Relay Retrofit Program
Application Manual

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2014/30/EU) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2014/35/EU). This conformity is the result of tests conducted by ABB in accordance with the product standards of the IEC 60255 series.

Safety information

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

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

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

Only trained and qualified persons are allowed to connect and operate RTB615.

National and local electrical safety regulations must always be followed.

The frame of RTB615 has to be carefully earthed using a separate PE connection point available on the RTB615 front plate.

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

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

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

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Section 1 Introduction

1.1 This manual

The application manual contains the Relay Retrofit Program overview and the application descriptions. The manual describes how the program deliverables can be used in the relay retrofit applications. The manual also provides information on the retrofit process and the recommendations for each supported relay type.

1.2 Intended audience

This manual addresses the service engineers and protection and control engineers responsible for planning, engineering, installing and commissioning of medium-voltage relay retrofit applications. The manual also addresses the personnel performing the replacement (installation and commissioning) of the relay.

The protection and control engineers must be experienced in electrical power engineering and have knowledge of the related technology, such as protection schemes and principles.

The installation and commissioning technicians must have basic knowledge of handling electronic equipment.

1.3 Product documentation

1.3.1 Product documentation set

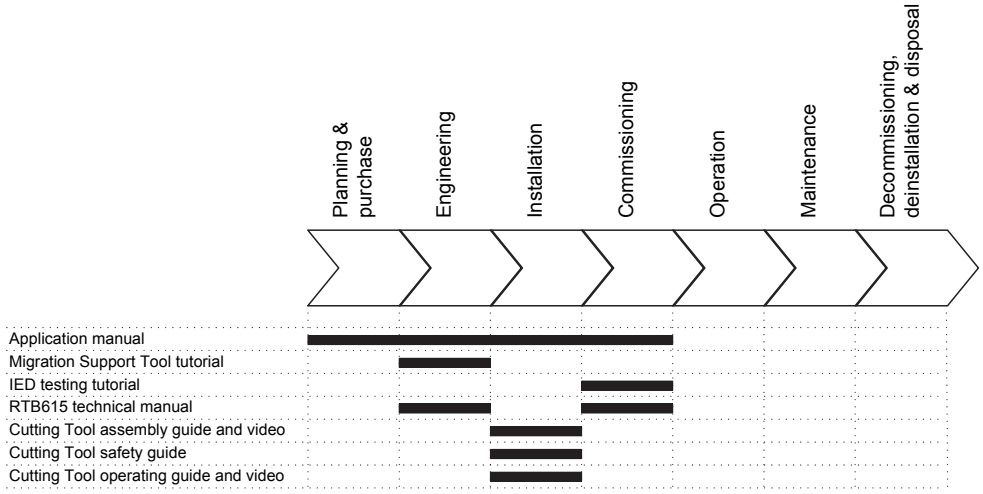


Figure 1: The intended use of documents during the product life cycle

The application manual contains the Relay Retrofit Program overview and the application descriptions. The manual describes how the program deliverables can be used in the relay retrofit applications. The manual also provides information on the retrofit process and the recommendations for each supported relay type.

Migration Support Tool tutorial shows the steps composing the process from collecting the existing relay parameter values to migrating those to the replacement IED settings.

IED testing tutorial illustrates the use of test templates in the Omicron Test Universe environment.

The RTB615 technical manual contains general information about the features of Relion® Test Box RTB615, presenting the different parts of the device and giving examples how to take advantage of the test box in different applications.

Cutting tool assembly guide and video illustrate how the cutting tool is prepared for operation.

Cutting tool safety guide contains safety recommendations to the user.

Cutting tool operating guide and video contain instructions on how to operate the tool during relay retrofit.

1.3.2 Document revision history

Document revision/date	History
A/2014-04-23	SPAJ 140 C, SPAJ 141 C, SPAJ 142 C, SPAM 150 C and SPAU 130 C added to the Relay Retrofit Program.
B/2015-01-07	Added support for SPAU 320 C1, SPAU 330 C1, MCX 912 and MCX 913.
C/2015-06-10	Cutting head assembly corrected in figures.
D/2019-07-01	Content updated

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

1.3.3 Related documentation

Name of the document	Document ID
Relay Retrofit Program Migration Support Tool Tutorial	1MRS757634
Relay Retrofit Program Testing Tutorial	1MRS757639
RTB615 Technical Manual	1MRS758004
Relay Retrofit Program Cutting Tool Assembly Guide	1MRS757994
Relay Retrofit Program Cutting Tool Assembly Guide (video)	1MRS757993
Relay Retrofit Program Cutting Tool Safety Guide	1MRS757995
Relay Retrofit Program Cutting Tool Operating Guide SPACOM 100	1MRS757998
Relay Retrofit Program Cutting Tool Operating Guide SPACOM 100 (video)	1MRS758001
Relay Retrofit Program Cutting Tool Operating Guide SPACOM 300	1MRS757999
Relay Retrofit Program Cutting Tool Operating Guide SPACOM 300 (video)	1MRS758002
Relay Retrofit Program Cutting Tool Operating Guide BBC Std. casing size 1	1MRS758000
Relay Retrofit Program Cutting Tool Operating Guide BBC Std. casing size 1 (video)	1MRS758003
Relay Retrofit Program Quick Start Guide	1MRS758005

See the 615 series documentation for detailed technical information on the replacement relay. Product series- and product-specific manuals can be downloaded from the ABB Website http://www.abb.com/substationautomation.

1.4 Symbols and conventions

1.4.1 Symbols

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

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

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

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

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

Although warning hazards are related to personal injury, it is necessary to understand that under certain operational conditions, operation of damaged equipment may result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Document conventions

A particular convention may not be used in this manual.

- Abbreviations and acronyms are spelled out in the glossary. The glossary also contains definitions of important terms.
- Parameter names are shown in italics.
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks.
  The corresponding parameter values are "On" and "Off".
- Input/output messages and monitored data names are shown in Courier font.
  When the function starts, the `START` output is set to TRUE.

Section 2 Relay Retrofit Program overview

2.1 Overview

ABB's life cycle extension initiative is aimed at supporting the life cycle management (LCM) of utility and industrial power distribution systems. One strategic consideration of the LCM of a power system is to extend the life cycle of a switchgear panel through retrofit programs targeted at selected switchgear equipment. A timely executed retrofit program for selected devices allows full utilization of the life cycle of the remaining switchgear components.

The Relay Retrofit program is based on using protection relays belonging to the Relion® product family as replacement devices, pre-designed installation accessories and the IED Migration Support tool. The carefully engineered program provides a controlled and repeatable procedure for replacing existing protection relays with modern protection relays. Various retrofit phases can be accurately scheduled and timely executed to minimize downtime of production or power distribution processes.

A number of ABB experts in power system protection have been involved in developing the program. The aim is to enable controlled and repeatable execution of relay retrofit projects. The tools and accessories simplify the work procedures.

The Relay Retrofit program for replacing selected relays with Relion 615 protection relays consists of a set of tools and accessories, documentation and training.

- IED Migration Support Tool
- Relion Test Box RTB615 with masking plates
- Test templates for replacement protection relays
- Wire markings and wiring harnesses
- Cover plates
- Cutting tool
- Documentation
- Training

Table 1: Supported retrofit project phases

Retrofit project phases	Tools and accessories
Engineering	IED Migration Support Tool Documentation
Installation	Wire markings and wiring harness Cutting tool Cover plates Documentation
Testing	Relion Test Box RTB615 Test templates for replacement protection relays Documentation

2.2 Existing relays and replacement IEDs

The selection of replacement IEDs for existing relays has been carefully considered based on expert knowledge of previous product generations and recent developments in protection and control technology. All selected replacement IEDs belong to the 615 series and their functionality corresponds to that of the existing relays. In addition, the 615 series offers the possibility to expand the functionality of the power protection system further, for example by adding an optional arc flash protection. The compact size of the IEDs minimizes the need for additional space in a retrofit installation.

The globally recognized product series features native support for the IEC 61850 standard for communication in substations, Parallel Redundancy Protocol (PRP) and the High-availability Seamless Redundancy (HSR) protocol included. Legacy protocols are also widely supported.

The order code for a replacement IED includes a fixed (in capital letters) and a non-fixed (in hashes (#)) part. The non-fixed part can be freely selected as when ordering any 615 series IED.

Table 2: Existing relay types and replacement IEDs

Relay type to be retrofitted	Replacement IED	Order code[1)]
SPAJ 140 C	REF615 Ver.4.0 FP1 IEC standard configuration “C”	#BFCAC##########1E
SPAJ 141 C	REF615 Ver.4.0 FP1 IEC standard configuration “C”	#BFCAD##########1E
SPAJ 142 C	REF615 Ver.4.0 FP1 IEC standard configuration “C”	#BFCAD##########1E
SPAM 150 C	REM615 Ver.4.0 FP1 IEC standard configuration “A”	#BMAAC##########1E
		#BMAAG##########1E[2)]
SPAU 130 C	REU615 Ver.4.0 FP1 IEC standard configuration “A”	#BUAEA##########1E
SPAU 320 C1	REU615 Ver.4.0 FP1 IEC standard configuration “A”	#BUAEA##########1E
SPAU 330 C1	REU615 Ver.4.0 FP1 IEC standard configuration “A”	#BUAEA##########1E
MCX 912	REM615 Ver.4.0 FP1 IEC standard configuration “A”	#BMAAC##########1E
MCX 913		#BMAAG##########1E[2)]

1) The order code for a replacement IED includes a fixed (in capital letters) and a non-fixed (in hashes (#)) part. The non-fixed part can be freely selected as when ordering any 615 series IED.
2) With RTD inputs

2.2.1 Version and compatibility information

Following software versions are the minimum requirements to support all relays released under the program. It is recommended to always use the latest available versions.

Relay Retrofit Program and IED Migration Support Tool (MST) are compatible with the following software versions.

Engineering

- ABB Retrofit Connectivity Package 1.1 or later
- ABB IED Connectivity Package REF615 Ver.4.1.1 or later
- ABB IED Connectivity Package REM615 Ver.4.1.1 or later
- ABB IED Connectivity Package REU615 Ver.4.1.1 or later
- CAP 505 Ver.2.4.0 or later (with serial cable SPA-ZP 5A3)
- MCX 912/913 Parameter Collection Form Ver. 1.0
- Protection and Control IED Manager PCM600 Ver.2.6 or later

Testing

- Omicron Test Universe 2.40 or later
- Relion Test Box RTB615 Ver.1.0 or later
- REF615 Omicron test template 1.0 or later for SPAJ 140 C, SPAJ 141 C and SPAJ 142 C retrofit
- REM615 Omicron test template 1.0 or later for SPAM 150 C retrofit
- REU615 Omicron test template 1.0 or later for SPAU 130 C retrofit
- REU615 Omicron test template 1.0 or later for SPAU 320 C1 and SPAU 330 C1 retrofit

RTB615 version 1.0 does not support the REM615 variant with RTD inputs #BMAAG##########1E nor the REU 615 variant #BUAEA##########1E.

Download connectivity packages from the ABB Web site http://www.abb.com/substationautomation or directly with Update Manager in PCM600.

2.3 Engineering

2.3.1 IED Migration Support tool

IED Migration Support tool (MST) is a flexible and powerful migration tool for relay configuration used during the retrofit process. The IED Migration Support tool processes the configuration, capabilities and parameters of the existing relay and maps them to the selected replacement IED. The result of the migration is a fully parameterized and configured replacement IED with the exception of communication configuration.

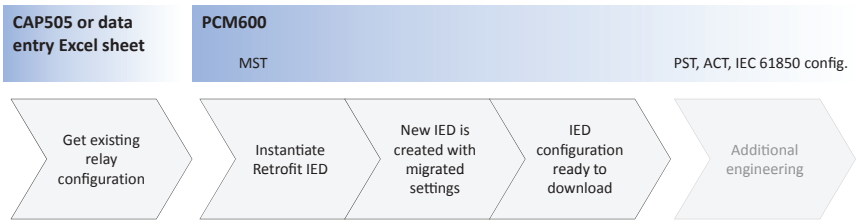


Figure 2: IED Migration Support tool process

Migration packages contain rules and conditions for each type of relay configuration migration. The IED Migration Support tool chooses the proper retrofit migration package during the migration process, based on the chosen relays, the existing one and replacement IED.

Every migration package is designed, tested and certified for each pair of existing relay and new IED. A migration package is designed considering different factors of the existing relay and the new IED.

- Capabilities, protection functions, input and output features, and so on
- Set of parameters and configurations

A retrofit migration package is identified using various properties.

- Existing relay, which is fully identified by its product name, for example, SPAJ 140 C.
- Replacement IED, which is fully identified by its product name and product order code. In particular, the order code is composed of a fixed part and a variable part (for example, #BMAAG##########1E). This variable part (indicated by '#') of the order code can be selected during the migration process.
- Release version. The version identifies the improvements into the migration package and changes to reflect compatibility with PCM600 version.
- Certification key. To guarantee the migration results, any migration package follows an internal certification process. Only certified packages should be used.

Always use the latest version of Retrofit Connectivity Package which also contains the latest released migration packages.

The use of un-certified packages may result in erroneous or not tested migration process and therefore can produce a new IED configuration that is faulty.

2.3.2 PCM600 tool

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

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

The whole substation configuration can be controlled and different tasks and functions can be performed with the individual tool components. PCM600 can operate with many different topologies, depending on the customer needs.

For more information, see the PCM600 documentation.

2.3.2.1 Connectivity packages

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

A connectivity package includes all the data which is used to describe the protection relay. For example, it contains a list of the existing parameters, data format used, units, setting range, access rights and visibility of the parameters. In addition, it contains code which allows software packages that use the connectivity package to properly communicate with the protection relay. It also supports localization of text even when it is read from the protection relay in a standard format such as COMTRADE.

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

2.3.2.2 Retrofit connectivity package

The Retrofit connectivity package contains the IED Migration Support Tool (MST), certified migration packages and related documentation.

The IED Migration Support tool processes the parameters of the existing relay and maps them to the selected replacement IED. It also defines the configuration of the IED. The result of the migration is a fully parameterized and configured replacement IED, with the exception of communication configuration.

The migration packages contain the existing relay specific migration rules. Certified migration packages are distributed inside the Retrofit connectivity package. The IED Migration Support tool can also utilize uncertified migration packages, which means that packages are created and tested by a third party but not officially certified and released under Relay Retrofit Program.

2.3.2.3 Project preparation

Installing connectivity packages

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

Download connectivity packages from the ABB Web site http://www.abb.com/substationautomation or directly with Update Manager in PCM600.

Installing connectivity packages by using the connectivity package installer

1. Close PCM600.
2. Run the **ABB Retrofit Connectivity Package Ver.n.msi** installer.
   (n = version number)
3. To install the connectivity package, follow the steps in the connectivity package installation wizard.

Installing connectivity packages by using Update Manager

1. In PCM600, click **Help** and select **Update Manager**.
   Run Update Manager with administrator rights.
2. Select **Get Connectivity Packages** from the menu on the left column.
3. Select all the required connectivity packages.
4. Click **Download and Install**.
   The status bar shows the installation status.

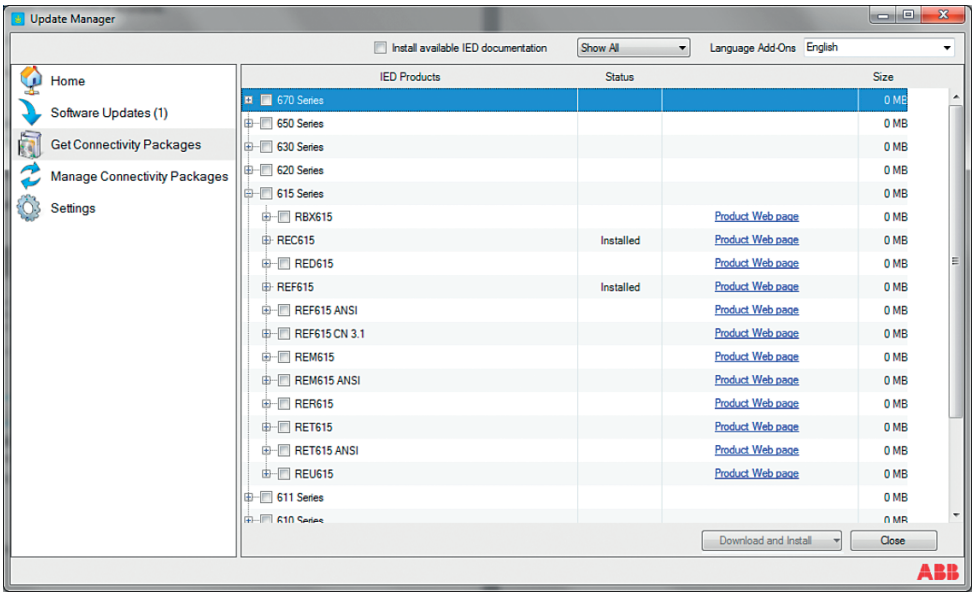


Figure 3: Selecting the connectivity packages

Activating connectivity packages

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

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

Always use the latest version of the connectivity package.

4. Click **Apply** to activate the connectivity package.
   PCM600 recognizes the installed connectivity packages during start-up, and the corresponding IED types are available in PCM600 when starting a new project.

Creating a new project

1. Start PCM600.
2. To see the projects that are currently available in the PCM600 database, click **File** and select **Open/Manage Project**.
   The **Open/Manage Project** dialog box opens.

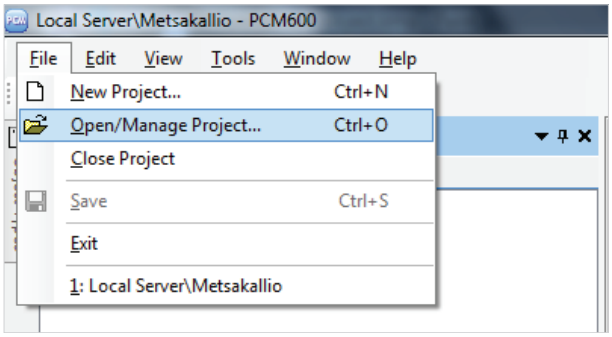


Figure 4: Managing projects

3. Select **Projects on my computer**.
   - If there are currently any projects or object tools open, close them.
4. Click **New Project**.
   The **Create New Project** dialog box opens.

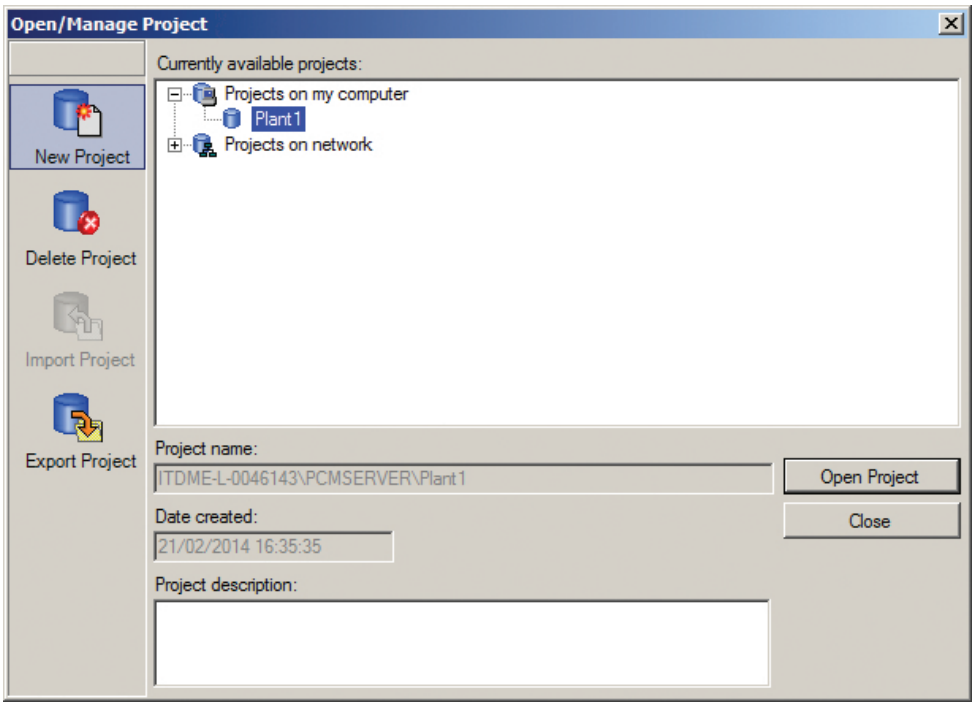


Figure 5: Creating new projects

5. In the **Project Name** box, give a name for the project.
   - Optionally, write a description of the project in the **Description** box.

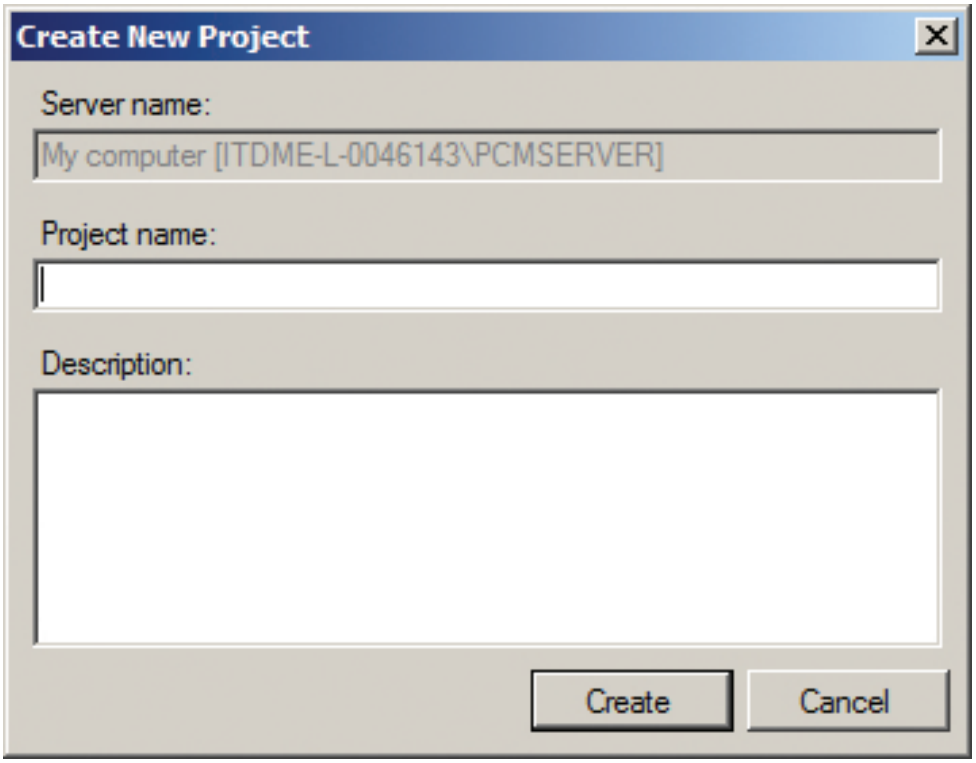


Figure 6: Naming the project

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

Building the plant structure

1. Create a new plant structure in PCM600.
   1.1. Right-click the **Plant Structure** view, point to **New** and select **Retrofit**.
   1.2. Select the **Retrofit IED** element to start the IED Migration Support tool. The IED Migration Support tool updates the Retrofit IED during the relay migration process.

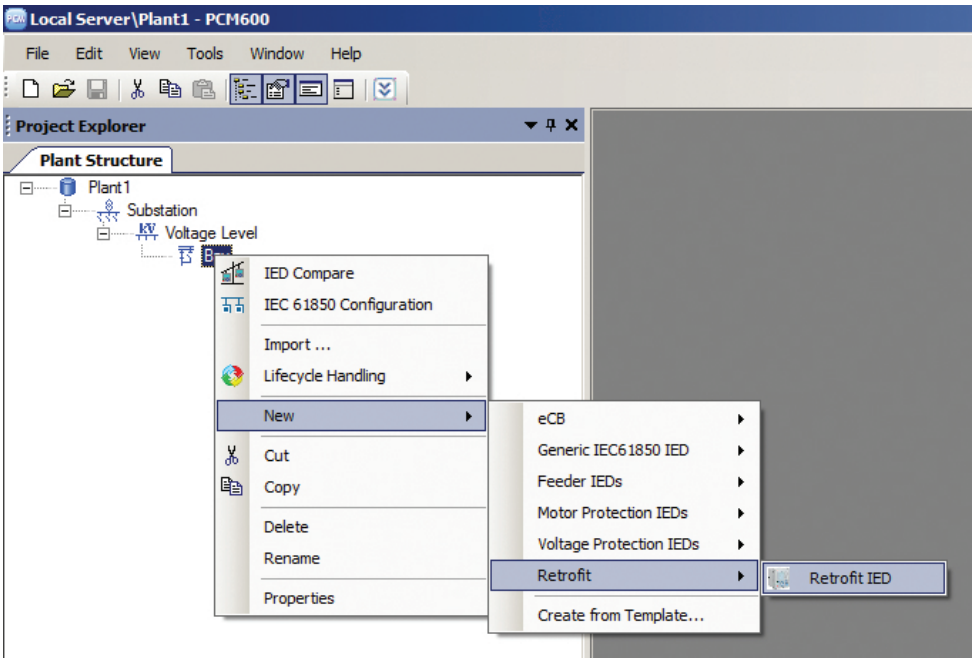


Figure 7: Starting the IED Migration Support tool

The IED Migration Support tool scans the installed migration packages once the Retrofit IED is instantiated.

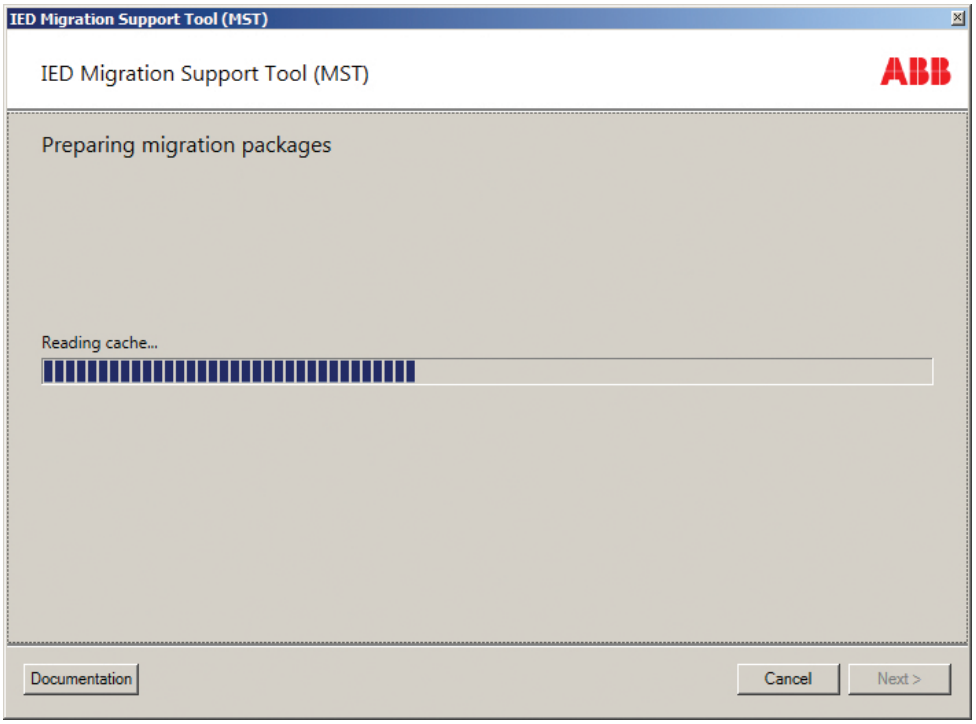


Figure 8: Scanning the migration packages

2. Click **Next**.

Reinstall the Retrofit Connectivity Package if errors occur while scanning the migration packages. If the problem persists, contact the ABB support.

2.3.3 Migration process

The IED Migration Support tool executes a migration process with several steps to complete the relay migration. Most of the steps require user inputs to get the proper information about the existing relay and the new IED.

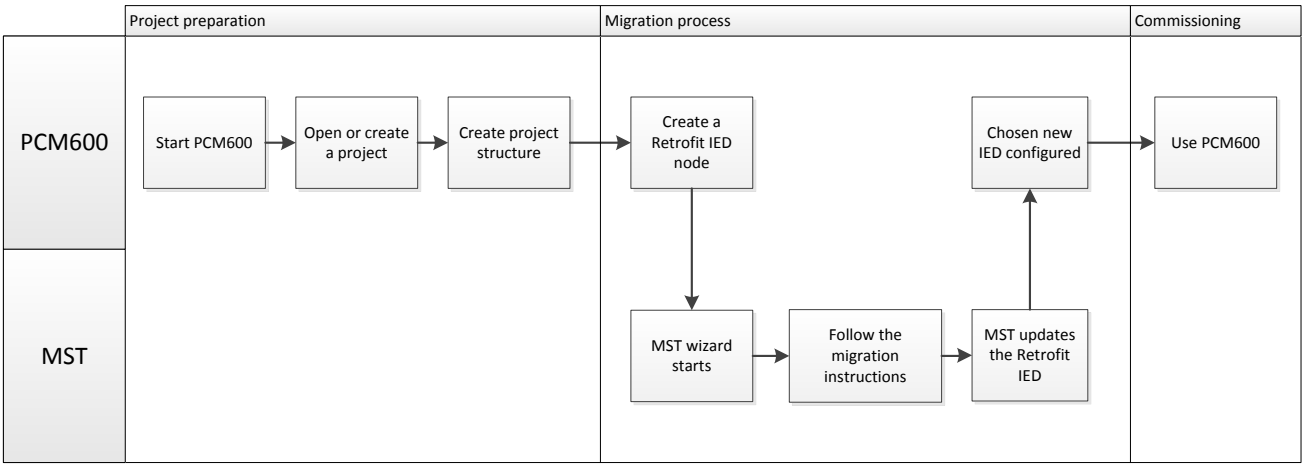


Figure 9: Migration process

1. PCM600 project preparation
   1.1. Starting the PCM600 tool.
   1.2. Opening a new or existing project.
   1.3. Creating or arranging the project structure (plant structure).
2. Relay migration process
   2.1. Creating a Retrofit IED: The IED Migration Support tool wizard opens.
   2.2. Migration selection: The IED Migration Support tool reads the installed migration packages, and queries for existing relay and new IED selection 2.
   2.3. Existing relay configuration: The existing relay configuration file should be selected.
   2.4. New IED configuration: The order code of the new IED should be filled with replacing the existing relay.
   2.5. Additional information: Additional information about the existing installation should be added.
   2.6. The IED Migration Support tool runs the migration and reports the results.
   2.7. Checking the reports and commiting the migration to PCM600 tool.
3. Commissioning with PCM600

3.1. New IED is made available in the plant structure.
3.2. Using PCM600 tool for various operations (For example, downloading the configuration to the IED).

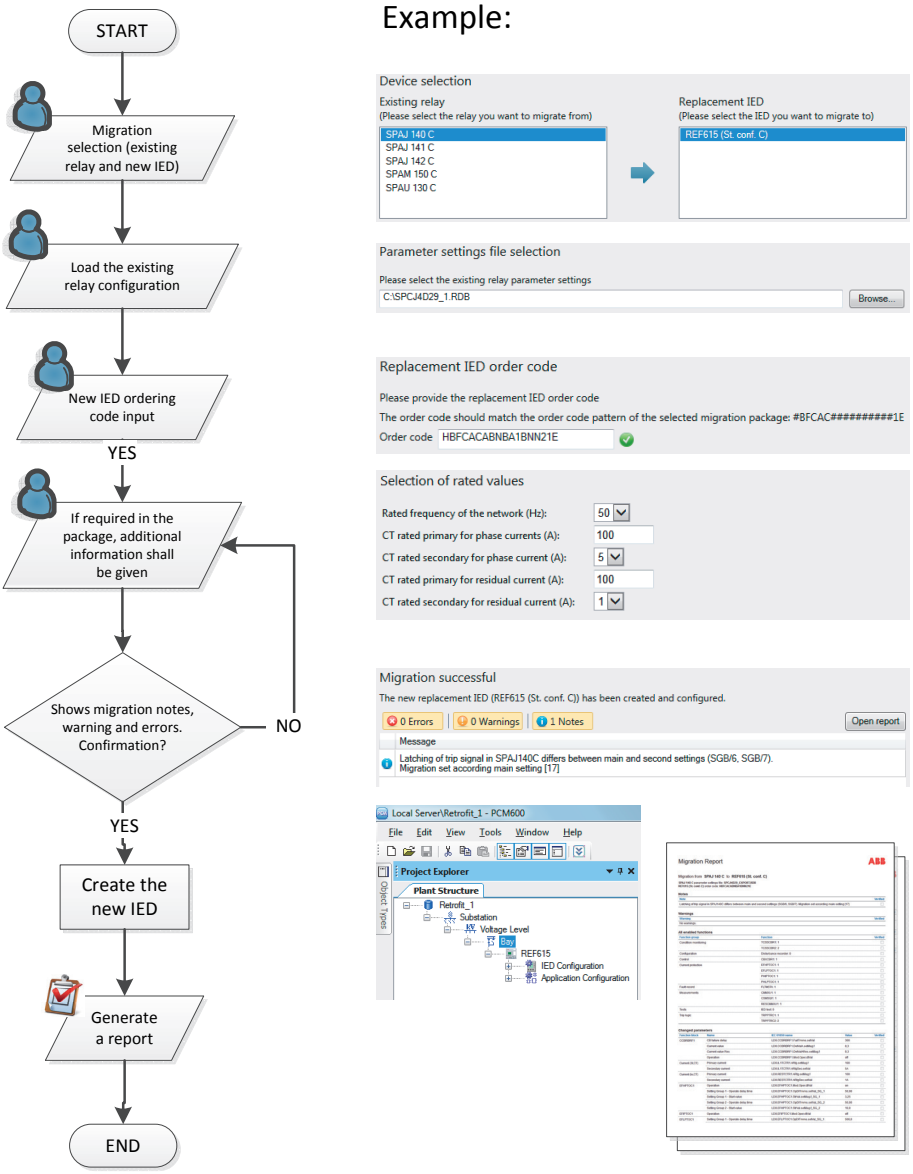


Figure 10: Details of the relay migration process

2.3.3.1 Selecting devices

1. Under **Existing relay**, select the existing relay to be migrated.

The list of existing relays which can be migrated by the IED Migration Support tool is dependent on the migration packages available on the local computer.

2. Under **Replacement IED**, select the retrofit IED to be migrated.
   The number and type of replacement IEDs depends on the installed migration packages. The latest and certified migration package is automatically chosen when a replacement IED is selected.
3. Under **Available mapping packages**, check that the correct migration package is selected and click **Next**.

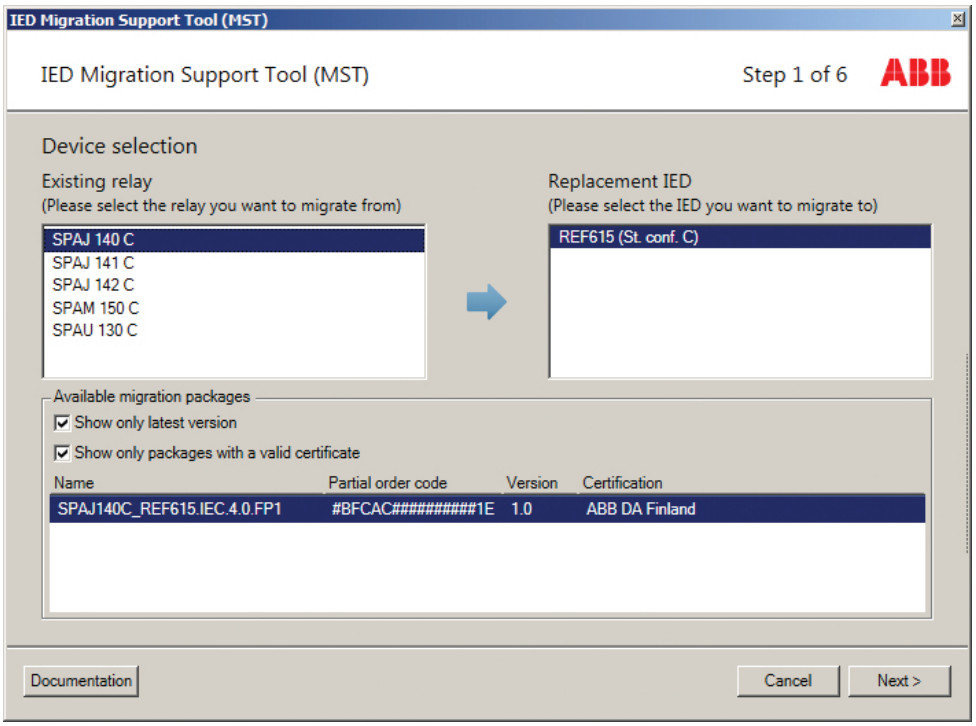


Figure 11: Selecting devices and migration packages

Table 3: Migration package details

Item	Description
Name	Name of the migration package which usually contains the existing relay and replacement IED names and versions.
Partial order code	Partial order code of the replacement IED which can be used for this retrofit.
Version	Version of the migration package
Certification	Certification credentials for the migration package

- Unselect **Show only latest version** to display all installed migration package versions corresponding to the device selection.
- Unselect **Show only certified and valid packages** to display all certified and uncertified migration packages, for example, for testing or demo purposes.
- If no certified migration packages for the selected combination of devices are available on the local computer, for example, during the testing or approval phase, the **Reading migration packages notification** appears. Click **Yes** to see a list of all certified and uncertified migration packages.

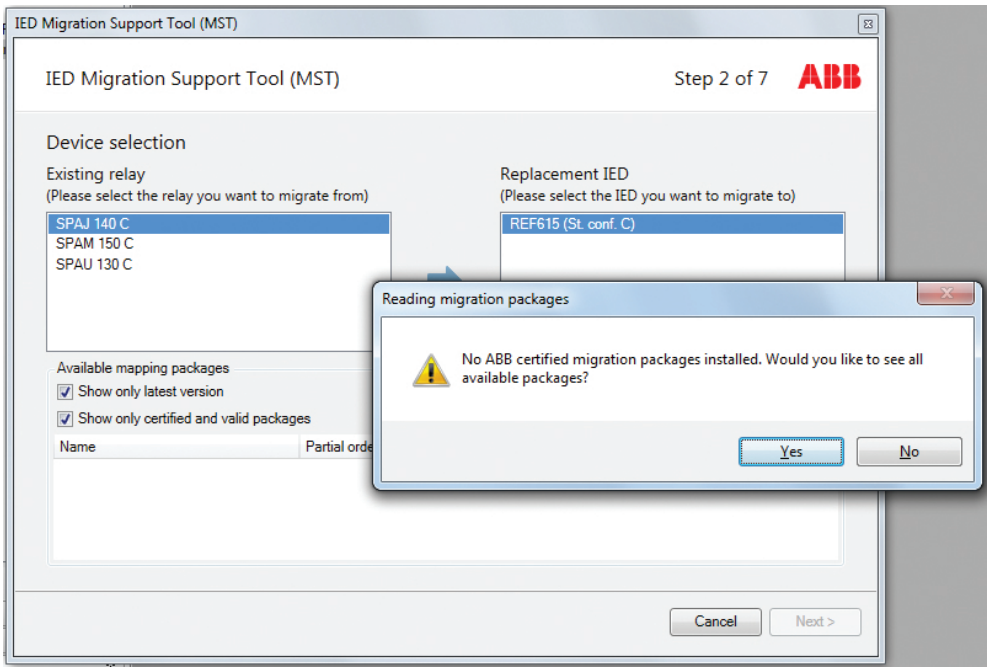


Figure 12: Selecting uncertified migration packages

Always use certified migration packages which have been tested and verified. An uncertified package may not be fully tested. ABB is not responsible for the improper use of the IED Migration Support tool on a real plant.

2.3.3.2 Defining the existing relay configuration

1. Under **Parameter settings file selection**, click **Browse** to locate the parameter settings file for the existing relay.
   If the existing relay can be configured using a dedicated engineering tool, the IED Migration Support tool requires a file generated by this engineering tool. This file contains all the configuration information of the existing relay.

To complete the migration successfully, use the latest version of the existing relay configuration file and ensure that it is up to date. Some parameters may have been changed during the time the relay and the plant have been in use.

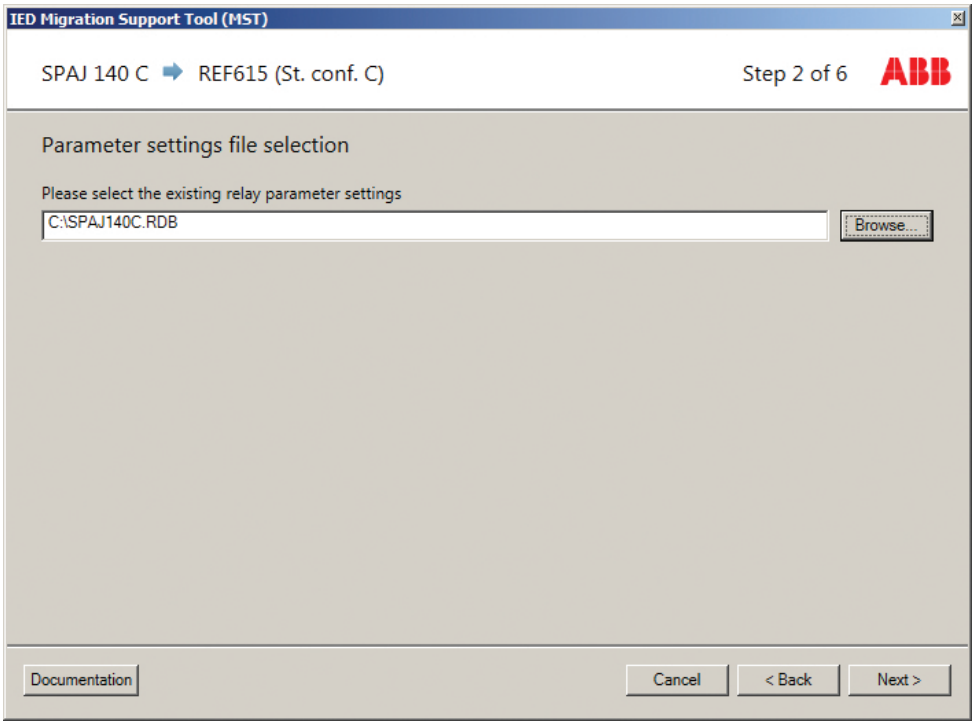


Figure 13: Selecting the existing relay parameters settings

2. Click **Next**.

If the existing relay does not have a dedicated engineering tool, the Relay Retrofit Program provides a simple way to gather all the required information. A data-entry Microsoft Excel sheet is designed for a specific existing relay as a tool for collecting the settings, protections and parameters of the relay. The data entry Excel sheets can generate a relay configuration file to be loaded into the IED Migration Support tool.

Any mistakes in the data-entry sheet affect the migration and possibly result in unwanted behavior of the new IED.

2.3.3.3 Defining the replacement IED order code

The migration package requires a partial fixed order code such as #BMAAG##########1E.

1. Under **Replacement IED order code**, type the order code of the retrofit IED.

See the product guide of the retrofit IED for order code details.

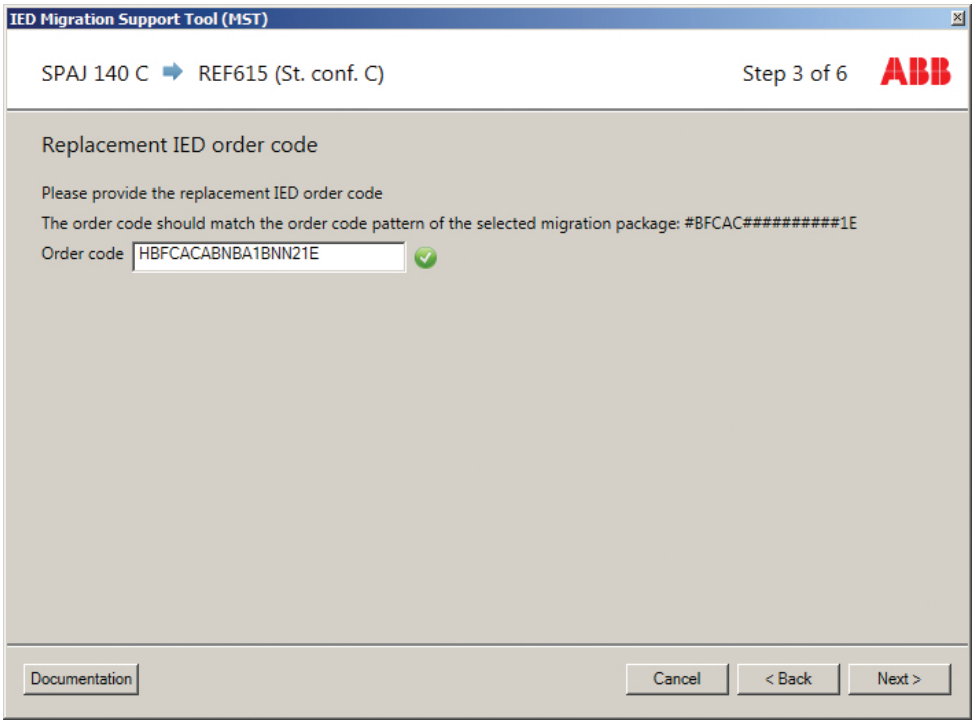


Figure 14: Defining the replacement IED order code

The IED Migration Support tool checks that the order code complies with the selected migration package. A valid code is indicated by a green check mark and errors by a red cross. The next step can be taken if the order code is correct. The IED Migration Support tool also checks the syntax of the order code but only PCM600 verifies it in the last migration.

2. Click **Next**.

2.3.3.4 Entering values manually

Depending on the migration package, the IED Migration Support tool may require additional information before starting the migration. The requested data, such as current and voltage transformer values or network frequency, concern the existing relay installation and are not stored in the configuration file.

1. Under **Selection of rated values**, define the rated frequency and current values. The information is required to complete the configuration of the retrofit IED according to the existing relay configuration, installation and use.

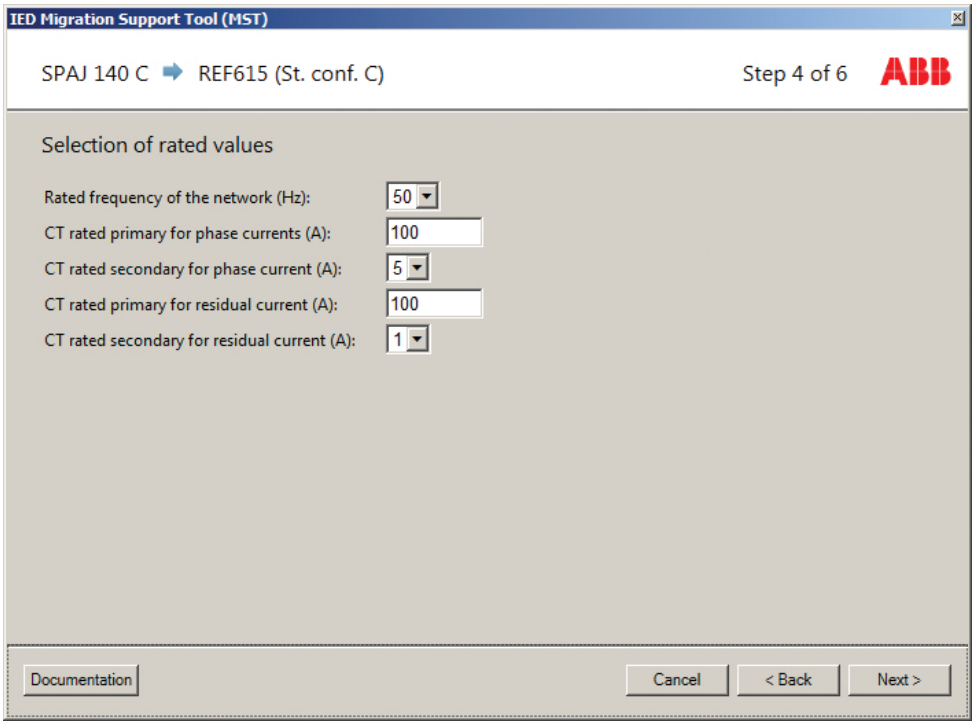


Figure 15: Defining additional information

2. Click **Next**.

Any information which refers to new functions offered by the retrofit IED can be enabled and configured using PCM600. It is possible to upgrade some IED or switchgear functions, for example protection functions or communication, in the retrofit IED.

2.3.3.5 Applying migration

1. Click **Migrate** to start the migration process.

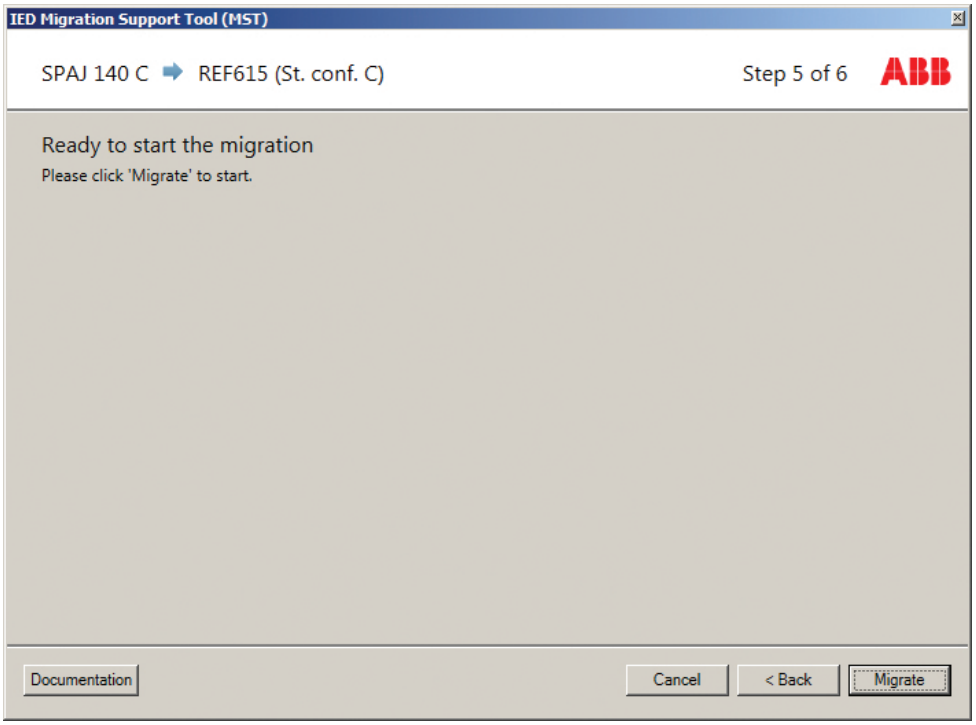


Figure 16: Starting the migration

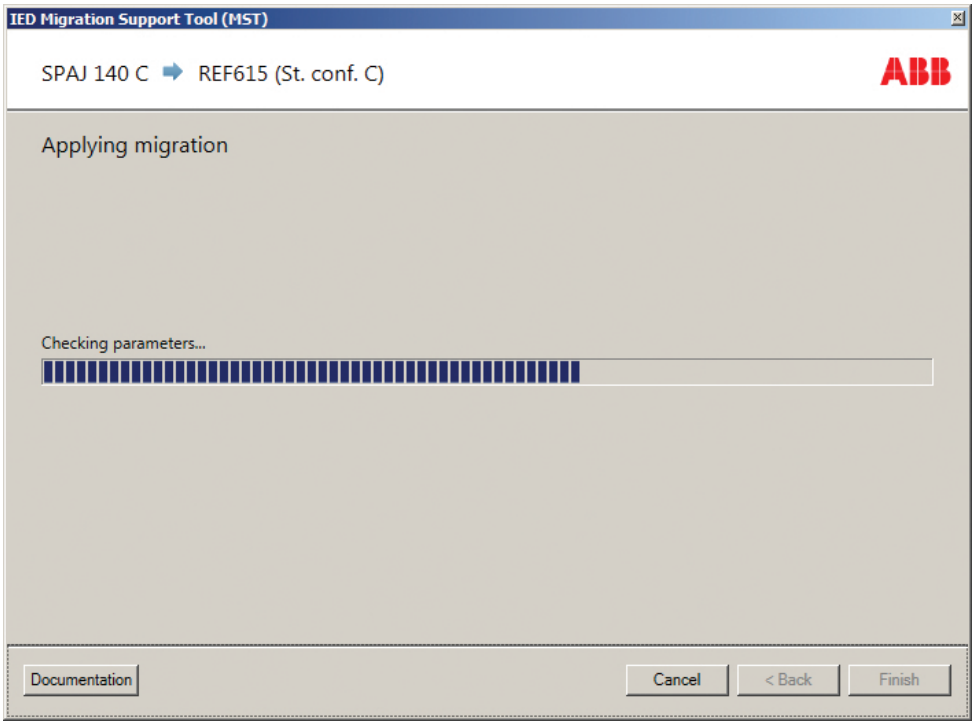


Figure 17: Applying the migration

Rules and conditions stored into the selected migration package are executed during the migration process.

2. Check the migration results.

Errors	Errors represent unexpected conditions which hinder the migration.
Warnings	Warnings inform about an acceptable compromise on features which cannot be fully migrated to the replacement IED. It is possible to click the Back button and return to the previous steps to adjust information. The migration can continue despite of the warnings.
Notes	Notes are informative messages only.

- Click **Errors**, **Warnings** and **Notes** after a successful migration to filter the results. By default, the list is unfiltered. See the related application manuals for further information on the messages.
- Click **Back** to check the previous pages or **Cancel** to exit the IED Migration Support tool if the migration is unsuccessful. The migration cannot be finished if error messages are present.
- Click **Open Report** to review, print or save the migration report to the selected location. By default, reports are saved in the drive where PCM600 is installed `<Drive:>\PCMDataBases\Retrofit\Reports`.

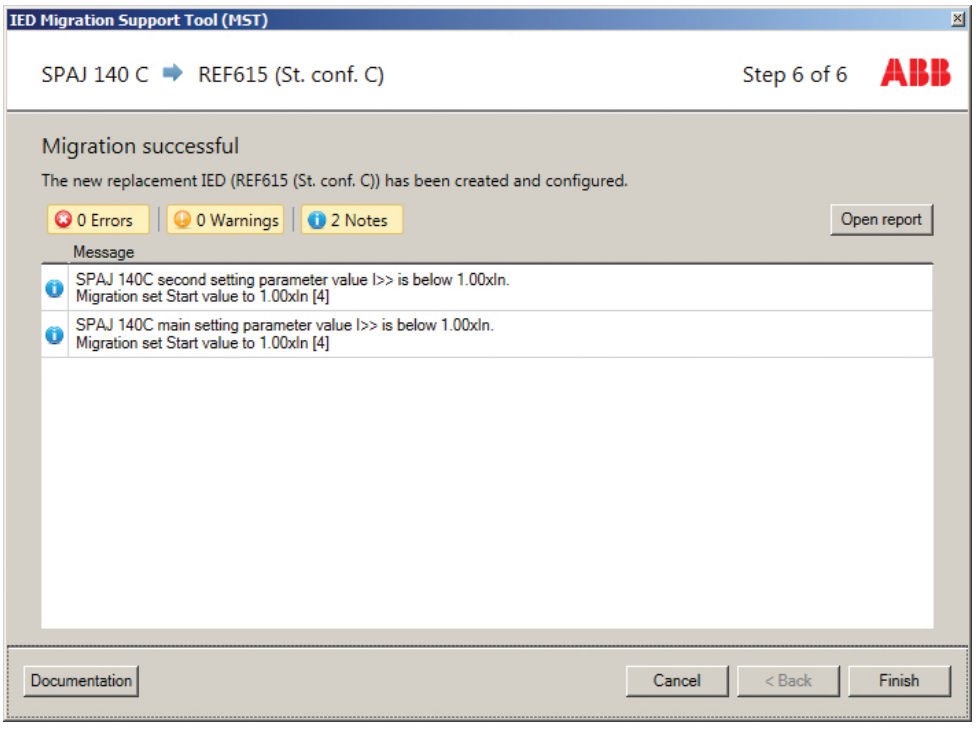


Figure 18: Successful migration

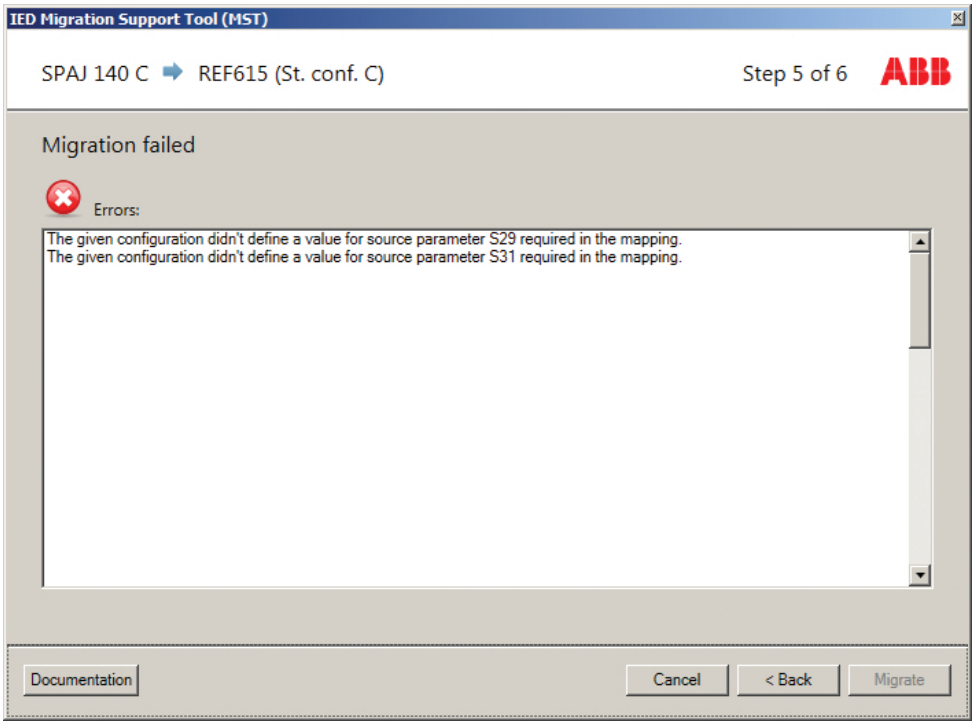


Figure 19: Unsuccessful migration

3. Click **Finish** to commit the migration.
4. Close the IED Migration Support tool and return to PCM600.

2.3.3.6 Commissioning

Once the migration runs correctly and the result is committed, the replacement IED in the PCM600 project is configured according the existing relay configuration and further settings specified in the IED Migration Support tool.

