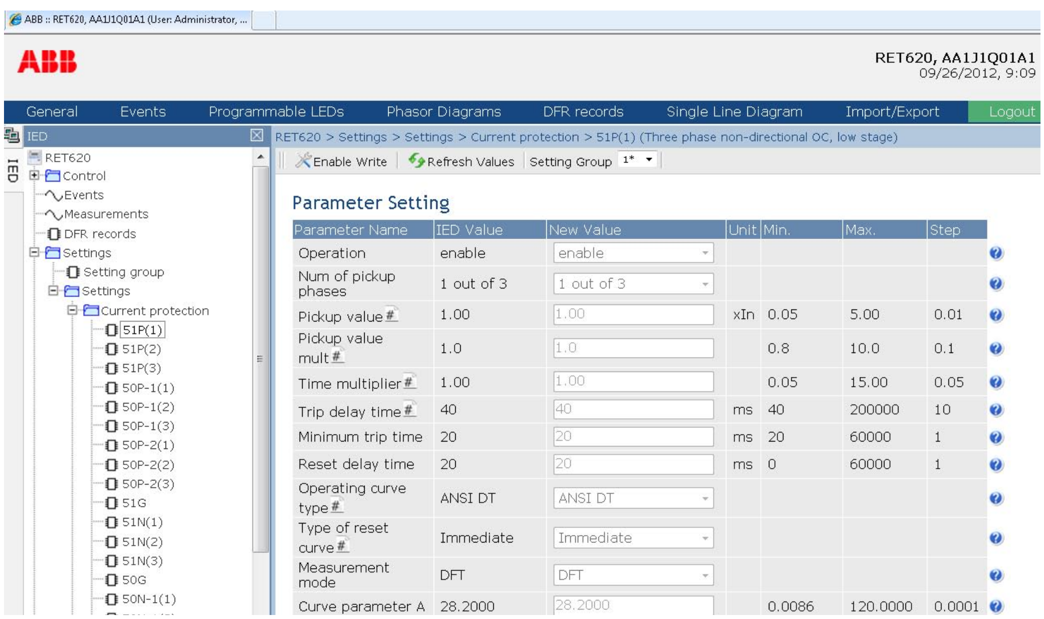


Figure 9: Example view of the WHMI

The WHMI can be accessed locally and remotely.

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

2.5 Authorization

The user categories have been predefined for the LHMI and the WHMI, each with different rights and default passwords.

The default passwords can be changed with Administrator user rights.

User authorization is disabled by default but WHMI always uses authorization.

Control operations are not allowed by WebHMI tool.

Table 4: Predefined user categories

User name	User rights
VIEWER	Read only access
OPERATOR	• Selecting remote or local state with R/L (only locally) • Changing setting groups • Controlling • Clearing alarm and indication LEDs and textual indications
ENGINEER	• Changing settings • Clearing event list • Clearing DFRs • Changing system settings such as IP address, serial baud rate or DFR settings • Setting the IED to test mode • Selecting language
ADMINISTRATOR	• All listed above • Changing password • Factory default activation

For user authorization for PCM600, see PCM600 documentation.

2.6 Communication

The IED supports different communication protocols: IEC 61850, Modbus® and DNP 3.0 Level 2 - all using TCP/IP. DNP3 and Modbus also support serial communication. Operational information and controls are available through these protocols. However, some communication functionality, for example, horizontal peer-to-peer communication between the IEDs and parameters setting, is only enabled by the IEC 61850 communication protocol.

The IEC 61850 communication implementation supports all monitoring and control functions. Additionally, parameter setting and DFR records can be accessed using the IEC 61850 protocol. Oscillographic files are available to any Ethernet-based application in the standard COMTRADE format. Further, the IED can send and receive binary signals from other IEDs (so called horizontal communication) using the IEC61850-8-1 GOOSE profile, where the highest performance class with a total transmission time of 3 ms is supported. Also, the IED supports sending and receiving of analog values using GOOSE messaging. The IED meets the GOOSE performance requirements for tripping applications in distribution substations, as defined by the IEC 61850 standard. The IED can simultaneously report events to five different clients on the station bus.

All communication connectors, except for the front port connector, are placed on integrated optional communication modules. The IED can be connected to Ethernet-based communication systems via the RJ-45 connector (100BASE-TX) or the fiber-optic LC connector (100BASE-FX). An optional serial interface is available for RS-232/RS-485 communication.

Section 3 REM620 configurations

3.1 REM620 variant list

REM620 is intended for protection and control mainly in MV motor applications. The product has three standard configurations covering a wide range of primary circuit configurations in distribution networks based on different system grounding methods.

Some of the functions included in the IED's standard configurations are optional at the time of placing the order. The description of standard configurations covers the full functionality including options, presenting the functionality, flexibility and eternal connections of REM620 with a specific configuration as delivered from the factory.

3.2 Presentation of standard configurations

Functional diagrams

The functional diagrams describe the IED's functionality from the protection, measuring, condition monitoring, recording, control and interlocking perspective. Diagrams show the default functionality with simple symbol logics forming principle diagrams. The external connections to primary devices are also shown, stating the default connections to measuring transformers. The positive measuring direction is towards the motor, away from the bus bar.

The functional diagrams are divided into sections with each section constituting one functional entity. The external connections are also divided into sections. Only the relevant connections for a particular functional entity are presented in each section.

Protection function blocks are part of the functional diagram. They are identified based on their ANSI function number/acronym, but the IEC based symbol and the IEC 61850 names are also included. Some function blocks are used several times in the configuration. To separate the blocks from each other, the IEC 61850 name and ANSI function number are appended with a running number, that is an instance number, from one upwards. The IED's internal functionality and the external connections are separated with a dashed line presenting the IED's physical casing.

Signal matrix

With Signal Matrix in PCM600 the user can modify the standard configuration according to the actual needs. The IED is delivered from the factory with default connections described in the functional diagrams for BI's, BO's, function to function connections and alarm LEDs. Signal Matrix has a number of different page views, designated as follows:

- Binary input
- Binary output
- Functions

There are six IED variant-specific setting groups. Parameters can be set independently for each setting group.

The active setting group (1...6) can be changed with a parameter. The active setting group can also be changed via a binary input if the binary input is enabled for this. To enable the change of the active setting group via a binary input, connect a free binary input with PCM600 to the BI_SG_x input of the Protection block.

Table 5: Binary input states and corresponding active setting groups

BI state	Active setting group
OFF	1
ON	2

The active setting group defined by a parameter is overridden when a binary input is enabled for changing the active setting group.

3.2.1 Standard configurations

The motor protection IED REM620 is available with three alternative standard configurations.

Table 6: Standard configuration (REM620)s

Description	Functional application configuration
Overcurrent, load loss, phase and neutral voltage, frequency and RTD protection and power system metering for medium to large motors.	A
Differential, overcurrent, load loss, phase and neutral voltage, frequency and RTD protection and power system metering for medium to large motors.	B
Differential, overcurrent, load loss, phase and neutral voltage, frequency and extended RTD protection and power system metering for medium to large motors.	C

Table 7: Supported functions

Function Application Configuration				ANSI/C37.2 - 2008
	Config A	Config B	Config C	REM
Protection				
Three-phase non-directional overcurrent protection, low stage, instance 1	●	●	●	51P
Three-phase non-directional overcurrent protection, high stage, instance 1	●	●	●	50P
Non-directional ground-fault protection, low stage, instance 1	●	●	●	51G
Non-directional ground-fault protection, high stage, instance 1	●	●	●	50G
Directional ground-fault protection, low stage, instance 1	●	●	●	67/51N
Residual overvoltage protection, instance 1	-	●	●	59G
Residual overvoltage protection, instance 2	●	●	●	59N
Three-phase undervoltage protection, instance 1	●	●	●	27
Three-phase overvoltage protection, instance 1	●	●	●	59
Positive-sequence undervoltage protection, instance 1	●	●	●	27PS
Negative-sequence overvoltage protection, instance 1	●	●	●	47
Frequency protection, instance 1	●	●	●	81
Negative-sequence overcurrent protection for motors, instance 1	●	●	●	46M-1
Negative-sequence overcurrent protection for motors, instance 2	●	●	●	46M-2
Loss of load supervision, instance 1	●	●	●	37M-1
Loss of load supervision, instance 2	●	●	●	37M-2
Motor load jam protection	●	●	●	51LR
Motor start-up supervision	●	●	●	66/51LRS
Phase reversal protection	●	●	●	46R
Thermal overload protection for motors	●	●	●	49M
Motor differential protection	-	●	●	87M
Circuit breaker failure protection, instance 1	●	●	●	50BF
Master trip, instance 1	●	●	●	86/94-1
Master trip, instance 2	●	●	●	86/94-2
Arc protection, instance 1	●	●	●	AFD-1
Arc protection, instance 2	●	●	●	AFD-2
Arc protection, instance 3	●	●	●	AFD-3
RTD based thermal protection, instance 1	●	●	●	38-1
RTD based thermal protection, instance 2	●	●	●	38-2
RTD based thermal protection, instance 3	●	●	●	38-3
RTD based thermal protection, instance 4	●	●	●	38-4
RTD based thermal protection, instance 5	●	●	●	38-5
RTD based thermal protection, instance 6	●	●	●	38-6
RTD based thermal protection, instance 7	●	●	●	38-7

Function Application Configuration				ANSI/C37.2 - 2008
	Config A	Config B	Config C	REM
Control				
Circuit-breaker control, instance 1	●	●	●	52
Emergency startup	●	●	●	62EST
Condition Monitoring				
Circuit-breaker condition monitoring, instance 1	●	●	●	52CM
Trip circuit supervision, instance 1	●	●	●	TCM-1
Trip circuit supervision, instance 2	●	●	●	TCM-2
Current circuit supervision	●	●	●	CCM
Fuse failure supervision, instance 1	●	●	●	60
Runtime counter for machines and devices, instance 1	●	●	●	OPTM-1
Runtime counter for machines and devices, instance 2	●	●	●	OPTM-2
Measurement				
Three-phase current measurement, instance 1	●	●	●	IA, IB, IC
Three-phase current measurement, instance 2	-	●	●	IA, IB, IC(2)
Sequence current measurement, instance 1	●	●	●	I1, I2, I0
Sequence current measurement, instance 2	-	●	●	I1, I2, I0(2)
Residual current measurement, instance 1	●	●	●	IG
Three-phase voltage measurement, instance 1	●	●	●	VA, VB, VC
Residual voltage measurement, instance 1	-	●	●	VG
Sequence voltage measurement, instance 1	●	●	●	V1, V2, V0
Single-phase power and energy measurement, instance 1	●	●	●	SP, SE
Three-phase power and energy measurement, instance 1	●	●	●	P, E
Load profile	●	●	●	LoadProf
Frequency measurement, instance 1	●	●	●	f
Other functions				
Minimum pulse timer (2 pcs), instance 1	●	●	●	TP-1
Minimum pulse timer (2 pcs), instance 2	●	●	●	TP-2
Minimum pulse timer (2 pcs), instance 3	●	●	●	TP-3
Minimum pulse timer (2 pcs), instance 4	●	●	●	TP-4
Pulse timer (8 pcs), instance 1	●	●	●	PT-1
Pulse timer (8 pcs), instance 2	●	●	●	PT-2
Time delay off (8 pcs), instance 1	●	●	●	TOF-1
Time delay off (8 pcs), instance 2	●	●	●	TOF-2
Time delay off (8 pcs), instance 3	●	●	●	TOF-3
Time delay off (8 pcs), instance 4	●	●	●	TOF-4
Time delay on (8 pcs), instance 1	●	●	●	TON -1
Time delay on (8 pcs), instance 2	●	●	●	TON -2
Time delay on (8 pcs), instance 3	●	●	●	TON -3
Time delay on (8 pcs), instance 4	●	●	●	TON -4

Function Application Configuration				ANSI/C37.2 - 2008
	Config A	Config B	Config C	REM
Set reset (8 pcs), instance 1	●	●	●	SR-1
Set reset (8 pcs), instance 2	●	●	●	SR-2
Set reset (8 pcs), instance 3	●	●	●	SR-3
Set reset (8 pcs), instance 4	●	●	●	SR-4
Move (8 pcs), instance 1	●	●	●	MV-1
Move (8 pcs), instance 2	●	●	●	MV-2
Move (8 pcs), instance 3	●	●	●	MV-3
Move (8 pcs), instance 4	●	●	●	MV-4
Move (8 pcs), instance 5	●	●	●	MV-5
Move (8 pcs), instance 6	●	●	●	MV-6
Move (8 pcs), instance 7	●	●	●	MV-7
Move (8 pcs), instance 8	●	●	●	MV-8
Generic control points, instance 1	●	●	●	CNTRL-1
Generic control points, instance 2	●	●	●	CNTRL-2
Generic control points, instance 3	●	●	●	CNTRL-3
Remote Generic control points, instance 1	●	●	●	RCNTRL-1
Local Generic control points, instance 1	●	●	●	LCNTRL-1
Generic Up-Down Counters, instance 1	●	●	●	CTR-1
Generic Up-Down Counters, instance 2	●	●	●	CTR-2
Generic Up-Down Counters, instance 3	●	●	●	CTR-3
Generic Up-Down Counters, instance 4	●	●	●	CTR-4
Generic Up-Down Counters, instance 5	●	●	●	CTR-5
Generic Up-Down Counters, instance 6	●	●	●	CTR-6
Generic Up-Down Counters, instance 7	●	●	●	CTR-7
Generic Up-Down Counters, instance 8	●	●	●	CTR-8
Generic Up-Down Counters, instance 9	●	●	●	CTR-9
Generic Up-Down Counters, instance 10	●	●	●	CTR-10
Generic Up-Down Counters, instance 11	●	●	●	CTR-11
Generic Up-Down Counters, instance 12	●	●	●	CTR-12
Programmable buttons(16 buttons), instance 1	●	●	●	FKEY
Logging functions				
Disturbance recorder	●	●	●	DFR
Fault recorder	●	●	●	FR
Sequence event recorder	●	●	●	SER

Each of the configurations can be re-configured to suit individual applications. Typically optional IO and some of the functions may not be configured at delivery. Only key functions such as tripping, breaker status inputs etc. are connected through the signal matrix tool.

Typical connection diagram for the default configuration as delivered from the factory is available for each alternative configuration. The diagrams show how to connect the primary apparatus to the IED assuming control functionality is also included in the IED. The configurations are prepared to cover for the most common applications but not all possibilities.

The number of protection elements including directional and non-directional Phase and Ground OC protections, motor jam protection, thermal overload, undervoltage / overvoltage functions, frequency functions etc., allow the user to fulfill any application requirement in protection and control of MV motors.

The advanced logic capability, where the user logic is prepared with a graphical tool, allows special applications including automatic opening, sequencing etc. The graphical configuration tool ensures simple and fast testing and commissioning.

Various modes of communication including optical connections ensure integration of the IED with the rest of the power system protection, control and automation.

The wide application flexibility makes this product an excellent choice for both new installations and the refurbishment of existing installations.

It is strongly suggested that reference to Engineering Manual be made at this stage for details on PCM600 and organizing a project with various IEDs, uploading settings to IED etc. It is recommended to familiarize oneself with the grouping of various functions under PCM600, IED to configure, change setttings connected with various functions. A typical screen shot is given below for ready reference. The next few paragraphs highlight a few steps to verify some of the important things in connection with analog inputs. The next sections give some of the settings suggestions and configuration possibilities which the users may navigate and set them as suggested by themselves.

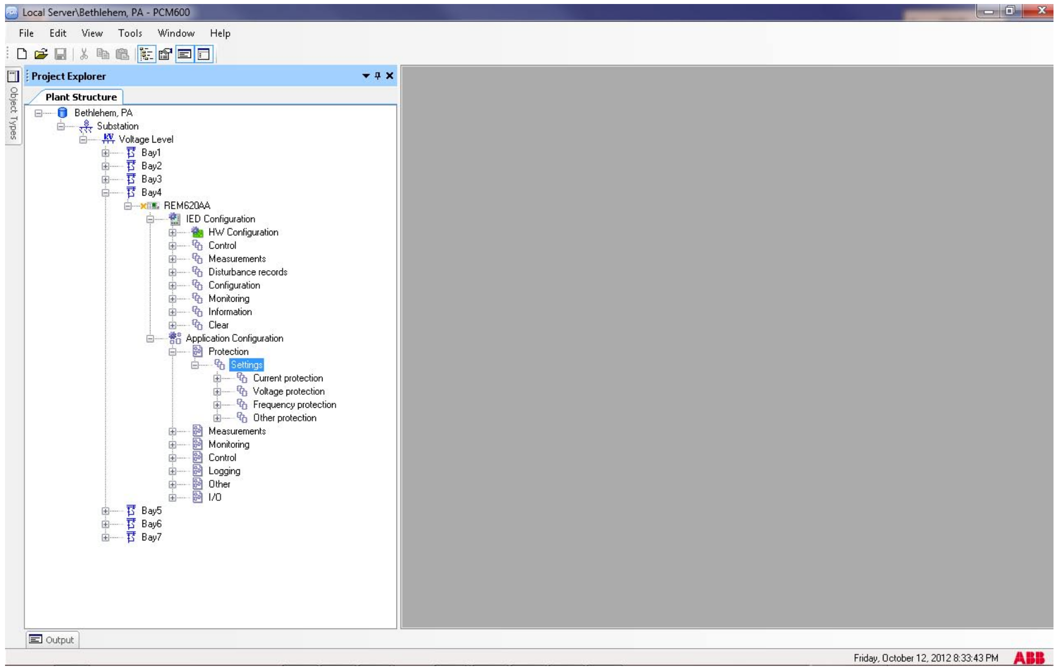


Figure 10: Example View of selecting settings under the plant structure of an IED in PCM600

3.2.2 Verifying the order code and some of the most important configurations of IED in project tree:

Once the PCM600 project with the correct IED ordering code is up and running the IED details may be verified by right clicking on the IED name and selecting 'properties'.

Details of the ordering code, technical key etc. are displayed as follows:

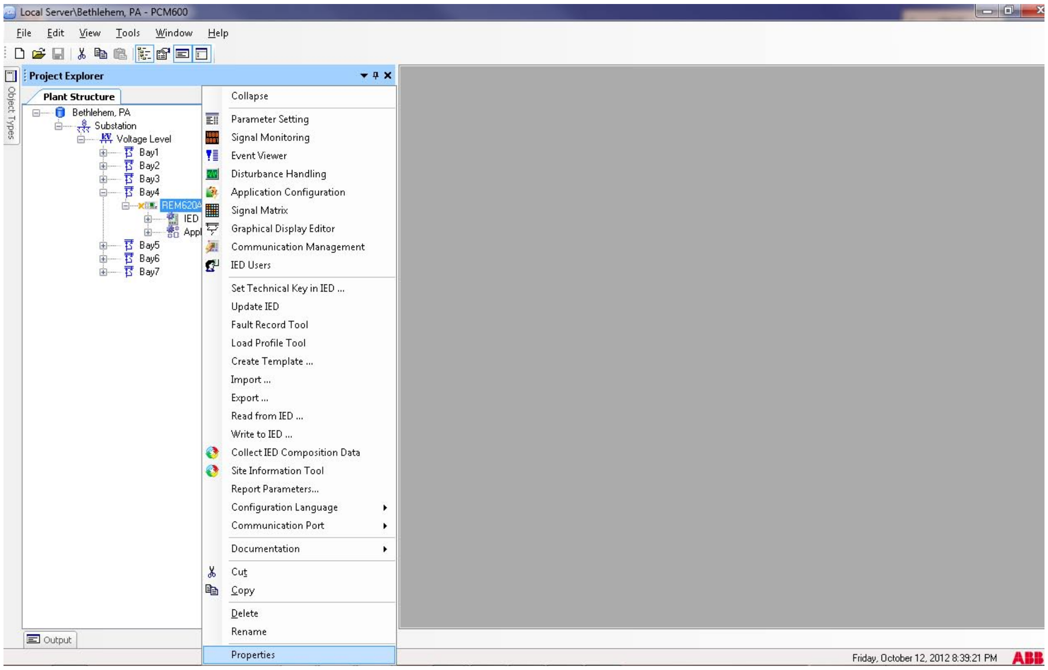


Figure 11: *PCM600 display with IED selected with a right click to display the menu and 'Properties' line of the menu just to be selected*

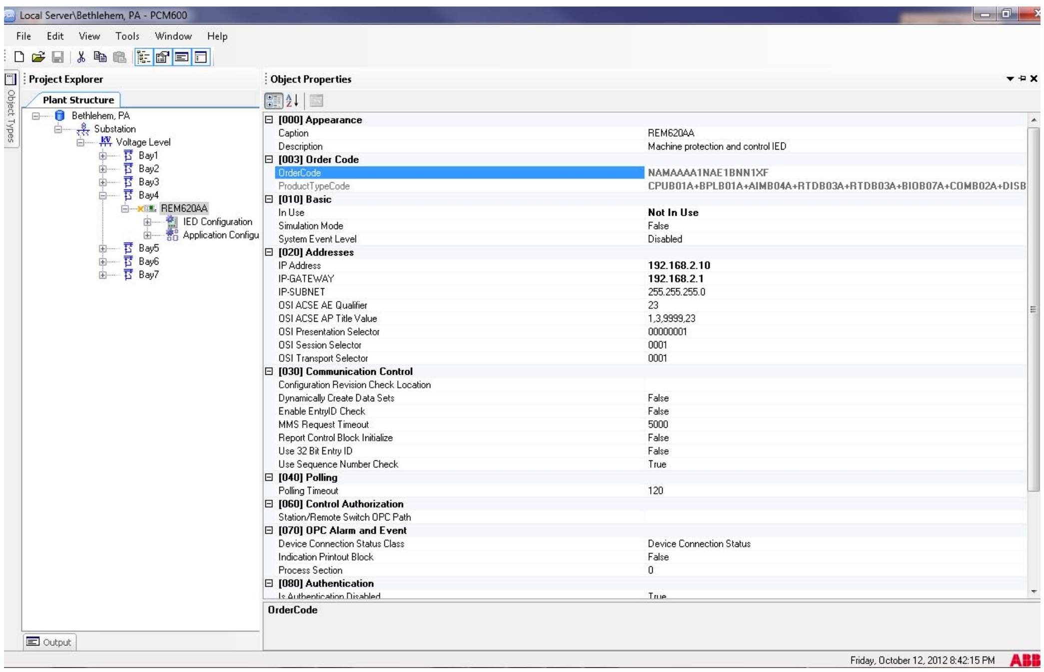


Figure 12: *Display of product code when 'properties' of an IED is selected*

It is also important that common system configurations such as frequency, phase sequence and group settings are also set properly and verified as shown in the following figures:

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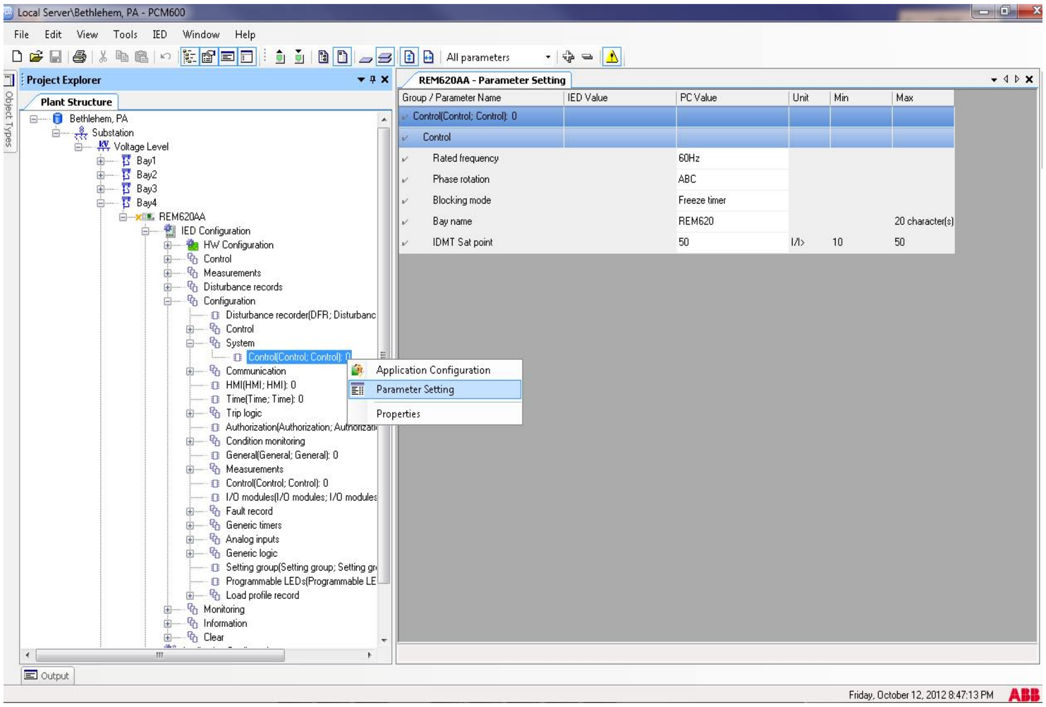


Figure 13: *Display of common system configuration settings*

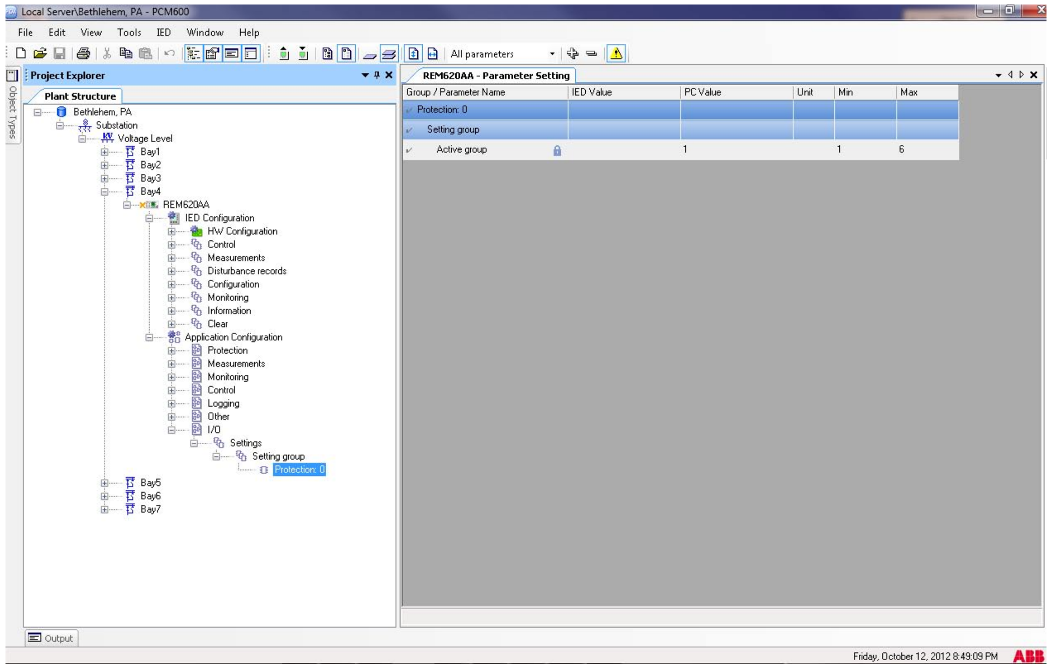


Figure 14: Display or setting of Setting Group

3.2.3 Analog Inputs configuration

In order to get correct measurement results as well as correct protection operations, the analog input channels must be configured and / or, especially with respect to the polarity. The polarity shown in the suggested connection diagrams have to be strictly followed.

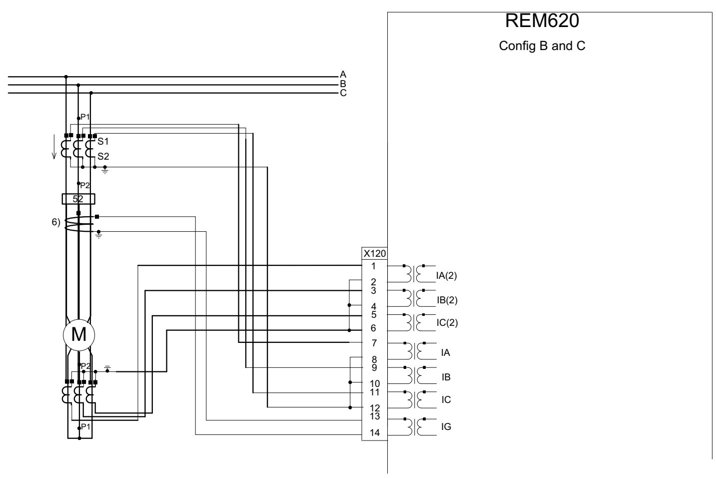


Figure 15: REM620 Typical CT connection diagram, marked with polarity

The polarity of CT and the internal connection are arranged in the above figure in such a way that for a fault in the feeder/ motor, indicated by an arrow in the picture, a proportional current would flow into terminal 7 of the IED with the same phase angle. If the actual CT polarity is found reversed, it is best to correct it at the installation. Polarity of CT inputs is very important not only for directional protection but also for metering, differential and restricted earth fault protections. When two breaker applications are involved, adequate care has to be exercised to ensure that the IED registers a current consistent with the power flow in the protected system under all circumstances both with respect to phase as well as ground fault protection measurements.

In case it is not possible to change the connections in field installation, it is possible to reverse the connections say at terminals 7 and 8 at the relay end provided documentation is corrected for the whole installation. Alternatively it is possible to correct polarity error inside the relay using PCM600. Select the IED→ IED Configuration → Configuration→

Then select the setting "Reverse Polarity" to "TRUE" as shown in the figure below.

In the same window, one can input the rated primary current rating of the CT. The secondary rated current is 5A by default but can be changed to 1A if required.

