SIEMENS

SIPROTEC

Multifunction Paralleling Devices 7VE61 and 7VE63

V4.60

Manual

C53000-G1176-C163-2

Note

For safety purposes, please note instructions and warnings in the Preface.

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 given in this document is reviewed regularly and any necessary corrections will be included in subsequent editions. We appreciate any suggestions for improvement.

We reserve the right to make technical improvements without notice.

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Order no.: C53000-G1176-C163-2

Preface

Purpose of this Manual

This manual describes the functions, operation, installation, and commissioning of devices 7VE61 and 7VE63. In particular, one will find:

- Information regarding the configuration of the scope of the device and a description of the device functions and settings → Chapter 2;
- Instructions for Installation and Commissioning → Chapter 3;
- Compilation of the Technical Data → Chapter 4;
- As well as a compilation of the most significant data for advanced users → Appendix A.

General information with regard to design, configuration, and operation of SIPROTEC 4 devices are set out in the SIPROTEC 4 System Description /1/.

Target Audience

Protection 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.

Applicability of this Manual

This manual applies to: SIPROTEC 4 Multifunction Paralleling Devices 7VE61 and 7VE63; firmware version V4.60.

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 established by means of tests conducted by Siemens AG in accordance with Article 10 of the Council Directive in agreement with the generic standards EN 61000-6-2 and EN 61000-6-4 for the EMC directive, and with the standard EN 60255-6 for the low-voltage directive. The device has been designed and produced for industrial use. The product conforms with the international standards of the series IEC 60255 and the German standard VDE 0435.

Additional Standards IEEE Std C37.90-*

IND. CONT. EQ.
69CA

IND. CONT. EQ.

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.

Our Customer Support Center provides a 24-hour service.

Phone: 01 80/5 24 70 00

Fax: 01 80/5 24 24 71

e-mail: support.energy@siemens.com

Training Courses

Enquiries regarding individual training courses should be addressed to our Training Center:

Siemens AG

Power Transmission and Distribution Power

Training Center

Humboldt Street 59

90459 Nuremberg

Telephone:0911 / 4 33-70 05

Fax:0911 / 4 33-79 29

Internet: www.ptd-training.de

Safety Information

This manual does not constitute a complete index of all required safety measures for operation of the equipment (module, device), as special operational conditions may require additional measures. However, it comprises important information that should be noted for purposes of personal safety as well as avoiding material damage. Information that is highlighted by means of a warning triangle and according to the degree of danger, is illustrated as follows.

DANGER!

Danger indicates that death, severe personal injury or substantial material damage will result if proper precautions are not taken.

WARNING!

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

Caution!

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

Note

indicates information on the device, handling of the device, or the respective part of the instruction manual which is important to be noted.

WARNING!

Qualified Personnel

Commissioning and operation of the equipment (module, device) as set out in this manual may only be carried out by qualified personnel. Qualified personnel in terms of the technical safety information as set out in this manual are persons who are authorized to commission, activate, to ground and to designate devices, systems and electrical circuits in accordance with the safety standards.

Use as prescribed

The operational equipment (device, module) may only be used for such applications as set out in the catalogue and the technical description, and only in combination with third-party equipment recommended or approved by Siemens.

The successful and safe operation of the device is dependent on proper handling, storage, installation, operation, and maintenance.

When operating an electrical equipment, certain parts of the device are inevitably subject to dangerous voltage. Severe personal injury or property damage may result if the device is not handled properly.

Before any connections are made, the device must be grounded to the ground terminal.

All circuit components connected to the voltage supply may be subject to dangerous voltage.

Dangerous voltage may be present in the device even after the power supply voltage has been removed (capacitors can still be charged).

Operational equipment with exposed current transformer circuits may not be operated.

The limit values as specified in this manual or in the operating instructions may not be exceeded. This aspect must also be observed during testing and commissioning.

Typographic and Symbol Conventions

The following text formats are used when literal information from the device or to the device appear in the text flow:

`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 operation software DIGSI), are marked in bold letters in monospace type style. The same applies to the titles of 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 Options`

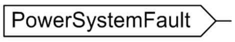
Possible settings of text parameters, which may appear word-for-word in the display of the device or on the screen of a personal computer (with operation software DIGSI), are additionally written in italics. The same applies to the options of the menus.

„`Messages`“

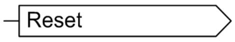
Designators for information, which may be output by the relay or required from other devices or from the switch gear, are marked in a monospace type style in quotation marks.

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

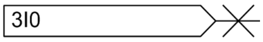
The following symbols are used in drawings:



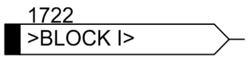
Device-internal logical input signal



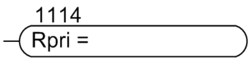
Device-internal logical output signal



Internal input signal of an analog quantity

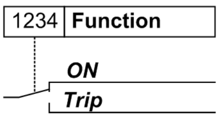


External binary input signal with number (binary input, input indication)



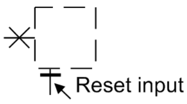
External binary output signal with number (device indication)

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

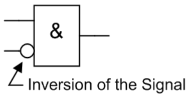


Example of a parameter switch designated **FUNCTION** with address 1234 and the possible settings ON and OFF

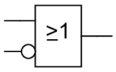
Besides these, graphical symbols are used in accordance with IEC 60617-12 and IEC 60617-13 or similar. Some of the most frequently used are listed below:



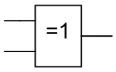
analog input values



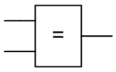
AND-gate operation of input values



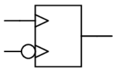
OR-gate operation of input values



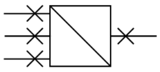
Exclusive OR gate (antivalence): output is active, if only **one** of the inputs is active



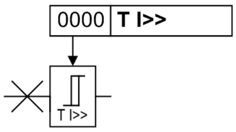
Coincidence gate: output is active, if **both** inputs are active or inactive at the same time



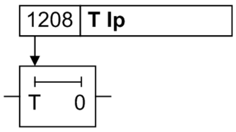
Dynamic inputs (edge-triggered) above with positive, below with negative edge



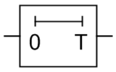
Formation of one analog output signal from a number of analog input signals



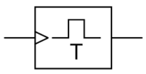
Limit stage with setting address and parameter designator (name)



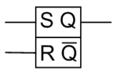
Timer (pickup delay T, example adjustable) with setting address and parameter designator (name)



Timer (dropout delay T, example non-adjustable)



Dynamic triggered pulse timer T (monoflop)



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

Contents

Introduction 1

This chapter introduces the SIPROTEC 4 7VE61 and 7VE63. It provides an overview of the scopes of application, features and of the functional scope.

1.1 Overall Operation

The multi-functional protection devices SIPROTEC 4 7VE61 and 7VE63 are equipped with a powerful microprocessor. All tasks, such as the acquisition of the measured quantities, issuing of commands to circuit breakers and other primary power system equipment, are processed fully digitally. Figure 1-1 shows the basic structure of the device.

Analog Inputs

The measuring inputs (MI) are galvanically isolated, transform the voltages from the primary transformers and adapt them to the internal processing level of the device. Six voltage inputs are available in the MI section.

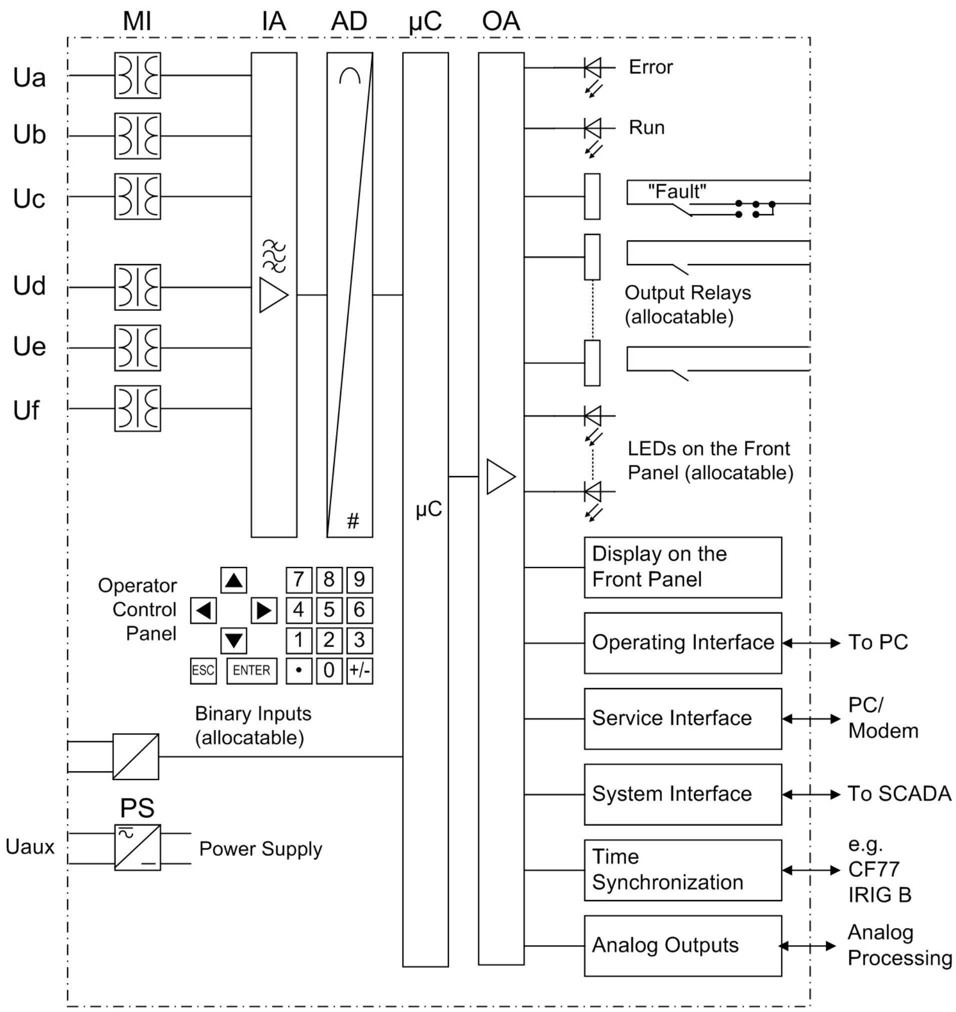


Figure 1-1 Hardware structure of the digital Multifunction Paralleling Devices 7VE61 and 7VE63 (maximal configuration)

The IA input amplifier group allows high impedance connection for analog input values and contains filters optimized for measured value processing bandwidth and speed.

The AD analog digital converter group contains high resolution $\Sigma\Delta$ digital converters (22 bits) and memory components for data transfer to the microcomputer.

Micro Computer System

The implemented software is processed in the microcomputer system (µC) Essential functions are:

- Filtering and preparation of the measured quantities
- Continuous monitoring of the measured quantities
- Processing of the algorithms for the synchrocheck function
- Monitoring of the pickup conditions for the individual protective functions
- Interrogation of limit values and sequences in time
- Controlling signals for logic functions
- Output of control commands for switching devices
- Signalling of synchronization and protection behaviour via LEDs, LCD, relays or serial interfaces
- Recording of messages, fault data and fault values for analysis
- 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 computer system 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 mainly commands that are issued to the switching devices and messages for remote signalling of events and states.

Front Elements

Light-emitting diodes (LEDs) and a display (LCD) on the front panel provide information on the functional status of the device and report events, states and measured values. The integrated control keys and numeric keys in conjunction with the LCD enable local interaction with the device. They allow the user to retrieve any kind of information from the device such as configuration and setting parameters, operational indications and fault messages (see also SIPROTEC 4 System Description /1/) and to change setting parameters.

Serial Interfaces

A personal computer running the DIGSI software can be connected to the serialoperator interface (PC port) on the front panel to conveniently operate all device functions.

A separate service interface can be provided for remote communication with the device via a personal computer using DIGSI 4. This interface is especially well suited for a permanent connection of the devices to the PC or for operation via a modem.

All data can be transferred to a central control or monitoring system via the serial system interface. Various protocols and physical arrangements are available for this interface to suit the particular application.

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

Further communication protocols can be implemented via additional interface modules.

Analog Outputs

Depending on the ordering variant and configuration, ports B and D can be equipped with analog output modules for the output of selected measured values (0 to 20 mA or 4 to 20 mA).

Power Supply

The functional units described are supplied by a power supply PS with the necessary power in the different voltage levels. Voltage dips may occur if the voltage supply system (substation battery) becomes short-circuited. Usually, they are bridged by a capacitor (see also Technical Data).

1.2 Application Scope

The digital paralleling devices 7VE61 and 7VE63 of the SIPROTEC 4 family are multifunctional compact devices, which may be used for parallel switching systems and generators. Its technical version warrants a high security during parallel switching. This can be reached by means of the $1^{1}/_{2}$ channel measurement technique in device 7VE61 or the two-channel measurement technique in 7VE63 and a special hardware design. Additionally, numerous monitoring functions serve as support.

Except for the synchronizing functions, in the devices 7VE61 and 7VE63 are available optional voltages and frequency functions. Thus, the devices can be used for the protection function and for network decoupling tasks.

The devices are recommended for the different applications:

7VE61:

- Synchrocheck monitoring for systems and manual synchronization. In this option a total of 3 synchronizers can parallel operate.
- Parallel switching for systems
- Systems Disconnection and Automatic Re-synchronization
- Automatic synchronization of small to medium generators.

7VE63:

- Operation with increased safety requirements through a two-channel feature.
- Parallel switching for high-voltage and extra high-voltage systems.
- Automatic synchronization of large generators.
- Operation of several synchronizers by a device (up to 8 are possible).
- Visualization of the condition system through a graphic display and local control.

Synchronization Functions

The devices recognize automatically the operating conditions and react depending on the pre-settings.

- In the operation mode „Synchrocheck“ will be checked the validity of a restart according to different considerations.
- In the operation mode „Switching Synchronous Systems“ will be determined the frequency difference with high accuracy. The connection will take place if the difference frequency is for a long time near to 0.
- If asynchronous conditions are available as in the case of synchronization for generators and systems, thus the speed can bring near automatically at the system frequency and the generator voltage at the system voltage. A considering factor of the circuit breaker closing time is that the generator will be switched to a point of synchronism.
- A very high security for recognition of a de-energized line or bus is achieved via the multi-voltage circuit and the multiple inquiries of the voltage. As a result, a connection of the network is trouble-free reestablished.

Protection and Automation Functions

Except for the synchronizing functions, in the devices 7VE61 and 7VE63 are available optional voltages and frequency functions. Thus, the devices can be used for the protection function and for network decoupling tasks.

The devices include the following basic functions:

- Overvoltage protection U>
- Undervoltage protection U<
- Overfrequency f>
- Underfrequency protection f<

- Rate-of-frequency df/dt>; –df/dt<
- Vector jump protection $\Delta\varphi$
- Fast threshold supervision of the voltages (U>; U<)

Control Functions

The device is equipped with control functions which operate, close and open, switchgear via the integrated operator panel, the system interface, binary inputs, and using a personal computer with DIGSI software.

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.

Messages and Measured Values; Fault Recording

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 messages can be allocated to a number of LEDs, externally processed via output contacts, linked with user-definable logic functions and/or issued via serial interfaces.

During a generator or network fault (fault in the power system), important events and state changes are stored in a fault annunciation buffer. The instantaneous or rms measured values during the fault are also stored in the device and are subsequently available for fault analysis.

Communication

Serial interfaces are available for the communication with operating, control and memory systems.

Front Interface

A 9-pin DSUB socket on the front panel is used for local communication with a personal computer. By means of the SIPROTEC 4 operating software DIGSI, all operational and evaluation tasks can be executed via this operator interface, such as specifying and modifying configuration parameters and settings, configuring user-specific logic functions, retrieving operational and fault messages and measured values, readout and display of fault recordings, querying of devices statuses and measured values.

Rear Interfaces

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

The service interface can be operated via electrical data lines and also allows communication via modem. For this reason, remote operation is possible via personal computer and the DIGSI operating 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. It can be operated via data lines or fibre optic cables. Several standard protocols are available for the data transfer:

- IEC 61850

  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. In parallel to the process control integration of the device, this interface can also be used for communication with DIGSI and for inter-relay communication via GOOSE.

- IEC 60870-5-103

  This profile also integrates the devices into the substation automation systems SINAUT LSA and SICAM.

- Profibus DP

  This protocol of automation technology allows transmission of indications and measured values.

- Modbus ASCII/RTU

  This protocol of automation technology allows transmission of indications and measured values.

- DNP 3.0

  This protocol of automation technology allows transmission of indications and measured values.

- It is also possible to provide an analog output (2 x 20 mA) for output of measured values.

1.3 Characteristics

General Characteristics

- Powerful 32-bit microprocessor system.
- Complete digital measured value processing and control, from sampling and digitalizing of measured values up to the switchon and switchoff decisions for power breakers and other switchgear.
- Total electrical separation between the internal processing stages of the device and the external transformer, control and DC supply circuits of the system because of the design of the binary inputs, outputs, and the DC converters.
- Easy device operation via an integrated operator panel or by means of a connected personal computer with the DIGSI operating program.
- Continuous computation and display of measured quantities.
- Storage of fault messages and instantaneous or rms values for fault recording.
- Continuous monitoring of measured values as well as of the hardware and software of the device.
- Communication with central control and memory storage equipment via serial interfaces, optionally via data cable, modem, or optic fibre lines.
- Battery-buffered real time clock that can be synchronized with an IRIG-B (or DCF77) signal, binary input signal, or system interface command.
- Statistics: Starting and trip commands from the device are counted.
- Operating Hours Counter: Tracking of operating hours of the device.
- Commissioning aids such as connection check, field rotation check, status display of all binary inputs and outputs, and test measurement recording.

Synchrocheck, Dead Line/Bus

- Settable minimum and maximum voltage;
- Verification of the synchronous conditions or the de-energized state is also possible before the manual closing of the circuit breaker, with separate limit values;
- Fast measuring of voltage difference U_{diff} of the phase angle difference α_{diff} and frequency difference f_{diff}
- Measurement via transformer (integrated vector group adaptation)
- Measuring voltages optionally for phase-phase or phase-earth.

Controlling Synchronous Networks

- Fast measuring of the voltage difference U_{diff} and of the phase angle difference α_{diff}
- The operating mode is automatically activated (pre-settings), if the frequency difference is $f_{diff} \approx 0$
- Measurement via transformer (integrated vector group adaptation)
- Measuring voltages optionally for phase-phase or phase-earth.

Controlling Asynchronous Networks

- Fast measuring of the voltage difference U_{diff} and of the frequency difference f_{diff}
- Consideration of the angle difference with prediction of the point of synchronism;
- Measurement via transformer (integrated vector group adaptation)

- Measuring voltages optionally for phase-phase or phase-earth

Undervoltage Protection 27

- Two-stage undervoltage measurement for one of the 6 input voltages of the device
- Separated tripping delay time
- Settable drop-off to pickup for both stages

Overvoltage Protection 59

- Two-stage overvoltage measurement for one of the 6 input voltages of the device
- Separated tripping delay time
- Settable drop-off to pickup for both stages

Frequency Protection 81 O/U

- Monitoring on undershooting (f<) and/or overshooting (f>) with 4 frequency limits and delay times that are independently adjustable.
- Insensitive to harmonics and abrupt phase angle changes.
- Settable undervoltage threshold.

Frequency Change Protection

- Monitors whether the frequency overshoots (df/dt>) and/or undershoots (df/dt<) a set limit value, with 4 individually settable limit values or delay times.
- Variable measuring windows
- Coupling to frequency protection pickup.
- Settable undervoltage threshold.

Vector Jump

- Sensitive phase jump detection to be used for network disconnection.

Analog Outputs

- Output of up to four analog operational measured values (depending on the variant ordered).

Threshold Value Monitoring

- 6 freely assignable messages for threshold monitoring.
- Implementation of fast monitoring tasks via CFC.

User-defined Functions

- Internal and external signals can be logically combined to establish user-defined logic functions.
- All common logic functions (AND, OR, NOT, Exclusive OR, etc.).
- Time delays and limit value interrogations.
- Processing of measured values, including zero suppression, adding a knee characteristic for a transducer input, and live-zero monitoring.

Breaker Control

- Circuit breakers can be opened and closed manually via programmable function keys, via the system interface (e.g. by SICAM or LSA), or via the operating interface (using a PC with DIGSI).
- Feedback information on circuit breakers states via the breaker auxiliary contacts.
- Plausibility monitoring of the circuit breaker position and monitoring of interlocking conditions for switching operations.

Monitoring

- Availability of the device is greatly increased by monitoring of the internal measurement circuits, auxiliary power supply, hardware, and software
- Monitoring of the input voltage circuit through double connection and opposite control
- Checking of the phase sequence
- Permanent monitoring of both closing relays BO1 and BO2;
- Opposite monitoring of the parallel starting algorithms

■

Functions 2

This chapter describes the individual functions of the SIPROTEC 4 device 7VE61 and 7VE63. It shows the setting possibilities for each function in maximum configuration. Guidelines for establishing setting values and, where required, formulae are given.

Based on the following information, it can also be determined which of the provided functions should be used.