1. Use PCM600 to engineer the replacement IED.

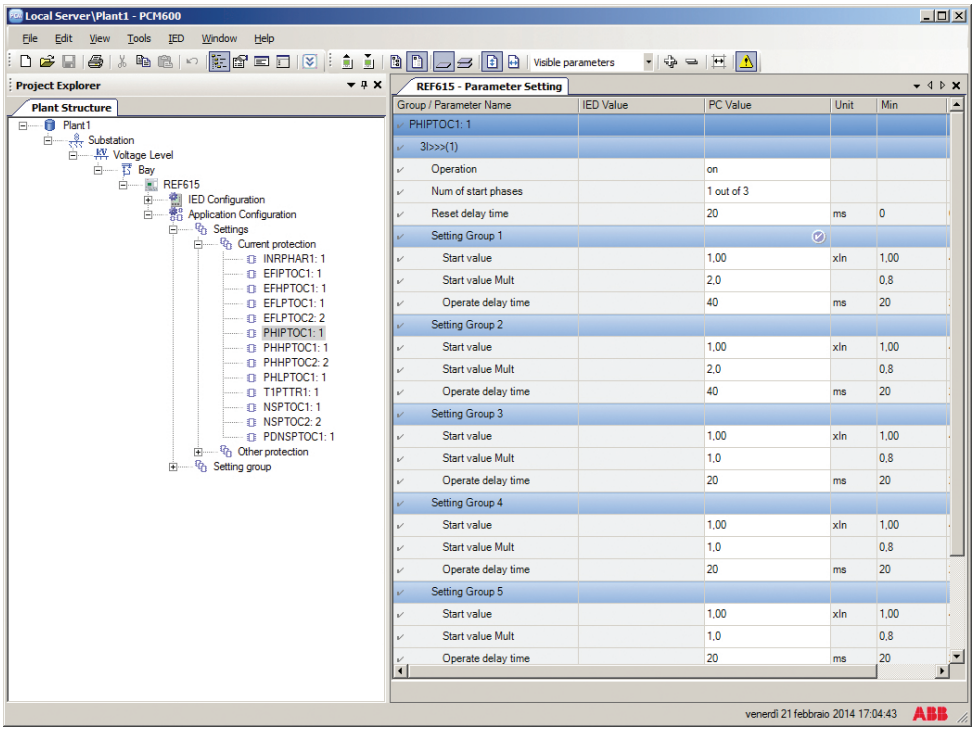


Figure 20: Using PCM600

2. After the migration, perform the commissioning tests of the IED to check the control and protection settings according the existing relay configuration and settings.
3. As communication configuration is not part of the Retrofit Connectivity Package, consider engineering the communication, if needed.

2.4 Installation

2.4.1 Cutting tool

The cutting tool is a dedicated device used for extending the existing panel cutout in order to accommodate the new replacing relay. The tool consists of a power unit and a cutting head. The power unit is a handheld battery-operated electrohydraulic power device. The cutting head consists of two parts, a punch and a die. The cutting tool can be used for panel metal sheet thickness of up to 2.5 mm.

The cutting tool enables a precise quality cut. The tool guides itself during the cutting operation. The extension of the existing panel cutout can be done to the most convenient direction as the actual case requires. The cutting tool offers a safe, secure and repeatable method for cutout extension.

The cutting tool is delivered in the form of a cutting tool kit. The cutting tool kit is packed into a plastic briefcase containing the power unit, either SPACOM 100/300 series or BBC (ABB) standard case size 1 cutting heads, two batteries and a battery charger. The cutting heads and new batteries are available as spare parts.

2.4.2 Cover plates

Cover plates are available for certain existing relay type retrofits. In case the existing panel cutout is larger than the one required by the new replacement IED, the cover plate can be used to adjust the size of the cutout. The cover plates come in light grey color (RAL7035 flat).

The cover plates have ready-made holes for attachment to the panel door. The cover plate can be used as a template for marking the drill holes in the panel door. After the holes have been drilled, the cover plate is attached with the supplied self-tapping screws.

2.4.3 Wire marking sets

Ready-made wire marking sets are available for retrofit cases, where the existing wiring from terminal blocks to the relay can be utilized.

Wire markings are provided as existing relay type dependent complete sets. The structure of the marking is followed by the terminal numbers of the replacement IED and then the terminal number of the existing relay. The press-on type markers come in white color with a printed black text. The wire marking set contains markings which cover all terminals of the new replacement IED.

The new wire markings have two functions. Firstly, the old markings are replaced by the new markings and the wires are connected to the right terminals of the new IED, without wiring tables or diagrams. Secondly, in certain cases, this can eliminate the need of updating the old drawings, especially if no additional wiring is added.

2.4.4 Wiring harness

Ready-made wiring harnesses are available for the retrofit cases, where the current condition of the wiring is set between the existing relay and the terminal block in the low voltage compartment.

A wiring harness is an existing relay type-specific wire. It is set based on the wiring of the relay and consists of marked wires for each terminal of the new replacement IED. The structure of the marking is followed by the terminal numbers of the replacement IED and then the terminal number of the existing relay. This enables the connection of the wiring harness to the new replacement IED. The low voltage compartment terminal block is based on the existing wiring tables or wiring diagrams. The wiring harness contains wires covering all the terminals of the new replacement IED.

The wire set is delivered inside a dark gray protective plastic braided sleeve. The length of the wiring harness is four meters and the color of the wires is black, except the yellow-green PE wire. The wires have white printed wire markings at 15 cm intervals. The wire type used is fine-stranded copper wire, either 1.5 mm^2, 2.5 mm^2 or 6.0 mm^2 in cross-section, depending on the related signal type. The wiring harness can be cut to the required length during installation.

2.5 Testing

The basic functionality of the replacement IED can be easily verified in the project laboratory before entering the site. The same functionality can be tested at the site using the RTB615 test box, thus reducing the amount of tests to be carried out when the 615 series plug-in unit is inserted to its original case and installed. By using the XRIO-based test templates for replacement, IEDs together with the secondary test devices RTB615 and Omicron considerably simplifies and speeds up the testing.

Retrofit program provides testing templates for specific IED models which replace the existing relays. These templates are verified by ABB together with migrated configuration from existing relay.

Benefits of RTB615 are quite similar for all applications. The test box provides a convenient interface to access plug-in unit’s hardware interfaces and an easy way to energize the IED. This helps planning and preparing easily reproducible test sequences at office. Tests can be automated by predefining relay characteristics, tolerances and trigger conditions and using the test templates to adapt the setting values for each IED being tested.

The final trip test (operating the circuit breaker) should always be done while the IED is inserted to its original case as a part of the installation.

Current and voltage transformers' correct phasing, ratio and circuit conductivity have to be checked while the IED plug-in unit is inserted to the original case as a part of the installation.

Following paragraphs give some examples how RTB615 can be utilized in different use cases.

2.5.1 Testing templates

During the migration phase, the parameter settings of the existing relay are migrated into the new replacement IED parameters and configuration. The testing phase is used to verify whether the new replacement IED is in full operation condition and the behavior corresponds to behavior of the existing relay.

Specific test templates are created to support this phase.

Each test template covers a specific existing relay and new IED set-up. The templates are designed to be used by the Omicron test universe. The templates support testing of protection features as per the existing relay functionalities. An editable report of the carried out tests is issued at the end of the test sequence.

When the test templates are applied, Omicron test universe guides through a semi-automated test sequence. The templates receive the IED settings from the Parameter Setting tool of PCM600 in XRIO-based format.

Testing templates can be downloaded from the
Relay Retrofit Program product webpage.

Before running the test template, make sure that the used Omicron set can inject the required current signals. If the required current level exceeds the capability of the tool set, the test is interrupted and the test view box reports the test failure with the "out of range" message.

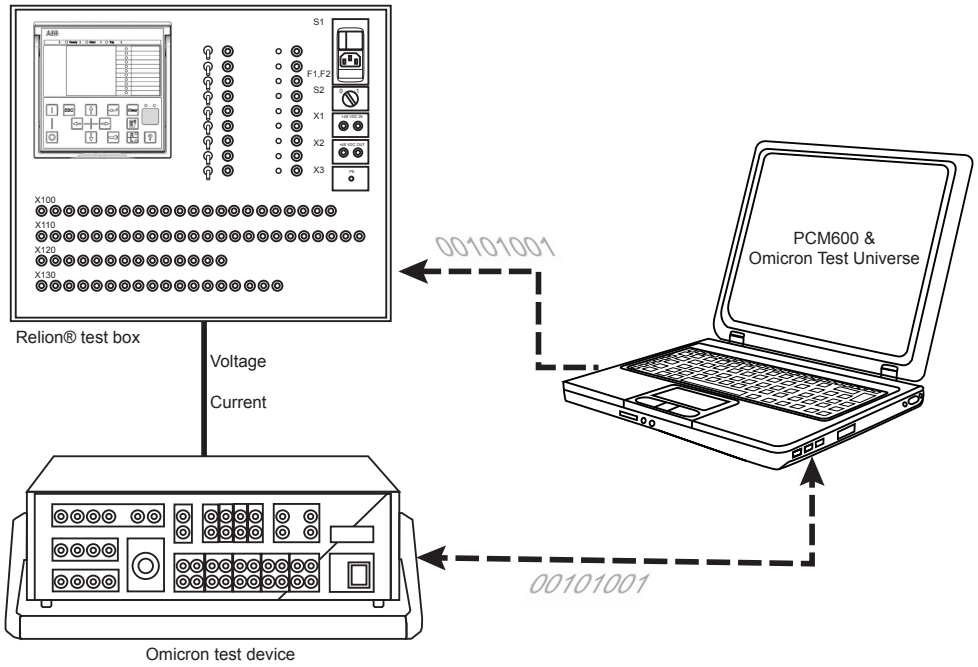


Figure 21: Test system based on RTB615 and Omicron toolset

2.5.2 Relion Test Box RTB615

RTB615 is a test box for 615 series plug-in units. The 615 series IED can be withdrawn from its original case and inserted to RTB615 for testing. The test box supports

periodical IED testing and commissioning of new or retrofit installations. It can also be used for demonstration or training purposes and as a support during the engineering phase. All the IED's analog inputs and binary input and output interfaces are readily available on the RTB615 front plate to connect to the secondary injection device, for example, Omicron or Megger.

Both analog and binary signals of the IED, and additional test switches and indication LEDs are available in the front panel of RTB615. The IED being tested can be energized using internal power supply or an external 48 V DC power supply. RTB615 does not support the physical connections available at the IED's communication card, including possible arc protection interfaces, nor testing of them.

Benefits of RTB615 are similar for all applications. The test box provides a convenient interface to access plug-in unit hardware interfaces and an easy way to energize the IED. This helps to plan and prepare easily reproducible test sequences at office. Tests can be automated by predefining relay characteristics, tolerances and trigger conditions by using the test templates to adapt the setting values for each IED under test.

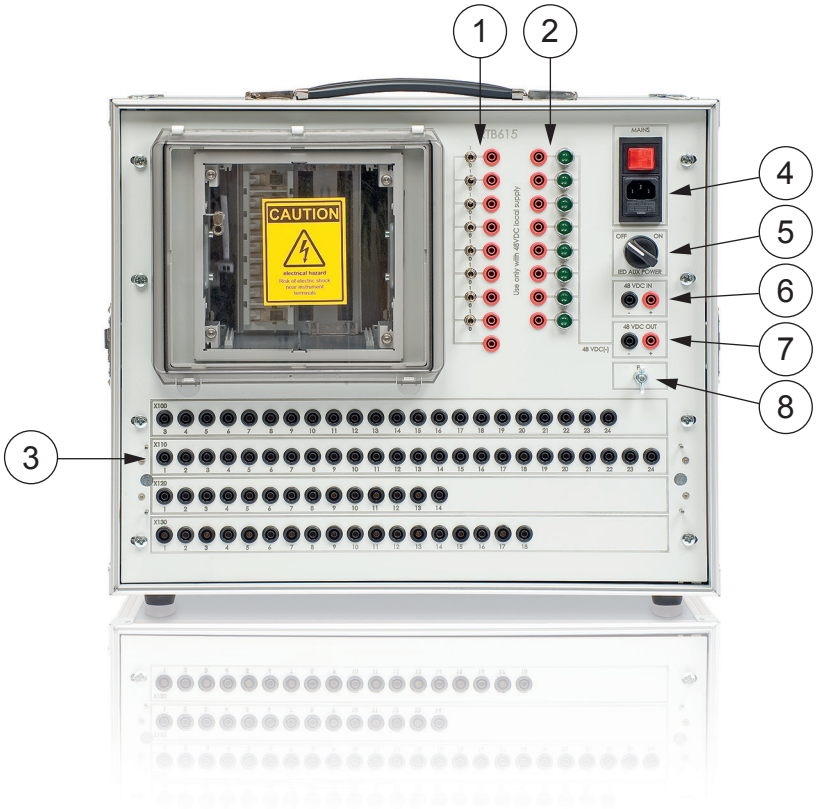


Figure 22: Front view of the Relion Test Box RTB615

1 Test switches
2 Indication LEDs
3 IED I/O interface terminals X100, X110, X120 and X130
4 Main power switch and mains wall plug connector
5 IED auxiliary power supply switch
6 48 V DC IN terminal
7 48 V DC OUT terminal
8 Protective earth (PE) terminal

2.5.2.1 Supported 615 series IEDs

RTB615 can be used with selected IEC 615 series IED variants, excluding RED615. Additionally, the REF615, REM615, RET615, REU615 and REV615 IED variants where the hardware slot X130 is in use are not supported. The 615 series IED versions having sensor inputs (instead of conventional CTs and VTs), 5 VT inputs, RTD/mA inputs or maximum number of binary inputs are not supported.

Due to mechanical interface reasons between 615 plug-in units and RTB615, only 615 series Ver.3.0 (D) onwards is supported. See the 615 installation manual for information on detaching and installing the plug-in unit.

Composition change notification is shown on the LHMI after inserting plug-in unit to the case. Press the ESC button on the IED to continue working.

Inserting a non-compatible 615 plug-in unit into RTB615 results in an IRF situation with the IED.

Table 4: Example of significant digits in the order code

Determinative digits in the 18 character order code																		
Digit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Order code	H	B	M	A	A	C	A	B	N	B	A	1	A	B	N	1	1	E

Table 5: 615 series IED order codes compatible with RTB615

3rd digit	5th digit	6th digit	7th digit	8th digit	18th digit
F	A	A	A	A	D or later
F	A	B	A	A	D or later
F	A	A	A	C	D or later
F	A	B	A	C	D or later
F	A	A	F	G	D or later
F	A	B	A	C	D or later
F	A	B	F	G	D or later
F or M	A	C	A	B	D or later
F or M	A	C	A	D	D or later
F or M	A	D	A	B	D or later
F or M	A	D	A	D	D or later
T or V	B	A	B	A	D or later
V	B	A	F	D	D or later
M or U	C	A	A	H	D or later
M	C	B	A	H	D or later
M	C	A	F	D	D or later
M	C	B	F	D	D or later

2.5.2.2 IED analog and binary interfaces

All the IED's analog input, binary input and output interfaces are available on the RTB615 front plate, to connect to the secondary injection and testing device. The connections can be done using standard banana type insulated connectors. The marking of the interfaces correspond to the markings of 615 series case rear connections and the related IED connection drawings.

The terminals 1 and 2 in the terminal row X100 are not available in the front plate. In the IED, these terminals are connected to the power supply module. For powering up the IED, see the specific section in this document.

The interface row marked with "X130" is a reservation for future needs. The IED versions where X130 hardware slot is used are not supported by RTB615.

The RTB615 connections towards secondary injection and testing device can be done in the same way as if the IED plug-in unit would be in its original case within the installation. Relevant circuit diagrams concerning the actual installation should be used to determine analog signals injection terminals and polarities as well as the expected binary input and output signals and corresponding terminals.

2.5.2.3 Masking plates

Masking plates are available for certain IED product variants of the Ver.4.0 FP1 release as an additional feature of RTB615. The masking plate is applied on the top of the terminal rows and it exposes only those signals which are relevant to the specific IED variant. The masking plate also provides references and functional names for the expected signal types.

Table 6: RTB615 and accessories

Item	Description	Order Code
Relion Test Box RTB615 (including masking plates)		2RCA031791
RTB615 masking plate	REF615 #BFCACAB#######1E and #BFCADAB#######1E	2RCA032077
RTB615 masking plate	REM615 #BMAACAD#######1E	2RCA032078

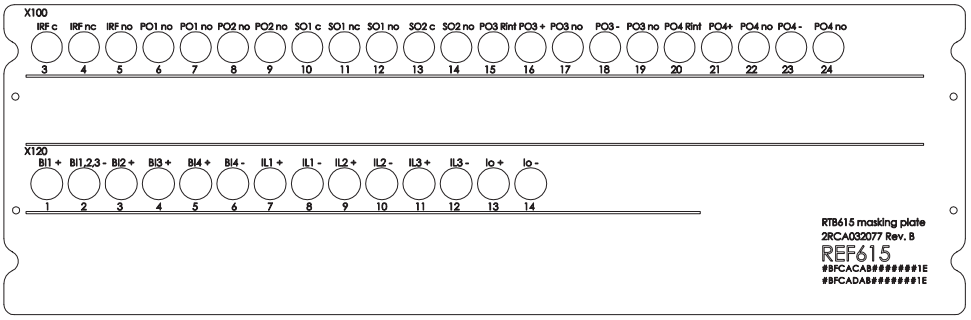


Figure 23: RTB615 masking plate for REF615

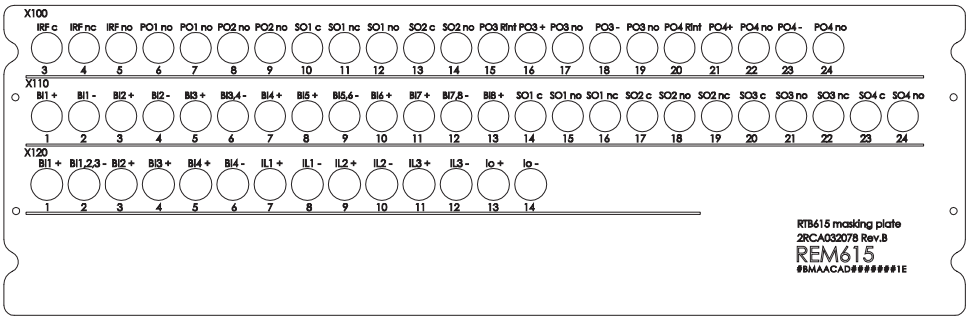


Figure 24: RTB615 masking plate for REM615

2.5.2.4 Test switches

RTB615 is equipped with eight switch controlled general purpose binary output terminals. They can be wired to the IED binary input terminals to simulate process signals connected to the IED.

The IED’s binary inputs' threshold voltage level has to be set according to the used voltage level. The parameter is found in the LHMI menu **Configuration/I/O modules/Common settings/ Threshold Voltage**.

2.5.2.5 Indication LEDs

RTB615 is equipped with eight general purpose indication LEDs with connection terminals. LEDs can be wired to any binary output terminal of the IED to indicate the concerned binary output status. Driving voltage positive pole (+ side) for the indication LEDs has to be taken from RTB615’s internal 48 V DC source marked as 48 VDC OUT. The indication LEDs' negative pole (- side) is permanently connected to this source.

2.5.2.6 Power supply

RTB615 can be powered up using the mains connection or using an external 48 V DC supply, for example, from the secondary injection (test) device. In case the mains connection is used, the supply rating has to be 100...240 V AC and 50...60 Hz. Figure 25 shows the RTB615 internal connections in detail. DUT refers to IED plug-in unit under test.

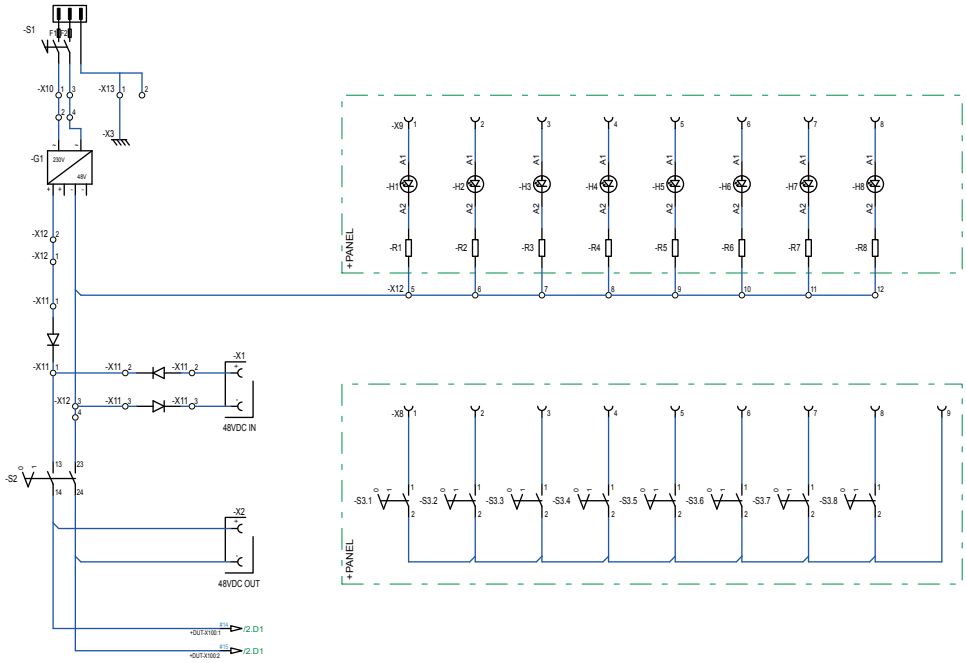
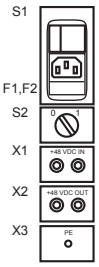


Figure 25: RTB615 internal connections concerning power supply circuits

Table 7: RBT615 power supply connectors and selection switch

	Connector	Description
	MAINS switch S1	100...240 V AC, 50...60 Hz, wall plug and the main switch for an in-built AC/DC converter. Fuses F1 and F2 for the mains connection can be found under the plastic hatch below the wall plug.
	IED AUX POWER switch S2	Switch for powering up the inserted IED plug-in unit. Powers up also the 48 V DC OUT connectors
	48 VDC IN connectors X1	Input connectors for an external 48 V DC power supply
	48 VDC OUT connectors X2	48 V DC output to supply the indication LEDs and test switches
	PE connector X13:2	Protective earth connection point

Section 3 SPAJ 140 C and SPAJ 142 C to REF615 Ver.4.0 FP1

3.1 Retrofit scope

Protection functions of SPAJ 14x C are replicated by REF615 with deviations.

- Memorized values are not reset in REF615 from binary input as it is done in SPAJ 14x C.
- Operating curve type parameter for PHLPTOC1 is migrated according to SPAJ 14x C main setting. SPAJ 140 C secondary setting value is ignored.
- Operating curve type parameter for EFLPTOC1 is migrated according to SPAJ 140 C and SPAJ 142 C main setting. SPAJ 140 C secondary setting value is ignored.
- In SPAJ 14x C, the latching feature of the overcurrent and the earth-fault trip signals can be selected separately. In REF615 the latching feature is configured so that the overcurrent and the earth-fault trip signals are grouped together. For both of the protection functions, activating the latching feature for trip output on either the overcurrent or the earth-fault protection, the functions on SPAJ 14x C results in the latching trip output feature in REF615.
- Functionality depending on SGR relay matrix cannot be migrated according to secondary settings. The dependent features of switchgroups SGR1, SGR2 and SGR3 are migrated according to the main settings.

3.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new

values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).
  - Selecting the replacement IED (type and order code)
  - Importing existing relay configuration (.rdb file)
  - Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
  - Entering system parameters
- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

3.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

Various system parameters are collected and imported to PCM600 upon request during the migration process.

- Rated frequency of the network (50 or 60 Hz)
- CT rated primary for phase currents (A)
- CT rated secondary for phase current (1 or 5 A)
- CT rated primary for residual current (A)
- CT rated secondary for residual current
  - 1 or 5 A in SPAJ 140 C
  - 0.2 or 1 A in SPAJ 142 C

3.2.2 Functions

The configuration of REF615 migrated from SPAJ 14x C contains all the functions belonging to standard configuration C, but only the functions that reproduce the behavior of the existing relay configuration are enabled.

On SPAJ 14x C, selector switchgroups SGF1 and SGF2 define which protection functions are enabled and disabled and the curve characteristics. These settings are considered when the REF615 configuration is generated.

Table 8: Functions included in configuration

SPAJ 14x C	REF615	Description	Enabled[1)]
$I>/I_n$	PHLPTOC1	Three-phase non-directional overcurrent protection, low stage, instance 1	Yes
	PHHPTOC1	Three-phase non-directional overcurrent protection, high stage, instance 1	No
	PHHPTOC2	Three-phase non-directional overcurrent protection, low stage, instance 2	No
$I>>/I_n$	PHIPTOC1	Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	Yes, if SGF2/5 = “0”
$I_0>/I_n$	EFLPTOC1	Non-directional earth-fault protection, low stage, instance 1	Yes
	EFLPTOC2	Non-directional earth-fault protection, low stage, instance 2	No
$I_0>>/I_n$	EFHPTOC1	Non-directional earth-fault protection, high stage, instance 1	Yes, if SGF2/6 = “0”
	EFIPTOC1	Non-directional earth-fault protection, instantaneous stage	No
	NSPTOC1	Negative sequence overcurrent protection, instance 1	No
	NSPTOC2	Negative sequence overcurrent protection, instance 2	No
	PDNSPTOC1	Phase discontinuity protection	No
	T1PTTR1	Three-phase thermal protection for feeders, cables and distribution transformers	No
CBFP	CCBRBRF1	Circuit breaker failure protection	Yes, if SGF1/4 = “1”
[2)]	INRPHAR1	Three-phase inrush detector	Yes, if SGF1/5 = “1”
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	Yes
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	CBXCBR1	Circuit-breaker control	Yes
	DARREC1	Auto-reclosing	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes

Table continues on next page

SPAJ 14x C	REF615	Description	Enabled[1)]
	RDRE1	Disturbance recorder	Yes
	CMMXU1	Three-phase current measurement, instance 1	Yes
	CSMSQI1	Sequence current measurement	Yes
	RESCMMXU1	Residual current measurement, instance 1	Yes

1) The function is enabled when the parameter *Operation* is set to “on” and disabled when the parameter is set to “off”.
2) In SPAJ 14x C, the set *Start current value I>>* of the high-set phase overcurrent stage can be doubled automatically on connection of the protected object to the network, that is, at the starting.

3.2.2.1 PHLPTOC1 settings

PHLPTOC1 replicates the behavior of SPAJ 14x C three-phase low-set overcurrent protection function with definite or inverse definite minimum time characteristic (I>/I_n).

The *Measurement mode* parameter is set to “RMS”.

- PHLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/1, SGF1/2, and SGF1/3. If the curve related values of main and second settings of these switchgroups differ, PHLPTOC1 *Operating curve type* is selected in accordance with the main settings only and a warning message is issued by IED Migration Support tool.
- PHLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/1, SGF1/2, and SGF1/3. If the curve related values of main and second settings of these switchgroups differ, the function which blocks the operation of PHLPTOC1 (in IDMT mode) by start of PHIPTOC1 is determined in accordance with the main settings only and a warning message is issued by the IED Migration Support tool.
- For SPAJ 14x C, the range of parameter *Operating time for I>* is 0.05…300 s. The corresponding parameter on REF615 is *Operating delay time* whose range is 50…200000 ms. Whenever the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, the PHLPTOC1 parameter *Operating delay time* is saturated to 200000 ms.

3.2.2.2 PHIPTOC1 settings

PHIPTOC1 replicates the behavior of SPAJ 14x C three-phase high-set overcurrent protection function with instantaneous or definite time characteristic (I>>/I_n)

PHIPTOC1 is enabled if SPAJ 14x C parameter SGF2/5 = “0”.

- If SPAJ 14x C switchgroup SGB/5 = “1”, the secondary setting can be selected from `BS` input. In this case, if the main and second settings of SGF2/5 differ, the only main setting is considered and PHIPTOC1 is enabled or disabled

accordingly. In this case, a cautionary note is issued by the IED Migration Support tool.
- If SPAJ 14x C *Start current I>>* is below 1.00, PHIPTOC1 *Start value* is set to "1.00" and a cautionary note is issued by the IED Migration Support tool.
- If automatic doubling of set start current of SPAJ 14x C is enabled (SGF1/5 = "1") and *Start current I>>* is above 20.00, PHIPTOC *Start value* is set to "20" and a cautionary note is issued by the IED Migration Support tool.
- If automatic doubling of set start current of SPAJ 14x C is enabled (SGF1/5 = "1"), the parameter *Start value Mult* is set to "2.0".
- For SPAJ 14x C, the range of parameter *Operating time for I>>* is 0.04…300 s. The corresponding parameter on REF615 is *Operate delay time* whose range is 50…200000 ms. If the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, PHIPTOC1 parameter *Operate delay time* is saturated to 200000 ms and a cautionary note is issued by the IED Migration Support tool.

3.2.2.3 EFLPTOC1 settings

EFLPTOC1 replicates the behavior of SPAJ 14x C low-set, non-directional earth-fault unit with definite time or inverse definite minimum time (IDMT) characteristic ($Io>/I_n$).

- EFLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/6, SGF1/7, SGF1/8. If curve related values of main and second settings of these switchgroups differ then EFLPTOC1 *Operating curve type* is selected in accordance with the main settings only and a cautionary note is issued by the IED Migration Support tool.
- EFLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/6, SGF1/7, and SGF1/8. If the curve related values of main and second settings of these switchgroups differ, the function which blocks the operation of EFLPTOC1 (in IDMT mode) by start of EFHPTOC1 is determined in accordance with the main settings only and a warning message is issued by the IED Migration Support tool.
- For SPAJ 14x C, the range of parameter *Operating time for I0>* is 0.05…300 s. The corresponding parameter on *REF615* is *Operate delay time* whose range is 50…200000 ms. If the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, the EFLPTOC1 parameter *Operate delay time* is saturated to 200000 ms and a cautionary note is issued by the IED Migration Support tool.

3.2.2.4 EFHPTOC1 settings

EFHPTOC1 replicates the behavior of SPAJ 14x C high-set, non-directional earth-fault unit with instantaneous or definite time function ($Io>>/I_n$).

- In SPAJ 14x C, the function Io>> is disabled when SGF2/6 = 1. If the switchgroup SGB/5 = 1, the selection of main or second settings is controlled with the external

control signal BS input. In this case, if the main and secondary setting value of SGF2/6 is different, EFHPTOC1 is enabled or disabled according to the main setting value of SGF2/6. A cautionary note is issued by the IED Migration Support tool.

- For SPAJ 14x C, the range of parameter *Operating time for I0>>* is 0.05…300 s. The corresponding parameter on REF615 is *Operate delay time* whose range is 50…200000 ms. If the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, EFHPTOC1 parameter *Operate delay time* is saturated to 200000 ms and a cautionary note is issued by the IED Migration Support tool.

3.2.2.5 CCBRF1 settings

CCBRF1 replicates the behavior of SPAJ 140 C and SPAJ 142 C Circuit Breaker Failure Protection (CBFP).

- If SPAJ 140 C and SPAJ 142 C switchgroup SGB/5 = “1”, the secondary setting can be selected from BS input. In this case, if the main and secondary setting values of SGF1/4 are different, the operation of CCBRF1 is enabled according to the main setting value of SGF1/4.
- If SPAJ 140 C and SPAJ 142 C software version is 037C, *CB Failure delay* is set to “160 ms” else the delay is derived from parameter *Operating time* for CB failure protection.
- REF615 parameters *Operating phase current* and *Operating residual current* are set to “0.3 I_n”.

3.2.2.6 INRPHAR1 settings

In SPAJ 14x C, if SGF1/5 the set *starting value for I>>* is doubled automatically when one of the phase currents rise from a value below 0.12 I> to a value exceeding 1.5 I> in less than 60 ms.

In REF615, this behavior is obtained by feeding ENA_MULT input of PHIPTOC1 with INRPHAR1 output.

- If SPAJ 14x C switchgroup SGB/5 = “1”, the secondary setting can be selected from BS input. Operation of INRPHAR1 is enabled or disabled according to the main setting value of SGF1/5. The secondary setting value of SGF1/5 is ignored.

3.2.3 I/O connections

I/O connections at the SPAJ 14x C terminals are remapped to the REF615 I/O terminal.

REF615 terminals have additional binary I/Os whose behavior does not depend on the SPAJ 14x C configuration.

Table 9: Binary inputs

REF615	SPAJ 14x C	Usage
X120-BI1	BS	If SGB/5 = “1” PROTECTION.BI_SG2 If SGB/1 = “1” PHLPTOC1.BLOCK If SGB/2 = “1” PHIPTOC1.BLOCK If SGB/3 = “1” EFLPTOC1.BLOCK If SGB/4 = “1” EFHPTOC1.BLOCK If SGB/8 = “1” TRPPTRC1.RST_LKOUT
X120-BI2	-	Circuit breaker closed indication
X120-BI3	-	Circuit breaker open indication
X120-BI4	-	Unused

Table 10: Binary outputs

REF615	SPAJ 14x C	Usage
X100-PO1	-	Close circuit breaker
X100-PO2	TS1	Start signal 1 or auxiliary trip signal
X100-PO3	TS2	Open circuit breaker/trip coil 1
X100-PO4	SS3	Open circuit breaker/trip coil 2
X100-SO1	SS1	General start indication
X100-SO2	SS2	General operation indication

The type of contacts (single or multiple pole, single or multiple throw) in the 615 series can be different from the SPACOM relays. See the REF615 standard configuration C connection diagram.

3.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections in REF615. The default connections can be viewed and changed with PCM600 according to the application requirements, if necessary.

Only SPAJ 14x C migrated functions are represented in the connection diagrams. REF615 also includes other functions whose connections are configured according to standard configuration C. See REF615 Application Manual.

Operation of additional REF615 functions is disabled if the corresponding functionality is not available in SPAJ 14x C. These functions can be visible in the connection diagrams even if disabled.

The connections in the application which are affected by the switchgroups SGF1, SGF2.5 and SGF2.6, SGR1, SGR2, SGR3 and SGB are based on the main setting value. In SPAJ 14x C, if the main and the second setting differ and the setting change is enabled from the BS input (SGB.5=1), a note is issued by the migration tool.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

3.2.4.1 Functional diagrams for protection

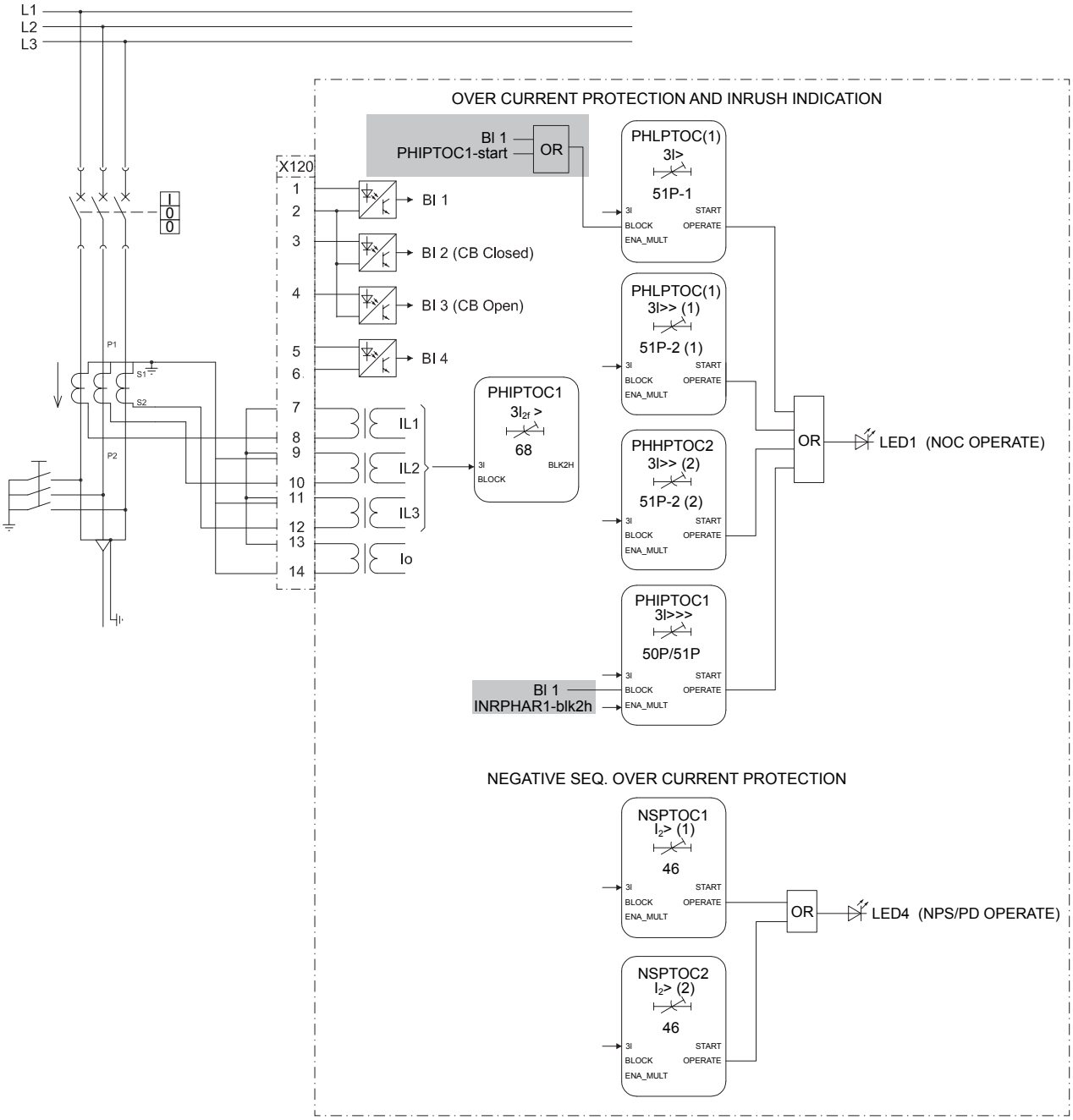


Figure 26: Overcurrent protection

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

- The high stage protections PHHPTOC1 and PHHPTOC2, and negative sequence overcurrent protection functions are disabled.
- BI1 input is connected to various function inputs based on the switchgroup conditions.
  - BLOCK input of PHLPTOC1, if SGB/1 = “1”
  - BLOCK input of PHIPTOC1, if SGB/2 = “1”

- PHLPTOC1 function works only in inverse mode and it is blocked by the PHIPTOC1-start signal. If SPAJ 14x C software version is prior to “183B” or, from “183B” version onwards, switchgroup SGX/2 = “1”.
- The inrush detection function INRPHAR1 is enabled if SPAJ 14x C switchgroup SGF1/5 = “1”. The output BLK2H enables multiplying (by 2) the active settings for PHIPTOC1 function.

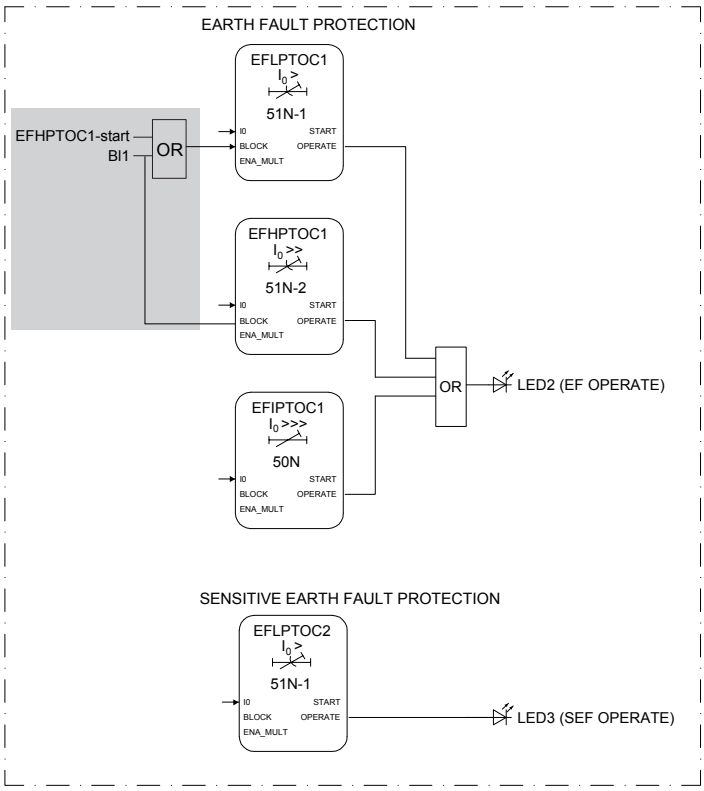


Figure 27: Non-directional earth-fault protection

- Sensitive earth-fault function protection EFLPTOC2 and the instantaneous earth-fault protection EFIPTOC1 are disabled.
- BI1 input is connected to the various function inputs based on the switchgroup conditions.

- BLOCK input of EFLPTOC1, if SGB/3 = “1”
- BLOCK input of EFHPTOC1, if SGB/4 = “1”

- EFLPTOC1 function works only in inverse mode and it is blocked by the EFHPTOC1-start signal. If SPAJ 140 C and SPAJ 142 C software version is prior “183B” or, from “183B” onwards, switchgroup SGX/2 = “1”.

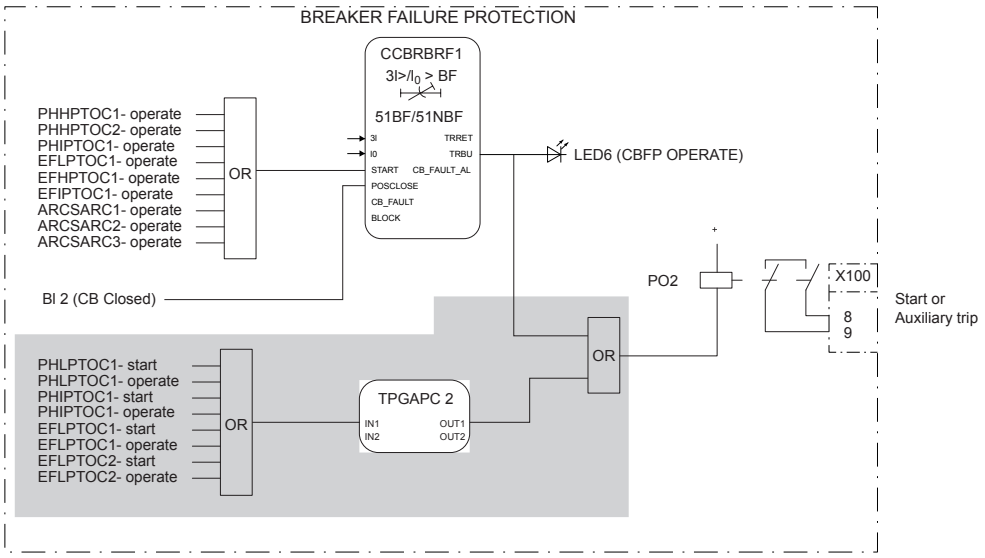


Figure 28: Circuit breaker failure protection, start or auxiliary trip

- PO2 output replicates SPAJ 14x C TS1 output (Start signal 1 or auxiliary trip signal).
- The breaker failure protection CCBRBRF1 is enabled if SPAJ 14x C switchgroup SGF1/4 = ”1”. It is initiated via the START input by a number of different protection stages in the IED. If SGR3 = ”0”, only the TRBU output is connected to the output PO2.
  - PHLPTOC1- start, if SGR3/1 = ”1”
  - PHLPTOC1- operate, if SGR3/2 =”1”
  - PHIPTOC1- start, if SGR3/3 = ”1”
  - PHIPTOC1- operate, if SGR3/4 = ”1”
  - EFLPTOC1- start, if SGR3/5 = ”1”
  - EFLPTOC1- operate, if SGR3/6 = ”1”
  - EFLPTOC2- start, if SGR3/7 = ”1”
  - EFLPTOC2- operate, if SGR3/8 = ”1”

3.2.4.2 Functional diagrams for control and interlocking

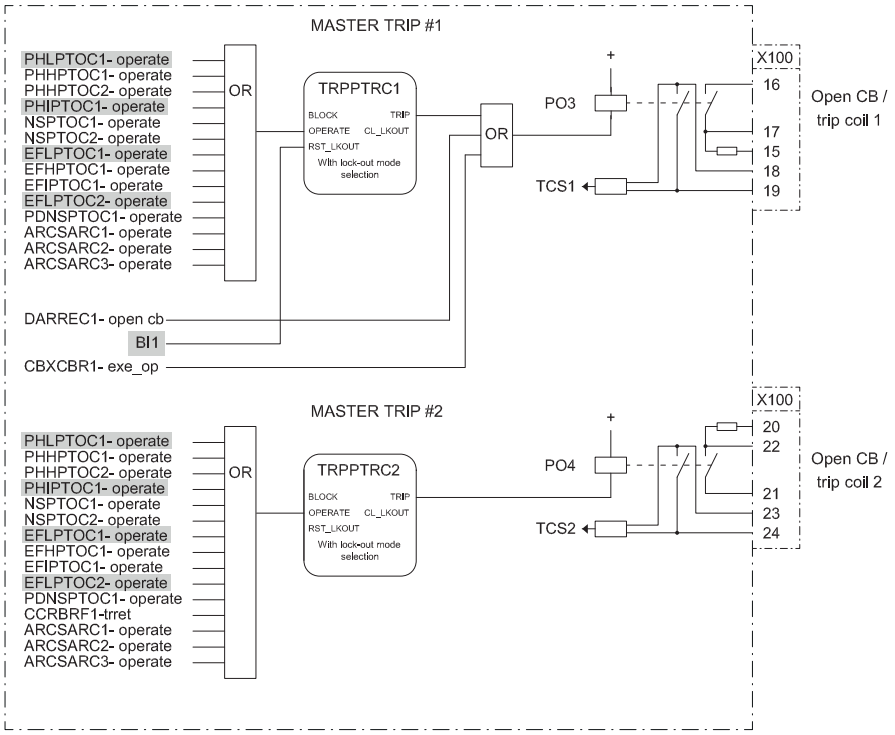


Figure 29: Master trip

Diagrams for control and interlocking features are configured according to Standard configuration C with few differences.

- `BI1` input is connected to the `RST_LKOUT` input of TRPPTRC1 if switchgroup SGB/8 = “1”.
- Trip output mode of TRPTRC1 is set according to SPAJ 14x C switchgroups SGB/6 and SGB/7.

Table 11: Protection functions

SGB/6 value	SGB/7 value	TRPPTRC1 operation mode
0	0	Non-latched
0	1	Latched (MST cautionary note)
1	0	Latched (MST cautionary note)
1	1	Latched

In SPAJ 14x C, trip output modes for overcurrent and earth-fault protections can be configured separately from switchgroups SGB/6 and SGB/7. In REF615, trip output mode is set from TRPPTRC1 and it is unique. In case SGB/6 and SGB/7 have different values, a note is

issued by IED Migration Support tool and the default value (latched) is kept for the parameter.

- Various function outputs are connected to TRPPTRC1 based on the switchgroup condition.
  - PHLPTOC1- operate, if SGR1/2 = “1”
  - PHIPTOC1- operate, if SGR1/4 = “1"
  - EFLPTOC1- operate, if SGR1/6 = “1”
  - EFHPTOC1- operate, if SGR1/8 = “1”
- Various function outputs are connected to TRPPTRC2 based on the switchgroup condition.
  - PHLPTOC1- operate, if SGR2/2 = “1”
  - PHIPTOC1- operate, if SGR2/4 = “1”
  - EFLPTOC1- operate, if SGR2/6 = ”1”
  - EFHPTOC1- operate, if SGR2/8 = “1”
- Trip output mode of TRPTRC2 is set to “Non-latched”.

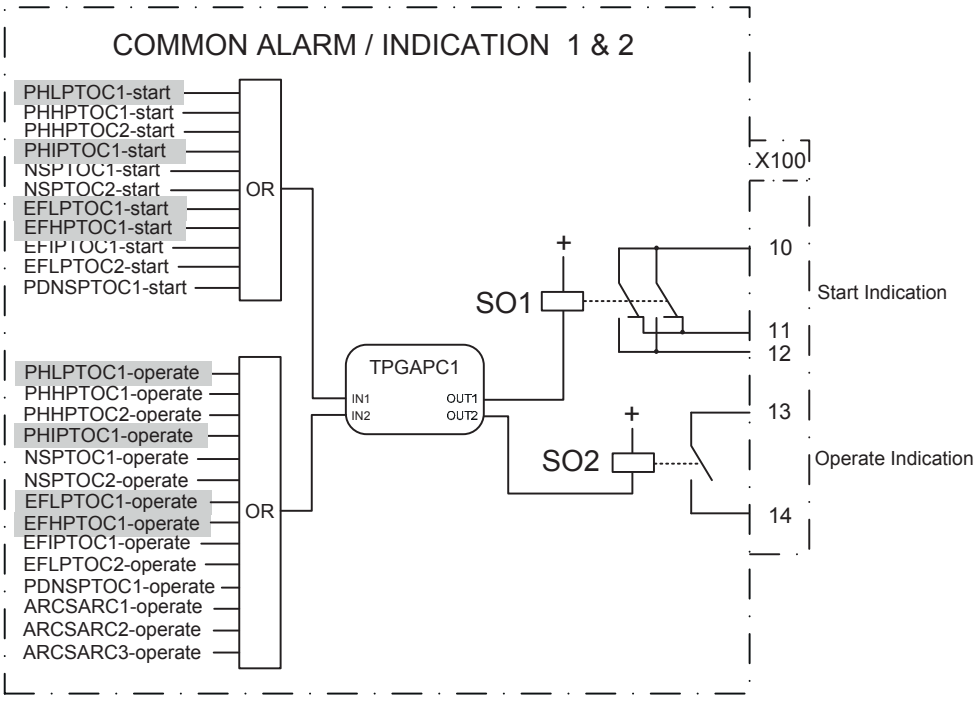


Figure 30: Alarm indication

- SO1 reproduces SPAJ 140 C and SPAJ 142 C SS1 output. Various function outputs are connected to SO1 via TPGAPC1 based on the switchgroup condition.

- PHLPTOC1-start, if SGR1/1 = “1”
- PHIPTOC1-start, if SGR1/3 = “1"
- EFLPTOC1-start, if SGR1/5 = “1”
- EFHPTOC1-start, if SGR1/7 = “1”

- SO2 reproduces SPAJ 140 C and SPAJ 142 CSS2 output. Various function outputs are connected to SO2 via TPGAPC1 based on the switchgroup condition.
  - PHLPTOC1-operate, if SGR2/1 = “1”
  - PHIPTOC1-operate, if SGR2/3 = “1”
  - EFLPTOC1-operate, if SGR2/5 = “1”
  - EFHPTOC1-operate, if SGR2/7 = “1”

3.2.4.3 Setting groups

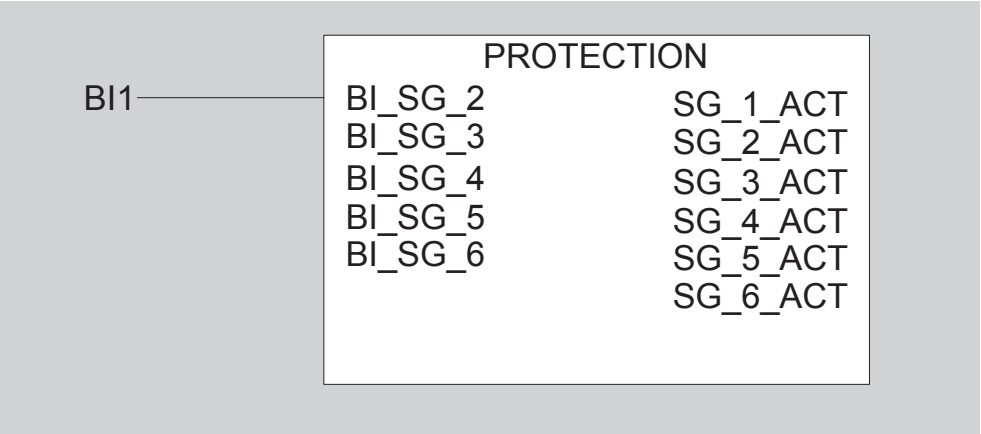


Figure 31: Setting groups

615 IEDs support six setting groups. SPAJ 14x C support two setting groups (main and second setting) which can be selected from binary input BS if switchgroup SGB/5 = “1”. REF615 setting group 2 is selected if BI1 is active and SGB/5 = “1”. The active setting group can be changed at run time.

The connections in the application which are affected by switchgroups SGF1, SGF2/5, SGF2/6, SGR1, SGR2, SGR3, and SGB are based on the main setting value. If the main and second setting differ in SPAJ 141 C, and the setting change is enabled from BS input (SGB/5 = “1”), a note is issued by the IED Migration Support tool.

3.3 Installation

3.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

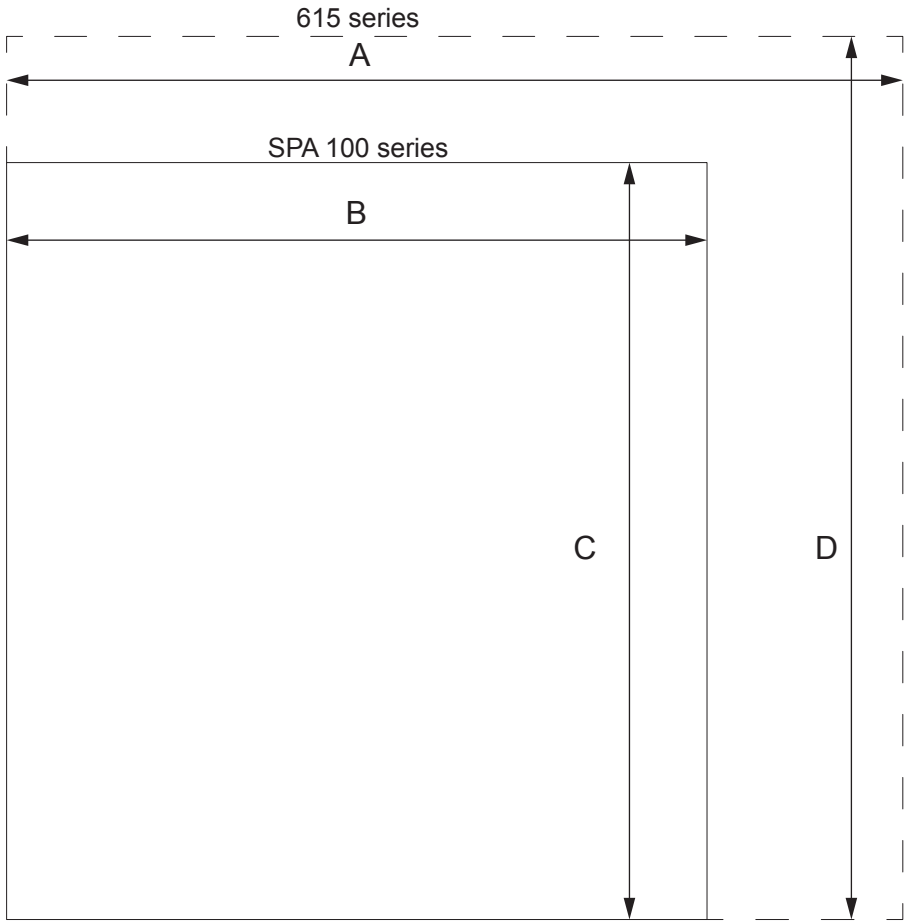


Figure 32: SPACOM 100 series and 615 series cut-outs

A 165.5 mm
B 129 mm
C 139 mm
D 161.5 mm

2. Mount the 615 series IED's case and insert the plug-in unit.

Cover plate is not required with the SPACOM 100 series.

See the 615 series installation manual for more information.

3.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

3.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting SPAJ 14x C with REF615.

