SIPROTEC

High Voltage Bay Control Unit 6MD66x

V 4.6

Manual

C53000-G1876-C102-5

Disclaimer of liability

We have checked the text of this manual against the hardware and software described. However, deviations from the description cannot be completely ruled out, so that no liability can be accepted for any errors or omissions contained in the information given.

The information in this manual is checked periodically, and necessary corrections will be included in future editions. We appreciate any suggested improvements.

We reserve the right to make technical improvements without notice.

4.60.03

6MD66x Manual
C53000-G1876-C102-5

Preface

Purpose of this Manual

This manual describes the functions, operation, installation and start-up of the High Voltage Bay Control Unit 6MD66x. In particular it contains:

- Information regarding the configuration of the device extent and descriptions of device functions and settings → Chapter 2;
- Instructions for mounting and commissioning → Chapter 3;
- Compilation of technical data→ Chapter 4;
- As well as a compilation of the most significant data for experienced users in Appendix A.

General information about design, configuration, and operation of SIPROTEC® 4 devices is laid down in the SIPROTEC® System Description /1/.

Target Audience

Engineers, commissioning engineers, personnel concerned with adjustment, checking, and service of selective protective equipment, automatic and control facilities and personnel of electrical facilities and power plants.

Scope of validity of the manual

This manual is valid for SIPROTEC® 4 High Voltage Bay Control Unit 6MD66x; Firmware version V 4.6.

Indication of 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 Council Directive 89/336/EEC) and concerning electrical equipment for use within specified voltage limits (Low Voltage Directive 73/23/EEC).

This conformity has been proved by tests performed according to Article 10 of the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 (for EMC Directive) and with the standard EN 60255-6 (for Low Voltage Directive) by Siemens AG.The device is designed and manufactured for application in industrial environment.

The device is designed and manufactured for application in industrial environment.

The product conforms with the international standards of IEC 60255 and the German standards VDE 0435.

Additional Support

Should further information on the System SIPROTEC® 4 be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the local Siemens representative.

Training Courses

Individual course offerings may be found in our Training Catalogue, or questions may be directed to our training centre in Nuremberg.

Instructions and Warnings

The warnings and notes contained in this manual serve for your own safety and for an appropriate lifetime of the device. Please observe them!

The following warning terms and standard definitions are used:

DANGER! indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Warning indicates that death, severe personal injury or substantial property damage **can** result if proper precautions are not taken.

Caution indicates that minor personal injury or property damage can result if proper precautions are not taken. This particularly applies to damage on or in the device itself and consequential damage thereof.

Note indicates information about the device or respective part of the instruction manual which is essential to highlight.

WARNING!

When operating an electrical device, certain parts of the device inevitably have dangerous voltages.

Failure to observe these precautions can result in fatality, personal injury, or extensive material damage.

Only qualified personnel shall work on and around this equipment. It must be thoroughly familiar with all warnings and safety notices of this manual as well as with the applicable safety regulations.

The successful and safe operation of this device is dependent on proper handling, installation, operation, and maintenance by qualified personnel under observance of all warnings and hints contained in this manual.

In particular the general erection and safety regulations (e.g. IEC, DIN, VDE, EN or other national and international standards) regarding the correct use of hoisting gear must be observed.

Definition

QUALIFIED PERSONNEL For the purpose of this instruction manual and product labels, a qualified person is one who is familiar with the installation, construction and operation of the equipment and the hazards involved. In addition, he has the following qualifications:

– Training and Instruction to energize, de-energize, clear, ground and tag circuits and equipment in accordance with established safety practices.

– Is trained in the proper care and use of protective equipment in accordance with established safety practices.

– Training in rendering first aid.

Typographic and Symbol Conventions

To designate terms which refer in the text to information of the device or for the device, the following fonts are used:

`Parameter Names`

Designators of configuration or function parameters which may appear word-for-word in the display of the device or on the screen of a personal computer (with DIGSI®), are marked in bold letters of a monospace type style. The same applies to headings of selection menus.

`1234A`

Parameter addresses have the same character style as parameter names. Parameter addresses contain the suffix **A** in the overview tables if the parameter can only be set in DIGSI ® via the option **Display additional settings**.

`Parameter States`

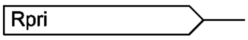
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI®), are additionally written in italics. This also applies to header bars for selection menus.

„`Indications`“

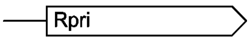
Designators for information, which may be output by the device or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

Deviations may be permitted in drawings and tables when the type of designator can be obviously derived from the illustration.

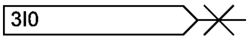
The following symbols are used in drawings:



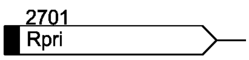
Device-internal logical input signal



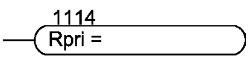
Device-internal (logical) output signal



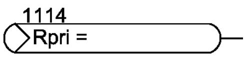
Internal input signal of an analog quantity



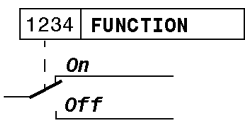
External binary input signal with number (binary input, input indication)



External binary output signal with number (device indication)

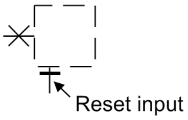


External binary output signal with number (device indication) used as input signal

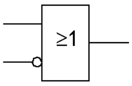


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings **ON** and **OFF**

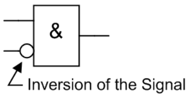
Besides these, graphical symbols are used according to IEC 60617-12 and IEC 60617-13 or symbols derived from these standards. The most frequent symbols are the following:



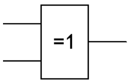
Input signal of an analog quantity



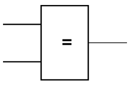
OR gate



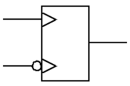
AND gate



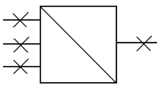
Exclusive OR (antivalence): output is active if only **one** of the inputs is active



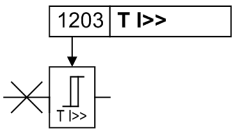
Coincidence: output is active if **both** inputs are active or inactive at the same time



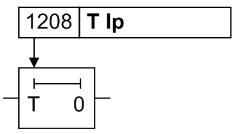
Dynamic input signals (edge–triggered) above with positive, below with negative edge



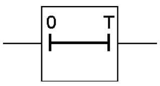
Formation of one analog output signal from a number of analog input signals



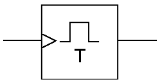
Limit value stage with parameter address and parameter name



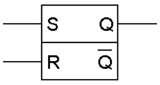
Timer (pickup delay T adjustable) with parameter address and parameter name



Time stage (reset delay T, nonadjustable)



Edge-controlled time stage with effective time T



Static memory (RS-flipflop) with setting input (S), resetting input (R), output (Q) and inverted output ($\overline{Q}$)

Contents

Introduction 1

The SIPROTEC® 6MD66x devices are introduced in this section. An overview of the devices is presented in their application, characteristics, and scope of functions.

1.1 Overall Operation

The digital, high-voltage SIPROTEC® 6MD66x bay controllers are equipped with a powerful microprocessor system. All tasks, from issuing commands to circuit breakers to the acquisition of measured quantities are processed in a completely digital way.

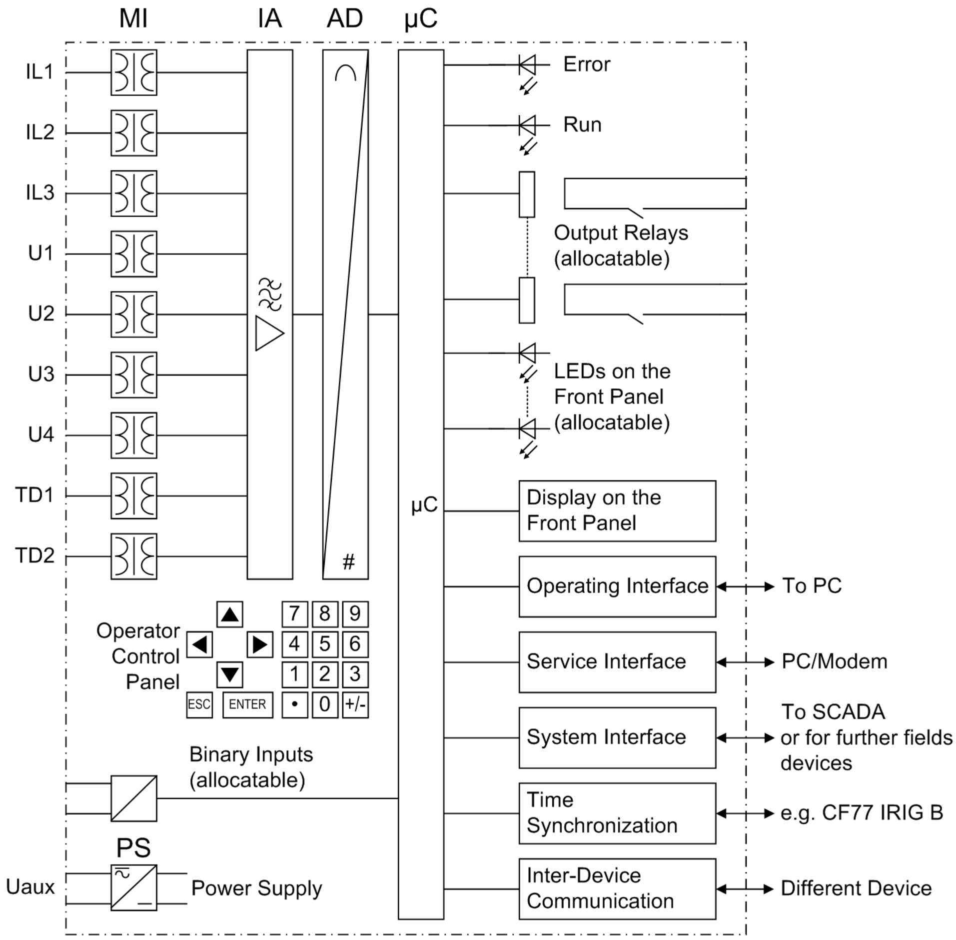


Figure 1-1 Hardware structure of the High Voltage Bay Control Unit 6MD66x

Analog Inputs

The measuring inputs (I_{Lx}, U_x) convert the currents and voltages coming from the transformers and adapt them to the level appropriate for the internal processing of the device. The device has three current inputs, four voltage inputs and two transducer inputs (20 mA).

The current and voltage inputs can be used separately for measured value acquisition. Within the scope of configuration, one- or three-phase evaluation functions are available for evaluation of the analog inputs and evaluation of measured quantities connected in an Aron connection.

With voltage inputs, both phase-earth and phase-phase voltages can be applied. In addition to a three-phase system, another reference voltage for synchronisation tasks or a displacement voltage V_n can be measured via the fourth voltage input.

Furthermore, two measuring transducer inputs are available.

The analogue values are transferred further to the IA input amplifier group.

The input amplification IA stage provides high-resistance terminations for the analogue input quantities. It consists of filters that are optimised with regard to bandwidth and processing speed.

The analogue-to-digital (AD) stage consists of a multiplexor, an analogue-to-digital (A/D) converter and memory components for the transmission of digital signals to the microcomputer system.

Microcomputer system

The control functions and the measurement quantities are processed in the microcomputer system μC. They especially consist of:

- Control of command outputs,
- Processing of indication inputs,
- Recording of indications,
- Control of signals for logical functions,
- Filtering and conditioning of the measured signals,
- Continuous monitoring of the measured quantities
- Monitoring the communication with other devices,
- Querying of limit values and time sequences,
- Management of the operating system and the associated functions such as data recording, real-time clock, communication, interfaces, etc.

Binary Inputs and Outputs

Binary inputs and outputs from and to the bay controller are routed via the I/O modules (inputs and outputs). The computer system obtains the information from the system (e.g remote resetting) or the external equipment (e.g. blocking commands). Outputs are, in particular, commands to the switchgear units and indications for remote signalling of important events and statuses.

Front Elements

With devices with integrated or detached operator panel, information such as messages related to events, states, measured values and the functional status of the device are provided via light-emitting diodes (LEDs) and a display screen (LCD) on the front panel.

Integrated control and numerical keys combined with the LC display allow „local operator communication“ between the operating staff and the device. Via these elements all information of the device such as configuration and setting parameters, operational indications and measured values can be accessed.

Another central function is the control of system equipment via the operator interface of the device.

Moreover, a front panel has a 9-pin D-subminiature connector for local communication with a personal computer using DIGSI.

Serial Interfaces

A serial **PC** interface is provided for local communications with the device through a personal computer using the operating program DIGSI®. This permits convenient operation of all functions of the device.

A serial **service** interface can likewise make communication via a PC with the device possible using DIGSI®. This port is especially well suited for the fixed wiring of the devices to the PC or operation via a modem.

Via the serial **system**interface all device data can be transferred to a central evaluation unit or to a control centre. Depending on the application, this interface, just like the service interface, can be equipped with varying physical transmission modes and different protocols.

Communication with other SIPROTEC® 4 devices which also have inter-relay communication can occur via the serial interface to the IRC (optional) on the device rear. This allows communication independent of the link to the SICAM SAS central controller.

A further interface is provided for the **time synchronization** of the internal clock via external synchronization sources.

Power Supply

These described functional units are supplied by a power supply PS with the necessary power in the different voltage levels. Transient dips of the supply voltage, which may occur during short-circuits or interruptions in the power supply system, are bridged by a capacitor (see also Technical Data).

1.2 Application Scope

The SIPROTEC® 6MD66x High Voltage Bay Control Units are integrated components of the SICAM energy automation system. Command outputs and indication inputs are especially adapted to the requirements of high-voltage technology.

When connecting the circuit breaker, the High Voltage Bay Control Unit can check if the synchronization conditions of the two subnetworks to be combined are met (synchrocheck). This makes the use of an additional external synchronization device unnecessary. The synchronization conditions can be configured conveniently with the DIGSI(r) operating program. The device distinguishes between synchronous and asynchronous networks and reacts differently in cicuit breaker close decision.

Interlocking, breaker failure protection and automatic reclosure function ensure a high switchgear availability.

Control Functions

The device provides a control function which can be accomplished for activating and deactivating switchgears via integrated operator panel, system interface, binary inputs, and the serial port using a personal computer with DIGSI®.

The status of the primary equipment can be transmitted to the device via auxiliary contacts connected to binary inputs. The present status (or position) of the primary equipment can be displayed on the device, and used for interlocking or plausibility monitoring. The number of the operating equipment to be switched is limited by the binary inputs and outputs available in the device or the binary inputs and outputs allocated for the switch position indications. Depending on the primary equipment being controlled, one binary input (single point indication) or two binary inputs (double point indication) may be used for this process.

The capability of switching primary equipment can be restricted by a setting associated with switching authority (Remote or Local), and by the operating mode (interlocked/non-interlocked, with or without password request).

Processing of interlocking conditions for switching (e.g. system interlocking) can be established with the aid of integrated, user-configurable logic functions.

Inter-relay communication through port C, abbreviated **IRC**, is a feature that allows the direct exchange of information, such as interlocking conditions, between SIPROTEC® 4 devices.

Indications and Measured Values

The indication list provides information about conditions in the power system and the device. Measurement quantities and values that are calculated can be displayed locally and communicated via the serial interfaces.

Device indications can be assigned to LEDs, externally processed via output contacts, linked with user-definable logic functions and/or issued via serial interfaces.

Communication

For communication with external operator and control systems and Inter-relay communication through port C, serial interfaces are available.

Please note that the following interfaces are optional or only available on certain device variants:

- **Operator** interface
  Service interface
- **System** interface

A 9-pin DSUB socket on the front cover is used for local communication with a PC. By means of the SIPROTEC® 4 operating software DIGSI®, all operational and evaluationn tasks can be executed via this **user** interface, such as specifying and modifying configuration poarameters and settings, configuring user-specific logic functions, retrieving operational messages and measured values, inquiring device conditions and measured quantities, issuing control commands.

Depending on the individual ordering variant, additional interfaces are located on the rear side of the device. They serve to establish an extensive communication with other digital operating, control and memory components:

As an extension to the universal operator program DIGSI®, a Web-Monitor is provided in the 6MD66x which can be activated by a long-distance transmission link and a browser (e.g. Internet Explorer). The WEB-Monitor is intended to be a commissioning aid and can display, for instance, parameters and measured values. Refer also to Section 2.14.

The **service** interface can be operated via electrical or optical data lines (fibre optics cables) and also allows communication via modem. For this reason, remote operation is possible via a personal computer and the DIGSI® operator software, e.g. to operate several devices via a central PC.

The **system** interface ensures the central communication between the device and the substation controller. The service interface can be operated through electrical or optical data cables.

The device may have a field bus coupling with PROFIBUS FMS. The PROFIBUS FMS according to DIN 19 245 is an open communication standard with particularly wide acceptance in process control and automation engineering, with especially high performance. A profile has been defined for the PROFIBUS communication that covers all of the information types required for process control engineering. The integration of the devices into the power automation system SICAM® can also take place with this profile.

Alternatively, the device can be operated via PROFIBUS DP.

In addition, standardized protocols in accordance with IEC 60 870-5-103 are available for data transmission. The integration of the devices into automation systems from other manufacturers can also take place with this profile.

An EN 100 module allows to integrate the devices into 100 Mbit Ethernet communication networks used by process control and automation systems and running IEC 61850 protocols.

Optionally, you can use an additional serial interface for Inter-relay communication through port C. It takes over communication with other SIPROTEC® 4 devices, regardless if the device is connected to the control center.

Note

The Appendix contains a list of the functions which can be handled via the respective interfaces.

1.3 Characteristics

General Features

- Powerful 32-bit microprocessor system.
- Complete digital measured value processing and control, from the sampling and digitalization of the analog input quantities to the initiation of outputs for tripping or closing circuit breakers.
- Complete galvanic and reliable separation between the internal processing circuits of the device and the external measurement, control, and power supply circuits because of the design of the analog input transducers, binary input and output modules, and the DC/DC or AC/DC converters.
- Extensive communication possibilities with external devices using different interfaces and protocols (as described above under "Communication").
- Complete set of functions necessary for the proper control of feeders or busbars.
- Easy device operation through an integrated operator panel or by means of a connected personal computer running DIGSI.
- Continuous calculation and display of measured and metered values on the front of the device
- Constant monitoring of the measurement quantities, as well as continuous self-diagnostics covering the hardware and software.
- Communication with central control equipment via serial interfaces is possible through the choice of data cable, modem, or fibre optic cable, as an option.
- Optional Inter-relay communication through port C for direct communication between the devices, regardless of their connection to the control centre.
- Internal clock which can be synchronized via a synchronization signal (DCF 77, IRIG B via satellite receiver), binary input or system interface.
- Storage of fault indications as well as instantaneous values for fault recording
- Commissioning aids such as connection check, status indication of all binary inputs and outputs, easy check of system interface and influencing of information of the system interface during test operation

Synchronization Function (optional)

- Checking of the synchronisation conditions of both subnetworks.
- Differentiation between synchronous and asynchronous networks.
- Consideration of the circuit breaker operating times with asynchronous networks.
- Saving of up to eight parameter sets for synchronization to be able to consider the differing properties of circuit breakers and network conditions.

Switchgear Interlocking

- Switchgear interlocking with bay or system interlocking
- Communication using inter-relay communication (IRC)
- Easy configuration of interlocking conditions

Circuit Breaker Failure Protection (optional)

- With definite time current stages for monitoring current flow through every pole of the circuit breaker
- Start by a trip command from the internal breaker failure protection function;
- Start by external trip functions possible
- Single-stage or two-stage
- Short dropout and overshoot times

Automatic Reclosure Function (optional)

- For reclosure after single-pole, three-pole or single-pole and three-pole tripping
- Single or multiple reclosure (up to 8 reclosure attempts)
- With separate action times for every reclosure attempt, optionally without action times
- With separate dead times after single-pole and three-pole tripping, separate for the first four reclosure attempts
- Controlled optionally by protection pickup with separate dead times after single, two-pole and three-pole pickup
- Optionally with adaptive dead time, reduced dead time and dead line check.

Control

- High security against incorrect switchings via system and bay related interlocking checks, including the information of neighbouring bays via inter relay communication.
- High variance with regard to switchgear types and operating modes.

Switching authority and switching mode

- Keylock switches for defining the control authority and the control mode.
- Logging keylock-switch positions.

Measured values

- Connection of measured values in accordance with one- or three-phase system or Aron connection.
- Flexible measured value processing with configurable measuring packets.

Metered values

- Formation of metered values from measured values
- Acquisition of pulse metered values via the binary inputs

User-defined functions

- Freely programmable links between internal and external signals for the implementation of user-defined logic functions (e.g. interlocking).
- Logic functions for Boolean and mathematical equations.
- Switching sequences and interlocks.
- Time delays and measured value set point interrogation.

Monitoring functions

- Increased reliability thanks to monitoring of internal measuring circuits, auxiliary power supply, hardware and software.
- Monitoring of communication including the evaluation of the number of faulty transmission messages.

Inter relay communication

- Direct exchange of information between the SIPROTEC® 4 devices, even without a connection to the SICAM control centre.
- A stationwide interlocked control is also possible if the connection to the control centre or the control centre itself is disturbed.

Web Monitor

- The Web-Monitor allows to display parameters, data and measured values for SIPROTEC® 4 devices and a quick view of an IRC combination. The combination data, device data, master data, combination structure and indications of each user are visualised. Web-Monitor also allows to display synchronisation ranges, a synchronoscope and synchronous networks. For this it uses Internet technology. The display is made by a Web browser. A special operator program (e.g. DIGSI 4) is not necessary.

Further functions

- Indication storage for the last 200 operational indications with real-time assignment.
- Fault recording and data transfer for fault recording for a maximum time range of 15 s

■

Functions

2

This chapter describes the numerous functions available on the SIPROTEC® 4 6MD66x. It shows the setting possibilities for all the functions in maximum configuration. Instructions for deriving setting values and formulae, where required are provided.

Additionally it may be defined which functions are to be used.

2.1 General Settings

The function parameters can be modified using the operating or service interface with a personal computer using DIGSI®. The procedure is described in detail in the SIPROTEC ® System Description /1/.

2.1.1 Functional scope

The High Voltage Bay Control Unit 6MD66x has functions whose scope can be adapted to the system conditions. Some functions (e.g. control authorization and mode) are available by default, whereas other functions must be added within the framework of configuration. The functional scope of the device is specified within the scope of configuration.

2.1.1.1 Configuring the Functional Scope

In DIGSI®, dialog box **Functional scope**, the functions Measuring transducer (various types) and Synchronization (1 to 8) are configured as **Enabled** or **Disabled**.

Functions that are configured as **Disabled** are not processed by the 6MD66x: There are no indications, and corresponding settings (functions, limit values) are not displayed.

Functions that are not needed can be hidden.

2.1.1.2 Setting Notes

Loading the Configuration Settings

Configuration settings can be loaded using a PC and the operating program DIGSI® and transferred via the operator interface on the front panel or via the rear service interface. Operation via DIGSI® is described in the SIPROTEC® System Description/1/.

For changing **configuration parameters in the device**, **password no.7** is required (for parameter set). Without the password, the settings may be read, but cannot be modified and transmitted to the device.

2.1.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	MU V_1	Disabled Enabled	Disabled	Measurement V
0	MU I_1	Disabled Enabled	Disabled	Measurement I
0	MU1P_1	Disabled Enabled	Enabled	Measurement 1phase 1.packet
0	MU1P_2	Disabled Enabled	Disabled	Measurement 1phase 2.packet
0	MU1P_3	Disabled Enabled	Disabled	Measurement 1phase 3.packet
0	MU3P_1	Disabled Enabled	Enabled	Measurement 3phase 1.packet
0	MUAron_1	Disabled Enabled	Disabled	Measurement Aron 1.packet
0	Synchronizing 1	Disabled Enabled	Disabled	Synchronizing Function 1
0	Synchronizing 2	Disabled Enabled	Disabled	Synchronizing Function 2
0	Synchronizing 3	Disabled Enabled	Disabled	Synchronizing Function 3
0	Synchronizing 4	Disabled Enabled	Disabled	Synchronizing Function 4
0	Synchronizing 5	Disabled Enabled	Disabled	Synchronizing Function 5
0	Synchronizing 6	Disabled Enabled	Disabled	Synchronizing Function 6
0	Synchronizing 7	Disabled Enabled	Disabled	Synchronizing Function 7
0	Synchronizing 8	Disabled Enabled	Disabled	Synchronizing Function 8
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
110	Trip mode	3pole only 1-/3pole	3pole only	Trip mode
133	Auto Reclose	1 AR-cycle 2 AR-cycles 3 AR-cycles 4 AR-cycles 5 AR-cycles 6 AR-cycles 7 AR-cycles 8 AR-cycles ADT Disabled	Disabled	Auto-Reclose Function
134	AR control mode	Pickup w/ Tact Pickup w/o Tact Trip w/ Tact Trip w/o Tact	Trip w/ Tact	Auto-Reclose control mode
139	BREAKER FAILURE	Disabled Enabled	Disabled	Breaker Failure Protection

2.1.2 Power System Data 1

To function, the device requires the **Rated Frequency** of the network. The default preset value must only be changed if the network of the application field has a different **Rated Frequency**.

2.1.2.1 Setting Notes

Rated Frequency

The **Rated Frequency** of the network in which the device is operating is set under the address 214. A default value is set.

Unom SECONDARY Unom SECONDARY TMax CLOSE CMD

The other parameters, **Unom SECONDARY**, **TMin TRIP CMD** and **TMax CLOSE CMD**, are only used for the automatic reclosure and the breaker failure protection function.

2.1.2.2 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
204	Unom SECONDARY	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
214	Rated Frequency	50 Hz 60 Hz	50 Hz	Rated Frequency
240	TMin TRIP CMD	0.02 .. 30.00 sec	0.10 sec	Minimum TRIP Command Duration
241	TMax CLOSE CMD	0.01 .. 30.00 sec	0.10 sec	Maximum Close Command Duration

2.1.3 Device, General Settings

The behaviour of 6MD66x devices can be set individually with various settings.

2.1.3.1 Function Description

The devices are equipped with an illuminated LC display for displaying process and device information. The light for the display is normally off.

Illumination is controlled:

- via an operator action,
  - **ON**, on actuating any key on the operator control panel or
  - **OFF**, after 10 minutes if no further operator input follows.
- via the binary input „`>Light on`“ (if configured correspondingly),
  - **ON**, if „`>Light on`“ ON or,
  - **OFF**, after the time set under **`T Backlight on`**.

The lighting can also be switched on and off with DIGSI® via the operator interface or the service interface.

2.1.3.2 Indications of the device

„Device OK“

Indication: The device is ready for operation.

The life contact is switched ON and the error LED is switched OFF with this message.

Value: On

„Reset Device“

Indication: The device has performed a startup.

Special communication indication: It is announced on the PROFIBUS that the SIPROTEC-VD has started the PD service (only the logged on partner).

Value: On

„Initial Start“

Indication: The device has performed an initial restart.

All buffers were cleared (additional information for start-up indication).

Value: On

„Resume“

Indication: The device has performed a restart.

All buffers remained intact (additional information for start-up indication).

Value: On

Tagging command for acknowledging the LEDs of SICAM or DIGSI®.

Value: On

„>Light on“

Display on/off via binary input.

Value: ON/OFF

„Chatter ON“ Central chatter suppression message.

This message indicates if the chatter suppression responded during a binary message subject to the chatter processing.

Value: ON, the chatter suppression responded for at least one binary message.

Value: OFF, chatter suppression did not respond for any binary message.

„Error PwrSupply“ Indication: The power supply unit is faulty.

Value: On

„Fail Battery“ Indication: The battery is faulty.

Value: On

„DataStop“ Data transmission blockage for indications, metered and measured values.

With data transmission blockage on, all information in the monitoring direction —of the device to the higher control centre— is marked with the **transmission blockage** bit. The actual transmission blockage is performed in the control center.

Value: ON/OFF

„>DataStop“ Predefined binary input for tagging and delete „`DataStop`“

Value: ON/OFF

„Test mode“ This operating mode is used for device tests during commissioning or maintenance. In test mode, all information in monitoring direction is marked with UBF test bit. This procedure serves to avoid that events caused by the test mode initiate unwanted reactions (horn, derived commands and indications, etc.) in higher-level system components (DIGSIDIGSI® or SICAM). This operating mode can be activated and deactivated by a tagging command in DIGSI®.

Value: ON/OFF

„HWTestMod“ Hardware test mode: DIGSI® switches ON this operating mode if the user activates the functions Set binary input, Set output relay, Set messages, for example, in start-up mode. DIGSI® switches OFF the hardware test mode when leaving the start-up area. After the switch-off command, the "Hardware test mode OFF" message is output and an initial device start-up is initiated after a period of 5 seconds.

Value: ON/OFF

„>Time Synch“ Input for the external minute pulse.

Value (fleeting): On

„SynchClock“ Acknowledgement of a clock synchronization.

Value (fleeting): On

„Clock SyncError“ Indication: Clock synchronisation error.

Value: ON, the synchronizing event is missing after the parametrized tolerance time.

Value: OFF, a synchronizing event has again arrived.

„DayLightSavTime“ Indication: Daylight saving time switchover.

Value: ON, a time synchronisation job with summertime was detected by the date-clocktime processing.

Value: OFF, a time synchronisation job without daylight saving time was detected.

„Settings Calc.“ Annunciation that a parametrization is current.

Value: ON, the function is reserved for parametrization.

Value: OFF, the function has been enabled again.

„Settings Check“ Message that the device operates with new parameters which are not yet continuously saved (on-line parameterization).

Value: ON, the test has begun.

Value: OFF, the test is ended, i.e. the device is either operative again, or the new parameters have been saved permanently, or no parameter check is current.

„Level-2 change“ The message is transmitted as ON as soon as the parameter set loaded via DIGSI ® was changed via an on-line parameterization and the device operates with these new settings. This indication is OFF as long as the parameter set loaded via DIGSI® is not changed or is again issued as OFF, if a parameter set was completely newly loaded and the device operates with these parameters. The information value of the message (ON/OFF) is preserved during an initial and a resume.

Value: ON, parameter changes online at the unit or via parametrisation command.

Value: OFF, parameter set completely reloaded.

„Local change“ Indication that the local operation setting was cancelled.

This message is reserved for DIGSI®.

„Error Board 1“ Indication: The BG1 module either does not exist or is defective.

The same applies to further modules BG2 to BGn.

Value: On

„Event Lost“ Fleeting indication Indication lost

„Error FMS1“ Fault in the PROFIBUS FMS connection, fibre optic cable 1 with double ring connection

„Error FMS2“ Fault in the PROFIBUS FMS connection, fibre optic cable 2 with double ring connection

„IRC fault“ Fault in inter relay communication as a group indication

„Bay Bus D n“ Bay bus disturbance with device 1 to n

„SysIntErr.“ Fault at system interface

2.1.3.3 Setting Notes

T Backlight on The hold time of the **display lighting** can be set. After the set time has expired, the lighting is automatically switched off.

DIGSI backplane The setting is automatically derived from the MLFB number set (item 12, functional interface). The interface should be bypassed only in exceptional cases.

2.1.3.4 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
401	T Backlight on	1 .. 60 min	10 min	Time Backlight on
402	DIGSI backplane	Disabled Port C Port D	Disabled	Serviceport for DIGSI
407	FltDisp.LED/LCD	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
408	Spont. FltDisp.	NO YES	NO	Spontaneous display of flt.annunciations

2.1.3.5 Information List

No.	Information	Type of Information	Comments
-	Distur.CFC	OUT	Disturbance CFC
-	Reset LED	IntSP	Reset LED
-	>Light on	SP	>Back Light on
-	DataStop	IntSP	Stop data transmission
-	Test mode	IntSP	Test mode
-	HWTestMod	IntSP	Hardware Test Mode
-	SynchClock	IntSP_Ev	Clock Synchronization
-	Error FMS1	OUT	Error FMS FO 1
-	Error FMS2	OUT	Error FMS FO 2
1	Not configured	OUT	No Function configured
2	Non Existent	OUT	Function Not Available
3	>Time Synch	SP_Ev	>Synchronize Internal Real Time Clock
5	>Reset LED	OUT	>Reset LED
15	>Test mode	OUT	>Test mode
16	>DataStop	SP	>Stop data transmission
51	Device OK	OUT	Device is Operational and Protecting
52	ProtActive	IntSP	At Least 1 Protection Funct. is Active
55	Reset Device	OUT	Reset Device
56	Initial Start	OUT	Initial Start of Device
67	Resume	OUT	Resume

No.	Information	Type of In-formation	Comments
68	Clock SyncError	IntSP	Clock Synchronization Error
69	DayLightSavTime	OUT	Daylight Saving Time
70	Settings Calc.	OUT	Setting calculation is running
71	Settings Check	OUT	Settings Check
72	Level-2 change	OUT	Level-2 change
73	Local change	OUT	Local setting change
110	Event Lost	OUT_Ev	Event lost
113	Flag Lost	OUT	Flag Lost
125	Chatter ON	OUT	Chatter ON
126	ProtON/OFF	IntSP	Protection ON/OFF (via system port)
127	AR ON/OFF	IntSP	Auto Reclose ON/OFF (via system port)
147	Error PwrSupply	OUT	Error Power Supply
177	Fail Battery	OUT	Failure: Battery empty
183	Error Board 1	OUT	Error Board 1
184	Error Board 2	OUT	Error Board 2
185	Error Board 3	OUT	Error Board 3
186	Error Board 4	OUT	Error Board 4
187	Error Board 5	OUT	Error Board 5
188	Error Board 6	OUT	Error Board 6
189	Error Board 7	OUT	Error Board 7
301	Pow.Sys.Flt.	OUT	Power System fault
302	Fault Event	OUT	Fault Event
320	Warn Mem. Data	OUT	Warn: Limit of Memory Data exceeded
321	Warn Mem. Para.	OUT	Warn: Limit of Memory Parameter exceeded
322	Warn Mem. Oper.	OUT	Warn: Limit of Memory Operation exceeded
323	Warn Mem. New	OUT	Warn: Limit of Memory New exceeded

2.1.4 Oscillographic Fault Records

2.1.4.1 Description

The device 6MD66x has a fault recording function. The instantaneous values of measured values

i_{L1}, i_{L2}, i_{L3} and u_{L1}, u_{L2}, u_{L3},

(voltages in accordance with connection) are sampled at intervals of 1 ms (for 50 Hz) and stored in a circulating buffer (20 samples per cycle). For a fault, the data are stored for an adjustable period of time, but no more than 5 seconds per fault. A total of 8 records can be saved within 15 s. The fault record memory is automatically updated with every new fault, so no acknowledgment is required. The storage of fault values can also be started by pickup of a protection function, via binary input and via the serial interface.

The data can be retrieved via the serial interfaces by means of a personal computer and evaluated with the protection data processing program DIGSI and the graphic analysis software SIGRA 4. The latter graphically represents the data recorded during the system fault and calculates additional information such as the impedance or RMS values from the measured values. Currents and voltages can be presented as desired as primary or secondary values. Binary signal traces (marks) of particular events e.g. „fault detection“, „tripping“ are also represented.

Unlike in protective devices, in the case of the 6MD66x, only secondary values are correctly represented in the fault records. The primary values should first be determined through the transformation ratio.

If the device has a serial system interface, the fault recording data can be passed on to a central device via this interface. Data are evaluated by appropriate programs in the central device. Currents and voltages are referred to their maximum values, scaled to their rated values and prepared for graphic presentation. Binary signal traces (marks) of particular events e.g. „fault detection“, „tripping“ are also represented.

In the event of transfer to a central device, the request for data transfer can be executed automatically and can be selected to take place after each fault detection by the protection, or only after a trip.

2.1.4.2 Setting Notes

General

Other settings pertaining to fault recording (waveform capture) are found in the submenu **Fault recording** of the **PARAMETER** menu. Waveform capture makes a distinction between the trigger instant for an oscillographic record and the criterion to save the record. Normally the trigger instant is the device pickup, i.e. the pickup of an arbitrary protective function is assigned the time. The criterion for saving may be both the device pickup (***Save w. Pickup***) or the device trip (***Save w. TRIP***). A trip command issued by the device can also be used as trigger instant (***Start w. TRIP***); in this case it is also the saving criterion.

Recording of an oscillographic fault record starts with the pickup by a protective function and ends with the dropout of the last pickup of a protective function. Usually this is also the extent of a fault recording (**WAVEFORM DATA** = ***Fault event***). If automatic reclosure is implemented, the entire system disturbance — possibly with several reclose attempts — up to the ultimate fault clearance can be stored (**WAVEFORM DATA** = ***Pow.Sys.Flt.***). This facilitates the representation of the entire system fault history, but also consumes storage capacity during the auto-reclosure dead time(s). This setting can only be altered with DIGSI® under **Additional Settings**.

The actual storage time begins at the pre-fault time **PRE. TRIG. TIME** ahead of the trigger instant, and ends at the post-fault time **POST REC. TIME**) after the storage criterion has reset. The maximum recording duration to each fault is entered in **MAX. LENGTH**.

The fault recording can also be triggered via a binary input, via the keypad on the front of the device or with a PC via the operator or service interface. The storage is then dynamically triggered. The length of a record for these special triggers is determined by parameter **BinIn CAPT.TIME** (upper bound is **MAX. LENGTH**). Pre-fault and post-fault times will be included. If the binary input time is set for ∞, then the length of the record equals the time that the binary input is activated (static), or t**MAX. LENGTH**, whichever is shorter.

2.1.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
901	WAVEFORMTRIGGE R	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
902	WAVEFORM DATA	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
903	MAX. LENGTH	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
904	PRE. TRIG. TIME	0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
905	POST REC. TIME	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
906	BinIn CAPT.TIME	0.10 .. 5.00 sec; ∞	0.50 sec	Capture Time via Binary Input

2.1.4.4 Information List

No.	Information	Type of Information	Comments
-	FltRecSta	IntSP	Fault Recording Start
4	>Trig.Wave.Cap.	SP	>Trigger Waveform Capture
30053	Fault rec. run.	OUT	Fault recording is running

2.1.5 Protocol

When detecting an interruption in communication between a SIPROTEC® 4 device and the PROFIBUS-DP/Profibus-FMS Master, marking „SysIntErr.“ (fault at system interface) is set to ON in the SIPROTEC® 4 device. The message is registered in the event buffer. Following, it can be processed in CFC and allocated to LEDs and output relays.

The state of the outputs or switching elements has not changed compared to the state before interruption of the communication. Local switching operations, however, are still possible.

After communication has been reestablished the message is set to OFF and data are taken from the telegrams again received by the PROFIBUS-DP Master.

2.1.5.1 Information List

No.	Information	Type of Information	Comments
-	SysIntErr.	IntSP	Error Systeminterface

2.2 Command Processing

The SIPROTEC® 6MD66x includes a command processing function for initiating switching operations in the system.

Control action can originate from four command sources:

- Local operation using the keypad on the local user interface of the device
- Operation using DIGSI® (also possible through a WEB Server via a long-distance data transmission link)
- Remote operation via network control centre or substation controller (e.g. SICAM®),
- Automatic functions (e.g., using binary inputs or CFC)

Switchgear with single and multiple busbars are supported. The number of switchgear devices to be controlled is limited only by the number of binary inputs and outputs present. An additional feature is the exchange of information (e.g. bay interlocking) through IRC. High security against inadvertent device operations can be ensured if interlocking checks are enabled. A standard set of optional interlocking checks is provided for each command issued to circuit breakers / switchgear.

2.2.1 General

The source of command are recorded in the event log at the moment of the command output.

2.2.1.1 Functional Description

The following source of command are possible:

Cause text	Command source
SC = Local	Local control using the keypad on the local user interface of the device
SC = SICAM	Local control of central device (e.g. SICAM®)
SC = Remote	Remote control of central device
SC = Auto	Automatic command of central device (e.g. SICAM® CFC)
SC = Auto device	Automatic command of device
SC = DIGSI	Control using DIGSI®

2.2.2 Control Device

Devices with integrated or detached operator panel can control switchgear via the operator panel of the device. Switchgear can be controlled via the PC operator interface and via the serial port with a link to the substation control equipment.

Prerequisites

The number of switchgear devices to be controlled is limited by the

– Binary inputs present

– Binary outputs present

2.2.2.1 Functional Description

Operation using the SIPROTEC® 4 Device

Commands can be initiated using the keypad on the local user interface of the relay. For this purpose, there are three independent keys located below the graphic display. The key CTRL causes the control display to appear in the LCD. Control of switching devices is possible within this display, or from the **Control** context menu, since the two control keys OPEN and CLOSE only become active as long as the control display is present. The LCD must be changed back to the default display for other, non-control, operational modes.

The navigation keys ▲, ▼, ◀, ▶ are used to select the desired device in the Control Display. The `I` key or the `O` key is then pressed to convey the intended control command.

Consequently, the switch icon in the control display flashes in setpoint direction. At the lower display edge, the user is requested to confirm his/her switching operation via the ENTER key. Then a safety prompt appears. Only after repeated confirmation using the ENTER key is the command action performed. If this confirmation is not performed within one minute, the setpoint flashing changes again to the corresponding actual status. Cancellation via the ESC key is possible at any time before the control command is issued or during breaker selection.

During normal processing, the control display indicates the new actual status after the control command was executed and the message „`command end`“ at the lower display edge. The indication „`FB reached`“ is displayed briefly before the final indication in the case of switching commands with a feedback.

If the selected control command is not accepted, because an interlocking condition is not met, then an error message appears in the display. The message indicates why the command was not accepted (see also SIPROTEC® 4 System Description /1/). This message must be acknowledged with Enter before any further control commands can be issued.

Operation using the DIGSI®

Control devices can be controlled via the operator control interface by means of the DIGSI® operating program installed on a PC.

The procedure to do so is described in the SIPROTEC® System Description /1/ (Control of Switchgear).

Operation using the System Interface

Control of switching devices can be performed via the serial system interface and a connection to the substation control and protection system. For this the required peripherals (connection...) must physically exist both in the device and in the system. Also, specific settings to the serial interface must be made in the device (see SIPROTEC® System Description /1/).

Note

The switching commands (indications) listed in the following Information List are default examples. As they are only examples they may be deleted or overwritten by the user.

2.2.2.2 Information List

No.	Information	Type of Information	Comments
-	Q0	CF_D2	circuit breaker Q0
-	Q0	DP	circuit breaker Q0
-	Q1	CF_D2	bus disconnector Q1
-	Q1	DP	bus disconnector Q1
-	Q2	CF_D2	bus disconnector Q2
-	Q2	DP	bus disconnector Q2
-	Q8	CF_D2	earthing isolator Q8
-	Q8	DP	earthing isolator Q8
-	Q9	CF_D2	feeder disconnector Q9
-	Q9	DP	feeder disconnector Q9
-	ReleaseQ0	IntSP	Release circuit breaker Q0
-	ReleaseQ1	IntSP	Release bus disconnector Q1
-	ReleaseQ2	IntSP	Release bus disconnector Q2
-	ReleaseQ8	IntSP	Release earthing isolator Q8
-	ReleaseQ9	IntSP	Release feeder disconnector Q9
31000	Q0 OpCnt=	VI	Q0 operationcounter=
31001	Q1 OpCnt=	VI	Q1 operationcounter=
31002	Q2 OpCnt=	VI	Q2 operationcounter=
31008	Q8 OpCnt=	VI	Q8 operationcounter=
31009	Q9 OpCnt=	VI	Q9 operationcounter=

2.2.3 Control Authorization

In conjunction with the power system control there are several command types that must be considered.

Applications

- Operation of circuit breakers, disconnectors and ground electrodes
- Raising and lowering transformer LTCs
- Control of Petersen coils
- „Manually overriding/updating“ information of process-dependent objects
- „Setting“ information of internal objects
- Setting and resetting internal buffers or data stocks
- Adding/removing additional information

Prerequisites

For more information see SIPROTEC® system description

2.2.3.1 Description

Commands to the System

These are all commands that are directly output to the switchgear to change their process state:

- Switching commands for the control of circuit breakers (asynchronous), disconnectors and ground electrodes,
- Step Commands, e.g. raising and lowering transformer LTCs
- Setpoint commands with configurable time settings, e.g. to control Petersen coils

Device-internal Commands

These commands do not directly operate command outputs. They serve for initiating internal functions, communicating the detection of status changes to the device or for acknowledging them.

- Manual override commands for „manual update“ of information on process-dependent objects such as indications and switching states, e.g. if the communication with the process is interrupted. Manually overridden objects are flagged as such in the information status and can be displayed accordingly.
- Tagging commands (for „setting“) the information value of internal objects, such as switching authority (remote/local), parameter changeovers, data transmission blocks and counter value deletion/presetting.
- Acknowledgment and resetting commands for setting and resetting internal buffers or data stocks.
- Information status commands to set/delete the additional „Information Status“ item of a process object, such as
  – Acquisition blocking
  – Output blocking.

Sequence in the command path

Security mechanisms in the command path ensure that a switch command can be carried out only if the test of previously established criteria has been successfully completed. In addition to general fixed prescribed tests, for each resource separately further interlocks can be configured. The actual execution of the command job also is then monitored. The entire sequence of a command is described briefly in the following.

Checking a Command Job

Please observe the following:

- Command entry, e.g. using the keypad on the local user interface of the device
  - Check password ⇒ access rights
  - Check switching mode (interlocking activated/deactivated) ⇒ selection of deactivated interlocking status.
- User configurable command checks
  - Switching authority
  - Device position check (set vs. actual comparison)
  - Interlocking, Zone Controlled (logic using CFC or IRC)
  - Interlocking, System Interlocking (centrally, using SICAM or IRC)
  - Double Operation Locking (interlocking against parallel switching operations)
  - Protection blocking (blocking of switching operations by protective functions in SIPROTEC4 protection devices)
- Fixed command checks
  - Internal process time (software watch dog which checks the time for processing the control action between initiation of the control and final close of the relay contact)
  - Configuration in Process (if configuration is in process, commands are denied or delayed)
  - Equipment enabled as output (if an piece of equipment was configured, but not configured to a binary input, the command is denied)
  - Output Blocking (if output blocking has been programmed for the circuit breaker, and is active at the moment the command is processed, then the command is denied)
  - Module hardware malfunction
  - Command in Progress (only one command can be processed at a time for one piece of equipment, object-related Double Operation Block)
  - 1–of–n check (for multiple allocations such as common contact relays it is checked if a command procedure was already initiated for the output relays concerned).

Command Execution Monitoring

The following is monitored:

- Interruption of a command because of a Cancel Command
- Running Time Monitor (feedback monitoring time)

Additional Information

Refer to Section 2.8 Switchgear Interlocking for additional information on command processing and for an information overview.

2.2.3.2 Information List

No.	Information	Type of Information	Comments
-	KeySwitch1	DP	Key Switch 1 (Local/Remote)
-	Cntrl Auth	IntSP	Control Authority
-	KeySwitch2	DP	Key Switch 2 (Interlocking OFF/ON)
-	ModeLOCAL	IntSP	Controlmode LOCAL
-	ModeREMOTE	IntSP	Controlmode REMOTE

2.2.4 Process Data

During the processing of the commands, independent of the further message routing and processing, command and process feedback information are sent to the message processing centre. These messages contain information on the cause. With the corresponding allocation (configuration) these messages are entered in the event list, thus serving as a report.

Applications

- Messages and Operating Messages in Relation to Switching Operations

Prerequisites

A listing of possible operating messages and their meaning as well as the command types needed for tripping and closing of the switchgear or for raising and lowering of transformer taps are described in the SIPROTEC System Description /1/.

2.2.4.1 Description

Acknowledgement of Commands to the Device Front

All messages with the source of command LOCAL are transformed into a corresponding response and shown in the display of the device.

Acknowledgement of commands to Local/Remote/Digsi

The acknowledgement of messages with source of command Local/ Remote/DIGSI are sent back to the initiating point independent of the routing (configuration on the serial digital interface).

The acknowledgement of commands is therefore not executed by a response indication as it is done with the local command but by ordinary command and feedback information recording.

Monitoring of feedback information

The processing of commands monitors the command execution and timing of feedback information for all commands. At the same time the command is sent, the monitoring time is started (monitoring of the command execution). This time controls whether the device achieves the required final result within the monitoring time. The monitoring time is stopped as soon as the feedback information arrives. If no feedback information arrives, a response "Timeout command monitoring time" appears and the process is terminated.

Commands and information feedback are also recorded in the event list. Normally the execution of a command is terminated as soon as the feedback information (FB+) of the relevant switchgear arrives or, in case of commands without process feedback information, the command output resets and a message is output.

The "plus" sign appearing in a feedback information confirms that the command was successful. The command was as expected, in other words positive. The "minus" is a negative confirmation and means that the command was not executed as expected.

2.3 Indication Processing

Indication processing in High Voltage Bay Control Unit 6MD66x is provided to assure a save and instantaneous transmission of information to the control centre. This is done by giving priority to feedback information from commands before measured values and other indications. Thus the user quickly gets an overview on the current status of the station even when data exchange is very high.

2.3.1 Description

Indication processing comprises the following

- Communication with the Substation Controller Utilizing the Priorization Principle
- Transmission of data to the bay devices connected via inter-relay communication
- Creation of group alarms in accordance with the configuration in CFC
- Display of the event list of the device, memorization of 200 indications
- Display of the signalizing LEDs (in accordance with the configuration carried out)

LED Display and Binary Outputs (output relays)

Important events and conditions are displayed, using LEDs on the front panel of the relay. The device furthermore has output relays for remote indication. All LEDs and binary outputs indicating specific indications can be freely configured. The relay is delivered with a default setting. The Appendix of this manual deals in detail with the delivery status and the allocation options.

The output relays and the LEDs may be operated in a latched or unlatched mode (each may be individually set).

The latched conditions are protected against loss of the auxiliary voltage. They are reset

- on site by pressing the LED key on the relay,
- Remotely using a binary input configured for that purpose,
- Using one of the serial interfaces.

Condition indications should not be latched. Also, they cannot be reset until the criterion to be reported is remedied. This applies to indications from monitoring functions or similar.

A green LED displays operational readiness ("RUN"), and cannot be reset. It goes out if the self-check feature of the microprocessor recognizes an abnormal occurrence, or if the auxiliary voltage fails.

When auxiliary voltage is present, but the relay has an internal malfunction, then the red LED ("ERROR") lights up and the processor blocks the relay.

Further information on the functionality, allocation of indications, on how to read out information via DIGSI® and the operator panel of the device etc. can be found in the SIPROTEC® system description /1/.

2.4 Measured value processing

Measured value processing of the SIPROTEC® device 6MD66x provides functions for recording, calculating and displaying varying measurement quantities. For further information please also refer to the SIPROTEC® System Description /1/.

In addition, the device contains the so-called measuring transducer blocks, which form various operands from the current and voltage input quantities.

2.4.1 Measurement, Transducer inputs 20 mA

The user-defined measured values are compiled in a parameter group. These measured values are created via DIGSI® CFC or arrive as r.m.s. values via inter-relay communication.

Applications

- Limit values are used to indicate when a measured value recorded as the operational measured value has exceeded the upper or lower limits.

2.4.1.1 Description

The two measuring transducer inputs (±20 mA) contained in the device are already specified in the default setting. These measuring transducer inputs supply non-linearized values which can be converted via DIGSI® CFC to measured values such as pressure or temperature.

Derived measured values are inserted from the information catalog.

Information on configuration of the user-defined measured values can be found in SIPROTEC® system description /1/.

2.4.1.2 Information List

No.	Information	Type of Information	Comments
996	Td1=	MV	Transducer 1
997	Td2=	MV	Transducer 2

2.4.2 General Information on Transducer Blocks

The measuring transducer blocks form various operands from the voltage and current inputs.

2.4.2.1 Functional Description

The measuring transducer function is explained via the following function blocks:

- Measuring transducer U (MU U)
- Measuring transducer I (MU I)
- Measuring transducer one-phase (MU1P)
- Measuring transducer three-phase (MU3P)
- Measuring transducer Aron (MUAron)

The individual measuring transducer blocks have to be **activated** in the **functional scope** of the device and are then displayed in the DIGSI® configuration matrix with their input channels and output quantities. They are assigned to current and voltage channels of the device. The output quantities can be assigned to various destinations, e.g. system interface, CFC or the display.

A functional description of the individual measuring transducer blocks and a list of the accompanying parameters and information can be found in the following chapters.

Table 2-1 Connection examples for a rated transformer voltage $V_{n\ secondary}$ from 100 V

Connection variants	**Input voltages Secondary**	**Functions**	**Parameter Transformer $V_{n\ sec}$**	**Comments**
Star connection	3 x $Vfeeder_{Ph-N}$ = 57.7 V 1 x V_{Ph-N} = 57.7 V	Measuring transducer 3-phase	100 V	for feeder operational measurements (see Figure A-9)
		Measuring transducer 1-phase	100 V	for reference operational measurements (see Figure A-8)
		SYNC function 1 to SYNC function 5	100 V[1)]	for synchronization function (see Figure A-11)
Ufeeder **delta connection** Uref **delta connection**	3 x VfeederPh-N = 57.7 V 1 x VPh-Ph = 100 V	Measuring transducer 3-phase	100 V	for feeder operational measurements (see Figure A-9)
		Measuring transducer 1-phase	173.2 V[2)]	for reference operational measurements (see Figure A-8)
		SYNC function 6 to SYNC function 8	100 V	for synchronization function (see Figure A-12)
Aron connection	2 x $Vfeeder_{Ph-Ph}$ = 100 V 1 x V_{Ph-Ph} = 100 V	Measuring transducer Aron	173.2 V[2)]	for feeder operational measurements (see Figure A-10)
		Measuring transducer 1-phase	173.2 V[2)]	for reference operational measurements (see Figure A-8)
		SYNC function 6 to SYNC function 8	100 V	for synchronization function (see Figure A-10)
Star connection, neutral earthed power supply	3 x $Vfeeder_{Ph-N}$ = 100 V 1 x V_{Ph-N} = 100 V	Measuring transducer 3-phase	173.2 V[2)]	for feeder operational measurements (see Figure A-9)
		Measuring transducer 1-phase	173.2 V[2)]	for reference operational measurements (see Figure A-8)
		SYNC function 1 to SYNC function 5	100 V	for synchronization function (see Figure A-11)

[1)] Within the SYNC function, the parameter **V transformer$_{n\ secondary}$** corresponds to the secondary input voltage.

[2)] Within the measuring transducer packets, the parameter **V transformer$_{n\ secondary}$** is secondary to the √3 x input voltage.

The secondary transformer voltages specified in the above table must be parameterized if the conversion factor set for the phase-to-phase voltages is the nominal system voltage U_N, and the conversion factor for the individual phase voltages is the voltage $U_N/\sqrt{3}$. The conversion factor can be set in the DIGSI matrix under Object properties - Measured value description of a measured value.

The parameter settings for the secondary transformer voltages and the conversion factors are mutually dependent. This will be briefly exemplified by a wye connection:

The nominal system voltage is 110 kV, the transformers used are 110 kV / 100 V. In the measuring transducer packages, the secondary voltage is set to 100 V, and the conversion factor voltages are set to 110 kV for the phase-to-phase and 63.5085 kV for the phase voltages. In the circuit breaker synchronization function, either the values 100 V secondary voltage and 110 kV conversion factor (both too large by the factor √3), or the phase values 57.735 V secondary voltage and 63.5085 kV conversion factor can be set. Both variants ensure the correct functioning of the synchronization function. Please note the definition of the lower and upper voltage threshold, which must be based on the actual secondary voltage (57.7 V).

2.4.3 Parameterizing Transducer Blocks

Configuration is to be performed in the High Voltage Bay Control Unit in each individual case. The device contains pre-defined measuring transducer blocks which can be activated individually.

2.4.3.1 Configuring the Measuring Transducer

The configuration of measured values is fundamentally different from the configuration of other SIPROTEC® 4 devices. It is explained with an example using the function block **Measuring transducer 3-phase**.

Selecting the Functional Scope

First select the measuring transducer blocks from the DIGSI® **Functional scope** dialog box which are to be contained in the functional scope of the device.

For this purpose, open the device and click **Functional scope** in the function selection.

Select the **available** entry on the **Measurement 3phase 1.packet** line in the **Scope** column and confirm with OK. The measurement transducer block is activated.

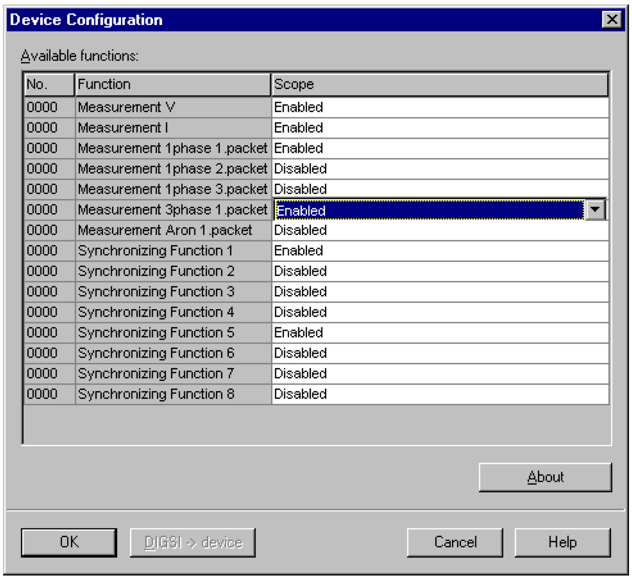


Figure 2-1 Functional scope dialog box

Parameterising

Click the **Measuring transducer** object under **Parameters** in the tree view of DIGSI®. The available measuring transducer blocks are listed in the list box.

Open **Measurement 3phase 1.packet** via the context menu and set the values of parameters **Secondary Voltage Nominal Value** (0.00 V to 200.0 V) and **Secondary Current Nominal Value** (0.00 A to 5.00 A) depending on your requirements.

You will find more information on this in the setting hint sections.

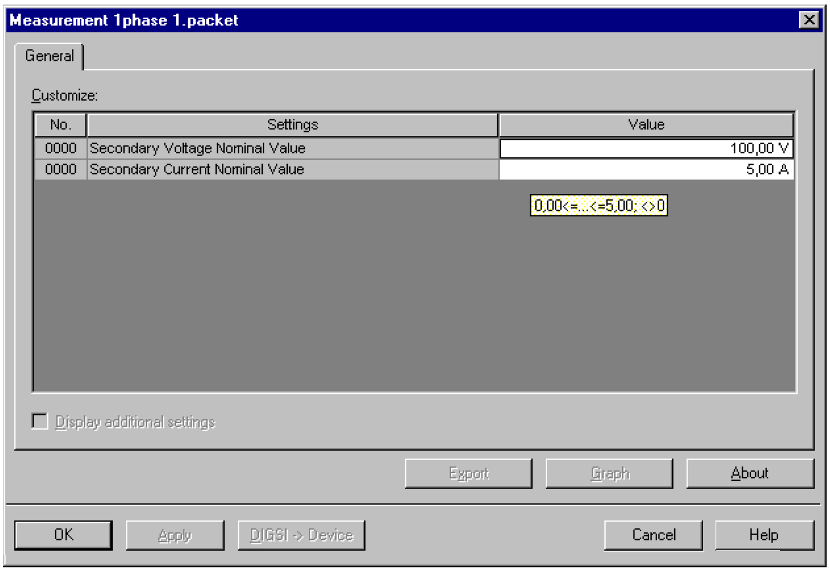


Figure 2-2 Dialog box for setting the parameters

2.4.3.2 Allocating a Measuring Transducer

Following configuration, the inputs and outputs of the activated measuring transformer block in the allocation matrix of DIGSI® are interconnected and the properties of the individual measured values, such as transmission threshold, are configured and interconnection in the CFC is performed.

Allocating Measured Value Channels

Open the allocation matrix of the device and select **Only measured and metered values** as the information type. The **MU3P_1** group is displayed.

Allocate the measured value channels **Mvchn** to the voltage/current inputs as the **source**.

Allocating Measured Values

Allocate the **calculated measured values** to a **destination**, e.g. to the system interface, the inter-relay communication, the CFC or the display.

Configuring Measured Values

Configure the properties of the measured values.

In the **Information item, No.** column of the allocation matrix, right-click the information item whose properties you would like to configure and open the **Object properties** dialog box via the **Properties**... context menu.

Select the **Measured value description** tab and make the settings.

The Measured value description tab is not relevant for the information items MP1_PHI (phase angle), MP1_WLF (active power factor) and MP1_BLF (reactive power factor) and therefore not available.

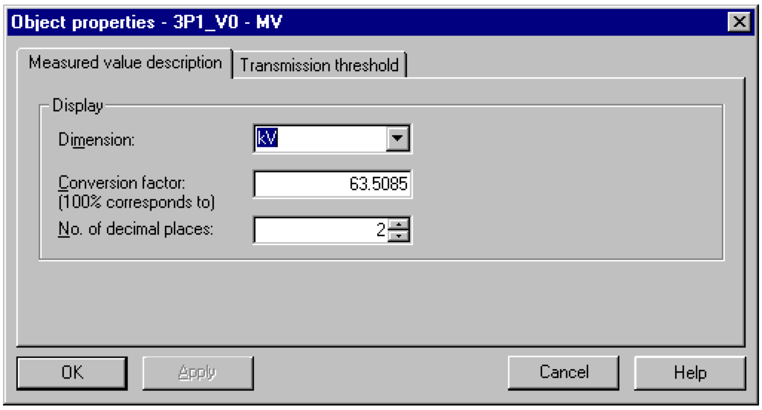


Figure 2-3 Object properties dialog box, Measured value description tab

Select the **Transmission threshold** tab and make the settings.

- **Use central threshold (10%)**

  Select this checkbox to use the factory-preset threshold value of 10%. This de-activates all the other input and output options in this tab.

- **Parameterized threshold**

  Enter a value between 0 and 2000 in this spin box. The set value multiplied by 0.1% results in the threshold value. This value is used without any further conditions, provided that neither the **Central threshold** checkbox, nor a defined switching object, has been selected.

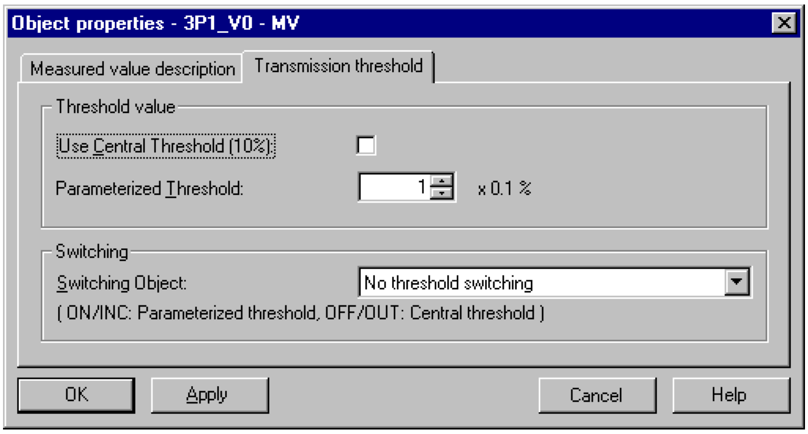


Figure 2-4 Object properties dialog box, Transmission threshold tab

Configure the **object properties** of the phase angle **3P1_PHI**.

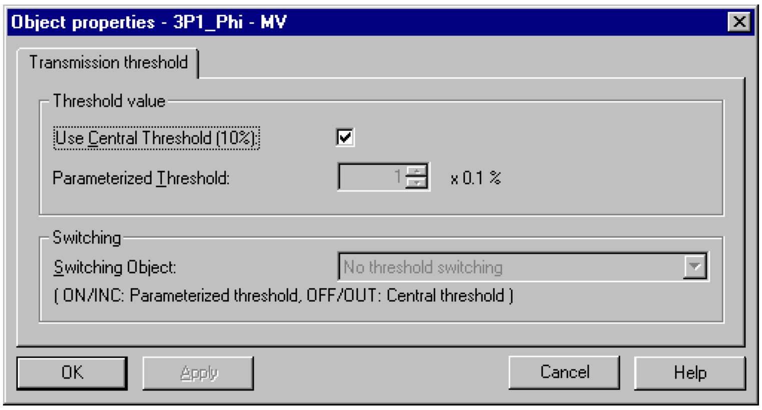


Figure 2-5 Object properties dialog box, Transmission threshold tab

Allocate the information item 3P1_PHI to C (CFC) as the destination and then link this in the corresponding CFC chart.

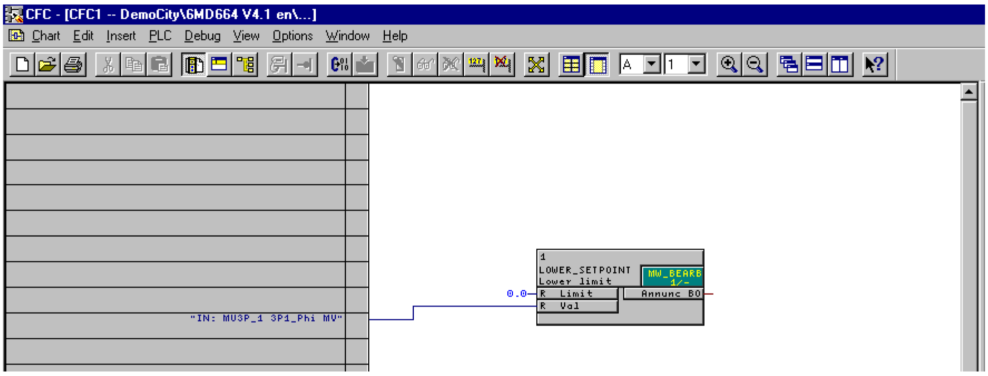


Figure 2-6 Example, **3P1_PHI** link in CFC

Configure the object properties of the block (e.g. LOWER_SETPOINT). For this purpose, right-click the **Limit** input of the block and select **Object properties** from the context menu.

Observe the working range of -180° to +180°; the value 100 (%) corresponds to 360°.

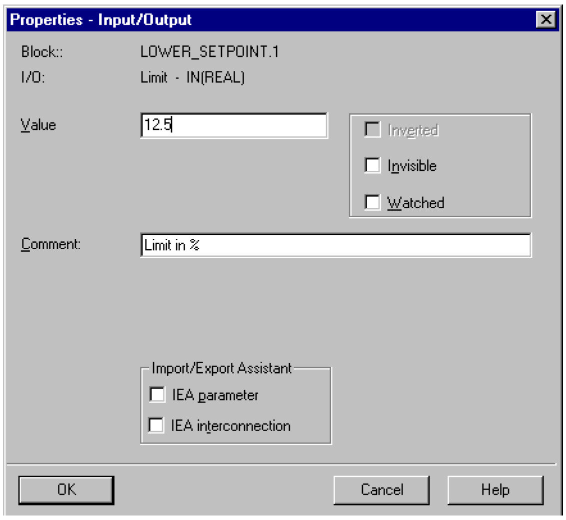


Figure 2-7 Example, properties of the LOWER_SETPOINT block

The set value 12.5 corresponds to an angle of 45°.

2.4.4 Measurement U

This packet serves to measure an individual **voltage**. The function provides the r.m.s. value of the fundamental component.

2.4.4.1 Description

The frequency of the voltage is determined from the input signal. If the secondary input voltage on the device falls below **10 V$_{\mathbf{eff}}$**, the frequency is marked as invalid. The overflow occurs when the secondary input voltage on the device exceeds **120 V$_{\mathbf{eff}}$**. The frequency continues being valid. The nominal frequency value is taken from **`P.System Data 1`**.

Routing of the measurement input to the respective measured value channel Voltage and the routing of the measuring results is performed with DIGSI®.

Specifications for secondary transformer voltage are made in the properties dialog box of **`MU U_1`**.

Information on allocation can be obtained from the SIPROTEC® system description/1/.

2.4.4.2 Setting Notes

SecVoltgNomVal The secondary factory-preset nominal transformer voltage can be set in the predefined range.

2.4.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	SecVoltgNomVal	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value

2.4.4.4 Information List

No.	Information	Type of Information	Comments
151.0002	U	MV	Voltage U
151.0021	f	MV	frequency
151.0022	Input U/I	MC	Voltage or Current Input U/I

2.4.5 Measurement I

This packet serves to measure an individual **current**. The function provides the r.m.s. value of the fundamental component.

2.4.5.1 Functional Description

The frequency of the current is determined from the input signal. If it falls below 10% of the rated value, the frequency is marked as invalid. The rated value of the frequency is taken from **`P.System Data 1`**.

Routing of the measurement input to the respective measured value channel Current and the routing of the measuring results is performed with DIGSI®.

Specifications for secondary transformer current are made in the properties dialog box of **`MU I_1`**.

Information on allocation can be obtained from the SIPROTEC® system description /1/.

2.4.5.2 Setting Notes

SecCurrNomVal The secondary factory-preset nominal transformer current can be set in the predefined range.

2.4.5.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	SecCurrNomVal	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value

2.4.5.4 Information List

No.	Information	Type of Information	Comments
151.0010	I	MV	Current I
151.0021	f	MV	frequency
151.0023	MwCh_I	MC	Current Input I

2.4.6 Measurement 1phase

This packet serves to perform a **monophase measurement** (current and voltage). The measuring results of the phase current and the phase voltage are r.m.s. values of the corresponding fundamental component.

2.4.6.1 Description

The **phase current** is set to the **current input** of the measuring transducer, whereas the **phase voltage** is set to the **voltage input**.

The **r.m.s. values** calculated from these two input signals, the **active power**, the **reactive power**, the **apparent power**, the **cos** Φ, the **sin** Φ and Φ the linked sizes and **frequency** calculated from the voltage (see information overview) are then present at the **measuring transducer output**.

The frequency is determined from the applied phase voltage. If the secondary input voltage on the device falls below **10 V_{eff}**, the frequency is marked as invalid. The overflow occurs when the secondary input voltage on the device exceeds **120 V_{eff}**. The rated value of the frequency is taken from `Power System Data 1`.

Routing of the measurement inputs to the respective measured value channels Phase current and Phase voltage and the routing of the measuring results is performed with DIGSI®.

Specifications for secondary transformer current and secondary transformer voltage are made in the properties dialog box of `MU1P_1`.

Information on allocation can be obtained from the SIPROTEC® system description /1/.

2.4.6.2 Setting Notes

SecVoltgNomVal The secondary factory-preset nominal transformer voltage can be set in the predefined range.

SecCurrNomVal The secondary factory-preset nominal transformer current can be set in the predefined range.

2.4.6.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	SecVoltgNomVal	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value

2.4.6.4 Information List

No.	Information	Type of Information	Comments
152.0002	1P1_U	MV	1P1 Voltage U
152.0010	1P1_I	MV	1P1 Current I
152.0015	1P1_P	MV	1P1 Active Power P
152.0016	1P1_Q	MV	1P1 Reactive Power Q
152.0017	1P1_S	MV	1P1 Apparent Power S
152.0018	1P1_φ	MV	1P1 Phase Angle Phi
152.0019	1P1_cosφ	MV	1P1 Active Power Factor Cosine Phi
152.0020	1P1_sinφ	MV	1P1 Reactive Power Factor Sine Phi
152.0021	1P1_f	MV	1P1 Frequency of U
152.0022	1P1Input_U	MC	1P1 Voltage Input U
152.0023	1P1Input_I	MC	1P1 Current Input I

2.4.7 Measurement 3phase

This packet serves to perform a three-phase measurement (current and voltage). The measuring results of the phase currents, phase voltages, phase-to-phase voltages, zero sequence current and zero sequence voltage are RMS values of the corresponding fundamental compound.

2.4.7.1 Description

The following phase currents are applied at the current inputs of the measuring transducer: $\mathbf{I_{L1}}$, $\mathbf{I_{L2}}$ and $\mathbf{I_{L3}}$, as were the voltages $\mathbf{U_{L1}}$, $\mathbf{U_{L2}}$ and $\mathbf{U_{L3}}$.

The **r.m.s values of phase currents**, **phase voltages**, **phase-to-phase voltages**, **zero sequence current** calculated from these six input signals, and the **zero sequence voltage**, **active power**, **reactive power**, **apparent power**, **cos** Φ, **sin** Φ and

Φ of the linked magnitudes and **frequency** calculated from the voltage $\mathbf{U_{L1}}$ (see Information overview table) are then applied at the measuring transducer output.

The frequency is determined from the applied phase voltage U_{L1}. If the secondary input voltage on the device falls below **10 $\mathbf{V_{eff}}$**, the frequency is determined from the phase voltage U_{L2} or U_{L3}. If all three voltages are too low, the rated frequency is used as frequency. In this case, the combined variables and the frequency itself are marked invalid. The phase-to-phase voltages and the zero variables start to fluctuate depending on the deviation from the rated frequency. The overflow occurs when the secondary input voltage on the device exceeds **120 $\mathbf{V_{eff}}$**. The rated value of the frequency is taken from **Power System Data 1**.

Routing of the measurement inputs to the respective measured value channels Phase currents and Phase voltages and the routing of the measuring results is performed with DIGSI®. The direction of rotation can be changed by exchanging the phases. Enter the display factors for the primary values for each required output when routing the results. In this context, it must be observed that the phase-to-phase value is indicated for the phase-earth voltages if the phase-to-phase voltage (nominal voltage) was set as primary value.

Specifications for secondary transformer current and secondary transformer voltage are made in the properties dialog box of **MU3P_1**. The phase-to-phase voltage is used as the value for the secondary transformer voltage.

2.4.7.2 Setting Notes

SecVoltgNomVal

The secondary factory-preset nominal transformer voltage can be set in the predefined range.

SecCurrNomVal

The secondary factory-preset nominal transformer current can be set in the predefined range.

2.4.7.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	SecVoltgNomVal	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value

2.4.7.4 Information List

No.	Information	Type of Information	Comments
153.0003	3P1_U0	MV	3P1 Zero Sequence Voltage
153.0004	3P1_U1	MV	3P1 Phase to Earth Voltage U1
153.0005	3P1_U2	MV	3P1 Phase to Earth Voltage U2
153.0006	3P1_U3	MV	3P1 Phase to Earth Voltage U3
153.0007	3P1_U12	MV	3P1 Phase to Phase Voltage U12
153.0008	3P1_U23	MV	3P1 Phase to Phase Voltage U23
153.0009	3P1_U31	MV	3P1 Phase to Phase Voltage U31

No.	Information	Type of Information	Comments
153.0011	3P1_I0	MV	3P1 Zero Sequence Current
153.0012	3P1_I1	MV	3P1 Phase Current I1
153.0013	3P1_I2	MV	3P1 Phase Current I2
153.0014	3P1_I3	MV	3P1 Phase Current I3
153.0015	3P1_P	MV	3P1 Active Power Three Phase
153.0016	3P1_Q	MV	3P1 Reactive Power Three Phase
153.0017	3P1_S	MV	3P1 Apparent Power Three Phase
153.0018	3P1_φ	MV	3P1 Phase Angle Three Phase
153.0019	3P1_cosφ	MV	3P1 Active Power Factor Three Phase
153.0020	3P1_sinφ	MV	3P1 Reactive Power Factor Three Phase
153.0021	3P1_f	MV	3P1 Frequency
153.0024	3P1InputU1	MC	3P1 Voltage Input U1
153.0025	3P1InputU2	MC	3P1 Voltage Input U2
153.0026	3P1InputU3	MC	3P1 Voltage Input U3
153.0027	3P1InputI1	MC	3P1 Current Input I1
153.0028	3P1InputI2	MC	3P1 Current Input I2
153.0029	3P1InputI3	MC	3P1 Current Input I3

2.4.8 Measurement Aron

The **ARON switching** enables the complete calculation of a three-phase system with only two voltage transformers and two current transformers. The measuring results of the phase currents, phase voltages, phase-to-phase voltages, zero sequence current and zero sequence voltage are r.m.s. values of the corresponding fundamental compound (see Figure A-10).

2.4.8.1 Description

Two phase currents (e.g. IL2 and IL3) and **two phase-to-phase voltages** (e.g. UL1L2 and UL1L3) are applied to the **measuring transducer inputs**.

The **r.m.s values of phase currents** calculated from these four input signals, **phase voltages**, **phase-to-phase voltages**, **zero sequence current**,**zero sequence voltage**, **active power**, **reactive power**, **apparent power**, **cos** Φ, **sin** Φ and Φ the linked sizes and **frequency** calculated from the voltage **UL1L2** (see Information overview table) are then applied at the **measuring transducer output**.

The frequency is determined by means of the applied U_{L1L2} voltage. If the secondary input voltage on the device falls below **10** $\mathbf{V_{eff}}$, the frequency is determined by means of the U_{L1L3} voltage. If both voltages are too low, the rated frequency is used as frequency. In this case, the combined variables and the frequency itself are marked invalid. The phase-to-phase voltages and the zero variables start to fluctuate depending on the deviation from the rated frequency. The rated value of the frequency is taken from **`Power System Data 1`**.

Routing of the measurement inputs to the respective measured value channels Currents and Voltages and the routing of the measuring results is performed with DIGSI®. Enter the display factors for the primary values for each required output when routing the results.

2.4.8.2 Setting Notes

SecVoltgNomVal

The secondary factory-preset nominal transformer voltage can be set in the predefined range.

SecCurrNomVal

The secondary factory-preset nominal transformer current can be set in the predefined range.

2.4.8.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	SecVoltgNomVal	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value

2.4.8.4 Information List

No.	Information	Type of Information	Comments
154.0007	A1_U12	MV	A1 Phase to Phase Voltage U12
154.0009	A1_U13	MV	A1 Phase to Phase Voltage U13
154.0013	A1_I2	MV	A1 Phase Current I2
154.0014	A1_I3	MV	A1 Phase Current I3
154.0015	A1_P	MV	A1 Active Power P
154.0016	A1_Q	MV	A1 Reactive Power Q
154.0017	A1_S	MV	A1 Apparent Power S
154.0018	A1_φ	MV	A1 Phase Angle Phi
154.0019	A1_cosφ	MV	A1 Active Power Factor Cosine Phi
154.0020	A1_sinφ	MV	A1 Reactive Power Factor Sine Phi
154.0021	A1_f	MV	A1 Frequency
154.0024	A1Input_U1	MC	A1 Voltage Input U1
154.0025	A1Input_U2	MC	A1 Voltage Input U2
154.0027	A1Input_I1	MC	A1 Current Input I1
154.0028	A1Input_I2	MC	A1 Voltage Input I2

2.5 Metered Value Processing

The device can add up counter pulses of an external counter recorded via a binary input. Additionally, the device can calculate energy values from measured values.

2.5.1 Description

Operation of pulse metered value

The High Voltage Bay Control Unit 6MD66x forms the metered value as a sum of the externally generated counter pulses of a power meter. The pulses are read in via a binary input. The metered value receives a unit based on the following table. It has the same precision as the external counter and can also be an adjusted metered value.

Operation of Measured Values Calculated from Metered Values

With the measured value calculated from metered values, the High Voltage Bay Control Unit 6MD66x forms the power from the applied current and voltage values or from any desired measured values and integrates this calculated power value over time. The result is a power value with the precision of the device (0.5%), i.e. an operating metered value which cannot be used for adjustment.

Table 2-2 Operating metered values

Measured values		Possible units
W_p+	Active power, output	kWh, MWh, GWh
W_p–	Active power, input	kWh, MWh, GWh
W_q+	Reactive power, output	kVARh, MVARh, GVARh
W_q–	Reactive power, input	kVARh, MVARh, GVARh

The following types of information can be allocated to a metered value window in the DIGSI® configuration matrix.

- Metered value calculated from measured values
- Pulse metered value

The same operations are possible with pulse and measured values calculated from metered values, e.g. reset - to set back to a specified value etc..

2.5.2 Using the Pulse Metered Value

In this example, the active power of a 3-phase system is to be integrated over time and displayed as a metered value. The pulse output of an external device which supplies the active power pulse accordingly, is to be applied to a binary input of the device. The energy corresponding to a pulse must be known.

Inserting a pulse metered value

Open the configuration matrix of the device and select **Only measured and metered values** as the information type.

Create the group **Energy** in the configuration matrix.

Open the information catalog and select the line **Pulse (PMV)** under **Power Meter → Pulse** .

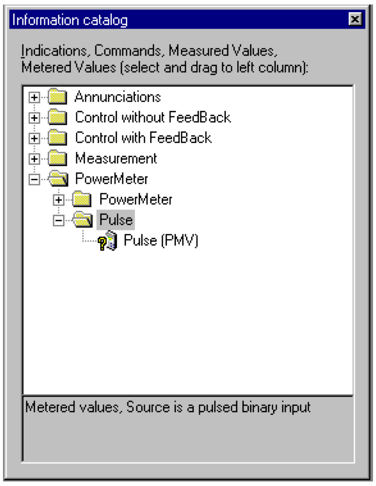


Figure 2-8 Selecting information type pulse metered value

Drag the selected information type with the left mouse button into the **Energy** group in the configuration matrix.

Configuring a Pulse Metered Value

Allocate the inserted pulse metered value in the configuration matrix to a binary input as the source.

Allocate the inserted pulse metered value in the configuration matrix to the destination **Metered value window**.

Configuring a Pulse Metered Value

The properties of the pulse metered values can be configured via a dialog box.

Right-click on the information item **PulseMV** in the **Information** column, **Display text** in the configuration matrix.

Select **Properties**... from the context menu. The **Object properties** dialog box is opened.

Select the tab **Measured value description** and enter the unit **kWh** and the desired number of decimal places.

Enter the value which corresponds to a pulse of the external counter in the unit selected above into the input box **Conversion factor**. For example, enter 0.1 if a pulse corresponds to the energy 0.1 kWh and the unit kWh was selected above.

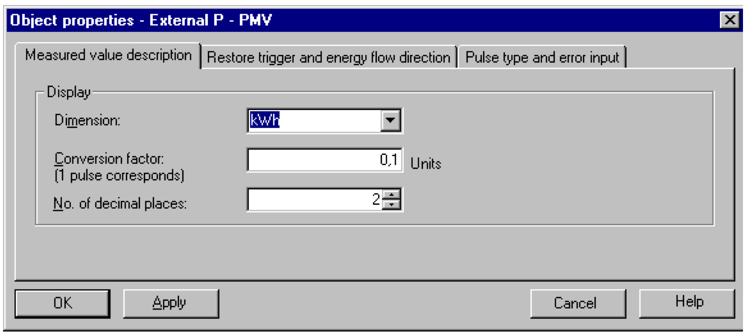


Figure 2-9 Object properties dialog box, Measured value description tab

Select the tab **Restore trigger** and **energy flow direction** and enter the restore trigger and energy flow direction.

Select the **Cyclic** option if the metered value is to be transmitted to the control centre at cyclic intervals. Otherwise select the **None** option. By clicking the **Settings** button, you end up in the dialog box for setting the corresponding **time interval**. **One minute is preset**.

Note

The settings made in the **Cyclical restoring** tab apply **globally** for all metered values.

Under Energy flow direction, you define whether the metered value summates the quantity of exported or imported energy by selecting one of the two options.

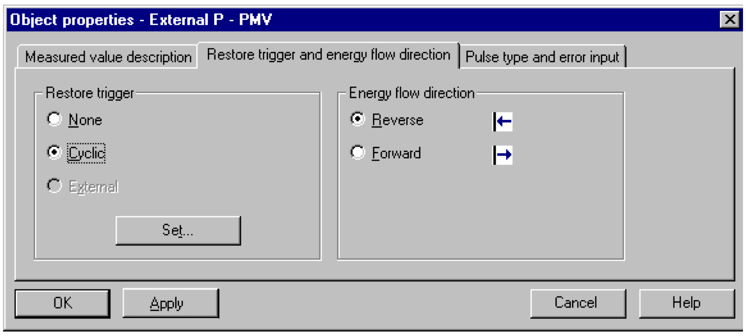


Figure 2-10 Object properties dialog box, Restore trigger and energy flow direction tab

Select the tab **Pulse type and error input** and make your settings there.

Select the **Wiping pulse / S0** option if the rising edge of a single pulse is to increment the metered value by one. Select the **Double current pulse** option if the falling edge of a double current pulse is to increment the metered value by one.

As soon as you route a pulse metered value to a binary input, the next binary input can be automatically routed as a fault input. A signal to this fault input can mark the count as corrupt. If you use this procedure, select the **Use fault input** checkbox. If it is not selected, the binary input following the metered pulse input is available to another application.

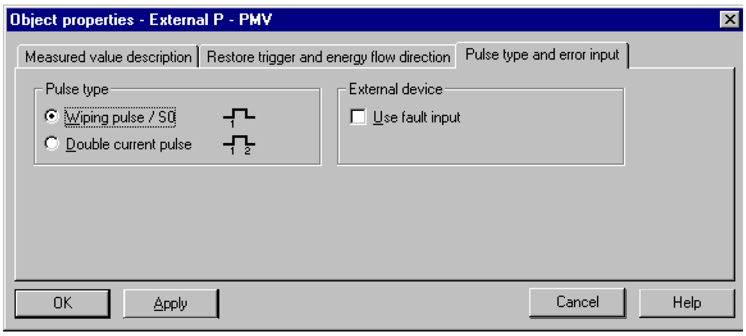


Figure 2-11 Object properties dialog box, Pulse type and error input tab

Accept the settings with **OK**.

2.5.3 Use Measured Value / Metered Value

In this example, the active power of a 3-phase system is to be integrated over time and displayed as a metered value. Here, a measuring transducer packet **MU3P_1** which must be identified as available in the function scope of the device is used. It is configured with the **secondary voltage nominal value** 100.00 V and the **secondary current nominal value** 1 A. The rated data of the network is 110 kV and 20 kA.

Inserting a Measured Value / Metered Value

Open the configuration matrix of the device and select **Only measured and metered values** as the information type.

Open the information catalog and select the line **PowerMeter (MVMV)** under **PowerMeter → PowerMeter** .

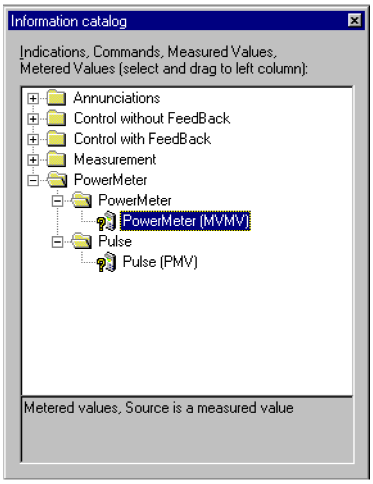


Figure 2-12 Selecting information type measured value metered value

Drag the selected information type with the left mouse button into the **MU3P_1** group in the configuration matrix.

Allocating a Measured Value / Metered Value

Allocate the inserted information item to the source **Measured value** in the configuration matrix and select **3P1_P** from the list.

Allocate the inserted information item to the **Metered value window** destination in the configuration matrix.

Configuring a Measured Value / Metered Value

The properties of the measured value / metered values can be configured via a dialog box.

Right-click on the information item **MeasVMV** in the **Information** column, **Display text** in the configuration matrix.

Select **Properties...** from the context menu. The **Object properties** dialog box is opened.

Select the tab **Measured value description** and enter the unit **MWh** and 2 as the number of decimal places.

Using the conversion factor, you can convert the input signal to match the selected unit and data of the measuring transducer. The conversion always refers to the 100% value of the input signal with measured values. If a measuring transducer packet supplies the currents and voltages as the power 3811 MW at a 100% value, this is the energy value which accumulates in a MWh.

100% power over one hour is equivalent to 60,000 pulses. The conversion factor to be entered is therefore the power divided by 60,000.

Enter the calculated value **0.0635** into the Conversion factor input box (3811 MW divided by 60,000).

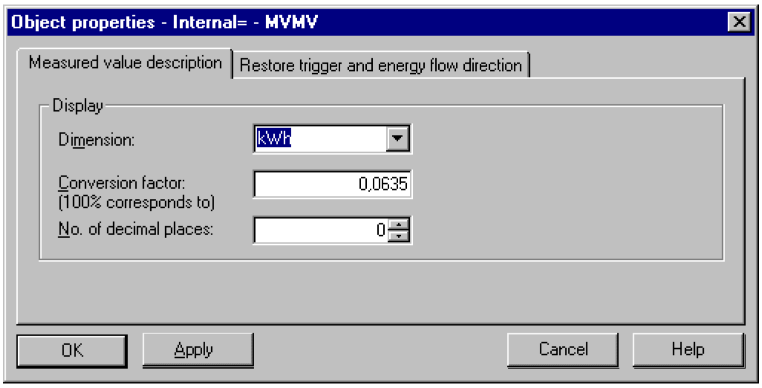


Figure 2-13 Object properties dialog box, Restore trigger and energy flow direction tab

Select the tab **Restore trigger and energy flow direction** and enter the restore trigger and energy flow direction.

Select the **Cyclic** option if the metered value is to be transmitted to the control centre at cyclic intervals. Otherwise select the **None** option.

By clicking the **Settings** button, you end up in the dialog box for setting the corresponding **time interval**. **One minute is preset**.

Note

The settings made in the **Cyclical restoring** tab in this dialog box apply **globally** for all metered values.

Under **Energy flow direction**, you define whether the metered value summates the quantity of exported or imported energy by selecting one of the two options.

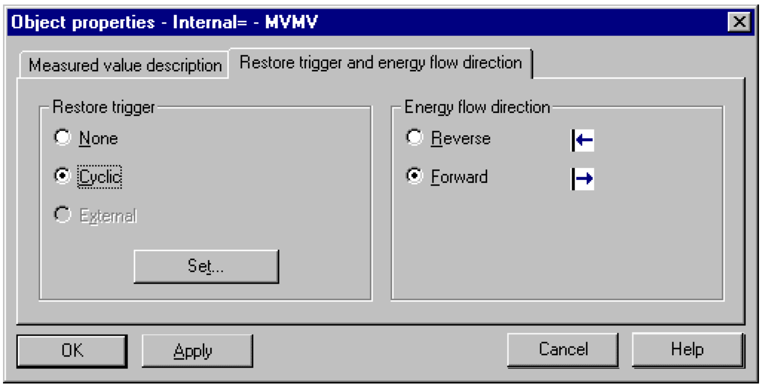


Figure 2-14 Object properties dialog box, Restore trigger and energy flow direction tab

Accept the settings with **OK**.

Predefined Metered Values

The figure below shows a list of predefined metered values.

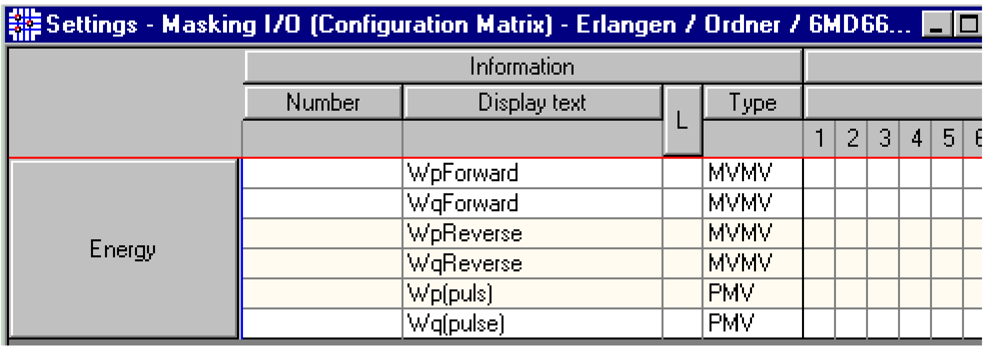


Figure 2-15 Default metered values

2.6 Threshold-Switch

Using the Threshold switch function, you can set transmission thresholds and allocate the threshold switches to individual or multiple measured values.

2.6.1 Description

The threshold value procedure consists of the Transmission threshold configuration dialog and the threshold switch.

Transmission threshold

The **transmission threshold** determines the transmission frequency of measured values. It is specified in percentage. If zero is selected as the threshold value for the transmission threshold, each measured value change will be transmitted to the higher-level station. This, however, would overload the communication line within short time. A threshold value not equal to zero results in all changes to new measured values being added compared to the last measured value transmitted. If the sum of the changes reaches the set percentage, a new measured value is transmitted at the next possible point in time.

Perform the settings in the DIGSI® configuration matrix. You can set the central threshold, configured threshold and switching object in the **object properties** of the measured value, tab **Transmission threshold**.

- Use **central threshold** (10%): Select this check box to use the factory-preset threshold value of 10 %. This de-activates all the other input and output options in this tab.
- **Parameterised threshold**: Set the desired value in this rotating box. The set value multiplied by 0.1 % results in the threshold value.
- **Switching object**: A changeover from the central and the parameterised threshold can be initiated by the status of a message. From the drop-down menu, select the indication whose status shall initiate a changeover.

The following figure serves as an example of summation formation for a threshold of 10%. Here, the values are summated (in the left example 4.5% / –3% / 3.5% => 11%) and transmitted at the next possible point in time in case the threshold is exceeded.

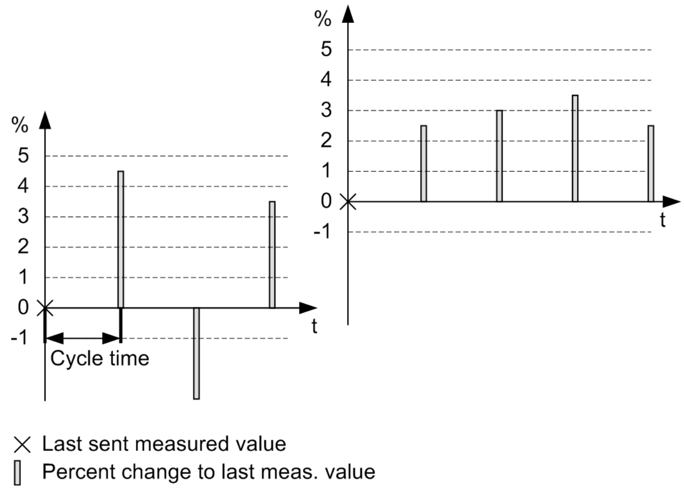


Figure 2-16 Summation for threshold value

Threshold switch

The group **Software switch** (in the DIGSI® configuration matrix) contains all potential switching objects. **Threshold 1** is the preset value.

You can add additional thresholds (single point indications) from the information catalog. Assign the threshold value switch to one or several measured values via the **Switching object** setting in the measured-value object properties.

2.6.2 Information List

No.	Information	Type of Information	Comments
-	ThreshVal1	IntSP	Threshold Value 1

2.7 Circuit breaker synchronisation

If the **synchronization function** of the device is active, the device can check whether the synchronization conditions of both subnetworks are fulfilled (synchrocheck) when the circuit breaker is closed.

The device distinguishes between **synchronous** and **asynchronous** networks and reacts differently on the connection.

Systems are called synchronous if their difference frequency is small. The concrete value depends on the parameter settings. In synchronous networks the CB operating time is not considered.

In asynchronous networks, on the other hand, the amount of difference frequency is bigger, and the time window for switching on is passed more quickly. Consequently, the circuit breaker operating time must be considered in this case. The control command is automatically pre-dated by this time in order to ensure that the circuit breaker contacts close exactly at the right time. The automation functions enabled in the device allow to automatically use various reference voltages of the active busbar for synchronization (whereby the individual reference voltage depends on the isolator position). It is possible to save and hold available for operation maximally eight different parameter sets for the synchronization function. In this way, it is possible to consider the various features of several circuit breakers.