2.1 General

The settings associated with the various device functions may be modified by using the operating or service interface in DIGSI. The procedure is set out in detail in the SIPROTEC System Description /1/. For changing configuration parameters in the device, password no. 7 (for parameter set; default setting: 000000) is required. Without the password, the settings may be read, but may not be modified and transmitted to the device.

The settings associated with the various device functions, limit values, etc. can be modified using the controls on the front panel of the device or by using the operator interface with DIGSI in conjunction with a personal computer. Password No. 5 (for single parameter; default setting: 000000).

2.1.1 Functional Scope

2.1.1.1 Functional Description

The devices 7VE61 and 7VE63 can have depending on the order variant except for the synchronization function over numerous protective and additional functions. The hardware and firmware is designed for this scope of functions.

Also individual functions can be enabled or disabled during configuration. Functions not needed can be thus be deactivated.

The available protection and synchronizing functions must be configured as ***Enabled*** or ***Disabled***. For individual functions a choice between several alternatives is possible, as described below.

Functions that are configured as disabled are not processed by the 7VE61 and 7VE63: There are no indications, and corresponding settings (functions, limit values) are not queried during configuration.

2.1.1.2 Setting Notes

Setting of the Functional Scope

Configuration settings can be entered using a PC and the software program DIGSI and transferred via the front serial port or the rear service interface. The operation via DIGSI is explained in the SIPROTEC 4 System Description.

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

The functional scope with the available options is set in the **Functional Scope** dialog box to match plant requirements.

Peculiarities

Most settings are self-explanatory. The special cases are described below.

If the setting group change function has to be used, address 103 **Grp Chge OPTION** must be set to ***Enabled***. In service, simple and fast change, over between up to four different groups of settings is possible. Only **one** setting group may be selected and used if this option is ***Disabled***.

Note

Available functions, default settings and selection possibilities depend on the ordered device variant (see Appendix A.1 for details). The following table shows the configuration settings of the maximal configuration.

Parameter 104 **FAULT VALUE** is used to specify whether the oscillographic fault recording should record ***Instant. values*** or ***RMS values***. If ***RMS values*** are stored, the available recording time increases by the factor 10.

The parameter 145 **df/dt Protect.** establishes for the frequency change protection whether this is to contain two or four stages or is ***Disabled***.

Up to 8 SYNC function groups are available for the synchronizing function. They are enabled in addresses 016x (x = 1 ... 8). Parameters 161 **SYNC function 1** to 168 **SYNC function 8** are used in addition to preselect the mode of operation:

1ph Sync check corresponds to the classical synchronizing function with in each case single-phase connection of the voltages to be compared.

3ph Sync check corresponds to the classical synchronizing function with in each case multi-phase connection of the voltages to be compared.

Note

A mixed parametrization of single-phase and three-phase synchrocheck between function groups is inadmissible and leads to an error indication.

1,5chan.Synchr with the 7VE61 or ***2chan.Synchr.*** with the 7VE63 corresponds to operation as a parallel device. Connection is multiphase, processing of data command issuing is done $1^1/_2$-channel with the 7VE61 or 2-channel with the 7VE63.

Note

A mixed parametrization of three-phase synchrocheck and $1^1/_2$ or 2-channel synchronising function is possible due to the identical connection.

If a function is not needed, ***Disabled*** is set. A synchronizing function group thus rendered ineffective is excluded in the menu item **Synchronization**, all other groups are displayed. The maximum number of the existing synchronising function groups is established by the device variant (see section „Function description of the synchronizing function“).

2.1.1.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	FAULT VALUE	Disabled Instant. values RMS values	RMS values	Fault values
140	UNDERVOLTAGE	Disabled Enabled	Enabled	Undervoltage Protection
141	OVERVOLTAGE	Disabled Enabled	Enabled	Overvoltage Protection

Addr.	Parameter	Setting Options	Default Setting	Comments
142	FREQUENCY Prot.	Disabled Enabled	Enabled	Over / Underfrequency Protection
145	df/dt Protect.	Disabled 2 df/dt stages 4 df/dt stages	2 df/dt stages	Rate-of-frequency-change protection
146	VECTOR JUMP	Disabled Enabled	Enabled	Jump of Voltage Vector
160	BALANC. (MLFB)	Disabled Enabled	Disabled	Balancing Commands (Siemens only MLFB)
161	SYNC function 1	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 1
162	SYNC function 2	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 2
163	SYNC function 3	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 3
164	SYNC function 4	Disabled 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 4
165	SYNC function 5	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 5
166	SYNC function 6	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 6
167	SYNC function 7	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 7
168	SYNC function 8	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 8
173	ANALOGOUTPUT B1	Disabled Enabled	Disabled	Analog Output B1 (Port B)
174	ANALOGOUTPUT B2	Disabled Enabled	Disabled	Analog Output B2 (Port B)
175	ANALOGOUTPUT D1	Disabled Enabled	Disabled	Analog Output D1 (Port D)
176	ANALOGOUTPUT D2	Disabled Enabled	Disabled	Analog Output D2 (Port D)
185	THRESHOLD	Disabled Enabled	Enabled	Threshold Supervision
186	EXT. TRIP 1	Disabled Enabled	Enabled	External Trip Function 1
187	EXT. TRIP 2	Disabled Enabled	Enabled	External Trip Function 2

Addr.	Parameter	Setting Options	Default Setting	Comments
188	EXT. TRIP 3	Disabled Enabled	Enabled	External Trip Function 3
189	EXT. TRIP 4	Disabled Enabled	Enabled	External Trip Function 4

2.1.2 Power System Data 1

The **P.System Data 1** include settings associated with all functions rather than a specific synchronizing, protection, control or monitoring function.

2.1.2.1 Setting Notes

General

The Power System Data 1 can be changed from the operator or service interface with a personal computer using DIGSI.

In DIGSI double-click on **Settings** to display the relevant selection.

Rated System Frequency

The nominal frequency of the system is set in Address 270 **Rated Frequency**. The factory setting of the model variant must only be changed if the device is to be used for a purpose other than intended when ordering.

Command Duration

In address 280 the minimum trip command duration **TMin TRIP CMD** is set. This duration is valid for all protection functions which can issue a trip command.

2.1.2.2 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
270	Rated Frequency	50 Hz 60 Hz 16,7 Hz	50 Hz	Rated Frequency
280	TMin TRIP CMD	0.01 .. 32.00 sec	0.15 sec	Minimum TRIP Command Duration

2.1.2.3 Information List

No.	Information	Type of Information	Comments
361	>FAIL:Feeder VT	SP	>Failure: Feeder VT (MCB tripped)
501	Relay PICKUP	OUT	Relay PICKUP
511	Relay TRIP	OUT	Relay GENERAL TRIP command
5588	>FAIL: VT Ua	SP	>Failure: VT Ua (MCB tripped)
5589	>FAIL: VT Ub	SP	>Failure: VT Ub (MCB tripped)

No.	Information	Type of Information	Comments
5590	>FAIL: VT Uc	SP	>Failure: VT Uc (MCB tripped)
5591	>FAIL: VT Ud	SP	>Failure: VT Ud (MCB tripped)
5592	>FAIL: VT Ue	SP	>Failure: VT Ue (MCB tripped)
5593	>FAIL: VT Uf	SP	>Failure: VT Uf (MCB tripped)
25007	U1:	VI	Voltage U1 at switch on
25008	f1:	VI	Frequency f1 at switch on
25009	U2:	VI	Voltage U2 at switch on
25010	f2:	VI	Frequency f2 at switch on
25011	dU:	VI	Voltagedifference at switch on
25012	df:	VI	Frequencydifference at switch on
25013	dα:	VI	Angledifference at switch on
25059	>Break. Contact	SP	>Breaker contacts

2.1.3 Change Group

Up to four independent setting groups can be created for establishing protection function settings.

Setting groups enable the user to save the various function settings for different applications and to retrieve these settings quickly. All setting groups are stored in the device. Only one setting group is active.

2.1.3.1 Description

Changing Setting Groups

During operation the user can locally switch between setting groups, using the operator panel, binary inputs (if so configured), the service interface per PC, or via the system interface.

A setting group includes the setting values for all functions that have been selected as ***Enabled*** during configuration (see Section 2.1.1.2). In 7VE61 and 7VE63 devices, four independent setting groups (A to D) are available. Whereas setting values may vary, the selected functions of each setting group remain the same.

2.1.3.2 Setting Notes

General

If multiple setting groups are not required, group A is the default selection. Then, the rest of this section is not applicable.

If the changeover option is desired, group changeover must be set to **Grp Chge OPTION** = ***Enabled*** (address 103) when the function extent is configured. For the setting of the function parameters, each of the required setting groups A to D (a maximum of 4) must be configured in sequence. The SIPROTEC 4 System Description gives further information on how to copy setting groups or reset them to their status at delivery and also how to change from one setting group to another.

Subsection 3.1 of this manual tells you how to change between several setting groups externally via binary inputs.

2.1.3.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
302	CHANGE	Group A Group B Group C Group D Binary Input Protocol	Group A	Change to Another Setting Group

2.1.3.4 Information List

No.	Information	Type of Information	Comments
-	GroupA act	IntSP	Setting Group A is active
-	GroupB act	IntSP	Setting Group B is active
-	GroupC act	IntSP	Setting Group C is active
-	GroupD act	IntSP	Setting Group D is active
7	>Set Group Bit0	SP	>Setting Group Select Bit 0
8	>Set Group Bit1	SP	>Setting Group Select Bit 1

2.1.4 Oscillographic Fault Records

The devices 7VE61 and 7VE63 are equipped with a fault memory which scans either the instantaneous values or the rms values of various measured quantities for storage in a ring buffer.

2.1.4.1 Functional Description

Mode of Operation

The instantaneous values of all 6 voltage measurement inputs and the associated voltage differences

u_a, u_b, u_c, u_d, u_e, u_f and $(u_a – u_d)$; $(u_b – u_e)$; $(u_c – u_f)$, ΔU, Δf, $\Delta\alpha$

are sampled at intervals of 1 ms (for 50 Hz) or 1.04 ms (for 60 Hz), and stored in a ring buffer (20 samples per cycle). For a fault, the data are recorded for a set period of time, but not for more than 10 seconds.

The rms values of measured values

U1, U2, f1, f2, ΔU, Δf, $\Delta\alpha$

can be deposited in a ring buffer, one measured value per half cycle. For a fault, the data are recorded for a set period of time, but not for more than 100 seconds.

Up to 8 fault records can be recorded in this buffer. The fault record memory is automatically updated with every new fault, so no acknowledgment is required. The fault record buffer can also be started via binary input, integrated operator interface or via 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. The latter graphically processes the data recorded during the system fault. Signals are additionally recorded as binary tracks (marks) e.g. „Pickup“, „Trip“, „CLOSE Command“, „Balancing Commands“ among others.

If the device has a serial system interface (IEC 60870–5–103), fault recording data can be passed on to a central device (e.g. SICAM) via this interface. Data are evaluated by appropriate programs in the central device. Voltages are referred to their maximum values, scaled to their rated values and prepared for graphic presentation. Binary signal traces (marks) are also recorded.

Transfer to a central device can be polled automatically, either after each fault detection by the protection, or only after a trip.

2.1.4.2 Setting Notes

Fault Recording

Fault recording (waveform capture) will only take place if address was set to 104 **FAULT VALUES** = ***Instantaneous values*** or ***RMS values***. Other settings pertaining to fault recording (waveform capture) are found in the **OSC. FAULT REC.** submenu of the **PARAMETER** menu. Waveform capture makes a distinction between the trigger for an oscillographic record and the criterion to save the record (address 401 **WAVEFORMTRIGGER**). Normally the trigger is the pickup of a protective element, i.e. when a protective element picks up the time is 0. The criterion for saving may be both the device pickup (***Save w. Pickup***) or the device trip (***Save w. Pickup***). A trip command issued by the device can also be used as trigger instant (***Save w. Pickup***); in this case it is also the saving criterion.

For the synchronising functions, two trigger criteria are likewise established. The indication "Syx running" (170.2022) corresponds to the "protection pickup". It is forced when the synchronizing function is started. The "protection tripping" corresponds to triggering with the CLOSE command. With the $1^{1}/_{2}$- and 2-channel version this is the AND combination `Sync CloseRel 1` & `Sync CloseRel 2`.

If the course of the CLOSE command is to be always recorded the setting ***Start w. TRIP*** is selected.

In 7VE61 and 7VE63, a waveform capture includes the complete course of a fault. 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.

The actual storage time encompasses the pre-fault time **PRE. TRIG. TIME** (address 404) ahead of the reference instant and and ends at the post-fault time **POST REC. TIME** (address 405) after the storage criterion has reset. The maximum recording duration to each fault (**MAX. LENGTH**) is set at address 403. The setting depends on the criterion for storage, the delay time of the protective functions and the desired number of stored fault events. The largest value here is 10 s for fault recording of instantaneous values, 100 s for recording of r.m.s. values (see address 104). A total of 8 records can be saved in this time.

Note: These times apply for 50 Hz. They will be different with another frequency. If ***RMS values*** are stored, the times stated for parameters 403 to 406 will be 10 times longer.

An oscillographic record can be triggered by a change in status of a binary input, or through the operating interface via PC. Storage is then triggered dynamically. The length of a record for these special triggers is set at address 406 **BinIn CAPT.TIME** (upper bound is **MAX LENGHT**, address 403). Pre- and post-fault times must still be added. If the binary input time is set to 8 , then the length of the record equals the time that the binary input is activated (static), or the **MAX LENGHT** (address 403), whichever is shorter.

2.1.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
401	WAVEFORMTRIGGE R	Save w. Pickup Save w. TRIP Start w. TRIP	Start w. TRIP	Waveform Capture
403	MAX. LENGTH	0.30 .. 10.00 sec	10.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	0.05 .. 5.00 sec	5.00 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	0.05 .. 2.00 sec	2.00 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	0.10 .. 10.00 sec; ∞	10.00 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 EN100-Modul 1

2.1.5.1 Function Description

An **EN100-Modul 1** allows to integrate the 7VE61 and 7VE63 into 100 Mbit communication networks used by process control and automation systems in accordance with IEC 61850. This standard provides consistent inter-relay communication without gateways or protocol converters. This allows open and interoperable use of SIPROTEC 4 devices even in heterogeneous environments. In parallel to the process control integration of the device, this interface can also be used for communication with DIGSI and for inter-relay communication via GOOSE.

2.1.5.2 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 ***Port B***.

2.1.5.3 Information List

No.	Information	Type of In-formation	Comments
009.0100	Failure Modul	IntSP	Failure EN100 Modul
009.0101	Fail Ch1	IntSP	Failure EN100 Link Channel 1 (Ch1)
009.0102	Fail Ch2	IntSP	Failure EN100 Link Channel 2 (Ch2)

2.2 Paralleling Functions

The paralleling facility is the main function of the 7VE61 and 7VE63 devices. A high degree of reliability and flexible adaptation to power system conditions allow different application areas. The following modes of operation are covered:

- Synchrocheck
- Switching Synchronous Systems
- Switching Asynchronous Systems
- Switching to dead line/dead busbar

2.2.1 Functional Description

When connecting generator and power system or two power systems, the synchronism check verifies that the switching does not endanger the generator or the stability of the power system. For this purpose the voltage vectors of the power system sections to be synchronised are checked within definite limits for compatibility.

2.2.1.1 Connection and definitions

Depending on the device variants, parametrization possibilities are provided for up to eight different synchronizing functions. The following describes the function and mode of operation for the first synchronising function (**SYNC Function group 1**). The same applies to function groups 2 to 8.

For proper functioning of the parallel devices 7VE61 and 7VE63 special conditions must be adhered to on connection to the voltage transformer circuits and the power breaker close coils.

Figure 2-1 shows a three-phase connection. The measuring voltage is the phase-to-phase voltage U_{L12} which is used for the synchronization function. The voltage inputs Ua and Ub can be connected on the side 1 and the voltage inputs Ud and Ue on the side 2. Since the winding sense of the voltage inputs Ub and Ue is changed opposite the other inputs, the connection of the corresponding second voltage input (Ub or Ue) takes place in inverse polarity (also anti-parallel). The sum of these voltages rotated by 180° to each other on each side must be zero. This allows a steady check of the measurement circuit as well as of the whole measuring channel of the voltage transformer circuit up to the recording of the measuring values.

At each third measurement input, for three-phase power systems a second phase-to-phase voltage (voltage U_{L23}) can be connected which — together with each first voltage — allows the phase sequence to be checked. For two or single-phase power systems (16.7 Hz) the third measurement input remains unused (see connection example in appendix A.3).

The device can also be connected to a V-connection (open delta connection) using two phase-phase voltages (see connection example in appendix A.3).

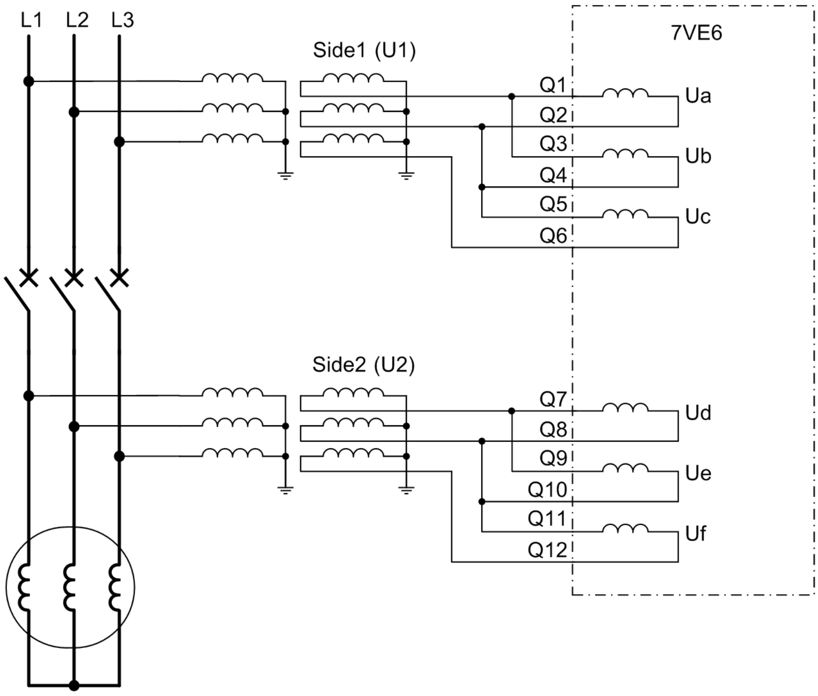


Figure 2-1 Connection to three phase voltage transformers (standard connection)

A possible special connection category for the synchrocheck is explained further below in this Function Description 2.2.1.8.

For the realization of the two-channel feature and the use of the monitoring functionality, the output relays BO1 (R1) and BO2 (R2) must be exclusively used for the CLOSE command. A typical connection is shown in figure 2-2.

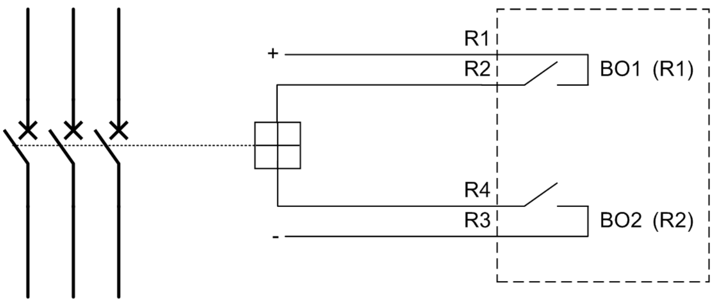


Figure 2-2 Interconnection of relays for the ON command

Important for understanding of the following versions is the definition of the values. In accordance with the figure 2-1 side 1 is the reference side. This is indexed with 1. This results for voltage U1 the frequency f1 and the phase angle α1. For the side to be synchronised index 2 is defined. The electrical values of side 2 are then the voltage U2, the frequency f2 and the phases angle α2.

Formation of the difference values requires definition of the absolute measurement error (Δx = measure value – true value). The reference value and thus the true value is side 1. This results in the following calculation regulations:

Difference voltage dU = U2 – U1

A positive result means that voltage U2 is larger than voltage U1. Otherwise the result is negative.

Difference frequency df = f2 – f1

A positive result means that for example the generator frequency is greater than the power system frequency. This would be the oversynchronous case. If undersynchronous conditions prevail, the result of the difference frequency is negative.

Phase angle difference dα = α2 – α1

Display is limited to ±180°. A positive result means that α2 **leads** by a maximum of 180°. A negative result causes α2 to **lag** by a maximum of 180°. Details are shown in figure 2-3. Phase angle α1 was set on the zero axis as a reference system.

If synchronous networks are present and the frequency f2 is greater than f1, this means that the angle dα changes from negative value to zero and then to a positive value. As illustrated in Figure 2-3, this is a counter-clockwise rotation (= mathematically positive). With f2 < f1 the rotation is in the counter-clockwise. By visualization of the synchroscope in the WEB-Browser (see „Commissioning Aids“) the illustration is rotated in Figure 2-3 in order to keep the usual phase sequence from conventional synchroscope (f2 > f1 — correction angle in counter-clockwise rotation).