Table 12: REF615 wiring harness description for retrofit of SPAJ 14x C

REF615, configuration C		SPAJ 14x C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1 (61)
X100:2	Uaux-	62	Uaux-	X100:2 (62)
X100:3	IRF	72	IRF	X100:3 (72)
X100:4	IRF	71	IRF	X100:4 (71)
X100:5	IRF	70	IRF	X100:5 (70)
X100:6	PO1	-	-	X100:6
X100:7	PO1	-	-	X100:7
X100:8	PO2	74	START 1	X100:8 (74)
X100:9	PO2	75	START 1	X100:9 (75)
X100:10	SO1	78	START 2	X100:10 (78)
X100:11	SO1	-	-	X100:11
X100:12	SO1	77	START 2	X100:12 (77)
X100:13	SO2	81	SIGNAL 1	X100:13 (81)
X100:14	SO2	80	SIGNAL 1	X100:14 (80)
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	TRIP	X100:16 (65)
X100:17	PO3	66	TRIP	X100:17 (66)
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	69	SIGNAL 2	X100:21 (69)
X100:22	PO4	68	SIGNAL 2	X100:22 (68)
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X120:1	BI1	10	EXTERNAL CONTROL	X120:1 (10)
X120:2	BI1	11	EXTERNAL CONTROL	X120:2 (11)
X120:3	BI2	-	-	X120:3

Table continues on next page

REF615, configuration C		SPAJ 14x C		Wiring
Terminal	Description	Terminal	Description	Marking
X120:4	BI3	-	-	X120:4
X120:5	BI4	-	-	X120:5
X120:6	BI4	-	-	X120:6
X120:7	IL1	2/3	IL1, 5A/1A	X120:7 (2/3)
X120:8	IL1	1	IL1	X120:8 (1)
X120:9	IL2	5/6	IL2, 5A/1A	X120:9 (5/6)
X120:10	IL2	4	IL2	X120:10 (4)
X120:11	IL3	8/9	IL3, 5A/1A	X120:11 (8/9)
X120:12	IL3	7	IL3	X120:12 (7)
X120:13	Io	26/27 [1] 27/28 [2]	Io, 1A/5A [1] Io, 0.2A/1A [2]	X120:13 (26/27/28)
X120:14	Io	25	Io	X120:14 (25)
	Earth	63	Earth	

1) SPAJ 140 C
2) SPAJ 142 C

3.3.2.2 SPAJ 140 C and SPAJ 142 C terminal layout and connection diagrams

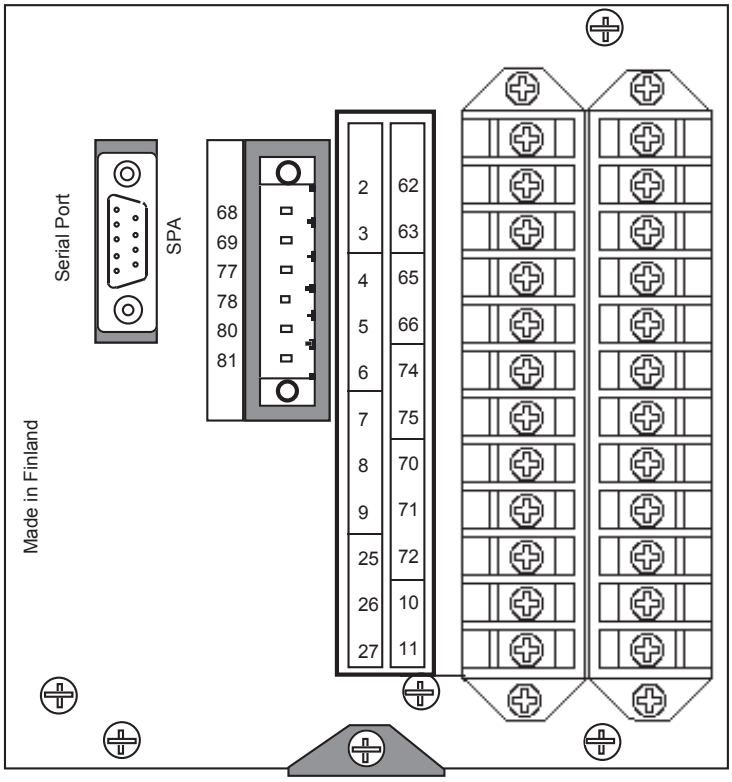


Figure 33: Terminal layout for SPAJ 140 C

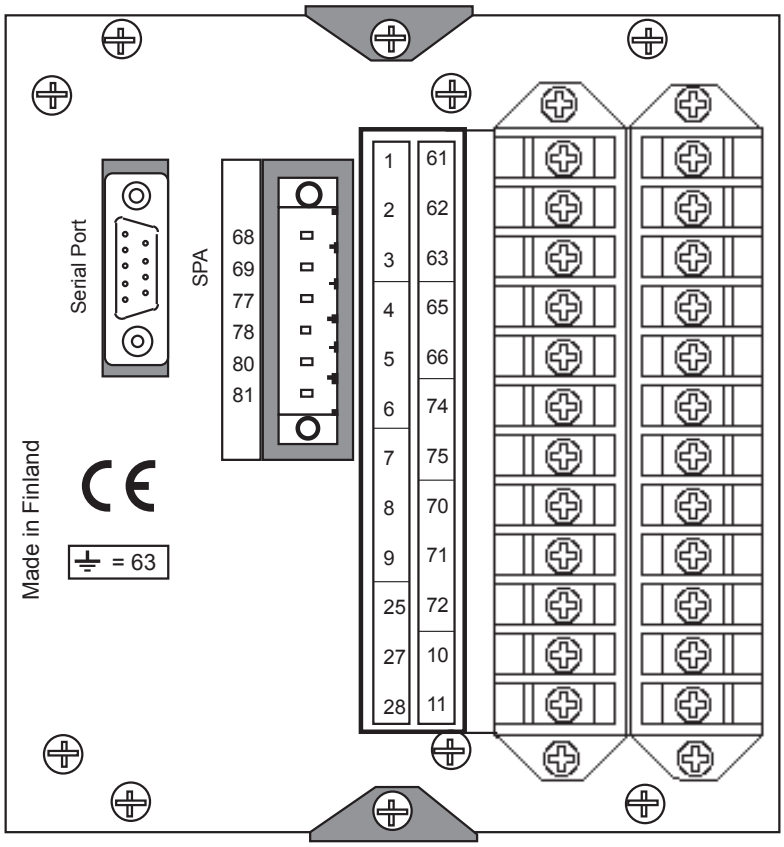


Figure 34: Terminal layout for SPAJ 142 C

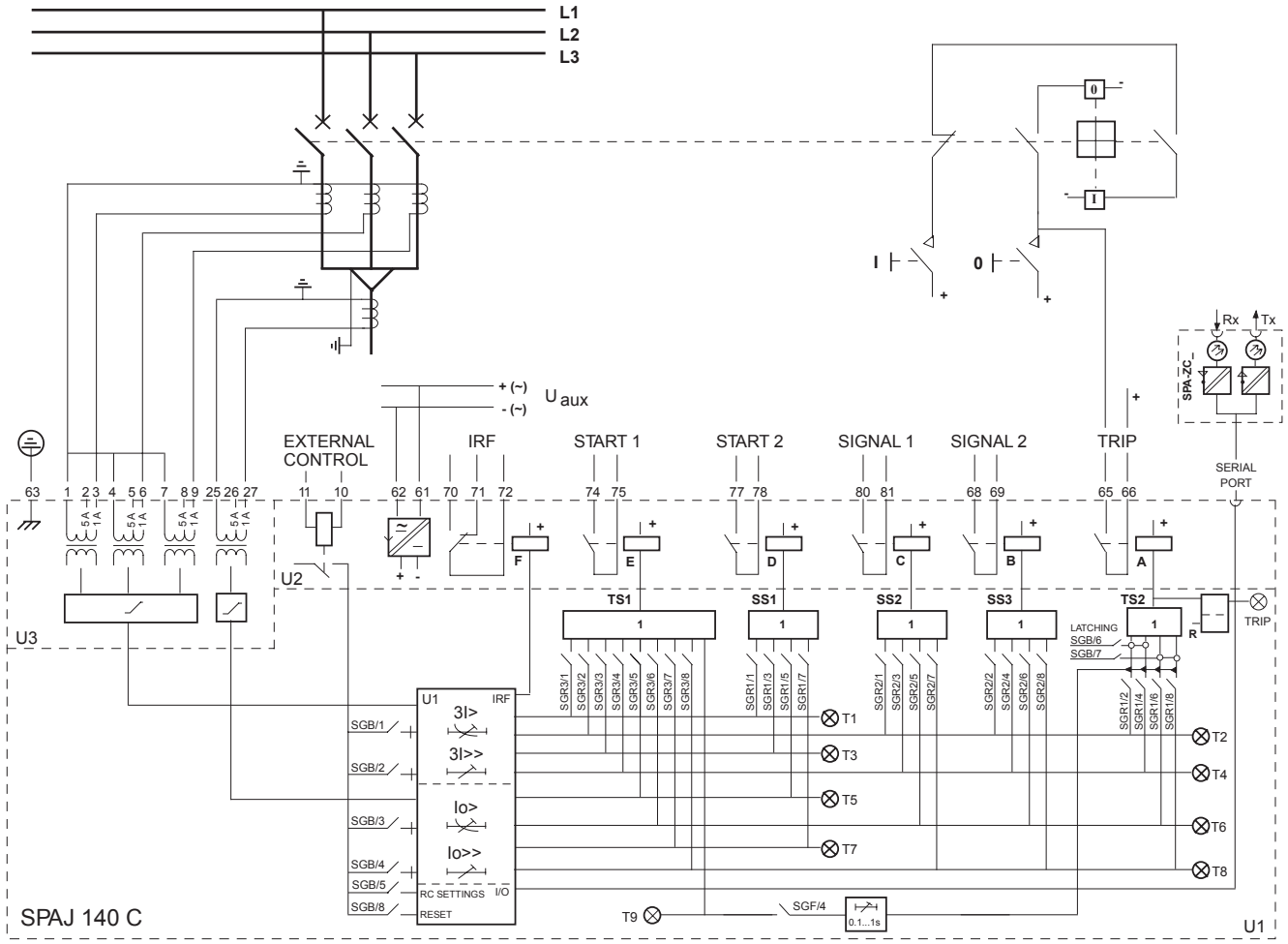


Figure 35: Connection diagram for SPAJ 140 C

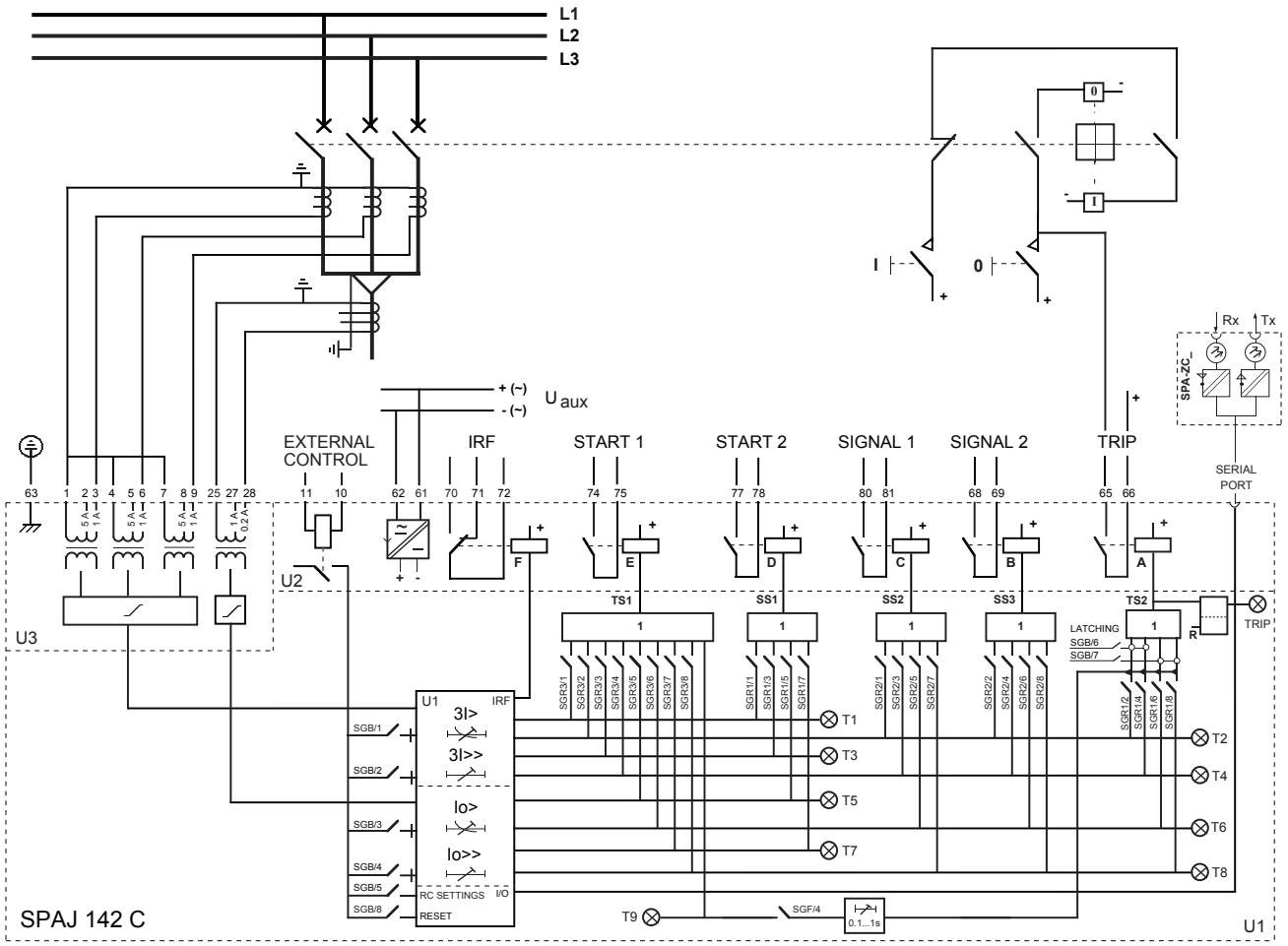


Figure 36: Connection diagram for SPAJ 142 C

3.3.2.3 REF615 terminal layout and connection diagrams

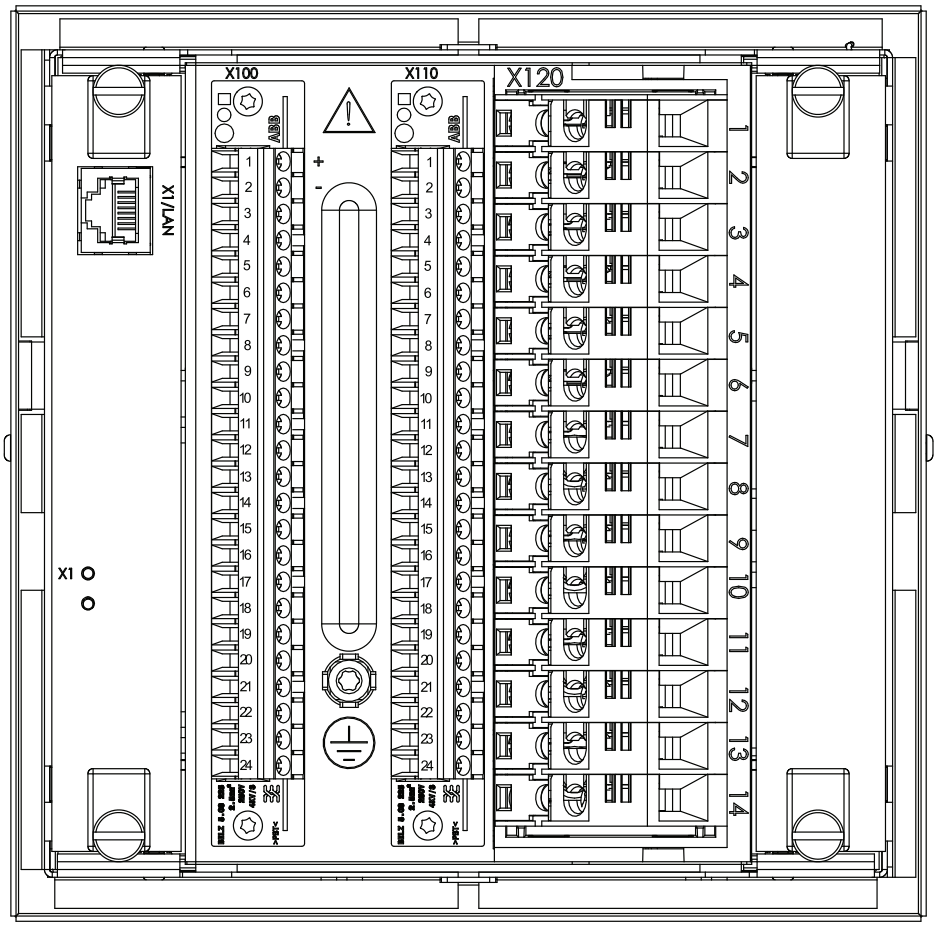


Figure 37: Terminal layout for the 615 series IEDs

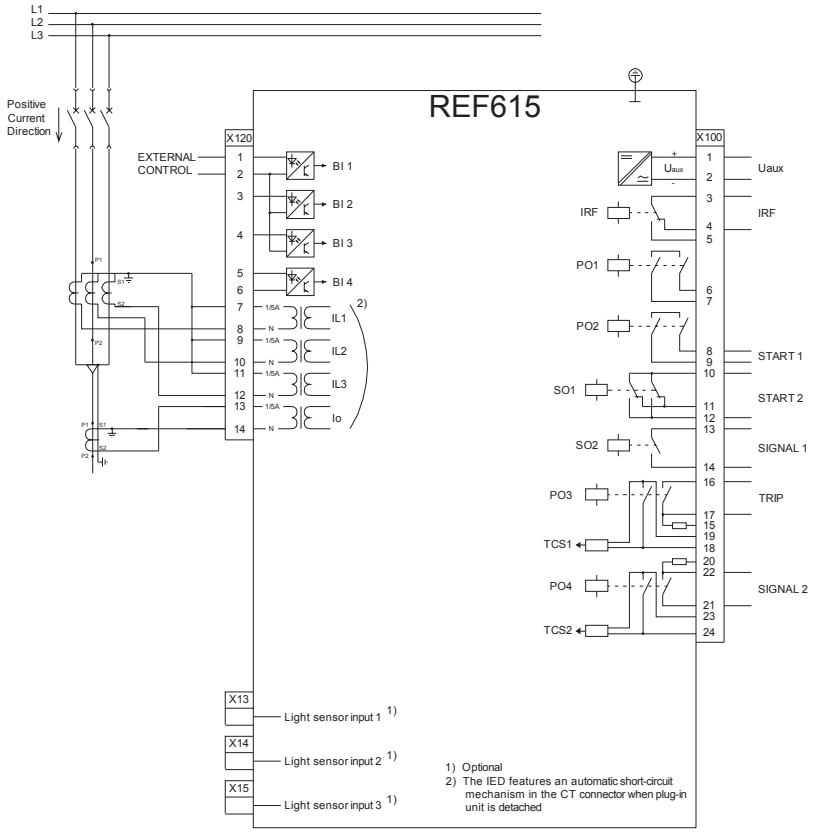


Figure 38: Connection diagram for REF615 with standard configuration C replacing SPAJ 140 C

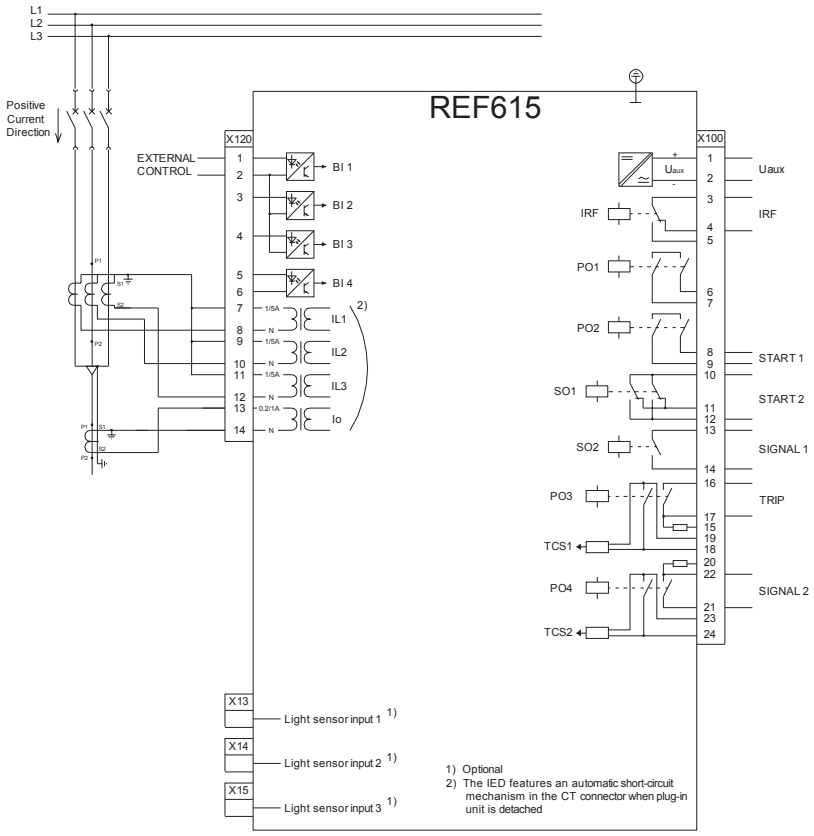


Figure 39: Connection diagram for REF615 with standard configuration C replacing SPAJ 142 C

Section 4 SPAJ 141 C to REF615 Ver.4.0 FP1

4.1 Retrofit scope

Protection functions of SPAJ 14x C are replicated by REF615 with deviations.

- Memorized values are not reset in REF615 with binary input as it is done in SPAJ 14x C.
- Operating curve type parameter for PHLPTOC1 is migrated according to SPAJ 14x C main setting. SPAJ 141 C secondary setting value is ignored.
- In SPAJ 14x C, the latching feature of the overcurrent and the earth-fault trip signals can be selected separately. In REF615, the latching feature is configured so that the overcurrent and the earth-fault trip signals are grouped together. For both of the protection functions, activating the latching feature for trip output on either the overcurrent or the earth-fault protection, functions on SPAJ 14x C results in the latching trip output feature in REF615.
- Functionality depending on SGR relay matrix cannot be migrated according to secondary settings. The dependent features of switchgroups SGR1, SGR2 and SGR3 are migrated according to the main settings.

4.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).
  - Selecting the replacement IED (type and order code)
  - Importing existing relay configuration (.rdb file)
  - Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
  - Entering system parameters
- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

4.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

Various system parameters are collected and imported to PCM600 upon request during the migration process.

- Rated frequency of the network (50 or 60 Hz)
- CT rated primary for phase currents (A)
- CT rated secondary for phase current (1 or 5 A)
- CT rated primary for residual current (A)
- CT rated secondary for residual current (0.2 or 1 A)

4.2.2 Functions

The configuration of REF615 migrated from SPAJ 141 C contains all the functions belonging to standard configuration C, but only the functions that reproduce the behavior of the existing relay configuration is enabled.

On SPAJ 141 C selector switchgroups SGF1 and SGF2 define which protection functions are enabled and disabled and the curve characteristics. These settings are considered when the REF615 configuration is generated.

Table 13: Functions included in configuration

SPAJ 141 C	REF615	Description	Enabled[1)]
$I>I_n$	PHLPTOC1	Three-phase non-directional overcurrent protection, low stage, instance 1	Yes
	PHHPTOC1	Three-phase non-directional overcurrent protection, high stage, instance 1	No
	PHHPTOC2	Three-phase non-directional overcurrent protection, low stage, instance 2	No
$I>>/I_n$	PHIPTOC1	Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	Yes, if SGF2/5 = “0”
$I_0>/I_n$	EFLPTOC1	Non-directional earth-fault protection, low stage, instance 1	Yes
$I_0>>/I_n$	EFLPTOC2	Non-directional earth-fault protection, low stage, instance 2	Yes, if SGF2/6 = “0”
	EFHPTOC1	Non-directional earth-fault protection, high stage, instance 1	No
	EFIPTOC1	Non-directional earth-fault protection, instantaneous stage	No
	NSPTOC1	Negative sequence overcurrent protection, instance 1	No
	NSPTOC2	Negative sequence overcurrent protection, instance 2	No
	PDNSPTOC1	Phase discontinuity protection	No
	T1PTTR1	Three-phase thermal protection for feeders, cables and distribution transformers	No
	PDNSPTOC1	Phase discontinuity protection	No
	T1PTTR1	Three-phase thermal protection for feeders, cables and distribution transformers	No
CBFP	CCBRBRF1	Circuit breaker failure protection	Yes, if SGF1/4 = “1”
[2)]	INRPHAR1	Three-phase inrush detector	Yes, if SGF1/5 = “1”
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	Yes
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	CBXCBR1	Circuit-breaker control	Yes
	DARREC1	Autoreclosing	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes
	RDRE1	Disturbance recorder	Yes

Table continues on next page

SPAJ 141 C	REF615	Description	Enabled[1)]
	CMMXU1	Three-phase current measurement, instance 1	Yes
	CSMSQI1	Sequence current measurement	Yes
	RESCMMXU1	Residual current measurement, instance 1	Yes

1) Function is enabled when the parameter *Operation* is set to “on” and disabled when the parameter is set to “off”.
2) In SPAJ 141 C the set *Start current value I>>* of the high-set phase overcurrent stage can be doubled automatically on connection of the protected object to the network, that is, at starting.

4.2.2.1 PHLPTOC1 settings

PHLPTOC1 replicates the behavior of SPAJ 14x C three-phase low-set overcurrent protection function with definite or inverse definite minimum time characteristic (I>/I_n).

The *Measurement mode* parameter is set to “RMS”.

- PHLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/1, SGF1/2, and SGF1/3. If the curve related values of main and second settings of these switchgroups differ, PHLPTOC1 *Operating curve type* is selected in accordance with the main settings only and a warning message is issued by IED Migration Support tool.
- PHLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAJ 14x C main settings of the switchgroups SGF1/1, SGF1/2, and SGF1/3. If the curve related values of main and second settings of these switchgroups differ, the function which blocks the operation of PHLPTOC1 (in IDMT mode) by start of PHIPTOC1 is determined in accordance with the main settings only and a warning message is issued by the IED Migration Support tool.
- For SPAJ 14x C, the range of parameter *Operating time for I>* is 0.05…300 s. The corresponding parameter on REF615 is *Operating delay time* whose range is 50…200000 ms. Whenever the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, the PHLPTOC1 parameter *Operating delay time* is saturated to 200000 ms.

4.2.2.2 PHIPTOC1 settings

PHIPTOC1 replicates the behavior of SPAJ 14x C three-phase high-set overcurrent protection function with instantaneous or definite time characteristic (I>>/I_n)

PHIPTOC1 is enabled if SPAJ 14x C parameter SGF2/5 = “0”.

- If SPAJ 14x C switchgroup SGB/5 = “1”, the secondary setting can be selected from `BS` input. In this case, if the main and second settings of SGF2/5 differ, the only main setting is considered and PHIPTOC1 is enabled or disabled

accordingly. In this case, a cautionary note is issued by the IED Migration Support tool.
- If SPAJ 14x C *Start current I>>* is below 1.00, PHIPTOC1 *Start value* is set to "1.00" and a cautionary note is issued by the IED Migration Support tool.
- If automatic doubling of set start current of SPAJ 14x C is enabled (SGF1/5 = "1") and *Start current I>>* is above 20.00, PHIPTOC *Start value* is set to "20" and a cautionary note is issued by the IED Migration Support tool.
- If automatic doubling of set start current of SPAJ 14x C is enabled (SGF1/5 = "1"), the parameter *Start value Mult* is set to "2.0".
- For SPAJ 14x C, the range of parameter *Operating time for I>>* is 0.04…300 s. The corresponding parameter on REF615 is *Operate delay time* whose range is 50…200000 ms. If the value of SPAJ 14x C parameter *Operating time for I>* is above 200 s, PHIPTOC1 parameter *Operate delay time* is saturated to 200000 ms and a cautionary note is issued by the IED Migration Support tool.

4.2.2.3 EFLPTOC1 settings

EFLPTOC1 replicates the behavior of SPAJ 141 C sensitive low-set, non-directional earth-fault unit with definite time characteristic (Io>/I_n).

- For SPAJ 141 C, the range of parameter *Operating time for I0>* is 0.05…300 s. The corresponding parameter on REF615 is *Operate delay time* whose range is 50…200000 ms. If the value of SPAJ 141 C parameter *Operating time for I>* is more than 200 s, the EFLPTOC1 parameter *Operate delay time* is saturated to 200000 ms and a warning message is issued by the IED Migration Support tool.

4.2.2.4 EFLPTOC2 settings

EFLPTOC2 replicates the behavior of SPAJ 141 C high-set, non-directional earth-fault unit with instantaneous or definite time function (Io>>/I_n).

- EFLPTOC2 is disabled when SGF2/6 ="1". If the switchgroup SGB/5 ="1", the selection of main or second settings is controlled with the external control signal BS input. In this case, if the main and secondary setting value of SGF2/6 is different, EFLPTOC2 is enabled or disabled according to the main setting value of SGF2/6. A warning message is issued by the IED Migration Support tool.
- For SPAJ 141 C, the range of parameter *Operating time for I0>>* is 0.05…300 s. The corresponding parameter on REF615 is *Operate delay time* whose range is 40…200000 ms. If the value of SPAJ 141 C parameter *Operating time for I>* is above 200 s, EFLPTOC2 parameter *Operate delay time* is saturated to 200000 ms and a warning message is issued by the IED Migration Support tool.

4.2.2.5 CCBRF1 settings

CCBRF1 replicates the behavior of SPAJ 141 C Circuit Breaker Failure Protection (CBFP).

- If SPAJ 141 C switchgroup SGB/5 = “1”, the secondary setting can be selected from BS input. In this case, if the main and secondary setting values of SGF1/4 are different, the operation of CCBRF1 is enabled according to the main setting value of SGF1/4.
- If SPAJ 141 C software version is 042A, *CB Failure delay* is set to “160 ms” else the delay is derived from parameter *Operating time* for CB failure protection.
- REF615 parameters *Operating phase current* and *Operating residual current* are set to “0.3 I_n”.

4.2.2.6 INRPHAR1 settings

In SPAJ 14x C, if SGF1/5 the set *starting value for I>>* is doubled automatically when one of the phase currents rise from a value below 0.12 I> to a value exceeding 1.5 I> in less than 60 ms.

In REF615, this behavior is obtained by feeding ENA_MULT input of PHIPTOC1 with INRPHAR1 output.

- If SPAJ 14x C switchgroup SGB/5 = “1”, the secondary setting can be selected from BS input. Operation of INRPHAR1 is enabled or disabled according to the main setting value of SGF1/5. The secondary setting value of SGF1/5 is ignored.

4.2.3 I/O connections

I/O connections at the SPAJ 14x C terminals are remapped to the REF615 I/O terminal.

REF615 terminals have additional binary I/Os whose behavior does not depend on the SPAJ 14x C configuration.

Table 14: Binary inputs

REF615	SPAJ 14x C	Usage
X120-BI1	BS	If SGB/5 = “1” PROTECTION.BI_SG2 If SGB/1 = “1” PHLPTOC1.BLOCK If SGB/2 = “1” PHIPTOC1.BLOCK If SGB/3 = “1” EFLPTOC1.BLOCK If SGB/4 = “1” EFHPTOC1.BLOCK If SGB/8 = “1” TRPPTRC1.RST_LKOUT
X120-BI2	-	Circuit breaker closed indication
X120-BI3	-	Circuit breaker open indication
X120-BI4	-	Unused

Table 15: Binary outputs

REF615	SPAJ 14x C	Usage
X100-PO1	-	Close circuit breaker
X100-PO2	TS1	Start signal 1 or auxiliary trip signal
X100-PO3	TS2	Open circuit breaker/trip coil 1
X100-PO4	SS3	Open circuit breaker/trip coil 2
X100-SO1	SS1	General start indication
X100-SO2	SS2	General operation indication

The type of contacts (single or multiple pole, single or multiple throw) in the 615 series can be different from the SPACOM relays. See the REF615 standard configuration C connection diagram.

4.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections in REF615. The default connections can be viewed and changed with PCM600 according to the application requirements, if necessary.

Only SPAJ 14x C migrated functions are represented in the connection diagrams. REF615 also includes other functions whose connections are configured according to standard configuration C. See REF615 Application Manual.

Operation of additional REF615 functions is disabled if the corresponding functionality is not available in SPAJ 14x C. These functions can be visible in the connection diagrams even if disabled.

The connections in the application which are affected by the switchgroups SGF1, SGF2.5 and SGF2.6, SGR1, SGR2, SGR3 and SGB are based on the main setting value. In SPAJ 14x C, if the main and the second setting differ and the setting change is enabled from the `BS` input (SGB.5=1), a note is issued by the migration tool.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

4.2.4.1 Functional diagrams for protection

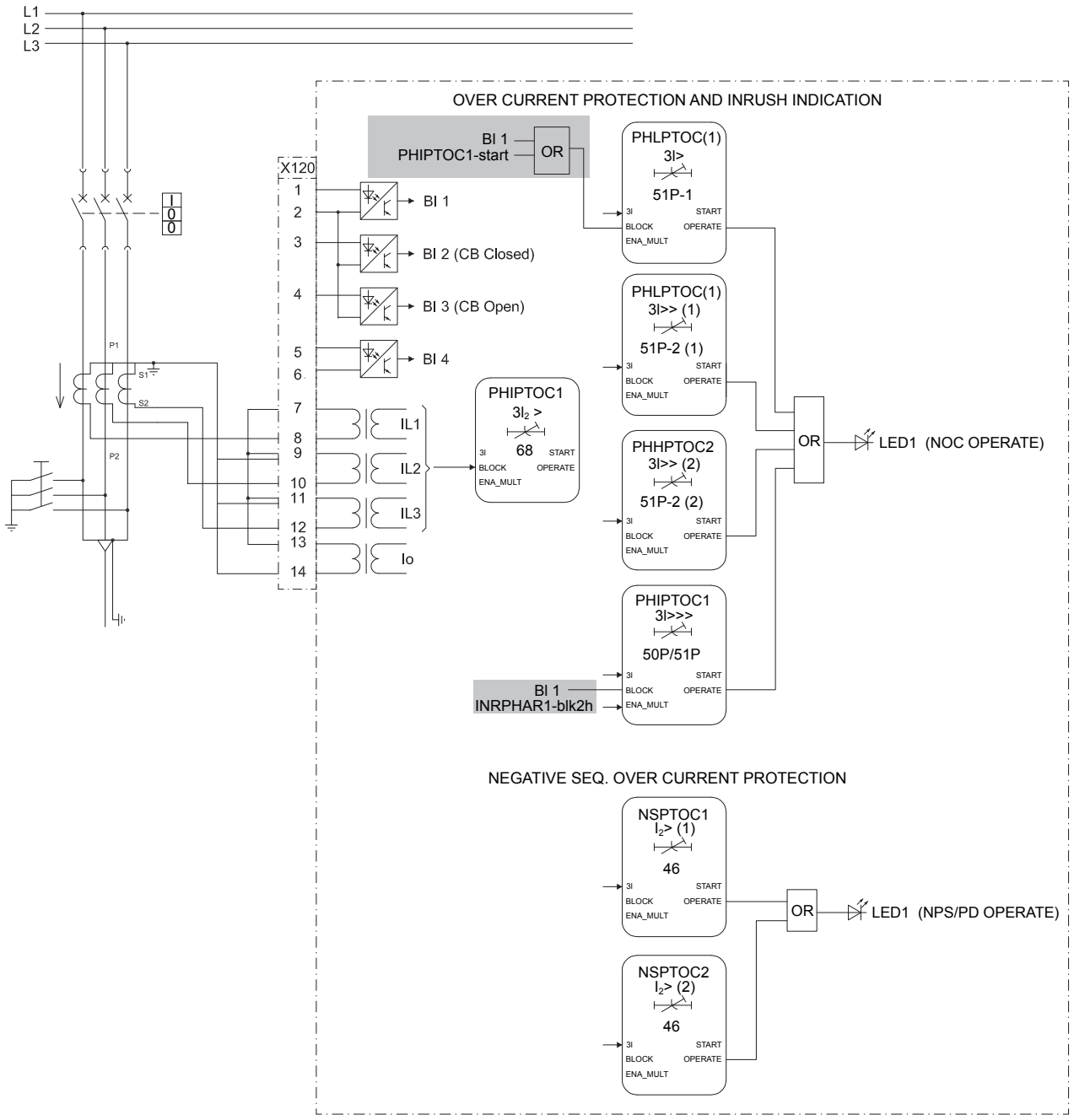


Figure 40: Overcurrent protection

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

- The high stage protection functions PHHPTOC1 and PHHPTOC2 and negative sequence overcurrent protections are disabled.
- BI1 input is connected to various function inputs based on the switchgroup condition.
  - BLOCK input of PHLPTOC1, if SGB/1 = “1”
  - BLOCK input of PHIPTOC1, if SGB/2 = ”1"
  - PHLPTOC1 function, if programmed in inverse mode and it is blocked by the PHIPTOC1-start signal
- The inrush detection function INRPHAR1 is enabled if SPAJ 14x C switchgroup SGF1/5 = “1”. Its output BLK2H enables multiplying (by two) the active settings for PHIPTOC1 function.

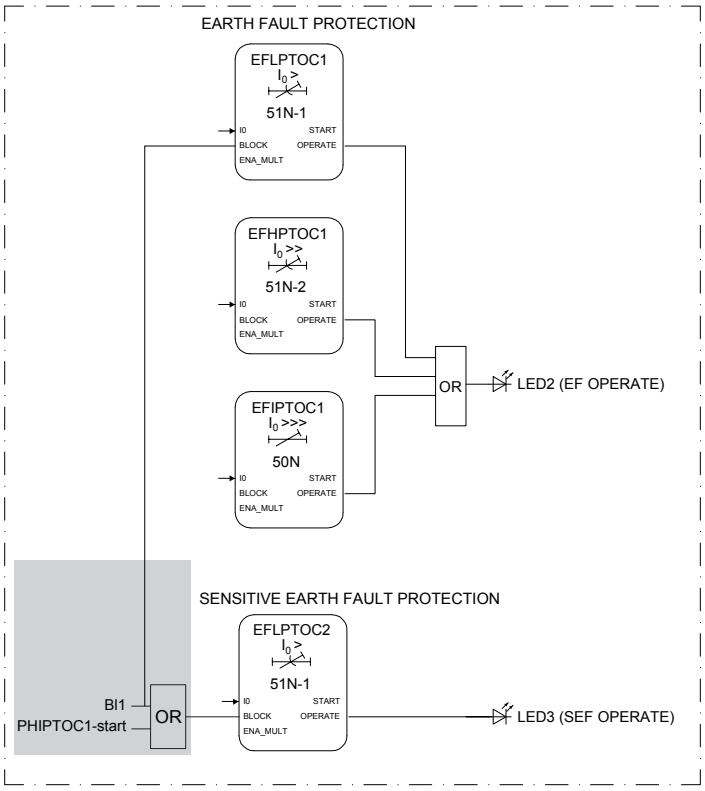


Figure 41: Non-directional earth-fault protection

- Earth-fault high set EFHPTOC1 and the instantaneous earth-fault protections are disabled.
- BI1 input is connected to various function inputs based on the switchgroup condition.
  - BLOCK input of EFLPTOC1, if SGB/3 is set to “1”
  - BLOCK input of EFLPTOC2, if SGB/4 is set to “1”
- EFLPTOC2 is blocked by the PHIPTOC1-start signal if switchgroup SGF1/6 = “1”.

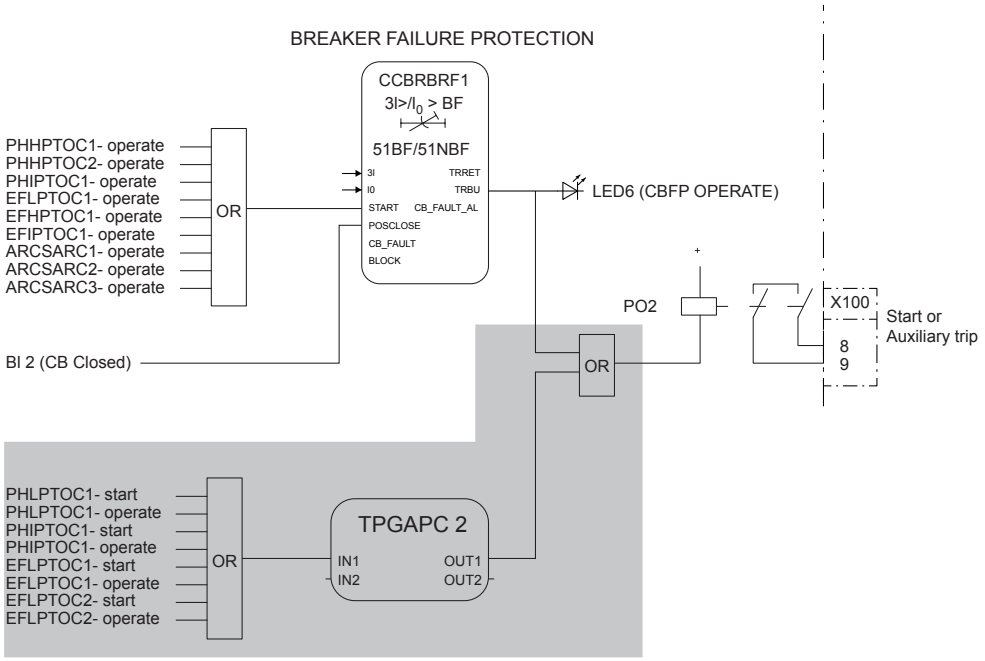


Figure 42: Circuit breaker failure protection, start or auxiliary trip

- PO2 output replicates SPAJ 14x C TS1 output (Start signal 1 or auxiliary trip signal).
- The breaker failure protection CCBRBRF1 is enabled if SPAJ 14x C switchgroup SGF1/4 = “1”. It is initiated via the START input by a number of different protection stages in the IED. If SGR3 = “0”, only the TRBU output is connected to the output PO2.
- TPGAPC2 is instantiated. Various function outputs are connected to TPGAPC2 based on the switchgroup condition.
  - PHLPTOC1- start, if SGR3/1 = “1”
  - PHLPTOC1- operate, if SGR3/2 = “1”
  - PHIPTOC1- start, if SGR3/3 = “1"
  - PHIPTOC1- operate, if SGR3/4 = “1”
  - EFLPTOC1- start, if SGR3/5 = ”1”
  - EFLPTOC1- operate, if SGR3/6 = “1”
  - EFLPTOC2- start, if SGR3/7= ”1”
  - EFLPTOC2- operate, if SGR3/8 = “1”

4.2.4.2 Functional diagrams for control and interlocking

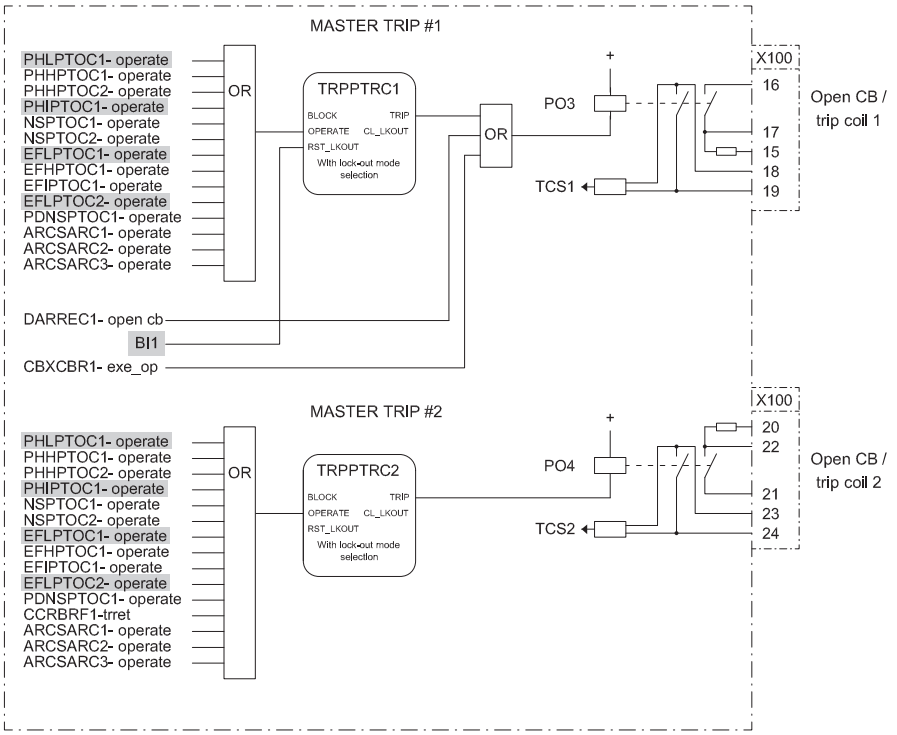


Figure 43: Master trip

Diagrams for control and interlocking features are configured according to Standard configuration C with a few differences.

- `BI1` input is connected to the `RST_LKOUT` input of TRPPTRC1 if switchgroup SGB/8 = “1”.
- Trip output mode of TRPTRC1 is set according to SPAJ 14x C switchgroup SGB/6 and SGB/7.

Table 16: Protection functions

SGB/6 value	SGB/7 value	TRPPTRC1 operation mode
0	0	Non-latched
0	1	Latched (warning)
1	0	Latched (warning)
1	1	Latched

In SPAJ 14x C, trip output modes for overcurrent and earth-fault protections can be configured separately from switchgroups SGB/6 and SGB/7. In REF615, trip output mode is set from TRPPTRC1 and is unique. In case if SGB/6 and SGB/7 have different values, a

warning is issued by IED Migration Support tool and the default value (latched) is kept for the parameter.

- Various function outputs are connected to TRPPTRC1 based on the switchgroup condition.
  - `PHLPTOC1- operate`, if SGR1/2 = “1”
  - `PHIPTOC1- operate`, if SGR1/4 = “1”
  - `EFLPTOC1- operate`, if SGR1/6 = “1”
  - `EFLPTOC2- operate`, if SGR1/8 = “1”
- Various function outputs are connected to TRPPTRC2 based on the switchgroup condition.
  - `PHLPTOC1- operate`, if SGR2/2 = “1”
  - `PHIPTOC1- operate`, if SGR2/4 = “1”
  - `EFLPTOC1- operate`, if SGR2/6 = “1”
  - `EFLPTOC2- operate`, if SGR2/8 = “1”
- Trip output mode of TRPTRC2 is set to “Non-latched”.

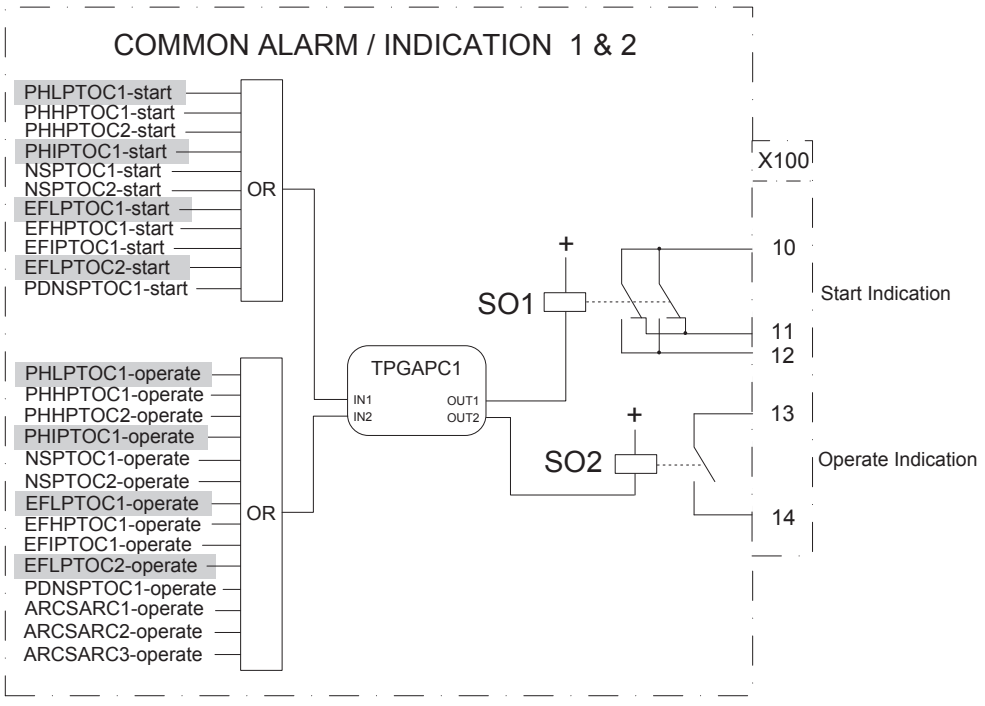


Figure 44: Alarm indication

- `SO1` reproduces SPAJ 14x C `SS1` output. Various function outputs are connected to `SO1` via TPGAPC1 based on the switchgroup condition.

- PHLPTOC1-start, if SGR1/1 = “1”
- PHIPTOC1-start, if SGR1/3 = “1”
- EFLPTOC1-start, if SGR1/5 = “1”
- EFLPTOC2-start, if SGR1/7 = “1”

- SO2 reproduces SPAJ 14x C SS2 output. Various function outputs are connected to SO2 via TPGAPC1 based on the switchgroup condition.
  - PHLPTOC1-operate, if SGR2/1 = “1”
  - PHIPTOC1-operate, if SGR2/3 = “1”
  - EFLPTOC1-operate, if SGR2/5 = “1”
  - EFLPTOC2-operate, if SGR2/7 = “1”

4.2.4.3 Setting groups

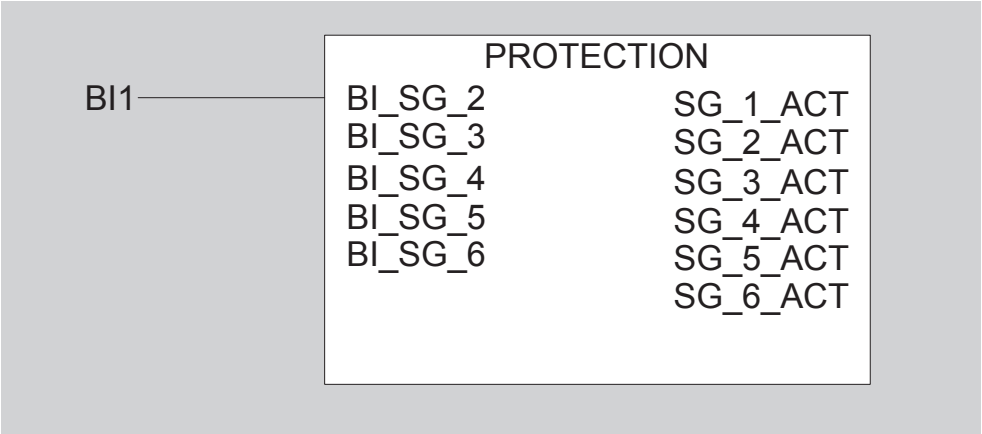


Figure 45: Setting groups

615 IEDs support six setting groups. SPAJ 14x C support two setting groups (main and second setting) which can be selected from binary input BS if switchgroup SGB/5 = “1”. REF615 setting group 2 is selected if BI1 is active and SGB/5 = “1”. The active setting group can be changed at run time.

The connections in the application which are affected by switchgroups SGF1, SGF2/5, SGF2/6, SGR1, SGR2, SGR3, and SGB are based on the main setting value. If the main and second setting differ in SPAJ 141 C, and the setting change is enabled from BS input (SGB/5 = “1”), a note is issued by the IED Migration Support tool.

4.3 Installation

4.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

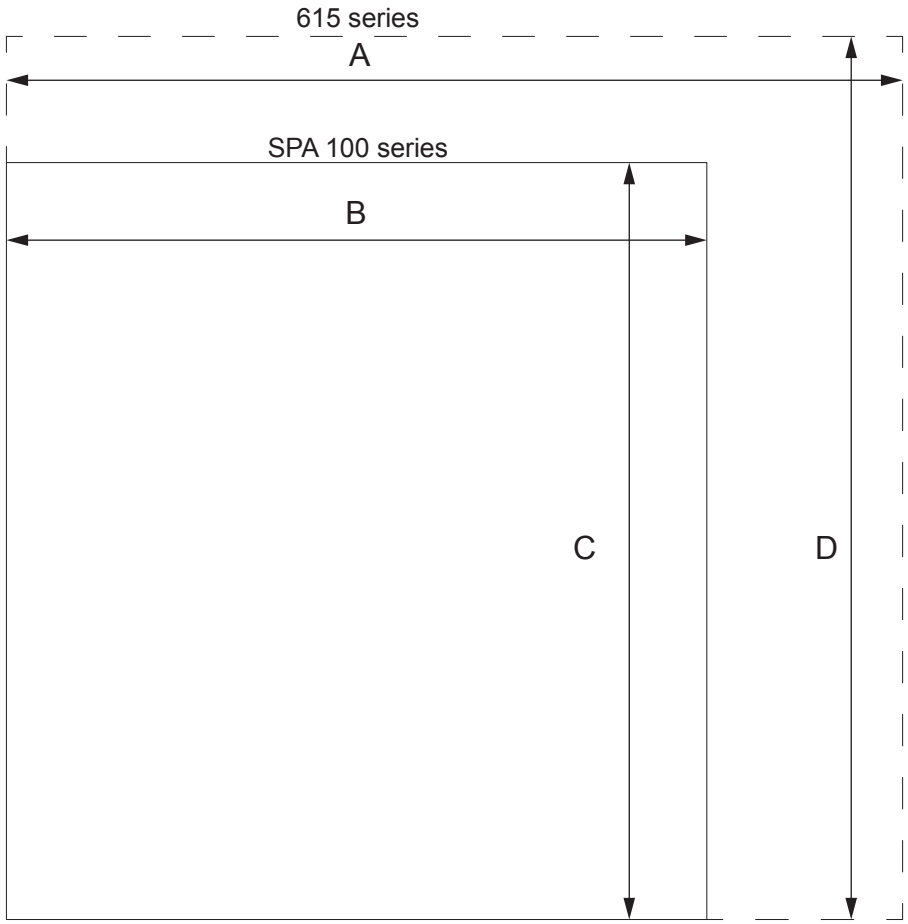


Figure 46: SPACOM 100 series and 615 series cut-outs

A 165.5 mm
B 129 mm
C 139 mm
D 161.5 mm

2. Mount the 615 series IED's case and insert the plug-in unit.

Cover plate is not required with the SPACOM 100 series.

See the 615 series installation manual for more information.

4.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

4.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting SPAJ 141 C with REF615.

Table 17: REF615 wiring harness description for retrofit of SPAJ 141 C

REF615, configuration C		SPAJ 141 C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1 (61)
X100:2	Uaux-	62	Uaux-	X100:2 (62)
X100:3	IRF	72	IRF	X100:3 (72)
X100:4	IRF	71	IRF	X100:4 (71)
X100:5	IRF	70	IRF	X100:5 (70)
X100:6	PO1	-	-	X100:6
X100:7	PO1	-	-	X100:7
X100:8	PO2	74	START 1	X100:8 (74)
X100:9	PO2	75	START 1	X100:9 (75)
X100:10	SO1	78	START 2	X100:10 (78)
X100:11	SO1	-	-	X100:11
X100:12	SO1	77	START 2	X100:12 (77)
X100:13	SO2	81	SIGNAL 1	X100:13 (81)
X100:14	SO2	80	SIGNAL 1	X100:14 (80)
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	TRIP	X100:16 (65)
X100:17	PO3	66	TRIP	X100:17 (66)
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	69	SIGNAL 2	X100:21 (69)
X100:22	PO4	68	SIGNAL 2	X100:22 (68)
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X120:1	BI1	10	EXTERNAL CONTROL	X120:1 (10)
X120:2	BI1	11	EXTERNAL CONTROL	X120:2 (11)
X120:3	BI2	-	-	X120:3

Table continues on next page

REF615, configuration C		SPAJ 141 C		Wiring
Terminal	Description	Terminal	Description	Marking
X120:4	BI3	-	-	X120:4
X120:5	BI4	-	-	X120:5
X120:6	BI4	-	-	X120:6
X120:7	IL1	2/3	IL1, 5A/1A	X120:7 (2/3)
X120:8	IL1	1	IL1	X120:8 (1)
X120:9	IL2	5/6	IL2, 5A/1A	X120:9 (5/6)
X120:10	IL2	4	IL2	X120:10 (4)
X120:11	IL3	8/9	IL3, 5A/1A	X120:11 (8/9)
X120:12	IL3	7	IL3	X120:12 (7)
X120:13	Io	27/28	Io, 0.2A/1A	X120:13 (26/27/28)
X120:14	Io	25	Io	X120:14 (25)
	Earth	63	Earth	

4.3.2.2 SPAJ 141 C terminal layout and connection diagrams

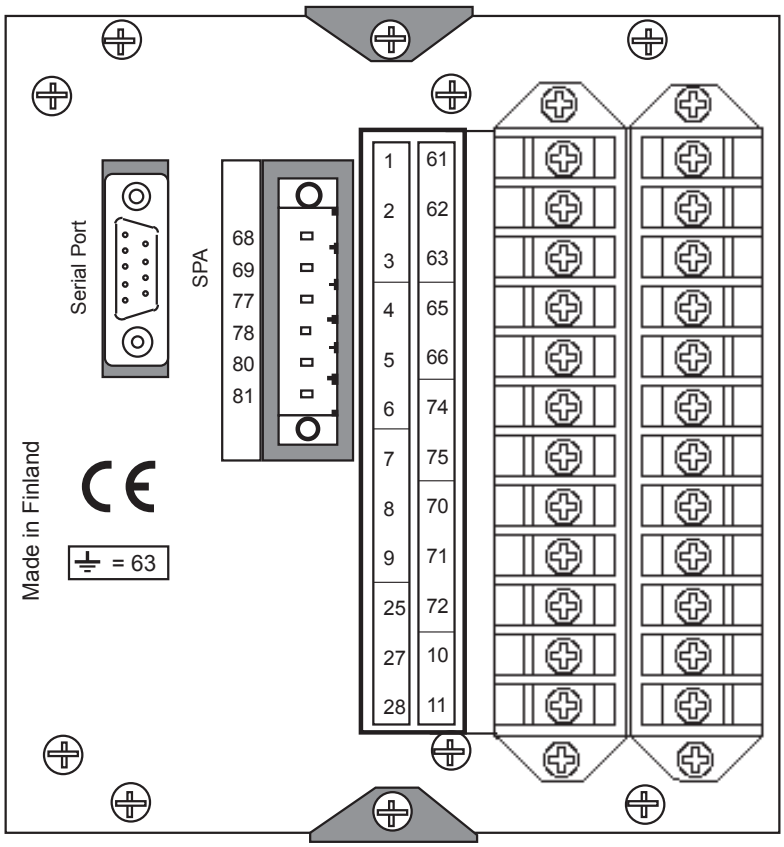


Figure 47: Terminal layout for SPAJ 141 C

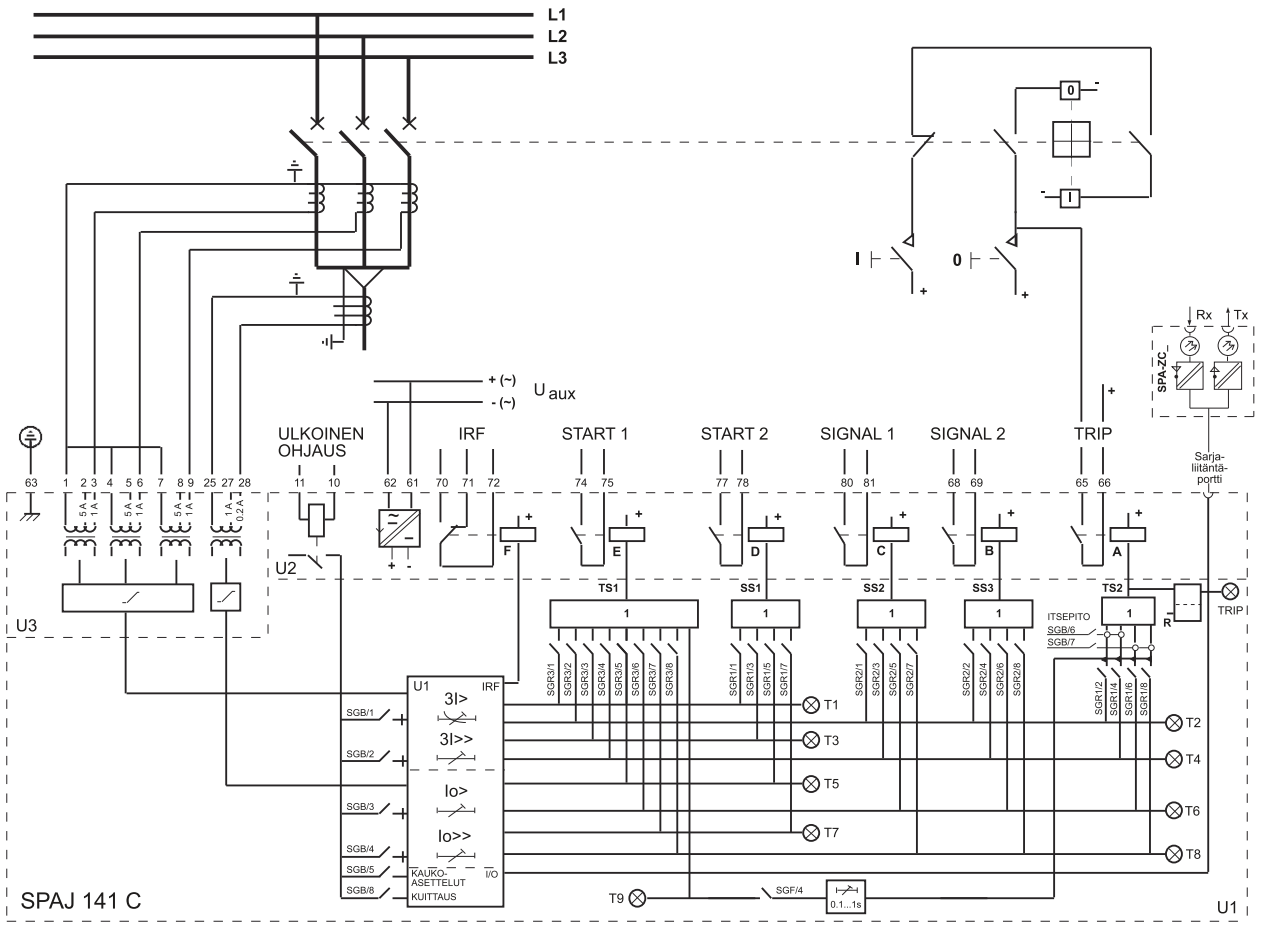


Figure 48: Connection diagram for SPAJ 141 C

4.3.2.3 REF615 terminal layout and connection diagrams

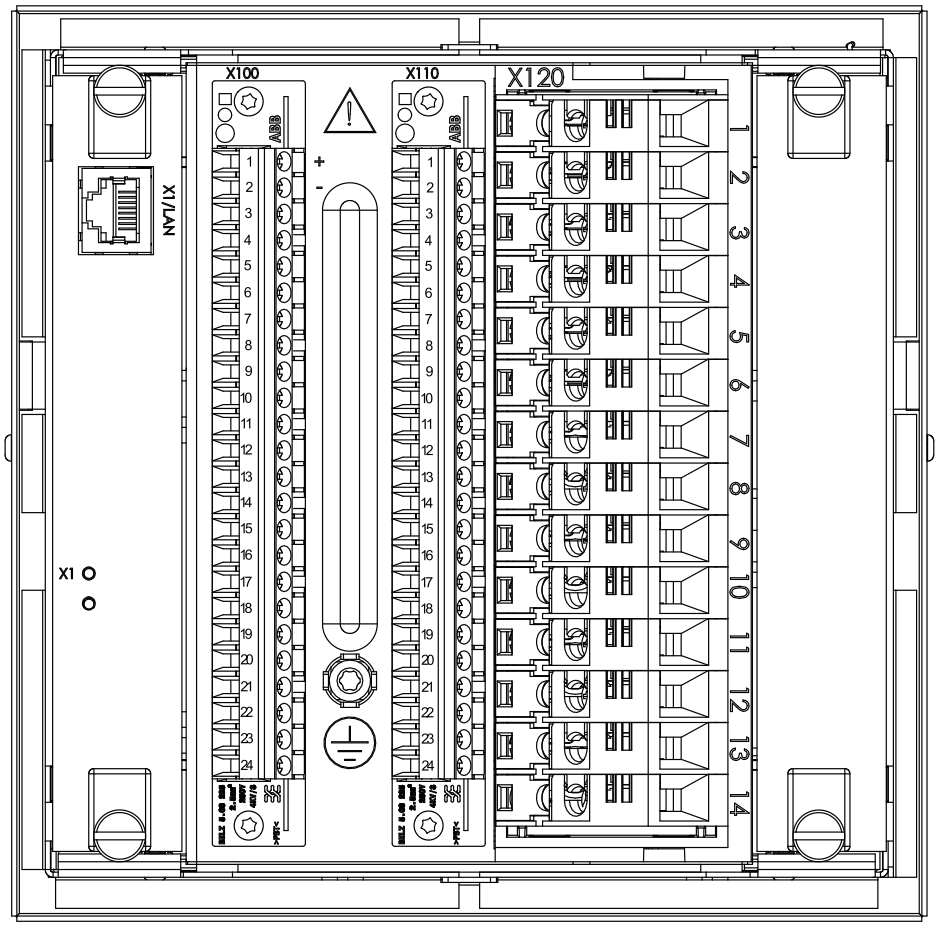


Figure 49: Terminal layout for the 615 series IEDs

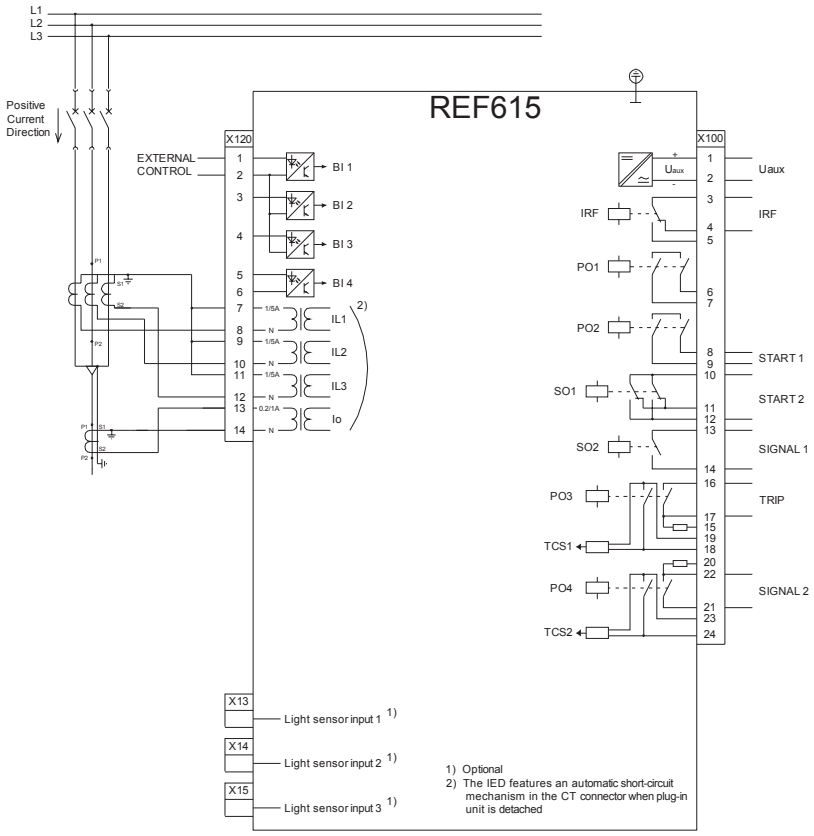


Figure 50: Connection diagram for REF615 with standard configuration C replacing SPAJ 141 C

Section 5 SPAM 150 C to REM615 Ver.4.0 FP1

5.1 Retrofit scope

Protection functions of SPAM 150 C are replicated by REM615 with deviations.