The synchronization function groups six to eight differ from the groups one to five essentially due to the connection of the voltage transformers. Various connection examples can be found in the Appendix.

2.7.1 SYNC Function groups 1 - 5

The SIPROTEC® 4 device 6MD66x has configuration options for eight different synchronization functions. The function and operation is described in the following using the **`SYNC function 1`**. Special features of SYNC functions 6 to 8 are compiled separately (see Section 2.7.3).

2.7.1.1 Functioning

The synchronisation function is used in the control system for connecting two subnetworks during operational switch or for operational switch on or on the protection level after a three-pin short or long interruption. The synchronisation function ensures that the connection is only performed if both subnetworks are synchronous to each other or the deviation is within the defined limits.

The connection is performed if the following conditions are met at the moment of establishing the isolated connection:

- Voltage magnitudes **`Umin`** < | U | < **`Umax`**
- Difference of voltage magnitudes | ΔU | < Δ **`Umax`**
- Frequencies **`fmin`** ≤ f ≤ **`fmax`**
- Difference of frequencies Δ f < Δ **`fmax`**
- Difference of angles $\Delta \alpha < \Delta \alpha_{max}$

For safety reasons, connection is only permitted below the curve shown in the diagram for large differences in frequency and long circuit-breaker operating times.

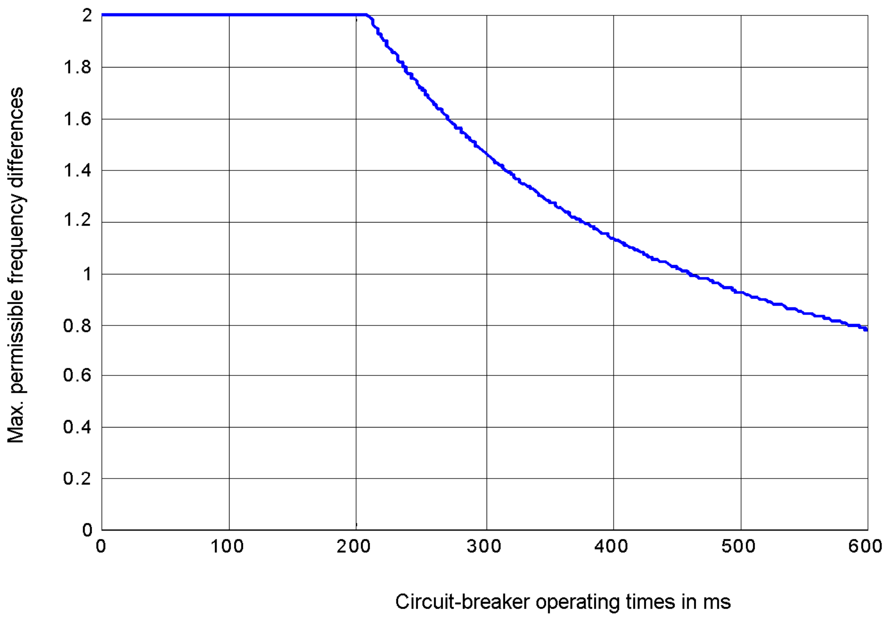


Figure 2-17 Maximum permissible difference in frequency as a function of the circuit-breaker operating time

The **Dead bus** and **Dead line connection** are special cases. In this case, connection is made depending on the configuration under the following conditions:

- Dead Line | U_{bb} | > **`Umin`** and | U_{line} | < **`Udead`** and **`fmin`** ≤ f_{bb} ≤ **`fmax`**
- Dead bus | U_{bb} | < **`Udead`** and | U_{line} | > **`Umin`** and **`fmin`** ≤ f_{line} ≤ **`fmax`**
- Dead line & Dead bus | U_{bb} | < **`Udead`** and | U_{line} | < **`Udead`**

Busbar voltage $\mathbf{U_{bb}}$ and feeder voltage $\mathbf{U_{line}}$ are assigned to voltages **U1** and **U2** depending on how the device is connected. Connection examples can be found in the Appendix.

The connection is performed on an idle busbar, on an idle feeder or on both.

A **synchronization comparison** with the runtime of the synchronization function can be executed by means of definitely applied voltages (normal case) or by means of a voltage application via relay.

The synchronisation comparison including an application of the voltage is necessary e.g. for multiple busbars or in case of a failure of the coupling circuit breaker (backup switching). Additional preparatory switching operations as well as the selection of the subsettings group are necessary for applying the voltage at the time of the comparison. The settings must be stored in the control device for each combination of subnetworks.

The measuring channels of the reference and feeder voltage must be assigned to each synchronization function group individually.

Voltage application

If the voltage application is used, the user must set a switching sequence with the following components:

- Voltage application
- Synchronisation
- Voltage deselection

The voltage application option ensures that a 250 ms delay is considered in the measuring algorithm after the synchronization start. In this way, the measured values can stabilize.

Field of application internal control, internal synchronisation

The synchronization with internal control and internal synchronization is the standard application with 6MD66x. Maximally 8 function groups (SYNC functions group 1 to 8) with different parameter sets are available.

The assignment of the synchronisation-requiring control device to the corresponding synchronisation settings group is performed via the **`SyncSD`** setting (control device to be synchronised).

By the time of the switching operation, the function group selection can be controlled dynamically via the **Sync. effective** input message. The **Sync. effective** input indication can be configured to a binary input, CFC or IRC. Unsynchronised switching is performed if no synchronization function is effective (**Sync. effective OFF**).

The contact between the control and the synchronization function is performed internally via indications:

- „`>Sy1 Meas`“ (Measurement request)
- „`Sync. CloseRel`“ (Enable switch-on)
- „`Sync. synchron`“ (in case of an error)

Field of Application External Control, Internal synchronization

The 6MD66x also enable the synchronisation via an external control and internal synchronisation.

To directly connect an external control, the setting of the **control device to be synchronised** must be set to **none**.

By the time of the switching operation, the function group selection can be controlled dynamically via the **Sync. effective** input message. The **Sync. effective** input indication can be configured to a binary input, CFC or IRC. Unsynchronised switching is performed if no synchronization function is effective (**Sync. effective OFF**).

In this case, the contact between the control and the synchronization function is performed internally via indications:

- „`>Sy1 Meas`“ (Measurement request), on binary input
- „`Sync. CloseRel`“, on relay (for outputting the switch-on command)
- „`Sync. synchron`“, on relay (for signalling the synchronous state)

Subfunctions

The synchronization check is composed of the two subfunctions control and synchronization.

- The **control** function ensures the coordination of the complete command procedure:
  - Coordination of the different switching directions
  - Standard interlockings such as timeout protection
  - Command connection/disconnection of the command relays
  - Command logging CO+/-, FB+/- and COE.
  - Feedback to the operator (operator response).
- The **Synchronisation** function processes the **measuring** phase of:
  - „`>Sy1 Meas`“ (Measurement request), start of measurement, to
  - „`Sync. CloseRel`“, switching release.

Command processing phases with synchrocheck

Depending on the setting and the current process condition, the individual phases of the command processing are executed, skipped or the command processing is aborted. When integrating the synchronization procedure into a switching sequence, the deselection phases must be processed correspondingly also in case of an abortion.

- **Voltage application**: The voltage application (applying measured values at the time of the switching operation) is optional. It is, for example, set via a switching sequence in CFC. The corresponding measured values must be switched to the device analog inputs via relays.
- **Selection of the SYNC function group**(if necessary): The SYNC function group selection (selection of a function group with its settings and indications) is optional. The selection is only required if several SYNC function groups are actually switched active. It is, for example, set via a switching sequence in CFC. The selection is performed by activating the input indication „`>Sy1 eff.`“ effective.
- **Switchgear interlocking**: This phase executes the control subfunction. It serves to execute all switchgear interlocking checks and to state if switching is permitted or not.

  In additon to this, it is checked if maximally one synchronisation function (measuring phase) is active.
- **Checking start conditions**: This phase executes the control subfunction. A check determines whether switching is to occur with or without synchronisation. It serves to execute all switchgear interlocking checks and to state if switching is permitted or not.

  In additon to this, it is checked if maximally one synchronisation function (measuring phase) is active.

  – **Control direction**:

  Control command = **ON**: Continue with synchronisation check.

  Control command = **OFF**: Continue with control phase (no synchronisation required).

  – **Synchronisation check**:

  Checks whether the control device concerned shall be switched on synchronised or evaluation of the number of input indications „`>Sy1 eff.`“ **= ON**.

  – **Analysis of the operating mode**

  Evaluation of the input indications of the selected group.

Table 2-3 **Start conditions check** phase, SYNC function group selection

Number of SYNC function groups including the control device to be switched	Number of input messages „>Sy1 eff.“ = ON	Reaction
0	Irrelevant	Unsynchronised control device, continue with **control** phase
≥ 1	0	Unsynchronised switching, continue with **control** phase
≥ 1	1	Unambiguous allocation, continue with operating mode analysis and activated group
>1	>1	Error, abort with BF (too many groups effective)

Table 2-4 **Start conditions check** phase, operating mode analysis

„Sync. Error“	„Sync. CloseRel“	Reaction
ON	Irrelevant	Abort with BF-
OFF	ON	Switching enable, continue with **control** phase
OFF	OFF	Continue with **Measuring** phase, tripping by: >SyMeasON

- **Measuring**: This phase executes the synchronisation subfunction.
  This phase is coordinated by means of input indications:
  - „`>Sy1 Meas`“, start/stop of measurement
  - „`>Sy1 dirCO`“, bypassing
  - „`>Sy1 rlblk`“, block switching enable

  The actual measuring procedure with the output messages starts afterwards:
  - „`Sync. CloseRel`“, switching enable (continue with control phase)
  - „`Sync. Error`“, synchronisation failed
  - „`Sync. block`“, switching enable blocked
  - „`Sync.MonTimeExc`“, monitoring time exceeded

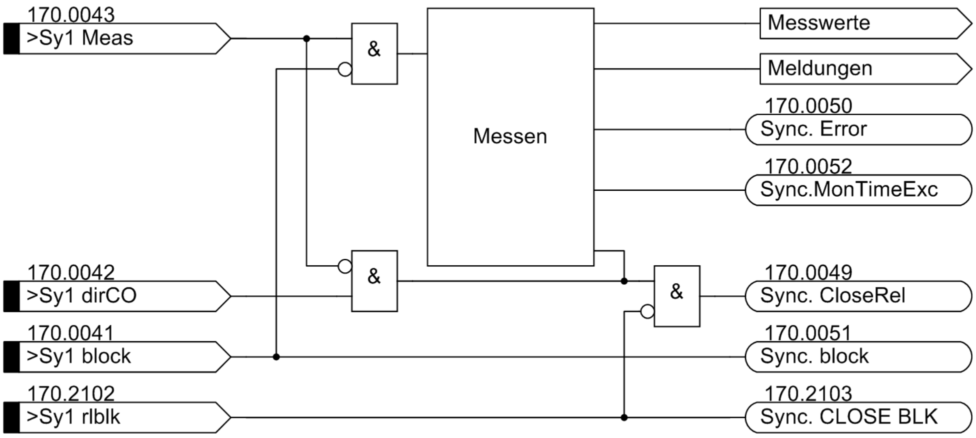


Figure 2-18 Input and output messages of the synchronization function

Table 2-5 Controlling the **measuring** phase

Action	Measuring	Reaction
„>Sy1 Meas“. ON and „>Sy1 dirCO“ = ON and „Sync. block“ = OFF		Switching enable: „Sync. CloseRel“ ON
„>Sy1 Meas“ ON and „>Sy1 dirCO“. = OFF	Start	
„>Sy1 Meas“. OFF	Stop	
Synchronisation conditions reached, or „>Sy1 dirCO“. ON and „>Sy1 rlblk“ = ON and „Sync. block“ = OFF	Stop	Switching enable: „Sync. CloseRel“ ON
Synchronisation conditions reached, or „>Sy1 dirCO“ ON and „Sync. block“ = ON	Stop	
„>Sy1 rlblk“ = OFF	Irrelevant	Switching releases are given: „Sync. block“ OFF
„>Sy1 rlblk“ = ON	Irrelevant	Switching enables are blocked: „Sync. block“ ON
„>Sy1 Meas“ ON and „>Sy1 block“ ON	Stop	Aborts the synchronization
Monitoring time exceeded T-SYN. DURATION	Stop	Indication: „Sync.MonTimeExc“ ON
Errors (problems in the synchronisation function)	Stop	Indication: „Sync. Error“ ON

A measurement request „`>Sy1 Meas`“ ON in the state „`>Sy1 rlblk`“ ON corresponds to the measurement initiation in the SINAUT LSA.

An abort of the **measuring** phase is initiated via „`>Sy1 Meas`“ OFF.

- **Control**: This phase executes the control subfunction.

  The command procedure is aborted for:
  – Abort command with **AC+**
  – Monitoring time exceeded **`T-SYN. DURATION`** with **CO-**
  – „`Sync. Error`“ ON, synchronisation failed with **CO-**

  The command procedure is started via the following indication:
  – „`Sync. CloseRel`“ ON, switching enable comes with **CO+**

  The normal command sequence runs afterwards.

- **Deselection of the SYNC function group**: The action selection of the SYNC function group must be terminated. This is also true for an abort of the command procedure.
- **Voltage deselection**: The voltage application action must be terminated. This is also true for an abort of the command procedure.

Interfaces

The following data are relevant for the user as an interface:

- **Commands**,
  Commands to the circuit breaker/the function from different initiators.
- **Input indications**,
  Indications for controlling the synchronisation function.
- **Output indications**,
  Indications on the state of the synchronisation function and indications on switch-impeding criteria.
- **Measuring channels**,
  Allocation of the logical inputs of the synchronisation function on the voltage transformer (analogue input).
- **Measured values**,
  calculated measured values of the synchronisation function.
- **Indications**,
  Indications on the command procedure (such as CO+/CO-).
- **Settings**,
  Settings for configuring properties.

Commands

Table 2-6 **Start conditions check** phase, operating mode analysis

Code	Explanation
Command ON/OFF to SyncSD	Control command from different initiators. ON: Control command for switching the control device on. (with or without synchronisation procedure) OFF: Control command for switching the control device off. (without synchronisation procedure)
Command abort - to SyncSD, or - to all	Abort command, a running command procedure, the synchronisation or switching procedure must be aborted. Abort of the synchronisation procedure is without conditions. Abort of the synchronisation procedure is only possible for a command with operating mode "impulse, interruptible".

Input indications

The input indications are enabled once per synchronization settings group. For this reason, they are configured as often as synchronization settings groups are required.

Table 2-7 Input indications, SYNC function groups

Code	Explanation
„>Sy1 eff.“	Function effective. Activation and deactivation of a function group. In the "Testing start conditions" phase, the SYNC function group is selected by means of this indication. For selecting a group or for a unique emergency control, a switching sequence must be set via CFC, e.g. for emergency control: - effective OFF - command ON - effective ON An emergency control can also be reached via „>Sy1 dirCO“ ON, however only if „>Sy1 rlblk“ OFF. ON: The group is effective. OFF: The group is ineffective (unsynchronised switching).
„>Sy1 block“	Aborts the synchronization
„>Sy1 rlblk“	Block switching enable. The synchronisation functions normally (the measuring function is executed), but a switching enable is prevented. The blocking of the switching enable is signalled via the „Sync. block“ output indication. ON: switching enables are blocked. OFF: switching enables are provided.
„>Sy1 dirCO“	Bypassing. The measuring function is bridged, i.e. a measurement for „>Sy1 rlblk“ OFF immediately initiates a switching enable. ON: The measuring function is skipped or stopped with „>Sy1 Meas“. ON. The switching enable is provided. OFF: The measuring function is started with „>Sy1 Meas“ ON.
„>Sy1 Meas“	Start/stop of the (measuring) synchronization function. ON: The synchronisation function is started. OFF: The synchronisation function is aborted.
„>Sy1U1>U2<“	Switch test V2 dead on / off. ON: Connection occurs even if voltage V2 is missing. (The threshold value for dead line or busbar can be configured.)

Code	Explanation
„>Sy1U1<U2>“	Switch test V1 dead on / off: ON: Connection occurs even if voltage V1 is missing. (The threshold value for dead line or busbar can be configured.)
„>Sy1U1<U2<“	Swtich test V1 & V2 dead on / off. ON: Connection occurs even if voltages U1 and U2 are missing. (The threshold value for dead line or busbar can be configured.)

Note

The meaning of indication „`>Sy1 block`“ has changed from version 4.30 on.

Old meaning: Block switching enable

New meaning: Abort synchronization

The new indication „`>Sy1 rlblk`“ now assumes the old meaning: Block switching enable.

Likewise, a compatible firmware extension has been implemented.

Measuring channels

The input measuring channels describe a measured-value channel and can be configured directly on an analog input in the DIGSI configuration matrix.

Table 2-8 Input measuring channels, function group FB_SYNC 1 to 5

Code	Explanation
„Sy1 ChU1“	Channel of voltage V1.
„Sy1 ChU2“	Channel of voltage V2.

Output indications

Status messages are output from the synchronization function. The status messages are output in the context of the active FB_SYNC function module.

Table 2-9 Output messages of the synchronisation function

Code	Explanation
„Sync. CloseRel“	Synchronisation conditions exist, switching is enabled. ON: This immediately leads to a switching command (triggering of command relays).
„Sync. Error“	Error, problems within the synchronisation function.
„Sync. block“	Aborts the synchronization.
„Sync. CLOSE BLK“	Blocking by external event.
„Sync.MonTimeExc“	Monitoring time exceeded
„Sync. synchron“	The networks meet the synchronisation conditions for asynchronous or synchronous networks.
„Sync. U1> U2<“	Condition V2 dead exists.
„Sync. U1< U2>“	Condition V1 dead exists.
„Sync. U1< U2<“	Condition U1 & U2 dead exists.
„Sync. Vdiff>“	The difference voltage amount is greater than the setting. The corresponding SVK_Udiff measured-value indication is transmitted additionally.
„Sync. fdiff>“	The difference voltage amount is greater than the setting. The corresponding SVK_Fdiff measured-value indication is transmitted additionally.

Code	Explanation
„Sync. α diff>“	The amount of the difference angle is greater than the setting. The corresponding SVK_Fdiff measured-value message is transmitted additionally, provided that the Fdiff < FdiffSyn condition is met.
„Sync. f1>>“	The f1 frequency is greater than the fmax setting. The corresponding SVK_F1 measured-value message is transmitted additionally.
„Sync. f1<<“	The f1 frequency is smaller than the fmin setting. The corresponding SVK_F1 measured-value message is transmitted additionally.
„Sync. f2>>“	The f2 frequency is smaller than the fmax setting. The corresponding SVK_F2 measured-value message is transmitted additionally.
„Sync. f2<<“	The f2 frequency is smaller than the fmin setting. The corresponding SVK_F2 measured-value indication is transmitted additionally.
„Sync. U1>>“	The U1 voltage is greater than the Vmax setting. The corresponding SVK_Usyn1 measured-value indication is transmitted additionally.
„Sync. U1<<“	The U1 voltage is smaller than the Vmin setting. The corresponding SVK_Usyn1 measured value indication is transmitted additionally, provided that Dead Bus is not switched on or that no Dead Bus voltage was set.
„Sync. U2>>“	The U2 voltage is greater than the Vmax setting. The corresponding SVK_Usyn2 measured-value indication is transmitted additionally.
„Sync. U2<<“	The U2 voltage is smaller than the Vmin setting. The corresponding SVK_Usyn2 measured value indication is transmitted additionally, provided that Dead Line is not switched on or that no Dead Line voltage was set.

Measured values

The measured values are calculated by the measuring function and made available for display or further processing (e.g. for limit-value determination in CFC).

The configuration specifies the way in which measured values are displayed, further processed and forwarded to the higher-level control centre.

The measured values are calculated for each SYNC function group. The storage is performed independent of the information objects.

Table 2-10 Synchronisation measured values

Code	Explanation
„Sync. U1“	Synchronisation voltage „Sync. U1“ is generally also the reference voltage.
„Sync. U2“	Synchronization voltage „Sync. U2“ is generally also the feeder voltage.
„Sync. Vdiff“	Difference of synchronisation voltages „Sync. U1“ and „Sync. U2“.
„Sync. α“	Angles between the voltages „Sync. U1“ and „Sync. U2“.
„Sync. f1“	Frequency of the synchronisation voltage „Sync. U1“.
„Sync. f2“	Frequency of the synchronisation voltage „Sync. U2“.
„Sync. fdiff“	Frequency difference between f(„Sync. U1“) and f(„Sync. U2“).

2.7.1.2 Setting Notes

T-CB close

The circuit breaker closing (operating) time indicates the runtime of the circuit breaker including all relay and contactor pickup times. It can be specified in the predefined range. A default value is preset.

Balancing U1/U2

Adaptation of the V1 and V2 voltages is possible with the **Balancing U1/U2**. It can be specified in the predefined range. A default value is preset.

α Tr. U1-U2

The phase angle offset is set with the angle adaptation initiated by the transformer vector group. The angle faults of imprecise primary transformers can also be corrected. The phase angle can be set in the predefined range. A default value is set.

SecTransNomVal1

Here, the secondary rated transformer voltage V1 of the measured-value input for the relevant reference voltage must be set on the input/output modules. In this context, it must be observed that, in case of a measuring voltage application, transformers with the same transformation ratio and the same connection must be used for all connectable voltages. The voltage can be set in the predefined range. A default value is preset.

SecTransNomVal2

Here, the secondary rated transformer voltage V2 of the measured-value input for the relevant reference voltage must be set on the input/output modules. In this context, it must be observed that, in case of a measuring voltage application, transformers with the same transformation ratio and the same connection must be used for all connectable voltages. The voltage can be set in the predefined range. A default value is preset.

SyncSD

Control device to be synchronized. The synchronization function can be used for controlling an internal or external command procedure. In case of an internal command processing, a connection to the control device to be synchronized is established at the parameter **SyncSD**. The command is initiated via a control command to the control device, e.g. from the control display. In case of an external command processing, the parameter is "none".

Umin

The lower voltage limit **Umin** specifies the minimum voltage which may be connected. It can be specified in the predefined range. A default value is preset.

Umax

The upper voltage limit **Umax** specifies the maximum voltage which may be connected. It can be specified in the predefined range. A default value is preset.

Udead

The voltage threshold indicates the voltage maximum up to which a line or busbar is detected as dead. It can be specified in the predefined range. A default value is preset.

Sync.U1>U2<

This parameter serves to specify if a connection is to take place in case of a healthy busbar and a dead line or dead generator (Dead Line). The default setting is No.

Sync.U1<U2>

This parameter serves to specify if a connection is to take place in case of a dead busbar and a healthy line (Dead Bus). The default setting is No.

Sync.U1<U2< This parameter serves to specify if a connection is to take place in case of a dead busbar and a dead line (Dead Line and Dead Bus). The default setting is No.

T-SYN. DURATION The maximum duration of synchronisation check must be set here. If the connection cannot be established successfully within this period, the synchronization procedure is aborted. It can be specified in the predefined range. A default value is preset.

fmin This setting defines the lower limit of the frequency range in which the synchronous connection is permissible. The working range of the measuring procedures is not influenced. The lower limit of the frequency working range must be lower than its upper limit. It can be specified in the predefined range. A default value is set.

fmax This setting defines the upper limit of the frequency working range in which the synchronous connection is permissible. The working range of the measuring procedures is not influenced. The upper limit of the frequency working range must be higher than its lower limit. It can be specified in the predefined range. A default value is set.

UdiffAsyn This setting indicates the maximum voltage difference of the amounts of V_{syn1} and U_{syn2} for asynchronous conditions. It can be specified in the predefined range. A default value is preset.

fdiff This setting indicates the maximum frequency difference up to which a connection is permissible for asynchronous systems. It can be specified in the predefined range. A default value is preset.

f SYNCHRON This setting indicates the maximum frequency difference up to which a connection is permissible for synchronous systems. It can be specified in the predefined range. A default value is preset.

UdiffSyn This setting indicates the maximum voltage difference of the amounts of U_{syn1} and U_{syn2} for synchronous conditions. It can be specified in the predefined range. A default value is preset.

αdiff This parameter indicates the maximum angle difference between the voltages of the subnetworks, for which the connection is performed. It becomes effective if the frequency difference of the subnetworks $\Delta f \leq F_{diffSyn}$ is valid, i.e. in operational condition "synchronous networks". If both subnetworks are detected by the device as "asynchronous", a fixed allowed difference angle of $\pm$ 5 degree is always considered. The angle can be set in the predefined range. A value is preset as the default.

T SYNCHRON This parameter indicates the switch delay time for synchronous networks. This is the minimum period, the **`UdiffSyn`** (maximum permissible voltage difference), **`f SYNCHRON`** (maximum permissible frequency difference) and **α`diff`** (angle difference) which must remain in the parameterised range until the control command is initiated. If a value leaves the parameterised range, the time counter is reset. It can be specified in the predefined range. A default value is set.

Note

To obtain a stable connection range, the measured values have a hysteresis:

± 10 % or ± 1 V for voltages (the respectively lower value is valid).

± 20 mHz for frequencies.

± 1 ° for angles.

2.7.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
0	T-CB close	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchro-nism-check
0	fmin	95 .. 105 %	95 %	Minimum frequency
0	fmax	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	20 .. 125 V	90 V	Minimum Voltage for Synchroni-zation
0	Umax	20 .. 140 V	110 V	Maximum Voltage for Synchroni-zation
0	Udead	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, syn-chronous
0	fdiff	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous

Addr.	Parameter	Setting Options	Default Setting	Comments
0	f SYNCHRON	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems

2.7.1.4 Information List

No.	Information	Type of Information	Comments
170.0001	>Sy1 eff.	SP	>Sync1 effective
170.0024	Sy1 ChU1	MC	Sync1, Voltage input U1
170.0025	Sy1 ChU2	MC	Sync1, Voltage input U2
170.0041	>Sy1 block	SP	>Sync1 block
170.0042	>Sy1 dirCO	SP	>Sync1 direct Command Output
170.0043	>Sy1 Meas	SP	>Sync1 Measuement only
170.0044	>Sy1U1>U2<	SP	>Sync1 switch to U1> and U2<
170.0045	>Sy1U1<U2>	SP	>Sync1 switch to U1< and U2>
170.0046	>Sy1U1<U2<	SP	>Sync1 switch to U1< and U2<
170.0049	Sync. CloseRel	OUT	Sync. Release of CLOSE Command
170.0050	Sync. Error	OUT	Synchronization Error
170.0051	Sync. block	OUT	Sync. blocked
170.0052	Sync.MonTimeExc	OUT	Sync. Monitoring Time exceeded
170.0053	Sync. synchron	OUT	Sync. Synchron
170.0054	Sync. U1> U2<	OUT	Sync. Condition U1> U2< fulfilled
170.0055	Sync. U1< U2>	OUT	Sync. Condition U1< U2> fulfilled
170.0056	Sync. U1< U2<	OUT	Sync. Condition U1< U2< fulfilled
170.0057	Sync. Vdiff>	OUT	Sync. Voltage difference exceeded
170.0058	Sync. fdiff>	OUT	Sync. frequency difference exceeded
170.0059	Sync. α diff>	OUT	Sync.angle difference exceeded
170.0060	Sync. f1>>	OUT	Sync. frequency f1 too high
170.0061	Sync. f1<<	OUT	Sync. frequency f1 too low
170.0062	Sync. f2>>	OUT	Sync. frequency f2 too high
170.0063	Sync. f2<<	OUT	Sync. frequency f2 too low
170.0064	Sync. U1>>	OUT	Sync. voltage U1 too high
170.0065	Sync. U1<<	OUT	Sync. voltage U1 too low
170.0066	Sync. U2>>	OUT	Sync. voltage U2 too high
170.0067	Sync. U2<<	OUT	Sync. voltage U2 too low
170.0070	Sync. U1	MV	Sync. voltage U1
170.0071	Sync. U2	MV	Sync. voltage U2
170.0072	Sync. Vdiff	MV	Sync. voltage difference U1,U2
170.0073	Sync. α	MV	Sync. angle between U1,U2
170.0074	Sync. f1	MV	Sync. frequency f1
170.0075	Sync. f2	MV	Sync. frequency f2
170.0076	Sync. fdiff	MV	Sync. frequency difference f1, f2
170.2102	>Sy1 rlblk	SP	>Sync1 release blocking
170.2103	Sync. CLOSE BLK	OUT	Sync. CLOSE command is BLOCKED

2.7.2 SYNC Function Group 6 - 8

The SYNC function groups 6 to 8 offer other variations for connection of the voltage transformer. Connection examples can be found in the Appendix.

2.7.2.1 Description

SYNC function groups 6 to 8 do not differ from SYNC function groups 1 to 5 in terms of function, operation and configuration options. They are described in detail in Chapter 2.7.1.

With SYNC function groups 6 to 8, two channels with phase-to-earth voltage (U11 and U12) are to be allocated for voltage U1. The phase-to-phase voltage U1 is to be formed from these voltages. The relevant phase-to-phase voltage is to be connected to voltage input U2.

Measuring channels

The input measuring channels describe a measured-value channel and can be configured directly on an analogue input with DIGSI®.

Table 2-11 Input measuring channels, function groups FB_SYNC 6 to 8

Code	Explanation
„Sy6 ChU11“	Channel of phase-to-earth voltage U11LE. This value is required for calculating a phase-phase voltage U1.
„Sy6 ChU12“	Channel of phase-to-earth voltage U12LE. This value is required for calculating a phase-phase voltage U1.
„Sy6 ChU2“	Channel of voltage U2.

2.7.3 Parameterizing the SYNC function

Synchronisation is a function which must be set as available in the functional scope.

2.7.3.1 Inserting the Synchronisation Function

First select the required synchronisation functions as **available** in the **Functional scope** dialog box in DIGSI®.

For this purpose, open the device and click **Functional scope** in the function selection and confirm with OK.

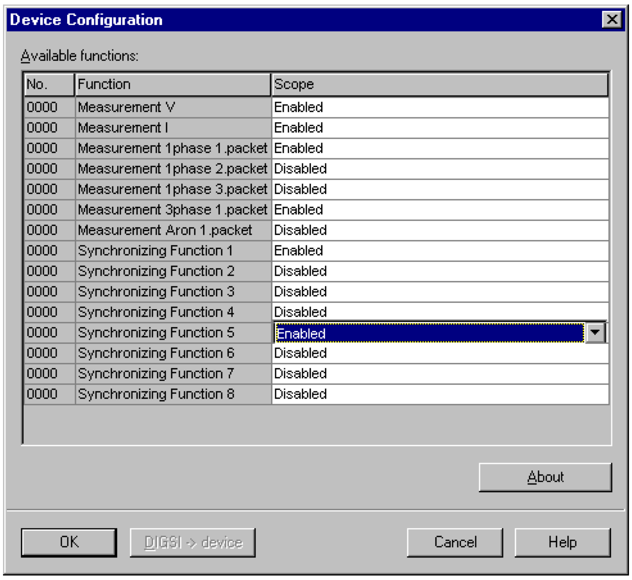


Figure 2-19 Specifying functional scope

2.7.3.2 Configuring Synchronisation

Click **Synchronisation** in the tree view of DIGSI®. The available synchronisation function groups are displayed in the list box under **Function selection**. Double-click the function group (e.g. SYNC function group 1) which you would like to configure. The dialog box for configuration is opened. It contains the tabs **System data**, **General**, **Asyn. condition** and **Syn. Condition**. See also Chapter 2.7.1, margin heading „Input Indications“.

Select the tab **System data** and make your settings.

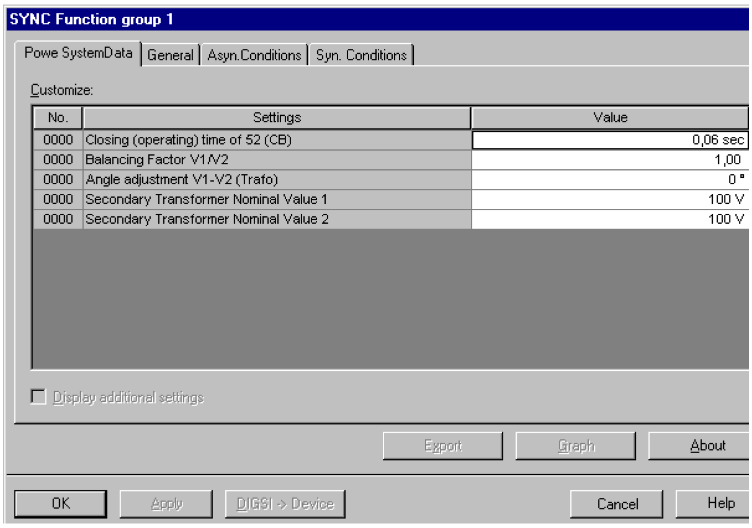


Figure 2-20 Synchronization, System data tab

Make additional settings in the tabs **General**, **Asyn. condition** and **Syn. Condition**.

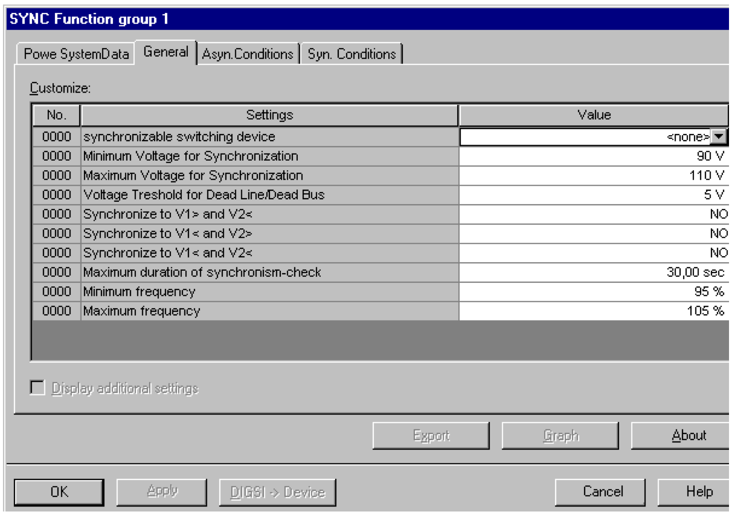


Figure 2-21 Synchronization, General tab

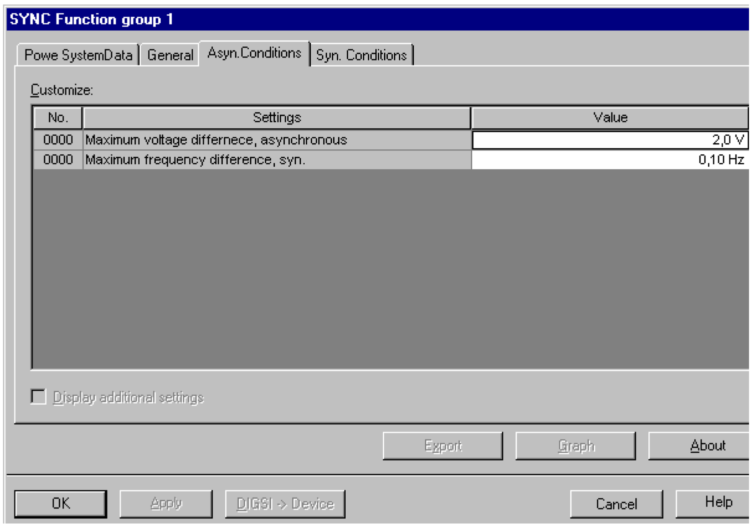


Figure 2-22 Synchronization, Asyn. tab Condition

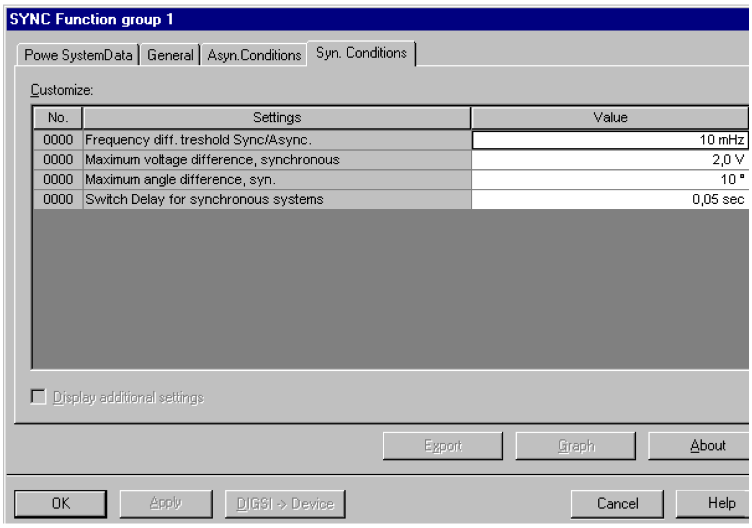


Figure 2-23 Synchronization, Syn. Conditions tab

Exit configuration of synchronisation with OK.

2.8 Switchgear Interlocking

The so-called CFC (Continuous Function Chart) allows to configure, among other things, the switchgear interlocking conditions in the 6MD66x bay controller in a comfortable graphical HMI. Cross-bay interlocking conditions (system interlocks) can be processed by an exchange of information between bay controllers. The inter-relay communication has its own interface for this. In bay controllers equipped with the new IEC61850 communication interface, information can also be exchanged directly through this Ethernet link. This is shown in the two figures below.

2.8.1 General

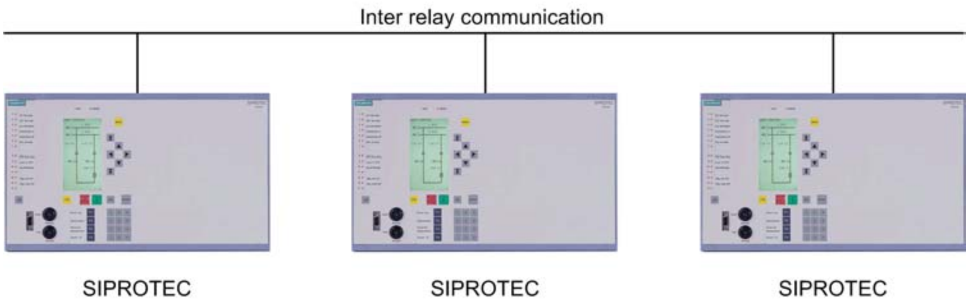


Figure 2-24 Switchgear interlocking system with 6MD66 and inter relay communication (IRC)

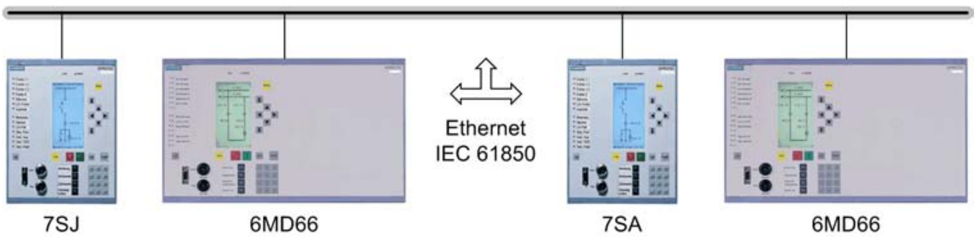


Figure 2-25 Switchgear interlocking system with 6MD66 and IEC61850—GOOSE

If a PROFIBUS FMS link to a substation controller exists, the system interlocking conditions can also be processed as before in the substation controller (SICAM SAS).

The following table shows the various possibilities at a glance.

Table 2-12 Switchgear interlocking with bay and system interlocking

	6MD66x Internally via CFC	Centrally by SICAM SAS via PROFIBUS FMS	Centrally via IEC60870-5-103	IEC 61850-GOOSE	Inter-Relay Communication (IRC)
Bay interlocking	X				
System interlocking		X	(X)[1]	X	X[2]

X = optimum solution

(X) = possible solution

[1] with system interlocking via IEC60870-5-103: No check of system interlocking possible with local control from the bay controller.

[2] Note limited number of devices (32 max.)

This means that you have various possibilities with system interlocking:

- If the bay controller is connected via PROFIBUS FMS to a SICAM SAS station controller, system interlocking can be interrogated in this way.
- If the IEC60870-5-103 protocol is selected as the system interface, the system interlocking should be checked using IRC, because in the case of local control from the bay controller (IEC103 slave) no interrogation can be sent to the IEC103 master (this is a feature of the IEC103 protocol).
- If communication with IEC61850 via Ethernet is used, information for the system interlocking is exchanged directly from one bay controller to the other (or to any other GOOSE-capable bay controllers). The Ethernet interface used is the same as for communication with the station controller (see Figure 2-25).
- Inter-relay communication IRC (see Section 2.12) can also be used for exchanging system interlocking information directly between devices. IRC nodes can only be SIPROTEC 6MD66x bay controllers. IRC is handled through a dedicated communication port (see Figure 2-24).

Figure 2-27 below shows a simple example of a circuit breaker interlock on a double busbar feeder (see Figure 2-26).

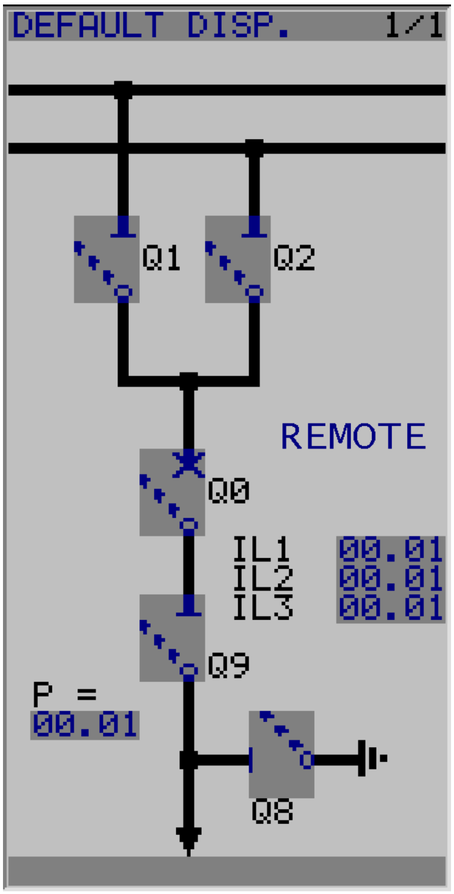


Figure 2-26 Double busbar feeder

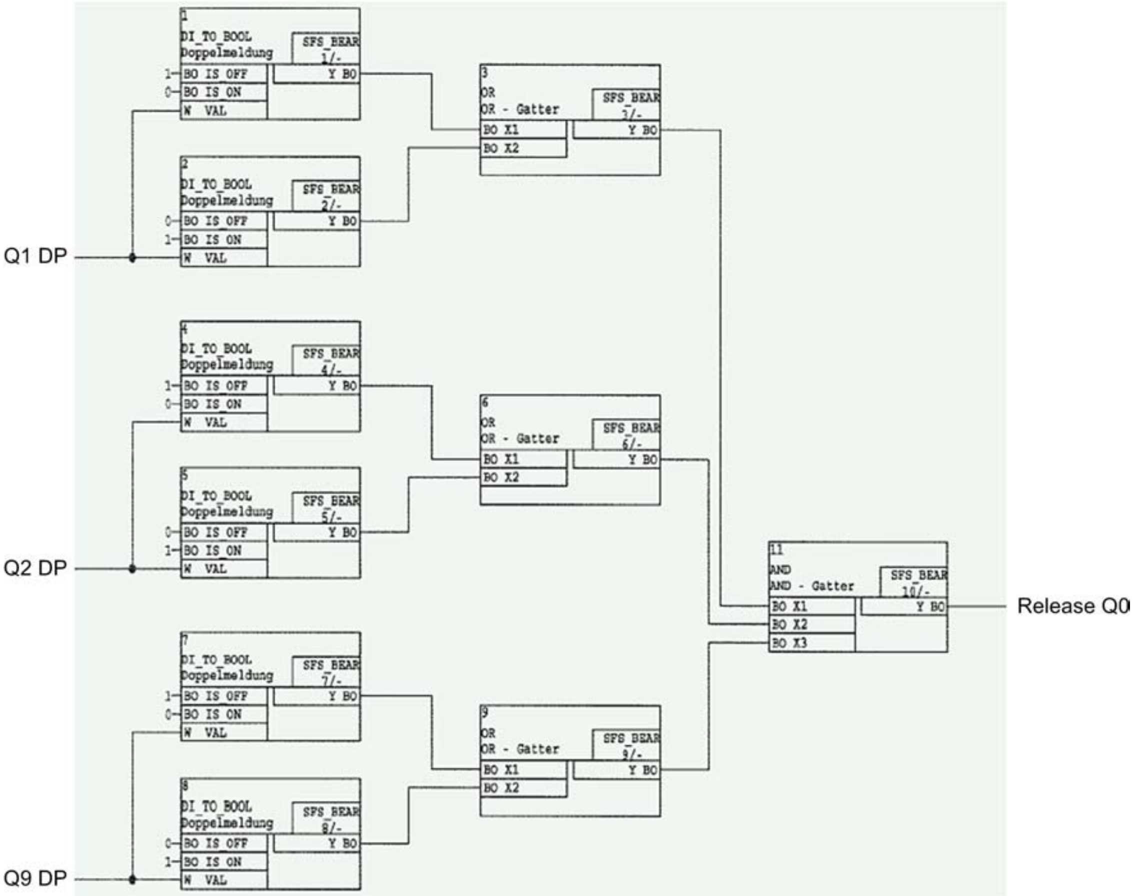


Figure 2-27 CFC interlocking chart

To release circuit breaker Q0, the position of the busbar disconnectors Q1 and Q2 and of line disconnector Q9 is interrogated ("0“ or "1“), i.e. whether they are in intermediate position or not. The result is ANDed and serves for releasing the circuit breaker. This means that the circuit breaker may be closed or opened, provided that non of the three disconnectors are in intermediate position. It is also possible to release the switching direction (close or open) separately.

The checks prior to command output also include the positions of the two key-operated switches: The top key-operated switch corresponds to the S5 function familiar from the 8TK switchgear interlocking system (remote/local switchover). The bottom key-operated switch switches over to unlocked command output (S1 function, position "interlocking OFF"). To draw attention to the fact that the configured interlocks are ineffective, the key cannot be removed in "Interlocking Off" position.

The key-operated switches are always included in the check prior to command output; they don't have to be configured (but they can be configured if required).

Because of the integrated "Interlocking" function, external switchgear interlocking equipment can be dispensed with.

Moreover, the following (configurable) checks are performed prior to a command output:

- Scheduled = Actual, i.e. is the switching equipment already in the correct position?
- Double operation, i.e,. is another command already being processed?
- Single commands, e.g. for earth switch control, can be secured by an extra code.

This is described in more detail in the following paragraphs.

Interlocked/Non-interlocked Switching

The configurable command checks in the SIPROTEC® 4 devices are also called „standard interlocking“. These checks can be activated using DIGSI® (interlocked switching/tagging) or deactivated (non-interlocked).

De-interlocked or non-interlocked switching means that the configured interlock conditions are not tested.

Interlocked switching means that all configured interlocking conditions are checked within the command processing. If a condition is not fulfilled, the command is rejected, marked with a minus sign (e.g. "**CO–**"), and a message to that effect is output.

The following table shows some types of commands and messages. For the device the messages designated with *) are displayed in the event logs, for DIGSI® they appear in spontaneous indications.

Type of Command	Control	Cause	Indication
Control issued	Switching	CO	CO+/–
Manual tagging (positive / negative)	Override	MT	MT+/–
Output blocking, Acquisition blocking	Acquisition blocking	ST	ST+/– *)
Information status command, Output blocking	Output blocking	OB	OB+/– *)
Abort command	Abort	CA	CA+/–

The "plus" appearing in the message is a confirmation of the command execution. The command output has a positive result, as expected. The "minus" is a negative confirmation and means that the result was unexpected. The command was rejected.

Possible command replies and their causes are dealt with in /1/. Figure 2-28 shows the **operational indications** relating to command execution and operation response information for a successful operation of the circuit breaker.

Interlocking checks can be configured individually for all switching devices and markings. Other internal commands such as overriding or abort are not tested, i.e. are executed independently of the interlockings.

```
EVENT LOG
---------------------
19.06.01 11:52:05,625
Q0          CO+ Close

19.06.01 11:52:06,134
Q0          FB+ Close
```

Figure 2-28 Example of an operational indication for switching circuit breaker 52

Standard Interlocking (fixed-programmed)

The standard interlockings contain the following fixed programmed tests for each switching device, which can be individually enabled or disabled using parameters:

- Switching direction check (scheduled = actual): The switching command is rejected, and an error indication is displayed if the circuit breaker is already in the set position. If this check is enabled, then it applies whether switch interlocking is activated or deactivated.

Interlocking (Bay Interlocking)

Logic combinations deposited in the device using CFC are scanned and taken into consideration for interlocked switching. Information to other bays can be processed as well (GOOSE or IRC).

- System interlocking to control centre (only possible with PROFIBUS FMS link to SICAM SAS): For checking the system interlocking a locally issued command to the central unit is instigated with switching authority = local. A switching device that is subject to system interlocking cannot be switched by DIGSI®.
- Blocked by protection: This interlocking option enabled for devices with integrated protection functions has no significance and no effect on the 6MD66x device version.
- Double operation locking: Parallel switchings are mutually interlocked; when a switching is being processed a second one cannot be executed.
- LOCAL switching authority: A switching command from the user interface of the device (command with command source LOCAL) is only allowed if the Key Switch (for devices without key switch via configuration) is set to LOCAL.
- DIGSI switching authority: Switching commands that are issued locally or remotely via DIGSI (command with command source DIGSI) are only allowed if the Key Switch (for devices without key switch via configuration) is set to REMOTE. If a DIGSI-PC communicates with the device, it deposits here its virtual device number (VD). DIGSI must have the same virtual device number (with REMOTE switching authority). Switch commands of the remote control are rejected.
- REMOTE switching authority: A remote control command (command with initiator source REMOTE) is only allowed if the Key Switch (for devices without key switch via configuration) is set to REMOTE.

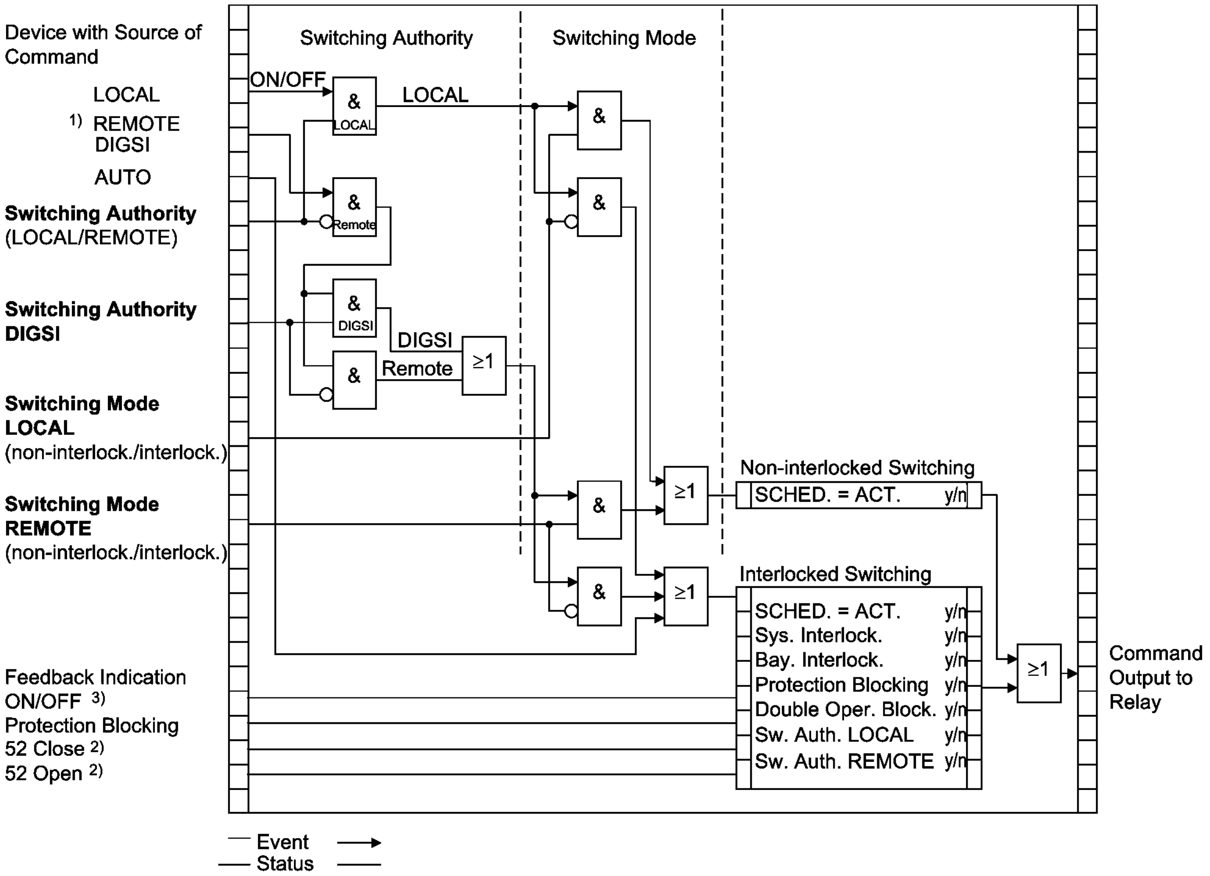


Figure 2-29 Standard interlockings

1) Initiator source REMOTE also includes LOCAL. (LOCAL: Command via control system in the station, REMOTE: Command via telecontrol station to power system management and from power system management to the device)

2) Release from testing of interlocking conditions

3) Not relevant for 6MD66x

For devices with operator panel the display shows the configured interlocking reasons. They are marked by letters explained in the following table.

Table 2-13 Interlocking Commands

Interlocking Commands	Command	Display
Switching authority	L	L
System interlocking	SI	A
Zone Control	Z	Z
SET = ACTUAL (switch direction check)	P	P
Blocked by protection 1)	B 1)	B 1)

1) Not relevant for 6MD66x

The following figure shows all interlocking conditions (which usually appear in the display of the device) for three switchgear items with the relevant abbreviations explained in the previous table. All parameterized interlocking conditions are indicated.

```
Interlocking       01/03
------------------------
Q0 Close/Open S - Z P B
Q1 Close/Open S - Z P B

Q8 Close/Open S - Z P B
```

Figure 2-30 Example of configured interlocking conditions

Switching Authority (for devices with operator panel)

For selection of switching permission the interlock condition „switching authority“ exists for selecting the command source with switching permission. For devices with operator panel, the following switching authority ranges are defined in the following priority sequence:

- LOCAL
- DIGSI®
- REMOTE

The object „Switching Authority“ serves to interlock or enable LOCAL control, but not remote or DIGSI commands. The 6MD66x is equipped with two key switches. The top switch is reserved for the switching authority. The „Local“ position allows local control, whereas the „Remote“ position allows remote control.

The „Switching authority DIGSI“ object is used for interlocking and allows commands to be initiated using DIGSI®. Commands are allowed for both a remote and a local DIGSI® connection. When a (local or remote) DIGSI PC logs on to the device, it enters its Virtual Device Number (VD). The device only accepts commands having that VD (with switching authority = OFF or REMOTE). When the DIGSI PC logs off, the VD is cancelled.

Commands are checked for their source and the device settings, and compared to the information set in the objects „Switching authority“ and „Switching authority DIGSI“.

Configuration:

Switching authority available:	y/n (create appropriate object)
Switching authority DIGSI® available:	y/n (create appropriate object)
Specific object (e.g. switching device):	Switching authority LOCAL (check for local commands: y/n)
Specific object (e.g. switching device):	Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI commands: y/n)

Table 2-14 Interlocking logic

Current Switching Authority Status	Switching authority DIGSI	Command issued with SC[3]=LOCAL	Command issued from SC=LOCAL or REMOTE	Command with SC=DIGSI
LOCAL (ON)	Not registered	not allocated	Interlocked [2] „interlocked because of LOCAL control“	Interlocked „DIGSI not logged on“
LOCAL (ON)	registered	not allocated	Interlocked [2] „interlocked because of LOCAL control“	Interlocked [2] „interlocked because of LOCAL control“
REMOTE (OFF)	Not registered	Interlocked [1]„Interlocked because of REMOTE control “	not allocated	Interlocked „DIGSI not logged on“
REMOTE (OFF)	registered	Interlocked [1]„Interlocked because of DIGSI control “	Interlocked [2] „interlocked because of DIGSI control“	not allocated

[1] Also „allowed“ if: „Switching authority LOCAL (check for local commands): n“

[2] Also „allowed“ if: „Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI commands): n“

[3] VQ = Source of command

SC = Auto SICAM:

Commands that are initiated internally (command processing in the CFC) are not subject to switching authority and are therefore always „allowed“.

Switching Authority (for devices without operator panel)

The dongle cable sets the switching authority of the device to „REMOTE“. The specifications of the previous section apply.

Switching Mode (for devices with operator panel)

The switching mode determines whether selected interlocking conditions will be activated or deactivated at the time of the switching operation.

The following switching modes (local) are defined:

- Local commands (SC=LOCAL)
  - interlocked (normal), or
  - non-interlocked switching.

The 6MD66x is equipped with two key switches. The bottom switch is reserved for the switching mode. The „Normal“ position allows interlocked switching while the „Interlocking OFF“ position allows non-interlocked switching.

The following switching modes (remote) are defined:

- Remote or DIGSI® commands (SC = LOCAL, REMOTE, or DIGSI)
  - interlocked, or
  - non-interlocked switching. Here de-interlocking occurs through a separate de-interlocking job. The position of the key-switch is irrelevant.
  - For commands from CFC (SC = AUTO SICAM), please observe the notes in the DIGSI CFC manual /3/ (block: BOOL after command).

Switching Mode (for devices without operator panel)

The F-cable sets the switching authority of the device to „Normal“. The specifications of the previous section apply.

Interlocks

Interlocks (e.g. via CFC) include the verification that predetermined switchgear position conditions are satisfied to prevent switching errors (e.g. disconnector vs. earth electrode, earth electrode only if no voltage applied) as well as verification of the state of other mechanical interlocking in the switchgear bay (e.g. High Voltage compartment doors).

Interlocks can be bay interlocks (all information is directly available in the bay controller) or system interlocks. In the latter case, the device receives information from adjacent bays through inter-relay communication (IRC) or IEC 61850–GOOSE.

Interlocking conditions can be programmed separately, for each switchgear, for device control OPEN and/or CLOSE.

The enable information with the data "switchgear is interlocked (OFF/NV/FLT) or enabled (ON)" can be set up,

- directly, using a single point or double point indication, key-switch, or internal indication (marking), or
- by means of a control logic via CFC.

The current status is queried for a control command and updated cyclically. The assignment is done via "Release object OPEN/CLOSE".

System Interlocking

System interlocking is checked in the control centre. This is only possible with a PROFIBUS FMS link to SICAM SAS.

Double Operation Locking

Parallel switching operations are interlocked. On arrival of a command all command objects are tested which are also subject to the blockage, as to whether a command is current for them. While the command is being executed, the block is in turn active for all other commands.

Device Status Check (setpoint = actual)

For switching commands, a check takes place whether the selected switching device is already in the scheduled/desired position (scheduled/actual comparison). This means, if a circuit breaker is already in the CLOSED position and an attempt is made to issue a closing command, the command will be refused, with the operating message "scheduled condition equals actual condition". Switching devices in the fault position are not interlocked by software means.

De-interlockings

De-interlockings can be bypassed to perform switching operations. This is either done internally by adding a bypass code to the command, or globally by so-called switching modes.

- SC=LOCAL
  - The switching modes "interlocked (latched)" or "non-interlocked (unlatched)" can be set via the key switch. The position "Interlocking OFF" corresponds to non-interlocked switching and serves the special purpose of unlocking the standard interlocks.
- REMOTE and DIGSI®
  - Commands issued by SICAM® or DIGSI® are unlocked via global switching mode REMOTE. For de-interlocking a separate job must be issued. De-interlocking is done in each case only for one switch action and only for commands of the same origin source.
  - Job: command to object "Switching mode REMOTE", ON
  - Job: switching command to "switching device"
- Derived command via CFC (automatic command, SC=Auto SICAM):
  - Behaviour configured in the CFC block ("BOOL to command").

2.8.2 Information overview

No.	Information	Type of Information	Explanation
—	KeySwitch1	DP	Key-operated switch (local/remote)
—	Cntrl Auth	IE	Control authority (derived from the position of the top key-operated switch. Meaning: local/remote toggling of switching mode.)
—	KeySwitch2	DP	Key-operated switch (unlocked/locked)
—	Mode LOCAL	IE	Switching mode Local (set by the device if the bottom key-operated switch is set to unlocked. Meaning: Unlocked local switching is possible; remote commands are still executed locked.)
—	Mode REMOTE	IE	Switching mode Remote (Set by the system interface. If this flag has been set, remote switching commands to the bay controller are carried out unlocked. Commands initiated locally on the bay controller remain locked. Corresponds to the function S1-Fern of the 8TK switchgear interlocking system.)

2.9 Circuit breaker failure protection (optional)

The circuit breaker failure protection provides rapid back-up fault clearance, in the event that the local circuit breaker fails to respond to a trip command from a protective device.

2.9.1 Function Description

General Remarks on Circuit breaker Failure Protection and Automatic Reclosure

The two functions circuit breaker failure protection (described in this chapter) and automatic reclosure (see Chapter 2.10) are available with software version V4.6.

Integrating these protection functions into a bay controller is useful for applications in which two circuit breakers are assigned to one feeder as it allows to do without extra equipment. Circuit breaker failure protection and automatic reclosure are order options, refer to the Appendix A.1.

An exemplary configuration showing the possible use of CB failure protection and automatic reclosure in the 6MD66x is shown in the figure below. Another possible configuration would be the one-and-one-half circuit breakers method.

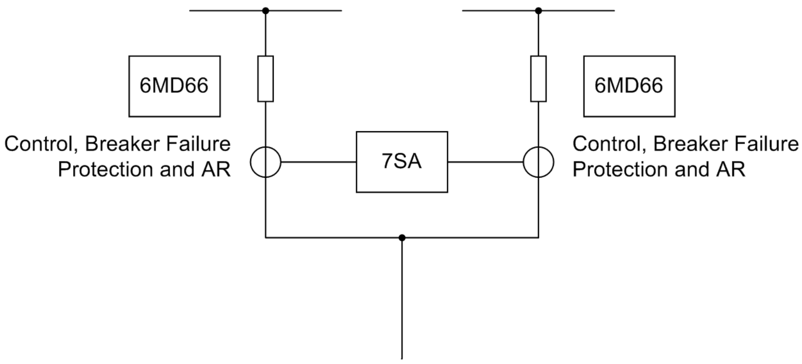


Figure 2-31 Feeder with two circuit breakers, simplified

Although the line protection function, in this example a 7SA distance protection, could provide automatic reclosure for both circuit breakers, this would require a highly complex logic of the CFC for the 7SA. As to breaker failure protection, the distance protection relay would not be able to perform it in this configuration because it works with a summation current. Integrating these two functions into the 6MD66x bay controller therefore allows to do without extra equipment and makes engineering easier.

As a special feature in comparison with pure protection devices, the current measuring inputs of the bay controller are connected with the instrument transformers in the substation, not with the protection transformers. This ensures the high measuring accuracy of 0.5% of the nominal value. However, the instrument transformers are more or less subject to saturation when a fault current passes through them. Measurement of the fault current is therefore not possible. However, detection and switch-off of the fault current is possible for the CB failure protection function. A type 0.5 FS 5 transformer should be used as primary transformer.

In order to simplify external wiring of the device, the 6MD66x bay controllers version V4.6 or higher have new command types which are capable of three-pole control of the protection devices. These commands have the following names in the DIGSI Information catalog:

- BR_D31Three-pole trip, single-pole close
- BR_D33Three-pole trip and three-pole close
- BR_D44Three-pole trip and close with common contact.

The allocation of the trip and close signals to the relay contacts for the new commands in the DIGSI configuration matrix is shown in the figure below.

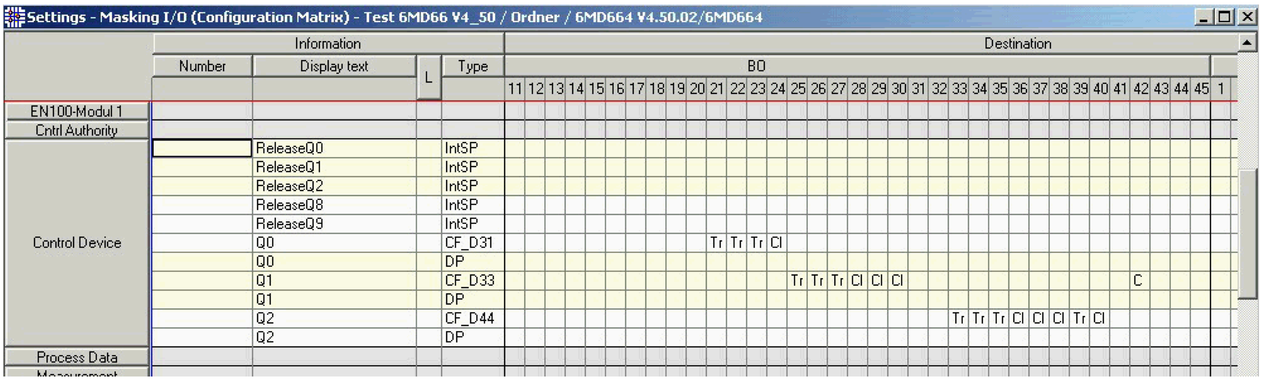


Figure 2-32 Routing of the new command types in the DIGSI matrix

The use one of these command types makes it sufficient to connect the circuit breaker exactly once to the control device. The three-pole control makes it possible for the protective funtion to use the same relays. I.e. the circuit breaker is wired as three-pole relay to the control device and both the protective function (breaker failure protection or AR) and the control function are allocated to the same relays in the configuration matrix. However, the feedbacks are to be allocated, as before, as double-point indications to the command and if required as single-pole ones to the protective function.

General

Whenever, e.g. a short-circuit protection relay of a feeder issues a trip command to the circuit breaker, this is repeated to the breaker failure protection (Figure 2-33). A timer T–BF in the breaker failure protection is started. The timer runs as long as a trip command is present and current continues to flow through the breaker poles.

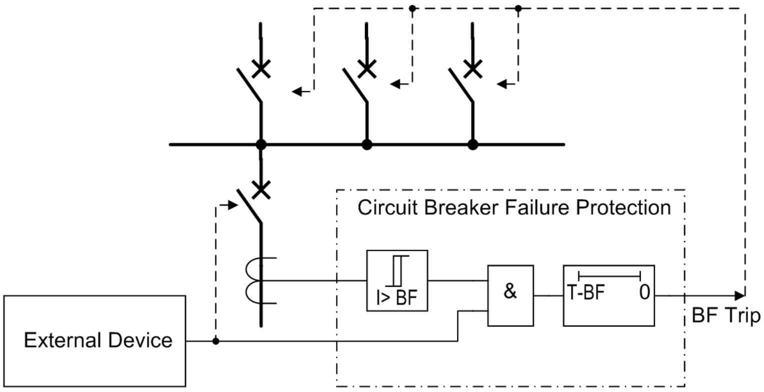


Figure 2-33 Simplified function diagram of circuit breaker failure protection with current flow monitoring

Normally, the breaker will open and interrupt the fault current. The current monitoring stage quickly resets (typical >10 ms) and stops the timer T–BF.

If the trip command is not carried out (breaker failure case), current continues to flow and the timer runs to its set limit. The breaker failure protection then issues a command to trip the back-up breakers and interrupt the fault current.

The reset time of the feeder protection is not relevant because the breaker failure protection itself recognizes the interruption of the current.

For protective functions where the tripping criterion is not dependent on current (e.g. Buchholz protection), current flow is not a reliable criterion for proper operation of the breaker. In such cases, the circuit breaker position can be derived from the auxiliary contacts of the breaker. Therefore, instead of monitoring the current, the condition of the auxiliary contacts is monitored (see Figure 2-34). For this purpose, the outputs from the auxiliary contacts must be fed to binary inputs on the relay (refer also to Section 2.11).

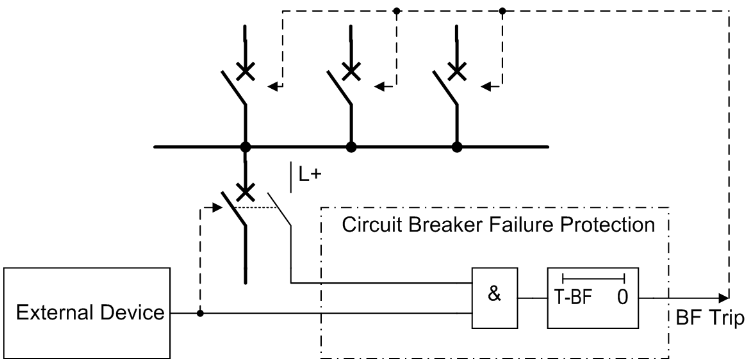


Figure 2-34 Simplified function diagram of circuit breaker failure protection controlled by circuit breaker auxiliary contact

Current flow monitoring

Each of the phase currents and an additional plausibility current (see below) are filtered by numerical filter algorithms so that only the fundamental component is used for further evaluation.

Special measures are taken in order to detect a current interruption. In case of sinusoidal currents the current interruption is detected after approximately 10 ms. With aperiodic DC current components in the fault current and/or in the current transformer secondary circuit after interruption (e.g. current transformers with linearized core), or saturation of the current transformers caused by the DC component in the fault current, it can take one AC cycle before the interruption of the primary current is reliably detected. This is generally the case in the 6MD66x because the device, in order to achieve the required measuring accuracy, is connected to the instrument transformers, and not to the protection transformers.

The detection of a current disconnection stops the delay times after which a trip command is issued. The pickup signal is not reset until disconnection has been reliably detected.

The currents are monitored and compared with the set threshold. Besides the three phase currents, two further current detectors are provided in order to allow a plausibility check (see Figure 2-35).

As plausibility current, the earth current I_E ($3 \cdot I_0$) is preferably used. If the earth current is not available, the device calculates it with the formula:

$$3 \cdot \underline{I}_0 = \underline{I}_{L1} + \underline{I}_{L2} + \underline{I}_{L3}$$

Additionally, the value calculated by 6MD66x of three times the negative sequence current $3 \cdot I_2$ is used for plausibility check. This is calculated according to the equation:

$$3 \cdot \underline{I}_2 = \underline{I}_{L1} + \underline{a}^2 \cdot \underline{I}_{L2} + \underline{a} \cdot \underline{I}_{L3}$$

where

$$\underline{a} = e^{j120°}.$$

These plausibility currents do not have any direct influence on the basic functionality of the breaker failure protection but they allow a plausibility check in that at least two current thresholds must have been exceeded before any of the breaker failure delay times can be started, thus providing high security against false operation.

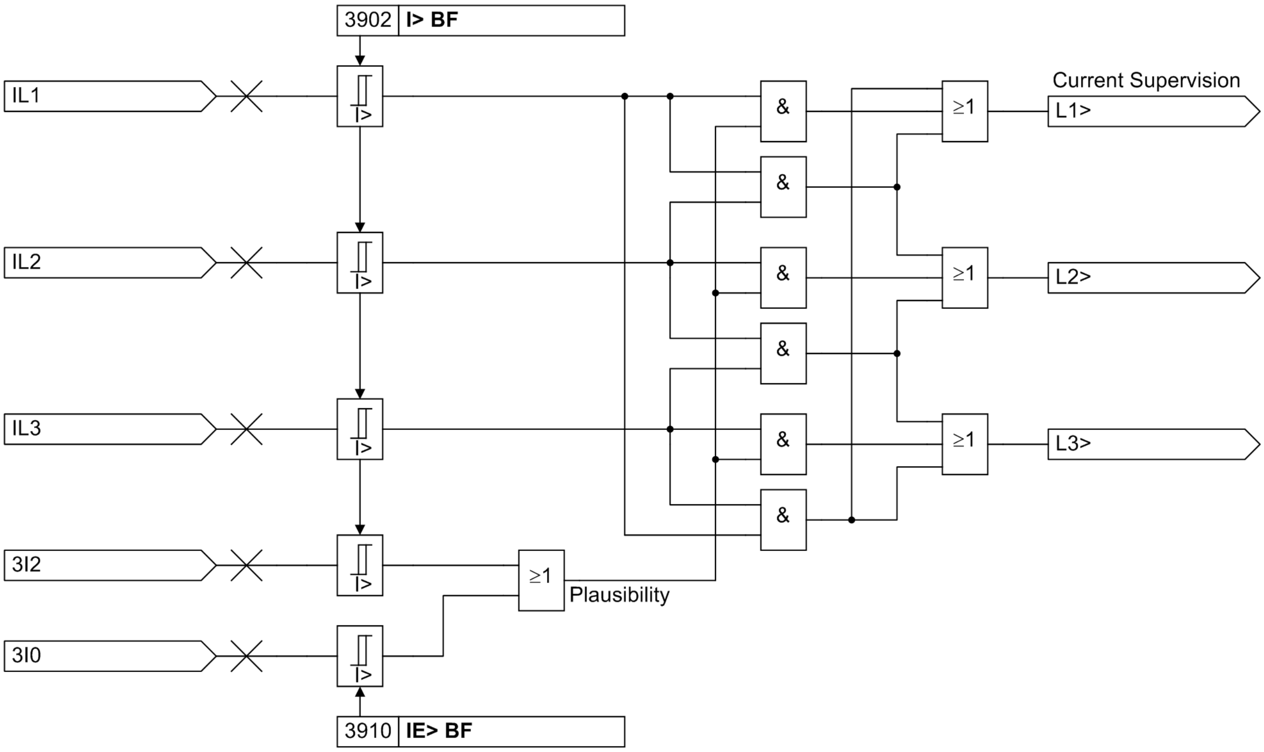


Figure 2-35 Current flow monitoring with plausibility currents $3{\cdot}I_0$ and $3{\cdot}I_2$

The design of the current transformers must ensure at least that even with maximum saturation the secondary current is above the limit threshold of the measuring inputs for at least 3 milliseconds per half-cycle. The limit threshold depends on the board type and can be 1.2 or 1.5 time the nominal current.

Processing of the Circuit Breaker AuxiliaryContacts

The position of the circuit breaker is derived from the central function control of the device (refer also to Section 2.11). Evaluation of the breaker auxiliary contacts is carried out in the breaker failure protective function only when the current flow monitoring **I> BF** has not picked up. Once the current flow criterion has picked up during the trip signal from the feeder protection, the circuit breaker is assumed to be open as soon as the current disappears, even if the associated auxiliary contact does not (yet) indicate that the circuit breaker has opened (see Figure 2-36). This gives preference to the more reliable current criterion and avoids false operation due to a defect, e.g. in the auxiliary contact mechanism or circuit. This interlock feature is provided for each individual phase as well as for three-pole trip.

It is possible to disable the auxiliary contact criterion. If you set the parameter switch **Chk BRK CONTACT** (Figure 2-38 top) to ***NO***, the breaker failure protection can only be started when current flow is detected. The position of the auxiliary contacts is then not evaluated even if the auxiliary contacts are connected to the device.

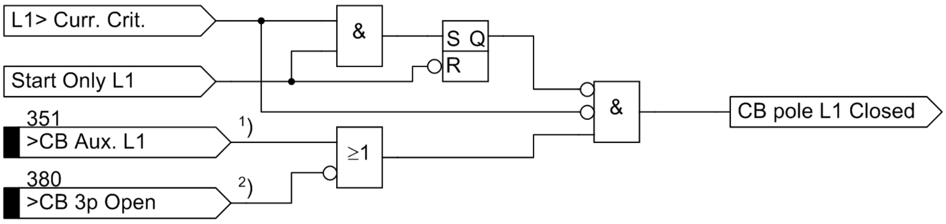


Figure 2-36 Interlock of the auxiliary contact criterion - example for phase L1

1) if phase-segregated auxiliary contacts are available

2) if series-connected NC contacts are available

On the other hand, current flow is not a reliable criterion for proper operation of the circuit breaker for faults which do not cause detectable current flow (e.g. Buchholz protection). Information regarding the position of the circuit breaker auxiliary contacts is required in these cases to check the correct response of the circuit breaker. For this purpose, the binary input „>BF Start w/o I“ No. 1439 is provided (Figure 2-38 left). This input initiates the breaker failure protection even if no current flow is detected.

Common phase initiation

Common phase initiation is used, for example, for lines without automatic reclosure, for lines with only three-pole automatic reclosure, for transformer feeders, or if the busbar protection trips. This is the only available initiation mode if the actual 6MD66x model is able to trip three-pole only.

If the breaker failure protection is intended to be initiated by further external protection devices, it is recommended, for security reasons, to connect two starting criteria to the device. Besides the trip command of the external relay to the binary input „>BF Start 3pole“ No. 1415 it is recommended to connect also the general device pickup to binary input „>BF release“ No. 1432. For Buchholz protection it is recommended that the trip command is connected to the device by two separate wire pairs.

Nevertheless, it is possible to initiate the breaker failure protection in single-channel mode should a separate release criterion not be available. The binary input „>BF release“ (No. 1432) must then not be assigned to any physical input of the device during configuration.

Figure 2-38 shows the operating principle. When the trip signal appears from a protective function and at least one current flow criterion (according to Figure 2-35) is present, the breaker failure protection is initiated and the corresponding delay time(s) is (are) started.

If the current criterion is not fulfilled for any of the phases, the position of the circuit breaker auxiliary contact(s) is queried provided that this is available according to Figure 2-37. If the circuit breaker poles have individual auxiliary contacts, the series connection of the three normally closed (NC) auxiliary contacts is used. The circuit breaker has operated correctly after a three-pole trip command only when none of the phases carries current or when all three NC auxiliary contacts have closed.

Figure 2-37 illustrates how the internal signal "CB pole „L1 closed“ is created (see Figure 2-38 left) if at least one circuit breaker pole is closed.

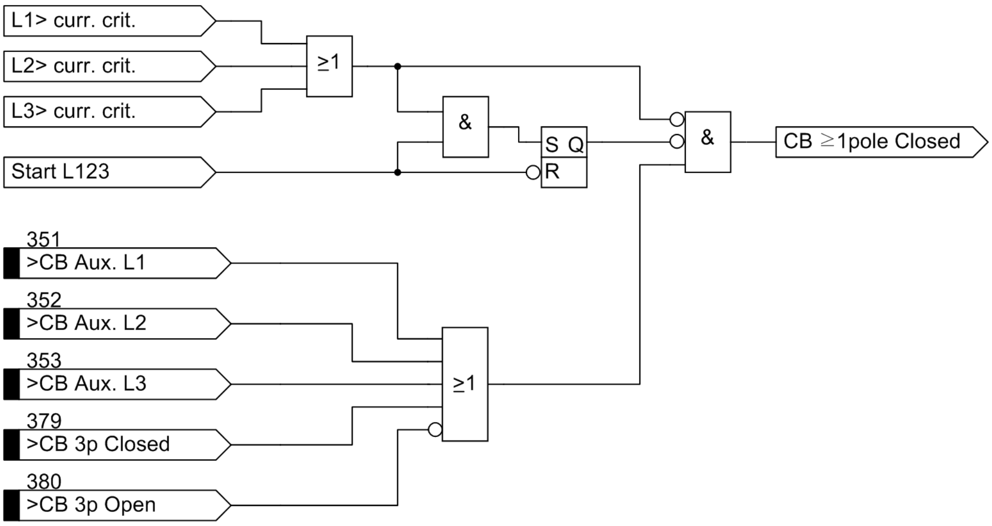


Figure 2-37 Creation of signal "CB ≥ any pole closed"

If all three binary inputs **>LS Pos.Ein Lx** are configured, the device dispenses with a three-pole check of „`>CB 3p Closed`“ and „`>CB 3p Open`“.

If an internal protection function or an external protection device trips without current flow, the breaker failure protection is initiated by the internal input „Start internal w/o I“, if the trip signal comes from the internal voltage protection or frequency protection, or by the external input „`>BF Start w/o I`“. In this case the start signal is maintained until the circuit breaker is reported to be open by the auxiliary contact criterion.

Initiation can be blocked via the binary input „`>BLOCK BkrFail`“ (e.g. during test of the feeder protection relay).

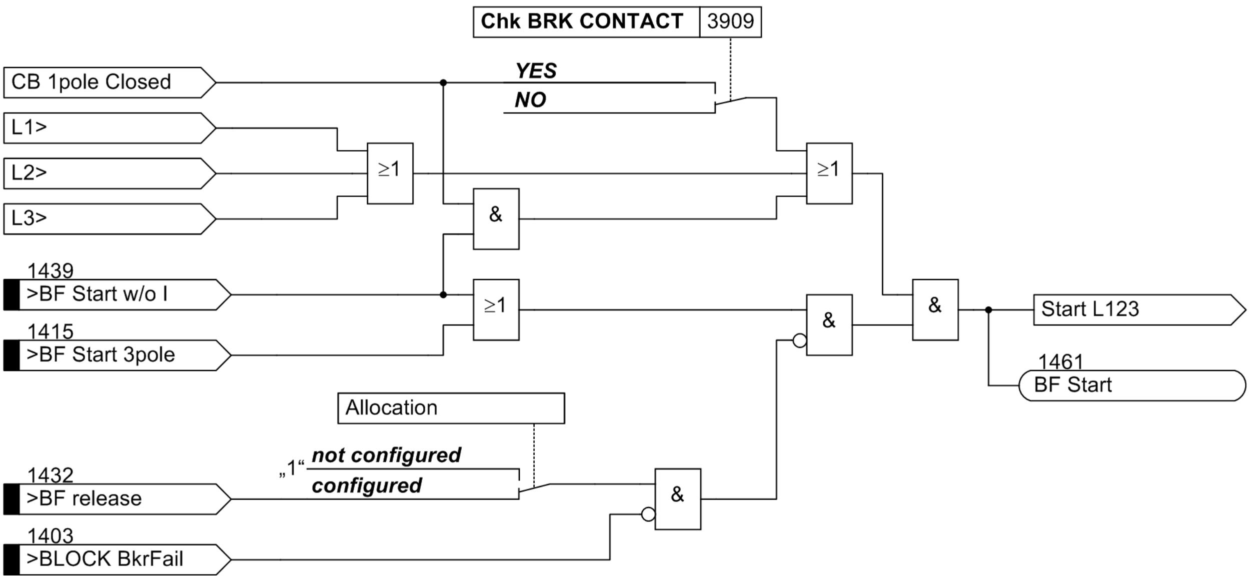


Figure 2-38 Breaker failure protection with common phase initiation

Phase segregated initiation

Phase segregated initiation of the breaker failure protection is necessary if the circuit breaker poles can be operated individually, e.g. if single-pole automatic reclosure is used. This is possible if the device is able to trip single-pole.

If the breaker failure protection is intended to be initiated by further external protection devices, it is recommended, for security reasons, to connect two binary inputs to the device. Besides the three trip commands of the external relay to the binary input „`>BF Start L1`“, „`>BF Start L2`“ and „`>BF Start L3`“ it is recommended to connect also, for example, the general device pickup to binary input „`>BF release`“. Figure 2-39 shows this connection.

Nevertheless, it is possible to initiate the breaker failure protection in single-channel mode should a separate release criterion not be available. The binary input „`>BF release`“ must then not be assigned to any physical input of the device during configuration.

If the external protection device does not provide a general fault detection signal, a general trip signal can be used instead. Alternatively, the parallel connection of a separate set of trip contacts can produce such a release signal as shown in Figure 2-40.

The starting condition logic for the delay times is shown in Figure 2-41. In principle, it is designed similar to that for the common phase initiation, but, individually for each of the three phases. Thus, current flow and initiation conditions are processed for each phase. In case of single-pole interruption before an automatic reclose cycle, current disappearance is reliably monitored for the tripped breaker pole only.

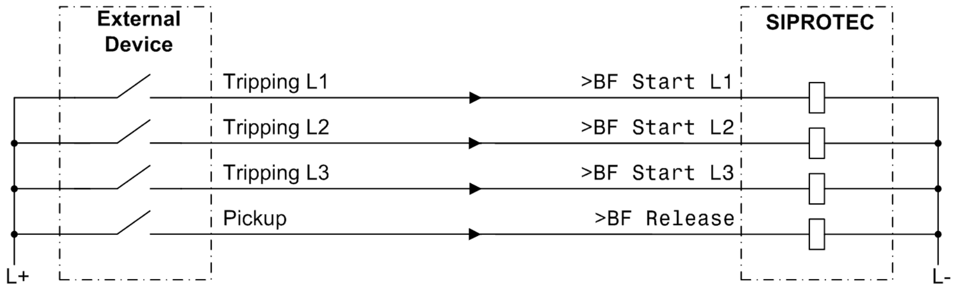


Figure 2-39 Breaker failure protection with phase segregated initiation — example for initiation by an external protection device with release by a fault detection signal

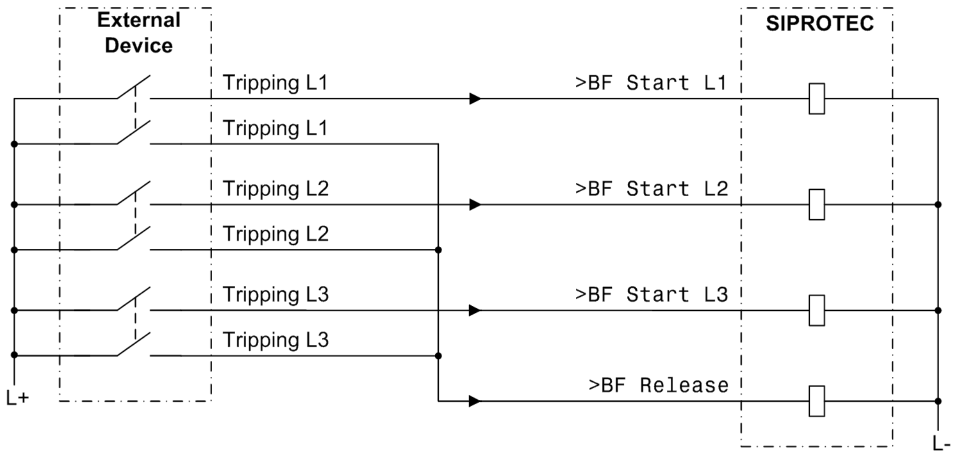


Figure 2-40 Breaker failure protection with phase segregated initiation — example for initiation by an external protection device with release by a separate set of trip contacts

The starting condition logic for the delay times is shown in Figure 2-36. In principle, it is designed similar to that for the common phase initiation, but, individually for each of the three phases. Thus, current flow and initiation conditions are processed for each phase. In case of single-pole interruption before an automatic reclose cycle, current disappearance is reliably monitored for the tripped breaker pole only.

The auxiliary contact criterion is also processed for each individual breaker pole. If however the breaker auxiliary contacts are not available for each individual breaker pole, then a single-pole trip command is assumed to be executed only once the series connection of the normally open (NO) auxiliary contacts is interrupted. This information is provided to the breaker failure protection by the central function control of the device (refer to Section 2.11).

The three-phase starting signal „Start L123“ is generated if trip signals appear in more than one pole (regardless from which protection function). Phase segregated initiation is then blocked. The input "BF Start w/o I" (e.g. from Buchholz protection) operates in three-phase mode as well. The function is the same as with common phase initiation.

The additional release-signal „`>BF release`“ (if assigned to a binary input) affects all initiation conditions. Initiation can be blocked via the binary input „`>BLOCK BkrFail`“ (e.g. during test of the feeder protection relay).

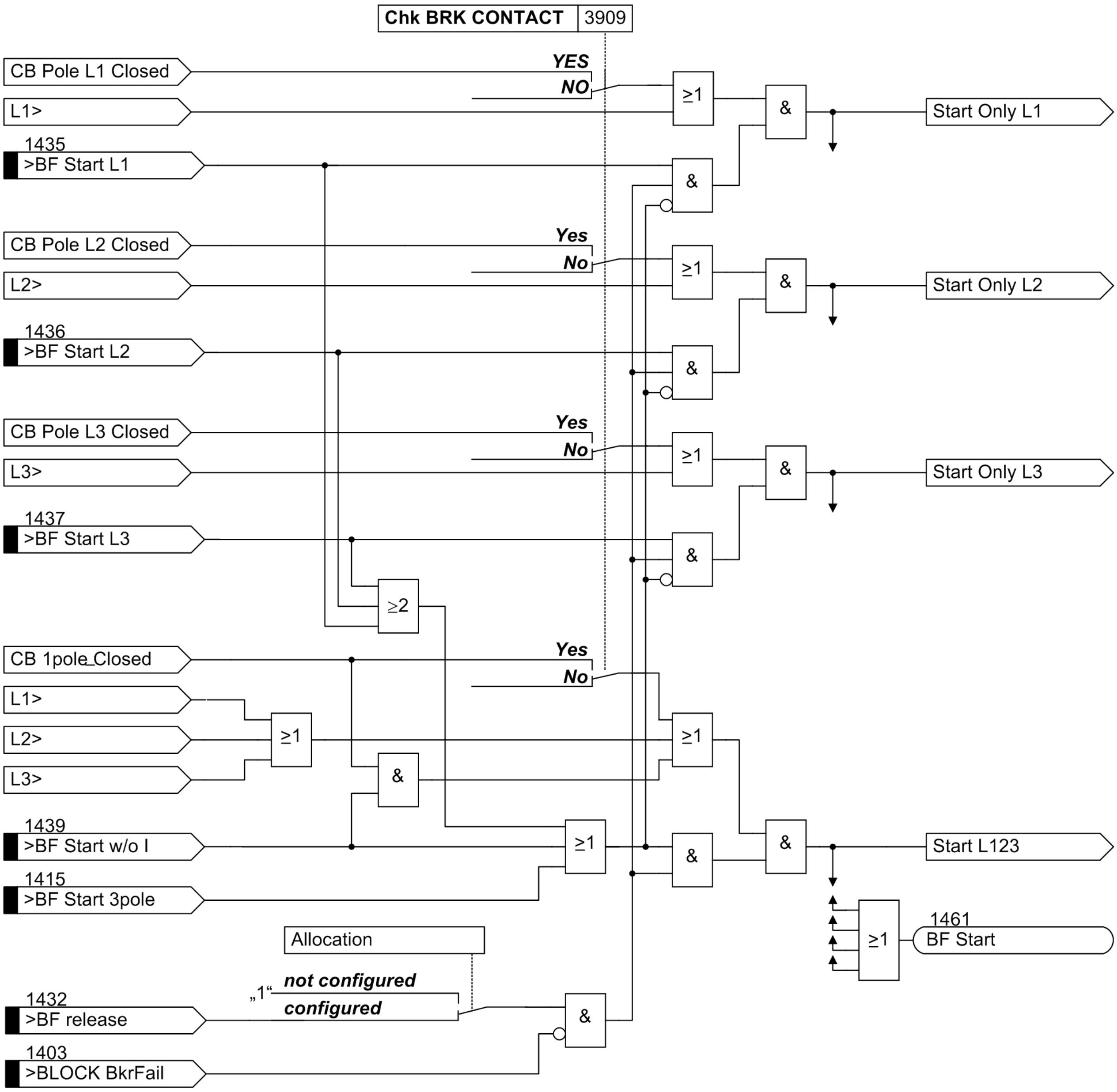


Figure 2-41 Initiation conditions with single-pole trip command

Delay Times

When the initiate conditions are fulfilled, the associated timers are started. The circuit breaker pole(s) must open before the associated time has elapsed.

Different delay timers are provided for operation after common phase initiation and phase segregated initiation. A third time stage can be used for two-stage breaker failure protection.

With single-stage breaker failure protection, the trip command is routed to the adjacent circuit breakers should the local feeder breaker fail (refer to Figure 2-33 or 2-34). The adjacent circuit breakers are all those which must trip in order to interrupt the fault current, i.e. the breakers which feed the bus-bar or the bus-bar section to which the feeder under consideration is connected. The possible initiation conditions for the breaker failure protection are those discussed above. Depending on the application of the feeder protection, common phase or phase segregated initiation conditions may occur. Tripping by the breaker failure protection is always three-pole.

The simplest solution is to start the delay timer **T2** (Figure 2-42). The phase-segregated initiation signals are omitted if the feeder protection always trips three-pole or if the circuit breaker is not capable of single-pole tripping.

If different delay times are required after a single-pole trip or three-pole trip it is possible to use the timer stages **T1-1pole** and **T1-3pole** according to Figure 2-43.

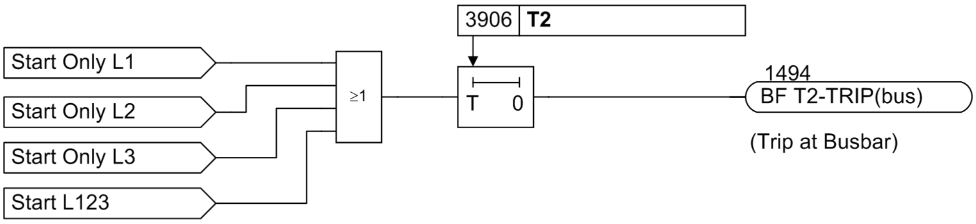


Figure 2-42 Single-stage breaker failure protection with common phase initiation

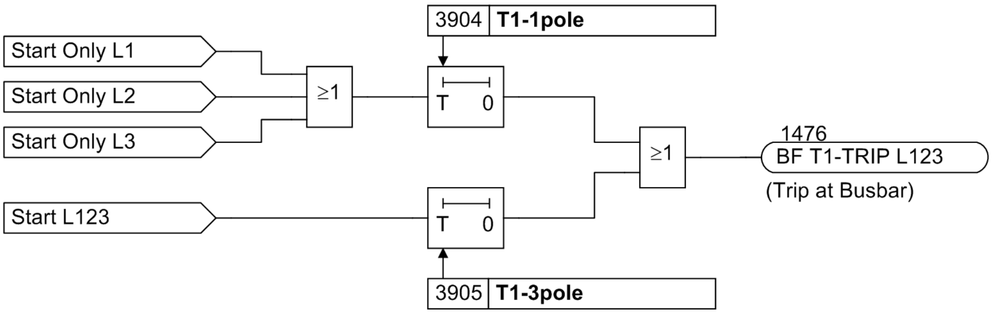


Figure 2-43 Single-stage breaker failure protection with different delay timers

With two-stage breaker failure protection, the trip command of the feeder protection is usually repeated, after a first time stage, to the feeder circuit breaker, often via a second trip coil or set of trip coils, if the breaker has not responded to the original trip command. A second time stage monitors the response to this repeated trip command and trips the breakers of the relevant bus-bar section, if the fault has not yet been cleared after this second time.

For the first time stage, a different time delay **T1-1pole** can be selected for a single-pole trip than for a three-pole trip by the feeder protection. Additionally, you can select (parameter **1p-RETRIP (T1)**) whether this repeated trip should be single-pole or three-pole.