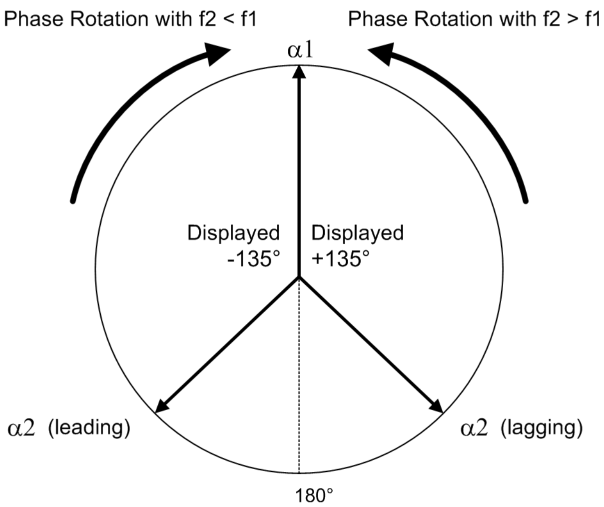


Figure 2-3 Phase angle difference representation dα

For the setting parameters only positive values were used. For unequivocal characterisation of the setting parameters the above mentioned value description was modified somewhat. Inequalities were used. The representation is explained using a difference voltage example. To allow asymmetrical settings, two setting thresholds are required.

A positive value for dU produces the condition U2 > U1. The parameter for the setting e.g. for asynchronous power systems is **dU ASYN U2>U1** (address 6130). For the second setting parameter which corresponds to a negative dU, the inequality U2 < U1 applies. The associated setting parameter for asynchronous power systems is **dU ASYN U2<U1** (address 6131).

An analogous procedure was used for the difference frequency and the difference phase angle.

2.2.1.2 Synchronization via Transformers

There are also power systems where in addition a power transformer is located between the voltage measuring points of the circuit breaker being synchronised. This is possible for example with unit connections if synchronization is done using the high-voltage circuit breaker (see figure 2-4).

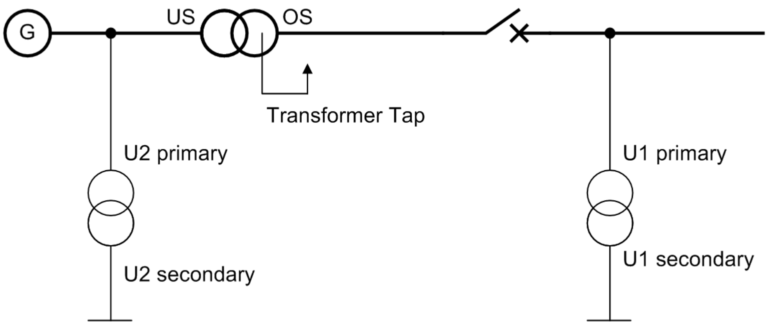


Figure 2-4 Synchronisation via a transformer

The 7VE61 and 7VE63 device takes into consideration via the entry of the parameter 6122 **ANGLE ADJUSTM.** the angle rotation and thus the vector group for the transformer. For transformers with tap changer the setting can be also notified to the device for example via binary code and other codes (implemented in the 7VE63). In the event of deviations from the rated transformation ratio the voltage amplitude is adapted accordingly.

Apart from the via the binary input, the tap changer information to the device can also be transmitted via the serial interface (e.g. Profibus DP). Logical allocation of binary tap changer information from the bus to the logical binary inputs is to be implemented via the CFC (Connect module).

Note

For transformers with tap changers for a quadrature or phase angle control the additional angle rotation in the voltage cannot be corrected. Here synchronism should always be done with the rated position of the tap changer (no angle rotation). Unrestricted synchronisation is always possible if voltage transformers are located on both sides of the circuit breaker.

2.2.1.3 $1^1/_2$– and 2–channel Version

A high degree of safety and reliability are achieved in the devices 7VE61 and 7VE63 by virtue of the multichannel capability. For this purpose a two-out of-two decision is implemented. Two independent conditions must always be fulfilled for the closure command. For the 7VE61 and 7VE63 devices and the two-out of-two decision is implemented differently. The following diagram shows the principal structure of the two versions used.

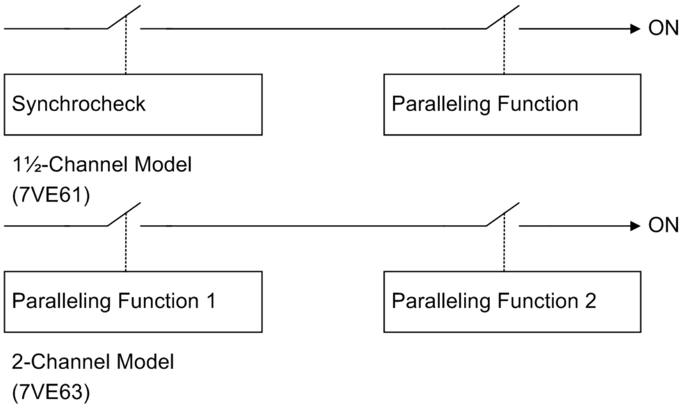


Figure 2-5 Design of a multi-channel redundancy

To distinguish the two versions, the terms $1^1/_2$-channel capability and 2-channel capability were introduced. They are explained in more detail in the following.

$1^1/_2$–channel Version

In the $1^1/_2$- channel version of the 7VE61 the paralleling function issues the closure command. The synchro-check function operates as an enable criterion and is set coarsely in the monitoring limits. The existing dependences for the setting values of the enable angle, the permissible frequency difference and the circuit breaker closing time make a little narrow the working range of the 7VE61 compared with the 2 channels 7VE63 (see the Seting Notes of the synchocheck).

2-channel Version

In 2-channel version of the 7VE63 two procedures independent of one another operate in parallel. The closure command is issued if both procedures decide for closure. The uniformity of the two channel device design is shown in the following figure.

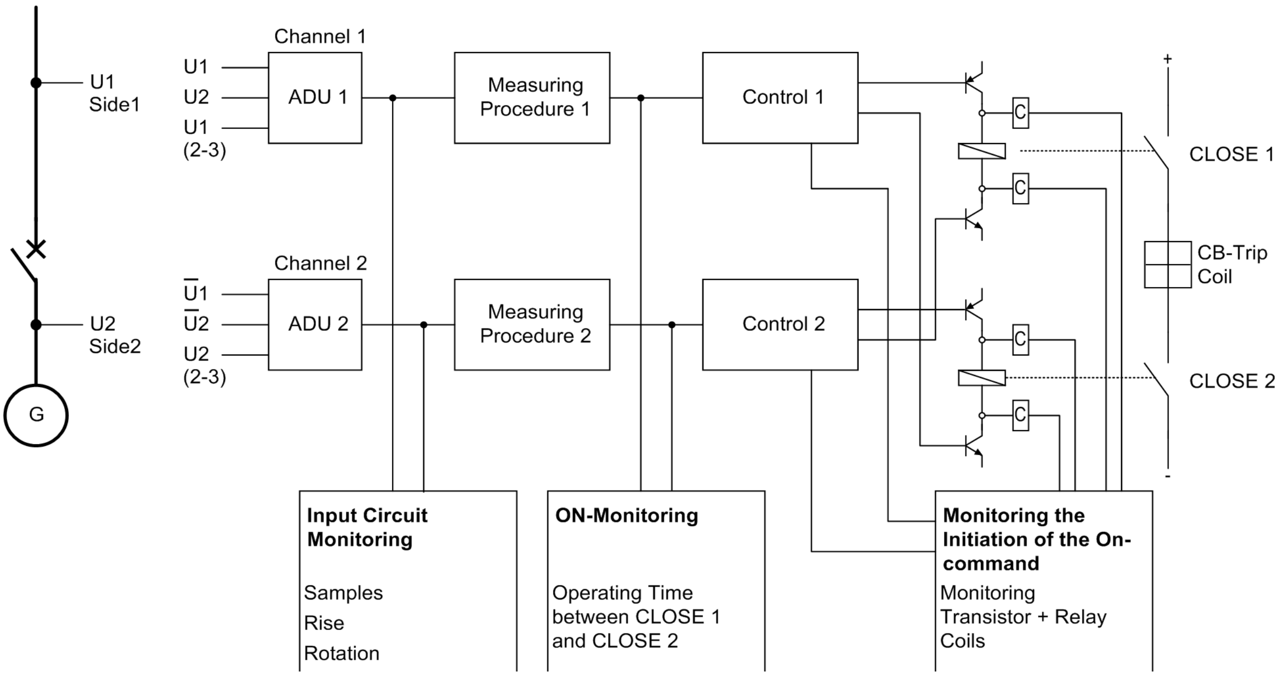


Figure 2-6 Two channel version

Uniform Multichannel Redundancy

To ensure high safety and reliability, not only the software was developed in diverse forms, but also essential hardware components were duplicated. In accordance with figure 2-6 or figure 2-1 the voltage inputs (U1 and $\overline{U1}$ as well as U2 and $\overline{U2}$) are duplicated and fed to two analog/digital converters. Measurement procedure 1 operates exclusively with voltages U1 and U2 and measurement procedure 2 with voltages rotated by 180° ($\overline{U1}$ or $\overline{U2}$). In the $1^1/_2$ channel version in measurement procedure 1 the synchrocheck function is applied and in measurement procedure 2 the parallel switch function. With the 2-channel version in measurement procedures 1 and 2 different parallel switch algorithms are processed.

If both procedures decide for closure, enabling is allocated for activating the breaker semiconductors. Two closure relays are activated each by two semiconductors. This avoids overfunctioning by semiconductor shorting. Further safety is provided acc. to figure 2-6 by the relay activation using the cross measurement procedure. The closure coils are activated by the contacts of the two relays. External interconnection is to be done such that the plus pole and the minus pole are separately switched.

Measurement Methods

To conform to multichannel redundancy, two diverse measurement algorithms are used. This excludes overfunctioning due to systematic errors. At the same time measurement procedures of different programmers are used, processed in independent tasks, and use different memory parts.

The different versions of the FIR-Filter (**F**inite **I**mpulse **R**esponse), takeover a central function which is characterised by a defined impulse response, linear phase and high stability. The filter was so designed that DC components and higher frequency disturbance signals which differ from the rated frequency, are effectively suppressed. In addition the "decimation filter" incorporated in the analog digital converter is of help in disturbance signal suppression.

The following table gives an overview of measurement conversion.

Table 2-1 Overview of the two measurement procedures

	Measurement procedure 1	Measurement procedure 2
Voltage measurement	With two orthogonal FIR filters (filter length 1 cycle and frequency correction) the real and imaginary components of the voltage vector are established. This produces the amplitude value (fundamental harmonic).	With two orthogonal FIR filters (filter length 1.25 cycles implemented using two displaced lowpass filters and frequency correction) the real and imaginary components of the voltage vector are established. This produces the amplitude value (fundamental harmonic).
Frequency Measurement	The frequency is calculated using a special filter procedure with series 60th order bandpass (3 cycles filter). The measurement procedure tolerates deviations from the rated frequency.	The frequency is determined by an angle difference measurement of the voltage vector(delta interval three cycles). Deviations from the rated frequency are corrected accordingly.
Angle Measurement	The arctan of the angle is established using the frequency corrected vector of the above FIR filter.	The arctan of the angle is established using the frequency corrected vector of the above FIR filter.
Connection „asynchronous power systems“	The connection condition is the angle, with the current measure value Δf the closure time of the breaker is converted to an angle, if the measured angle agrees with the „CB angle“ the closure command results.	Connection condition is the time, using Δf $\Delta\alpha$ is converted to a time; if the time proportional to the angle agrees with the CB closure time, the closure command results.

2.2.1.4 Monitoring Procedure

In figure 2-6 in addition essential monitoring procedures are shown which are explained in the following. The measure values are fed to 2 analog/digital converters (ADC) where the second ADC processes value rotated by180° ($\overline{U1}$; $\overline{U2}$). The monitoring procedures checke the entire transformer circuits including internal acquisition and storage, for plausibility, and block the measurement procedures in the event of deviations.

With the **Sampled value monitoring** for each sampled value the following equations are processed for the two voltages U1 and U2:

I u1(k) + $\overline{u1}$(k) I $\leq \Delta u$

I u1(k) + $\overline{u1}$(k) I $\leq \Delta u$

If an admissible voltage Δu is exceeded, an error must be present in measured value acquisition or storage (voltage transformer, ADC, memory). If this fault occurs several times, a disturbance indication (25037 „`Sync Fail Ch U1`“; 25038 „`Sync Fail Ch U2`“) is created for each channel and the synchronizing functions are blocked.

This channel monitoring is only used with configuration as a parallel switching device. This monitoring is not provide for single-phase synchrocheck applications.

The **Jump monitoring** (data continuity monitoring) is intended to register a flipping of higher value bits which can falsely produce a large sampled value and thus lead to amplitude and angle measurement errors. Possible causes are: ADC errors, memory errors or induced disturbances (EMC). Consecutive sampled values are monitored in accordance with the following relationship.

I ua(k) – ua(k–1) I $\leq \Delta u_{max}$

I ub(k) – ub(k–1) I $\leq \Delta u_{max}$

I ud(k) – ud(k–1) I $= \Delta u_{max}$

I ue(k) – ue(k–1) I $= \Delta u_{max}$

If the number of faults per cycle are exceeded, the closure command is blocked and an indication issued (25054 „Sync Fail Data“).

This monitoring is only used with configuration as a parallel switching device. This function is not provide for single-phase synchrocheck applications.

Not shown in figure 2-6, an additional **ADC monitoring** is effective for inputs U1 and U2. This monitoring operates for all connection variants. For this purpose each free fourth analog channel of the ADC is interconnected. For each sampled value of the voltage inputs Ua (corresponds to U1) and Ue (corresponds to U2), consistency with the original channels is checked for the other ADC.

$| ua(k)_{ADC1} - ua(k)_{ADC2} | \leq \Delta u$

$| ue(k)_{ADC1} - ue(k)_{ADC2} | \leq \Delta u$

If the limit is transgressed, the synchronizing function is blocked and at the same time the device is terminated (live contact is activated), since an error is assumed in the ADCs. An alarm is issued in parallel with this (25036.„Error ADC“).

The **Phase sequence check** detects connection and other faults. It is effective if a multi-phase voltage connection results (see figure 2-1) and the parameter 6113 **PHASE SEQUENCE** is set to ***L1 L2 L3*** for a clockwise phase sequence or ***L1 L3 L2*** for an anticlockwise phase sequence. If different phase sequences or those other than the setting are established at inputs U1 and U2, the synchronising function is blocked and corresponding indications are issued (25039 „SyncSeq U1 fail“;25040 „SyncSeq U2 fail“). For checking purposes the phase sequence appears as an operational measured value for both inputs.

The measurement algorithms and logic functions are in to be found in the displayed measure procedures 1 and 2. Different measurement procedures are used in accordance with the two-channel capability in order to exclude overfunctioning caused by process conditioned (systematic) errors. In addition other procedures are effective in the background. The closure monitoring checks the **Consistency** of both measurement procedures. If both procedures do not result in the closure command within a prescribed period, this causes a rejection and an indication („Sync sup. α“) is issued.

Additionally, it is monitored whether both measuring procedures are operating in the same mode (SYNCHRONOUS or ASYNCHRONOUS). If this is not the case, message „Sync sup.asym.“ is generated and no close commands can be issued. Should this condition prevail for one minute, the synchronization is terminated with the fault message e.g. „Sy1 Error“.

The start input must be activated again for continuation of synchronisation. These monitorings are operative with two channel mode.

Overfunctionings of **Relay triggering** are avoided by the two-channel activation of both closure relays. With this both measurement procedures cross activate the semiconductors. In addition in the background coil activation is monitored. For this purpose the semiconductors are activated individually and the response is read back. Both interruptions and a shorted semiconductor are detected. Detected errors result in a blocking of the device and a corresponding indication („Error Relay R1“ or „Error Relay R2“) is issued.

Furthermore monitoring is supported by a **Plausibility settings check** as well as by the **Number of synchronizing function groups**:

- Check for uniquivocality of the function group (only one in each case may be selected)
- Check of configuration (mixed configuration single-phase/multi-phase is not permitted)
- Parametrization check (valid limits)
- Evaluation of monitoring functions

On absent or multiple selection of synchronizing function group the indication „Sy1 active“ drops out. On synchronisation start in addition the indication „Sync FG-Error“ is output.

In the event of configurations errors the indication „Sy1 active“ drops out and the indication „Sync Fail.Conf.“ appears.

Furthermore, specific thresholds and settings of the selected function group are checked with regard to parametrization. If there is a condition which is not plausible, the indication „Sy1 active“ drops out and the indication „Sy1 ParErr“ is output additionally.

If a voltage transformer fault appears at the device via binary inputs (mcb tripping) „>FAIL: VT Ua“ to „>FAIL: VT Uf“, likewise synchronization is not started. Note here that of the 6 available binary inputs those are allocated whose associated voltages Ua to Uf are referred to for synchronization.

During privatisation of the device (annunciation „Level-2 change“) synchronisation is not permitted for safety reasons.

All these indications lead to a stopping and resetting of the synchronising function.

A summary of all monitorings is given in section 2.5.

2.2.1.5 Multiple Synchronizing Points

Depending on the scope of delivery (see table2-2) multiple synchronising points can be operated. The setting parameters are deposited here for each circuit breaker being synchronised, in so-called synchronising function groups. In the maximum variant the 7VE63 operates up to 8 synchronising points. Selection uses either binary inputs or the serial interface.

Table 2-2 Maximum number of synchronising function groups

Device	7VE61*			7VE63*		
14. Order No position	A	B or C	D	A	B or C	D
Number of Sync function groups	3	2	4	3	2	8

However, several synchronizing functional groups may be used for one synchronizer/switching object if synchronization is to be performed with different parameters. Allocation of switchgear component and SYNC function group must then be accomplished dynamically (whichever is the function group to operate with) via one of the binary inputs from „>Sy1 activ“ to „>Sy8 activ“.

If the assignment to the SYNC function groups is clear, the binary inputs are not required.

Selecting one SYNC function group several times, causes output of an error indication („Sync FG-Error“).

Synchronization of Power Units

On synchronizing large power units it is recommended in principle that one parallel switching device (7VE63) is used per unit. This results in two typical synchronizing points: The generator circuit breaker or the power system circuit breaker.

The paralleling device is connected to the voltage transformer or the circuit breaker via external auxiliary relays. On selecting the synchronizing point the measured values are connected and connection to the circuit breaker being synchronised results. This starts the synchronizing procedure. In principle the device also allows a test synchronising. In addition to the start input (Annunciation 222.2011 „>Sync Start“) the commissioning input for test synchronising (Annunciation 222.2340 „>COM Test sync.“) has to be pressed.

The logic functionality (CFC) allows also the parallel switch device to undertake activation of the switchover relays. The corresponding logic must be provided for this in accordance with application. This method has advantages for activation of the parallel switched device via the serial interface.

2.2.1.6 Operating Range/Measured values

Operating Range

The operating range of the synchronizing function is defined by the configured voltage limits **Umin** and **Umax**, and the fixed frequency band $f_N \pm 3$ Hz.

If measurement is started and one or both voltages are outside the operating range, or one voltage leaves the permissible range, corresponding messages indicate this behaviour („Sync. f1>>“, „Sync. f1<<“, „Sync. U1>>“, „Sync. U1<<“, etc.).

Measured Values

The measured values of the synchrocheck are displayed in separate boxes for primary and secondary measured values and percentages. The measured values are displayed and updated only while a synchrocheck is requested.

The following is displayed:

- Value of reference voltage U1
- Value of the voltage to be synchronized U2
- Frequency value f1 and f2
- Differences of Voltage, Frequency and Angle
- Phase Rotation U1 and U2
- The active synchronizing functional groups

The models featuring a four-line display have pre-defined default displays which show in different combinations the above mentioned measured values comprised on one display (see Appendix A.4).

2.2.1.7 Synchrocheck

The synchrocheck function is used for example for additional enabling on manual close or manual synchronizing for safety reasons.

In this mode the variables ΔU, Δf and $\Delta\varphi$ are checked before connecting both power system components. When the setting values are reached an enabling command is issued for the duration when all conditions for synchronization are fulfilled, but at least for an adjustable time period.

The corresponding logic is shown in figure 2-7.