- In SPAM 150 C, the latching of earth-fault and unbalanced trip signals can be configured from an independent setting. Latching for the general trip signal of all the protection functions can be configured from another setting. In REM615, the latching feature is configured so that all the trip signals are grouped together. Activating one of the latching features on SPAM 150 C results in latching the general trip output feature in REM615.

5.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).

- Selecting the replacement IED (type and order code)
- Importing existing relay configuration (.rdb file)
- Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
- Entering system parameters

- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

5.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

During the migration process, the control mode of the primary switching device, normally open (NO) for circuit breaker tripping or normally closed (NC) for contactor control, has to be selected. This information is readable from the front plate of SPAM 150 C.

Additionally, various system parameters are collected and imported to PCM600 upon request.

- Rated frequency of the network (50 or 60 Hz)
- CT rated primary for phase currents (A)
- CT rated secondary for phase current (1 or 5 A)
- CT rated primary for residual current (A)
- CT rated secondary for residual current (1 or 5 A)

5.2.2 Functions

The configuration of REM615 migrated from SPAM 150 C contains all the functions of standard configuration A, but only the functions that reproduce the behavior of the existing relay configuration are activated. On SPAM 150 C, selector switchgroups SGF define which protection functions are enabled and disabled and the curve characteristics. These settings are considered when the REM615 configuration is generated.

Table 18: Functions included in REM615 standard configuration A

SPAM 150 C	REM615	Description	Enabled[1)]
$I_s>I_n$	PHLPTOC1	Three-phase non-directional overcurrent protection, low stage, instance 1	Yes, if (SGF/7) = “0” or (SGF/7 = “1” and SG4/1 = “1”)
$I>>/I_n$	PHIPTOC1[2)]	Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	Yes, if (SGF/1 = “1”) or (SGF/1 = “0” and SGF/3,4 > 0,0)
$I_0[\%I_n]$	EFLPTOC1	Non-directional earth-fault protection, low stage, instance 1	Yes
	EFHPTOC1	Non-directional earth-fault protection, high stage, instance 1	No
$\Delta I[\%I_L]$	MNSPTOC1	Negative sequence overcurrent protection for motors, instance 1	Yes, if SGF/5 = “1”
	MNSPTOC2	Negative sequence overcurrent protection for motors, instance 2	No
$I<[\%I_\Theta]$	LOFLPTUC1	Loss of load supervision	Yes, if SGF/8 = “1”
	JAMPTOC1	Motor load jam protection	No
I_s/I_n $\Sigma t_{Si}[S]$	STTPMSU1	Motor startup supervision	Yes, if SGF/7 = “1” and SG4/1 = “0”
Phase Reversal	PREVPTOC1	Phase reversal protection	Yes, if SGF/6 = “1”
I_Θ/I_n	MPTTR1	Thermal overload protection for motors	Yes
	CCBRBRF1	Circuit breaker failure protection	No
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	No
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	MAPGAPC1	Multi-purpose protection, instance 1	No
	MAPGAPC2	Multi-purpose protection, instance 2	No
	MAPGAPC3	Multi-purpose protection, instance 3	No
	MAPGAPC4	Multi-purpose protection, instance 4	No
	MAPGAPC5	Multi-purpose protection, instance 5	No
	MAPGAPC6	Multi-purpose protection, instance 6	No
	CBXCBR1	Circuit breaker control	No
	DCXSWI1	Disconnector control, instance 1	No
	DCXSWI2	Disconnector control, instance 2	No
	ESXSWI1	Earthing switch control	No
	DCSXSWI1	Disconnector position indication, instance 1	No
	DCSXSWI2	Disconnector position indication, instance 2	No
	DCSXSWI3	Disconnector position indication, instance 3	No

Table continues on next page

SPAM 150 C	REM615	Description	Enabled[1)]
	ESSXSWI1	Earthing switch indication, instance 1	No
	ESSXSWI2	Earthing switch indication, instance 2	No
	ESMGAPC1	Emergency startup	No
	SSCBR1	Circuit-breaker condition monitoring	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes
	CCRDIF1	Current circuit supervision	Yes
	MDSOPT1	Runtime counter for machines and devices	Yes
	RDRE1	Disturbance recorder	Yes
	CMMXU1	Three-phase current measurement, instance 1	Yes
	CSMSQI1	Sequence current measurement	Yes
	RESCMMXU1	Residual current measurement, instance 1	Yes
	XRGGIO130	RTD/mA measurement	No

1) The function is enabled when the parameter operation is set to “on” and disabled when the parameter is set to “off”.
2) If SGF/1=0 and at least one among SGF/3 and SGF/4 is set, PHIPTOC1 is used only for blocking protection function EFLPTOC1.

5.2.2.1 PHLPTOC1 settings

PHLPTOC1 replicates the behavior of SPAM 150 C motor startup supervision (I_s>/ I_n). PHLPTOC1 parameter *Operating curve type* and curve parameterization are derived from SPAM 150 C switchgroups SGF.

- If SGF/7 = “0”, PHLPTOC1 *Operating curve time* is set to “IEC Def. time”.
- If SGF/7 = “1” and SG4/2 = “1”, PHLPTOC1 *Operating curve time* is set to “Programmable”.
- If SGF/7 = “1” and SG4/2 = “0”, PHLPTOC1 is disabled.

For SPAM 150 C, the range of parameter *Starting value of the Is unit* is 1.0…10.0 × I_n. The corresponding parameter on REM615 is *Start value* whose range is 1.0…5.0 × I_n. Whenever the value of SPAM 150 C parameter *Starting value of the Is unit* exceeds 5.0 × I_n, PHLPTOC1 parameter *Start value* is saturated to 5.0 × I_n and a warning message is issued by the IED Migration Support tool.

5.2.2.2 PHIPTOC1 settings

PHIPTOC1 replicates the behavior of SPAM 150 C high-set stage of the overcurrent unit. PHIPTOC1 is enabled if SGF/1 is set to “1”.

If SGF/1 = “1” and at least one of the conditions SGF/3 = “1” and SGF/4 = “1” are satisfied, PHIPTOC1 blocks the function EFLPTOC1.

- If SPAM 150 C parameter *Start value for stage I>>* is below one, PHIPTOC1 *Start value* is set to one and a warning message is issued by the IED Migration Support tool.

5.2.2.3 EFLPTOC1 settings

EFLPTOC1 replicates the behavior of the SPAM 150 C earth-fault unit. This is always enabled.

5.2.2.4 MNSPTOC1 settings

MNSPTOC1 replicates the behavior of the SPAM 150 C unbalance or incorrect phase sequence protection unit.

This is enabled if SGF/5 = “1”.

5.2.2.5 LOFLPTUC1 settings

LOFLPTUC1 protection replicates the behavior of the SPAM 150 C undercurrent unit.

LOFLPTUC1 is enabled if SGF/8 = “1”.

- If SPAM 150 C parameter I_Θ (Thermal trip current setting) is such that *Starting value of stage I<* multiplied by I_Θ exceeds one, LOFLPTUC1 *Start value* is set to “1” and a warning message is issued by the IED Migration Support tool.

5.2.2.6 STTPMSU1 settings

STTPMSU1 replicates the behavior of the SPAM 150 C startup stall protection unit.

The function is enabled if SGF/7 = “1” and SG4/1 = “0”.

If switchgroup SGB/1 = “1”, STTPMSU1 parameter *Operation mode* is set to value “3” (ITT+ STALL) else *Operation mode* is set to “1” (ITT).

- If SPAM 150 C parameter t_s (*Operate time of Is or Is*^{2}) is below two seconds, STTPMSU1 parameter *Lock rotor time* is set to “2 sec” and a warning message is issued by the IED Migration Support tool.
- If SPAM 150 C parameter t_s is below one second, the 615 parameter *Motor start-up time* is set to “1 sec” and a warning message is issued by the IED Migration Support tool.

5.2.2.7 PREVPTOC1 settings

PREVPTOC1 replicates the behavior of SPAM 150 C phase reversal unit.

This is enabled if SGF/6 = “1”.

- If SPAM 150 C parameter I_Θ (Thermal trip current setting) is such that $0.75 \times I_\Theta > 1$, the 615 parameter *Start value* is set to “1”.

5.2.2.8 MPTTR1 settings

MPTTR1 replicates the behavior of the SPAM 150 C thermal overload unit.

- If SPAM 150 C parameter *t6x* (Thermal unit stall time setting) is such that t6 × 32.15 < 80 s, the 615 parameter *Time constant start* and *Time constant normal* are set to “80 sec”.
- If SPAM 150 C parameters *Kc* (Cooling time multiplier setting) and *t6x* are such that Kc × t6 × 32.15 < 80 s, the 615 parameter *Time constant stop* is set to “80 sec”.
- If SPAM 150 C parameters *Kc* (Cooling time multiplier setting) and *t6x* are such that Kc × t6 × 32.15 > 8000 s, the 615 parameter *Time constant stop* is set to “8000 sec”.

5.2.3 I/O connections

I/O connections at the SPAM 150 C terminals are remapped to the REM615 I/O terminal.

REF615 terminals have additional binary I/Os whose behavior does not depend on the SPAM 150 C configuration.

Table 19: Binary inputs

REM615	SPAM 150 C	Usage
X120-BI1	BS	If SGB/1 = “1” PHLPTOC1.BLOCK not (STTPMSU1.STALL_IND) If SGB/2 = “1” RESTART_INHIBIT If SGB/3 = “1” MNSPTOC1.BLOCK and PREVPTOC1.BLOCK If SGB/4 = “1” EFLPTOC1.BLOCK If SGB/5 = “1” TRPPTRC1.OPERATE If SGB/6 = “1” TRPPTRC.RST_LKOUT
X120-BI2	-	Circuit breaker closed indication
X120-BI3	-	Circuit breaker open indication
X120-BI4	-	External restart inhibit

Table 20: Binary outputs

REM615	SPAM 150 C	Usage
X100-PO1	TS1	Restart enable
X100-PO2	SS2	Prior alarm or Trip signal 2
X100-SO1	-	Open command
Table continues on next page		

REM615	SPAM 150 C	Usage
X100-SO2	SS1	Start indication
X100-PO3	TS2	Open circuit breaker/Trip coil 1
X100-PO4	SS3	Open circuit breaker/trip

The type of contacts (single or multiple pole, single or multiple throw) in the 615 series can be different from the SPACOM relays. See the REM615 standard configuration A connection diagram.

5.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections in REM615. The default connections can be viewed and changed with PCM600 according to the application requirements, if necessary.

Only SPAM 150 C migrated functions are represented in the connection diagrams. REM615 also includes other functions whose connections are configured according to standard configuration A. See REM615 Application Manual.

Operation of additional REM615 functions is disabled if the corresponding functionality is not available in SPAM 150 C. These functions can be visible in the connection diagrams even if disabled.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

5.2.4.1 Functional diagrams for protection

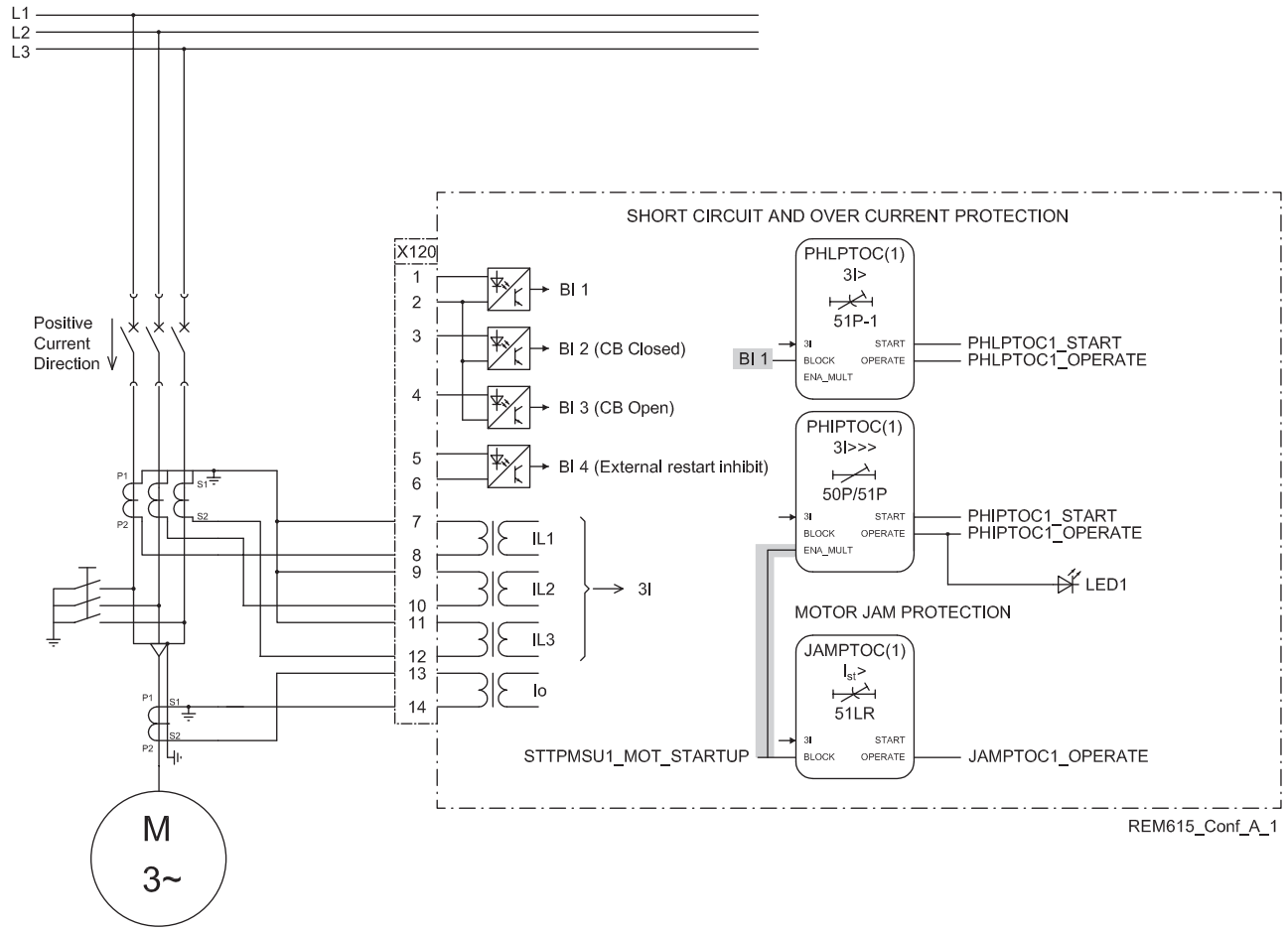


Figure 51: Overcurrent protection

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

- The motor jam protection function JAMPTOC1, the high stage protection functions PHHPTOC1 and PHHPTOC2 and negative sequence overcurrent protection functions are disabled.
- PHLPTOC1 is blocked by `BI1` if SGB/1 = “1”.
- `MOT_START` output of STTPMSU1 is connected to `ENA_MULT` input of PHIPTOC1 if SGF/2 = “1”.

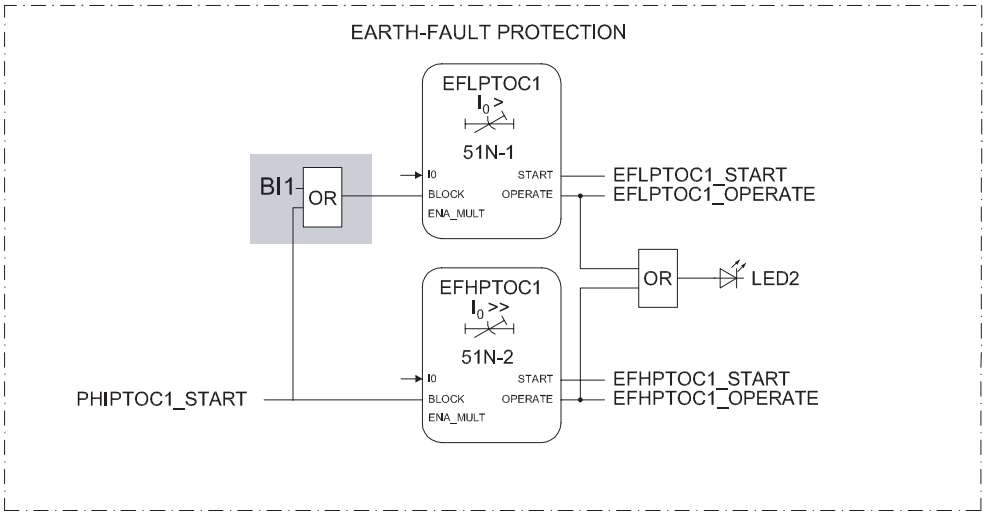


Figure 52: Non-directional earth-fault protection

- EFLPTOC1 is blocked by the `START` output of PHIPTOC1, if SGF/1 = “0” and at least one of the conditions SGF/3 = “1” and SGF/4 = “1” is true.
- EFLPTOC is blocked by `BI1` if SGB/4 = “1”.
- EFHPTOC1 is disabled.

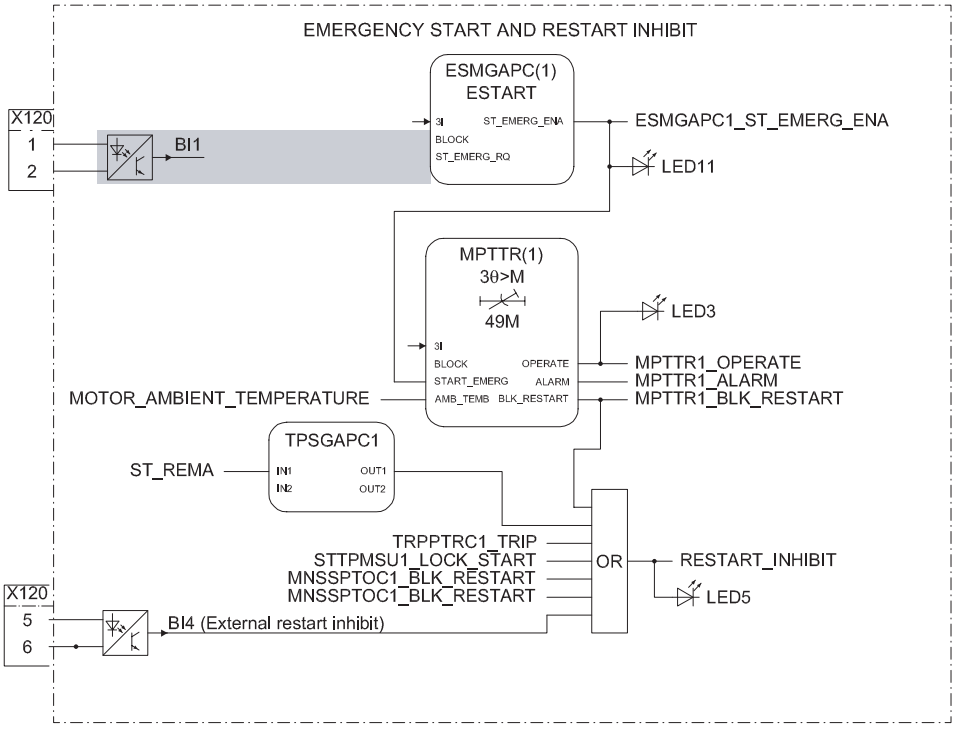


Figure 53: Emergency start and restart inhibit

- The BLOCK input of the emergency start function ESMGAPC1 is not connected to any source.

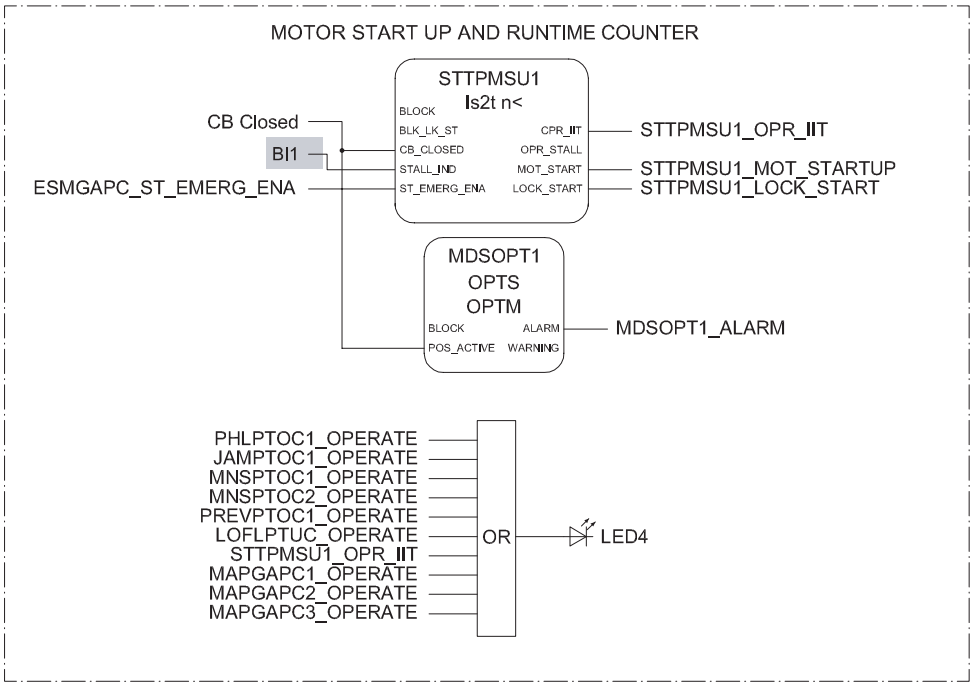


Figure 54: Motor startup supervision

- Binary input BI1 is inverted and connected to STALL_IND input of STTPMSU1, if SGB/1 = “1”.

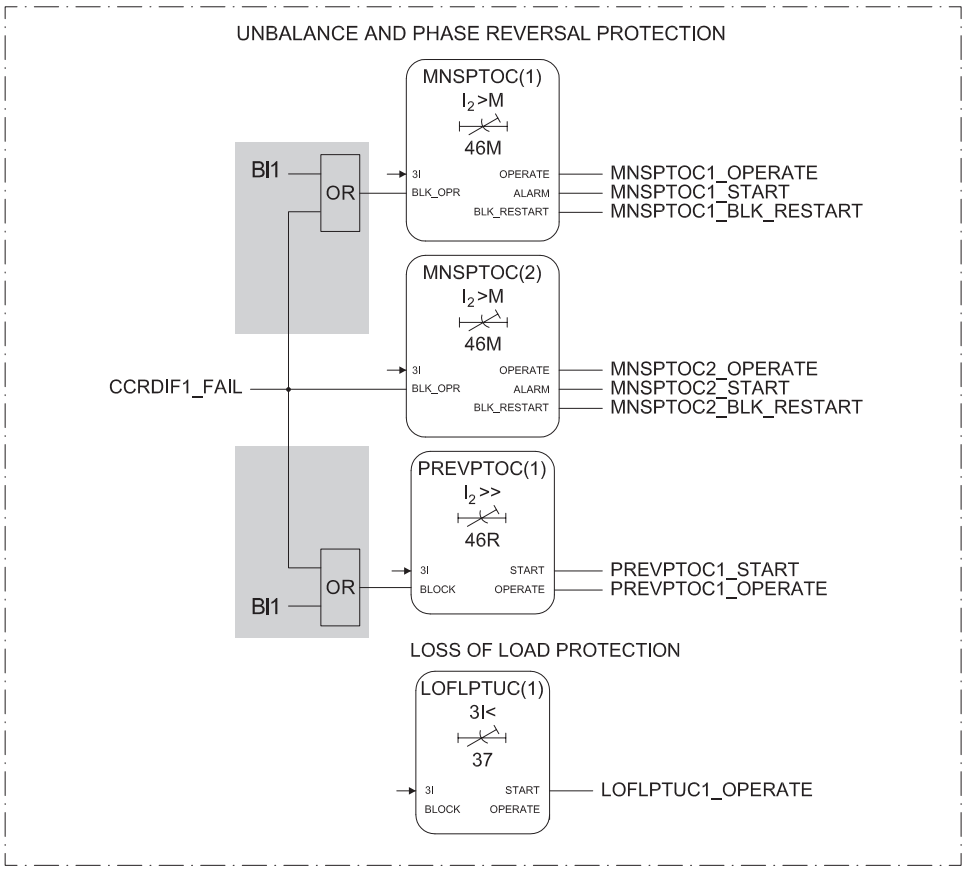


Figure 55: Phase unbalance protection

- Protection function MNSPTOC1 is enabled if SGF/6 = “1”. `CCRDIF_FAIL` output and input `BI1` are connected to MNSPTOC1 block input if switchgroup SGB/3 = “1”.
- Protection function MNSPTOC2 is disabled.
- Protection PREVPTOC1 is enabled if SGF/6 = “1”. `CCRDIF_FAIL` output and input `BI1` are connected to PREVPTOC1 block input if switchgroup SGB/3 = ”1”.
- Protection function LOFLPTUC1 is enabled if SGF/8 = “1”.

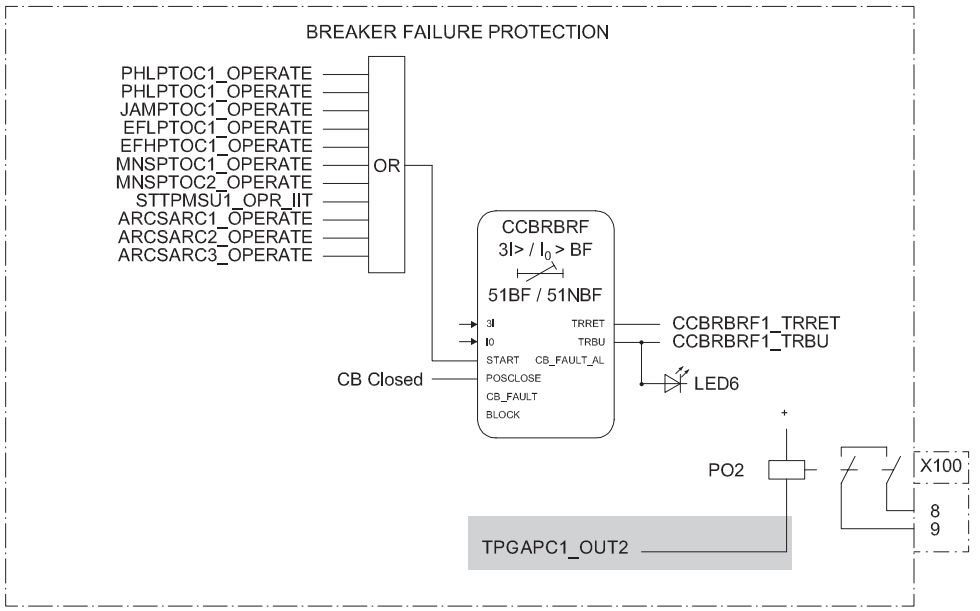


Figure 56: Circuit breaker failure protection

- The circuit-breaker failure protection CCBRBRF1 is disabled and disconnected from PO2 (X100:8/9).
- PO2 (X100:8/9) is connected to TPGAPC1 OUT2 if at least one among SGR1/1, SGR1/2 and SGR1/3 is set.

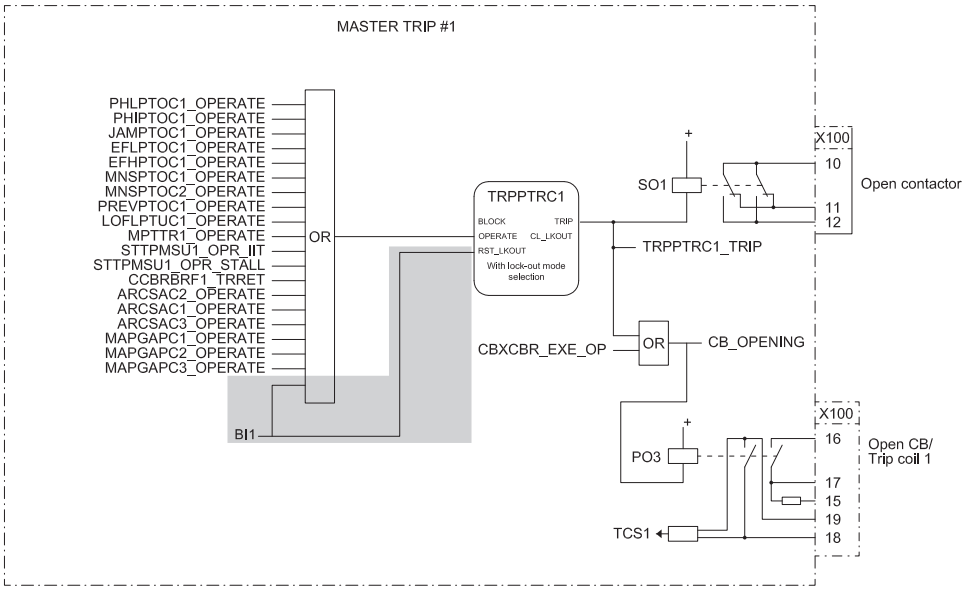


Figure 57: Master trip

- The operate signal from protection function EFLPTOC1 is connected to the Master Trip TRPPTRC1 if switchgroup SGR1/8 = “1”.
- Binary input BI1 is connected to the Master Trip if SGB/5 = ”1”.
- TRPPTRC1 provides lockout and latching function, event generation and the trip signal duration setting. If the lockout operation mode is selected and SGB/6 = “1”, binary input BI1 is assigned to the RST_LKOUT input of the Master Trip to enable external reset with a push button.

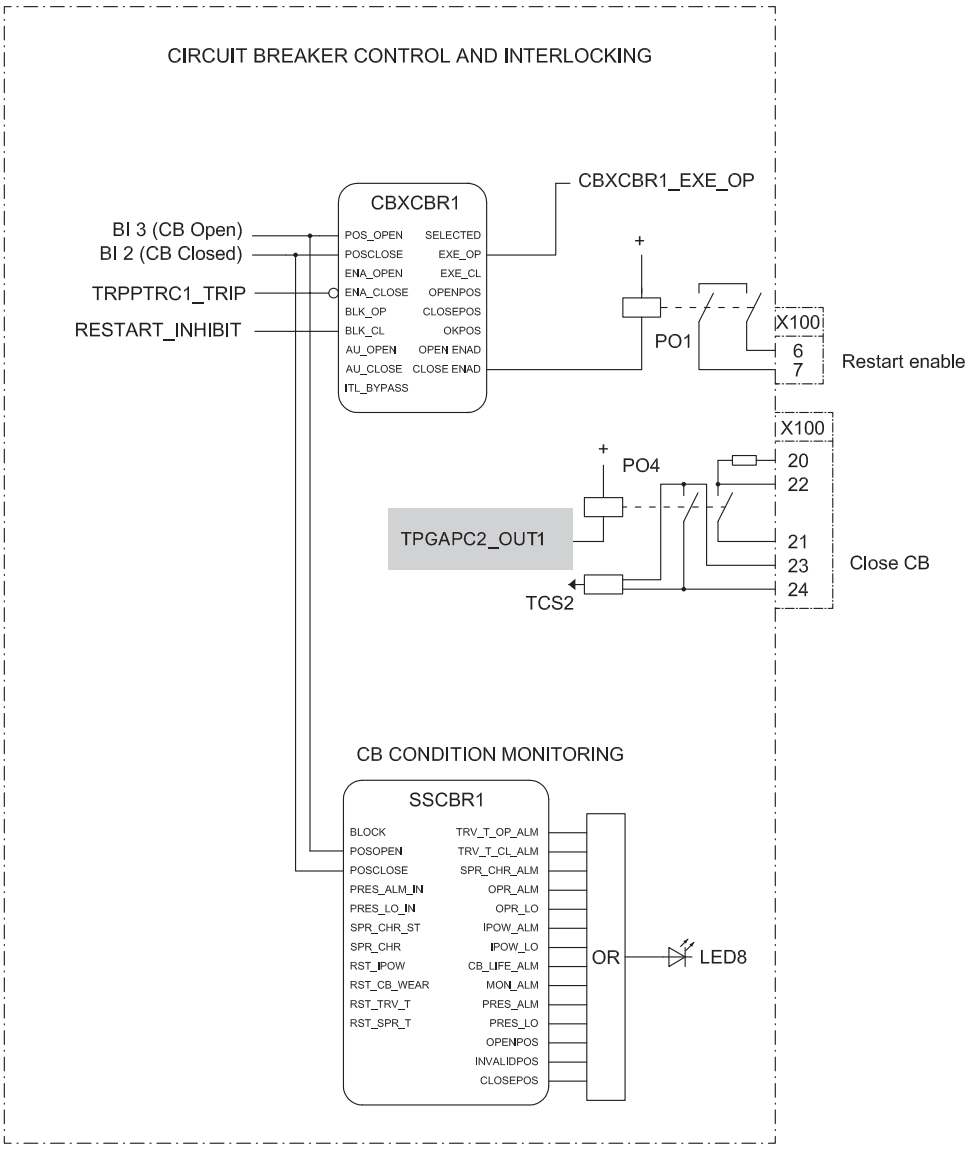


Figure 58: Circuit breaker control

- The circuit breaker control and condition monitoring functions are disabled.
- Output PO4 is driven by TPGAPC2.

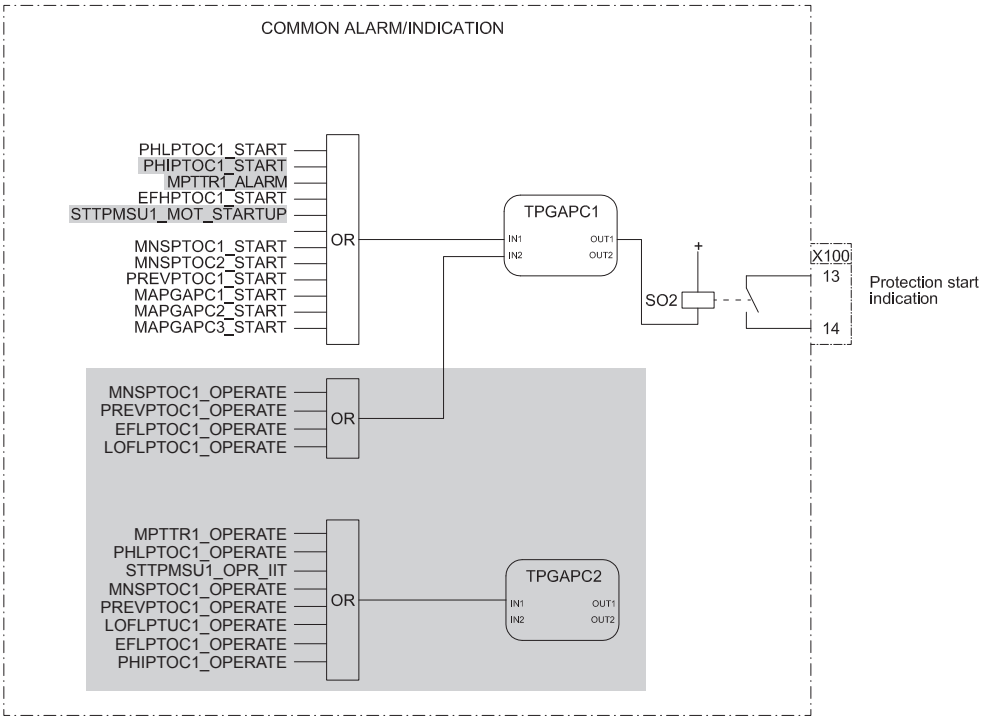


Figure 59: Common alarm indication

- TPGAPC1 and TPGAPC2 are enabled.
- Signal IN1 of TPGAPC1 collects the start signals of protection functions and is connected to SO2 (X100:13/14).
  - MPTTR1_ALARM, if SGR2/1 = “1”
  - PHLPTOC1_START, if SGR4/3 = “1”
  - PHIPTOC1_START, if SGR2/3 = “1”
  - EFHPTOC1_START
  - STTPMSU1_MOT_STARTUP, if SGR2/2 = “1”
  - MNSPTOC1_START
  - MNSPTOC2_START
  - PREVPTOC1_START
  - MAPGAPC1_START
  - MAPGAPC2_START
  - MAPGAPC3_START
- Input signal IN2 of TPGAPC1 is connected to PO2 (X100:8/9). If at least one among SGR1/1, SGR1/2, SGR1/3 and SGR1/4 is set, IN2 signal collects the output signals of various protection functions.
  - MPTTR1_ALARM, if SGR1/1 = “1”
  - MPTTR1_OPERATE, if SGR1/2 = “1”
  - PHLPTOC1_OPERATE, if SGR1/3 = “1”
  - STTPMSU1_OPR_IIT, if SGR1/3 = “1”

- PHIPTOC1_OPERATE, if SGR1/4 = “1”
- MNSPTOC1_OPERATE, if SGR1/5 = “1”
- PREVPTOC1_OPERATE, if SGR1/5 = “1”
- EFLPTOC1_OPERATE, if SGR1/6 = “1”
- LOFLPTUC1_OPERATE, if SGR1/7 = “1”

- Input signal IN1 of TPGAPC2 collects the start signals and is connected to PO4 (X100:20-24).
  - MPTTR1_OPERATE, if SGR2/4 = “1”
  - PHLPTOC1_OPERATE, if SGR2/5 = “1”
  - STTPMSU1_OPR_IIT, if SGR2/5 = “1"
  - MNSPTOC1_OPERATE, if SGR2/6 = “1”
  - PREVPTOC1_OPERATE, if SGR2/6 = “1”
  - LOFLPTUC1_OPERATE, if SGR2.8 = “1”
  - EFLPTOC1_OPERATE, if SGR2.7 = “1”
  - PHIPTOC1_OPERATE

5.3 Installation

5.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

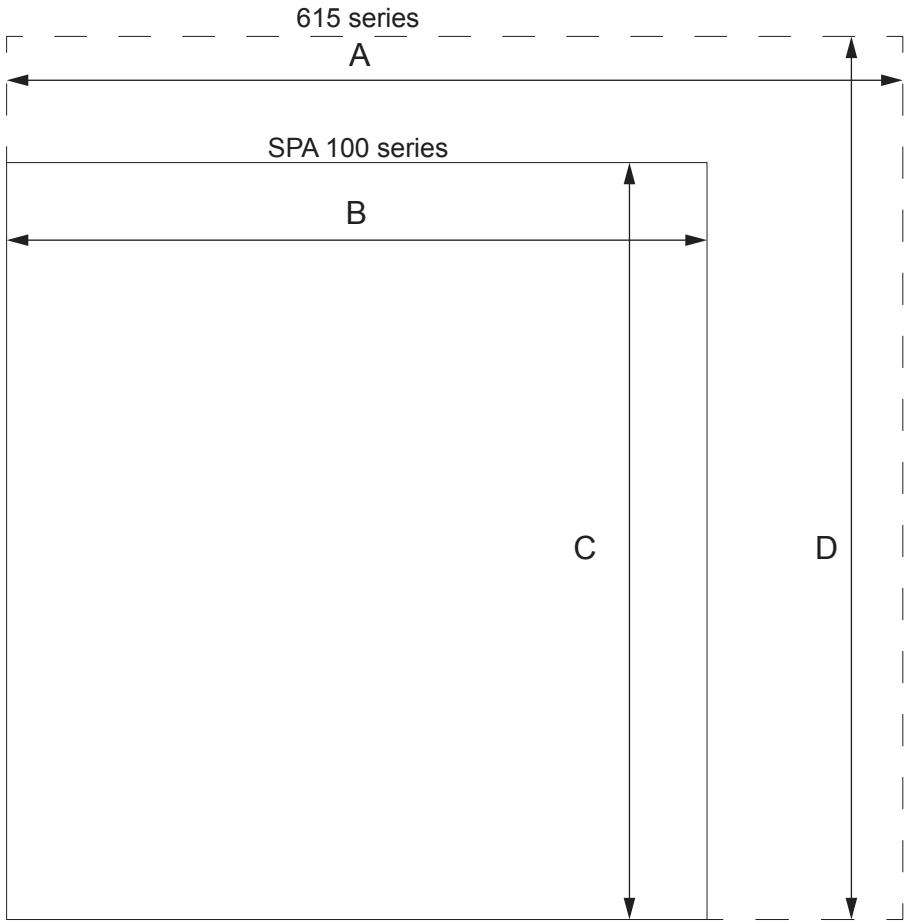


Figure 60: SPACOM 100 series and 615 series cut-outs

A 165.5 mm
B 129 mm
C 139 mm
D 161.5 mm

2. Mount the 615 series IED's case and insert the plug-in unit.

Cover plate is not required with the SPACOM 100 series.

See the 615 series installation manual for more information.

5.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

5.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting SPAM 150 C with REM615.

Table 21: REM615 wiring harness description for retrofit of SPAM 150 C

REM615, configuration A		SPAM 150 C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1 (61)
X100:2	Uaux-	62	Uaux-	X100:2 (62)
X100:3	IRF	72	IRF	X100:3 (72)
X100:4	IRF	71	IRF	X100:4 (71)
X100:5	IRF	70	IRF	X100:5 (70)
X100:6	PO1	74	RESTART ENABLE	X100:6 (74)
X100:7	PO1	75	RESTART ENABLE	X100:7 (75)
X100:8	PO2	80	SIGNAL 2	X100:8 (80)
X100:9	PO2	81	SIGNAL 2	X100:9 (81)
X100:10	SO1	-	-	X100:10
X100:11	SO1	-	-	X100:11
X100:12	SO1	-	-	X100:12
X100:13	SO2	77	START	X100:13 (77)
X100:14	SO2	78	START	X100:14 (78)
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	TRIP	X100:16 (65)
X100:17	PO3	66	TRIP	X100:17 (66)
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	68	SIGNAL 1	X100:21 (68)
X100:22	PO4	69	SIGNAL 1	X100:22 (69)
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X120:1	BI1	10	CONTROL INPUT	X120:1 (10)
X120:2	BI1	11	CONTROL INPUT	X120:2 (11)

Table continues on next page

REM615, configuration A		SPAM 150 C		Wiring
Terminal	Description	Terminal	Description	Marking
X120:3	BI2	-	-	X120:3
X120:4	BI3	-	-	X120:4
X120:5	BI4	-	-	X120:5 (n.a.)
X120:6	BI4	-	-	X120:6 (n.a.)
X120:7	IL1	2/3	IL1, 5A/1A	X120:7 (2/3)
X120:8	IL1	1	IL1	X120:8 (1)
X120:9	IL2	5/6	IL2, 5A/1A	X120:9 (5/6)
X120:10	IL2	4	IL2	X120:10 (4)
X120:11	IL3	8/9	IL3, 5A/1A	X120:11 (8/9)
X120:12	IL3	7	IL3	X120:12 (7)
X120:13	Io	26/27	IL3, 2A/5A	X120:13 (26/27)
X120:14	Io	25	IL3	X120:14 (25)
	Earth	63	Earth	

5.3.2.2 SPAM 150 C terminal layout and connection diagrams

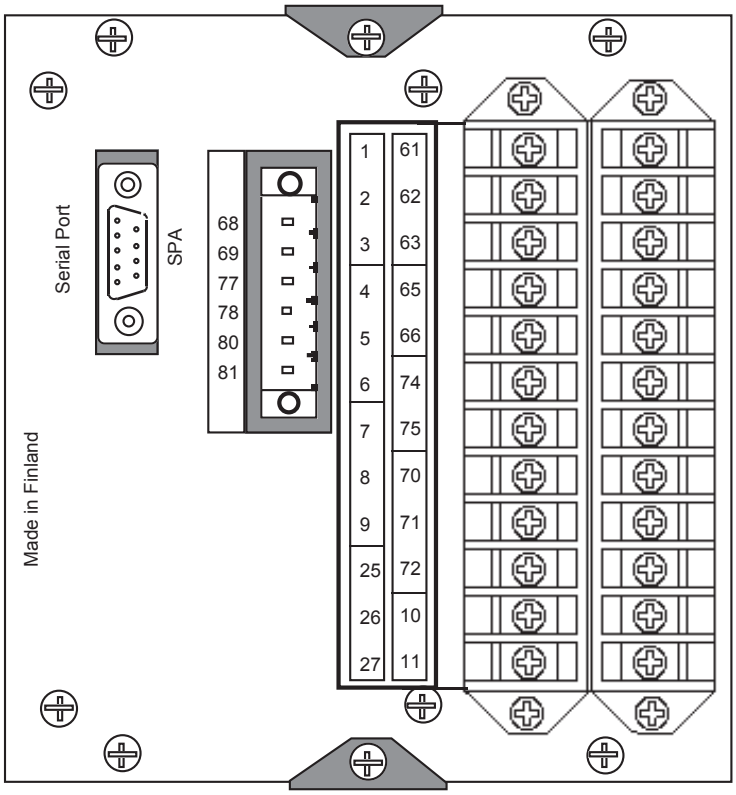


Figure 61: Terminal layout for SPAM 150 C

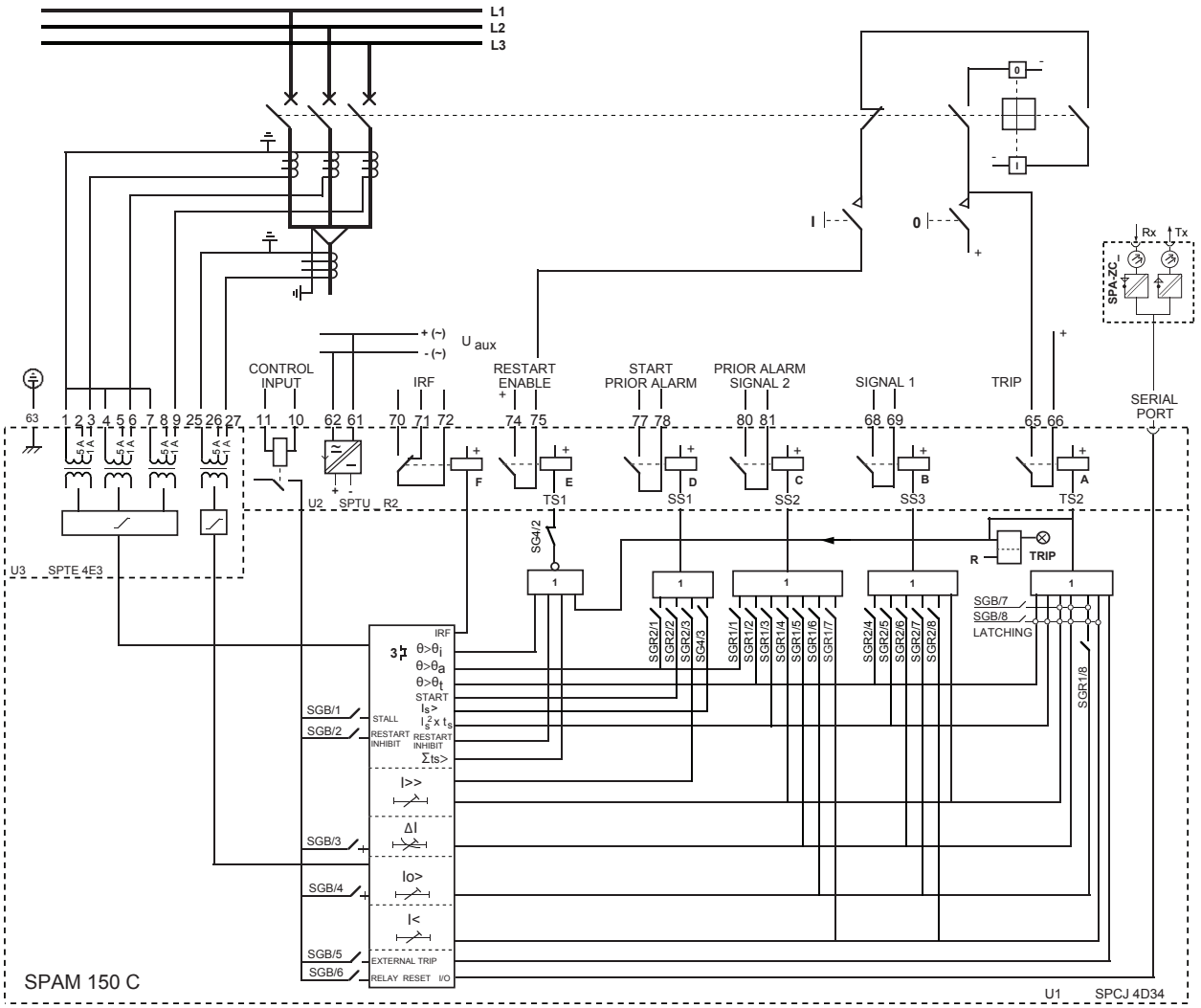


Figure 62: Connection diagram for SPAM 150 C

5.3.2.3 REM615 terminal layout and connection diagrams

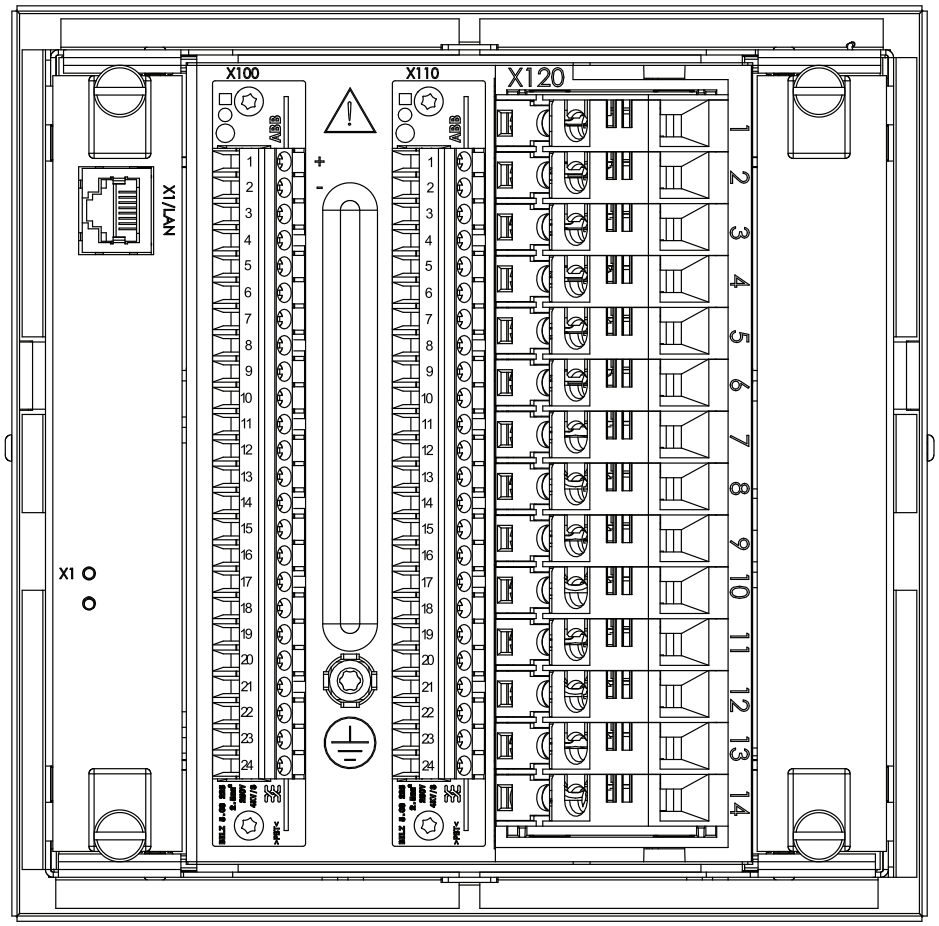


Figure 63: Terminal layout for the 615 series IEDs

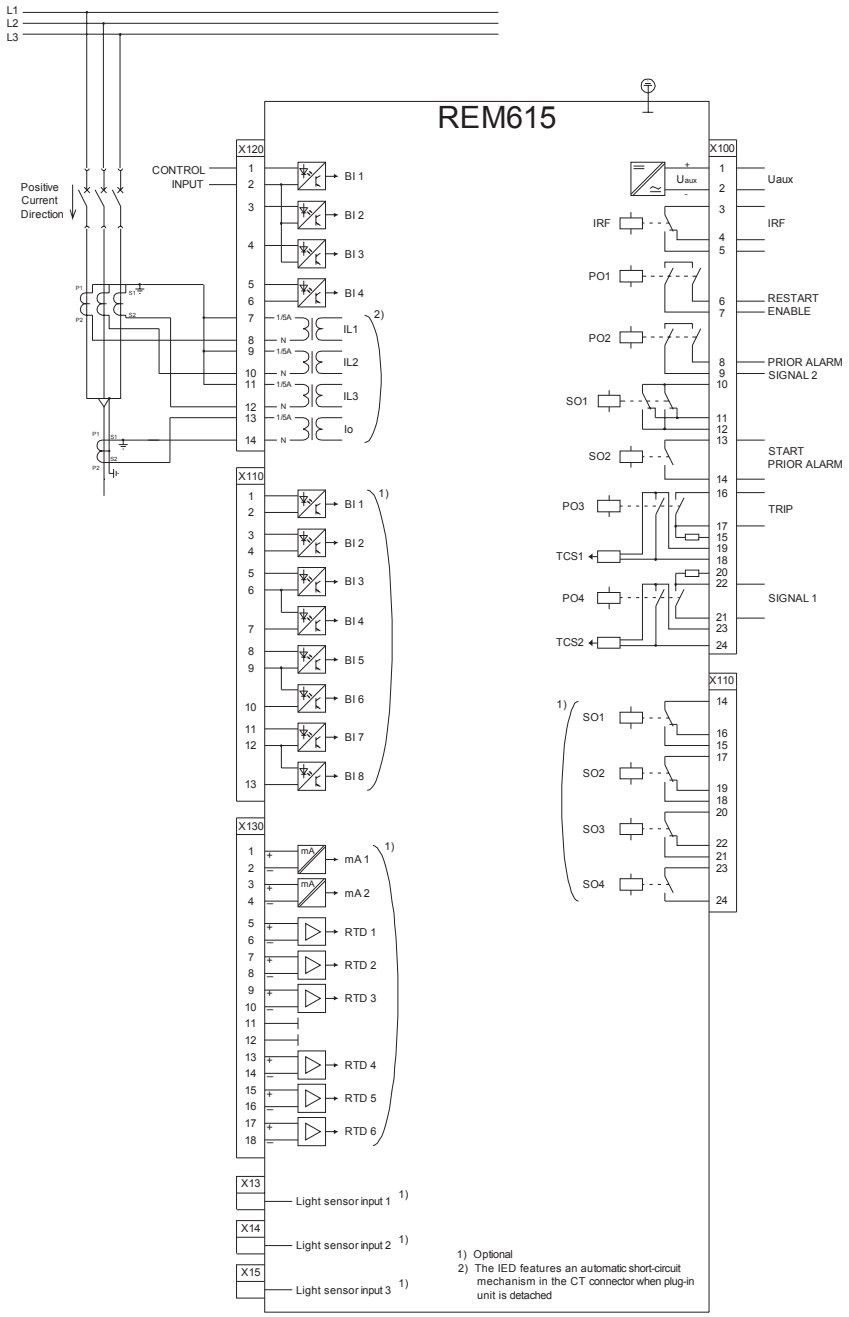


Figure 64: Connection diagram for REM615 with standard configuration A replacing SPAM 150 C

Section 6 SPAU 130 C to REU615 Ver.4.0 FP1

6.1 Retrofit scope

Switch SG1/7 defines the start time selection of U< and U> functions. If the position of the switch SG1/7 differs in main and remote settings, the position of the main setting is considered in migration and a warning message is issued by the IED Migration Support tool.

6.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).
  - Selecting the replacement IED (type and order code)
  - Importing existing relay configuration (.rdb file)
  - Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
  - Entering system parameters
- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

6.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

Various SPAU 130 C parameters are collected and imported to PCM600 upon request during the migration process.

The following settings are read from the potentiometer knobs and switchgroup SG1 for SPCU 3C14 unit.

- Starting value of stage U> (× Un)
- Operate time t> of stage U> (s)
- Starting value of stage U< (× Un)
- Operate time t< of stage U< (s)
- Switchgroup SG1 (checksum)

The configuration of external blocking signal and output relays is read from Switchgroup SGR on the front panel of the relay.

- SGR/1 Route the external blocking signal to U< stage
- SGR/2 Route the U< start signal to output relay D (77-78)
- SGR/3 Route the U> start signal to output relay D (77-78)
- SGR/4 Route the U< operate signal to output relay D (77-78)
- SGR/5 Route the U< operate signal to output relay C (80-81)
- SGR/6 Route the U< operate signal to output relay A (65-66)
- SGR/7 Route the U> operate signal to output relay C (80-81)
- SGR/8 Route the U> operate signal to output relay B (68-69)

The following system parameters are collected and imported to PCM600 upon request during the migration process.