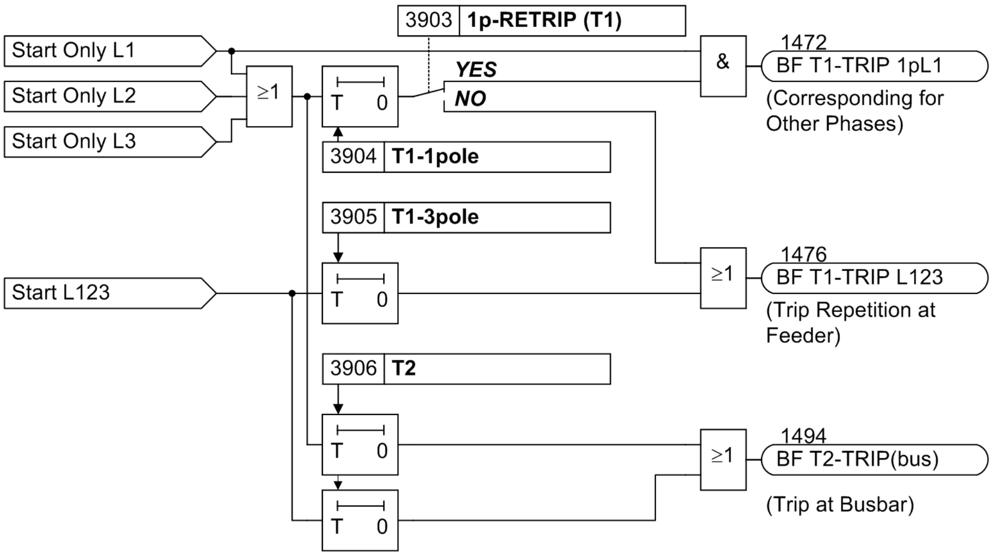


Figure 2-44 Two-stage breaker failure protection with phase segregated initiation

Circuit Breaker not Operational

There may be cases when it is already obvious that the circuit breaker associated with a feeder protection relay cannot clear a fault, e.g. when the tripping voltage or the tripping energy is not available.

In such a case it is not necessary to wait for the response of the feeder circuit breaker. If provision has been made for the detection of such a condition (e.g. control voltage monitor or air pressure monitor), the monitor alarm signal can be fed to the binary input „`>CB faulty`“ of the 6MD66x. On occurrence of this alarm and a trip command by the feeder protection, a separate timer **`T3-BkrDefective`**, which is normally set to 0, is started (Figure 2-45). Thus, the adjacent circuit breakers (bus-bar) are tripped immediately in case the feeder circuit breaker is not operational.

With Bkr Defective you can set which of the regular time delays T1 and T2 of the breaker failure protection, if any, are to be used in the case of a circuit breaker malfunction.

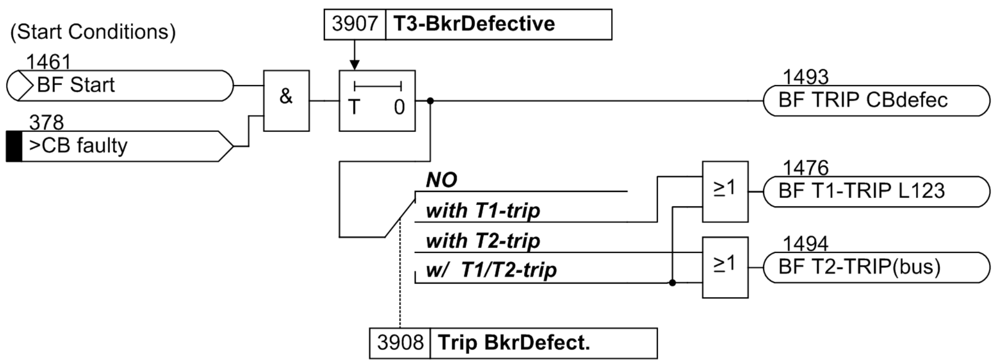


Figure 2-45 Circuit breaker faulty

Transfer trip to the remote end circuit breaker

The device has the facility to provide an additional intertrip signal to the circuit breaker at the remote line end in the event that the local feeder circuit breaker fails. For this, a suitable protection signal transmission link is required (e.g. via communication cable, power line carrier transmission, radio transmission, or optical fibre transmission). With devices using digital transmission via protection interface, the remote commands can be applied.

To perform this intertrip, the desired command — usually the trip command which is intended to trip the adjacent breakers — is assigned to a binary output of the device. The contact of this output triggers the transmission device. When using digital signal transmission the command is connected to a remote command via the user-defined logic (CFC).

End Fault Protection

An end fault is defined here as a short–circuit which has occurred at the end of a line or protected object, between the circuit breaker and the current transformer set.

This situation is shown in Figure 2-46. The fault is located — as seen from the current transformers (= measurement location) — on the bus-bar side, thus, it will not be regarded by the feeder protection relay as a feeder fault. It can only be detected by either a reverse stage of the feeder protection or by a busbar protection. Nevertheless, a trip command given to the feeder circuit breaker cannot clear the fault since the opposite end continues to feed the fault. Thus, the fault current does not stop flowing even though the feeder circuit breaker has properly responded to the trip command.

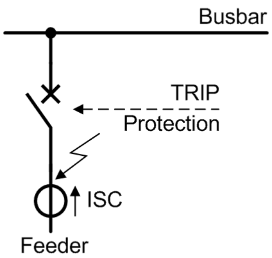


Figure 2-46 End fault between circuit breaker and current transformers

The end fault protection has the task to recognize this situation and to transmit a trip signal to the remote end(s) of the protected object to clear the fault. For this purpose, the output command „`BF EndFlt TRIP`“ is available to trigger a signal transmission device (e.g. power line carrier, radio wave, or optical fibre) — if applicable, together with other commands that need to be transferred or (when using digital signal transmission) as command via the protection interface.

The end fault is recognized when the current continues flowing although the circuit breaker auxiliary contacts indicate that the breaker is open. An additional criterion is the presence of any breaker failure protection initiate signal. Figure 2-47 illustrates the functional principle. If the breaker failure protection is initiated and current flow is detected (current criteria „L*>“ according to Figure 2-35), but no circuit breaker pole is closed (auxiliary contact criterion „any pole closed“), then the timer **`T-EndFault`** is started. At the end of this time an intertrip signal is transmitted to the opposite end(s) of the protected object.

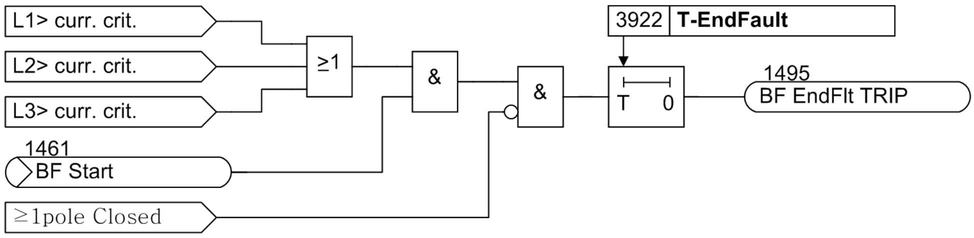


Figure 2-47 Operation scheme of end fault protection

Pole Discrepancy Supervision

The pole discrepancy supervision has the task to detect discrepancies in the position of the three circuit breaker poles. Under steady-state operating conditions, either all three poles of the breaker must be closed, or all three poles must be open. Discrepancy is permitted only for a short time interval during a single-pole automatic reclose cycle.

The scheme functionality is shown in Figure 2-48. The signals which are processed here are the same as those used for the breaker failure protection. The pole discrepancy condition is established when at least one pole is closed („ ≥ one pole closed") and at the same time not all three poles are closed („ ≥ one pole open").

Additionally, the current criteria (from Figure 2-35) are processed. Pole discrepancy can only be detected when current is not flowing through all three poles (<3), i.e. through only one or two poles. When current is flowing through all three poles, all three poles must be closed even if the breaker auxiliary contacts indicate a different status.

If pole discrepancy of the breaker poles is detected, this is indicated in each phase by a „fault detection signal". This signal identifies the pole which was open before the trip command of the pole discrepancy supervision occurred.

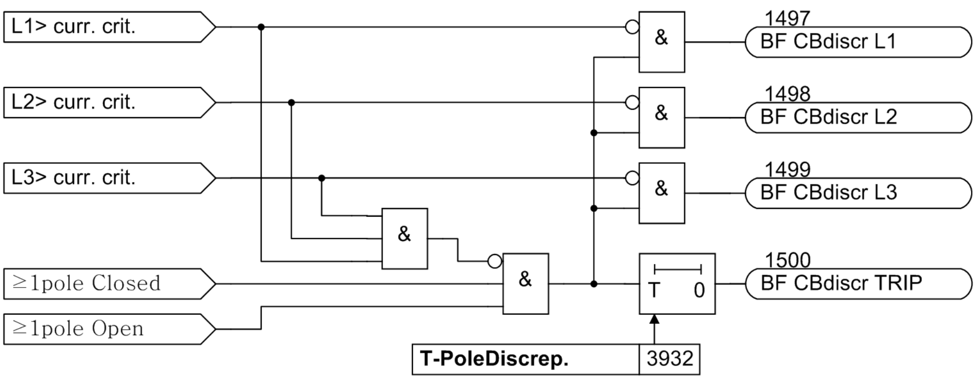


Figure 2-48 Function diagram of pole discrepancy supervision

Flash-Over Protection (FOP)

When the circuit breaker is open, the flashover protection detects a loss of insulation in the circuit breaker. To do so, the circuit breaker auxiliary contacts, the three phase currents, the three phase voltages and the circuit breaker switching commands are all monitored.

Flashover can occur if:

- The insulation medium in the circuit breaker fails.
- The voltage difference at the circuit breaker exceeds its specified insulation voltage.

The flashover protection generates two indications/commands:

- „Flashover suspected“: Allows to repeat the trip command to the breaker in order to switch selectively the circuit breaker concerned, e.g. in the case of a breaker auxiliary contact failure.
- „Breaker failure FOP“: This command opens the higher-level circuit breakers and the remote end circuit breakers, as in conventional breaker failure protection.

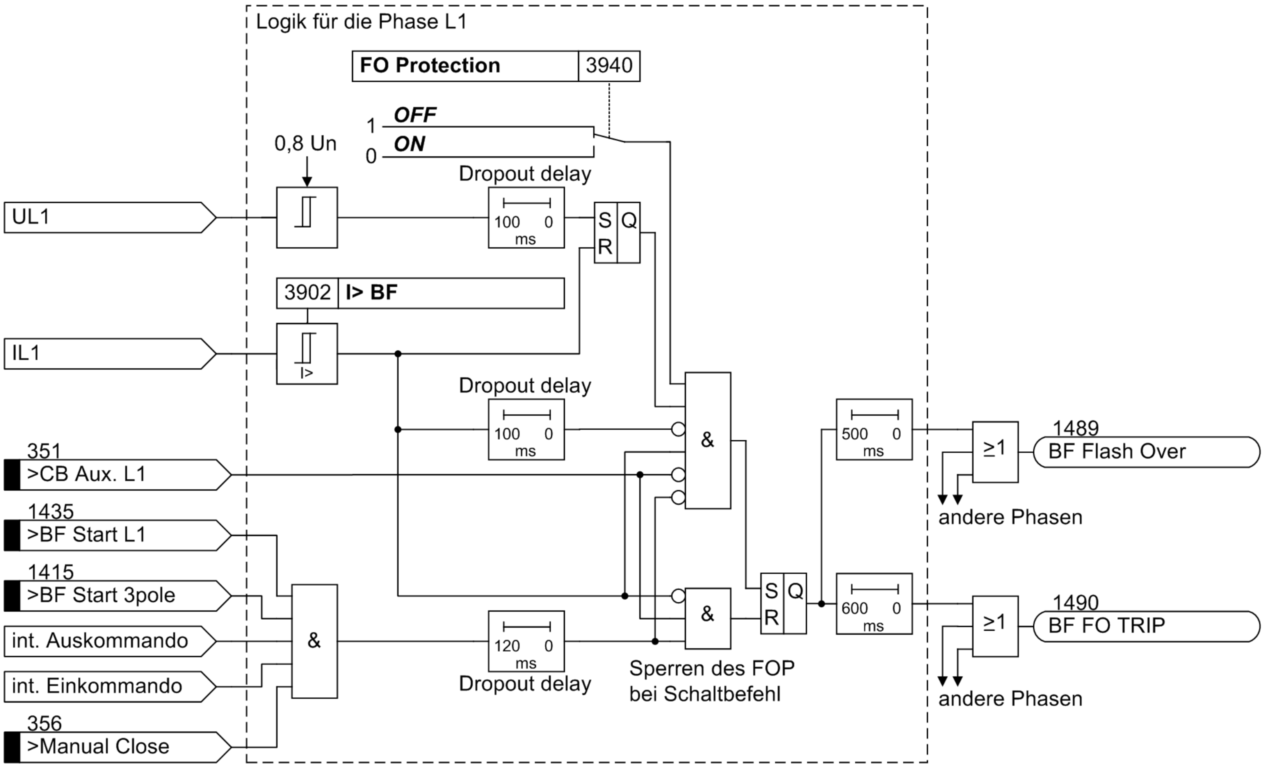


Figure 2-49 Operation scheme of the flashover protection

The phase-to-earth voltage is monitored to ensure that the flashover protection picks up only if at least 80 per cent of the nominal voltage are or were available for up to 100 ms prior to current measurement. If the current exceeds the set threshold **I> BF** (set in address 3902), the current measurement detects a breaker failure. The auxiliary contact signals of the individual breaker poles **>LS Pos.Ein Lx** indicate that the respective breaker pole is open. Since the auxiliary contacts are of decisive importance for the operation of the flashover protection, this protection can only pick up if **>LS Pos.Ein Lx** is also allocated to binary inputs.

In order to avoid spurious pickup of the flashover protection when switching the circuit breaker, the switching commands are also registered and used to block the flashover protection. These include:

- The binary inputs „>BF Start L1“, „>BF Start L2“ and „>BF Start L3“ (address 1435,1436 and 1437) for the phases. if this binary input signal is active, an external protection device opens the associated breaker pole.
- Binary input „>BF Start 3pole“. if this binary input signal is active, an external protection device opens all three breaker poles.
- The binary signal >ManClose, if the circuit breaker is closed manually.
- The internal commands „AR CLOSE command“ or „AR forced three-pole trip“, generated by the 6MD66x's automatic reclosure function .

CT Allocation

The allocation of the current transformers to the phase currents required for the breaker failure protection function is checked (**MVChn Ix**). If not all three current transformers have a phase current allocated to it, the plausibility check detects an error and outputs an alarm to that effect. If the flashover protection (**FO Protection** in address 3940) is active, the plausibility check for transformer allocation comprises the voltage transformers as well (**MVChn Ux**).

This function is only effective if it is switched on, not blocked, and the transformer allocation is OK. This state is shown by the indication **BF effective**.

The parameter **3911 Plausib. check** is used to switch the plausibility check for transformer allocation in special cases, e.g. if only single-pole breaker failure protection is required for protecting a reactor.

Connection Examples

Unlike SIPROTEC protection devices, where the allocation of the measuring transducers to the measured quantities is always fixed, the measured quantities in the 6MD66x can be freely allocated to the individual function blocks. Allocation is performed by linking in the DIGSI configuration matrix a column (for the transformer) with a line (for the currents).

Connection examples and a sample configuration for the measuring inputs, trip commands and auxiliary contacts is provided in the Appendix.

2.9.2 Setting Notes

General

The breaker failure protection and its ancillary functions (end fault protection, pole discrepancy supervision and flashover protection) can only operate if they were configured ***Enabled*** during configuration of the scope of functions (address 139 **BREAKER FAILURE**).

Circuit Breaker Failure Protection

The breaker failure protection is switched ***ON*** or ***OFF*** at address 3901 **FCT BreakerFail**.

The current threshold **I> BF** (address 3902) should be selected such that the protection will operate with the smallest expected short-circuit current. A setting of 10 % below the minimum fault current for which breaker failure protection must operate is recommended. On the other hand, the value should not be set lower than necessary.

If the breaker failure is configured with zero sequence current threshold (address 139 =), the pickup threshold for the zero sequence current **3I0> BF** (address 3912) can be set independently of **I> BF**.

Normally, the breaker failure protection evaluates the current flow criterion as well as the position of the breaker auxiliary contact(s). If the auxiliary contact(s) status is not available in the device, this criterion cannot be processed. In this case, set address 3909 **Chk BRK CONTACT** to ***NO***.

Two-stage Breaker Failure Protection

With two-stage operation, the trip command is repeated after a time delay T1 to the local feeder breaker, normally to a different set of trip coils of this breaker. A choice can be made whether this trip repetition shall be single-pole or three-pole if the initial trip of the external protection device was single-pole (provided single-pole trip is possible). This choice is made in parameter **1p-RETRIP (T1)**. Set this parameter to ***YES*** if you wish single-pole trip for the first stage, otherwise to ***NO***.

If the breaker does not respond to this trip repetition, the adjacent circuit breakers are tripped after T2, i.e. the circuit breakers of the busbar or of the concerned busbar section and, if necessary, also the circuit breaker at the remote end unless the fault has been cleared.

Separate delay times can be set

- for single- or three-pole trip repetition to the local feeder circuit breaker after a **1**-pole trip of the feeder protection **T1-1pole** at address 3904,
- for three-pole trip repetition to the local feeder circuit breaker after **3**-pole trip of the feeder protection **T1-3pole** (address 3905),
- for trip of the adjacent circuit breakers (busbar zone and remote end if applicable) **T2** at address 3906.

The delay times are determined from the maximum operating time of the feeder circuit breaker, the reset time of the current detectors of the breaker failure protection, plus a safety margin which allows for any tolerance of the delay timers. The time sequence is illustrated in Figure 2-50. The dropout time for sinusoidal currents is ≤ 15 ms. If current transformer saturation is anticipated, the time should be set to 25 ms.

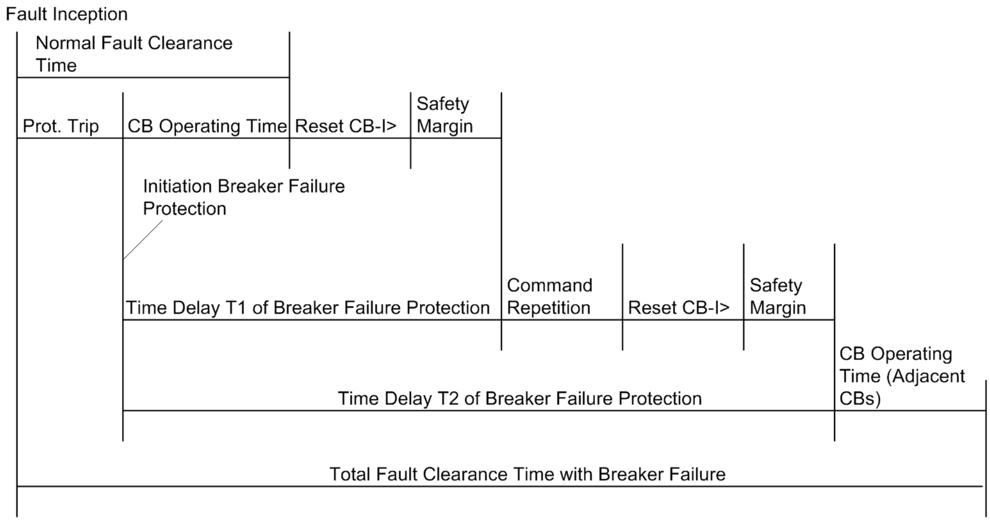


Figure 2-50 Time sequence example for normal clearance of a fault, and with circuit breaker failure, using two-stage breaker failure protection

Single-stage Breaker Failure Protection

With single-stage operation, the adjacent circuit breakers (i.e. the breakers of the busbar zone and, if applicable, the breaker at the remote end) are tripped after a delay time **T2** (address 3906) following initiation, should the fault not have been cleared within this time.

The timers **T1-1pole** (address 3904) and **T1-3pole** (address 3905) are then set to ∞ since they are not needed.

However, you may use the T1-timers for single-stage protection if you wish to utilize the facility of setting different delay times after single-pole trip and three-pole trip of the feeder protection. In this case set **T1-1pole** (address 3904) and **T1-3pole** (address 3905) separately, but address 3903 **1p-RETRIP (T1)** to ***NO***, to avoid a single-pole trip to the busbar. Set **T2** (address 3906) to ∞ or equal to **T1-3pole** (address 3905). Be sure that the correct trip commands are assigned to the desired trip relay(s).

The delay times are determined from the maximum operating time of the feeder circuit breaker, the reset time of the current detectors of the breaker failure protection, plus a safety margin which allows for any tolerance of the delay timers. The time sequence is illustrated in Figure 2-51. The dropout time for sinusoidal currents is ≤ 15 ms. If current transformer saturation is anticipated, the time should be set to 25 ms.

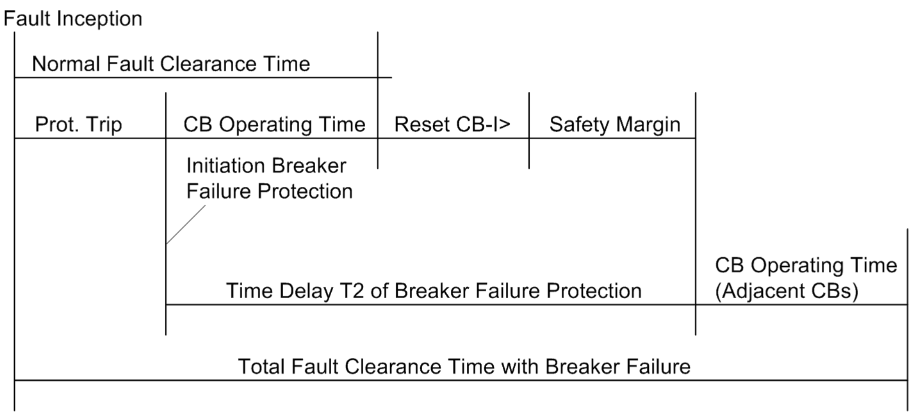


Figure 2-51 Time sequence example for normal clearance of a fault, and with circuit breaker failure, using single-stage breaker failure protection

Circuit Breaker not Operational

If the circuit breaker associated with the feeder is not operational (e.g. control voltage failure or air pressure failure), it is apparent that the local breaker cannot clear the fault. If the relay is informed about this disturbance (via the binary input „`>CB faulty`“), the adjacent circuit breakers (busbar and remote end if applicable) are tripped after the time **`T3-BkrDefective`** (address 3907) which is usually set to **`0`**.

Address 3908 **`Trip BkrDefect.`** determines to which output the trip command is routed in the event that the breaker is not operational when a feeder protection trip occurs. Select that output which is used to trip the adjacent breakers (bus-bar trip).

End Fault Protection

The end fault protection can be switched separately ***`ON`*** or ***`OFF`*** in address 3921 **`End Flt. stage`**. An end fault is a short-circuit between the circuit breaker and the current transformer set of the feeder. The end fault protection presumes that the device is informed about the circuit breaker position via breaker auxiliary contacts connected to binary inputs.

If, during an end fault, the circuit breaker is tripped by a reverse stage of the feeder protection or by the bus-bar protection (the fault is a bus-bar fault as determined from the location of the current transformers), the fault current will continue to flow, because the fault is fed from the remote end of the feeder circuit.

The time **`T-EndFault`** (address 3922) is started when, during the time of pickup condition of the feeder protection, the circuit breaker auxiliary contacts indicate open poles and, at the same time, current flow is still detected (address 3902). The trip command of the end fault protection is intended for the transmission of an intertrip signal to the remote end circuit breaker.

Thus, the delay time must be set such that it can bridge out short transient apparent stub fault conditions which may occur during switching of the breaker.

Pole Discrepancy Supervision

The pole discrepancy supervision can be switched ***`ON`*** or ***`OFF`*** independently at address 3931 **`PoleDiscrepancy`**. It is only useful if the breaker poles can be operated individually. It avoids that only one or two poles of the local breaker are open during steady state. It has to be provided that either the auxiliary contacts of each pole or the series connection of the NO auxiliary contacts and the series connection of the NC auxiliary contacts are connected to the device's binary inputs. If these conditions are not fulfilled, switch address 3931 ***`OFF`***.

The delay time **`T-PoleDiscrep.`** (address 3932) determines how long a breaker pole discrepancy condition of the feeder circuit breaker, i.e. only one or two poles open, may be present before the pole discrepancy supervision issues a three-pole trip command. This time must clearly be longer than the duration of a single-pole automatic reclose cycle. The time should be less than the permissible duration of an unbalanced load condition which is caused by the unsymmetrical position of the circuit breaker poles. Conventional values are 2 s to 5 s.

2.9.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
3901	FCT BreakerFail	ON OFF	OFF	Breaker Failure Protection is
3902	I> BF	0.05 .. 1.20 A	0.10 A	Pick-up threshold I>
3903	1p-RETRIP (T1)	NO YES	YES	1pole retrip with stage T1 (local trip)
3904	T1-1pole	0.00 .. 30.00 sec; ∞	0.00 sec	T1, Delay after 1pole start (local trip)
3905	T1-3pole	0.00 .. 30.00 sec; ∞	0.00 sec	T1, Delay after 3pole start (local trip)
3906	T2	0.00 .. 30.00 sec; ∞	0.15 sec	T2, Delay of 2nd stage (busbar trip)
3907	T3-BkrDefective	0.00 .. 30.00 sec; ∞	0.00 sec	T3, Delay for start with defective bkr.
3908	Trip BkrDefect.	NO with T1-trip with T2-trip w/ T1/T2-trip	NO	Trip output selection with defective bkr
3909	Chk BRK CONTACT	NO YES	YES	Check Breaker contacts
3911	Plausib. check	YES NO	YES	plausibility check transformer masking
3912	3I0> BF	0.05 .. 1.20 A	0.10 A	Pick-up threshold 3I0>
3921	End Flt. stage	ON OFF	OFF	End fault stage is
3922	T-EndFault	0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay of end fault stage
3931	PoleDiscrepancy	ON OFF	OFF	Pole Discrepancy supervision
3932	T-PoleDiscrep.	0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay with pole discrepancy
3940	FO Protection	ON OFF	OFF	Flash Over Protection

2.9.4 Information List

No.	Information	Type of Information	Comments
1401	>BF on	SP	>BF: Switch on breaker fail protection
1402	>BF off	SP	>BF: Switch off breaker fail protection
1403	>BLOCK BkrFail	SP	>BLOCK Breaker failure
1415	>BF Start 3pole	SP	>BF: External start 3pole
1432	>BF release	SP	>BF: External release
1435	>BF Start L1	SP	>BF: External start L1
1436	>BF Start L2	SP	>BF: External start L2
1437	>BF Start L3	SP	>BF: External start L3
1439	>BF Start w/o I	SP	>BF: External start 3pole (w/o current)
1440	BkrFailON/offBI	IntSP	Breaker failure prot. ON/OFF via BI
1451	BkrFail OFF	OUT	Breaker failure is switched OFF
1452	BkrFail BLOCK	OUT	Breaker failure is BLOCKED
1453	BkrFail ACTIVE	OUT	Breaker failure is ACTIVE
1454	BF Mask. Error	OUT	Breaker fail. masking error transformer
1461	BF Start	OUT	Breaker failure protection started
1472	BF T1-TRIP 1pL1	OUT	BF Trip T1 (local trip) - only phase L1
1473	BF T1-TRIP 1pL2	OUT	BF Trip T1 (local trip) - only phase L2
1474	BF T1-TRIP 1pL3	OUT	BF Trip T1 (local trip) - only phase L3
1476	BF T1-TRIP L123	OUT	BF Trip T1 (local trip) - 3pole
1489	BF Flash Over	OUT	BF Flash Over
1490	BF FO TRIP	OUT	BF Flash Over Trip
1493	BF TRIP CBdefec	OUT	BF Trip in case of defective CB
1494	BF T2-TRIP(bus)	OUT	BF TRIP T2 (busbar trip)
1495	BF EndFlt TRIP	OUT	BF Trip End fault stage
1496	BF CBdiscrSTART	OUT	BF Pole discrepancy pickup
1497	BF CBdiscr L1	OUT	BF Pole discrepancy pickup L1
1498	BF CBdiscr L2	OUT	BF Pole discrepancy pickup L2
1499	BF CBdiscr L3	OUT	BF Pole discrepancy pickup L3
1500	BF CBdiscr TRIP	OUT	BF Pole discrepancy Trip

2.10 Automatic reclosure function (optional)

Experience shows that about 85 % of the arc faults on overhead lines are extinguished automatically after being tripped by the protection. This means that the line can be reclosed. Reclosure is performed by an automatic reclosure function (AR).

Automatic reclosure is only permitted on overhead lines because the option of automatic extinguishing of a fault arc only exists there. It should not be used in any other case. If the protected object consists of a mixture of overhead lines and other equipment (e.g. overhead line directly connected to a transformer or overhead line/cable), it must be ensured that reclosure can only be performed in the event of a fault on the overhead line.

If the circuit breaker poles can be operated individually, a single-phase auto-reclosure is usually initiated for single-phase faults and a three-pole auto-reclosure for multiple-phase faults in the network with earthed system starpoint. If the fault still exists after automatic reclosure (arc has not disappeared, there is a metallic fault), then the protective elements will re-trip the circuit breaker. In some systems several reclosing attempts are performed.

The integrated automatic reclosure function of the 6MD66x device is controlled by an external protection. Signals between the 6MD66x and the protection device are exchanged through the binary inputs and outputs. If both devices have an IEC61850 interface, information can also be exchanged through the GOOSE mechanism. The automatic reclosure function contained in this device is an optional one (MLFB-dependent).

2.10.1 Function Description

The auto-reclose function is initiated by a trip command from a feeder protection. This functionality is presented in detail in the figure and description below.

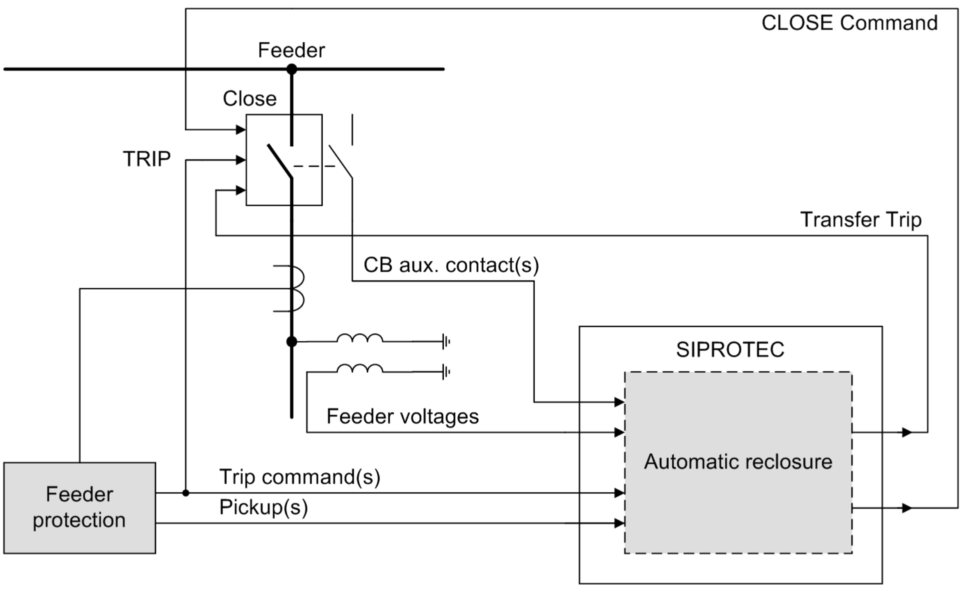


Figure 2-52 Example application of AR functions

A typical reclosure operation proceeds as follows. The feeder protection picks up because of a network fault, and after expiry of the tripping delay outputs a trip command that opens the connected circuit breaker and disconnects the feeder from the infeed.

The pickup and trip signals are transmitted to the 6MD66x through binary inputs. After expiry of a dead time, the device outputs a close command to the circuit breaker to reconnect the faulted feeder.

The isolation of the line from voltage often results in extinction of the electric arc caused by the network fault, so that after the reclosure the feeder protection no longer detects a fault. The reclosure was in that case successful.

In cases where the fault is not yet eliminated after reclosing the circuit breaker, this cycle may be repeated several times. The figure below shows a case where the network fault is not cleared until the second trip command.

The action times and blocking times, which are also shown in the figure, serve for the control of the AR function and can be adapted to the local network conditions by parameter settings. This is described in more detail farther below.

The indication AR in progress is generated by the AR for the duration of all AR cycles.

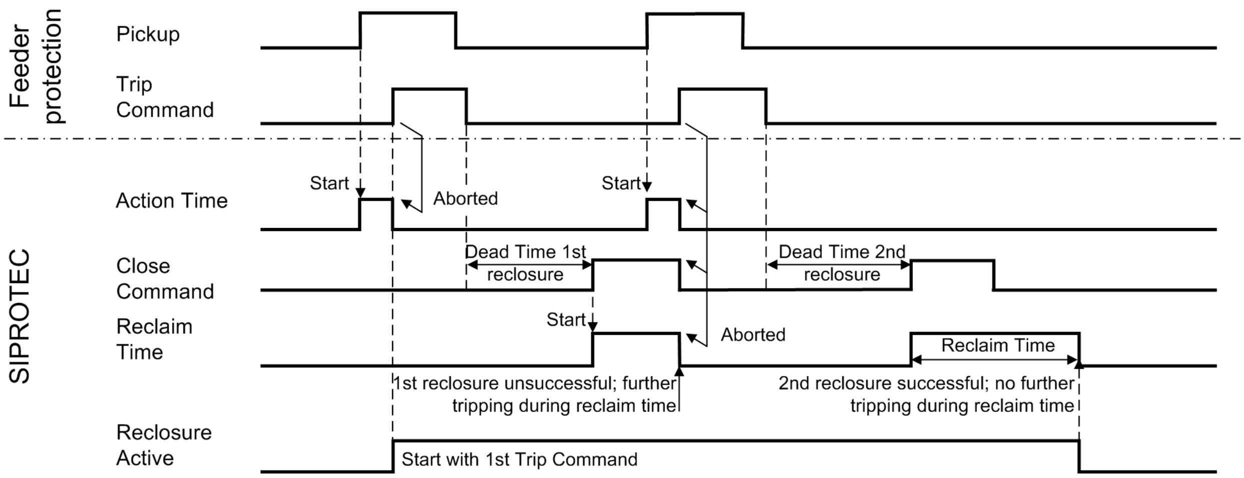


Figure 2-53 Example of a chronological sequence of a double reclosure operation

The integrated automatic reclosure function allows up to 8 reclosure attempts. The number of reclosing cycles is set in DIGSI under "Functional Scope - Automatic Reclosing (No. 133)". The first four interrupt cycles can operate with different parameters (action and dead times, single/three-pole). The parameters of the fourth cycle also apply for the fifth cycle and onwards.

Connection of the Measured Voltages

The automatic reclose function is provided with optional control modes that use the phase-to-earth voltages of the protected feeder as input quantities. Unlike SIPROTEC protection devices, where the allocation of the measuring transducers to the measured quantities is always fixed, the measured quantities in the 6MD66x can be freely allocated. This is done with the phase-to-earth voltages in the automatic reclose function. They are allocated by linking in the DIGSI configuration matrix each column representing a transducer with a line representing the voltage „`Input U1`“ ... .

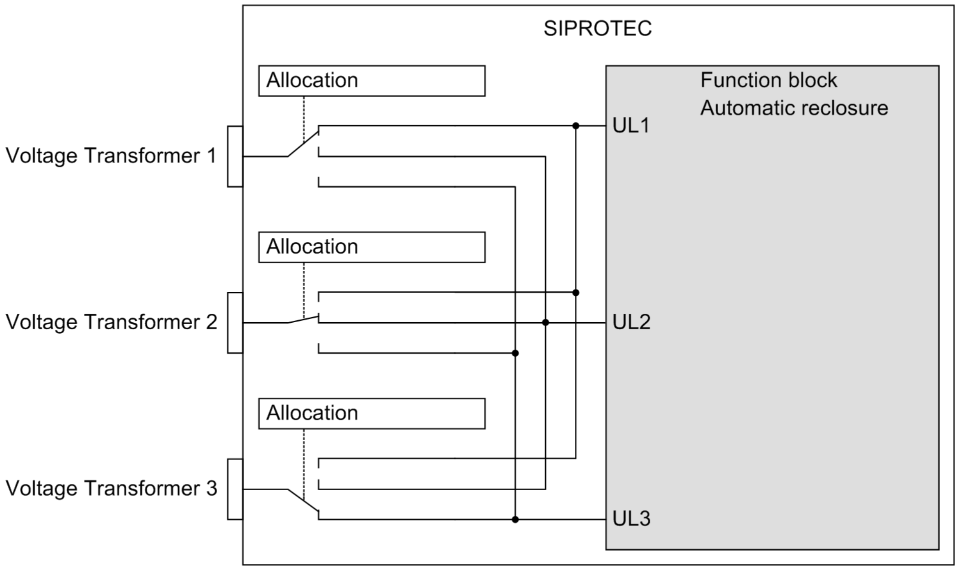


Figure 2-54 Allocation of voltage inputs for the automatic reclosure function

In case automatic reclosure functions depending on the voltage values are enabled, a plausibility check is conducted which examines whether a voltage transformer is assigned to each voltage input of the automatic reclosing. If this is not the case, the automatic reclosure function is indicated as ineffective and the „`AR Mask. Error`“ alarm indication is output.

Circuit Breaker Commands

Basically, the automatic reclose function can output two types of commands to a circuit breaker: a three-pole trip command (forced three-pole trip), and a three-pole close command. Commands are output through the output relays provided in the 6MD66x.

The procedure of assigning the circuit breaker to the automatic reclosure function is based on entering close and trip command indications in a circuit breaker object as state. The choice of the circuit breaker object can be made using the **`Cmd.via control`** parameter. These objects can in turn be assigned to output relays of the 6MD66x using the DIGSI configuration matrix. If the **`Cmd.via control`** parameter is set to „None“ to perform the circuit breaker assignment, no switching object is closed and the AR Close command common to protective devices is generated. It can be allocated to output relays as a normal single indication. The transfer trip indication is generated independent of whether this parameter is set or not.

The figure below illustrates the procedure on a configuration example:

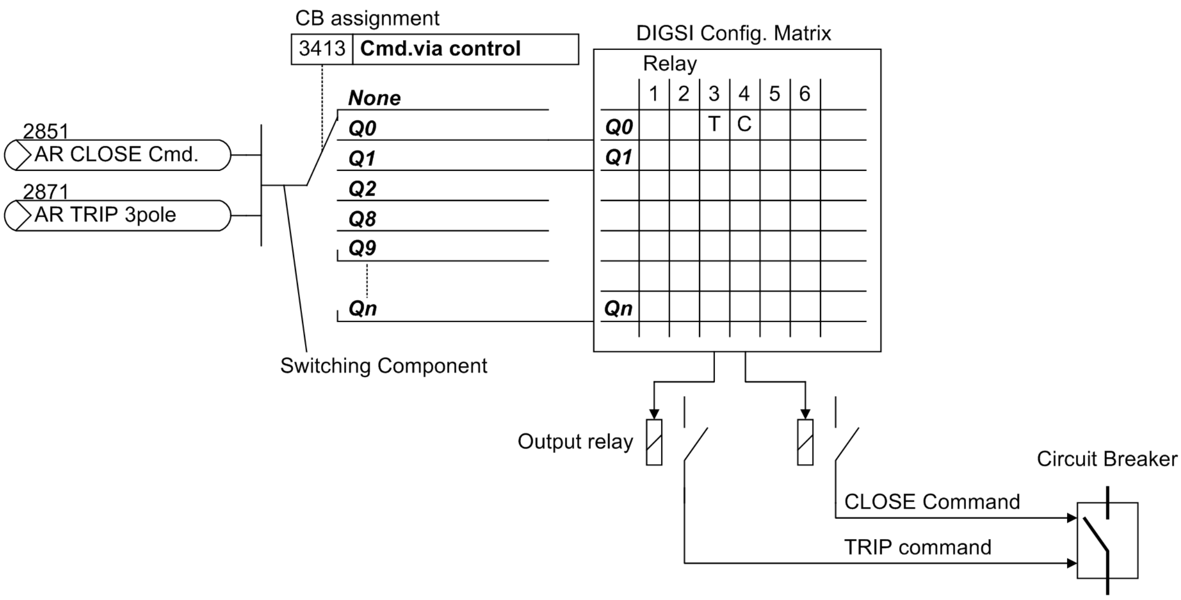


Figure 2-55 Allocation of the circuit breaker to the automatic reclosure function

Circuit Breaker Auxiliary Contacts

The logic functions of the AR evaluate, among other things, the circuit breaker position. This is done using the binary signals transmitted by the circuit breaker auxiliary contacts, which are routed to appropriately configured binary inputs of the 6MD66x.

The circuit breaker position is evaluated not only by the AR but also by the breaker failure protection function, if the device is equipped with it.

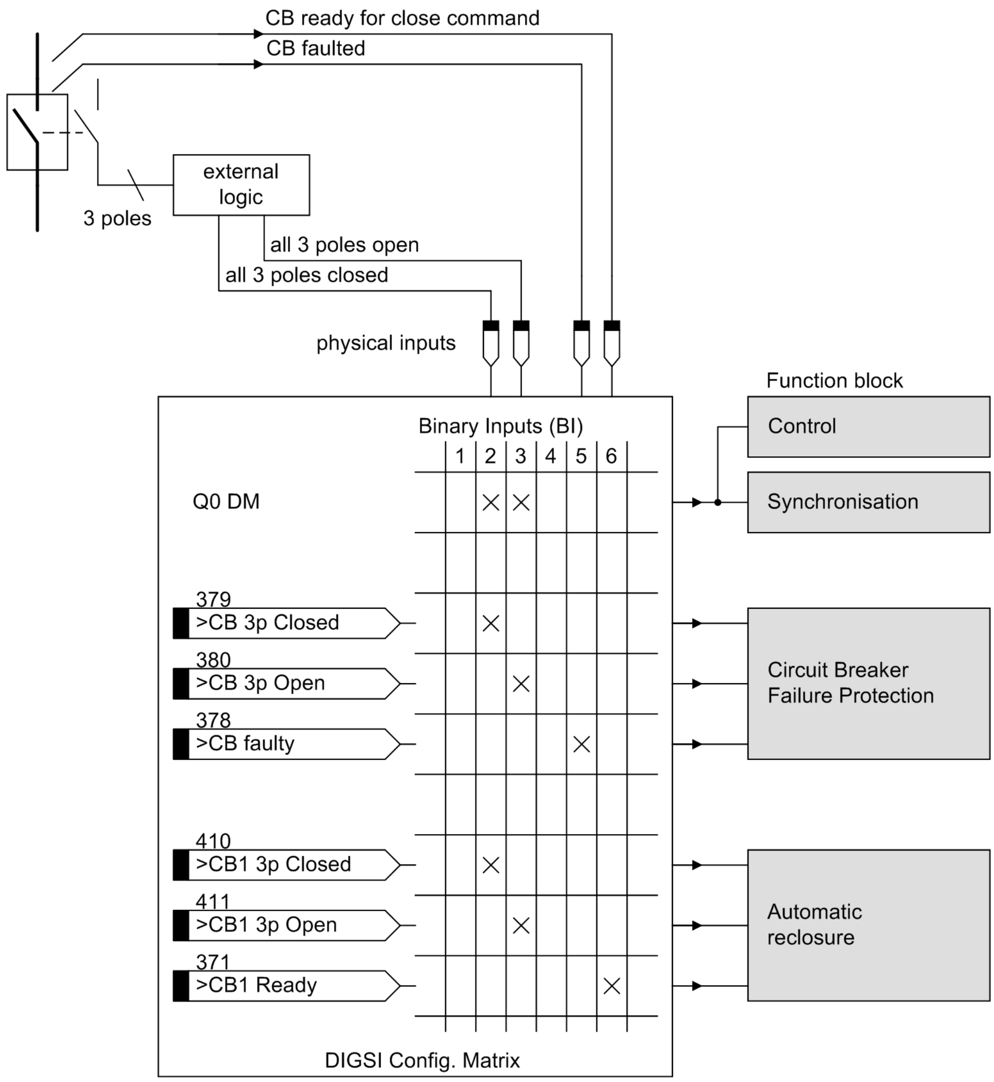


Figure 2-56 Example for allocation of CB auxiliary contacts to function blocks

Starting Conditions

The AR function is started by the detection of a rising-edge trip command from the protection device operating in conjunction with the AR. What happens on starting the AR is determined by the setting of the parameter AR CONTROL MODE. This parameter specifies whether the AR is controlled by trip command or by pickup, and whether it operates with or without cyclic control by action times.

The automatic reclosing is not started if the circuit breaker has not been ready for at least one TRIP–CLOSE–TRIP–cycle at the instant of the first trip command. This can be achieved by setting parameters.

Action Times

It is often desirable to remove the ready for reclosure state if the short-circuit condition was sustained for a certain time, e.g. because it is assumed that the arc has burned in to such an extent that there is no longer any chance of automatic arc extinction during the reclose dead time.

The automatic reclosure function of the 6MD66x can be operated with or without action times (configuration parameter **`AR control mode`**). Without action time, initiation takes place as soon as the first trip command appears.

When operating with action time, an action time is available for each reclose cycle. The action times are started through binary inputs. If no trip command is present before the action time expires, the corresponding reclose cycle is not carried out.

For each reclosure cycle, you may set whether or not it allows the initiation. Following the first general pickup, only the action times of those cycles that are set such that they may start off the recloser are considered since the other cycles are not allowed to be the first cycle under any circumstances. By means of the action times and the permission to start the recloser (permission to be the first cycle that is executed) it is possible to determine which reclose cycles are executed depending on the time used by the protection function to trip.

Example 1: 3 cycles are set. Starting of the auto-reclosure is allowed for at least the first cycle. The action times are set as follows:

- 1st Reclosure: T Action = 0.2 s;
- 2nd Reclosure: T Action = 0.8 s;
- 3rd Reclosure: T Action = 1.2 s;

Since reclosure is ready before the fault occurs, the first trip of a time overcurrent protection following a fault is fast, i.e. before the end of any action time. The automatic reclosure function is therefore started (the first cycle is initiated). After unsuccessful reclosure the 2nd cycle would then become active; but the time overcurrent protection would not trip in this example until after 1s according to its grading time. Since the action time for the second cycle was exceeded here, it is blocked. The 3rd cycle with its parameters is therefore carried out now. If the trip command only appeared more than 1.2s after the 1st reclosure, there would have been no further reclosure.

Example 2: 3 cycles are set. Starting is only allowed for the first. The action times are set as in example 1. The first protection trip takes place 0.5 s after starting. Since the action time for the 1st cycle has already expired at this time, this cannot start the automatic reclose function. As the 2nd and 3rd cycles are not permitted to start the reclose function they will also not be initiated. Therefore no reclosure takes place as no starting took place.

Example 3: 3 cycles are set. At least the first two cycles are set such that they can start the recloser. The action times are set as in example 1. The first protection trip takes place 0.5 s after starting. Since the action time for the 1st cycle has already expired at this time, it cannot start the automatic reclosure function, but the 2nd cycle, for which initiating is allowed, is activated immediately. This 2nd cycle therefore starts the automatic reclosure circuit, the 1st cycle is practically skipped.

Control Mode of the Automatic Reclosure

The dead times — these are the times from elimination of the fault (drop off of the trip command or signalling via auxiliary contacts) to the initiation of the automatic close command — may vary, depending on the automatic reclosure control mode selected when determining the functional scope and the resulting signals of the starting protective functions.

In control mode ***TRIP ...*** (With TRIP command...) single-pole or single/three-pole reclose cycles are possible if the device and the circuit breaker are suitable. In this case, different dead times (for every AR-cycle) are possible after single-pole tripping and after three-pole tripping. The tripping protection function determines the type of tripping: single-pole or three-pole. Selection of the dead time depends on this.

In control mode ***PICKUP ...*** (With PICKUP...) different dead times can be set for every reclosure cycle after three-phase faults. Selection of the dead time in this case depends on the type of fault determined by the initiating protective function at the instant that the trip command resets. This operating mode allows the dead times to be dependent on the type of fault in the case of three-pole reclose cycles.

In the control mode with cyclic control by action times, the cycle action times are started by the pickup.

In the control mode without cyclic control by action times, the pickup signal from the protection device is irrelevant. The AR cycles are always performed in chronological order (1st cycle, 2nd cycle etc.).

Reclosure Block

Different conditions lead to blocking of the automatic reclosure. No reclosure is, for example, possible if it is blocked via a binary input. If the automatic reclosure has not yet been started, it cannot be started at all. If a reclose cycle is already in progress, dynamic blocking takes place (see below).

Each individual cycle may also be blocked via binary input. In this case the cycle concerned is declared as invalid and will be skipped in the sequence of permissible cycles. If blocking takes place while the cycle concerned is already running, this leads to aborting of the reclosure, i.e. no reclosure takes place even if other valid cycles have been parameterised.

Internal blocking signals, with a limited duration, arise during the course of the reclose cycles:

The reclaim time **T-RECLAIM** begins with every automatic reclosure command. If the reclosure is successful, all the functions of the automatic reclosure return to the quiescent state at the end of the blocking time; a fault after expiry of the reclaim time is treated as a new fault in the network. Re-tripping by a protection function during the reclaim time initiates the next reclose cycle in the case of multiple reclosure; if no further reclosure is permitted, the last reclosure cycle is declared as unsuccessful if re-tripping within the reclaim time takes place. The automatic reclosure is blocked dynamically.

The dynamic blocking locks the reclosure for the duration of the dynamic blocking time (0.5 s). This occurs, for example, after a final tripping or other events which block the auto reclose function after it has been started. Restarting is locked out for this time. When this time expires, the automatic reclosure function returns to its quiescent state and is ready for a new fault in the network.

If the circuit breaker is closed manually (by the control discrepancy switch connected to a binary input, the local control possibilities or via one of the serial interfaces), the automatic reclosure is blocked for a manual-close-blocking time **T-BLOCK MC**. If a trip command is issued during this time, it can be assumed that a metallic short-circuit is the cause (e.g. closed earth switch). Every trip command within this time is therefore a final trip. With the user definable logic functions (CFC) further control functions can be processed in the same way as a manual–close command.

Interrogation of Circuit Breaker Ready

A precondition for automatic reclosure following clearance of a short-circuit is that the circuit breaker is ready for at least one TRIP-CLOSE-TRIP cycle when the automatic reclosure circuit is started (i.e. at the time of the first trip command). The readiness of the circuit breaker is signalled to the device through the binary input „>CB1 Ready“ (No. 371).

In the event of a single cycle reclosure this interrogation is usually sufficient. Since, for example, the air pressure or the spring tension for the circuit breaker mechanism drops after the trip, no further interrogation should take place.

Especially when multiple reclosing attempts are programmed, it is recommended to monitor the circuit breaker condition not only prior to the first, but also before each following reclosing attempt. Reclosure will be blocked until the binary input indicates that the circuit breaker is ready to complete another CLOSE-TRIP cycle.

The recovery time of the circuit breaker can be monitored by the 6MD66x. This monitoring time **CB TIME OUT** starts as soon as the CB indicates the not ready state. The dead time may be extended if the ready state is not indicated when it expires. However, if the circuit breaker does not indicate its ready status for a longer period than the monitoring time, reclosure is locked out dynamically (see also above under margin heading „Reclosure Block“).

Monitoring with an AR Cycle in Progress

Monitoring of the circuit breaker readiness is also performed before a reclosure and during the dead time, if it has been released for the cycle with the parameter **ADT CB? CLOSE**. When the binary input **>CB ready** goes OFF, the AR is not dynamically blocked at once, but the CB ready monitoring time **CB TIME OUT** is started. This CLOSE command management provides a controlled delay of the CLOSE command to allow the circuit breaker a recovery time after its previous trip before completing another close/trip cycle. This recovery time is used, for instance, to build up sufficient air pressure for the next switching operations.

If the BI **>CB ready** goes ON again before the monitoring time has elapsed, the monitoring time will be reset, and the AR continues.

- If the CB monitoring time is still running at the end of the regular dead time, the dead time will be extended by the rest of the CB monitoring time. If the readiness of the CB returns within the maximum permissible extension of the dead time defined by parameter **T-DEAD EXT.**, and before expiry of the CB monitoring time, the AR will be continued, and the monitoring time reset.

  If the CB monitoring time is still running at the end of the maximum permissible extension of the dead time defined by parameter **T-DEAD EXT.**, the automatic reclosure function will be blocked dynamically.

  If the monitoring time elapses before the circuit breaker signals its readiness, the automatic reclosure function will be blocked dynamically.

  The dynamic blocking aborts the reclosure attempt. No CLOSE command is generated. After expiry of the settable dynamic blocking time **T BLK DYN**, the AR will be reset.

Processing the Circuit Breaker Auxiliary Contacts

If the circuit breaker auxiliary contacts are connected to the device, the reaction of the circuit breaker is also checked for plausibility. The circuit breaker auxiliary contacts can be connected to the device through the binary inputs „>CB1 3p Closed“, „>CB1 3p Open“ and single-pole **>CB1Pole Lx**. These binary signals inform the AR whether the circuit breaker is open, closed or in intermediate position. No current criterion is used. Whether auxiliary contacts are evaluated depends on which of them are allocated, if any.

- No CB auxiliary contact allocated

  If no circuit breaker auxiliary contacts are allocated, the AR cannot detect the switching status of the circuit breaker. Monitoring for "CB open without TRIP" and starting the dead time in dependence of the circuit breaker feedback is not possible in this case. The AR is controlled by the TRIP command instead.

- Circuit breaker signal „>CB1 3p Open“ allocated

  If binary signal „>CB1 3p Open“ alone is used, the circuit breaker is considered three-pole open while the signal is active. If the binary signal is active and no trip command applies, the automatic reclosure function is statically blocked when it is in normal state, dynamically blocked when it is running and the „CB not ready“ indication is output. The dead time is started while the automatic reclosure function is running if the binary input becomes active following the trip command. An intermediate position of the circuit breaker cannot be detected for this type of allocation.

- Circuit breaker signals „`>CB1 3p Closed`“ or **>CB Pole Lx** allocated

  If binary signal „`>CB1 3p Closed`“ is used, the circuit breaker is considered three-pole closed while the signal is active. If the **>CB Aux. Lx** signals are allocated, the state of each pole of the cicruit breaker can be determined what is especially important for a single-pole reclosure. If such a binary signal is active and no trip command applies, the automatic reclosure function is blocked statically when it is in normal state, dynamically when it is running and the „`CB not ready`“ indication output. The dead time is started while the automatic reclosure function is running if the binary input becomes inactive following the trip command. An intermediate position of the circuit breaker cannot be detected for this type of allocation.
- Circuit breaker signals „`>CB1 3p Open`“ and „`>CB1 3p Closed`“ allocated

  If both binary signals are used, the circuit breaker is considered open, when „`>CB1 3p Open`“ is active and „`>CB1 3p Closed`“ inactive. An vice versa, the circuit breaker is considered closed, when „`>CB1 3p Open`“ is inactive and „`>CB1 3p Closed`“ active. All other states are considered intermediate position. If the circuit breaker is in intermediate position or opens without a trip command being detected, the automatic reclosure is blocked statically when it is in normal state and dynamically when it is running. The start of the dead time takes place while the automatic reclosure is running, when the circuit breaker is considered open. The static blocking of the automatic reclosure function is indicated via the „`AR is blocked`“ indication, dynamic via „`AR not ready`“ and the blocking cause via „`CB not ready`“ in both cases.

Sequence of a Three-pole Interrupt Cycle

If the automatic reclosure function is ready, the short-circuit protection trips three pole for all faults inside the stage selected for reclosure. The auto reclose function is then started. When the trip command resets or the circuit breaker opens (auxiliary contact criterion) an (adjustable) dead time starts. At the end of this dead time the circuit breaker receives a close command. At the same time, the (adjustable) blocking time is started. If during configuration of the protective functions in **`AR control mode`** = ***`PICKUP ...`*** was set, different dead times can be parameterised depending on the type of protection pickup.

If the fault is cleared (successful reclosure), the reclaim time expires and all functions return to their quiescent state. The fault is cleared.

If the fault is not cleared (unsuccessful reclosure), the short-circuit protection issues a final trip with the protection stage that is selected to operate without reclosure. Any fault during the reclaim time leads to a final trip.

After unsuccessful reclosure (final tripping) the automatic reclosure is blocked dynamically (see also margin heading „Reclose Block“, above).

The sequence above applies for single reclosure cycles. In 6MD66x multiple reclosure (up to 8 cycles) is also possible (see below).

Sequence of a Single-pole Interrupt Cycle

Single-pole reclose cycles are only possible with the appropriate device version and if this was selected during the configuration of the protective functions (**`Trip mode`**, see also Section 2.1.1.2). Of course, the circuit breaker must also be suitable for single-pole tripping.

If the automatic reclosure function is ready, the short-circuit protection trips single pole for all single-phase faults inside the stage selected for reclosure. Single-pole tripping is of course only possible by short-circuit protective functions which can determine the faulty phase.

If only single-pole reclosure is selected, then the fault protection issues a final three-pole trip with the stage that is valid/selected without reclosure. Any three-pole trip is final. The automatic reclose function is blocked dynamically (see also margin heading „Reclosure Block“, above).

The automatic reclosure function is started following a single-pole trip. The (adjustable) dead time for the single-pole reclose cycles starts with reset of the trip command or opening of the circuit breaker pole (auxiliary contact criterion). After expiry of the dead time, the circuit breaker receives a close command. At the same time, the (adjustable) reclaim time is started. If the reclosure is blocked during the dead time following a single-pole trip, immediate three-pole tripping can take place as an option (forced three-pole coupling).

If the fault is cleared (successful reclosure), the reclaim time expires and all functions return to their quiescent state. The fault is cleared.

If the fault is not cleared (unsuccessful reclosure), the short-circuit protection issues a final trip with the protection stage that is valid/selected without reclosure. All faults during the reclaim time also lead to the issue of a final three-pole trip.

After unsuccessful reclosure (final tripping) the automatic reclosure is blocked dynamically (see also margin heading „Reclose Block“, above).

The sequence above applies for single reclosure cycles. In 6MD66x multiple reclosure (up to 8 cycles) is also possible (see below).

Sequence of a Single and Three-pole Interrupt Cycle

This operating mode is only possible with the appropriate device version and if this was selected during configuration of the protective functions (see also Section 2.1.1.2). Of course, the circuit breaker must also be suitable for single-pole tripping.

If the automatic reclosure function is ready, the short-circuit protection trips single-pole for single-phase faults and three-pole for multi-phase faults. Single-pole tripping is of course only possible with short-circuit protective functions that can determine the faulty phase. The valid protection stage selected for reclosure ready state applies for all fault types.

The automatic reclosure function is started in the event of a trip. Depending on the type of fault, the (adjustable) dead time for the single-pole reclose cycle or the (separately adjustable) dead time for the three-pole reclose cycle starts following the reset of the trip command or opening of the circuit breaker (pole). After expiry of the dead time, the circuit breaker receives a close command. At the same time, the (adjustable) reclaim time is started. If the reclosure is blocked during the dead time following a single-pole trip, immediate three-pole tripping can take place as an option (forced three-pole coupling).

If the fault is cleared (successful reclosure), the reclaim time expires and all functions return to their quiescent state. The fault is cleared.

If the fault is not cleared (unsuccessful reclosure), the short-circuit protection initiates a final three-pole trip with the protection stage that is valid/selected when reclosure is not ready. All faults during the reclaim time also lead to the issue of a final three-pole trip.

After unsuccessful reclosure (final tripping), the automatic reclosure is blocked dynamically (see also margin heading „Reclose Block“, above).

The sequence above applies for single reclosure cycles. In 6MD66x multiple reclosure (up to 8 cycles) is also possible (see below).

Multiple Reclosure

If a short-circuit still exists after a reclosure attempt, further reclosure attempts can be made. Up to 8 reclosure attempts are possible with the automatic reclosure function integrated in the 6MD66x.

The first four reclosure cycles are independent of each other. Each one has separate action and dead times, can operate single-or three-pole and can be blocked separately via binary inputs. The parameters and intervention possibilities of the fourth cycle also apply to the fifth cycle and onwards.

The sequence is the same in principle as in the different reclosure programs described above. However, if the first reclosure attempt was unsuccessful, the reclosure function is not blocked, but instead the next reclose cycle is started. The appropriate dead time starts with the reset of the trip command or opening of the circuit breaker (pole) (auxiliary contact criterion). The circuit breaker receives a new close command after expiry of the dead time. At the same time the reclaim time is started.

Until the set maximum number of permissible auto-reclose cycles has been reached, the reclaim time is reset with every new trip command after reclosure and started again with the next close command.

If one of the reclosing attempts is successful, i.e. the fault disappeared after reclosure, the blocking time expires and the automatic reclosing system is reset. The fault is cleared.

If none of the cycles is successful, the short-circuit protection initiates a final three-pole trip after the last permissible reclosure, following a protection stage active without auto-reclosure. The automatic reclosure is blocked dynamically (see also margin heading „Reclose Block“, above).

Handling Evolving Faults

When single-pole and single-and three-pole reclose cycles are executed in the network, particular attention must be paid to sequential faults.

Sequential faults are faults which occur during the dead time after clearance of the first fault.

There are various ways of handling sequential faults in the 6MD66x depending on the requirements of the network:

For the **detection** of an evolving fault you can select whether the trip command of the external protection during the dead time or every further pickup is the criterion for an evolving fault.

There are also various selectable possibilities for the **response** of the internal auto-reclose function to a detected evolving fault.

- **`EV. FLT. MODE`** ***`blocks AR`***:

  The reclosure is blocked as soon as an evolving fault is detected. Tripping as a result of the sequential fault is three-pole. This applies irrespective of whether three-pole cycles are permitted or not. There are no further reclosure attempts; the auto-reclosure is blocked dynamically (see also margin heading „Reclose Block“, above).

- **`EV. FLT. MODE`** ***`starts 3p AR`***:

  As soon as a sequential fault is detected the recloser switches over to a three-pole reclose cycle. All trip commands are now three-pole. The separately settable dead time for sequential faults starts with the clearance of the sequential fault; after the dead time the circuit breaker receives a close command. The further sequence is the same as for single and three-pole cycles.

  The complete dead time in this case consists of the portion of the single-pole dead time up to clearance of the sequential fault plus the dead time for the sequential fault. This makes sense because the duration of the three-pole dead time is most important for the stability of the network.

If reclosure is blocked due to a sequential fault without the protection issuing a three-pole trip command (e.g. for sequential fault detection with starting), the device can send a three-pole trip command so that the circuit breaker does not remain open with one pole (forced three-pole coupling).

Dead Line Check (DLC)

If the voltage of a disconnected phase does not disappear following a trip, reclosure can be prevented. A prerequisite for this function is that the voltage transformers are connected on the line side of the circuit breaker. To select this function the dead line check must be activated. The automatic reclosure function then checks the disconnected line for no-voltage: the line must have been without voltage for at least an adequate measuring time during the dead time. If this was not the case, the reclosure is blocked dynamically.

A voltage detection fault causes blocking of the automatic reclosure function in the dead line check mode. Voltage detection faults are, for example, pickup of the voltage failure monitoring or the „`>FAIL:Feeder VT`“ binary signal.

This no-voltage check on the line is of advantage if a small generator (e.g. wind generator) is connected along the line.

Reduced Dead Time (RDT)

If automatic reclosure is performed in connection with time-graded protection, non-selective tripping before reclosure is often unavoidable in order to achieve fast, simultaneous tripping at all line ends. The 6MD66x has a „reduced dead time (RDT)“ procedure which reduces the effect of the short-circuit on healthy line sections to a minimum. For the reduced dead time procedure, all phase-to-phase and phase-to-earth voltages are measured. These voltages must exceed the limit voltage **`U-live>`** (address 3440) for the duration of the voltage measuring time **`T U-stable`** (address 3438). The setting value of **`U-live>`** is converted accordingly for the phase-to-phase voltages. The voltage transformers must be located on the line side of the circuit breaker.

In the event of a short-circuit close to one of the line ends, the surrounding lines can initially be tripped because, for example, a distance protection detects the fault in its overreaching zone Z1B (Figure 2-57, relay location III). If the network is meshed and there is at least one other infeed on the busbar B, the voltage there returns immediately after clearance of the fault. For single-pole tripping it is sufficient if there is an earthed transformer with delta winding connected at busbar B which ensures symmetry of the voltages and thus induces a return voltage in the open phase. This allows a distinction between the faulty line and the unfaulted line to be made as follows:

Since line B - C is only tripped singled-ended at C, it receives a return voltage from the end B which is not tripped so that at C the open phase(s) also has(have) voltage. If the device detects this at position III, reclosure can take place immediately or in a shorter time (to ensure sufficient voltage measuring time). The healthy line B - C is then back in operation.

Line A–B is tripped at both ends. No voltage is therefore present identifying the line as the faulted one at both ends. The normal dead time comes into service here.

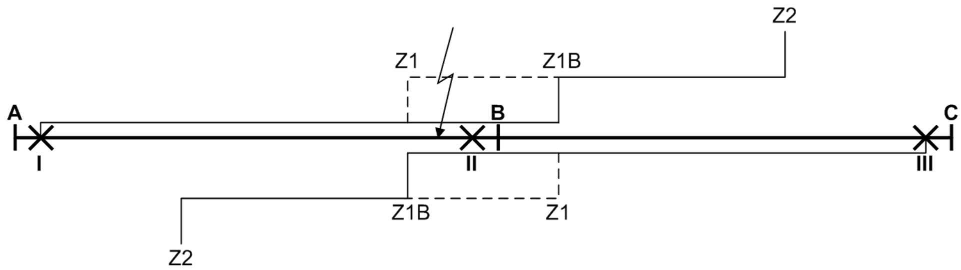


Figure 2-57 Example of a reduced dead time (RDT)

A, B, C Busbars

I, II, III Relay locations

X Tripped circuit breakers

Adaptive Dead Time (ADT)

In all the previous alternatives it was assumed that defined and equal dead times were set at both line ends, if necessary for different fault types and/or reclose cycles.

It is also possible to set the dead times (if necessary different for various fault types and/or reclose cycles) at one line end only and to configure the adaptive dead time at the other end (or ends). This can be done provided that the voltage transformers are located on the line side of the circuit breaker or that facilities for transfer of a close command to the remote line end exists.

Figure 2-58 shows an example with voltage measurement. It is assumed that the device I is operating with defined dead times whereas the adaptive dead time is configured at position II. It is important that the line is at least fed from busbar A, i.e. the side with the defined dead times.

With the adaptive dead time, the automatic reclosure function at line end II decides independently if and when reclosure is sensible and allowed and when it is not. The criterion is the line voltage at end II, which was re-applied from end I following reclosure there. Reclosure therefore takes place at end II as soon as it is apparent that voltage has been re-applied to the line from end I. All phase-to-phase and phase-to-earth voltages are monitored.

In the illustrated example, the lines are disconnected at positions I, II and III. At I reclosure takes place after the parameterized dead time. At III a reduced dead time can take place (see above) if there is also an infeed on busbar B.

If the fault has been cleared (successful reclosure), line A - B is re-connected to the voltage at busbar A through position I. Device II detects this voltage and also recloses after a short delay (to ensure a sufficient voltage measuring time). The fault is cleared.

If the fault has not been cleared after reclosure at I (unsuccessful reclosure), a switch on to fault occurs at I, no healthy voltage appears at II. The device there detects this and does not reclose.

In the case of multiple reclosure the sequence may be repeated several times following an unsuccessful reclosure until one of the reclosures attempts is successful or a final trip takes place.

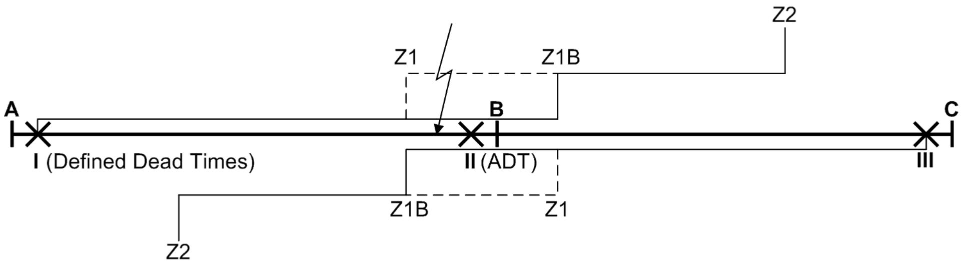


Figure 2-58 Example of adaptive dead time (ADT)

A, B, C	Busbars
I, II, III	Relay locations
X	Tripped circuit breakers

As is shown by the example, the adaptive dead time has the following advantages:

- The circuit breaker at position II is not reclosed at all if the fault persists and is not unnecessarily stressed as a result.
- With non-selective tripping by overreach at position III no further trip and reclose cycles occur here because the short-circuit path via busbar B and position II remains interrupted even in the event of several reclosure attempts.
- At position I overreach is allowed in the case of multiple reclosures and even in the event of final tripping because the line remains open at position II and therefore no actual overreach can occur at I.

The adaptive dead time also includes the reduced dead time because the criteria are the same. There is no need to set the reduced dead time as well.

Control of the Automatic Reclosure by the TRIP Command

If the auto-reclosure is controlled by the **trip command**, the following inputs and outputs are recommended to be used:

The automatic reclosure function is started via the Binary inputs:

2711 „`>AR Start`“	General fault detection for the automatic reclosure circuit (only required for action time),
2712 „`>Trip L1 AR`“	Trip command L1 for the automatic reclosure circuit,
2713 „`>Trip L2 AR`“	Trip command L2 for the automatic reclosure circuit,
2714 „`>Trip L3 AR`“	Trip command L3 for the automatic reclosure circuit.

The general fault detection determines the starting of the action times. It is also necessary if the automatic reclosure circuit is to detect sequential faults by fault detection. In other cases this input information is superfluous.

The trip commands decide whether the dead time for single-pole or three-pole reclose cycles is activated or whether the reclosure is blocked in the event of a three-pole trip (depending on the set dead times).

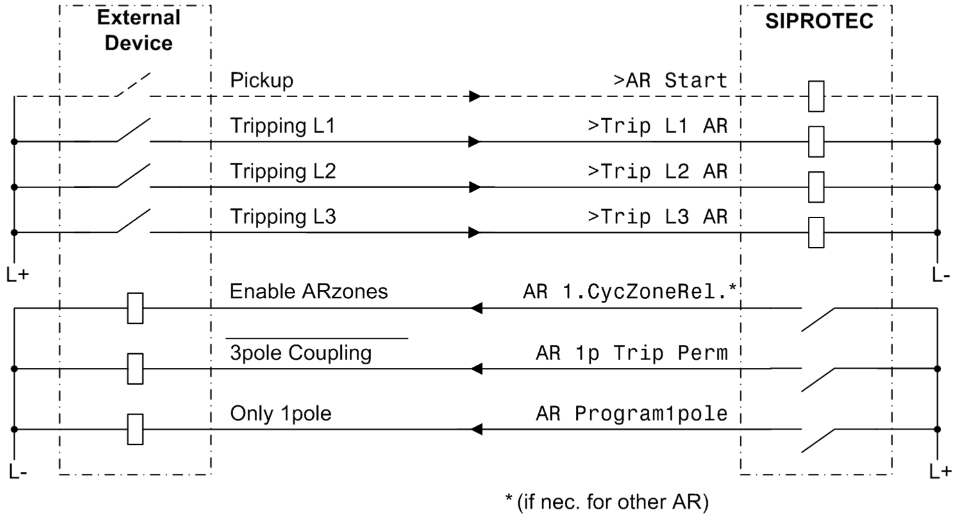


Figure 2-59 Connection example with external protection device for 1-/3-pole reclosure; AR control mode = with TRIP

Figure 2-59 shows as a connection example the interconnection between the automatic reclosure of 6MD66x and a protection device.

To achieve three-pole coupling of the external protection and to release, if necessary, its accelerated stages before reclosure the following output functions are suitable:

2864 „`AR 1p Trip Perm`“ Internal automatic reclosure function ready for single-pole reclose cycle, i.e. allows single-pole tripping (logic inversion of the three-pole coupling).

2889 „`AR 1.CycZoneRel`“ Internal automatic reclosure function ready for the first reclose cycle, i.e. releases the stage of the external protection device for reclosure, the corresponding outputs can be used for other cycles. This output can be omitted if the external protection does not require an overreaching stage (e.g. differential protection or comparison mode with distance protection).

2820 „`AR Program1pole`“ Internal automatic reclosure function is programmed for one pole, i.e. only recloses after single-pole tripping. This output can be omitted if no overreaching stage is required (e.g. differential protection or comparison mode with distance protection).

Instead of the three-phase-segregated trip commands, the single-pole and three-pole tripping may also be signalled to the internal automatic reclosure function — provided that the external protection device is capable of this. In that case, the following binary inputs of the 6MD66x are assigned:

2711 „`>AR Start`“	General fault detection for the internal automatic reclosure function (only required for action time),
2715 „`>Trip 1pole AR`“	Trip command single-pole for the internal automatic reclosure,
2716 „`>Trip 3pole AR`“	Trip command three-pole for the internal automatic reclosure function,

If only three-pole reclosure cycles are to be executed, it is sufficient to assign the binary input „`>Trip 3pole AR`“ (No. 2716) for the trip signal. Figure 2-61 shows an example. Any overreaching stages of the external protection are enabled again by „`AR 1.CycZoneRel`“ (No. 2889) and of further cycles, if applicable.

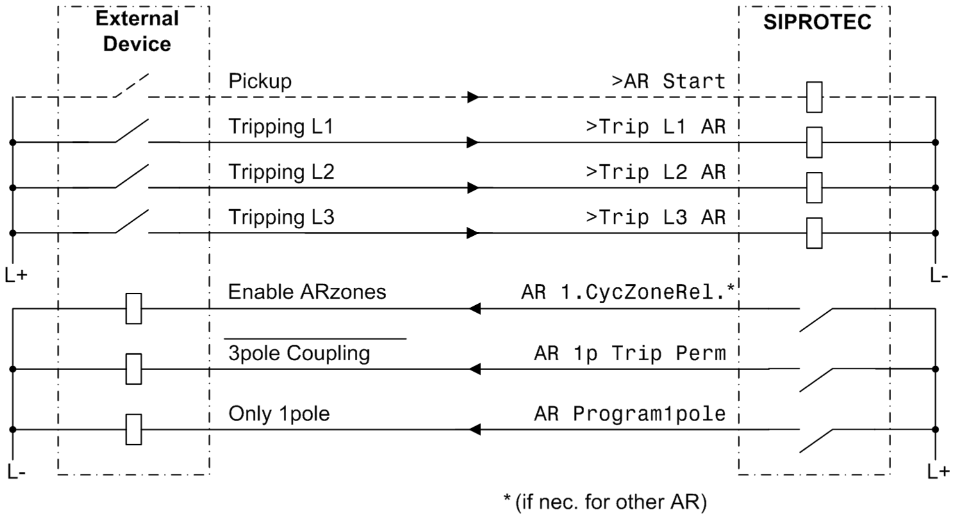


Figure 2-60 Connection example with external protection device for 1-/3-pole reclosure; AR control mode = with TRIP

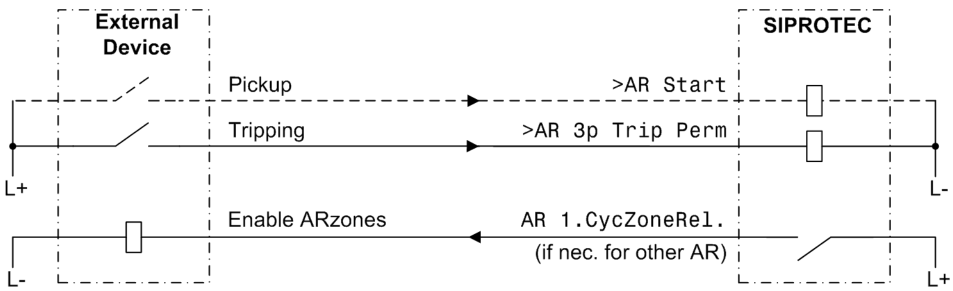


Figure 2-61 Connection example with external protection device for 3-pole reclosure; AR control mode = with TRIP

But if the internal automatic reclose function is controlled by the **pickup** (only possible for three-pole tripping: 110 **`Trip mode`** = ***`3pole only`***), the phase-dedicated pickup signals of the external protection must be connected if distinction shall be made between different types of fault. The general trip command then suffices for tripping (No. 2746). Figure 2-62 shows a connection example.

Control of the Automatic Reclosure by the Pickup Signal

If, on the other hand, the internal auto-reclosure is controlled by the pickup, the phase-dedicated pickup signals must be connected from the external protection. The general trip command then suffices for tripping. Connection examples in the figure below.

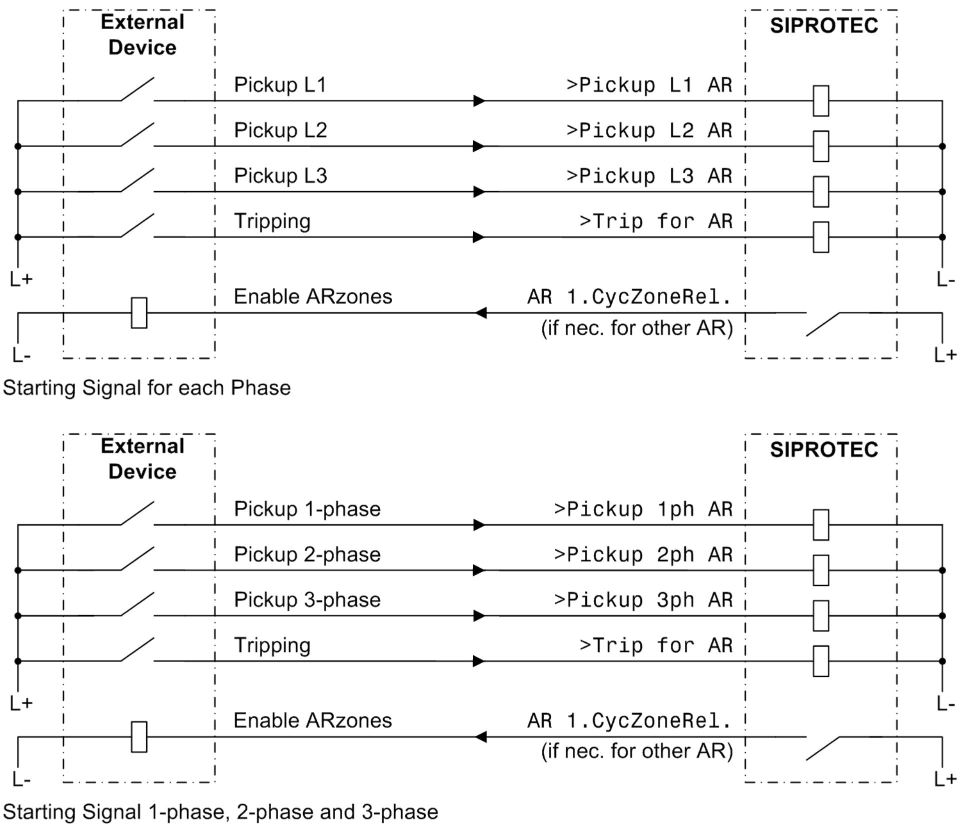


Figure 2-62 Connection example with external protection device for fault detection dependent dead time — dead time control by pickup signals of the protection device; AR control mode = with PICKUP

2.10.2 Setting Notes

General

If no reclosure is required on the feeder for which the 6MD66x is used (e.g. for cables, transformers, motors or similar), the automatic reclosure function must be removed during configuration of the device (see Section 2.1.1.2). The auto reclose function is then totally disabled, i.e. the automatic reclosure is not processed in the 6MD66x. No signals regarding the auto reclose function are generated, and the binary inputs for the auto reclose function are ignored. All parameters for setting the auto reclose function are inaccessible and of no significance.

For the auto reclose function to be active, all three possible methods for switching it ON/OFF must be switched ON:

- Parameter settings
- Binary inputs
- System interface

When the device is started up, the AR is switched ON through binary inputs and the system interface, if it has not been explicitly switched OFF through the system interface.

Basically, the AR can only be reactivated from the same source from which it was deactivated. If it was switched OFF by more than one mechanism, all sources must switch the AR back ON before it becomes active again.

If the internal automatic reclosure function is to be used, the user must select during the configuration of the functions (Section 2.1.1.2) the type of reclosure in address **Auto Reclose** and the AR control mode in **AR control mode**.

Up to 8 reclosure attempts are allowed with the integrated automatic reclosure function in the 6MD66x. There are individual settings and common settings, which apply for one or more of the reclose cycles. It is possible to set different individual parameters for the first four reclose cycles. From the fifth cycle on the parameters for the fourth cycle apply.

The automatic reclosing function can be turned ***ON*** or ***OFF*** with the parameter **AUTO RECLOSE**.

A prerequisite for automatic reclosure taking place after a trip due to a short-circuit is that the circuit breaker is ready for at least one TRIP-CLOSE-TRIP cycle at the time the automatic reclosure circuit is started, i.e. at the time of the first trip command. The readiness of the circuit breaker is signalled to the device through the binary input „>CB1 Ready“ (FNo 371). If no such signal is available, leave the setting **CB? 1.TRIP** = ***NO*** because no automatic reclosure would be possible at all otherwise. If circuit breaker interrogation is possible, you should set **CB? 1.TRIP** = ***YES***.

Furthermore, the circuit breaker ready state can also be interrogated prior to every reclosure. This is set when setting the individual reclose cycles (see below).

To check the ready status of the circuit breaker is regained during the dead times, you can set a circuit breaker ready monitor time in **CB TIME OUT**. The time is set slightly longer than the recovery time of the circuit breaker after a TRIP-CLOSE-TRIP cycle. If the circuit breaker is not ready again by the time this timer expires, no reclosure takes place, the automatic reclosure function is blocked dynamically.

Waiting for the circuit breaker to be ready can lead to an increase of the dead times. Interrogation of a synchro-check (if used) can also delay reclosure. To avoid uncontrolled prolongation, it is possible to set a maximum prolongation of the dead time in this case in **T-DEAD EXT.**. This prolongation is unlimited if the setting ∞ is applied. This setting can only be altered with DIGSI® under **Additional Settings**. Remember that longer dead times are only permissible after three-pole tripping when no stability problems arise or when a synchro-check takes place before reclosure.

Generally, the monitoring time should be longer than the maximum duration of the synchronization process.

The reclaim time **T-RECLAIM** defines the time that must elapse, after a successfulreclosing attempt, before the automatic reclosing function is reset. Re-tripping of a protective function within this time initiates the next reclose cycle in the event of multiple reclosure; if no further reclosure is permitted, the last reclosure is treated as unsuccessful. The reclaim time must therefore be longer than the longest response time of a protective function which can start the automatic reclosure circuit.

A few seconds are generally sufficient. In areas with frequent thunderstorms or storms, a shorter reclaim time may be necessary to avoid feeder lockout due to sequential lightning strikes or flashovers.

A longer reclaim time should be chosen where circuit breaker supervision is not possible (see above) during multiple reclosures, e.g. because of missing auxiliary contacts and information on the circuit breaker ready status. In this case, the reclaim time should be longer than the time required for the circuit breaker mechanism to be ready.

The blocking duration following Manual-Close detection **T-BLOCK MC** must guarantee the circuit breaker to open and close reliably (0.5 s to 1 s). If a fault is detected by a protective function within this time after closing of the circuit breaker was detected, no reclosure takes place and a final three-pole trip command is issued. If this is not desired, set the blocking duration to **0**.

The options for handling evolving faults are described in Section 2.10 under margin heading „Handling Evolving Faults“. The treatment of evolving faults is not necessary on line ends where the adaptive dead time is applied (**Auto Reclose** = ***ADT***).

The detection of an evolving fault can be defined in **EV. FLT. RECOG.**. **EV. FLT. RECOG.** ***with PICKUP*** means that, during a dead time, every **pickup** of a protective function will be interpreted as an evolving fault. With **EV. FLT. RECOG.** ***with TRIP*** a fault during a dead time is only interpreted as an evolving fault if it has led to a **trip command** by a protective function. This may also include trip commands which are coupled in from external via a binary input or which have been transmitted from an opposite end of the protected object. If an external protection device operates together with the internal auto-reclosure, evolving fault detection with pickup presupposes that a pickup signal from the external device is also connected to the 6MD66x; otherwise an evolving fault can only be detected with the external trip command even if ***with PICKUP*** was set here.

EV. FLT. MODE ***blocks AR*** means that no reclosure takes place after detection of an evolving fault. This is always useful when only single-pole reclosure is to take place or when stability problems are expected due to the subsequent three-pole dead time. If a three-pole reclose cycle is to be initiated by tripping of the evolving fault, set **EV. FLT. MODE** = ***starts 3p AR***. In this case, a separately adjustable three-pole dead time is started with the three-pole trip command due to the sequential fault. This is only useful if three-pole reclosure is also permitted.

T-Start MONITOR monitors the reaction of the circuit breaker after a trip command. If the CB has not opened during this time (from the beginning of the trip command), the automatic reclosure is blocked dynamically. The criterion for circuit breaker opening is the position of the circuit breaker auxiliary contact or the disappearance of the trip command. If a circuit breaker failure protection (internal or external) is used on the feeder, this time should be shorter than the delay time of the circuit breaker failure protection so that no reclosure takes place if the circuit breaker fails.

If the reclosure command is transmitted to the opposite end, this transmission can be delayed by the time setting in **T RemoteClose**. This transmission is only possible if the device operates with adaptive dead time at the remote end (**Auto Reclose** = ***ADT*** at the remote end). This parameter is otherwise irrelevant. On the one hand, this delay serves to prevent the remote end device from reclosing unnecessarily when local reclosure is unsuccessful. On the other hand, it should be noted that the line is not available for energy transport until the remote end has also closed. This delay must therefore be added to the dead time for consideration of the network stability.

Forced Three-pole Trip

If reclosure is blocked during the dead time of a single-pole cycle without a three-pole trip command having been initiated, the breaker remains open at one pole. With **AR TRIP 3pole** it is possible to determine that the tripping logic of the device issues a three-pole trip command in this case (pole discrepancy prevention for the CB poles). Set this parameter to ***YES*** if the CB can be tripped single-pole and has no pole discrepancy protection itself. Nevertheless, the device pre-empts the pole discrepancy supervision of the CB because the forced three-pole trip of the device is immediately initiated as soon as the reclosure is blocked following a single-pole trip or if the CB auxiliary contacts report an implausible breaker state (see also Section 2.10 at margin heading „Processing the Circuit Breaker Auxiliary Contacts“). The forced three-pole coupling is also activated when only three-pole cycles are allowed, but a single-pole trip is signalled externally via a binary input.

The forced three-pole coupling is unnecessary if only a common three-pole control of the CB is possible.

Dead Line Check / Reduced Dead Time

With **DLC or RDT** the dead line check or the reduced dead time function can be activated. Either the one or the other can be used as the two options are contradictory. The voltage transformers must be connected to the line side of the circuit breaker if either of these modes is to be used. If this is not the case or if neither of the two functions is used, set **DLC or RDT** = ***WITHOUT***. If the adaptive dead time is used (see below), the parameters mentioned here are omitted because the adaptive dead time implies the properties of the reduced dead time.

DLC or RDT = ***DLC*** means that the dead line check of the line voltage is used. This only enables reclosure after it becomes apparent that the line is dead. In this case, the phase-earth voltage limit is set in **U-dead<** below which the line is considered voltage-free (disconnected). The setting is applied in Volts secondary. If setting is performed from a personal computer using DIGSI®, this value may be entered as a primary value. **T U-stable** determines the measuring time available for determining the no-voltage condition. **U-dead<** is irrelevant here.

DLC or RDT = ***RDT*** means that the reduced dead time is used. This is described in detail in Section 2.10 at margin heading „Reduced Dead Time (RDT)“. In this case the setting of **U-live>** determines the limit voltage, Phase–Earth, above which the line is considered to be fault-free. The setting must be smaller than the lowest expected operating voltage. The setting is applied in Volts secondary. If setting is performed from a personal computer using DIGSI®, this value may be entered as a primary value. **T U-stable** determines the measuring time available for determining the voltage. It should be longer than any transient voltage oscillations resulting from line energization. **U-dead<** is irrelevant here.

Adaptive Dead Time (ADT)

When operating with adaptive dead time, it must be ensured in advance that **one** end per line operates with defined dead times and has an infeed. The other (or the others in multi-branch lines) may operate with adaptive dead time. It is essential that the voltage transformers are located on the line side of the circuit breaker. Details about this function can be found in Section 2.10 at margin heading „Adaptive Dead Time (ADT)“.

For the line end with defined dead times the number of desired reclose cycles must be set during the configuration of the protective functions in **Auto Reclose**. For the devices operating with adaptive dead time, **Auto Reclose** = ***ADT*** must be set during the configuration of the protective functions. Only the parameters described below are interrogated in the latter case. No settings are then made for the individual reclosure cycles. The adaptive dead time implies functionality of reduced dead time.

The adaptive dead time may be voltage-controlled or Remote–CLOSE–controlled. Both are possible at the same time. In the first case, reclosure takes place as soon as the return voltage, after reclosure at the remote end, is detected. For this purpose the device must be connected to voltage transformers located on the line side. In the case of Remote-CLOSE, the autoreclosure waits until the Remote-CLOSE command is received from the remote end.

The action time **T-ACTION ADT** is the timeframe after pickup of the external protection which can start the automatic reclosure function within which the trip command must appear. If no trip command is issued until the action time has expired, there is no reclosure. Depending on the configuration of the function scope (see Section 2.1.1.2), the action time may also be omitted; this applies especially when an initiating protective function has no fault detection signal.

The dead times are determined by the reclosure command of the device at the line end with the defined dead times. In cases where this reclosure command does not appear, e.g. because the reclosure was in the meantime blocked at this end, the readiness of the local device must return to the quiescent state at some time. This takes place after the maximum wait time **T-MAX ADT**. This must be long enough to include the last reclosure of the remote end. In the case of single cycle reclosure, the sum of the maximum dead time plus reclaim time of the other device is sufficient. In the case of multiple reclosure the worst case is that all reclosures of the other end except the last one are unsuccessful. The time of all these cycles must be taken into account. To save having to make exact calculations, it is possible to use the sum of all dead times and all protection operating times plus one reclaim time.

The single-pole release is signalled to the external protection device operation in conjunction with the 6MD66x through a binary input. The external protection device must not trip single-pole until it has received that signal.

In **ADT CB? CLOSE** it can be determined whether circuit-breaker ready is interrogated before reclosure after an adaptive dead time. With the setting ***YES***, the dead time may be extended if the circuit breaker is not ready for a CLOSE–OPEN–cycle when the dead time expires. The maximum extension that is possible is the circuit breaker monitoring time; this was set for all reclosure cycles together in **CB TIME OUT** (see above). Details about the circuit-breaker monitoring can be found in the function description, Section 2.10, at margin heading „Interrogation of the Circuit Breaker Ready State“.

If there is a danger of stability problems in the network during a three-pole reclosure cycle, set **ADT SynRequest** to ***YES***. In this case a check is made before reclosure following a three-pole trip whether the voltages of the feeder and busbar are sufficiently synchronous. This on condition that either the internal synchronism and voltage check function is available or that an external device is available for synchronism check. If only single-pole reclose cycles are executed or no stability problems are expected during three-pole dead times (e.g. due to closely meshed networks or in radial networks), set **ADT SynRequest** to ***NO***.

T U-stable and **U-live>** are only significant if the voltage-controlled adaptive dead time is used. Set in **U-live>** the limit voltage phase–earth above which the line is considered to be fault-free. The setting must be smaller than the lowest expected operating voltage. The setting is applied in Volts secondary. If setting is performed from a personal computer using DIGSI®, this value may be entered as a primary value. **T U-stable** determines the measuring time available for determining the voltage. It should be longer than any transient oscillations resulting from line energization.

1. Reclosure Cycle

If working on a line with adaptive dead time, no further parameters are needed for the individual reclose cycles in this case. All the following parameters assigned to the individual cycles are then superfluous and inaccessible.

1.AR: START is only available if the automatic reclosure is configured with action time in the operating mode, i.e. if during configuration of the protective functions (see Section 2.1.1.2) **AR control mode** = ***Pickup w/ Tact*** or ***Trip w/ Tact*** was set (the first setting only applies to three-pole tripping). It determines whether automatic reclosure should be started at all with the first cycle. This parameter is included mainly for the sake of uniformity of the parameters for every reclosure attempt and is set to ***YES*** for the first cycle. If several cycles are performed, you can (at **AR control mode** = ***Pickup ...***) set this parameter and different action times to control the effectiveness of the individual cycles. Notes and examples can be found in Section 2.10 at margin heading „Action Times“.

The action time **1.AR: T-ACTION** is the timeframe after pickup of the external protection which can start the automatic reclosure function within which the trip command must appear. If no trip command is issued until the action time has expired, there is no reclosure. Depending on the configuration of the functional scope, the action time may also be omitted; this applies especially when an initiating protective function of the external protection device has no fault detection signal.

Depending on the configured operating mode of the automatic reclosure (**AR control mode**), only **1.AR Tdead1Trip** and **1.AR Tdead3Trip** (if **AR control mode** = ***with TRIP...***) are available, or **1.AR Tdead1Trip** to **1.AR Tdead3Trip** (if **AR control mode** = ***with PICKUP ...***).

In **AR control mode** = ***with TRIP...*** you can set different dead times for single-pole and three-pole reclose cycles. Whether single-pole or three-pole tripping takes place depends solely on the initiating protective functions of the external protection device. Single-pole tripping is only possible, of course, if the device and the corresponding protective function are also capable of single-pole tripping.

Table 2-15 AR control mode = **with TRIP ...**

1.AR Tdead1Trip	is the dead time after single-pole tripping,
1.AR Tdead3Trip	is the dead time after three-pole tripping.

If you only want to allow a single-pole reclosure cycle, set the dead time for three-pole tripping to ∞. If you only want to allow a three-pole reclosure cycle, set the dead time for single-pole tripping to ∞. The protection will then trip three-pole regardless of the fault type, since it does not receive the signal for single-pole release from the 6MD66x.

The dead time after single-pole tripping (if set) **1.AR Tdead1Trip** should be long enough for the short-circuit arc to be extinguished and the surrounding air to be deionized so that the reclosure promises to be successful. The longer the line, the longer is this time due to the charging of the conductor capacitances. Usual values are 0.9 s to 1.5 s.

For three-pole tripping (**1.AR Tdead3Trip**) the stability of the network is the main concern. Since the disconnected line cannot transfer any synchronizing forces, only a short dead time is often permitted. The usual values are 0.3 s to 0.6 s. If the device is operating with a synchronism check device, a longer dead time may be tolerated under certain circumstances. Longer three-pole dead times are also possible in radial networks.