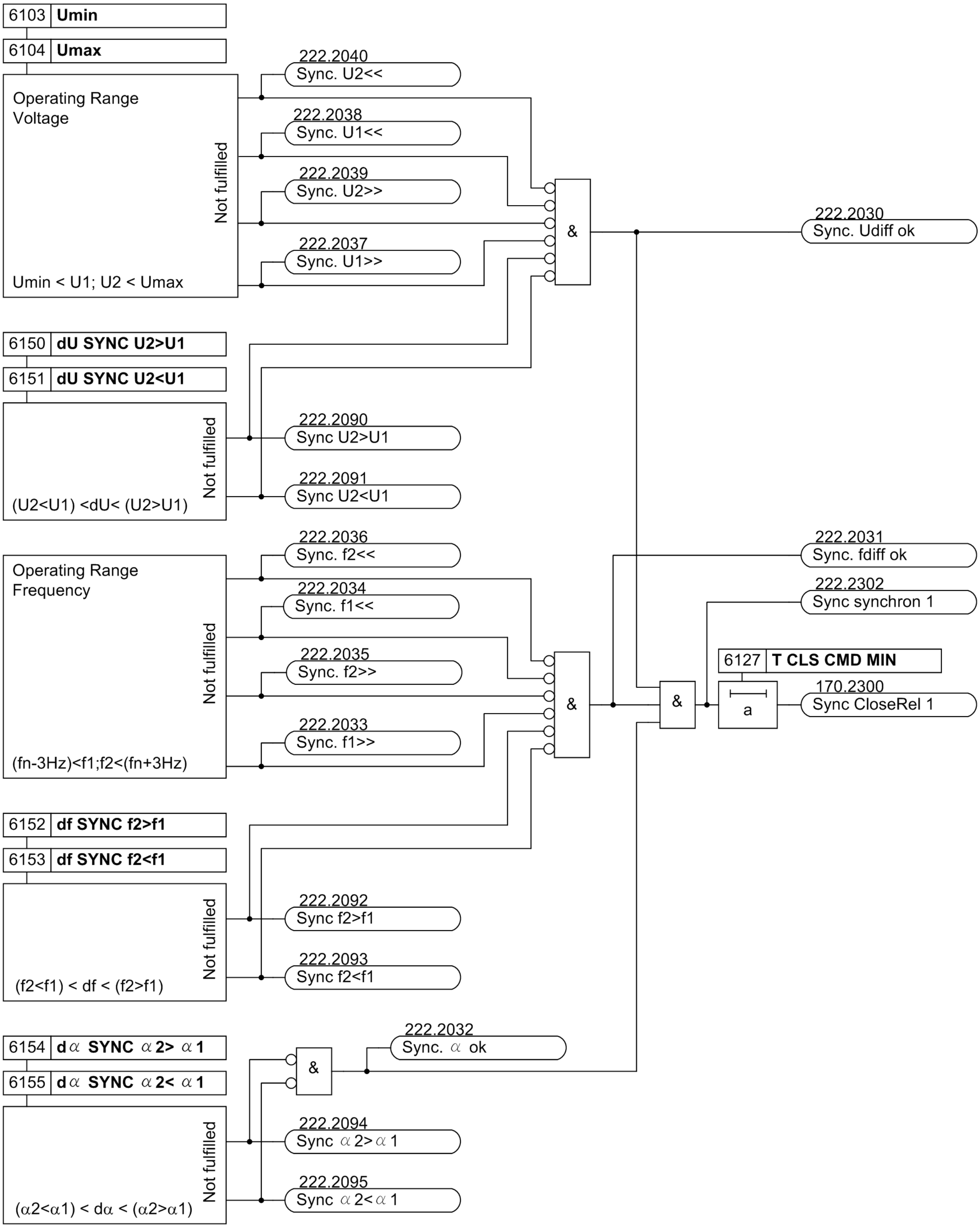


Figure 2-7 Logic diagram of the synchronization function (illustration for one channel)

If the corresponding conditions are fulfilled the indications „Sync. Udiff ok“, „Sync. fdiff ok“ and „Sync. α ok“ are issued.

The indications in the left part of the logic diagram describe if general conditions are fulfilled or not. This indication category will be explained using two examples. The annunciation „Sync. U2<<“ shows that the voltage U2 is outside the operating range and is smaller than the set minimum threshold. The annunciation „Sync U2<U1“ is produced if the difference voltage is outside the setting limits. Here the lower setting value 6151 **dU SYNC U2<U1** is not reached. This indication contains indirect information that voltage U2 must unconditionally be increased for a successful synchronisation. Thus this indication category can be used for remote indications. This is useful if galvanically isolated power systems are to be synchronised.

Application Instruction 1

The synchrocheck function is incorporated in the software package of the paralleling device and uses the closure logic of the paralleling function. If the synchronizing function group (synchrocheck) was selected and a measurement request or a start command issued, the synchrocheck function is active and issues an enabling if the conditions are fulfilled. This is followed automatically by a termination of the device. If enabling is to be used again, a further measurement request must be issued. For this reason activation is recommended for manual synchronising (manual close) in accordance with figure 2-8. The point to be synchronised is selected via the binary input (e.g. „>Sy1 activ“). With this information the internal measurement software is started and checks the synchronizing conditions in accordance with the above logic (figure 2-7). A measurement request is started automatically with the manual close signal and thus the internal logic started. Since synchronization conditions exist with proper handling, the parallel switch device immediately allocates enabling. The internal signal operating time is less than 10 ms. There must be between selection of the synchronizing function group and measurement request, a time of at least 100 ms.

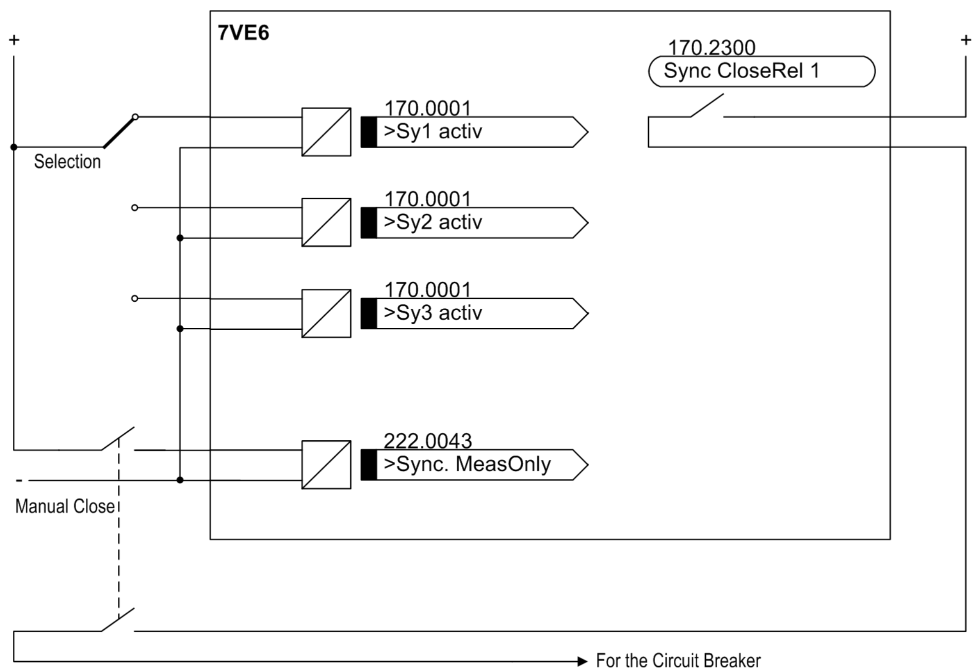


Figure 2-8 Connection — Manual synchronization

Application Instruction 2

If a release message is to be generated as soon as the synchrocheck conditions (ΔU, Δf, $\Delta\alpha$) have been met, the message „Sync synchron 1“ must be configured on the respective release contact. Another prerequisite is to activate the binary input message „>BLK Sync CLOSE“. This can be done directly via a binary input or it can be derived from the CFC. A further prerequisite is the selection of the point to be synchronized and the start of the synchrocheck function via the measurement request or start command. As long as the measurement request remains, or the synchrocheck function has been started and not stopped, or the monitoring time has elapsed, the message „`Sync synchron 1`“ is generated upon compliance with the synchrocheck conditions.

The following figure illustrates a possible example of using the CFC.

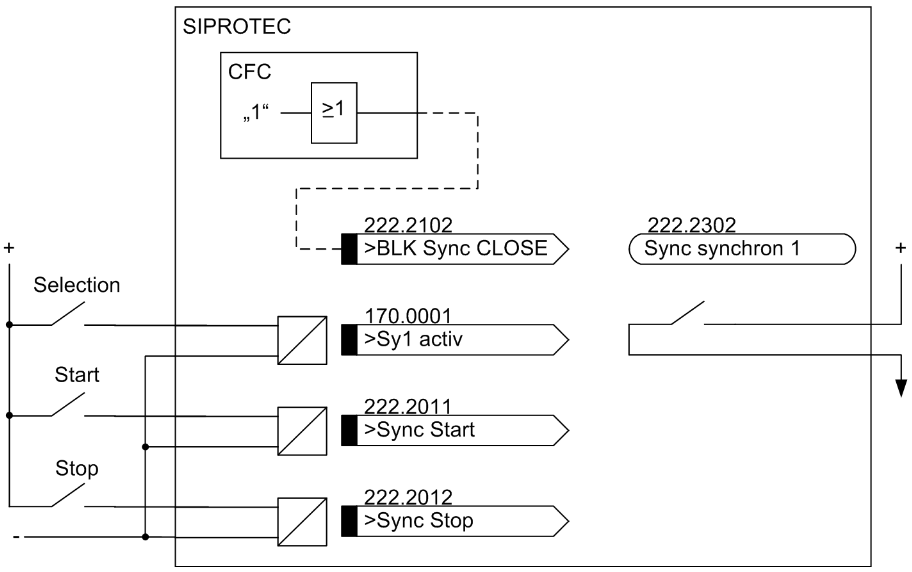


Figure 2-9 Connection in continuous activation

2.2.1.8 Switching to Dead Line/Busbar

Connecting two components of a power system is also possible if at least one of the both components is de-energized. No voltage is recognized, if the measured voltage is smaller than the threshold 6105 **U<**. Three phase connection increases safety since multiple voltages must meet the conditions.

Besides release under synchronous conditions, the following additional release conditions can be selected for the check:

SYNC U1>U2< =	Release on the condition that component U_1 is energized and component U_2 is de-energized.
SYNC U1<U2> =	Release on the condition that component U_1 is de-energized and component U_2 is energized.
SYNC U1<U2< =	Release on the condition stating that component U_1 and component U_2 are de-energized.

Each of these conditions can be enabled or disabled individually; combinations are thus also possible (e.g., release if **SYNC U1>U2<** or **SYNC U1<U2>** are fulfilled).

The threshold below which a power system component is considered as de-energized is defined by parameter **U<**. If the measured voltage exceeds the threshold **U>**, a power system component is energized. Thus, with a multiple-phase connection at side U_1 and with activated phase sequence monitoring, all three voltages have to be placed via the threshold **U>**, so that the side U_1 is recognized as energized (see Figure 2-10). With single-phase connection, of course, only one voltage has to exceed the pickup value.

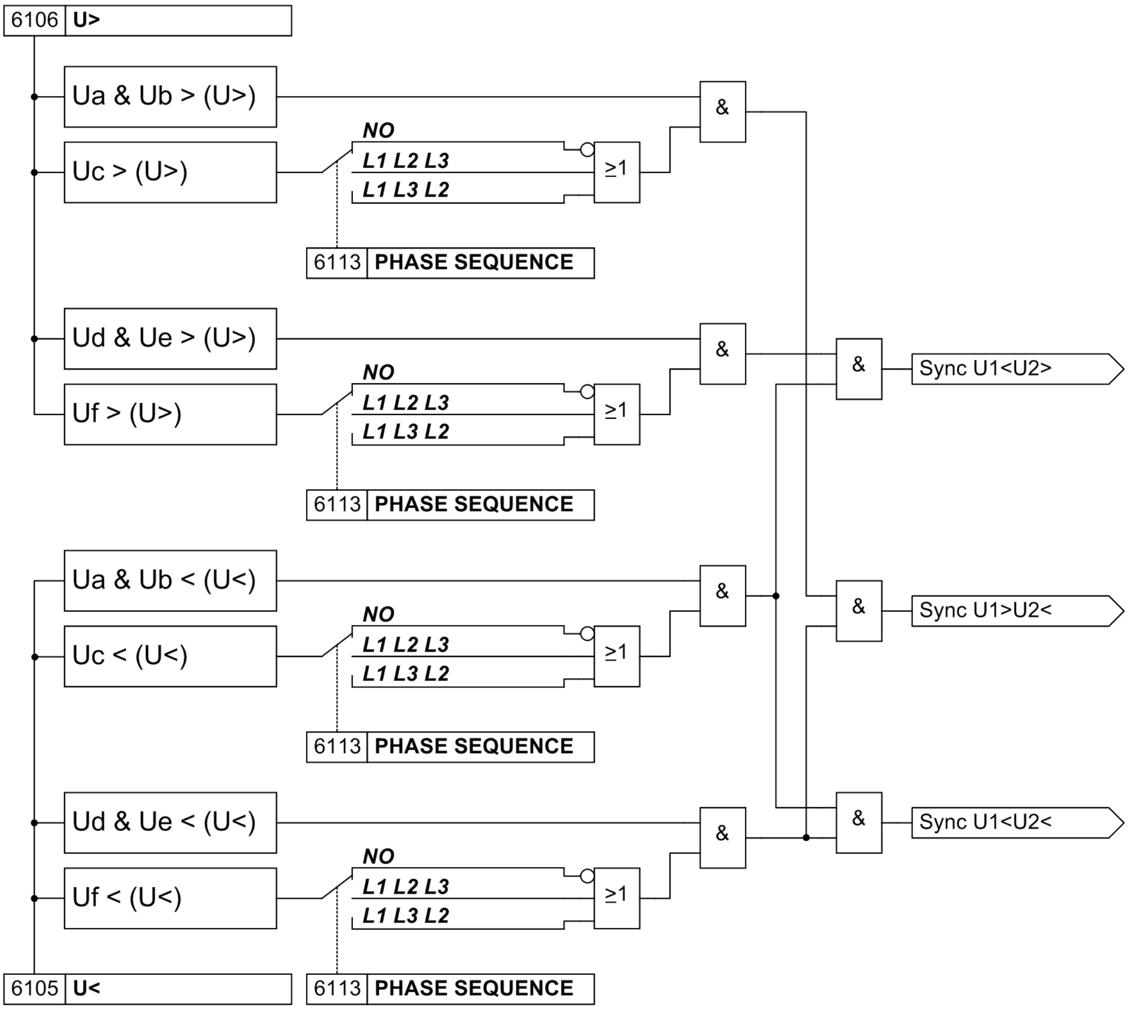


Figure 2-10 Logic diagram: Connection to dead line/bus with three-phase synchrocheck

The close check condition required can be indicated to the device by setting parameter. Alternatively it is also possible to activate the corresponding condition via binary input. The associated logic is shown in figure 2-11.

The logic diagram does not show that the voltage transformer protection switch is also scanned. If this is active, in principle no enabling is allocated. It is therefore obligatory to configure this (see Connection examples in Appendix).

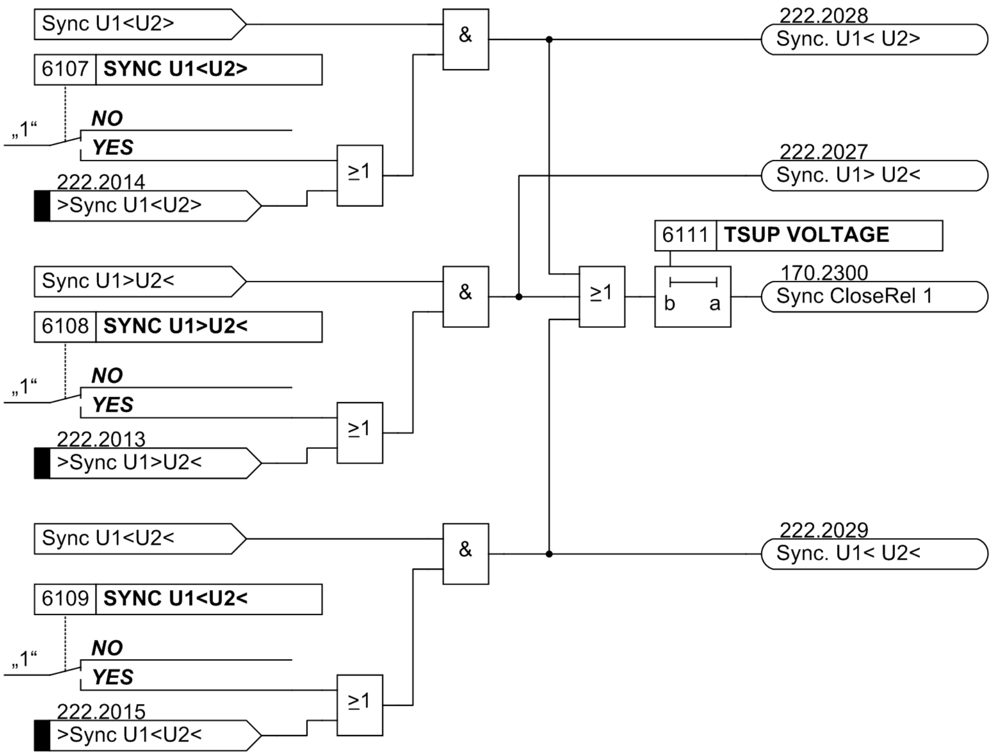


Figure 2-11 Enabling conditions for switching to dead line/bus

Before granting e.g. an enabling for connecting the energized power system component V_1 to the de-energized power system component $V_{2,}$ the following conditions are checked:

- Is the reference voltage V_1 is above the setting value **Umin** and **U>** but below the maximum voltage **Umax**?
- Is the voltage to be synchronized V_2 below the setting value **U<**?
- Is the frequency f_1 within the permitted operating range $f_N \pm 3$ Hz?

After successful termination of the check the release is granted.

For switching the de-energized component 1 to the energized component 2 or connecting the de-energized component 1 to the equally de-energized component 2 the conditions to be fulfilled correspond with those stated above.

The associated indications displaying the enabling via the corresponding condition are „Sync. U1> U2<“, „Sync. U1< U2>“ and „Sync. U1< U2<“.

Via binary inputs „>Sync U1>U2<“, „>Sync U1<U2>“ and „>Sync U1<U2<“ the enabling conditions can be issued externally also provided the synchronization is controlled externally.

Parameter **TSUP VOLTAGE** (address 6111) can be set to configure a monitoring time which requires the above stated additional enabling conditions at least to be present for de-energized switching, before switching is allowed.

Blocking

Blocking the entire synchronizing function 1 is possible via binary input „>BLOCK Sy1“. The message signaling this condition is made via „Sy1 BLOCK“. When blocking the measurement is terminated and the entire function is reset. A new measurement can only be performed with a new measurement request.

Via binary input „>BLK Sync CLOSE“ it is possible to only block the release signal for closing („Sync CloseRel 1“). When blocking is active, measurement continues. The blocking is indicated by the message

„Sync. CLOSE BLK“. When blocking is reset and release conditions are fulfilled, the release signal for closing is issued.

2.2.1.9 Switching Synchronous Systems

Synchronous power systems are involved if galvanically coupled power systems are switched in parallel. A typical characteristic for synchronous power systems is frequency identity ($\Delta f \approx 0$). This state is detected if the frequency difference undershoots the setting value of the parameter **F SYNCHRON**. If additionally conditions $\Delta\alpha$ and ΔU are fulfilled over the set time 6146 **T SYNC-DELAY**, the closure command is issued. The associated logic diagram with the corresponding setting parameters is shown in figure 2-12 for one of the both channels. The sequence in the 2nd channel is identical to the 2-channels version of the 7VE63. The release occurs here with positive result of all decisive criteria „Sync CloseRel 2“. First the release of both channels allows a synchronization.

In the $1^1/_2$-channel version of the 7VE61, the 1st channel represents a synchrocheck function. It opens a measurement window in which a synchronization is permitted. Only if the release of the 2nd channel falls into this measurement window, a synchronization is possible.

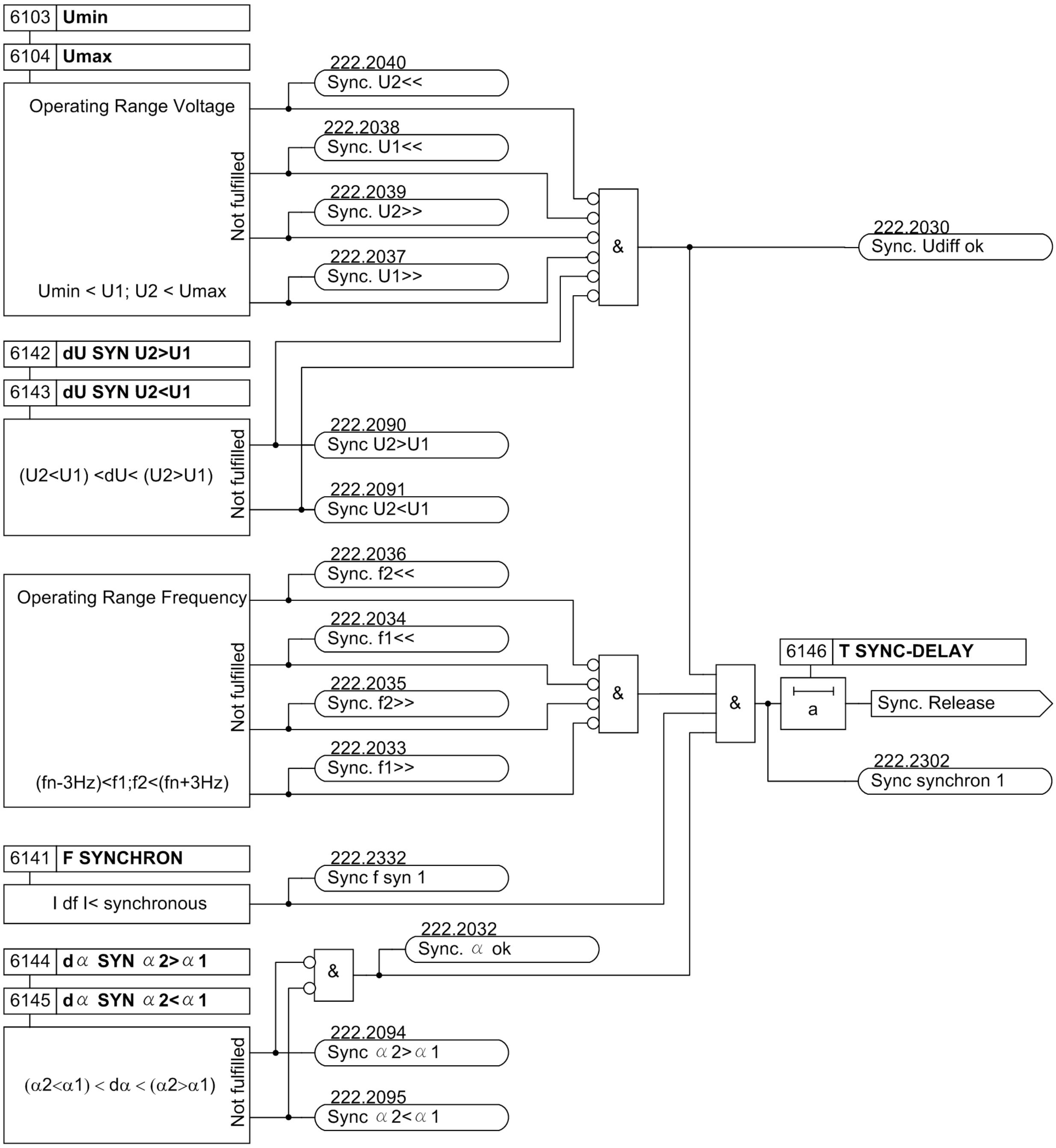


Figure 2-12 Logic diagram: Switching synchronous systems (illustration for channel 1)

2.2.1.10 Switching Asynchronous Systems

This state occurs with the power system and generator (open generator circuit breaker). Here the conditions voltage difference ΔU and frequency difference Δf are checked, and taking into consideration the angle difference and the operating time of the circuit breaker, the closure command time is calculated so that the voltage vectors are identical at the instant the circuit breaker poles ($\Delta U \approx 0$, $\Delta\alpha \approx 0$) make contact.