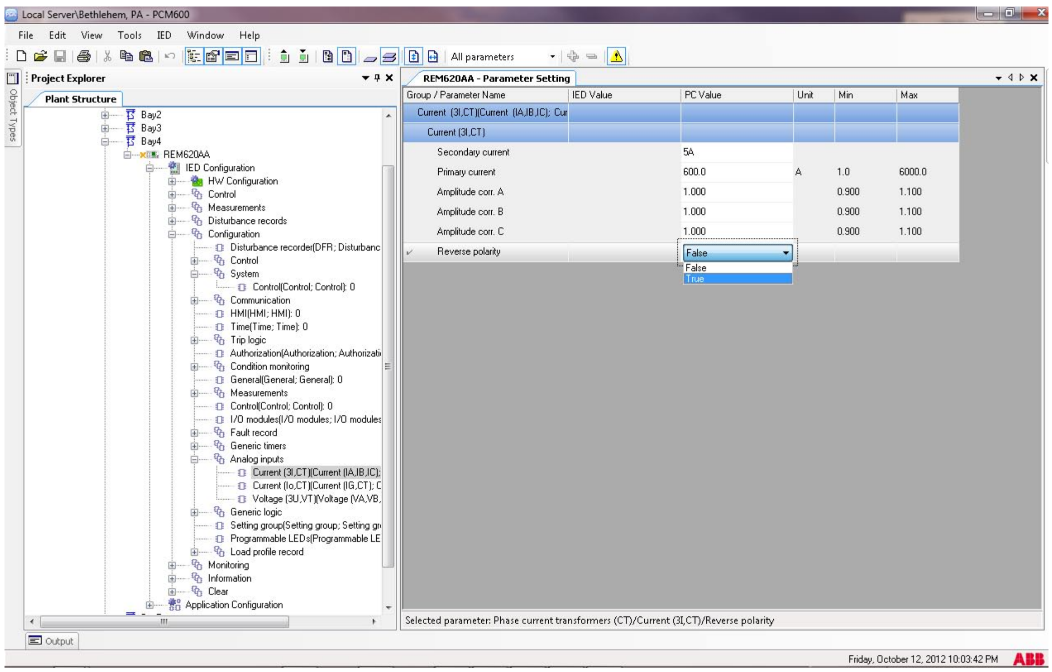


Figure 16: Modifying Reverse Polarity setting of CT input to IED

The IG analog input may be fed from either residual connection of the phase CTs or from Core Balance CT (CBCT / Window type CT). To cater to the case CBCT is connected to this input, provision is made to set the primary and secondary input ratings independent of the phase CTs. CBCT input is highly recommended with non-effectively grounded systems. In effectively grounded system, if the CBCT is not catered, it is required to connect residual connection of the phase CTs to IG input, otherwise ground fault protections 51G and 50G will be ineffective.

Just as CTs inputs, it is also important to verify the VT input configurations and settings before going ahead with further setting the IED. In PCM600 tool, on the concerned IED, select VT inputs and make sure the connection inputs chosen are Delta (alternatively WYE) and appropriate primary and secondary values are input both for main bus VT inputs. The next figure indicates various possibilities of connecting the VT input to the relay.

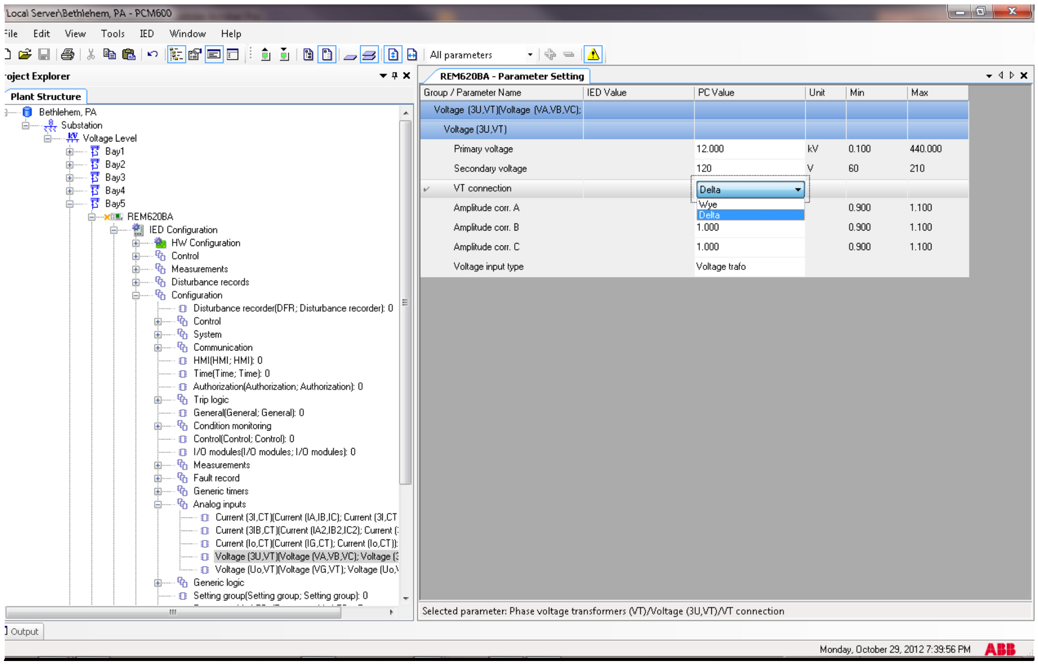


Figure 17: Selecting 'Wye' or 'Delta' setting of VT input to IED

Delta configuration has to be selected when the primary PT is connected in Open Delta (V) configuration. Different possibilities of connections of VTs are possible as detailed below.

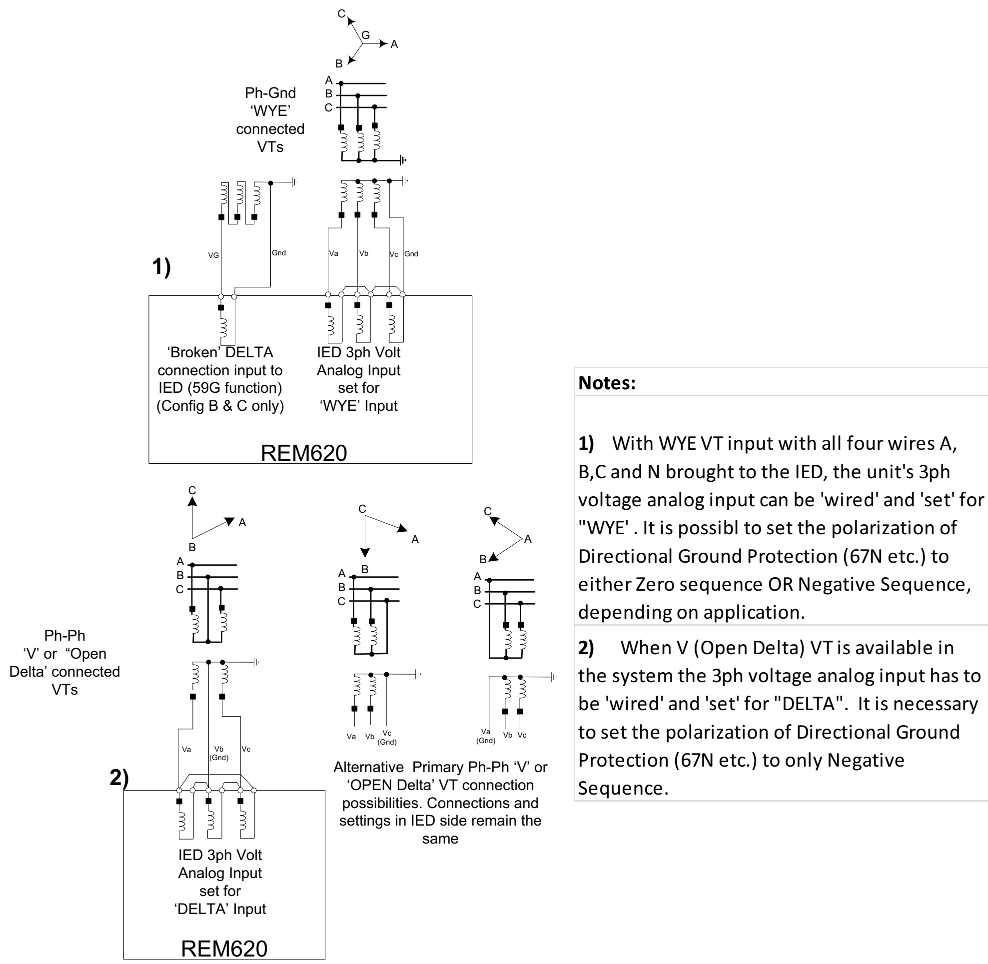


Figure 18: VT Input Possibilities in REM620

3.2.4 Application choice:

3.2.4.1 Configuration A:

This configuration is eminently suitable for most of the applications in MV systems involving single breaker control, protection but without differential protection. The IED has the capability to measure twelve number RTD inputs.

The RTD inputs are processed through a series of level detectors (38-1 to 38-7) to derive necessary alarm and trip signals.

3.2.4.2 Configuration B and C:

This configuration is similar to config A above but with additional phase differential protection and the possibility to wire in Broken Delta VT input for connection to neutral voltage displacement function 59G.

Differential protection calls for additional CT cores in the neutral side of the individual phases of the motor. These CTs are mounted within the motor before neutral formation. Alternatively the CTs may be provided external to the motor, in which case, the terminal box of the motor shall have individual terminals for each phase on neutral side as well (Phase and Neutral terminal of each phase winding, totalling six terminals).

The neutral CTs are to be ordered preferably with identical characteristics with the phase side CT cores in the switchgear panels. A slight variation in the characteristics may be tolerated, subject to adjustments in settings.

Config C has 2 additional RTD inputs in the slot ID X130, while Config B has 4 additional Binary inputs instead. The RTD inputs (12nos in Config B and 14nos in configC) are processed through a series of level detectors (38-1 to 38-7) to derive necessary alarm and trip signals.

3.3 Standard configuration for order code functional application A

3.3.1 Applications

This standard configuration is mainly intended for medium to large circuit breaker controlled induction motors. This configuration includes non- directional and directional phase and ground overcurrent, phase distance, voltage and frequency protection.

The IED with this standard configuration is delivered from the factory with default settings and parameters. The end-user flexibility for incoming, outgoing and internal signal designation within the IED enable this configuration to be further adapted to different primary power system layouts and the related functionality needs by modifying the internal functionality using PCM600.

3.3.2 Functions

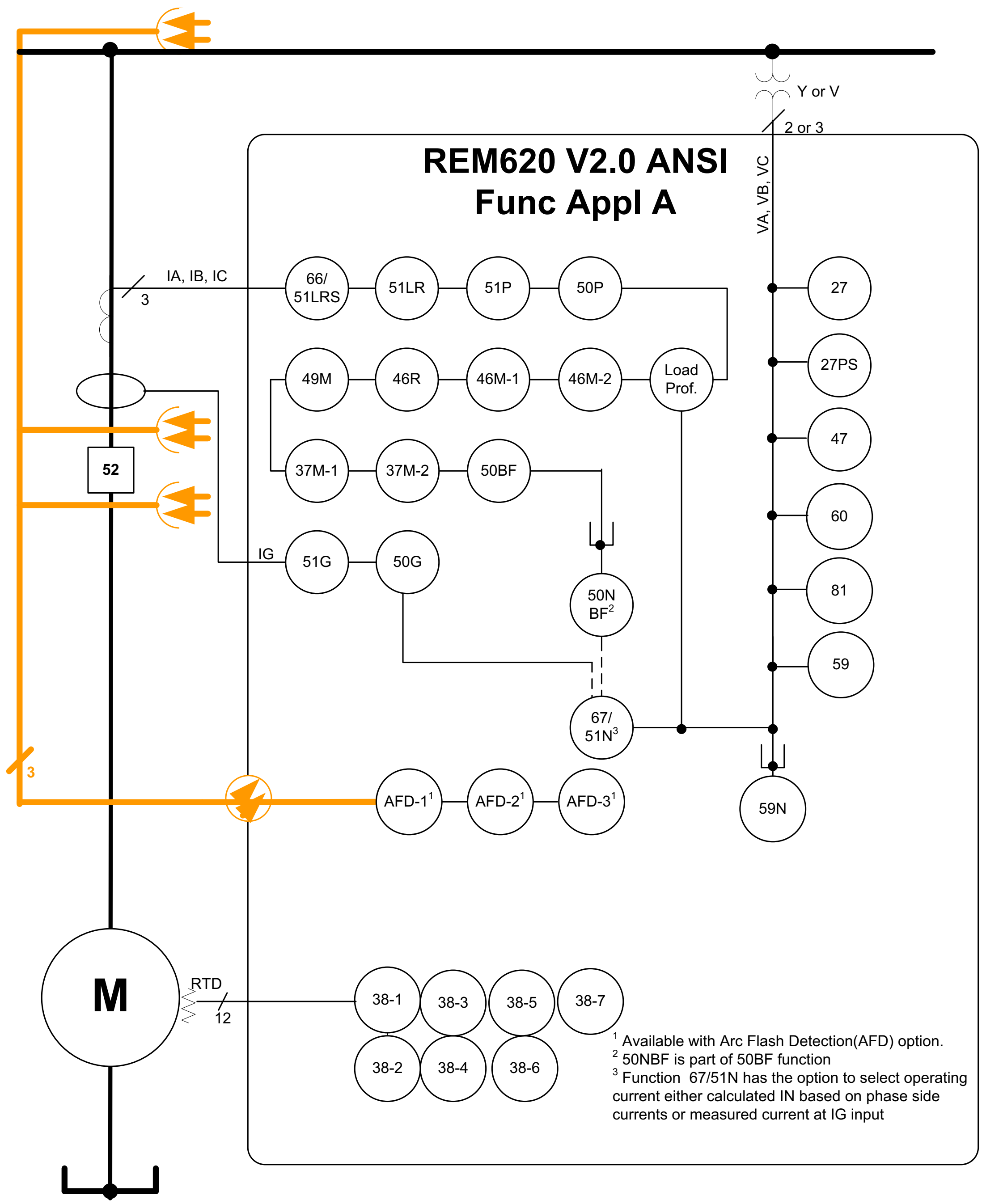


Figure 19: Functions included in REM620 Standard Configuration A

Table 8: Functions included in the REM620 standard configuration A

Application Function				A
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	AA
Protection				
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P	3I> (1)	•
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P	3I>> (1)	•
Non-directional ground-fault protection, low stage, instance 1	EFLPTOC1	51G	Io> (1)	•
Non-directional ground-fault protection, high stage, instance 1	EFHPTOC1	50G	Io>> (1)	•
Directional ground-fault protection, low stage, instance 1	DEFLPDEF1	67/51N	Io> -> (1)	•
Residual overvoltage protection, instance 2	ROVPTOV2	59N	Uo> (2)	•
Three-phase undervoltage protection, instance 1	PHPTUV1	27	3U< (1)	•
Three-phase overvoltage protection, instance 1	PHPTOV1	59	3U> (1)	•
Positive Sequence undervoltage protection, instance 1	PSPTUV1	27PS	U1< (1)	•
Negative-sequence overvoltage protection, instance 1	NSPTOV1	47	U2> (1)	•
Frequency protection, instance 1	FRPFRQ1	81	f>/f<,df/dt (1)	•
Negative-sequence overcurrent protection for motors, instance 1	MNSPTOC1	46M-1	I2>M(1)	•
Negative-sequence overcurrent protection for motors, instance 2	MNSPTOC2	46M-2	I2>M(2)	•
Loss of load supervision, instance 1	LOFLPTUC1	37M-1	3I<(1)	•
Loss of load supervision, instance 2	LOFLPTUC2	37M-2	3I<(2)	•
Motor load jam protection	JAMPTOC1	51LR	Ist>	•
Motor start-up supervision	STTPMSU1	66/51LRS	Is2t n<	•
Phase reversal protection	PREVPTOC1	46R	I2>>	•
Thermal overload protection for motors	MPTTR1	49M	3Ith>M	•
Circuit breaker failure protection, instance 1	CCBRBRF1	50BF	3I>/Io>BF (1)	•
Master trip, instance 1	TRPPTRC1	86/94-1	Master Trip (1)	•
Master trip, instance 2	TRPPTRC2	86/94-2	Master Trip (2)	•
Arc protection, instance 1	ARCSARC1	AFD-1	ARC (1)	•
Arc protection, instance 2	ARCSARC2	AFD-2	ARC (2)	•
Arc protection, instance 3	ARCSARC3	AFD-3	ARC (3)	•
RTD based thermal protection, instance 1	MAPGAPC1	38-1	ThA> ThB>	•
RTD based thermal protection, instance 2	MAPGAPC2	38-2	ThA> ThB>	•
RTD based thermal protection, instance 3	MAPGAPC3	38-3	ThA> ThB>	•
RTD based thermal protection, instance 4	MAPGAPC4	38-4	ThA> ThB>	•
RTD based thermal protection, instance 5	MAPGAPC5	38-5	ThA> ThB>	•
RTD based thermal protection, instance 6	MAPGAPC6	38-6	ThA> ThB>	•
RTD based thermal protection, instance 7	MAPGAPC7	38-7	ThA> ThB>	•

Application Function				A
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	AA
Control				
Circuit-breaker control, instance 1	CBXCBR1	52-1	I <-> O CB (1)	•
Emergency startup	ESMGAPC1	62EST	ESTART	•
Condition Monitoring				
Circuit-breaker condition monitoring, instance 1	SSCBR1	52CM-1	CBCM (1)	•
Trip circuit supervision, instance 1	TCSSCBR1	TCM-1	TCS (1)	•
Trip circuit supervision, instance 2	TCSSCBR2	TCM-2	TCS (2)	•
Current circuit supervision	CCRDIF1	CCM	MCS 3I	•
Fuse failure supervision, instance 1	SEQRFUF1	60	FUSEF (1)	•
Runtime counter for machines and devices, instance 1	MDSOPT1	OPTM-1	OPTS(1)	•
Runtime counter for machines and devices, instance 2	MDSOPT2	OPTM-2	OPTS(2)	•
Measurement				
Three-phase current measurement, instance 1	CMMXU1	IA, IB, IC	3I	•
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0	I1, I2, I0	•
Residual current measurement, instance 1	RESCMMXU1	IG	Io	•
Three-phase voltage measurement, instance 1	VMMXU1	VA, VB, VC	3U	•
Sequence voltage measurement, instance 1	VSMSQI1	V1, V2, V0	U1, U2, U0	•
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE	SP, SE	•
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E	•
Load profile	LDPMSTA1	LoadProf	LoadProf	•
Frequency measurement, instance 1	FMMXU1	f	f	•
Other functions				
Minimum pulse timer (2 pcs), instance 1	TPGAPC1	TP-1	TP (1)	•
Minimum pulse timer (2 pcs), instance 2	TPGAPC2	TP-2	TP (2)	•
Minimum pulse timer (2 pcs), instance 3	TPGAPC3	TP-3	TP (3)	•
Minimum pulse timer (2 pcs), instance 4	TPGAPC4	TP-4	TP (4)	•
Pulse timer (8 pcs), instance 1	PTGAPC1	PT-1	PT (1)	•
Pulse timer (8 pcs), instance 2	PTGAPC2	PT-2	PT (2)	•
Time delay off (8 pcs), instance 1	TOFGAPC1	TOF-1	TOF (1)	•
Time delay off (8 pcs), instance 2	TOFGAPC2	TOF-2	TOF (2)	•
Time delay off (8 pcs), instance 3	TOFGAPC3	TOF-3	TOF (3)	•
Time delay off (8 pcs), instance 4	TOFGAPC4	TOF-4	TOF (4)	•
Time delay on (8 pcs), instance 1	TONGAPC1	TON -1	TON (1)	•
Time delay on (8 pcs), instance 2	TONGAPC2	TON -2	TON (2)	•
Time delay on (8 pcs), instance 3	TONGAPC3	TON -3	TON (3)	•
Time delay on (8 pcs), instance 4	TONGAPC4	TON -4	TON (4)	•
Set reset (8 pcs), instance 1	SRGAPC1	SR-1	SR (1)	•

Application Function				A
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	AA
Set reset (8 pcs), instance 2	SRGAPC2	SR-2	SR (2)	•
Set reset (8 pcs), instance 3	SRGAPC3	SR-3	SR (3)	•
Set reset (8 pcs), instance 4	SRGAPC4	SR-4	SR (4)	•
Move (8 pcs), instance 1	MVGAPC1	MV-1	MV (1)	•
Move (8 pcs), instance 2	MVGAPC2	MV-2	MV (2)	•
Move (8 pcs), instance 3	MVGAPC3	MV-3	MV (3)	•
Move (8 pcs), instance 4	MVGAPC4	MV-4	MV (4)	•
Move (8 pcs), instance 5	MVGAPC5	MV-5	MV (5)	•
Move (8 pcs), instance 6	MVGAPC6	MV-6	MV (6)	•
Move (8 pcs), instance 7	MVGAPC7	MV-7	MV (7)	•
Move (8 pcs), instance 8	MVGAPC8	MV-8	MV (8)	•
Generic control points, instance 1	SPCGGIO1	CNTRL-1	SPC(1)	•
Generic control points, instance 2	SPCGGIO2	CNTRL-2	SPC(2)	•
Generic control points, instance 3	SPCGGIO3	CNTRL-3	SPC(3)	•
Remote Generic control points, instance 1	SPCRGGIO1	RCNTRL-1	SPCR(1)	•
Local Generic control points, instance 1	SPCLGGIO1	LCNTRL-1	SPCL(1)	•
Generic Up-Down Counters, instance 1	UDFCNT1	CTR-1	CTR(1)	•
Generic Up-Down Counters, instance 2	UDFCNT2	CTR-2	CTR(2)	•
Generic Up-Down Counters, instance 3	UDFCNT3	CTR-3	CTR(3)	•
Generic Up-Down Counters, instance 4	UDFCNT4	CTR-4	CTR(4)	•
Generic Up-Down Counters, instance 5	UDFCNT5	CTR-5	CTR(5)	•
Generic Up-Down Counters, instance 6	UDFCNT6	CTR-6	CTR(6)	•
Generic Up-Down Counters, instance 7	UDFCNT7	CTR-7	CTR(7)	•
Generic Up-Down Counters, instance 8	UDFCNT8	CTR-8	CTR(8)	•
Generic Up-Down Counters, instance 9	UDFCNT9	CTR-9	CTR(9)	•
Generic Up-Down Counters, instance 10	UDFCNT10	CTR-10	CTR(10)	•
Generic Up-Down Counters, instance 11	UDFCNT11	CTR-11	CTR(11)	•
Generic Up-Down Counters, instance 12	UDFCNT12	CTR-12	CTR(12)	•
Programmable buttons (16 buttons), instance 1	FKEYGGIO1	FKEY	FKEY	•
Logging functions				
Disturbance recorder	RDRE1	DFR	DFR	•
Fault recorder	FLMSTA1	FR	FR	•
Sequence event recorder	SER	SER	SER	•

3.3.3 Default Input/Output (I/O) assignments

Table 9: Default connections for analog inputss

Analog input	Default usage	Connector pins
IA	Phase A current	X120-7, 8
IB	Phase B current	X120-9, 10
IC	Phase C current	X120-11, 12
IG	Ground current	X120-13,14
VA	Phase A voltage	X120-1,2
VB	Phase B voltage	X120-3,4
VC	Phase C voltage	X120-5,6
X105-RTD1	Stator Temperature-1	X105-9,10,15
X105-RTD2	Stator Temperature-2	X105-11,12,15
X105-RTD3	Stator Temperature-3	X105-13,14,15
X105-RTD4	Motor Bearing Temperature-1	X105-17,18,16
X105-RTD5	Load Bearing Temperature-1	X105-19,20,16
X105-RTD6	Load Case Temperature	X105-21,22,16
X110-RTD1	Stator Temperature-4	X110-9,10,15
X110-RTD2	Stator Temperature-5	X110-11,12,15
X110-RTD3	Stator Temperature-6	X110-13,14,15
X110-RTD4	Motor Bearing Temperature-2	X110-17,18,16
X110-RTD5	Load Bearing Temperature-2	X110-19,20,16
X110-RTD6	Ambient Temperature	X110-21,22,16

Table 10: Default connections for binary inputs

Binary input	Default usage	Connector pins
X115-BI2	Circuit breaker open position	X115-3, 4
X115-BI3	Circuit breaker closed position	X115-5, 6

Table 11: Default connections for binary outputs

Binary output	Default usage	Connector pins
X100-PO1	Close circuit breaker	X100 – 6,7
X100-PO2	Breaker failure backup trip to upstream breaker	X100 – 8,9
X100-SO1		
X100-SO2	Motor Overload Alarm	X100 - 13,14
X100-PO3	Open circuit breaker / Master Trip -1	X100 - 15,16,17,18,19
X100-PO4	Open circuit breaker / Master Trip -2	X100 - 20,21,22,23,24

Binary output	Default usage	Connector pins
X110-SO1		X110-14,15,16
X110-SO2		X110-17,18,19
X110-SO3		X110-20,21,22
X110-SO4		X110-23,24

*Table 12: High speed binary output connections**

Binary output	Default usage	Connector pins
X115-HSO1	Open circuit breaker / Master Trip -1	X115 – 15,16
X115-HSO2	Trip from ARC-2 protection	X115 – 19,20
X115-HSO3	Trip from ARC-3 protection	X115 – 23,24
*Available only if IED has been ordered with High speed binary output (HSO) card		

Table 13: Default connections for LEDs

LED	LED Label
LED 1	Phase A
LED 2	Phase B
LED 3	Phase C
LED 4	Neutral, Neutral / Ground, Neutral / SEF
LED 5	Overcurrent
LED 6	Undercurrent
LED 7	Locked Rotor / Jam
LED 8	Voltage protection
LED 9	Phase Rev. / Neg. Sequence
LED 10	Overload Alarm / Trip
LED 11	Arc Flash Detection

Some of the alarm LED channel connections in the standard configuration depends on the optional functionality and are available according to order code.

3.3.4 Typical connection diagram

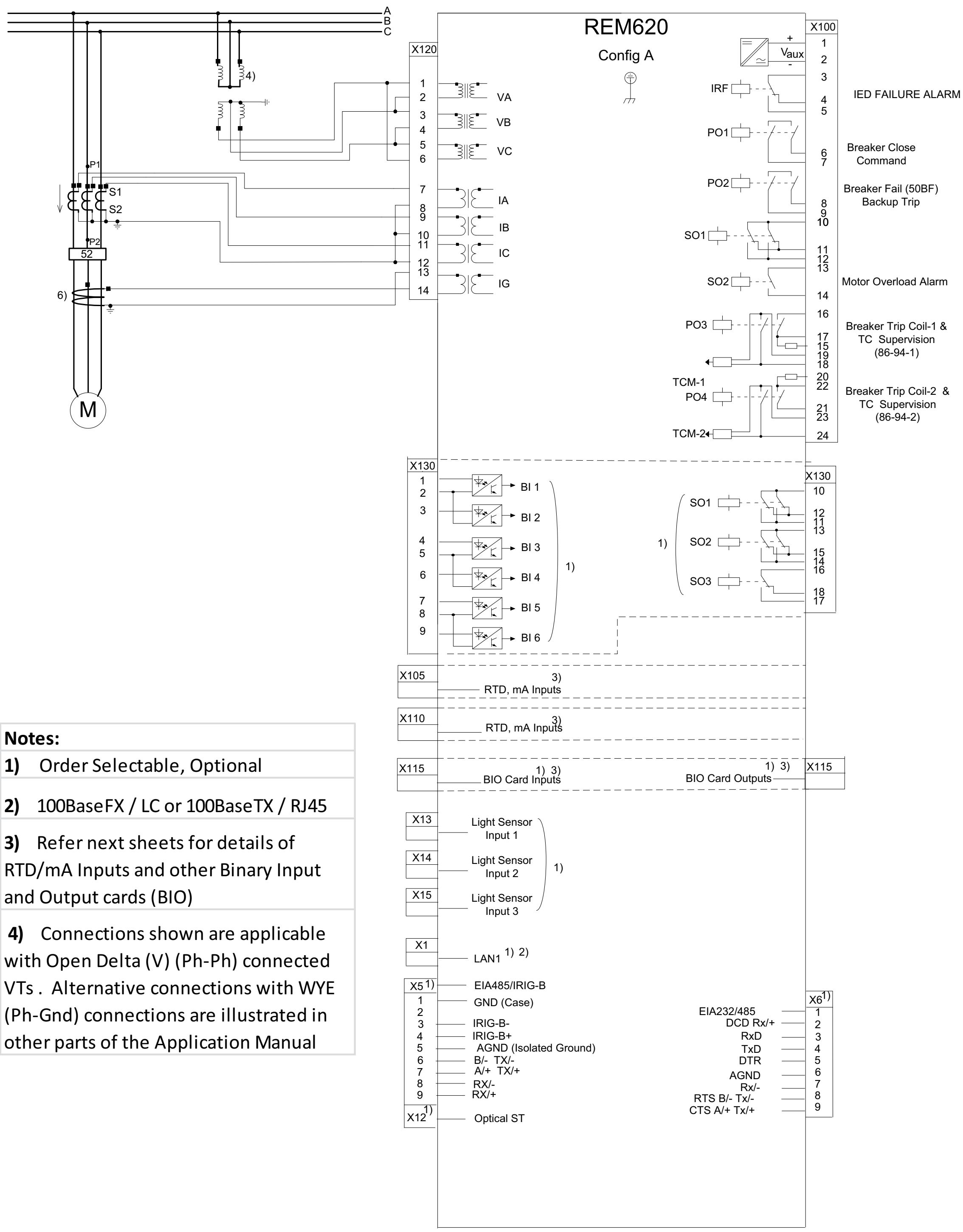


Figure 20: Typical connection diagram of REM620 (Config A)