- Rated frequency of the network (50 or 60 Hz)
- Primary voltage (kV)
- Phase-to-phase voltage (100 or 110 V)

6.2.2 Functions

The configuration of REU615 migrated from SPAU 130 C contains all the functions belonging to the standard configuration A, but only the functions that reproduce the behavior of the existing relay configuration are enabled.

On SPAU130 selector switchgroup, SG1 is set from the front panel. The SG1 values can be checked and modified from the IED Migration Support tool during the migration process. SG1 defines the curve characteristics, operating time setting ranges and start delay. This setting is taken into account when the REU615 configuration is generated.

Table 22: Functions included in configuration

SPAU 130 C	REU615	Description	Enabled (1)
	ROVPTOV1	Residual overvoltage protection, instance 1	No
	ROVPTOV2	Residual overvoltage protection, instance 2	No
	ROVPTOV3	Residual overvoltage protection, instance 3	No
U</U_n	PHPTUV1	Three-phase undervoltage protection, instance 1	Yes
	PHPTUV2	Three-phase undervoltage protection, instance 2	No
	PHPTUV3	Three-phase undervoltage protection, instance 3	No
U>/U_n	PHPTOV1	Three-phase overvoltage protection, instance 1	Yes
	PHPTOV2	Three-phase overvoltage protection, instance 2	No
	PHPTOV3	Three-phase overvoltage protection, instance 3	No
	PSPTUV1	Positive-sequence undervoltage protection, instance 1	No
	PSPTUV2	Positive-sequence undervoltage protection, instance 2	No
	NSPTOV1	Negative-sequence overvoltage protection, instance 1	No
	NSPTOV2	Negative-sequence overvoltage protection, instance 2	No
	FRPFRQ1	Frequency protection, instance 1	No
	FRPFRQ2	Frequency protection, instance 2	No
	FRPFRQ3	Frequency protection, instance 3	No
	FRPFRQ4	Frequency protection, instance 4	No
	FRPFRQ5	Frequency protection, instance 5	No
	FRPFRQ6	Frequency protection, instance 6	No
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	Yes
	ARCSARC1	Arc protection, instance 1	No

Table continues on next page

SPAU 130 C	REU615	Description	Enabled (1)
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	LSHDPFRQ1	Load shedding and restoration, instance 1	No
	LSHDPFRQ2	Load shedding and restoration, instance 2	No
	LSHDPFRQ3	Load shedding and restoration, instance 3	No
	LSHDPFRQ4	Load shedding and restoration, instance 4	No
	LSHDPFRQ5	Load shedding and restoration, instance 5	No
	CBXCBR1	Circuit-breaker control	No
	DCXSWI1	Disconnector control, instance 1	No
	DCXSWI2	Disconnector control, instance 2	No
	ESXSWI1	Earthing switch control	No
	DCSXSWI1	Disconnector position indication, instance 1	No
	DCSXSWI2	Disconnector position indication, instance 2	No
	DCSXSWI3	Disconnector position indication, instance 3	No
	ESSXSWI1	Earthing switch indication, instance 1	No
	ESSXSWI2	Earthing switch indication, instance 2 1)	No
	SECRSYN1	Synchronism and energizing check	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes
	RDRE1	Disturbance recorder	Yes
	VMMXU1	Three-phase voltage measurement	Yes
	RESVMMXU1	Residual voltage measurement	Yes
	VSMSQI1	Sequence voltage measurement	Yes
	FMMXU1	Frequency measurement	Yes

1) Function is enabled when the parameter operation is set to “on” and disabled when the parameter is set to “off”.

6.2.2.1 ROVPTOV1 settings

ROVPTOV1 replicates the behaviour of SPAU 320 C1 residual low-set overvoltage protection function with definite time characteristic ($U_o >/ U_n$).

In SPAU 320 C1, the settings *start current Uo>* and *operate time t>* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- In SPAU 320 C1, remote settings can be selected with SPA parameter V150. If SPAU 320 C1 *start voltage Uo>* in main setting is above 100% × U_n, ROVPTOV1 *Start value* in Setting Group 1 is set to “1.000” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>* in remote

setting is above 100% × Un, ROVPTOV1 *Start value* in Setting Group 2 is set to "1.000" and a note is issued by the IED Migration Support tool.

- If SPAU 320 C1 *start voltage Uo>* in main setting is below 1% × U_n, ROVPTOV1 *Start value* in Setting Group 1 is set to "0.010" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>* in remote setting is below 1% × Un, ROVPTOV1 *Start value* in Setting Group 2 is set to "0.010" and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is above 300 s, ROVPTOV1 *Operate delay time* in Setting Group 1 is set to "300000 ms" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is above 300 s, ROVPTOV1 *Operate delay time* in Setting Group 2 is set to "300000 ms" and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is below 0.04 s, ROVPTOV1 *Operate delay time* in Setting Group 1 is set to "40 ms" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is below 0.04 s, ROVPTOV1 *Operate delay time* in Setting Group 2 is set to "40 ms" and a note is issued by the IED Migration Support tool.

6.2.2.2 ROVPTOV2 settings

ROVPTOV2 replicates the behaviour of SPAU 320 C1 residual high-set overvoltage protection function with definite time characteristic ($U_{0/} >> U_n$).

In SPAU 320 C1, settings *start voltage Uo>>* and *operate time t>>* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to "RMS".

- In SPCU 1C6 module *Uo>>* stage can be set out of operation by setting the *start voltage Uo>>* to infinite (∞or "999"). If the *start voltage setting Uo>>* differs in main and remote settings, only the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage Uo>>* in main setting is above 100% × U_n, ROVPTOV2 *Start value* in Setting Group 1 is set to "1.000" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>>* in remote setting is above 100% × U_n, ROVPTOV2 *Start value* in Setting Group 2 is set to "1.000" and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage Uo>>* in main setting is below 1% × U_n, ROVPTOV2 *Start value* in Setting Group 1 is set to "0.010" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>>* in remote setting is below 1% × U_n, ROVPTOV2 *Start value* in Setting Group 2 is set to "0.010" and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>>* in main setting is above 300 s, ROVPTOV2 *Operate delay time* in Setting Group 1 is set to "300000 ms" and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>>* in remote

setting is above 300 s, ROVPTOV2 *Operate delay time* in Setting Group 2 is set to “300000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>>* in main setting is below 0.04 s, ROVPTOV2 *Operate delay time* in Setting Group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>>* in remote setting is below 0.04 s, ROVPTOV2 *Operate delay time* in Setting Group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.

6.2.2.3 PHPTUV1 settings

PHPTUV1 replicates the behavior of SPAU 130 C three-phase low-set undervoltage protection function with definite time characteristic (U</U_n).

In SPAU 130 C settings, *start voltage* U< and *operate time* t< can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process. *Measurement mode* is set to “RMS”.

- The remote settings can be selected with SPA parameter *V150*. Switch SG1/7 defines the U< *start delay time*. This delay is reproduced on REU615 with TONGAPC1 function. If the position of switch SG1/7 differs in main and remote settings, only then the position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- The switch SG1/6 defines the selection of automatic blocking of U< function. If the position of switch SG1/6 differs in main and remote settings only then the main setting value is considered in migration and a note is issued by the IED Migration Support tool.
- If *start voltage* U< in main setting is over 1.2 × U_n, PHPTUV *start value* in setting group 1 is set to “1.20” and a note is issued by the IED Migration Support tool. If *start voltage* U< in remote setting is over 1.2 × U_n, PHPTUV *start value* in setting group 2 is set to “1.20” and a note is issued by the IED Migration Support tool.
- If *start voltage* U< in main setting is below 0.05 × U_n, then PHPTUV REU615 *start value* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If *start voltage* U< in remote setting is below 0.05 × U_n, PHPTUV REU615 *start value* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If *operate time* t< in main setting is over 300 s, PHPTUV *operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 130 C *operate time* t< in remote setting is over 300 s, PHPTUV *operate delay time* in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If *operate time* t< in main setting is below 0.06 s, PHPTUV *operate delay time* in setting group 1 is set to “60 ms” and a note is issued by the IED Migration Support tool. If SPAU 130 C *operate time* t< in remote setting is under 0.06 s, PHPTUV *operate delay time* in setting group 2 is set to “60 ms” and a note is issued by the IED Migration Support tool.

6.2.2.4 PHPTOV1 settings

PHPTOV1 replicates the behavior of SPAU 130 C three-phase high-set overvoltage protection function with definite or inverse definite minimum time characteristic (U>/ U_n).

In SPAU 130 C settings *start voltage* U> and *start time selection* of U> are selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

- The remote settings can be selected with SPA parameter *V150*. Switch SG1/2 defines the U> *start time delay*. This delay is reproduced on REU615 with TONGAPC1 function. If the position of switch SG1/2 differs in the main and remote settings, only then the position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If *start voltage U>* in main setting is over 1.6 × U_n, PHPTOV1 *start value* in setting group 1 is set to “1.60” and a note is issued by the IED Migration Support tool. If SPAU 130 C *start voltage U>* in remote setting is over 1.6 × Un, PHPTOV1 *start value* in setting group 2 is set to “1.60” and a note is issued by the IED Migration Support tool.
- If *start voltage U>* in main setting is under 0.05 × U_n, PHPTOV1 *start value* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 130 C *start voltage U>* in remote setting is under 0.05 × U_n, PHPTOV1 *start value* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If *operate time t>* in main setting is over 300 s, PHPTOV1 *operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 130 C *operate time t>* in second setting is over 300 s, PHPTOV1 *operate delay time* in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If *operate time t>* in main setting is under 0.04 s, PHPTOV1 *operate delay time* in setting group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 130 C *operate time t>* in remote setting is under 0.04 s, PHPTOV1 *operate delay time* in setting group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 130 C *time multiplier k>* in main setting is under 0.05, PHPTOV1 *time multiplier* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 130 C *time multiplier k>* in remote setting is under 0.05, PHPTOV1 *time multiplier* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If *time multiplier k>* in main setting is over 1, PHPTOV1 *time multiplier* in setting group 1 is set to “1” and a note is issued by IED the IED Migration Support tool. If SPAU 130 C *time multiplier k>* in remote setting is over 1, PHPTOV1 *time multiplier* in setting group 2 is set to “1” and a note is issued by the IED Migration Support tool.

6.2.3 I/O connections

I/O connections at SPAU 130 C terminals are remapped to REU615 I/O terminal.

REU615 terminals have additional binary I/Os whose behavior do not depend on SPAU 130 C configuration.

Table 23: Binary inputs

REU615	SPAU 130 C	Usage
BI1 (X110:1/2)	BS (10/11)	if SGR/1 = “1” PHPTUV1.BLOCK
BI2 (X110:3/4)	-	Manual restore group 1 in LSHDPFRQ1
BI3 (X110:5/6)	-	Manual restore group 2 in LSHDPFRQ2
BI4 (X110:7/6)	-	Unused
BI5 (X110:8/9)	-	Voltage transformer truck in indication
BI6 (X110:10/9)	-	Voltage transformer truck out indication
BI7 (X110:11/12)	-	Earthing switch closed indication
BI8 (X110:13/12)	-	Earthing switch open indication
BI1 (X130:1/2)	-	Unused
BI2 (X130:3/4)	-	Line voltage transformer MCB open
BI3 (X130:5/6)	-	Bus voltage transformer MCB open
BI4 (X130:7/8)	-	Lock-out reset

Table 24: Binary outputs

REU615	SPAU 130 C	Usage
PO1 (X100:6/7)	Trip 2 (68/69)	if SGR/8 = “1” PHPTOV1.OPERATE PHPTUV1.OPERATE
PO2 (X100:8/9)	-	Unused
SO1 (X100:10/11/12)	-	PHPTOV1.START PHPTUV1.START
SO2 (X100:13/14)	-	Unused
PO3 (X100:16/17)	Trip 1 (65/66)	PHPTUV1.OPERATE PHPTOV1.OPERATE
PO4 (X100:20/21/22/23/24)	-	Master trip 2
SO1 (X110:14/16)	Start 1 (77/78)	if SGR/3 = “1” PHPTOV1. START if SGR/2 = “1” PHPTUV1. START if SGR/4 = “1” PHPTUV.OPERATE
Table continues on next page		

REU615	SPAU 130 C	Usage
SO2 (X110:17/18/19)	-	Connected to “Load Shedding Group 2” but unused
SO3 (X110:20/21/22)	-	Connected to “Load restore group 1” but unused
SO4 (X110:23/24)	Signal 1 (80/81)	if SGR/5 = “1” PHPTUV1.OPERATE if SGR/7 = “1” PHPTOV1.OPERATE

The type of contacts (single or multiple pole; single or multiple throw) in 615 series can be different from SPACOM relays. See the REU615 standard configuration A connection diagram.

6.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-function connections in REU615. The default connections can be viewed and changed with PCM600 according to the application requirements.

Only SPAU 130 C migrated functions are represented in the connection diagrams. REU615 also includes other functions whose connections are configured according to Standard configuration A. See the REU615 Application Manual.

Operation of additional REU615 functions is disabled if the corresponding functionality is not available in SPAU 130 C. These functions can be visible in the connection diagrams even if disabled.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in grey.

6.2.4.1 Functional diagrams for protection

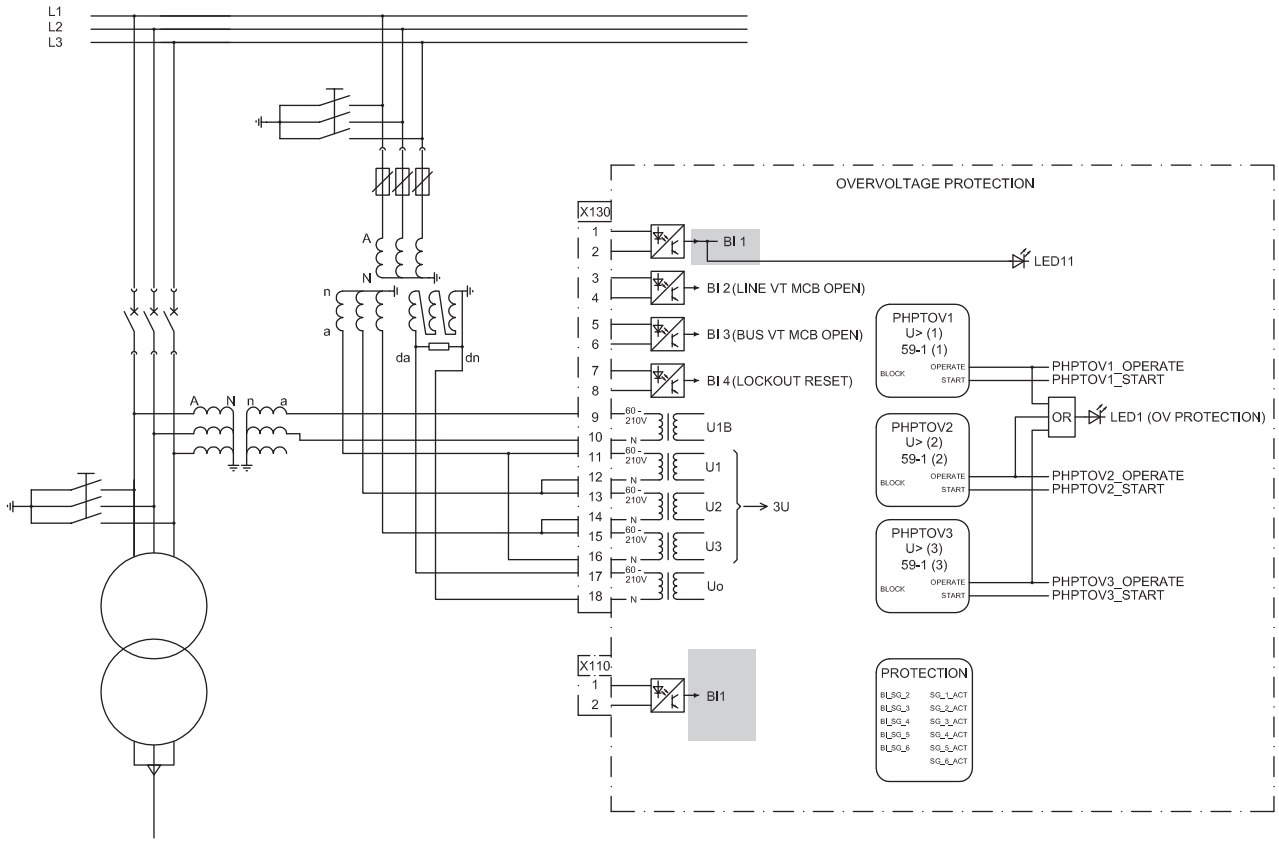


Figure 65: Overvoltage protection

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

- Only PHPTOV2 and PHPTOV3 are disabled.
- PROTECTION function is disabled.

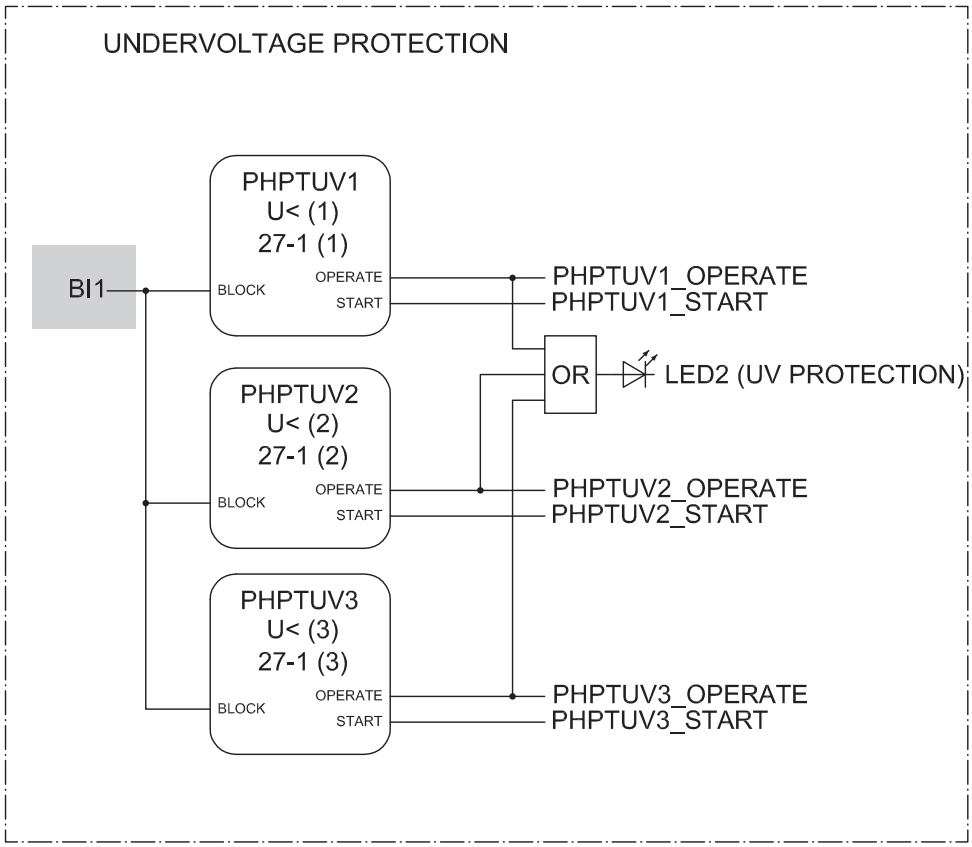


Figure 66: Undervoltaget protection

- Only PHPTUV2 and PHPTUV3 are disabled.

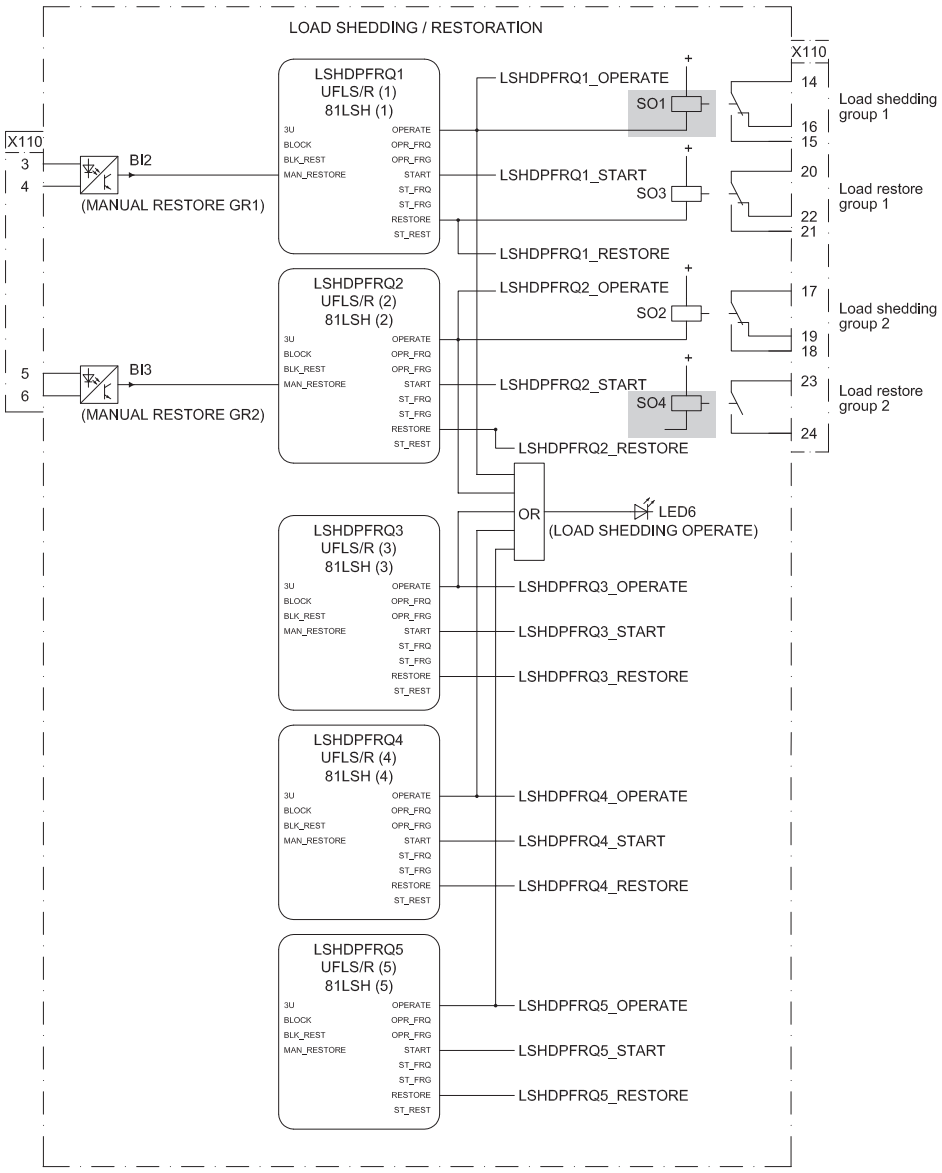


Figure 67: Load-shedding and restoration

- All the five load-shedding and restoration stages are present but all of them are disabled.
- X110:SO1 and X110:SO4 are used for start and operate signals of overvoltage protection stages.

6.2.4.2 Functional diagrams for control and interlocking

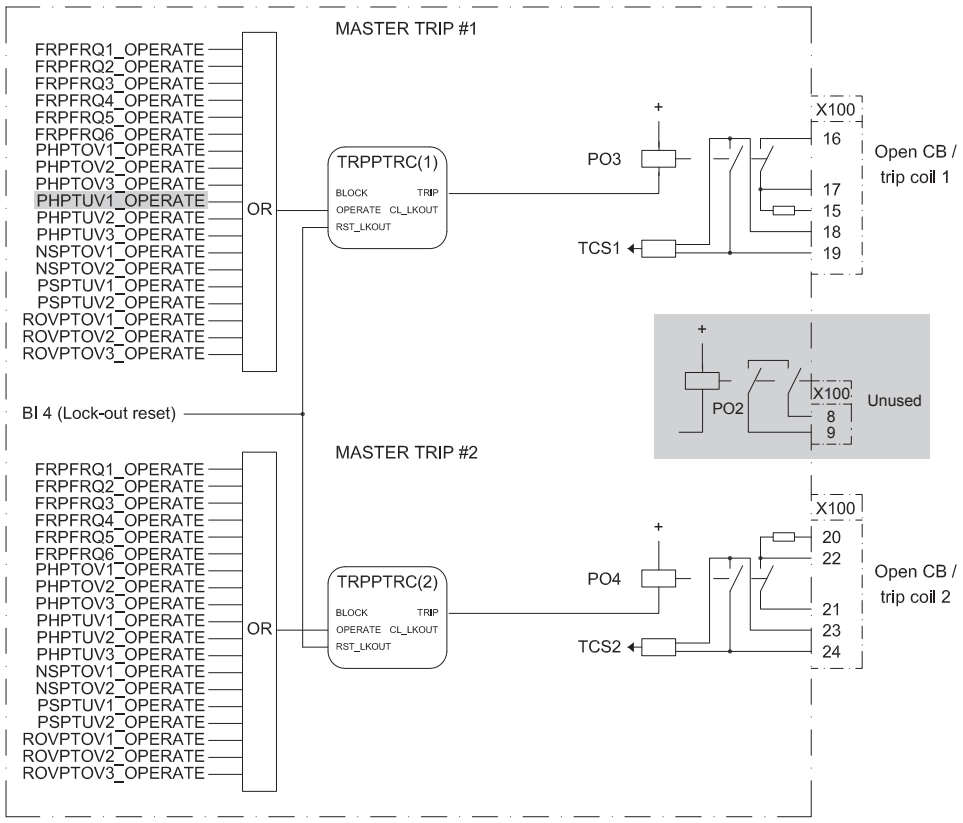


Figure 68: Master trip

The operate signals from the protections are connected to the two trip output contacts PO3 (X100:15-19) and PO4 (X100:20-24) via the corresponding Master Trips TRPPTRC1 and TRPPTRC2.

- PHPTUV1_OPERATE signal is connected to TRPPTRC1 if SGR/8 is set.
- PO2 (X100:8/9) is unused.

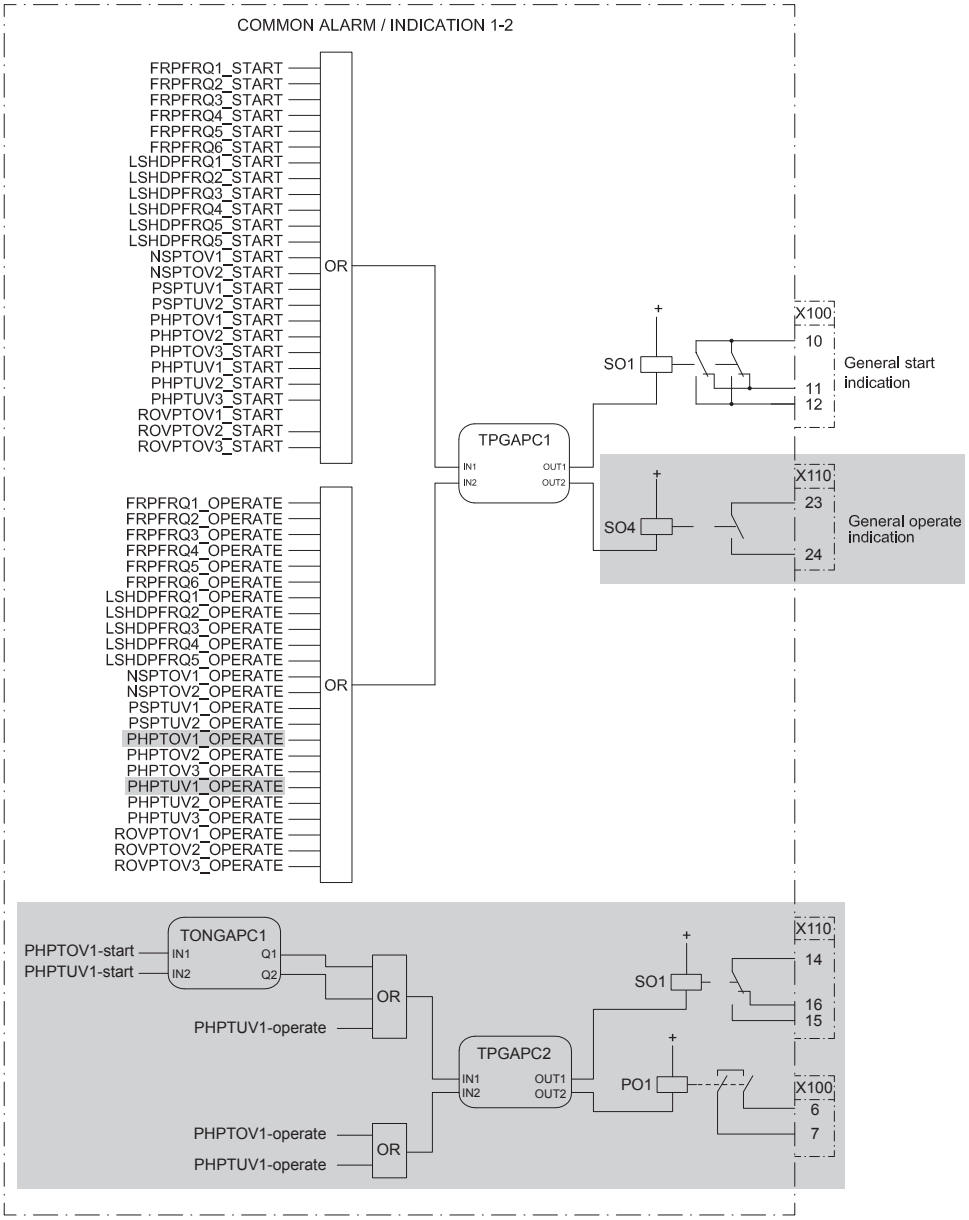


Figure 69: Alarm indication

The signal outputs from the IED are connected to TPGAPC1 to give dedicated information.

- Start of any protection function SO1 (X100:10/11/12)
- Operation (trip) of any protection function SO4 (X110:23/24). This reproduces SPAU 130 C Signal1 and various voltage protection functions are connected to SO4 depending on the switchgroup condition.

- PHPTOV1_OPERATE, if SGR/7 = “1”
- PHPTUV1_OPERATE, if SGR/5 = “1”

The signal outputs from the IED are connected to TPGAPC2.

- Operation (trip) and start of PHPTUV1 and start of PHPTOV1 SO1 (X110:14-16). This reproduces SPAU 130 C Start1. Thus various voltage protection functions are connected to SO1 depending on the switchgroup condition.
  - PHPTOV1-start, if SGR/3 = “1”
  - PHPTUV1-start, if SGR/2 = “1”
  - PHPTUV1-operate, if SGR/4 = “1”
- Operation (trip) of PHPTUV1 and PHPTOV1 PO1 (X100: 6-7). This reproduces SPAU 130 C Trip2. Operate signal of PHPTOV1 is connected to PO1 if SGR/8 = “1”.

6.2.4.3 Setting groups

SPAU 130 C supports main and remote settings which are migrated to setting groups 1 and 2 in REU615.

Changing setting groups from binary input is not supported by SPAU 130 C. This option is not configured on REU615. Setting groups can be changed only from HMI.

6.3 Installation

6.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

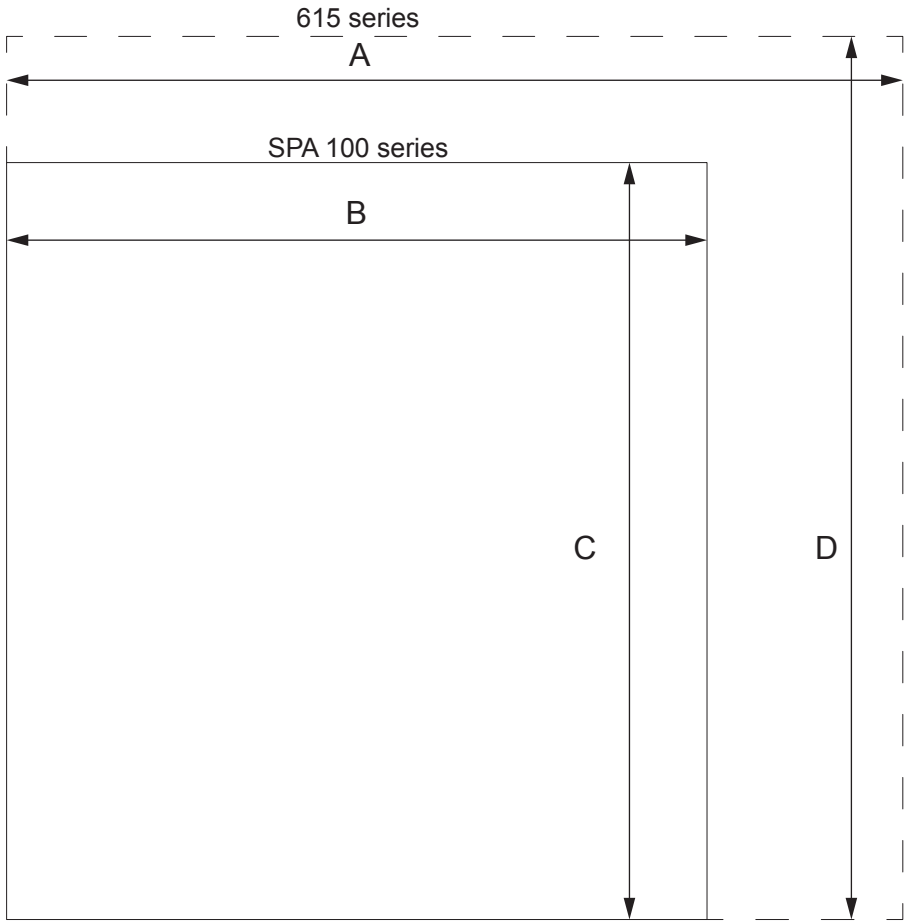


Figure 70: SPACOM 100 series and 615 series cut-outs

A 165.5 mm
B 129 mm
C 139 mm
D 161.5 mm

2. Mount the 615 series IED's case and insert the plug-in unit.

Cover plate is not required with the SPACOM 100 series.

See the 615 series installation manual for more information.

6.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

6.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting SPAU 130 C with REU615.

Table 25: REU615 wiring harness description for retrofit of SPAU 130 C

REU615, configuration A		SPAU 130 C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1 (61)
X100:2	Uaux-	62	Uaux-	X100:2 (62)
X100:3	IRF	72	IRF	X100:3 (72)
X100:4	IRF	71	IRF	X100:4 (71)
X100:5	IRF	70	IRF	X100:5 (70)
X100:6	PO1	68	TRIP2	X100:6 (68)
X100:7	PO1	69	TRIP2	X100:7 (69)
X100:8	PO2	-	-	X100:8
X100:9	PO2	-	-	X100:9
X100:10	SO1	-	-	X100:10
X100:11	SO1	-	-	X100:11
X100:12	SO1	-	-	X100:12
X100:13	SO2	-	-	X100:13.
X100:14	SO2	-	-	X100:14
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	TRIP1	X100:16 (65)
X100:17	PO3	66	TRIP1	X100:17 (66)
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	-	-	X100:21
X100:22	PO4	-	-	X100:22
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X110:1	BI1	10	BS1	X130:1 (10)
X110:2	BI1	11	BS1	X130:2 (11)
X110:3	BI2	-	-	X110:3
X110:4	BI2	-	-	X110:4
X110:5	BI3	-	-	X110:5

Table continues on next page

REU615, configuration A		SPAU 130 C		Wiring
Terminal	Description	Terminal	Description	Marking
X110:6	BI3,4	-	-	X110:6
X110:7	BI4	-	-	X110:7
X110:8	BI5	-	-	X110:8
X110:9	BI5, 6	-	-	X110:9
X110:10	BI6	-	-	X110:10
X110:11	BI7	-	-	X110:11
X110:12	BI7, 8	-	-	X110:12
X110:13	BI8	-	-	X110:13
X110:14	SO1	78	START1	X110:14 (78)
X110:15	SO1	-	-	X110:15
X110:16	SO1	77	START1	X110:16 (77)
X110:17	SO2	-	-	X110:17
X110:18	SO2	-	-	X110:18
X110:19	SO2	-	-	X110:19
X110:20	SO3	-	-	X110:20
X110:21	SO3	-	-	X110:21
X110:22	SO3	-	-	X110:22
X110:23	SO4	81	SIGNAL1	X110:23 (81)
X110:24	SO4	80	SIGNAL1	X110:24 (80)
X130:1	BI1	-	-	X130:1
X130:2	BI1	-	-	X130:2
X130:3	BI2	-	-	X130:3
X130:4	BI2	-	-	X130:4
X130:5	BI3	-	-	X130:5
X130:6	BI3	-	-	X130:6
X130:7	BI4	-	-	X130:7
X130:8	BI4	-	-	X130:8
X130:9	U12B	-	-	X130:9
X130:10	U12B	-	-	X130:10
X130:11	U1	14/15	U12, 100V/110V	X130:11 (14/15)
X130:12	U1	13	U12	X130:12 (13)
X130:13	U2	17/18	U23, 100V/110V	X130:13 (17/18)
X130:14	U2	16	U23	X130:14 (16)
X130:15	U3	20/21	U31, 100V/110V	X130:15 (20/21)
X130:16	U3	19	U31	X130:16 (19)
X130:17	Uo	-	-	X130:17
X130:18	Uo	-	-	X130:18
	Earth	63	Earth	Earth

6.3.2.2 SPAU 130 C terminal layout and connection diagrams

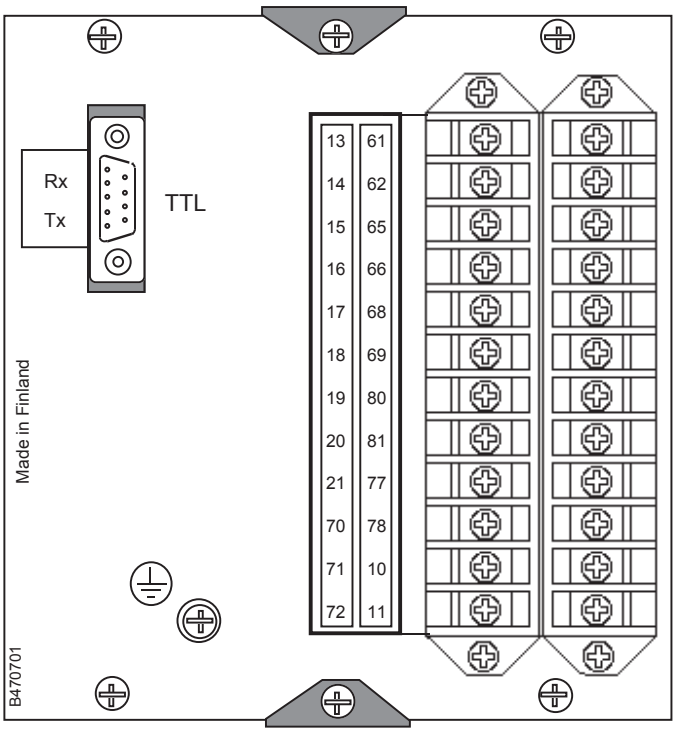


Figure 71: Terminal layout for SPAU 130 C

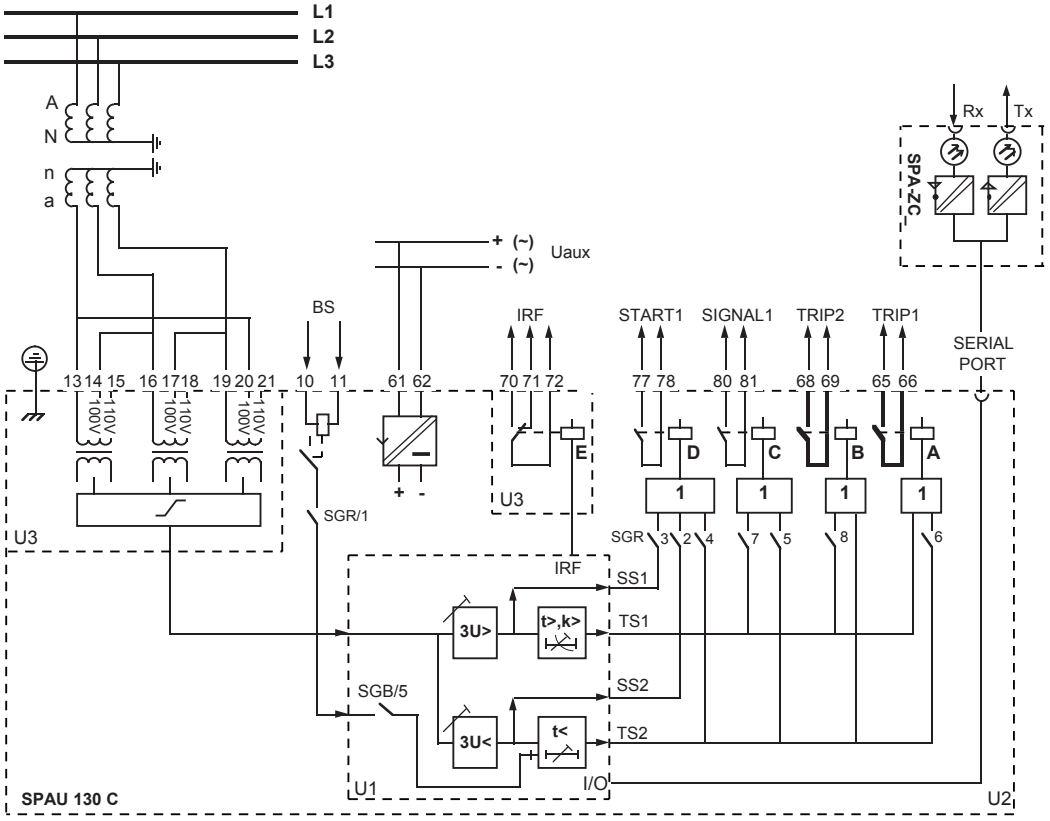


Figure 72: Connection diagram for SPAU 130 C

6.3.2.3 REU615 terminal layout and connection diagrams

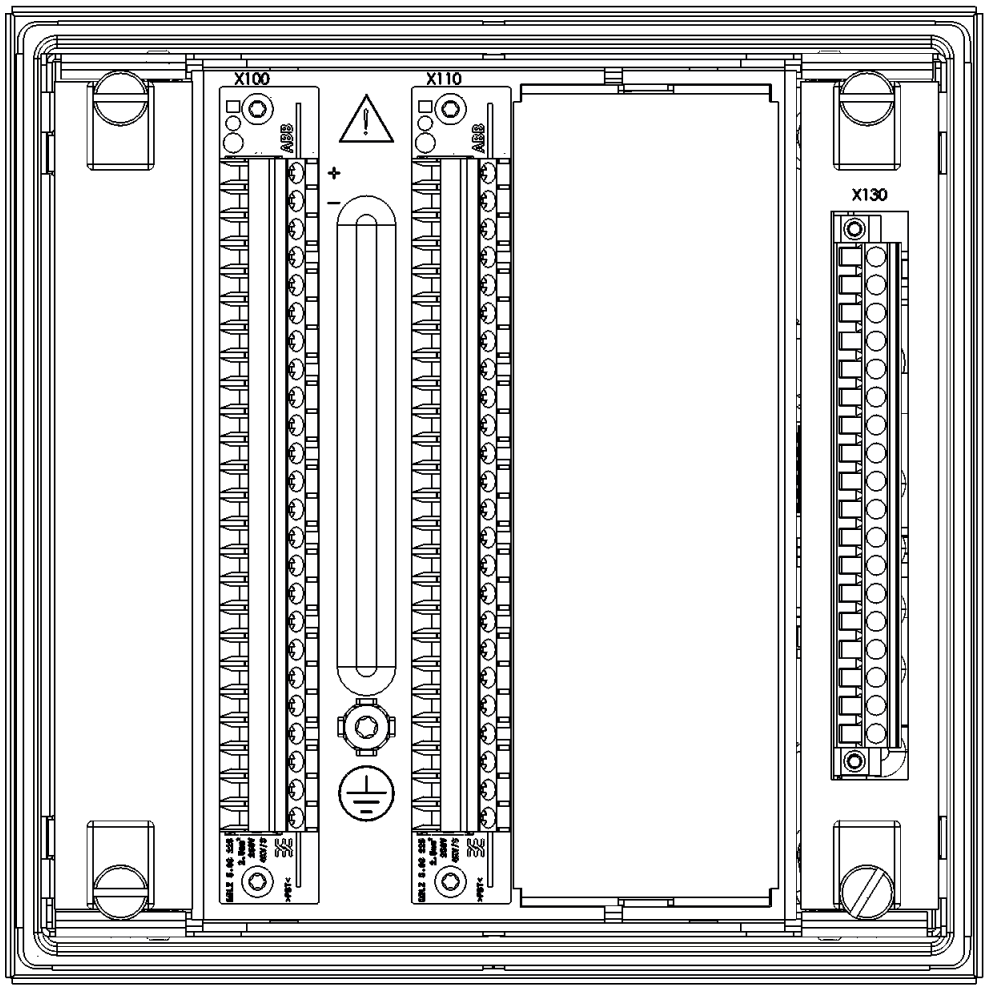


Figure 73: Terminal layout for the 615 series IEDs

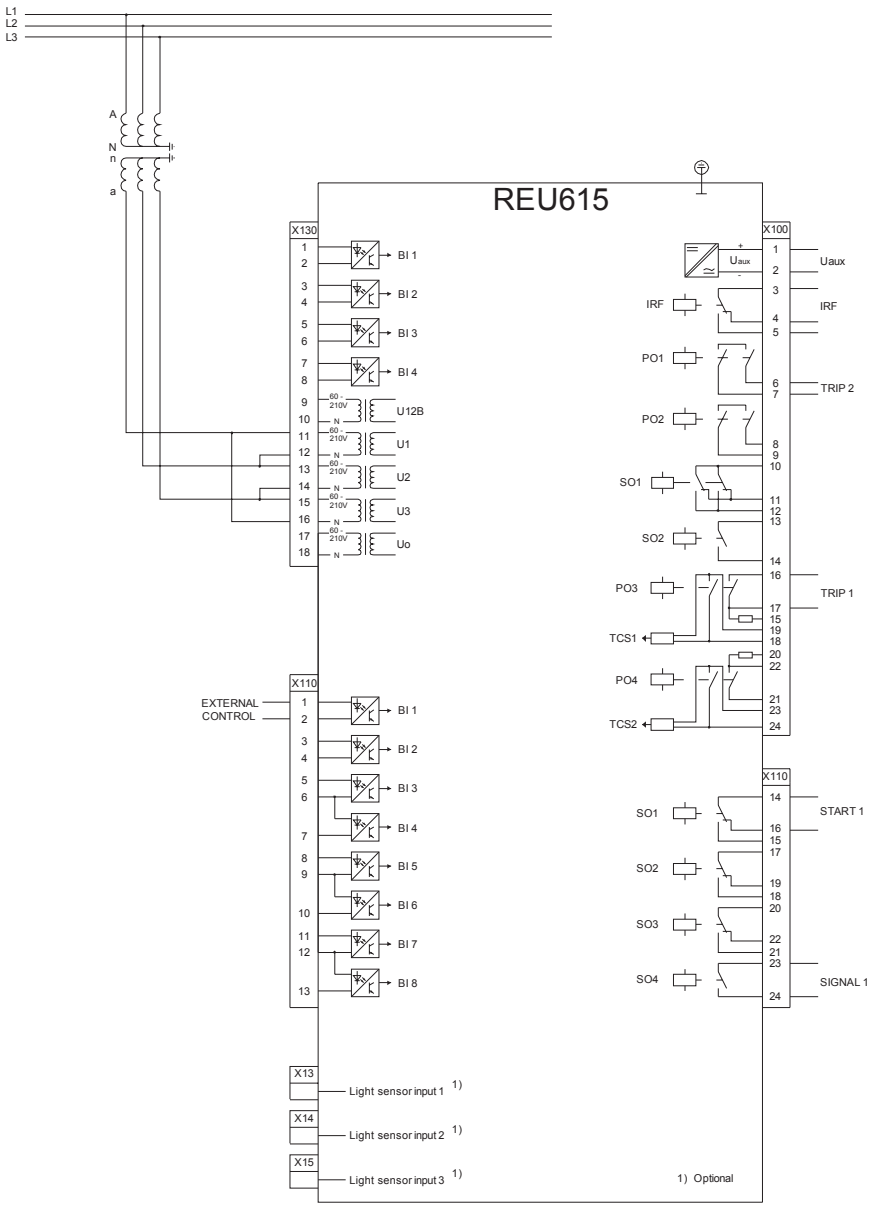


Figure 74: Connection diagram for REU615 with standard configuration A replacing SPAU 130 C

Section 7 SPAU 320 C1 to REU615 Ver.4.0 FP1

7.1 Retrofit scope

Protection functions of SPAU 320 C1 are replicated by REU615 with a deviation.

- SPAU 320 C1 unit SPCU 1C6 can be programmed with a latching feature for the tripping signal with switch SG1/4. This feature is not migrated to REU615.

7.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).
  - Selecting the replacement IED (type and order code)
  - Importing existing relay configuration (.rdb file)
  - Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
  - Entering system parameters
- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

7.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

Various system parameters are collected and imported to PCM600 upon request during the migration process.

- Rated frequency of the network (50 or 60 Hz)
- Secondary rated voltage (100 or 110 V)
- Primary rated voltage (0.100…440.000 kV)
- Secondary rated residual voltage (100 or 110 V)
- Primary rated residual voltage (0.100…440.000 kV)

7.2.2 Functions

The configuration of REU615 migrated from SPAU 320 C1 contains all the functions of Standard configuration A, but only the functions that reproduce the behaviour of the existing relay configurations are enabled.

On SPAU 320 C1, there are three types of selector switchgroups, SGR to configure the output relays, SGB to configure the blocking signal and SG1 to define additional functions as operating time setting ranges and start delay. The switchgroup SGR is located at the front panel of the output relay module. The circuit boards of the relay modules SPCU1C1 and SPCU 1C6 contains the programming switchgroup SGB. SG1 is located on the front panels of the relay modules. The positions of the switches can be read and reported to the IED Migration Support tool during the migration process. These settings are considered when REU615 configuration is generated.

Table 26: Functions included in configuration

SPAU 320 C1	REU615	Description	Enabled [1)]
$U_o>/U_n$	ROVPTOV1	Residual overvoltage protection, instance 1	Yes
$U_o>>/U_n$	ROVPTOV2	Residual overvoltage protection, instance 2	Yes
	ROVPTOV3	Residual overvoltage protection, instance 3	No
$U</U_n$	PHPTUV1	Three-phase undervoltage protection, instance 1	Yes

Table continues on next page

SPAU 320 C1	REU615	Description	Enabled [1]
	PHPTUV2	Three-phase undervoltage protection, instance 2	No
	PHPTUV3	Three-phase undervoltage protection, instance 3	No
U>/U_n	PHPTOV1	Three-phase overvoltage protection, instance 1	Yes
	PHPTOV2	Three-phase overvoltage protection, instance 2	No
	PHPTOV3	Three-phase overvoltage protection, instance 3	No
	PSPTUV1	Positive-sequence undervoltage protection, instance 1	No
	PSPTUV2	Positive-sequence undervoltage protection, instance 2	No
	NSPTOV1	Negative-sequence overvoltage protection, instance 1	No
	NSPTOV2	Negative-sequence overvoltage protection, instance 2	No
	FRPFRQ1	Frequency protection, instance 1	No
	FRPFRQ2	Frequency protection, instance 2	No
	FRPFRQ3	Frequency protection, instance 3	No
	FRPFRQ4	Frequency protection, instance 4	No
	FRPFRQ5	Frequency protection, instance 5	No
	FRPFRQ6	Frequency protection, instance 6	No
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	Yes
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	LSHDPFRQ1	Load shedding and restoration, instance 1	No
	LSHDPFRQ2	Load shedding and restoration, instance 2	No
	LSHDPFRQ3	Load shedding and restoration, instance 3	No
	LSHDPFRQ4	Load shedding and restoration, instance 4	No
	LSHDPFRQ5	Load shedding and restoration, instance 5	No
	CBXCBR1	Circuit-breaker control	No
	DCXSWI1	Disconnector control, instance 1	No
	DCXSWI2	Disconnector control, instance 2	No
	ESXSWI1	Earthing switch control	No
	DCSXSWI1	Disconnector position indication, instance 1	No
	DCSXSWI2	Disconnector position indication, instance 2	No
	DCSXSWI3	Disconnector position indication, instance 3	No
	ESSXSWI1	Earthing switch indication, instance 1	No

Table continues on next page

SPAU 320 C1	REU615	Description	Enabled [1]
	ESSXSWI2	Earthing switch indication, instance 2	No
	SECRSYN1	Synchronism and energizing check	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes
	RDRE1	Disturbance recorder	Yes
	VMMXU1	Three-phase voltage measurement	Yes
	RESVMMXU1	Residual voltage measurement	Yes
	VSMSQI1	Sequence voltage measurement	Yes
	FMMXU1	Frequency measurement	Yes

1) The function is enabled when the parameter *Operation* is set to “on” and disabled when the parameter is set to “off”

7.2.2.1 ROVPTOV1 settings

ROVPTOV1 replicates the behaviour of SPAU 320 C1 residual low-set overvoltage protection function with definite time characteristic (U_o >/ U_n).

In SPAU 320 C1, the settings *start current Uo>* and *operate time t>* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- In SPAU 320 C1, remote settings can be selected with SPA parameter V150. If SPAU 320 C1 *start voltage Uo>* in main setting is above 100% × U_n, ROVPTOV1 *Start value* in Setting Group 1 is set to “1.000” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>* in remote setting is above 100% × Un, ROVPTOV1 *Start value* in Setting Group 2 is set to “1.000” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage Uo>* in main setting is below 1% × U_n, ROVPTOV1 *Start value* in Setting Group 1 is set to “0.010” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>* in remote setting is below 1% × Un, ROVPTOV1 *Start value* in Setting Group 2 is set to “0.010” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is above 300 s, ROVPTOV1 *Operate delay time* in Setting Group 1 is set to “300000 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is above 300 s, ROVPTOV1 *Operate delay time* in Setting Group 2 is set to “300000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is below 0.04 s, ROVPTOV1 *Operate delay time* in Setting Group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is below 0.04 s, ROVPTOV1 *Operate delay time* in Setting Group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.

7.2.2.2 ROVPTOV2 settings

ROVPTOV2 replicates the behaviour of SPAU 320 C1 residual high-set overvoltage protection function with definite time characteristic (U_{o} >> U_n).

In SPAU 320 C1, settings *start voltage Uo>>* and *operate time t>>* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- In SPCU 1C6 module *Uo>>* stage can be set out of operation by setting the *start voltage Uo>>* to infinite (∞or “999”). If the *start voltage setting Uo>>* differs in main and remote settings, only the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage Uo>>* in main setting is above 100% × U_n, ROVPTOV2 *Start value* in Setting Group 1 is set to “1.000” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>>* in remote setting is above 100% × U_n, ROVPTOV2 *Start value* in Setting Group 2 is set to “1.000” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage Uo>>* in main setting is below 1% × U_n, ROVPTOV2 *Start value* in Setting Group 1 is set to “0.010” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage Uo>>* in remote setting is below 1% × U_n, ROVPTOV2 *Start value* in Setting Group 2 is set to “0.010” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>>* in main setting is above 300 s, ROVPTOV2 *Operate delay time* in Setting Group 1 is set to “300000 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>>* in remote setting is above 300 s, ROVPTOV2 *Operate delay time* in Setting Group 2 is set to “300000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>>* in main setting is below 0.04 s, ROVPTOV2 *Operate delay time* in Setting Group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>>* in remote setting is below 0.04 s, ROVPTOV2 *Operate delay time* in Setting Group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.

7.2.2.3 PHPTUV1 settings

PHPTUV1 replicates the behaviour of SPAU 320 C1 single-phase low-set undervoltage protection function with definite (DT) or inverse definite minimum time (IDMT) characteristic (U </ U_n).

In SPAU 320 C1, the settings *start voltage U<* and *operate time t<* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- Switch SG1/8 defines the *U< start delay time*. This delay is reproduced on REU615 with TONGAPC1 function. If the position of switch SG1/8 differs in main and remote settings, only the position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- In SPAU 320 C1, switch SG1/5 defines the selection of automatic blocking of *U<* function. If the position of switch SG1/5 differs in main and remote settings, only the main setting value is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage U<* in main setting is above 1.2 × U_n, PHPTUV1 *Start value* in Setting Group 1 is set to “1.20” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage U<* in remote setting is above 1.2 × U_n, PHPTUV1 *Start value* in Setting Group 2 is set to “1.20” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage U<* in main setting is below 0.05 × U_n, PHPTUV1 *Start value* in Setting Group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage U<* in remote setting is below 0.05 × U_n, PHPTUV1 *Start value* in Setting Group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t<* in main setting is above 300 s, PHPTUV1 *Operate delay time* in Setting Group 1 is set to “300000 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t<* in remote setting is above 300 s, PHPTUV1 *Operate delay time* in Setting Group 2 is set to “300000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t<* in main setting is below 0.06 s, PHPTUV1 *Operate delay time* in Setting Group 1 is set to “60 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t<* in remote setting is below 0.06 s, PHPTUV1 *Operate delay time* in Setting Group 2 is set to “60 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *time multiplier k<* in main setting is above 1.00, PHPTUV1 *time multiplier k<* in Setting Group 1 is set to “1.00” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *time multiplier k<* in remote setting is above 1.00, PHPTUV1 *time multiplier k<* in Setting Group 2 is set to “1.00” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *time multiplier k<* in main setting is below 0.05, PHPTUV1 *time multiplier k<* in Setting Group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *time multiplier k<* in remote setting is below 0.05, PHPTUV1 *time multiplier k<* in Setting Group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.

7.2.2.4 PHPTOV1 settings

PHPTOV1 replicates the behavior of SPAU 320 C1 Single-phase overvoltage protection function with definite (DT) or inverse definite minimum time (IDMT) characteristic ($U >/ U_n$).

In SPAU 320 C1, the settings *start voltage U>* and *operate time t>* are selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

- Switch SG1/2 defines the *U> start time delay*. This delay is reproduced on REU615 with TONGAPC1 function. If the position of switch SG1/2 differs in main and remote settings, only the position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage U>* in main setting is above 1.6 × U_n, PHPTOV1 *Start value* in Setting Group 1 is set to “1.60” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage U>* in remote setting is above 1.6 × U_n, PHPTOV1 *Start value* in Setting Group 2 is set to “1.60” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *start voltage U>* in main setting is below 0.05 × U_n, PHPTOV1 *Start value* in Setting Group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *start voltage U>* in remote setting is below 0.05 × U_n, PHPTOV1 *Start value* in Setting Group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is above 300 s, PHPTOV1 *Operate delay time* in Setting Group 1 is set to “300000 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is above 300 s, PHPTOV1 *Operate delay time* in Setting Group 2 is set to “300000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *operate time t>* in main setting is below 0.04 s, PHPTOV1 *Operate delay time* in Setting Group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *operate time t>* in remote setting is below 0.04 s, PHPTOV1 *Operate delay time* in Setting Group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *time multiplier k>* in main setting is above 1, PHPTOV1 *Time multiplier* in Setting Group 1 is set to “1.00” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *time multiplier k>* in remote setting is above 1, PHPTOV1 Time multiplier in Setting Group 2 is set to “1.00” and a note is issued by the IED Migration Support tool.
- If SPAU 320 C1 *time multiplier k>* in main setting is below 0.05, PHPTOV1 *Time multiplier* in Setting Group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 320 C1 *time multiplier k>* in remote setting is below 0.05, PHPTOV1 *Time multiplier* in Setting Group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.

7.2.3 I/O connections

I/O connections at SPAU 320 C1 terminals are re-mapped to REU615 I/O terminal.

REU615 terminals have additional binary I/Os whose behaviour does not depend on SPAU 320 C1 configuration.