The generator can be automatically brought to synchronism conditions by the balancing commands for voltage and frequency (see below).

Enabling for closure is issued if the conditions are fulfilled in accordance with the logic diagram 2-13. The close command is issued at a time before synchronization corresponding to the operating time of the circuit breaker. 2-channels version of the 7VE63 occurs with the basically sequence acc. to the logic diagram also in the 2nd channel. If all measuring decisions result positive, the 2nd channel releases „Sync CloseRel 2“.

In the $1^{1}/_{2}$-channel version of the 7VE61, the 1st channel represents a synchrocheck function. A time window is opened into which the release command of the other channel has to be interrupted in order to enable a synchronization. This results in certain dependencies between the setting values for the time window, circuit breaker closing time and permissible frequency deviation (see section Setting Instructions 2.2.2.1).

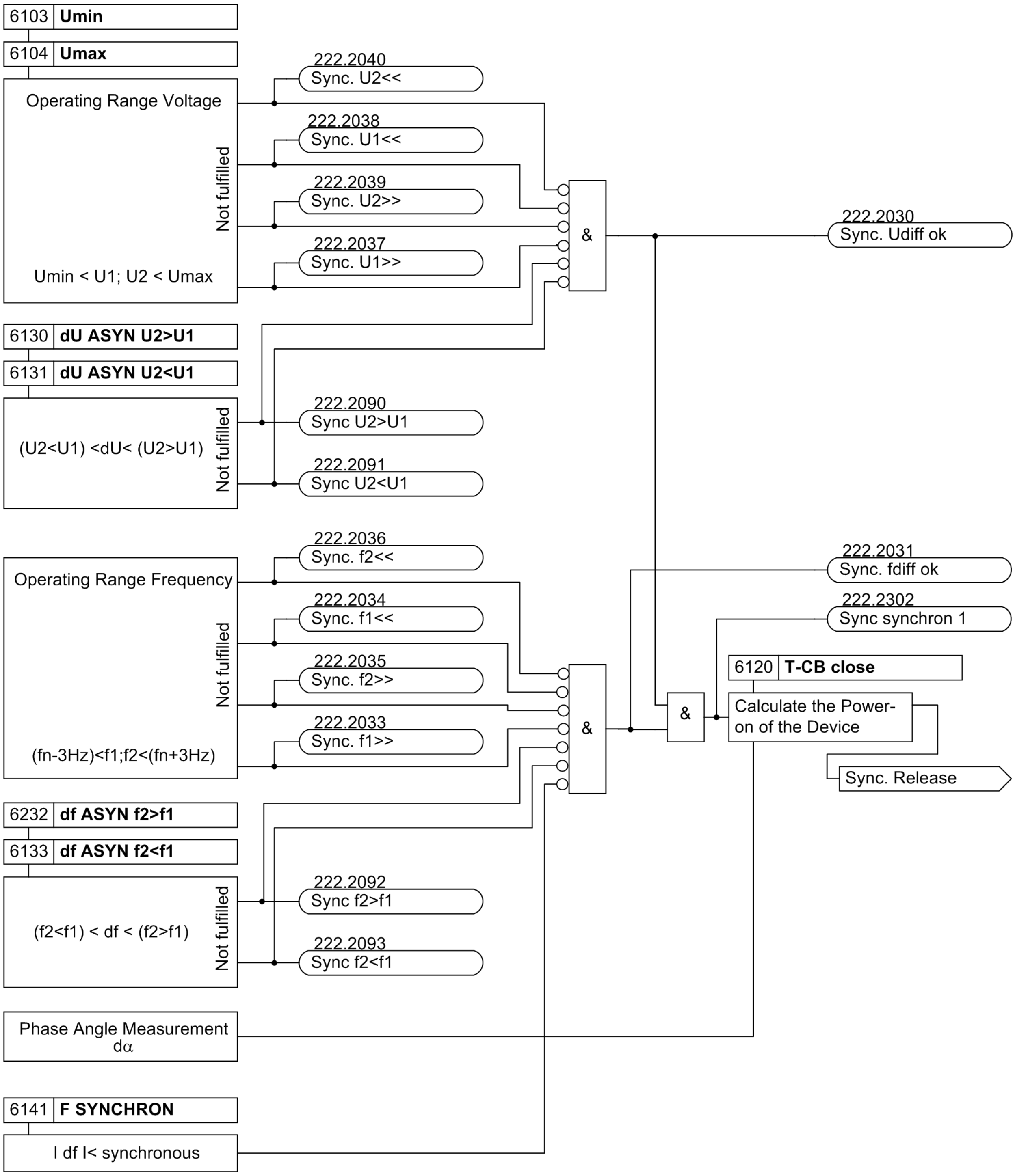


Figure 2-13 Logic diagram: Switching asynchronous networks (illustration for channel 1)

Measurement Sequence

In the two-channel 7VE63 the measurement voltages in the two-channel are evaluated in accordance with two different measurement procedures. Each measurement procedure operates with its own measurement value records and calculates the difference between voltages, frequencies and angles using different algorithms.

The first measurement procedure determines the connection time instant in accordance with the angle criterion. If all conditions are fulfilled the closure command „`Sync CloseRel 1`“ is issued. The second measurement procedure determines the connection time instant using the time criterion. If all conditions are fulfilled the closure command „`Sync CloseRel 2`“ is issued.

The following figure shows the formation of the closure time instant for an asynchronous connection.

Clearly evident is consideration of the circuit breaker operating time, since the closure command was issued before the synchronizing instant. Both measurement procedures are almost identical. They can however very somewhat. This is monitored. This means that both procedures must have issued the closure command within a tolerance range (see also Subsection „monitorings“).

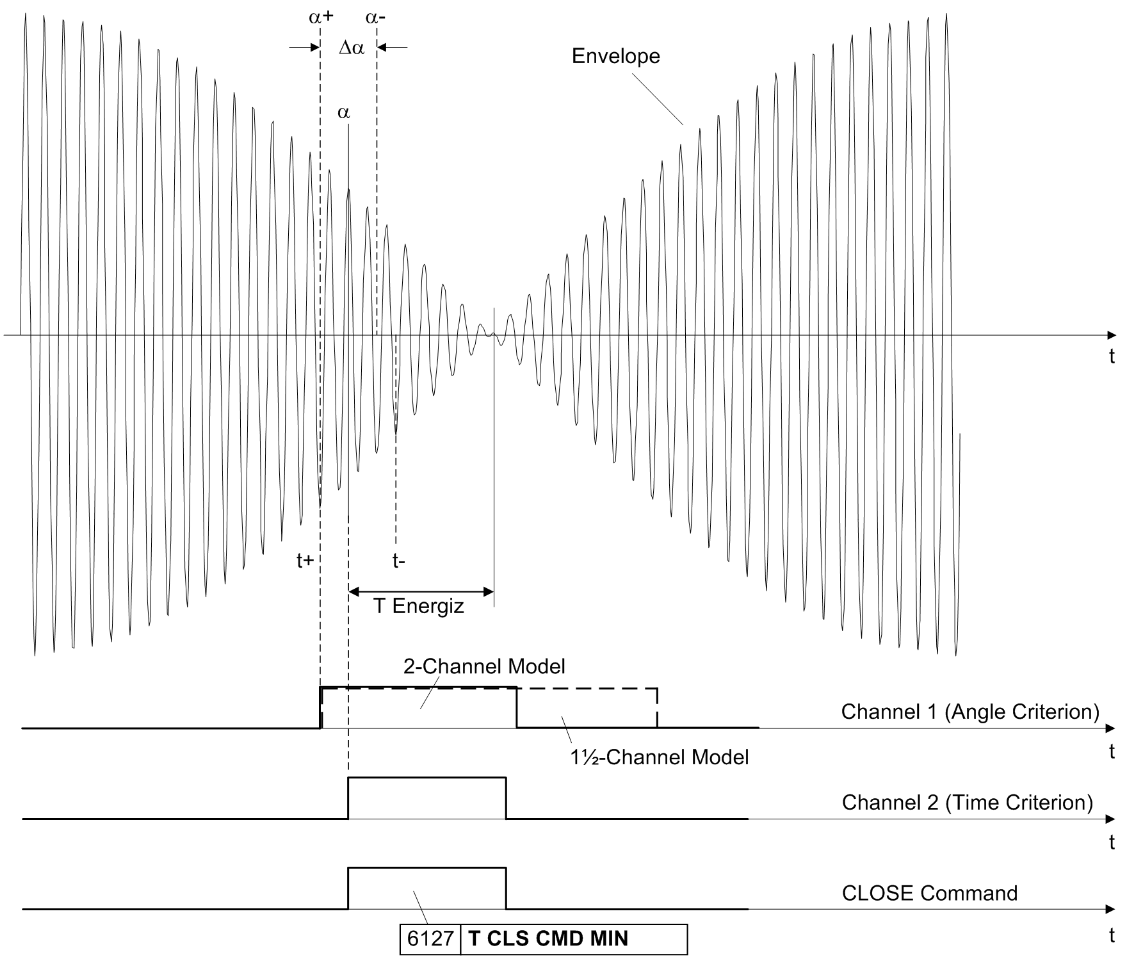


Figure 2-14 Generation of CLOSE commands from angle criterion and time criterion on asynchronous connection

The logic CLOSE commands of both schemes are sent to two hardware monitored relays (BO1 and BO2). Via their in series connected contacts the CLOSE command is sent to the circuit breaker trip coil.

2.2.1.11 Control and Closure Logic

This section provides an overview of further essential logic components. From the control side the following procedure is assumed:

- Selection of the synchronizer (measuring quantities connection, interconnection with the circuit breaker and selection of the synchronizing functional groups)
- Start of synchronizing

The synchronism can be started in different ways. An overview can be seen in figure 2-15.

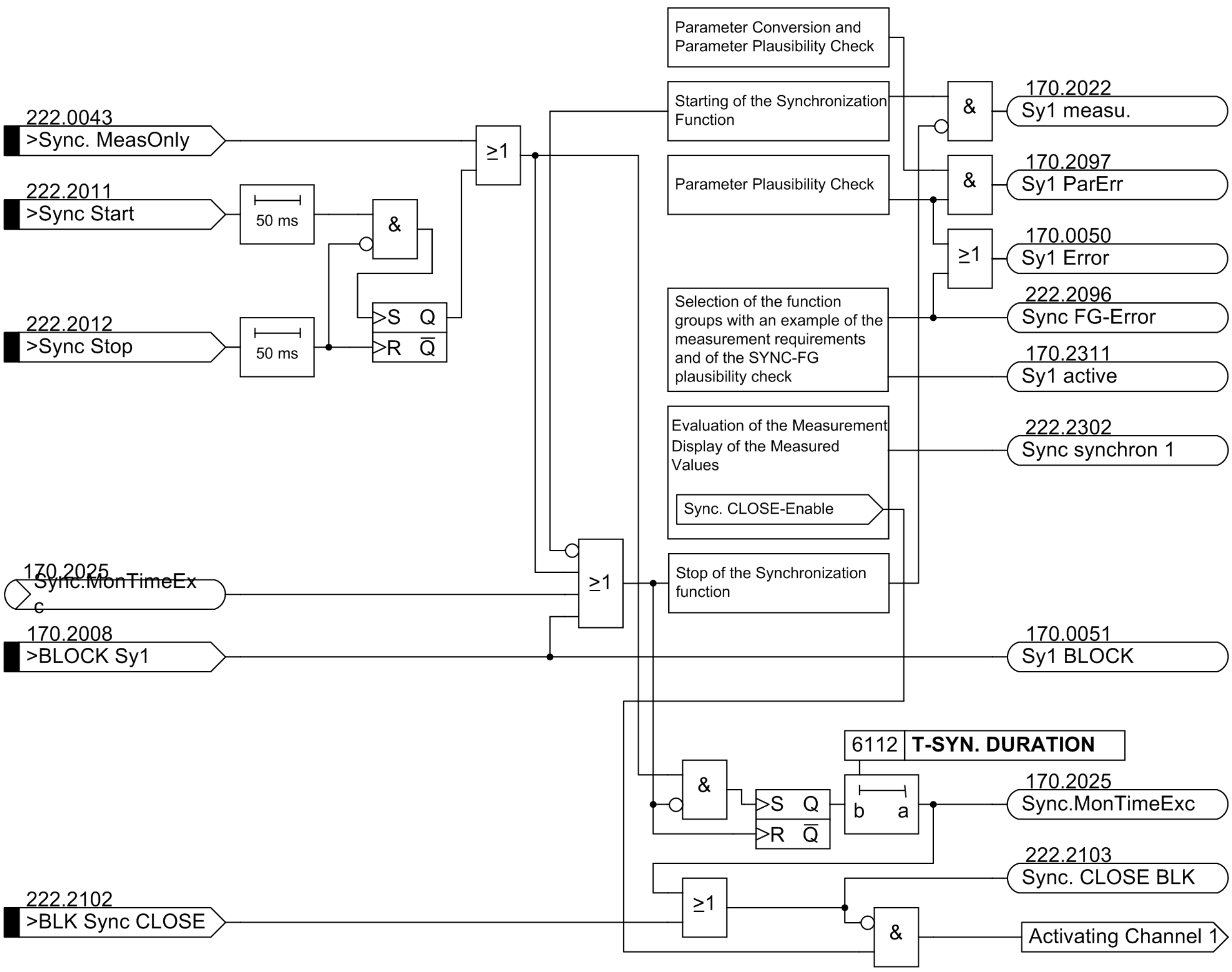


Figure 2-15 Start logic (illustration for one channel)

The start input „>Sync Start“ is to be used with parallel connection. Here a short pulse is sufficient (>100 ms). The information is recorded in the flip-flop and the rest logic is released. Simultaneously, the monitoring time is started. If this elapses without previous closing, the function is terminated. If a running synchronization should be interrupted, the stop input „>Sync Stop“ has to be pressed. The stop input is dominant to the start input. Alternatively synchronization can also be interrupted using the blocking input „>BLOCK Sy1“. The corresponding annunciation „Sy1 BLOCK“ is produced.

The logic described in the individual sections is processed in each procedure separately. The logic shown in figure 2-16 uses in time supervision (below right), the same operating mode is monitored - both procedures must have detected „synchronous switching“ or „asynchronous switching“ - (upper left) and in the event of positive conditions both closure commands are issued.

Using the parameter 6001 **COM. TESTSYNC.** or the binary input 222.2340 „>COM Test sync.“ a synchronization test can be carried out. This synchronization test is started as a normal synchronization. However, the messages „Sync CloseRel 1“ and „Sync CloseRel 2“ are suppressed, do not press the CLOSE relay BO1 and BO2 and instead, the annunciations 222.2341 „Test CloseRel 1“ and 222.2342 „Test CloseRel 2“ are displayed, so long as the synchronism is successfully established.

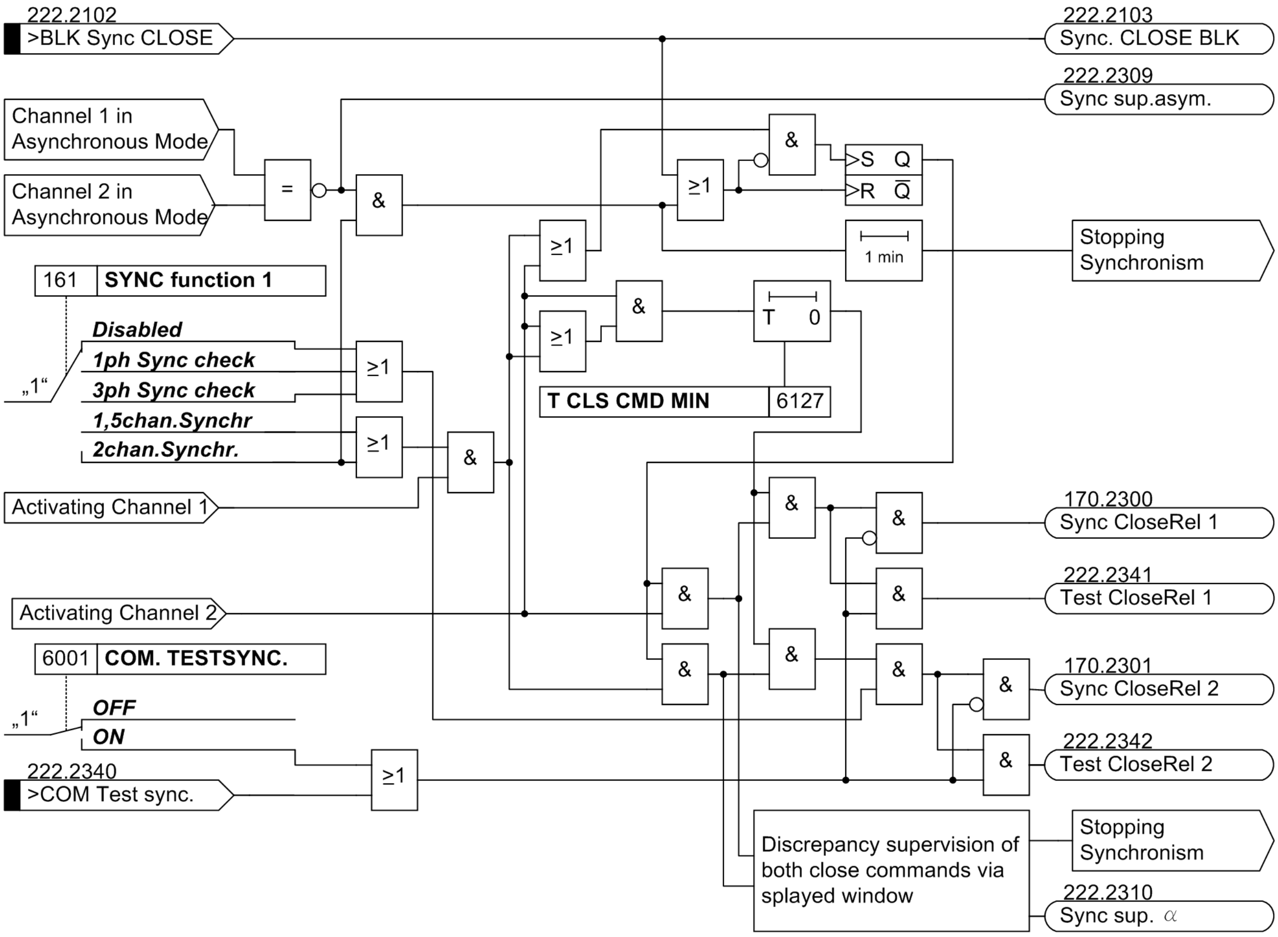


Figure 2-16 Logic for CLOSE command energization

2.2.1.12 Automatic Synchronizing of Generators

Functional Description

For devices variants with balancing commands 7VE6**-*****-***C** or **D**** fully automatic synchronising of the generator with the power system is possible. If the synchronizing conditions are not fulfilled the device automatically outputs actuator signals. The actuator signals are proportional to the voltage or frequency difference i.e. with greater differences longer actuator commands are issued. Generator voltage and speed are influenced by the particular controllers so that fast connection is made possible.