For **AR control mode** = ***with PICKUP ...*** it is possible to make the dead times dependent on the type of fault detected by the initiating protection function(s) of the external protection device.

Table 2-16 AR control mode = **with PICKUP ...**

1.AR Tdead 1Flt	is the dead time after single-phase pickup,
1.AR Tdead 2Flt	is the dead time after two-phase pickup,
1.AR Tdead 3Flt	is the dead time after three-phase pickup.

If the dead time is to be the same for all types of faults, set all three parameters the same. Note that these settings only cause different dead times for different pickups. The tripping can only be three-pole.

With the setting in address**EV. FLT. MODE** ***starts 3p AR***, it is possible to apply a separate dead time **1.AR: Tdead EV.** for the three-pole dead time after clearance of the evolving fault (see above at heading „General“). Stability aspects are also decisive here. Normally the setting constraints are similar to **1.AR Tdead3Trip**.

In **1.AR: CB? CLOSE** it can be determined whether the readiness of the circuit breaker is interrogated before this first reclosure. With the setting ***YES***, the dead time may be extended if the circuit breaker is not ready for a CLOSE–OPEN–cycle when the dead time expires. The maximum extension that is possible is the circuit breaker monitoring time; this was set for all reclosure cycles together in **CB TIME OUT** (see above). Details about the circuit-breaker monitoring can be found in the function description, Section 2.10, at margin heading „Interrogation of the Circuit Breaker Ready State“.

If there is a danger of stability problems in the network during a three-pole reclosure cycle, set **1.AR SynRequest** to ***YES***. In this case, a check is made before every reclosure following three-pole tripping whether the voltages of the feeder and busbar are sufficiently synchronized. This on condition that either the internal synchronism and voltage check function is available or that an external device is available for synchronism check. If only single-pole reclose cycles are executed or no stability problems are expected during three-pole dead times (e.g. due to closely meshed networks or in radial networks), set **1.AR SynRequest** to ***NO***.

2. to 4th Reclosure Cycle

If several cycles have been set in the configuration of the scope of protective functions, you can set individual reclosure parameters for the 2nd to 4th cycles. The same options are available as for the first cycle. Again, only some of the parameters shown below will be available depending on the selections made during configuration of the scope of protective functions of the external protection device.

For the 2nd cycle:

2.AR: START	Start in 2nd cycle generally allowed
2.AR: T-ACTION	Action time for the 2nd cycle
2.AR Tdead 1Flt	Dead time after single-phase pickup
2.AR Tdead 2Flt	Dead time after two-phase pickup
2.AR Tdead 3Flt	Dead time after three-phase pickup
2.AR Tdead1Trip	Dead time after single-pole tripping
2.AR Tdead3Trip	Dead time after three-pole tripping
2.AR: Tdead EV.	Dead time after evolving fault
2.AR: CB? CLOSE	CB ready interrogation before reclosing
2.AR SynRequest	Sync. check after three-pole tripping

For the 3rd cycle:

3.AR: START	Start in 3rd cycle generally allowed
3.AR: T-ACTION	Action time for the 3rd cycle
3.AR Tdead 1Flt	Dead time after single-phase pickup
3.AR Tdead 2Flt	Dead time after two-phase pickup
3.AR Tdead 3Flt	Dead time after three-phase pickup
3.AR Tdead1Trip	Dead time after single-pole tripping
3.AR Tdead3Trip	Dead time after three-pole tripping
3.AR: Tdead EV.	Dead time after evolving fault
3.AR: CB? CLOSE	CB ready interrogation before reclosing
3.AR SynRequest	Sync. check after three-pole tripping

For the 4th cycle:

4.AR: START	Start in 4th cycle generally allowed
4.AR: T-ACTION	Action time for the 4th cycle
4.AR Tdead 1Flt	Dead time after single-phase pickup
4.AR Tdead 2Flt	Dead time after two-phase pickup
4.AR Tdead 3Flt	Dead time after three-phase pickup
4.AR Tdead1Trip	Dead time after single-pole tripping
4.AR Tdead3Trip	Dead time after three-pole tripping
4.AR: Tdead EV.	Dead time after evolving fault
4.AR: CB? CLOSE	CB ready interrogation before reclosing
4.AR SynRequest	Sync. check after three-pole tripping

5th to 8th Reclosure Cycle

If more than four cycles were set during configuration of the functional scope, the dead times preceding the fifth (5th) through the ninth (9th) reclosing attempts are equal to the open breaker time which precedes the fourth (4th) reclosing attempt.

Notes on the Information Overview

The most important information about automatic reclosure is briefly explained insofar as it was not mentioned in the following lists or described in detail in the preceding text.

„`>BLK 1.AR-cycle`“ (No. 2742) to „`>BLK 4.-n. AR`“ (No. 2745)

The respective auto-reclose cycle is blocked. If the blocking state already exists when the automatic reclosure function is initiated, the blocked cycle is not executed and may be skipped (if other cycles are permitted). The same applies if the automatic reclosure function is started (running), but not internally blocked. If the block signal of a cycle appears while this cycle is being executed (in progress), the automatic reclosure function is blocked dynamically; no further automatic reclosures cycles are then executed.

„`AR 1.CycZoneRel`“ (No. 2889) to „`AR 4.CycZoneRel`“ (No. 2892)

The automatic reclosure is ready for the respective reclosure cycle. This information indicates which cycle will be run next. For example, external protection functions can use this information to release accelerated or overreaching trip stages prior to the corresponding reclose cycle.

„`AR is blocked`“ (No. 2783)

The automatic reclosure is blocked (e.g. circuit breaker not ready). This information indicates to the operational information system that in the event of an upcoming system fault there will be a final trip, i.e. without reclosure. If the automatic reclosure has been started, this information does not appear.

„`AR not ready`“ (No. 2784)

The automatic reclosure is not ready for reclosure at the moment. In addition to the „`AR is blocked`“ (No. 2783) mentioned above there are also obstructions during the course of the auto-reclosure cycles such as „action time run out“ or „last reclaim time running“. This information is particularly helpful during testing because no protection test cycle with reclosure may be initiated during this state.

„`AR in progress`“ (No. 2801)

This information appears following starting of the auto reclose function, i.e. with the first trip command that can start the auto reclose function. If this reclosure was successful (or any in the case of multiple cycles), this information resets with the expiry of the last reclaim time. If no reclosure was successful or if reclosure was blocked, it ends with the last – the final – trip command.

„`AR Sync.Request`“ (No. 2865)

Measuring request to an external synchronism check device. „`AR Sync.Request`“ is only relevant if the parameter 3413 **`Cmd.via control`** is set to „No“, since only in that case synchronization is performed by an external synchronism check device. The information appears at the end of a dead time subsequent to three-pole tripping if a synchronism request was parameterized for the corresponding cycle. Reclosure only takes place when the synchronism check device has provided release signal „`>Sync.release`“ (No. 2731).

Cmd.via control (No. 3413)

The control device to be switched (Q0, Q1 etc.) can be specified with this parameter. The control device can be closed (CLOSE command) or opened (in case of a forced three-pole trip). The advantage of this setting is that plausibility checks are performed for the device.

If **Cmd.via control** is set to „No“, the CLOSE command is output using the single-point indications 2851 „AR CLOSE Cmd.“. The setting of **Cmd.via control** has also an effect on the synchronization of the breaker closure (if synchronization is desired). If a control device is set, synchronization is always performed using an internal synchronization module. If **Cmd.via control** is set to „No“ control device, synchronization is performed via binary input 2731 „AR CLOSE Cmd.“.

Internal SYNC (No. 3414)

This parameter is relevant if commands are output via a control device (Q0, Q1 etc.) and synchronization of the breaker closure is desired. In that case the synchronization module is specified in this parameter.

The control device stated in the setting of the selected synchronization module must be the same as in parameter 3413 **Cmd.via control**.

„>Sync.release“ (No. 2731)

Release of reclosure by an external synchronism check device if this was requested by the output information „AR Sync.Request“ (No. 2865).

2.10.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
3401	AUTO RECLOSE	OFF ON	OFF	Auto-Reclose Function
3402	CB? 1.TRIP	YES NO	NO	CB ready interrogation at 1st trip
3403	T-RECLAIM	0.50 .. 300.00 sec	3.00 sec	Reclaim time after successful AR cycle
3404	T-BLOCK MC	0.50 .. 300.00 sec; 0	1.00 sec	AR blocking duration after manual close
3406	EV. FLT. RECOG.	with PICKUP with TRIP	with TRIP	Evolving fault recognition
3407	EV. FLT. MODE	blocks AR starts 3p AR is ignored	starts 3p AR	Evolving fault (during the dead time)
3408	T-Start MONITOR	0.01 .. 300.00 sec	0.20 sec	AR start-signal monitoring time
3409	CB TIME OUT	0.01 .. 300.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time

Addr.	Parameter	Setting Options	Default Setting	Comments
3410	T RemoteClose	0.00 .. 300.00 sec; ∞	∞ sec	Send delay for remote close command
3411A	T-DEAD EXT.	0.50 .. 300.00 sec; ∞	10.00 sec	Maximum dead time extension
3413	Cmd.via control	(Setting options depend on configuration)	None	Close command via control device
3414	Internal SYNC	(Setting options depend on configuration)	None	Internal synchronisation
3420	AR w/ DIST.	YES NO	YES	AR with distance protection
3421	AR w/ SOTF-O/C	YES NO	YES	AR with switch-onto-fault overcur-rent
3422	AR w/ W/I	YES NO	YES	AR with weak infeed tripping
3423	AR w/ EF-O/C	YES NO	YES	AR with earth fault overcurrent prot.
3424	AR w/ DTT	YES NO	YES	AR with direct transfer trip
3425	AR w/ BackUpO/C	YES NO	YES	AR with back-up overcurrent
3430	AR TRIP 3pole	YES NO	YES	3pole TRIP by AR
3431	DLC or RDT	WITHOUT RDT DLC	WITHOUT	Dead Line Check or Reduced Dead Time
3432	ADT Op. mode	w/ VoltageCheck w/ RemoteClose	w/ VoltageCheck	Operating mode for Adaptive Dead Time
3433	T-ACTION ADT	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3434	T-MAX ADT	0.50 .. 3000.00 sec	5.00 sec	Maximum dead time
3435	ADT 1p allowed	YES NO	NO	1pole TRIP allowed
3436	ADT CB? CLOSE	YES NO	NO	CB ready interrogation before re-closing
3437	ADT SynRequest	YES NO	NO	Request for synchro-check after 3pole AR
3438	T U-stable	0.10 .. 30.00 sec	0.10 sec	Supervision time for dead/ live voltage
3440	U-live>	30 .. 90 V	48 V	Voltage threshold for live line or bus
3441	U-dead<	2 .. 70 V	30 V	Voltage threshold for dead line or bus
3450	1.AR: START	YES NO	YES	Start of AR allowed in this cycle
3451	1.AR: T-ACTION	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3453	1.AR Tdead 1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3454	1.AR Tdead 2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults

Addr.	Parameter	Setting Options	Default Setting	Comments
3455	1.AR Tdead 3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3456	1.AR Tdead1Trip	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1pole trip
3457	1.AR Tdead3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3458	1.AR: Tdead EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3459	1.AR: CB? CLOSE	YES NO	NO	CB ready interrogation before re-closing
3460	1.AR SynRequest	YES NO	NO	Request for synchro-check after 3pole AR
3461	2.AR: START	YES NO	NO	AR start allowed in this cycle
3462	2.AR: T-ACTION	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3464	2.AR Tdead 1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3465	2.AR Tdead 2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3466	2.AR Tdead 3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3467	2.AR Tdead1Trip	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip
3468	2.AR Tdead3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3469	2.AR: Tdead EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3470	2.AR: CB? CLOSE	YES NO	NO	CB ready interrogation before re-closing
3471	2.AR SynRequest	YES NO	NO	Request for synchro-check after 3pole AR
3472	3.AR: START	YES NO	NO	AR start allowed in this cycle
3473	3.AR: T-ACTION	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3475	3.AR Tdead 1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3476	3.AR Tdead 2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3477	3.AR Tdead 3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3478	3.AR Tdead1Trip	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip
3479	3.AR Tdead3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3480	3.AR: Tdead EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3481	3.AR: CB? CLOSE	YES NO	NO	CB ready interrogation before re-closing
3482	3.AR SynRequest	YES NO	NO	Request for synchro-check after 3pole AR
3483	4.AR: START	YES NO	NO	AR start allowed in this cycle
3484	4.AR: T-ACTION	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3486	4.AR Tdead 1Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3487	4.AR Tdead 2Flt	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3488	4.AR Tdead 3Flt	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3489	4.AR Tdead1Trip	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip

Addr.	Parameter	Setting Options	Default Setting	Comments
3490	4.AR Tdead3Trip	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3491	4.AR: Tdead EV.	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3492	4.AR: CB? CLOSE	YES NO	NO	CB ready interrogation before re-closing
3493	4.AR SynRequest	YES NO	NO	Request for synchro-check after 3pole AR

2.10.4 Information List

No.	Information	Type of In-formation	Comments
2701	>AR on	SP	>AR: Switch on auto-reclose function
2702	>AR off	SP	>AR: Switch off auto-reclose function
2703	>AR block	SP	>AR: Block auto-reclose function
2711	>AR Start	SP	>External start of internal Auto reclose
2712	>Trip L1 AR	SP	>AR: External trip L1 for AR start
2713	>Trip L2 AR	SP	>AR: External trip L2 for AR start
2714	>Trip L3 AR	SP	>AR: External trip L3 for AR start
2715	>Trip 1pole AR	SP	>AR: External 1pole trip for AR start
2716	>Trip 3pole AR	SP	>AR: External 3pole trip for AR start
2727	>AR RemoteClose	SP	>AR: Remote Close signal
2731	>Sync.release	SP	>AR: Sync. release from ext. sync.-check
2737	>BLOCK 1pole AR	SP	>AR: Block 1pole AR-cycle
2738	>BLOCK 3pole AR	SP	>AR: Block 3pole AR-cycle
2739	>BLK 1phase AR	SP	>AR: Block 1phase-fault AR-cycle
2740	>BLK 2phase AR	SP	>AR: Block 2phase-fault AR-cycle
2741	>BLK 3phase AR	SP	>AR: Block 3phase-fault AR-cycle
2742	>BLK 1.AR-cycle	SP	>AR: Block 1st AR-cycle
2743	>BLK 2.AR-cycle	SP	>AR: Block 2nd AR-cycle
2744	>BLK 3.AR-cycle	SP	>AR: Block 3rd AR-cycle
2745	>BLK 4.-n. AR	SP	>AR: Block 4th and higher AR-cycles
2746	>Trip for AR	SP	>AR: External Trip for AR start
2747	>Pickup L1 AR	SP	>AR: External pickup L1 for AR start
2748	>Pickup L2 AR	SP	>AR: External pickup L2 for AR start
2749	>Pickup L3 AR	SP	>AR: External pickup L3 for AR start
2750	>Pickup 1ph AR	SP	>AR: External pickup 1phase for AR start
2751	>Pickup 2ph AR	SP	>AR: External pickup 2phase for AR start
2752	>Pickup 3ph AR	SP	>AR: External pickup 3phase for AR start
2780	AR Mask. Error	OUT	AR: Masking error voltage transformer
2781	AR off	OUT	AR: Auto-reclose is switched off
2782	AR on	IntSP	AR: Auto-reclose is switched on
2783	AR is blocked	OUT	AR: Auto-reclose is blocked
2784	AR not ready	OUT	AR: Auto-reclose is not ready
2787	CB not ready	OUT	AR: Circuit breaker not ready
2788	AR T-CBreadyExp	OUT	AR: CB ready monitoring window expired

No.	Information	Type of Information	Comments
2796	AR on/off BI	IntSP	AR: Auto-reclose ON/OFF via BI
2801	AR in progress	OUT	AR in progress
2809	AR T-Start Exp	OUT	AR: Start-signal monitoring time expired
2810	AR TdeadMax Exp	OUT	AR: Maximum dead time expired
2818	AR evolving Flt	OUT	AR: Evolving fault recognition
2820	AR Program1pole	OUT	AR is set to operate after 1p trip only
2821	AR Td. evol.Flt	OUT	AR dead time after evolving fault
2839	AR Tdead 1pTrip	OUT	AR dead time after 1pole trip running
2840	AR Tdead 3pTrip	OUT	AR dead time after 3pole trip running
2841	AR Tdead 1pFlt	OUT	AR dead time after 1phase fault running
2842	AR Tdead 2pFlt	OUT	AR dead time after 2phase fault running
2843	AR Tdead 3pFlt	OUT	AR dead time after 3phase fault running
2844	AR 1stCyc. run.	OUT	AR 1st cycle running
2845	AR 2ndCyc. run.	OUT	AR 2nd cycle running
2846	AR 3rdCyc. run.	OUT	AR 3rd cycle running
2847	AR 4thCyc. run.	OUT	AR 4th or higher cycle running
2848	AR ADT run.	OUT	AR cycle is running in ADT mode
2851	AR CLOSE Cmd.	OUT	AR: Close command
2852	AR Close1.Cyc1p	OUT	AR: Close command after 1pole, 1st cycle
2853	AR Close1.Cyc3p	OUT	AR: Close command after 3pole, 1st cycle
2854	AR Close 2.Cyc	OUT	AR: Close command 2nd cycle (and higher)
2861	AR T-Recl. run.	OUT	AR: Reclaim time is running
2862	AR successful	OUT	AR successful
2863	Definitive Trip	OUT	Definitive TRIP
2864	AR 1p Trip Perm	OUT	AR: 1pole trip permitted by internal AR
2865	AR Sync.Request	OUT	AR: Synchro-check request
2871	AR TRIP 3pole	OUT	AR: TRIP command 3pole
2889	AR 1.CycZoneRel	OUT	AR 1st cycle zone extension release
2890	AR 2.CycZoneRel	OUT	AR 2nd cycle zone extension release
2891	AR 3.CycZoneRel	OUT	AR 3rd cycle zone extension release
2892	AR 4.CycZoneRel	OUT	AR 4th cycle zone extension release
2893	AR Zone Release	OUT	AR zone extension (general)
2894	AR Remote Close	OUT	AR Remote close signal send

2.11 Function control

The function logic with its associated process monitor coordinates the sequence of the protective functions, processes functional decisions, and processes data received from the system. In particular, this includes:

Applications

- Line energization recognition,
- Processing of the circuit breaker position(s),
- Openpole detector,
- Voltage supervision,
- Fault detection logic,
- Tripping logic.

2.11.1 Line Energization Recognition

The line energization recognition function is relevant in the 6MD66x if the automatic reclosing function is activated. When a protected object is manually switched onto a fault, it is desirable to avoid a reclosure, i.e. to block the AR.

The manual closing command must be indicated to the device via a binary input. In order to be independent of the duration that the switch is closed, the command is set to a defined length in the device (adjustable with the address `1150` **`SI Time Man.Cl`**). The figure below shows the logic diagram.

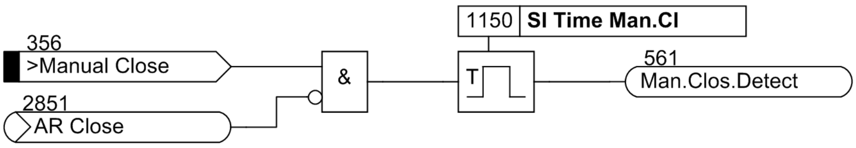


Figure 2-63 Logic diagram of the manual closing procedure

If the device has an integrated automatic reclosure, the integrated manual closure logic of the 6MD66x automatically distinguishes between an external control command via the binary input and an automatic reclosure by the internal automatic reclosure so that the binary input „`>Manual Close`“ can be connected directly to the control circuit of the close coil of the circuit breaker (Figure 2-64). Each reclosure that is not initiated by the internal automatic reclosure function is interpreted as a manual reclosure, even it has been initiated by a control command from the device.

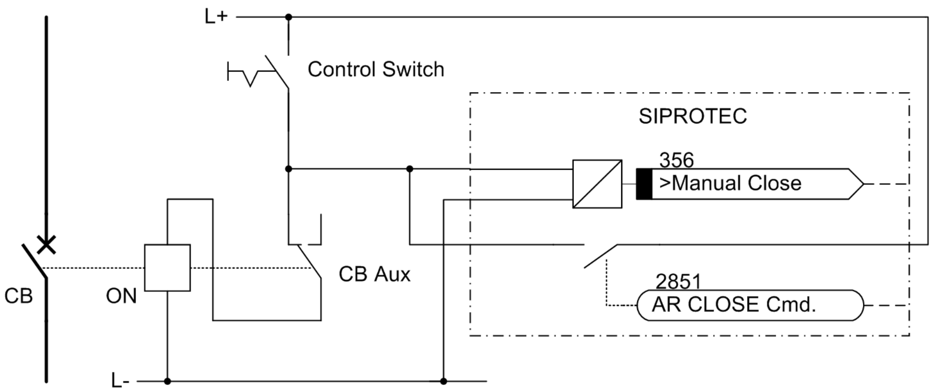


Figure 2-64 Manual closure with internal automatic reclosure

CB	Circuit breaker
ON	Circuit breaker close coil
CBaux	Circuit breaker auxiliary contact

2.11.2 Detection of the circuit breaker position

For Protection Purposes

Various functions of the 6MD66x need information on the circuit breaker position in order to function optimally. These are:

- Plausibility check prior to automatic reclosure,
- Circuit breaker failure protection,
- Verification of the dropout condition for the trip command.

A circuit breaker position logic is incorporated in the device (Figure 2-65). Depending on the type of auxiliary contact(s) provided by the circuit breaker and the method in which these are connected to the device, there are several alternatives of implementing this logic.

In most cases it is sufficient to furnish the status of the circuit breaker with its auxiliary contacts via a binary input to the device. This always applies if the circuit breaker is only switched three-pole. Then the NO auxiliary contact of the circuit breaker is connected to a binary input which must be configured to the input function „>CB 3p Closed“ (No. 379). The other inputs are then not used and the logic is restricted in principle to simply passing of this input information on.

If the circuit breaker poles can be switched individually, and only a parallel connection of the NO individual pole auxiliary contacts is available, the relevant binary input (BI) is allocated to the function „>CB 3p Open“ (No. 380). The remaining inputs are again not used in this case.

If the circuit breaker poles can be switched individually, and the individual auxiliary contacts are available, an individual binary input should be used for each auxiliary contact if this is possible and if the device can and should trip single-pole. With this configuration, the device can process the maximum amount of information. Three binary inputs are used for this purpose:

- „>CB Aux. L1“ (No. 351) for the auxiliary contact of pole L1,
- „>CB Aux. L2“ (No. 352) for the auxiliary contact of pole L2,
- „>CB Aux. L3“ (No. 353) for the auxiliary contact of pole L3.

The inputs No. 379 „>CB 3p Closed“ and No. 380 „>CB 3p Open“ are not used in this case, even if they are configured to binary inputs and receive signals.

If the circuit breaker can be switched individually, two binary inputs are sufficient if both the parallel as well as series connection of the auxiliary contacts of the three poles are available. In this case, the parallel connection of the auxiliary contacts is routed to the input function „`>CB 3p Closed`“ (No. 379) and the series connection is routed to the input function „`>CB 3p Open`“ (No. 380).

Please note that Figure 2-65 shows the complete logic for all connection alternatives. For each particular application, only a portion of the inputs is used as described above.

The eight output signals of the circuit breaker position logic can be processed by the individual protection and supplementary functions. The output signals are blocked if the signals transmitted from the circuit breaker are not plausible: for example, the circuit breaker cannot be open and closed at the same time. Furthermore, no current can flow over an open breaker contact.

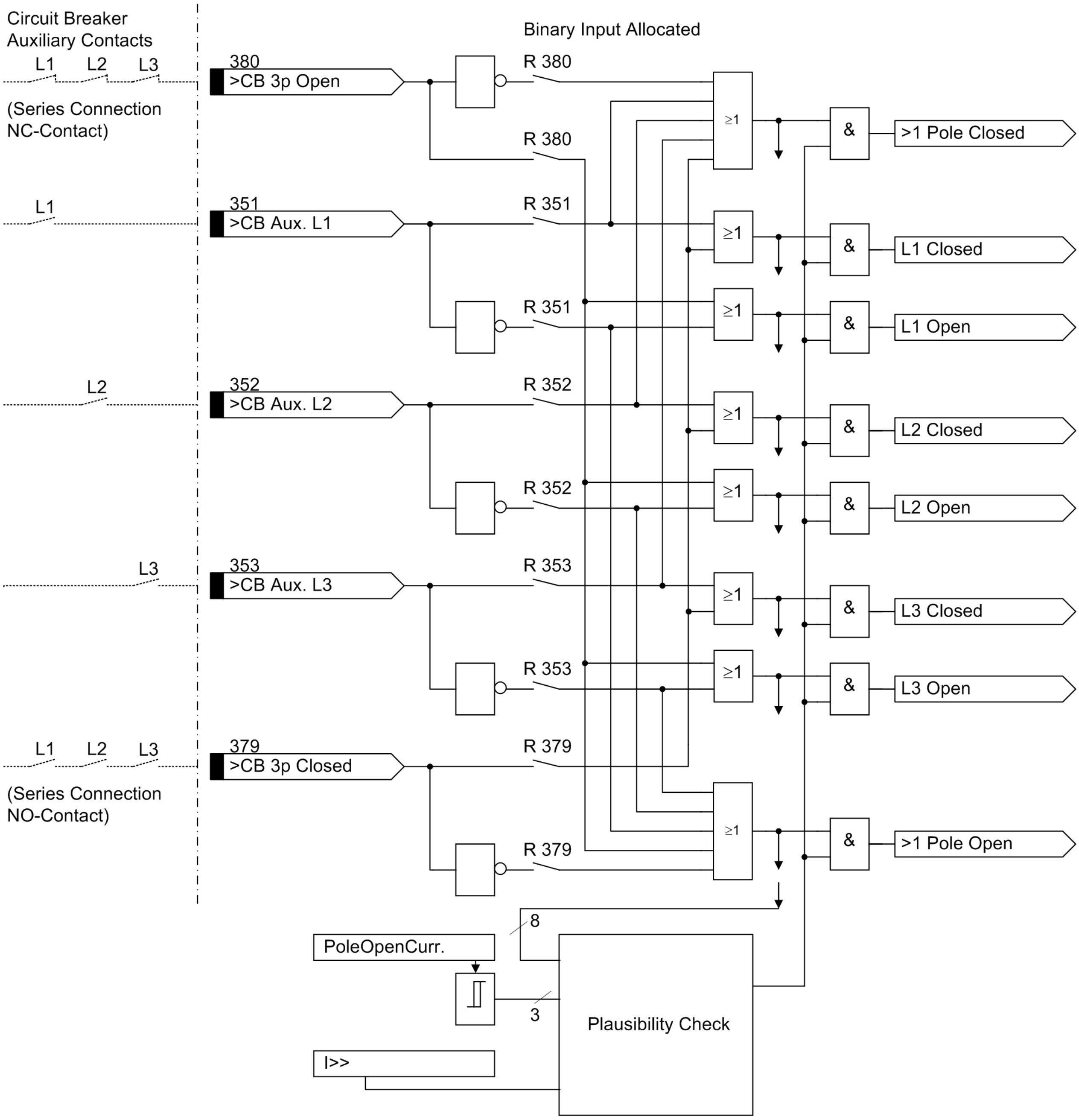


Figure 2-65 Circuit breaker position logic

Automatic Reclosure

Separate binary inputs comprising information on the position of the circuit breaker are available for the automatic reclosure. This is important for

- The plausibility check before automatic reclosure (refer to Section 2.10),

When using $1^1/_2$ or 2 circuit breakers in each feeder, the automatic reclosure function is referred to **one** circuit breaker. The feedback information of this circuit breaker can be connected separately to the device.

For this, separate binary inputs are available, which should be treated the same and configured additionally if necessary. These have a similar significance as the inputs described above for protection applications and are marked with „CB1 ...“ to distinguish them, i.e.:

- „`>CB1 3p Closed`“ (No. 410) for the series connection of the NO auxiliary contacts of the CB,
- „`>CB1 3p Open`“ (No. 411) for the series connection of the NC auxiliary contacts of the CB,
- „`>CB1 Pole L1`“ (No. 366) for the auxiliary contact of pole L1,
- „`>CB1 Pole L2`“ (No. 367) for the auxiliary contact of pole L2,
- „`>CB1 Pole L3`“ (No. 368) for the auxiliary contact of pole L3.

2.11.3 Open-pole Detector

The open-pole detector determines on the basis of the measured current and voltage whether the line section to be protected is isolated.

Parameter 1130 **PoleOpenCurrent** serves to specify the residual current that will be used as the criterion whether the line is de-energized.

The "open_pole_i“ signal of a phase is set as soon as the phase current drops below the configured threshold "PoleOpenCurrent". The signal is stabilised by means of a hysteresis; stabilisation over time is not provided.

The negative effects of current transformer saturation and limitation, which are to be expected in the 6MD66x when the currents exceed approx. 1.2In, are not taken into account because the maximum current limit **PoleOpenCurrent** is 1.0In.

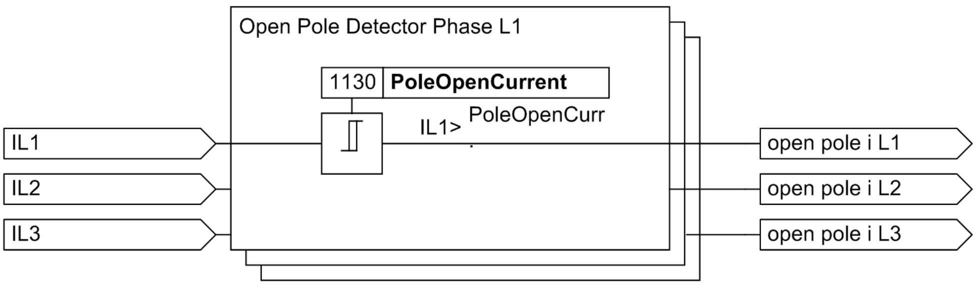


Figure 2-66 Creation process of the "open_pole_i“ signals

In the stabilisation of the open-pole detector, the following hysteresis is used for the parameters **PoleOpenCurrent**:

- Pickup thresholdParameterised threshold
- Dropout threshold1.1*parameterised threshold

2.11.4 Voltage Supervision

If the automatic reclosure function of the 6MD66x is configured with the operation mode "Dead line check", it also makes sense to set the appropriate parameters for activation the voltage supervision function. If the voltage supervision detects a failure of the phase-to-earth voltages, the automatic reclosure is blocked. Voltage supervision is based on a plausibility check between the phase currents and the phase-to-earth voltages. Where the circuit breaker auxiliary contacts are available, i.e. configured to binary inputs, they should also be used for supervision.

A failure of the measured voltage is detected if the following conditions are met at the same time:

- All three phase-to-earth voltages are less than **`U<max (3ph)`**,
- At least one phase current is larger than **`PoleOpenCurrent`** or at least one breaker pole is closed (can be set),
- No protection function has picked up,
- This condition persists for a settable time **`T V-Supervision`** (default setting: 3 s).

This time **`T V-Supervision`** is required to prevent that a voltage failure is detected before the protection picks up.

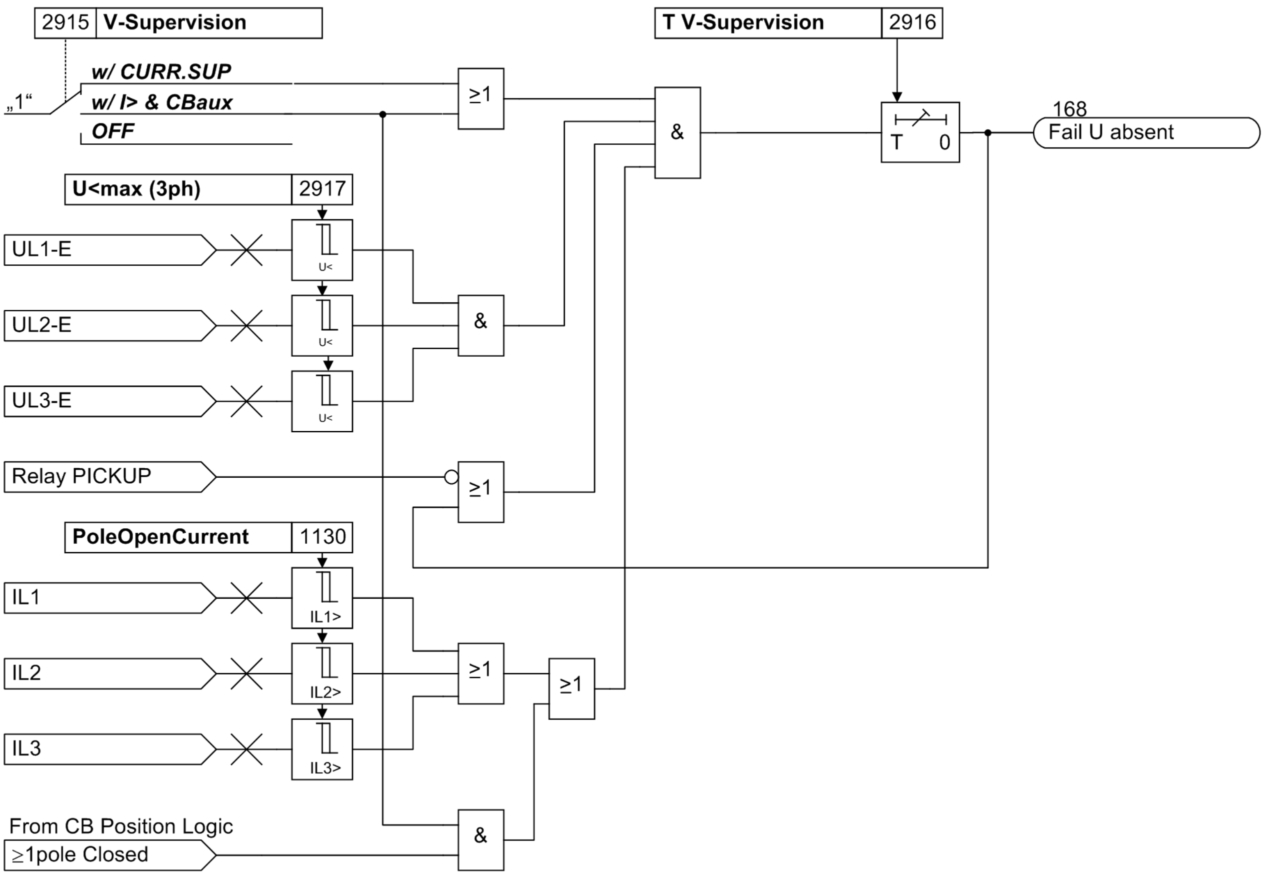


Figure 2-67 Logic diagram of the fuse failure monitor

2.11.5 Pickup Logic for the Entire Device

Phase Segregated Pickup

The pickup logic combines the fault detection (pickup) signals of all protection functions. In the case of those protection functions that allow for phase segregated pickup, the pickup is output in a phase segregated manner. Thus, the alarms „`Relay PICKUP L1`“, „`Relay PICKUP L2`“ and „`Relay PICKUP L3`“ are available.

General Pickup

The pickup signals are combined with OR and lead to a general pickup of the device. It is signalled with the alarm „`Relay PICKUP`“. If no protection function of the device has picked up any longer, „`Relay PICKUP`“ disappears (indication: „OFF“).

General device pickup is a precondition for a series of internal and external functions that occur subsequently. The following are among the internal functions controlled by general device pickup:

- Opening of fault case: from general device pickup to general device dropout, all fault indications are entered in the trip log.
- Initialization of fault storage: the storage and maintenance of fault values can also be made dependent on the occurrence of a trip command.
- Generation of spontaneous indications: certain fault indications can be displayed as so-called spontaneous indications (see „Spontaneous Indications“ below). This indication can also be made dependent on the general device trip.
- Start action time of automatic reclosure (if available and used).

Spontaneous Indications

Spontaneous indications are alarms that are displayed automatically after a general pickup of the device or after the trip command of the device. In the case of 6MD66x they are the following:

„Relay PICKUP“:	protective function that picked up;
„S/E/F TRIP“:	protection function which tripped (only device with graphic display);
„`PU Time`“:	the operating time from the general pickup to the dropout of the device, the time is given in ms;
„`TRIP Time`“:	the operating time from general pickup to the first trip command of the device, in ms;

2.11.6 Tripping Logic of the Entire Device

Three-pole Tripping

The following protection functions implemented in the 6MD66x carry out a three-pole trip command:

- Tripping of the breaker failure protection for the local circuit breaker, if the conditions for single-pole tripping are not fulfilled,
- Tripping of the breaker failure protection for the adjacent circuit breakers,
- Three-pole transfer trip of the automatic reclosure function.

If a single-pole tripping is generally not possible or not desired, the output function **Relay TRIP 3ph.** is used for the output of commands to the circuit breaker. In these cases the following sections regarding single-pole tripping are not of interest.

Single-pole Tripping

In the 6MD66x, single-pole tripping is only provided for tripping of the local circuit breaker, if the conditions for a trip are fulfilled (single-pole starting via binary input, and parameter 3903 **1p-RETRIP (T1)** of the breaker failure protection set to "yes"). The general phase-segregated trip command alarms are „Relay TRIP L1“, „Relay TRIP L2“ and „Relay TRIP L3“. These alarms can be allocated to LEDs or output relays. In the event of three-pole tripping all three alarms pick up. .

General Trip

All trip signals for the protective functions are connected by OR and generate the message „Relay TRIP“. This can be allocated to LED or output relay.

Terminating the Tripping Command

Once a trip command is initiated, it is phase segregatedly latched (in the event of three-pole tripping for each of the three poles) (refer to Figure 2-68). At the same time, the minimum trip command duration **TMin TRIP CMD** is started. This ensures that the trip command is output for a sufficiently long time to the circuit breaker even if the tripping protection function resets very rapidly. The trip commands can only be terminated when the last protection function dropped out (i.e. functions no longer pick up) AND the minimum trip signal duration has expired.

A single-pole trip command leads to the single-pole trip command alarms „Relay TRIP 1pL1“ to „Relay TRIP 1pL3“.

A further condition for the reset of the trip command is that the circuit breaker has opened, in the event of single-pole tripping the relevant circuit breaker pole. In the function control of the device, this is checked by means of the circuit breaker position feedback (Section „Detection of the Circuit Breaker Position“) and the flow of current. The residual current **PoleOpenCurrent** that is certainly undershot when the circuit breaker pole is open is set in address 1130. Address 1135 **Reset Trip CMD** determines under which conditions a trip command is reset. If ***CurrentOpenPole*** is set, the trip command is reset as soon as the current disappears. It is important that the value set in address 1130 **PoleOpenCurrent** (see above) is undershot. If ***Current AND CB*** is set, the circuit breaker auxiliary contact must send a message that the circuit breaker is open. It is a prerequisite for this setting that the position of the auxiliary contacts is allocated via a binary input. If this additional condition is not required for resetting the trip command (e.g. if test sockets are used for protection testing), it can be switched off with the setting .

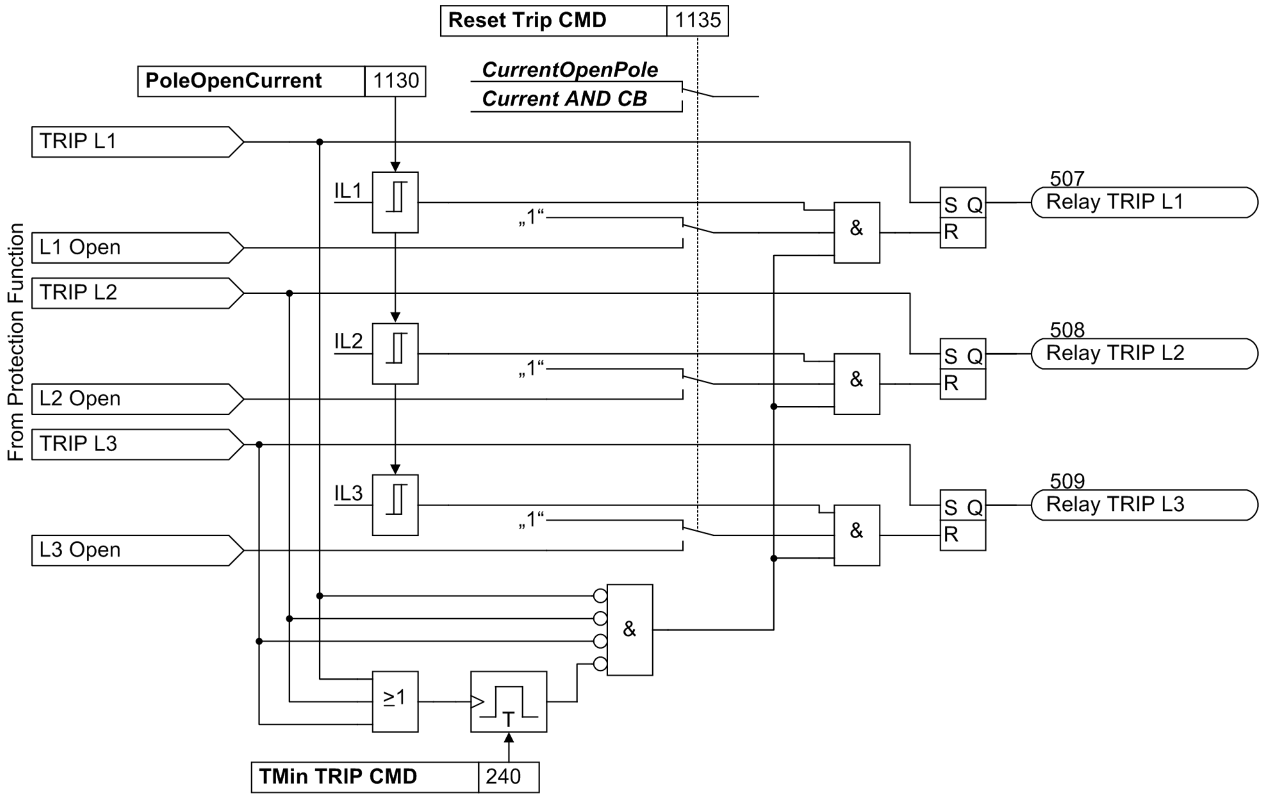


Figure 2-68 Storage and termination of the trip command

Trip-dependent Indications

The recording of indications masked to local LEDs, and the maintenance of spontaneous indications, can be made dependent on whether the device has issued a trip command. The information will then not be output if a protection function (i.e. the breaker failure protection) has picked up in the event of a fault, but the 6MD66x has not tripped because the pickup was reset first.

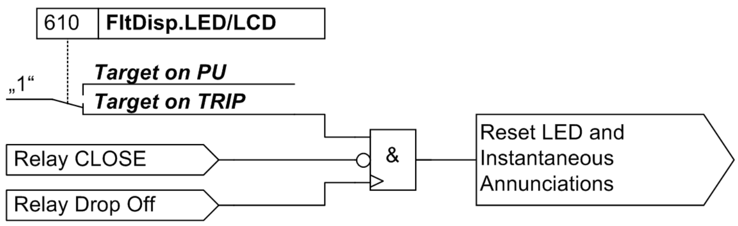


Figure 2-69 Logic diagram of the command-dependent alarms

Switching Statistics

The number of trips of the local circuit breaker initiated by the device 6MD66x are counted. Their number is counted separately for each breaker pole.

If the device is equipped with the integrated automatic reclosure, the automatic close commands are also counted, separately for reclosure after single-pole tripping, after three-pole tripping as well as separately for the first reclosure cycle and other reclosure cycles.

The counter and memory levels are secured against loss of auxiliary voltage. They can be set to zero or to any other initial value. For more details, refer to the SIPROTEC® 4 System Description.

2.11.7 Setting Notes

Command Duration

The setting of the minimum trip signal duration **TMin TRIP CMD** (address 240 was already discussed in Subsection 2.1.2. This setting applies to all protective functions that initiate tripping.

2.12 Inter-relay communication through port C

Inter-relay communication through port C, abbreviated **IRC**, allows the exchange of information between SIPROTEC® 4 devices without a SICAM control centre. For this purpose, devices are connected to each other via an RS485 connection or an external converter and fibre optic cable. Process information such as indications and measured values (RMS values) are transferred via this bus.

Configuration of the Inter-relay communication through port C is performed with the DIGSI® operating program. To be able to manage 32 Users/Fault indications, you need DIGSI® as from version 4.5.

Communication works cyclically on the basis of an image protocol. The cycle time is constant in fault-free operation and dependent on the baud rate, the amount of process information and the number of connected devices. Please refer also to "Relationship between the number of users and transmission time“. All SIPROTEC® 4 devices communicating with each other are called users of an IRC combination. An IRC combination can handle a maximum of thirty two users.

Applications

- An Inter-relay communication through port C setup always makes sense if the same process information needs to made available to several SIPROTEC® 4 devices. Instead of sending the same process information to several SIPROTEC® 4 devices per single line wiring, it is only sent to a single SIPROTEC® 4 device. The other SIPROTEC® 4 devices receive the required process information via the serial IRC bus.
- An application for the Inter-relay communication through port C could be the interlocking conditions within a bay with a $1^1/_2$ circuit breaker method operated with three bay controllers.
- A quick view of the IRC combination provides the Web Monitor (see Chapter 2.14). Combination data, device data, master data, combination structure and messages of each user are displayed there.
- The OLM (Optical Link Module) interface modules required for an optical connection of the IRC user can be found in the accessory list in the Appendix.

Prerequisites

Certain requirements must be fulfilled to build an IRC combination.

The participating SIPROTEC® 4 devices must be suited toward Inter-relay communication through port C (available only for 6MD66).

A corresponding communications module must be installed in the SIPROTEC® 4 devices.

The DIGSI® operating program must be installed on the PC.

The project must contain at least two SIPROTEC® 4 devices which fulfill the requirements for Inter-relay communication through port C and an IRC combination (can be created via configuration).

2.12.1 Function Principle

The IRC is based on the **Master-Slave principle**. One SIPROTEC® 4 device of the IRC combination operates as the master. All other nodes are slaves. The master sends queries to all the slaves one after the other. On receiving this query, each slave transmits its particular process information meant for the IRC combination. The master collects all the process information it receives and collates it, together with its own information, into a single message. It then sends this message to all the slaves. From this message, each slave then extracts the process information which is relevant to the particular slave.

Note

Due to the cyclical method of operation of the IRC, only those indications are transferred whose value changes are pending longer than the actual cycle time, which can be 50 ms or more.

Electrical RS485 connection

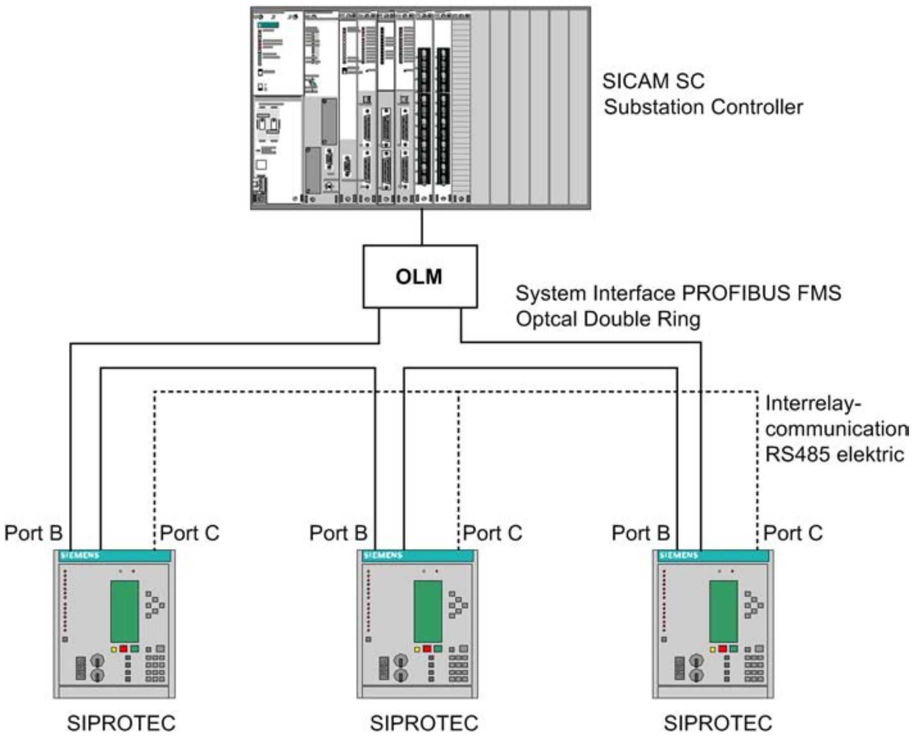


Figure 2-70 Connection of bay controllers to inter-relay communication (electrical)

The connection between the devices occurs electrically via an RS485 interface. The electrical connections are terminated with resistors at the ends (first and last device), which are set via jumpers in the 6MD66x device. The jumper settings can be found in Chapter **Installation and Commissioning**.

Optical connection OLM

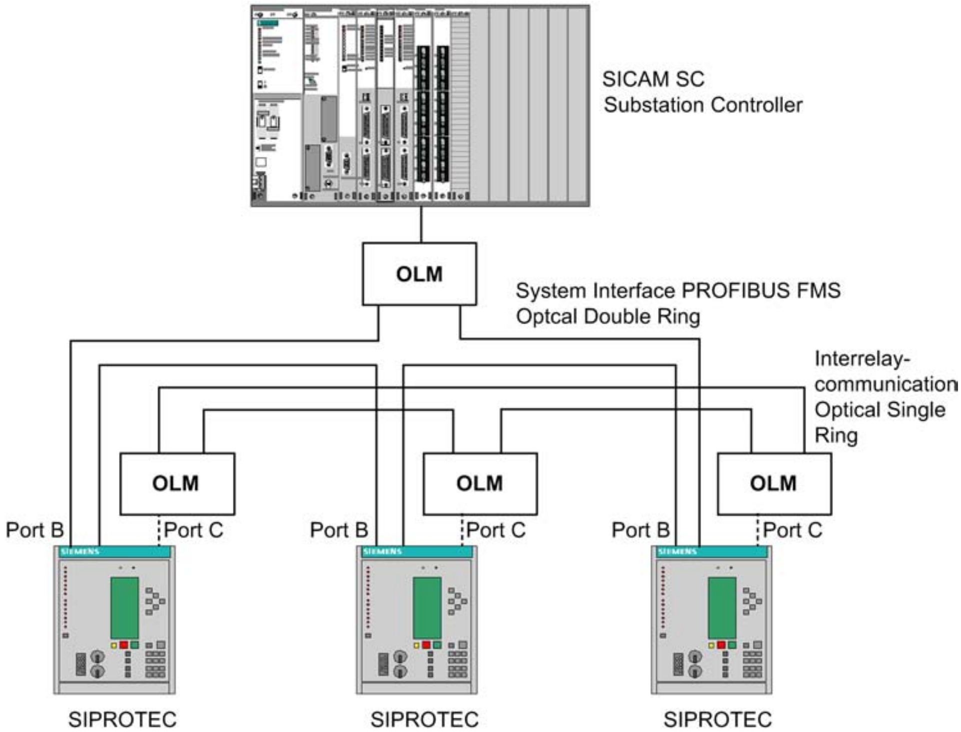


Figure 2-71 Connection of bay controllers to inter-relay communication (optical)

An OLM is used as an interface converter (optical/electrical). The connection from the 6MD66x device to the OLM occurs electrically via an RS485 interface. The electrical connections are to be terminated with resistors. These terminating resistors are set with jumpers in the 6MD66x device and with DIL switches (S1, switch 1 and 2) in the OLM. The jumper settings can be found in Chapter **Installation and Commissioning**.

The connection of the interface converters is optical (in series) and its operation is asynchronous. A theoretical baud rate of 9600 Baud to 115200 Baud is set with a DIL switch (S2, switch 5 off, 6 on, 7 on, 8 off). A matching setting can be selected in DIGSI® using the interface settings.

Application Example

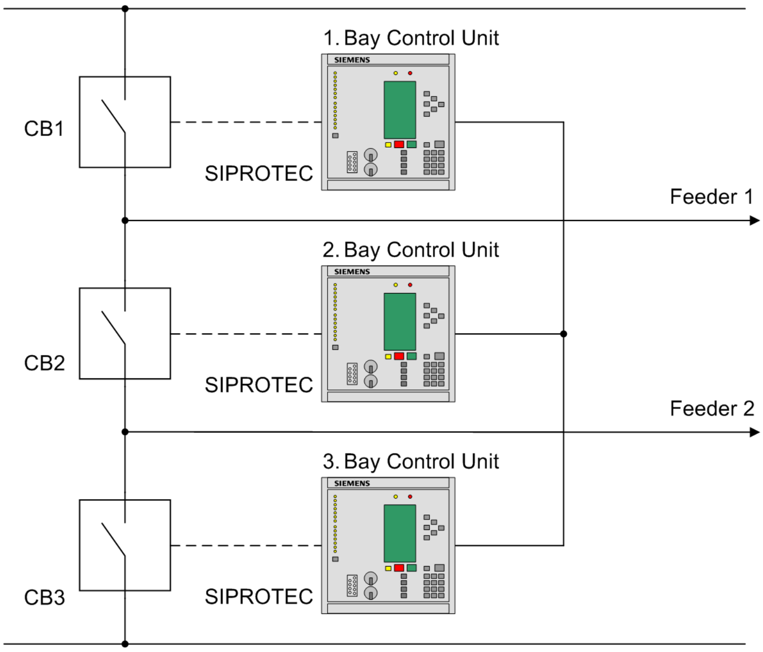


Figure 2-72 $1^1/_2$– Circuit breaker method, disconnector and earth electrode not shown

2.12.2 Configuring Inter-relay Communication

The procedure for configuring the devices connected with each other in the Inter-relay communication through port C is explained in the following sections.

Insert SIPROTEC® 4 device

Objects of type **SIPROTEC device** are inserted into the project structure from the device catalog via drag and drop. Right-click an object of type **Folder**. In the context menu, click **Insert new object** → **SIPROTEC device**. The window **Device catalog** opens. Alternatively click **Device catalog** in the context menu.

When selecting a device type, note that this must be suitable for a Inter-relay communication through port C. After placing the object within the project, the dialog box **Properties - SIPROTEC device** opens, as usual.

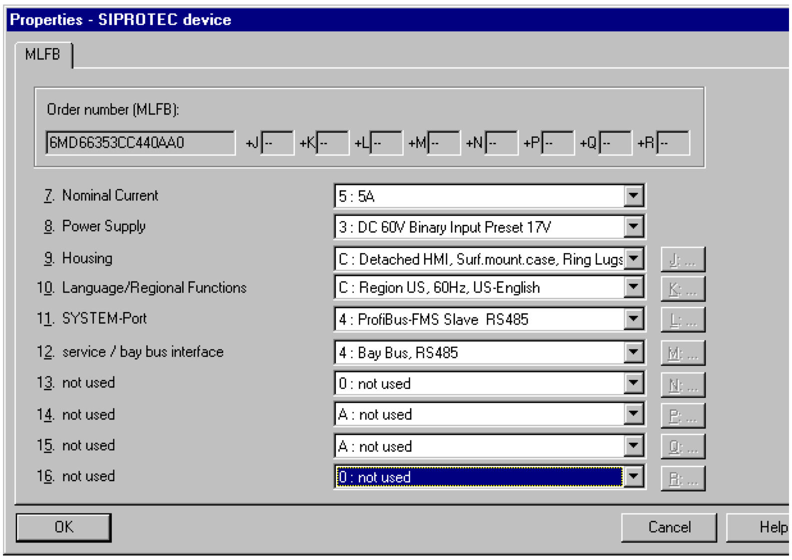


Figure 2-73 Properties SIPROTEC device dialog box

Importing a SIPROTEC® 4 device

In addition to inserting a new device, a device which is already available in another project can be imported into the project structure. It is to be noted here that a device can then only participate in an IRC combination if it is imported as a **SIPROTEC device**. A **SIPROTEC variant** cannot participate in an IRC combination, as the VD address is not unique.

Right-click an object of type Folder. In the context menu, click **Import device**.... The **Import device** dialog box opens.

Select the alternative **As SIPROTEC** device and confirm with **OK**.

Specifying the Device Model

Select an order number (MLFB number) to specify the device model in DIGSI®. It is important to select the entry **Inter-Relay Communication** from the drop-down list box **Function interface**. Click **OK** when you have defined the entire device model.

Proceed in a similar manner with the rest of the objects of type **SIPROTEC device** which are to be users of the IRC combination.

An object of type **IRC combination** is inserted with the DIGSI® Manager. The nodes of an IRC combination and the required transmission parameters are specified here.

Inserting an IRC Combination

The users of an IRC combination and the required transmission parameters are defined in an object of type **IRC combination**. This object also contains information which comes from the parameter set about the update status of an IRC combination.

You can only insert an object of type **IRC combination** within an object of type **Folder**.

Right-click an object of type **Folder**. In the context menu, click **Insert new object** → **IRC combination**.

Within a project you can insert any number of objects of type **IRC combination**.

The placement of the object within the project does not have any effect on its functionality. Each SIPROTEC® 4 device suitable for an IRC combination is available within a project as a node to each object of type **IRC combination**.

You must only remember that each SIPROTEC® 4 device can only function as a node of a single IRC combination at any one time. However, you should select the placement taking clarity of layout into account.

Several IRC combinations can also be managed within a single project. Each IRC combination is represented here by its own object of type **IRC combination**.

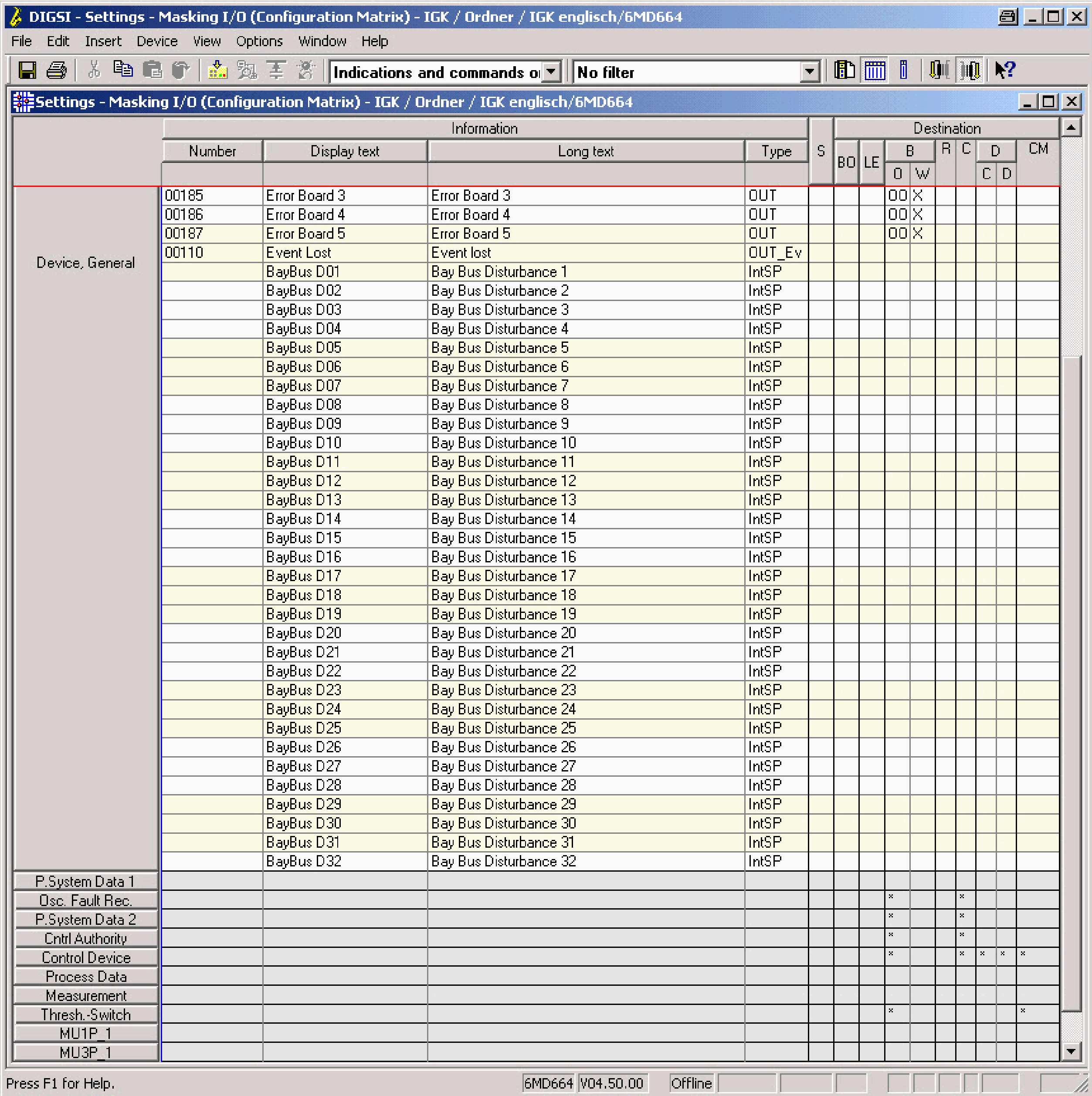
IRC Failure Indication

For devices selected via the MLFB numbers, additional failure indications **Bay Bus Disturbance** (n = 1 - 32 for possible number of devices) are generated in the **Device** group of the device matrix. These failure indications can be allocated individually.

These failure indications are set to **ON** by the IRC failure monitor at the beginning of the failure and to **OFF** during establishment of a connection after the transmission of the current state of process information. On failure of one of the devices, an alarm to that effect is issued (e.g. Bay Bus D04 to ON) which can be seen in all other devices. With the configuration you now ensure that only those interlock conditions are blocked which require information from the affected device. All other interlocks receiving information via the IRC are available as before.

The master repeats the slave query in case of faulty messages. The number of repetitions is configurable. A large number of repetitions (with message errors or a poor connection) extends the cycle time of the bus. Only one repetition should be set for fibre-optic connections.

After a connection failure, the master attempts to establish a new connection after a configurable number of bus cycles (pauses). As each (failed) connection establishment extends the bus cycle time, the number of pauses should be as large as possible. Otherwise, a large number of pauses extends the time until a failed device operates on the bus again. A good initial value here is 10 bus cycles.



	Information				S	Destination								
	Number	Display text	Long text	Type		BO	LE	B O	B W	R	C	D C	D D	CM
Device, General	00185	Error Board 3	Error Board 3	OUT				OO	X					
	00186	Error Board 4	Error Board 4	OUT				OO	X					
	00187	Error Board 5	Error Board 5	OUT				OO	X					
	00110	Event Lost	Event lost	OUT_Ev										
		BayBus D01	Bay Bus Disturbance 1	IntSP										
		BayBus D02	Bay Bus Disturbance 2	IntSP										
		BayBus D03	Bay Bus Disturbance 3	IntSP										
		BayBus D04	Bay Bus Disturbance 4	IntSP										
		BayBus D05	Bay Bus Disturbance 5	IntSP										
		BayBus D06	Bay Bus Disturbance 6	IntSP										
		BayBus D07	Bay Bus Disturbance 7	IntSP										
		BayBus D08	Bay Bus Disturbance 8	IntSP										
		BayBus D09	Bay Bus Disturbance 9	IntSP										
		BayBus D10	Bay Bus Disturbance 10	IntSP										
		BayBus D11	Bay Bus Disturbance 11	IntSP										
		BayBus D12	Bay Bus Disturbance 12	IntSP										
		BayBus D13	Bay Bus Disturbance 13	IntSP										
		BayBus D14	Bay Bus Disturbance 14	IntSP										
		BayBus D15	Bay Bus Disturbance 15	IntSP										
		BayBus D16	Bay Bus Disturbance 16	IntSP										
		BayBus D17	Bay Bus Disturbance 17	IntSP										
		BayBus D18	Bay Bus Disturbance 18	IntSP										
		BayBus D19	Bay Bus Disturbance 19	IntSP										
		BayBus D20	Bay Bus Disturbance 20	IntSP										
		BayBus D21	Bay Bus Disturbance 21	IntSP										
		BayBus D22	Bay Bus Disturbance 22	IntSP										
		BayBus D23	Bay Bus Disturbance 23	IntSP										
		BayBus D24	Bay Bus Disturbance 24	IntSP										
		BayBus D25	Bay Bus Disturbance 25	IntSP										
		BayBus D26	Bay Bus Disturbance 26	IntSP										
		BayBus D27	Bay Bus Disturbance 27	IntSP										
		BayBus D28	Bay Bus Disturbance 28	IntSP										
		BayBus D29	Bay Bus Disturbance 29	IntSP										
		BayBus D30	Bay Bus Disturbance 30	IntSP										
		BayBus D31	Bay Bus Disturbance 31	IntSP										
		BayBus D32	Bay Bus Disturbance 32	IntSP										
P.System Data 1														
Osc. Fault Rec.								x			x			
P.System Data 2								x			x			
Cntrl Authority								x			x			
Control Device								x			x	x	x	x
Process Data														
Measurement														
Thresh.-Switch								x						x
MU1P_1														
MU3P_1														

Figure 2-74 IRC fault indications

2.12.3 Correlation between Number of Nodes and Transmission Time

The correlation between the number of IRC nodes, the number of information items configured to IRC, the connection baud rate and the cycle time achieved for information transmission has been established by tests. The test result is shown in the figure below

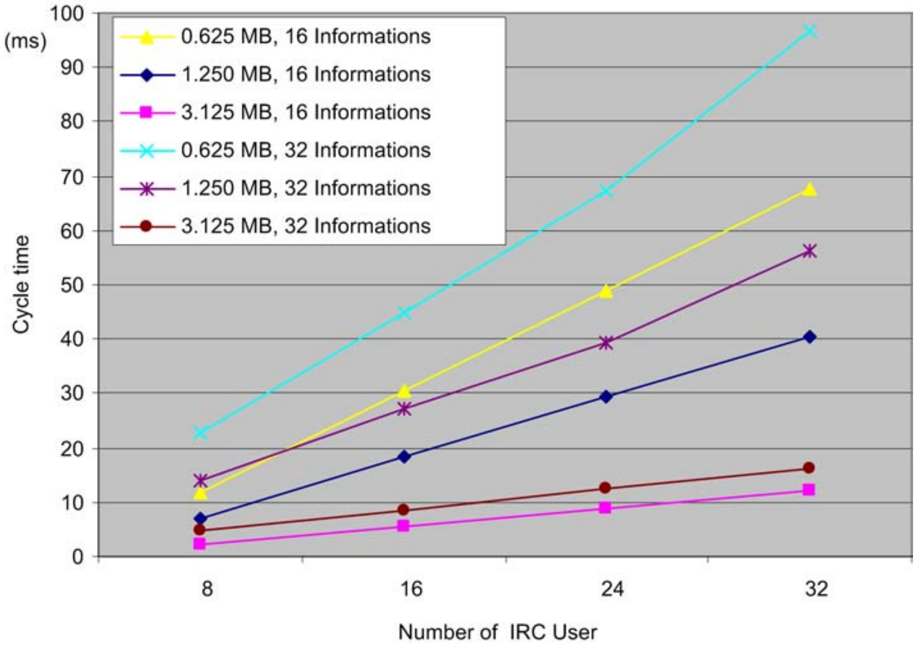


Figure 2-75 Correlation with number of IRC nodes

The figure above shows that a high baud rate must be set for large systems with many users and many IRC allocated information items to receive acceptable cycle times. For more than 16 users, the maximum possible baud rate of 3.125 MBd should be selected (possible only when using the HDLC transmission mode). The HDLC mode is normally recommended; the UART mode offers only the advantage of reducing the workload of CPU users by setting automatic address detection. However, this is usually not necessary.

The number of information items is to be understood per device, i.e. 16 or 32 information items per device This means that the maximum amount of information that can be transmitted simultaneously is 32 x 32 = 1024 items.

The direct correlation between cycle time and baud rate is illustrated in the figure below.

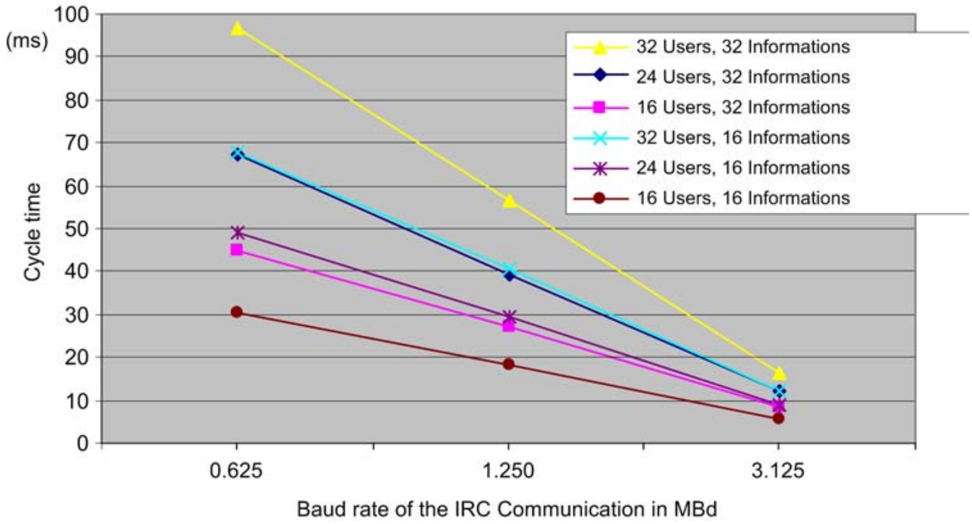


Figure 2-76 Correlation with IRC communication baud rate

Here again it can be seen that in large systems with a large amount of indications to be transmitted the maximum baud rate of 3.125 MBaud must be set to achieve acceptable cycle times for the interlocking application.

2.12.4 Selecting a Combination Node

An IRC combination can include up to thirty two users as from DIGSI® V4.5. Older DIGSI versions allows a maximum of sixteen users. These users are stored as a property of the object type IRC combination. To select the user of an IRC combination, open the Properties dialog box of the respective object.

Right-click the object of type **IRC combination**. Click **Object properties** in the context menu. The dialog box **Properties - IRC combination** opens. Select the **Node** tab.

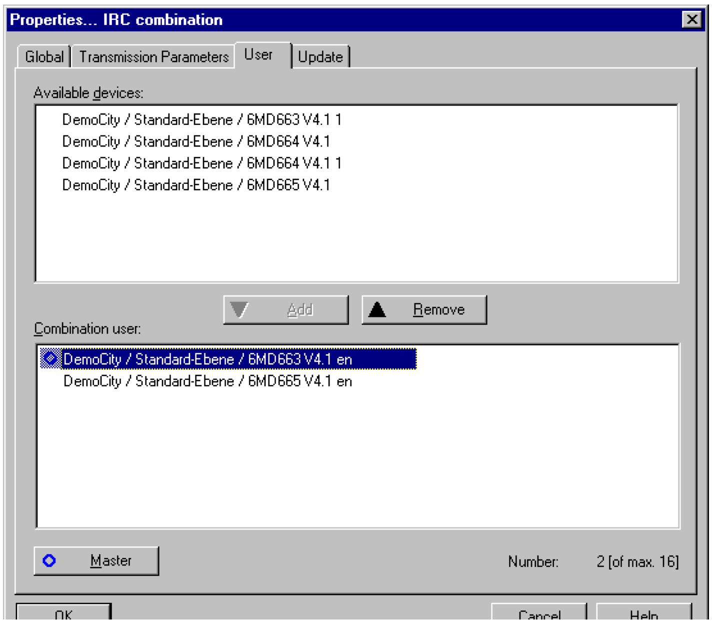


Figure 2-77 Properties dialog box — IRC combination, Node tab

Available Devices

The names of all SIPROTEC® 4 devices which can operate as nodes for the processed IRC combination are shown in the box **Available devices**. These are the devices from the current project which fulfil the requirements for Inter-relay communication through port C, and which are not already nodes of another IRC combination. In addition to the name of a SIPROTEC® 4 device, its position within the project is also displayed.

Selecting a Node

To add a SIPROTEC® 4 device to the IRC combination, select its name in the box **Available devices**. Then click Add.

To remove a SIPROTEC® 4 device from the IRC combination, select its name in the **Combination nodes** box. Then click Remove.

Several devices can be added to, or removed from, the IRC combination simultaneously through multiple selection. Alternatively, add or remove a SIPROTEC® 4 device with a double-click on its name in the appropriate box.

An **IRC combination** can comprise a **maximum** of **thirty-two nodes**. When this number has been reached, a fault indication is displayed as soon as you want to add another SIPROTEC® 4 device.

Specifying a Master

Each IRC combination requires a SIPROTEC® 4 device as a master. The first SIPROTEC® 4 device you select is automatically defined as the master. The master device is labelled in the box **Combination nodes** with a blue circle to the left of the name of the device.

If another SIPROTEC® 4 device is to be used as a master, select its name in the box **Combination nodes**. Then click **Master**.

If the device labelled as the master is removed from the combination, the first SIPROTEC® 4 device in the list of nodes is automatically defined as the new master.

Basically, any device in the IRC combination can function as a master. The master function requires additional processor performance. You should therefore select a device which is subjected to the least usage by the actual program run.

Accepting Settings

To apply your settings, click **OK**. The **Properties - IRC combination** dialog box is closed.

2.12.5 Allocating Information of the Individual Devices Involved

The purpose of the IRC combination is to distribute process information between SIPROTEC® 4 devices. You must therefore make the following decisions for each SIPROTEC® 4 device participating in an IRC combination:

- Which process information from the SIPROTEC® 4 device should be made available to the other devices in the IRC combination?
- Which process information from the SIPROTEC® 4 device should be assignable to process information received from the IRC combination?

You make this selection for each SIPROTEC® 4 device individually in the DIGSI® allocation matrix.

Open the SIPROTEC device with the DIGSI® device processing function. Double-click the object **Allocate** to display the device matrix.

IRC Columns

One column with the name **O** is provided in the device matrix for the **IRC combination as source** and **IRC combination as destination**. These columns are fundamentally only visible when the functionality of the IRC has been defined in the device model. These columns are shielded as soon as you select the information filter **Only commands**. This is explained by the fact that commands cannot be swapped within an IRC combination.

Allocatable Information Types

The following information types can be allocated within an IRC combination:

- Single point indication (only SI, not SI_F)
- Double point indication (only OI, not OI_F)
- Internal single indication (only IE, not IE_F), must be selected as destination (not EM!)
- Internal double point indication
- Bit pattern indication
- Transformer tap indication
- Limit value
- User-defined limit value
- Measured value
- User-defined measured value
- External metered value (only ExMV, not MVMV and PMV)

Routing Information to the IRC Source

Information that is routed to **IRC as source** can be assigned to information of other nodes of the IRC combination during the course of the run process. Information received from an IRC combination is represented within the SIPROTEC® 4 device by information specific to this device. The assignment between received information and device-specific information takes place with the combination matrix.

Routing Information to the IRC Destination

Information that is routed to **IRC as destination** can be forwarded to other nodes of the IRC combination. This forwarding procedure is also defined using the combination matrix.

Routing Rules

Several rules must be observed when routing information. A consistency check monitors whether these rules are complied with.

- Information initiated by a device or a function (e.g. device ready) cannot be routed as a source.
- Information can only be routed to the **IRC as source** if it has not already been routed to another source. Similarly, any item of information routed to the **IRC as source** may not be routed to any other sources.
- An item of information cannot be simultaneously routed to the **IRC as source** and to the **IRC as target**.
- Overall, **32 items of information** can be routed to the **IRC as target**.
- Source and destination must be the same data type (e.g. correct: type SI to SI or ExtSi; incorrect: type SI to OI).
- Indications coming from the source IRC should be configured as external indications (ExtSi, ExtDI).

2.12.6 Routing Information between the Devices Involved

You have specified information for each individual SIPROTEC® 4 device within an IRC combination with the device matrix.

You must decide,

- what information is to be transmitted from which source device to which destination device, and
- what information is to be created in the destination device by the information it has received.

Note

The combination matrix is structured similarly to the device matrix. The mechanisms, e.g. to hide and show lines and columns, are identical to those of the device matrix. An extensive description of combination matrix operation can be found in the SIPROTEC® System Description /1/.

Combination Matrix

Several requirements must be fulfilled in order to open the combination matrix:

- The combination matrix may not already have been opened for another IRC combination.
- The IRC combination for which the combination matrix is to be opened must comprise at least two SIPROTEC® 4 devices.
- No SIPROTEC® 4 device which functions as a node in the combination may be opened for editing.

Right-click an object of type **IRC combination**. Click **Open object** in the context menu. Alternatively, you can double-click the object. The combination matrix opens.

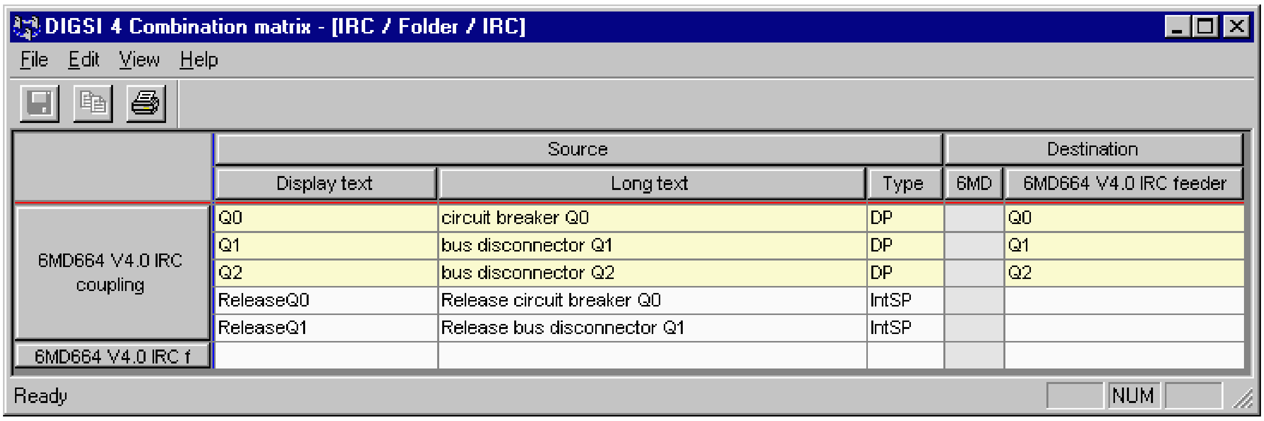


Figure 2-78 IRC combination matrix

Structure of the Combination Matrix

After opening the combination matrix you will see that it is divided up both horizontally and vertically. Several columns or rows can be visually combined into blocks by clicking the button at the top or left margin of the combination matrix.

Horizontally, the matrix is divided into two main areas: **Source** and **Destination**. Information is compiled vertically in groups.

- **Source**

  Information serves as the source. It is described by the display text, the long text and the type. In the combination matrix, all information is displayed which you have routed to the destination **IRC combination** for each SIPROTEC® 4 device individually in the device matrix.

- **Destination**

  The destination designates the SIPROTEC® 4 device to which information is forwarded. A destination column is shown in the combination matrix for each node device in an IRC combination.

- **Group**

  A group represents the scope of information that a node of an IRC combination makes available to the other nodes. A group is therefore shown in the combination matrix for each SIPROTEC® 4 device contained in an IRC combination. Each group bears the same name as the related SIPROTEC® 4 device.

Routing Information Items

Information which has been routed in the device matrix to the **IRC as destination** is made available in the combination matrix as source information. Conversely, all information which has been routed in the device matrix to **IRC as source** is made available in the combination matrix as destination information. Note that the destination information is not visible until a routing action takes place.

To route a source information to a specific SIPROTEC® 4 device in the combination matrix, click the common cell of **Information** and **Destination device**. The cell is transformed into a drop-down list box. It offers the display texts of the destination information routed as the source in the destination device and which is of the same data type. Select one of these information packets. Repeat this procedure for all the remaining assignments.

Routing Rules

Some rules must also be observed when routing information within the combination matrix. Their compliance is also monitored, however, as with the device matrix via automatic consistency checking.

- Only one source information packet may be assigned to a destination information packet. However, a source information packet can be routed to several destination information packets.
- The sort and type of source and destination information packets must be identical. You cannot, for example, route a single message to an output indication. However, there are two exceptions: incoming-outgoing indications and in-out indications can be routed between each other. This also applies to double point indications and double point indications with fault positions.

Saving and Terminating Routings

All your routings must be explicitly saved. Click **File** → **Save as** on the menu bar for this.

To close the combination matrix click **File** → **Exit** in the menu bar.

2.12.7 Setting Communication Parameters for Individual Devices

A special communication module must be installed in each SIPROTEC® 4 device provided for Inter-relay communication through port C. This module is already installed and correctly allocated if you ordered a SIPROTEC® 4 device with Inter-relay communication through port C. For this reason, this section is only relevant for upgrading. The slot to which this communication module is connected in the SIPROTEC® 4 device is the only setting which needs to be made in the device-specific communication parameters.

Right-click the object of type **SIPROTEC device** for which you want to edit the parameter for the Inter-relay communication through port C. Click **Object properties** in the context menu. The dialog box **Properties - SIPROTEC device** opens. Select the **Inter-relay communication** tab.

Note

This tab is only available if the following requirements are fulfilled simultaneously:

The current SIPROTEC® 4 device is fundamentally suitable for Inter-relay communication through port C.

Inter-relay Communication has been selected as the function interface in the Communications modules tab.

The SIPROTEC® 4 device is already a node in an IRC combination.

Setting a Slot

Note

A modification to the slot setting, in comparison to the delivery setting, should only be made if there is just cause and only with the required system knowledge!

The set slot and the actual slot are not automatically checked for consistency. Please carefully check your settings yourself.

In the **Slot** drop-down list box select the name of the slot in which the communications module is installed in the SIPROTEC® 4 device.

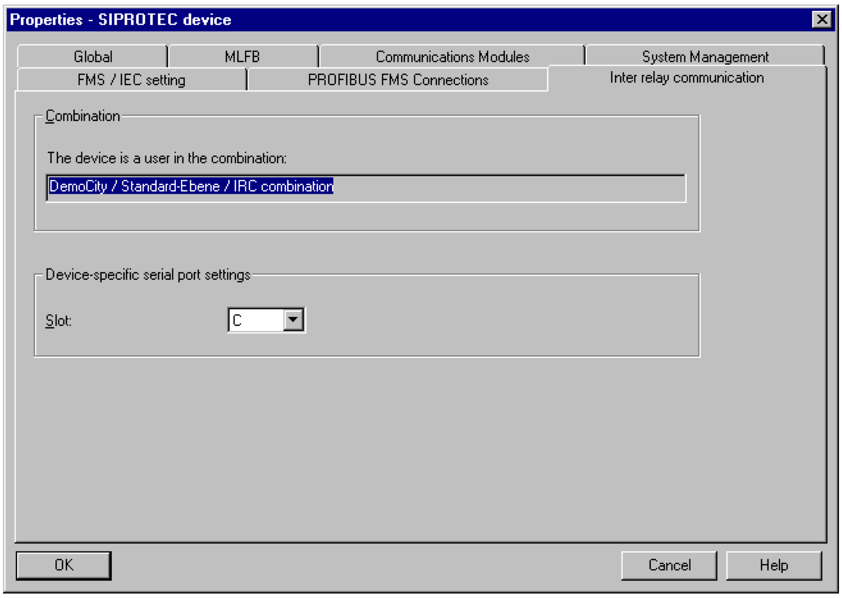


Figure 2-79 Properties - SIPROTEC device dialog box, Inter-relay Communication tab

To apply your settings, click **OK**. The **Properties - SIPROTEC device** dialog box is closed.

The parameter is not activated until the parameter set is updated.

2.12.8 Setting communication parameters for a combination

While the slot to which this communications module is connected is the only setting which needs to be made in the device-specific communication parameters, several settings need to be taken into consideration for the combination as a whole. The settings which need to be made are summarized in two groups:

- **Interface settings**

  These serial interface settings must be identical for all the SIPROTEC® 4 devices in the IRC combination. Otherwise the devices are not able to communicate with one another. They are therefore defined centrally for the combination.

- **Bus parameters**

  Settings relating to the bus arbitration only affect the parameter set of the SIPROTEC® 4 device which serves as the master in the IRC combination. However, as each participating SIPROTEC® 4 device can fundamentally be defined as the master, these settings are also made during configuration of the IRC combination.

Right-click the object of type **IRC combination**. Click **Object properties** in the context menu. The dialog box **Properties - IRC combination** opens. Select the **Transmission parameters** tab.

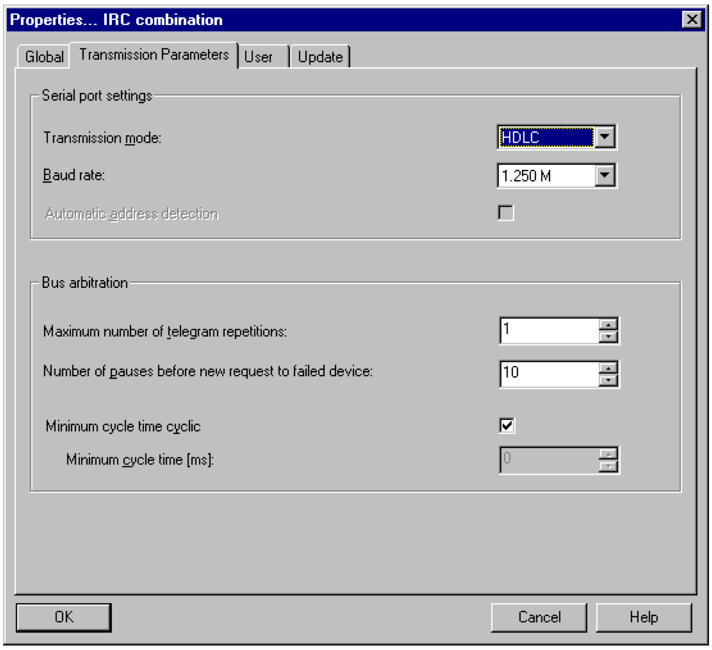


Figure 2-80 Properties dialog box — IRC combination, Transmission parameters tab

Note

We recommend using the preset transmission parameters, namely HDLC. The transmission speed - baud rate - that should be achieved must be determined and set in accordance with system conditions.

Specifying Interface Settings

The following interface settings can be set:

- **Transmission Schemes**

  Select the name of a transmission mode from this drop-down list box. You can choose between **UART** and **HDLC**. HDLC ensures an approx. 15% greater transmission density than UART using the same baud rate.

- **Baud rate**

  Select a baud rate from this drop-down list box. Which baud rates are available for selection depend on the transmission mode you have selected. The higher the transmission rate, the shorter the cycle time or the more nodes can be connected to the bus with the same cycle time. The processor load of the master increases when the cycle time is small and when many slaves are connected to the bus. In exceptional cases, the parameter **Minimal cycle time** must be increased for this reason.

- **Automatic address detection**

  If this check box is activated, the SIPROTEC® 4 device only considers a message it receives if it is addressed to it. This action relieves the load on the CPU of the SIPROTEC® 4 device. This option can only be selected if **UART** is set as the transmission mode.

Setting the Bus Arbitration

The following parameters can be set for bus arbitration:

- **Maximum number of message repeats**

  If a message is corrupted during transmission, it can be sent again. In this spin box you can enter how many attempts should be made to transmit a message. A maximum of three new transmission attempts are allowed.

- **Number of pauses before a new query is sent to a failed device**

  If a SIPROTEC® 4 device in the combination has failed, the master can exempt it from queries for a certain number of cycles. To do this, select a value between 0 and 254 in the drop-down list box.

- **Minimum cycle time**

  The cycle time defines the total duration of a cycle, during which all slave devices are queried by the master device. Select a value between 10 and 10,000 ms. from the spin box. As the length of the cycle time depends on the capacity of the master, the cycle time actually achieved may be higher than the value set in the parameters. To ensure that the master uses the shortest possible cycle time, select the check box **Minimum cycle time, continuous**.

2.12.9 Checking and Updating Parameter Sets

The parameter sets of individual or all combination nodes must be updated either when configuring an IRC combination for the first time, or if the settings of single combination parameters have been altered, according to the modifications which have been made.

Right-click the object of type **IRC combination**. Click **Object properties** in the context menu. The dialog box **Properties - IRC combination** opens. Select the **Updating** tab.

The **Updating** tab gives an overview of the update status of the parameter sets of the individual combination nodes.

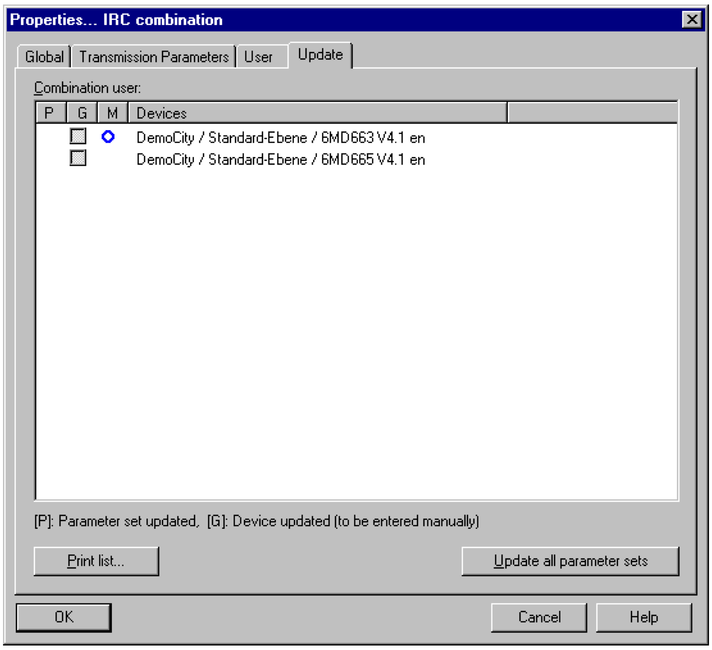


Figure 2-81 Properties dialog box — IRC combination, Updating tab

Checking the Update Status

Every device in DIGSI® which has a current parameter set is designated in column **P** with a check mark. If this parameter set has already been transmitted to the real SIPROTEC® 4 device, you can manually make a note of this by entering a check mark in column **G**. To do this, click in the corresponding check box. This selection can only be set if the parameter set in DIGSI® 4 is up to date.

It is automatically deleted if changes have been made which affect the parameter set of the SIPROTEC® 4 device concerned.

DIGSI® itself detects which parameter sets are no longer up to date. As soon as the update command has been issued, these parameter sets are updated one after the other. However, it is important for you to know after which modification which SIPROTEC® 4 device needs to be reinitialized.

Here is a brief overview:

- Changing the slot for the communications module: parameter set of the node concerned.
- Modification of a serial interface setting on the tab **Transmission parameters**: parameter sets of all nodes.
- Modification of a bus parameter in the tab **Transmission parameters**: parameter set of the master.
- Routing changes in the combination matrix: parameter sets of both nodes concerned.
- Routing changes in the device matrix of a SIPROTEC® 4 device to IRC as the destination: parameter set of the node concerned.
- Deleting or adding a node: parameter sets of all nodes.

Updating Parameter Sets

To update all outdated parameter sets, click **Update all parameter sets**. Messages detailing the progress of updating are shown in the **Report** window. The parameter sets are updated in DIGSI®.

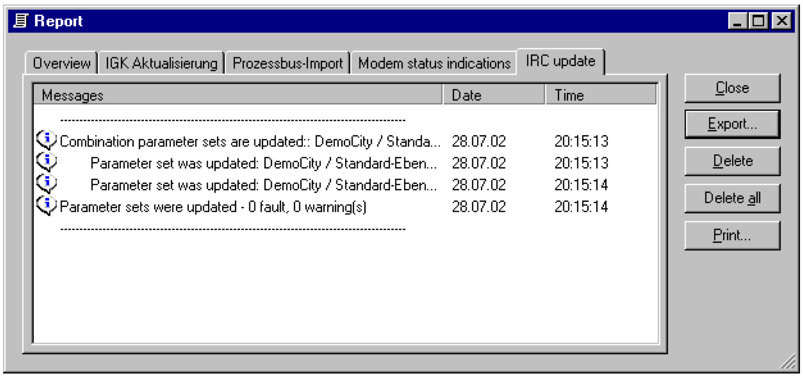


Figure 2-82 Report, IRC update tab

If you have made changes in the combination matrix, you can update these changes immediately in the affected parameter sets. Click **File** → **Save and Generate Parameter Sets** on the menu bar for this.

2.12.10 Printing Combination Information

You can print the following information relating to an IRC combination:

- Transmission parameter settings of the IRC combination.
- The names of the SIPROTEC® 4 devices in the IRC combination, including the classification letters of the selected slots.
- Update information for each individual node in the IRC combination.

Right-click an object of type **IRC combination**. Click **Delete** → **Object contents** in the context menu. The **Print Combination Information** dialog box opens.

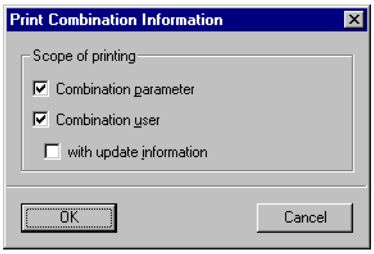


Figure 2-83 Print combination information dialog box

Specifying the Scope of Printing

You specify the scope of the information to be printed by selecting individual check-boxes. Subsequently click **OK**. The **Print Manager** window opens. This window allows you to call up a page preview for the information you want to print. You can influence the presentation in the **Print Manager** window.

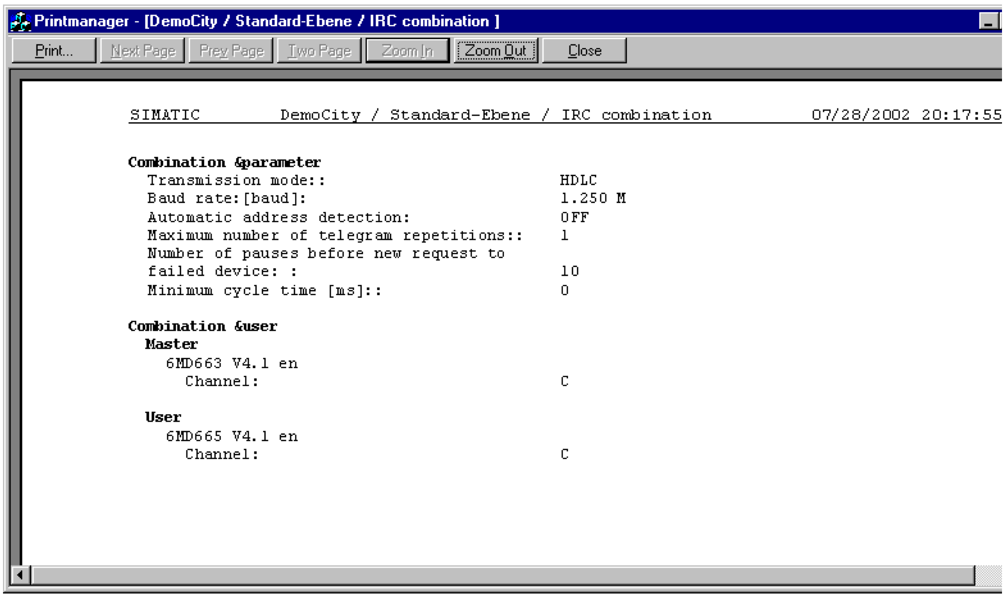


Figure 2-84 IRC combination, print manager

Scrolling

Click **Next** to show the next print page. This button is inactive if the last available print page is already being displayed. Then click **Previous** to show the previous print page. This button is inactive if the first print page is already being displayed.