Table 27: Binary inputs

REU615 signal name (terminal)	SPAU 320 C1 signal name (terminal)	Usage
BI1 (X110:1/2)	BS (10/11)	if (unit 1) SGB/4 = “1” ROVPTOV1.BLOCK
		if (unit 1) SGB/5 = “1” ROVPTOV2.BLOCK
		if (unit 2) SGB/5 = “1” PHPTUV1.BLOCK
BI2 (X110:3/4)	-	Manual restore group 1 in LSHDPFRQ1
BI3 (X110:5/6)	-	Manual restore group 2 in LSHDPFRQ2
BI4 (X110:7/6)	-	Unused
BI5 (X110:8/9)	-	Voltage transformer truck in indication
BI6 (X110:10/9)	-	Voltage transformer truck out indication
BI7 (X110:11/12)	-	Earthing switch closed indication
BI8 (X110:13/12)	-	Earthing switch open indication
BI1 (X130:1/2)	-	Unused
BI2 (X130:3/4)	-	Line voltage transformer MCB open
BI3 (X130:5/6)	-	Bus voltage transformer MCB open
BI4 (X130:7/8)	-	Lockout reset

Table 28: Binary outputs

REU615 signal name (terminal)	SPAU 320 C1 signal name (terminal)	Usage
PO1 (X100:6/7)	Output relay B (67/68/69)	if SGR/5 = “1” PHPTOV1.OPERATE
		if SGR/6 = “1” PHPTUV1.OPERATE
		ROVPTOV2.OPERATE
PO2 (X100:8/9)	Output relay E (79/80/81)	ROVPTOV1.OPERATE
SO1 (X100:10/11/12)	-	PHPTOV1.START
		PHPTUV1.START
		ROVPTOV1.START
		ROVPTOV2.START
SO2 (X100:13/14)	-	Unused
PO3 (X100:16/17)	Output relay A (65/66)	if SGR/3 = “1” ROVPTOV1.OPERATE
		if SGR/4 = “1“ ROVPTOV2.OPERATE
		if SGR/1 = “1” PHPTOV1.OPERATE
		if SGR/2 = “1” PHPTUV1.OPERATE
PO4 (X100:20/21/22/23/24)	-	Master trip 2

Table continues on next page

REU615 signal name (terminal)	SPAU 320 C1 signal name (terminal)	Usage
SO1 (X110:14/16)	Output relay D (76/77/78)	if SGR/8 = “1” PHPTUV1. START
		PHPTUV1.OPERATE
SO2 (X110:17/18/19)	-	Connected to “Load Shedding Group 2” but unused
SO3 (X110:20/21/22)	-	Connected to “Load restore group 1” but unused
SO4 (X110:23/24)	Output relay C (73/74/75)	if SGR/7 = ”1” PHPTOV1.START
		PHPTOV1.OPERATE

The type of contacts (single or multiple pole; single or multiple throw) in 615 series can be different from SPACOM relays. See the connection diagram for REU615 standard configuration A.

Normal close contacts (terminals 67, 73, 76 or 79) are not supported in this migration. If normal close contacts are required, the resulting REU615 configuration must be revised, that is, some additional engineering is required.

7.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections in REU615. The default connections can be viewed and changed with PCM600 according to the application requirements, if necessary.

Only SPAU 320 C1 migrated functions are represented in the connection diagrams. REU615 also includes other functions whose connections are configured according to standard configuration A. See REU615 Application Manual.

Operation of additional REU615 functions is disabled if the corresponding functionality is not available in SPAU 320 C1. These functions can be visible in the connection diagrams even if disabled.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

7.2.4.1 Functional diagrams for protection

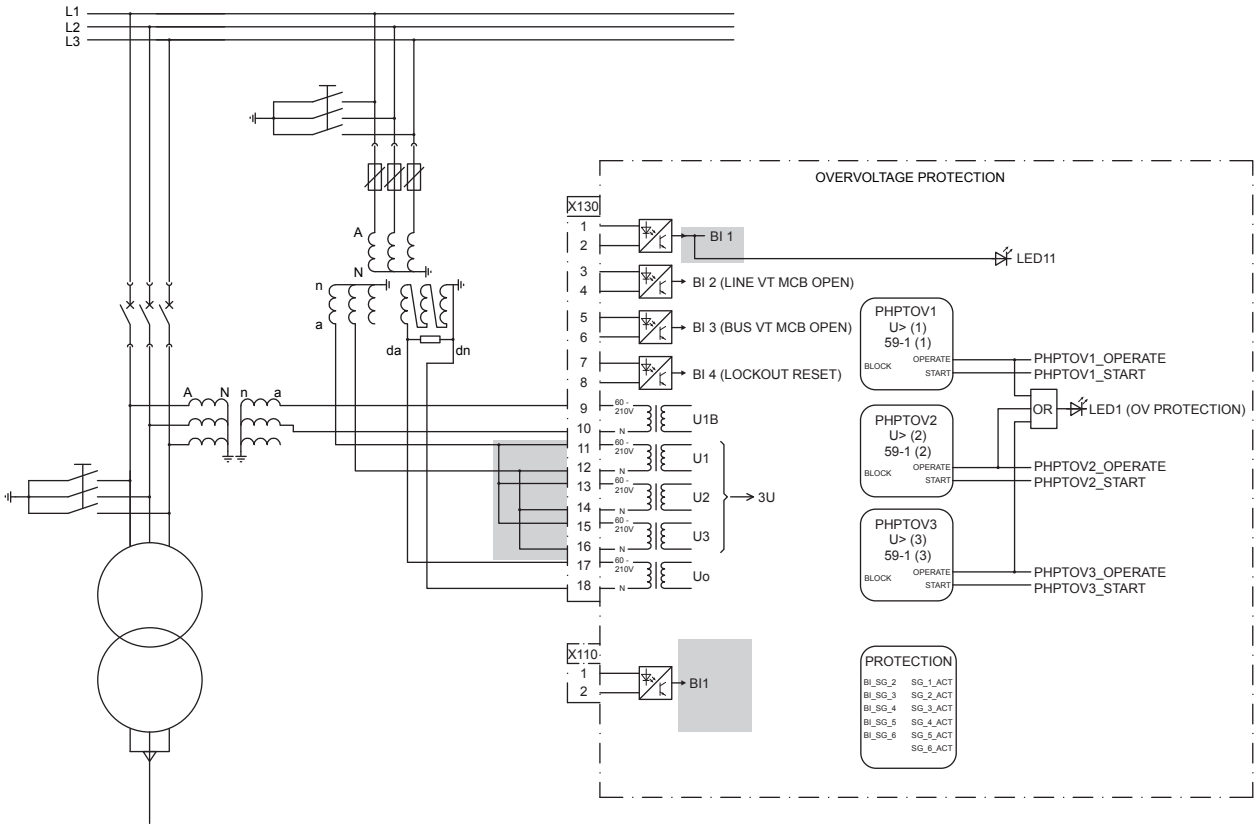


Figure 75: Overvoltage protection

- PHPTOV2 and PHPTOV3 are disabled.
- SPAU 320 C1 has one phase-to-phase input for phase voltages. In REU615, this is done by connecting the one phase-to-phase voltage to all three voltage inputs (X130:11/12, X130:13/14 and X130:15/16).
- PROTECTION for parameter setting group is disabled.

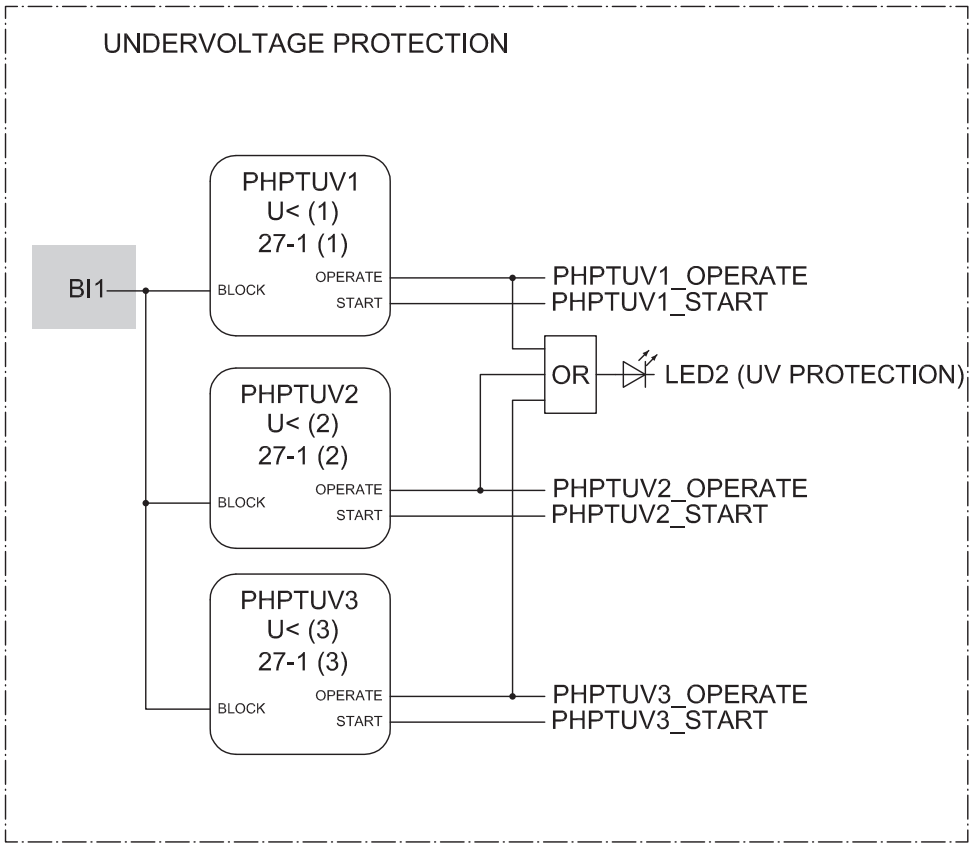


Figure 76: Undervoltage protection

- PHPTUV2 and PHPTUV3 are disabled.

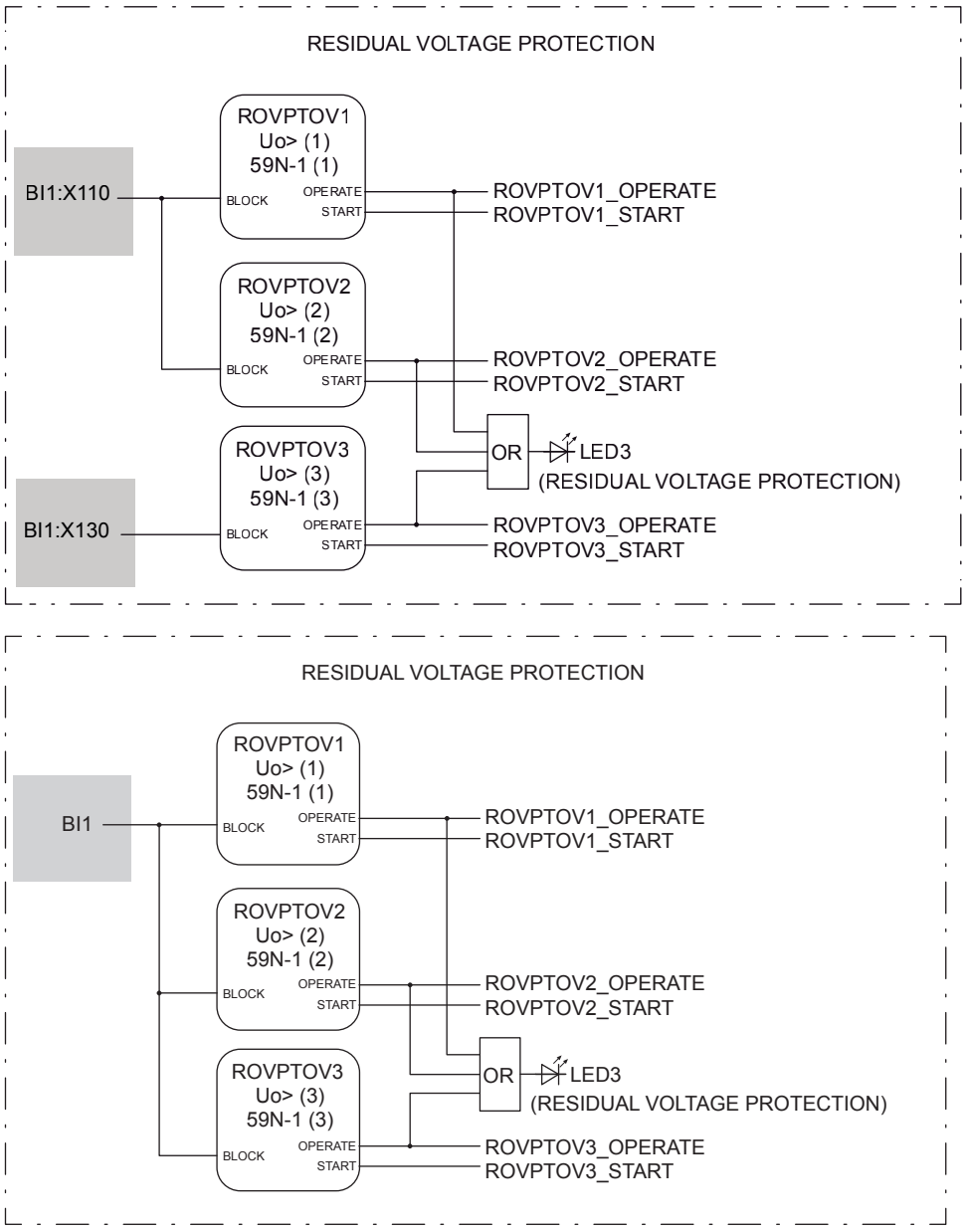


Figure 77: Residual overvoltage protection

- ROVPTOV3 is disabled.

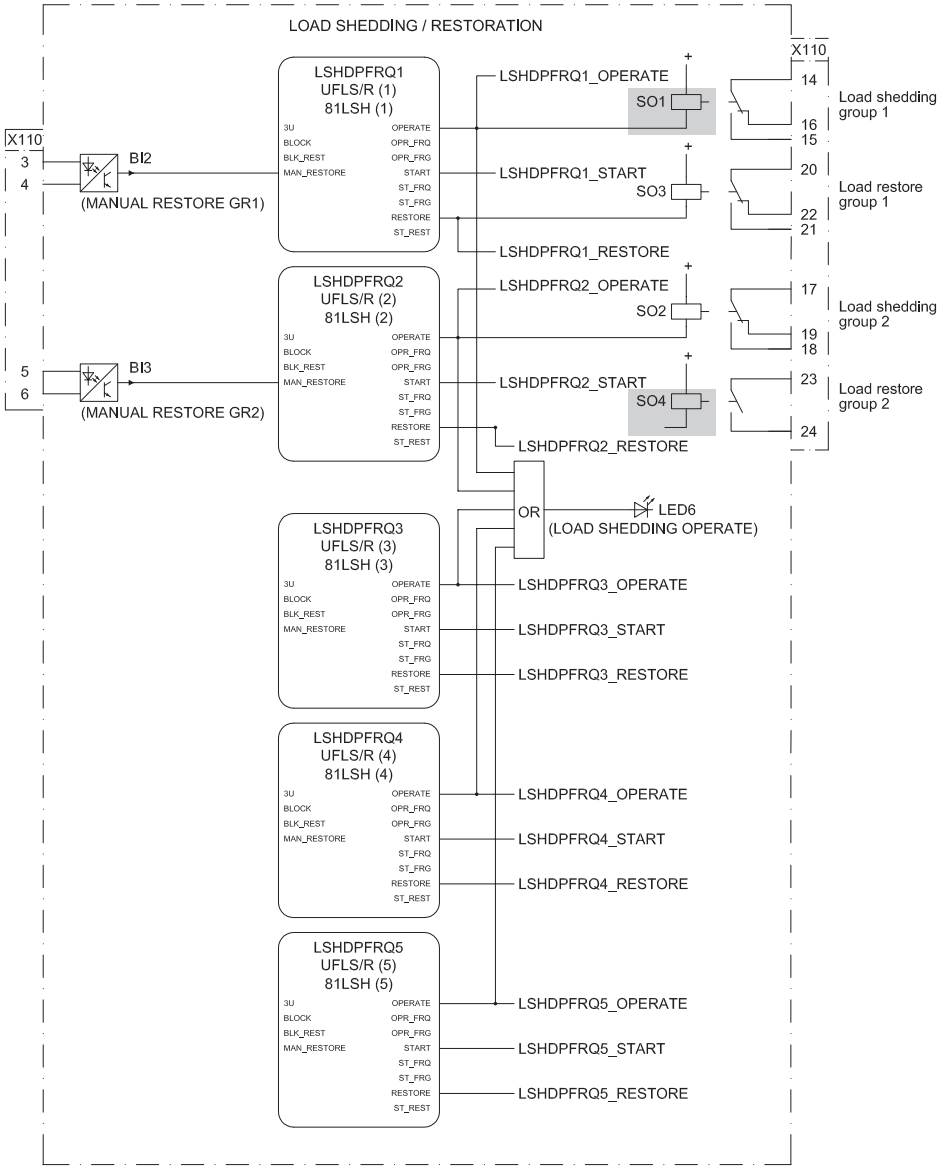


Figure 78: Load shedding and restoration

- All five load shedding and restoration stages are present but all of them are disabled.
- X110:SO1 and X110:SO4 are used for start and operate signals of under and overvoltage protection stages.

7.2.4.2 Functional diagram for control and interlocking

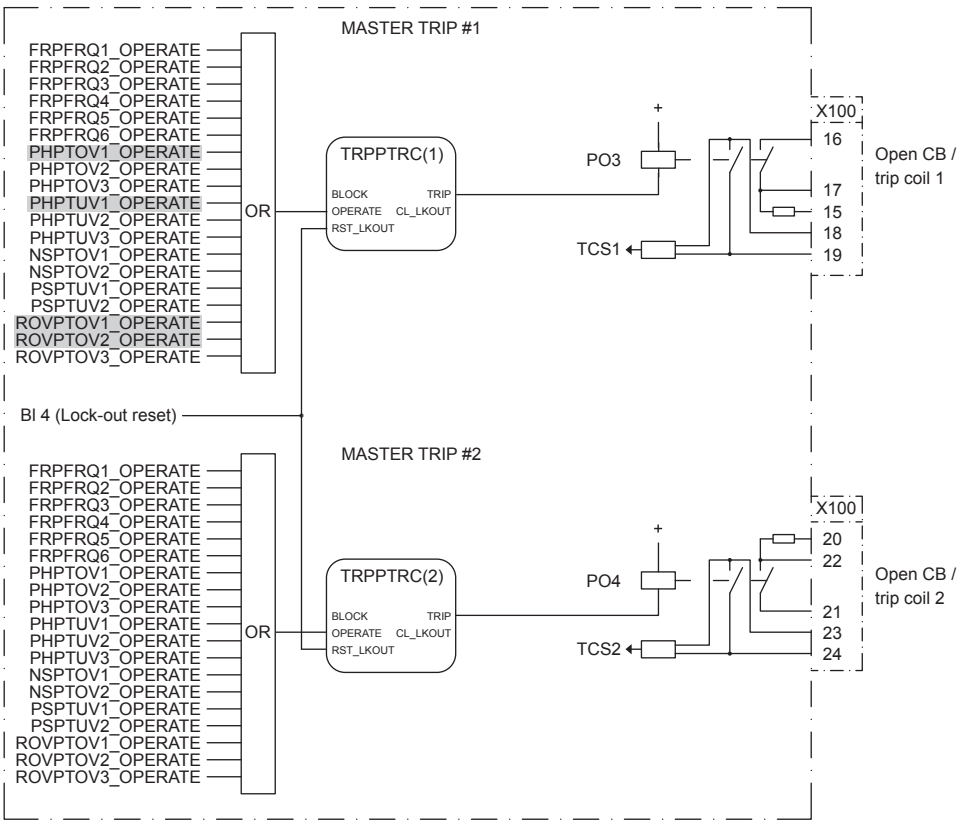


Figure 79: Master trip

The operate signals from the protections are connected to the two trip output contacts PO3 (X100:15-19) and PO4 (X100:20-24) via the corresponding Master Trips TRPPTRC1 and TRPPTRC2.

Various function outputs are connected to TRPPTRC1 based on the switchgroup conditions.

- PHPTOV1_OPERATE, if SGR/1 = “1”
- PHPTUV1_OPERATE, if SGR/2 = “1”
- ROVPTOV1_OPERATE, if SGR/3 = “1”
- ROVPTOV2_OPERATE, if SGR/4 = “1”

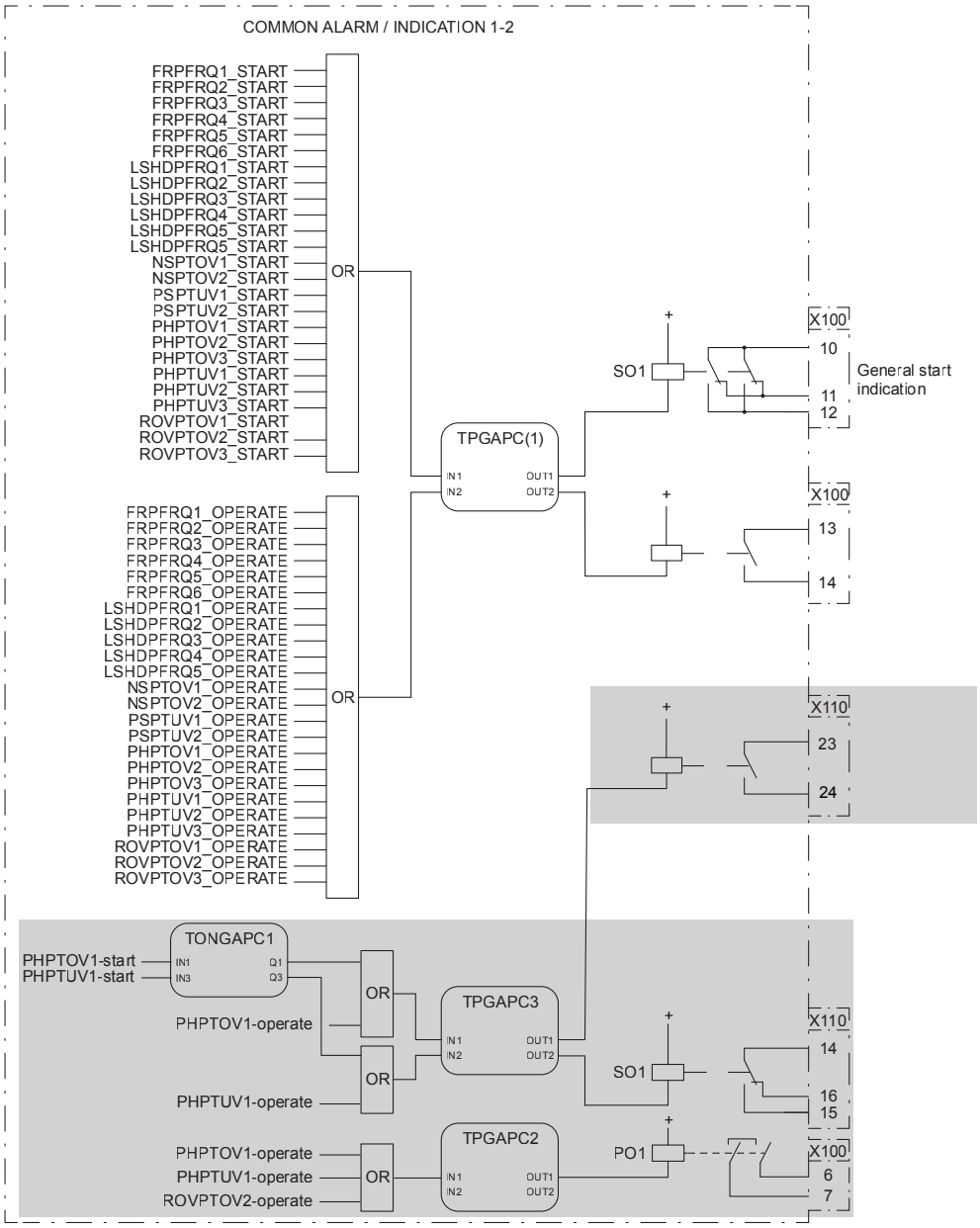


Figure 80: Alarm indication

The start of any protection function from the IED is connected to TPGAPC1 to give general start information SO1 (X100:10-12).

The signal outputs from the overvoltage and undervoltage protection functions are connected to TPGAPC3 to give dedicated information.

- Operation (trip) and start of PHPTOV1 SO4 (X110:23-24) reproduces SPAU 320 C1 Output relay C. Thus, the following voltage protection functions are connected to SO4 depending on the switchgroup condition.

- PHPTOV1_START, if SGR/7 = “1”
- PHPTOV1_OPERATE, always connected

- Operation (trip) and start of PHPTUV1 SO1 (X110:14-16) reproduces SPAU 320 C1 Output relay D. Thus, the following voltage protection functions are connected to SO1 depending on the switchgroup condition.
  - PHPTUV1-start, if SGR/8 = “1”
  - PHPTUV1-operate, always connected

The signal outputs from the overvoltage and undervoltage protection functions are connected to TPGAPC2 to give dedicated operation (trip) information.

- Operation (trip) of PHPTUV1 and PHPTOV1 PO1 (X100:6-7) reproduces SPAU 320 C1 output relay B.
  - Operate signal from PHPTOV1 is connected to PO1, if SGR/5 = “1”
  - Operate signal from PHPTUV1 is connected to PO1, if SGR/6 = “1”
  - Operate signal from ROVPTOV2 is always connected to PO1

7.2.4.3 Setting groups

SPAU 320 C1 supports main and remote settings which are migrated to setting groups 1 and 2 in REU615. The desired setting groups can be selected with SPA bus parameter *V152*.

Changing setting groups from binary input is not supported by SPAU 320 C1. This option is not configured on REU615. Setting groups can be changed only from HMI.

7.3 Installation

7.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

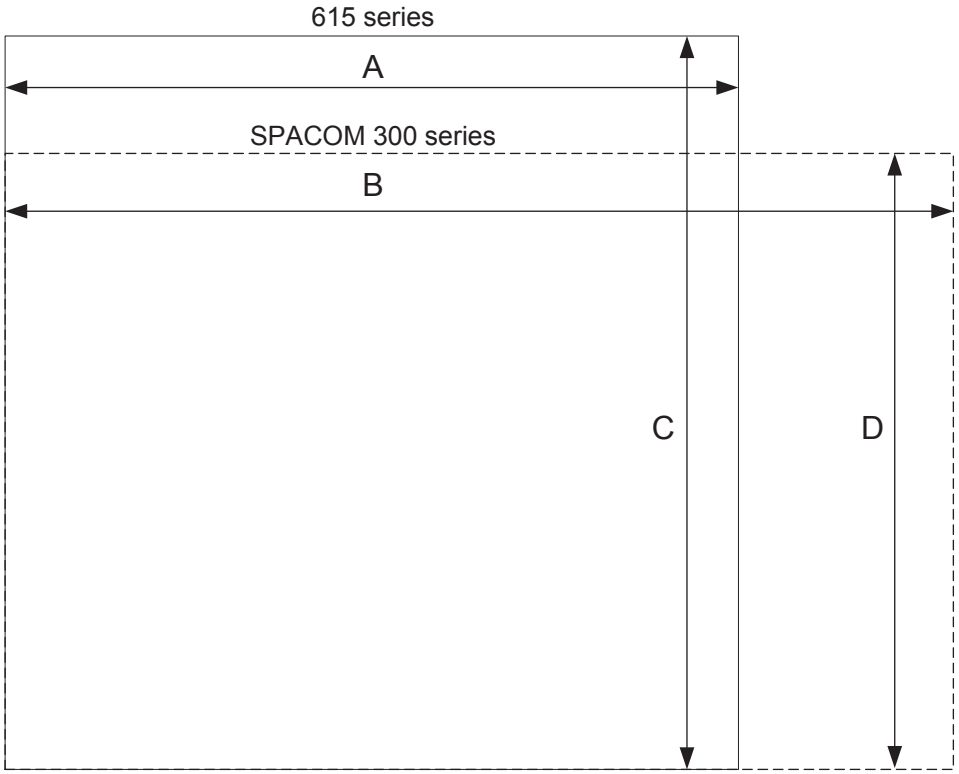


Figure 81: SPACOM 300 series and 615 series cut-outs

A 165.5 mm
B 214 mm
C 165.5 mm
D 139 mm

2. Insert a cover plate (2RCA027885A0001) to hide visible parts of the old opening.
3. Mount the 615 series IED's case and insert the plug-in unit.

See the 615 series installation manual for more information.

7.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

7.3.2.1 Wiring harness and wire markings

Table 29: REU615 wiring harness description for retrofit of SPAU 320 C1

REU615, configuration A		SPAU 320C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1/61
X100:2	Uaux-	62	Uaux-	X100:2/62
X100:3	IRF	72	IRF	X100:3/72
X100:4	IRF	71	IRF	X100:4/71
X100:5	IRF	70	IRF	X100:5/70
X100:6	PO1	68	Output relay B	X100:6/68
X100:7	PO1	69	Output relay B	X100:7/69
X100:8	PO2	80	Output relay E	X100:8/80
X100:9	PO2	81	Output relay E	X100:9/81
X100:10	SO1	-	-	X100:10
X100:11	SO1	-	-	X100:11
X100:12	SO1	-	-	X100:12
X100:13	SO2	-	-	X100:13
X100:14	SO2	-	-	X100:14
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	Output relay A	X100:16/65
X100:17	PO3	66	Output relay A	X100:17/66
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	-	-	X100:21
X100:22	PO4	-	-	X100:22
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X110:1	BI1	10	BS1	X110:1/10
X110:2	BI1	11	BS1	X110:2/11
X110:3	BI2	-	-	X110:3
X110:4	BI2	-	-	X110:4
X110:5	BI3	-	-	X110:5
X110:6	BI3,4	-	-	X110:6
X110:7	BI4	-	-	X110:7
X110:8	BI5	-	-	X110:8
X110:9	BI5, 6	-	-	X110:9
X110:10	BI6	-	-	X110:10
X110:11	BI7	-	-	X110:11
X110:12	BI7, 8	-	-	X110:12

Table continues on next page

REU615, configuration A		SPAU 320C		Wiring
Terminal	Description	Terminal	Description	Marking
X110:13	BI8	-	-	X110:13
X110:14	SO1	78	Output relay D	X110:14/78
X110:15	SO1	76	Output relay D	X110:15/76
X110:16	SO1	77	Output relay D	X110:16/77
X110:17	SO2	-	-	X110:17
X110:18	SO2	-	-	X110:18
X110:19	SO2	-	-	X110:19
X110:20	SO3	-	-	X110:20
X110:21	SO3	-	-	X110:21
X110:22	SO3	-	-	X110:22
X110:23	SO4	74	Output relay C	X110:23/74
X110:24	SO4	75	Output relay C	X110:24/75
X130:1	BI1	-	-	X130:1
X130:2	BI1	-	-	X130:2
X130:3	BI2	-	-	X130:3
X130:4	BI2	-	-	X130:4
X130:5	BI3	-	-	X130:5
X130:6	BI3	-	-	X130:6
X130:7	BI4	-	-	X130:7
X130:8	BI4	-	-	X130:8
X130:9	U12B	-	-	X130:9
X130:10	U12B	-	-	X130:10
X130:11	U12	14/15	U12, 100V/110V	X130:11/14/15
X130:12	U12	13	U12	X130:12/13
X130:13	U23	17/18	U23, 100V/110V	X130:13/17/18

7.3.2.2 SPAU 320 C1 terminal layout and connection diagrams

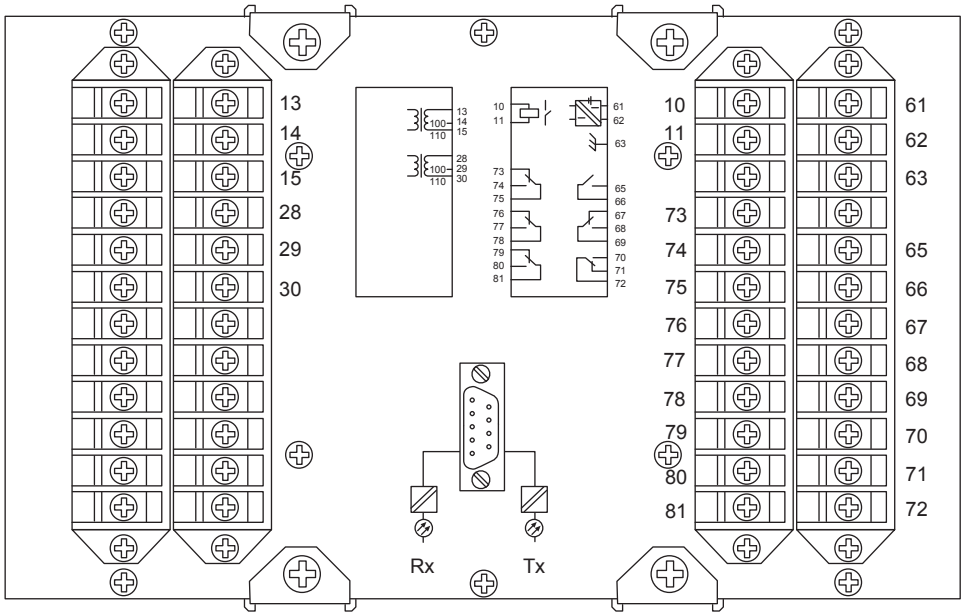


Figure 82: Terminal layout for SPAU 320 C1

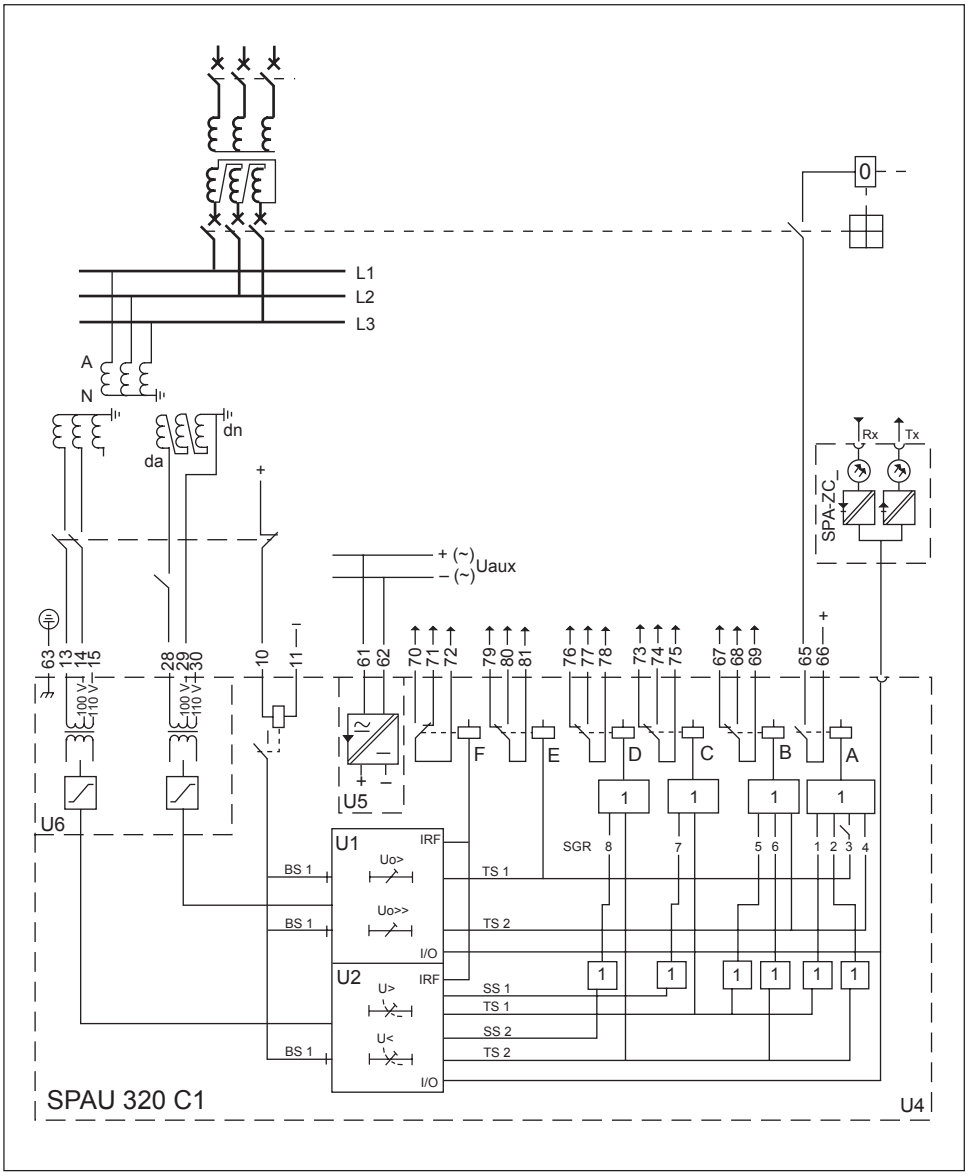


Figure 83: Connection diagram for SPAU 320 C1

7.3.2.3 REU615 terminal layout and connection diagrams

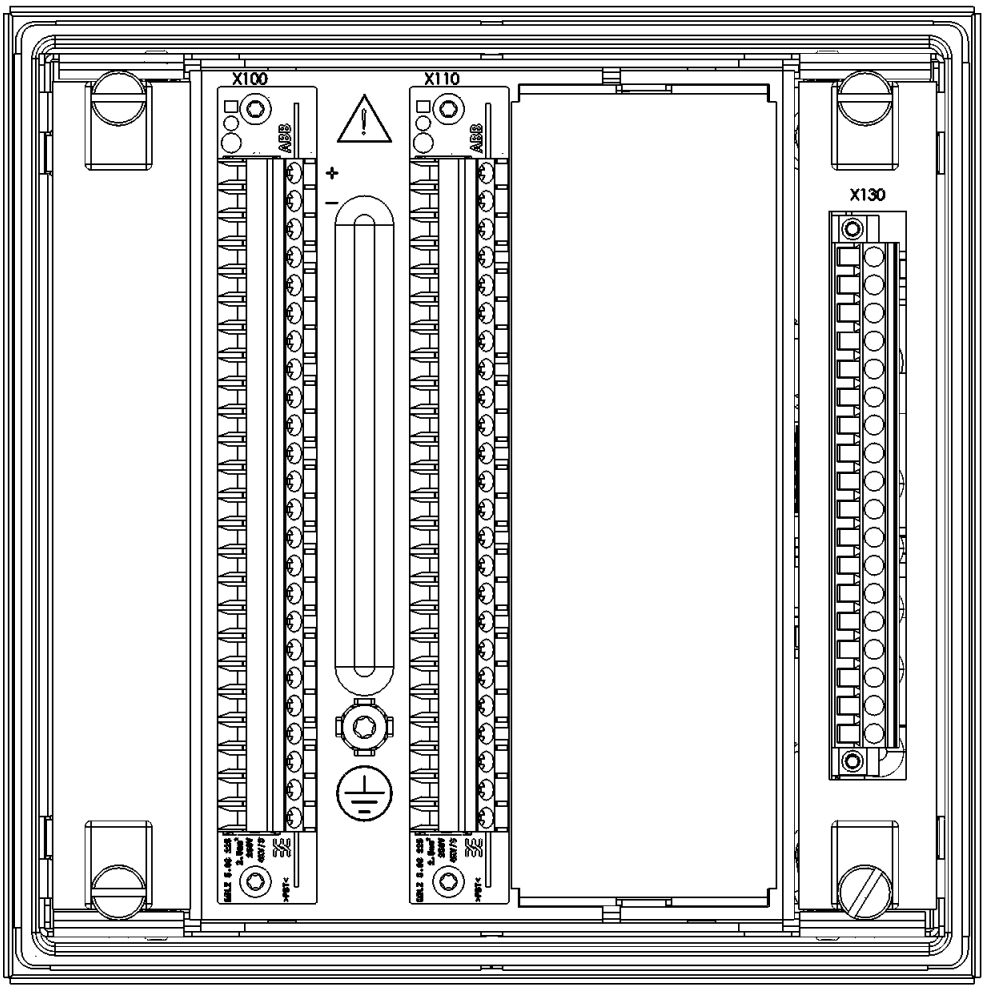


Figure 84: Terminal layout for the 615 series IEDs

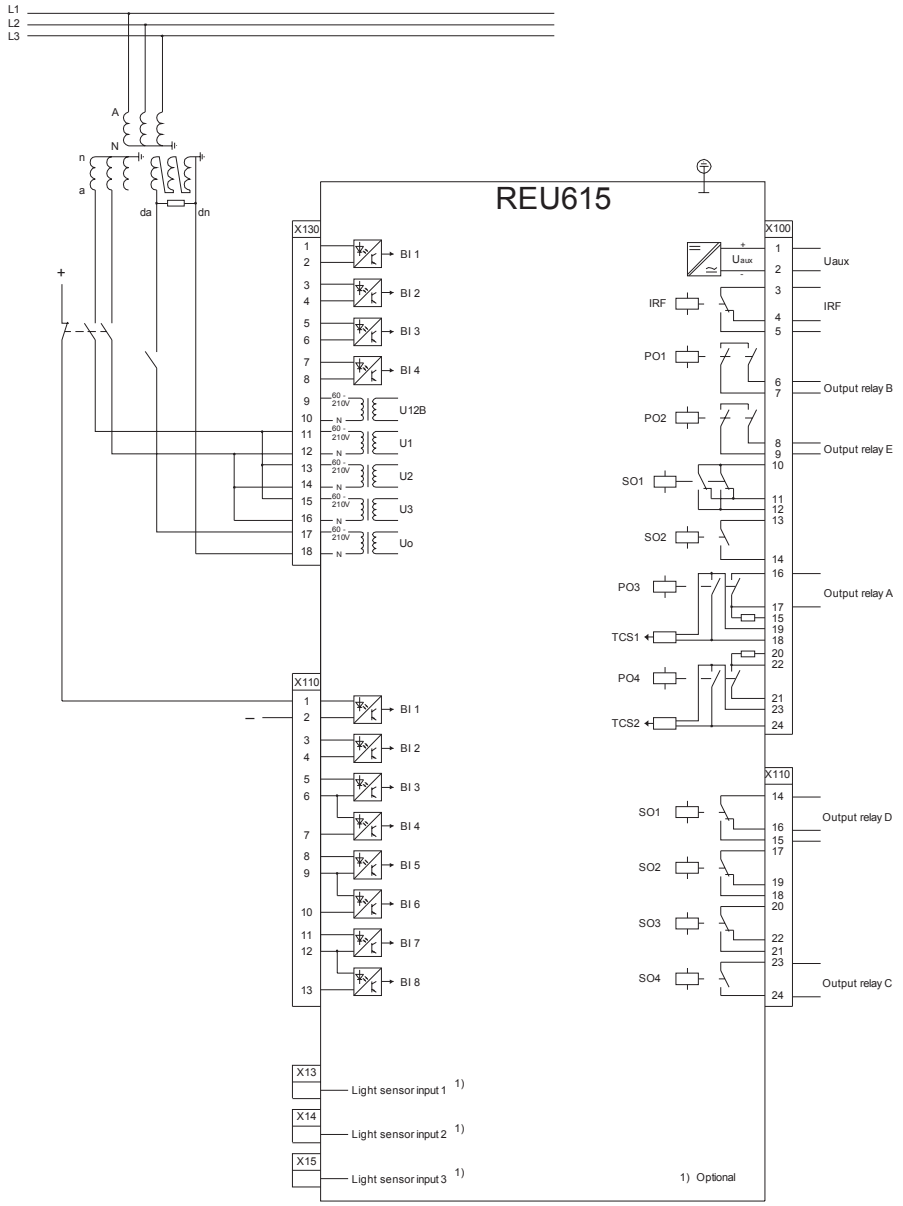


Figure 85: Connection diagram for REU615 with standard configuration A replacing SPAU 320 C1

Section 8 SPAU 330 C1 to REU615 Ver.4.0 FP1

8.1 Retrofit scope

Protection functions of SPAU 330 C1 are replicated by REU615 with a deviation.

- SPAU 330 C1 unit SPCU 1C6 can be programmed with a latching feature for the tripping signal with switch SG1/4. This feature is not migrated to REU615.

SPAU 330 C can be configured for single-phase operation (SG1/1 =1). In REU615, this is done by connecting the single-phase voltage to all three voltage inputs X120-1,2, X120-3,4 and X120-5,6.

8.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

CAP505

- Reading the configuration from the SPACOM relay or manually entering parameter values.

In CAP505 tool, the actual values read from the SPACOM relay are called present values. The manually entered values are called new values. After relay writing and reading operations present and new values become identical.

PCM600

- Instantiating a new retrofit IED (IED Migration Support tool from PCM600).

- Selecting the replacement IED (type and order code)
- Importing existing relay configuration (.rdb file)
- Selecting the set of values to use using the IED Migration Support tool, if the *Present and New* values differ in .rdb file
- Entering system parameters

- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

8.2.1 Existing relay and system engineering information

The configuration of the SPACOM relay can be retrieved via the serial connection using CAP 505 tool. Parameters are read from the display of the SPACOM relay and manually inserted in CAP 505. The configuration parameters are exported from CAP 505 in .rdb file format and imported in PCM600 during the migration process.

Various system parameters are collected and imported to PCM600 upon request during the migration process.

- Rated frequency of the network (50 or 60 Hz)
- Secondary rated voltage (100 or 110 V)
- Primary rated voltage (0.100…440.000 kV)
- Secondary rated residual voltage (100 or 110 V)
- Primary rated residual voltage (0.100…440.000 kV)

8.2.2 Functions

The configuration of REU615 migrated from SPAU 330 C1 contains all the functions belonging to the standard configuration A, but only the functions that reproduce the behavior of the existing relay configuration are enabled.

On SPAU 330 C1, there are three types of selector switchgroups: SGR to configure the output relays, SGB to configure blocking signal and SG1 to define additional functions as operating time setting ranges and start delay.

The switchgroup SGR is located at the front panel of the output relay module. The circuit boards of the relay modules SPCU 1C1 and SPCU 3C14 contain the programming switchgroup SGB. SG1 is located on the front panels of the relay

modules. The position of the switches can be read and reported to the IED Migration Support tool during the migration process. These settings are considered when REU615 configuration is generated.

Table 30: Functions included in configuration

SPAU 330 C1	REU615	Description	Enabled [1)]
$U_o>/U_n$	ROVPTOV1	Residual overvoltage protection, instance 1	Yes
$U_o>>/U_n$	ROVPTOV2	Residual overvoltage protection, instance 2	Yes
	ROVPTOV3	Residual overvoltage protection, instance 3	No
$U</U_n$	PHPTUV1	Three-phase undervoltage protection, instance 1	Yes
	PHPTUV2	Three-phase undervoltage protection, instance 2	No
	PHPTUV3	Three-phase undervoltage protection, instance 3	No
$U>/U_n$	PHPTOV1	Three-phase overvoltage protection, instance 1	Yes
	PHPTOV2	Three-phase overvoltage protection, instance 2	No
	PHPTOV3	Three-phase overvoltage protection, instance 3	No
	PSPTUV1	Positive-sequence undervoltage protection, instance 1	No
	PSPTUV2	Positive-sequence undervoltage protection, instance 2	No
	NSPTOV1	Negative-sequence overvoltage protection, instance 1	No
	NSPTOV2	Negative-sequence overvoltage protection, instance 2	No
	FRPFRQ1	Frequency protection, instance 1	No
	FRPFRQ2	Frequency protection, instance 2	No
	FRPFRQ3	Frequency protection, instance 3	No
	FRPFRQ4	Frequency protection, instance 4	No
	FRPFRQ5	Frequency protection, instance 5	No
	FRPFRQ6	Frequency protection, instance 6	No
	TRPPTRC1	Master trip, instance 1	Yes
	TRPPTRC2	Master trip, instance 2	Yes
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	LSHDPFRQ1	Load shedding and restoration, instance 1	No
	LSHDPFRQ2	Load shedding and restoration, instance 2	No
	LSHDPFRQ3	Load shedding and restoration, instance 3	No
	LSHDPFRQ4	Load shedding and restoration, instance 4	No
	LSHDPFRQ5	Load shedding and restoration, instance 5	No

Table continues on next page

SPAU 330 C1	REU615	Description	Enabled [1]
	CBXCBR1	Circuit-breaker control	No
	DCXSWI1	Disconnector control, instance 1	No
	DCXSWI2	Disconnector control, instance 2	No
	ESXSWI1	Earthing switch control	No
	DCSXSWI1	Disconnector position indication, instance 1	No
	DCSXSWI2	Disconnector position indication, instance 2	No
	DCSXSWI3	Disconnector position indication, instance 3	No
	ESSXSWI1	Earthing switch indication, instance 1	No
	ESSXSWI2	Earthing switch indication, instance 2	No
	SECRSYN1	Synchronism and energizing check	No
	TCSSCBR1	Trip circuit supervision, instance 1	Yes
	TCSSCBR2	Trip circuit supervision, instance 2	Yes
	RDRE1	Disturbance recorder	Yes
	VMMXU1	Three-phase voltage measurement	Yes
	RESVMMXU1	Residual voltage measurement	Yes
	VSMSQI1	Sequence voltage measurement	Yes
	FMMXU1	Frequency measurement	Yes

1) Function is enabled when the parameter *Operation* is set to “on” and disabled when the parameter is set to “off”.

8.2.2.1 ROVPTOV1 settings

ROVPTOV1 replicates the behavior of SPAU 330 C1 residual low-set overvoltage protection function with definite time characteristic (Uo>/U_n).

In SPAU 330 C1, settings *start voltage Uo>* and *operate time t>* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- In SPAU 330 C1, remote settings can be selected with the SPA parameter *V150*. If SPAU 330 C1 *start voltage Uo>* in main setting is over 100% × Un, ROVPTOV1 *Start value* in setting group 1 is set to “1.000” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage Uo>* in remote setting is over 100% × Un, ROVPTOV1 *Start value* in setting group 2 is set to “1.000” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage Uo>* in main setting is under 1% × Un, ROVPTOV1 *Start value* in setting group 1 is set to “0.010” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage Uo>* in remote setting is under 1% × Un, ROVPTOV1 *Start value* in setting group 2 is set to “0.010” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>* in main setting is over 300 s, ROVPTOV1 *Operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>* in remote

setting is over 300 s, ROVPTOV1 *Operate delay time* in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>* in main setting is under 0.04 s, ROVPTOV1 *Operate delay time* in setting group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>* in remote setting is under 0.04 s, ROVPTOV1 *Operate delay time* in setting group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.

8.2.2.2 ROVPTOV2 settings

ROVPTOV2 replicates the behavior of SPAU 330 C1 residual high-set overvoltage protection function with definite time characteristic (Uo>>/U_n).

In SPAU 330 C1, settings *start voltage Uo>>* and *operate time t>>* can be selected from the dedicated knobs. The values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- In the SPCU 1C6 module, Uo>> stage can be set out of operation by setting the *start voltage Uo>>* to infinite (“∞” or “999”). If the setting *start voltage Uo>>* differs in main and remote settings, only main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage Uo>>* in main setting is over 100% × Un, ROVPTOV2 *Start value* in setting group 1 is set to “1.000” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage Uo>>* in remote setting is over 100% × U_n, ROVPTOV2 *Start value* in setting group 2 is set to “1.000” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage Uo>>* in main setting is under 1% × Un, the ROVPTOV2 *Start value* in setting group 1 is set to “0.010” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage Uo>>* in remote setting is under 1% × Un, ROVPTOV2 *Start value* in setting group 2 is set to “0.010” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>>* in main setting is over 300 s, ROVPTOV2 *Operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>>* in remote setting is over 300 s, ROVPTOV2 *Operate delay time* in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>>* in main setting is under 0.04 s, ROVPTOV2 *Operate delay time* in setting group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>>* in remote setting is under 0.04 s, ROVPTOV2 *Operate delay time* in setting group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.

8.2.2.3 PHPTUV1 settings

PHPTUV1 replicates the behavior of SPAU 330 C1 three-phase low-set undervoltage protection function with definite or inverse definite minimum time characteristic (U</U_n).

In SPAU 330 C1, settings *start voltage U<* and *operate time t<* can be selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- Switch SG1/7 defines the *U< start delay* time. This delay is reproduced on REU615 with the TONGAPC1 function. If the position of switch SG1/7 differs in main and remote settings, only position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- In SPAU 330 C1, switch SG1/6 defines the selection of automatic blocking of the U< function. If the position of switch SG1/6 differs in main and remote settings, only the main setting value is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage U<* in main setting is over 1.2 × Un, PHPTUV1 *Start value* in setting group 1 is set to “1.20” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage U<* in remote setting is over 1.2 × Un, PHPTUV1 *Start value* in setting group 2 is set to “1.20” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage U<* in main setting is under 0.05 × Un, PHPTUV1 *Start value* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage U<* in remote setting is under 0.05 × Un, PHPTUV1 *Start value* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t<* in main setting is over 300 s, PHPTUV1 *Operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t<* in remote setting is over 300 s, PHPTUV1 *Operate delay* time in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t<* in main setting is under 0.06 s, PHPTUV1 *Operate delay time* in setting group 1 is set to “60 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t<* in remote setting is under 0.06 s, PHPTUV1 *Operate delay time* in setting group 2 is set to “60 ms” and a note is issued by the IED Migration Support tool.

8.2.2.4 PHPTOV1 settings

PHPTOV1 replicates the behavior of SPAU 330 C1 three-phase overvoltage protection function with definite or inverse definite minimum time characteristic (U>/U_n).

In SPAU 330 C1, settings *start voltage U>* and *operate time t>* are selected from the dedicated knobs. These values can be checked and modified from the IED Migration Support tool during the migration process.

The *Measurement mode* parameter is set to “RMS”.

- Switch SG1/2 defines the *U> start time* delay. This delay is reproduced on REU615 with the TONGAPC1 function. If the position of switch SG1/2 differs in main and remote settings, only position of the main setting is considered in migration and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage U>* in main setting is over 1.6 × U_n, PHPTOV1 *Start value* in setting group 1 is set to “1.60” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage U>* in remote setting is over 1.6 × U_n, PHPTOV1 *Start value* in setting group 2 is set to “1.60” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *start voltage U>* in main setting is under 0.05 × U_n, PHPTOV1 *Start value* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *start voltage U>* in remote setting is under 0.05 × U_n, PHPTOV1 *Start value* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>* in main setting is over 300 s, PHPTOV1 *Operate delay time* in setting group 1 is set to “300 000 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>* in remote setting is over 300 s, PHPTOV1 *Operate delay time* in setting group 2 is set to “300 000 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *operate time t>* in main setting is under 0.04 s, PHPTOV1 *Operate delay time* in setting group 1 is set to “40 ms” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *operate time t>* in remote setting is under 0.04 s, PHPTOV1 *Operate delay time* in setting group 2 is set to “40 ms” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *time multiplier k>* in main setting is over 1, PHPTOV1 *Time multiplier* in setting group 1 is set to “1.00” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *time multiplier k>* in remote setting is over 1, PHPTOV1 *Time multiplier* in setting group 2 is set to “1.00” and a note is issued by the IED Migration Support tool.
- If SPAU 330 C1 *time multiplier k>* in main setting is under 0.05, PHPTOV1 *Time multiplier* in setting group 1 is set to “0.05” and a note is issued by the IED Migration Support tool. If SPAU 330 C1 *time multiplier k>* in remote setting is under 0.05, PHPTOV1 *Time multiplier* in setting group 2 is set to “0.05” and a note is issued by the IED Migration Support tool.

8.2.3 I/O connections

I/O connections at SPAU 330 C1 terminals are remapped to REU615 I/O terminal.

REU615 terminals have additional binary I/Os whose behavior does not depend on SPAU 330 C1 configuration.

Table 31: Binary inputs

REU615	SPAU 330 C1	Usage
BI1 (X110:1/2)	BS (10/11)	if (unit 1) SGB/4 = “1” ROVPTOV1.BLOCK
		if (unit 1) SGB/5 = “1” ROVPTOV2.BLOCK
		if (unit 2) SGB/5 = “1” PHPTUV1.BLOCK
BI2 (X110:3/4)	Not available	Manual restore group 1 in LSHDPFRQ1
BI3 (X110:5/6)	Not available	Manual restore group 2 in LSHDPFRQ2
BI4 (X110:7/6)	Not available	Unused
BI5 (X110:8/9)	Not available	Voltage transformer truck in indication
BI6 (X110:10/9)	Not available	Voltage transformer truck out indication
BI7 (X110:11/12)	Not available	Earthing switch closed indication
BI8 (X110:13/12)	Not available	Earthing switch open indication
BI1 (X130:1/2)	Not available	Unused
BI2 (X130:3/4)	Not available	Line voltage transformer MCB open
BI3 (X130:5/6)	Not available	Bus voltage transformer MCB open
BI4 (X130:7/8)	Not available	Lockout reset

Table 32: Binary outputs

REU615	SPAU 330 C1	Usage
PO1 (X100:6/7)	Start B (67/68/69)	if SGR/5 = “1” PHPTOV1.OPERATE
		if SGR/6 = “1” PHPTUV1.OPERATE
		ROVPTOV2.OPERATE
PO2 (X100:8/9)	Start E (79/80/81)	ROVPTOV1.OPERATE
SO1 (X100:10/11/12)	Not available	PHPTOV1.START
		PHPTUV1.START
		ROVPTOV1. START
		ROVPTOV2. START
SO2 (X100:13/14)	Not available	Unused
PO3 (X100:16/17)	Trip 1 (65/66)	if SGR/3 = “1” ROVPTOV1.OPERATE
		if SGR/4 = “1” ROVPTOV2.OPERATE
		if SGR/1 = “1” PHPTOV1.OPERATE
		if SGR/2 = “1” PHPTUV1.OPERATE
PO4 (X100:20/21/22/23/24)	Not available	Master trip 2
SO1 (X110:14/16)	Start D (76/77/78)	if SGR/8 = “1” PHPTUV1. START
		PHPTUV1.OPERATE
SO2 (X110:17/18/19)	Not available	Connected to “Load Shedding Group 2” but unused

Table continues on next page

REU615	SPAU 330 C1	Usage
SO3 (X110:20/21/22)	Not available	Connected to “Load restore group 1” but unused
SO4 (X110:23/24)	Start C (73/74/75)	if SGR/7 = “1” PHPTOV1.START
		PHPTOV1.OPERATE

The type of contacts (single or multiple pole; single or multiple throw) in 615 series can be different from SPACOM relays. See the REU615 standard configuration A connection diagram.

Normally closed contacts (terminals 67, 73, 76 or 79) are not supported in this migration. If normally closed contacts are required, the resulting REU615 configuration must be revised and some additional engineering is required.

8.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function-to-function connections in REU615. The default connections can be viewed and changed with PCM600 according to the application requirements, if necessary.

Only SPAU 330 C1 migrated functions are represented in the connection diagrams. REU615 also includes other functions whose connections are configured according to standard configuration A. See REU615 Application Manual.