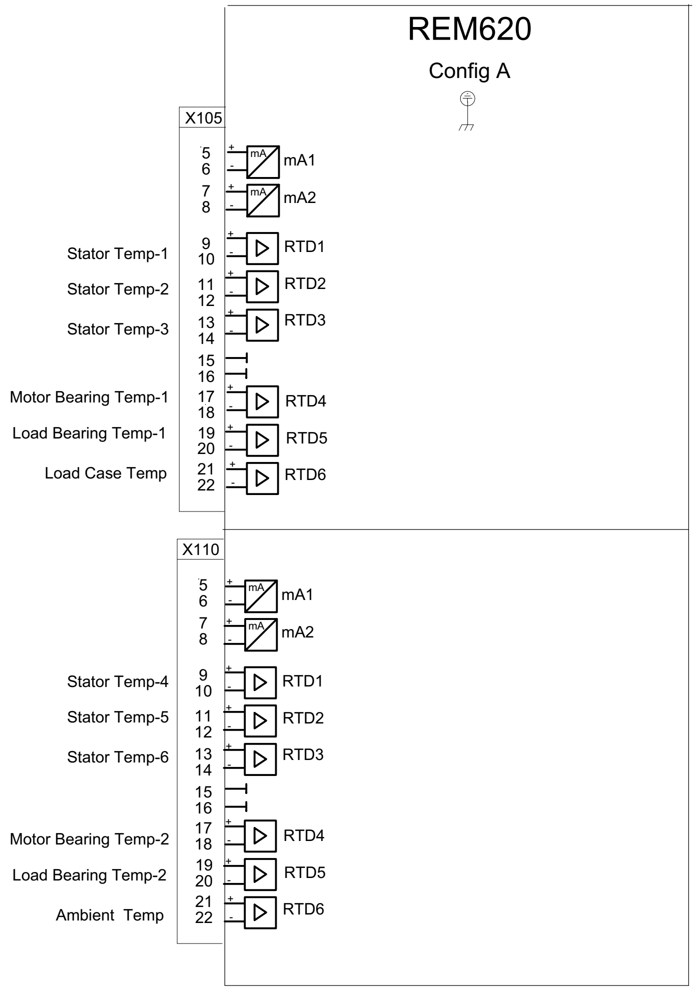
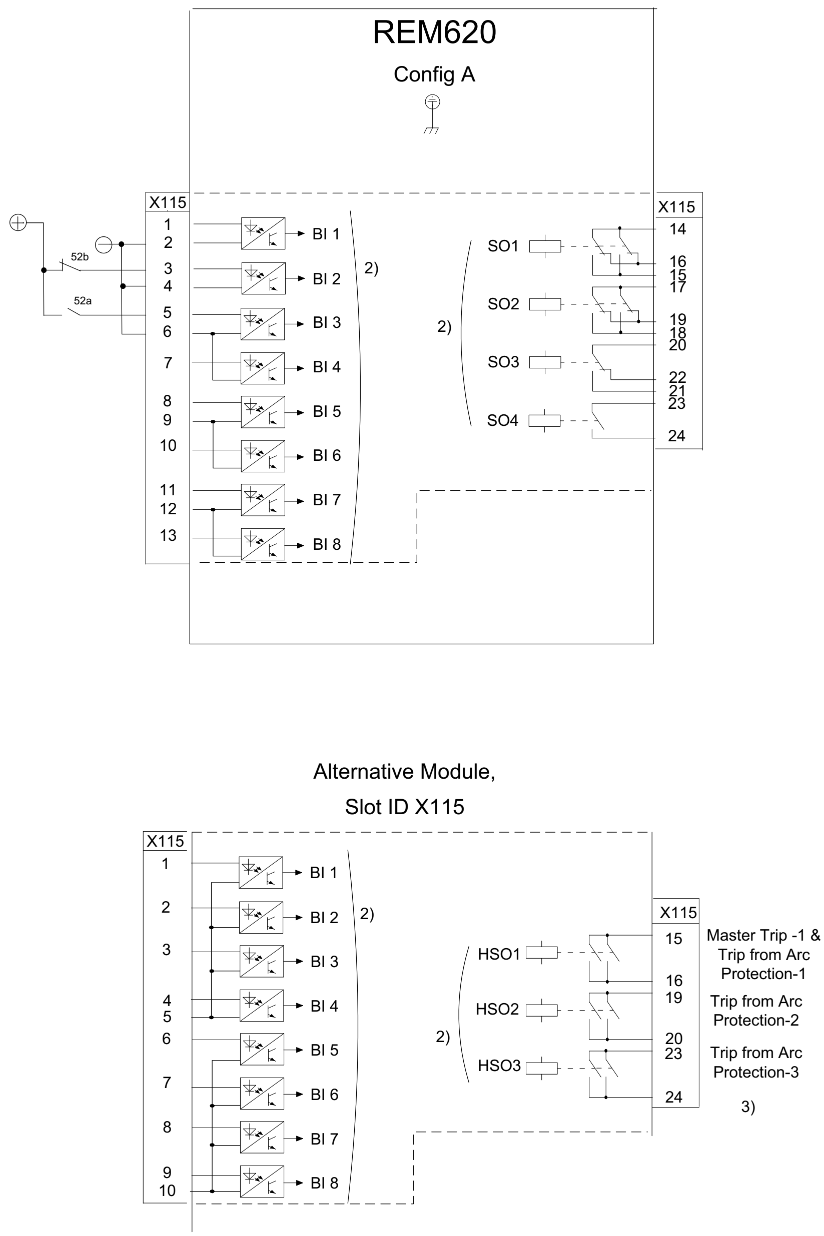


Figure 21: Typical BIO module equipment arrangement and connections for REM620, Config A (Slot X105 and X110)



2) Order Selectable, Optional alternatives

3) Default outputs configured with High Speed Outputs when Arc protection option is chosen

Figure 22: Typical BIO module equipment arrangement and connections for REM620, Config A (Slot X115)

The logics and routing of signals inside the IED with respect to protection and tripping are summarized in the next few sheets:

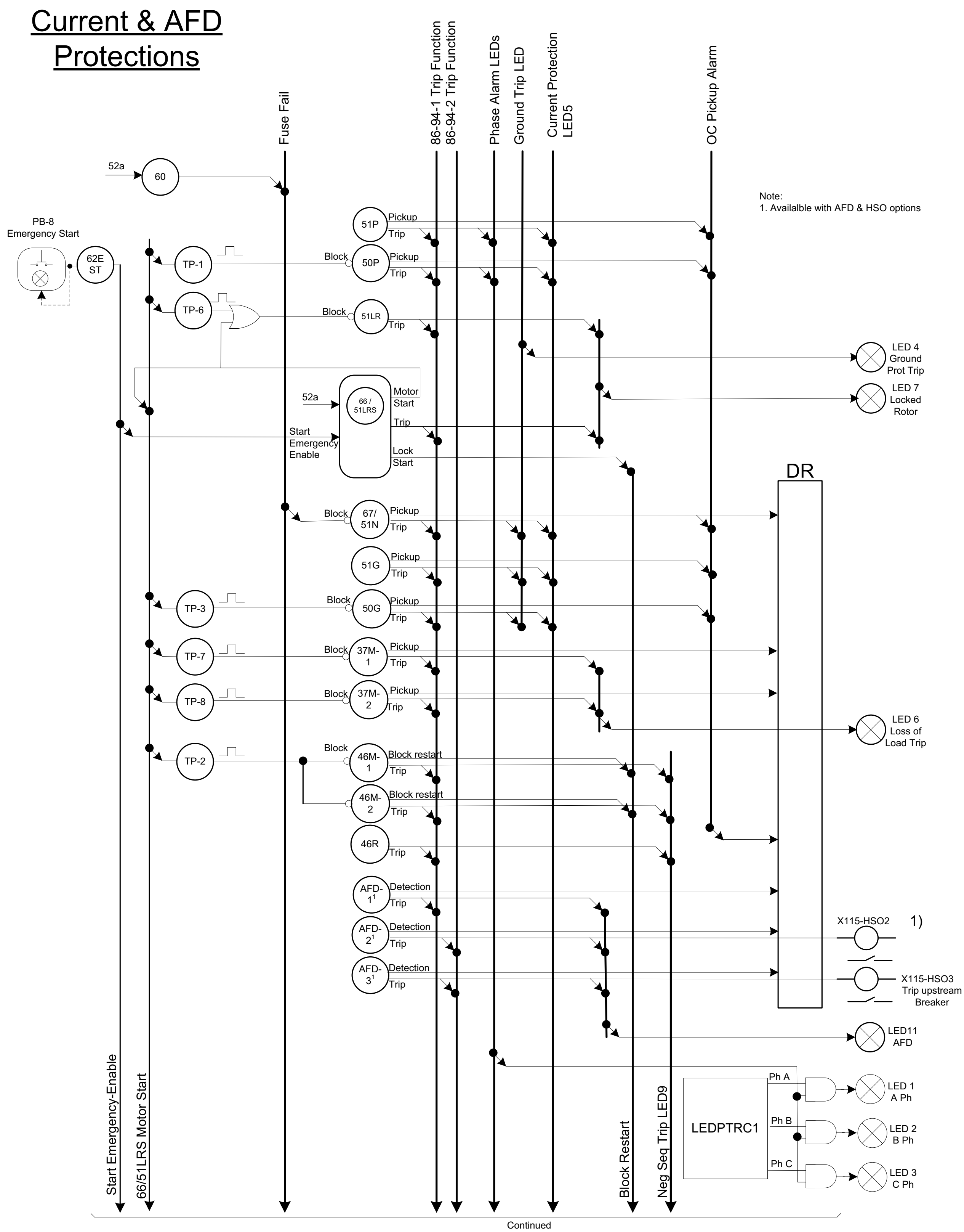


Figure 23: Simplified Logic Diagram for Current Protections, REM620, Config A

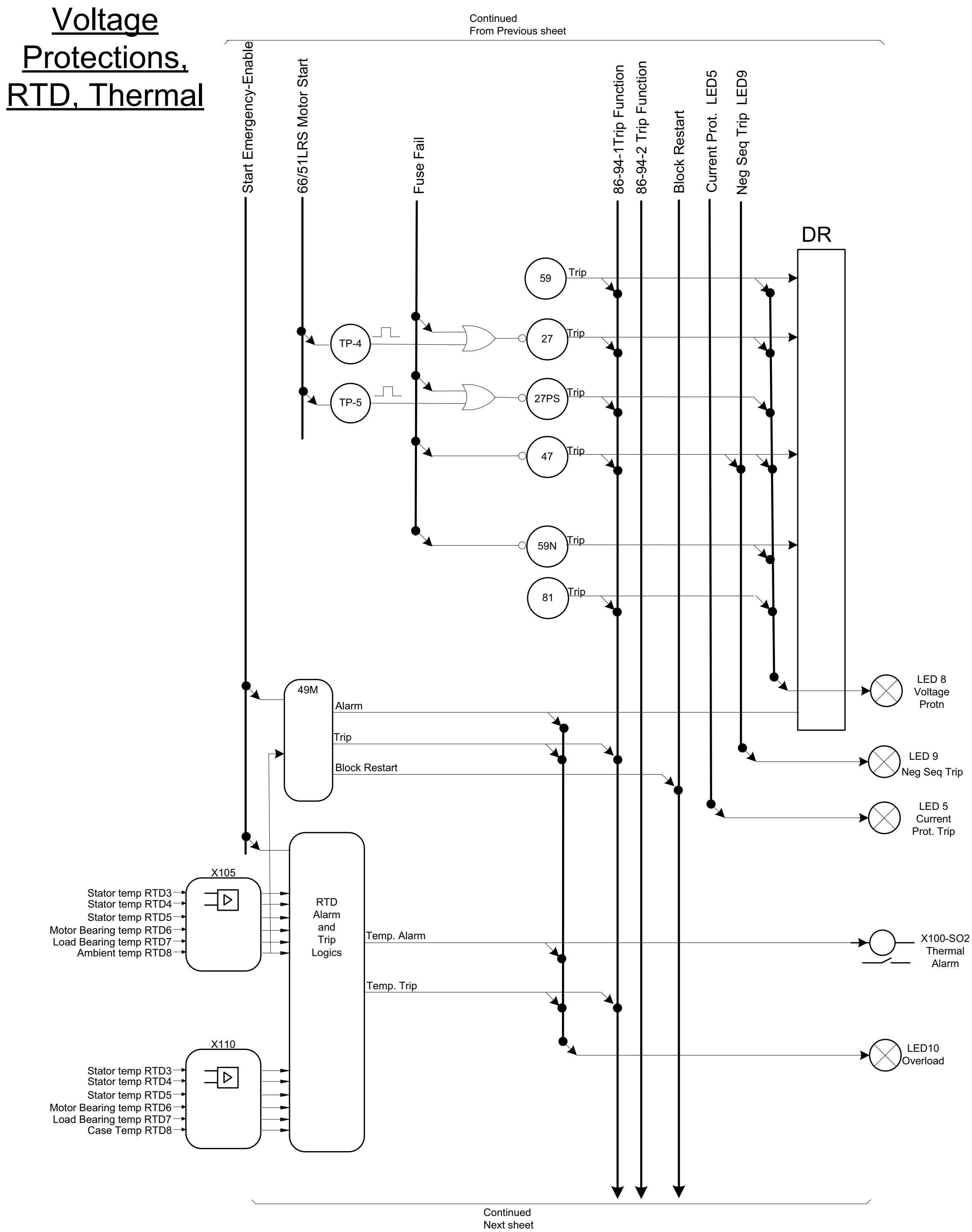


Figure 24: Simplified Logic Diagram for Other Protections, REM620, Config A

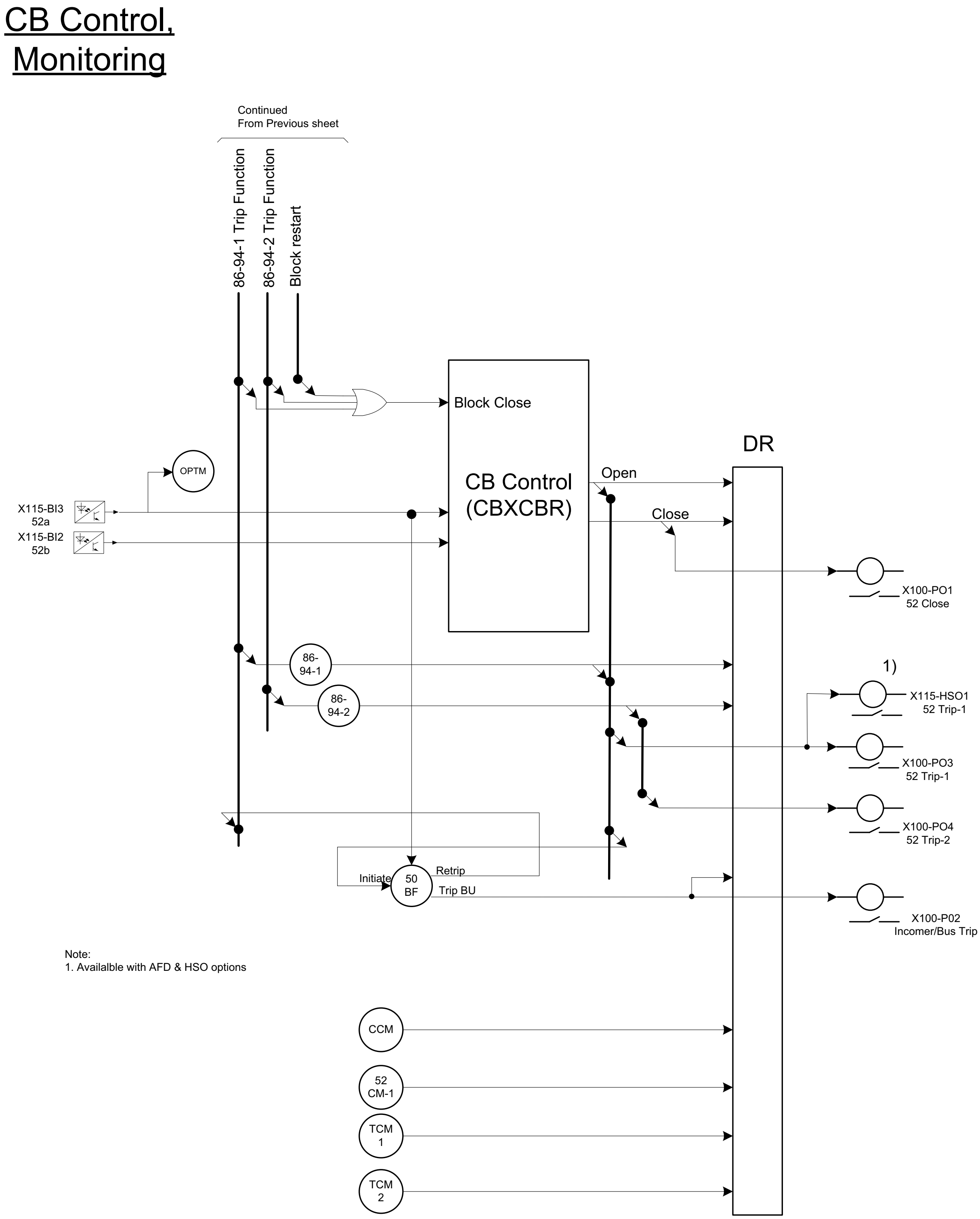


Figure 25: Simplified Logic Diagram for CB Control and Monitoring, REM620, Config A

3.3.5 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections. The default connections can be viewed and changed with PCM 600 according to the application requirements, if necessary.

The analog channels, measurements from CTs and VTs, have fixed connections to the different function blocks inside the IED's standard configuration.

The signal marked with IA, IB and IC represents the three phase currents. The signal IG represents the measured ground current, fed either from residual connection or an external BCT depending on the application.

The signal marked with VA, VB and VC represents the three phase system voltages on the bus. These inputs are connected in Delta, which are typically fed from delta (V connected) VTs from the system. When WYE connected VT is available in the system, the VT inputs in the IED are WYE connected and configuration setting is suitably changed.

When power system is provided with Open delta VT (V connected), since there is no way to measure or estimate the system zero sequence voltage, directional ground fault protection will have to be polarized by negative sequence voltage polarization method only.

REM 620 offers six different settings group which the user can set based on individual needs. Each group can then, be activated/ deactivated by using the programmable button offered in the front panel of the unit. In addition to this the programmable button can also be used for enabling/disabling switch mode, emergency restart, sensitive earth fault detection etc. Figure 26 shows the default mapping for the available programmable buttons.

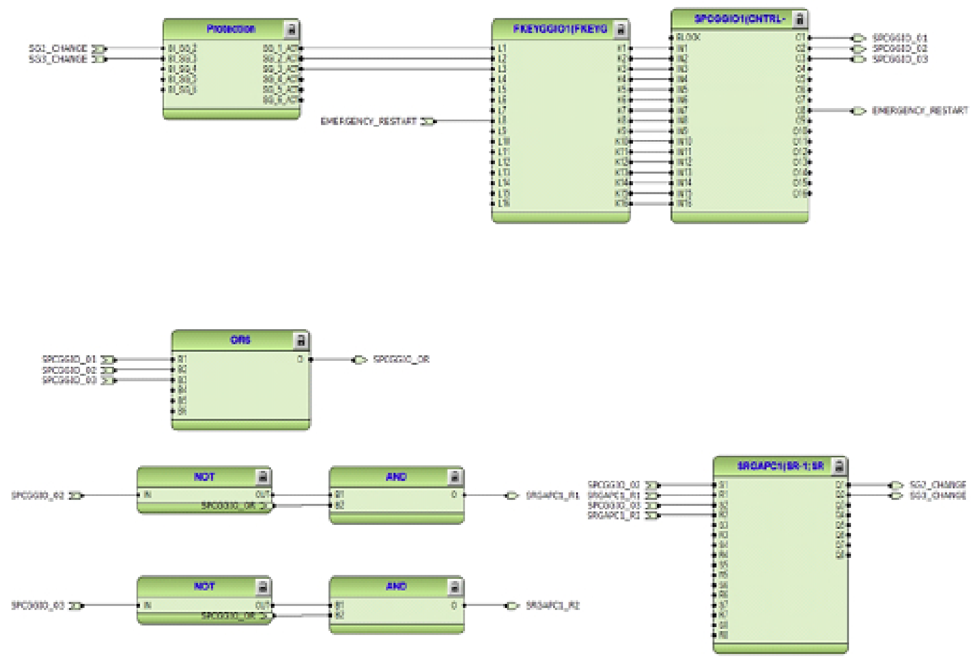


Figure 26: Default mapping on programmable buttons

3.3.6 Functional diagrams for protection

The functional diagrams describe the IED's protection functionality in detail and according to the factory set default connections.

All trip signals are connected to the Master Trip and also to the alarm LEDs. Alarm LEDs 1, 2 and 3 are used for phase segregated information of faults.

Two, three-phase overcurrent protection (51P and 50P) stages are provided for overcurrent and short-circuit protection of motor. 51P can be used for overcurrent protection and 50P for the short-circuit protection. Apart from three-phase overcurrent protection, motor jam protection (51LR) is also available for protecting the motor under locked rotor or mechanical jam situations during running conditions.

The operation of 51P is not blocked as default by any functionality and so setting should be set such as to avoid unnecessary false trip or alarm. The operation of 50P is blocked by motor startup supervision function.

51LR is blocked by the motor startup protection (66/51LRS) to avoid operation of 51LR during motor starting condition. The operation of 51P and 50P is connected to alarm LED 5, and 51LR (along with motor startup protection) is connected to alarm LED 7.

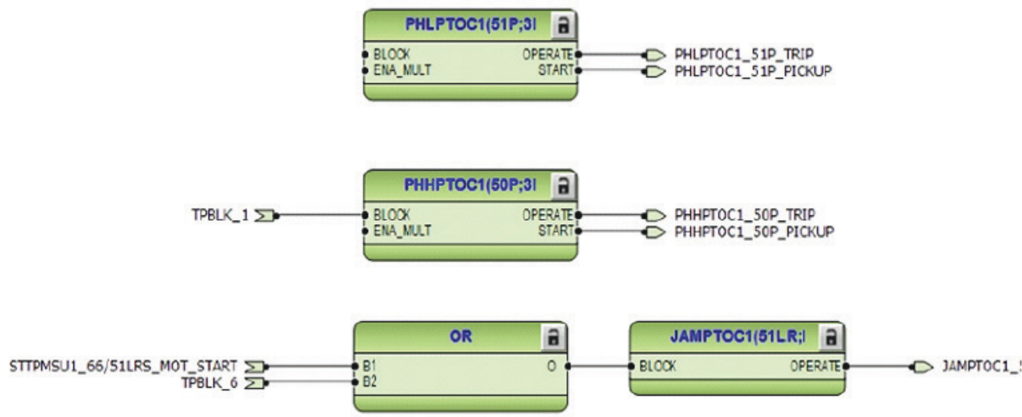


Figure 27: Three phase overcurrent and motor jam protection

Alarm LEDs 1, 2 and 3 are configured so as to indicate which phase has resulted into tripping of 50P and 51P. Overcurrent faults in Phase A, B and C is mapped to Alarm LEDs 1, 2 and 3 respectively.

Two non-directional ground-fault protection (51G and 50G) stages, operated off the measured ground fault analog input IG, are provided to detect phase-to-ground faults that may be a result of, for example, insulation ageing or sudden failure of insulation.

The operation of 51G not blocked as default by any functionality, while 50G is blocked by startup supervision function. The operation of ground-fault protection functions is connected to alarm LED 4.

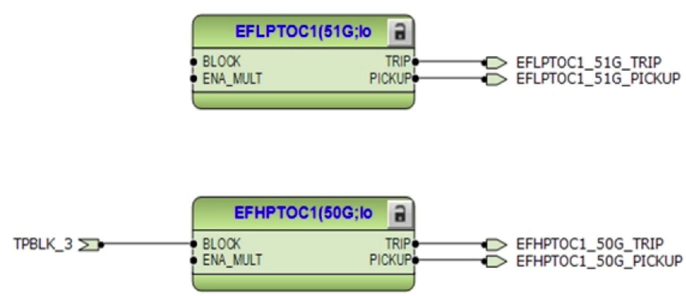


Figure 28: Non-directional ground fault protection

A single stage directional ground-fault protection (67/51N) is provided. If the fuse failure situation is detected all directional ground-fault protection functions will be blocked. While setting the directional element, it is necessary to choose either V0 calculated or Negative sequence voltage polarization. While either one may be selected with WYE connected VT, it is essential to choose negative sequence voltage polarization with Delta (V connected) VT input from which zero sequence voltage cannot be derived. The function can also be set non-directional. Provision is available to make the operating current selectable either from the calculated zero sequence current from current inputs IA, IB, IC or the measured IG current input.

Figure 29: Directional ground fault protection

Configuration also includes pickup alarm, the pickup outputs from 50P, 51P, 50G, 51G and 67/51N are connected together to have a combined overcurrent pickup alarm which is connected to disturbance recorder as default.

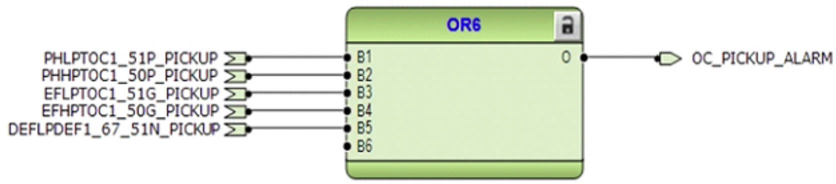


Figure 30: Overcurrent pickup alarms

One undervoltage, positive sequence undervoltage and overvoltage protections (27, 27PS and 59) offer protection against abnormal phase voltage conditions. A failure in the voltage measuring circuit is detected by the fuse failure function and the activation is connected to undervoltage protection functions to avoid faulty undervoltage tripping.

Negative-sequence overvoltage (47) protection functions enable voltage based unbalance protection.

The residual overvoltage protection (59N) provides ground-fault protection by detecting abnormal level of residual voltage. It can be used, for example, as a nonselective backup protection for the selective directional ground-fault functionality.

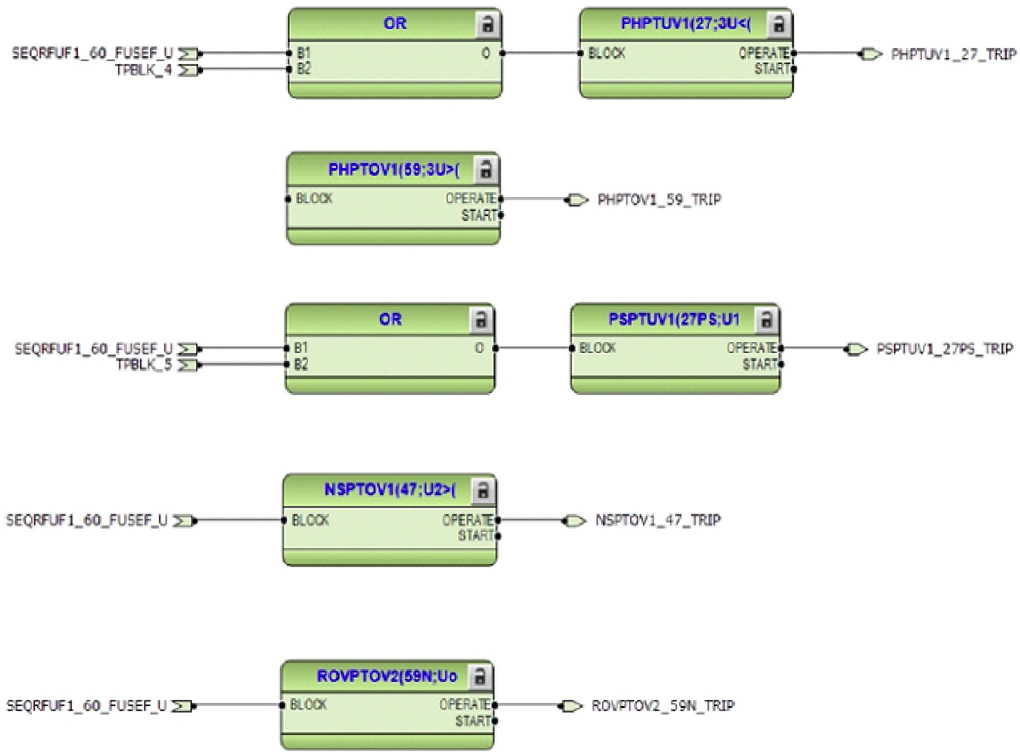


Figure 31: Voltage protection functions

The selectable under frequency or over frequency protection (81) prevents damage to network components under unwanted frequency conditions.

The function contains a selectable rate of change of the frequency (gradient) protection to detect an increase or decrease in the fast power system frequency at an early stage. This can be used as an early indication of a disturbance in the system.

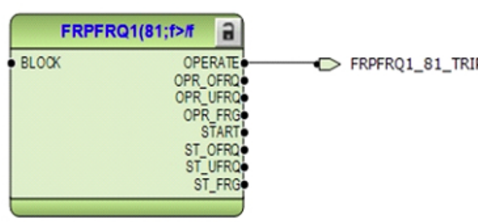


Figure 32: Frequency protection functions

Two negative-sequence overcurrent protection (46M-1 and 46M-2) stages are provided for phase unbalance protection. These functions are used to protect the motor against phase unbalance caused by, for example, a broken conductor. Excessive negative sequence current results into overheating of the motor eventually resulting into insulation damage.

This configuration also includes phase reversal protection (46R), based on the calculated negative phase-sequence current. It detects too high negative phase sequence current values during motor start up, caused by incorrectly connected phases, which in turn causes the motor to rotate in the reverse direction.

The operation of 46M-1, 46M-2 and 46R is not blocked as default by any functionality. The operation of these protection functions is connected to alarm LED 9.

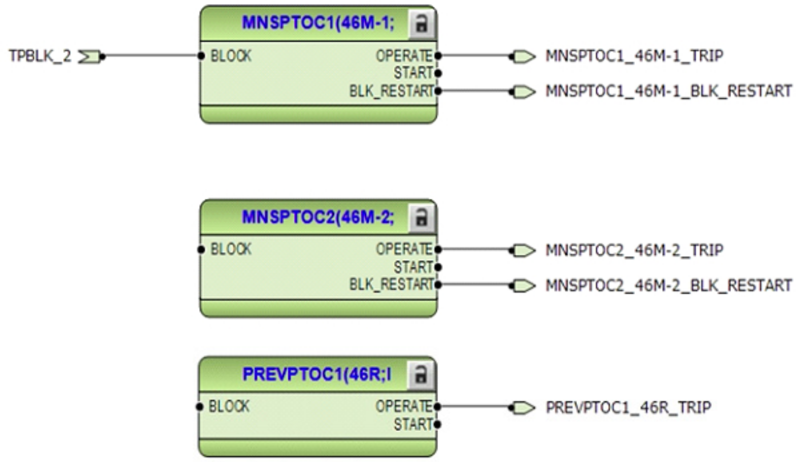


Figure 33: Negative sequence and phase reversal protection

The thermal overload protection function (49M) detects short and long term overloads under varying load conditions. When the emergency start request is issued for the emergency start function, it activates the corresponding input of the thermal overload function. When the thermal overload function has issued a restart blocking, which inhibits the closing of the breaker during machine overload condition; the emergency start request removes this blocking and enables the user to start the motor again.

The alarm and operation of thermal overload protection function is connected to alarm LED 10.

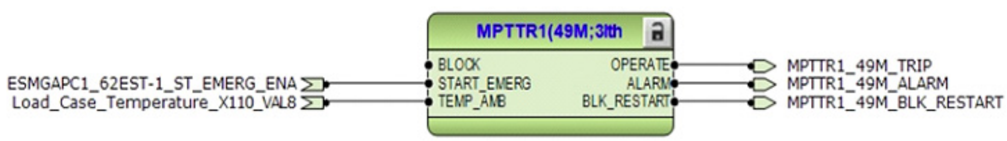


Figure 34: Motor thermal overload protection

There are 12 RTD inputs available in the IED. Six of them are configured for inputs stator temperature, two for motor bearing temperatures, two for load bearing temperatures, one for motor casing temperature and one for ambient temperature.

The maximum of the stator RTD temperature is taken to a level detector 38-6 to generate overload alarm.

The maximum of the stator RTD temperatures and higher of the two motor bearing temperatures are set against level detectors(38-1, 38-2) and ORed to generate a signal Trip on stator / bearing temperature. Level detector 38-6 detectors too high temperature levels from stator and is arranged to trip the motor.