Changing the Display Mode

Click **One page / two pages** to alternate between a single page view and a two page view.

Changing the Scale of the Display

Click **Zoom** to zoom the display of the print page in defined stages. This button is inactive as soon as the largest possible display size has been reached. Alternatively, click with the left mouse button for as long as the mouse cursor is in the display area. When you do this the display of the print page is also zoomed in defined stages. Click **Zoom out** to zoom out the display of the print page in defined stages. This button is inactive as soon as the smallest possible display size has been reached.

Note

An enlarged or shrunken view has no influence on the print results.

Printing Information

Click **Print** to print the displayed information.

2.12.11 Time Synchronisation

In addition to transmitting the process information, the IRC can synchronise the time in the connected devices. The master, which synchronises its time via a radio clock for example, passes on the time each minute to the connected slaves. Time synchronisation via IRC must be set in the slaves for this.

Open the SIPROTEC device with the DIGSI® device processing function. Double-click in the data window on **Time synchronisation**. The **Time Synchronisation & Time Format** dialog box is displayed.

Select the entry **Inter-relay communication** from the **Time synchronisation source** list box and confirm the entry with **OK**.

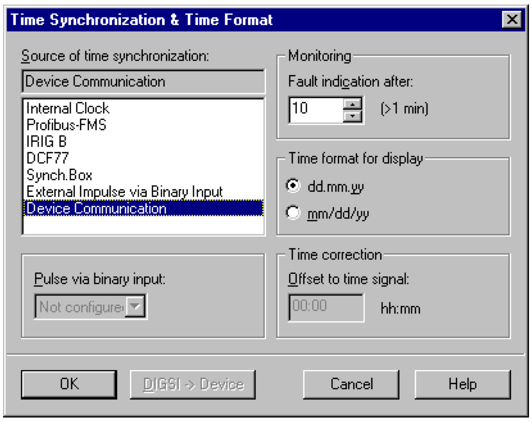


Figure 2-85 Time synchronisation & time format dialog box

Note

The time synchronisation source stated in the master must not be Inter-relay communication through port C. Rather, the configured source must be the one used by the master itself, e.g. "Time signal DCF 77".

2.13 Inter relay communication with GOOSE through Ethernet

The release of the software version V4.6 makes it possible for all 6MD66x bay controllers to allow for communication according to the new IEC61850 standard. An addition to connection to the substation controller, it also enables a connection between bay controllers and protective devices. This allows for an inter relay communication functionality via this Ethernet interface as well, as described in the previous Chapter 2.12. In the IEC61850 communication standard, this field to field communication is called GOOSE (Generic Object Orientated Substation Event).

Advantages of the GOOSE communication compared to the previous inter relay communication:

— No dedicated interface required; communication takes place through the system interface

— Large selection of possible partner devices. Other SIPROTEC4 devices, such as 7SJ or 7SA, are also equipped with IEC61850 GOOSE. This communication standard is also being adopted by other manufacturers.

— No master-slave scheme; each node can send and receive autonomously.

This section shows on a simple example how to build up a substation switchgear interlocking scheme based on GOOSE communication with 6MD66x bay controllers.

Applications

- Inter-relay communication with IEC61850-GOOSE can be used for the exchange of information between bay controllers. No substation controller is required for this. One main application for bay controllers is cross-bay switchgear interlocking. However, other process information can be exchanged with GOOSE as well (as with IRC in general), such as measured or metered values.

Prerequisites

The 6MD66x devices participating in GOOSE inter-relay communication must meet the following requirements:

Device software version at least V4.6

Equipped with an EN100 communication module for communication with IEC61850 (MLFB: 11th digit = 9, extension –L0R, optical EN100 module planned for the future)

DIGSI version at least V4.6 with station configuration editor (ordering option)

At least two such devices must have been created in the DIGSI project. Also, an IEC61850 substation must be created ("Insert new object“ in DIGSI Manager). This new object allows to access the station configurator (by double-clicking after configuration of the substation, refer to following chapters).

2.13.1 Function Principle

Unlike IRC, GOOSE does not use the master-slave principle. Each node sends and receives information autonomously according to its configuration in the system configurator.

The devices are connected to switches using Ethernet patch cables, as shown in the figure below.

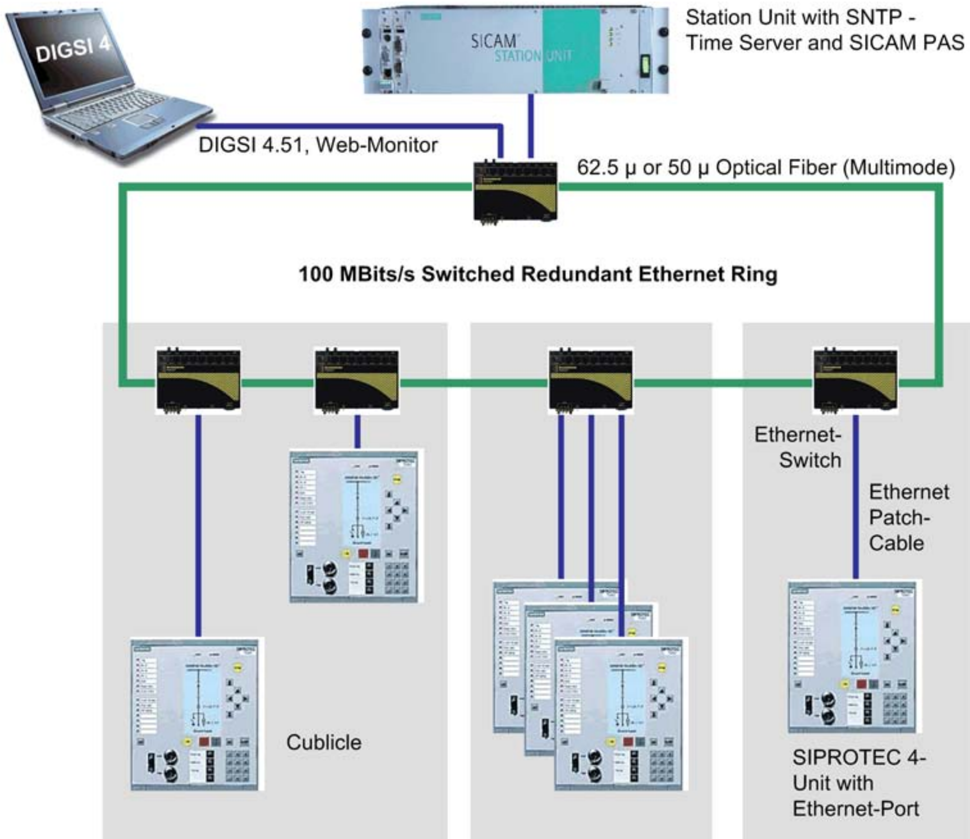


Figure 2-86 Nodes of an IEC61850 Ethernet

The Ethernet link is used both for inter-relay communication with GOOSE and for communication with the SICAM PAS station unit.

2.13.2 Parameterizing the GOOSE Communication

Let us consider the example of a switchgear interlocking application in which 2 feeders of a double busbar exchange information with the bus coupler (see the figure below).

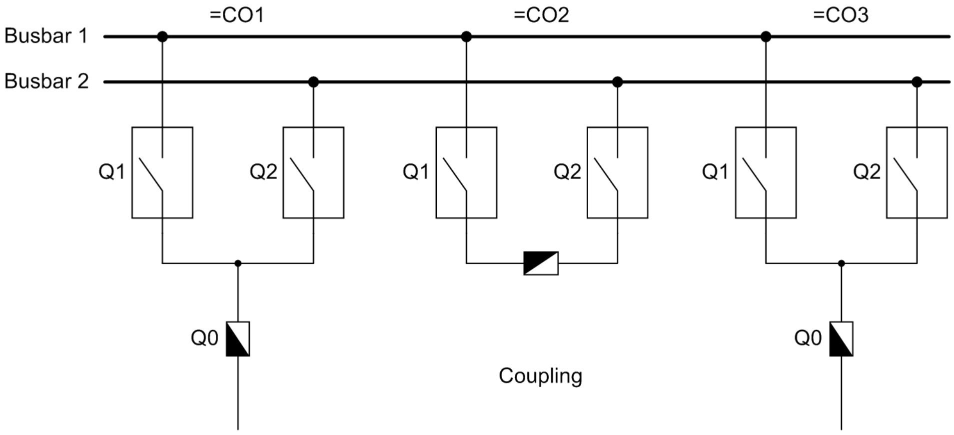


Figure 2-87 Single line display of the example "Switchgear interlocking with GOOSE"

In the two feeder bays C01 and C03, switching of the busbar disconnectors Q1 and Q2 is allowed if the bus coupler C02 is closed. The coupler must not be opened if both busbar disconnectors are closed in either bay C01 or C03 (bus coupler lock-in).

The information required for these interlocking conditions is to be exchanged directly between the three 6MD66x bay controllers via IEC61850-GOOSE. Each of the three bays has a bay controller assigned to it, as shown in the figure below.

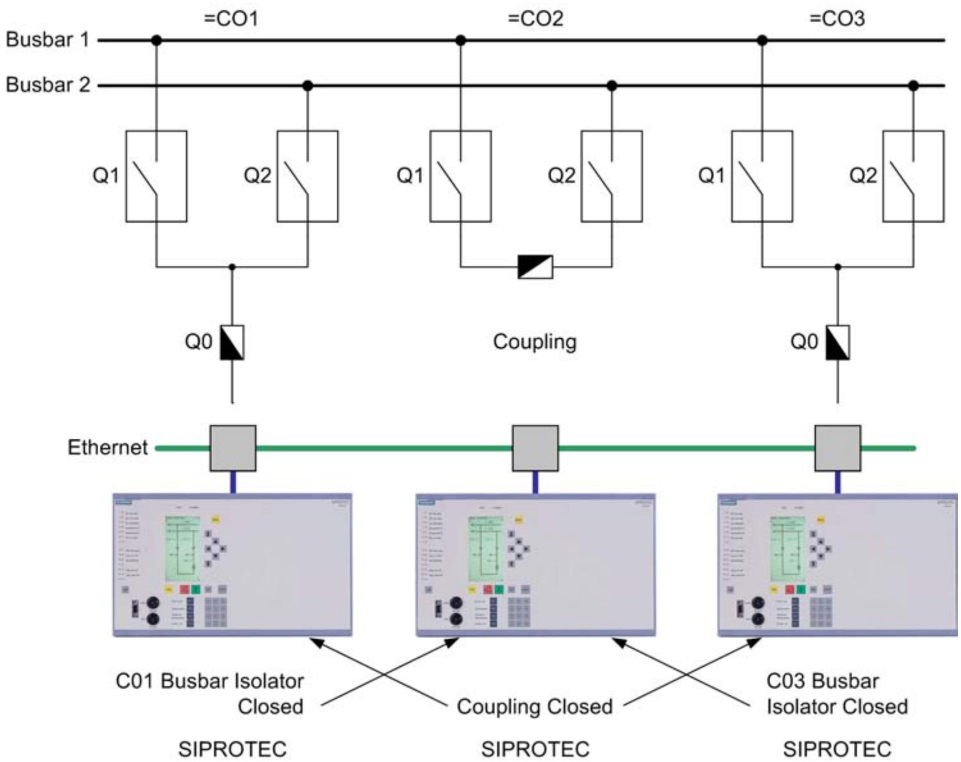


Figure 2-88 Assignment of GOOSE nodes to system

From the bus coupler C02, the information "CouplClsd“ (ON if the coupler is closed) is sent to the two feeders. This information is generated in the CFC of the bus coupler C02 from the feedback signals of the three switching devices. The two feeders send to the bus coupler the information "C01BBDiscClsd“ and "C03BBDiscClsd“, which is likewise generated in the CFC (ON if the busbar disconnectors Q1 and Q2 are both CLOSED).

In a fist step, the information to be transmitted must be configured in the DIGSI configuration matrix for all three devices. In addition, the information to be received is also configured; this principle is known from IRC.

The figure below shows the information to be configured in the configuration matrix.

Number	Display text	Long text	Type	Source BI	Source F	Source S	Source C	Dest. BO	Dest. LE	Dest. B O	Dest. B W	Dest. S	Dest. X	Dest. C	Dest. D C	Dest. D D	Dest. CM
	C01BBDiscC	C01 Busbar Disconnector Closed	IntSP				X			00		X					
	Coupl Clsd	Coupler Closed	ExSP			X				00				X			

Number	Display text	Long text	Type	Source BI	Source F	Source S	Source C	Dest. BO	Dest. LE	Dest. B O	Dest. B W	Dest. S	Dest. X	Dest. C	Dest. D C	Dest. D D	Dest. CM
	C01BBDiscC	C01 Busbar Disconnector Closed	ExSP			X				00				X			
	C03BBDiscC	C03 Busbar Disconnector Closed	ExSP			X				00				X			
	Coupl Clsd	Coupler Closed	IntSP				X			00		X					

Number	Display text	Long text	Type	Source BI	Source F	Source S	Source C	Dest. BO	Dest. LE	Dest. B O	Dest. B W	Dest. S	Dest. X	Dest. C	Dest. D C	Dest. D D	Dest. CM
	Coupl Clsd	Coupler Closed	ExSP			X				00				X			
	C03BBDiscC	C03 Busbar Disconnector Closed	IntSP				X			00		X					

Figure 2-89 Configuration matrix of devices C01, C02, C03

You can see, for example, that C01SSTrGes information (busbar isolator is closed in field C01) is formed in CFC (source "C") and sent to the system interface (destination "S"). Thus, it is available to all other GOOSE users. This is used by the C02 field, where the "C01SSTrGes" information with source "S" and destination "C" was created. This information is thus collected by the system interface and processed in CFC. The information items with destination "S" are of type internal marking (IE) and information items with source "S" of type external single message (exEM).

If IRC and GOOSE are operated simultaneously, either IRC or GOOSE may be set as the source of information items, but not both at the same time.

As soon as an information item is configured to "System interface" as either source or target, the following selection box will appear in DIGSI:

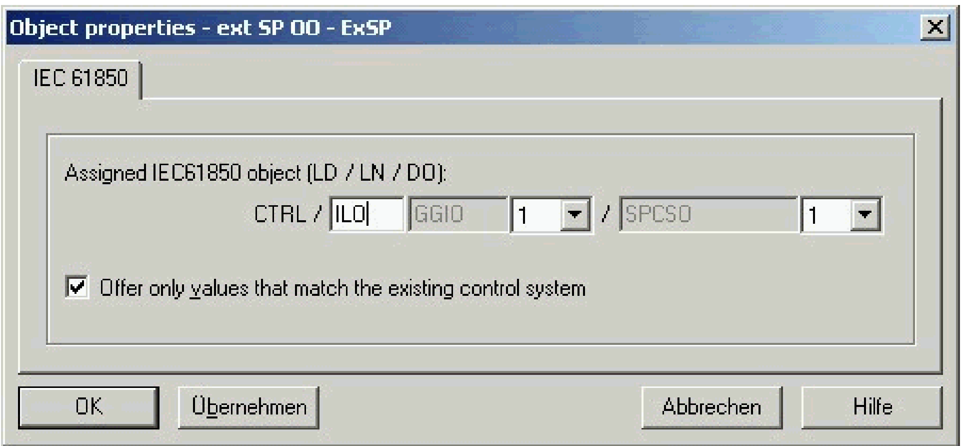


Figure 2-90 Selection box for allocating IEC61850 addresses

This box is used to assign addresses for the IEC61850 communication. The numbers assigned by DIGSI are suggestions and can be manually modified (this is only recommended for special cases). The logical node CTRL (Control) is permanently assigned to user-defined indications and commands. The prefix of the logical node is not preset and can be freely selected. In this example, SFS is chosen for switchgear interlocking; up to 11 characters can be entered.

2.13.3 Communication connection status

The status of the communication connection (disturbed / undisturbed) is supplied with each transmitted message as information status. In case of a disturbed GOOSE connection, the information has a status of "not updated". This status can be extracted from the information using, for example, the new "DI_GET_STATUS" status module in CFC (for double messages) and should also be processed in the interlocking. This status corresponds to IRC_Fault when communicating via Port C.

2.13.4 Selecting the GOOSE Nodes

In the next step, all nodes for the GOOSE inter-relay communication are selected in the system configurator. To do so, create an IEC61850 substation (right-click in the DIGSI Manager – Insert new object – IEC61850 substation) and right-click it. Go to the "Nodes“ tab.

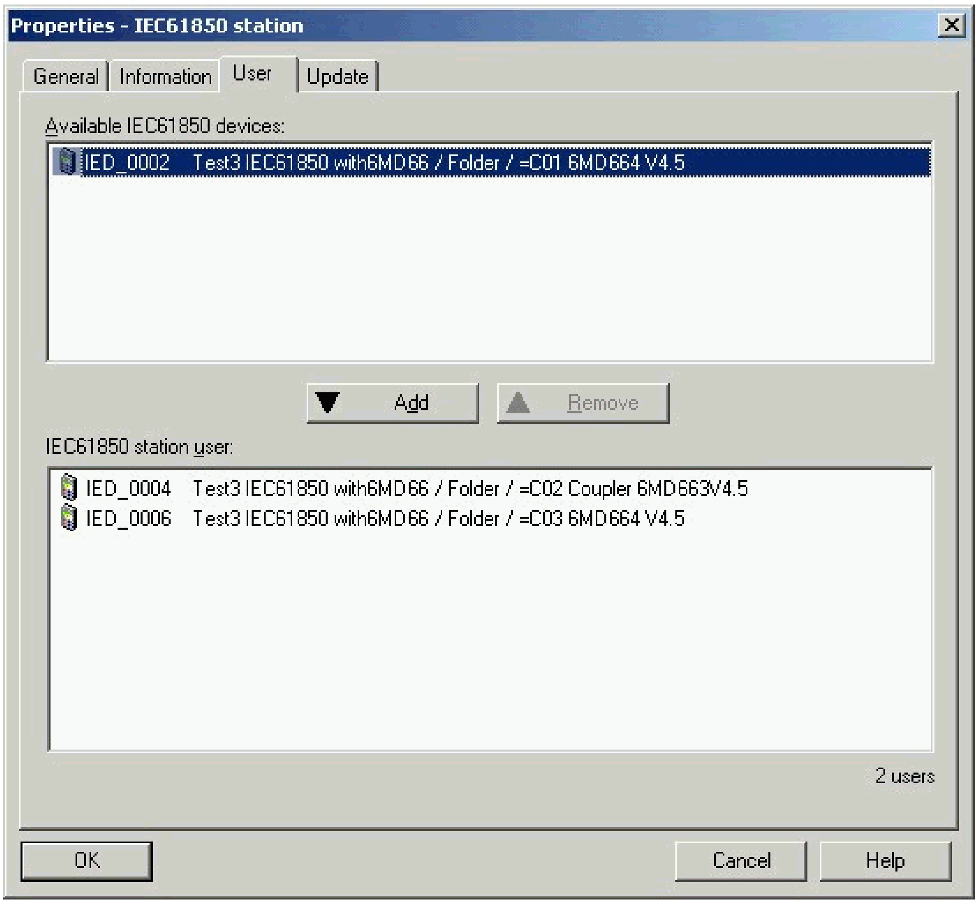


Figure 2-91 Specifying nodes

At the beginning, all devices in a DIGSI project that have an IEC61850 interface are displayed in the top window. Highlight the nodes for the IEC61850-GOOSE communication (in this example all three devices) and click the "Add" arrow. All three nodes are now moved to the bottom window and are available for configuration in the system configurator.

This procedure is the same as that in the traditional IRC.

2.13.5 Creating an IP Network with the System Configurator

Now double-click the system configurator to open it. The devices selected as "nodes" of the GOOSE communication must have been opened at least once with DIGSI. The system configurator has the two views "Network“ and "Configuration“, as shown in the figure below. Select first the "Network" view.

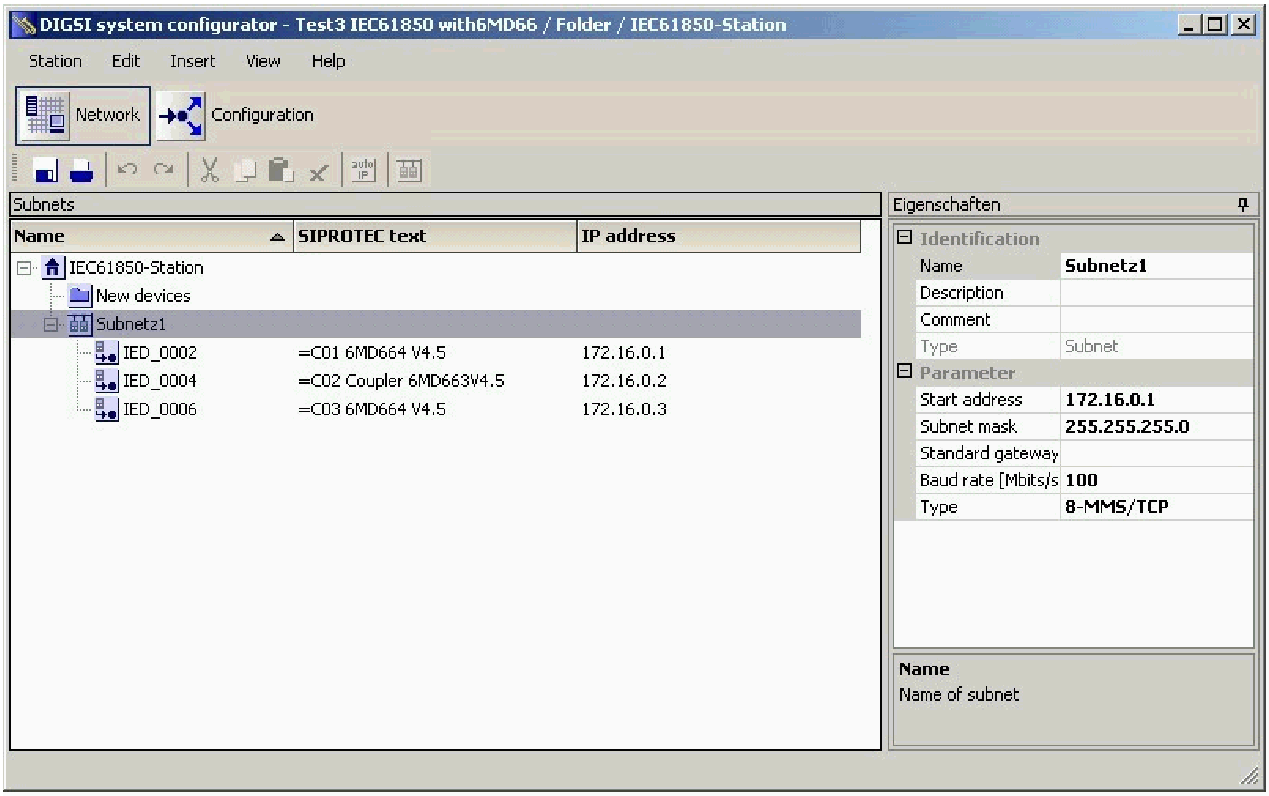


Figure 2-92 Specifying addresses of Ethernet nodes in the system configurator

The system configurator creates a subnet for the nodes and assigns the IP addresses automatically. The addresses can be changed manually if they do not fit into an existing network configuration. If the IP network is to be used exclusively for the GOOSE communication of the configured nodes, the addresses can be left as they are.

2.13.6 Routing Information between Nodes

Go now to the "Configuration" view to interlink the information provided by the GOOSE nodes.

First of all, assign a name to the application. To do so, select the subnet containing the GOOSE nodes (here Subnet1), and insert an "application" (menu bar – Insert – Application), as shown in the figure below.

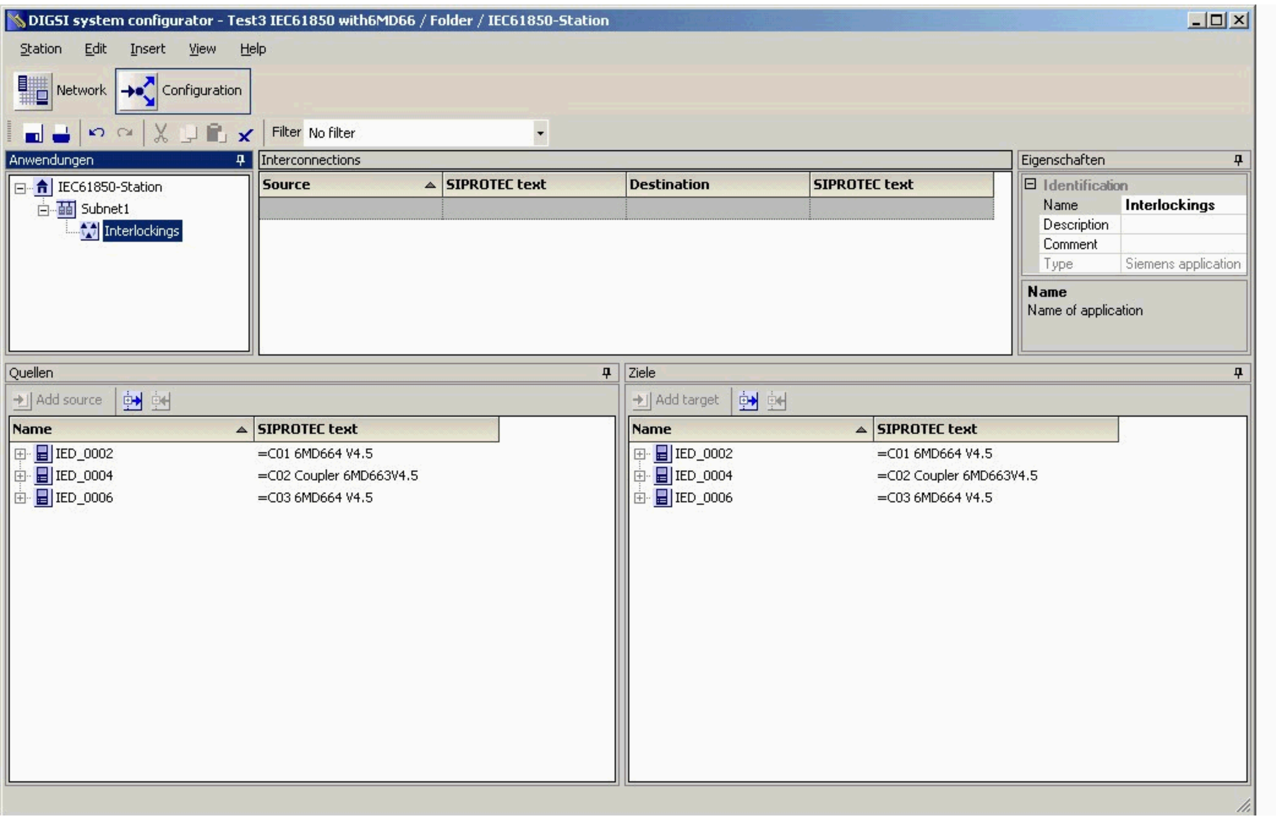


Figure 2-93 Starting the GOOSE configuration

Assign a meaningful name to the application, e.g. "Switchgear interlocking".

The "Configuration" view is composed of three important windows. In the top centre, the links between source and target are shown. At the bottom left, the possible source information is shown in a selection list, and at the bottom right the possible target information.

After you have created an application, the three devices belonging to the subnet appear in the source and target lists.

First, select a source information of the device C01 6MD66x. To do this, click the device in the "Sources" window. This opens a tree view with the four Logical Devices which are contained in the device: CRTL, DR, EXT and MEAS. The previously generated information items for interlocking can be found in the Logical Device CTRL. The required information items can be found at the very bottom of the list under CTRL. Source information is C01SSTrGes. This information is available under the Logical Node SFSGGIO1.

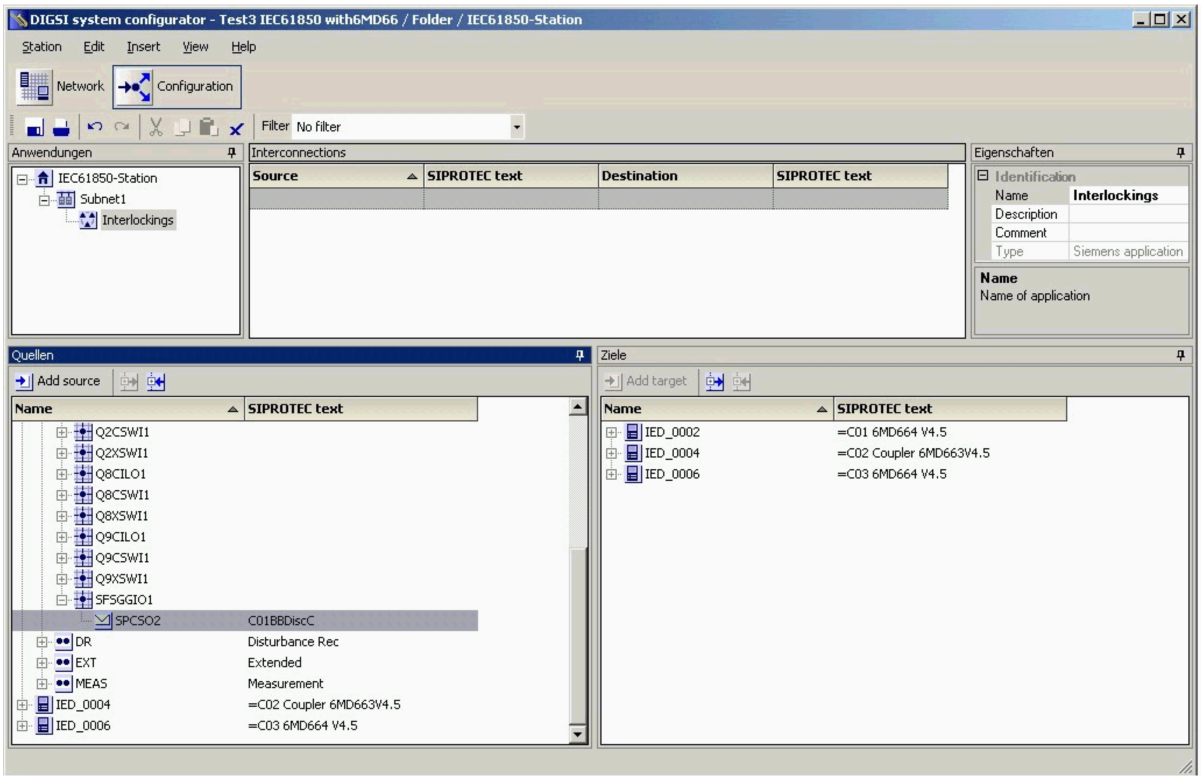


Figure 2-94 Selecting the source information

Use the "Add source“ button, which is activated when you select the information, to copy this information to the link list.

Proceed in the same way for the other two items of source information from the other two devices. You will obtain the following result:

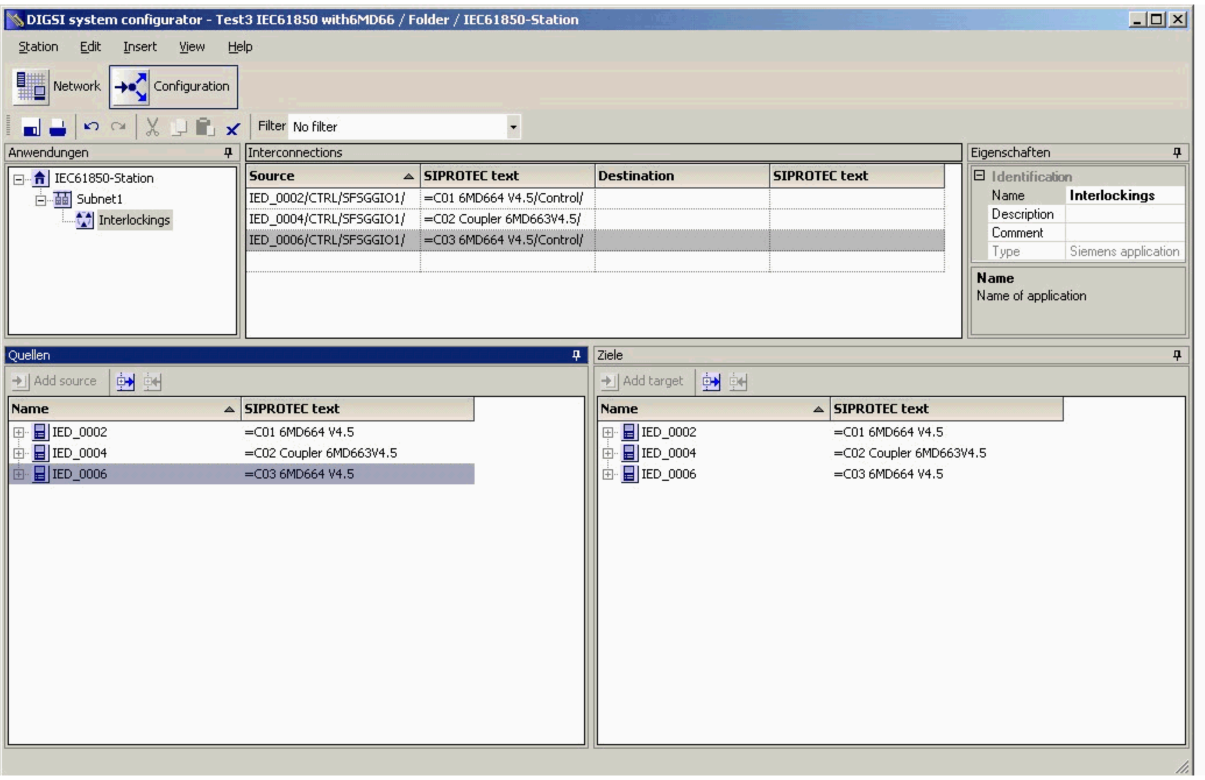


Figure 2-95 Routing of all source information

Proceed in the same way for the target information. Before clicking the "Add target" button, however, select from the link list the line which contains the required source information. For instance, the information "C01 Busbar disconnector closed" from bay C01 must be routed to the information of the same name in the bus coupler.

After routing all information items, the link list looks like this:

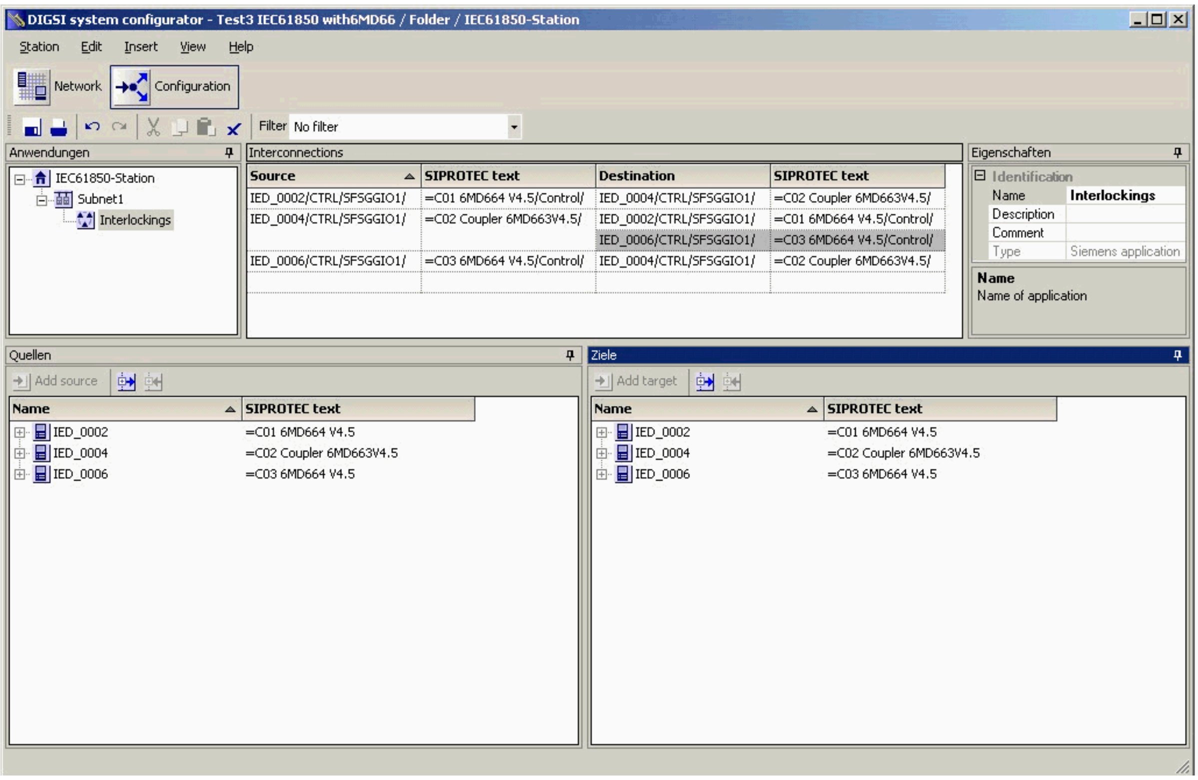


Figure 2-96 Routing of all target information

Unlike the source information, the target information is not copied but moved. Each item of information can appear exactly once as a target (uniqueness), whereas an item of source information can have several targets. For instance, the information "Bus coupler closed" from C02 is transmitted to both feeder devices, C01 and C03.

To make navigation in the tables easier, the familiar SIPROTEC texts are always displayed in parallel next to the IEC61850 information names.

Save now the station with "Station – Save“ from the menu bar. The SCD file describing the station configuration is now saved.

2.13.7 Update Parameter Sets and Print Status

The last step is now to add the links created in the link list to the parameter sets of the three devices. To do so, close the station configurator, right-click the IEC61850 station and select once again "Object properties“.

There you select the "Update" tab, which looks now like this.

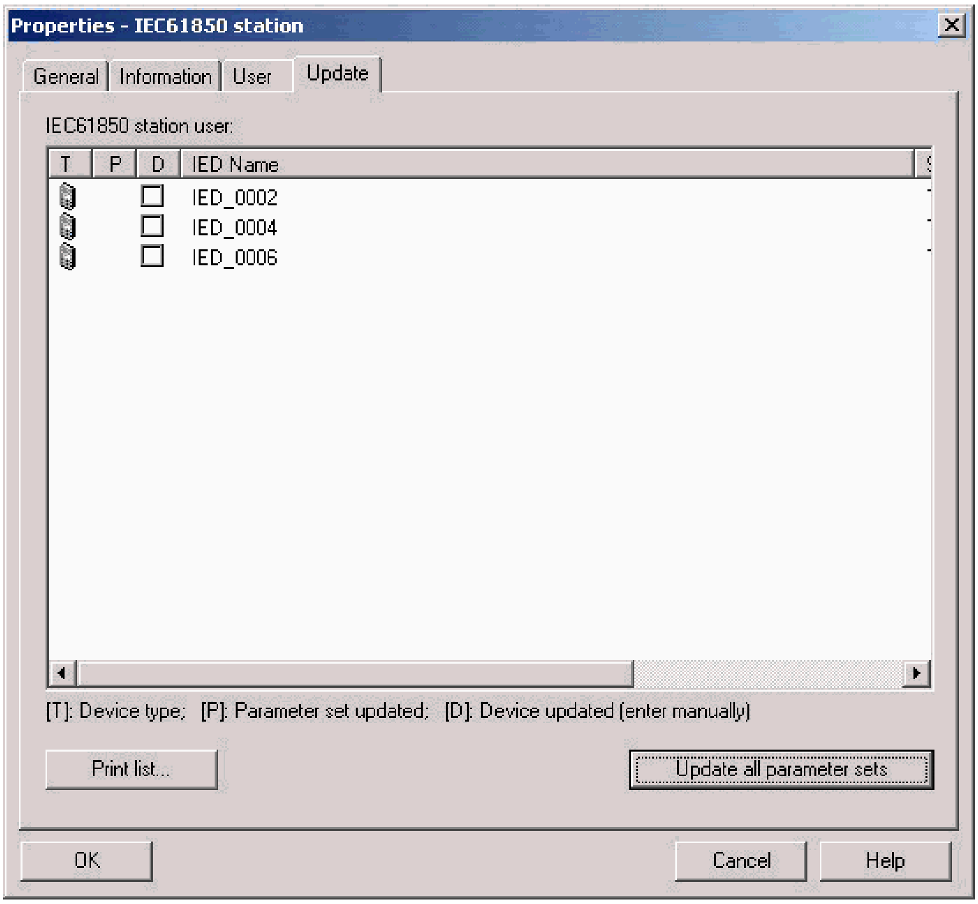


Figure 2-97 Updating nodes

By clicking the button "Update all parameter sets“, you prompt the DIGSI Manager to add the routing information to the device parameter sets.

A report is created, which can also be printed.

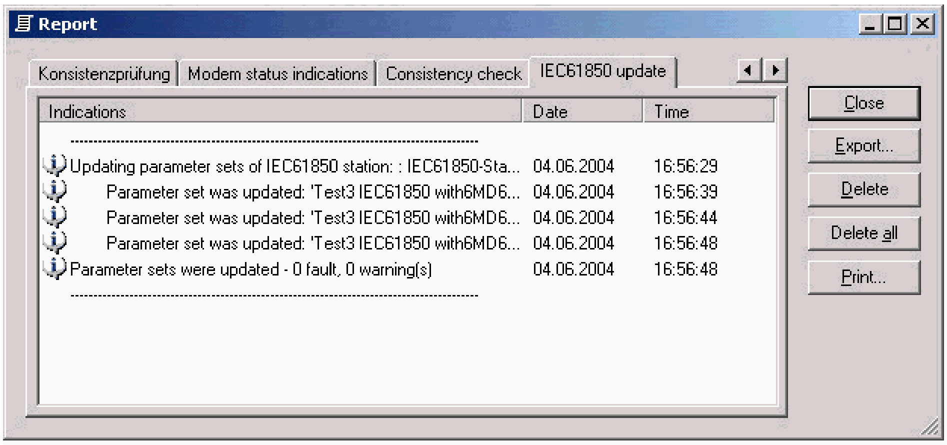


Figure 2-98 Updating report

After the update has been completed without errors, the nodes are marked with a checkmark in the column "P". When changes are made in individual devices or in the GOOSE configuration, this checkmark shows clearly which parameter sets are up to date and which are not.

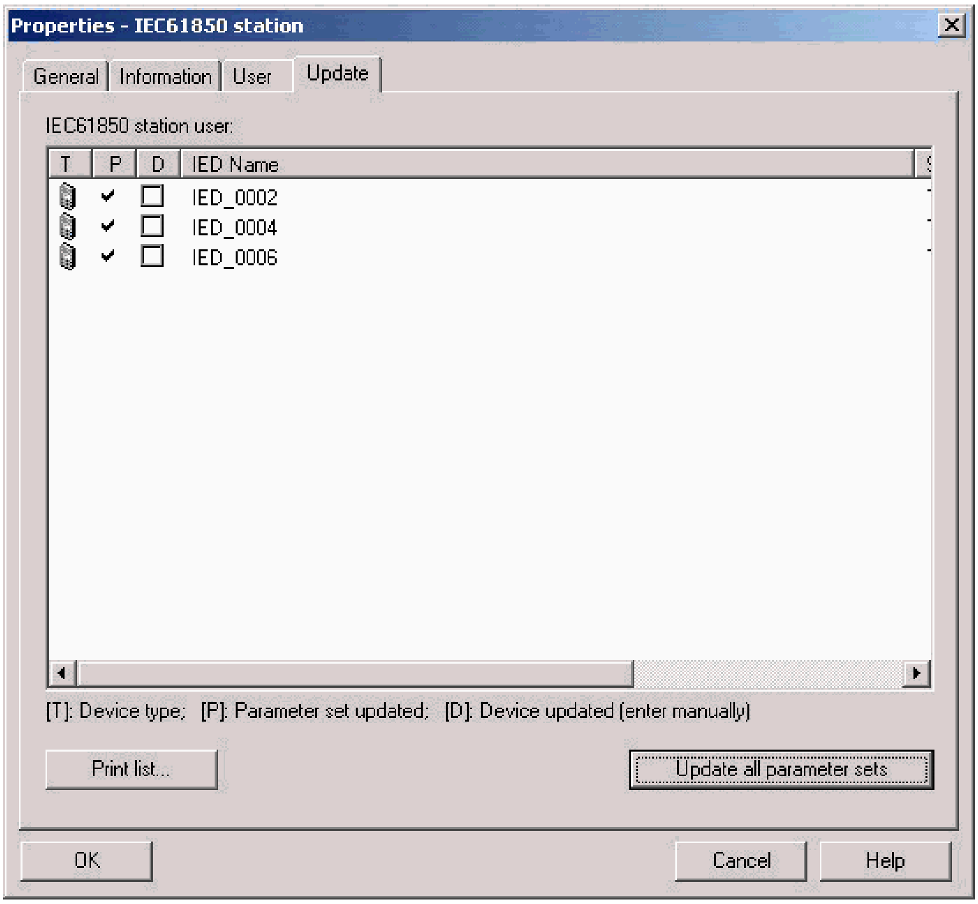


Figure 2-99 Updated parameter sets

You can now load the parameter sets into the SIPROTEC4 6MD66x devices.

2.13.8 Time Synchronization

Time synchronization is not possible with the GOOSE mechanism; in IEC61850 a client-server mechanism is provided for that purpose. In SIPROTEC4 devices, a client functionality is implemented for NTP (Network Time Protocol).

If such a time server is available in the network, it can be used for time setup of the devices connected through IEC61850. For instance, the SICAM PAS Station Controller can be used as an NTP time server.

To configure the device, open it with DIGSI and select "Time synchronization". Since the introduction of IEC61850, the option "Ethernet NTP“ is available there.

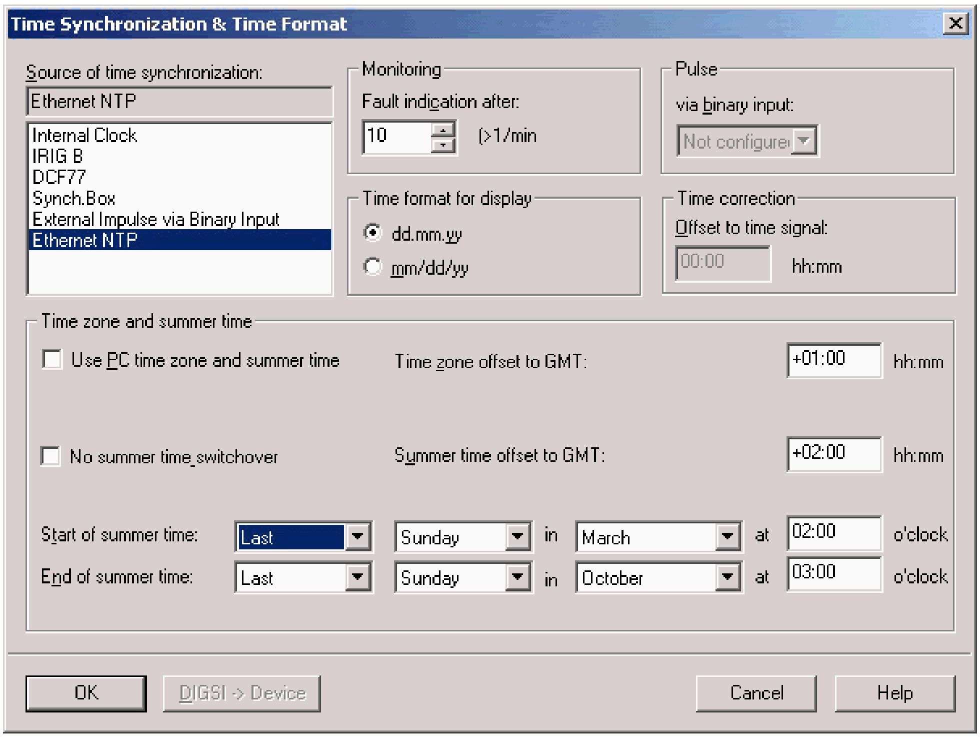


Figure 2-100 “Time synchronization” dialog box

A prerequisite for this is that an appropriate time server exists in the network.

2.13.9 Setting Notes

Interface Selection

No settings are required for operation of the Ethernet system interface module (IEC 61850, **`EN100-Modul 1`**). If the device is equipped with such a module (see MLFB), the module is automatically configured to the interface available for it, namely .

2.14 Web-Monitor

The Web Monitor makes possible the display of parameters, data and measuring values for SIPROTEC 4- devices during installation or during operation. For this it uses Internet technology.

The SIPROTEC-Web Monitor provides several functions for all devices, the others are available depending on the device. The 6MD66x specific functions are monitoring of the IRC combination and monitoring of the synchronizing function. Among general installation notes, this manual also describes functions of the SIPROTEC Web Monitor which are specific for 6MD66x only. The general functions are available in the Help file on DIGSI-CD (as from version DIGSI V4.60).

The display is made by a Web Browser, e.g. Internet Explorer. Using the Web browser you can find, for example, a quick view of an IRC combination. Combination data, device data, master data, combination structure and process data of each user can be displayed there. In case of synchronizing function, the Web Monitor enables the display of switching ranges of a synchroscope and of synchronous networks.

Prerequisites

The Web-Monitor runs on the operator PC and requires only standard software. The following software programs / operating systems must be installed:

Operating system: Microsoft Windows XP, Microsoft Windows 2000, Microsoft Windows NT, Microsoft Windows ME, Microsoft Windows 98

Internet browser: Netscape Communicator Version 4.7, Netscape Communicator Version 6.x or higher, or Microsoft Internet Explorer Version 5.0 or higher. Java must be installed and activated.

Long-distance data transmission network: The required software component is included in Microsoft Windows XP, Microsoft Windows 2000, Microsoft Windows NT and Windows 98. This component is only needed if the device is connected through a serial interface.

Network adapter: The required software component is integrated into Microsoft Windows XP, Microsoft Windows 2000, Microsoft Windows NT and Windows 98. This component is only needed when connecting the device via an Ethernet interface (possible for devices with EN100 interface).

2.14.1 General

During installation, the device parameterization created must be controlled in devices and their functions checked. The Web Monitor supports you during the simple and clear determination and display of important measuring values.

Discrepancies in the wiring or the parameterisation can be found and solved quickly.

To run the Web-Monitor, a link from the operator PC to the protection device via its front and rear operator interface (service interface) is necessary. This can be made directly by the 9-pole DIGSI cable by means of an existing long-distance data connection. Remote access via a modem is possible as well. An Internet browser must be installed on the operator PC (see paragraph on system requirements). DIGSI 4 is usually installed on the operator PC as well.

Please make sure that DIGSI 4 and the Web-Monitor do not use the same operator interface at the same time. A serial simultaneous access would lead to data collisions. This means that either DIGSI 4 OR the Web-Monitor can use a device interface.

Before the Web-Monitor is started, DIGSI 4 must be exited or you should at least have finished making the settings and allocations in DIGSI 4. It is possible to simultaneously operate DIGSI 4 at the front operator interface via a COM port of the operator PC and the Web-Monitor at the rear operating interface via an other COM port of the operating PC.

The Web-Monitor is composed of HTML pages containing Java applets which are stored in the EEPROM of the 6MD66x SIPROTEC 4 device. It is an integral part of the SIPROTEC 4 device firmware and need not be separately installed. All that needs to be created on the operator PC is a long-distance data transmission network used for selection and communication. After the link has been successfully established through the data transmission network, the browser is started and the TCP-IP address of the protection device entered in it. The server address of the device, which is its homepage address, is transmitted to the browser and displayed as an HTML page. This TCP-IP address is set at the front and service interface using DIGSI 4, or directly on the device using the integrated operator interface.

Note

The process can only be monitored. Control the process through the data transmission link is only possible after a control feature has been set up and established. You can, either directly on the device or with DIGSI 4, modify a parameter in such a way that the device control feature contained in the Web-Monitor allows also the input of numerical values. You can then modify in the Web-Monitor parameters which are normally set only directly on the device, because passwords can now be entered from the keyboard.

2.14.2 Functions

Basic Functionality

The basic functionality designates functions that are generally available, i.e. not device-dependent.

These include:

- Device operation
- Indications
- Fault record overview
- Measured value overview
- Diagnosis
- Device file system
- CFC

A function description can be found in the Online Help of DIGSI as from version V4.60.

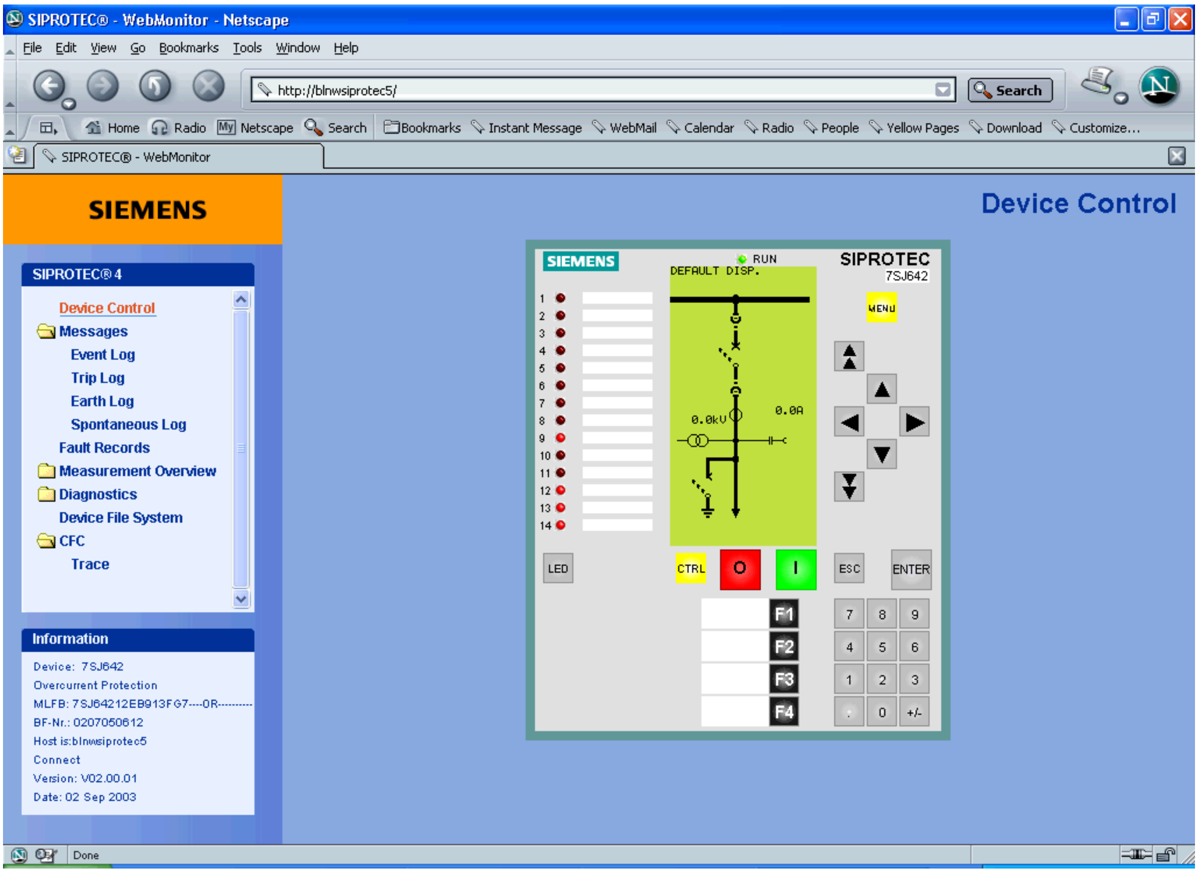


Figure 2-101 Web-monitor - Basic display

The above figure of the device operation view shows a device connected through the data transmission link with its control (keyboard) and display elements (display, LEDs, inscriptions). The device can be operated with the keys shown in the display in the same way as with the sealed keypad on the device.

Siemens recommends to block the controller using the Web Monitor. This can be achieved by allowing "Read only" access for the interface through which the Web browser accesses the device. You can receive this parameter in DIGSI via "Interfaces - Operator Interface at the Device" (for access via serial interface) or via "Interfaces - Ethernet at the device" (for access via Ethernet interface, refer to the following Figure).

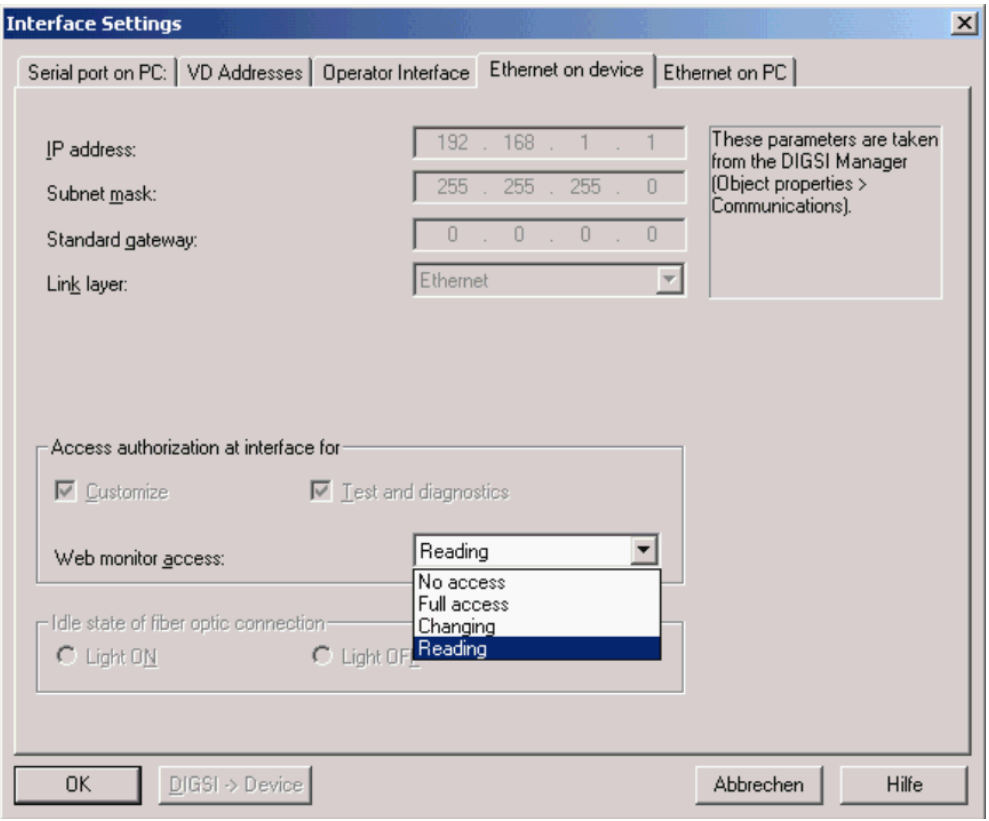
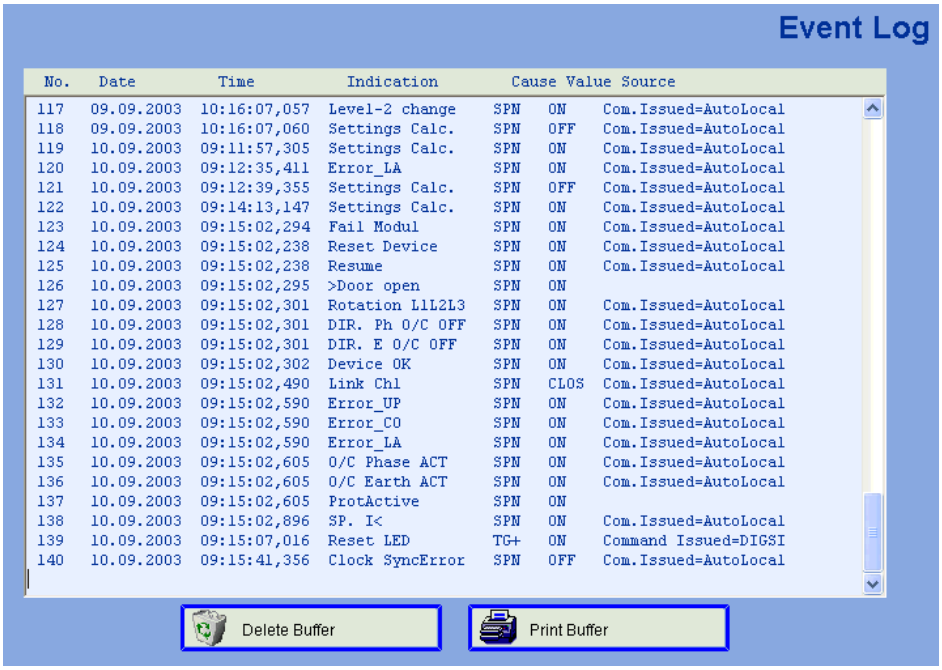


Figure 2-102 Setting the authorization for the Web Monitor for an access via Ethernet interface

The figure below shows as an example the indications from the operational indication buffer arranged in a list. These indications are displayed with their short text stored in the device.



Event Log

No.	Date	Time	Indication	Cause	Value	Source
117	09.09.2003	10:16:07,057	Level-2 change	SPN	ON	Com.Issued=AutoLocal
118	09.09.2003	10:16:07,060	Settings Calc.	SPN	OFF	Com.Issued=AutoLocal
119	10.09.2003	09:11:57,305	Settings Calc.	SPN	ON	Com.Issued=AutoLocal
120	10.09.2003	09:12:35,411	Error_LA	SPN	ON	Com.Issued=AutoLocal
121	10.09.2003	09:12:39,355	Settings Calc.	SPN	OFF	Com.Issued=AutoLocal
122	10.09.2003	09:14:13,147	Settings Calc.	SPN	ON	Com.Issued=AutoLocal
123	10.09.2003	09:15:02,294	Fail Modul	SPN	ON	Com.Issued=AutoLocal
124	10.09.2003	09:15:02,238	Reset Device	SPN	ON	Com.Issued=AutoLocal
125	10.09.2003	09:15:02,238	Resume	SPN	ON	Com.Issued=AutoLocal
126	10.09.2003	09:15:02,295	>Door open	SPN	ON	
127	10.09.2003	09:15:02,301	Rotation L1L2L3	SPN	ON	Com.Issued=AutoLocal
128	10.09.2003	09:15:02,301	DIR. Ph O/C OFF	SPN	ON	Com.Issued=AutoLocal
129	10.09.2003	09:15:02,301	DIR. E O/C OFF	SPN	ON	Com.Issued=AutoLocal
130	10.09.2003	09:15:02,302	Device OK	SPN	ON	Com.Issued=AutoLocal
131	10.09.2003	09:15:02,490	Link Ch1	SPN	CLOS	Com.Issued=AutoLocal
132	10.09.2003	09:15:02,590	Error_UP	SPN	ON	Com.Issued=AutoLocal
133	10.09.2003	09:15:02,590	Error_CO	SPN	ON	Com.Issued=AutoLocal
134	10.09.2003	09:15:02,590	Error_LA	SPN	ON	Com.Issued=AutoLocal
135	10.09.2003	09:15:02,605	O/C Phase ACT	SPN	ON	Com.Issued=AutoLocal
136	10.09.2003	09:15:02,605	O/C Earth ACT	SPN	ON	Com.Issued=AutoLocal
137	10.09.2003	09:15:02,605	ProtActive	SPN	ON	
138	10.09.2003	09:15:02,896	SP. I<	SPN	ON	Com.Issued=AutoLocal
139	10.09.2003	09:15:07,016	Reset LED	TG+	ON	Command Issued=DIGSI
140	10.09.2003	09:15:41,356	Clock SyncError	SPN	OFF	Com.Issued=AutoLocal

Delete Buffer
Print Buffer

Figure 2-103 Event log

Device-specific Functionality

In addition to the general basic functionality, the Web-Monitor for the 6MD66x comprises the PRC functions IRC combination with user details and the synchronization functions. All in all, the following information can be displayed with the Web-Monitor.

IRC combination

- Combination data
- Device data
- Master data
- Combination structure
- Node details

The IRC combination function of the Web-Monitor is started with the menu item "RC“ in the operator menu. An IRC combination can comprise up to 32 nodes. Nodes are displayed in a list, with their node number and status (ON or OFF). Nodes connected with the Web-Monitor are shown in red. The nodes and their numbers are mouse-sensitive. This means that on moving the mouse over the node the cursor shape changes to a hand, and the colour of the node changes. By clicking on a node, you can then display details of that node – up to 32 items of process information – with the indications parameterised for it and the associated values.

The synchronization function includes the following views:

- Synchronization ranges

  The synchronization ranges are displayed in a coordinate system. The X axis shows the frequency and the Y axis the voltage.
- Synchronoscope

  The synchronoscope is dynamically visualized by three diagrams showing respectively the difference angle, the difference voltages and the difference frequency.
- Synchronous networks

  Synchronous networks are visualized by a pie chart and the current measured values.

The figure below shows an example of the synchronoscope with selection list, pie/bar chart and the current measured values.

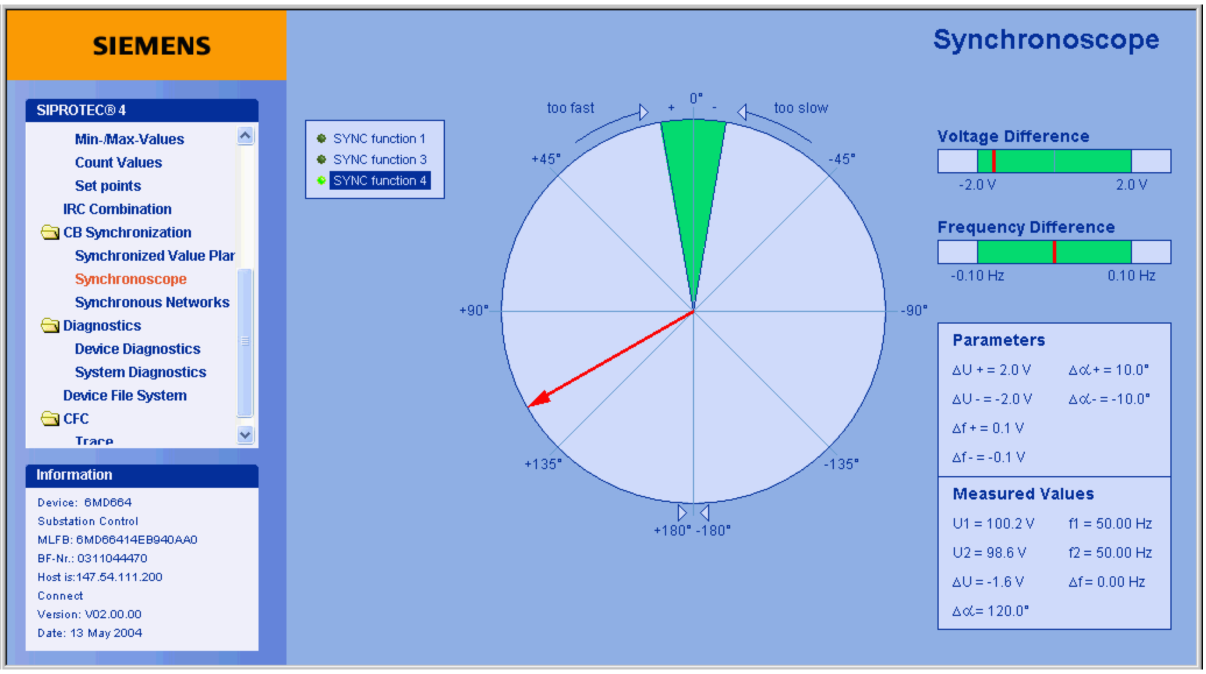


Figure 2-104 Web-monitor - Synchronoscope

All currently parameterized functions are shown in a list. An LED icon shows the current status of the selected group: bright green (ON) for active, and dark green (OFF) for inactive. For an inactive function group, only the parameter settings are shown, whereas for an active function group the current measured values are displayed as well. On startup, the first active function group found is displayed automatically. All measured values are read out directly in the device — about every 100 ms — and visualized in tables or diagrams.

2.14.3 Operating Modes

The Web-Monitor works in the following operating modes set between the operator PC and the SIPROTEC 4 device:

Direct Serial Link

Direct link between the device's front or rear service interface and the serial interface of the operator PC. For this link the 9-pin cable must be used that is supplied as an accessory with DIGSI.

Dial-up Connection Through a Modem

Serial connection of the rear service port of the device with a modem in the system. This connection can be electrically implemented via RS232 (over short distance) or via fibre optics. The connection to the system modem is established from the office or from any other system using a switched line. DIGSI-Remote can also be carried out using this connection. Thus, parameters of a remote device can also be changed during the installation.

Operation with a Star Coupler

Connection between the device's rear service interface and a star coupler using a direct optical link. Connection of the operator PC's serial interface to a star coupler. In this way several devices can be operated within the system; the existing installation can be used for central operation of protection devices.

Operation with Ethernet

Link through an Ethernet interface. This type of connection requires an EN100 communication module inside the device, and a connection of that module to a local network.

For more information of the basic functionality, the installation and the operating system-specific configuration please refer to the Web-Monitor online help provided on the DIGSI CD.

Access regulation for Web Monitor

The Web Monitor access rights are assigned with DIGSI using the **Interfaces** entry. For this purpose, Siemens recommends to allow **Read** authorization; in doing so, neither the event list can be deleted, nor a command output, nor a saved LED reset via the Web Monitor. If you specify the **Full access** level, all these operating actions can also be carried out through the Web Monitor.

Note

The **No access** level is ineffective yet, i.e. here, the user receives full access rights as well. For this, refer to Figure 2-102.

■

Mounting and Commissioning 3

This chapter is intended for experienced commissioning staff. They should be familiar with commissioning control devices, using the network and with the safety rules and instructions. Some hardware adaptations to the system data may become necessary. Some of the primary tests require the devices (line, transformer, etc.) to carry load.

3.1 Mounting and Connections

General

WARNING!

Warning of improper transport, storage, installation, and application of the device.

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

Trouble free and safe use of this device depends on proper transport, storage, installation, and application of the device according to the warnings in this instruction manual.

Of particular importance are the general installation and safety regulations for work in a high-voltage environment (for example, ANSI, IEC, EN, DIN, or other national and international regulations). These regulations must be observed.

3.1.1 Configuration Information

Prerequisites

For installation and connection, the following conditions and limitations apply:

The rated device data is checked as recommended in the SIPROTEC® System Description /1/. The compliance with these data is verified with the Power System Data.

Connection variants

Connection examples for the current and voltage transformer circuits are given in the Appendix.

Currents/Voltages

As the voltage inputs of the 6MD66x device have an operating range from 0 to 170 V, this means that phase-phase voltages can be assessed up to $\sqrt{3} \cdot 170\ \text{V} = 294\ \text{V}$.

Binary inputs and outputs

The configuration of the binary inputs and outputs, i.e. the individual adaptation to the system conditions, is described in /1/. The connections to the system are dependent on this actual configuration.

3.1.2 Hardware Modifications

3.1.2.1 General

Hardware modifications concerning, for instance, nominal currents, the control voltage for binary inputs or termination of serial interfaces might be necessary. Follow the procedure described in this subsection, whenever hardware modifications are done.

Auxiliary voltage

The various input voltage ranges (60/110 VDC and 220 to 250 VDC) of the auxiliary voltage can be changed to one another by changing the plug-in jumpers. When the device is delivered, these jumpers are set according to the name-plate sticker. Generally, they need not be altered (see also ordering data in the Appendix).

Life contact

The life contact of the device is a changeover contact, from which either the opener or closer can be applied to the device connections F3 and F4 via a jumper (X40 on the CPU module). The assignment of the plug-in jumper to the contact type and the spatial arrangement of the jumper are described in the following.

Rated currents

The input transformers of the device are set to a nominal current of 1 A or 5 A by burden switching. The positioning of the plug-in jumpers has been executed in the factory according to the indications on the rating plate. All jumpers must be set for one nominal current, i.e. respectively one jumper (X61 to X63) for each input transformer and additionally the common jumper X60.

Should you perform a change here, you must not forget to communicate this change to the device also via the parameter Transformer current I, secondary in the measuring transducer packets.

Control voltage for binary inputs

In the delivery status, the binary inputs are set in a way ensuring that a direct current equalling the supply voltage is set as control variable. If the rated values differ from the power system control voltage, it may be necessary to change the switching threshold of the binary inputs.

To change the switching threshold of a binary input, a jumper must be reallocated in each case.

Note

If binary inputs are used for trip circuit monitoring, note that two binary inputs (or a binary input and a replacement resistor) are connected in series. The switching threshold must lie clearly below one half of the rated control voltage.

Replacing interfaces

The serial interfaces are replaceable. The interfaces which can be replaced, and how this is done, is described in the Interface modules section.

Terminating serial interfaces

If the device is equipped with a serial RS485 interface or PROFIBUS, they must be terminated with resistors at the last device on the bus to ensure reliable data transmission. For this purpose termination resistors are provided on the PCB of the CPU processor module and on the PROFIBUS interface module which can be connected via jumpers. Both jumpers must be always plugged in identically.

The termination resistors are disabled on unit delivery.

3.1.2.2 Disassembly

Disassembly of the Device

Note

It is assumed for the following steps that the device is not operative.

Work on the Printed Circuit Boards

Caution!

Caution when changing jumper settings that affect nominal values of the device

As a consequence, the ordering number (MLFB) and the ratings that are stated on the nameplate do no longer match the actual device properties.

If such changes are necessary, the changes should be clearly and fully noted on the device. Self adhesive stickers are available that can be used as replacement name-plates.

To perform work on the printed circuit boards, such as checking or moving switching elements or exchanging modules, proceed as follows:

- Prepare the working area. Provide a grounded mat for protecting components subject to damage from electrostatic discharges (ESD). The following equipment is needed:
  - screwdriver with a 5 to 6 mm wide tip,
  - 1 Philips screwdriver,
  - 5 mm socket or nut driver.
- Unfasten the screw-posts of the D-subminiature connector on the back panel at location „A“.
- If the device has additional system interfaces on slots „B“ to „D“ in addition to the service interface on slot „A“, the screws located diagonally to the interfaces must be removed.
- Remove the four or six caps on the front cover and loosen the screws that become accessible.
- Carefully take off the front cover. With device versions with a detached operator panel it is possible to remove the front cover of the device right after having unscrewed all screws.

Work on the Plug Connectors

Caution!

Mind electrostatic discharges

Non–observance can result in minor personal injury or property damage.

When handling with plug connectors, electrostatic discharges may emerge by previously touching an earthed metal surface must be avoided.

Do not plug or withdraw interface connections under power!

When performing work on plug connectors, proceed as follows:

- Release the connector of the ribbon cable between CPU processor module (1) and front cover at the front cover itself. Press the top latch of the plug connector up and the bottom latch down so that the plug connector of the ribbon cable is pressed out.

  These activities are not necessary if the device has a detached operator panel. However, on the CPU processor module (1) the 7-pin plug connector X16 behind the subminiature socket and the plug connector of the ribbon cable (connected to the 68-pin plug connector on the rear side) must be removed.
- Disconnect the ribbon cables between the CPU unit (1) and the input/output modules I/O-4 (2) and I/O-5 (3).
- Remove the modules and place them on a surface suitable for electrostatically sensitive modules (ESD).
- Check jumpers and change/remove if necessary.

Module Arrangement of 6MD662

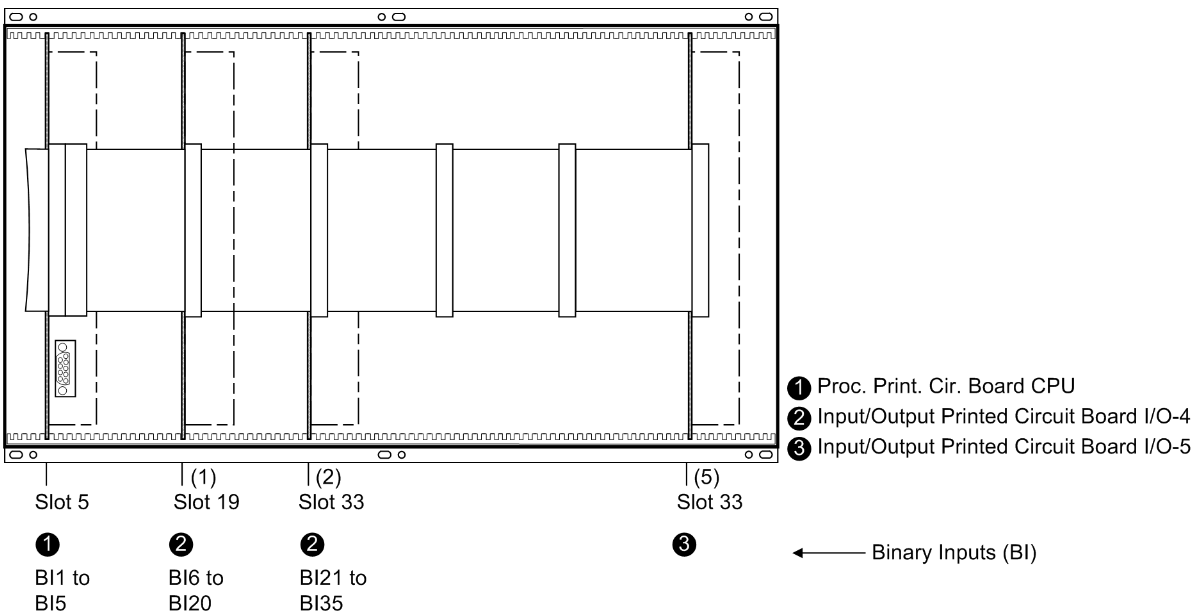


Figure 3-1 Front view of a 662 device after removing the front cover (simplified and reduced in scale)

Module Arrangement of 6MD663

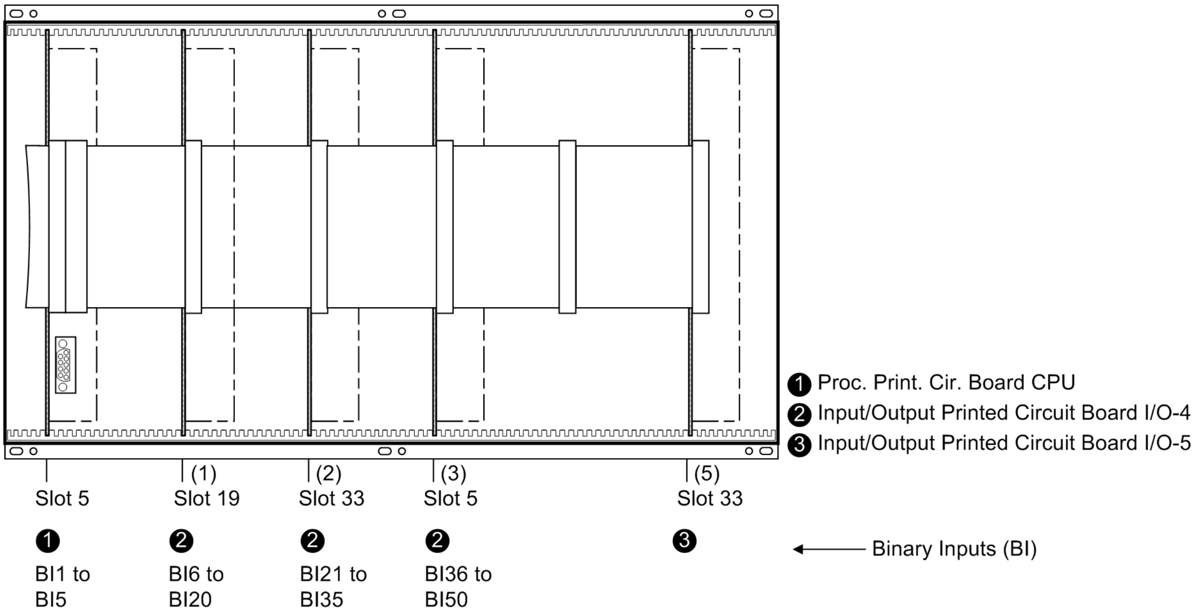


Figure 3-2 Front view of a 663 device after removing the front cover (simplified and reduced in scale)

Module Arrangement 6MD664

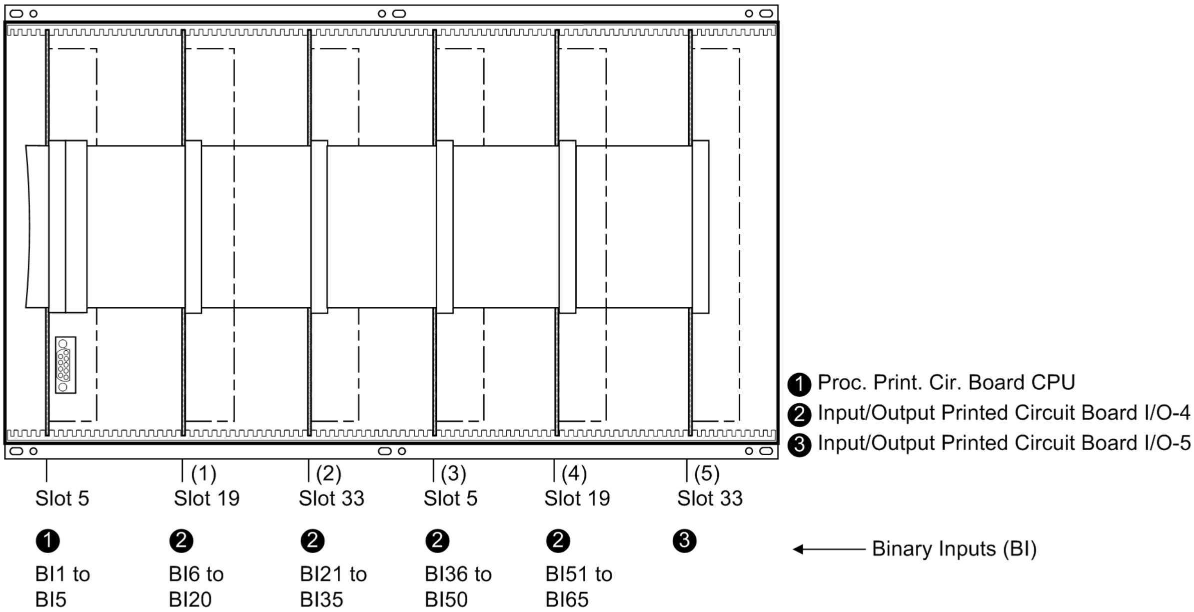


Figure 3-3 Front view of a 664 device after removing the front cover (simplified and reduced in scale)

3.1.2.3 Switching Elements on Printed Circuit Boards

CPU processor module

Check the set rated voltage of the integrated power supply, the quiescent state of the life contact, the selected control voltages of binary inputs BI1 to BI5 and the integrated RS232/RS485 interface using the layout of the PCB of the CPU processor module and the tables below.

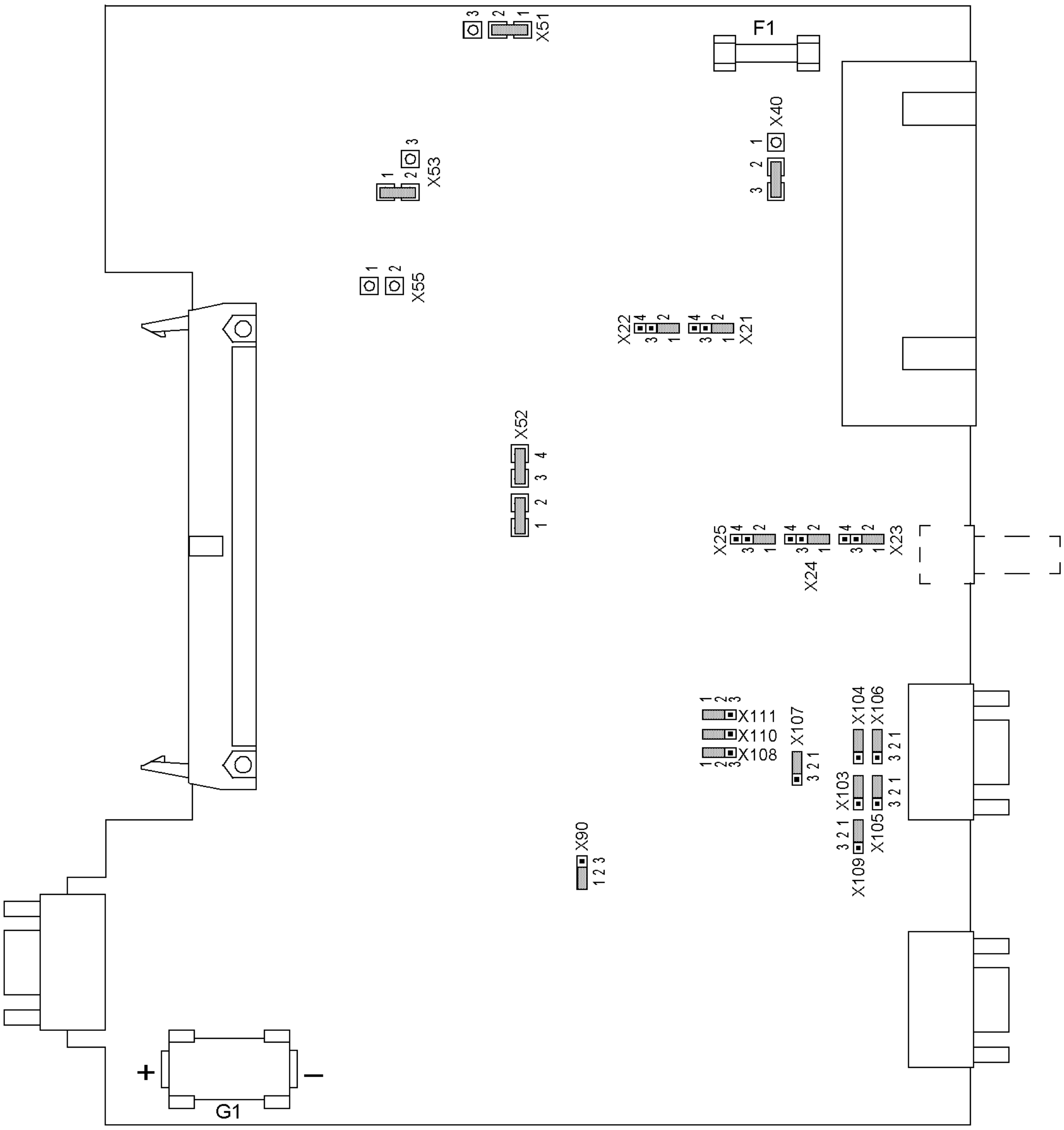


Figure 3-4 Processor module CPU with representation of the jumpers required for checking the settings

Table 3-1 Jumper setting of the rated voltage of the integrated **power supply** on the CPU processor module

Jumper	Rated voltage			
	24 to 48 V DC	60 V DC	110 V DC	220 to 250 V DC
X51	Not used	1-2	1-2	2-3
X52	Not used	1-2 and 3-4	1-2 and 3-4	2-3
X53	Not used	1-2	1-2	2-3
X55	Not used	Open	Open	1-2

Table 3-2 Jumper position of the quiescent state of the **Life contact** on the CPU processor module

Jumper	Open in the quiescent state	Closed in the quiescent state	Presetting
X40	1-2	2-3	2-3

Table 3-3 Jumper setting of the **control voltages** of the binary inputs BI1 to BI5 on the CPU processor module

Binary input	Jumper	Threshold 19 V[1)]	Threshold 88 V[2)]	Threshold 176 V[3)]
BI1	X21	1-2	2-3	3-4
BI2	X22	1-2	2-3	3-4
BI3	X23	1-2	2-3	3-4
BI4	X24	1-2	2-3	3-4
BI5	X25	1-2	2-3	3-4

1) Factory settings for devices with rated supply voltages of 24 V DC to 60 V DC
2) Factory settings for devices with rated supply voltage DC 110 V
3) Factory settings for devices with rated supply voltages of 220 V DC to 250 V DC

Table 3-4 Jumper settings of the integrated **RS232/RS485 interface** on the CPU processor module

Jumper	RS232	RS485
X105 to X110	1-2	2-3

Note

Jumpers X105 to X110 must be set to the same position.

The presetting of the jumpers corresponds to the configuration ordered.

The R485 interface can be converted into an RS232 interface by modifying the jumpers.

For an order with MLFB position 12 the same as 0, the interface is set to RS232.

Table 3-5 Jumper setting for **CTS (Flow control)** on the CPU processor module

Jumper	/CTS from Interface RS232	/CTS triggered by /RTS
X111	1-2	2-3

The jumper is always inserted at position 2-3 at the factory.

The jumper must be set to 2–3 for the RS232 connection of DIGSI®.

Jumper setting 2–3 is also required for the connection via star coupler or fibre optic cable; we recommend the connection cable Order No. 7XV5100–4 for this purpose.

Jumper setting 1–2 is required for a modem connection; we recommend a standard connection cable (9-pin/25-pin) for this.

Table 3-6 Jumper setting of the **terminating resistors** of the **RS232/RS485 interface** on the CPU processor module

Jumper	Termination resistor Connected	Termination resistor Disconnected	Factory setting
X103	2-3	1-2	1-2
X104	2-3	1-2	1-2

Provided that they are not terminated externally via resistors, each last device must be configured via the jumpers X103 and X104.

Note

Both jumpers must always be plugged in the same way!

Jumper X90 serves for internal test purposes. The factory setting 1–2 must not be changed.

I/O-4 module

The selected control voltages of the binary inputs BE6 to BE65 are checked according to the table below. The assignment of the binary inputs to the installation location of the module can be found in Section **Module arrangement**.

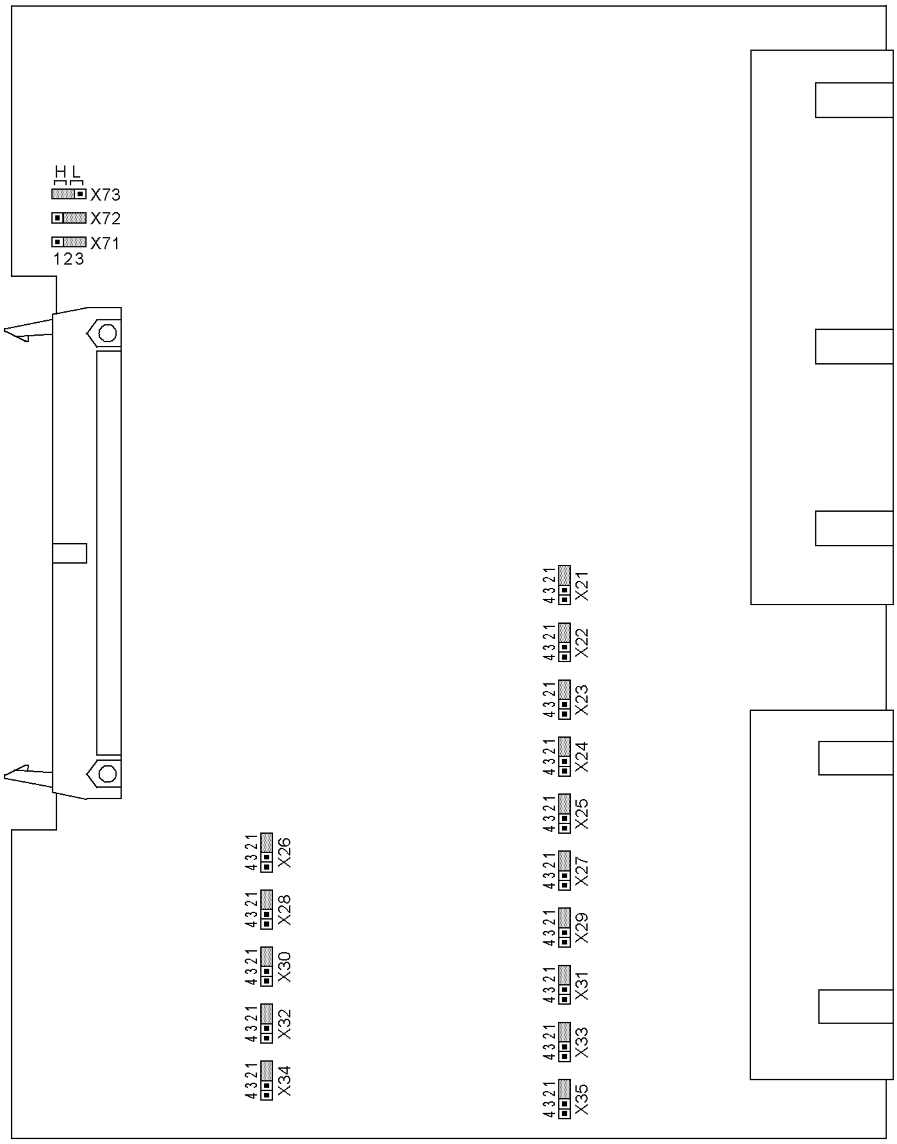


Figure 3-5 I/O-4 input/output module with representation of the jumpers required for checking the settings

Table 3-7 Jumper setting for the control voltages of the binary inputs BI6 through BI65 on the I/O-4 input/output module

Binary input				**Jumper**	**Threshold 19 V[1)]**	**Threshold 88 V[2)]**	**Threshold 176 V[3)]**
BI6	BI21	BI36	BI51	X21	1-2	2-3	3-4
BI7	BI22	BI37	BI52	X22	1-2	2-3	3-4
BI8	BI23	BI38	BI53	X23	1-2	2-3	3-4
BI9	BI24	BI39	BI54	X24	1-2	2-3	3-4
BI10	BI25	BI40	BI55	X25	1-2	2-3	3-4
BI1	BI26	BI41	BI56	X26	1-2	2-3	3-4
BI12	BI27	BI42	BI57	X27	1-2	2-3	3-4
BI13	BI28	BI43	BI58	X28	1-2	2-3	3-4
BI14	BI29	BI44	BI59	X29	1-2	2-3	3-4
BI15	BI30	BI45	BI60	X30	1-2	2-3	3-4
BI16	BI31	BI46	BI61	X31	1-2	2-3	3-4
BI17	BI32	BI47	BI62	X32	1-2	2-3	3-4
BI18	BI33	BI48	BI63	X33	1-2	2-3	3-4
BI19	BI34	BI49	BI64	X34	1-2	2-3	3-4
BI20	BI35	BI50	BI65	X35	1-2	2-3	3-4

[1)] Factory settings for devices with rated supply voltages of 24 V DC to 60 V DC
[2)] Factory settings for devices with supply voltages DC 110 V
[3)] Factory settings for devices with rated supply voltages of 220 V DC to 250 V DC

Jumpers X71, X72 and X73 on the input/output module C-I/O-4 are used to set the bus address and must not be changed. The table shows the factory setting of the jumpers.