By means of the balancing commands of the 7VE6 to the speed controller of the drive machine, generator frequency is brought quickly to the parallel connection point. At the same time the generator voltage is matched to the power system voltage by actuator commands to the voltage controller of the generator or to the taps changer of the transformer. On parametrization of the device it is possible to establish whether parallel connection is to be done only in the oversynchronous or undersynchronous state, or in both states.

If both sides have exactly the same frequency but different phase angles, no synchronisation is possible. In such a case the 7VE6 causes a small change of frequency and thus a gradual change of phase angle by means of a short actuator pulse („Kick impulse“).

Control Variables

The controller changes its setpoint values by actuator pulses, in accordance with their pulse length. To adapt to the dynamics of the controller and the generator, voltage change **dU2 / dt** and frequency change **df2 / dt** as well as minimum and maximum pulse lengths can be adjusted. If the setpoint is adjusted by the pulse, the controller requires some time to adapt the controller variables to the new setpoint. To dampen state changes, the next actuator command is issued only after this response time has expired. This time can be likewise parametrized as **T U PAUSE** or **T f PAUSE**.

The main effect of the times is shown in figure 2-17. The actuator time depends on the measured difference values (dU or df) and on the set control speed (dU/dt or df/dt). For larger actuator times a restriction results from the maximum pulse length. If the actuator time is larger, it is distributed among several pulses. Calculated actuator times less than the required minimum pulse time are output.

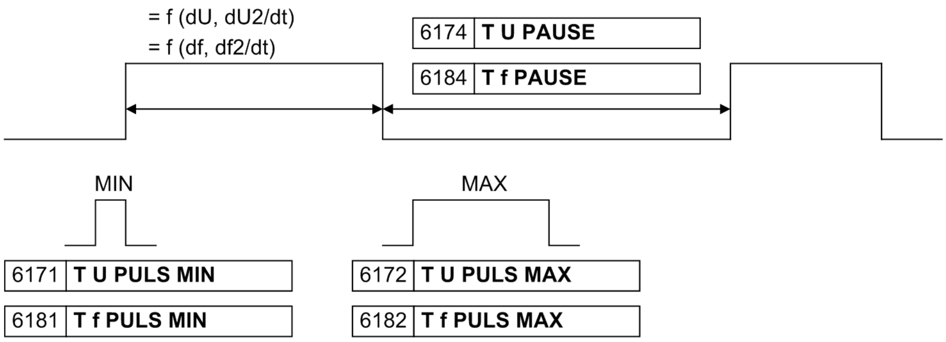


Figure 2-17 Actuator and pause

Voltage Balancing

The amplitude of side 2 can be adjusted using actuator pulses via the voltage controller or the transformer tap changer. The permissible range for the synchronization is defined by parameters 6130 **dU ASYN U2>U1** and 6131 **dU ASYN U2<U1**. The mean value of the two setting parameters is used as a target value for deriving the setting pulse. In case of very unsettled power system conditions it may be advantageous to filter the measured values (smoothing mean value formation). Parameter 6175 **SMOOTHING U** under DIGSI is used for this purpose.

In combination with the frequency adjustment the overexcitation (U/f) is continuously monitored. If the set threshold is exceeded, a limitation of the control outputs takes place, so that the permissible overexcitation is achieved. Setting parameter 6176 **(U/Un) / (f/fn)** can only be accessed via the operating program DIGSI.

On balancing of voltage via transformer tap changer, no variable actuator pulses can be output since the transformer can only be adjusted by one whole tapping. For this purpose a pulse of defined length is required, matched to the tap changer. The time for the pulse is established by the parameter 6172 **T U PULS MAX**. After each pulse the response time is awaited 6174**T U PAUSE**.

Frequency Balancing

Balancing commands to the speed controller of the drive machine are issued for as long as the generator is outside the admissible frequency band for asynchronous connection, determined by the parameters. Within the asynchronous operating range, actuator pulses should be issued only if the phase angles of both voltages differ, their difference $\Delta\alpha$ being far from 0°. In the envelope curve this corresponds to an increasing amplitude. If the connection point is being approached, no further frequency adjustment commands should be issued. For this purpose — assuming a calculated ideal switching time instant — a time period 6189 **T SW-ON MIN** can be set during which no further actuator pulses are issued or commenced pulses are aborted, as shown in Figure 2-18.

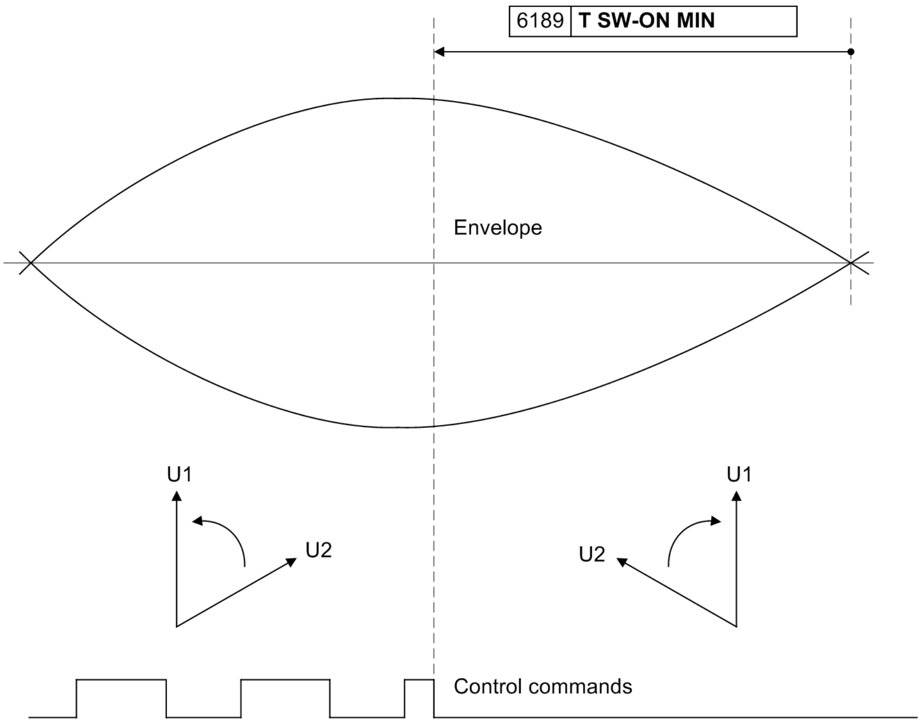


Figure 2-18 Output of the frequency adjustment commands

If the generator is in the synchronous operating range („stationery synchronous vector"), only short-term pulses („Kick impulses") are then output, adjusting the frequency of the fixed frequency value by (–0.10 to +0,10 Hz) under parameter 6188 **Δf KICK**.

If unsettled frequency conditions prevail which cause excessive adjustments, it is of advantage to somewhat average the frequency measured value. This is possible via parameter 6186 **SMOOTHING f**. This setting can only be changed with the operating program DIGSI.

Enabling Logic

In order that an output of setpoints can be performed, the following conditions of the voltages U1 and U2 and their frequencies have to be maintained:

Voltages	1 V to 200 V
Frequencies	$0{,}5 \cdot f_N$ to $1{,}5 \cdot f_N$

with f_N = 50 Hz, 60 Hz or 16,7 Hz

In addition balancing commands are possible only after either synchronization was started or the binary input „>Start Balanc." was activated (see logic diagram 2-19). Blocking of balancing commands is possible at any time using a binary input. Balancing commands are interrupted if the synchronous operating range is recognized, meaning Δf < Parameter 6141 **F SYNCHRON**. In this range only kick impulses are admissible. As long as the pause time after an adjustment pulse is current or as soon as a closure command is issued, likewise no adjustment pulses are admissible. Balancing commands are permitted in the synchronous operating range only if the time lies until the next possible connection over the described period with the parameter 6189 **T SW-ON MIN**.

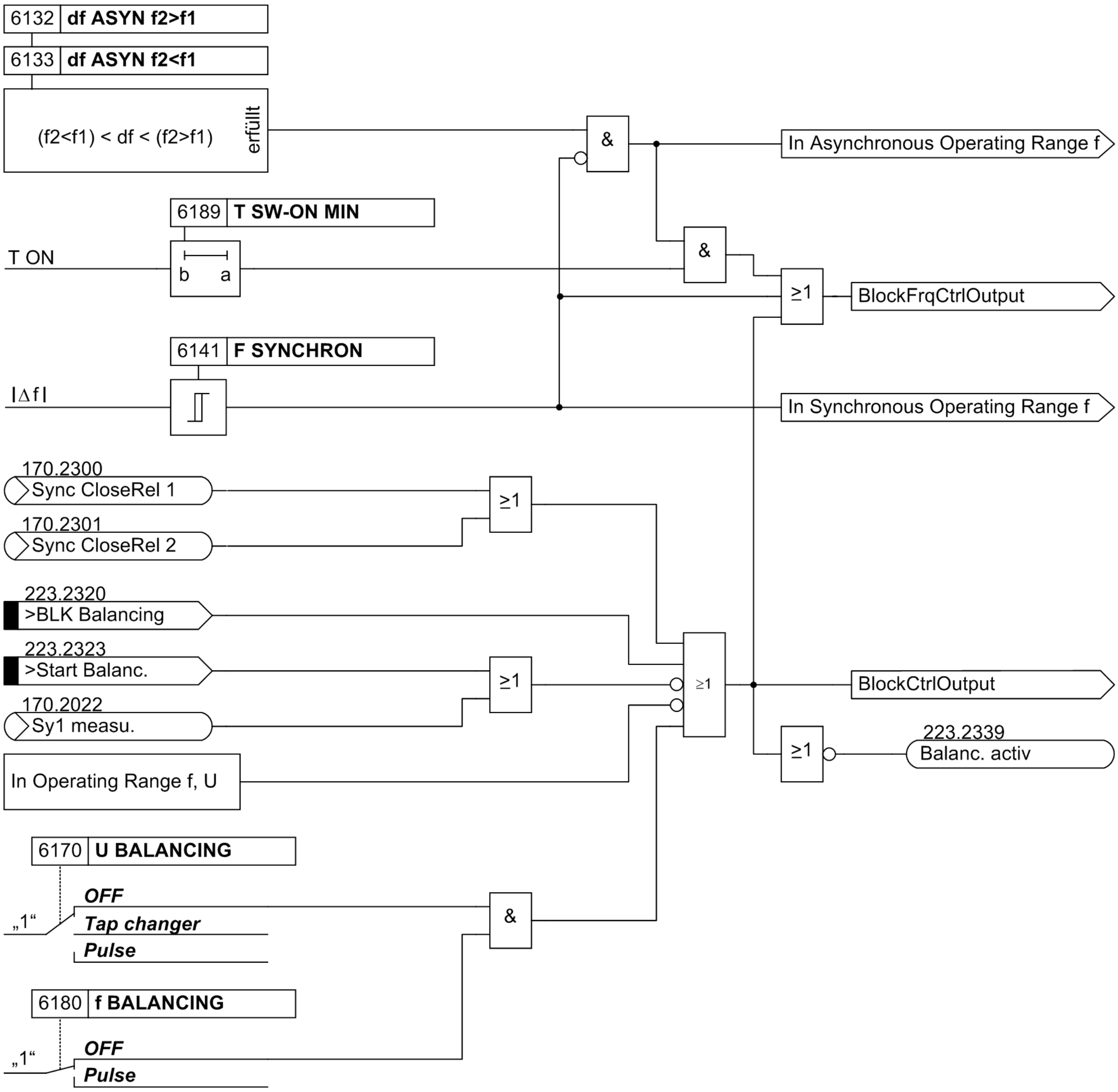


Figure 2-19 Logic diagram for blocking balancing commands

Output of Balancing Commands

If there are no blockages, a pulse time is computed and started on the basis of the parameter settings and the particular difference values from the setpoint. After the impulse time has elapsed, the dead time is started. If setpoints are exceeded during output, i.e. if the sign of the voltage or frequency difference changes, the actuator pulse is aborted and after expiry of the dead time a pulse is started in the opposite direction. Figure 2-20 shows the logic diagram for generation of the voltage actuator pulses, Figure 2-21 the logic diagram for the generation of the frequency actuator pulses.

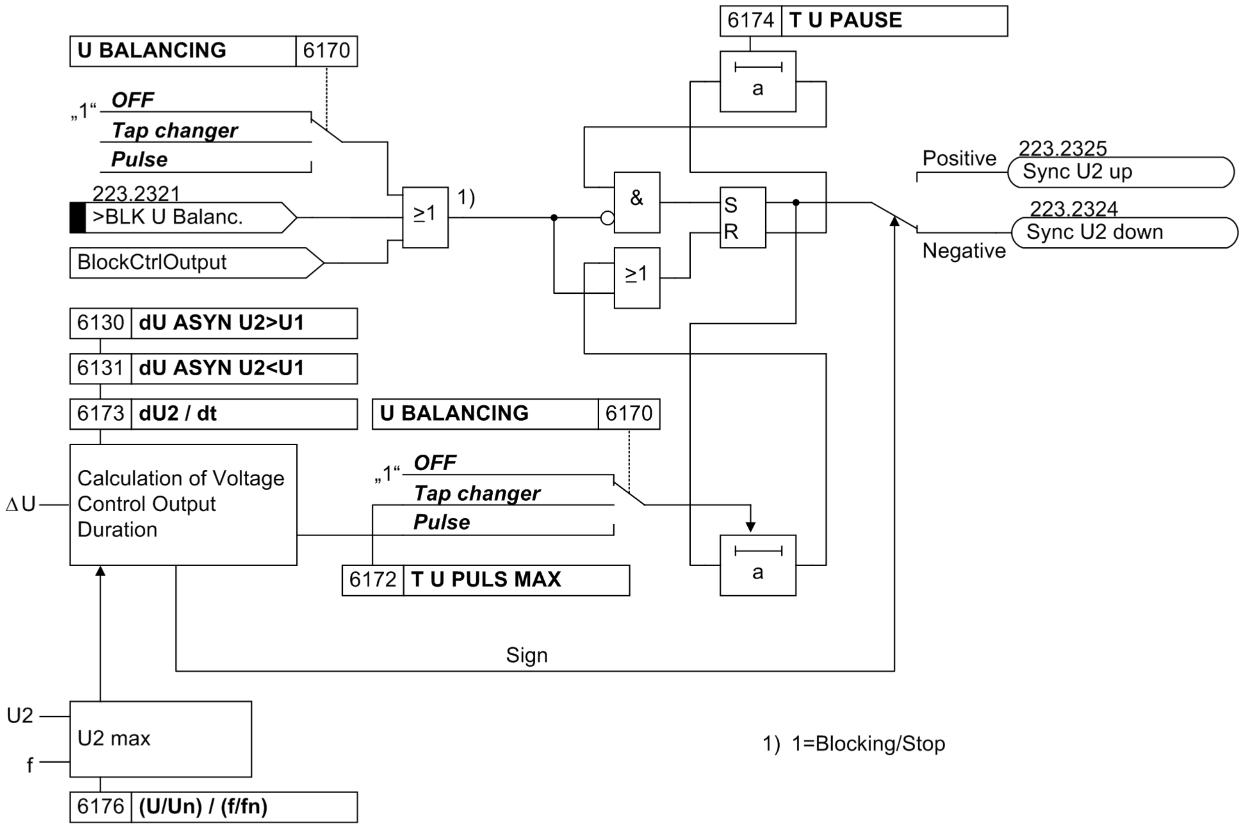


Figure 2-20 Logic diagram for generation of voltage balancing pulses

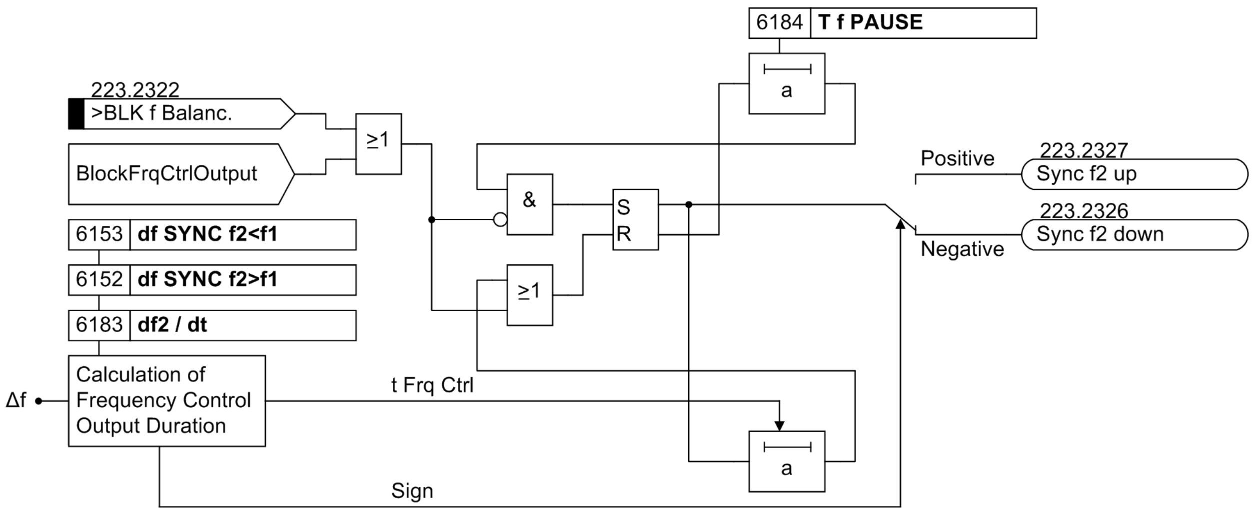


Figure 2-21 Logic diagram for generation of frequency balancing pulses

If the synchronous operating range is detected, i.e. the frequency difference Δf is less than parameter 6141 **F SYNCHRON**, the connection conditions however are not yet fulfilled (ΔU and Δα are not in the admissible range), then „kick impulses“ may be issued if the voltage controllers will not converge within a short time. This is the case if the time to synchronism exceeds a particular time.

If for the parameter 6132 **df ASYN f2>f1** a nonzero value is set, i.e. parallel switching from the oversynchronous range is permitted, then the target value 6188 **Δf KICK** should be set to a positive value because kicking is done in the target value direction **Δf KICK**.

Within the range of very small frequency deviations, actuator pulses are output with the minimum pulse time set under parameter 6171 **T U PULS MIN**, so long no kick impulse is displayed. Figure 2-22 shows the operating range of the actuator and kick commands. Figure 2-22 also contains the parameter 6185 **Δf SET POINT**. This forms the target value for deriving the frequency balancing pulse. I.e. the generator speed is brought to this setpoint.

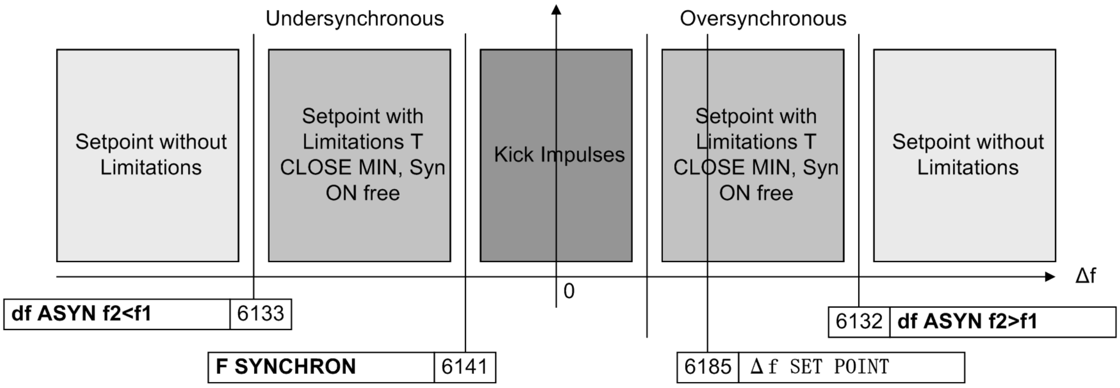


Figure 2-22 Operating ranges balancing commands/kick impulses

The balancing commands are output as binary data only through the corresponding indications, directly via the field bus (Profibus DP). Note that the minimum time for an adjustment pulse cannot be shorter than the cycle time of the Profibus.

2.2.1.13 Interaction with Control Functionality

The paralleling devices 7VE61 and 7VE63 are equipped with the same control function as all SIPROTEC 4 devices. For control tasks the 7VE63 is particularly suitable since it avails of numerous binary inputs and outputs, a graphic display for switch diagrams and the required key switches (local and remote control or interlocked and non interlocked operation). The synchrocheck function also operates with the device control. The corresponding interconnection is established via parameter 6102 **SyncSD**. If the required synchronization device is here entered, e.g. ***Q0***, then the synchronization functional group works in conjunction with the internal control.

If a CLOSE command is issued, the control accounts for the fact that the switchgear component requires synchronization. The control sends a measurement request („Sy1 Ctrl“) to the synchrocheck function which is then started. Having completed the check, the synchrocheck function issues the enabling indication () to which the control responds by ending the switching operation positively or negatively (see figure 2-23).