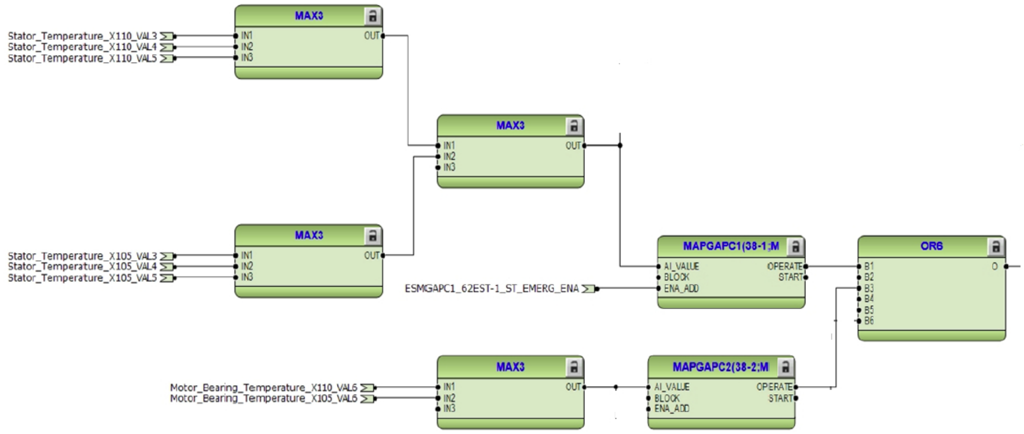


Figure 35: *RTD measurement of stator temperatures and bearing temperatures*

The maximum of all bearing temperatures is compared against set level in (38-7) to generate high bearing temperature signal. The higher of the load-bearing temperatures are fed to level detector 38-3 to generate high load bearing temperature signal. Level detectors 38-4 and 38-5 are used to detect high inputs from ambient and load casing respectively.

An alarm signal is generated based on level detectors 38-4,38-5 and 38-6.

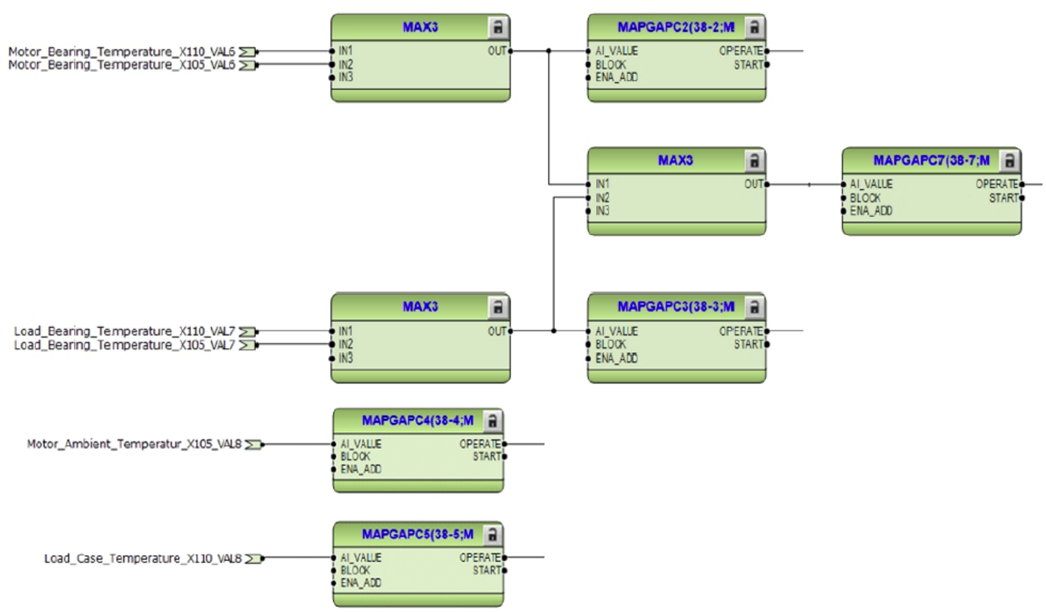


Figure 36: *Level detection of various temperatures from RTD inputs*

With the motor startup supervision function (66/51LRS) the starting of the motor is supervised by monitoring three-phase currents or the status of the energizing circuit breaker of the motor. It is also possible to connect the speed switch to determine the locked rotor situation.

The operation of 66/51LRS (along with motor jam protection) is connected to alarm LED 7.

A number of signals TPBLK are generated with necessary delays to block various function.

When the emergency start request is activated by 62EST and if 66/51LRS is in lockout state, which inhibits motor starting, the lockout is deactivated and emergency starting is available.

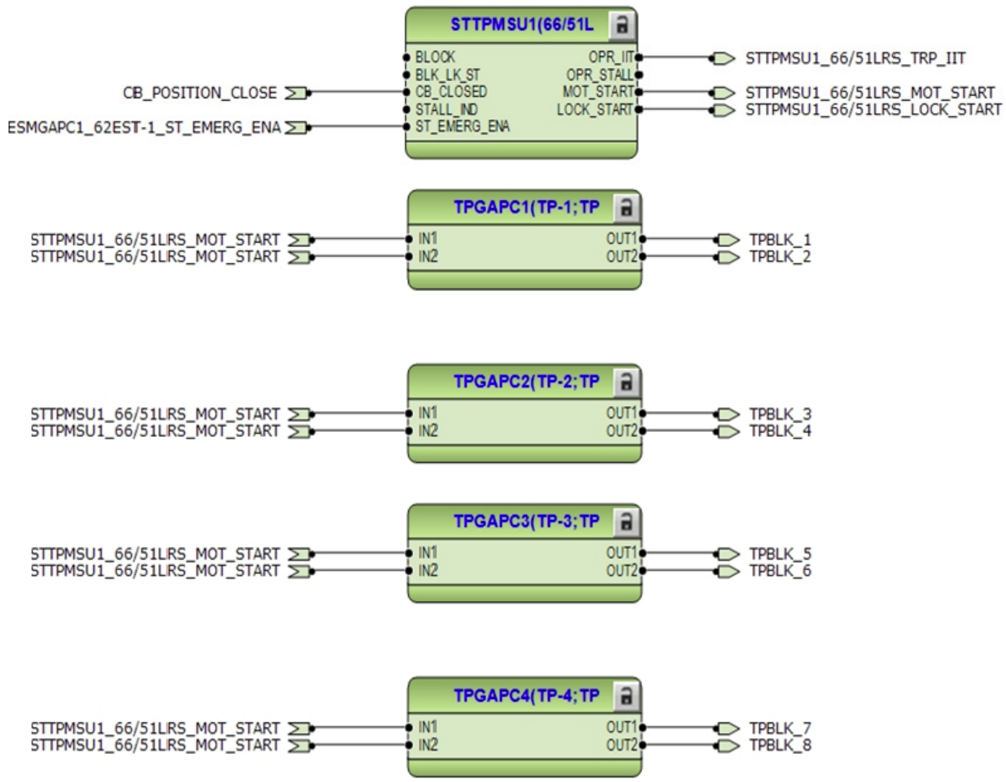


Figure 37: *Motor startup supervision*

Two, loss of load protection (37M-1 and 37M-2) stages are provided for detecting sudden loss of load on the motor. The loss of load situation can happen, for example, if there is damaged pump or due to sudden breakdown in conveyor belt.

Operation of 37M-1 and 37M-2 is blocked by the motor startup protection (66/51LRS) to avoid operation during motor starting condition. The operation of these protection functions is connected to alarm LED 6.

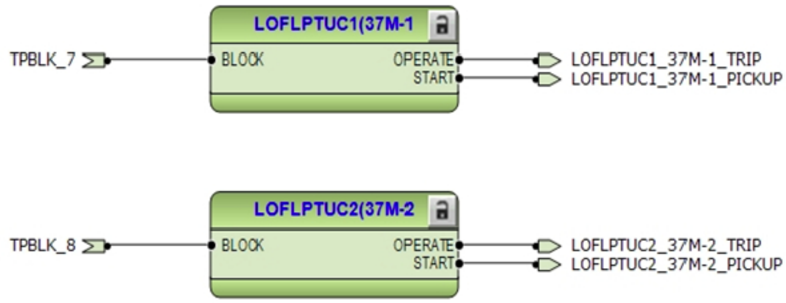


Figure 38: Loss of load protection

The circuit-breaker failure protection (50BF) is initiated via the start input by a number of different protection functions in the IED. 50BF offers different operating modes associated with the circuit-breaker position and the measured phase and residual currents.

50BF has two operating outputs: TRRET and TRBU. The TRBU output is used to give a backup trip to the circuit breaker feeding upstream. For this purpose, the TRBU trip output signal is connected to the output PO2 (X100: 8-9).

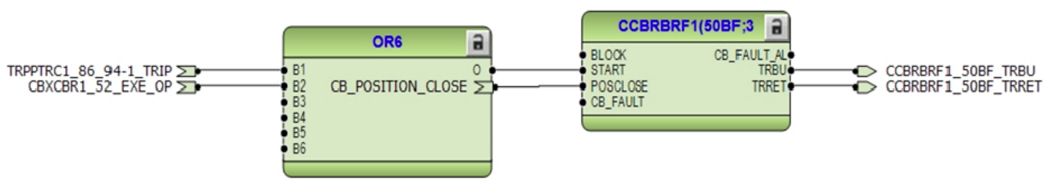


Figure 39: Circuit breaker failure protection

Three arc protection (ARC-1, ARC-2 and ARC-3) stages are included as an optional function. The arc protection offers individual function blocks for three ARC sensors that can be connected to the IED. Each arc protection function block has two different operation modes, with or without the phase and residual current check.

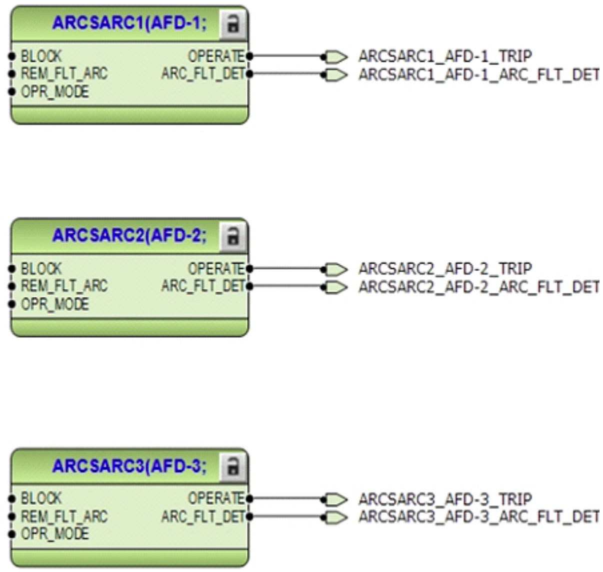


Figure 40: Arc protection

Trip signal from AFD-1 is connected to Master trip 1, available at PO3 (X100: 15-19). The trip signal from AFD-2 and AFD-3 is connected to master trip 2, available at PO4 (X100: 20-24). The operation of these protection functions is connected to alarm LED 11.

If the IED has been ordered with high speed binary outputs, then trip signal from AFD-2 and AFD-3 are also connected directly to high speed output HS02 (X115:19-20) and HS03(X115:23-24) respectively. A parallel output of master trip 1 is also routed to HSO1 (X115:15-16) so trip from AFD1 can be transferred out faster for tripping.

Two master trip logics (86/94-1 and 86/94-2) are provided as a trip command collector.

86/94-1 collects the trip signals from 51P, 50P, 51G, 50G, 67/51N, 46M-1, 37M-1, 46R, 46M-1, 51LR, 66/51LRS and ARC-1 protection functions and is connected to trip output contact PO3 (X100:15-19) and also to high speed output HS01 (X115:15-16) for IEDs ordered with high speed binary output cards.

Open control commands to the circuit breaker from the local or remote is also connected directly to the output PO3 (X100:15-19) from circuit breaker control (52) function block.

86/94-2 collects the trip signals from ARC-2 and ARC-3 protection functions and is connected to trip output contact PO4 (X100:20-24).

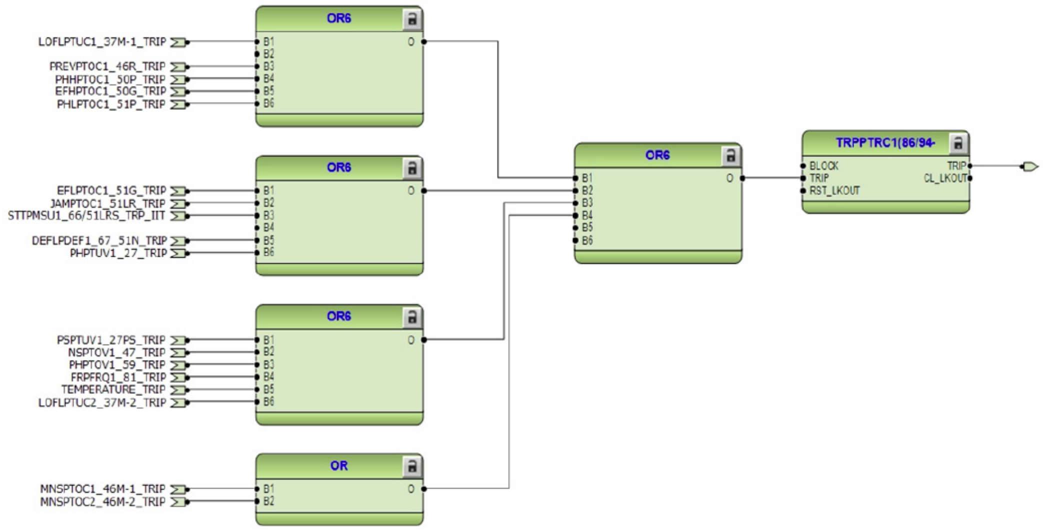


Figure 41: Master trip logic 1

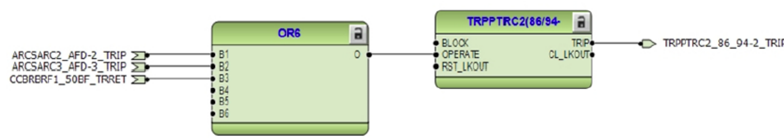


Figure 42: Master trip logic 2

86/94-1 and 86/94-2 provides the lockout/latching function, event generation and the trip signal duration setting. If the lockout operation mode is selected, one binary input can be reassigned to the RST_LKOUT input of the Master Trip to enable eternal reset with a pushbutton.

3.3.7 Functional diagrams for control functions

The emergency start function (62EST) allows motor startups although the restart inhibit is activated. The emergency start is enabled for ten minutes when the function pushbutton 8 is pressed (or alternatively through a binary input which may be configured if necessary). On the rising edge of the emergency start signal:

- Calculated thermal level is set slightly below the restart inhibit level to allow at least one motor startup.
- Value of the cumulative startup time counter 66/51LRS is set slightly below the set restart inhibit value to allow at least one motor startup.

A new emergency start cannot be made until the emergency start signal has been reset and the emergency start time of 10 minutes has expired.

Figure 43: Emergency start

The circuit breaker closing is enabled when the ENA_CLOSE input is activated. The input can be activated by the configuration logic, which is a combination of the disconnector or breaker truck and ground switch position status and the status of the Master Trip logics and gas pressure alarm and circuit-breaker spring charging. The OK_POS output of the CBXCBR can also be connected to the interlocking logic enabling the breaker closing, thus breaker closing in intermediate state can be prevented. With the present configuration, the activation of ENA_CLOSE input is configured using only Master Trip logic 86/94-1 and 86/94-2 i.e. the circuit breaker cannot be closed in case master trip is active.

Configuration also includes motor restart inhibit logic. When the motor restart is inhibited, the BLK_CLOSE input is activated and closing of the breaker is not possible. When all conditions of the circuit breaker closing are fulfilled, the EE_CL output of the 52 is activated and PO1 output (X100:6-7) is closed if closing command is given.

The motor restart inhibit is activated when there is

- An active trip command or
- Motor startup supervision has issued lockout or
- Motor unbalance function has issued restart blocking or
- Motor thermal overload function has issued restart blocking

The ITL_BYPASS input can be used, for example, to always enable the closing of the circuit breaker when the circuit breaker truck is in the test position, despite of the interlocking conditions being active when the circuit breaker truck is closed in service position.

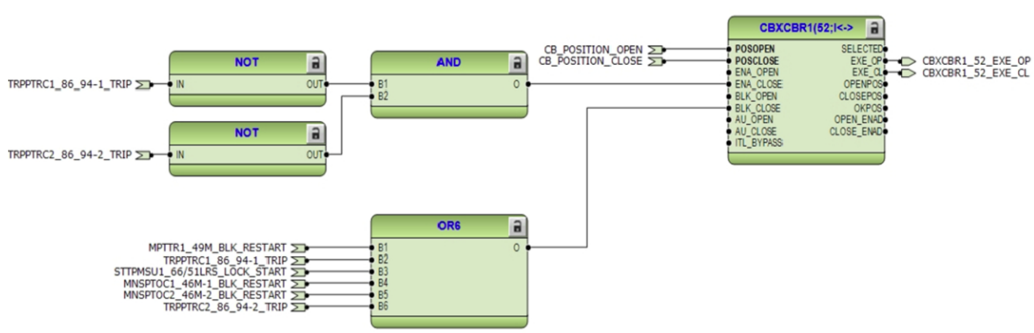


Figure 44: Circuit breaker control

If the ENA_CLOSE and BLK_CLOSE signals are completely removed from the breaker control function block 52 with PCM600, the function assumes that the breaker close commands are allowed continuously.

3.3.8 Functional diagrams for condition monitoring

Two trip circuit monitoring (TCM-1 and TCM-2) stages are provided to supervise the trip circuit of the circuit breaker connected at PO3 (X100:15-19) and PO4 (X100:20-24).

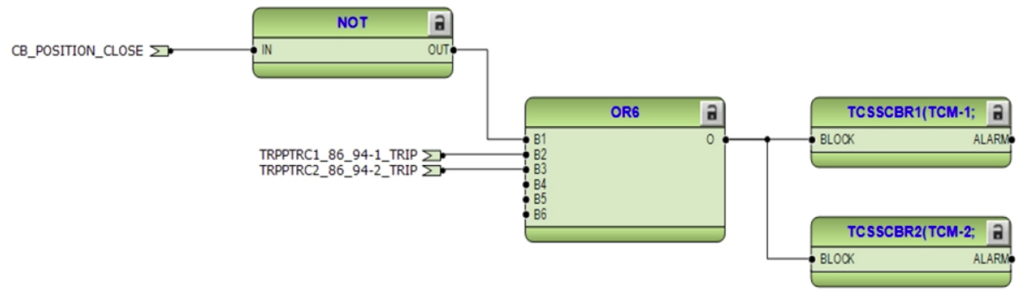


Figure 45: Trip circuit monitoring

The TCM-1 and TCM-2 functions are blocked by 86/94-1, 86/94-2 and the circuit-breaker open position signal.

By default TCM-1 and TCM-2 are not configured in the configuration.

By default it is expected that there is no eternal resistor in the circuit breaker tripping/closing coil circuit connected parallel with circuit breaker normally open/closed auxiliary contact.

A failure in current measuring circuits is detected by current circuit supervision function (CCM). When a failure is detected, function activates and can be used to block protection functions which operates using calculated sequence component currents for example 46M, thus avoiding mal-operation.

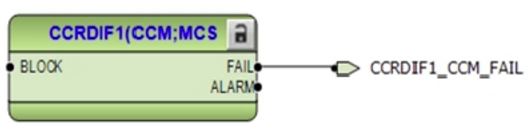


Figure 46: Current circuit supervision

A failure of the fuse or MCB feeding the voltage inputs to the IED is detected by Fuse failure supervision (60). When activated the function is arranged to block a number of voltage dependent functions such as undervoltage (27), negative sequence protection (47), directional overcurrent protection (67/51N), avoiding nuisance tripping of the motor.

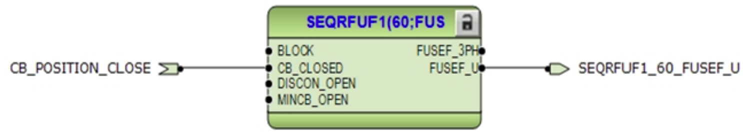


Figure 47: Fuse failure supervision

Two motor run time counter (OPTM-1 and OPTM-2) stages are provided to calculate and present the total number of motor running hours; these running hours are incremented when the energizing circuit breaker is in closed position.

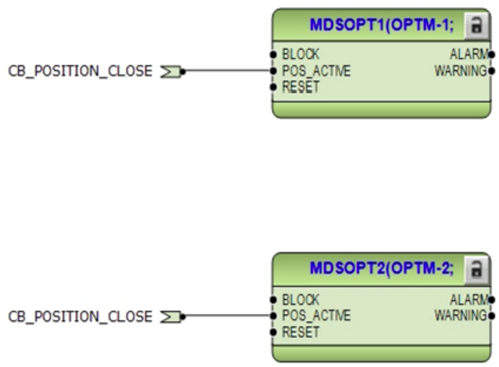


Figure 48: Run time counter

By default OPTM-1 and OPTM-2 are not configured in the configuration.

The circuit breaker condition monitoring function (52CM) supervises the circuit breaker status based on the binary input information connected and measured current levels. The function introduces various supervision alarms.

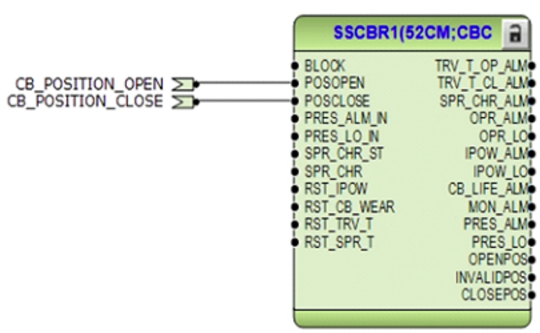


Figure 49: Circuit breaker condition monitoring

By default 52CM is not configured in the configuration.

3.3.9 Functional diagrams for Measurements

The phase current inputs to the IED are measured by three-phase current measurement (IA, IB, IC) function block. The current input is connected to the X120 card in the back panel. Similarly the sequence and residual current are measured by sequence current measurement (I1, I2, I0) and residual current measurement (IG) function blocks respectively.

The phase voltage inputs are also connected to the X120 card in the back panel. The voltages are measured by (VA,VB,VC) function block. Similarly the sequence voltages are measured by sequence voltage measurement (V1, V2, V0) function block.

The measurements can be seen from the LHMI and is available using the measurement option in the menu selection. Based on the settings, function blocks can generate low alarm/warning, high alarm/warning signals for the measured current values.

The frequency measurement of the power system (f) is available. Also single (SPEMMXU1) and three phase (PEMMXU1) power measurements are available.

The load profile (LoadProf) function is also included into measurements sheet. The load profile function offers ability to observe the history of the loading of the corresponding motor.

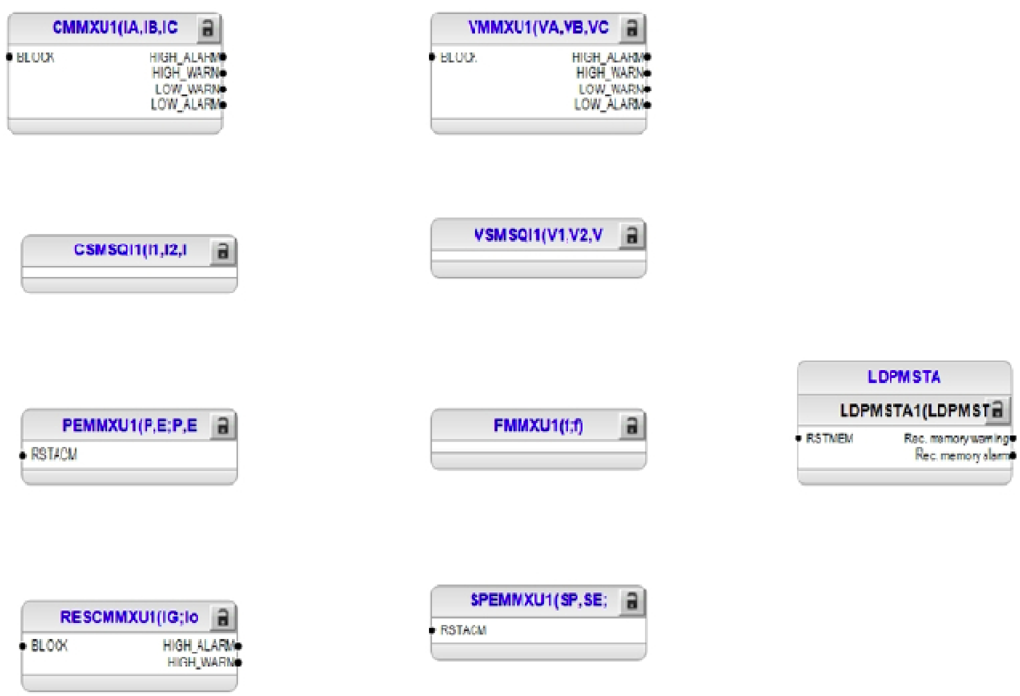


Figure 50: Current, voltage, power and energy measurements and load profile function

3.3.10 Functional diagrams for other functions

Configuration also includes other miscellaneous basic functions which are not configured, but can be used for creating general purpose logics. These functions include:

- Four instance of Minimum Pulse Timer TP-1, TP-2, TP-3 and TP-4,
- Two instance of Pulse Timer PT-1 and PT-2,
- Four instance of Time delay off TOF-1, TOF-2, TOF-3 and TOF-4,
- Four instance of Time delay on TON-1, TON-2, TON3 and TON-4,
- Four instance of Set reset logic SR-1, SR-2, SR-3 and SR-4,
- Eight instance of Move logic MV-1, MV-2, MV-3, MV-4, MV-5, MV-6, MV-7 and MV-8,
- Three instance of Generic control points CNTRL-1, CNTRL-2 and CNTRL-3,
- One Remote Generic Control Points, RCNTRL-1,
- One Local Generic Control Points, LCNTRL-1,
- Twelve Generic Up-Down counters UDFNCT1, UDFCNT2. UDFCNT12 and,
- One Programmable buttons (16 buttons) FKEY.

3.3.11 Function diagrams for logging functions

The disturbance recorder DFR consists of 12 analog and 64 binary channels. The analog channels are pre configured in the IED as follows for this specific configuration:

Table 14: List of analog channels connected to DFR (REM Config A)

Ch. No	Channel
1	IA
2	IB
3	IC
4	IG
5	VA
6	VB
7	VC
8	
9	
10	
11	
12	

A few channels of the binary channel are connected to trigger the digital fault recorder and are shown in Figure 51. More connection can be made as per individual needs. Also, when disturbance recorder is triggered, the analog values available at the analog inputs are recorded by the fault recorder FR.

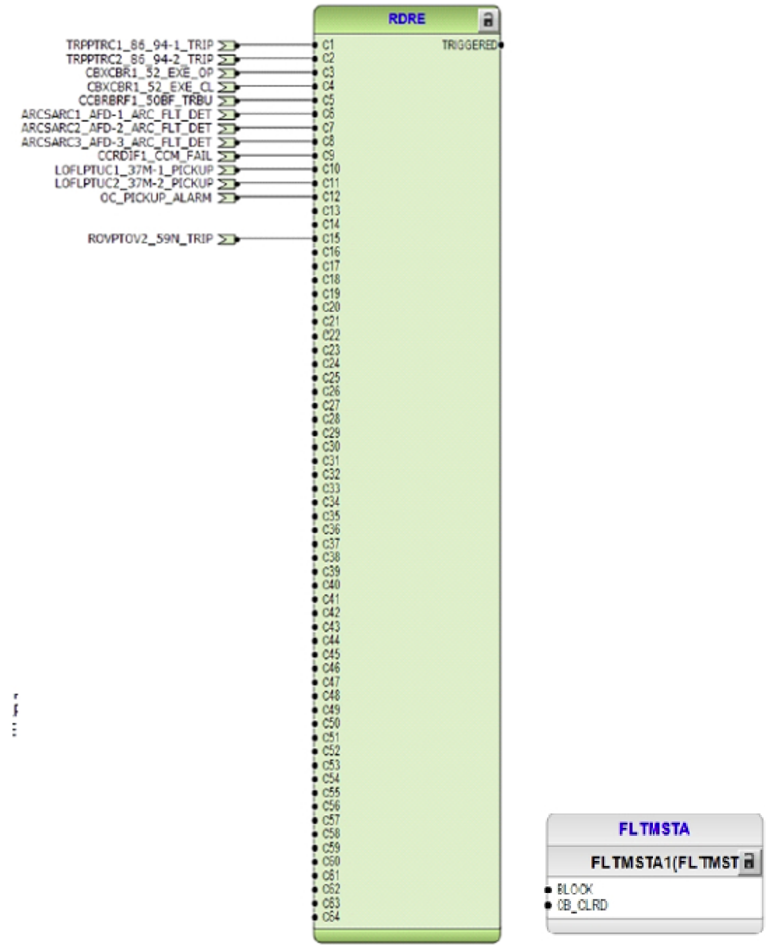


Figure 51: 64 channel Disturbance and fault recorder

3.3.12 Functional diagrams for I/O and Alarm LEDs

The default binary I/O connected in the configuration and Alarm LEDs are indicated in Figure 52 to Figure 53.

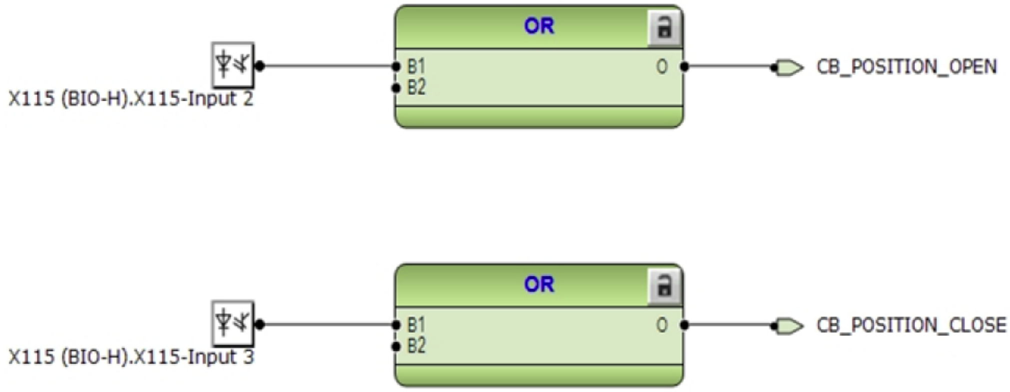


Figure 52: Binary inputs

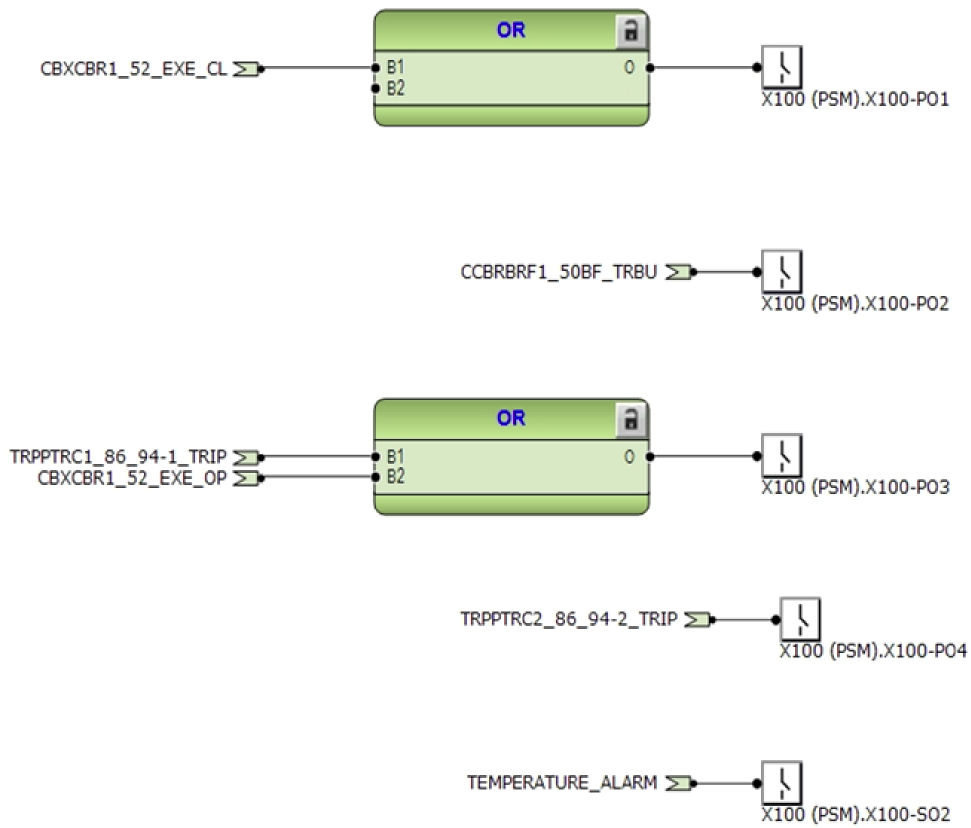


Figure 53: Binary outputs

When HS BO outputs are ordered, the output signal arrangement will be additionally as follows:

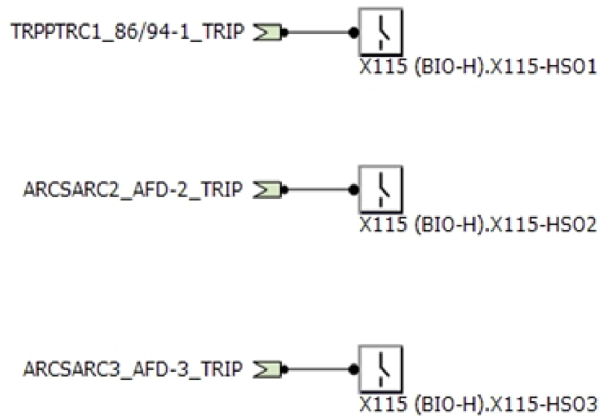


Figure 54: Additional signal outputs configured with AFD and HS BO option

High speed binary outputs (HSO) are available only if IED with High speed binary card has been ordered.