Table 3-8 Module address jumper settings of input/output modules I/O-4

Jumper	Insertion slot			
	Slot 19 (1)	Slot 33 (2)	Slot 5 (3)	Slot 19 (4)
X71	1-2 (H)	2-3 (L)	1-2 (H)	2-3 (L)
X72	2-3 (L)	1-2 (H)	1-2 (H)	2-3 (L)
X73	2-3 (L)	2-3 (L)	2-3 (L)	1-2 (H)

I/O-5 module

Check the set rated currents of the current input transformers here. All jumpers must be set for one rated current, i.e. respectively one jumper (X61 to X63) for each input transformer and additionally the common jumper X60.

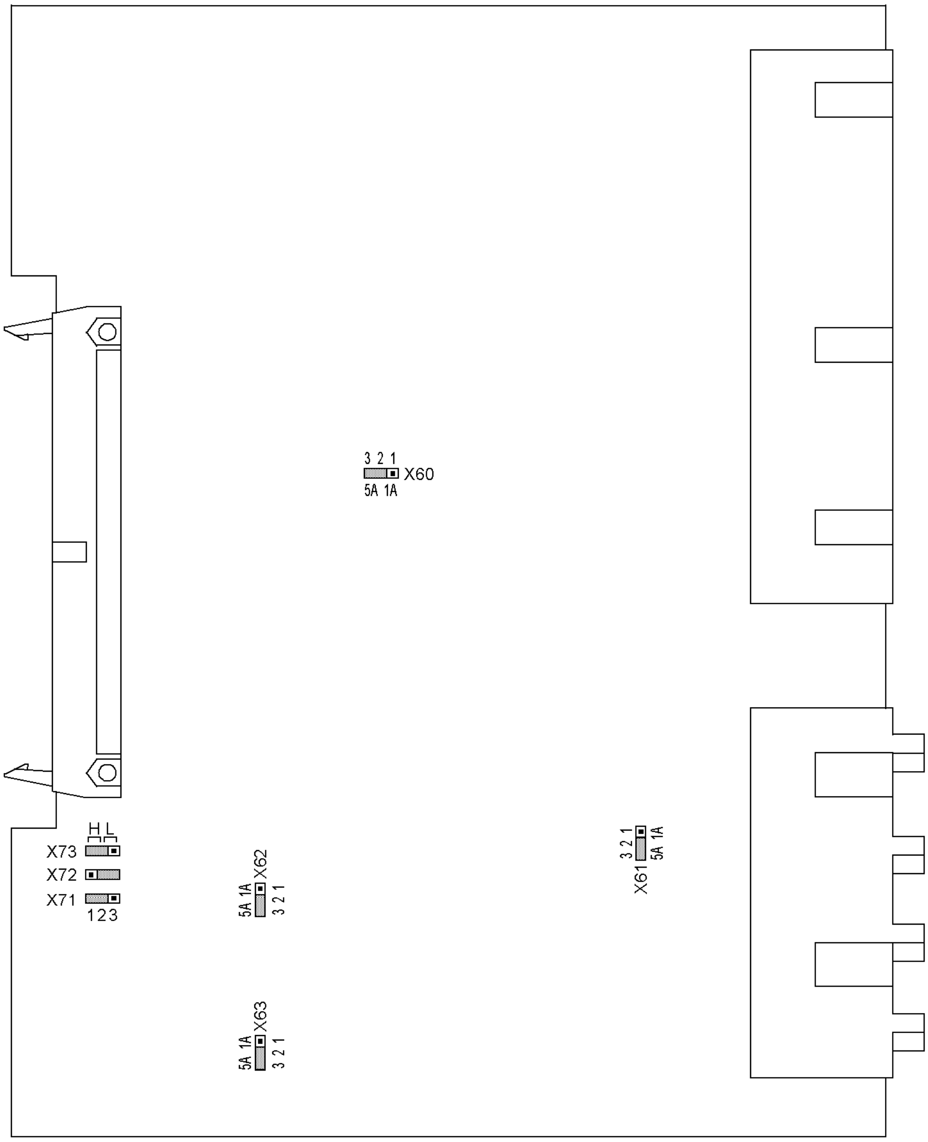


Figure 3-6 I/O-5 input/output module with representation of the jumpers required for checking the settings

Jumpers X71, X72 and X73 on the input/output module I/O-5 are used to set the bus address and must not be changed. The table shows the factory setting of the jumpers. The insertion slot of the module is described in Section **Module arrangement**.

Jumpers X60 - X63 serve for setting the nominal current secondary current 1 A or 5 A. All jumpers must be set identically.

Table 3-9 Jumper settings of the **Module Address** of the input/output module I/O-5

6MD662	
Jumper	Position
X71	1-2
X72	1-2
X73	2-3
6MD663	
Jumper	Position
X71	2-3
X72	2-3
X73	1-2
6MD664	
Jumper	Position
X71	1-2
X72	2-3
X73	1-2

3.1.2.4 Interface Modules

Replacing inter-face modules

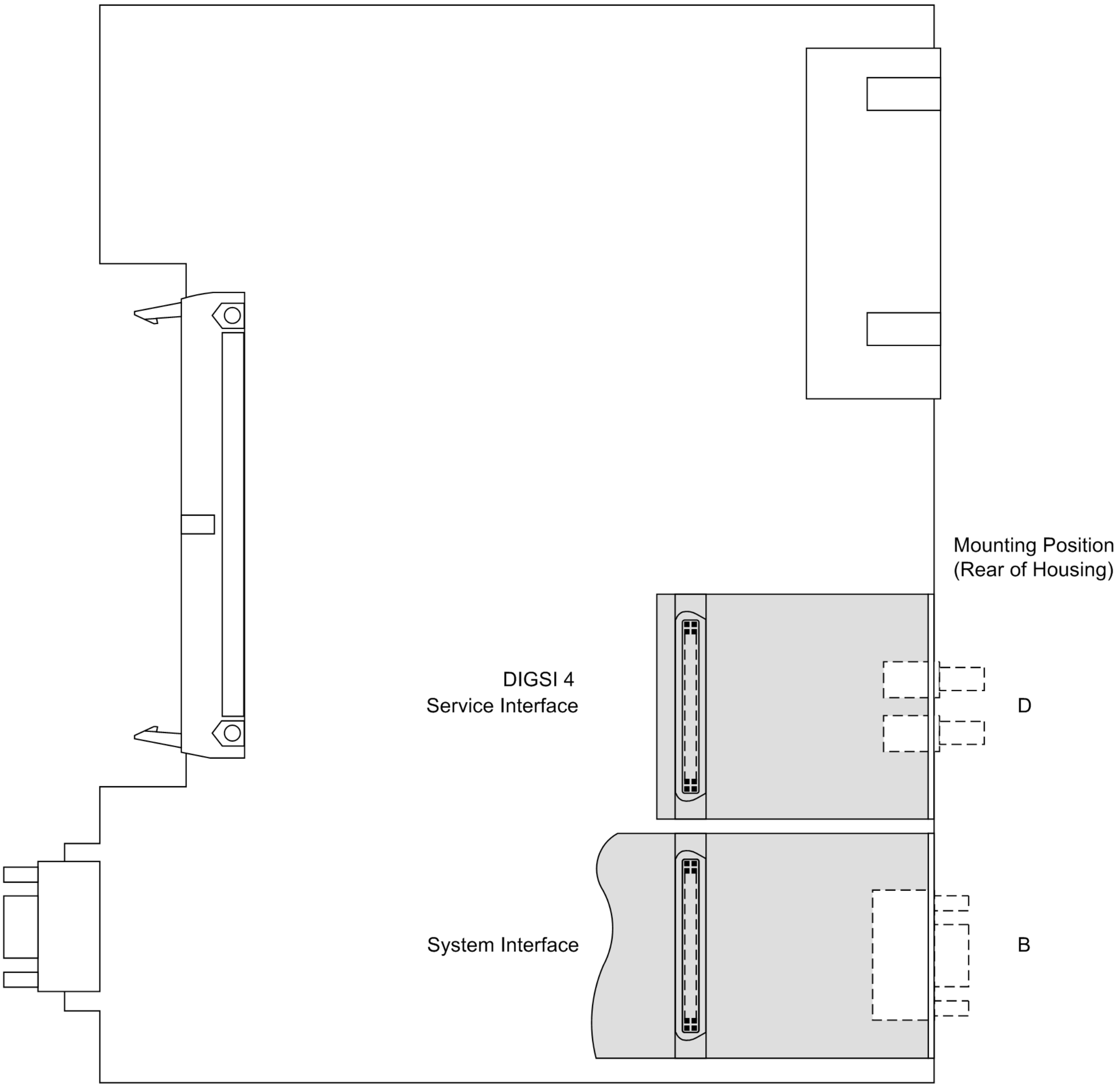


Figure 3-7 Example, CPU processor module with interface modules

Note

Please observe the following: Only interface modules with which the device can be ordered in accordance with the factory order code (see Appendix) can be used.

Table 3-10 Exchangeable interface modules

Interface	Insertion slot	Replacement module
System interface	B	RS485
		FO 820 nm
		PROFIBUS FMS RS485
		PROFIBUS FMS Single ring
		PROFIBUS FMS Double ring
		PROFIBUS DP RS485
		PROFIBUS DP Double ring
		IEC 61850 Ethernet electrical
DIGSI® Service interface	D	FO 820 nm

The order numbers of the replacement modules are listed in the Appendix.

Serial interfaces with bus capability

For bus-capable interfaces a termination is necessary at the bus for each last device, i.e. terminating resistors must be connected. With the 6MD66x device, this concerns the variants with RS485 or PROFIBUS interfaces.

The termination resistors are located on the corresponding PROFIBUS interface module, which is located on the CPU processor module or directly on the PCB of the CPU processor module.

On delivery the jumpers are set so that the terminating resistors are disconnected. Both jumpers of a module must always be plugged in the same way.

Jumper	Terminating resistor	
	switched ON	switched off
X3	1–2	2–3
X4	1–2	2–3

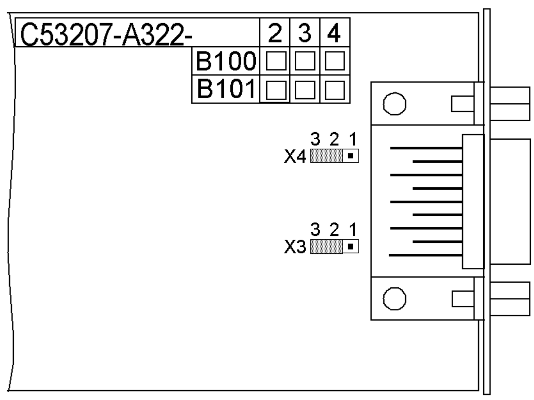


Figure 3-8 Position of the jumpers for configuration of termination resistors of the PROFIBUS FMS and PROFIBUS DP interface

Terminating resistors for the PROFIBUS interface can also be implemented externally (e.g. on the connection module). In this case, the terminating resistors located on the PROFIBUS interface module or directly on the PCB of the processor board CPU must be disconnected.

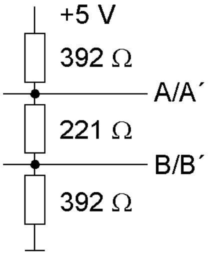


Figure 3-9 Termination of the RS485 interface (external)

Note

The RS485 interface used with this device for the inter-relay communication cannot be provided with terminating resistors externally as shown in the figure above, as the +5 V voltage is not routed out with this device (please refer also to Table 3-11). The RS485 interface on the processor module can be terminated directly on the processor module (see the CPU module for the jumper setting).

External termination of the RS485 bus is only possible between the lines A/A` and B/B` with 120 Ω at each end of the bus. The resulting resistance may not be less than 60 Ω.

The possible data transmission rate depends on the distance to be spanned and the quality of the data line used. Distances up to 1000 m (3,300 ft.) are possible.

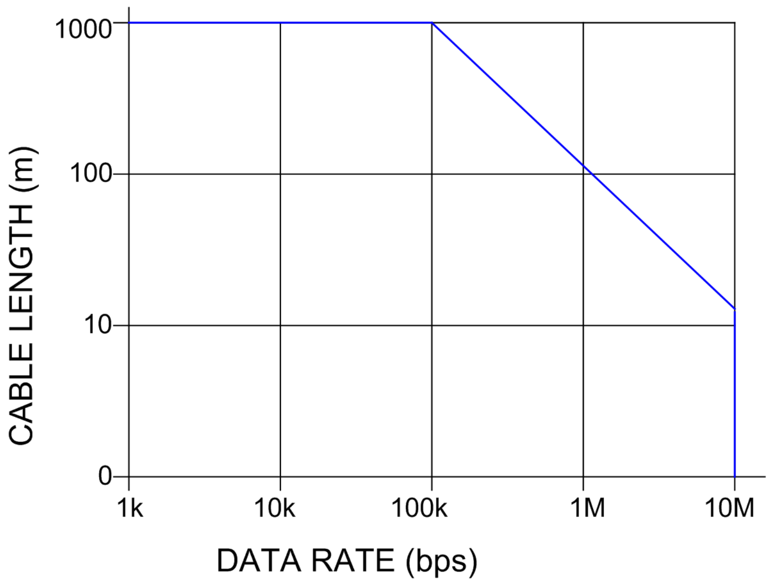


Figure 3-10 Correlation between data rate and bus length

IEC 61850 Ethernet (EN100)

The Ethernet interface module has no jumpers. No hardware modifications are required to use it.

3.1.2.5 Reassembly

To reassemble the device, proceed as follows:

- Insert the modules carefully in the housing. For the model of the device designed for surface mounting, use the metal lever to insert the CPU processor module. The installation is easier with the lever.
- First, plug the connector of the ribbon cable onto the input/output module I/O and then onto the CPU processor module. Be careful that no connector pins are bent! Don't apply force!
- Insert the plug connector of the ribbon cable between the processor module CPU and the front cover into the socket of the front cover. This action does not apply to the device version with detached operator panel. Instead of this, the connector of the ribbon cable derived from the 68-pin connector on the device rear panel must be plugged on the connector of the processor module CPU. The 7-pin X16 connector belonging to the ribbon cable must be plugged behind the D-subminiature female connector. The plugging position is not relevant in this context as the connection is protected against polarity reversal.
- Press the latches of the plug connectors together.
- Replace the front cover and secure to the housing with the screws.
- Mount the covers.
- Re-fasten the interfaces on the rear of the device housing. This activity is not necessary if the device is designed for surface mounting.

3.1.3 Mounting

3.1.3.1 Panel Flush Mounting

- Remove the four covers at the corners and 2 in the centre above and below on the front cover. This exposes the 6 elongated holes in the mounting bracket.
- Insert the device into the panel cut-out and secure with the six screws. Dimensional drawings can be found in the Technical data section.
- Replace the 6 covers.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm^2.
- Connections are realized via the plug terminals or screw terminals on the rear side of the device according to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centred in the connection chamber, in such a way that the screw thread fits in the hole of the lug. Section /1/ has pertinent information regarding wire size, lugs, bending radii, etc.

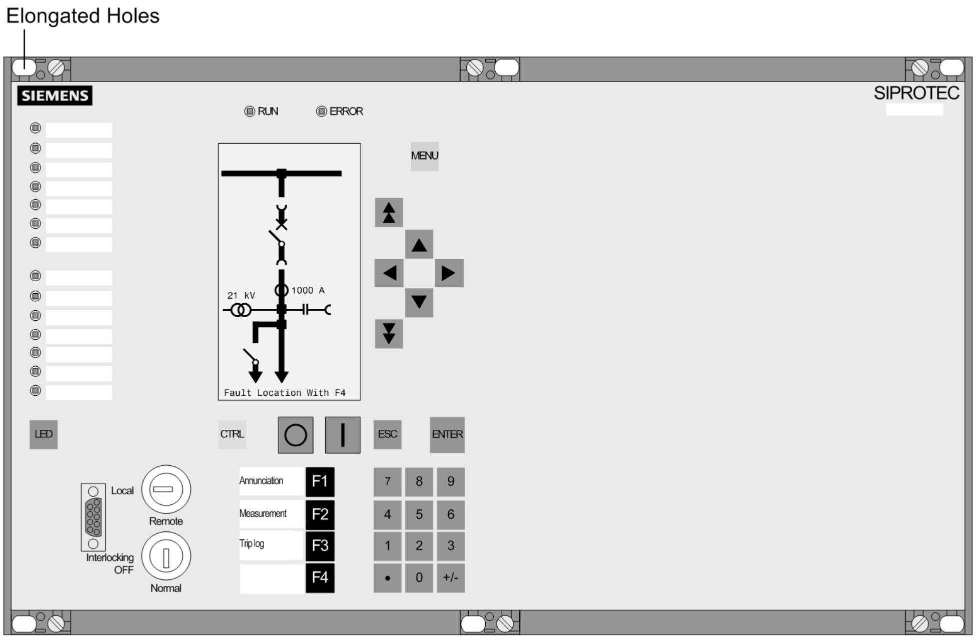


Figure 3-11 Example of panel flush mounting of a device (housing size $^1/_1$)

3.1.3.2 Rack Mounting and Cubicle Mounting

To install the device in a frame or cubicle, two mounting brackets are required. The ordering codes are stated in Appendix, Section A.1.

- Loosely screw the two mounting brackets in the rack or cubicle with four screws.
- Remove the four covers at the corners and 2 in the centre above and below on the front cover. This exposes the 6 elongated holes in the mounting bracket.
- Tighten the unit with 6 screws at the angle brackets.
- Replace the 6 covers.
- Tighten the mounting brackets to the rack or cubicle using eight screws.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm ^{2}.
- Establish connections via the plug-in or screw connections on the rear panel of the housing according to circuit diagram. For screw connections with forked lugs or direct connection, before inserting wires the screws must be tightened so that the screw heads are flush with the outer edge of the connection block. A ring lug must be centred in the connection chamber in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® System Description /1/ has pertinent information regarding wire size, lugs, bending radii, etc.

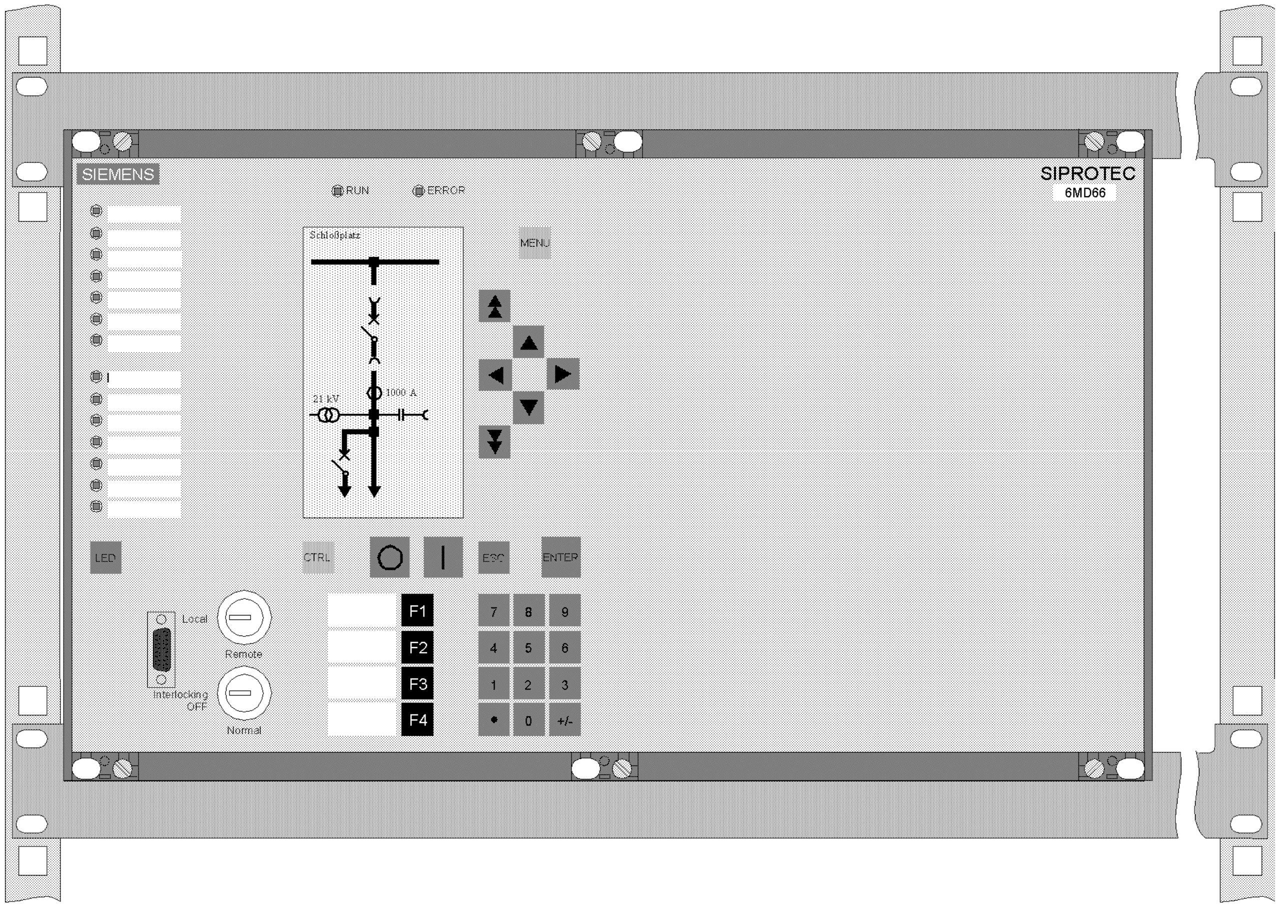


Figure 3-12 Assembly of a 6MD66x in the rack or cabinet

3.1.3.3 Mounting with detached operator panel

Caution!

Be careful when removing or plugging the connector between device and detached operator panel

Non–observance of the following measure can result in property damage. Without the cable the device is not ready for operation!

Do never pull or plug the connector between the device and the detached operator panel during operation while the device is alive!

For mounting the **device** proceed as follows:

- Tighten the device by means of 10 screws. The dimensional drawing can be found in the Technical data section.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm ^{2}.
- Connections are realised via the plug terminals or screw terminals on the rear side of the device according to the circuit diagram. When using forked lugs for direct connections or screw terminal, the screws, before having inserted the lugs and wires, must be tightened in such a way that the screw heads are even with the terminal block. A ring lug must be centred in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® system description /1/ has pertinent information regarding wire size, lugs, bending radii, etc.

For mounting the **operator panel** please observe the following:

- Remove the 4 covers on the corners of the front plate. This exposes the 4 elongated holes in the mounting bracket.
- Insert the operator panel into the panel cut-out and fasten with four screws. The dimensional drawing can be found in the Technical data section.
- Mount the four covers.
- Connect the ground on the rear plate of the operator control element to the protective ground of the panel using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm ^{2}.
- Connect the operator panel to the device. Furthermore, plug the 68-pin connector of the cable belonging to the operator panel into the corresponding connection at the rear side of the device (see SIPROTEC® system description /1/).

3.1.3.4 Mounting without operator panel

For mounting the **device** proceed as follows:

- Tighten the device by means of 10 screws. The dimensional drawing can be found in the Technical data section.
- Connect the ground on the rear plate of the device to the protective ground of the panel. Using at least one M4 screw. The cross-sectional area of the ground wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the ground wire must be at least 2.5 mm ^{2}.
- Establish connections via the plug-in or screw connections on the rear panel of the housing according to circuit diagram. For screw connections with forked lugs or direct connection, before inserting wires the screws must be tightened so that the screw heads are flush with the outer edge of the connection block. A ring lug must be centred in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC® System Description has pertinent information regarding wire size, lugs, bending radii, etc.

Caution!

Be careful when pulling or plugging the dongle cable

Non–observance of the following measures can result in minor personal injury or property damage:

Never pull or plug the dongle cable while the device is live! Without the cable the device is not ready for operation!

The connector of the dongle cable at the device must always be plugged during operation!

For mounting the **D-subminiature connector of the dongle cable** please observe the following:

- Fasten the 9-pin socket of the dongle cable with the accompanying fastening parts according to the following figure (example). The dimensional diagram for the panel or cabinet cut-out can be found in the Technical data section.
- Plug the 68-pin connector of the cable into the corresponding connection at the rear side of the device.

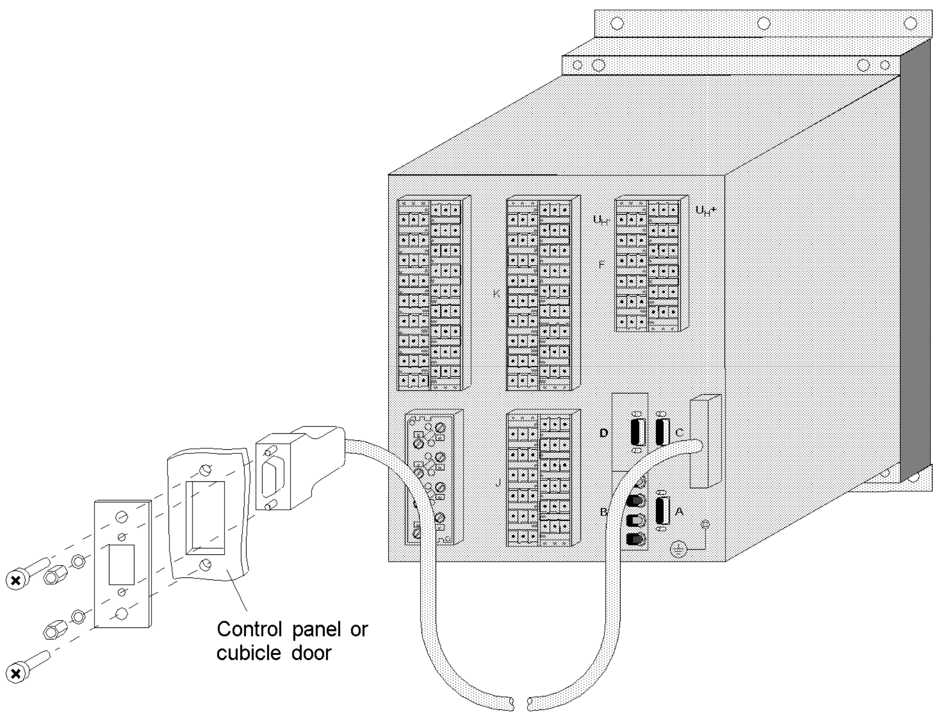


Figure 3-13 Plugging the subminiature connector of the dongle cable into the control panel or cabinet door (example housing size $^1/_2$)

Note

The dongle cable is included in the scope of delivery of the operator interface.

3.2 Checking Connections

3.2.1 Checking the Data Connections of the Serial Interfaces

The following tables illustrate the pin assignment of the various serial device interfaces and of the time synchronization interface. The position of the connections can be seen in the following figure.

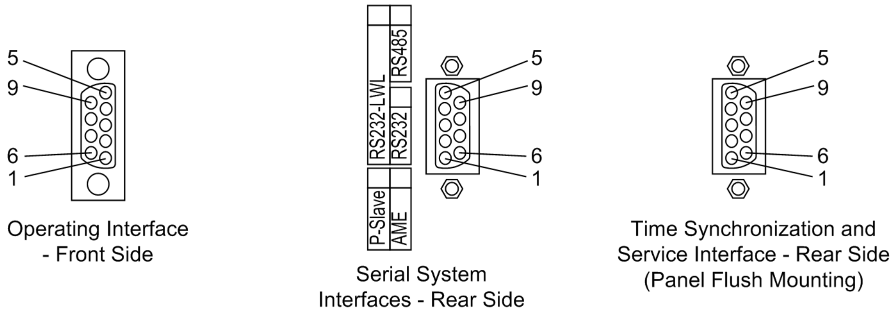


Figure 3-14 9-pin D-subminiature female connectors

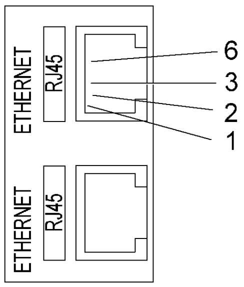


Figure 3-15 Ethernet connector

3.2.2 Operator interface

When the recommended communication cable is used, correct connection between the SIPROTEC® 4 device and the PC is automatically ensured. See the Appendix, Section A.1 for an ordering description of the cable.

3.2.3 Service / function interface

Check the data connection if the service is used to communicate with the device via hard wiring or a modem. The same applies for the IRC connection.

3.2.4 System interface

For versions equipped with a serial interface to a control center, the user must check the data connection. The visual check of the assignment of the transmission and reception channels is of particular importance. With RS232 and fibre optic interfaces, each connection is dedicated to one transmission direction. Therefore the output of one device must be connected to the input of the other device and vice versa.

With data cables, the connections are designated according to DIN 66020 and ISO 2110:

- TxD = Data Output
- RxD = Data Input
- $\overline{\text{RTS}}$ = Request to Send
- $\overline{\text{CTS}}$ = Clear to Send
- GND = Signal/Chassis Ground

The cable shield is to be earthed at **both ends**. For extremely EMC-loaded environments the GND may be integrated into a separate individually shielded wire pair to improve the immunity to interference. The following tables list the assignments of the D-subminiature connector for the various serial interfaces.

Table 3-11 The assignments of the subminiature connector for the various interfaces

Pin No.	Operator interface	RS232	RS485	PROFIBUS FMS Slave, RS485 PROFIBUS DP Slave, RS485	Ethernet EN 100
1	–				Tx+
2	RxD	RxD	–	–	Tx–
3	TxD	TxD	A/A’ (RxD/TxD-N)	B/B’ (RxD/TxD-P)	Rx+
4	–	–	–	CNTR-A (TTL)	—
5	GND	GND	C/C’ (GND)	C/C’ (GND)	—
6	–	–	–	+5 V (max. load < 100 mA)	Rx+
7	–	$\overline{\text{RTS}}$	–[1]	–	—
8	–	$\overline{\text{CTS}}$	B/B’ (RxD/TxD-P)	A/A’ (RxD/TxD-N)	—
9	–	–	–	–	not existent

[1] Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface. Pin 7 must therefore not be connected!

3.2.5 Termination

For bus-capable interfaces a termination is necessary at the bus for each last device, i.e. terminating resistors for the RS485 or PROFIBUS interfaces must be connected.

The terminating resistors are located on the RS485 and PROFIBUS interface module, which is located on the CPU processor module.

If the bus is extended, make sure again that only the last device on the bus has the terminating resistors switched-in, and that all other devices on the bus do not.

WARNING!

Warning of faulty data transmission!

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

The external terminating resistors provided in the PROFIBUS connectors cannot be used for the RS485 standard, as the +5 V voltage is not routed out to the standard RS485 interface (see also note on Figure 3-9). If the external termination of the PROFIBUS connectors are used, the RS485 bus will not work correctly. !

3.2.6 Time Synchronization Interface

Either 5 VDC, 12 VDC or 24 VDC time synchronization signals can be processed if the connections are made as indicated in the table below.

Table 3-12 D-subminiature connector assignment of the time synchronization interface

Pin No.	Designation	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Line
4	M_TSYNC 1)	Return Line 1)
5	Shield	Shield Potential
6	–	–
7	P12_TSIG	Input 12 V
8	P_TSYNC 1)	Input 24 V 1)
9	SHIELD	Shield Potential

1) assigned, but not used

3.2.7 Optical Fibres

WARNING!

Laser injection!

Do not look directly into the fibre-optic elements!

Signals transmitted via optical fibres are unaffected by interference. The fibres guarantee electrical isolation between the connections. Transmit and receive connections are shown with the symbols for transmit and for receive.

The character idle state for the optical fibre interface is „Light off“. If this setting is to be changed, use the operating program DIGSI®, as described in the SIPROTEC® System Description.

3.2.8 Checking system connections

Before the device is energized for the first time, the device should be in the final operating environment for at least 2 hours to equalize the temperature, to minimize humidity and avoid condensation. Connections are checked with the device at its final location. The plant must first be switched off and grounded.

WARNING!

Warning of dangerous voltages

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Therefore, only qualified people who are familiar with and adhere to the safety procedures and precautionary measures shall perform the inspection steps.

Caution!

Be careful when operating the device on a battery charger without a battery

Non-observance of the following measure can lead to unusually high voltages and consequently, the destruction of the device.

Do not operate the device on a battery charger without a connected battery. (Limit values can be found in the technical data).

Proceed as follows in order to check the system connections:

- The protective circuit breakers of the auxiliary power supply and of the measuring voltage must be switched OFF.
- Check the continuity of all current and voltage transformer connections against the system and connection diagrams:
  - Are the current transformers earthed properly?
  - Do the current transformer connections have the same polarity?
  - Is the phase assignment of the current transformers correct?
  - Is the earthing of the voltage transformers correct?
  - Do the voltage transformer connections have the same, correct polarity?
  - Is the phase assignment of the voltage transformers correct?
  - Is the polarity for current input IE correct (if used)?
  - Is the polarity for voltage input UE correct (if used for broken delta winding)?
- The short-circuit feature of the current circuits of the device is to be checked. This may be performed with secondary test equipment or other test equipment for checking continuity.
  - Remove the screws of the front cover.
  - Remove the ribbon cable connected to the input/output module I/O-5 and pull the module out until there is no contact between the module and the rear connections of the device.

  – Check continuity on the connection side, for each current connection pair.
  – Insert the module again firmly; press the ribbon cable with care. Be careful that no connector pins are bent! Don't apply force!
  – At the terminals of the device, again check continuity for each pair of terminals.
  – Reinstall the front cover and tighten it with screws.

- Connect an ammeter in the supply circuit of the power supply. A range of about 2.5 A to 5 A for the meter is appropriate.
- Switch on mcb for auxiliary voltage (supply protection), check the voltage level and, if applicable, the polarity of the voltage at the device terminals or at the connection modules.
- The current input should correspond to the power input in neutral position of the device. The measured steady state current should be insignificant. Transient movement of the ammeter merely indicates the charging current of capacitors
- Remove the voltage from the power supply by opening the mcb.
- Remove ammeter; re-establish normal auxiliary voltage connection.
- Apply voltage to the power supply.
- Switch on voltage transformer protective circuit breaker.
- Check direction of rotating field on the device terminals.
- Open the mcb for the voltage transformers and the power supply.
- Check the trip and close circuits to the power system circuit breakers.
- Check control lines from and to the other devices.
- Check signalling lines.
- Switch on mcb.

3.3 Commissioning

WARNING!

Warning of dangerous voltages when operating an electrical device

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Only qualified people shall work on and around this device. They must be thoroughly familiar with all warnings and safety notices in this instruction manual as well as with the applicable safety steps, safety regulations, and precautionary measures.

The device is to be grounded to the substation ground before any other connections are made.

Hazardous voltages can exist in the power supply and at the connections to current transformers, voltage transformers, and test circuits.

Hazardous voltages can be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

After removing voltage from the power supply, wait a minimum of 10 seconds before re-energizing the power supply. This wait allows the initial conditions to be firmly established before the device is re-energized.

The limit values given in Technical Data (Chapter 10) must not be exceeded, neither during testing nor during commissioning.

When testing the device with secondary test equipment, make sure that no other measurement quantities are connected and that the TRIP command lines and possibly the CLOSE command lines to the circuit breakers are interrupted, unless otherwise specified.

DANGER!

Hazardous voltages during interruptions in secondary circuits of current transformers

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Short-circuit the current transformer secondary circuits before current connections to the device are opened.

For the commissioning switching operations have to be carried out. A prerequisite for the prescribed tests is that these switching operations can be executed without danger. They are accordingly not meant for operational checks.

WARNING!

Warning of dangers evolving from improper primary tests

Non-observance of the following measures can result in death, personal injury or substantial property damage.

Primary test may only be carried out by qualified personnel, who are familiar with the commissioning of protection systems, the operation of the plant and the safety rules and regulations (switching, earthing, etc.).

3.3.1 Test Mode and Transmission Block

If the device is connected to a central or main computer system via the SCADA interface, then the information that is transmitted can be influenced. This is only possible with some of the protocols available (see Table „Protocol-dependent functions“ in the Appendix A.5).

If **Test mode** is active, then a message sent by a SIPROTEC® 4 device to the main system has an additional test bit. This bit allows the message to be recognized as resulting from testing and not an actual fault or power system event. Furthermore it can be determined by activating the **Transmission block** that no indications at all are transmitted via the system interface during test mode.

The SIPROTEC® System Description /1/ describes how to activate and deactivate test mode and blocked data transmission. Note that when DIGSI® is being used, the program must be in the **Online** operating mode for the test features to be used.

3.3.2 Testing System Ports

Prefacing Remarks

If the device features a system interface and uses it to communicate with the control centre, the DIGSI® device operation can be used to test if annunciations are transmitted correctly. This test option should however definitely „not“ be used while the device is in service on a live system.

DANGER!

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the testing mode during „real“ operation performing transmission and reception of messages via the system interface.

Note

After termination of the hardware test, the device will reboot. All annunciation buffers are erased. If required, these buffers should be extracted with DIGSI® prior to the test.

The interface test is carried out Online using DIGSI®:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click on **Testing Messages for System Interface** shown in the list view. The dialogue box **Testing System Interface** opens (refer to the following figure).

Structure of the Test Dialogue Box

In the column **Indication** the display texts of all indications are displayed which were allocated to the system interface in the matrix. In the column **Status SETPOINT** the user has to define the value for the messages to be tested. Depending on the indication type, several input fields are offered (e.g.„`Indication coming`“/ „`Indication going`“). By clicking on one of the buttons you can select the desired value from the pull-down menu.

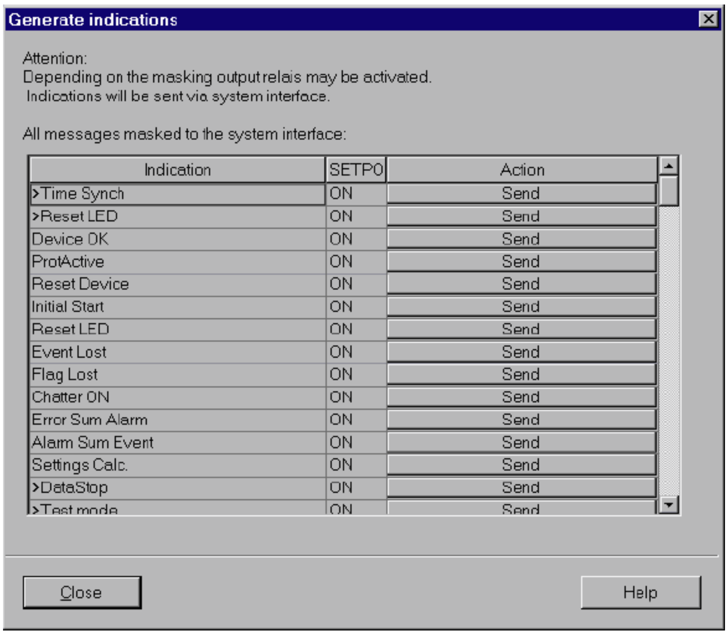


Figure 3-16 System interface test with dialog box: Generate indications — example

Changing the Operating State

Following the first operation of one of the keys in the column **Action** you will be asked for the password No. 6 (for hardware test menus). Having entered the correct password indications can be issued individually. To do so, click on **Send**. The corresponding indication is issued and can be read out either from the event log of the SIPROTEC® 4 device or from the central master computer.

As long as the window is open, further tests can be performed.

Test in Message Direction

For all information that is transmitted to the central station test in **Status Scheduled** the desired options in the list which appears:

- Make sure that each checking process is carried out carefully without causing any danger (see above and refer to DANGER!)
- Click on Send in the function to be tested and check whether the transmitted information reaches the central station and shows the desired reaction. Data which are normally linked via binary inputs (first character „>“) are likewise indicated to the central station with this procedure. The function of the binary inputs itself is tested separately.

Exiting the Test Mode

To end the System Interface Test, click on **Close**. The device is briefly out of service while the start-up routine is executed. The dialogue box closes.

Test in Command Direction

The information transmitted in command direction must be indicated by the central station. Check whether the reaction is correct.

3.3.3 Checking the Binary Inputs and Outputs

Prefacing Remarks

The binary inputs, outputs, and LEDs of a SIPROTEC® 4 device can be individually and precisely controlled using DIGSI®. This feature is used to verify control wiring from the device to plant equipment during commissioning. This test option should however definitely not be used while the device is in service on a „live“ system.

DANGER!

Danger evolving from operating the equipment (e.g. circuit breakers, disconnectors) by means of the test function

Non-observance of the following measure will result in death, severe personal injury or substantial property damage.

Equipment used to allow switching such as circuit breakers or disconnectors is to be checked only during commissioning. Do not under any circumstances check them by means of the testing mode during „real“ operation performing transmission and reception of messages via the system interface.

Note

After termination of the hardware test, the device will reboot. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI® prior to the test.

The hardware test can be done using DIGSI® in the online operating mode:

- Open the **Online** directory by double-clicking; the operating functions for the device appear.
- Click on **Test**; the function selection appears in the right half of the screen.
- Double-click in the list view on **Hardware Test**. The dialog box of the same name opens (see the following figure).

Structure of the Test Dialogue Box

The dialog box is divided into three groups: **BI** for binary inputs, **REL** for output relays, and **LED** for light-emitting diodes. On the left of each group is an accordingly labelled button. By double-clicking these buttons you can show or hide the individual information of the selected group.

In the column **Status** the current status of the particular hardware component is displayed. It is displayed symbolically. The actual states of the binary inputs and outputs are displayed by the symbol of opened and closed switch contacts, those of the LEDs by a symbol of a lit or extinguished LED.

The opposite state of each element is displayed in the column **Scheduled**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.

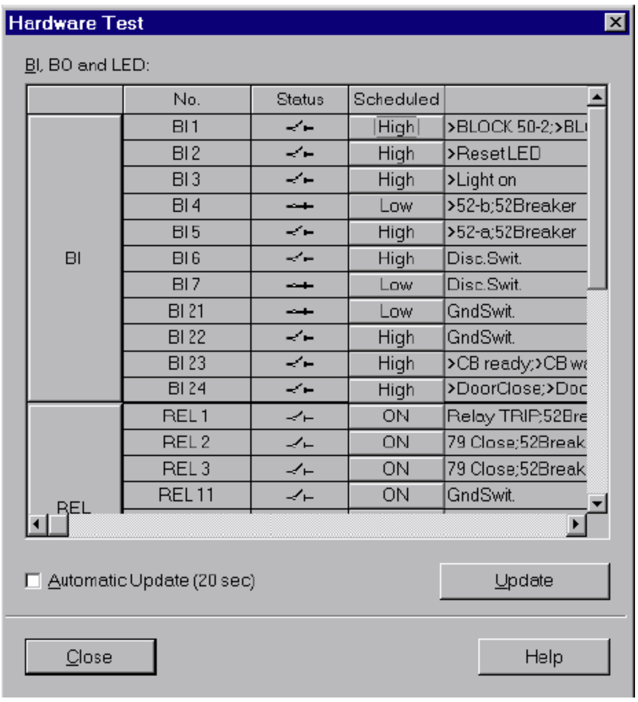


Figure 3-17 Testing of the binary inputs and outputs — example

Changing the Operating State

To change the condition of a hardware component, click on the associated switching field in the **Scheduled** column.

Password No. 6 (if activated during configuration) will be requested before the first hardware modification is allowed. After entry of the correct password a condition change will be executed. Further condition changes remain possible while the dialog box is open.

Test of the Binary Outputs

Each individual output relay can be energized allowing a check of the wiring between the output relay of the 6MD66x and the system, without having to generate the message that is assigned to the relay. As soon as the first change of state for any of the output relays is initiated, all output relays are separated from the internal device functions, and can only be operated by the hardware test function. This means, that e.g. a TRIP command coming from a control command from the operator panel to an output relay cannot be executed.

Proceed as follows in order to check the output relay :

- Ensure that the switching of the output relay can be executed without danger (see above under DANGER!).
- Each output relay must be tested via the corresponding **Scheduled**-cell in the dialog box.
- The test sequence must be terminated (refer to margin heading „Exiting the Procedure“), to avoid the initiation of inadvertent switching operations by further tests.

Test of the Binary Inputs

To test the wiring between the plant and the binary inputs of the 6MD66x the condition in the system which initiates the binary input must be generated and the response of the device checked.

To do this, the dialog box **Hardware Test** must again be opened to view the physical state of the binary inputs. The password is not yet required.

Proceed as follows in order to check the binary inputs:

- Activate in the system each of the functions which cause the binary inputs.
- The response of the device must be checked in the **Status** column of the dialog box. To do this, the dialog box must be updated. The options may be found below under the margin heading „Updating the Display“.
- Terminate the test sequence (see below under the margin heading „Exiting the Procedure“).

If however the effect of a binary input must be checked without carrying out any switching in the plant, it is possible to trigger individual binary inputs with the hardware test function. As soon as the first state change of any binary input is triggered and the password no. 6 has been entered, all binary inputs are separated from the plant and can only be activated via the hardware test function.

Test of the LEDs

You can check the LED in the same way like the other in/output components. As soon as you have initiated the first state change for any LED, all LEDs are disconnected from the functionality of the device and can only be operated by the hardware test function. This means e.g. that no LED is illuminated anymore by a device function or by pressing the LED reset button.

Updating the Display

During the opening of the dialog box **Hardware Test** the operating states of the hardware components which are current at this time are read in and displayed.

An update occurs:

- for each hardware component, if a command to change the condition is successfully performed,
- for all hardware components if the **Update**button is clicked,
- for all hardware components with cyclical updating (cycle time is 20 seconds) if the **Automatic Update (20sec)** field is marked.

Exiting the Test Mode

To end the hardware test, click on **Close**. The dialog box closes. The device becomes unavailable for a brief start-up period immediately after this. Then all hardware components are returned to the operating conditions determined by the plant settings.

3.3.4 Tests for the Circuit Breaker Failure Protection

General

If the device is equipped with the breaker failure protection and this function is used, the integration of this protection function into the system must be tested under practical conditions.

Because of the manifold application facilities and various configuration possibilities of the plant it is not possible to give a detailed description of the necessary test steps. It is important to consider the local conditions and the protection and plant drawings.

Before starting the circuit breaker tests it is recommended to insulate at both ends the feeder which is to be tested, i.e. line disconnectors and busbar disconnectors should be open so that the breaker can be operated without risk.

Caution!

Also for tests on the local circuit breaker of the feeder a trip command to the surrounding circuit breakers can be issued for the busbar.

Non-observance of the following measure can result in minor personal injury or property damage.

Therefore, primarily it is recommended to interrupt the tripping commands to the adjacent (busbar) breakers, e.g. by inrrupting the corresponding pickup voltage supply.

Before the breaker is closed again for normal operation the trip command of the feeder protection routed to the circuit breaker must be disconnected so that the trip command can only be initiated by the breaker failure protection.

Although the following list does not claim to be complete, it may also contain points which are to be ignored in the current application.

Auxiliary Contacts of the CB

The circuit breaker auxiliary contact(s) form an essential part of the breaker failure protection system in case they have been connected to the device. Make sure the correct assignment has been checked.

External Initiation Conditions

If the breaker failure protection can also be started by external protection devices, the external start conditions should be checked. Single-pole or three-pole tripping is possible depending on the setting of the breaker failure protection. Note that the internal pole discrepancy supervision or the pole discrepancy supervision of the breaker itself may lead to a later three-pole trip. Therefore check first how the parameters of the breaker failure protection are set. See Section 2.9.2, addresses `3901` onwards.

In order for the breaker failure protection to be started, a current must flow at least through the monitored phase and the earth. This may be a secondary injected current.

After every start, the message „`BF Start`“ (No. 1461) must appear in the spontaneous or fault indications.

Only if single-pole starting possible:

- Start by single-pole trip command of the external protection: L1

  Binary input functions „`>BF Start L1`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command (dependent on settings).

- Start by single-pole trip command of the external protection: L2

  Binary input functions „`>BF Start L2`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command (dependent on settings).

- Start by single-pole trip command of the external protection: L3

  Binary input functions „`>BF Start L3`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command (dependent on settings).

- Starting by trip command of the external protection via all three binary inputs L1, L2 and L3:

  Binary input functions „`>BF Start L1`“, „`>BF Start L2`“ and „`>BF Start L3`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command three-pole

For three-pole starting:

- Three-pole starting by trip command of the external protection:

  Binary input functions „`>BF Start 3pole`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command (dependent on settings).

Switch off test current.

If start is possible without current flow:

- Starting by trip command of the external protection without current flow:

  Binary input functions „`>BF Start w/o I`“ and, if necessary, „`>BF release`“ (in spontaneous or fault indications). Trip command (dependent on settings).

Busbar Tripping

The most important thing is the check of the correct distribution of the trip commands to the adjacent circuit breakers in case of breaker failure.

The adjacent circuit breakers are those of all feeders which must be tripped in order to ensure interruption of the fault current should the local breaker fail. These are therefore the circuit breakers of all feeders which feed the busbar or busbar section to which the feeder with the fault is connected.

A general detailed test guide cannot be specified, because the layout of the surrounding circuit breakers largely depends on the system topology.

In particular with multiple busbars the trip distribution logic for the surrounding circuit breakers must be checked. Here check for every busbar section that all circuit breakers which are connected to the same busbar section as the feeder circuit breaker under observation are tripped, and no other breakers.

Tripping of the Remote End

If the trip command of the circuit breaker failure protection must also trip the circuit breaker at the remote end of the feeder under observation, the transmission channel for this remote trip must also be checked. This is done together with transmission of other signals according to Sections „Testing of the Teleprotection Scheme with ...“ further below.

Termination of the Checks

All temporary measures taken for testing must be undone, e.g. especially switching states, interrupted trip commands, changes to setting values or individually switched off protection functions.

3.3.5 Triggering Oscillographic Recordings for Test

In order to be able to test the stability of the protection during switchon procedures also, switchon trials can also be carried out at the end. Oscillographic records obtain the maximum information about the behaviour of the protection.

Prerequisite

Along with the capability of storing fault recordings via pickup of the protection function, the 6MD66x also has the capability of initiating a measured value recording using the operator program DIGSI via the serial interface and via binary inputs. For the latter, event „>Trig.Wave.Cap.“ must be allocated to a binary input. Triggering of the recording then occurs, for example, via the binary input when the protection object is switched on.

An oscillographic recording that is externally triggered (that is, without a protective element pickup or device trip) is processed by the device as a normal oscillographic recording, and has a number for establishing a sequence. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Start Triggering Oscillographic Recording

In order to start a test measurement recording via DIGSI, select in the left of the window the operator function **Test**. Double-click in the list view the entry **Test Wave Form** (see Figure 3-18).

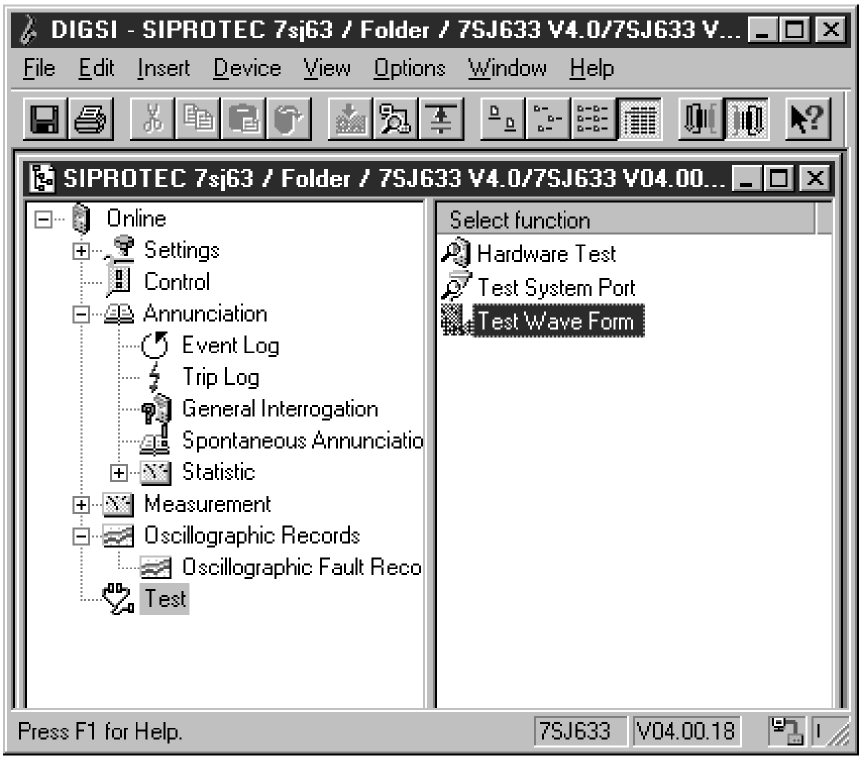


Figure 3-18 Triggering oscillographic recording with DIGSI — Example

Oscillographic recording is immediately started. During the recording, an annunciation is output in the left area of the status line. Bar segments additionally indicate the progress of the procedure.

The SIGRA or the Comtrade Viewer program is required to view and analyse the oscillographic data.

3.3.6 Testing User-defined Functions

CFC Logic

The device has a vast capability for allowing functions to be defined by the user, especially with the CFC logic. Any special function or logic added to the device must be checked.

Naturally, general test procedures cannot be given. Rather, the configuration of these user defined functions and the necessary associated conditions must be known and verified. Of particular importance are possible interlocking conditions of the switchgear (circuit breakers, isolators, etc.).

3.3.7 Trip/Close Tests for the Configured Operating Devices

Control by Local Command

If the configured operating devices were not switched sufficiently in the hardware test already described, all configured switching devices must be switched on and off from the device via the integrated control element. The feedback information of the circuit breaker position injected via binary inputs is read out at the device and compared with the actual breaker position. With 6MD66x this is easy to do with the control display.

The switching procedure is described in the SIPROTEC® 4 System Description /1/. The switching authority must be set in correspondence with the source of commands used. With the switch mode it is possible to select between interlocked and non-interlocked switching. Note that non-interlocked switching constitutes a safety risk.

DANGER!

A test cycle successfully started by the automatic reclosure function can lead to the closing of the circuit breaker!

Non-observance of the following statement will result in death, severe personal injury or substantial property damage.

Be fully aware that OPEN-commands sent to the circuit breaker can result in a trip-close-trip event of the circuit breaker by an external reclosing device.

Control from a Remote Control Centre

If the device is connected to a remote substation via a system interface, the corresponding switching tests may also be checked from the substation. Please also take into consideration that the switching authority is set in correspondence with the source of commands used.

3.4 Final Preparation of the Device

Firmly tighten all screws. Tighten all terminal screws, including those that are not used.

Caution!

Inadmissable tightening torques

Non–observance of the following measure can result in minor personal injury or property damage.

The tightening torques must not be exceeded as the threads and terminal chambers may otherwise be damaged!

In case service settings were changed, check if they are correct. Check if power system data, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2). All desired elements and functions must be set **ON**. Ensure that a copy of the setting values is stored on the PC.

The user should check the device-internal clock and set/synchronize it if necessary, provided that it is not synchronized automatically. Refer to the SIPROTEC® System Description /1/ for more information on this.

The indication buffers are deleted under **MAIN MENU** → **Annunciation** → **Set/Reset**, so that in the future they only contain information on actual events and states (see also /1/). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC® System Description /1/).

The counters of the operational measured values (e.g. operation counter, if available) are reset under **Main Menu** → **Measurement** → **Reset**.

Press the ESC key, several times if necessary, to return to the default display. The default display appears in the display (e.g. display of operation measured values).

Clear the LEDs on the front panel by pressing the LED key, so that they only show real events and states. In this context, also output relays probably memorized are reset. Pressing the LED key also serves as a test for the LEDs on the front panel because they should all light when the button is pushed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green „RUN“ LED must be on. The red „ERROR“ LED must not be lit.

Close the protective switches. If test switches are available, then these must be in the operating position.

The device is now ready for operation.

■

Technical Data 4

This chapter provides the technical data of the device SIPROTEC® 6MD66x and its individual functions, including the limiting values that under no circumstances may be exceeded. The electrical and functional data for the maximum functional scope are followed by the mechanical specifications with dimensional diagrams.

4.1 General

4.1.1 Analog Inputs

Current inputs

Rated system frequency	f_{Nom}	50 Hz or 60 Hz	(adjustable)
Rated current	I_{Nom}	1 A or 5 A	
Burden per phase and ground path			
- at I_N = 1 A		Approx. 0.05 VA	
- at I_N = 5 A		Approx. 0.3 VA	
Current overload capability			
- thermal (RMS)		200 A for 1 s 15 A for 10 s 12 A continuous	
- dynamic (peak value)		250 I_{Nom} (half-cycle)	
Precision (MLFB pos. 7 = 1.5)		≤ 0.5% of measured value at 50% to 120 % I_N (under reference conditions)	
Precision for 150% In (MLFB pos. 7 = 2.6)		≤ 0.5% of measured value at 50% to 150% I_N (under reference conditions)	

Voltage inputs

Secondary nominal voltage	80 V to 125 V
Measuring range	0 V to 170 V
Burden at 100 V	Approx. 0.3 VA
Voltage overload capacity	
- thermal (RMS)	230 V continuous
Precision	≤ 0.5 % of measured value at 50 % to 120 % U_{Nom}(under reference conditions)

Measuring transducer inputs

Input current	-20 mA DC to +20 mA DC
Overload capability	± 100 mA continuous
Input resistance	10 Ω
Power input	5.8 mW at 24 mA
Precision	< 1 % from rated value (under reference conditions)

Limit range behaviour, current

Overflow (MLFB pos. 7 = 1.5)	Phase current > 1.2 x rated current The derived quantities P, Q, S, cosΦ, sinΦ and Φ also overflow as a result.
Overflow for 150% In (MLFB pos. 7 = 2.6)	Phase current > 1.5 x rated current The derived quantities P, Q, S, cosΦ, sinΦ and Φ also overflow as a result.

Limit range behaviour, voltage

Overflow	Secondary input voltage at the device > 120 V_{eff} The derived quantities P, Q, S, cosΦ, sinΦ and Φ also overflow as a result.

Limit range behaviour, power

Zero, invalid	A phase voltage < 0.1 x rated voltage or the nominal apparanet power S < 1 %
Overflow	A phase current or a phase-earth voltage in overflow

Limit range behaviour, cosΦ, sinΦ, Φ

Zero, invalid	A phase voltage < 0.1 x rated voltage or the nominal apparanet power S < 1 %
Overflow	A phase current or a phase-earth voltage in overflow

Limit range behaviour, frequency

Zero, invalid	Frequency < 45 Hz or secondary input voltage at device < 10 V_{rms}
Overflow	Frequency > 65 Hz

4.1.2 Auxiliary voltage

DC voltage

Voltage supply via integrated AC/DC converter		
Rated auxiliary DC U_{aux}	24/48 V DC	60 V DC
Permissible voltage ranges	19 to 58 V DC	48 to 72 V DC
Rated auxiliary DC U_{aux}	110 V DC	220 to 250 V DC
Permissible voltage ranges	88 to 132 V DC	176 to 300 V DC
Superimposed AC ripple voltage, Peak to peak, IEC 60 255-11	≤15 % of the auxiliary voltage	
Quiescent power consumption		Approx. 10.0 W
Power consumption plus energised relay		Approx. 0.27 W
Bridging time for failure/short-circuit, IEC 60 255 255–11	≤ 50 ms at U ≥ 110 VDC	
	≤ 20 ms at U ≥ 24 VDC	

4.1.3 Binary inputs and outputs

Binary inputs

Variant	Number	
6MD662*-	35 (configurable)	
6MD663*-	50 (configurable)	
6MD664*-	65 (configurable)	
Rated voltage range	24 V DC to 250 V DC, bipolar	
Peak current at high level	80 mA (τ = 1.5 ms)	
Binary input	BI1....65	
Current consumption, energised (independent of the control voltage)	Approx. 1.8 mA per BI	
Pickup times	approx. 4 ms	
Switching thresholds	adjustable with jumpers	
for rated voltages	24/48/60 V DC	$U_{high} \geq 19$ V– $U_{low} \leq 10$ V–
for rated voltages	110 V DC	$U_{high} \geq 88$ V– $U_{low} \leq 66$ V–
for rated voltages	220 to 250 V DC	$U_{high} \geq 176$ V– $U_{low} \leq 132$ V–
Maximum permissible voltage	300 V DC	
Impulse filter on input	220 nF at 220 V with recovery time > 60 ms	

Output Relays

Flag/command relay[1])	
Number and Information	According to the order variant (allocatable)
Order variant	
6MD662*-	25
6MD663*-	35
6MD664*-	45
Contacts per relay	1 NO contact
Switching capability ON	1000 W/VA [1])
Switching capability OFF	30 VA 40 W resistive 25 W/VA at L/R ≤ 50ms
Switching voltage	250 V
Permissible current per contact / inrush peak	5 A continuous 30 A ≤ 0.5 s
Permissible current per contact On common path	5 A continuous 30 A for 0.5 s
Life contact	1 with 1 NO contact or 1 NC contact (switchable)
Switching capability ON	30 W/VA
Switching capability OFF	20 VA
Switching voltage	250 V
Permissible current	1 A continuous
[1])Maximum permissible number of simultaneously energised relays: 29	

4.1.4 Communications interfaces

Operator Interface

Connection	Front side, non-isolated, RS232, 9 pin D-subminiature female connector for connection of a PC
Operation	With DIGSI®
Transmission Speed	Min. 4.800 Baud; max. 115, 200 Baud; Factory Setting: 38 400 Baud; Parity: HE'D
Maximum Distance of Transmission	49 feet (15 m)

Service/modem interface

	Connection	Isolated interface for data transfer
	Operation	with DIGSI®
	Transmission speed	min. 4,800 Baud; max. 115,200 Baud; Factory setting 38 400 Baud
RS232/RS485		RS232/RS485 according to the ordering variant
	Connection for flush-mounted case	Rear panel, mounting location „C“, 9-pin D-subminiature female connector
	Surface-mounting housing	At the housing mounted case on the case bottom; Shielded data cable
	Test voltage	500 V; 50 Hz
RS232	Channel distance	49.215 ft. (15 m)
RS485	Channel distance	3,281 ft. (1,000 m)
Fibre optic cable (FO)	FO connector type	ST connector
	Connection for flush-mounted case	Rear panel, mounting location „D“
	For panel surface-mounted case	At the housing mounted case on the case bottom
	Optical wavelength	λ = 820 nm
	Laser Class I according to EN 60825-1/-2	Using glass fibre 50/125 μm or using glass fibre 62.5/125 μm
	Permissible link signal attenuation	max. 8 dB, with glass fibre 62.5/125 μm
	Channel distance	max. 0.93 mi. (1.5 km)
	Character idle state	Selectable, factory setting „Light off“

Inter-relay communication interface

Transmission speed		
electrical	HDLC	125 KBaud, 250 KBaud, 1 MBaud, 1.25 MBaud, 2 MBaud, 2.5 MBaud, 3.125 MBaud
	UART	115 KBaud, 250 KBaud
optical	HDLC	125 KBaud
	UART	500 KBaud
Isolated interface for data transfer		
RS485	Connection for flush-mounted case	Rear panel, mounting location „C“, 9-pin D-subminiature female connector
	Surface-mounting case	At the housing mounted case on the case bottom; Shielded data cable
	Test voltage	500 V; 50 Hz
	Channel distance	max. 1,000 m. (1 km)

System interface

PROFIBUS FMS and PROFIBUS DP		
RS485	Connection for flush-mounted case	Rear panel, mounting location „E“, 9-pin D-subminiature female connector
	For panel surface-mounted case	At the housing mounted case on the case bottom
	Test voltage	500 V; 50 Hz
	Transmission speed	up to 1.5 MBd
	Channel distance	3,281 ft. (1,000 m) at ≤ 93.75 kBd 1,640.5 ft. (500 m) at ≤ 187.5 kBd 656.2 ft. (200 m) at ≤ 1.5 MBd
Fibre optic cable FO	FO connector type	ST connector single ring / double ring according to the order for FMS; for DP only double ring available
	Connection for flush-mounted case	Rear panel, mounting location „E“
	For panel surface-mounted case	In console housing on the bottom side, only RS485 1)
	Transmission speed	up to 1.5 MBd
	Recommended:	> 500 kBd with normal casing ≤ 57,600 Bd with detached operator panel
	Optical wavelength	λ = 820 nm
	Laser Class I according to EN 60825-1/-2	Using glass fibre 50/125 µm or using glass fibre 62.5/125 µm
	Permissible link signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Maximum channel distance between two modules with redundant optical ring topology, baud rates ≥ 500 kB/s and glass fibre 62.5/125 µm	6562 ft. (2,000 m) for glass fibre 62.5/125 µm With plastic fibre: 6.562 ft. (2 m) At 500 kB/s, 5,249.6 ft. (1,600 m) At 1,500 kB/s, 1,738.93 ft. (530 m)
IEC 60,870-5-103		
RS485	Isolated interface for data transfer to a master terminal	
	Connection for flush-mounted case	Rear panel, mounting location „E“, 9-pin D-subminiature female connector
	For panel surface-mounted case	At the housing mounted case on the case bottom
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 4,800 Baud; max. 38,400 Baud; Factory setting 38,400 Baud
	Channel distance	max. 0.621 mi. (1 km)

Fibre optics (FO)		
	FO connector type	ST connector
	Connection for Flush-Mounted Housing	Rear panel, mounting location „E“
	For surface-mounted case	In console housing on the bottom side, only RS485 [1)]
	optical wavelength	λ = 820 nm
	Laser Class I according to EN 60825-1/-2	When glass fibre used 50/12 µm, or 62.5/125 µm when glass fibre used
	Admissible optical signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Channel distance	1.5 km. (2.5 kg)
	Character idle state	Selectable, factory setting „Light off“
Ethernet electrical (EN 100) for IEC61850		
	Connection for Flush-Mounted Housing	Rear panel, mounting location „B“ 2 x RJ45 female connector 100BaseT acc. to IEEE802.3
	Connection for panel surface mounting housing	Not available
	Test voltage (female con-nector)	500 V; 50 Hz
	Transmission rate	100 MBit/s
	Channel distance	20 m. (2.5 kg)

1) Common use of the OLM/G12 (OLM V3) with the optical PROFIBUS interfaces of the SIPROTEC® 4 devices may only use the OLM/G12 in compatibility mode (DIL switch S7 = ON)! The reason for this is the fact that the redundancy technology of the OLM V2 is implemented in the SIPROTEC® PROFIBUS interfaces, and this varies from OLM V3. An OLM V3 behaves in the same manner as an OLM V2 in compatibility mode. With an incorrect setting, secure data transmission cannot be guaranteed.

Time synchronization interface

Time Synchronization	DCF 77 / IRIG B Signal (telegram format IRIG-B000)
Connection for Flush-Mounted Housing	Rear panel, mounting location „A“ 9-pin D-subminiature female connector
For surface-mounted case	At two-tier terminals on housing bottom
Rated signal voltages	Selectable 5 V, 12 V or 24 V

Signal Levels and Burdens:

	Nominal signal input voltage		
	5 V	12 V	24 V
U_{IIHigh}	6.0 V	15.8 V	31 V
U_{ILow}	1.0 V at I_{ILow} = 0.25 mA	1.4 V at I_{ILow} = 0.25 mA	1.9 V at I_{ILow} = 0.25 mA
I_{IHigh}	4.5 mA to 9.4 mA	4.5 mA to 9.3 mA	4.5 mA to 8.7 mA
R_I	890 Ω at U_I = 4 V	1930 Ω at U_I = 8.7 V	3780 Ω at U_I = 17 V
	640 Ω at U_I = 6 V	1700 Ω at U_I = 15.8 V	3560 Ω at U_I = 31 V

4.1.5 Electrical Tests

Specifications

Standards:	IEC 60255 (product standards) ANSI/IEEE Std C37.90.0/.1/.2 UL 508 DIN 57435 Part 303 See also standards for individual tests

Insulation Test

Standards:	IEC 60255-5 and IEC 60870-2-1
High Voltage Test (routine test) All circuits except power supply, Binary Inputs, Communication Interface and Time Synchronization Interfaces	2.5 kV (rms), 50 Hz
High Voltage Test (routine test) Auxiliary Voltage and Binary Inputs	3.5 kV DC
Voltage test (routine test): only isolated communication and time synchronisation interfaces	500 V (rms), 50 Hz
Impulse Voltage Test (type test) All Circuits Except Communication and Time Synchronization Interfaces, Class III	5 kV (peak value); 1.2/50 μs; 0.5 J; 3 positive and 3 negative pulses at intervals of 1 s

EMC Tests for Interference Immunity (type tests)

Standards:	IEC 60255-6 and -22 (product standards) EN 50082-2 (generic standard) DIN 57435 Part 303
High frequency test IEC 60255-22-1, Class III and VDE 0435 part 303, class III	2.5 kV (peak value); 1 MHz; τ = 15 μs; 400 pulses per s; test duration 2 s; R_i = 200 Ω
Electrostatic discharge IEC 60255-22-2, Class IV and IEC 61000-4-2, Class IV	8 kV contact discharge; 15 kV air discharge, both polarities; 150 pF; R_i = 330 Ω
Exposure to HF field, non-modulated IEC 60255-22-3 (report), Class III	10 V/m; 27 MHz to 500 MHz
Irradiation with HF field, amplitude modulated IEC 61000-4-3, Class III	10 V/m; 80 MHz to 1000 MHz; 80 % AM; 1 kHz
Irradiation with HF field, pulse modulated IEC 61000-4-3/ENV 50 204, Class III	10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle of 50 %
Fast Transient Disturbance Variables / Burst IEC 60255-22-4 and IEC 61000-4-4, Class IV	4 kV; 5/50 ns; 5 kHz; burst length = 15 ms; repetition rate 300 ms; both polarities: R_i = 50 Ω; test duration 1 min
High energy surge voltages (SURGE), IEC 61000-4-5 Installation Class 3 Auxiliary voltage Measuring inputs, binary inputs and relay outputs	Impulse: 1.2/50 μs Common mode: 2 kV; 12 Ω; 9 μF Diff. mode:1 kV; 2 Ω; 18 μF Common mode: 2 kV; 42Ω; 0. 5 μF diff. mode: 1 kV; 42Ω; 0. 5 μF

Line conducted HF, amplitude modulated IEC 61000-4-6, Class III	10 V; 150 kHz to 80 MHz; 80 % AM; 1 kHz
Power System Frequency Magnetic Field IEC 61000-4-8, Class IV IEC 60255-6	30 A/m continuous; 300 A/m for 3 s; 50 Hz 0.5 mT; 50 Hz
Oscillatory Surge Withstand Capability ANSI/IEEE Std C37.90.1	2.5 to 3 kV (peak value); 1 to 1.5 MHz; damped oscillation; 50 surges per s; test duration 2 s; R_i = 150 Ω to 200 Ω
Fast Transient Surge Withstand Cap. ANSI/IEEE Std C37.90.1	4 kV to 5 kV: 10/150 ns: 50 pulses per s; both polarities: test duration 2 s: R_i = 80 Ω
Radiated Electromagnetic Interference ANSI/IEEE C37.90.2	35 V/m; 25 MHz to 1000 MHz
Damped Oscillations IEC 60694, IEC 61000-4-12	2.5 kV (peak value), polarity alternating 100 kHz, 1 MHz, 10 MHz and 50 MHz, R_i = 200 Ω

EMC Tests for Noise Emission (type test)

Standard:	EN 50081-* (generic standard)
Radio Noise Voltage to Lines, Only Power Supply Voltage IEC-CISPR 22	150 kHz to 30 MHz Limit Class B
Interference field strength IEC-CISPR 22	30 MHz to 1000 MHz Limit Class B
Harmonic Currents on the Network Lead at 230 VAC IEC 61000-3-2	Device is to be assigned Class D; (applies only for devices with > 50 VA power consumption)
Voltage fluctuations and flicker on the network incoming feeder at 230 VAC IEC 61000-3-3	Limits are observed

4.1.6 Mechanical Stress Tests

Vibration and Shock Stress during Stationary Operation

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 10 Hz to 60 Hz: ± 0.075 mm amplitude; 60 Hz to 150 Hz: 1 g acceleration Frequency sweep rate 1 Octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal 5 g acceleration, duration 11 ms, each 3 shocks in both directions of the 3 axes
Seismic Vibration IEC 60255-21-3, Class 1; IEC 60068-3-3	Sinusoidal 1 Hz to 8 Hz: ±3.5 mm amplitude (horizontal axis) 1 Hz to 8 Hz: ±1.5 mm amplitude (vertical axis) 8 Hz to 35 Hz: 1 g acceleration (horizontal axis) 8 Hz to 35 Hz: 0.5 g acceleration (vertical axis) Frequency sweep 1 octave/min 1 cycle in 3 orthogonal axes

Vibration and Shock Stress During Transport

Standards:	IEC 60255-21 and IEC 60068
Oscillation IEC 60255-21-1, Class 2; IEC 60068-2-6	Sinusoidal 5 Hz to 8 Hz: ± 7.5 mm amplitude; 8 Hz to 15 Hz: 2 g acceleration Frequency sweep 1 octave/min 20 cycles in 3 orthogonal axes
Shock IEC 60255-21-2, Class 1; IEC 60068-2-27	Semi-sinusoidal 15 g acceleration, duration 11 ms, 3 shocks each in both directions of the 3 axes
Continuous Shock IEC 60255-21-2, Class 1; IEC 60068-2-29	Semi-sinusoidal 10 g acceleration, duration 16 ms, 1000 shocks each in both directions of the 3 axes
Note: All stress test data apply for devices in factory packaging.	

4.1.7 Climatic stress tests

Temperatures

Standards:	IEC 60255-6
Type tested (acc. to IEC 60086-2-1 and -2, Test Bd, for 16 h)	–5 °C to +55 °C
Permissible temporary operating temperature (tested for 96 h)	–20 °C to +70 °C in quiescent state, i.e. no pickup and no indications (legibility of display may be restricted from +131 °F (+55 °C))
Recommended for permanent operation (according to IEC 60 255-6)	+23 °F to +131 °F (–5 °C to +55 °C)
Limiting temperatures for storage	–13 °F to +131 °F (–25 °C to +55 °C)
Limit temperatures during transport	–13 °F to +158 °F (–25 °C to +70 °C)
Storage and transport of the device with factory packaging!	
Limiting temperatures for normal operation (i.e. output relays not energized)	–4 °F to +158 °F (–20 °C to +70 °C)
Limiting temperatures with maximum load (max. cont. permissible input and output quantities)	–23 °F to +104 °F (–5 °C to +40 °C)

Humidity

Permissible humidity	Mean value per year ≤ 75 % relative humidity; on 56 days of the year up to 93 % relative humidity; condensation must be avoided!
Siemens recommends that all devices be installed such that they are not exposed to direct sunlight, nor subject to large fluctuations in temperature that may cause condensation to occur.	

4.1.8 Service Conditions

The protective device is designed for use in an industrial environment and an electrical utility environment. Proper installation procedures should be followed to ensure electromagnetic compatibility (EMC).

In addition, the following is recommended:

- All contacts and relays that operate in the same cubicle, cabinet, or relay panel as the numerical protective device should, as a rule, be equipped with suitable surge suppression components.
- For substations with operating voltages of 100 kV and above, all external cables should be shielded with a conductive shield grounded at both ends. For substations with lower operating voltages, no special measures are normally required.
- Do not withdraw or insert individual modules or boards while the protective device is energized. In withdrawn condition, some components are electrostatically endangered; during handling the ESD standards (for **E**lectrostatic **S**ensitive **D**evices) must be observed. They are not endangered when inserted into the case.

4.1.9 Constructive versions

Case	7XP20
Dimensions	See dimensional drawings, Section 4.10
Weight (maximum number of components) approx.	
662 in flush-mount case	10 kg. (2.5 kg)
663 in flush-mount case	23.1525 lb. (10.5 kg)
664 in flush-mount case	24.255 lb. (11 kg)
663 in case for detachted operator panel	27.5625 lb. (12.5 kg)
664 in case for detachted operator panel	28.665 lb. (13 kg)
Detached operator panel	5.5125 lb. (2.5 kg)
International protection under IEC 60 529	
For equipment of the flush-mount housing	
Front	IP 51
Rear	IP20
In flush-mount case and in model with detached operator panel	
Front	IP 51
Rear	IP 50
For personal protection	IP 2x with cover cap

4.2 Breaker control

Number of controlled switchgear units	Depends on the number of binary inputs and outputs available
- 662	2-pin command output: 5 switchgears 1 $^1/_2$-pin command output: 6 switchgears
- 663	2-pin command output: 8 switchgears 1 $^1/_2$-pin command output: 10 switchgears
- 664	2-pin command output: 11 switchgears 1 $^1/_2$-pin command output: 14 switchgears
Interlocking	Freely programmable interlocking
Indications	Single point, double point, output, tagging and tap indications, bit patterns and counters
Commands	Single command / double command Pulse and continuous outputs
Switching command to circuit breaker	1-, 1$^1/_2$ - and 2-pin
Programmable logic controller	PLC logic, graphic input tool
Local control	Control via menu control, control keys Assignment of function keys
Remote control	Using communication interfaces Using substation automation system (e.g. SICAM) Using DIGSI® (e.g. via Modem)

4.3 Circuit Breaker Synchronisation

Operating modes	
Test programs	Synchronisation check, live bus / dead line live bus / dead line dead bus and dead line bypassing, or combination of them
Synchronisation	Closing the circuit breaker under synchronous and asynchronous power conditions possible (with circuit breaker operating time)
Voltages	
Maximum working voltage	20 V to 140 V (phase-to-phase) (1 V increments)
V< for dead status V> for live status	1 V to 60 V (phase-to-phase) (1 V increments) 20 V to 125 V (phase-to-phase) (1 V increments)
Tolerances Dropout	2 % of pickup value or 2 V Approx. 0.9 (V>) or 1.1 (V<); max. 1 V
Δ V measurements	
Quantity difference Tolerance	1 V to 40 V (phase-to-phase) (0.1 V increments) 1 V
Synchronous power conditions	
ΔΦ Measurement Tolerance	2 ° to 60 ° (1 ° increments) 2 °
Δf-measurement Tolerance	0.03 Hz to 2.00 Hz (0.01 Hz increments) 15 mHz The maximum permissible frequency difference depends on the circuit breaker operating time
Max. angle error	5 ° for Δf ≤ 2 Hz
Enable delay	0.00 s to 60.00 s (0.01 s increments)
Asynchronous power conditions	
Δf-measurement Tolerance	0.03 Hz to 2.00 Hz (0.01 Hz increments) 15 mHz The maximum permissible frequency difference depends on the circuit breaker operating time
Synchronous/asynchronous limits	0.01 Hz to 0.04 Hz (1 mHz increments)
Circuit breaker operating time	0.01 s to 0.60 s (0.01 s increments)
Times	
Minimum measuring time	Approx. 80 ms
Synchronisation function delay after start	250 ms
Maximum wait time (max. synchronisation duration	0.01 s to 600.00 s (0.01 s increments)
Tolerance of all timers	1 % of setting value or 10 ms

Operating range	
Synchrocheck at rated frequency	50 Hz ± 2 Hz 60 Hz ± 2 Hz

4.4 User defined functions (CFC)

Function Modules and Possible Assignments to Task Levels

Function Block	Explanation	Sequence Level			
		MW_ BEARB	PLC1_ BEARB	PLC_ BEARB	SFS_ BEARB
ABSVALUE	Magnitude Calculation	X	—	—	—
ADD	Addition	X	X	X	X
AND	AND - Gate	X	X	X	X
BOOL_TO_CO	Boolean to Control (conversion)	—	X	X	—
BOOL_TO_DI	Boolean to Double Point (conversion)	—	X	X	X
BOOL_TO_IC	Bool to Internal SI, Conversion	—	X	X	X
BUILD_DI	Create Double Point Annunciation	—	X	X	X
CMD_CANCEL	Cancel Command	—	—	—	X
CMD_CHAIN	Switching Sequence	—	X	X	—
CMD_INF	Command Information	—	—	—	X
CONNECT	Connection	—	X	X	X
D_FF	D- Flipflop	—	X	X	X
D_FF_MEMO	Status Memory for Restart	X	X	X	X
DI_TO_BOOL	Double Point to Boolean (conversion)	—	X	X	X
DIV	Division	X	X	X	X
DM_DECODE	Decode Double Point	X	X	X	X
DYN_OR	Dynamic OR	X	X	X	X
LIVE_ZERO		X	—	—	—
LONG_TIMER	Timer (max.1193h)	X	X	X	X
LOOP	Feedback Loop	X	X	X	X
LOWER_SETPOINT	Lower Limit	X	—	—	—
MUL	Multiplication	X	X	X	X
NAND	NAND - Gate	X	X	X	X
NEG	Negator	X	X	X	X
NOR	NOR - Gate	X	X	X	X
OR	OR - Gate	X	X	X	X
REAL_TO_INT	Adaptor	X	X	X	X
RS_FF	RS- Flipflop	—	X	X	X
SQUARE_ROOT	Root Extractor	X	X	X	X
SR_FF	SR- Flipflop	—	X	X	X
SUB	Substraction	X	X	X	X
TIMER	Timer	—	X	X	—
UPPER_SETPOINT	Upper Limit	X	—	—	—

Function Block	Explanation	Sequence Level			
		MW_ BEARB	PLC1_ BEARB	PLC_ BEARB	SFS_ BEARB
X_OR	XOR - Gate	X	X	X	X
ZERO_POINT	Zero Supression	X	—	—	—

General Limits

Designation	Limit	Comments
Maximum number of all CFC charts considering all task levels	32	When the limit is exceeded, an error message is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.
Maximum number of all CFC charts considering one task level	16	Only Error Message (record in device fault log, evolving fault in processing procedure)
Maximum number of all CFC inputs considering all charts	400	When the limit is exceeded, an error message is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.
Maximum number of inputs of one chart for each task level (number of unequal information items of the left border per task level)	400	Only fault annunciation (record in device fault log); here the number of elements of the left border per task level is counted. Since the same information is indicated at the border several times, only unequal information is to be counted.
Maximum number of reset-resistant flipflops D_FF_MEMO	50	When the limit is exceeded, an error message is output by the device. Consequently, the device is put into monitoring mode. The red ERROR-LED lights up.

Device-specific limits

Code	Limits [1)]
Maximum number of synchronous changes of chart inputs per task level	50
Maximum number of chart outputs per task level	150

[1)] When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring.

General Limits

<table>
<tr><th colspan="5">Additional Limits [1] for the Following 4 CFC Blocks</th></tr>
<tr><th>Sequence Level</th><th colspan="4">Maximum Number of Blocks in the Priority Classes</th></tr>
<tr><td></td><td>LONG_TIMER</td><td>TIMER[2]</td><td>CMD_CHAIN</td><td>D_FF_MEMO</td></tr>
<tr><td>MW_BEARB</td><td rowspan="4">18</td><td></td><td></td><td rowspan="4">50</td></tr>
<tr><td>PLC1_BEARB</td><td rowspan="2">9</td><td rowspan="2">20</td></tr>
<tr><td>PLC_BEARB</td></tr>
<tr><td>SFS_BEARB</td><td></td><td></td></tr>
</table>

1) When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring.

2) In a CFC chart with the blocks Timer or Short_Timer, the time resolution must not be specified smaller than the one set for the device in the timer setting (with 6MD66xx <10ms). If time settings are used, which are smaller than the time resolution, the Timer does not run with start pulse.

Device-specific Limits

Maximum number of TICKS [1] on the task levels	
Priority class	**Limit in TICKS**
MW_BEARB (Measured value processing)	3000
PLC1_BEARB (slow PLC processing)	5000
PLC_BEARB (fast PLC processing)	1000
SFS_BEARB (interlocking)	3000

1) When the sum of TICKS of all blocks exceeds the limits before-mentioned, an error message is output by CFC.

Processing times in TICKS required by the individual elements

Element		Number of TICKS
Block, basic requirement		5
Each input more than 3 inputs for generic modules		1
Connection to an input signal		6
Connection to an output signal		7
Additional for each chart		1
	CMD_CHAIN	34
	D_FF_MEMO	6
	LOOP	8
	DM_DECODE	8
	DYN_OR	6
	ADD	26
	SUB	26
	MUL	26
	DIV	54
	SQUARE_ROOT	83

4.5 Operational Measured values

Operational measured values for currents	I_{L1}; I_{L2}; I_{L3} in A (kA) primary and in A secondary or in % of I_{Nom}
Range (MLFB pos. 7 = 1.5)	10 % to 120 % I_N
Range for 150% In (MLFB pos. 7 = 2.6)	10% to 150% I_N
Tolerance (MLFB pos. 7 = 1.5)	< 1% of I_N at | f-f_N | < 5 Hz and at 10% to 50% I_N < 0.5% of measured value at | f-f_N | < 5 Hz and at 50 % to 120 % I_N
Tolerance for 150% In (MLFB pos. 7 = 2.6)	< 1 % of I_{Nom} at | f-f_{Nom} | < 5 Hz and at 10 % to 50 % I_{Nom} < 0.5 % of measured value at | f-f_{Nom} | < 5 Hz and at 50 % to 150 % I_N
Operational measured values for voltages	$U_{measured}$ in kV primary, in U secondary or in % of U_{Nom}
Range	10 % to 120 % of U_{Nom}
Tolerance	< 1 % of U_{Nom} at | f-f_{Nom} | < 5 Hz and at 10 % to 50 % U_{Nom} < 0.5 % of measured value at | f-f_{Nom} | < 5 Hz and at 50 % to 120 % U_{Nom}
Operational measured values for power	S, apparent power in kVAr (MVAr or GVAr) primary and in % of S_{Nom}
Range	50 % to 120 % S/S_{Nom}
Tolerance *)	< 0.5 % of measured value at | f-f_{Nom} | < 5 Hz for U/U_{Nom} and I/I_{Nom} = 50 to 120 %
	P, real power in kW (MW or GW) primary and in % P_{Nom}
Range	for | cos Φ | = 0.707 to 1.00
Tolerance *)	< 0.5 % of measured value at | f-f_{Nom} | < 5 Hz For U/U_{Nom} and I/I_{Nom} = 50 to 120 %
	Q, reactive power in kVAr (MVAr or GVAr) primary and in % of Q_{Nom}
Range	For | sin Φ | = 0.707 to 1.00
Tolerance *)	< 0.5 % of measured value at | f-f_{Nom} | < 5 Hz For U/U_{Nom} and I/I_{Nom} = 50 to 120 %
Operating measured value for power factor	cos φ
Range	for | cos Φ | = 0.707 to 1.00
Tolerance	< 0.5 % of measured value at | f-f_{Nom} | < 5 Hz For U/U_{Nom} and I/I_{Nom} = 50 to 120 % and at | cos Φ | < 0.707 < ± 0.01 %
Operating measured value for power factor	sin φ
Range	For | sin Φ | = 0.707 to 1.00
Tolerance	< 0.5% of measured value at | f-f_N | < 5 Hz For U/U_{Nom} and I/I_{Nom} = 50 to 120 % and at | sin Φ | < 0.707 < ± 0.01 %
Operational measured values for angles	φ in °
Tolerance	< ± 0.5 °
Operational measured values for frequency	f in Hz

Range	± 20 mHz at U/U_{Nom} = 10 to 120 % and at $f = f_{Nom}$ ± 5 Hz
Tolerance	20 mHz
Measuring transducer limit range behaviour	
Current, overflow range (MLFB pos. 7 = 1.5)	Phase current > 1.2 I_N The derived quantities P, Q, C, sin φ, cos φ, and φ are then invalid
Current, overflow range for 150% In (MLFB pos. 7 = 2.6)	Phase current > 1.5 I_N The derived quantities P, Q, C, sin φ, cos φ, and φ are then invalid
Voltage, overflow range	Voltage > 1.2 I_{Nom} The derived phase-phase voltages and quantities P, Q, C, sin φ, cos φ, and φ are then invalid
Power, zero range, are invalid	P, Q, S A phase voltage < $0.1U_{Nom}$ or the nominal apparanet power S < 1 %
Power, overflow range	A phase current or a phase-earth voltage in overflow
Phase angle, zero range, are invalid	sin φ, cos φ, and φ A phase voltage < $0.1U_{Nom}$ or the nominal apparanet power S < 1 %
Frequency, zero range, is invalid	f < 45 Hz or a phase voltage < $0.1U_{Nom}$
Frequency, overflow range	f > 65 Hz
Measured values, technical data of the 20 mA inputs	
Rated input current	- 20 to 20 mA DC
Measuring range	-24 to 24 mA DC
Input resistance	1 Ω ± 1 %
Active power input	5.76 W at I_{Nom} = 24 mA
Tolerance	1.0 %, relative to rated value of 20 mA
Metered values as binary pulses	
Max. metered frequency	50 Hz
Metered values calculated from current and voltage	
Precision	< 0.5 % of measured value at $\mid f-f_{Nom} \mid$ < 5 Hz and at 50 % to 120 % U_{Nom} or at 50 % to 120 %/150% I_N
*) Tolerance values apply to system frequency 50 Hz; with system frequency 60 Hz < 1%	

4.6 Circuit Breaker Failure Protection (optional)

Circuit Breaker Monitoring

Current flow monitoring	for I_N = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_N = 5 A	0.25 A to 100.00 A	
Zero sequence current monitoring	for I_N = 1 A	0.05 A to 20.00 A	Increments 0.01 A
	for I_N = 5 A	0.25 A to 100.00 A	
Dropout to pickup ratio		Approx. 0.95	
Tolerance		5 % of setting value or 1 % of nominal current	
Monitoring of circuit breaker auxiliary contact position			
- for three-pole tripping		Binary input for circuit breaker auxiliary contact	
- for single-pole tripping		1 binary input for auxiliary contact per pole or 1 binary input for series connection NO contact and NC contact	
Note: The circuit breaker failure protection can also operate without the indicated circuit breaker auxiliary contacts, but the function range is then reduced. Auxiliary contacts are necessary for the circuit breaker failure protection for tripping without or with a very low current flow (e.g. Buchholz protection, stub fault protection, circuit breaker pole discrepancy monitoring).			

Initiation Conditions

For circuit breaker failure protection	Internal or external single-pole trip [1)] Internal or external three-pole trip [1)] Internal or external three-pole trip without current [1)]

[1)] Via binary inputs

Times

Pickup time	approx. 25 ms with measured quantities present, approx. 25 ms after switch-on of measured quantities	
Drop-off time, internal (overshoot time)	≤ 30 ms	
Delay times for all stages	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

End Fault Protection

with signal transmission to the opposite line end		
Pickup time	approx. 25 ms	
Time Delay	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

Pole Discrepancy Supervision

Initiation criterion	not all poles are closed or open	
Pickup time	approx. 55 ms	
Monitoring time	0.00 s to 30.00 s; ∞	Increments 0.01 s
Tolerance	1 % of setting value or 10 ms	

Transformer class

Recommended CT class	Type 0.5 FS 5 (connection to transducer!)