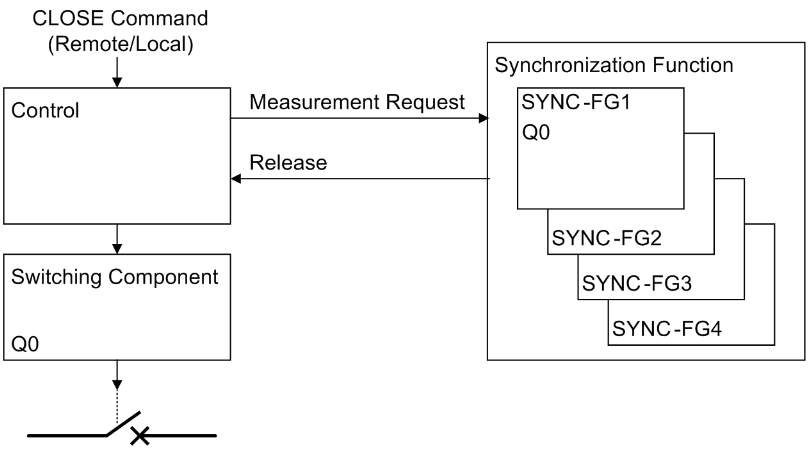


Figure 2-23 Interaction of control and synchrocheck

2.2.1.14 Commissioning Tools

The devices 7VE61 and 7VE63 are designed so that they can be commissioned without external test equipment and recorders. There is also, among others, a protected commissioning aid password (IBS Tool). With this tool, the CLOSE time can be automatically measured via the device (internal command up to closing the circuit breaker poles). This process is recorded with the oscillographic fault record.

All measured values relevant for commissioning are available in the operational measured values. The performance of the synchronizing function and of the device is documented in detail in addition in the operational indication and synchronising indication buffers. The connection conditions are established in the synchronisation recording.

A trial at synchronisation is still possible. All procedure run in the device but the two closure relays R1 (BO1) and R2 (BO2) are not activated. This state can be achieved also via binary input.

The commissioning aids are activated via the parameter 6001 **COM. TESTSYNC.** = ***ON***.

WEB-Server

As an extension to the universal operating program DIGSI, a web server is contained in the 7VE6*, which can be activated by means of a remote transmission connection and a browser (e.g. Internet Explorer). The advantage of this solution is on the one hand that the device can be operated by using standard software tools, and in principle the Intranet/Internet infrastructure.

On the other hand individual information can be deposited in the device without complication. In addition to purely numerical values, visualisations facilitate device operation. In particular, defined information and a very high control security are achieved via graphic illustrations. Figure shows a sample general view, as it is known from the classical synchronization function (cursor definition see in „Connection and Definitions“ in Section 2.2.2). The actual state of the synchronization conditions is clearly evident.

Naturally additional measured value diagrams and indication buffers can be called up. Using the integrated device operation simulation, in addition for commissioning purposes selected setting values can be adapted.

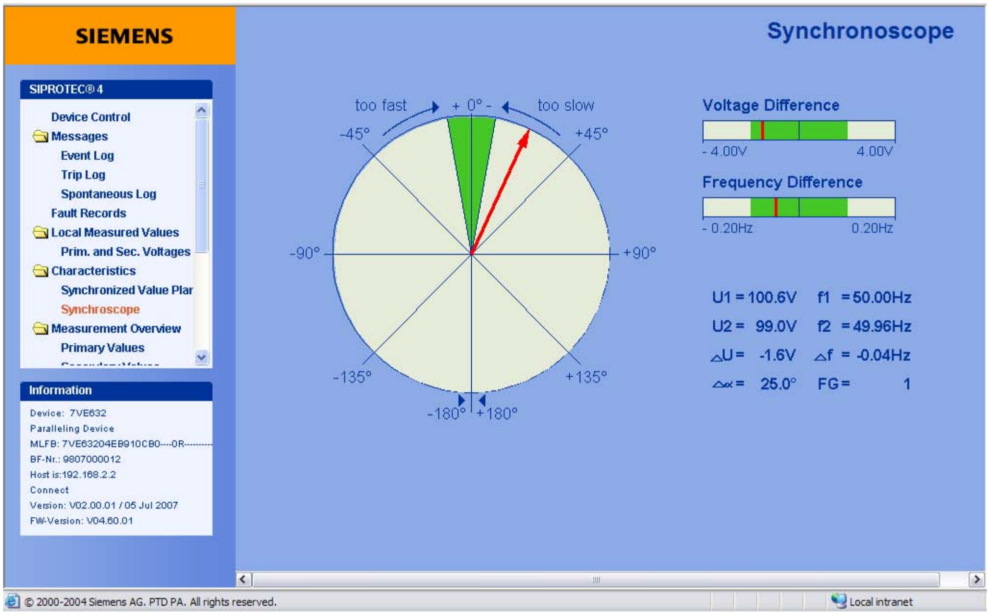


Figure 2-24 Browser control – Visualisation of the synchronisation values (Synchroscope)

To avoid simultaneous operation at the device and at the PC, the commissioning a can be adjusted under password protection only, at the device, or changed from one option to another.

Further details are given in the setting instructions and in chapter „Mounting and Commissioning“.

2.2.2 SYNC Function group 1

Depending on the device variants, parametrization possibilities are provided for up to eight different synchronizing functions. The following describes the setting notes, parameter and annunciations for the first synchronising function (**SYNC Function group 1**). The same applies to function groups 2 to 8.

2.2.2.1 Setting Notes

General

On setting the **P.System Data 1** (see Section 2.1.2.1) the device allocates a rated value of significance for the synchronizing function:

270 **Rated Frequency**: The operating range of the synchronizing function refers to the nominal frequency of the power system = (f_N ± 3 Hz).

The synchronizing function can only operate if during configuration of the functional scope (see subsection 2.1.1.2) under at least one of the addresses 161 **SYNC function 1** to 168 **SYNC function 8** was set as present. The operating mode can be preselected:

1ph Sync check corresponds to the classical synchronizing function with in each case single-phase connection of the voltages to be compared. Observe thereby that this selection involves a fixed allocation between synchronizing function group and voltage channels. The allocation is shown in the following table

Table 2-3 Allocation between synchronizing function group and voltage channel for single-phase synchro check.

Synchronizing Function Group	Voltage Channels		Device Connections	
1	Ua	Ud	Q1, Q2	Q7, Q8
2	Ub	Ue	Q3, Q4	Q9, Q10
3	Uc	Uf	Q5, Q6	Q11, Q12

A possible connection variant for a single-phase synchro check is shown in the following diagram with further details.

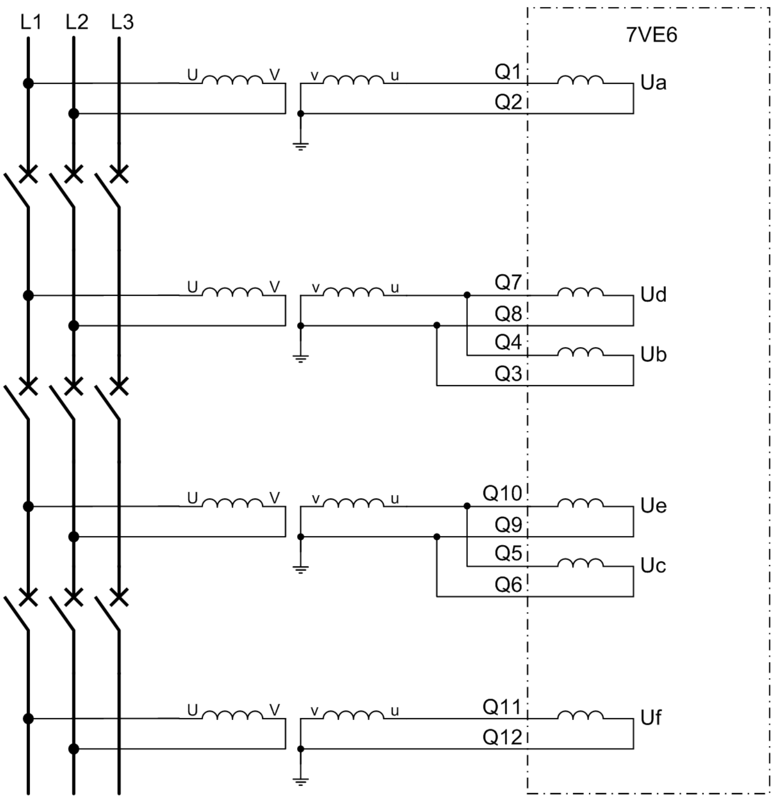


Figure 2-25 Single-channel synchrocheck function for 3 synchronizers

Thereby three circuit breakers can be monitored more or less in parallel. This saves wiring switching and checking expense. This application example is of particular significance in $1^1/_2$ circuit breaker technology.

3ph Sync check corresponds to the classical synchronizing function with possible in each case three-phase connection of the voltages to be compared. With this standard connection (see connection example in appendix A.3) a high degree of safety is offered. The phase sequence check is also active (with set parameter 6x13 **PHASE SEQUENCE** = ***L1 L2 L3*** or ***L1 L3 L2***) and on switching to an idle bus several voltages are scanned. This manages the single fault condition (broken wire in the voltage connection).

1,5chan.Synchr with the 7VE61 or ***2chan.Synchr.*** with the 7VE63 corresponds to operation as a paralleling device. Standard connection is three-phase (see connection example in appendix A.3), data are processed up to command issuing $1^1/_2$ channel with the 7VE61, or two-channel with the 7VE63 with the monitorings mentioned in the function description. Alternative connection variant are likewise shown in appendix A.3 or treated under „Connections and Definitions“ in Section 2.2.1.

If the function is not required ***Disabled*** is to be set. A synchronizing function group thus rendered ineffective is disabled in the menu item **Synchronization**; other groups in this menu are displayed enabled.

Only the corresponding indications of the **SYNC Function group 1** are pre-allocated for IEC 60870–5–103. If other function groups (2 to 8) are configured and if their indications are to be disposed of via IEC, they must first be configured to the SYS interface.

Selecting one of the displayed SYNC function groups in DIGSI opens a dialog box with the tabs , Power System, , , , U Balancing, f Balancing and Tap changer in which the individual settings for synchronism can be made. The following settings are carried out via **SYNC Function group 1** in address block 6**1**. For the SYNC function groups **2** to **8** the same applies correspondingly, the associated addresses start with 6**2** to 6**8**.

General Settings

The general limit values for the synchronizing function of the SYNC group 1 are set under addresses 6101 to 6120.

Under address 6101 **Synchronizing** can be set to switch the entire synchronous function group 1 ***ON***- or ***OFF***. If switched off, the synchronous check does not verify the synchronization conditions and no enabling occurs.

Address 6102 **SyncSD** is used to select the switchgear component to which the synchronizing settings are to be applied. If the option ***none*** is selected the function can be used as an external synchronizing feature. It will then be triggered via binary input messages. This corresponds to standard use as a parallel device.

Parameters 6103 **Umin** and 6104 **Umax** set the upper and lower limits for the operating voltage range for U1 or U2 and thus determine the operating range for the synchronizing function. If the values leave this band, a message will be output. A typical setting is approx. ±10 % of rated voltage.

Address 6105 **U<** indicates the voltage threshold below which the feeder or the busbar can safely be considered switched off (for checking a de-energized feeder or busbar). For this a preset value of approx. 5 % rated voltage was selected.

Address 6106 **U>** indicates the voltage threshold above which the feeder or busbar can safely be considered energized (for checking an energized feeder or busbar). It must be set below the minimal anticipated operational undervoltage. For this reason a setting value of approx. 80 % rated voltage is recommended.

The setting for the mentioned voltage values is made in secondary volts.

Addresses 6107 to 6110 are set to specify the enabling conditions for the closing check. The following addresses mean:

6107 **SYNC U1<U2>** = Component U1 must be de-energized, component U2 must be energized (connection to reference without voltage, dead bus);

6108 **SYNC U1>U2<** = Component U1 must be energized, component U2 must be de-energized (connection to feeder without voltage, dead line);

6109 **SYNC U1<U2<** = Power supply unit U1 and U2 must both be dead (connection with dead reference and dead feeder, Dead Bus/Dead Line);

These possible enabling conditions are independent of each other and can also be combined.

For safety reasons enablings are switched off in the presetting and are thus set to ***NO***.

Parameter **TSUP VOLTAGE** (address 6111) can be set to configure a monitoring time which requires above stated release conditions to be present for at least de-energized switching before switching is allowed. The preset value of considers transient responses and can be applied without modification.

Enabling via synchronous check can be limited to a configurable synchronous monitoring time **T-SYN. DURATION** (address 6112). The configured conditions must be fulfilled within this time. Otherwise release is not granted and the synchronizing function is stopped. If this time is set to ∞, the conditions will be checked until they are fulfilled. This is also the preset value. On establishing a time limit operational conditions must be observed. They must be established in accordance with each system.

With parameter 6113 **PHASE SEQUENCE** you can disable the phase sequence check for the U1 and U2 voltages together or enable them together for clockwise rotation (***L1 L2 L3***) or anticlockwise rotation (***L1 L3 L2***). This parameter is not displayed for single-phase synchronization check.

With enabled phase sequence check this voltage input (Uc; Uf) is referred to additionally to detect a disconnected or energized line or busbar (see also subsection „Switch to dead busbar/dead line“ in the function description of the synchronizing function).

Power System Data

The power system data for the synchronizing function are set at addresses 6120 to 6127.

The circuit breaker closing time **T-CB close** at address 6120 is required if the device is to close also under asynchronous system conditions. The device will then calculate the time for the close command such that the voltages are in phase in the instant the breaker poles make contact. Please note that this should include the operating time of the breaker as well as the operating time of an auxiliary relay that may be connected in the closing circuit. You can determined the breaker operating time by means of the 7VE61 and 7VE63 (see commissioning notes in Chapter 3).

Note

Note that for safety reasons the circuit breaker closing time is preset to ∞, asynchronous connection is therefore not possible using the delivery setting. In this case the indication „Syx ParErr“ for the selected synchronizing function group x is issued.

If the circuit breaker closing time via evaluating fault records is obtained, in this way the measured value can be directly transferred. On the contrary, if an external timer is used, the measured time of an internal running time of 22 ms at f_N = 50 or 60 Hz and of 42 ms at f_N = 16.7 Hz is to be add.

With the **Balancing U1/U2** (address 6121) different VT ratios of the two parts of the power system can be considered (see example in the following figure 2-26). In order that the device can compare both secondary voltages, the voltage U2 is multiplied with the **Balancing U1/U2** and this value is also displayed in the operational measured values.

Note

Since voltage U1 is by definition the reference voltage, the secondary voltage $U2_{sec}$ alone is multiplied by the **Balancing U1/U2**.

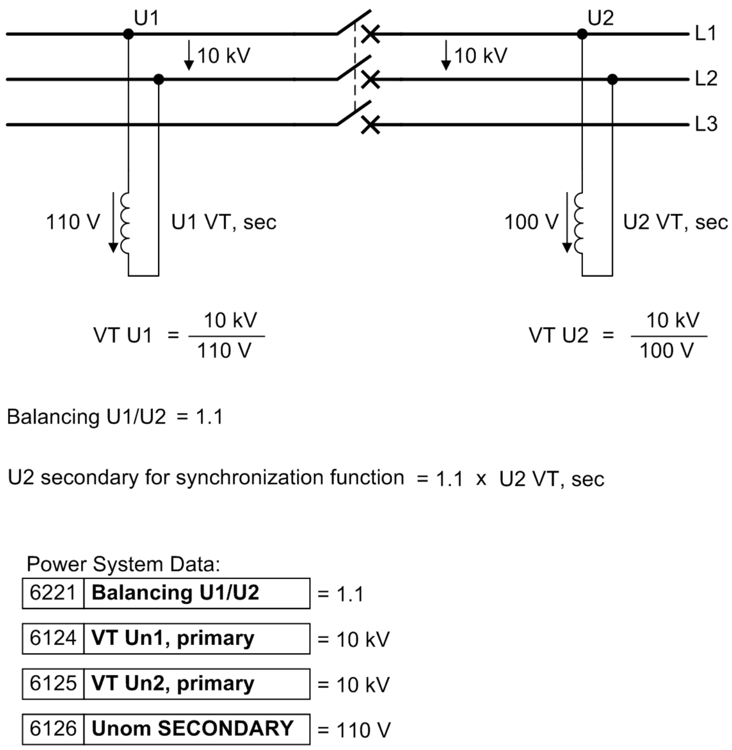
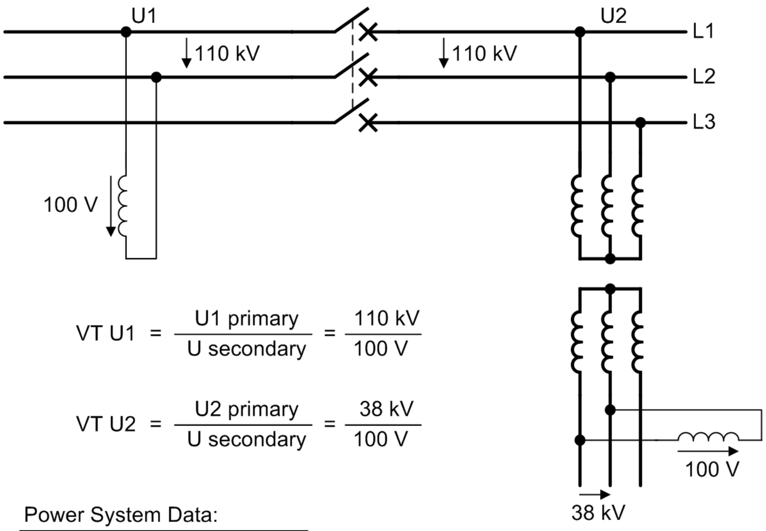


Figure 2-26 Station configuration with various VTs

Normally different secondary rated values are rare and the factor remains therefore at ***1.00***. If the voltage transformers are differently loaded however, amplitude errors may result. This can be compensated for using the **Balancing U1/U2**. The setting value must be established after commissioning on the primary system (see Commissioning instructions in chapter 3).

The parameter may also be used to adapt with a transformer tapping switch the individual voltage stages for synchronization. For this the parameter 6121 can be provided with various values suitable to the individual voltage levels. If therefore the transformer in the following diagram has 3 stages, 3 synchronizing function groups are used and set identically except for the parameter 6121.



Power System Data:

6121	Balancing U1/U2	= 1.0
6124	VT Un1, primary	= 110 kV
6125	VT Un2, primary	= 38 kV
6126	Unom SECONDARY	= 100 V

Figure 2-27 Example of measurement via transformer

In the 3 function groups values are taken from the following table and entered for the adaptation factor 6121 **Balancing U1/U2**. Via input indication „>Sy1 activ“ to „>Sy8 activ“ the synchronizing function suitable for the current transformer tap can be selected. This can occur directly via binary input or be derived from the CFC.

Table 2-4 Possible Transformator Settings

Transformer Tap	Primary rated voltage U2	Balancing Factor U1/U2
1	36.0 kV	1,06
2	37.0 kV	1,03
3	38.0 kV	1,00

The parameter 6122 **ANGLE ADJUSTM.** is used to correct any phase angle errors between the voltage transformers in degree steps. A possible correction value should be derived during commissioning.

Using the setting parameters **Balancing U1/U2** and **ANGLE ADJUSTM.** system versions can be managed where voltage transformers are connected differently or different voltage transformers are used on side 1 and side 2. The setting can be explained by two examples. In the diagram 2-28 the two-pole isolated voltage transformers are connected to different phase-to-phase voltages. Both primary and secondary voltages are equal.

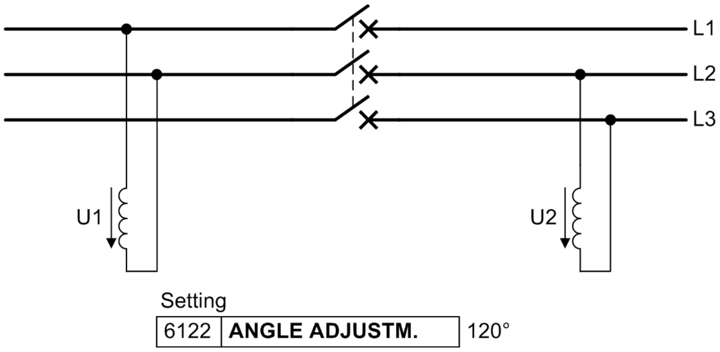


Figure 2-28 Connections U1 (L1–L2) and U2 (L2–E)

Figure 2-29 shows the combination for two-pole and single-pole isolated voltage transformer.Since both voltage transformers have the same transformatio ratio, the secondary voltage differs in amplitude by the factor $\sqrt{3}$ and by the phase angle 150° in accordance with the selected connection.

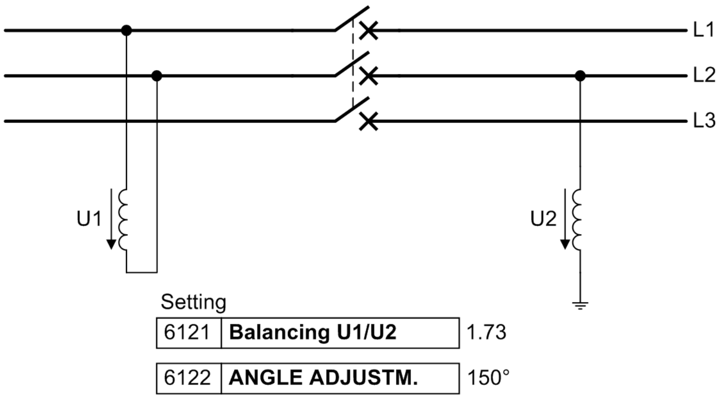


Figure 2-29 Connections U1 (L1–L2) and U2 (L2–E)

If a power transformer lies between the voltage transformers of the circuit breaker to be synchronised, the phase angle rotation of a vector group differing from zero must be corrected. A typical application is shown in figure 2-30. At parameter 6122 **ANGLE ADJUSTM.** the rated apparent power is entered.