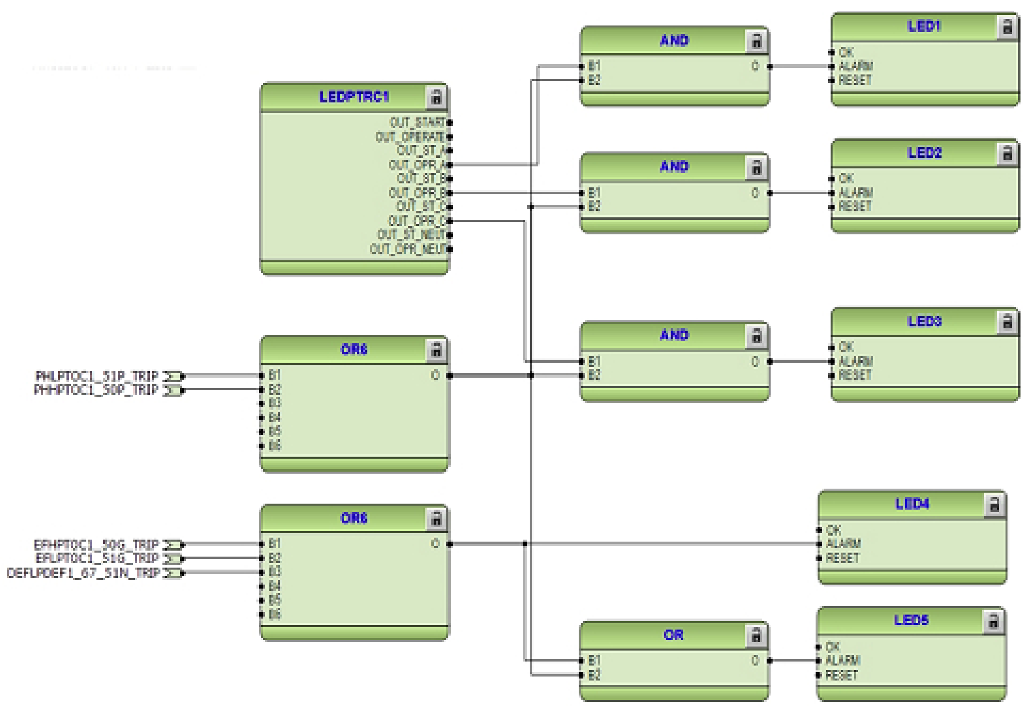


Figure 55: Alarm LEDs 1 - 5

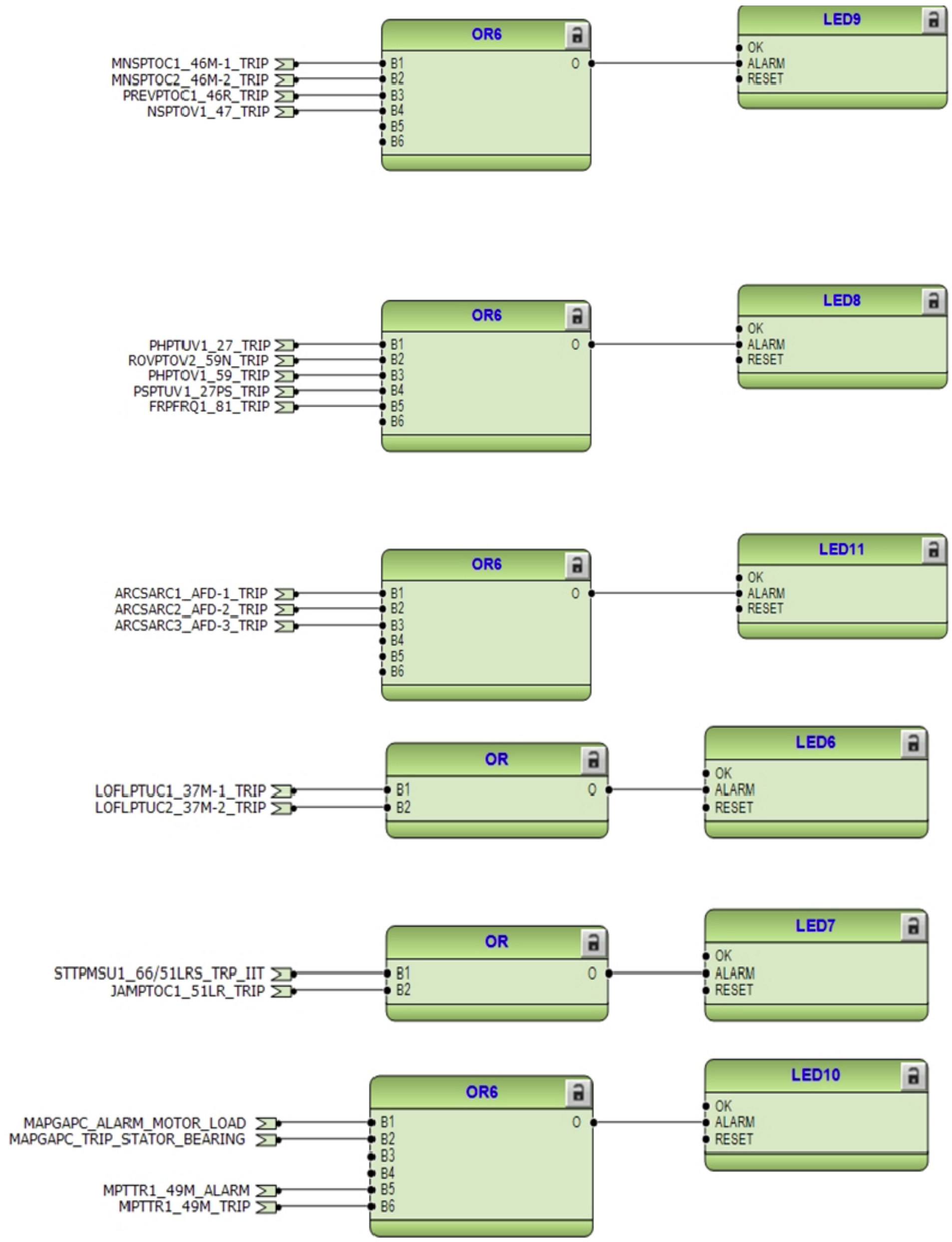


Figure 56: *Alarm LEDs 6 - 11*

3.4 Standard configuration for order code functional applications B or C

3.4.1 Applications

This standard configuration is mainly intended for medium to large circuit breaker-controlled induction motors. This configuration includes differential, non-directional and directional phase and ground overcurrent, phase distance, voltage and frequency protections.

The IED with this standard configuration is delivered from the factory with default settings and parameters. The end-user flexibility for incoming, outgoing and internal signal designation within the IED enable this configuration to be further adapted to different primary power system layouts and the related functionality needs by modifying the internal functionality using PCM600.

3.4.2 Functions

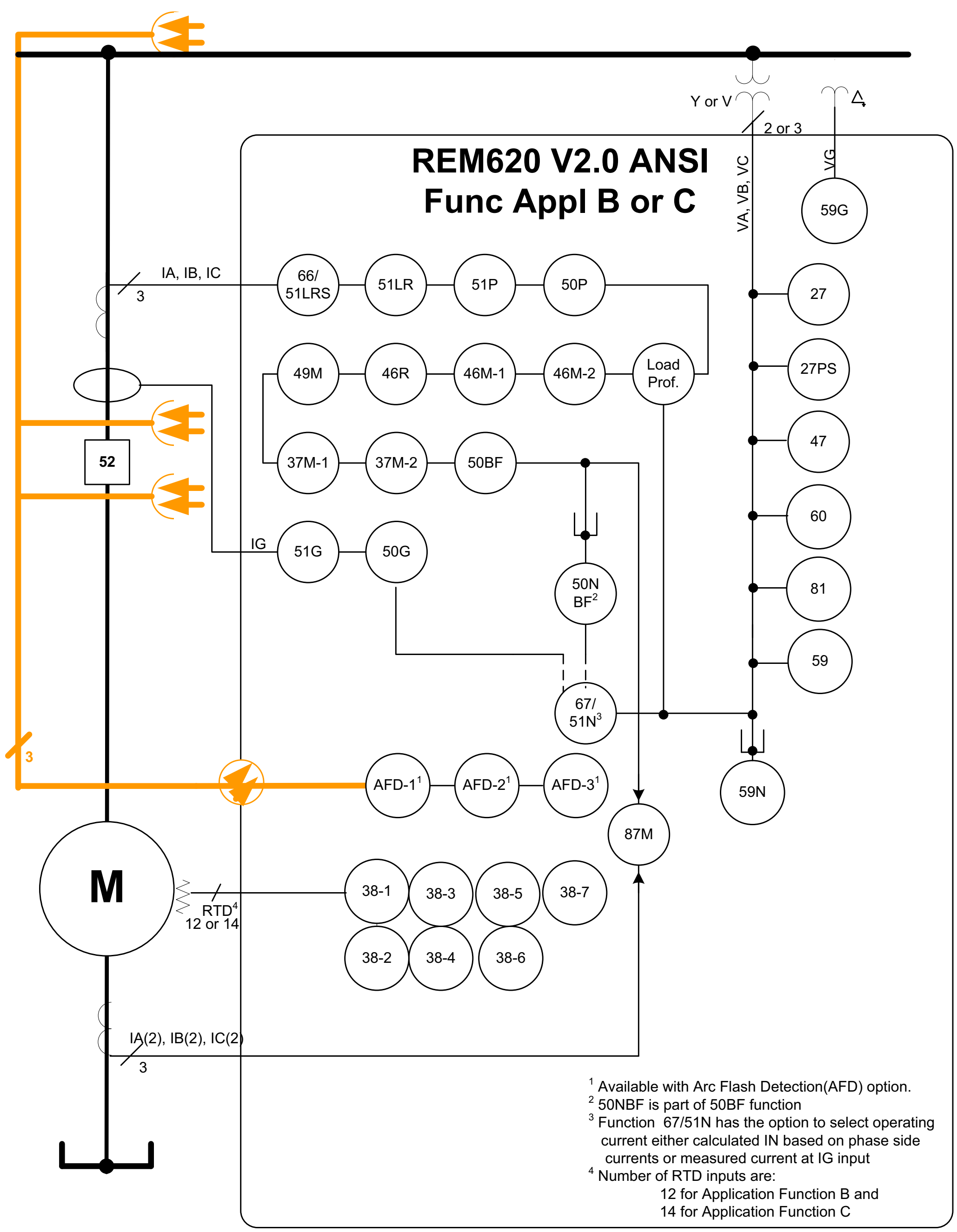


Figure 57: Functions included in the REM620 standard configuration B or C

Table 15: Functions included in the REM620 standard configuration B & C

Function Application Configuration				Config	
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	B	C
Protection					
Three-phase non-directional overcurrent protection, low stage, instance 1	PHLPTOC1	51P	3I> (1)	•	•
Three-phase non-directional overcurrent protection, high stage, instance 1	PHHPTOC1	50P	3I>> (1)	•	•
Non-directional ground-fault protection, low stage, instance 1	EFLPTOC1	51G	Io> (1)	•	•
Non-directional ground-fault protection, high stage, instance 1	EFHPTOC1	50G	Io>> (1)	•	•
Directional ground-fault protection, low stage, instance 1	DEFLPDEF1	67/51N	Io> -> (1)	• [1,2)]	• [1,2)]
Residual overvoltage protection, instance 1	ROVPTOV1	59G	Uo> (1)	•	•
Residual overvoltage protection, instance 2	ROVPTOV2	59N	Uo> (2)	•	•
Three-phase undervoltage protection, instance 1	PHPTUV1	27	3U< (1)	•	•
Three-phase overvoltage protection, instance 1	PHPTOV1	59	3U> (1)	•	•
Positive Sequence undervoltage protection, instance 1	PSPTUV1	27PS	U1< (1)	•	•
Negative-sequence overvoltage protection, instance 1	NSPTOV1	47	U2> (1)	•	•
Frequency protection, instance 1	FRPFRQ1	81	f>/f<,df/dt (1)	•	•
Negative-sequence overcurrent protection for motors, instance 1	MNSPTOC1	46M-1	I2>M(1)	•	•
Negative-sequence overcurrent protection for motors, instance 2	MNSPTOC2	46M-2	I2>M(2)	•	•
Loss of load supervision, instance 1	LOFLPTUC1	37M-1	3I<(1)	•	•
Loss of load supervision, instance 2	LOFLPTUC2	37M-2	3I<(2)	•	•
Motor load jam protection	JAMPTOC1	51LR	Ist>	•	•
Motor start-up supervision	STTPMSU1	66/51LRS	Is2t n<	•	•
Phase reversal protection	PREVPTOC1	46R	I2>>	•	•
Thermal overload protection for motors	MPTTR1	49M	3Ith>M	•	•
Motor differential protection	MPDIF1	87M	3dI>M	•	•
Circuit breaker failure protection, instance 1	CCBRBRF1	50BF	3I>/Io>BF (1)	•	•
Master trip, instance 1	TRPPTRC1	86/94-1	Master Trip (1)	•	•
Master trip, instance 2	TRPPTRC2	86/94-2	Master Trip (2)	•	•
Arc protection, instance 1	ARCSARC1	AFD-1	ARC (1)	•	•
Arc protection, instance 2	ARCSARC2	AFD-2	ARC (2)	•	•
Arc protection, instance 3	ARCSARC3	AFD-3	ARC (3)	•	•
RTD based thermal protection, instance 1	MAPGAPC1	38-1	ThA> ThB>	•	•
RTD based thermal protection, instance 2	MAPGAPC2	38-2	ThA> ThB>	•	•

Function Application Configuration				Config	
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	B	C
RTD based thermal protection, instance 3	MAPGAPC3	38-3	ThA> ThB>	•	•
RTD based thermal protection, instance 4	MAPGAPC4	38-4	ThA> ThB>	•	•
RTD based thermal protection, instance 5	MAPGAPC5	38-5	ThA> ThB>	•	•
RTD based thermal protection, instance 6	MAPGAPC6	38-6	ThA> ThB>	•	•
RTD based thermal protection, instance 7	MAPGAPC7	38-7	ThA> ThB>	•	•
Control					
Circuit-breaker control, instance 1	CBXCBR1	52-1	I <-> O CB (1)	•	•
Emergency startup	ESMGAPC1	62EST	ESTART	•	•
Condition Monitoring					
Circuit-breaker condition monitoring, instance 1	SSCBR1	52CM-1	CBCM (1)	•	•
Trip circuit supervision, instance 1	TCSSCBR1	TCM-1	TCS (1)	•	•
Trip circuit supervision, instance 2	TCSSCBR2	TCM-2	TCS (2)	•	•
Current circuit supervision	CCRDIF1	CCM	MCS 3I	•	•
Fuse failure supervision, instance 1	SEQRFUF1	60	FUSEF (1)	•	•
Runtime counter for machines and devices, instance 1	MDSOPT1	OPTM-1	OPTS(1)	•	•
Runtime counter for machines and devices, instance 2	MDSOPT2	OPTM-2	OPTS(2)	•	•
Measurement					
Three-phase current measurement, instance 1	CMMXU1	IA, IB, IC	3I	•	•
Three-phase current measurement, instance 2	CMMXU2	IA, IB, IC(2)	3I(B)	•	•
Sequence current measurement, instance 1	CSMSQI1	I1, I2, I0	I1, I2, I0	•	•
Sequence current measurement, instance 2	CSMSQI2	I1, I2, I0(2)	I1, I2, I0 (B)	•	•
Residual current measurement, instance 1	RESCMMXU 1	IG	Io	•	•
Three-phase voltage measurement, instance 1	VMMXU1	VA, VB, VC	3U	•	•
Residual voltage measurement, instance 1	RESVMMXU 1	VG	Uo	•	•
Sequence voltage measurement, instance 1	VSMSQI1	V1, V2, V0	U1, U2, U0	•	•
Single-phase power and energy measurement, instance 1	SPEMMXU1	SP, SE	SP, SE	•	•
Three-phase power and energy measurement, instance 1	PEMMXU1	P, E	P, E	•	•
Load profile	LDPMSTA1	LoadProf	LoadProf	•	•
Frequency measurement, instance 1	FMMXU1	f	f	•	•
Other functions					
Minimum pulse timer (2 pcs), instance 1	TPGAPC1	TP-1	TP (1)	•	•
Minimum pulse timer (2 pcs), instance 2	TPGAPC2	TP-2	TP (2)	•	•
Minimum pulse timer (2 pcs), instance 3	TPGAPC3	TP-3	TP (3)	•	•
Minimum pulse timer (2 pcs), instance 4	TPGAPC4	TP-4	TP (4)	•	•

Function Application Configuration				Config	
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	B	C
Pulse timer (8 pcs), instance 1	PTGAPC1	PT-1	PT (1)	•	•
Pulse timer (8 pcs), instance 2	PTGAPC2	PT-2	PT (2)	•	•
Time delay off (8 pcs), instance 1	TOFGAPC1	TOF-1	TOF (1)	•	•
Time delay off (8 pcs), instance 2	TOFGAPC2	TOF-2	TOF (2)	•	•
Time delay off (8 pcs), instance 3	TOFGAPC3	TOF-3	TOF (3)	•	•
Time delay off (8 pcs), instance 4	TOFGAPC4	TOF-4	TOF (4)	•	•
Time delay on (8 pcs), instance 1	TONGAPC1	TON -1	TON (1)	•	•
Time delay on (8 pcs), instance 2	TONGAPC2	TON -2	TON (2)	•	•
Time delay on (8 pcs), instance 3	TONGAPC3	TON -3	TON (3)	•	•
Time delay on (8 pcs), instance 4	TONGAPC4	TON -4	TON (4)	•	•
Set reset (8 pcs), instance 1	SRGAPC1	SR-1	SR (1)	•	•
Set reset (8 pcs), instance 2	SRGAPC2	SR-2	SR (2)	•	•
Set reset (8 pcs), instance 3	SRGAPC3	SR-3	SR (3)	•	•
Set reset (8 pcs), instance 4	SRGAPC4	SR-4	SR (4)	•	•
Move (8 pcs), instance 1	MVGAPC1	MV-1	MV (1)	•	•
Move (8 pcs), instance 2	MVGAPC2	MV-2	MV (2)	•	•
Move (8 pcs), instance 3	MVGAPC3	MV-3	MV (3)	•	•
Move (8 pcs), instance 4	MVGAPC4	MV-4	MV (4)	•	•
Move (8 pcs), instance 5	MVGAPC5	MV-5	MV (5)	•	•
Move (8 pcs), instance 6	MVGAPC6	MV-6	MV (6)	•	•
Move (8 pcs), instance 7	MVGAPC7	MV-7	MV (7)	•	•
Move (8 pcs), instance 8	MVGAPC8	MV-8	MV (8)	•	•
Generic control points, instance 1	SPCGGIO1	CNTRL-1	SPC(1)	•	•
Generic control points, instance 2	SPCGGIO2	CNTRL-2	SPC(2)	•	•
Generic control points, instance 3	SPCGGIO3	CNTRL-3	SPC(3)	•	•
Remote Generic control points, instance 1	SPCRGGIO1	RCNTRL-1	SPCR(1)	•	•
Local Generic control points, instance 1	SPCLGGIO1	LCNTRL-1	SPCL(1)	•	•
Generic Up-Down Counters, instance 1	UDFCNT1	CTR-1	CTR(1)	•	•
Generic Up-Down Counters, instance 2	UDFCNT2	CTR-2	CTR(2)	•	•
Generic Up-Down Counters, instance 3	UDFCNT3	CTR-3	CTR(3)	•	•
Generic Up-Down Counters, instance 4	UDFCNT4	CTR-4	CTR(4)	•	•
Generic Up-Down Counters, instance 5	UDFCNT5	CTR-5	CTR(5)	•	•
Generic Up-Down Counters, instance 6	UDFCNT6	CTR-6	CTR(6)	•	•
Generic Up-Down Counters, instance 7	UDFCNT7	CTR-7	CTR(7)	•	•
Generic Up-Down Counters, instance 8	UDFCNT8	CTR-8	CTR(8)	•	•
Generic Up-Down Counters, instance 9	UDFCNT9	CTR-9	CTR(9)	•	•
Generic Up-Down Counters, instance 10	UDFCNT10	CTR-10	CTR(10)	•	•
Generic Up-Down Counters, instance 11	UDFCNT11	CTR-11	CTR(11)	•	•
Generic Up-Down Counters, instance 12	UDFCNT12	CTR-12	CTR(12)	•	•
Programmable buttons (16 buttons), instance 1	FKEYGGIO1	FKEY	FKEY	•	•

Function Application Configuration				Config	
Function	IEC 61850	ANSI C37.2-2008	IEC 60617	B	C
Logging functions					
Disturbance recorder	RDRE1	DFR	DFR	•	•
Fault recorder	FLMSTA1	FR	FR	•	•
Sequence event recorder	SER	SER	SER	•	•

3.4.3 Default Input/Output (I/O) assignments

Table 16: Default connections for analog inputs

Analog input	Default usage	Connector pins
IA	Phase A current	X120-7, 8
IB	Phase B current	X120-9, 10
IC	Phase C current	X120-11, 12
IG	Ground current	X120-13,14
IA(2)	Phase A current (Neutral side of motor)	X120-1,2
IB(2)	Phase B current (Neutral side of motor)	X120-3,4
IC(2)	Phase C current (Neutral side of motor)	X120-5,6
VA	Phase A voltage	X130-11,12
VB	Phase B voltage	X130-13,14
VC	Phase C voltage	X130-15,16
VG	Broken delta voltage	X130-17,18
X105-RTD1	Stator Temperature-1	X105-9,10,15
X105-RTD2	Stator Temperature-2	X105-11,12,15
X105-RTD3	Stator Temperature-3	X105-13,14,15
X105-RTD4	Motor Bearing Temperature-1	X105-17,18,16
X105-RTD5	Load Bearing Temperature-1	X105-19,20,16
X105-RTD6	Load Case Temperature	X105-21,22,16
X110-RTD1	Stator Temperature-4	X110-9,10,15
X110-RTD2	Stator Temperature-5	X110-11,12,15
X110-RTD3	Stator Temperature-6	X110-13,14,15
X110-RTD4	Motor Bearing Temperature-2	X110-17,18,16
X110-RTD5	Load Bearing Temperature-2	X110-19,20,16
X110-RTD6	Ambient Temperature	X110-21,22,16

Table 17: Default connections for analog inputs (Only for Config C)

RTD input	Default usage	Connector pins
X130-RTD1	RTD Input-13	X130-3,4,5
X130-RTD2	RTD Input-14	X130-6,7,8

Table 18: Default connections for binary inputs

Binary input	Default usage	Connector pins
X115-BI2	Circuit breaker closed position	X115-3, 4
X115-BI3	Circuit breaker open position	X115-5, 6

Table 19: Default connections for binary outputs

Binary output	Default usage	Connector pins
X100-PO1	Close circuit breaker	X100 – 6,7
X100-PO2	Breaker failure backup trip to upstream breaker	X100 – 8,9
X100-SO1		
X100-SO2	Motor Overload Alarm	X100 – 13, 14
X100-PO3	Open circuit breaker / Master Trip -1	X100 - 15,16,17,18,19
X100-PO4	Open circuit breaker / Master Trip -2	X100 - 20,21,22,23,24
X110-SO1		X110-14,15,16
X110-SO2		X110-17,18,19
X110-SO3		X110-20,21,22
X110-SO4		X110-23,24

*Table 20: High speed binary output connections**

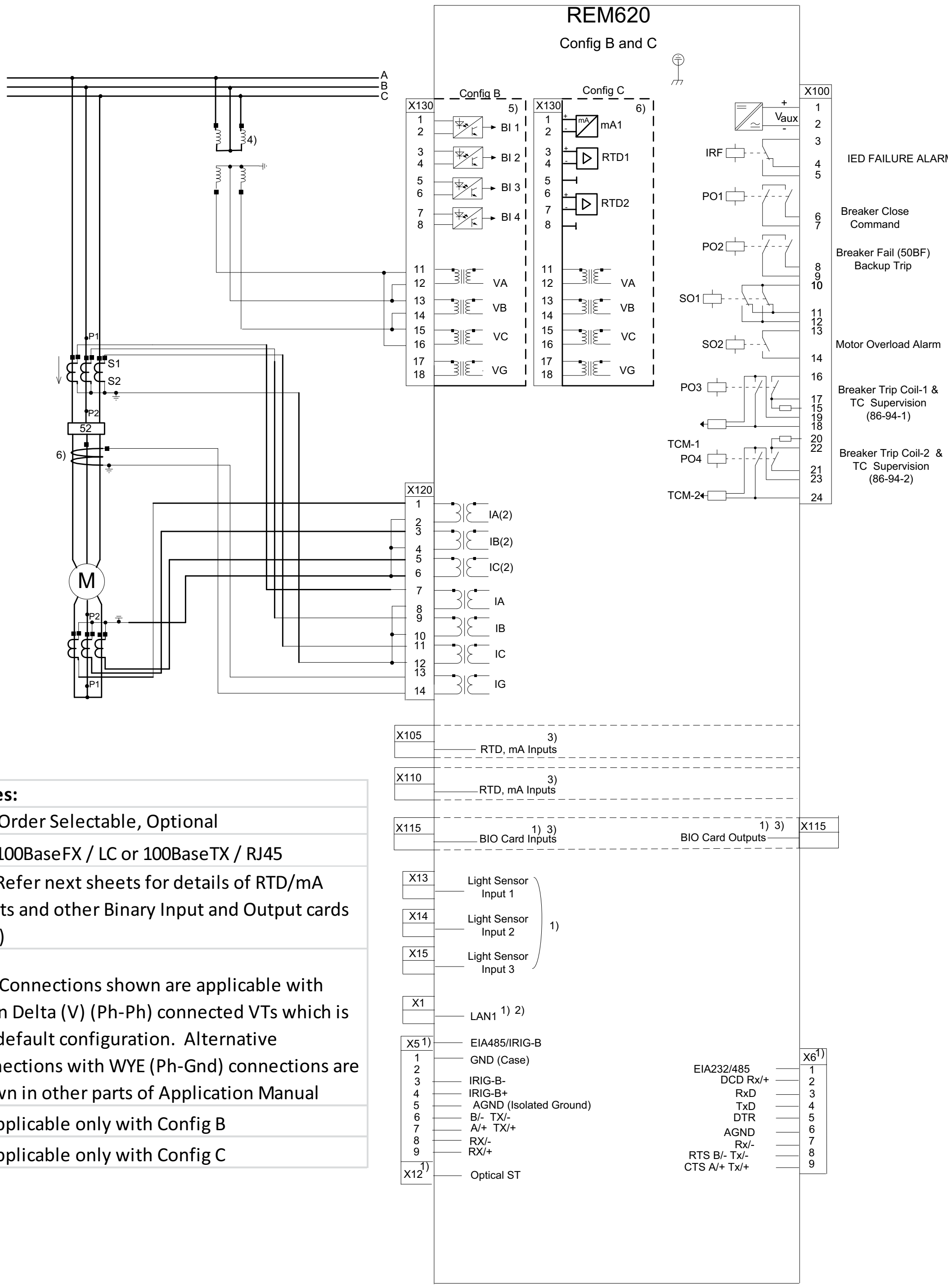
Binary output	Default usage	Connector pins
X115-HSO1	Open circuit breaker / Master Trip -1	X115 – 15,16
X115-HSO2	Trip from ARC-2 protection	X115 – 19,20
X115-HSO3	Trip from ARC-3 protection	X115 – 23,24
*Available only if IED has been ordered with High speed binary output (HSO) card		

Table 21: Default connections for LEDs

LED	LED label
LED 1	Phase A
LED 2	Phase B
LED 3	Phase C
LED 4	Neutral, Neutral / Ground
LED 5	Overcurrent and differential
LED 6	Undercurrent
LED 7	Locked rotor / Jam
LED 8	Voltage Protection
LED 9	Phase Rev / Neg. Sequence.
LED 10	Overload Alarm/Trip
LED 11	Arc Flash Detection

Some of the alarm LED channel connections in the standard configuration depends on the optional functionality and are available according to order code.