4.7 Automatic Reclosure Function (optional)

Automatic Reclosures

Number of reclosures	Max. 8, first 4 with individual settings	
Type (depending on ordered version)	1-pole, 3-pole or 1-/3-pole	
Control	With pickup or trip command	
Action times Initiation possible without pickup and action time	0.01 s to 300.00 s; ∞	Increments 0.01 s
Different dead times before reclosure can be set for all operating modes and cycles	0.01 s to 1800.00 s; ∞	Increments 0.01 s
Dead times after evolving fault recognition	0.01 s to 1800.00 s	Increments 0.01 s
Reclaim time after reclosure	0.50 s to 300.00 s	Increments 0.01 s
Blocking time after dynamic blocking	0.5 s	
Blocking time after manual closing	0.50 s to 300.00 s; 0	Increments 0.01 s
Start signal monitoring time	0.01 s to 300.00 s	Increments 0.01 s
Circuit breaker monitoring time	0.01 s to 300.00 s	Increments 0.01 s

Adaptive Dead Time (ADT)/ Reduced Dead Time (RDT)/ Dead Line Check

Adaptive dead time	With voltage measurement or with close command transmission	
Action times Initiation possible without pickup and action time	0.01 s to 300.00 s; ∞	Increments 0.01 s
Maximum dead time	0.50 s to 3000.00 s	Increments 0.01 s
Voltage measurement dead line or bus	2 V to 70 V (Ph-E)	Increments 1 V
Voltage measurement live or bus	30 V to 90 V (Ph-E)	Increments 1 V
Voltage measuring time	0.10 s to 30.00 s	Increments 0.01 s
Time delay for close command transmission	0.00 s to 300.00 s; ∞	Increments 0.01 s

4.8 Inter-relay communication

Number of users in the IRC combination	Max. 32
Number of information items which each IRC user can apply to the IRC bus	Max. 32
Minimum appearance duration for indications which are to be transferred via inter relay communication	20 ms (due to IRC cycle time)

4.9 Auxiliary Functions

Time Allocation

Resolution for Event Log	1 ms
Maximum Time Deviation (Internal Clock)	0.01 %
Battery	Lithium battery 3 V/1 Ah, type CR 1/2 AA Message „Battery Fault“ for insufficient battery charge

Commissioning Aids

	Operational measured values Switching device test Test alarms

Clock

Time Synchronisation		DCF 77/IRIG B-Signal (telegram format IRIG-B000) Binary input Communication
Operating modes of the clock management		
No.	Operating Mode	Comments
1	Internal clock	Internal synchronisation via RTC (default)
2	IEC 60870-5-103	External synchronisation via system interface (IEC 60870-5-103)
3	PROFIBUS FMS	External synchronisation using PROFIBUS interface
4	Time signal IRIG B	External synchronisation using IRIG B
5	Time signal DCF77	External synchronisation via time signal DCF 77
6	Time signal synchro-box	External synchronisation via the time signal SIMEAS-Synch.Box
7	Pulse via binary input	External synchronisation with pulse via binary input
8	Field bus (DNP, Modbus)	External synchronisation using field bus
9	IRC (only 6MD66)	—
10	NTP (IEC 61850)	External synchronisation using system interface (IEC 61850)

4.10 Dimensions

4.10.1 Panel surface mounting and cabinet mounting

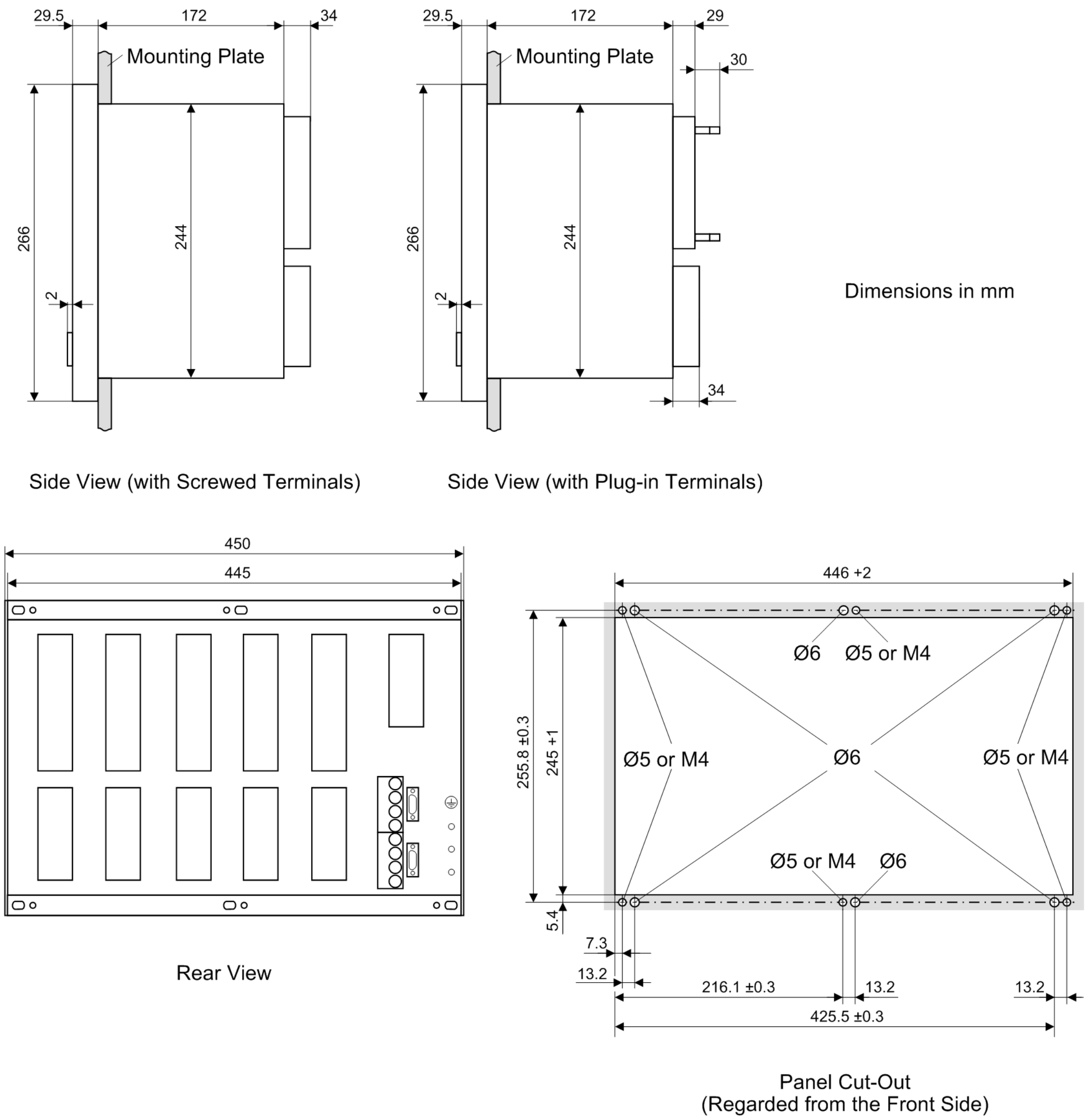


Figure 4-1 Dimensional drawing of a 6MD66x for panel surface and cabinet mounting

4.10.2 Mounting with detached operator panel or without operator panel

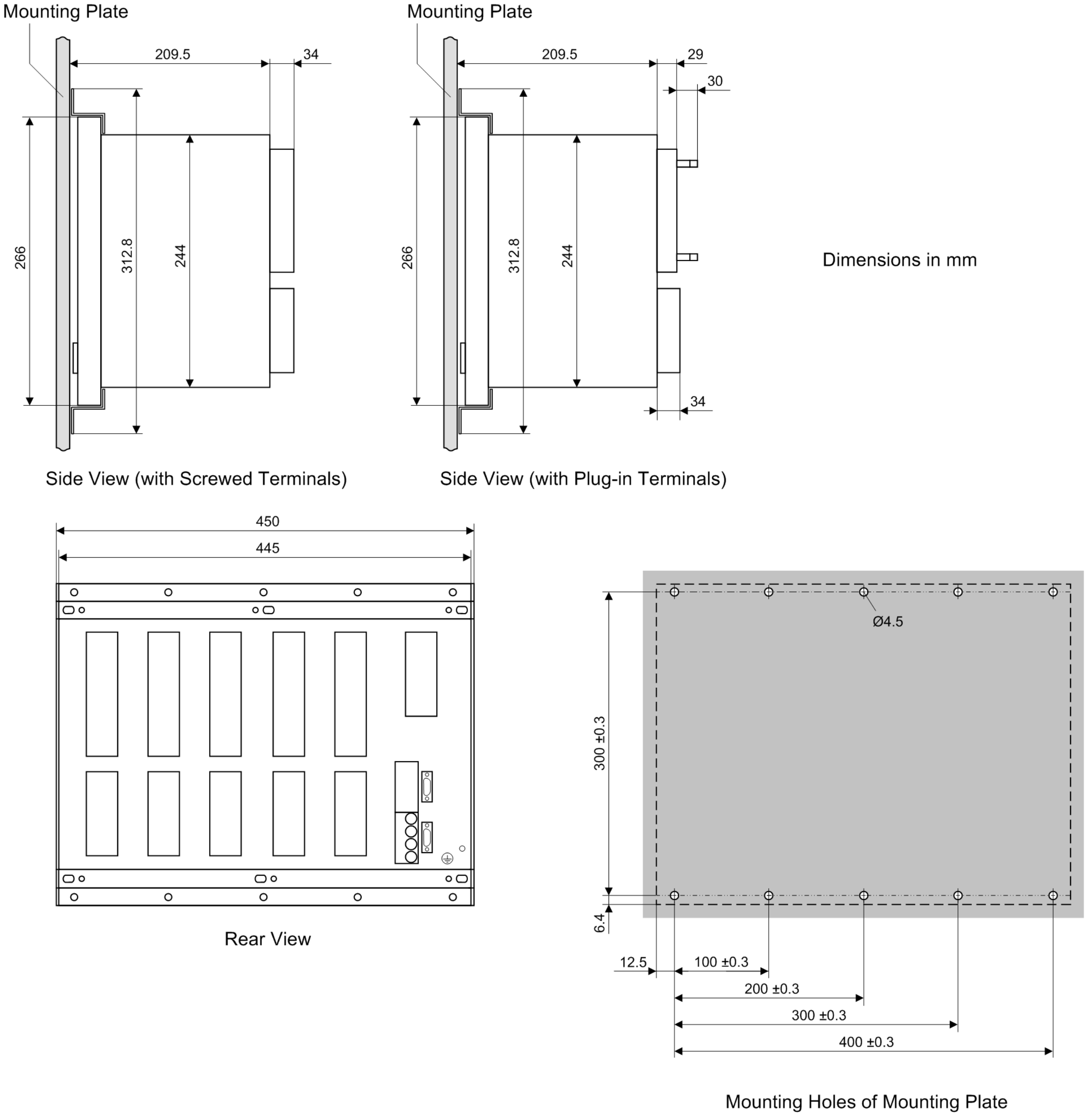


Figure 4-2 Dimensional drawing of a 6MD66x for surface mounting with/without operator control unit

4.10.3 Detached Operator Panel

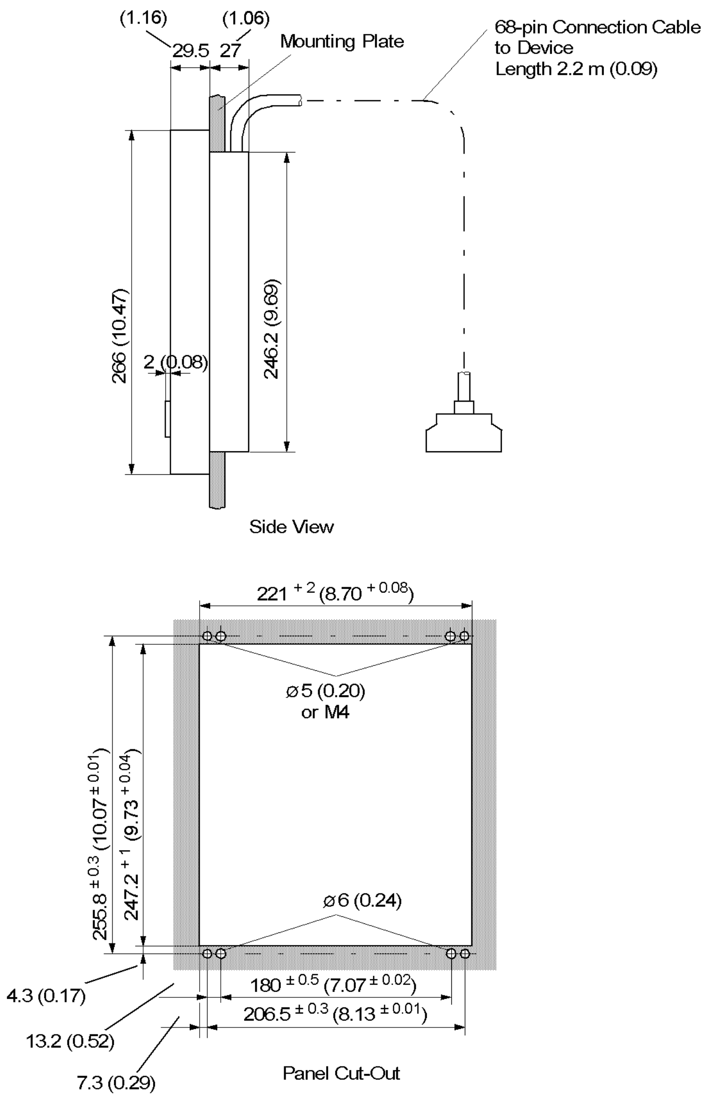


Figure 4-3 Dimensional drawing of a detached operator panel

4.10.4 D-subminiature connector of dongle cable (panel or cubicle door cutout)

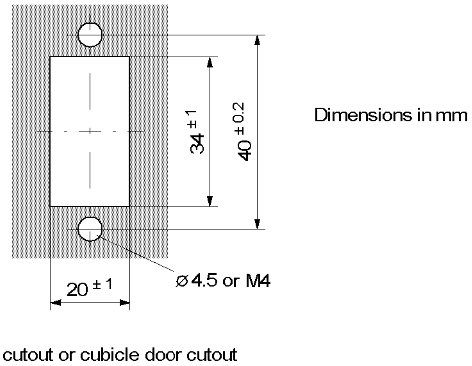


Figure 4-4 Dimensions of panel flush or cubicle door cutout of D-subminiature female connector of dongle cable

■

Appendix A

This appendix is primarily a reference for the experienced user. This section provides ordering information for the models of this device. Connection diagrams for indicating the terminal connections of the models of this device are included. Following the general diagrams are diagrams that show the proper connections of the devices to primary equipment in many typical power system configurations. Tables with all settings and all information available in this device equipped with all options are provided. Default settings are also given.

A.1 Ordering Information and Accessories

A.1.1 Ordering Information

A.1.1.1 6MD66x V 4.6

						6	7		8	9	10	11	12		13	14	15	16		17	18	19
High-voltage bay controller	6	M	D	6	6			—						—		A	A	0	+	L		

Equipment	Item 6
35 single-point indications 22 one-pole single commands (can also be compiled with double-pole commands and double commands) Three current transformers, four voltage transformers, two measurement inputs 20 mA	2
50 single point indications 32 one-pole single commands (can also be compiled with double-pole commands and double commands) Three current transformers, four voltage transformers, two measurement inputs 20 mA	3
65 single point indications 42 one-pole single commands (can also be compiled with double-pole commands and double commands) Three current transformers, four voltage transformers, two measurement inputs 20 mA	4

Rated current	Item 7
I_N = 1 A	1
I_N = 1 A 150% In [2)]	2
I_N = 5 A	5
I_N = 5 A 150% In [2)]	6

Power Supply, Binary Input Pickup Threshold Setting	Item 8
24 to 48 VDC, binary input threshold 19 V [1)]	2
60 VDC, binary input threshold 19 V [1)]	3
110 VDC, binary input threshold 88 V [1)]	4
220 to 250 VDC, binary input threshold 176 V [1)]	5

Construction	Item 9
Surface-mounting case, detached operator panel, installation in a low-voltage compartment Plug-in terminals (2 pin / 3 pin connectors) [2)]	A
Surface-mounting case, no operator panel, installation in a low-voltage compartment Plug-in terminals (2 pin / 3 pin connectors) [2)]	B
Surface-mounting case, detached operator panel, installation in a low-voltage compartment Screw-type terminals (direct connection / ring and spade lugs) [2)]	C
Flush mounted case with integrated local operation (graphic display, keyboard) Plug-in terminals (2/3 pin connectors)	D
Flush mounted case with integrated local operation (graphic display, keyboard) Screw-type terminals (direct connection / ring and spade lugs)	E
Surface-mounting case, no operator panel, installation in a low-voltage compartment, screw-type terminals (direct connection / ring and spade lugs) [2)]	F

Region-specific Default / Language Settings and Function Versions	Item 10
Region DE, 50 Hz, IEC, Language German (Language can be changed)	A
Region World, 50/60 Hz, IEC/ANSI, Language English (Language can be changed)	B
Region US, 60 Hz, ANSI, Language American English (language can be changed)	C
Region World, 50/60 Hz, IEC/ANSI, Language Spanish (language can be changed)	E

System Interface (Rear Side, Port B)	Item 11
No system interface	0
IEC-Protocol, electrical RS485	2
IEC-Protocol, Optical, 820 nm, ST-Connector	3
PROFIBUS FMS Slave, electrical RS485	4
PROFIBUS FMS Slave, optical, single ring, ST connector	5
PROFIBUS FMS Slave, optical, double ring, ST connector	6
For further interface options see Additional Information L	9

Service/Function Interface (Rear of Device, Interface C and D)	Item 12
No DIGSI interface at the back	0
DIGSI/Modem, electrical RS232, interface C:	1
DIGSI/Modem, electrical RS458, interface C:	2
DIGSI/Modem, optical 820 nm, ST connector, interface D	3
Inter relay communication, electrical RS458, interface C	4
Inter relay communication, electrical RS458, interface C and DIGSI, optical 820 nm, ST-Connector, interface D	5

Control System Functionality	Pos. 14	Pos. 15
Full functionality (measured value processing and display), with CB synchronization	A	A
No measured value processing, no measured value display, with synchronization	F	A
Full functionality (measured value processing and display), without CB synchronization	A	F
No measured value processing, no measured value display, without synchronization	F	F

Protection Functionality	Pos. 16
Without	0
with the automatic reclosure function (AR) incl. fault record	1
with circuit breaker failure protection (CBF) incl. fault record	2
with automatic reclosure (AR) and circuit breaker failure protection (CBF) incl. fault record	3
with the fault record functionality	4

Additional information L on further system interfaces (device rear) (only if item 11 = 9)	Item 17	Item 18	Item 19
PROFIBUS DP Slave, RS485 [2)]	L	0	A
PROFIBUS DP Slave, 820 nm, optical double ring, ST connector [2)]	L	0	B
IEC61850, 100 MBit Ethernet, electrical, double, RJ45-Connector	L	0	R
IEC 61850, 100 MBit Ethernet, optical, double, ST-Connector[3)]	L	0	S

1) The thresholds can be changed between 19 V, 88 V and 176 V for each indication input
2) Can only be ordered if the 6th digit is „3“ or „4“
3) Deliverable as of 01/2005

A.1.2 Accessories

Exchangeable interface modules

Name	Order No.
RS485	C53207-A351-D642-1
FO 820 nm	C53207-A351-D643-1
PROFIBUS FMS RS485	C53207-A351-D603-1
PROFIBUS FMS Double ring	C53207-A351-D606-1
PROFIBUS FMS single ring	C53207-A351-D609-1

Optical Link Module (OLM)

Name	Order No.
Optical Link Module	6GK1502–3CB10
Power supply 24 V DC for OLM	7XV5810–0BA00

Cover caps

Covering cap for terminal block type	Order No.
18-pin voltage terminal, 12-pin current terminal	C73334-A1-C31-1
12-pin voltage terminal, 8-pin current terminal	C73334-A1-C32-1

Short-circuit links

Covering cap for terminal type	Order No.
Voltage terminal (18-pin, 12-pin)	C73334-A1-C34-1
12-pin/8-pin voltage terminal	C73334-A1-C33-1

Socket housing

Socket housing	Order No.
2-pin	C73334-A1-C35-1
3-pin	C73334-A1-C36-1

Mounting Rails for 19"-Racks

Name	Order No.
Angle Strip (Mounting Rail)	C73165-A63-C200-2

Battery

Lithium battery 3 V/1 Ah, type CR 1/2 AA	Order No.
VARTA	6127 501 501
SONNENSCHEIN	1110 150 301

Interface Cable

Interface cable between PC and SIPROTEC	Order No.
Cable with 9-pin male/female connections	7XV5100-4

Round cable assembly, 3-pin

Name	Order No.
Round cable assembly, 3-pin	C73195-A100-B65-1

DIGSI operating software

DIGSI protection operation and configuration software	Order No.
DIGSI, basic version with licenses for 10 computers	7XS5400–0AA00
DIGSI, complete version with all option packages	7XS5402–0AA00

Display Editor

Software for creating basic and mimic control pictures (option package of the complete version of DIGSI)	Order No.
Display Editor 4; Full version with license for 10 PCs	7XS5420–0AA0

Graphic Tools

Graphic Tools	Order No.
Full version with licenses for 10 computers	7XS5430–0AA0

DIGSI REMOTE 4

Software for remotely operating protective devices via a modem (and possibly a star connector) using DIGSI (option package of the complete version of DIGSI)	7XS5440–1AA0

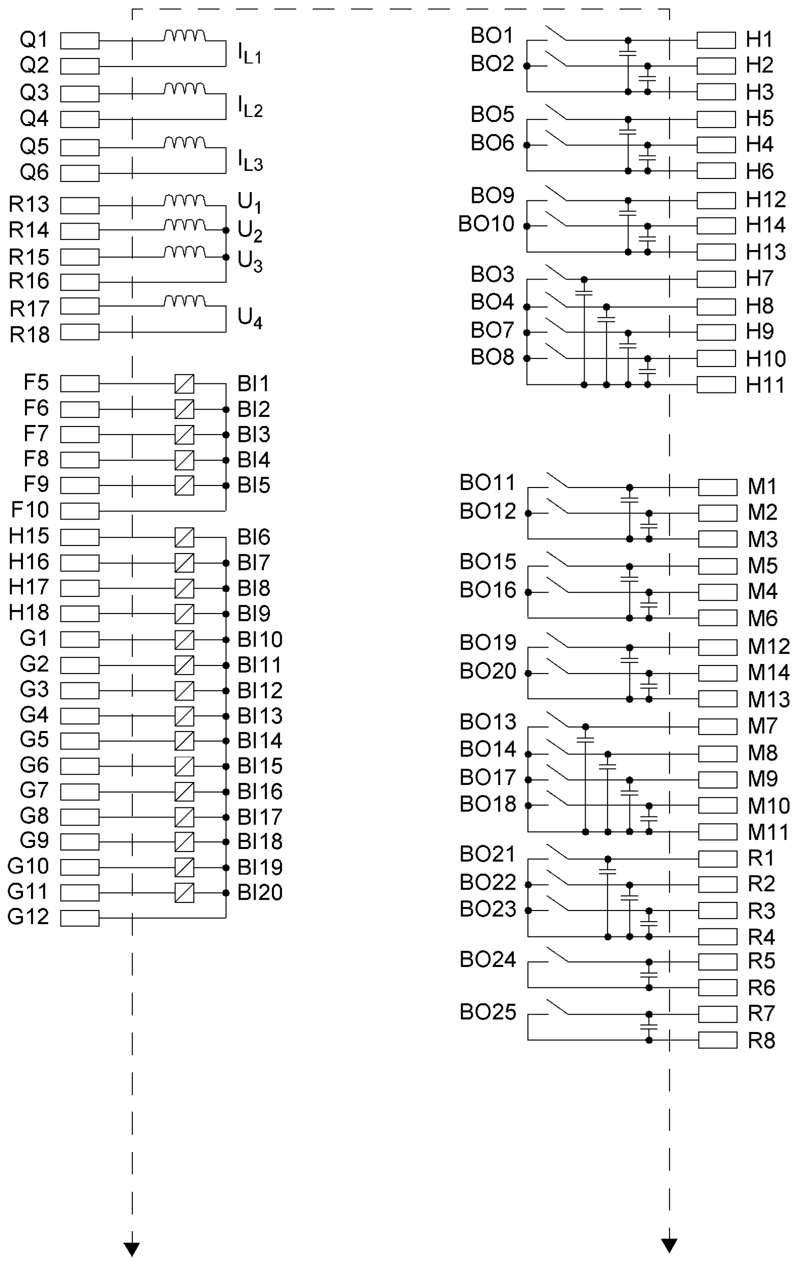
SIMATIC CFC 4

Graphical software for setting interlocking (latching) control conditions and creating additional functions (option package of the complete version of DIGSI)	7XS5450–0AA0

A.2 Terminal Assignments

A.2.1 Panel Flush Mounting or Cabinet Mounting

6MD662*-*D/E
(Page 1)



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6MD662*-*D/E (Page 2)

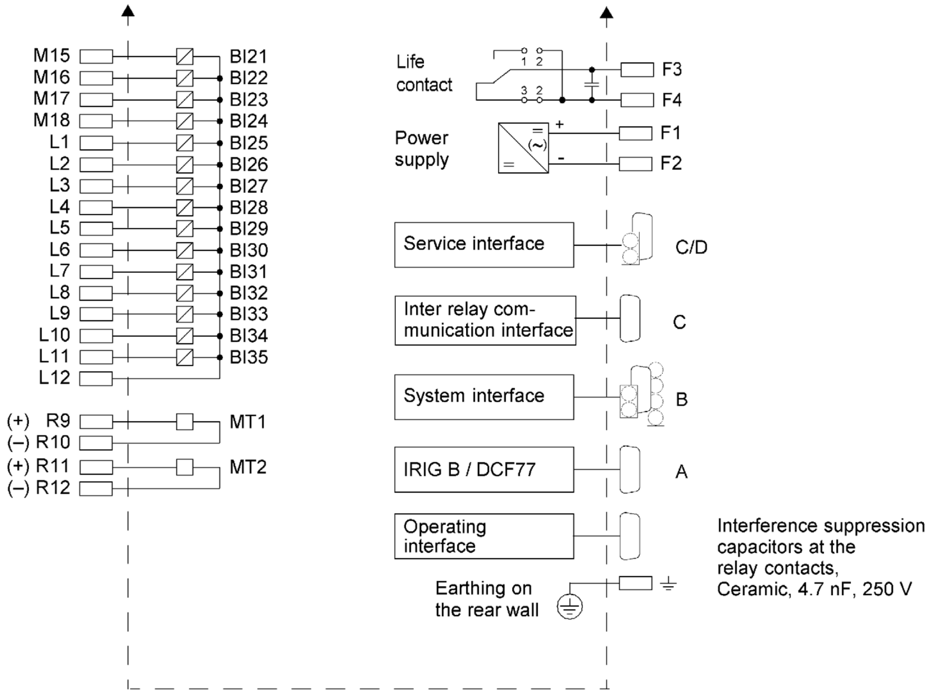
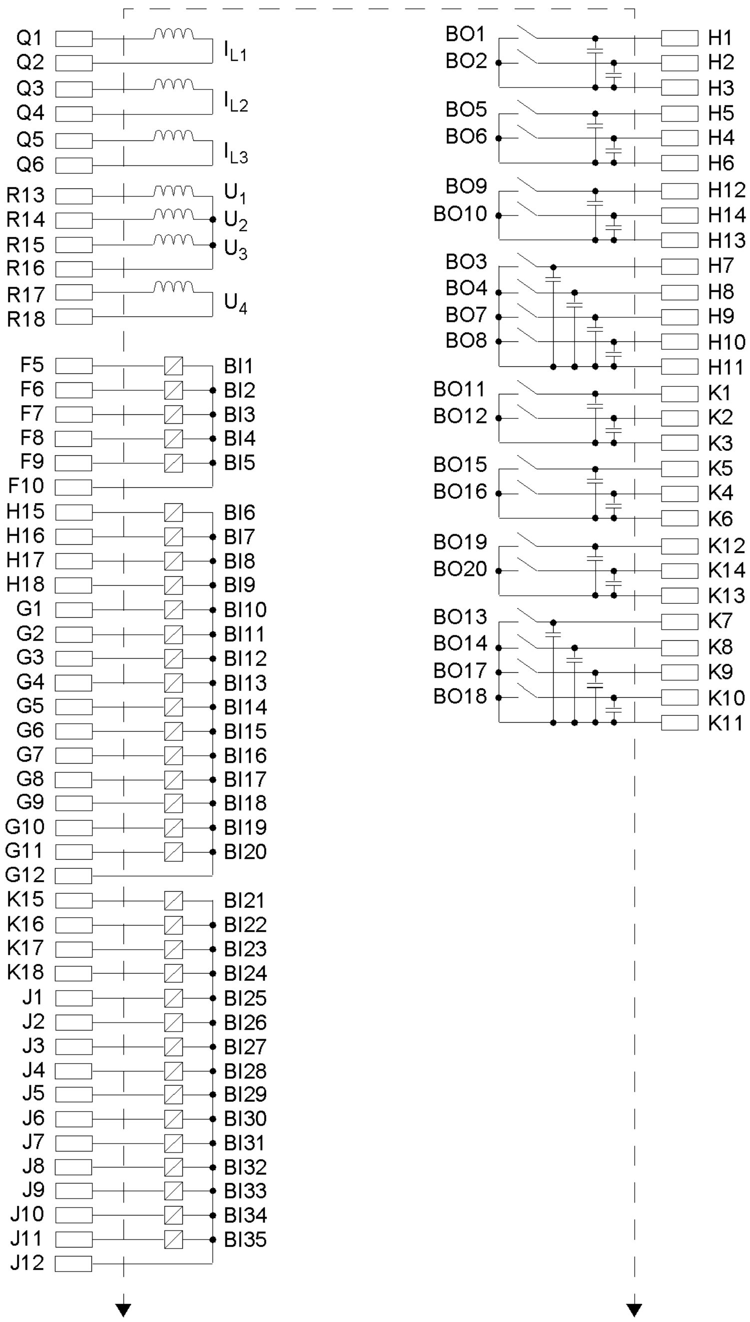


Figure A-1 General diagram for 662*-*D/E (panel flush mounted or cubicle mounted)

6MD663*-*D/E (Page 1)



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6MD663*-*D/E (Page 2)

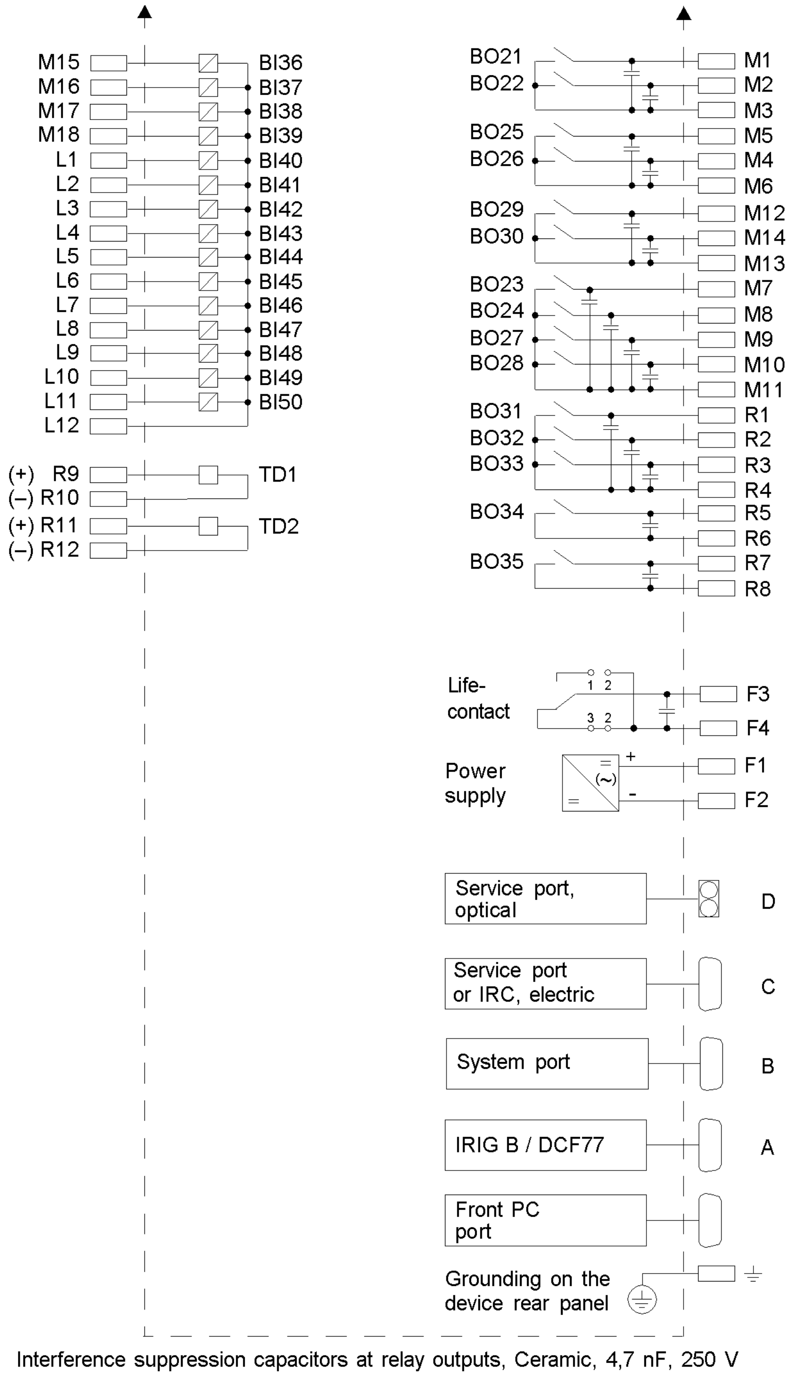
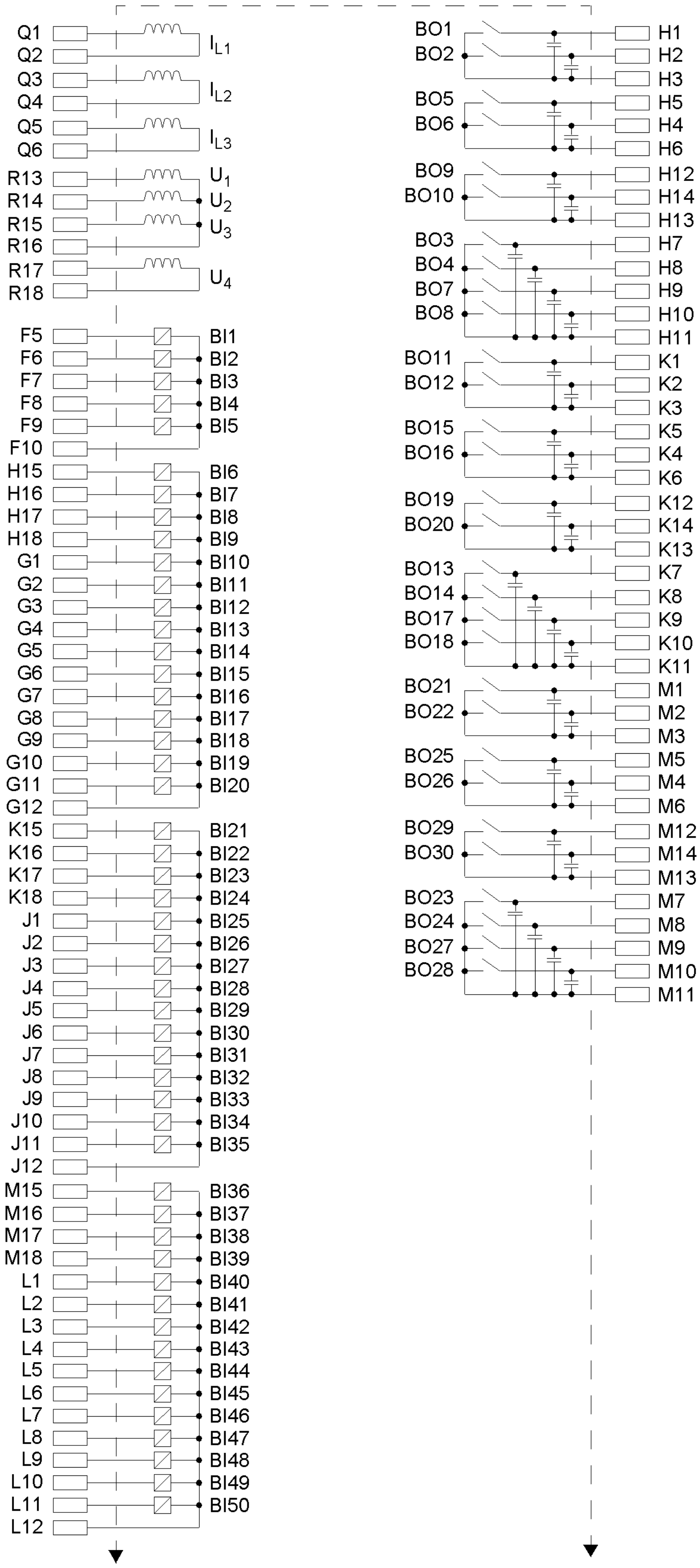


Figure A-2 General diagram for 663*-*D/E (panel flush mounted or cubicle mounted)

6MD664*-*D/E (Page 1)



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6MD664*-*D/E
(Page 2)

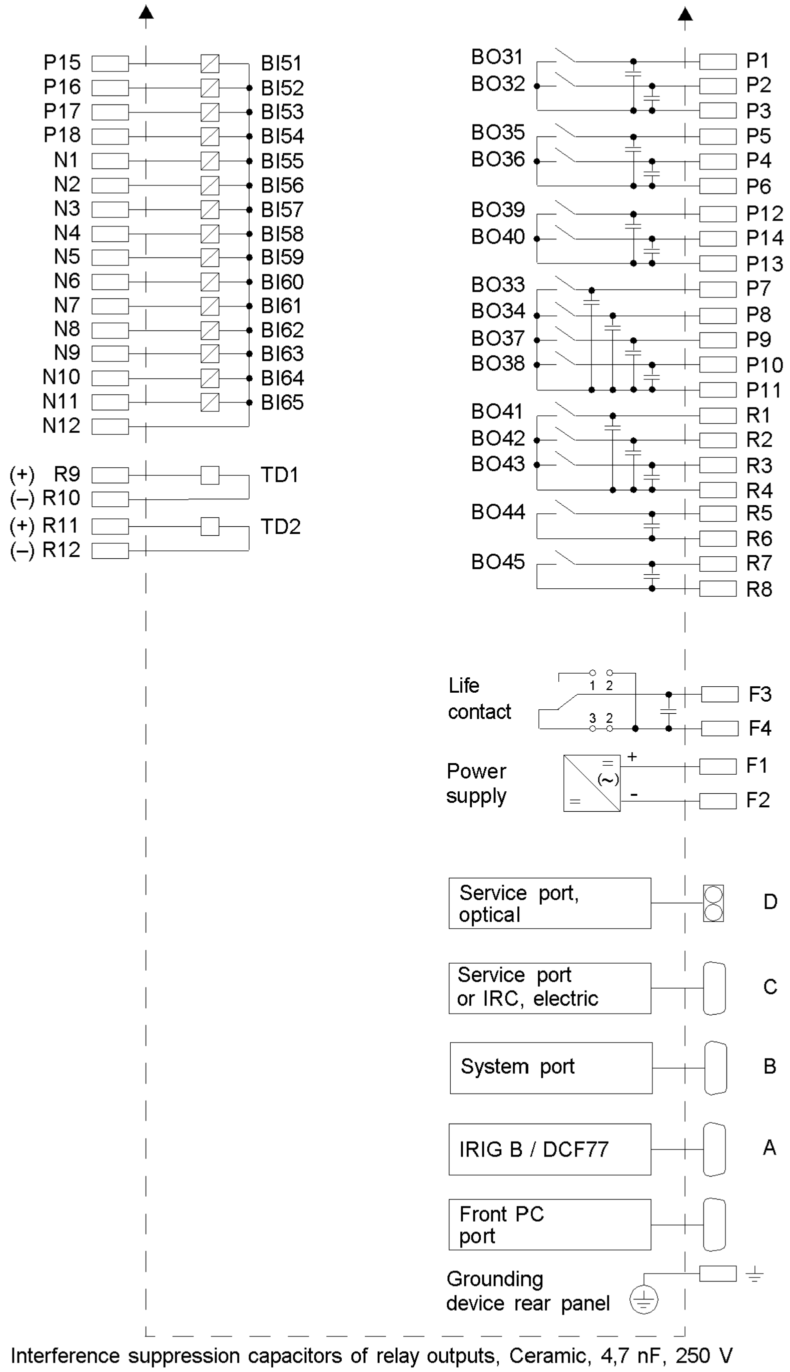
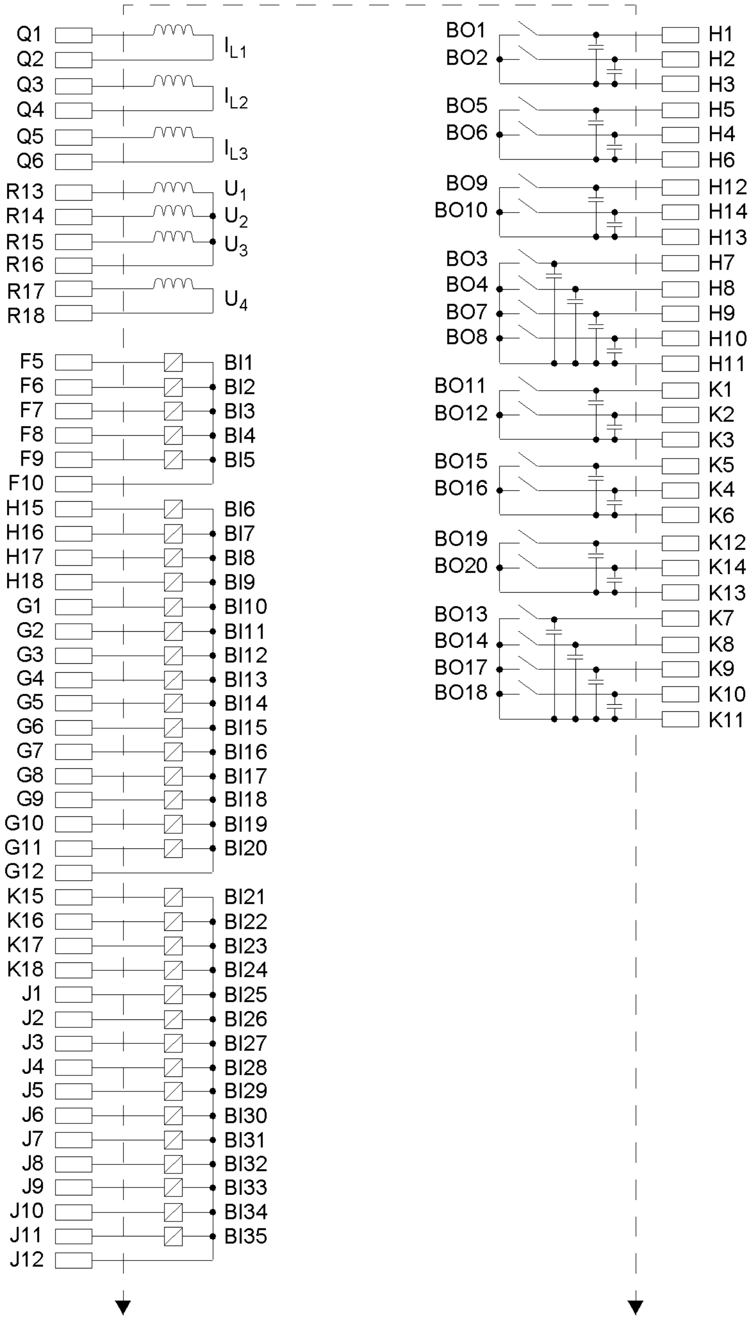


Figure A-3 General diagram for 664*-*D/E (panel flush mounted or cubicle mounted)

A.2.2 Housing with Detached Operator Panel

6MD663*-*A/C (Page 1)



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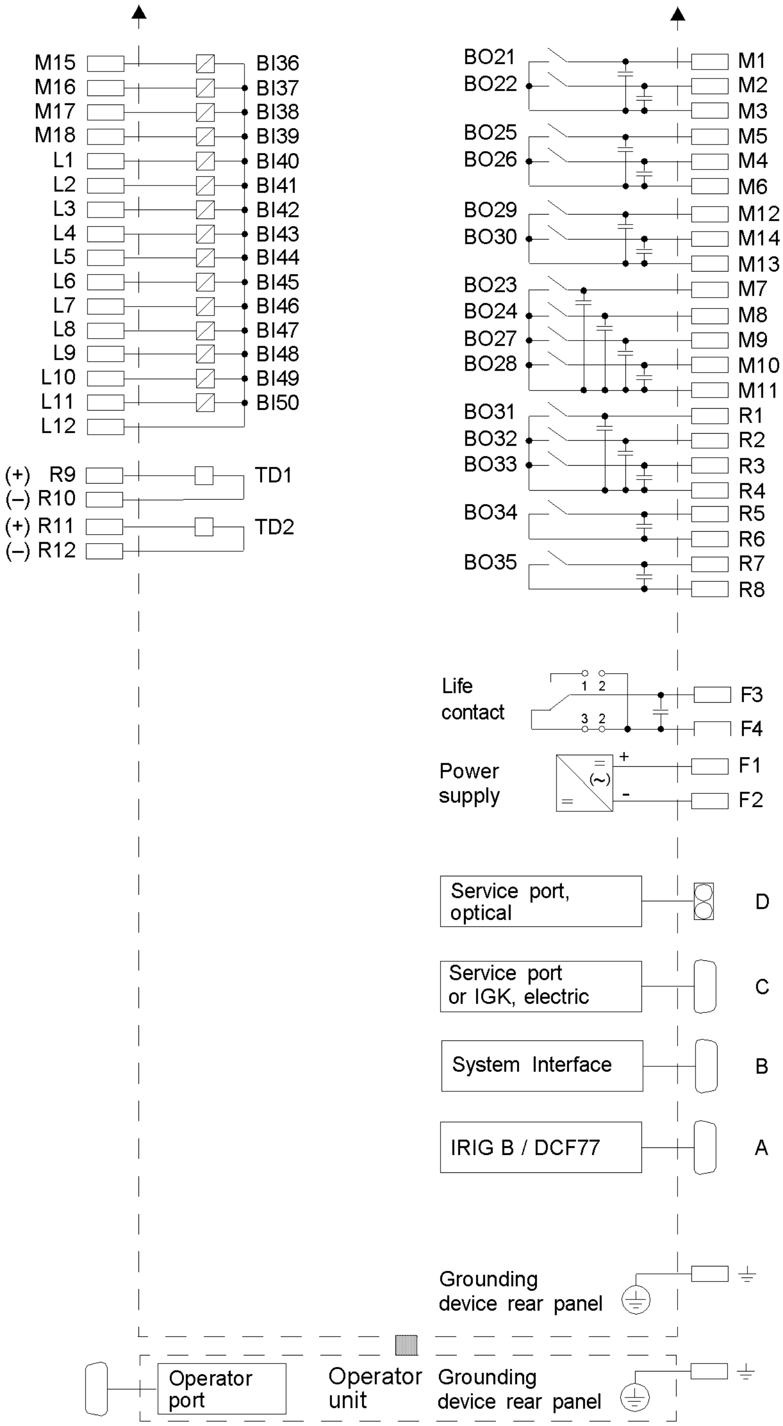
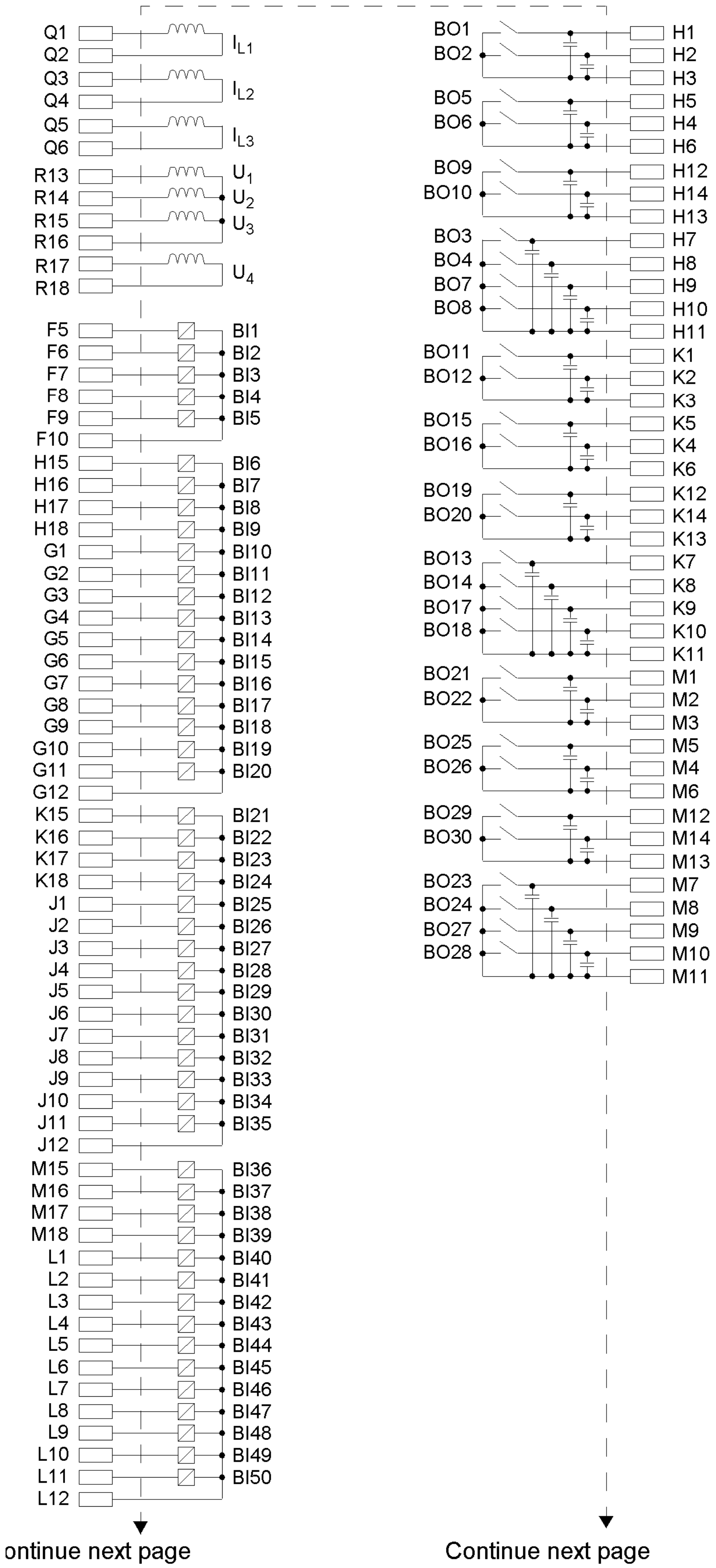
6MD663*-*A/C (Page 2)



Interference suppression capacitors of relay outputs, Ceramic, 4,7 nF, 250 V

Figure A-4 General diagram 663*-*A/C (panel surface mounting with detached operator panel)

6MD664*-*A/C (Page 1)



6MD664*-*A/C (Page 2)

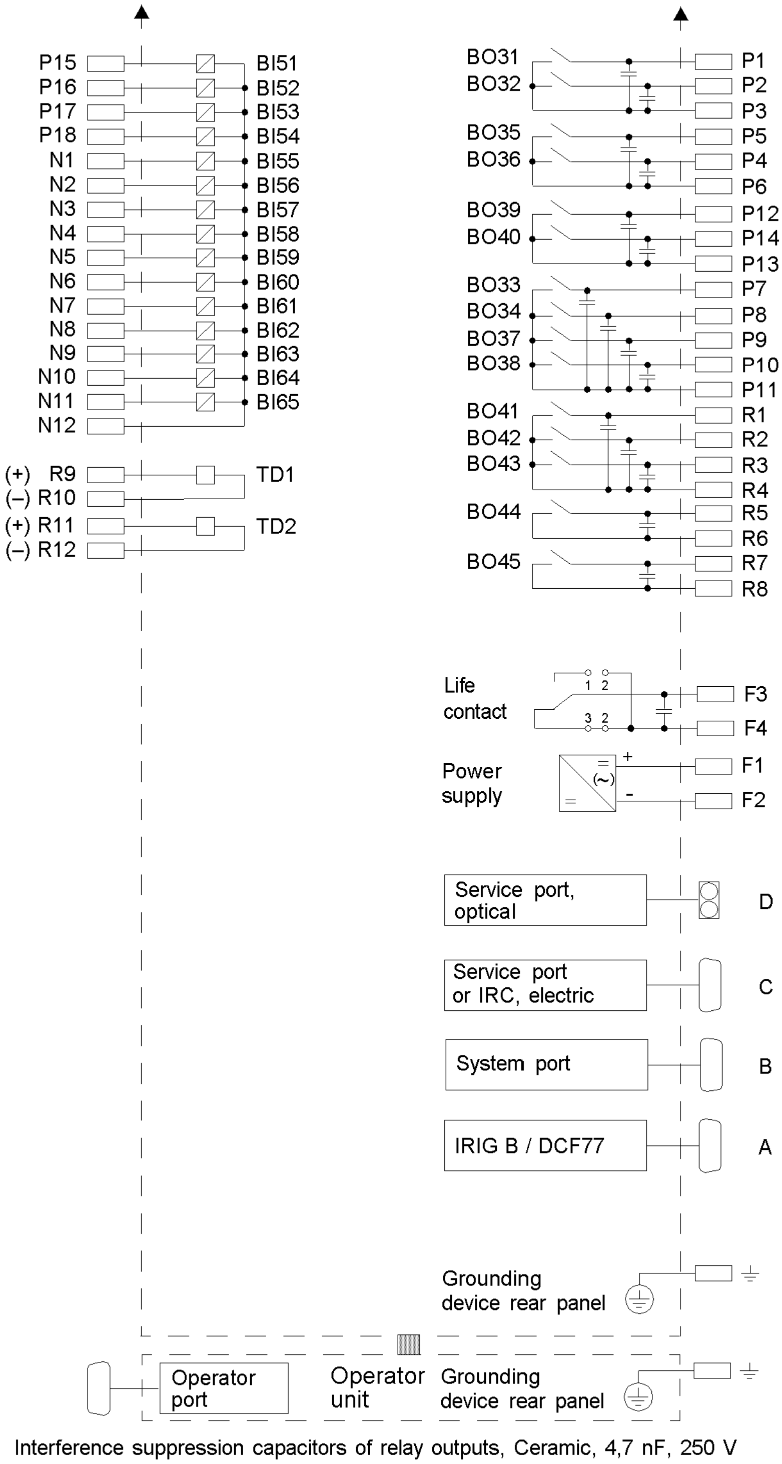
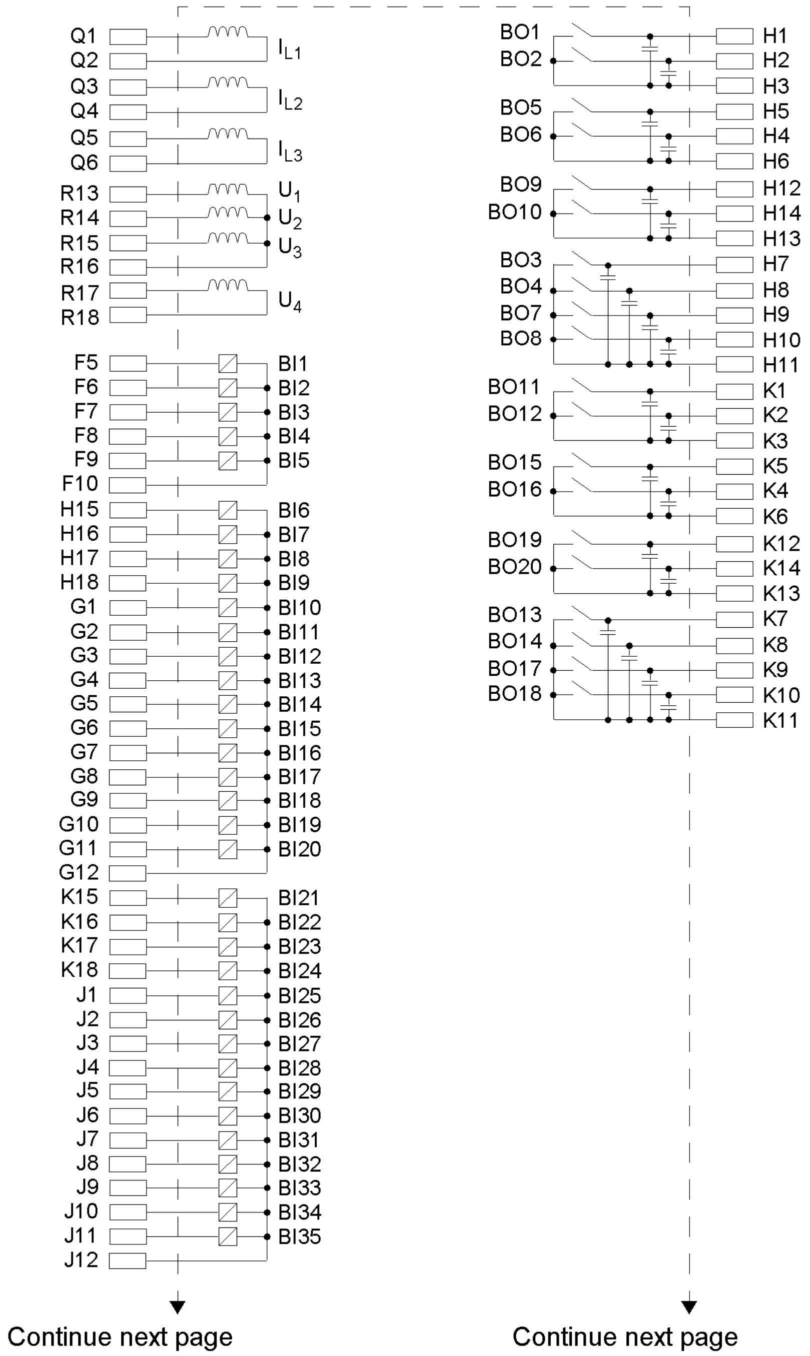


Figure A-5 General diagram 664*-*A/C (panel surface mounting with detached operator panel)

A.2.3 Housing for installation without operator panel

6MD663*-*B/F (Page 1)



6MD663*-*B/F (Page 2)

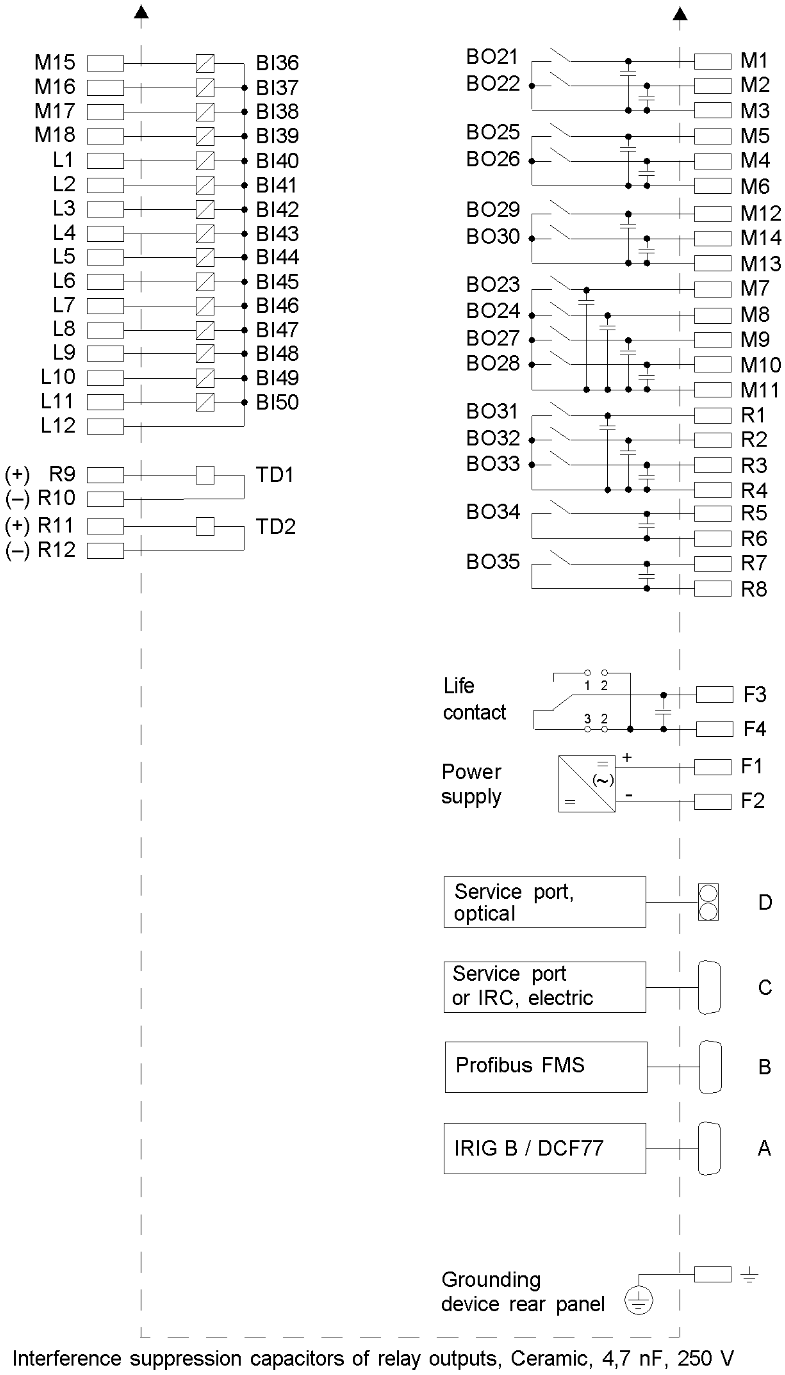
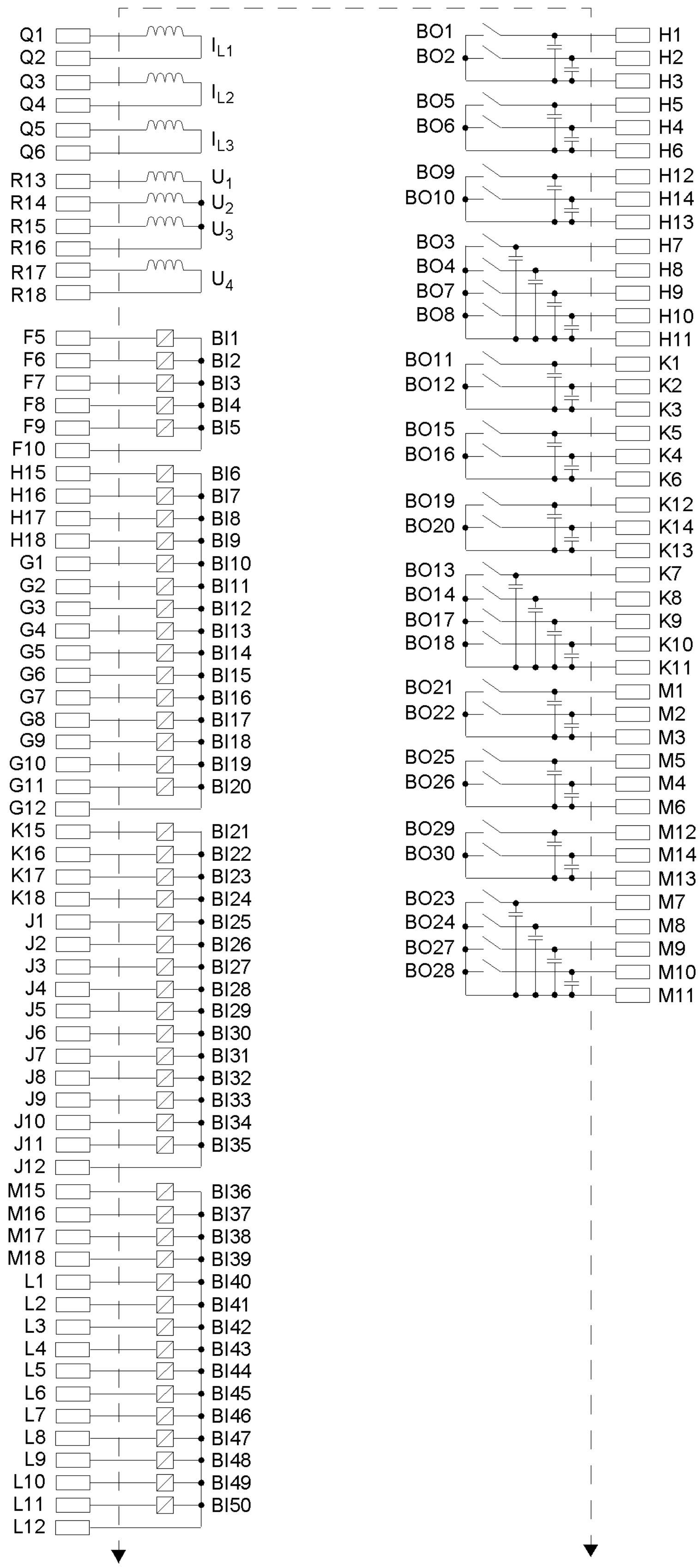


Figure A-6 General diagram 663*-*B/F (devices for panel surface mounting without operator panel)

6MD664*-*B/F (Page 1)



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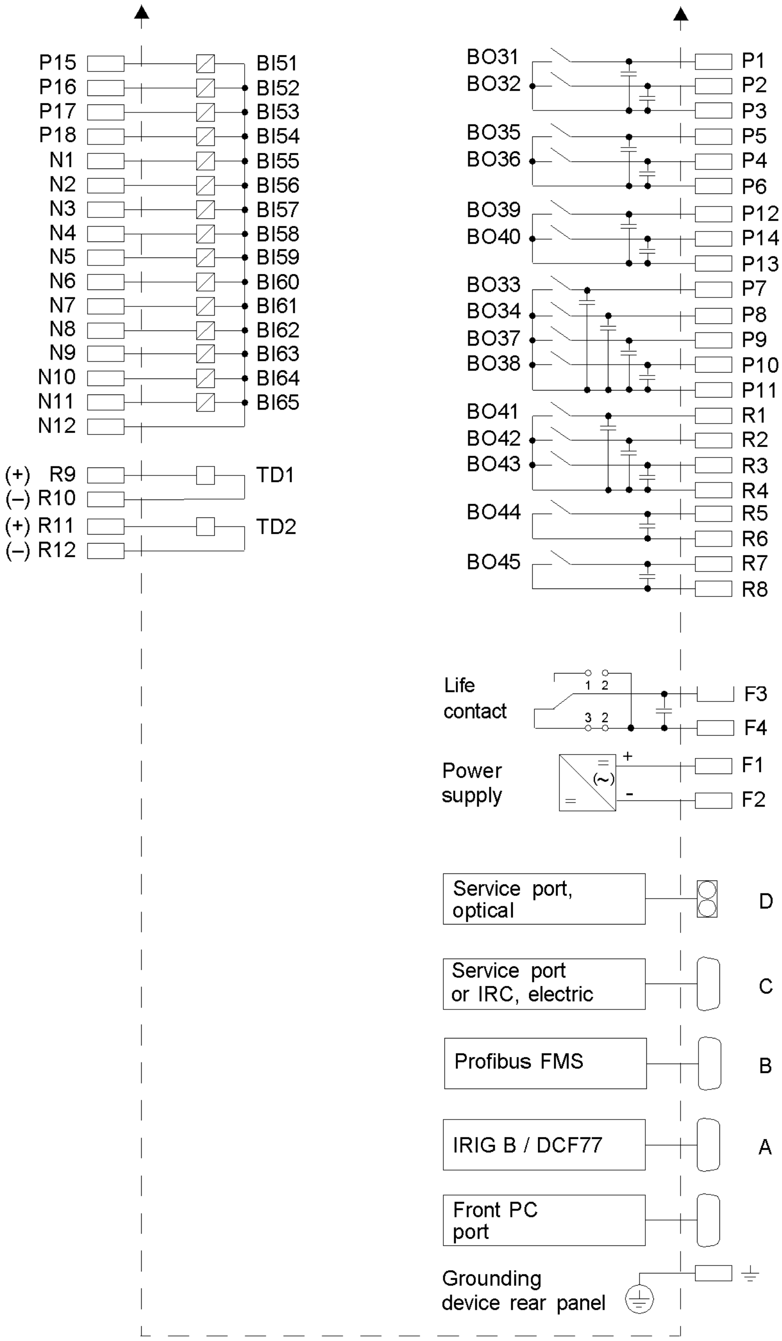
6MD664*-*B/F (Page 2)



Interference suppression capacitors of relay outputs, Ceramic, 4,7 nF, 250 V

Figure A-7 General diagram 664*-*B/F (devices for panel surface mounting without operator panel)

A.3 Connection Examples

A.3.1 Connection Examples for Measured Values and Synchronization

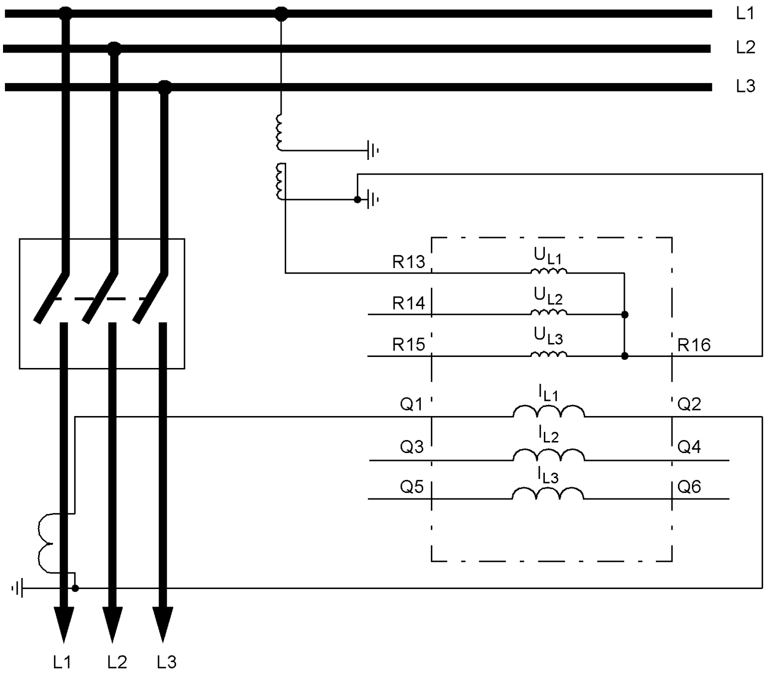


Figure A-8 Transformer connections to a current transformer and a voltage transformer (1-phase measuring transducer packet)

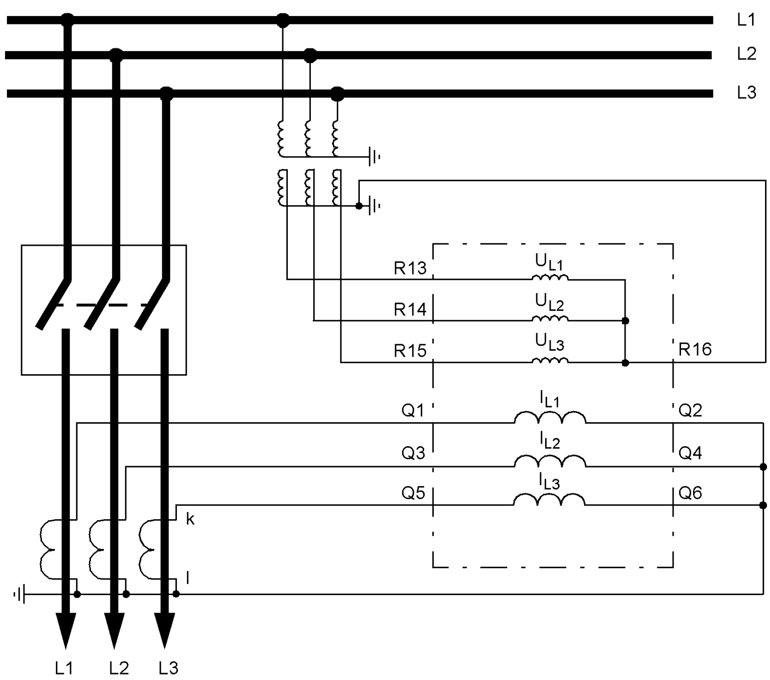


Figure A-9 Transformer connections to 3 current transformers and 3 voltage transformers (3-phase measuring transducer packet)

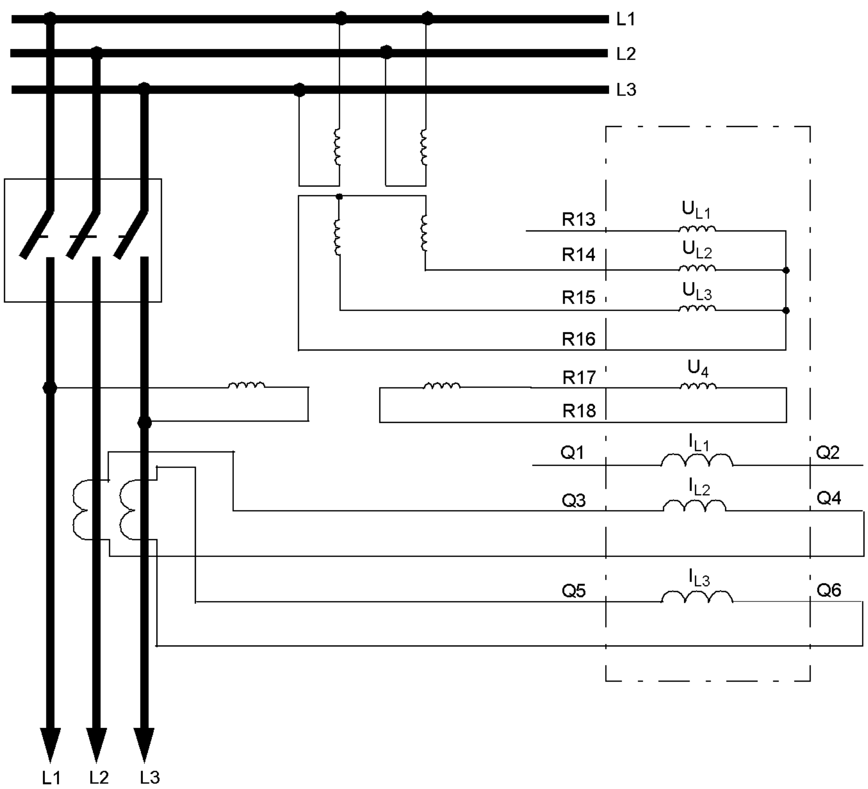


Figure A-10 Transformer connections to 2 current transformers and 2 voltage transformers for an Aron connection and circuit breaker synchronization connection with V_{LL}

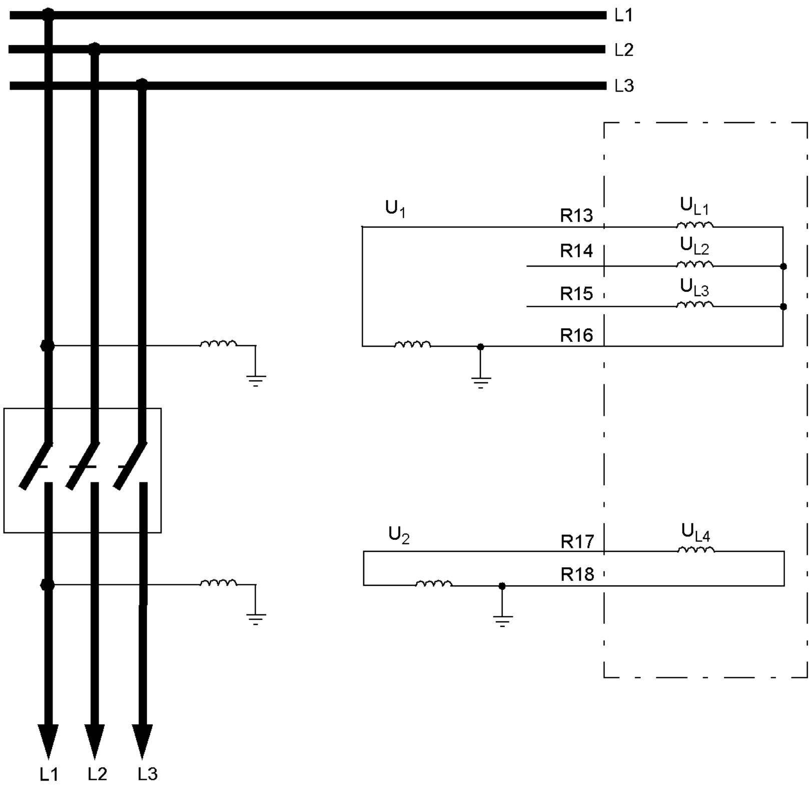


Figure A-11 Connection of measured values for the synchronization blocks 1 to 5 (measurement transducer connection in accordance with connection examples 1 and 2)

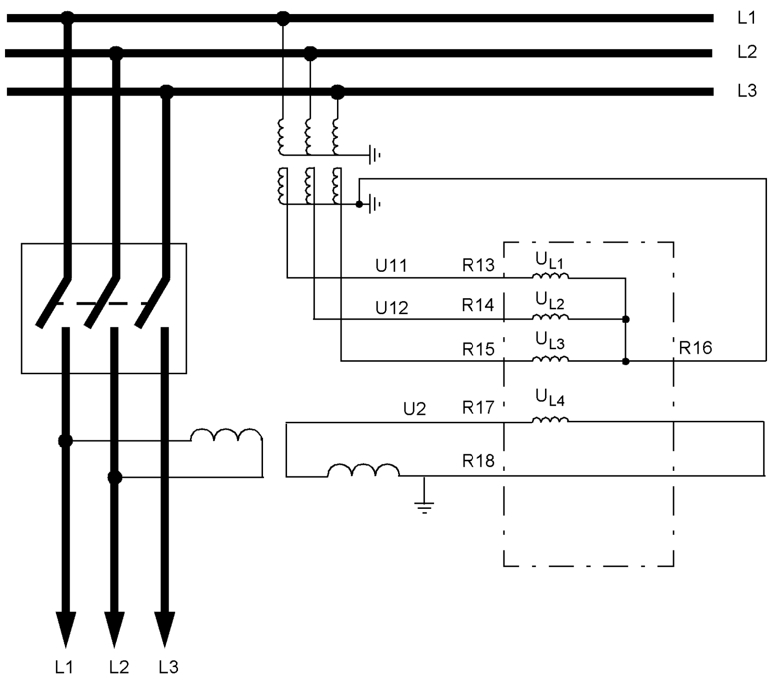


Figure A-12 Connection of measured values for the synchronization blocks 6 to 8 (measurement transducer connection in accordance with connection examples 1 and 2)

A.3.2 Configuration Examples for Breaker Failure Protection and Automatic Reclosure

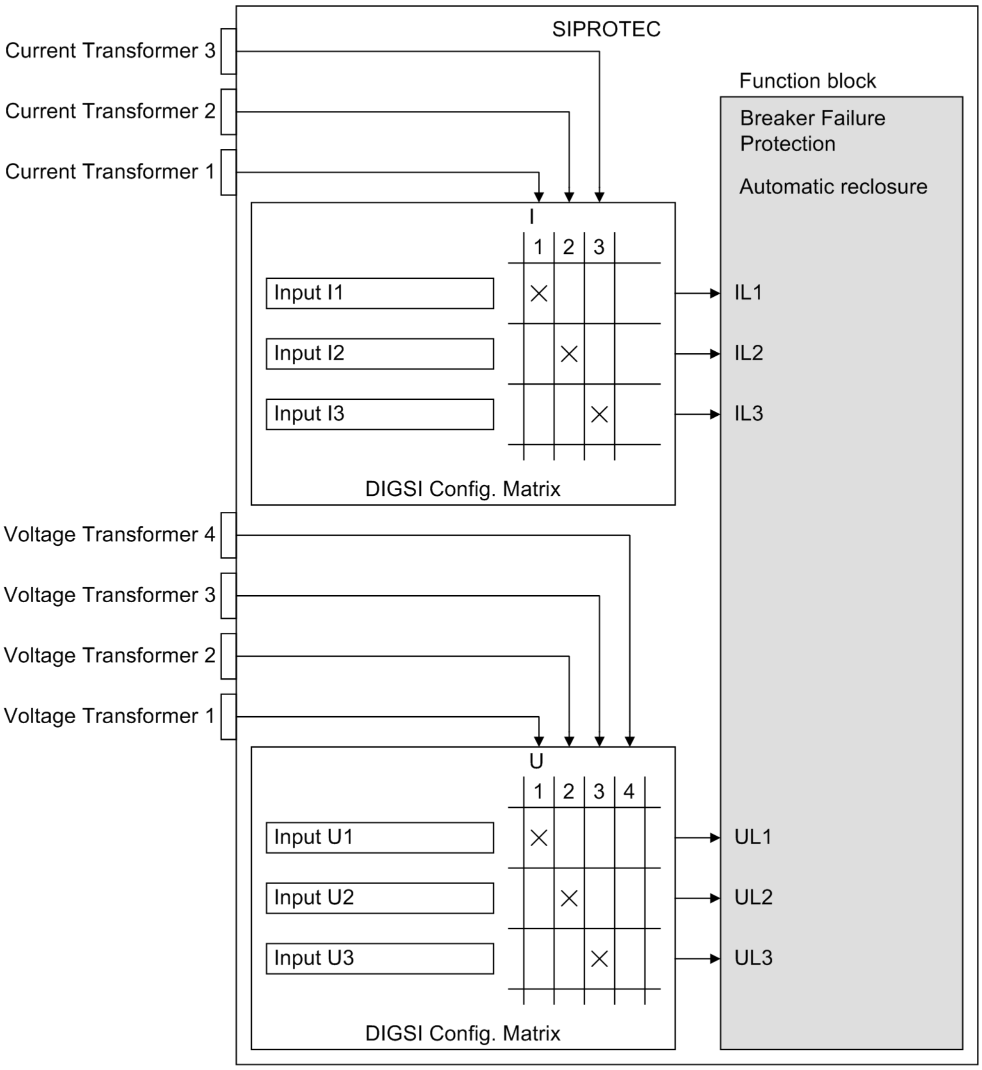


Figure A-13 Example allocation of the measuring inputs for the breaker failure protection

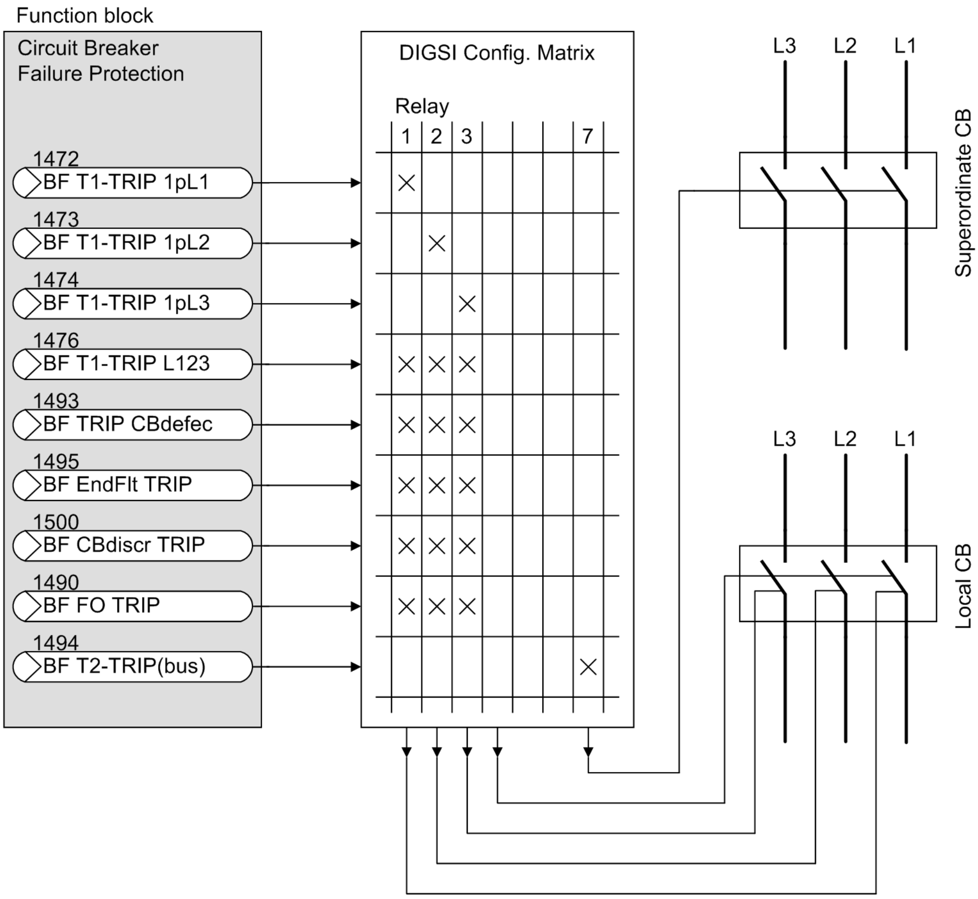


Figure A-14 Example allocation of the trip commands from breaker failure protection

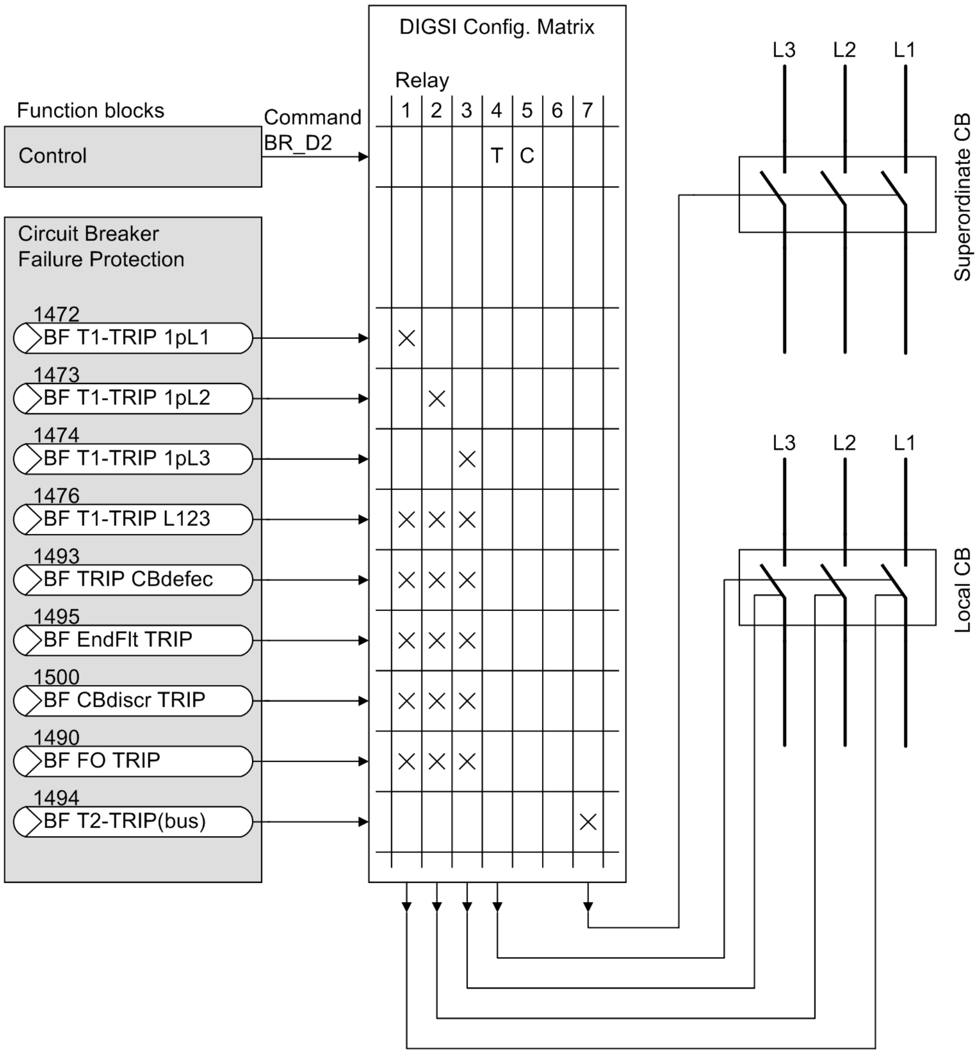


Figure A-15 Example allocation of the trip commands from breaker failure protection and control

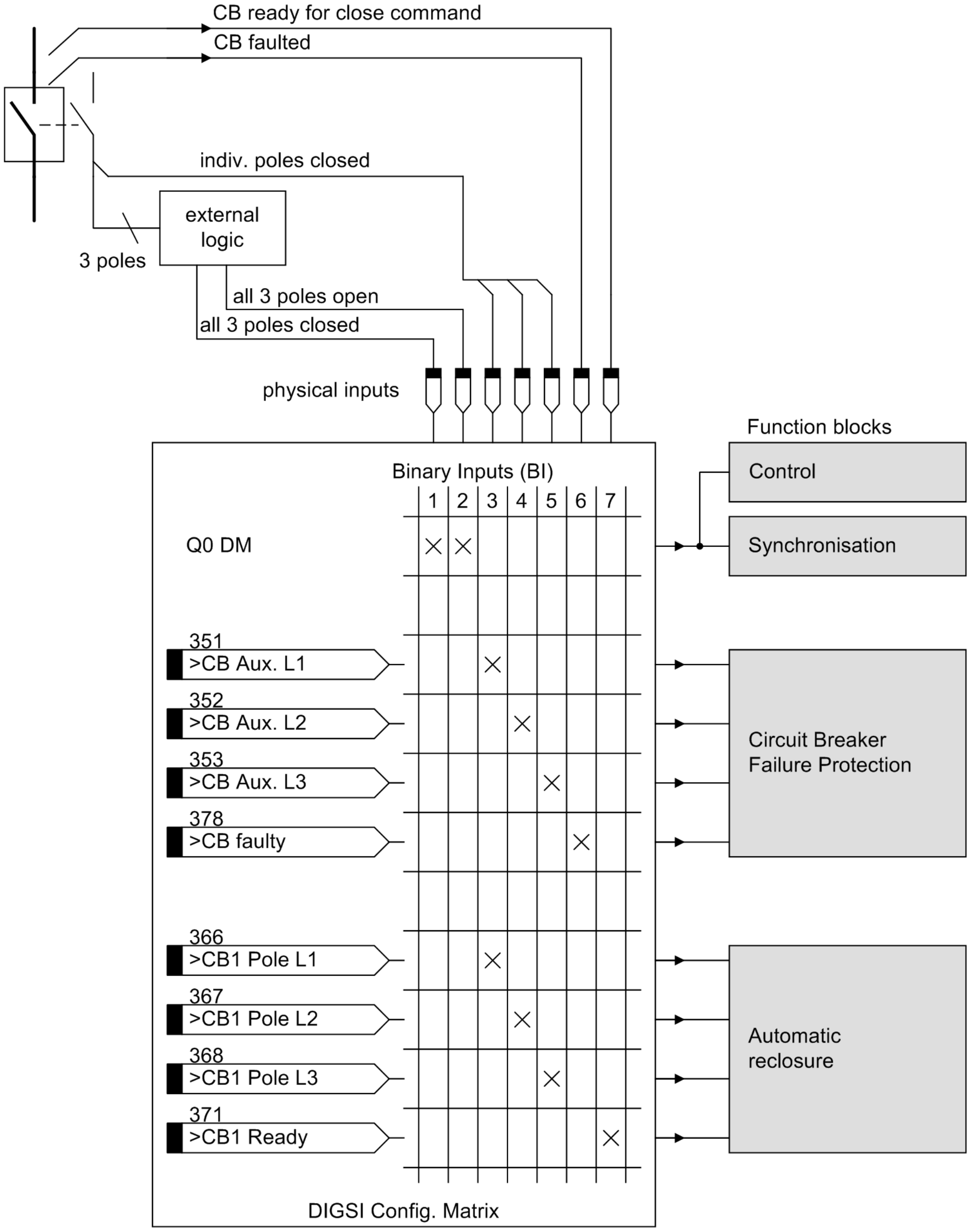


Figure A-16 Example allocation of the auxiliary contacts with identical circuit breaker for BF protection and AR and single-pole signals

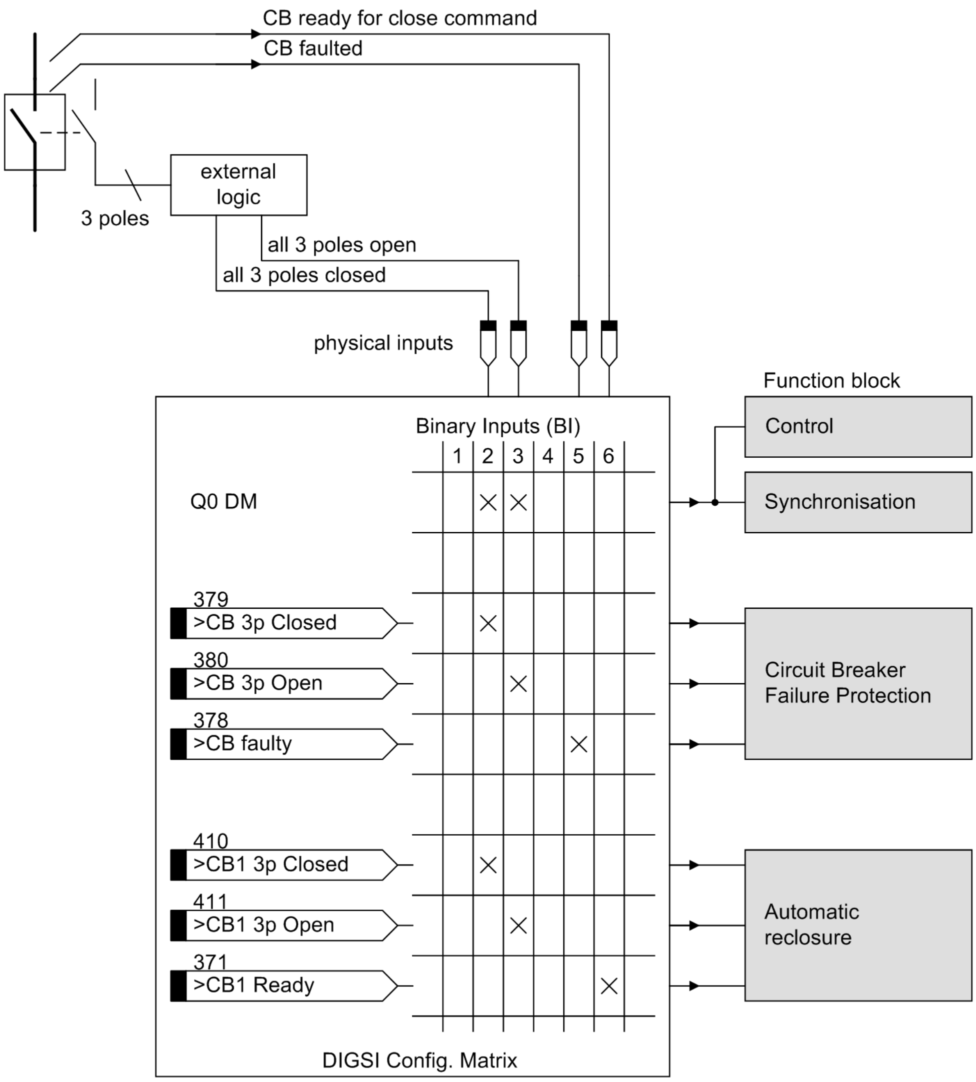


Figure A-17 Example allocation of the auxiliary contacts with identical circuit breaker for BF protection and AR and three-pole signals

A.4 Default Settings

When the device leaves the factory, a large number of LED indications, binary inputs and outputs as well as function keys are already preset. They are summarised in the following table.

A.4.1 LEDs

Table A-1 LED Indication Presettings

LEDs	Allocated Function	Function No.	Description
LED	none	-	-

A.4.2 Binary Input

Table A-2 Binary input presettings for all devices and ordering variants

Binary Input	Allocated Function	Function No.	Description
BI6	Q0		circuit breaker Q0
BI7	Q0		circuit breaker Q0
BI8	Q1		bus disconnector Q1
BI9	Q1		bus disconnector Q1
BI10	Q2		bus disconnector Q2
BI11	Q2		bus disconnector Q2
BI12	Q8		earthing isolator Q8
BI13	Q8		earthing isolator Q8
BI14	Q9		feeder disconnector Q9
BI15	Q9		feeder disconnector Q9

A.4.3 Binary Output

Table A-3 Output relay presettings for all devices and ordering variants

Binary Output	Allocated Function	Function No.	Description
BO1	Q0 OPEN	-	circuit breaker Q0 -
BO2	Q0 CLOSE	-	circuit breaker Q0 -
BO3	Q1 OPEN	-	bus disconnector Q1 -
BO4	Q1 CLOSE	-	bus disconnector Q1 -
BO6	Q0 Common contact	-	circuit breaker Q0 -
BO7	Q2 OPEN	-	bus disconnector Q2 -
BO8	Q2 CLOSE	-	bus disconnector Q2 -
BO9	Q1 Common contact	-	bus disconnector Q1 -
BO10	Q2 Common contact	-	bus disconnector Q2 -
BO11	Q8 OPEN	-	earthing isolator Q8 -
BO12	Q8 CLOSE	-	earthing isolator Q8 -
BO15	Q9 OPEN	-	feeder disconnector Q9 -
BO16	Q9 CLOSE	-	feeder disconnector Q9 -
BO19	Q8 Common contact	-	earthing isolator Q8 -
BO20	Q9 Common contact	-	feeder disconnector Q9 -

A.4.4 Function Keys

Table A-4 Applies to all devices and ordered variants

Function Keys	Allocated Function	Function No.	Description
F1	Display of operational indications	-	-
F2	Display of the primary operational measured values	-	-

A.4.5 Default Display

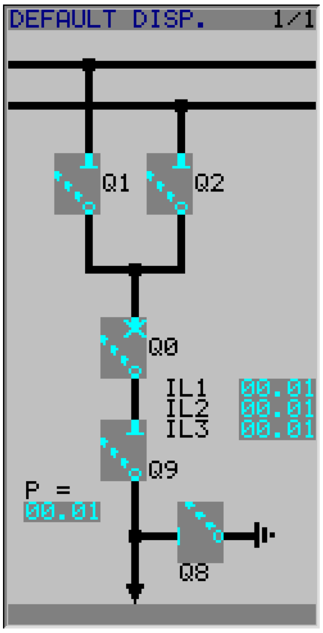


Figure A-18 Default display 6MD66x

A.4.6 Pre-defined CFC Charts

A CFC is already installed when the SIPROTEC® 4 device is delivered.