Operation of additional REU615 functions is disabled if the corresponding functionality is not available in SPAU 330 C1. These functions can be visible in the connection diagrams even if disabled.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

8.2.4.1 Functional diagrams for protection

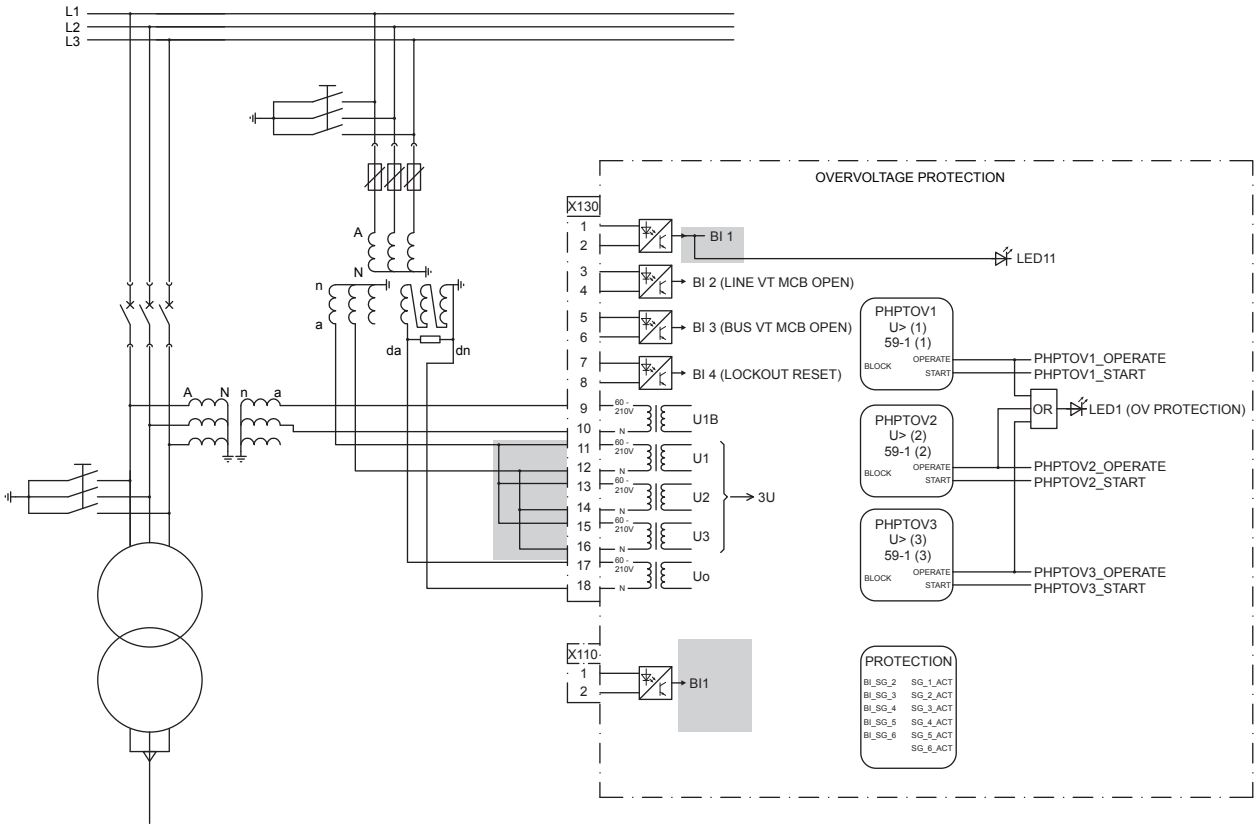


Figure 86: Overvoltage protection

- PHPTOV2 and PHPTOV3 are disabled.
- SPAU 330 C1 has one phase-to-phase input for phase voltages. In REU615, this is done by connecting one phase-to-phase voltage to all three voltage inputs (X130:11/12, X130:13/14 and X130:15/16).
- Function block PROTECTION for parameter setting group is disabled.

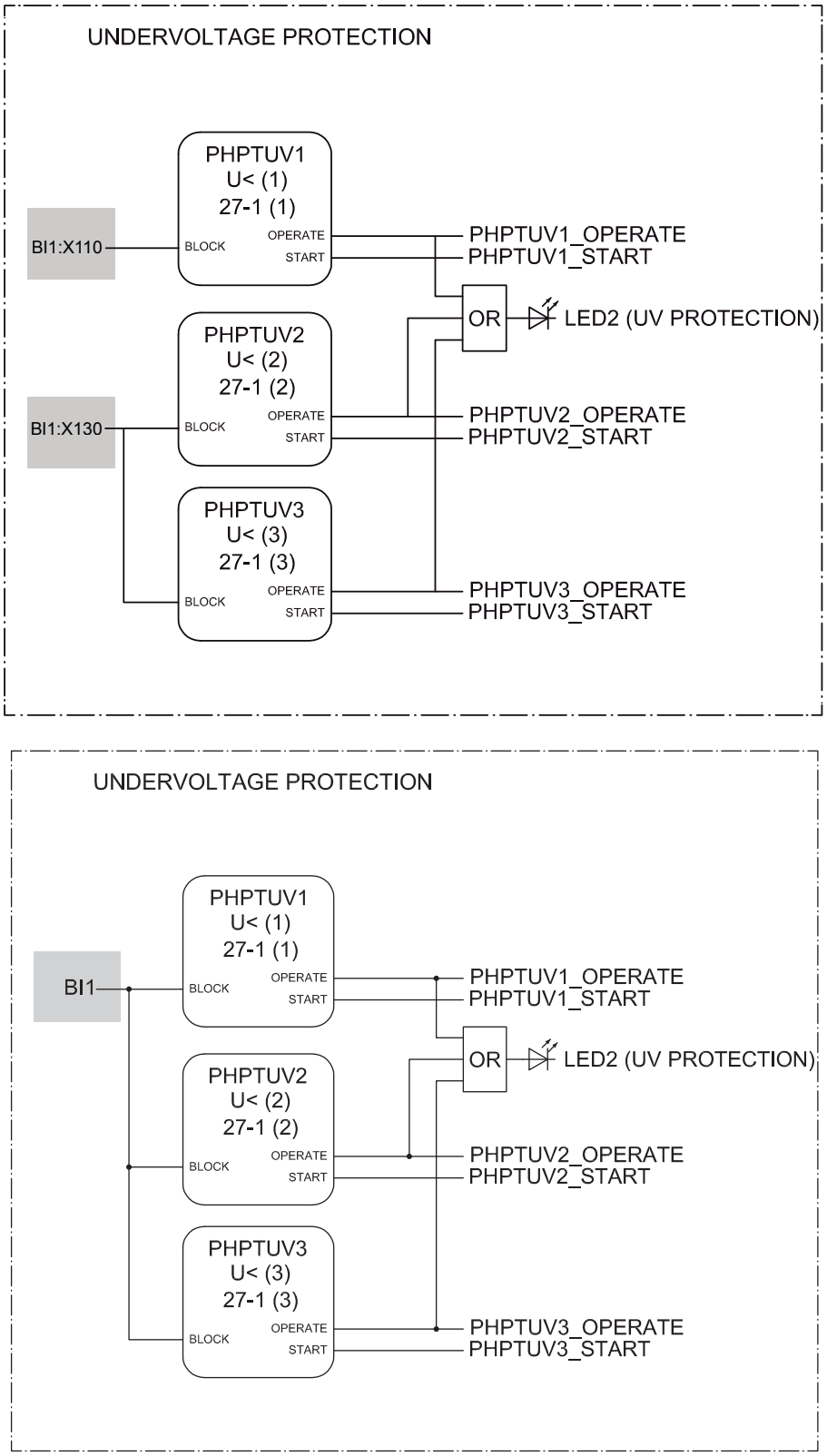


Figure 87: Undervoltage protection

- PHPTUV2 and PHPTUV3 are disabled.

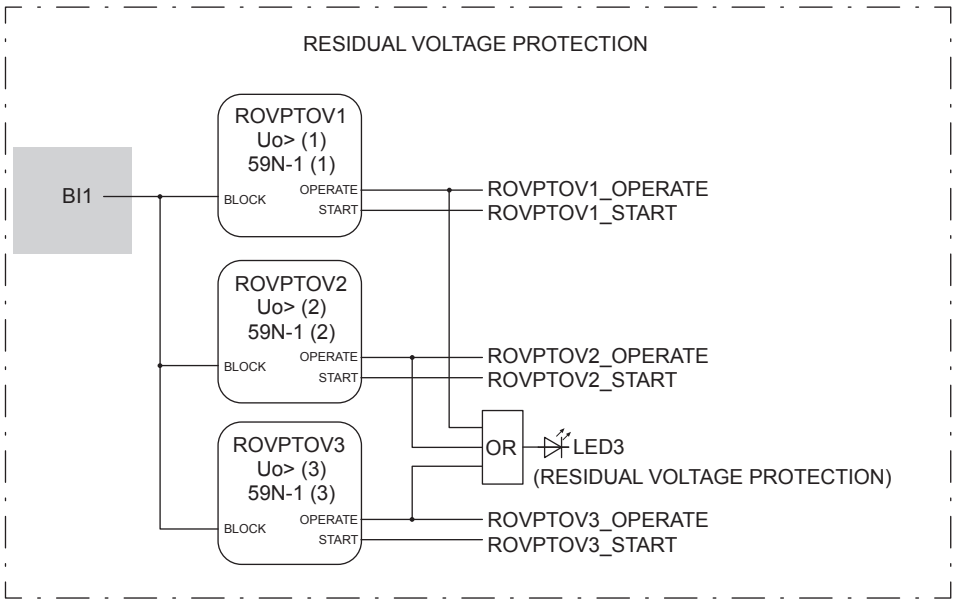


Figure 88: Residual overvoltage protection

- ROVPTOV3 is disabled.

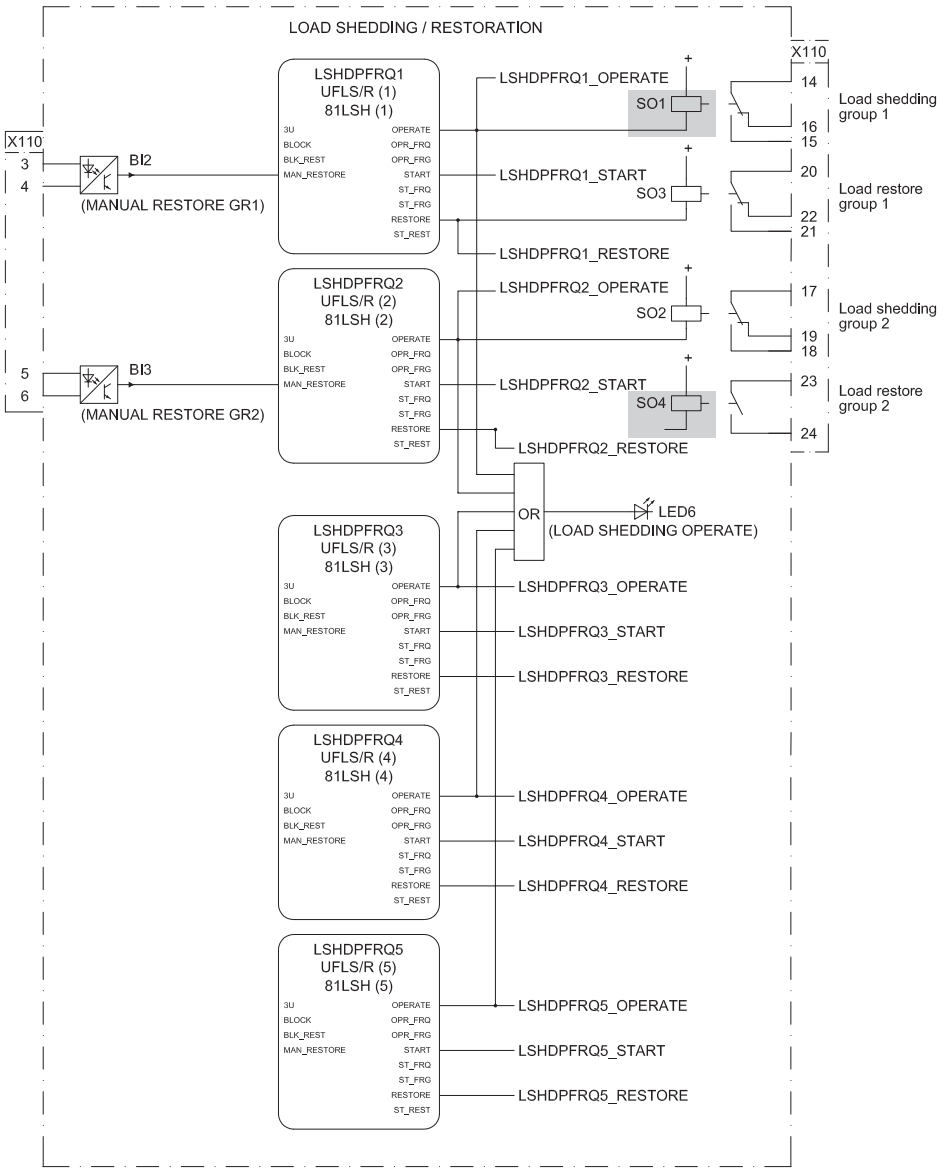


Figure 89: Load shedding and restoration

- All five load shedding and restoration stages are present but disabled.
- X110:SO1 and X110:SO4 are used for start and operate signals of undervoltage and overvoltage protection stages.

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

8.2.4.2 Functional diagram for control and interlocking

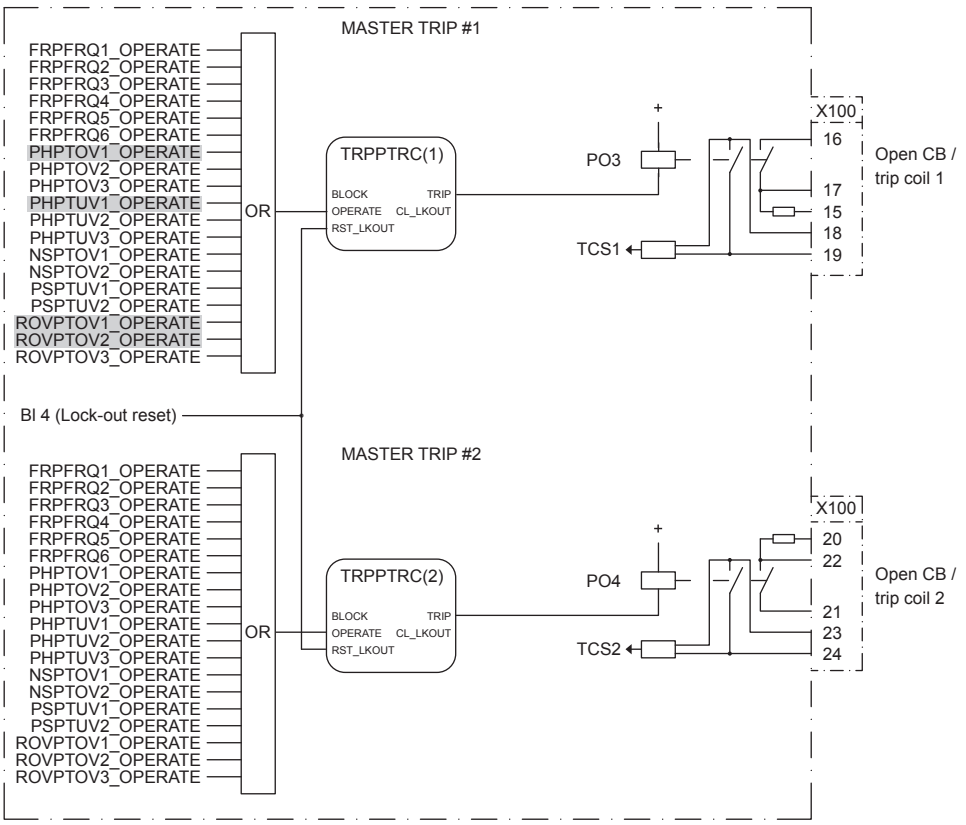


Figure 90: Master trip

The operate signals from the protections are connected to the two trip output contacts PO3 (X100:15-19) and PO4 (X100:20-24) via the corresponding Master Trips TRPPTRC1 and TRPPTRC2.

Various function outputs are connected to TRPPTRC1 based on the switchgroup conditions.

- PHPTOV1_OPERATE, if SGR/1 = "1"
- PHPTUV1_OPERATE, if SGR/2 = "1"
- ROVPTOV1_OPERATE, if SGR/3 = "1"
- ROVPTOV2_OPERATE, if SGR/4 = "1"

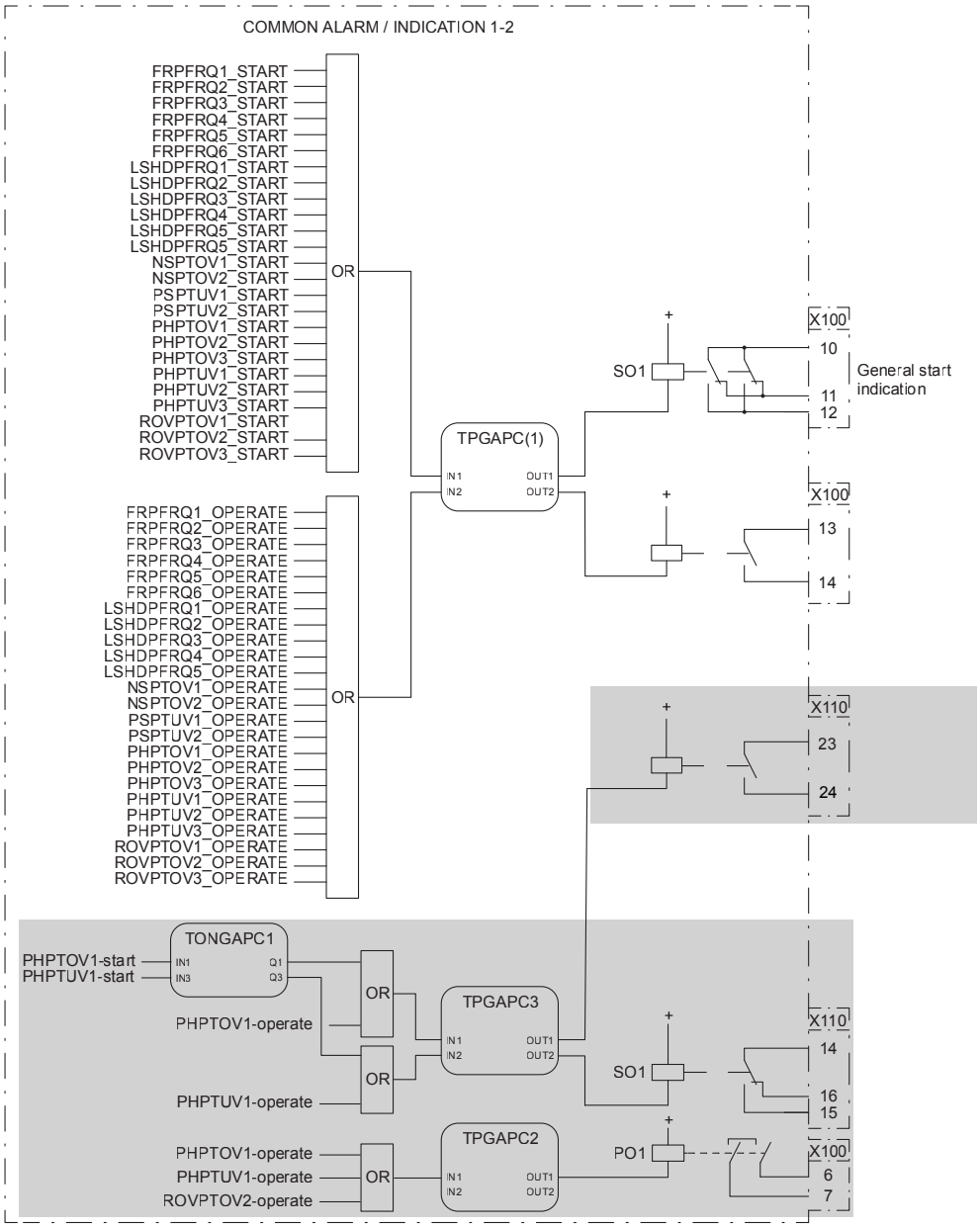


Figure 91: Alarm indication

The start of any protection function from the IED is connected to TPGAPC1 to give general start information SO1 (X100:10-12).

Operation (trip) of any protection function is connected to TPGAPC1 but not connected to any output.

The signal outputs from the overvoltage and undervoltage protection functions are connected to TPGAPC3 to give dedicated operation and start information.

- Operation (trip) and start of PHPTOV1 SO4 (X110: 23-24). This reproduces SPAU 330 C1 output relay C. Thus the following voltage protection functions are connected to SO4 depending on the switchgroup condition.
  - PHPTOV1_START, if SGR/7 = “1”
  - PHPTOV1_OPERATE, always connected
- Operation (trip) and start of PHPTUV1 SO1 (X110: 14-16). This reproduces SPAU 330 C1 output relay D. Thus the following voltage protection functions are connected to SO1 depending on the switchgroup condition.
  - PHPTUV1-start, if SGR/8 = “1”
  - PHPTUV1-operate, always connected

The signal outputs from the overvoltage and undervoltage protection functions are connected to TPGAPC2 to give dedicated information.

- Operate signal from PHPTOV1 is connected to PO1, if SGR/5 = “1”
- Operate signal from PHPTUV1 is connected to PO1, if SGR/6 = “1”
- Operate signal from ROVPTOV2 is always connected to PO1

8.2.4.3 Setting groups

SPAU 330 C1 supports main and remote settings which are migrated to Setting Group 1 and 2 in REU615. The setting groups can be selected with SPA-bus parameter *V152*.

SPAU 320 C1 and REU615 do not support setting group change from binary input. Setting groups can be changed only from HMI.

8.3 Installation

8.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the SPACOM series relay.

1. Widen the original SPACOM relay hole.
   1.1. Use cutting tool with dedicated cutting head for SPACOM 100/300 series to get the appropriate cut-out on the switchgear door hosting REF615 IED.
   1.2. Widen the cut-out to whichever of the four directions as per the existing installation requirement.

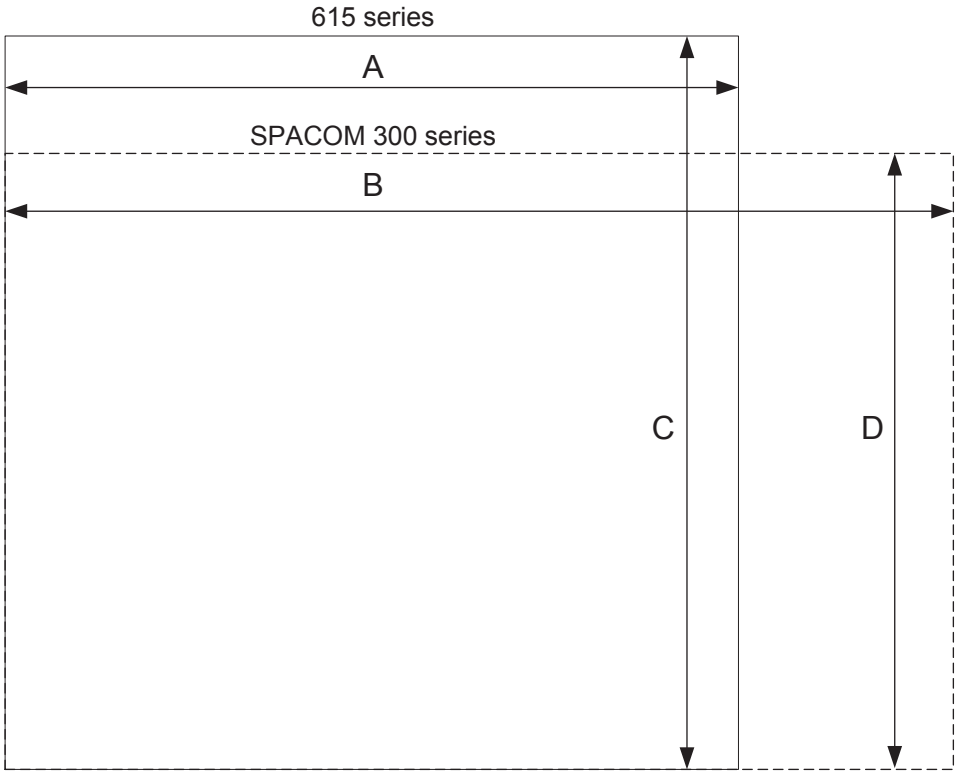


Figure 92: SPACOM 300 series and 615 series cut-outs

A 165.5 mm
B 214 mm
C 165.5 mm
D 139 mm

2. Insert a cover plate (2RCA027885A0001) to hide visible parts of the old opening.
3. Mount the 615 series IED's case and insert the plug-in unit.

See the 615 series installation manual for more information.

8.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

8.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting SPAU 330 C1 with REU615.

Table 33: REU615 wiring harness description for retrofit of SPAU 330 C1

REU615, configuration A		SPAU 330C		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	61	Uaux+	X100:1/61
X100:2	Uaux-	62	Uaux-	X100:2/62
X100:3	IRF	72	IRF	X100:3/72
X100:4	IRF	71	IRF	X100:4/71
X100:5	IRF	70	IRF	X100:5/70
X100:6	PO1	68	Start B Signal	X100:6/68
X100:7	PO1	69	Start B Signal	X100:7/69
X100:8	PO2	80	Start E Signal	X100:8/80
X100:9	PO2	81	Start E Signal	X100:9/81
X100:10	SO1	-	-	X100:10
X100:11	SO1	-	-	X100:11
X100:12	SO1	-	-	X100:12
X100:13	SO2	-	-	X100:13
X100:14	SO2	-	-	X100:14
X100:15	PO3	-	-	X100:15
X100:16	PO3	65	Trip 1 Signal	X100:16/65
X100:17	PO3	66	Trip 1 Signal	X100:17/66
X100:18	PO3	-	-	X100:18
X100:19	PO3	-	-	X100:19
X100:20	PO4	-	-	X100:20
X100:21	PO4	-	-	X100:21
X100:22	PO4	-	-	X100:22
X100:23	PO4	-	-	X100:23
X100:24	PO4	-	-	X100:24
X110:1	BI1	10	BS1	X110:1/10
X110:2	BI1	11	BS1	X110:2/11
X110:3	BI2	-	-	X110:3
X110:4	BI2	-	-	X110:4
X110:5	BI3	-	-	X110:5
X110:6	BI3,4	-	-	X110:6
X110:7	BI4	-	-	X110:7
X110:8	BI5	-	-	X110:8
X110:9	BI5, 6	-	-	X110:9
X110:10	BI6	-	-	X110:10
X110:11	BI7	-	-	X110:11

Table continues on next page

REU615, configuration A		SPAU 330C		Wiring
Terminal	Description	Terminal	Description	Marking
X110:12	BI7, 8	-	-	X110:12
X110:13	BI8	-	-	X110:13
X110:14	SO1	78	Start D Signal	X110:14/78
X110:15	SO1	76	Start D Signal	X110:15/76
X110:16	SO1	77	Start D Signal	X110:16/77
X110:17	SO2	-	-	X110:17
X110:18	SO2	-	-	X110:18
X110:19	SO2	-	-	X110:19
X110:20	SO3	-	-	X110:20
X110:21	SO3	-	-	X110:21
X110:22	SO3	-	-	X110:22
X110:23	SO4	74	Start C Signal	X110:23/74
X110:24	SO4	75	Start C Signal	X110:24/75
X130:1	BI1	-	-	X130:1
X130:2	BI1	-	-	X130:2
X130:3	BI2	-	-	X130:3
X130:4	BI2	-	-	X130:4
X130:5	BI3	-	-	X130:5
X130:6	BI3	-	-	X130:6
X130:7	BI4	-	-	X130:7
X130:8	BI4	-	-	X130:8
X130:9	U12B	-	-	X130:9
X130:10	U12B	-	-	X130:10
X130:11	U1	14/15	U12, 100V/110V	X130:11/14/15
X130:12	U1	13	U12	X130:12/13
X130:13	U2	17/18	U23, 100V/110V	X130:13/17/18
X130:14	U2	16	U23	X130:14/16
X130:15	U3	20/21	U31, 100V/110V	X130:15/20/21
X130:16	U3	19	U31	X130:16/19
X130:17	U0	29/30	Uo, 100V/110V	X130:17/29/30
X130:18	U0	28	Uo	X130:18/28
	Earth	63	Earth	/63

8.3.2.2 SPAU 330 C1 terminal layout and connection diagrams

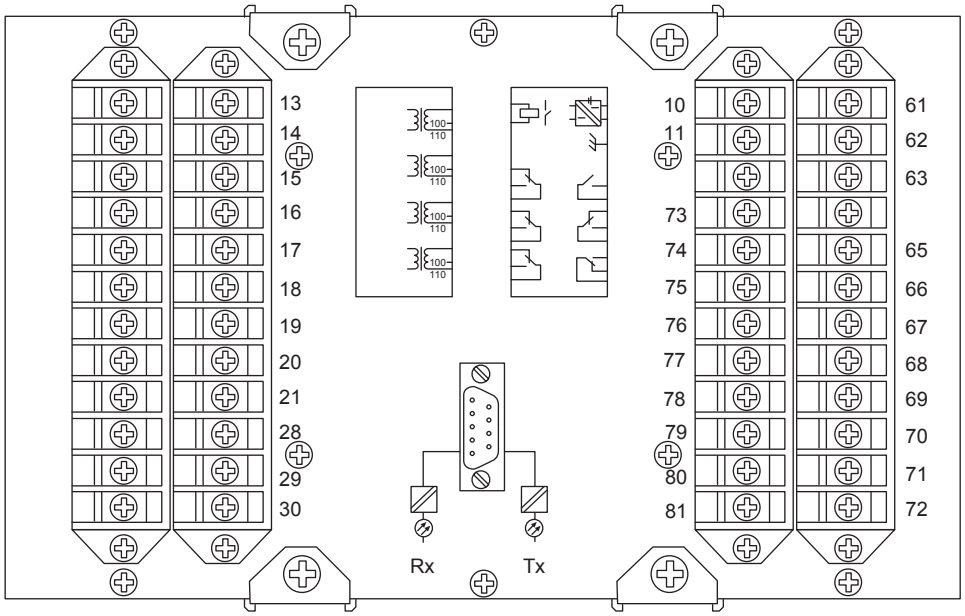


Figure 93: Terminal layout for SPAU 330 C1

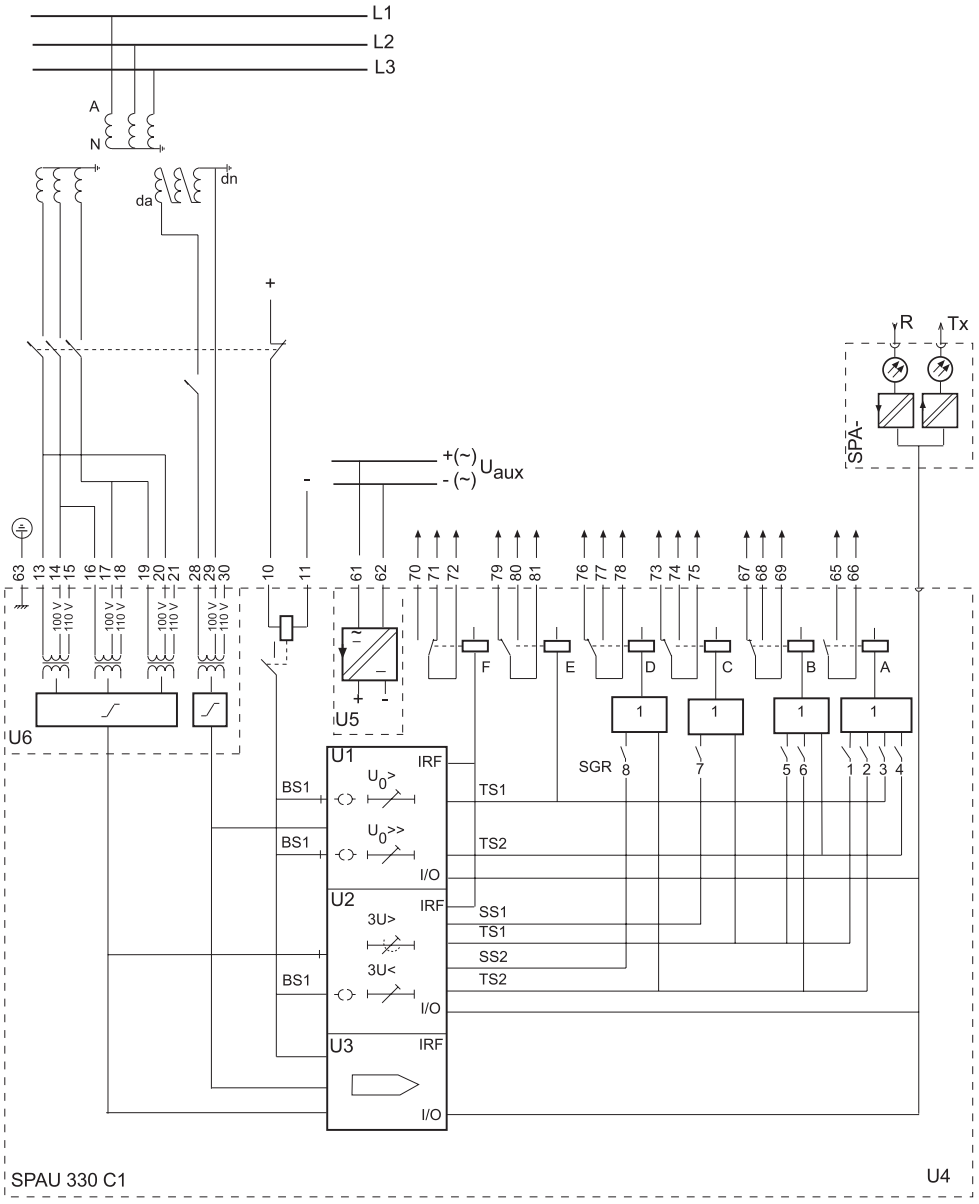


Figure 94: Connection diagram for SPAU 330 C1

8.3.2.3 REU615 terminal layout and connection diagrams

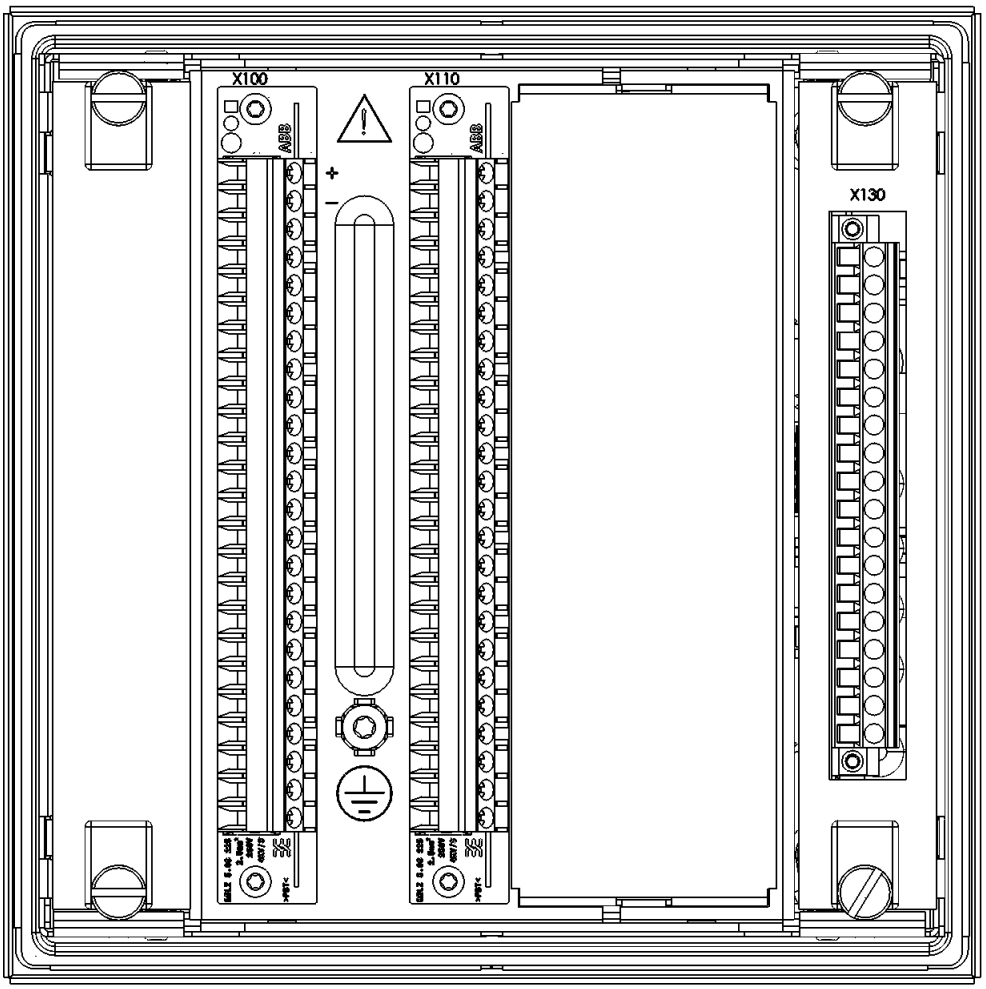


Figure 95: Terminal layout for the 615 series IEDs

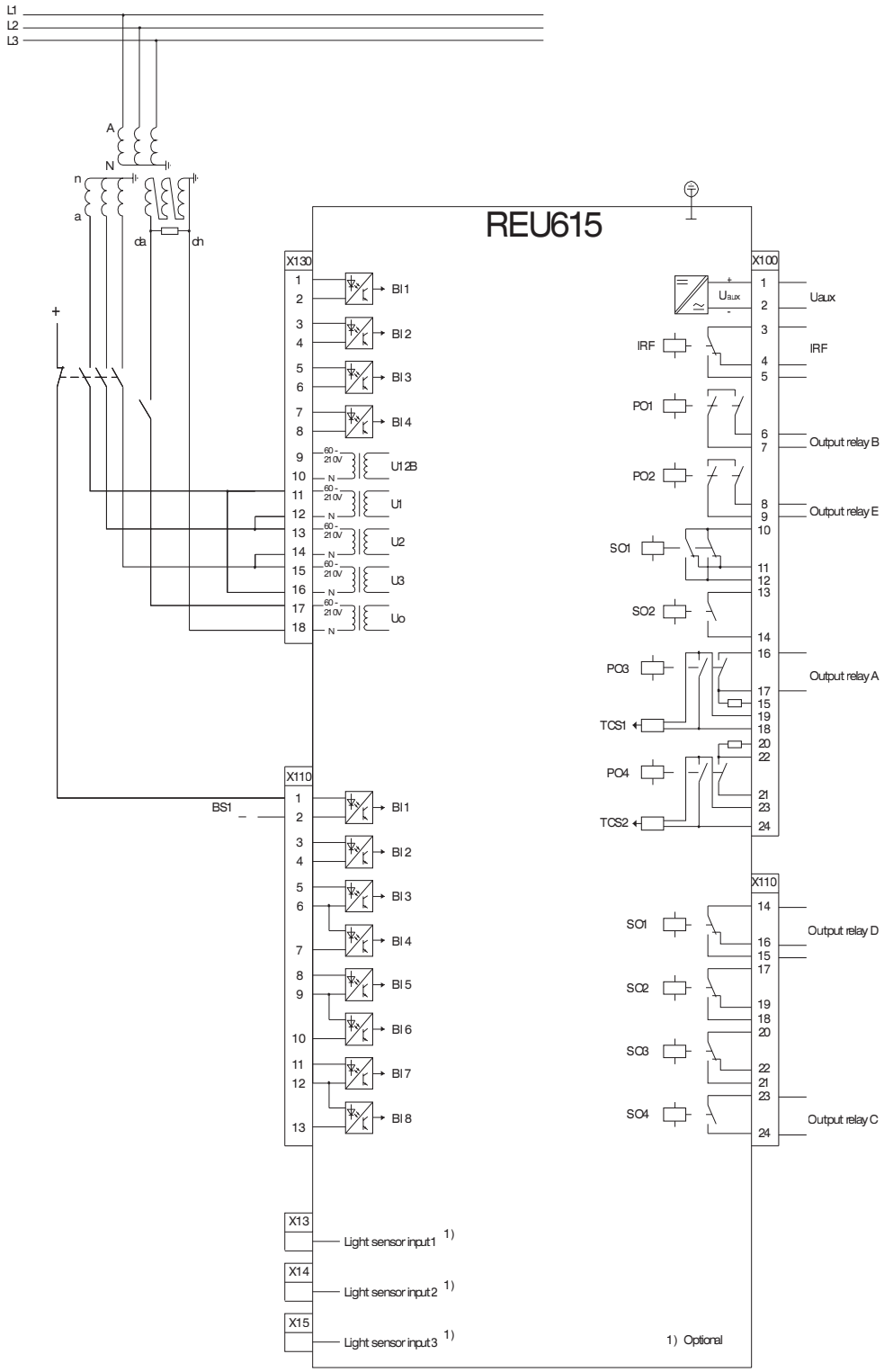


Figure 96: Connection diagram for REU615 with standard configuration A replacing SPAU 330 C1

Section 9 MCX 912 and MCX 913 to REM615 Ver. 4.0 FP1

9.1 Retrofit scope

Protection functions of MCX 912 and MCX 913 are replicated by REM615 with deviations.

- REM615 supports only one instance of *Overcurrent protection I>* (Mode 03, Mode 43 and Mode 45) at the same time. If more than one instance is used in MCX 91x relay, the settings are taken from the first active instance. Other instances are ignored in migration.
- REM615 supports only one instance of *Short circuit protection I>>* (Mode 01 and Mode 41) at the same time. If both instances are used in MCX 91x relay, the settings are taken from the first instance. In this case, the second instance is ignored.
- REM615 does not support *Temperature rise* (Mode 20).
- REM615 supports only value “0” for *Start with overheating* (Mode 21).
- REM615 does not support *Max demand value* (Mode 90).

9.2 Engineering

In retrofit applications, the target of the configuration phase is to parameterize and configure the replacement IED to reproduce the features and functions of the existing relay. The configuration process comprises of various steps with different tools depending on the project.

Parameter collection form

- MCX 91x relay does not have a communication interface. The parameter values used in the existing relay have to be collected using a Microsoft Excel based parameter collection form.
- Parameter collection form can export parameter values to a text file in a comma-separated (CSV) format. The .csv file is imported to the IED Migration Support tool during the migration process.

PCM600

- Instantiating a new retrofit IED using the IED Migration Support tool in PCM600.

- Selecting the replacement IED (type and order code)
- Importing existing relay configuration (.csv file)

- Creating a 615 series IED under PCM600 plant structure using the IED Migration Support tool.
- Writing configuration to the IED.

Project specific additional engineering phases

- Using Application Configuration tool in PCM600 to add functionality to the migrated configuration, if required.
- Communication engineering with relevant PCM600 tools, if required.

No engineering activity is required for wiring as marking sets and wiring harness are available.

ARC and RTD options are not used in the migrated configuration even if these optional features are selected for REM615.

9.2.1 Existing relay and system engineering information

The parameters of MCX 91x are read from the relay display. All the needed information is collected to a Microsoft Excel based parameter collection form. The configuration parameters are exported from the Microsoft Excel template as a .csv file and imported in PCM600 during the migration process.

Different REM615 system configuration parameters are set based on the information provided in the parameter collection form.

- General system settings
  - *Rated frequency* is set based on the MCX 91x name plate.
  - *Blocking mode* is set to value “Block all”.
- Analog input settings and phase currents
  - *Secondary current* is set to “1A” or “5A” based on the collected value.
  - *Primary current* is set to the collected value.
- Analog input settings and residual currents
  - *Secondary current* is set to “1A” or “5A” based on the collected value.
  - *Primary current* is set to the collected value.

9.2.2 Functions

Table 34: Functions included in configuration

MCX 91x	REM615	Description	Enabled
Mode 03 Mode 43 Mode 45	PHLPTOC1	Three-phase non-directional overcurrent protection, low stage, instance 1	Yes[1)2)]
Mode 01 Mode 41	PHIPTOC1	Three-phase non-directional overcurrent protection, instantaneous stage, instance 1	Yes[1)2)]
Mode 07	EFLPTOC1	Non-directional earth-fault protection, low stage, instance 1	Yes[1)]
	EFHPTOC1	Non-directional earth-fault protection, high stage, instance 1	No
Mode 05	MNSPTOC1	Negative sequence overcurrent protection for motors, instance 1	Yes[1)]
	MNSPTOC2	Negative sequence overcurrent protection for motors, instance 2	No
Mode 15	LOFLPTUC1	Loss of load supervision	Yes[1)]
Mode 11	JAMPTOC1	Motor load jam protection	Yes[1)]
Mode 11 Mode 13 Mode 17	STTPMSU1	Motor startup supervision	Yes[1)]
	PREVPTOC1	Phase reversal protection	No
Mode 30 Mode 31	MPTTR1	Thermal overload protection for motors	Yes[1)]
	CCBRBRF1	Circuit breaker failure protection	No
Reset button	TRPPTRC1	Master trip, instance 1	Yes[3)]
	TRPPTRC2	Master trip, instance 2	No
	ARCSARC1	Arc protection, instance 1	No
	ARCSARC2	Arc protection, instance 2	No
	ARCSARC3	Arc protection, instance 3	No
	MAPGAPC1	Multi-purpose protection, instance 1	No
	MAPGAPC2	Multi-purpose protection, instance 2	No
	MAPGAPC3	Multi-purpose protection, instance 3	No
	MAPGAPC4	Multi-purpose protection, instance 4	No
	MAPGAPC5	Multi-purpose protection, instance 5	No
	MAPGAPC6	Multi-purpose protection, instance 6	No
	CBXCBR1	Circuit breaker control	No
	DCXSWI1	Disconnector control, instance 1	No
	DCXSWI2	Disconnector control, instance 2	No
	ESXSWI1	Earthing switch control	No
	DCSXSWI1	Disconnector position indication, instance 1	No
	DCSXSWI2	Disconnector position indication, instance 2	No

Table continues on next page

MCX 91x	REM615	Description	Enabled
	DCSXSWI3	Disconnector position indication, instance 3	No
	ESSXSWI1	Earthing switch indication, instance 1	No
	ESSXSWI2	Earthing switch indication, instance 2	No
	ESMGAPC1	Emergency startup	No
	SSCBR1	Circuit-breaker condition monitoring	No
	TCSSCBR1	Trip circuit supervision, instance 1	No
	TCSSCBR2	Trip circuit supervision, instance 2	No
	CCRDIF1	Current circuit supervision	No
Mode 98	MDSOPT1	Runtime counter for machines and devices	Yes
	RDRE1	Disturbance recorder	Yes
	FLTMSTA	Fault record	Yes
Mode 40	CMMXU1	Three-phase current measurement, instance 1	Yes
	CSMSQI1	Sequence current measurement	Yes
	RESCMMXU1	Residual current measurement, instance 1	Yes
	XRGGIO130	RTD/mA measurement	No

1) Function is disabled if any of the three conditions is true.

- Function is not included in the set of functions defined by function selector (Mode 47).
- Tripping matrix is set to zero.
- Function parameter (Mode x) is set to zero.

2) REM615 has only one instance of PHLPTOC and PHIPTOC functions.
3) If trip matrix of MCX contains value “3” for latched trip.

Additional 20 ms is added to each REM615 *Operate delay time* settings because fault detection time is included in REM615 values.

9.2.2.1 PHLPTOC1 settings

PHLPTOC1 replicates the MCX 91x *Overcurrent protection I>* (Mode 03, Mode 43 and Mode 45) in REM615.

MCX relay has three overcurrent protection function instances. REM615 has only one instance of PHLPTOC. Only one stage is used in motor application.

PHLPTOC1 also supports IDMT inverse time characteristics.

If only one instance of function is used, the settings of the active instance are used. If more than one instance is used, the settings are used from the lowest instance number and the other instances are ignored. In this case, warning messages are issued to migration report for ignored instances.

- *Operation* parameter of PHLPTOC1 is set “on” if function parameters (Mode 03, Mode 43 and Mode 45) do not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 103, Mode 143 and Mode 141) does not have value “0”.
- It is possible to set MCX 91x greater than PHLPTOC1 *Start value* setting maximum value “5”. A warning message is issued, if necessary.
- Additional 20 ms has been added to PHLPTOC1 *Operate delay time* setting because fault detection time is included in REM615 values.
- Output signals `OPERATE` and `START` are connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.2 PHIPTOC1 settings

PHIPTOC1 replicates the behaviour of MCX 91x short circuit protection I>> (Mode 01 and Mode 41) in REM615.

MCX relay has two short-circuit protection function instances. REM615 has only one instance of PHIPTOC, but typically the second instance is used as a backup.

If only one instance of function is used, the settings of active instance is used. If both instances are used, the settings from the first instance is used and warning message is issued to migration report.

- *Operation* parameter of PHIPTOC1 is set “on” if function parameters (Mode 01 and Mode 41) do not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 101 and Mode 141) does not have value “0”.
- It is possible to set MCX 91x value below PHIPTOC1 *Start value* setting minimum value “1”. A warning message is issued, if necessary.
- Additional 20 ms is added to PHIPTOC1 *Operate delay time* setting because fault detection time is included in REM615 values.
- Output signals `OPERATE` and `START` are connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.3 EFLPTOC1 settings

EFLPTOC1 replicates the behaviour of MCX 91x earth-fault protection (Mode 07) in REM615.

- *Operation* parameter of EFLPTOC1 is set to “on” if the function parameter (Mode 07) does not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 107) does not have value “0”.
- Setting *Io signal Sel* is set to “Calculated Io” or “Measured Io” according to Mode 09.
- Setting *Start value* is calculated taking the calculated or measured Io into account. It is possible to set MCX 91x below EFLPTOC1 *Start value* setting minimum value “0.01”. A note is generated, if necessary.
- Additional 20 ms is added to EFLPTOC1 *Operate delay time* setting because fault detection time is included in REM615 values.
- It is possible to set MCX 91x below EFLPTOC1 *Operate delay time* setting minimum value “40ms”. A note is generated, if necessary.
- Output signals `OPERATE` and `START` are connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.4 LOFLPTUC1 settings

LOFLPTUC1 replicates the behaviour of MCX 91x protection against low load (Mode 15) in REM615. For loss of load checking, the MCX relay has current setting Mode 15 and time setting Mode 16.

- *Operation* setting of LOFLPTUC1 is set “on” if function parameter (Mode 15) does not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 115) does not have value “0”.
- *Start value low* is set to value “0.1 × Mode 00”.
- *Start value high* is set to value “Mode 00 × Mode 15”
- *Operate delay time* is set to value “Mode 16 × 1000”. If the calculated value is less than REM615 minimum limit, the IED Migration Support tool uses minimum value and issues a note to migration report.
- Output signals `OPERATE` and `START` are connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.5 JAMPTOC1 settings

JAMPTOC1 replicates the behaviour of MCX 91x locked rotor protection (Mode 11) in REM615.

The MCX relay contains Mode 11, a locked rotor protection which functions like a simple overcurrent protection. This function is not blocked by any other function in the MCX relay and is active during motor startup. The start and trip signals can be freely connected via parameterized tripping matrix to the signalling relay MRI, MRII, tripping relay ARI or ARII. The signaling and tripping relays can be connected to a speed switch to prevent a motor start when the locked rotor time is less than the motor startup time.

For retrofit purposes, JAMPTOC1 is used with the settings. JAMPTOC1 is not blocked during motor startup. The locked rotor protection in the STTPMSU1 is not used because the speed switch must not be present in all retrofit panels.

In REM615, start is not available from JAMPTOC1 and cannot be used in tripping matrix.

- *Operation* setting of JAMPTOC1 is set “on” if function parameter (Mode 11) does not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 111) does not have value “0”.
- *Start value* setting is set to value “Mode 00 × Mode 11”. If calculated value is less than REM615 minimum limit, the IED Migration Support tool issues a note to migration report.
- *Operation delay time* setting is set to value “Mode 12 × 1000”. If calculated value is greater than REM615 maximum limit, the IED Migration Support tool issues a note to migration report.
- Output signal `OPERATE` is connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.6 MNSPTOC1 settings

MNSPTOC1 replicates the behaviour of MCX 91x negative phase sequence protection (Mode 05) in REM615.

The proper operation of MNSPTOC1 is dependent on which wiring variant has been originally used for MCX 91x relay. Information of used wiring variant is available through parameter collection form. Mode 09 defines if the calculation is internal or external and a separate question defines if Io current transformer is present.

Different wiring variants are described in detail in the installation section.

- *Operation* parameter of MNSPTOC1 is set “on” if function parameter (Mode 05) does not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 105) does not have value “0”.
- It is possible to set MCX 91x greater than MNSPTOC1 *Start value* setting maximum value “0.5”. A note is generated, if necessary.
- It is possible to set MCX 91x greater than MNSPTOC1 *Operate delay time* setting maximum value “120000 ms”. A note is generated, if necessary.
- Migration package generates a note for which wiring variant to be used.
- Output signals `OPERATE` and `START` are connected to X100 `PO1`, `PO2`, `PO3` and `PO4` outputs according to the tripping matrix.

9.2.2.7 STTPMSU1 settings

STTPMSU1 replicates the behavior of MCX 91x motor starting protection (Mode 13) and protection against too many motor starts (Mode 17 and Mode 18).

- *Operation* parameter of STTPMSU1 is set “on” if function parameters (Mode 13, Mode 17 and Mode 18) do not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 113 and Mode 117) does not have value “0”.
- *Operation Red rate* is used to protect against too many motor starts. Motor startup time is collected from user because it is not available in MCX relay as a parameter. If Mode 17 is enabled, the value of parameter is calculated as Motor startup time × 3600/Mode 19.
- *Cumulative time Lim* is used to protect against too many motor starts.
- *Motor start-up A* and *Motor start-up time* are calculated to give the same inverse operation curve, although the setting values can look quite different.

In REM615, STTPMSU1 is used for counting starts, but there is no separation between warm and cold starts. STTPMSU1 does not count the number of starts. Instead, the cumulative time is used for starts.

A trip signal in the meaning of the MCX relay in not available in the STTPMSU1. REM615 settings are based on Mode 17.

9.2.2.8 MPTTR1 settings

MPTTR1 replicates the behavior of MCX 91x thermal overload protection (Mode 30 and Mode 31). The MCX relay has only one heating time constant which has to be used for the *Time constant start* and *Time constant normal* parameter in REM615. The REM615 Θ_A and Θ_B handling is eliminated by setting the parameter *Weighting factor p* fix to “100%”.

- *Operation* parameter of MPTTR1 is set “on” if function parameter (Mode 30) does not have value “0”, the function belongs to function set defined by function selector (Mode 47) and trip matrix (Mode 130) does not have value “0”.
- *Rated current* is set to value of Mode 00 if *Operation* parameter is “on”.
- *Overload factor* is set to value “sqr (Mode 31/100)”. If the calculated value is out of REM615 setting range, the minimum or maximum value is used and the IED Migration Support tool issues a note to migration report.
- *Alarm thermal value* is set to value ”Mode 30/Mode 31 × 100%”. If calculated value is below the minimum value of REM615, the IED Migration Support tool issues a note to migration report.

- *Restart thermal value* is calculated as (Mode 31 - Mode32)/Mode 31 × 100%. If the calculated value is greater than the maximum value of REM615, the IED Migration Support tool issues a note to migration report.
- *Weighting factor* parameter value is set to “100%” if Mode 33 is less than “66”. Otherwise, the value is set to “110.5 - 0.158 × Mode 33”.
- *Time constant normal* is set to value “Mode 33 × 60”. If the calculated value is out of REM615 setting range, correct behavior is achieved by adjusting *weighting factor p* setting.
- *Time constant start* setting value is copied from *Time constant normal*.
- *Time constant stop* is set to value “Mode 34 × 60”. If calculated value is out of REM615 setting range, the IED Migration Support tool issues a note to migration report.
- Output signals OPERATE and START are connected to X100 PO1, PO2, PO3 and PO4 outputs according to the tripping matrix.

9.2.2.9 CMMXU1 settings

CMMXU1 replicates the behavior of MCX 91x display of mean value and maximum mean value (Mode 40, Mode 89 and Mode 90).

- *Demand interval* parameter does not support value “8 minutes” and it is set to “10 minutes”.
- *Max demand value* (Mode 90) is not supported by REM615.

REM615 supports calculated demand values per phase and actual phase currents.

9.2.2.10 MDSOPT1 settings

MDSOPT1 replicates the behavior of MCX 91x operating hours counter (Mode 98).

When POS_ACTIVE is active, the count is continuously added to the time duration until it is deactivated. The OPR_TIME output is the total duration for which POS_ACTIVE is active. The unit of time duration count for OPR_TIME is hour. The value of OPR_TIME is available through the monitored data view.

The OPR_TIME output has a continuously increasing value and it is stored in a nonvolatile memory. When POS_ACTIVE is active, the OPR_TIME count starts increasing from the previous value. The count of OPR_TIME saturates at a final value of “299999”, that is, no further increment is possible. The activation of RESET can reset the count to the *Initial value* setting.

MDSOPT1 is used to count the operation hours. The POS_ACTIVE input is connected to the function CMMXU1 output HIGH_WARN. This output is active when the current exceeds 0.1 × IE (The MCX relay counts the hours when the relay is ready

and the current is >=0.1 × IE). MDSOPT1 activates the WARNING output when the counter reaches the MCX value “9999 × 10” h. This output is connected to the MDSOPT1 input RESET to set the counter back to *Initial value* = “0”.

- *Parameter Warning* value is set to fixed value “99990”.
- *Parameter Alarm* value is set to fixed value “299999”.
- REM615 does not support setting of the counter value from the HMI.

CMMXU1 parameter *A high limit* is used to start and stop the operation hour counting of the function MDSOPT1.

9.2.3 I/O connections

I/O connections at MCX 91x terminals are remapped to REM615 I/O terminal.

REM615 terminals have additional binary I/Os whose behavior does not depend on MCX 91x configuration.

Table 35: Binary inputs

REM615	MCX 91x	Usage
BI1 (X120:1/2)	Blocking input (E:1,3,4 or 5/2)	Selective or complete blocking of output relays are based on MCX switch S4 and S65 positions.
BI2 (X120:3/2)	N/A	Circuit breaker closed
BI3 (X120:4/2)	N/A	Circuit breaker open
BI4 (X120:5/6)	N/A	External restart inhibit

Table 36: Binary outputs

REM615	MCX 91x	Usage
PO1 (X100:6/7)	MRI (E:11/12)	Signal relay I[1)]
PO2 (X100:8/9)	MRII (E:7/8)	Signal relay II[1)]
SO1 (X100:10/11,(12))	N/A	Connect parallel with PO3 signal for switchover contact
SO2 (X100:13/14)	N/A	Unused
PO3 (X100:15/19)	ARI (A:4/5)	Tripping relay I[1)]
PO4 (X100:20/24)	ARII (A:8/9)	Tripping relay II[1)]

1) Behavior of the output relays is defined by MCX tripping matrix functionality

9.2.4 Functional diagrams

The functional diagrams describe the default input, output, alarm LED and function to-function connections in REM615. The default connections can be viewed and changed with PCM600 according to the application requirements.

Only MCX 91x migrated functions are represented in the connection diagrams. REM615 also includes other functions whose connections are configured according to standard configuration A. See REM615 Application Manual.

Operation of additional REM615 functions is disabled if the corresponding functionality is not available in MCX 91x. These functions are visible in the connection diagrams even if disabled.

Blocking input behavior and protection function connection to output relays are defined by settings provided during the migration.

The parts affected by the migration compared to the 615 series standard configuration are highlighted in gray.