3.4.4 Typical connection diagrams



Notes:
1) Order Selectable, Optional
2) 100BaseFX / LC or 100BaseTX / RJ45
3) Refer next sheets for details of RTD/mA Inputs and other Binary Input and Output cards (BIO)
4) Connections shown are applicable with Open Delta (V) (Ph-Ph) connected VTs which is the default configuration. Alternative connections with WYE (Ph-Gnd) connections are shown in other parts of Application Manual
5) Applicable only with Config B
6) Applicable only with Config C

Figure 58: Typical connection diagram of REM620 (Config B or C)

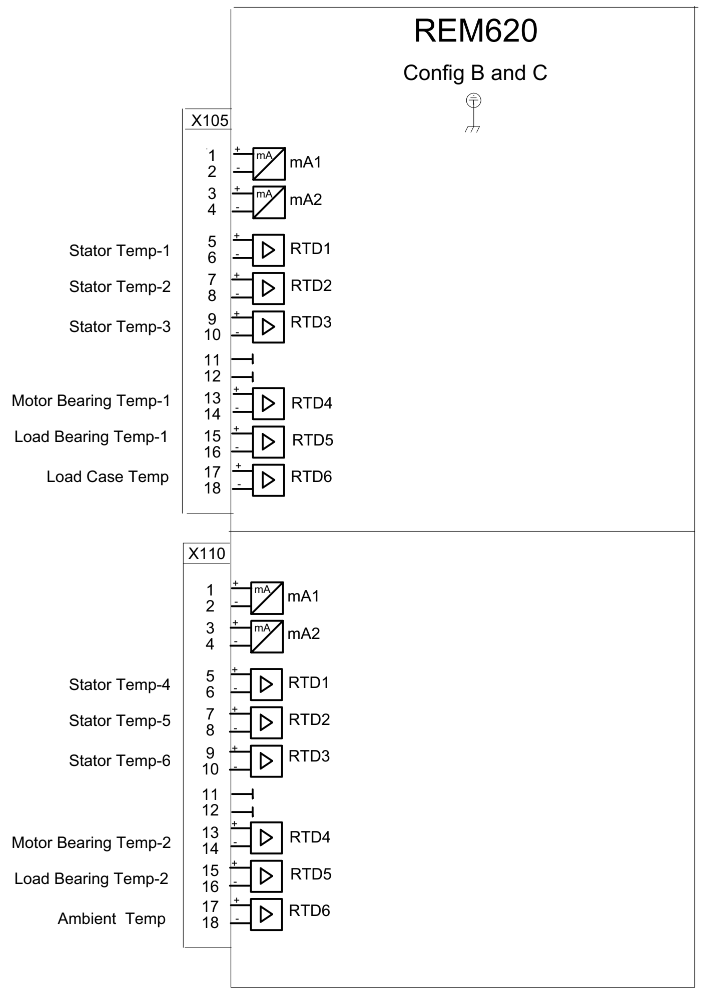
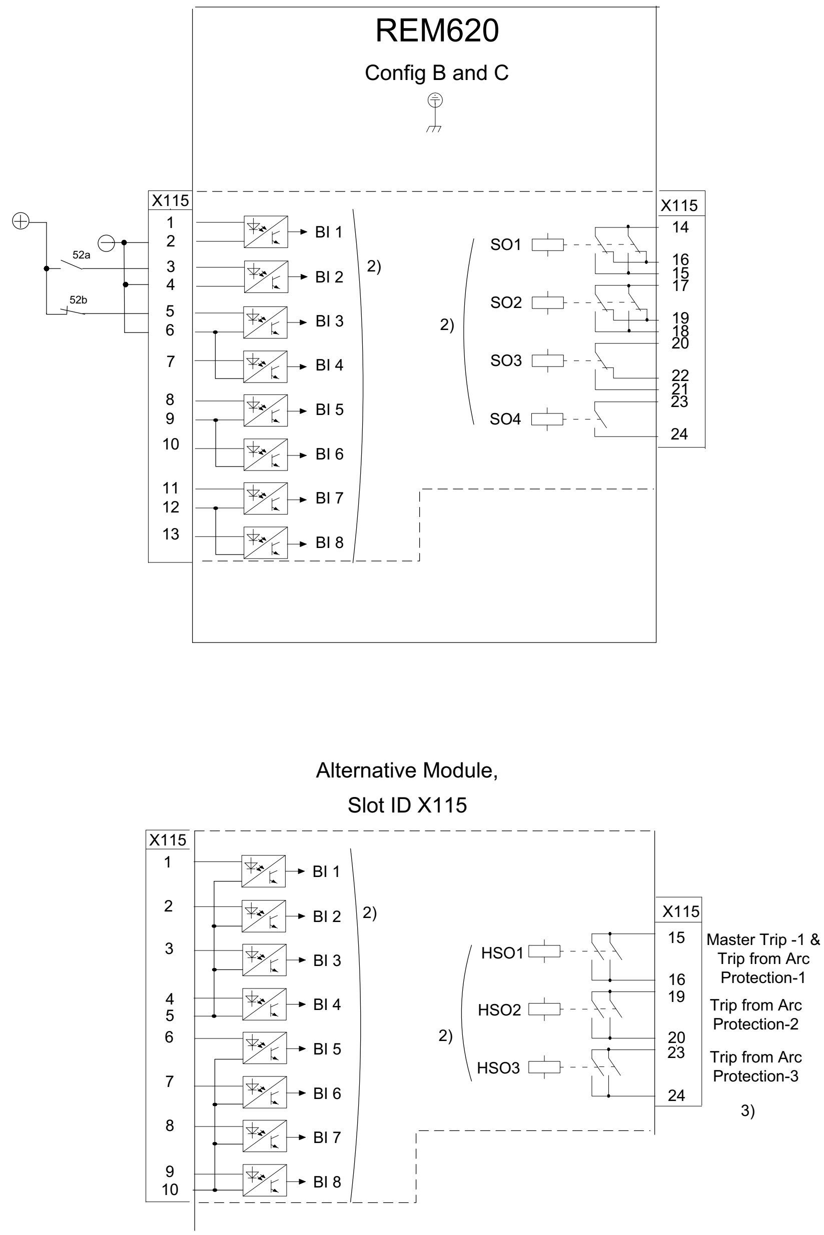


Figure 59: Typical BIO module equipment arrangement and connections for REM620, Config B or C (Slot X105 and X110)



2) Order Selectable, Optional alternatives

3) Default outputs configured with High Speed Outputs when Arc protection option is chosen

Figure 60: Typical BIO module equipment arrangement and connections for REM620, Config B or C (Slot X115)

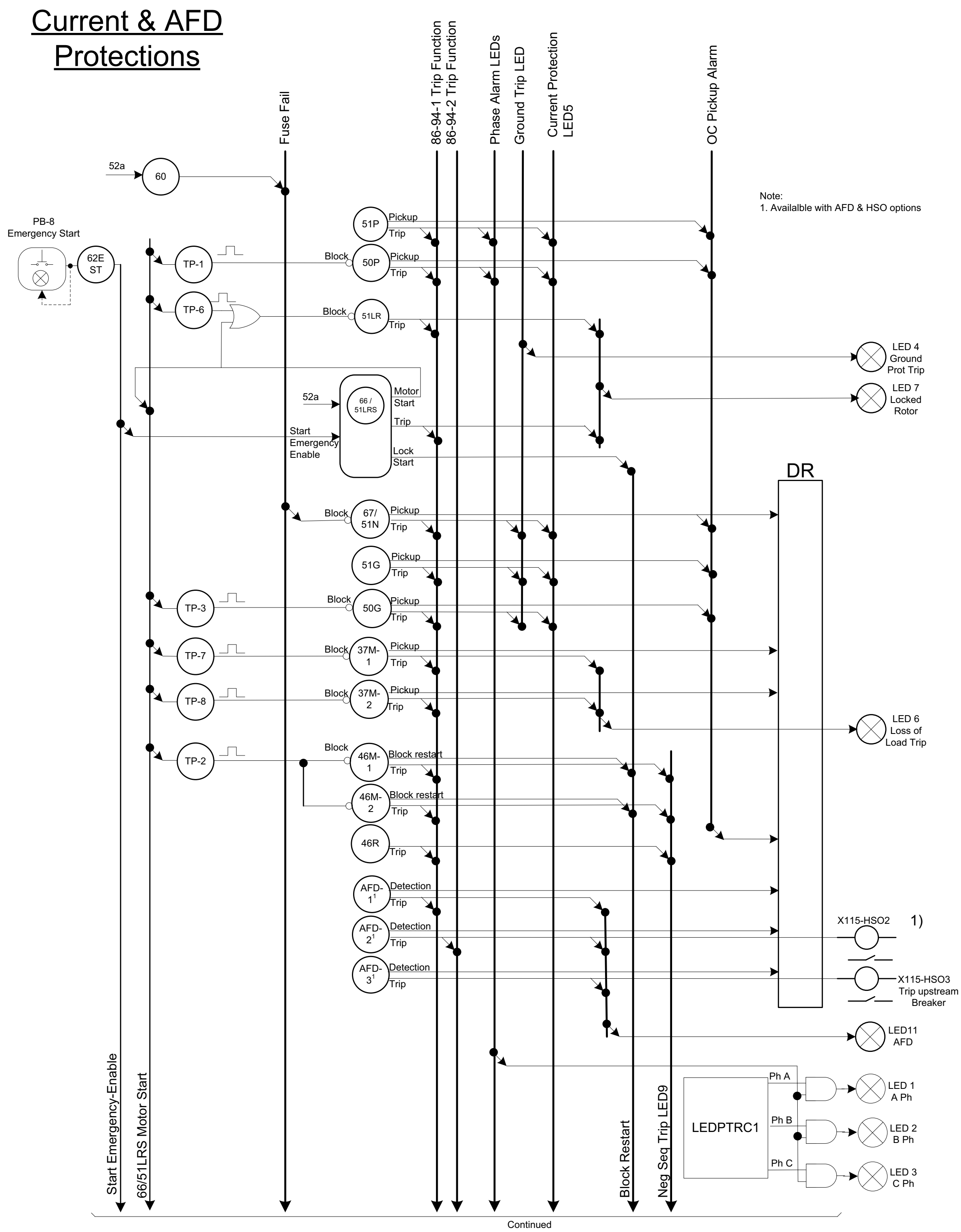


Figure 61: Simplified Logic Diagram for Current Protections, REM620, Config B or C

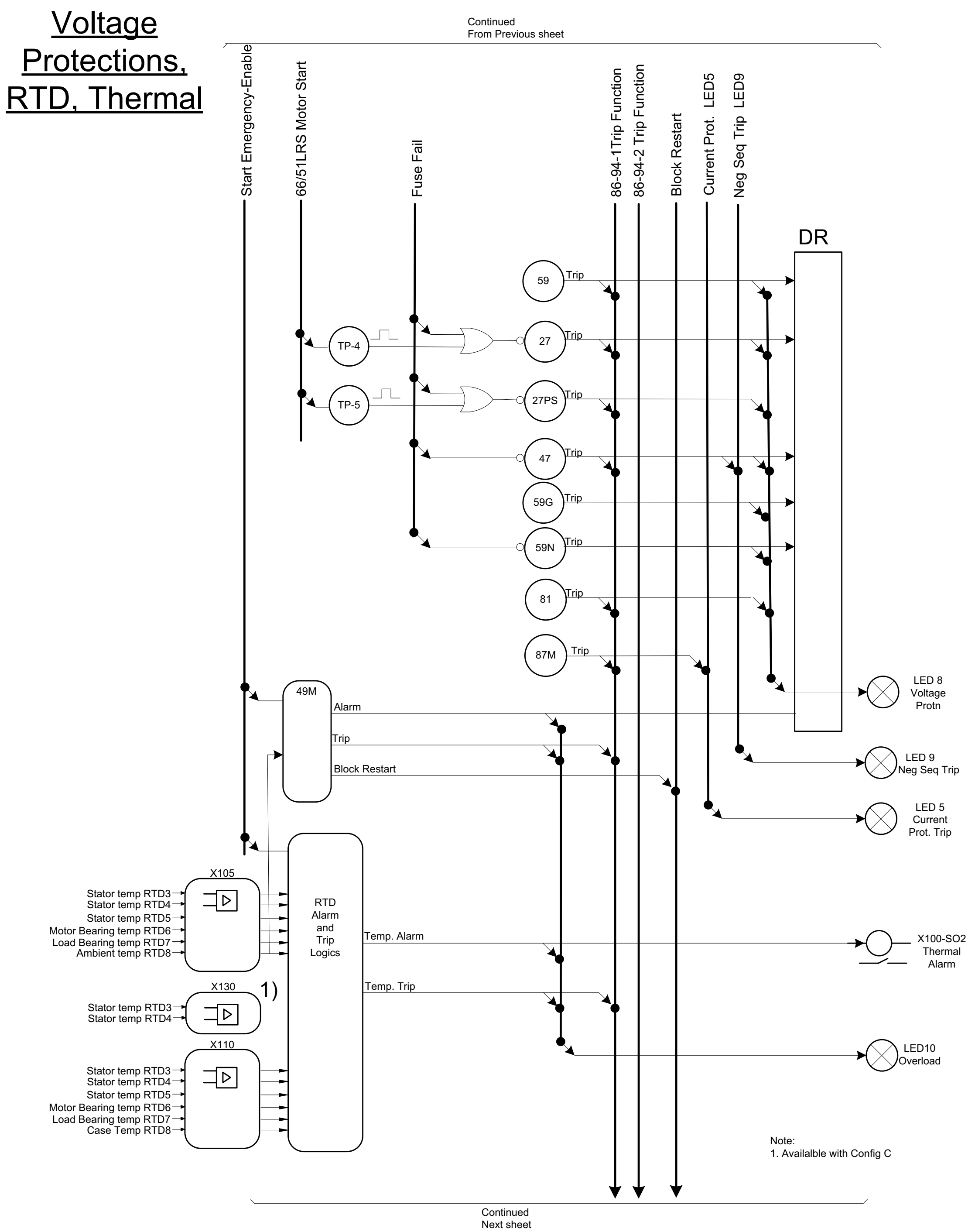


Figure 62: Simplified Logic Diagram for other Protections, REM620, Config B or C

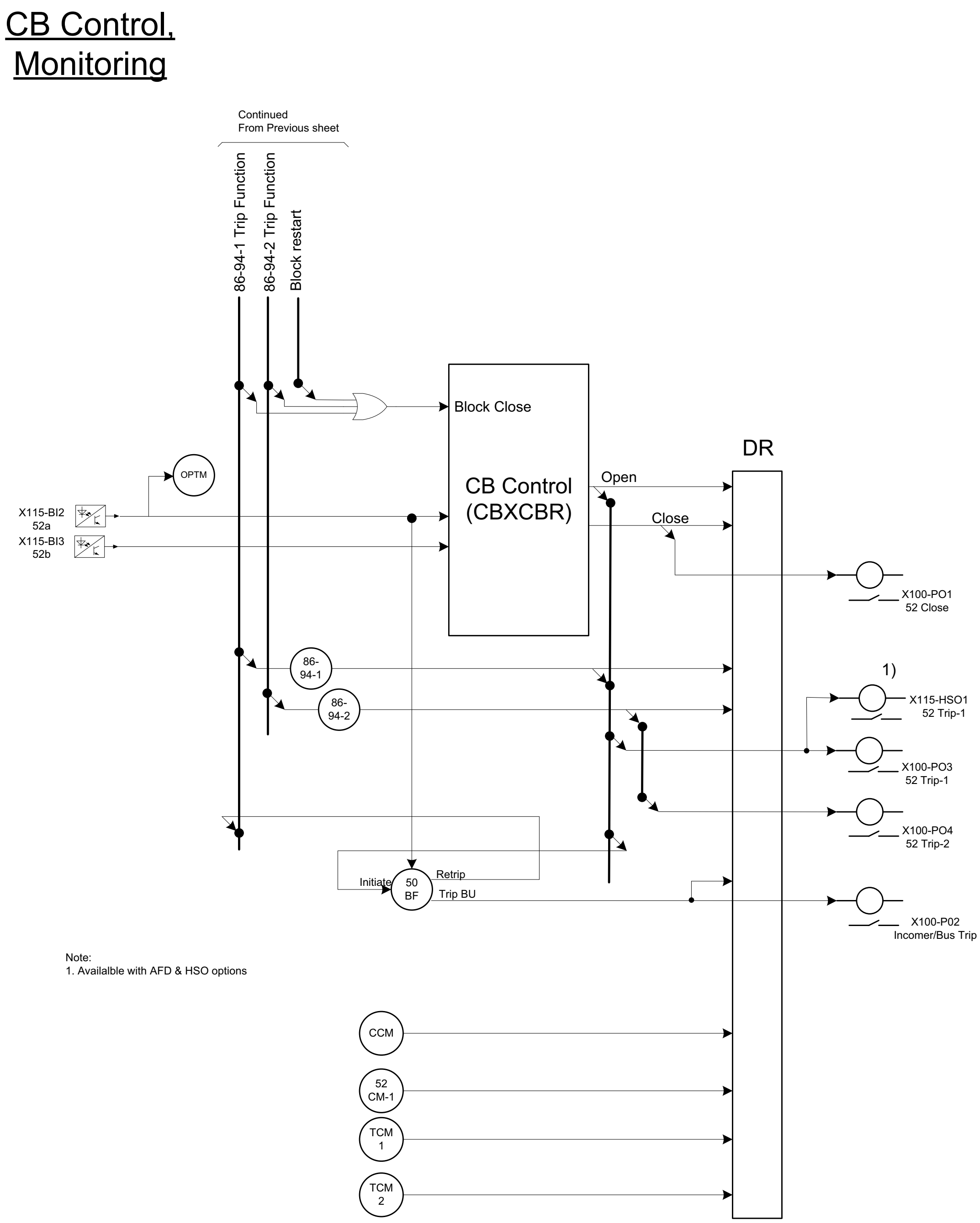


Figure 63: *Simplified Logic Diagram for CB Control and Monitoring, REM620, Config B or C*

3.4.5 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections. The default connections can be viewed and changed with PCM 600 according to the application requirements, if necessary.

The analog channels, measurements from CTs and VTs, have fixed connections to the different function blocks inside the IED's standard configuration.

The signal marked with IA, IB and IC represents the three phase currents. The signal marked with IA, IB, IC(2), represent the three phase currents on motor neutral side. The signal IG represents the measured ground current, fed either from residual connection or an external BCT depending on the application.

The signal marked with VA, VB and VC represents the three phase system voltages on the bus. These inputs are connected in Delta, which are typically fed from delta (V connected) VTs from the system. When WYE connected VT is available in the system, the VT inputs in the IED are WYE connected and configuration setting is suitably changed.

When power system is provided with Open delta VT (V connected), since there is no way to measure or estimate the system zero sequence voltage, directional ground fault protection will have to be polarized by negative sequence voltage polarization method only.

REM 620 offers six different settings group which the user can set based on individual needs. Each group can then, be activated/ deactivated by using the programmable button offered in the front panel of the unit. In addition to this the programmable button can also be used for enabling/disabling switch mode, emergency restart, sensitive earth fault detection etc. Figure 64 shows the default mapping for the available programmable buttons.

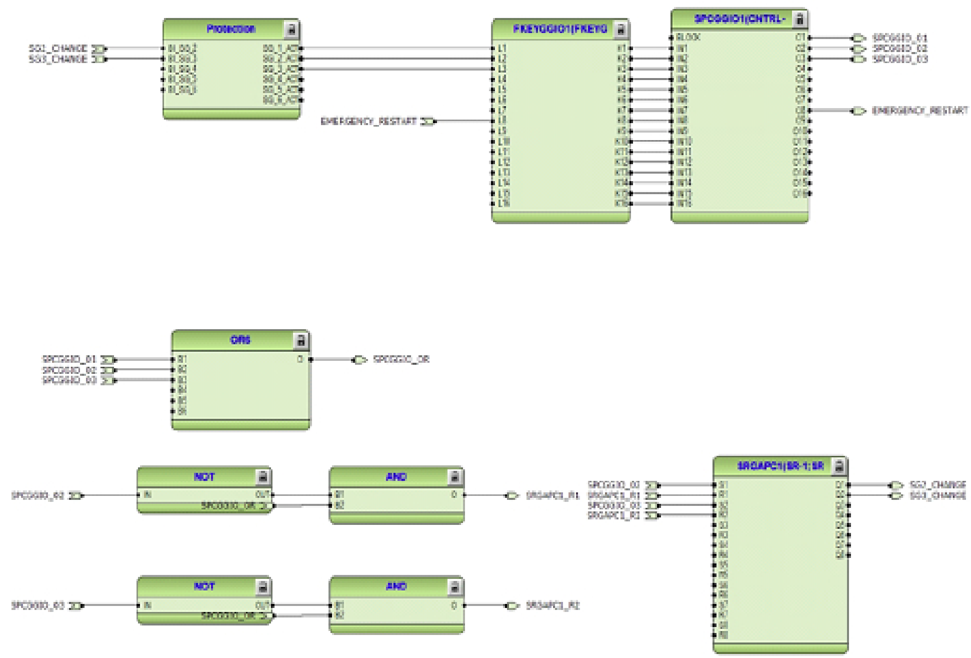


Figure 64: Default mapping on programmable buttons

3.4.6 Functional diagrams for protection

The functional diagrams describe the IED's protection functionality in detail and according to the factory set default connections.

All trip signals are connected to the Master Trip and also to the alarm LEDs. Alarm LEDs 1, 2 and 3 are used for phase segregated information of faults.

Two, three-phase overcurrent protection (51P and 50P) stages are provided for overcurrent and short-circuit protection of motor. 51P can be used for overcurrent protection and 50P for the short-circuit protection. Apart from three-phase overcurrent protection, motor jam protection (51LR) is also available for protecting the motor under locked rotor or mechanical jam situations during running conditions.

The operation of 51P is not blocked as default by any functionality and so setting should be set such as to avoid unnecessary false trip or alarm. The operation of 50P is blocked by motor startup supervision function.

51LR is blocked by the motor startup protection (66/51LRS) to avoid operation of 51LR during motor starting condition. The operation of 51P and 50P is connected to alarm LED 5, and 51LR (along with motor startup protection) is connected to alarm LED 7.

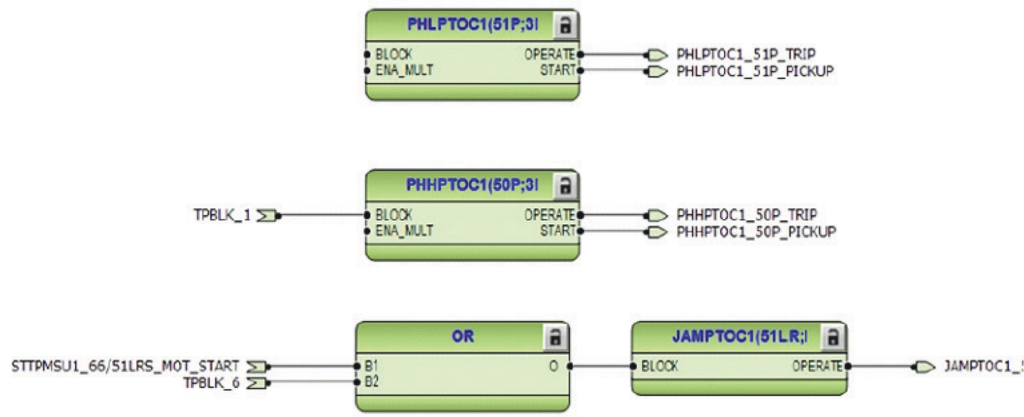


Figure 65: Three phase overcurrent and motor jam protection

Alarm LEDs 1, 2 and 3 are configured so as to indicate which phase has resulted into tripping of 50P and 51P. Overcurrent faults in Phase A, B and C is mapped to Alarm LEDs 1, 2 and 3 respectively.

Two non-directional ground-fault protection (51G and 50G) stages, operated off the measured ground fault analog input IG, are provided to detect phase-to-ground faults that may be a result of, for example, insulation ageing or sudden failure of insulation.

The operation of 51G not blocked as default by any functionality, while 50G is blocked by startup supervision function. The operation of ground-fault protection functions is connected to alarm LED 4.

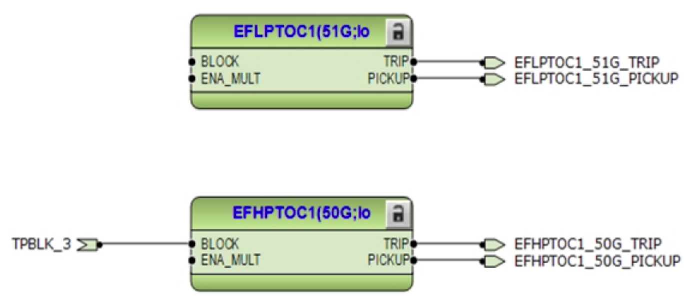


Figure 66: Non-directional ground fault protection

A single stage directional ground-fault protection (67/51N) is provided. If the fuse failure situation is detected all directional ground-fault protection functions will be blocked. While setting the directional element, it is necessary to choose either V0 calculated or Negative sequence voltage polarization. While either one may be selected with WYE connected VT, it is essential to choose negative sequence voltage polarization with Delta (V connected) VT input from which zero sequence voltage cannot be derived. The function can also be set non-directional. Provision is available to make the operating current selectable either from the calculated zero sequence current from current inputs IA, IB, IC or the measured IG current input.

Figure 67: Directional ground fault protection

Configuration also includes pickup alarm, the pickup outputs from 50P, 51P, 50G, 51G and 67/51N are connected together to have a combined overcurrent pickup alarm which is connected to disturbance recorder as default.

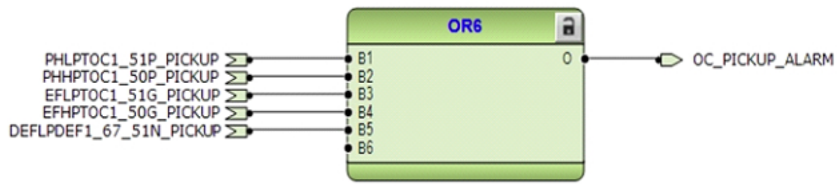


Figure 68: Overcurrent pickup alarms

One undervoltage, positive sequence undervoltage and overvoltage protections (27, 27PS and 59) offer protection against abnormal phase voltage conditions. A failure in the voltage measuring circuit is detected by the fuse failure function and the activation is connected to undervoltage protection functions to avoid faulty undervoltage tripping.

Negative-sequence overvoltage (47) protection functions enable voltage based unbalance protection.

The residual overvoltage protection (59N) provides ground-fault protection by detecting abnormal level of residual voltage. It can be used, for example, as a nonselective backup protection for the selective directional ground-fault functionality.

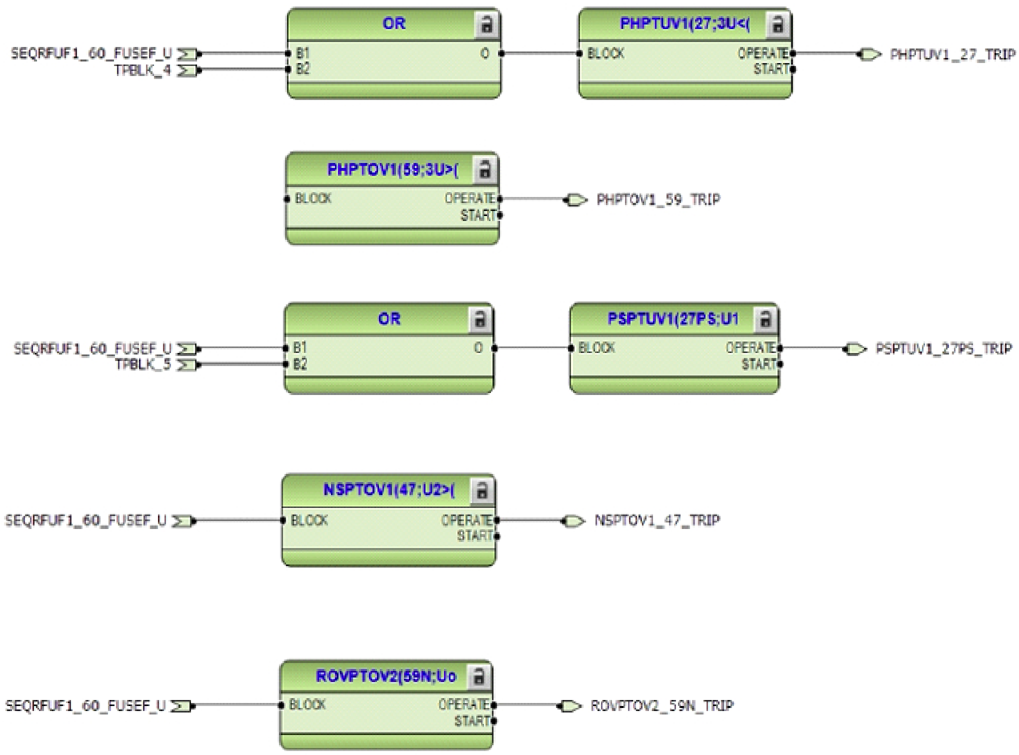


Figure 69: Voltage protection functions

The residual overvoltage protection 59G is operated of measured broken delta voltage input and can provide backup protection against abnormal system operating conditions. In default configuration, the output is arranged light up LED8.

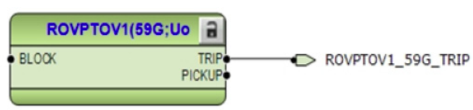


Figure 70: Residual overvoltage protection, operated off broken delta VT input

The selectable under frequency or over frequency protection (81) prevents damage to network components under unwanted frequency conditions.

The function contains a selectable rate of change of the frequency (gradient) protection to detect an increase or decrease in the fast power system frequency at an early stage. This can be used as an early indication of a disturbance in the system.

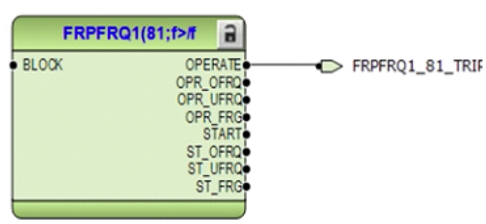


Figure 71: Frequency protection functions

Two negative-sequence overcurrent protection (46M-1 and 46M-2) stages are provided for phase unbalance protection. These functions are used to protect the motor against phase unbalance caused by, for example, a broken conductor. Excessive negative sequence current results into overheating of the motor eventually resulting into insulation damage.

This configuration also includes phase reversal protection (46R), based on the calculated negative phase-sequence current. It detects too high negative phase sequence current values during motor start up, caused by incorrectly connected phases, which in turn causes the motor to rotate in the reverse direction.

The operation of 46M-1, 46M-2 and 46R is not blocked as default by any functionality. The operation of these protection functions is connected to alarm LED 9.