Key switches

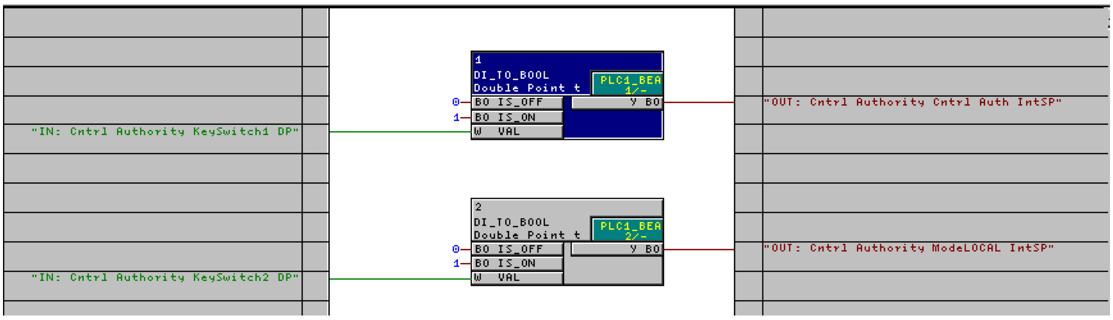


Figure A-19 CFC chart **keyswitches**

By interconnecting both DI_TO_BOOL blocks, the **Switching Authority** function of both key switches of the device is implemented.

Interlocking

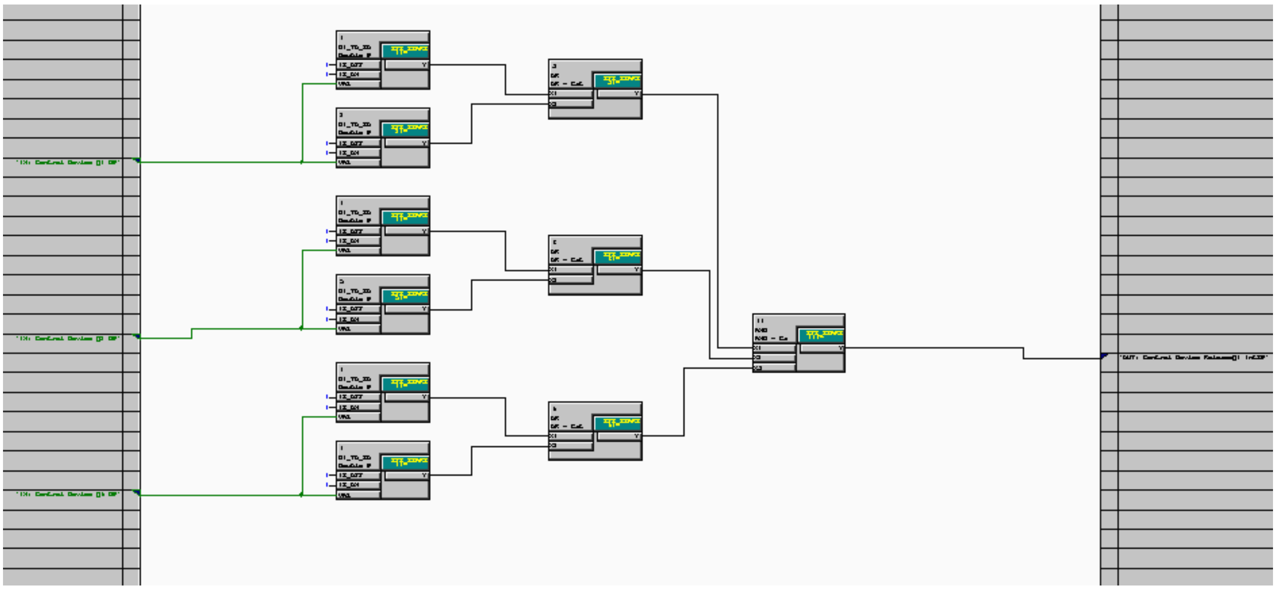


Figure A-20 CFC chart interlocking 1/2

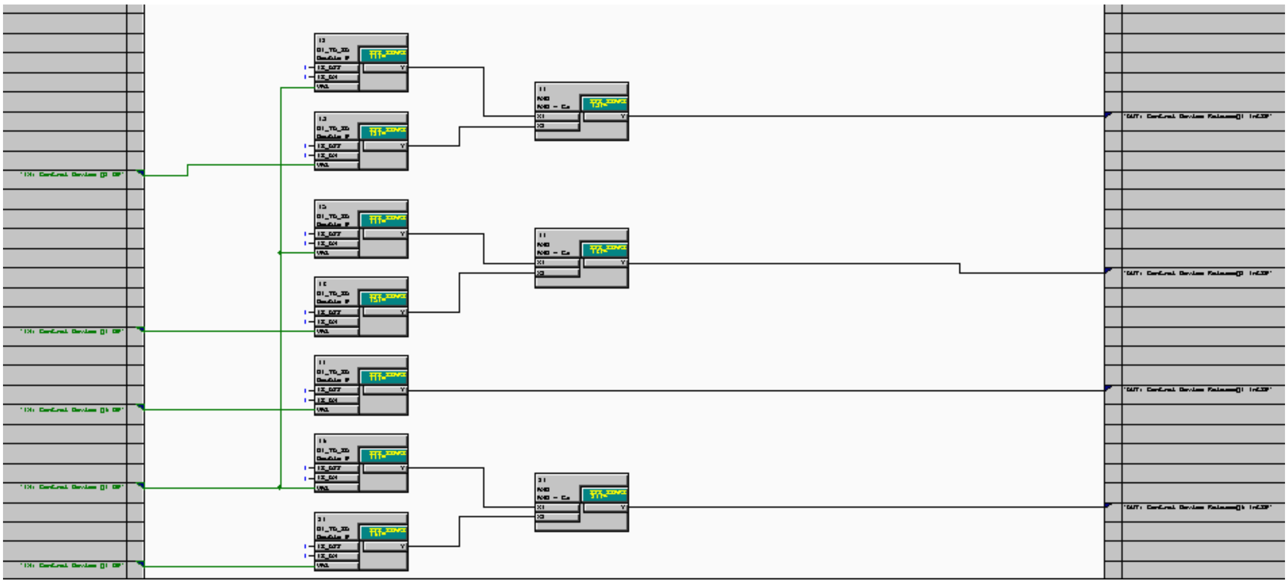


Figure A-21 CFC chart interlocking 2/2

The CFC chart starts the interlocking check which is performed when switching operations of switching elements linked on the left side are executed.

A.5 Protocol-dependent Functions

Protocol → / Function ↓	IEC 60870–5–103	IEC 61850 Ethernet (EN100) Inter-relay communication (IRC, optional)	PROFIBUS DP	PROFIBUS FMS
Operational measured values	Yes	Yes	Yes (without current message)	Yes
Metered values	Yes	Yes	Yes (without current message)	Yes
Indications	Yes	Yes (setting taggings; without time stamp)	Yes (without time stamp)	Yes
Commands	According to VDEW (no system interlocking with local control)	According to VDEW (no system interlocking with local control) Yes (setting taggings; without time stamp)	Yes (without status information)	Yes
Time synchronisation	Yes	Yes	Yes (not available with all control centres)	Yes
Commissioning aids				
Measured value indication blocking	Yes	Yes	No	Yes
Generation of test indications	Yes	Yes	Yes	Yes
Physical properties				
Transmission mode	Cyclically/Event	Cyclically/Event	Cyclically	Cyclically/Event
Baud rate	4800 to 38400	up to 100 MBaud	Up to 1.5 MBaud (optical), up to 6 MBaud (electrical)	up to 1.5 MBaud
Type	Electrical: RS485 Optical: ST connector	Ethernet TP Electrical: RS485 optical via external converter	Electrical: RS485 Optical: ST connector (double ring)	Electrical: RS485 Optical: ST connector (single or double ring)

A.6 Functional Scope

Addr.	Parameter	Setting Options	Default Setting	Comments
0	MU V_1	Disabled Enabled	Disabled	Measurement V
0	MU I_1	Disabled Enabled	Disabled	Measurement I
0	MU1P_1	Disabled Enabled	Enabled	Measurement 1phase 1.packet
0	MU1P_2	Disabled Enabled	Disabled	Measurement 1phase 2.packet
0	MU1P_3	Disabled Enabled	Disabled	Measurement 1phase 3.packet
0	MU3P_1	Disabled Enabled	Enabled	Measurement 3phase 1.packet
0	MUAron_1	Disabled Enabled	Disabled	Measurement Aron 1.packet
0	Synchronizing 1	Disabled Enabled	Disabled	Synchronizing Function 1
0	Synchronizing 2	Disabled Enabled	Disabled	Synchronizing Function 2
0	Synchronizing 3	Disabled Enabled	Disabled	Synchronizing Function 3
0	Synchronizing 4	Disabled Enabled	Disabled	Synchronizing Function 4
0	Synchronizing 5	Disabled Enabled	Disabled	Synchronizing Function 5
0	Synchronizing 6	Disabled Enabled	Disabled	Synchronizing Function 6
0	Synchronizing 7	Disabled Enabled	Disabled	Synchronizing Function 7
0	Synchronizing 8	Disabled Enabled	Disabled	Synchronizing Function 8
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
110	Trip mode	3pole only 1-/3pole	3pole only	Trip mode
133	Auto Reclose	1 AR-cycle 2 AR-cycles 3 AR-cycles 4 AR-cycles 5 AR-cycles 6 AR-cycles 7 AR-cycles 8 AR-cycles ADT Disabled	Disabled	Auto-Reclose Function
134	AR control mode	Pickup w/ Tact Pickup w/o Tact Trip w/ Tact Trip w/o Tact	Trip w/ Tact	Auto-Reclose control mode
139	BREAKER FAILURE	Disabled Enabled	Disabled	Breaker Failure Protection

A.7 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	SecVoltgNomVal	MU U_1	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MU I_1	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	SecVoltgNomVal	MU1P_1	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MU1P_1	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	SecVoltgNomVal	MU1P_2	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MU1P_2	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	SecVoltgNomVal	MU1P_3	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MU1P_3	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	SecVoltgNomVal	MU3P_1	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MU3P_1	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	SecVoltgNomVal	MUAron_1	0.00 .. 200.00 V; < > 0	100.00 V	Secondary Voltage Nominal Value
0	SecCurrNomVal	MUAron_1	0.00 .. 5.00 A; < > 0	1.00 A	Secondary Current Nominal Value
0	T-CB close	SYNC function 1	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 1	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 1	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 1	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 1	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 1	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 1	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 1	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 1	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 1	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 1	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 1	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 1	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 1	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 1	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 1	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 1	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 1	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 1	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 1	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 1	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 2	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 2	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 2	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 2	95 .. 105 %	105 %	Maximum frequency

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	SyncSD	SYNC function 2	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 2	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 2	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 2	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 2	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 2	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 2	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 2	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 2	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 2	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 2	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 2	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 2	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 2	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 2	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 2	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 2	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 3	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 3	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 3	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 3	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 3	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 3	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 3	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 3	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 3	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 3	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 3	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 3	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 3	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 3	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 3	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 3	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 3	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 3	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 3	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	f SYNCHRON	SYNC function 3	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 3	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 4	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 4	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 4	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 4	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 4	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 4	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 4	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 4	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 4	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 4	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 4	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 4	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 4	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 4	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 4	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 4	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 4	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 4	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 4	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 4	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 4	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 5	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 5	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 5	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 5	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 5	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 5	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 5	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 5	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 5	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 5	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 5	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 5	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 5	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 5	YES NO	NO	Synchronize to U1< and U2>

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	Sync.U1<U2<	SYNC function 5	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 5	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 5	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 5	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 5	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 5	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 5	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 6	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 6	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 6	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 6	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 6	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 6	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 6	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 6	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 6	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 6	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 6	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 6	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 6	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 6	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 6	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 6	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 6	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 6	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 6	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 6	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 6	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 7	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 7	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 7	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 7	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 7	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 7	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 7	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 7	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 7	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
0	Umin	SYNC function 7	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 7	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 7	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 7	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 7	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 7	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 7	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 7	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 7	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 7	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 7	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 7	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
0	T-CB close	SYNC function 8	0.01 .. 0.60 sec	0.06 sec	Closing (operating) time of CB
0	T-SYN. DURATION	SYNC function 8	1.00 .. 600.00 sec	30.00 sec	Maximum duration of synchronism-check
0	fmin	SYNC function 8	95 .. 105 %	95 %	Minimum frequency
0	fmax	SYNC function 8	95 .. 105 %	105 %	Maximum frequency
0	SyncSD	SYNC function 8	(Setting options depend on configuration)	None	synchronizable switching device
0	Balancing U1/U2	SYNC function 8	0.80 .. 1.20	1.00	Balancing Factor U1/U2
0	α Tr. U1-U2	SYNC function 8	0 .. 360 °	0 °	Angle adjustment U1-U2 (Trafo)
0	SecTransNomVal1	SYNC function 8	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 1
0	SecTransNomVal2	SYNC function 8	0.00 .. 170.00 V; < > 0	100.00 V	Secondary Transformer Nominal Value 2
0	Umin	SYNC function 8	20 .. 125 V	90 V	Minimum Voltage for Synchronization
0	Umax	SYNC function 8	20 .. 140 V	110 V	Maximum Voltage for Synchronization
0	Udead	SYNC function 8	1 .. 60 V	5 V	Voltage Treshold for Dead Line/Dead Bus
0	Sync.U1>U2<	SYNC function 8	YES NO	NO	Synchronize to U1> and U2<
0	Sync.U1<U2>	SYNC function 8	YES NO	NO	Synchronize to U1< and U2>
0	Sync.U1<U2<	SYNC function 8	YES NO	NO	Synchronize to U1< and U2<
0	UdiffSyn	SYNC function 8	0.5 .. 40.0 V	2.0 V	Maximum voltage difference, synchronous
0	fdiff	SYNC function 8	0.01 .. 2.00 Hz	0.10 Hz	Maximum frequency difference, syn.
0	αdiff	SYNC function 8	2 .. 60 °	10 °	Maximum angle difference, syn.
0	UdiffAsyn	SYNC function 8	0.5 .. 40.0 V	2.0 V	Maximum voltage differnece, asynchronous
0	f SYNCHRON	SYNC function 8	10 .. 40 mHz	10 mHz	Frequency diff. treshold Sync/Async.
0	T SYNCHRON	SYNC function 8	0.00 .. 60.00 sec	0.05 sec	Switch Delay for synchronous systems
204	Unom SECONDARY	P.System Data 1	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
214	Rated Frequency	P.System Data 1	50 Hz 60 Hz	50 Hz	Rated Frequency
240	TMin TRIP CMD	P.System Data 1	0.02 .. 30.00 sec	0.10 sec	Minimum TRIP Command Duration

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
241	TMax CLOSE CMD	P.System Data 1	0.01 .. 30.00 sec	0.10 sec	Maximum Close Command Duration
302	CHANGE	Change Group	Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group
401	T Backlight on	Device, General	1 .. 60 min	10 min	Time Backlight on
402	DIGSI backplane	Device, General	Disabled Port C Port D	Disabled	Serviceport for DIGSI
407	FltDisp.LED/LCD	Device, General	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
408	Spont. FltDisp.	Device, General	NO YES	NO	Spontaneous display of flt.annunciations
901	WAVEFORMTRIGGER	Osc. Fault Rec.	Save w. Pickup Save w. TRIP Start w. TRIP	Save w. Pickup	Waveform Capture
902	WAVEFORM DATA	Osc. Fault Rec.	Fault event Pow.Sys.Flt.	Fault event	Scope of Waveform Data
903	MAX. LENGTH	Osc. Fault Rec.	0.30 .. 5.00 sec	2.00 sec	Max. length of a Waveform Capture Record
904	PRE. TRIG. TIME	Osc. Fault Rec.	0.05 .. 0.50 sec	0.25 sec	Captured Waveform Prior to Trigger
905	POST REC. TIME	Osc. Fault Rec.	0.05 .. 0.50 sec	0.10 sec	Captured Waveform after Event
906	BinIn CAPT.TIME	Osc. Fault Rec.	0.10 .. 5.00 sec; ∞	0.50 sec	Capture Time via Binary Input
1130A	PoleOpenCurrent	P.System Data 2	0.05 .. 1.00 A	0.10 A	Pole Open Current Threshold
1135	Reset Trip CMD	P.System Data 2	CurrentOpenPole Current AND CB	CurrentOpenPole	RESET of Trip Command
1150A	SI Time Man.Cl	P.System Data 2	0.01 .. 30.00 sec	0.30 sec	Seal-in Time after MANUAL closures
2915	V-Supervision	Measurem.Superv	w/ CURR.SUP w/ I> & CBaux OFF	w/ CURR.SUP	Voltage Failure Supervision
2916A	T V-Supervision	Measurem.Superv	0.00 .. 30.00 sec	3.00 sec	Delay Voltage Failure Supervision
2917	U<max (3ph)	Measurem.Superv	2 .. 100 V	5 V	Maximum Voltage Threshold U< (3phase)
3401	AUTO RECLOSE	Autoreclosure	OFF ON	OFF	Auto-Reclose Function
3402	CB? 1.TRIP	Autoreclosure	YES NO	NO	CB ready interrogation at 1st trip
3403	T-RECLAIM	Autoreclosure	0.50 .. 300.00 sec	3.00 sec	Reclaim time after successful AR cycle
3404	T-BLOCK MC	Autoreclosure	0.50 .. 300.00 sec; 0	1.00 sec	AR blocking duration after manual close
3406	EV. FLT. RECOG.	Autoreclosure	with PICKUP with TRIP	with TRIP	Evolving fault recognition
3407	EV. FLT. MODE	Autoreclosure	blocks AR starts 3p AR is ignored	starts 3p AR	Evolving fault (during the dead time)
3408	T-Start MONITOR	Autoreclosure	0.01 .. 300.00 sec	0.20 sec	AR start-signal monitoring time
3409	CB TIME OUT	Autoreclosure	0.01 .. 300.00 sec	3.00 sec	Circuit Breaker (CB) Supervision Time
3410	T RemoteClose	Autoreclosure	0.00 .. 300.00 sec; ∞	∞ sec	Send delay for remote close command
3411A	T-DEAD EXT.	Autoreclosure	0.50 .. 300.00 sec; ∞	10.00 sec	Maximum dead time extension
3413	Cmd.via control	Autoreclosure	(Setting options depend on configuration)	None	Close command via control device
3414	Internal SYNC	Autoreclosure	(Setting options depend on configuration)	None	Internal synchronisation
3420	AR w/ DIST.	Autoreclosure	YES NO	YES	AR with distance protection
3421	AR w/ SOTF-O/C	Autoreclosure	YES NO	YES	AR with switch-onto-fault overcurrent

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
3422	AR w/ W/I	Autoreclosure	YES NO	YES	AR with weak infeed tripping
3423	AR w/ EF-O/C	Autoreclosure	YES NO	YES	AR with earth fault overcurrent prot.
3424	AR w/ DTT	Autoreclosure	YES NO	YES	AR with direct transfer trip
3425	AR w/ BackUpO/C	Autoreclosure	YES NO	YES	AR with back-up overcurrent
3430	AR TRIP 3pole	Autoreclosure Autoreclosure	YES NO	YES	3pole TRIP by AR
3431	DLC or RDT	Autoreclosure	WITHOUT RDT DLC	WITHOUT	Dead Line Check or Reduced Dead Time
3432	ADT Op. mode	Autoreclosure	w/ VoltageCheck w/ RemoteClose	w/ VoltageCheck	Operating mode for Adaptive Dead Time
3433	T-ACTION ADT	Autoreclosure	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3434	T-MAX ADT	Autoreclosure	0.50 .. 3000.00 sec	5.00 sec	Maximum dead time
3435	ADT 1p allowed	Autoreclosure	YES NO	NO	1pole TRIP allowed
3436	ADT CB? CLOSE	Autoreclosure	YES NO	NO	CB ready interrogation before re-closing
3437	ADT SynRequest	Autoreclosure	YES NO	NO	Request for synchro-check after 3pole AR
3438	T U-stable	Autoreclosure Autoreclosure	0.10 .. 30.00 sec	0.10 sec	Supervision time for dead/ live voltage
3440	U-live>	Autoreclosure Autoreclosure	30 .. 90 V	48 V	Voltage threshold for live line or bus
3441	U-dead<	Autoreclosure Autoreclosure	2 .. 70 V	30 V	Voltage threshold for dead line or bus
3450	1.AR: START	Autoreclosure	YES NO	YES	Start of AR allowed in this cycle
3451	1.AR: T-ACTION	Autoreclosure	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3453	1.AR Tdead 1Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3454	1.AR Tdead 2Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3455	1.AR Tdead 3Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3456	1.AR Tdead1Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1pole trip
3457	1.AR Tdead3Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3458	1.AR: Tdead EV.	Autoreclosure	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3459	1.AR: CB? CLOSE	Autoreclosure	YES NO	NO	CB ready interrogation before re-closing
3460	1.AR SynRequest	Autoreclosure	YES NO	NO	Request for synchro-check after 3pole AR
3461	2.AR: START	Autoreclosure	YES NO	NO	AR start allowed in this cycle
3462	2.AR: T-ACTION	Autoreclosure	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3464	2.AR Tdead 1Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3465	2.AR Tdead 2Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3466	2.AR Tdead 3Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3467	2.AR Tdead1Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip
3468	2.AR Tdead3Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3469	2.AR: Tdead EV.	Autoreclosure	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3470	2.AR: CB? CLOSE	Autoreclosure	YES NO	NO	CB ready interrogation before re-closing
3471	2.AR SynRequest	Autoreclosure	YES NO	NO	Request for synchro-check after 3pole AR
3472	3.AR: START	Autoreclosure	YES NO	NO	AR start allowed in this cycle
3473	3.AR: T-ACTION	Autoreclosure	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3475	3.AR Tdead 1Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3476	3.AR Tdead 2Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3477	3.AR Tdead 3Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
3478	3.AR Tdead1Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip
3479	3.AR Tdead3Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3480	3.AR: Tdead EV.	Autoreclosure	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3481	3.AR: CB? CLOSE	Autoreclosure	YES NO	NO	CB ready interrogation before re-closing
3482	3.AR SynRequest	Autoreclosure	YES NO	NO	Request for synchro-check after 3pole AR
3483	4.AR: START	Autoreclosure	YES NO	NO	AR start allowed in this cycle
3484	4.AR: T-ACTION	Autoreclosure	0.01 .. 300.00 sec; ∞	0.20 sec	Action time
3486	4.AR Tdead 1Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 1phase faults
3487	4.AR Tdead 2Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	1.20 sec	Dead time after 2phase faults
3488	4.AR Tdead 3Flt	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3phase faults
3489	4.AR Tdead1Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	∞ sec	Dead time after 1pole trip
3490	4.AR Tdead3Trip	Autoreclosure	0.01 .. 1800.00 sec; ∞	0.50 sec	Dead time after 3pole trip
3491	4.AR: Tdead EV.	Autoreclosure	0.01 .. 1800.00 sec	1.20 sec	Dead time after evolving fault
3492	4.AR: CB? CLOSE	Autoreclosure	YES NO	NO	CB ready interrogation before re-closing
3493	4.AR SynRequest	Autoreclosure	YES NO	NO	Request for synchro-check after 3pole AR
3901	FCT BreakerFail	Breaker Failure	ON OFF	OFF	Breaker Failure Protection is
3902	I> BF	Breaker Failure	0.05 .. 1.20 A	0.10 A	Pick-up threshold I>
3903	1p-RETRIP (T1)	Breaker Failure	NO YES	YES	1pole retrip with stage T1 (local trip)
3904	T1-1pole	Breaker Failure	0.00 .. 30.00 sec; ∞	0.00 sec	T1, Delay after 1pole start (local trip)
3905	T1-3pole	Breaker Failure	0.00 .. 30.00 sec; ∞	0.00 sec	T1, Delay after 3pole start (local trip)
3906	T2	Breaker Failure	0.00 .. 30.00 sec; ∞	0.15 sec	T2, Delay of 2nd stage (busbar trip)
3907	T3-BkrDefective	Breaker Failure	0.00 .. 30.00 sec; ∞	0.00 sec	T3, Delay for start with defective bkr.
3908	Trip BkrDefect.	Breaker Failure	NO with T1-trip with T2-trip w/ T1/T2-trip	NO	Trip output selection with defective bkr
3909	Chk BRK CONTACT	Breaker Failure	NO YES	YES	Check Breaker contacts
3911	Plausib. check	Breaker Failure	YES NO	YES	plausibility check transformer masking
3912	3I0> BF	Breaker Failure	0.05 .. 1.20 A	0.10 A	Pick-up threshold 3I0>
3921	End Flt. stage	Breaker Failure	ON OFF	OFF	End fault stage is
3922	T-EndFault	Breaker Failure	0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay of end fault stage
3931	PoleDiscrepancy	Breaker Failure	ON OFF	OFF	Pole Discrepancy supervision
3932	T-PoleDiscrep.	Breaker Failure	0.00 .. 30.00 sec; ∞	2.00 sec	Trip delay with pole discrepancy
3940	FO Protection	Breaker Failure	ON OFF	OFF	Flash Over Protection

A.8 Information List

Indications for IEC 60 870-5-103 are always reported ON / OFF if they are subject to general interrogation for IEC 60 870-5-103. If not, they are reported only as ON.

New user-defined indications or such newly allocated to IEC 60 870-5-103 are set to ON / OFF and subjected to general interrogation if the information type is not a spontaneous event („.._Ev“). Further information on messages can be found in detail in the SIPROTEC® 4 System Description, Order No. E50417-H1100-C151.

In columns „Event Log“, „Trip Log“ and „Ground Fault Log“ the following applies:

UPPER CASE NOTATION “ON/OFF”: definitely set, not allocatable

lower case notation “on/off”: preset, allocatable

*: not preset, allocatable

<blank>: neither preset nor allocatable

In column „Marked in Oscill.Record“ the following applies:

UPPER CASE NOTATION “M”: definitely set, not allocatable

lower case notation “m”: preset, allocatable

*: not preset, allocatable

<blank>: neither preset nor allocatable

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
-	Disturbance CFC (Distur.CFC)	Device, General	OUT	on off				LED			BO					
-	Reset LED (Reset LED)	Device, General	IntSP	on				LED			BO		106	19	1	No
-	>Back Light on (>Light on)	Device, General	SP	on off				LED	BI		BO					
-	Stop data transmission (DataStop)	Device, General	IntSP	on off				LED			BO		240	20	1	Yes
-	Test mode (Test mode)	Device, General	IntSP	on off				LED			BO		106	21	1	Yes
-	Hardware Test Mode (HWTestMod)	Device, General	IntSP	on off				LED			BO					
-	Clock Synchronization (SynchClock)	Device, General	IntSP_Ev	*				LED			BO					
-	Error FMS FO 1 (Error FMS1)	Device, General	OUT	on off				LED			BO					
-	Error FMS FO 2 (Error FMS2)	Device, General	OUT	on off				LED			BO					
-	Group A (Group A)	Change Group	IntSP	ON OFF	*		*	LED			BO		106	23	1	Yes
-	Group B (Group B)	Change Group	IntSP	ON OFF	*		*	LED			BO		106	24	1	Yes
-	Group C (Group C)	Change Group	IntSP	ON OFF	*		*	LED			BO		106	25	1	Yes
-	Group D (Group D)	Change Group	IntSP	ON OFF	*		*	LED			BO		106	26	1	Yes

No.	Description	Function	Type of In-for-mation	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
-	Fault Recording Start (FltRecSta)	Osc. Fault Rec.	IntSP	ON OFF	*		m	LED			BO					
-	Key Switch 1 (Local/Remote) (KeySwitch1)	Cntrl Authority	DP	on off				LED								
-	Control Authority (Cntrl Auth)	Cntrl Authority	IntSP	ON OFF				LED					101	85	1	Yes
-	Key Switch 2 (Interlocking OFF/ON) (KeySwitch2)	Cntrl Authority	DP	on off				LED								
-	Controlmode LOCAL (ModeLO-CAL)	Cntrl Authority	IntSP	ON OFF				LED					101	86	1	Yes
-	Controlmode REMOTE (ModeR-EMOTE)	Cntrl Authority	IntSP	ON OFF				LED								
-	circuit breaker Q0 (Q0)	Control Device	CF_D 2	on off							BO		240	160	20	
-	circuit breaker Q0 (Q0)	Control Device	DP	on off					BI			CB	240	160	1	Yes
-	bus disconnector Q1 (Q1)	Control Device	CF_D 2	on off							BO		240	161	20	
-	bus disconnector Q1 (Q1)	Control Device	DP	on off					BI			CB	240	161	1	Yes
-	bus disconnector Q2 (Q2)	Control Device	CF_D 2	on off							BO		240	162	20	
-	bus disconnector Q2 (Q2)	Control Device	DP	on off					BI			CB	240	162	1	Yes
-	earthing isolator Q8 (Q8)	Control Device	CF_D 2	on off							BO		240	164	20	
-	earthing isolator Q8 (Q8)	Control Device	DP	on off					BI			CB	240	164	1	Yes
-	feeder disconnector Q9 (Q9)	Control Device	CF_D 2	on off							BO		240	163	20	
-	feeder disconnector Q9 (Q9)	Control Device	DP	on off					BI			CB	240	163	1	Yes
-	Release circuit breaker Q0 (ReleaseQ0)	Control Device	IntSP	on off				LED			BO					
-	Release bus disconnector Q1 (ReleaseQ1)	Control Device	IntSP	on off				LED			BO					
-	Release bus disconnector Q2 (ReleaseQ2)	Control Device	IntSP	on off				LED			BO					
-	Release earthing isolator Q8 (ReleaseQ8)	Control Device	IntSP	on off				LED			BO					
-	Release feeder disconnector Q9 (ReleaseQ9)	Control Device	IntSP	on off				LED			BO					
-	Threshold Value 1 (ThreshVal1)	Thresh.-Switch	IntSP	on off				LED	BI	FC TN	BO	CB				
-	Error Systeminterface (SysIn-tErr.)	Protocol	IntSP	on off				LED			BO					
1	No Function configured (Not con-figured)	Device, General	OUT													
2	Function Not Available (Non Exis-tent)	Device, General	OUT													
3	>Synchronize Internal Real Time Clock (>Time Synch)	Device, General	SP_E v	*				LED	BI	FC TN	BO		135	48	1	No
4	>Trigger Waveform Capture (>Trig.Wave.Cap.)	Osc. Fault Rec.	SP	on	*		m	LED	BI		BO					
5	>Reset LED (>Reset LED)	Device, General	OUT													

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
7	>Setting Group Select Bit 0 (>Set Group Bit0)	Change Group	SP	*	*		*	LED	BI		BO					
8	>Setting Group Select Bit 1 (>Set Group Bit1)	Change Group	SP	*	*		*	LED	BI		BO					
009.0100	Failure EN100 Modul (Failure Modul)	EN100-Modul 1	IntSP	on off			*	LED			BO					
009.0101	Failure EN100 Link Channel 1 (Ch1) (Fail Ch1)	EN100-Modul 1	IntSP	on off			*	LED			BO					
009.0102	Failure EN100 Link Channel 2 (Ch2) (Fail Ch2)	EN100-Modul 1	IntSP	on off			*	LED			BO					
15	>Test mode (>Test mode)	Device, General	OUT													
16	>Stop data transmission (>DataStop)	Device, General	SP	*			*	LED	BI		BO		135	54	1	Yes
51	Device is Operational and Protecting (Device OK)	Device, General	OUT	on off				LED			BO		135	81	1	Yes
52	At Least 1 Protection Funct. is Active (ProtActive)	Device, General	IntSP	on off				LED			BO		106	18	1	Yes
55	Reset Device (Reset Device)	Device, General	OUT	on				LED			BO					
56	Initial Start of Device (Initial Start)	Device, General	OUT	on				LED			BO		106	5	1	No
67	Resume (Resume)	Device, General	OUT	on				LED			BO					
68	Clock Synchronization Error (Clock SyncError)	Device, General	IntSP	on off				LED			BO					
69	Daylight Saving Time (DayLightSavTime)	Device, General	OUT	on off				LED			BO					
70	Setting calculation is running (Settings Calc.)	Device, General	OUT	on off				LED			BO		106	22	1	Yes
71	Settings Check (Settings Check)	Device, General	OUT	*				LED			BO					
72	Level-2 change (Level-2 change)	Device, General	OUT	on off				LED			BO					
73	Local setting change (Local change)	Device, General	OUT	*				LED			BO					
110	Event lost (Event Lost)	Device, General	OUT_Ev	*			*	LED			BO		135	130	1	No
113	Flag Lost (Flag Lost)	Device, General	OUT													
125	Chatter ON (Chatter ON)	Device, General	OUT	on off				LED			BO		135	145	1	Yes
126	Protection ON/OFF (via system port) (ProtON/OFF)	Device, General	IntSP	ON OFF	*		*	LED			BO					
127	Auto Reclose ON/OFF (via system port) (AR ON/OFF)	Device, General	IntSP	ON OFF	*		*	LED			BO					
147	Error Power Supply (Error PwrSupply)	Device, General	OUT	on off				LED			BO					
168	Failure: Voltage absent (Fail U absent)	Measurem.Superv	OUT	ON OFF	*		*	LED			BO		135	187	1	Yes
170.0001	>Sync1 effective (>Sy1 eff.)	SYNC function 1	SP	on off				LED	BI		BO					
170.0001	>Sync2 effective (>Sy2 eff.)	SYNC function 2	SP	on off				LED	BI		BO					
170.0001	>Sync3 effective (>Sy3 eff.)	SYNC function 3	SP	on off				LED	BI		BO					
170.0001	>Sync4 effective (>Sy4 eff.)	SYNC function 4	SP	on off				LED	BI		BO					
170.0001	>Sync5 effective (>Sy5 eff.)	SYNC function 5	SP	on off				LED	BI		BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.0001	>Sync6 effective (>Sy6 eff.)	SYNC function 6	SP	on off				LED	BI		BO					
170.0001	>Sync7 effective (>Sy7 eff.)	SYNC function 7	SP	on off				LED	BI		BO					
170.0001	>Sync8 effective (>Sy8 eff.)	SYNC function 8	SP	on off				LED	BI		BO					
170.0041	>Sync1 block (>Sy1 block)	SYNC function 1	SP	on off				LED	BI		BO					
170.0041	>Sync2 block (>Sy2 block)	SYNC function 2	SP	on off				LED	BI		BO					
170.0041	>Sync3 block (>Sy3 block)	SYNC function 3	SP	on off				LED	BI		BO					
170.0041	>Sync4 block (>Sy4 block)	SYNC function 4	SP	on off				LED	BI		BO					
170.0041	>Sync5 block (>Sy5 block)	SYNC function 5	SP	on off				LED	BI		BO					
170.0041	>Sync6 block (>Sy6 block)	SYNC function 6	SP	on off				LED	BI		BO					
170.0041	>Sync7 block (>Sy7 block)	SYNC function 7	SP	on off				LED	BI		BO					
170.0041	>Sync8 block (>Sy8 block)	SYNC function 8	SP	on off				LED	BI		BO					
170.0042	>Sync1 direct Command Output (>Sy1 dirCO)	SYNC function 1	SP	on off				LED	BI		BO					
170.0042	>Sync2 direct Command Output (>Sy2 dirCO)	SYNC function 2	SP	on off				LED	BI		BO					
170.0042	>Sync3 direct Command Output (>Sy3 dirCO)	SYNC function 3	SP	on off				LED	BI		BO					
170.0042	>Sync4 direct Command Output (>Sy4 dirCO)	SYNC function 4	SP	on off				LED	BI		BO					
170.0042	>Sync5 direct Command Output (>Sy5 dirCO)	SYNC function 5	SP	on off				LED	BI		BO					
170.0042	>Sync6 direct Command Output (>Sy6 dirCO)	SYNC function 6	SP	on off				LED	BI		BO					
170.0042	>Sync7 direct Command Output (>Sy7 dirCO)	SYNC function 7	SP	on off				LED	BI		BO					
170.0042	>Sync8 direct Command Output (>Sy8 dirCO)	SYNC function 8	SP	on off				LED	BI		BO					
170.0043	>Sync1 Measuement only (>Sy1 Meas)	SYNC function 1	SP	on off				LED	BI		BO					
170.0043	>Sync2 Measurement only (>Sy2 Meas)	SYNC function 2	SP	on off				LED	BI		BO					
170.0043	>Sync3 Measurement only (>Sy3 Meas)	SYNC function 3	SP	on off				LED	BI		BO					
170.0043	>Sync4 Measurement only (>Sy4 Meas)	SYNC function 4	SP	on off				LED	BI		BO					
170.0043	>Sync5 Measurement Only (>Sy5 Meas)	SYNC function 5	SP	on off				LED	BI		BO					
170.0043	>Sync6 Measurement only (>Sy6 Meas)	SYNC function 6	SP	on off				LED	BI		BO					
170.0043	>Sync7 Measurement only (>Sy7 Meas)	SYNC function 7	SP	on off				LED	BI		BO					
170.0043	>Sync8 Measurement only (>Sy8 Meas)	SYNC function 8	SP	on off				LED	BI		BO					
170.0044	>Sync1 switch to U1> and U2< (>Sy1U1>U2<)	SYNC function 1	SP	on off				LED	BI		BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.0044	>Sync2 switch to U1> and U2< (>Sy2U1>U2<)	SYNC function 2	SP	on off				LED	BI		BO					
170.0044	>Sync3 switch to U1> and U2< (>Sy3U1>U2<)	SYNC function 3	SP	on off				LED	BI		BO					
170.0044	>Sync4 switch to U1> and U2< (>Sy4U1>U2<)	SYNC function 4	SP	on off				LED	BI		BO					
170.0044	>Sync5 switch to U1> and U2< (>Sy5U1>U2<)	SYNC function 5	SP	on off				LED	BI		BO					
170.0044	>Sync6 switch to U1> and U2< (>Sy6U1>U2<)	SYNC function 6	SP	on off				LED	BI		BO					
170.0044	>Sync7 switch to U1> and U2< (>Sy7U1>U2<)	SYNC function 7	SP	on off				LED	BI		BO					
170.0044	>Sync8 switch to U1> and U2< (>Sy8U1>U2<)	SYNC function 8	SP	on off				LED	BI		BO					
170.0045	>Sync1 switch to U1< and U2> (>Sy1U1<U2>)	SYNC function 1	SP	on off				LED	BI		BO					
170.0045	>Sync2 switch to U1< and U2> (>Sy2U1<U2>)	SYNC function 2	SP	on off				LED	BI		BO					
170.0045	>Sync3 switch to U1< and U2> (>Sy3U1<U2>)	SYNC function 3	SP	on off				LED	BI		BO					
170.0045	>Sync4 switch to U1< and U2> (>Sy4U1<U2>)	SYNC function 4	SP	on off				LED	BI		BO					
170.0045	>Sync5 switch to U1< and U2> (>Sy5U1<U2>)	SYNC function 5	SP	on off				LED	BI		BO					
170.0045	>Sync6 switch to U1< and U2> (>Sy6U1<U2>)	SYNC function 6	SP	on off				LED	BI		BO					
170.0045	>Sync7 switch to U1< and U2> (>Sy7U1<U2>)	SYNC function 7	SP	on off				LED	BI		BO					
170.0045	>Sync8 switch to U1< and U2> (>Sy8U1<U2>)	SYNC function 8	SP	on off				LED	BI		BO					
170.0046	>Sync1 switch to U1< and U2< (>Sy1U1<U2<)	SYNC function 1	SP	on off				LED	BI		BO					
170.0046	>Sync2 switch to U1< and U2< (>Sy2U1<U2<)	SYNC function 2	SP	on off				LED	BI		BO					
170.0046	>Sync3 switch to U1< and U2< (>Sy3U1<U2<)	SYNC function 3	SP	on off				LED	BI		BO					
170.0046	>Sync4 switch to U1< and U2< (>Sy4U1<U2<)	SYNC function 4	SP	on off				LED	BI		BO					
170.0046	>Sync5 switch to U1< and U2< (>Sy5U1<U2<)	SYNC function 5	SP	on off				LED	BI		BO					
170.0046	>Sync6 switch to U1< and U2< (>Sy6U1<U2<)	SYNC function 6	SP	on off				LED	BI		BO					
170.0046	>Sync7 switch to U1< and U2< (>Sy7U1<U2<)	SYNC function 7	SP	on off				LED	BI		BO					
170.0046	>Sync8 switch to U1< and U2< (>Sy8U1<U2<)	SYNC function 8	SP	on off				LED	BI		BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 1	OUT	on off				LED			BO		41	201	1	Yes
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 2	OUT	on off				LED			BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 3	OUT	on off				LED			BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 4	OUT	on off				LED			BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 5	OUT	on off				LED			BO					

No.	Description	Function	Type of In-for-mation	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 6	OUT	on off				LED			BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 7	OUT	on off				LED			BO					
170.0049	Sync. Release of CLOSE Command (Sync. CloseRel)	SYNC function 8	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 1	OUT	on off				LED			BO		41	202	1	Yes
170.0050	Synchronization Error (Sync. Error)	SYNC function 2	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 3	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 4	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 5	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 6	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 7	OUT	on off				LED			BO					
170.0050	Synchronization Error (Sync. Error)	SYNC function 8	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 1	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 2	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 3	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 4	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 5	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 6	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 7	OUT	on off				LED			BO					
170.0051	Sync. blocked (Sync. block)	SYNC function 8	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 1	OUT	on off				LED			BO		41	205	1	Yes
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 2	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 3	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 4	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 5	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 6	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 7	OUT	on off				LED			BO					
170.0052	Sync. Monitoring Time exceeded (Sync.MonTimeExc)	SYNC function 8	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 1	OUT	on off				LED			BO		41	206	1	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 2	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 3	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 4	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 5	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 6	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 7	OUT	on off				LED			BO					
170.0053	Sync. Synchron (Sync. synchron)	SYNC function 8	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 1	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 2	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 3	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 4	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 5	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 6	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 7	OUT	on off				LED			BO					
170.0054	Sync. Condition U1> U2< fulfilled (Sync. U1> U2<)	SYNC function 8	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 1	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 2	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 3	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 4	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 5	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 6	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 7	OUT	on off				LED			BO					
170.0055	Sync. Condition U1< U2> fulfilled (Sync. U1< U2>)	SYNC function 8	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 1	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 2	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 3	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 4	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 5	OUT	on off				LED			BO					

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log On/Off	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 6	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 7	OUT	on off				LED			BO					
170.0056	Sync. Condition U1< U2< fulfilled (Sync. U1< U2<)	SYNC function 8	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 1	OUT	on off				LED			BO		41	207	1	Yes
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 2	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 3	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 4	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 5	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 6	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 7	OUT	on off				LED			BO					
170.0057	Sync. Voltage difference exceeded (Sync. Vdiff>)	SYNC function 8	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 1	OUT	on off				LED			BO		41	208	1	Yes
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 2	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 3	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 4	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 5	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 6	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 7	OUT	on off				LED			BO					
170.0058	Sync. frequency difference exceeded (Sync. fdiff>)	SYNC function 8	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 1	OUT	on off				LED			BO		41	209	1	Yes
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 2	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 3	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 4	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 5	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 6	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 7	OUT	on off				LED			BO					
170.0059	Sync.angle difference exceeded (Sync. α diff>)	SYNC function 8	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 1	OUT	on off				LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 2	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 3	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 4	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 5	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 6	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 7	OUT	on off				LED			BO					
170.0060	Sync. frequency f1 too high (Sync. f1>>)	SYNC function 8	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 1	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 2	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 3	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 4	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 5	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 6	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 7	OUT	on off				LED			BO					
170.0061	Sync. frequency f1 too low (Sync. f1<<)	SYNC function 8	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 1	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 2	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 3	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 4	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 5	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 6	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 7	OUT	on off				LED			BO					
170.0062	Sync. frequency f2 too high (Sync. f2>>)	SYNC function 8	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 1	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 2	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 3	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 4	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 5	OUT	on off				LED			BO					

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log On/Off	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 6	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 7	OUT	on off				LED			BO					
170.0063	Sync. frequency f2 too low (Sync. f2<<)	SYNC function 8	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 1	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 2	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 3	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 4	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 5	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 6	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 7	OUT	on off				LED			BO					
170.0064	Sync. voltage U1 too high (Sync. U1>>)	SYNC function 8	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 1	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 2	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 3	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 4	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 5	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 6	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 7	OUT	on off				LED			BO					
170.0065	Sync. voltage U1 too low (Sync. U1<<)	SYNC function 8	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 1	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 2	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 3	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 4	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 5	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 6	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 7	OUT	on off				LED			BO					
170.0066	Sync. voltage U2 too high (Sync. U2>>)	SYNC function 8	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 1	OUT	on off				LED			BO					

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Log Buffers: Trip (Fault) Log On/Off	Log Buffers: Ground Fault Log ON/OFF	Log Buffers: Marked in Oscill. Record	Configurable in Matrix: LED	Configurable in Matrix: Binary Input	Configurable in Matrix: Function Key	Configurable in Matrix: Relay	Configurable in Matrix: Chatter Suppression	IEC 60870-5-103: Type	IEC 60870-5-103: Information Number	IEC 60870-5-103: Data Unit	IEC 60870-5-103: General Interrogation
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 2	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 3	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 4	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 5	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 6	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 7	OUT	on off				LED			BO					
170.0067	Sync. voltage U2 too low (Sync. U2<<)	SYNC function 8	OUT	on off				LED			BO					
170.2102	>Sync1 release blocking (>Sy1 rlblk)	SYNC function 1	SP	on off				LED	BI		BO					
170.2102	>Sync2 release blocking (>Sy2 rlblk)	SYNC function 2	SP	on off				LED	BI		BO					
170.2102	>Sync3 release blocking (>Sy3 rlblk)	SYNC function 3	SP	on off				LED	BI		BO					
170.2102	>Sync4 release blocking (>Sy4 rlblk)	SYNC function 4	SP	on off				LED	BI		BO					
170.2102	>Sync5 release blocking (>Sy5 rlblk)	SYNC function 5	SP	on off				LED	BI		BO					
170.2102	>Sync6 release blocking (>Sy6 rlblk)	SYNC function 6	SP	on off				LED	BI		BO					
170.2102	>Sync7 release blocking (>Sy7 rlblk)	SYNC function 7	SP	on off				LED	BI		BO					
170.2102	>Sync8 release blocking (>Sy8 rlblk)	SYNC function 8	SP	on off				LED	BI		BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 1	OUT	on off				LED			BO		41	204	1	Yes
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 2	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 3	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 4	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 5	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 6	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 7	OUT	on off				LED			BO					
170.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC function 8	OUT	on off				LED			BO					
177	Failure: Battery empty (Fail Battery)	Device, General	OUT	on off				LED			BO					
183	Error Board 1 (Error Board 1)	Device, General	OUT	on off				LED			BO					
184	Error Board 2 (Error Board 2)	Device, General	OUT	on off				LED			BO					
185	Error Board 3 (Error Board 3)	Device, General	OUT	on off				LED			BO					
186	Error Board 4 (Error Board 4)	Device, General	OUT	on off				LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
187	Error Board 5 (Error Board 5)	Device, General	OUT	on off				LED			BO					
188	Error Board 6 (Error Board 6)	Device, General	OUT	on off				LED			BO					
189	Error Board 7 (Error Board 7)	Device, General	OUT	on off				LED			BO					
301	Power System fault (Pow.Sys.Flt.)	Device, General	OUT	on off	ON OFF		*						135	231	2	Yes
302	Fault Event (Fault Event)	Device, General	OUT	*	ON		*						135	232	2	Yes
320	Warn: Limit of Memory Data exceeded (Warn Mem. Data)	Device, General	OUT	on off	*		*	LED			BO					
321	Warn: Limit of Memory Parameter exceeded (Warn Mem. Para.)	Device, General	OUT	on off	*		*	LED			BO					
322	Warn: Limit of Memory Operation exceeded (Warn Mem. Oper.)	Device, General	OUT	on off	*		*	LED			BO					
323	Warn: Limit of Memory New exceeded (Warn Mem. New)	Device, General	OUT	on off	*		*	LED			BO					
351	>Circuit breaker aux. contact: Pole L1 (>CB Aux. L1)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	1	1	Yes
352	>Circuit breaker aux. contact: Pole L2 (>CB Aux. L2)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	2	1	Yes
353	>Circuit breaker aux. contact: Pole L3 (>CB Aux. L3)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	3	1	Yes
356	>Manual close signal (>Manual Close)	P.System Data 2	SP	*	*		*	LED	BI		BO					
361	>Failure: Feeder VT (MCB tripped) (>FAIL:Feeder VT)	P.System Data 2	SP	ON OFF	*		*	LED	BI		BO		150	38	1	Yes
366	>CB1 Pole L1 (for AR,CB-Test) (>CB1 Pole L1)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	66	1	Yes
367	>CB1 Pole L2 (for AR,CB-Test) (>CB1 Pole L2)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	67	1	Yes
368	>CB1 Pole L3 (for AR,CB-Test) (>CB1 Pole L3)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	68	1	Yes
371	>CB1 READY (for AR,CB-Test) (>CB1 Ready)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	71	1	Yes
378	>CB faulty (>CB faulty)	P.System Data 2	SP	*	*		*	LED	BI		BO					
379	>CB aux. contact 3pole Closed (>CB 3p Closed)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	78	1	Yes
380	>CB aux. contact 3pole Open (>CB 3p Open)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	79	1	Yes
410	>CB1 aux. 3p Closed (for AR, CB-Test) (>CB1 3p Closed)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	80	1	Yes
411	>CB1 aux. 3p Open (for AR, CB-Test) (>CB1 3p Open)	P.System Data 2	SP	*	*		*	LED	BI		BO		150	81	1	Yes
501	Relay PICKUP (Relay PICKUP)	P.System Data 2	OUT	*	*		m	LED			BO		106	84	2	Yes
503	Relay PICKUP Phase L1 (Relay PICKUP L1)	P.System Data 2	OUT	*	*		m	LED			BO		106	64	2	Yes
504	Relay PICKUP Phase L2 (Relay PICKUP L2)	P.System Data 2	OUT	*	*		m	LED			BO		106	65	2	Yes
505	Relay PICKUP Phase L3 (Relay PICKUP L3)	P.System Data 2	OUT	*	*		m	LED			BO		106	66	2	Yes
507	Relay TRIP command Phase L1 (Relay TRIP L1)	P.System Data 2	OUT	*	*		m	LED			BO		106	69	2	No
508	Relay TRIP command Phase L2 (Relay TRIP L2)	P.System Data 2	OUT	*	*		m	LED			BO		106	70	2	No

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
509	Relay TRIP command Phase L3 (Relay TRIP L3)	P.System Data 2	OUT	*	*		m	LED			BO		106	71	2	No
510	Relay GENERAL CLOSE command (Relay CLOSE)	P.System Data 2	OUT	*	*	*	*	LED			BO					
511	Relay GENERAL TRIP command (Relay TRIP)	P.System Data 2	OUT	*	ON		m	LED			BO		106	68	2	No
512	Relay TRIP command - Only Phase L1 (Relay TRIP 1pL1)	P.System Data 2	OUT	*	*		*	LED			BO					
513	Relay TRIP command - Only Phase L2 (Relay TRIP 1pL2)	P.System Data 2	OUT	*	*		*	LED			BO					
514	Relay TRIP command - Only Phase L3 (Relay TRIP 1pL3)	P.System Data 2	OUT	*	*		*	LED			BO					
515	Relay TRIP command Phases L123 (Relay TRIP 3ph.)	P.System Data 2	OUT	*	*		*	LED			BO					
536	Relay Definitive TRIP (Definitive TRIP)	P.System Data 2	OUT	ON	ON	*	*	LED			BO		150	180	2	Yes
545	Time from Pickup to drop out (PU Time)	P.System Data 2	VI													
546	Time from Pickup to TRIP (TRIP Time)	P.System Data 2	VI													
561	Manual close signal detected (Man.Clos.Detect)	P.System Data 2	OUT	ON	*		*	LED			BO		150	211	1	No
563	CB alarm suppressed (CB Alarm Supp)	P.System Data 2	OUT	*	*	*		LED			BO					
1000	Number of breaker TRIP commands (# TRIPs=)	Statistics	VI													
1001	Number of breaker TRIP commands L1 (TripNo L1=)	Statistics	VI													
1002	Number of breaker TRIP commands L2 (TripNo L2=)	Statistics	VI													
1003	Number of breaker TRIP commands L3 (TripNo L3=)	Statistics	VI													
1401	>BF: Switch on breaker fail protection (>BF on)	Breaker Failure	SP	*	*		*	LED	BI		BO					
1402	>BF: Switch off breaker fail protection (>BF off)	Breaker Failure	SP	*	*		*	LED	BI		BO					
1403	>BLOCK Breaker failure (>BLOCK BkrFail)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1415	>BF: External start 3pole (>BF Start 3pole)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1432	>BF: External release (>BF release)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1435	>BF: External start L1 (>BF Start L1)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1436	>BF: External start L2 (>BF Start L2)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1437	>BF: External start L3 (>BF Start L3)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1439	>BF: External start 3pole (w/o current) (>BF Start w/o I)	Breaker Failure	SP	ON OFF	*		*	LED	BI		BO					
1440	Breaker failure prot. ON/OFF via BI (BkrFailON/offBI)	Breaker Failure	IntSP	ON OFF	*		*	LED			BO					
1451	Breaker failure is switched OFF (BkrFail OFF)	Breaker Failure	OUT	ON OFF	*		*	LED			BO		166	151	1	Yes
1452	Breaker failure is BLOCKED (BkrFail BLOCK)	Breaker Failure	OUT	ON OFF	ON OFF		*	LED			BO		166	152	1	Yes

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
1453	Breaker failure is ACTIVE (BkrFail ACTIVE)	Breaker Failure	OUT	ON OFF	*		*	LED			BO		166	153	1	Yes
1454	Breaker fail. masking error transformer (BF Mask. Error)	Breaker Failure	OUT	ON OFF	*		*	LED			BO					
1461	Breaker failure protection started (BF Start)	Breaker Failure	OUT	*	ON OFF		m	LED			BO		166	161	1	Yes
1472	BF Trip T1 (local trip) - only phase L1 (BF T1-TRIP 1pL1)	Breaker Failure	OUT	*	ON		m	LED			BO					
1473	BF Trip T1 (local trip) - only phase L2 (BF T1-TRIP 1pL2)	Breaker Failure	OUT	*	ON		m	LED			BO					
1474	BF Trip T1 (local trip) - only phase L3 (BF T1-TRIP 1pL3)	Breaker Failure	OUT	*	ON		m	LED			BO					
1476	BF Trip T1 (local trip) - 3pole (BF T1-TRIP L123)	Breaker Failure	OUT	*	ON		m	LED			BO		166	176	2	Yes
1489	BF Flash Over (BF Flash Over)	Breaker Failure	OUT	*	ON		*	LED			BO					
1490	BF Flash Over Trip (BF FO TRIP)	Breaker Failure	OUT	*	ON		m	LED			BO					
1493	BF Trip in case of defective CB (BF TRIP CBdefec)	Breaker Failure	OUT	*	ON		m	LED			BO		166	193	2	Yes
1494	BF TRIP T2 (busbar trip) (BF T2-TRIP(bus))	Breaker Failure	OUT	*	ON		m	LED			BO		106	85	2	Yes
1495	BF Trip End fault stage (BF EndFlt TRIP)	Breaker Failure	OUT	*	ON		m	LED			BO		166	195	2	Yes
1496	BF Pole discrepancy pickup (BF CBdiscrSTART)	Breaker Failure	OUT	*	ON OFF		*	LED			BO		166	196	2	Yes
1497	BF Pole discrepancy pickup L1 (BF CBdiscr L1)	Breaker Failure	OUT	*	ON OFF		*	LED			BO					
1498	BF Pole discrepancy pickup L2 (BF CBdiscr L2)	Breaker Failure	OUT	*	ON OFF		*	LED			BO					
1499	BF Pole discrepancy pickup L3 (BF CBdiscr L3)	Breaker Failure	OUT	*	ON OFF		*	LED			BO					
1500	BF Pole discrepancy Trip (BF CBdiscr TRIP)	Breaker Failure	OUT	*	ON		m	LED			BO		166	200	2	Yes
2701	>AR: Switch on auto-reclose function (>AR on)	Autoreclosure	SP	*	*		*	LED	BI		BO					
2702	>AR: Switch off auto-reclose function (>AR off)	Autoreclosure	SP	*	*		*	LED	BI		BO					
2703	>AR: Block auto-reclose function (>AR block)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2711	>External start of internal Auto reclose (>AR Start)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2712	>AR: External trip L1 for AR start (>Trip L1 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2713	>AR: External trip L2 for AR start (>Trip L2 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2714	>AR: External trip L3 for AR start (>Trip L3 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2715	>AR: External 1pole trip for AR start (>Trip 1pole AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2716	>AR: External 3pole trip for AR start (>Trip 3pole AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2727	>AR: Remote Close signal (>AR RemoteClose)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2731	>AR: Sync. release from ext. sync.-check (>Sync.release)	Autoreclosure	SP	*	*		*	LED	BI		BO					
2737	>AR: Block 1pole AR-cycle (>BLOCK 1pole AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
2738	>AR: Block 3pole AR-cycle (>BLOCK 3pole AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2739	>AR: Block 1phase-fault AR-cycle (>BLK 1phase AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2740	>AR: Block 2phase-fault AR-cycle (>BLK 2phase AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2741	>AR: Block 3phase-fault AR-cycle (>BLK 3phase AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2742	>AR: Block 1st AR-cycle (>BLK 1.AR-cycle)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2743	>AR: Block 2nd AR-cycle (>BLK 2.AR-cycle)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2744	>AR: Block 3rd AR-cycle (>BLK 3.AR-cycle)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2745	>AR: Block 4th and higher AR-cycles (>BLK 4.-n. AR)	Autoreclosure	SP	ON OFF	*		*	LED	BI		BO					
2746	>AR: External Trip for AR start (>Trip for AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2747	>AR: External pickup L1 for AR start (>Pickup L1 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2748	>AR: External pickup L2 for AR start (>Pickup L2 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2749	>AR: External pickup L3 for AR start (>Pickup L3 AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2750	>AR: External pickup 1phase for AR start (>Pickup 1ph AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2751	>AR: External pickup 2phase for AR start (>Pickup 2ph AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2752	>AR: External pickup 3phase for AR start (>Pickup 3ph AR)	Autoreclosure	SP	*	ON		*	LED	BI		BO					
2780	AR: Masking error voltage transformer (AR Mask. Error)	Autoreclosure	OUT	*	ON		*	LED			BO					
2781	AR: Auto-reclose is switched off (AR off)	Autoreclosure	OUT	ON OFF	*		*	LED			BO		40	81	1	Yes
2782	AR: Auto-reclose is switched on (AR on)	Autoreclosure	IntSP	*	*		*	LED			BO		106	16	1	Yes
2783	AR: Auto-reclose is blocked (AR is blocked)	Autoreclosure	OUT	ON OFF	*		*	LED			BO		40	83	1	Yes
2784	AR: Auto-reclose is not ready (AR not ready)	Autoreclosure	OUT	*	ON		*	LED			BO					
2787	AR: Circuit breaker not ready (CB not ready)	Autoreclosure	OUT	*	*		*	LED			BO		40	87	1	No
2788	AR: CB ready monitoring window expired (AR T-CBreadyExp)	Autoreclosure	OUT	*	ON		*	LED			BO					
2796	AR: Auto-reclose ON/OFF via BI (AR on/off BI)	Autoreclosure	IntSP	*	*		*	LED			BO					
2801	AR in progress (AR in progress)	Autoreclosure	OUT	*	ON		*	LED			BO		40	101	2	Yes
2809	AR: Start-signal monitoring time expired (AR T-Start Exp)	Autoreclosure	OUT	*	ON		*	LED			BO					
2810	AR: Maximum dead time expired (AR TdeadMax Exp)	Autoreclosure	OUT	*	ON		*	LED			BO					
2818	AR: Evolving fault recognition (AR evolving Flt)	Autoreclosure	OUT	*	ON		*	LED			BO					
2820	AR is set to operate after 1p trip only (AR Program1pole)	Autoreclosure	OUT	*	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
2821	AR dead time after evolving fault (AR Td. evol.Flt)	Autoreclosure	OUT	*	ON		*	LED			BO					
2839	AR dead time after 1pole trip running (AR Tdead 1pTrip)	Autoreclosure	OUT	*	ON		*	LED			BO					
2840	AR dead time after 3pole trip running (AR Tdead 3pTrip)	Autoreclosure	OUT	*	ON		*	LED			BO					
2841	AR dead time after 1phase fault running (AR Tdead 1pFlt)	Autoreclosure	OUT	*	ON		*	LED			BO					
2842	AR dead time after 2phase fault running (AR Tdead 2pFlt)	Autoreclosure	OUT	*	ON		*	LED			BO					
2843	AR dead time after 3phase fault running (AR Tdead 3pFlt)	Autoreclosure	OUT	*	ON		*	LED			BO					
2844	AR 1st cycle running (AR 1stCyc. run.)	Autoreclosure	OUT	*	ON		*	LED			BO					
2845	AR 2nd cycle running (AR 2ndCyc. run.)	Autoreclosure	OUT	*	ON		*	LED			BO					
2846	AR 3rd cycle running (AR 3rdCyc. run.)	Autoreclosure	OUT	*	ON		*	LED			BO					
2847	AR 4th or higher cycle running (AR 4thCyc. run.)	Autoreclosure	OUT	*	ON		*	LED			BO					
2848	AR cycle is running in ADT mode (AR ADT run.)	Autoreclosure	OUT	*	ON		*	LED			BO					
2851	AR: Close command (AR CLOSE Cmd.)	Autoreclosure	OUT	*	ON		m	LED			BO		106	128	1	No
2852	AR: Close command after 1pole, 1st cycle (AR Close1.Cyc1p)	Autoreclosure	OUT	*	*		*	LED			BO					
2853	AR: Close command after 3pole, 1st cycle (AR Close1.Cyc3p)	Autoreclosure	OUT	*	*		*	LED			BO					
2854	AR: Close command 2nd cycle (and higher) (AR Close 2.Cyc)	Autoreclosure	OUT	*	*		*	LED			BO					
2861	AR: Reclaim time is running (AR T-Recl. run.)	Autoreclosure	OUT	*	*		*	LED			BO					
2862	AR successful (AR successful)	Autoreclosure	OUT	*	*		*	LED			BO					
2863	Definitive TRIP (Definitive Trip)	Autoreclosure	OUT	*	*		*	LED			BO		40	163	1	Yes
2864	AR: 1pole trip permitted by internal AR (AR 1p Trip Perm)	Autoreclosure	OUT	*	*		*	LED			BO					
2865	AR: Synchro-check request (AR Sync.Request)	Autoreclosure	OUT	*	*		*	LED			BO					
2871	AR: TRIP command 3pole (AR TRIP 3pole)	Autoreclosure	OUT	*	ON		*	LED			BO					
2889	AR 1st cycle zone extension release (AR 1.CycZoneRel)	Autoreclosure	OUT	*	*		*	LED			BO					
2890	AR 2nd cycle zone extension release (AR 2.CycZoneRel)	Autoreclosure	OUT	*	*		*	LED			BO					
2891	AR 3rd cycle zone extension release (AR 3.CycZoneRel)	Autoreclosure	OUT	*	*		*	LED			BO					
2892	AR 4th cycle zone extension release (AR 4.CycZoneRel)	Autoreclosure	OUT	*	*		*	LED			BO					
2893	AR zone extension (general) (AR Zone Release)	Autoreclosure	OUT	*	*		*	LED			BO					
2894	AR Remote close signal send (AR Remote Close)	Autoreclosure	OUT	*	ON		*	LED			BO					
2895	No. of 1st AR-cycle CLOSE commands,1pole (AR #Close1./1p=)	Statistics	VI													
2896	No. of 1st AR-cycle CLOSE commands,3pole (AR #Close1./3p=)	Statistics	VI													

No.	Description	Function	Type of Information	Log Buffers				Configurable in Matrix					IEC 60870-5-103			
				Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	LED	Binary Input	Function Key	Relay	Chatter Suppression	Type	Information Number	Data Unit	General Interrogation
2897	No. of higher AR-cycle CLOSE commands,1p (AR #Close2./1p=)	Statistics	VI													
2898	No. of higher AR-cycle CLOSE commands,3p (AR #Close2./3p=)	Statistics	VI													
30053	Fault recording is running (Fault rec. run.)	Osc. Fault Rec.	OUT	*	*		*	LED			BO					
31000	Q0 operationcounter= (Q0 OpCnt=)	Control Device	VI	*												
31001	Q1 operationcounter= (Q1 OpCnt=)	Control Device	VI	*												
31002	Q2 operationcounter= (Q2 OpCnt=)	Control Device	VI	*												
31008	Q8 operationcounter= (Q8 OpCnt=)	Control Device	VI	*												
31009	Q9 operationcounter= (Q9 OpCnt=)	Control Device	VI	*												

A.9 Group Alarms

No.	Description	Function No.	Description
-	-	-	-

A.10 Measured Values

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
-	Wp Forward (WpForward)	Energy	133	51	No	205	-	CFC	CD	DD
-	Wq Forward (WqForward)	Energy	133	52	No	205	-	CFC	CD	DD
-	Wp Reverse (WpReverse)	Energy	133	53	No	205	-	CFC	CD	DD
-	Wq Reverse (WqReverse)	Energy	133	54	No	205	-	CFC	CD	DD
-	Pulsed Energy Wp (active) (Wp(puls))	Energy	133	55	No	205	-	CFC	CD	DD
-	Pulsed Energy Wq (reactive) (Wq(puls))	Energy	133	56	No	205	-	CFC	CD	DD
151.0002	Voltage U (U)	MU U_1	-	-	-	-	-	CFC	CD	DD
151.0010	Current I (I)	MU I_1	-	-	-	-	-	CFC	CD	DD
151.0021	frequency (f)	MU U_1	-	-	-	-	-	CFC	CD	DD
151.0021	frequency (f)	MU I_1	-	-	-	-	-	CFC	CD	DD
151.0022	Voltage or Current Input U/I (Input U/I)	MU U_1	-	-	-	-	-			
151.0023	Current Input I (MwCh_I)	MU I_1	-	-	-	-	-			
152.0002	1P1 Voltage U (1P1_U)	MU1P_1	106	146	No	3	2	CFC	CD	DD
			134	152	No	9	1			
152.0002	1P2 Voltage U (1P2_U)	MU1P_2	134	153	No	9	1	CFC	CD	DD
152.0002	1P3 Voltage U (1P3_U)	MU1P_3	134	154	No	9	1	CFC	CD	DD
152.0010	1P1 Current I (1P1_I)	MU1P_1	106	146	No	3	1	CFC	CD	DD
			134	152	No	9	2			
152.0010	1P2 Current I (1P2_I)	MU1P_2	134	153	No	9	2	CFC	CD	DD
152.0010	1P3 Current I (1P3_I)	MU1P_3	134	154	No	9	2	CFC	CD	DD
152.0015	1P1 Active Power P (1P1_P)	MU1P_1	106	146	No	3	3	CFC	CD	DD
			134	152	No	9	3			
152.0015	1P2 Active Power P (1P2_P)	MU1P_2	134	153	No	9	3	CFC	CD	DD
152.0015	1P3 Active Power P (1P3_P)	MU1P_3	134	154	No	9	3	CFC	CD	DD
152.0016	1P1 Reactive Power Q (1P1_Q)	MU1P_1	106	146	No	3	4	CFC	CD	DD
			134	152	No	9	4			
152.0016	1P2 Reactive Power Q (1P2_Q)	MU1P_2	134	153	No	9	4	CFC	CD	DD
152.0016	1P3 Reactive Power Q (1P3_Q)	MU1P_3	134	154	No	9	4	CFC	CD	DD
152.0017	1P1 Apparent Power S (1P1_S)	MU1P_1	134	152	No	9	5	CFC	CD	DD
152.0017	1P2 Apparent Power S (1P2_S)	MU1P_2	134	153	No	9	5	CFC	CD	DD
152.0017	1P3 Apparent Power S (1P3_S)	MU1P_3	134	154	No	9	5	CFC	CD	DD
152.0018	1P1 Phase Angle Phi (1P1_φ)	MU1P_1	134	152	No	9	6	CFC	CD	DD
152.0018	1P2 Phase Angle Phi (1P2_φ)	MU1P_2	134	153	No	9	6	CFC	CD	DD
152.0018	1P3 Phase Angle Phi (1P3_φ)	MU1P_3	134	154	No	9	6	CFC	CD	DD
152.0019	1P1 Active Power Factor Cosine Phi (1P1_cosφ)	MU1P_1	134	152	No	9	7	CFC	CD	DD
152.0019	1P2 Active Power Factor Cosine Phi (1P2_cosφ)	MU1P_2	134	153	No	9	7	CFC	CD	DD
152.0019	1P3 Active Power Factor Cosine Phi (1P3_cosφ)	MU1P_3	134	154	No	9	7	CFC	CD	DD
152.0020	1P1 Reactive Power Factor Sine Phi (1P1_sinφ)	MU1P_1	134	152	No	9	8	CFC	CD	DD
152.0020	1P2 Reactive Power Factor Sine Phi (1P2_sinφ)	MU1P_2	134	153	No	9	8	CFC	CD	DD
152.0020	1P3 Reactive Power Factor Sine Phi (1P3_sinφ)	MU1P_3	134	154	No	9	8	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
152.0021	1P1 Frequency of U (1P1_f)	MU1P_1	134	152	No	9	9	CFC	CD	DD
152.0021	1P2 Frequency of U (1P2_f)	MU1P_2	134	153	No	9	9	CFC	CD	DD
152.0021	1P3 Frequency of U (1P3_f)	MU1P_3	134	154	No	9	9	CFC	CD	DD
152.0022	1P1 Voltage Input U (1P1Input_U)	MU1P_1	-	-	-	-	-			
152.0022	1P2 Voltage Input U (1P2Input_U)	MU1P_2	-	-	-	-	-			
152.0022	1P3 Voltage Input U (1P3Input_U)	MU1P_3	-	-	-	-	-			
152.0023	1P1 Current Input I (1P1Input_I)	MU1P_1	-	-	-	-	-			
152.0023	1P2 Current Input (1P2Input_I)	MU1P_2	-	-	-	-	-			
152.0023	1P3 Current Input I (1P3Input_I)	MU1P_3	-	-	-	-	-			
153.0003	3P1 Zero Sequence Voltage (3P1_U0)	MU3P_1	134	151	No	9	1	CFC	CD	DD
153.0004	3P1 Phase to Earth Voltage U1 (3P1_U1)	MU3P_1	106	148	No	9	4	CFC	CD	DD
			134	151	No	9	2			
153.0005	3P1 Phase to Earth Voltage U2 (3P1_U2)	MU3P_1	106	148	No	9	5	CFC	CD	DD
			134	151	No	9	3			
153.0006	3P1 Phase to Earth Voltage U3 (3P1_U3)	MU3P_1	106	148	No	9	6	CFC	CD	DD
			134	151	No	9	4			
153.0007	3P1 Phase to Phase Voltage U12 (3P1_U12)	MU3P_1	134	151	No	9	5	CFC	CD	DD
153.0008	3P1 Phase to Phase Voltage U23 (3P1_U23)	MU3P_1	134	151	No	9	6	CFC	CD	DD
153.0009	3P1 Phase to Phase Voltage U31 (3P1_U31)	MU3P_1	134	151	No	9	7	CFC	CD	DD
153.0011	3P1 Zero Sequence Current (3P1_I0)	MU3P_1	134	151	No	9	8	CFC	CD	DD
153.0012	3P1 Phase Current I1 (3P1_I1)	MU3P_1	106	148	No	9	1	CFC	CD	DD
			134	151	No	9	9			
153.0013	3P1 Phase Current I2 (3P1_I2)	MU3P_1	106	148	No	9	2	CFC	CD	DD
			134	151	No	9	10			
153.0014	3P1 Phase Current I3 (3P1_I3)	MU3P_1	106	148	No	9	3	CFC	CD	DD
			134	151	No	9	11			
153.0015	3P1 Active Power Three Phase (3P1_P)	MU3P_1	106	148	No	9	7	CFC	CD	DD
			134	151	No	9	12			
153.0016	3P1 Reactive Power Three Phase (3P1_Q)	MU3P_1	106	148	No	9	8	CFC	CD	DD
			134	151	No	9	13			
153.0017	3P1 Apparent Power Three Phase (3P1_S)	MU3P_1	134	151	No	9	14	CFC	CD	DD
153.0018	3P1 Phase Angle Three Phase (3P1_φ)	MU3P_1	-	-	-	-	-	CFC	CD	DD
153.0019	3P1 Active Power Factor Three Phase (3P1_cosφ)	MU3P_1	134	151	No	9	15	CFC	CD	DD
153.0020	3P1 Reactive Power Factor Three Phase (3P1_sinφ)	MU3P_1	-	-	-	-	-	CFC	CD	DD
153.0021	3P1 Frequency (3P1_f)	MU3P_1	106	148	No	9	9	CFC	CD	DD
			134	151	No	9	16			
153.0024	3P1 Voltage Input U1 (3P1InputU1)	MU3P_1	-	-	-	-	-			
153.0025	3P1 Voltage Input U2 (3P1InputU2)	MU3P_1	-	-	-	-	-			
153.0026	3P1 Voltage Input U3 (3P1InputU3)	MU3P_1	-	-	-	-	-			
153.0027	3P1 Current Input I1 (3P1InputI1)	MU3P_1	-	-	-	-	-			
153.0028	3P1 Current Input I2 (3P1InputI2)	MU3P_1	-	-	-	-	-			
153.0029	3P1 Current Input I3 (3P1InputI3)	MU3P_1	-	-	-	-	-			
154.0007	A1 Phase to Phase Voltage U12 (A1_U12)	MUAron_1	134	155	No	9	1	CFC	CD	DD
154.0009	A1 Phase to Phase Voltage U13 (A1_U13)	MUAron_1	134	155	No	9	2	CFC	CD	DD
154.0013	A1 Phase Current I2 (A1_I2)	MUAron_1	134	155	No	9	3	CFC	CD	DD
154.0014	A1 Phase Current I3 (A1_I3)	MUAron_1	134	155	No	9	4	CFC	CD	DD
154.0015	A1 Active Power P (A1_P)	MUAron_1	134	155	No	9	5	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
154.0016	A1 Reactive Power Q (A1_Q)	MUAron_1	134	155	No	9	6	CFC	CD	DD
154.0017	A1 Apparent Power S (A1_S)	MUAron_1	134	155	No	9	7	CFC	CD	DD
154.0018	A1 Phase Angle Phi (A1_φ)	MUAron_1	134	155	No	9	8	CFC	CD	DD
154.0019	A1 Active Power Factor Cosine Phi (A1_cosφ)	MUAron_1	134	155	No	9	9	CFC	CD	DD
154.0020	A1 Reactive Power Factor Sine Phi (A1_sinφ)	MUAron_1	134	155	No	9	10	CFC	CD	DD
154.0021	A1 Frequency (A1_f)	MUAron_1	134	155	No	9	11	CFC	CD	DD
154.0024	A1 Voltage Input U1 (A1Input_U1)	MUAron_1	-	-	-	-	-			
154.0025	A1 Voltage Input U2 (A1Input_U2)	MUAron_1	-	-	-	-	-			
154.0027	A1 Current Input I1 (A1Input_I1)	MUAron_1	-	-	-	-	-			
154.0028	A1 Voltage Input I2 (A1Input_I2)	MUAron_1	-	-	-	-	-			
170.0024	Sync1, Voltage input U1 (Sy1 ChU1)	SYNC function 1	-	-	-	-	-			
170.0024	Sync2, Voltage input U1 (Sy2 ChU1)	SYNC function 2	-	-	-	-	-			
170.0024	Sync3, Voltage input U1 (Sy3 ChU1)	SYNC function 3	-	-	-	-	-			
170.0024	Sync4, Voltage input U1 (Sy4 ChU1)	SYNC function 4	-	-	-	-	-			
170.0024	Sync5, Voltage input U1 (Sy5 ChU1)	SYNC function 5	-	-	-	-	-			
170.0025	Sync1, Voltage input U2 (Sy1 ChU2)	SYNC function 1	-	-	-	-	-			
170.0025	Sync2, Voltage input U2 (Sy2 ChU2)	SYNC function 2	-	-	-	-	-			
170.0025	Sync3, Voltage input U2 (Sy3 ChU2)	SYNC function 3	-	-	-	-	-			
170.0025	Sync4, Voltage input U2 (Sy4 ChU2)	SYNC function 4	-	-	-	-	-			
170.0025	Sync5, Voltage input U2 (Sy5 ChU2)	SYNC function 5	-	-	-	-	-			
170.0025	Sync6, Voltage input U2 (Sy6 ChU2)	SYNC function 6	-	-	-	-	-			
170.0025	Sync7, Voltage input U2 (Sy7 ChU2)	SYNC function 7	-	-	-	-	-			
170.0025	Sync8, Voltage input U2 (Sy8 ChU2)	SYNC function 8	-	-	-	-	-			
170.0030	Sync6, Voltage input U1, 1.PE (Sy6 ChU11)	SYNC function 6	-	-	-	-	-			
170.0030	Sync7, Voltage input U1, 1.PE (Sy7 ChU11)	SYNC function 7	-	-	-	-	-			
170.0030	Sync8, Voltage input U1, 1.PE (Sy8 ChU11)	SYNC function 8	-	-	-	-	-			
170.0031	Sync6, Voltage input U1, 2.PE (Sy6 ChU12)	SYNC function 6	-	-	-	-	-			
170.0031	Sync7, Voltage input U1, 2.PE (Sy7 ChU12)	SYNC function 7	-	-	-	-	-			
170.0031	Sync8, Voltage input U1, 2.PE (Sy8 ChU12)	SYNC function 8	-	-	-	-	-			
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 1	130	1	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 2	130	2	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 3	130	3	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 4	130	4	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 5	130	5	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 6	130	6	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 7	130	7	No	9	1	CFC	CD	DD
170.0070	Sync. voltage U1 (Sync. U1)	SYNC function 8	130	8	No	9	1	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 1	130	1	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 2	130	2	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 3	130	3	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 4	130	4	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 5	130	5	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 6	130	6	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 7	130	7	No	9	3	CFC	CD	DD
170.0071	Sync. voltage U2 (Sync. U2)	SYNC function 8	130	8	No	9	3	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 1	130	1	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 2	130	2	No	9	2	CFC	CD	DD

No.	Description	Function	IEC 60870-5-103					Configurable in Matrix		
			Type	Information Number	Compatibility	Data Unit	Position	CFC	Control Display	Default Display
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 3	130	3	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 4	130	4	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 5	130	5	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 6	130	6	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 7	130	7	No	9	2	CFC	CD	DD
170.0072	Sync. voltage difference U1,U2 (Sync. Vdiff)	SYNC function 8	130	8	No	9	2	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 1	130	1	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 2	130	2	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 3	130	3	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 4	130	4	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 5	130	5	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 6	130	6	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 7	130	7	No	9	6	CFC	CD	DD
170.0073	Sync. angle between U1,U2 (Sync. α)	SYNC function 8	130	8	No	9	6	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 1	130	1	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 2	130	2	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 3	130	3	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 4	130	4	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 5	130	5	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 6	130	6	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 7	130	7	No	9	4	CFC	CD	DD
170.0074	Sync. frequency f1 (Sync. f1)	SYNC function 8	130	8	No	9	4	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 1	130	1	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 2	130	2	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 3	130	3	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 4	130	4	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 5	130	5	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 6	130	6	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 7	130	7	No	9	7	CFC	CD	DD
170.0075	Sync. frequency f2 (Sync. f2)	SYNC function 8	130	8	No	9	7	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 1	130	1	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 2	130	2	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 3	130	3	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 4	130	4	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 5	130	5	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 6	130	6	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 7	130	7	No	9	5	CFC	CD	DD
170.0076	Sync. frequency difference f1, f2 (Sync. fdiff)	SYNC function 8	130	8	No	9	5	CFC	CD	DD
996	Transducer 1 (Td1=)	Measurement	134	136	No	9	1	CFC	CD	DD
997	Transducer 2 (Td2=)	Measurement	134	136	No	9	2	CFC	CD	DD
15100	Voltage Input U1 (Input U1)	P.System Data 2	-	-	-	-	-			
15101	Voltage Input U2 (Input U2)	P.System Data 2	-	-	-	-	-			
15102	Voltage Input U3 (Input U3)	P.System Data 2	-	-	-	-	-			
15110	Current Input I1 (Input I1)	P.System Data 2	-	-	-	-	-			
15111	Current Input I2 (Input I2)	P.System Data 2	-	-	-	-	-			
15112	Current Input I3 (Input I3)	P.System Data 2	-	-	-	-	-			

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Literature

/1/ SIPROTEC 4 System Description; E50417-H1176-C151-A5

/2/ SIPROTEC DIGSI, Start UP; E50417-G1176-C152-A2

/3/ DIGSI CFC, Manual; E50417-H1100-C098-A5

/4/ SIPROTEC SIGRA 4, Manual; E50417-H1100-C070-A3

/5/ PROFIBUS DP Communication profile (available on DIGSI CD and on the Internet); C53000–L1840–B001–03

/6/ PROFIBUS DP Bus mapping 6MD663 / 6MD664 (available on DIGSI CD and on the Internet); C53000–L1840–B011–03

/7/ SIPROTEC Ethernet module IEC 61850 with 100 Mbit electrical interface, C53000-B1174-C167-02

Glossary

Battery	The buffer battery ensures that specified data areas, flags, timers and counters are retained retentively.
Bay controllers	Bay controllers are devices with control and monitoring functions without protective functions.
Bit pattern indication	Bit pattern indication is a processing function by means of which items of digital process information applying across several inputs can be detected together in parallel and processed further. The bit pattern length can be specified as 1, 2, 3 or 4 bytes.
BP_xx	→ Bit pattern indication (Bitstring Of x Bit), x designates the length in bits (8, 16, 24 or 32 bits).
C_xx	Command without feedback
CF_xx	Command with feedback
CFC	Continuous Function Chart. CFC is a graphical editor with which a program can be created and configured by using ready-made blocks.
CFC blocks	Blocks are parts of the user program delimited by their function, their structure or their purpose.
Chatter blocking	A rapidly intermittent input (for example, due to a relay contact fault) is switched off after a configurable monitoring time and can thus not generate any further signal changes. The function prevents overloading of the system when a fault arises.
Combination devices	Combination devices are bay devices with protection functions and a control display.
Combination matrix	From DIGSI V4.6 onward, up to 32 compatible SIPROTEC 4 devices can communicate with one another in an Inter Relay Communication combination (IRC combination). Which device exchanges which information is defined with the help of the combination matrix.
Communication branch	A communications branch corresponds to the configuration of 1 to n users that communicate by means of a common bus.
Communication reference CR	The communication reference describes the type and version of a station in communication by PROFIBUS.

Component view In addition to a topological view, SIMATIC Manager offers you a component view. The component view does not offer any overview of the hierarchy of a project. It does, however, provide an overview of all the SIPROTEC 4 devices within a project.

COMTRADE Common Format for Transient Data Exchange, format for fault records.

Container If an object can contain other objects, it is called a container. The object Folder is an example of such a container.

Control display The display which is displayed on devices with a large (graphic) display after you have pressed the control key is called the control display. It contains the switchgear that can be controlled in the feeder with status display. It is used to perform switching operations. Defining this display is part of the configuration.

Data pane → The right-hand area of the project window displays the contents of the area selected in the → navigation window, for example indications, measured values, etc. of the information lists or the function selection for the device configuration.

DCF77 The extremely precise official time is determined in Germany by the "Physikalisch-Technische-Bundesanstalt PTB" in Braunschweig. The atomic clock station of the PTB transmits this time via the long-wave time-signal transmitter in Mainflingen near Frankfurt/Main. The emitted time signal can be received within a radius of approx. 1,500 km from Frankfurt/Main.

Device container In the Component View, all SIPROTEC 4 devices are assigned to an object of type Device container. This object is a special object of DIGSI Manager. However, since there is no component view in DIGSI Manager, this object only becomes visible in conjunction with STEP 7.

Double command Double commands are process outputs which indicate 4 process states at 2 outputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions)

Double-point indication Double-point indications are items of process information which indicate 4 process states at 2 inputs: 2 defined (for example ON/OFF) and 2 undefined states (for example intermediate positions).

DP → Double-point indication

DP_I → Double point indication, intermediate position 00

Drag and drop Copying, moving and linking function, used at graphics user interfaces. Objects are selected with the mouse, held and moved from one data area to another.

Earth The conductive earth whose electric potential can be set equal to zero at every point. In the area of earth electrodes the earth can have a potential deviating from zero. The term "Earth reference plane" is often used for this state.

Earth (verb)	This term means that a conductive part is connected via an earthing system to the → earth.
Earthing	Earthing is the total of all means and measures used for earthing.
Electromagnetic compatibility	Electromagnetic compatibility (EMC) is the ability of an electrical apparatus to function fault-free in a specified environment without influencing the environment unduly.
EMC	→ Electromagnetic compatibility
ESD protection	ESD protection is the total of all the means and measures used to protect electrostatic sensitive devices.
ExBPxx	External bit pattern indication via an ETHERNET connection, device-specific → Bit pattern indication
ExC	External command without feedback via an ETHERNET connection, device-specific
ExCF	External command with feedback via an ETHERNET connection, device-specific
ExDP	External double point indication via an ETHERNET connection, device-specific → Double point indication
ExDP_I	External double point indication via an ETHERNET connection, intermediate position 00, device-specific → Double point indication
ExMV	External metered value via an ETHERNET connection, device-specific
ExSI	External single point indication via an ETHERNET connection, device-specific → Single point indication
ExSI_F	External single point indication via an ETHERNET connection, device-specific → Transient information, → Single point indication
Field devices	Generic term for all devices assigned to the field level: Protection devices, combination devices, bay controllers.
Floating	→ Without electrical connection to the → Earth.
FMS communication branch	Within an FMS communication branch, the users communicate on the basis of the PROFIBUS FMS protocol via a PROFIBUS FMS network.
Folder	This object type is used to create the hierarchical structure of a project.
General interrogation (GI)	During the system start-up the state of all the process inputs, of the status and of the fault image is sampled. This information is used to update the system-end process

image. The current process state can also be sampled after a data loss by means of a GI.

GOOSE message	GOOSE-messages (Generic Object Oriented Substation Event) are data packets which will be transferred via the Ethernet-communication system in case of event-controlled. They serve to the direct information exchange of the device to each other. The cross-communication between the bay devices is implemented via this mechanism.
GPS	Global Positioning System. Satellites with atomic clocks on board orbit the earth twice a day on different paths in approx. 20,000 km. They transmit signals which also contain the GPS universal time. The GPS receiver determines its own position from the signals received. From its position it can derive the delay time of a satellite signal and thus correct the transmitted GPS universal time.
Hierarchy level	Within a structure with higher-level and lower-level objects a hierarchy level is a container of equivalent objects.
HV field description	The HV project description file contains details of fields which exist in a ModPara-project. The actual field information of each field is stored in a HV field description file. Within the HV project description file, each field is allocated such a HV field description file by a reference to the file name.
HV project description	All the data is exported once the configuration and parameterization of PCUs and submodules using ModPara has been completed. This data is split up into several files. One file contains details about the fundamental project structure. This also includes, for example, information detailing which fields exist in this project. This file is called a HV project description file.
ID	Internal double point indication → Double point indication
ID_S	Internal double point indication, intermediate position 00 → Double point indication
IEC	International Electrotechnical Commission, international standardisation body
IEC address	Within an IEC bus a unique IEC address has to be assigned to each SIPROTEC 4 device. A total of 254 IEC addresses are available for each IEC bus.
IEC communication branch	Within an IEC communication branch the users communicate on the basis of the IEC60-870-5-103 protocol via an IEC bus.
IEC61850	International communication standard for communication in substations. The objective of this standard is the interoperability of devices from different manufacturers on the station bus. An Ethernet network is used for data transfer.
Initialization string	An initialization string comprises a range of modem-specific commands. These are transmitted to the modem within the framework of modem initialization. The commands can, for example, force specific settings for the modem.

Inter relay communication → IRC combination

IRC combination Inter Relay Communication, IRC, is used for directly exchanging process information between SIPROTEC 4 devices. You require an object of type IRC combination to configure an inter relay communication. Each user of the combination and all the necessary communication parameters are defined in this object. The type and scope of the information exchanged between the users is also stored in this object.

IRIG-B Time signal code of the Inter-Range Instrumentation Group

IS Internal single point indication → Single point indication

IS_F Internal indication transient → Transient information, → Single point indication

ISO 9001 The ISO 9000 ff range of standards defines measures used to assure the quality of a product from the development stage to the manufacturing stage.

Link address The link address gives the address of a V3/V2 device.

List view The right pane of the project window displays the names and icons of objects which represent the contents of a container selected in the tree view. Because they are displayed in the form of a list, this area is called the list view.

LV Limit value

LVU Limit value, user-defined

Master Masters may send data to other users and request data from other users. DIGSI operates as a master.

Metered value Metered values are a processing function with which the total number of discrete similar events (counting pulses) is determined for a period, usually as an integrated value. In power supply companies the electrical work is usually recorded as a metered value (energy purchase/supply, energy transportation).

MLFB MLFB is the abbreviation for "MaschinenLesbare FabrikateBezeichnung" (machine-readable product designation). This is the equivalent of an order number. The type and version of a SIPROTEC 4 device are coded in the order number.

Modem connection This object type contains information on both partners of a modem connection, the local modem and the remote modem.

Modem profile A modem profile consists of the name of the profile, a modem driver and may also comprise several initialization commands and a user address. You can create several modem profiles for one physical modem. To do so you need to link various initialization commands or user addresses to a modem driver and its properties and save them under different names.

Modems	Modem profiles for a modem connection are stored in this object type.
MV	Measured value
MVMV	Metered value which is formed from the measured value
MVT	Measured value with time
MVU	Measured value, user-defined
Navigation pane	The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree.
Object	Each element of a project structure is called an object in DIGSI.
Object properties	Each object has properties. These might be general properties that are common to several objects. An object can also have specific properties.
Off-line	In offline mode a connection to a SIPROTEC 4 device is not required. You work with data which are stored in files.
OI_F	Output Indication Transient → Transient information
On-line	When working in online mode, there is a physical connection to a SIPROTEC 4 device. This connection can be implemented as a direct connection, as a modem connection or as a PROFIBUS FMS connection.
OUT	Output indication
Parameter set	The parameter set is the set of all parameters that can be set for a SIPROTEC 4 device.
Phone book	User addresses for a modem connection are saved in this object type.
PMV	Pulse metered value
Process bus	Devices with a process bus interface allow direct communication with SICAM HV modules. The process bus interface is equipped with an Ethernet module.
PROFIBUS	PROcess FIeld BUS, the German process and field bus standard, as specified in the standard EN 50170, Volume 2, PROFIBUS. It defines the functional, electrical, and mechanical properties for a bit-serial field bus.
PROFIBUS address	Within a PROFIBUS network a unique PROFIBUS address has to be assigned to each SIPROTEC 4 device. A total of 254 PROFIBUS addresses are available for each PROFIBUS network.

Project	Content-wise, a project is the image of a real power supply system. Graphically, a project is represented as a number of objects which are integrated in a hierarchical structure. Physically, a project consists of a number of directories and files containing project data.
Protection devices	All devices with a protective function and no control display.
Reorganizing	Frequent addition and deletion of objects results in memory areas that can no longer be used. By reorganizing projects, you can release these memory areas again. However, a cleanup also reassigns the VD addresses. The consequence is that all SIPROTEC 4 devices have to be reinitialized.
RIO file	Relay data Interchange format by Omicron.
RSxxx-interface	Serial interfaces RS232, RS422/485
SCADA Interface	Rear serial interface on the devices for connecting to a control system via IEC or PROFIBUS.
Service port	Rear serial interface on the devices for connecting DIGSI (for example, via modem).
Setting parameters	General term for all adjustments made to the device. Parameterization jobs are executed by means of DIGSI or, in some cases, directly on the device.
SI	→ Single point indication
SI_F	→ Single point indication transient → Transient information, → Single point indication
SICAM SAS	Modularly structured station control system, based on the substation controller → SICAM SC and the SICAM WinCC operator control and monitoring system.
SICAM SC	Substation Controller. Modularly structured substation control system, based on the SIMATIC M7 automation system.
SICAM WinCC	The SICAM WinCC operator control and monitoring system displays the state of your network graphically, visualizes alarms, interrupts and indications, archives the network data, offers the possibility of intervening manually in the process and manages the system rights of the individual employee.
Single command	Single commands are process outputs which indicate 2 process states (for example, ON/OFF) at one output.
Single point indication	Single indications are items of process information which indicate 2 process states (for example, ON/OFF) at one output.
SIPROTEC	The registered trademark SIPROTEC is used for devices implemented on system base V4.

SIPROTEC 4 device This object type represents a real SIPROTEC 4 device with all the setting values and process data it contains.

SIPROTEC 4 variant This object type represents a variant of an object of type SIPROTEC 4 device. The device data of this variant may well differ from the device data of the original object. However, all variants derived from the original object have the same VD address as the original object. For this reason they always correspond to the same real SIPROTEC 4 device as the original object. Objects of type SIPROTEC 4 variant have a variety of uses, such as documenting different operating states when entering parameter settings of a SIPROTEC 4 device.

Slave A slave may only exchange data with a master after being prompted to do so by the master. SIPROTEC 4 devices operate as slaves.

Time stamp Time stamp is the assignment of the real time to a process event.

Topological view DIGSI Manager always displays a project in the topological view. This shows the hierarchical structure of a project with all available objects.

Transformer Tap Indication Transformer tap indication is a processing function on the DI by means of which the tap of the transformer tap changer can be detected together in parallel and processed further.

Transient information A transient information is a brief transient → single-point indication at which only the coming of the process signal is detected and processed immediately.

Tree view The left pane of the project window displays the names and symbols of all containers of a project in the form of a folder tree. This area is called the tree view.

TxTap → Transformer Tap Indication

User address A user address comprises the name of the user, the national code, the area code and the user-specific phone number.

Users From DIGSI V4.6 onward , up to 32 compatible SIPROTEC 4 devices can communicate with one another in an Inter Relay Communication combination. The individual participating devices are called users.

VD A VD (Virtual Device) includes all communication objects and their properties and states that are used by a communication user through services. A VD can be a physical device, a module of a device or a software module.

VD address The VD address is assigned automatically by DIGSI Manager. It exists only once in the entire project and thus serves to identify unambiguously a real SIPROTEC 4 device. The VD address assigned by DIGSI Manager must be transferred to the SIPROTEC 4 device in order to allow communication with DIGSI Device Editor.

VFD A VFD (Virtual Field Device) includes all communication objects and their properties and states that are used by a communication user through services.

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