9.2.4.1 Functional diagrams for protection

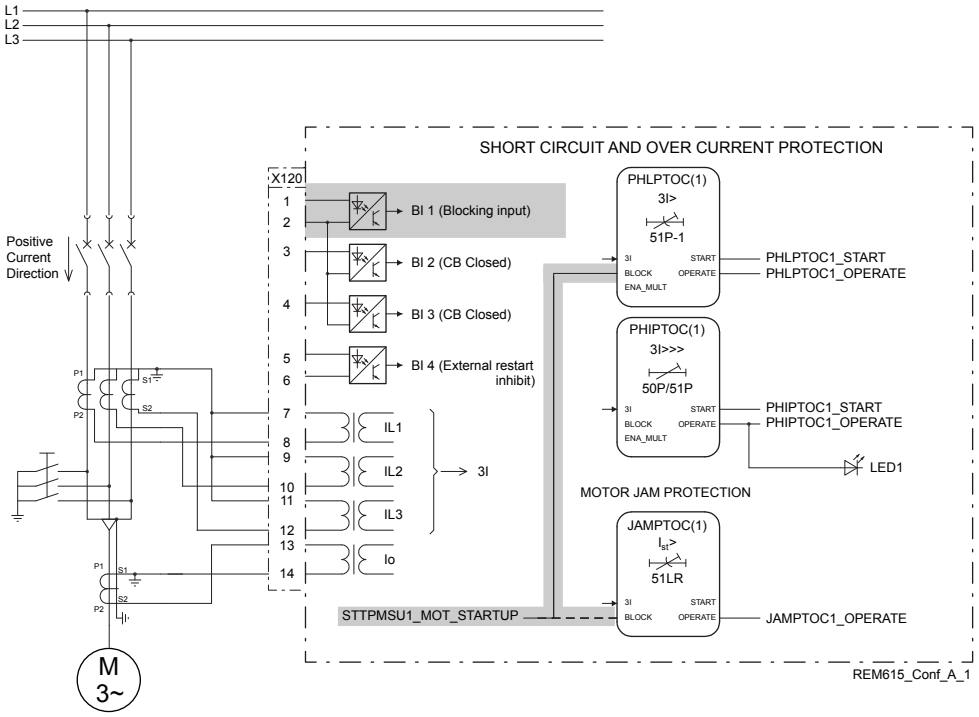


Figure 97: Overcurrent protection

Functional diagrams illustrate the external connections defined in the 615 series standard configuration. Check the connection diagram to see the actual external connections of the replacement IED.

- PHLPTOC1, PHIPTOC1 and JAMPTOC1 are enabled if conditions are fulfilled during migration.
- X120:BI1 is used as a blocking input.
- `MOT_STARTUP` output of STTPMSU1 is connected to `BLOCK` input of PHLPTOC1 instead of `BLOCK` input of JAMPTOC1.

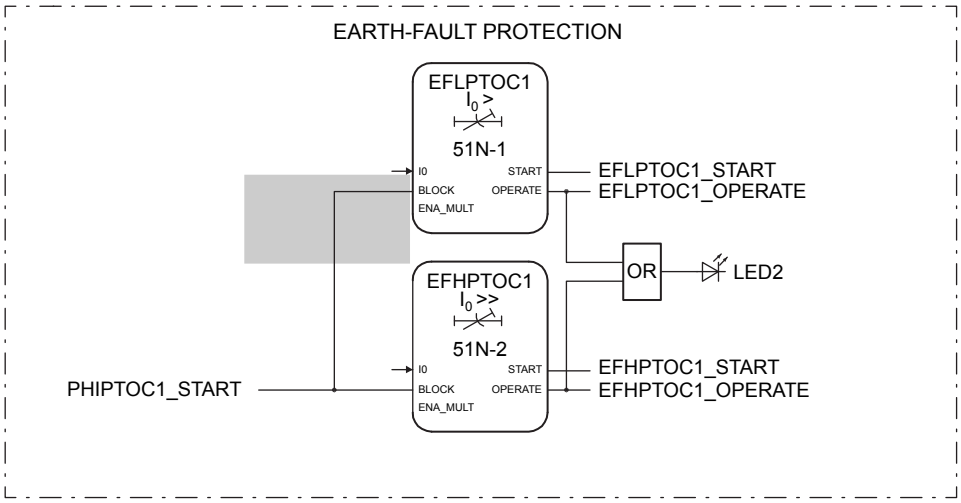


Figure 98: Non-directional earth-fault protection

- EFLPTOC1 is enabled if conditions are fulfilled during migration.
- Connection from `START` output of PHIPTOC1 to `BLOCK` input of EFLPTOC1 is removed.
- EFHPTOC1 is disabled in migration.

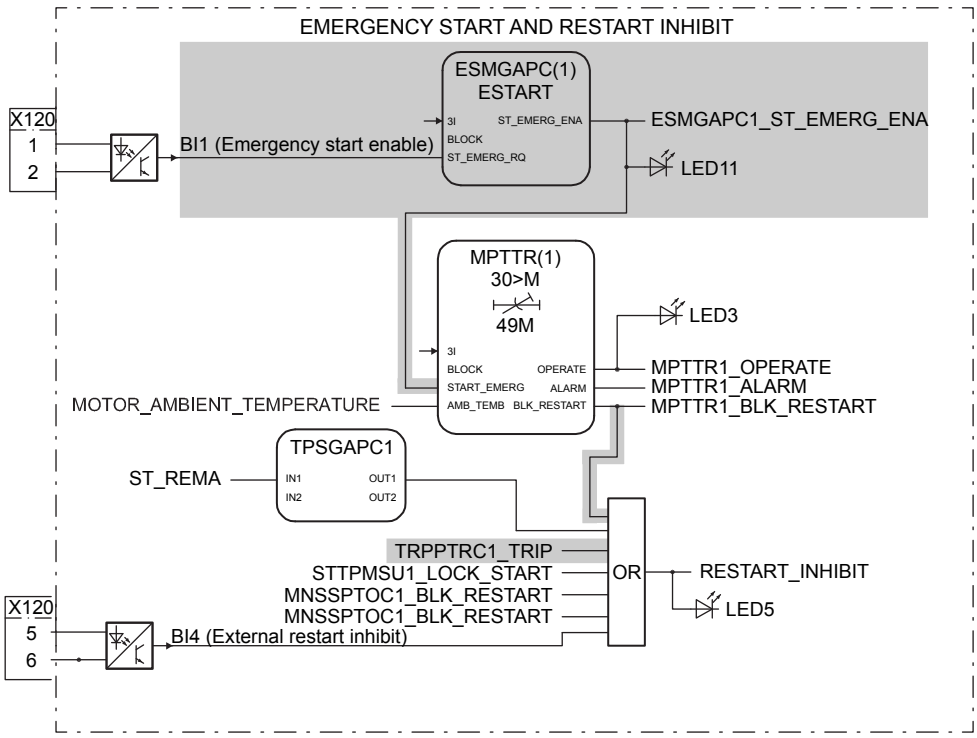


Figure 99: Emergency start and restart inhibit

- ESMGAPC1 is disabled.
- X120:BI1 is used as a blocking input and its behavior is defined by settings of S4 and S65 during the migration.
- MPTTR1 function is enabled if conditions are fulfilled during migration.
- START_EMERG input of MPTTRI1 is disconnected.
- BLK_RESTART output of MPTTR1 and TRIP output of TRPPTRC1 are disconnected from the OR condition for RESTART_INHIBIT signal.

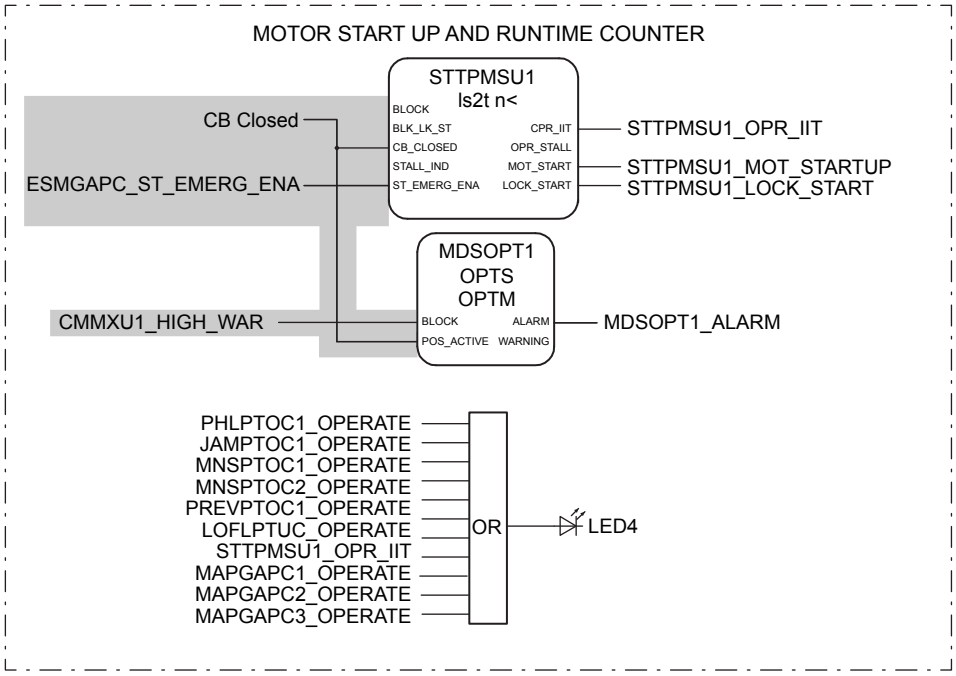


Figure 100: Motor startup supervision

- STTPMSU1 function is enabled if conditions are fulfilled during migration.
- ST_EMERG_ENA input is disconnected.
- CB Closed signal is disconnected.
- MDSOPT1 is enabled.
- BLOCK input of MDSOPT is connected to HIGH_WARN output of CMMXU1.

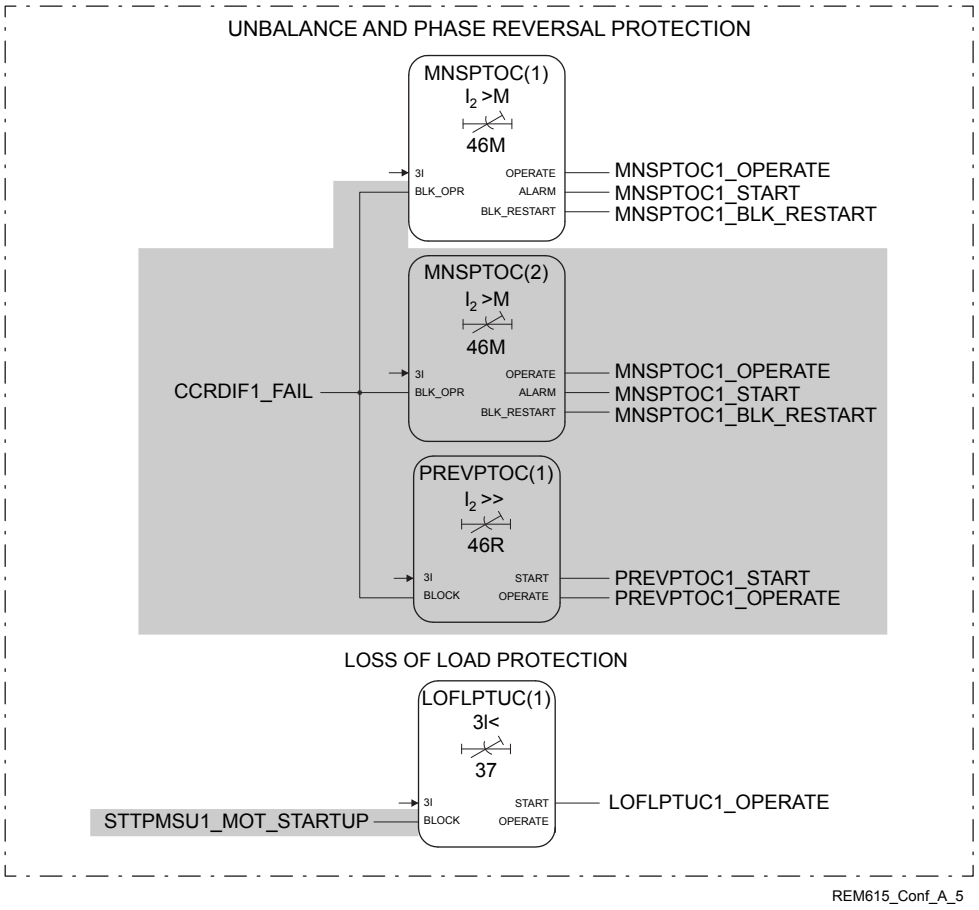


Figure 101: Phase unbalance protection

- MNSPTOC1 and LOFLPTUC1 are enabled if conditions are fulfilled during migration.
- `BLK_OPER` input of MNSPTOC1 is disconnected.
- `BLOCK` input of LOFLPTUC1 is connected to `MOT_STARTUP` output of STTPMSU1.
- MNSPTOC2 and PREVPTOC1 are disabled.

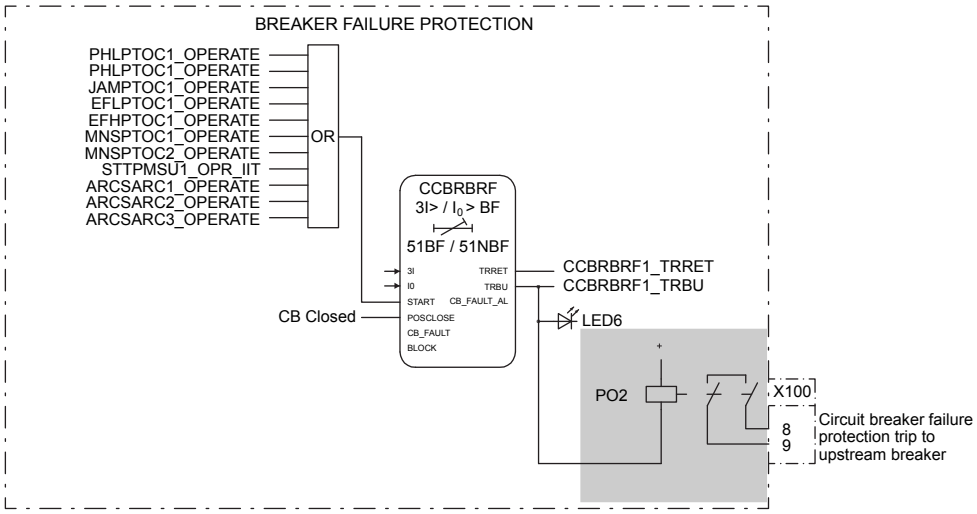


Figure 102: Circuit breaker failure protection

- CCBRBRF1 is disabled and disconnected from the output `PO2`.

9.2.4.2 Functional diagrams for disturbance recorder and supervision

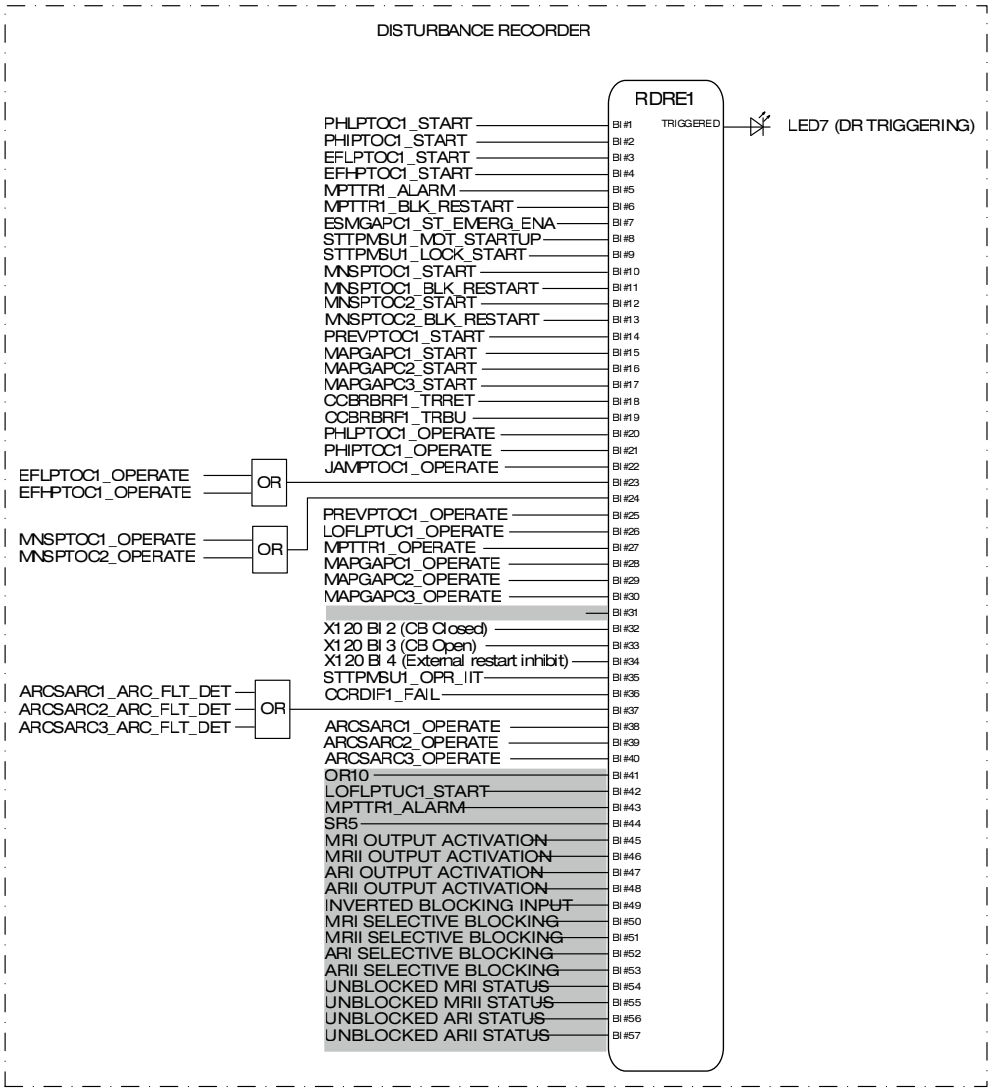


Figure 103: Disturbance recorder

- Modifications to the original disturbance recorder connections are highlighted with gray background.

9.2.4.3 Functional diagrams for control and interlocking

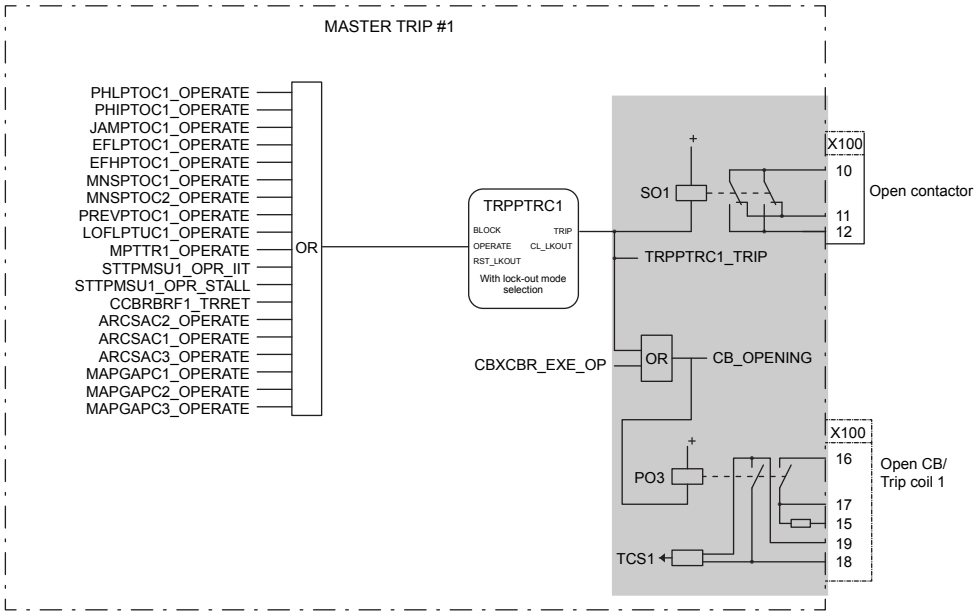


Figure 104: Master trip

- TRPPTRC1 function is used to reset latched trip if value “3” is used in MCX 91x tripping matrix.
- Routing from protection function output to output relays is done by the IED Migration Support tool. This logic is based on settings in MCX tripping matrix.

9.2.4.4 MCX 91x tripping matrix functionality

In MCX 91x, the start and trip signals of all protection functions are routed to output relays through tripping matrix. This functionality is copied to REM615 based on the information provided in the parameter collection form.

Table 37: MCX 91x tripping matrix

Matrix mode	Symbol	IEC 61850	Value			
			MR I X100:PO1	MR II X100:PO2	AR I X100:PO3	AR II X100:PO4
101	$I_{>>1}$	PHIPTOC1	0...3	0...3	0...3	0...3
103	$I_{>1}$	PHLPTOC1	0...3	0...3	0...3	0...3
105	I_2	MNSPTOC1	0...3	0...3	0...3	0...3
107	I_0	EFLPTOC1	0...3	0...3	0...3	0...3
111	$I_{bl.R.}$	JAMPTOC1	0 and 2	0 and 2	0 and 2	0 and 2
113	I_{Start}	STTPMSU1	0...3	0...3	0...3	0...3
115	$I_<$	LOFLPTUC1	0...3	0...3	0...3	0...3
117	N_{kalt}	STTPMSU1	0...3	0...3	0...3	0...3

Table continues on next page

Matrix mode	Symbol	IEC 61850	Value			
			MR I X100:PO1	MR II X100:PO2	AR I X100:PO3	AR II X100:PO4
120	$\Delta\vartheta_3$	-	-	-	-	-
130	$\Delta\vartheta_1$	MPTTR1	0...3	0...3	0...3	0...3
141	$I_{>>2}$	PHIPTOC1	0...3	0...3	0...3	0...3
143	$I_{>2}$	PHLPTOC1	0...3	0...3	0...3	0...3
145	$I_{>3}$	PHLPTOC1	0...3	0...3	0...3	0...3
0 = Not connected 1 = Start 2 = Trip 3 = Trip latched						

9.3 Installation

9.3.1 Mounting

The 615 series IED can be mounted on the switchgear door using the hole left by the MCX 91x relay.

1. Widen the original MCX 91x relay cut-out in horizontal direction.
   1.1. Use a cutting tool with a cutting head for MCX 91x to get the appropriate cut-out on the switchgear door hosting the 615 series IED.

   See the detailed instructions on how to perform cutting in the Relay Retrofit Program Cutting Tool Operating Guide, BBC Std. casing size 1, 1MRS758000.
2. Insert a cover plate (2RCA031788A0001) to hide the visible parts of the original MCX 91x opening.

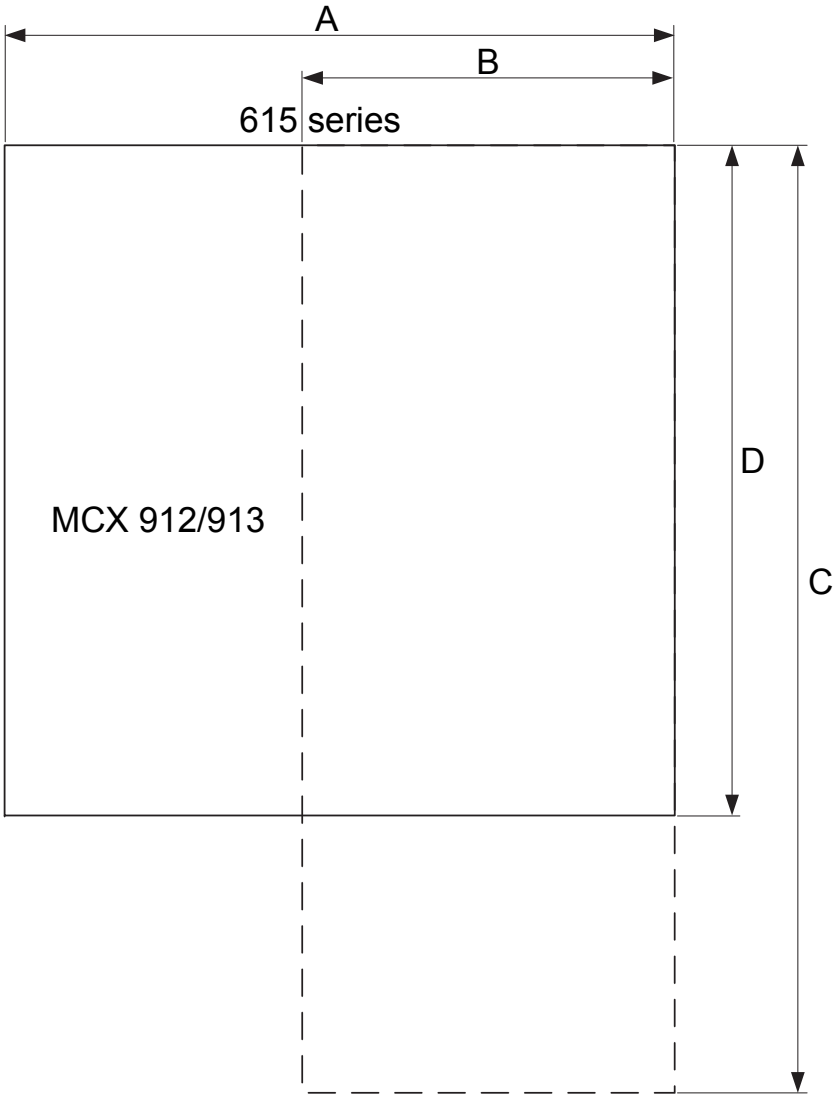


Figure 105: MCX 91x and 615 series cut-outs

A 165.5 mm
B 92 mm
C 234 mm
D 165.5 mm

3. Mount the 615 series IED's case and insert the plug-in unit.

See the 615 series installation manual for more information.

9.3.2 Connecting

- If the existing wiring is in good condition and still usable, use the dedicated marking sets.
- If the existing wiring has to be replaced, use the dedicated wiring harness.

9.3.2.1 Wiring harness and wire markings

Wiring harness is available for retrofitting MCX 91x with REM615.

Table 38: Wiring variants for CT connections

REM615, configuration A		MCX 91x		Wiring
Terminal	Description	Terminal	Description	Marking
X100:1	Uaux+	E20	Uaux+	X100:1 (E20)
X100:2	Uaux-	E19	Uaux-	X100:2 (E19)
X100:3	IRF	E15	stand-by	X100:3 (E15)
X100:4	IRF	E17	stand-by	X100:4 (E17)
X100:5	IRF	E16	stand-by	X100:5 (E16)
X100:6	PO1	E11	MRI	X100:6 (E11)
X100:7	PO1	E12	MRI	X100:7 (E12)
X100:8	PO2	E7	MRII	X100:8 (E7)
X100:9	PO2	E8	MRII	X100:9 (E8)
X100:10	SO1	-	-	X100:10
X100:11	SO1	-	-	X100:11
X100:12	SO1	-	-	X100:12
X100:13	SO2	-	-	X100:13
X100:14	SO2	-	-	X100:14
X100:15	PO3	-	-	X100:15
X100:16	PO3	A4	ARI	X100:16 (A4)
X100:17	PO3	-	-	X100:17
X100:18	PO3	-	-	X100:18
X100:19	PO3	A5	ARI	X100:19 (A5)
X100:20	PO4	-	-	X100:20
X100:21	PO4	A8	ARII	X100:21 (A8)
X100:22	PO4	-	-	X100:22
X100:23	PO4	-	-	X100:23
X100:24	PO4	A9	ARII	X100:24 (A9)
X120:1	BI1	E1/E3/E4/E5	Blocking input	X120:1 (E1/E3/E4/E5)
X120:2	BI1	E2	Blocking input	X120:2 (E2)
X120:3	BI2	-	-	X120:3
X120:4	BI3	-	-	X120:4

Table continues on next page

REM615, configuration A		MCX 91x		Wiring
Terminal	Description	Terminal	Description	Marking
X120:5	BI4	-	-	X120:5
X120:6	BI4	-	-	X120:6
X120:7	IL1	A2	R (variant 1,2,3)	X120:7 (A2)
X120:8	IL1	A3	R (variant 1)	X120:8 (A3)
X120:9	IL2	A6	S (variant 1,2)	X120:9 (A6)
X120:9	IL1	A3	R (variant 3)	X120:9 (A3)
X120:11	IL3	A10	T (variant 1,2,3)	X120:11 (A10)
X120:13	Io/IL3	A6	Io (variant 3)	X120:13 (A6)
X120:14	Io/IL3	A7	Io (variant 2,3)	X120:14 (A7)
-	Earth	-	Earth	-

CT wiring variant 1 (Internal Io)

Based on the information provided in the parameter collection form, MCX 91x migration report shows a note.

```
CT wiring variant 1 is used here. REM615 MNSPTOC1 needs
all three phase currents for proper work. The Io current
transformer is not present and the parameter mode 09
gives the information internal calculation of Io. The
normal wiring from external CT's (L1, L2, L3) to REM615
CT's is used.
```

Table 39: Wires used for wiring harness

Description	REM615 terminal	Wiring marking
IL1	X120:7	X120:7 (A2)
	X120:8[1)]	X120:8 (A3)
IL2	X120:9	X120:9 (A6)
	X120:10[1)]	-
IL3	X120:11	X120:11 (A10)
	X120:12[1)]	-
I_0	X120:13	-
	X120:14	-

1) The signals are connected together. See the connection diagram for details.

CT Wiring variant 2 (External Io)

Based on the information provided in the parameter collection form, MCX 91x migration report shows a note.

```
CT wiring variant 2 is used here. REM615 MNSPTOC1 needs
all three phase currents for proper work. The Io current
```

transformer is not present and the parameter mode 09 gives the information external metering of Io. The normal wiring from external CT's (L1, L2, L3) to REM615 CT's is used and additionally the REM615 Io transformer has to be added in the star point.

Table 40: Wires used for wiring harness

Description	REM615 terminal	Wiring marking
IL1	X120:7	X120:7 (A2)
	X120:8[1)]	-
IL2	X120:9	X120:9 (A6)
	X120:10[1)]	-
IL3	X120:11	X120:11 (A10)
	X120:12[1)]	-
I_0	X120:13[1)]	-
	X120:14	X120:14 (A7)

1) The signals are connected together. See the connection diagram for details.

CT Wiring variant 3 (External Io with CBCT)

Based on the information provided in the parameter collection form, MCX 91x migration report shows a note.

CT wiring variant 3 is used here. REM615 MNSPTOC1 needs all three phase currents for proper work. The Io current transformer is present and the parameter mode 09 gives the information external metering of Io. Beside the normal wiring from external CT's (L1,L3) to REM615 CT's the sum of -(IL1+IL2) has to be connected to the REM615 L2 transformer and additionally the REM615 Io transformer has to be connected to the external Io transformer.

Table 41: Wires used for wiring harness

Description	REM615 terminal	Wiring marking
IL1	X120:7	X120:7 (A2)
	X120:8[1)]	-
IL2	X120:9	X120:9 (A3)
	X120:10[1)]	-
Table continues on next page		

Description	REM615 terminal	Wiring marking
IL3	X120:11	X120:11 (A10)
	X120:12[1)]	-
I_0	X120:13	X120:13 (A6)
	X120:14	X120:14 (A7)

1) The signals are connected together. See the connection diagram for details.

9.3.2.2 MCX 91x terminal layout and connection diagrams

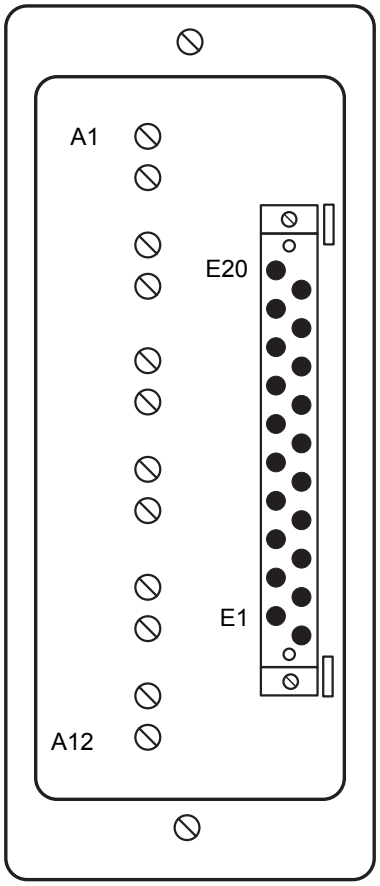


Figure 106: Terminal layout for MCX 91x

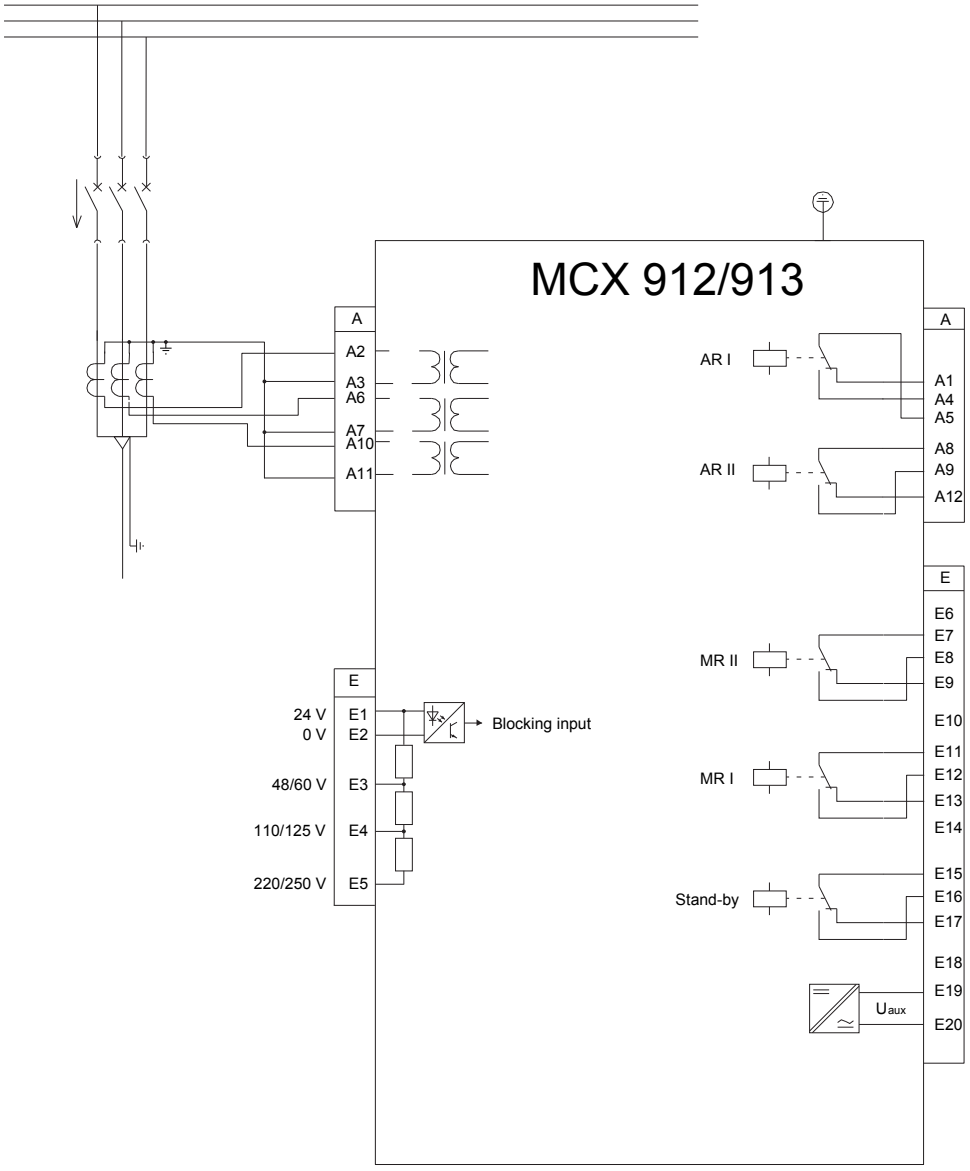


Figure 107: Connection diagram for MCX 91x wiring variant 1 (Internal Io)

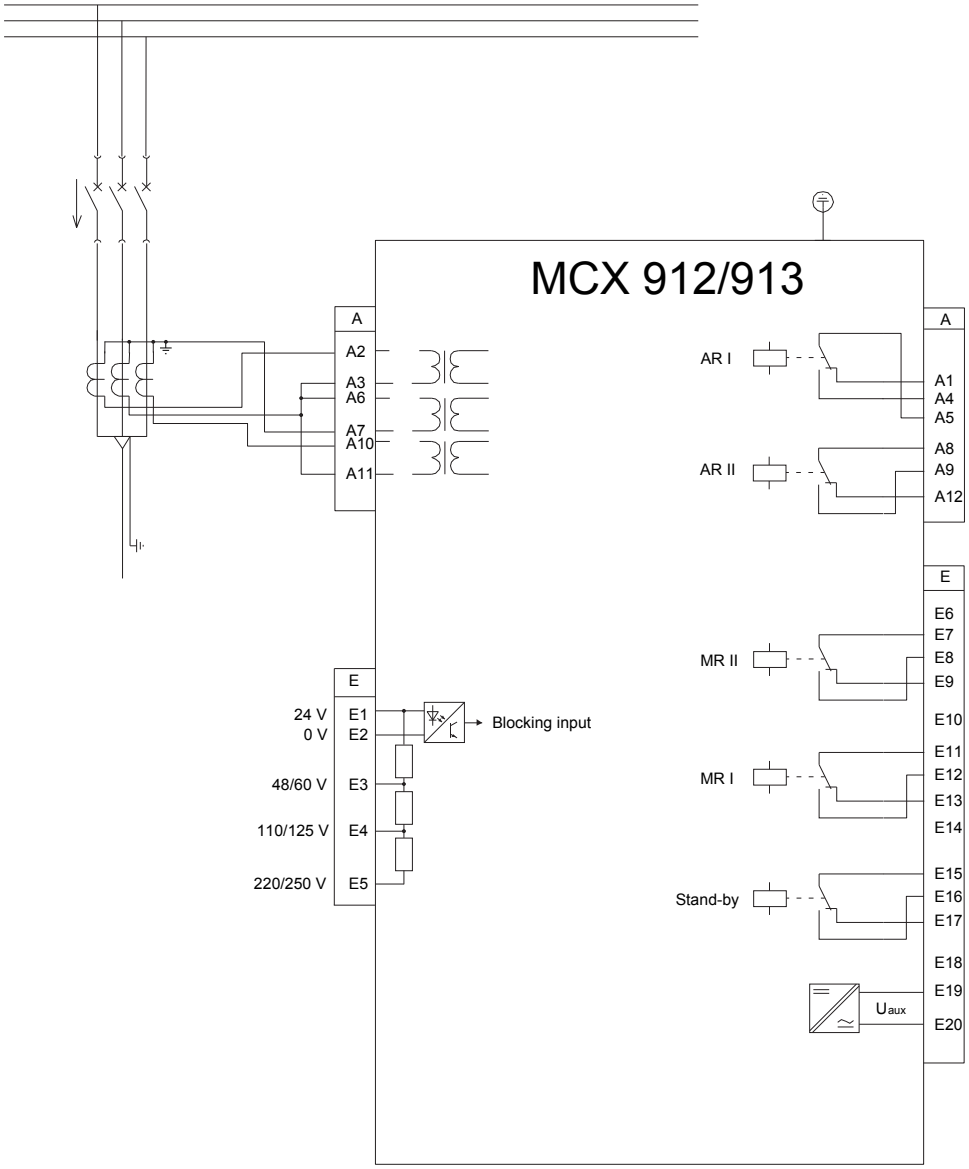


Figure 108: Connection diagram for MCX 91x wiring variant 2 (External Io)

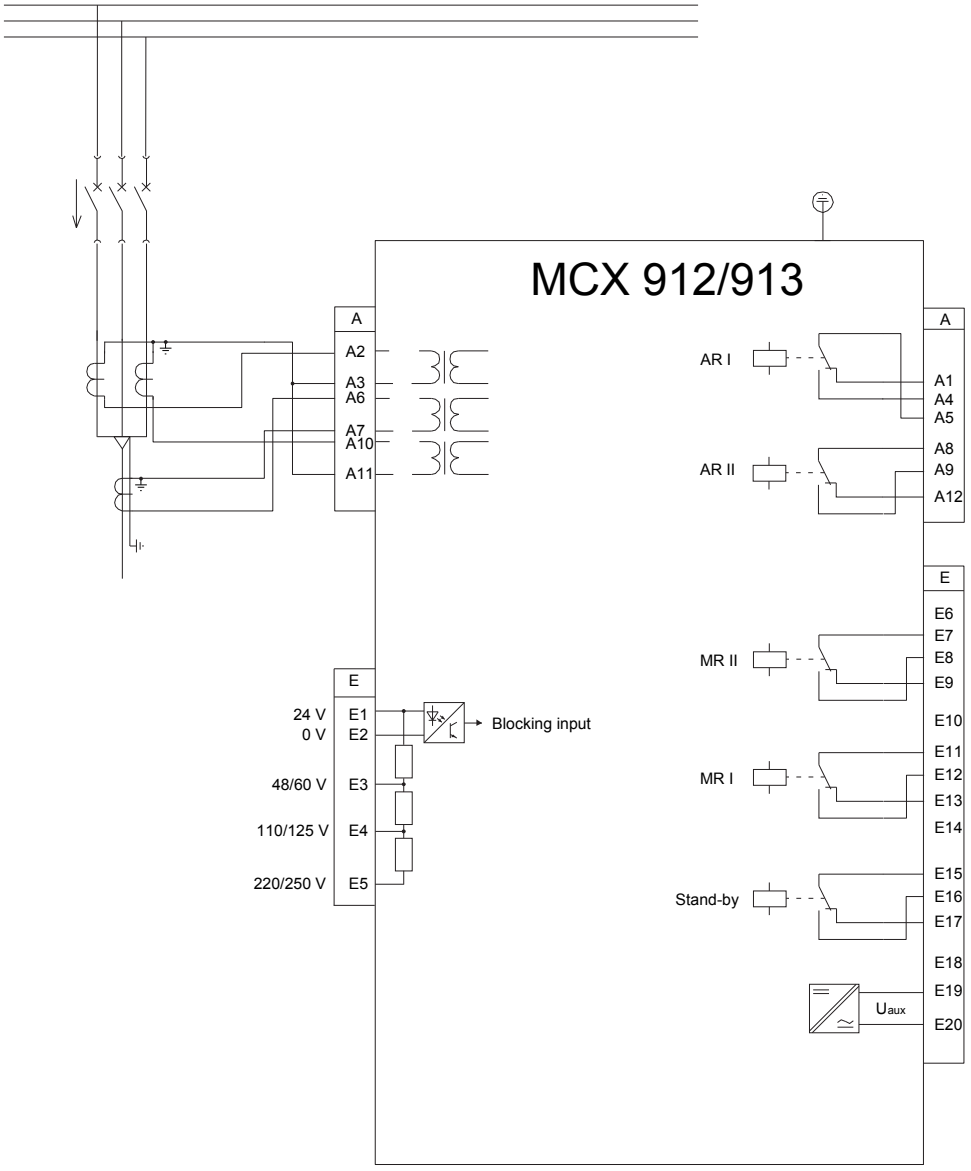


Figure 109: Connection diagram for MCX 91x wiring variant 3 (External Io with CBCT)

9.3.2.3 REM615 terminal layout and connection diagrams

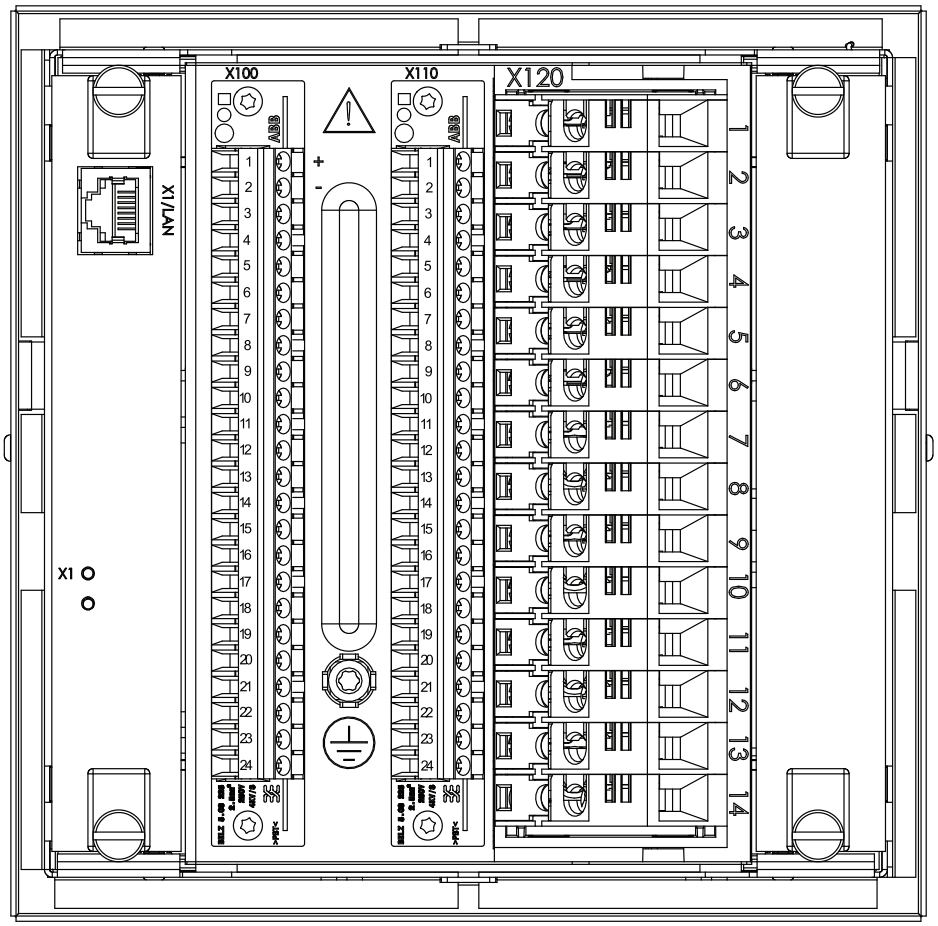


Figure 110: Terminal layout for the 615 series IEDs

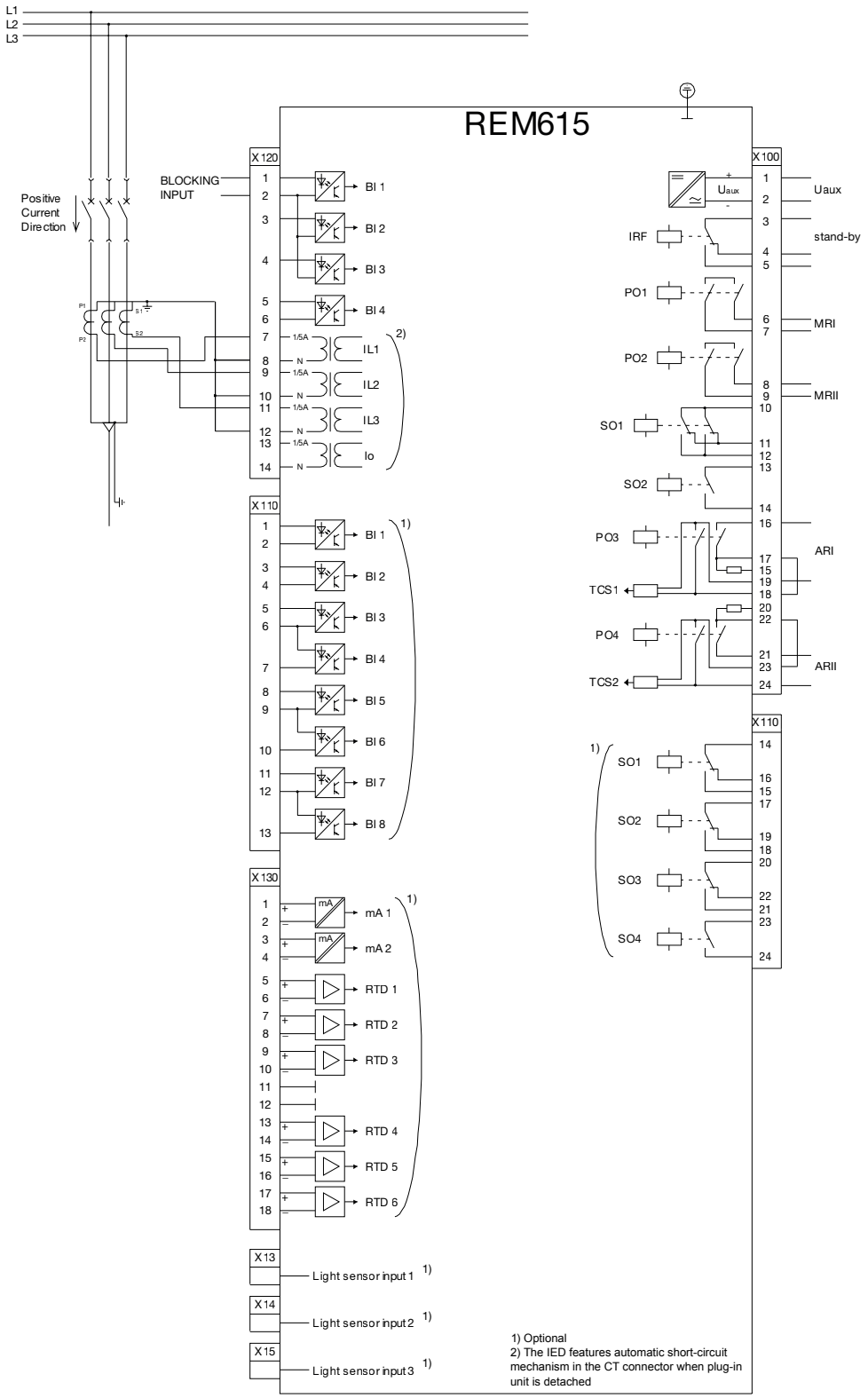


Figure 111: Connection diagram for REM615 wiring variant 1 (Internal Io)

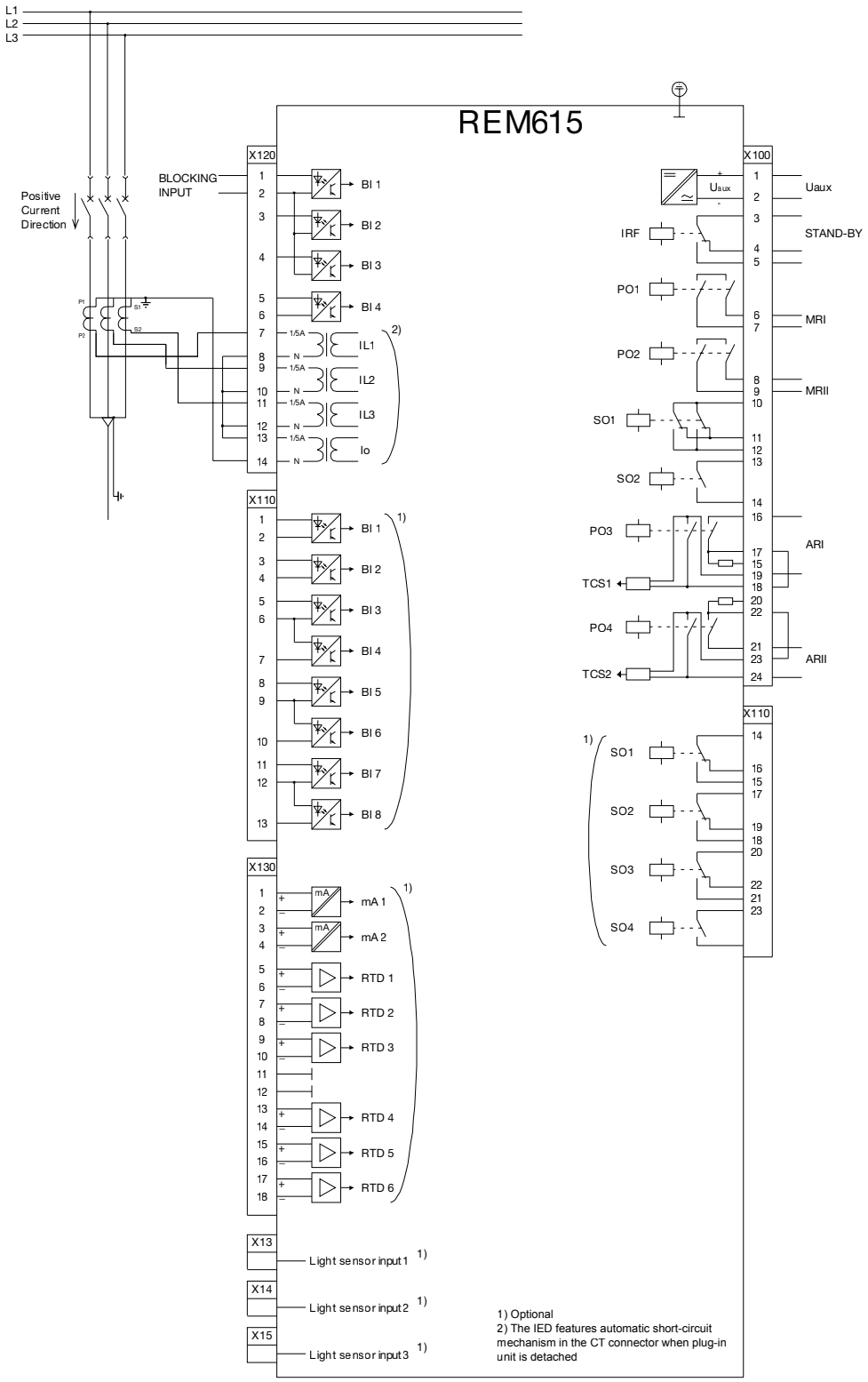


Figure 112: Connection diagram for REM615 wiring variant 2 (External Io)

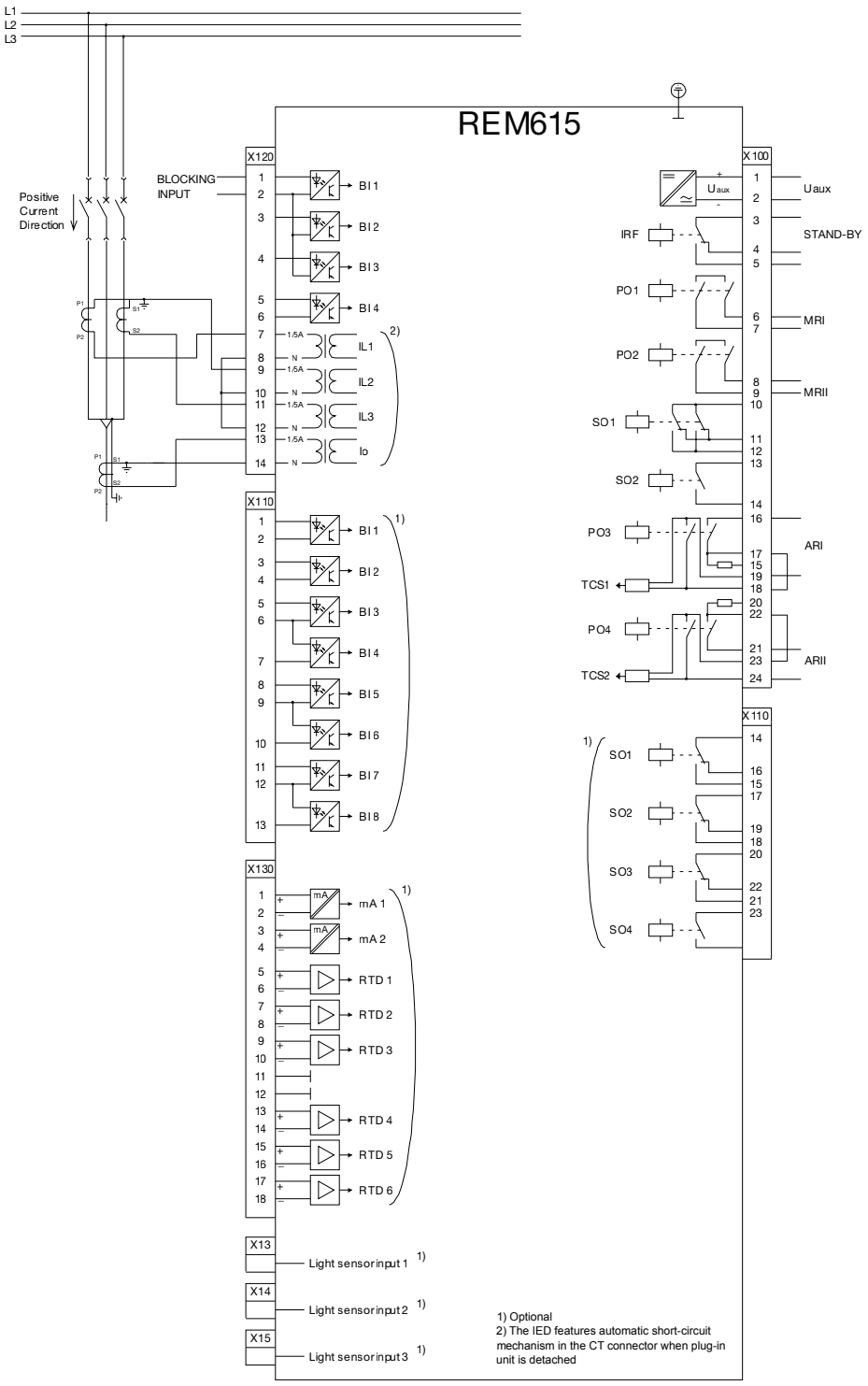


Figure 113: Connection diagram for REM615 wiring variant 3 (External Io with CBCT)

Section 10 Glossary

615 series	Series of numerical protection and control relays for protection and supervision applications of utility substations, and industrial switchgear and equipment
CB	Circuit breaker
CBCT	Core balance current transformer
CBFP	Circuit breaker failure protection
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
Cover plate	Used to adjust the cut-out size if the existing panel cut-out is larger than required by the replacement IED or has a different format
CT	Current transformer
Cutting tool	Dedicated device, consisting of a power unit and a cutting head, for machining the existing panel cut-out
DT	Definite time
DUT	Device under test
Existing relay	Protection relay, installed in a MV indoor switchgear panel low voltage compartment door, to be replaced by a modern IED
HMI	Human-machine interface
HSR	High-availability seamless redundancy
I/O	Input/output
IDMT	Inverse definite minimum time
IEC 61850	International standard for substation communication and modeling
IED	Intelligent electronic device
IRF	1. Internal fault 2. Internal relay fault
LCM	Life cycle management
LED	Light-emitting diode
LHMI	Local human-machine interface
MCB	Miniature circuit breaker
MCX 912	Multifunctional relay

MCX 913	Multifunctional relay
Migration package	Contains the existing relay specific parameter and configuration migration rules for the IED Migration Support Tool
MST	IED Migration Support Tool
NC	Normally closed
NO	Normally open
PCM600	Protection and Control IED Manager
PE	1. Polyethylene 2. Protective earth
PRP	Parallel redundancy protocol
RED615	Line differential protection and control relay
REF615	Feeder protection and control relay
Relion Test Box RTB615	Also known as RTB615. 615 series plug-in unit test facility which provides auxiliary power for the plug-in unit and an interface for a secondary test device such as Omicron.
REM615	Motor protection and control relay
RET615	Transformer protection and control relay
Retrofit connectivity package	Consists of the IED Migration Support Tool and the Relay Retrofit Program documentation
REU615	Voltage protection and control relay
REV615	Capacitor bank protection and control relay
RMS	Root-mean-square (value)
RTB615	Relion Test Box
RTD	Resistance temperature detector
SGB	Switchgroup for digital inputs
SGF	Switchgroup for functions
SGR	Switchgroup for output contacts
SPA	Strömberg protection acquisition. ABB proprietary serial master-slave protocol used in substation automation for point-to-point communication.
SPAJ 14x C	Combined overcurrent and earth-fault relays SPAJ 140 C, SPAJ 141 C and SPAJ 142 C
SPAM 150 C	Motor protection relay
SPAU 130 C	Three-phase voltage relay
SPAU 320 C1	Overvoltage, undervoltage and residual voltage relay

SPAU 330 C1	Overvoltage, undervoltage and residual voltage relay
VT	Voltage transformer
Wire markings	Provided as complete sets which correspond to the terminal setup of the existing relay and the replacement IED. Available for all of the relays supported in the Relay Retrofit Program.
Wiring harness	Existing relay type specific wire set including marked wires for each terminal of the replacement IED. Delivered inside a braided sleeve.
XRIO	eXtended Relay Interface by OMICRON

ABB Distribution Solutions
Electrification Service
P.O. Box 503
FI-65101 VAASA, Finland
Phone +358 10 22 11

www.abb.com/service
www.abb.com/mediumvoltage

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