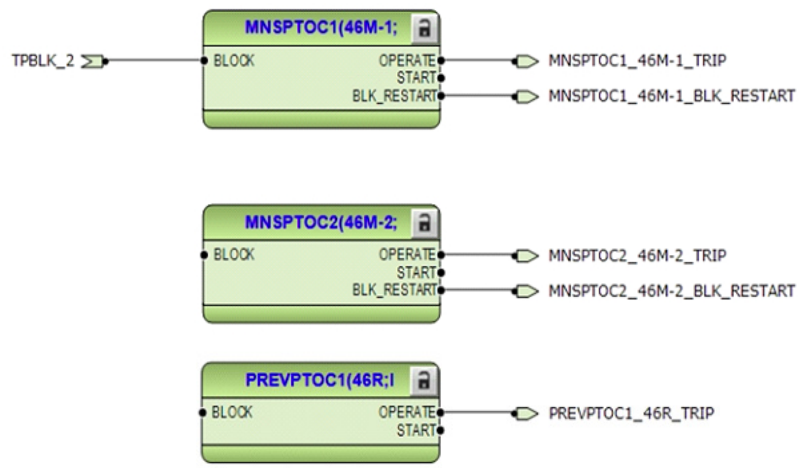


Figure 72: Negative sequence and phase reversal protection

The differential protection (87M) for the motor detects internal severe faults. CTs are adequate size need to be provided on motor phase as well as neutral side. The protection is arranged to trip the breaker as well as configured to light up LED5.

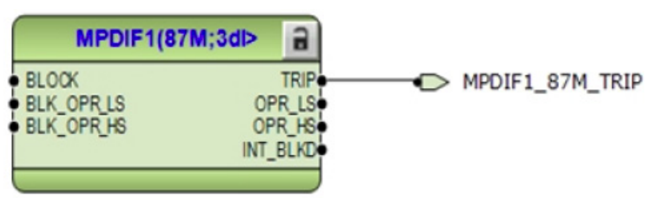


Figure 73: Motor Differential Protection

The thermal overload protection function (49M) detects short and long term overloads under varying load conditions. When the emergency start request is issued for the emergency start function, it activates the corresponding input of the thermal overload function. When the thermal overload function has issued a restart blocking, which inhibits the closing of the breaker during machine overload condition; the emergency start request removes this blocking and enables the user to start the motor again.

The alarm and operation of thermal overload protection function is connected to alarm LED 10.

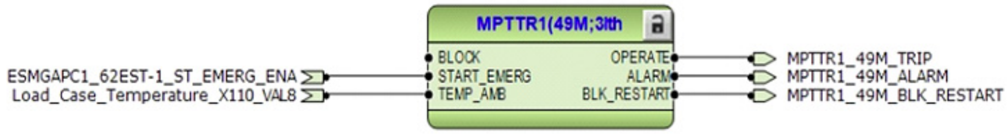


Figure 74: Motor thermal overload protection

There are 12 RTD inputs in Config B and 14 RTD inputs in Config C available in the IED. Six of them are configured for inputs stator temperature, two for motor bearing temperatures, two for load bearing temperatures, one for motor casing temperature and one for ambient temperature.

The maximum of the stator RTD temperature is taken to a level detector 38-6 to generate overload alarm.

The maximum of the stator RTD temperatures and higher of the two motor bearing temperatures are set against level detectors(38-1, 38-2) and ORed to generate a signal Trip on stator / bearing temperature. Level detector 38-6 detectors too high temperature levels from stator and is arranged to trip the motor.

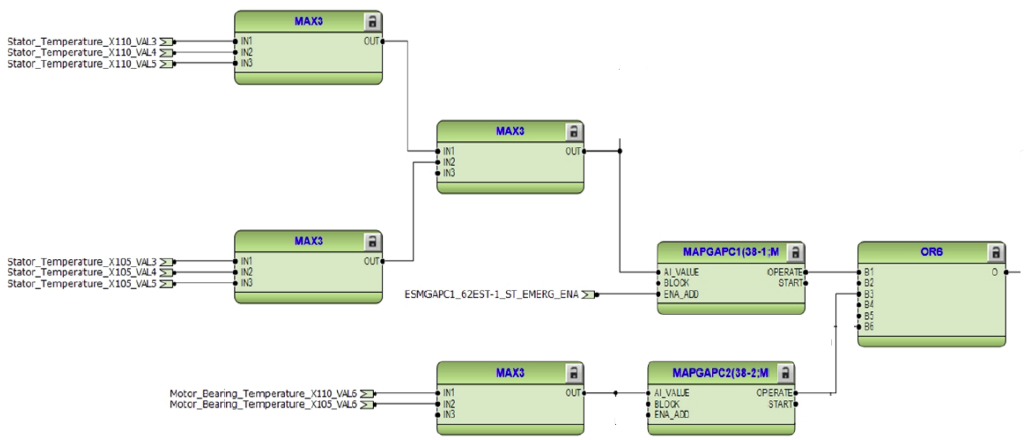


Figure 75: RTD measurement of stator temperatures and bearing temperatures

The maximum of all bearing temperatures is compared against set level in (38-7) to generate high bearing temperature signal. The higher of the load-bearing temperatures are fed to level detector 38-3 to generate high load bearing temperature signal. Level detectors 38-4 and 38-5 are used to detect high inputs from ambient and load casing respectively.

An alarm signal is generated based on level detectors 38-4,38-5 and 38-6.

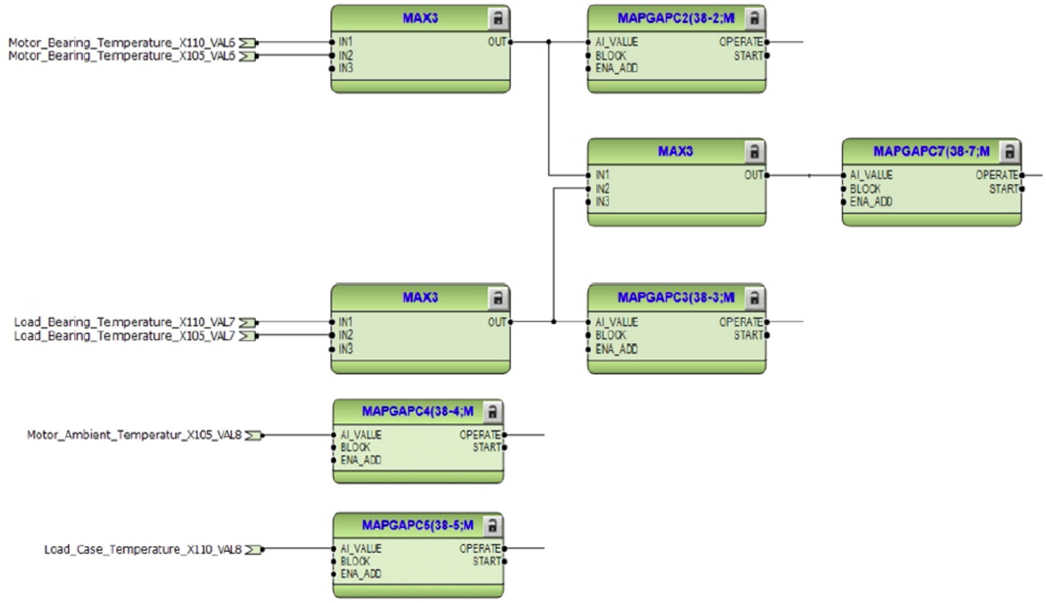


Figure 76: Level detection of various temperatures from RTD inputs

With the motor startup supervision function (66/51LRS) the starting of the motor is supervised by monitoring three-phase currents or the status of the energizing circuit breaker of the motor. It is also possible to connect the speed switch to determine the locked rotor situation.

The operation of 66/51LRS (along with motor jam protection) is connected to alarm LED 7.

A number of signals TPBLK are generated with necessary delays to block various function.

When the emergency start request is activated by 62EST and if 66/51LRS is in lockout state, which inhibits motor starting, the lockout is deactivated and emergency starting is available.

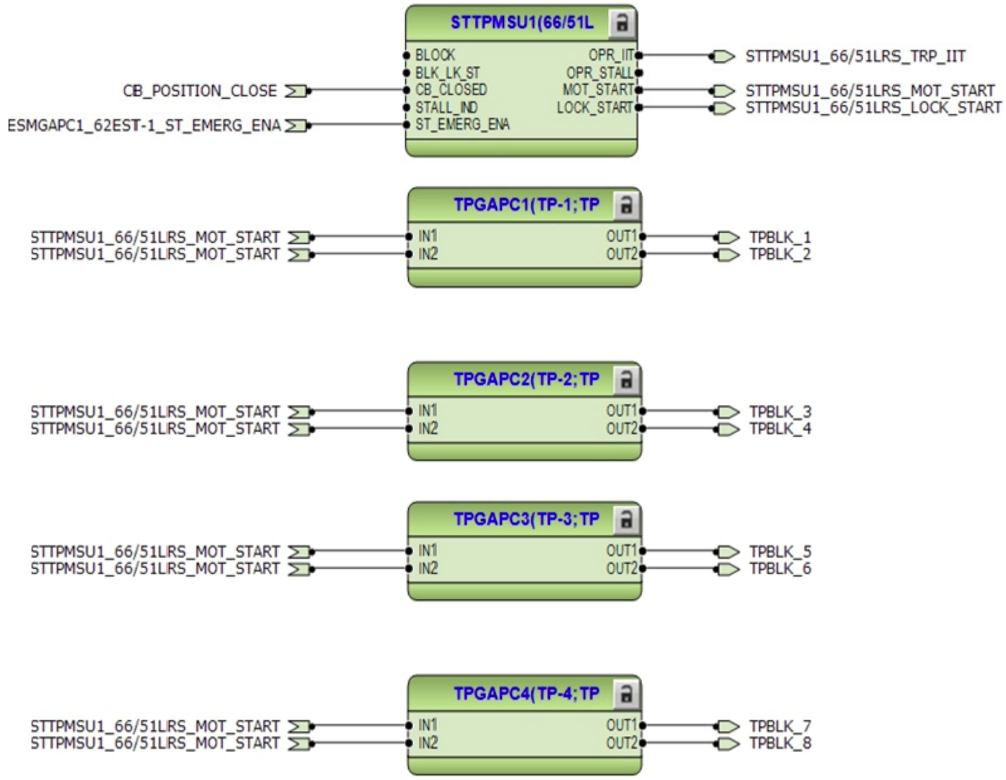


Figure 77: Motor startup supervision

Two, loss of load protection (37M-1 and 37M-2) stages are provided for detecting sudden loss of load on the motor. The loss of load situation can happen, for example, if there is damaged pump or due to sudden breakdown in conveyor belt.

Operation of 37M-1 and 37M-2 is blocked is blocked by the motor startup protection (66/51LRS) to avoid operation during motor starting condition. The operation of these protection functions is connected to alarm LED 6.

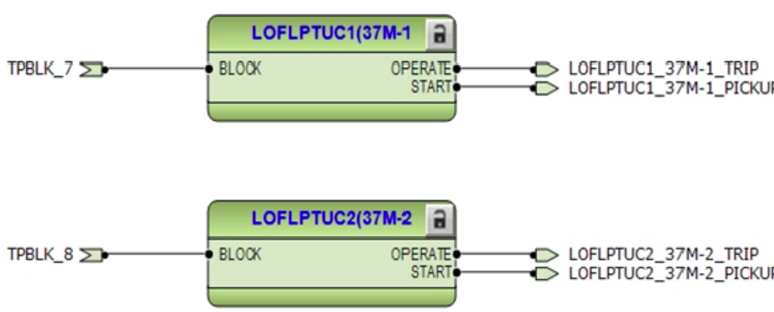


Figure 78: Loss of load protection

The circuit-breaker failure protection (50BF) is initiated via the start input by a number of different protection functions in the IED. 50BF offers different operating modes associated with the circuit-breaker position and the measured phase and residual currents.

50BF has two operating outputs: TRRET and TRBU. The TRBU output is used to give a backup trip to the circuit breaker feeding upstream. For this purpose, the TRBU trip output signal is connected to the output PO2 (X100: 8-9).

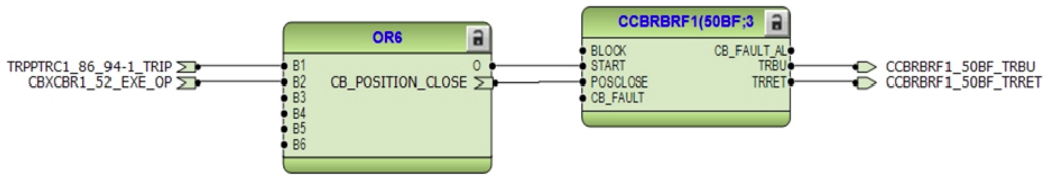


Figure 79: Circuit breaker failure protection

Three arc protection (ARC-1, ARC-2 and ARC-3) stages are included as an optional function. The arc protection offers individual function blocks for three ARC sensors that can be connected to the IED. Each arc protection function block has two different operation modes, with or without the phase and residual current check.

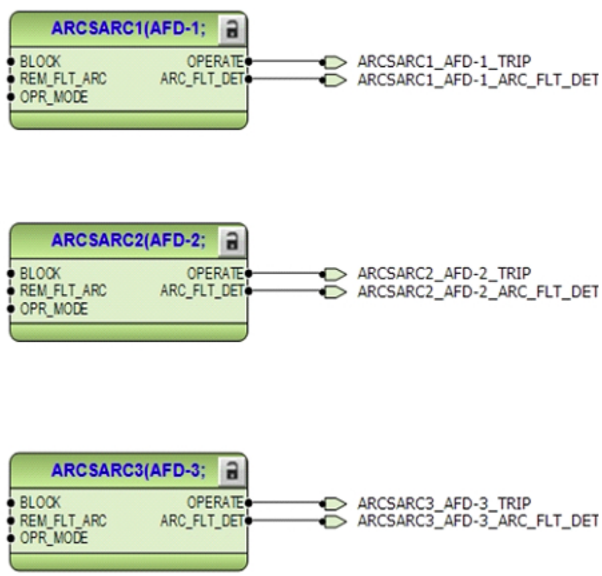


Figure 80: Arc protection

Trip signal from AFD-1 is connected to Master trip 1, available at PO3 (X100: 15-19). The trip signal from AFD-2 and AFD-3 is connected to master trip 2, available at PO4 (X100: 20-24). The operation of these protection functions is connected to alarm LED 11.

If the IED has been ordered with high speed binary outputs, then trip signal from AFD-2 and AFD-3 are also connected directly to high speed output HS02 (X115:19-20) and HS03(X115:23-24) respectively. A parallel output of master trip 1 is also routed to HSO1 (X115:15-16) so trip from AFD1 can be transferred out faster for tripping.

Two master trip logics (86/94-1 and 86/94-2) are provided as a trip command collector.

86/94-1 collects the trip signals from 51P, 50P, 51G, 50G, 67/51N, 46M-1, 37M-1, 46R, 46M-1, 51LR, 66/51LRS and ARC-1 protection functions and is connected to trip output contact PO3 (X100:15-19) and also to high speed output HS01 (X115:15-16) for IEDs ordered with high speed binary output cards.

Open control commands to the circuit breaker from the local or remote is also connected directly to the output PO3 (X100:15-19) from circuit breaker control (52) function block.

86/94-2 collects the trip signals from ARC-2 and ARC-3 protection functions and is connected to trip output contact PO4 (X100:20-24).

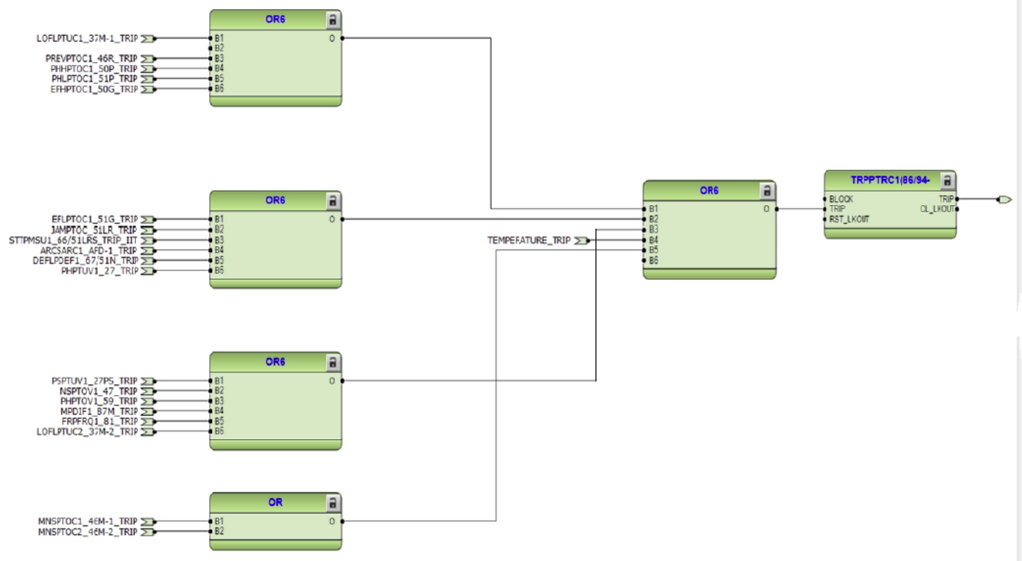


Figure 81: Master trip logic 1

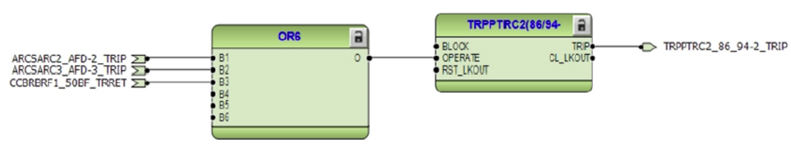


Figure 82: Master trip logic 2

86/94-1 and 86/94-2 provides the lockout/latching function, event generation and the trip signal duration setting. If the lockout operation mode is selected, one binary input can be reassigned to the RST_LKOUT input of the Master Trip to enable eternal reset with a pushbutton.

3.4.7 Functional diagrams for control functions

The emergency start function (62EST) allows motor startups although the restart inhibit is activated. The emergency start is enabled for ten minutes when the function pushbutton 8 is pressed (or alternatively through a binary input which may be configured if necessary). On the rising edge of the emergency start signal:

- Calculated thermal level is set slightly below the restart inhibit level to allow at least one motor startup.
- Value of the cumulative startup time counter 66/51LRS is set slightly below the set restart inhibit value to allow at least one motor startup.

A new emergency start cannot be made until the emergency start signal has been reset and the emergency start time of 10 minutes has expired.

Figure 83: Emergency start

The circuit breaker closing is enabled when the ENA_CLOSE input is activated. The input can be activated by the configuration logic, which is a combination of the disconnector or breaker truck and ground switch position status and the status of the Master Trip logics and gas pressure alarm and circuit-breaker spring charging. The OK_POS output of the CBXCBR can also be connected to the interlocking logic enabling the breaker closing, thus breaker closing in intermediate state can be prevented. With the present configuration, the activation of ENA_CLOSE input is configured using only Master Trip logic 86/94-1 and 86/94-2 i.e. the circuit breaker cannot be closed in case master trip is active.

Configuration also includes motor restart inhibit logic. When the motor restart is inhibited, the BLK_CLOSE input is activated and closing of the breaker is not possible. When all conditions of the circuit breaker closing are fulfilled, the EE_CL output of the 52 is activated and PO1 output (X100:6-7) is closed if closing command is given.

The motor restart inhibit is activated when there is

- An active trip command or
- Motor startup supervision has issued lockout or
- Motor unbalance function has issued restart blocking or
- Motor thermal overload function has issued restart blocking

The ITL_BYPASS input can be used, for example, to always enable the closing of the circuit breaker when the circuit breaker truck is in the test position, despite of the interlocking conditions being active when the circuit breaker truck is closed in service position.

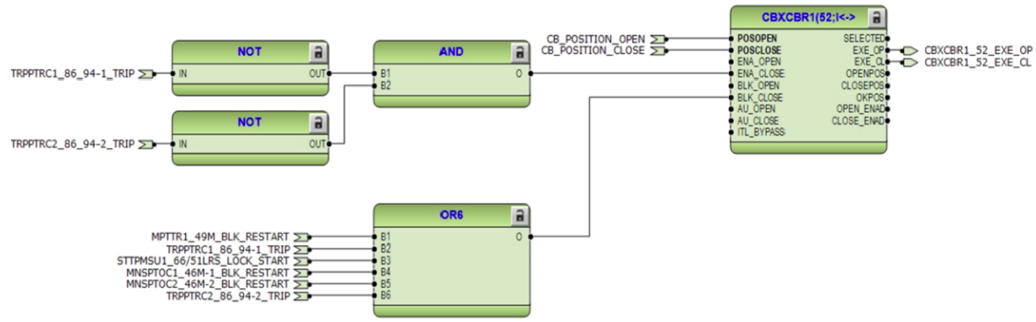


Figure 84: Circuit breaker control

If the ENA_CLOSE and BLK_CLOSE signals are completely removed from the breaker control function block 52 with PCM600, the function assumes that the breaker close commands are allowed continuously.

3.4.8 Functional diagrams for condition monitoring

Two trip circuit monitoring (TCM-1 and TCM-2) stages are provided to supervise the trip circuit of the circuit breaker connected at PO3 (X100:15-19) and PO4 (X100:20-24).

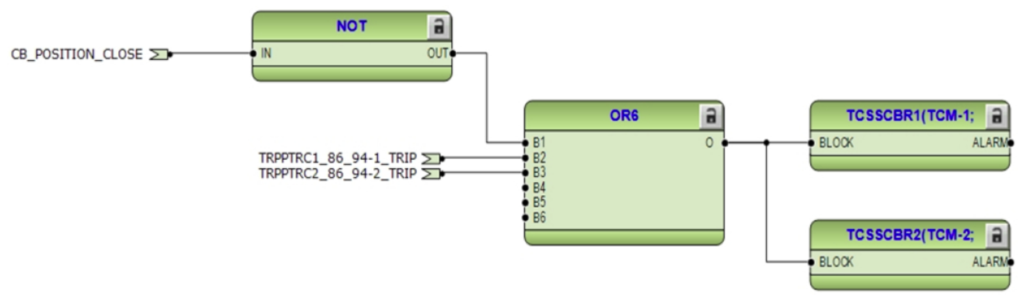


Figure 85: Trip circuit monitoring

The TCM-1 and TCM-2 functions are blocked by 86/94-1, 86/94-2 and the circuit-breaker open position signal.

By default TCM-1 and TCM-2 are not configured in the configuration.

By default it is expected that there is no eternal resistor in the circuit breaker tripping/closing coil circuit connected parallel with circuit breaker normally open/closed auxiliary contact.

A failure in current measuring circuits is detected by current circuit supervision function (CCM). When a failure is detected, function activates and can be used to block protection functions which operates using calculated sequence component currents for example 46M, thus avoiding mal-operation.

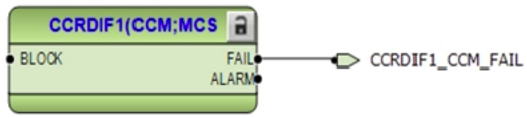


Figure 86: Current circuit supervision

A failure of the fuse or MCB feeding the voltage inputs to the IED is detected by Fuse failure supervision (60). When activated the function is arranged to block a number of voltage dependent functions such as undervoltage (27), negative sequence protection (47), directional overcurrent protection (67/51N), avoiding nuisance tripping of the motor.

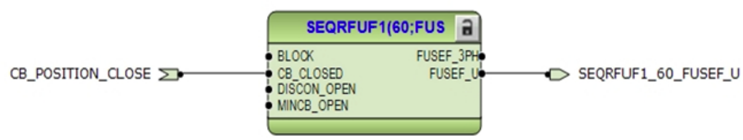


Figure 87: Fuse failure supervision

Two motor run time counter (OPTM-1 and OPTM-2) stages are provided to calculate and present the total number of motor running hours; these running hours are incremented when the energizing circuit breaker is in closed position.

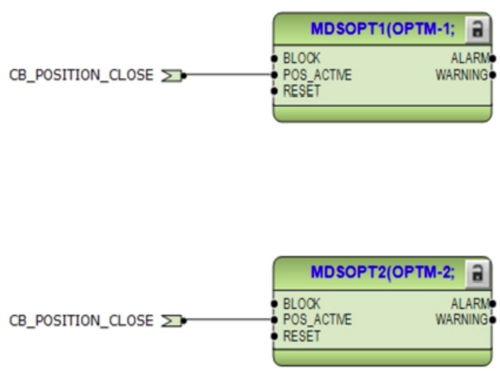


Figure 88: Run time counter

By default OPTM-1 and OPTM-2 are not configured in the configuration.

The circuit breaker condition monitoring function (52CM) supervises the circuit breaker status based on the binary input information connected and measured current levels. The function introduces various supervision alarms.

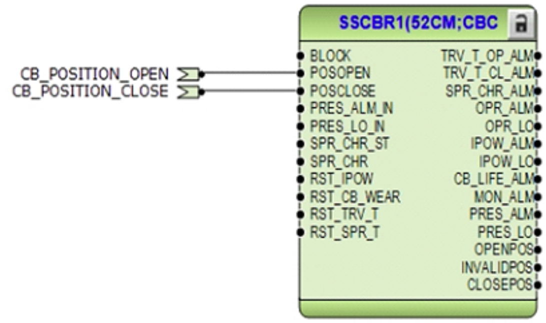


Figure 89: Circuit breaker condition monitoring

By default 52CM is not configured in the configuration.

3.4.9 Functional diagrams for Measurements

The phase current inputs to the IED are measured by three-phase current measurement (IA, IB, IC) and (IA,IB,IC(2)) function block. for phase and neutral lead current measurements respectively. The current input is connected to the X120 card in the back panel. Similarly the sequence and residual current are measured by sequence current measurement (I1, I2, I0), (I1,I2,I0(2)) and residual current measurement (IG) function blocks respectively.

The phase voltage inputs are connected to the X120 card in the back panel. The voltages are measured by (VA,VB,VC) function block. Similarly the sequence voltages are measured by sequence voltage measurement (V1, V2, V0) function block.

The measurements can be seen from the LHMI and is available using the measurement option in the menu selection. Based on the settings, function blocks can generate low alarm/warning, high alarm/warning signals for the measured current values.

The frequency measurement of the power system (f) is available. Also single (SPEMMXU1) and three phase (PEMMXU1) power measurements are available.

The load profile (LoadProf) function is also included into measurements sheet. The load profile function offers ability to observe the history of the loading of the corresponding motor.

Figure 90: Current, voltage, power and energy measurements and load profile function

3.4.10 Functional diagrams for other functions

Configuration also includes other miscellaneous basic functions which are not configured, but can be used for creating general purpose logics. These functions include:

- Four instance of Minimum Pulse Timer TP-1, TP-2, TP-3 and TP-4,
- Two instance of Pulse Timer PT-1 and PT-2,
- Four instance of Time delay off TOF-1, TOF-2, TOF-3 and TOF-4,
- Four instance of Time delay on TON-1, TON-2, TON3 and TON-4,
- Four instance of Set reset logic SR-1, SR-2, SR-3 and SR-4,
- Eight instance of Move logic MV-1, MV-2, MV-3, MV-4, MV-5, MV-6, MV-7 and MV-8,
- Three instance of Generic control points CNTRL-1, CNTRL-2 and CNTRL-3,
- One Remote Generic Control Points, RCNTRL-1,
- One Local Generic Control Points, LCNTRL-1,
- Twelve Generic Up-Down counters UDFNCT1, UDFCNT2. UDFCNT12 and,
- One Programmable buttons (16 buttons) FKEY.

3.4.11 Function diagrams for logging functions

The disturbance recorder DFR consists of 12 analog and 64 binary channels. The analog channels are pre configured in the IED as follows for this specific configuration:

Table 22: List of analog channels connected to DFR (REM Config B and Config C)

Ch. No	Channel
1	IA
2	IB
3	IC
4	IG
5	IA2
6	IB2
7	IC2
8	VA
9	VB
10	VC
11	VG
12	

A few channels of the binary channel are connected to trigger the digital fault recorder and are shown in Figure 91. More connection can be made as per individual needs. Also, when disturbance recorder is triggered, the analog values available at the analog inputs are recorded by the fault recorder FR.

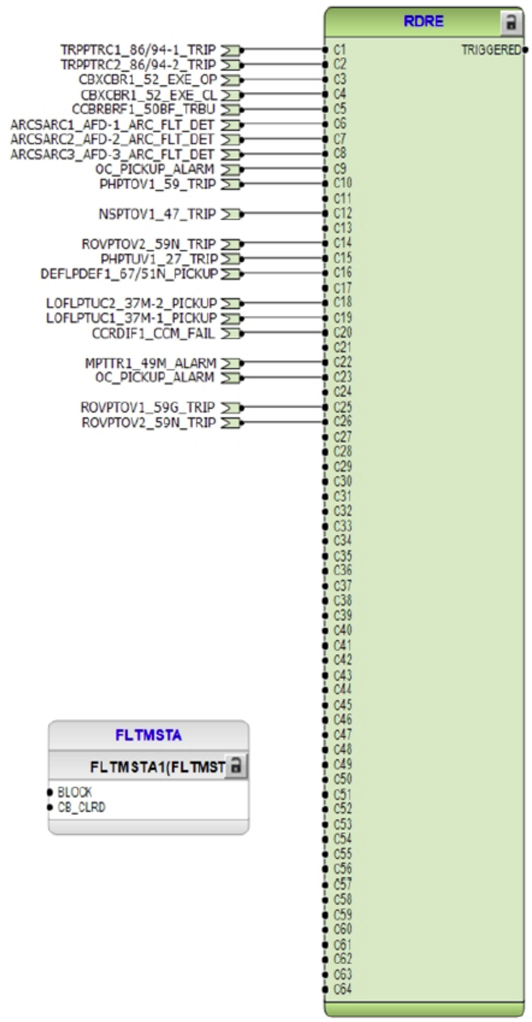


Figure 91: 64 channel Disturbance and fault recorder

3.4.12 Functional diagrams for I/O and Alarm LEDs

The default binary I/O connected in the configuration and Alarm LEDs are indicated in Figure 52 to Figure 93.

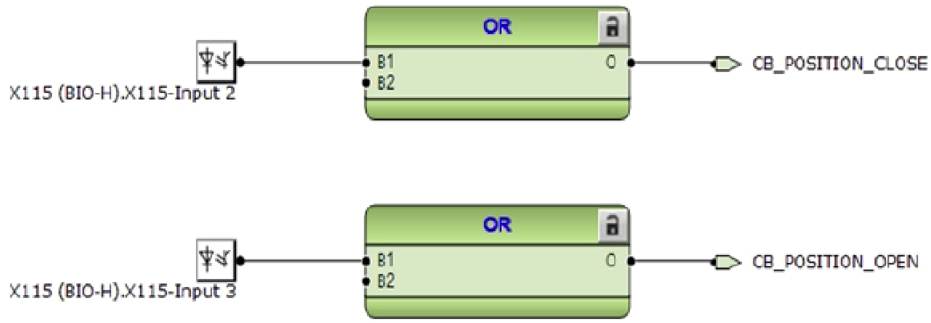


Figure 92: Binary inputs

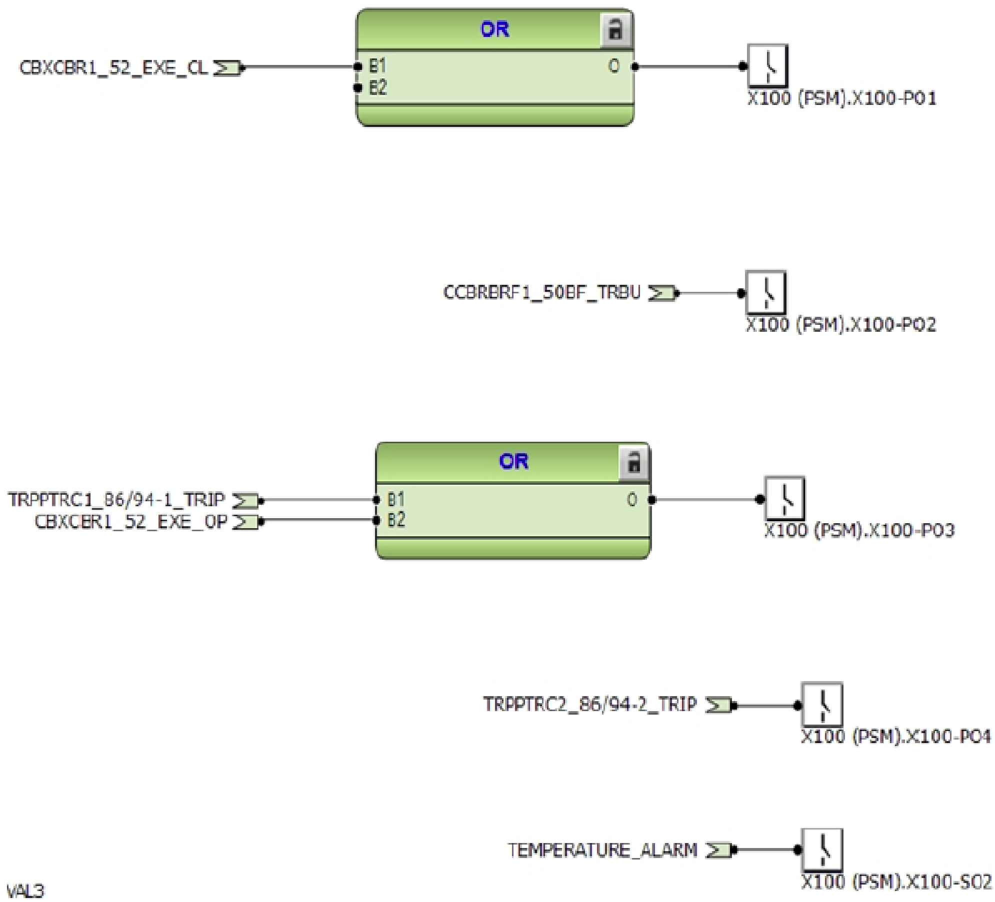


Figure 93: Binary outputs

When HS BO outputs are ordered, the output signal arrangement will be additionally as follows:

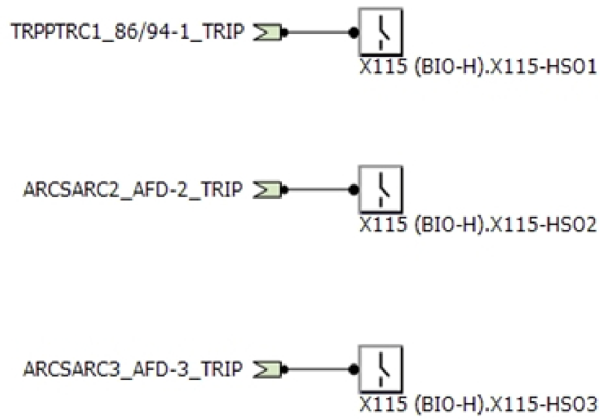


Figure 94: Additional signal outputs configured with AFD and HS BO option

High speed binary outputs (HSO) are available only if IED with High speed binary card has been ordered.

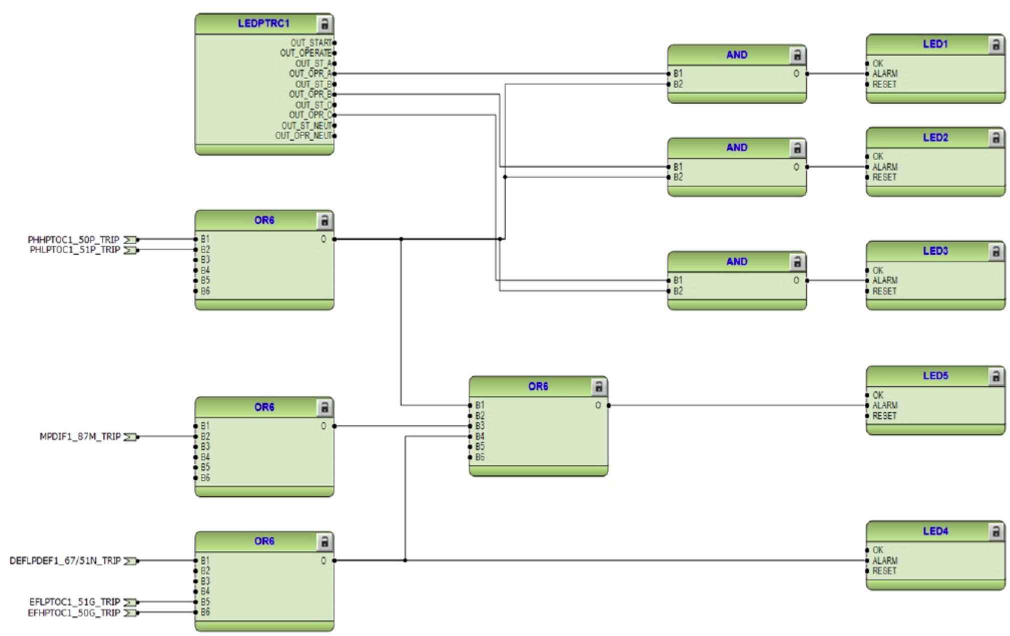


Figure 95: Alarm LEDs 1 - 5

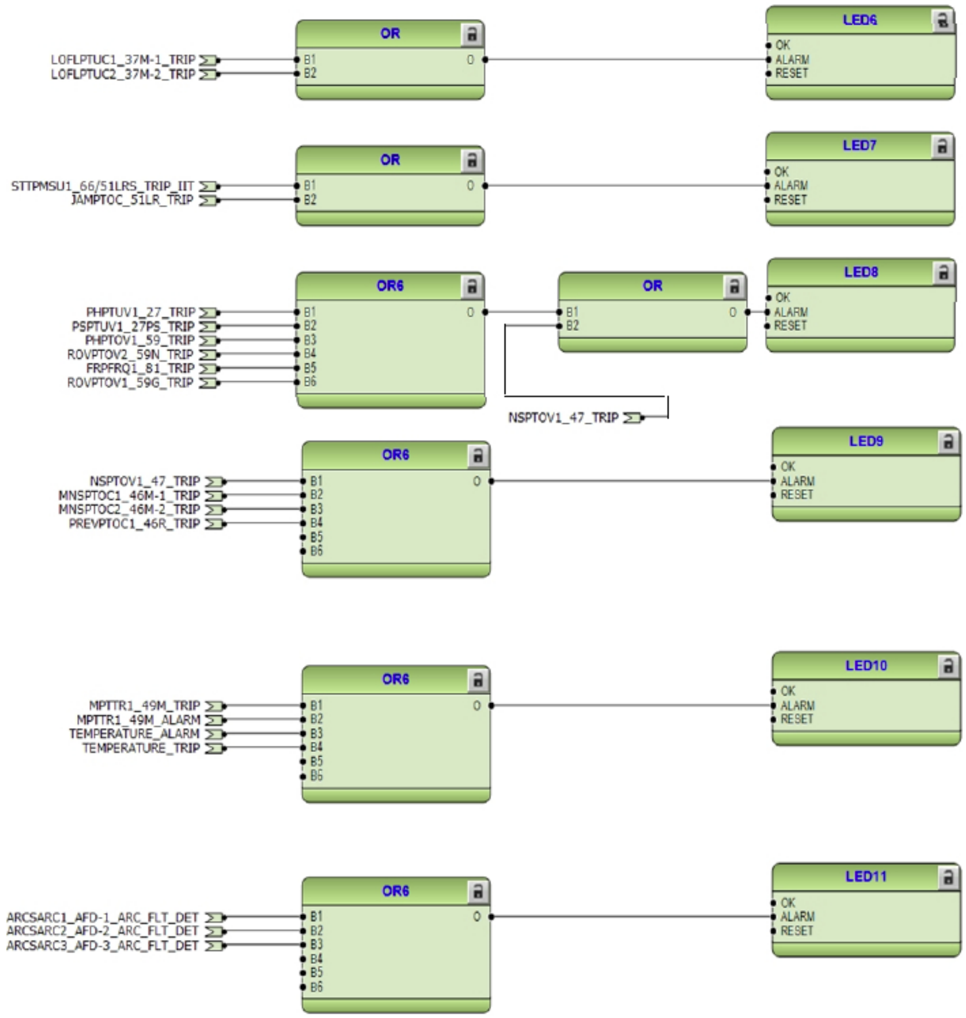


Figure 96: Alarm LEDs 6 - 11

Section 4 Requirement of current transformers

4.1 Current transformer requirement for protection

For reliable and correct operation of protection, the CT has to be chosen carefully. The distortion of the secondary current of a saturated CT may endanger the operation, selectivity, and co-ordination of protection. However, when the CT is correctly selected, a fast and reliable protection can be enabled. The selection of a CT depends not only on the CT specifications but also on the network fault current magnitude, desired protection objectives, and the actual CT burden. The protection settings of the IED should be defined in accordance with the CT performance as well as other factors. Appropriate 'C' class CT should be used based on the total resistances of the CT secondary circuit.

4.1.1 AC saturation

The TOC curve of the earlier electromechanical relays was achieved by allowing partial saturation of the internal magnetic circuits. Currents much higher than the higher limits of the TOC relays, which cause 'partial' saturation of the CTs should not affect the applications. However, if an application involves severe CT saturation, the relay may not function. Where the CT ratio is very low, CT secondary currents could exceed 20 times rated current causing severe saturation. The net outputs of such CTs may become so low (Figure 97) that operation of most of the protections become impossible.

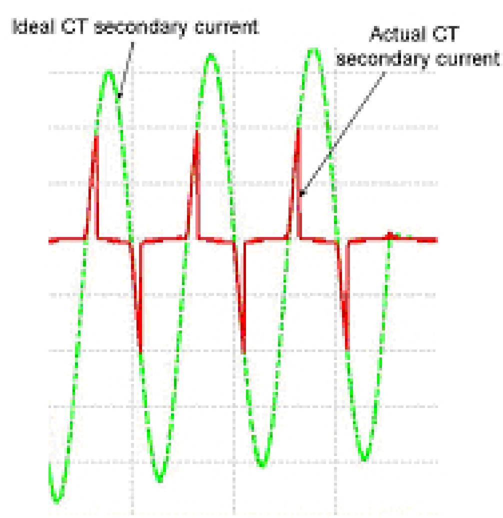


Figure 97: CT secondary waveform when severe AC saturation occurs

To avoid saturation, the CT shall develop adequate voltage such that

$$V_X > I_f (R_{CT}+R_L+R_B)$$ (Equation 1

where,

	I_f	= Fault current on CT secondary (Amps)
	R_{CT}	= CT Secondary resistance (Ohms)
	R_L	= CT Secondary total lead resistance (Ohms)
and	R_B	=CT secondary connected burden (Ohms)

The lead resistance R_L is the total secondary loop lead resistance. In case of single phase to ground faults, the current from the CT secondary flows through the phase connection and returns through the neutral wire. Hence twice the 'one-way' lead resistance shall be considered. In case of multi-phase faults, the phase currents cancel out with negligible current in the common neutral return lead. Hence the lead resistance for such faults will be just that of the 'one-way' lead. Special cases arise with delta connected CTs. In all such cases a very careful evaluation of how the CT under question drives currents through the leads would be necessary.

4.1.2 Transient saturation:

Transients, especially the decaying DC waveform in the primary current, cause the CT to go into saturation and produce distorted current waveform. Once the transients vanish the steady state performance of the CT gets restored.

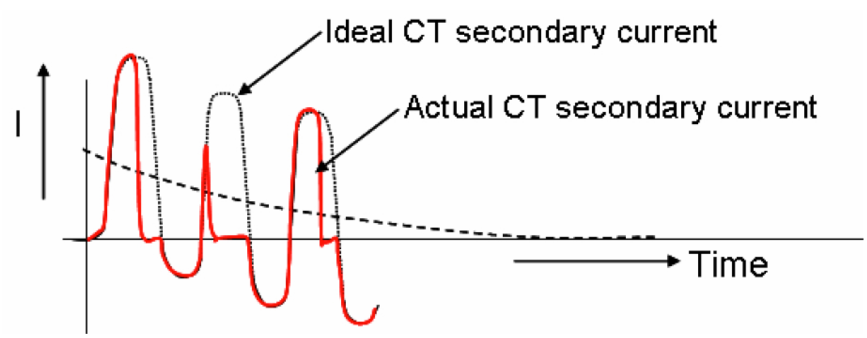


Figure 98: CT waveform when saturation occurs due to DC transients

It can be shown that the CT shall have enough capacity to develop the following voltage not to saturate at all for a combination of AC and DC transient.

$$V_X > I_f (1+X/R) (R_{CT}+R_L+R_B)$$ Equation 2)

where,

	I_f	= Fault current on CT secondary (Amps)
	X	= System Primary Reactance (in Ohms)
	R_{CT}	= CT Secondary resistance (Ohms)
	R_L	= CT Secondary total lead resistance (Ohms)
and	R_B	=CT secondary connected burden (Ohms)

Note that there is an additional factor (1+X/R) on the right side of the equation compared to the equation applied for AC saturation, Equation (1).

The ANSI specifies CTs for protection performance by a letter (See IEEE Std C57.13-1993). The classification codes are **C**, **K** and **T**. The classification **C** is widely used for protection. They indicate that the winding is uniformly wound around the core with negligible leakage flux. The **C** class CT is furnished with excitation characteristics which can be used to "**C**alculate" the CT performance. The standard ratings are C100, C200, C400, C800 corresponding to 100, 200, 400 and 800 volts respectively at 100A CT secondary. This would mean the design burdens are 1, 2, 4 and 8 Ohms respectively. Other burdens such as 0.1, 0.2 and 0.5 with corresponding voltages 10, 20, 50 are also specified but are not often used for HV and EHV applications. ANSI specifies the power factor of the burden at 0.5.

A steady state current error of 10% is allowed at 100A secondary, which translates into 10A excitation current. It is easy to look up the CT excitation characteristics corresponding to 10A excitation current and find out the induced voltage inside the CT. Subtracting the internal drop of $\mathbf{R_{CT}}$ through 100A fault current from the voltage should be above 100, 200, 400 or 800V to classify the CT as either C100, C200, 400 or 800.

The **K** classification is the same as **C** rating but the knee-point voltage must be at least 70% of the secondary terminal voltage rating. The letter **T** indicates the ratio error must be determined by '**T**est'. There are other classification types **H** and **L**, which are older specifications and are no longer in use.

An ANSI C800 CTs will have a saturation voltage of about,

$$Vx = 100(R_{CT} + 8)$$

Equation 3

Here 100 represents the recommended maximum CT secondary current of the CT during fault conditions (= 20 times nominal current of 5A), 8 is the burden expected to be connected to C800 class CT.

Comparing against the earlier equation (3), to avoid saturation,

$$100(R_{CT} + 8) > I_f\,(1+X/R)\,(R_{CT}+R_L+R_B)$$

Equation 4

Define Ni = 100/If

$$Nr = \{R_{CT} + 8(\text{design burden for C800})\} / (R_{CT}+R_L+R_B)$$

Substituting in (4) above,

$$(1+X/R) < Ni\ Nr$$

Equation 5

4.1.3 Remanence flux:

An additional dimension to the above issue is the residual magnetizing field left over in the CT core on clearance of a fault. When a fault with a heavy DC transient occurs, the flux density may go to a very high level. Once the fault is cleared, due to magnetic retention of the excited material, a certain amount of magnetism is retained. This has been found to be as high as 90% in some of the magnetic material.

In other words, in order to design a CT which will always reproduce the currents accurately, it may be necessary to increase the CT size by a term $(\mathbf{1+X/R})/(1-\psi)$ where ψ represents the per unit of maximum flux remaining in the CT core after removal of the primary fault current.

For example if the residual flux is 25%, $\psi = 0.25$. So the resultant CT sizing requirement goes up by a factor $\mathbf{1/(1-\psi)} = 1/(1-0.25) = 1.33$. In other words the requirement goes up by 33%. In case the CT retains 90% residual flux, it can be seen that the requirement of the CT size goes up by a factor of 900%.

The continuity or polarity of a current transformer is tested before putting it into service. DC test current injected into the CT will cause a unidirectional flux build up, sufficient to cause adequate remanence magnetic flux that may interfere with relay operation. It is very difficult to get rid of the remanence flux once established. Special de-magnetizing procedure is adopted to reduce the remaining flux.

Various methods are used to reduce the effects of remanence (Std. IEEE C37.110):

a Using different grades of steel for the core

b Gapped core

c Biased core CTs.

Of the three, the second method is widely practiced.

4.1.4 Practical CT sizing considering CT saturation:

The inequality considered earlier assumes no saturation. Modern high-speed relays operate quite fast, often taking an internal trip decision quite earlier than the onset of saturation even after considering remanence.

It is possible to calculate the time to saturate for any CT given the set of saturation voltage, remanence level, details of connected burden etc. Once the time to saturation is known a quick check against the time of operation of the protective relay would indicate whether the application would function properly with respect to the CT characteristics. Special care is needed when high speed autoreclose is concerned since the remanance magnetism and the CT secondary transient effects are the maximum when a reclose is attempted with a permanent fault on the line. Figure 99 provides a graphical representation of time to saturation of a CT. Detailed mathematical terms to calculate 'time-to-saturate' are available in IEEE C37.110.

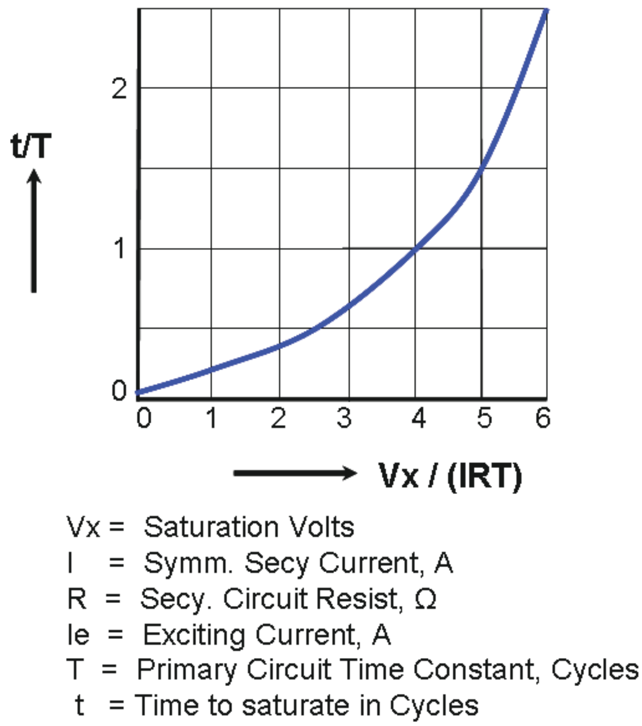


Figure 99: Time to saturate as a function of the saturation voltage and secondary circuit resistance

IEC standards have special classifications for CTs with gaps and specify their performance and remanence limits (IEC-60044-6).

4.1.5 CT Requirements for various protection applications

Once the CT specifications are known, it is necessary to match against the requirements of the protections. The following highlight some of the most often used protections and how CTs are matched for proper performance.

4.1.5.1 Time OC protection

TOC protection demands currents up to about 20 to 30 times the set current. The transient saturation is not of concern since the protection operating times are much after the CT comes out of saturation. AC saturation is of concern and CT saturation voltage has to be checked against the voltage generated during maximum fault conditions at which grading with other protections are provided.

4.1.5.2 High set

The operating times of High-set Phase or Ground OC elements are of the order of about a cycle. To ensure high speed of operation, it is essential to check both AC saturation as well as transient saturation of the CT. Where CT saturation cannot be avoided, it is necessary that the highset operates before the CT starts saturating on transients.

4.1.5.3 Distance protection

The lines usually carry higher primary amperes. The ratios are high resulting typically in currents much lower than 100A. Saturation during transient is of major concern. Saturation is accepted after the operation of the Zone-1 operation. Delayed elements of Zone-2 and Zone-3 can be given necessary logic circuits to ride through the saturation time of the current transformers before recovery occurs after the DC transients decay or some minor errors in their operating times are tolerated. In sub-transmission systems and distribution systems, when distance protection is applied, typically the feeder impedance would be much higher than the source impedance and have a lower X/R ratio than the step down sub-station energizing the feeder. The main concern of saturation is thus of close up forward faults. If the fault is very severe to be of concern of CT saturation, a CT design with a time to saturate time of 10-20msec works fine in most of the cases.

4.1.5.4 Differential & REF protection

Biased differential protection applications have operating characteristics with pickup increasing with higher through fault currents. This is defined by a slope of the bias characteristics. The higher the slope, the larger is the tolerance of the relay to errors and CT saturation. Some differential protections have multiple slope characteristics. A minimum time to saturate for the high speed protections such as the above would be about 10mSec, based on which the CT sizing can be verified.

Section 5 IED physical connections

5.1 Inputs

5.1.1 Auxiliary supply voltage input

The auxiliary voltage of the IED is connected to terminals X100/1-2. At DC supply, the positive lead is connected to terminal X100-1. The permitted auxiliary voltage range is marked on the LHMI of the IED on the top of the HMI of the plug-in unit.

Table 23: Auxiliary voltage supply

Terminal	Description
X100-1	+ Input
X100-2	- Input2

5.1.2 Binary inputs

The binary inputs can be used, for example, to generate a blocking signal, to unlatch output contacts, to trigger the digital fault recorder or for remote control of IED settings. Eight number binary inputs in REM620 are part of Binary Input and Output Modules (BIO) located in Slot IDs X115 as standard. Additional 4 binary inputs are available as part of AIM in Slot X130 when Config B is ordered. In Config A, six binary inputs can be catered as optional in slot X130, as part of a BIO Module option.

The following tables give terminal numbers of Binary Inputs available depending on the type of AIM or BIO module. A prefix as to the slod ID has to be attached based on the ordering code.

Table 24: Binary input terminals in BIO (8BI+4BO) in slots X115, all Configurations of REM620

Terminal	Description
X115-1 X115-2	BI1, + BI1, -
X115-3 X115-4	BI2, + BI2, -
X115-5 X115-6	BI3, + BI3, -
X115-7 X115-6	BI4, + BI4, -
X115-8 X115-9	BI5, + BI5, -
X115-10 X115-9	BI6, + BI6, -
X115-11 X115-12	BI7, + BI7, -
X115-13 X115-12	BI8, + BI8, -

Table 25: Binary input terminals in BIO (8BI+3HSO) in slots X115, alternative option, all Configurations of REM620

Terminal	Description
X115-1 X115-5	BI1, + BI1, -
X115-2 X115-5	BI2, - BI2, +
X115-3 X115-5	BI3, + BI3, -
X115-4 X115-5	BI4, + BI4, -
X115-6 X115-10	BI5, + BI5, -
X115-7 X115-10	BI6, + BI6, -
X115-8 X115-10	BI7, + BI7, -
X115-9 X115-10	BI8, + BI8, -

Table 26: Binary input terminals in BIO (6BI+3BO) in slots X130, Optional, only for Configuration A of REM620

Terminal	Description
X130-1 X130-2	BI1, + BI1, -
X130-3 X130-2	BI2, + BI2, -
X130-4 X130-5	BI3, + BI3, -
X130-6 X130-5	BI4, + BI4, -
X130-7 X130-8	BI5, + BI5, -

Terminal	Description
X130-9 X130-8	BI6, + BI6, -

Table 27: Binary input terminals, part of AIM 0006, position X130, Config B of REM620, standard

Terminal	Description
X130-1 X130-2	BI1, + BI1, -
X130-3 X130-4	BI2, + BI2, -
X130-5 X130-6	BI3, + BI3, -
X130-7 X130-8	BI4, + BI4, -

5.1.3 Optional light sensor inputs

If the IED is provided with the optional communication module with light sensor inputs, the pre-manufactured lens-sensor fibers are connected to inputs X13, X14, and X15, see the connection diagrams. For further information, see arc flash detector.

The IED is provided with connection sockets X13, X14 and X15 only if the optional communication module with light sensor inputs has been installed. If the arc flash detector option is selected when ordering an IED, the light sensor inputs are included in the communication module.

Table 28: Light sensor input connectors

Terminal	Description
X13	Input Light sensor 1
X14	Input Light sensor 2
X15	Input Light sensor 3

5.2 Outputs

5.2.1 Outputs for tripping and controlling

Output contacts PO1, PO2, PO3 and PO4 are heavy-duty trip contacts capable of controlling most circuit breakers. On delivery from the factory, the trip signals from all the protection stages are routed to PO3 and PO4.

Table 29: Output contacts

Terminal	Description
X100-6 X100-7	PO1, NO PO1, NO
X100-8 X100-9	PO2, NO PO2, NO
X100-15 X100-16 X100-17 X100-18 X100-19	PO3, NO (TCM resistor) PO3, NO PO3, NO PO3 (TCM1 input), NO PO3 (TCM1 input), NO
X100-20 X100-21 X100-22 X100-23 X100-24	PO4, NO (TCM resistor) PO4, NO PO4, NO PO4 (TCM2 input), NO PO4 (TCM2 input), NO

The IED can be ordered with BIO cards with High Speed Power Outputs in designated slots. When Arc protection is ordered with HSO outputs, that protection is configured to energize one or more of those outputs by default.

Table 30: Binary High Speed Output terminals in BIO (8BI+3HSO) in slot X115, alternative with high speed power outputs

Terminal	Description
X115-15 X115-16	HSO1, NO HSO1, NO
X115-19 X115-20	HSO2, NO HSO2, NO
X115-23 X115-24	HSO3, NO HSO3, NO

5.2.2 Outputs for signaling

Output contacts SO1 and SO2 in slot X100 or SO1, SO2, SO3 and SO4 in slot X130 or SO1, SO2 and SO3 in slot X130 (optional, only in Config A) can be used for signaling on pickup and tripping of the IED.

As an alternative, instead of the outputs SO1, SO2, SO3 and SO4 in slot X130, high speed power outputs contacts HS01, HS02 and HS03 can be ordered.

On delivery from the factory, the pickup and alarm signals from all the protection stages are routed to signaling outputs.

Table 31: Output contacts X100

Terminal	Description
X100-10 X100-11 X100-12	SO1, common SO1, NC SO1, NO
X100-13 X100-14	SO2, NO SO2, NO

Table 32: Binary signal output terminals in BIO (8BI+4BO) in slot X115

Terminal	Description
X115-14 X115-15 X115-16	SO1, common SO1, NO SO1, NC
X115-17 X115-18 X115-19	SO2, common SO2, NO SO2, NC
X115-20 X115-21 X115-22	SO3, common SO3, NO SO3, NC
X115-23 X115-24	SO4, common SO4, NO

5.2.3 IRF

The IRF contact functions as an output contact for the self-supervision system of the protection IED. Under normal operating conditions, the IED is energized and the contact is closed (X100/3-5). When a fault is detected by the self-supervision system or the auxiliary voltage is disconnected, the output contact drops off and the contact closes (X100/3-4).

Table 33: IRF contact

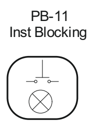
Terminal	Description
X100-3	IRF, common
X100-4	Closed; IRF, or V_{aux} disconnected
X100-5	Closed; no IRF, and V_{aux} connected

Section 6 Glossary

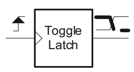
615/620 series	Series of numerical IEDs for basic, inexpensive and simple protection and supervision applications of utility substations, and industrial switchgear and equipment 100BASE-FXA physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses fibre-optic cabling
100BASE-TX	A physical media defined in the IEEE 802.3 Ethernet standard for local area networks (LANs) that uses twisted-pair cabling category 5 or higher with RJ-45 connectors
ANSI	American National Standards Institute
BI	Binary input
BI/O	Binary input/output
BO	Binary output
CB	Circuit breaker
CT	Current transformer
CBCT	Core Balance Current Transformer
DFR	Digital fault recorder
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.
EMC	Electromagnetic compatibility
GOOSE	Generic Object Oriented Substation Event
HMI	Human-machine interface
HSO	High-speed output which is a hybrid discrete/electromechanical output that is rated as a power output.
HW	Hardware
IEC 61850	International standard for substation communication and modelling
IED	Intelligent electronic device
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.
IRIG-B	Inter-Range Instrumentation Group's time code format B LANLocal area network

LC	Connector type for glass fiber cable
LCD	Liquid crystal display
LED	Light-emitting diode
LHMI	Local human-machine interface
mA	Milli-ampere transducer whose measured current is directly proportional to actual current being monitored
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
MV	Medium voltage
PCM600	Protection and Control IED Manager
PO	Power output
RJ-45	Galvanic connector type
RS-232	Serial interface standard
RS-485	Serial link according to EIA standard RS485
RTD	Resistive temperature device whose calculated resistance is directly proportional to temperature.
SO	Signal output
TCP/IP	Transmission Control Protocol/Internet Protocol
TCS	Trip-circuit supervision
WAN	Wide area network
WCT	Window Type CT (Also refer to CBCT)
WHMI	Web human-machine interface

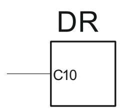
Legend



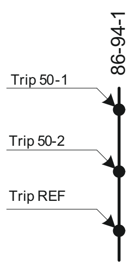
Push Button(with embedded LED) 11 on the front of the IED with legend 'Inst Blocking'



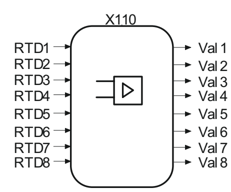
T Flip Flop (output changes state on input rising edge)



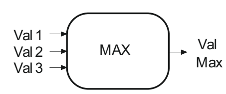
Disturbance Recorder (C10 - Input Channel 10)



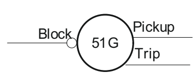
Signals *Trip 50-1, Trip 50-2* and *Trip REF* are ORed to form signal *86-94-1*



RTD Input Slot ID X110, Configured with signals from Bearing temp., Ambient Temperature etc.

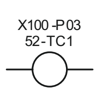


Val Max ouptut is the maximum of three analog input values Val1, Val2 and Val3

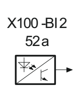


Protection Function 51G, with *Pickup* and *Trip* signal outputs, Protection blocked when input signal *Block* is high

Alarm LED 1 on the front of the IED, with legend '*A Ph*'



Binary Output PO3, on Slot ID X100, configured with signal 52-TC1
(PO- Power contact, SO- Signal Contact, HSO- High Speed output)



Binary Input B12, on Slot ID X100, configured with signal Input *52a*

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