The transformer vector group is defined from the high voltage side to the low voltage side. The reference voltage transformer U1 is connected to the high voltage side of the transformer. The phase angle rotation is to be entered in accordance with the vector group. A vector group numeral e.g. 5 means an angled rotation 5 · 30° = 150°. This value is set at address 6122.

If the voltage connection U1 is on the system lower voltage side, the extension angle should be set to 360°. For a transformer with vector group 5 this corresponds to 360° – (5 · 30°) = 210°

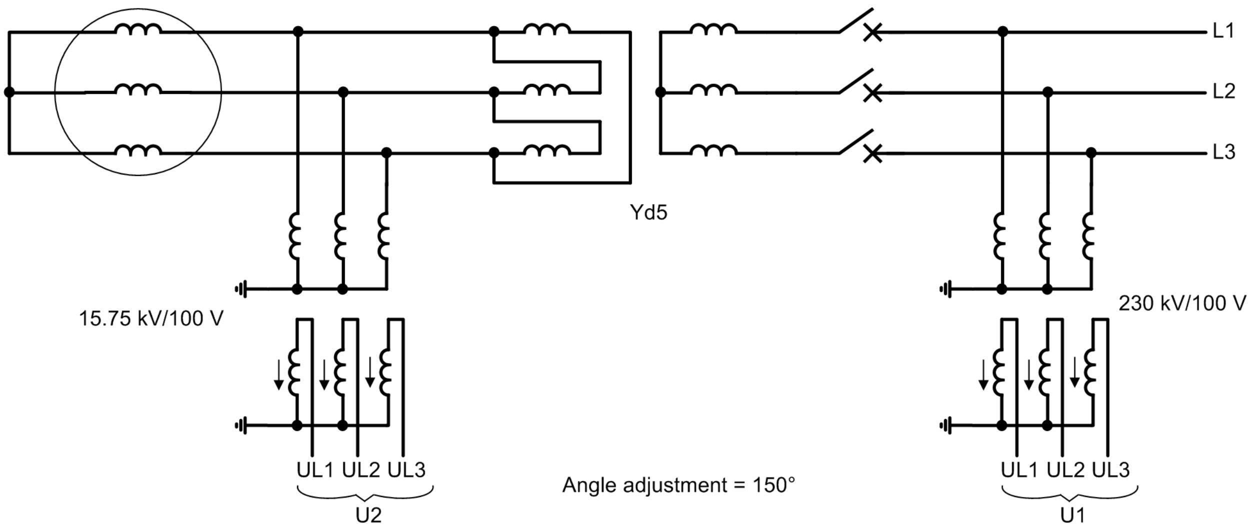


Figure 2-30 Consideration of a phase angle rotation

At address 6124 **VT Un1, primary** the primary transformer rated voltage of side 1 is entered for correct primary representation of the measured values. Analog to this the primary transformer rated voltage of side 2 is entered under address 6125 **VT Un2, primary**.

Address 6126 **Unom SECONDARY** represents the secondary transformer rated voltage.

Under address 6127 **T CLS CMD MIN**, sets the duration of the closing command to the circuit breaker. This must always be greater than the circuit breaker closing time (address 6120); such that the circuit breaker safely completes the closure and has interrupted closure control circuit with its auxiliary contact. For safety reasons, the time should not be set longer than necessary.

The default setting of ***0.1 s*** corresponds to common circuit breakers; however, the particular power system must be checked.

Asynchronous Conditions

With asynchronous systems a connection command is issued by the synchronizing function so that, taking into consideration the operating time of the circuit breaker (address 6120 **T-CB close**), the power systems are coupled when the vectors are in phase. Apart from the circuit breaker closing time (make-time) 6120 **T-CB close** 6130 to 6133 for this purpose are relevant.

With parameters 6130 **dU ASYN U2>U1** (admissible voltage difference, if U2 is greater than U1) and 6131 **dU ASYN U2<U1** (admissible voltage difference if U2 is less than U1) the admissible voltage differences can be also set asymmetrically.

To prevented the reactive power loading of the generator after connection from becoming too large, a setting of 2 % of rated voltage has proven suitable.

Parameters 6132 **df ASYN f2>f1** (admissible frequency difference if f2 exceeds f1) and 6133 **df ASYN f2<f1** (admissible frequency difference if f2 is less than f1) restrict the operating range for asynchronous connection. The availability of two parameters enables an asymmetrical release to be set.

A usual setting value is about 0.1 Hz. This keeps the possible active power compensation within limits on connection.

Synchronous Conditions

Parameter 6140 **SYNC PERMIS.** selects whether on undershooting of the threshold **F SYNCHRON** (see below) only the synchronism conditions are checked (***YES***) or under all circumstances the breaker operating time is to be also considered (***NO***).

On synchronism of generators this operating mode is to be disabled. The parameter must be at ***NO***. On the other hand a main application is synchronisation of power systems.

Parameter 6141 **F SYNCHRON** serves as an automatic threshold between synchronous and asynchronous switching. If the frequency difference is below the specified threshold, the power systems are considered to be synchronous and the regulations for synchronous switching apply. If it is above the threshold, the switching is asynchronous with consideration of the time left until the voltages are in phase.

A raising of the threshold may be necessary if drives (e.g. reciprocating compressor) burden the power system differently in each half cycle and thus negatively influence frequency measurement accuracy.

Parameters 6142 **dU SYNC U2>U1** and 6143 **dU SYNC U2<U1** allowed the admissible voltage differences to be set asymmetrically also. The setting value can actually be selected higher than for asynchronous conditions. This is dictated by the system conditions (e.g. greater voltage drops due to current limiting reactor).

Parameters 6144 **dα SYNC α2> α1** and 6145 **dα SYNC α2< α1** restrict the operating range for synchronous switching with regard to admissible angle difference. These two parameters allow an asymmetrical switching range to be configured (see also figure 2-31).

The preset value for the angle must possibly be increased if current limiting reactors cause a larger phase shift. This however increases the compensation current when switching near the limits.

Moreover, the enable time delay **T SYNC-DELAY** (address 6146) can be set after which all synchronous conditions must at least be fulfilled for the closing command to be generated. A particular degree of power system quiescence is then awaited. The default setting of ***10 s*** has proven to be a good value.

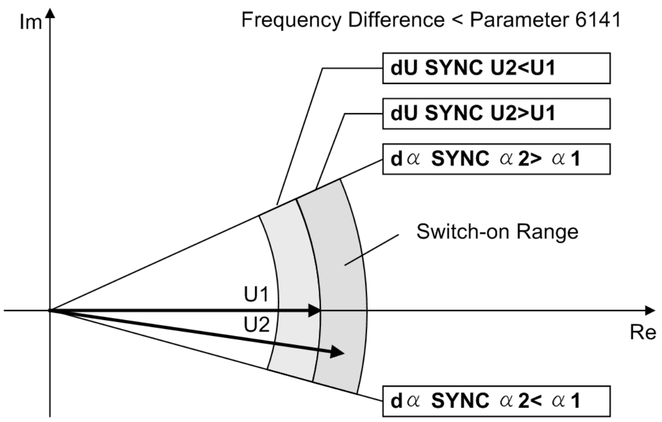


Figure 2-31 Switching under synchronous system conditions

Ranges in the U,f Diagram

Figure 2-32 shows the setting parameters both for synchronous as well as asynchronous conditions, in the U, f diagram. With synchronous power systems the frequency band is in principle very narrow.

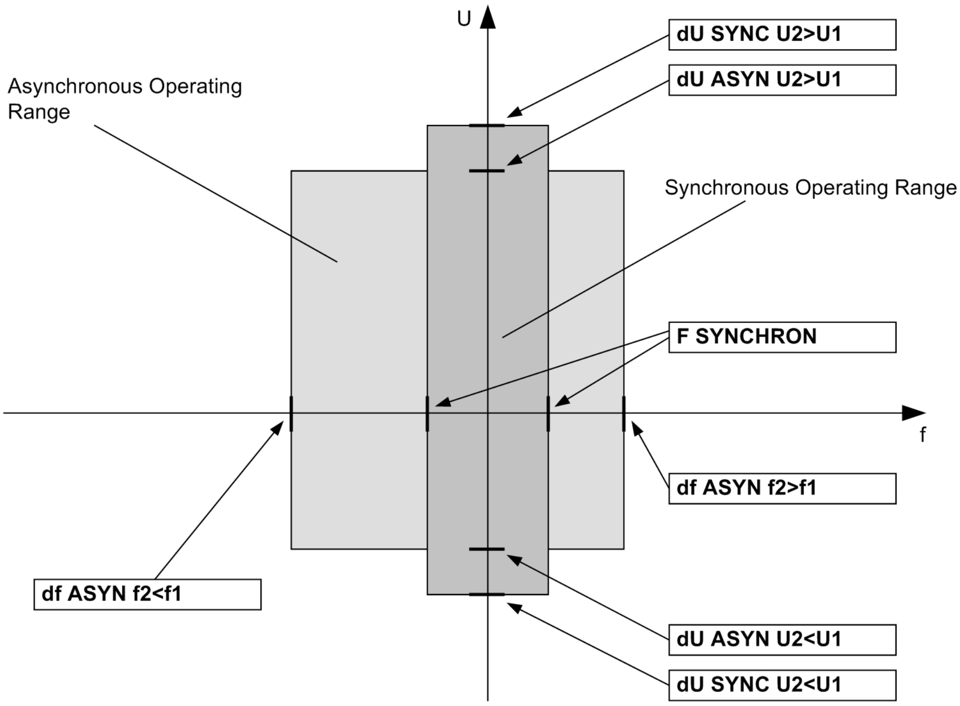


Figure 2-32 Operating range under synchronous and asynchronous conditions for voltage (U) and frequency (f)

Synchrocheck

Addresses 6150 **dU SYNC U2>U1** (permissible voltage difference, if U2 is greater than U1) and 6151 **dU SYNC U2<U1** (permissible voltage difference, if U2 is smaller than U1) can be used to set the permissible voltage differences asymmetrically. The availability of two parameters enables an asymmetrical release to be set.

The parameters 6152 **df SYNC f2>f1** (permissible frequency difference, if f2 is greater than f1) and 6153 **df SYNC f2<f1** (permissible frequency difference, if f2 is smaller than f1) determine the permissible frequency differences. The availability of two parameters enables an asymmetrical release to be set.

The parameters 6154 **dα SYNC α2> α1** (permissible angle difference, if α2 is greater than α1) and 6155 **dα SYNC α2< α1** (permissible angle difference, if α2 is smaller than α1) confine the operating range for synchronous switching. The availability of two parameters enables an asymmetrical release to be set.

The preset parameters were selected for the application „Enabling for manual synchronisation of a generator“ and correspond to the parameters as for asynchronous conditions. The angle setting relates to the admissible angle error which a generator still tolerates without excessive stress. Setting is to be done in accordance with generator. ***10°*** is a typical value.

With frequency difference of 0.1 Hz at 10°, the time interval to the instant of synchronization is 10°/0.1 Hz · 360° = 280 ms. Within this time period the manual close command should occur. The operating time of the device 7VE61 and 7VE63 is approx. 10 ms. With an assumed circuit breaker closing time of 60 ms, approx. 2.5° before the synchronizing instant the manual ON command must occur.

With the $1^1/_2$ channel version of the 7VE61, the synchrocheck function operates as an enable criterion and is set coarsely in the monitoring limits. Therefore the dependences for the setting values of the forward angle are $\Delta\alpha$, permissible frequency difference Δf and circuit breaker closing time T_E according to the following formula:

$$\Delta f = \frac{\Delta\alpha}{360°} \cdot \frac{1}{T_{close}}$$

The permissible frequency deviations Δf (Parameter 6120 **T-CB close** or 6152 **df SYNC f2>f1**) decrease with high circuit breaker closing time (Parameter 6153 **df SYNC f2<f1**) depending on the selected forward

angle $\Delta\alpha$(Parameter 6154 **dα SYNC α2> α1** or 6155 **dα SYNC α2< α1**) as illustrated in Figure 2-33. This displays the area below the example for the drawn curves $\Delta\ \alpha$ = 60° and $\Delta\alpha$ = 30° of the particular working range of the 7VE61. A meaningful selectable circuit breaker setting time is set only in the range of the particular curve.

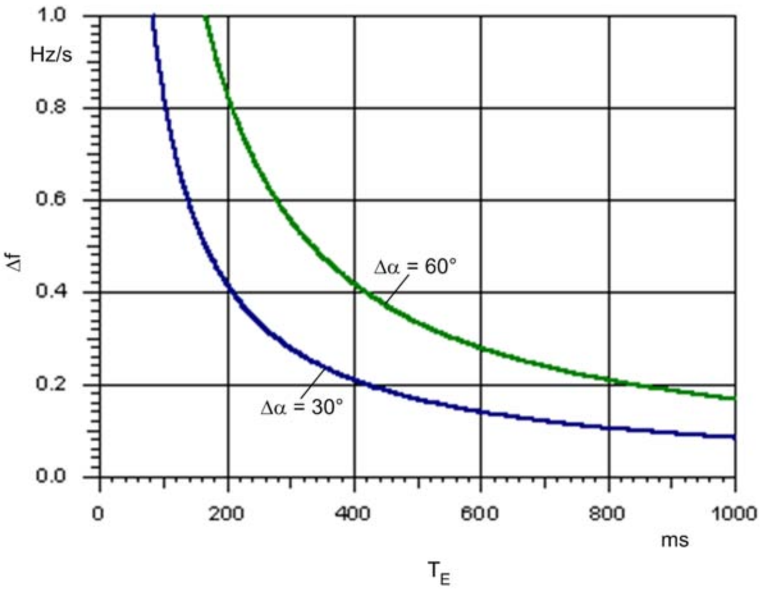


Figure 2-33 Working range in the 1[1]/[2] channel version of the 7VE61

Transformer Taps

With the device variant 7VE63 transformer tap acquisition can be implemented via binary inputs for up to 62 stages.

For inserting transformer tap indications the following procedure is necessary:

- A transformer tap indication must be inserted in the configuration matrix under DIGSI (see figure 2-34).
- The characteristics of a transformer tap indication must be set (see figure 2-35). For the common parametrizable coding (binary code, BCD code, „1-of-n“ code) four selection values (number of taps, number of bits, display offset and stage jump) establish which bit patterns correspond to the individual transformer taps and in which form they are represented in the device display and in the event buffer.

  On input of the „Moving contact“ option the tap setting is recognized as valid and applied when the moving contact signals that the taps have been reached.
- The indication must be allocated to a binary input. Only then does this transformer tap appear in the selection of the parameter 6160 **TAP CHG. OBJ.**. Please note with regard to numbering that only directly consecutive binary inputs can be used.

After selection of the transformer tap indication under address 6160 this is incorporated in the synchronisation depending on setting of the parameters 6161 and 6162. For this 6161 **#STEP NOM. VOLT** describes the tap number for primary rated voltage U1 and 6162 **TAP STEP** interval between the taps in %.

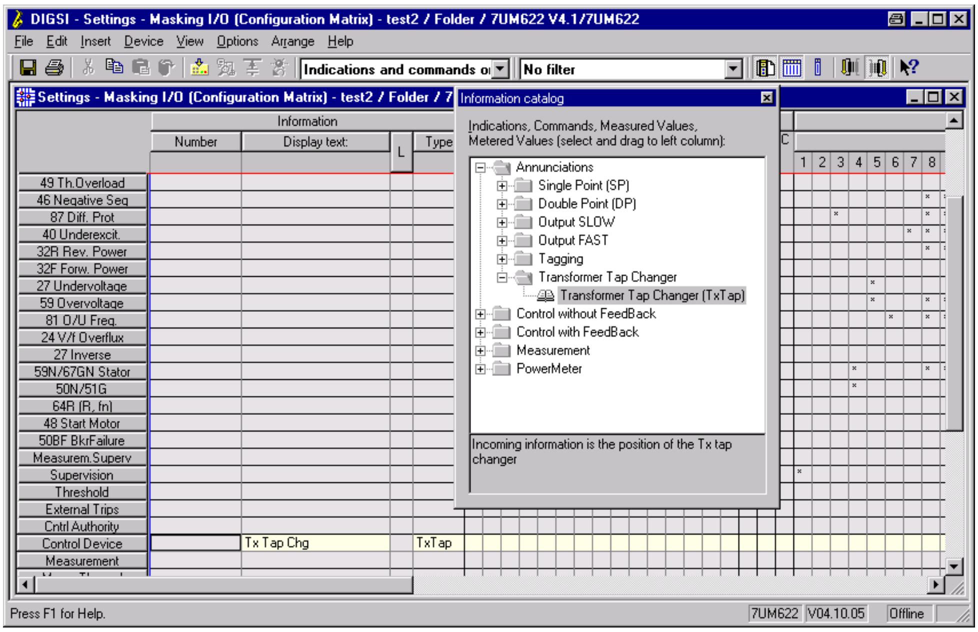


Figure 2-34 Example of Matrix and Information Catalogue

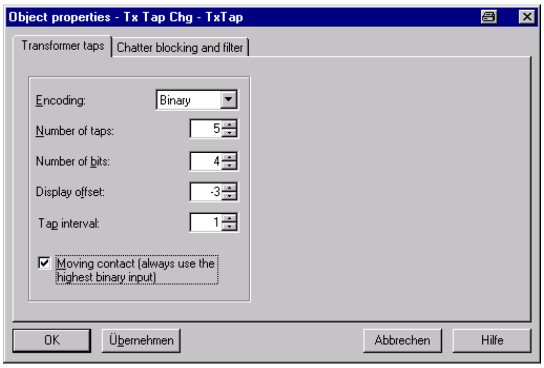


Figure 2-35 Setting examples of object properties of a transformer tap indication

Example:

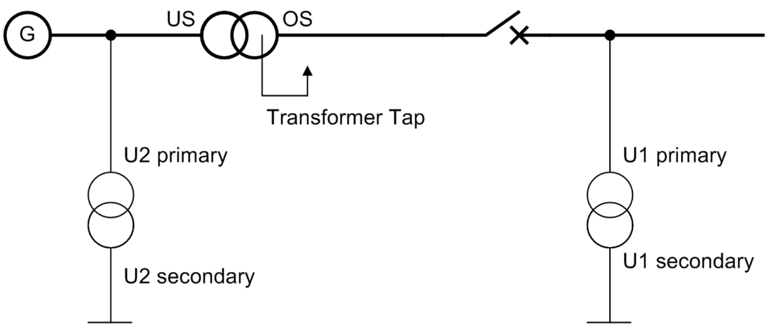


Figure 2-36 Synchronisation via a transformer

Consider a transformer as shown in the Figure above with the following data

Primary rated voltage U1	525.00 kV
Primary rated voltage U2	18.00 kV
Secondary rated voltage	100 V
Number of taps	5, with moving contact
Increment between the taps	2,5 %
Tap number for secondary rated voltage	0
Tap interval	1
Display offset	–3

Parametrization of the transformer tap „Controller 1“ and the synchronizing function is to be done in accordance with the following table and the input of the object characteristics in accordance with figure 2-35.

Table 2-5 Parametrization example for transformer tap control

Par. No.	Parameter	Setting
6124	VT Un1, primary	525.00 kV
6125	VT Un2, primary	18.00 kV
6126	Unom SECONDARY	100 V
6160	TAP CHG. OBJ.	Controller 1
6161	#STEP NOM. VOLT	0
6162	TAP STEP	2,5 %

When correcting the voltage, the reference voltage U1 is left constant and the corresponding U2 corrected. In the example according to Figure 2-4, it is assumed that the generator with nominal voltage is operated and that the nominal voltage is also available at the busbar. Thus, Ua = Ub = 100 V (with phase sequence also Uc = 100 V) is measured at the busbar side voltage transformer on the secondary side and Ud = Ue = 100 V (with phase sequence also Uf = 100 V) is measured at the generator side voltage transformer also on the secondary side.

For the voltages U1, U2 and the difference voltage, the following secondary sides values apply and they can be as well displayed as operational measured values:

BCD code at the operator panel	Display at the device	$U_{OS\ Trans}$/kV Primary	$U_{OS\ Trans}$/V as „secondary“ transformer value	Ud; Ue/V Secondary (generator side)	U2/V Secondary (Corrected)	U1/V Secondary	dU/V Secondary
0000	**** (invalid)				---		---
0001	–2	498,75	95,00	100,0	95,0	100,0	–5,0
0010	–1	511,875	97,50	100,0	97,5	100,0	–2,5
0011	0	525,000	100,00	100,0	100,0	100,0	0
0100	0	538,125	102,50	100,0	102,5	100,0	+2,5
0101	2	551,250	105,00	100,0	105,0	100,0	+5,0
0110	**** (invalid)				---		---

GOOSE Application

It is possible to transfer a transformer tap setting per GOOSE via the Ethernet from a SIPROTEC device (e.g. 6MD66x) to the device 7VE632x for evaluation in the synchronization function. For this purpose, the transformer tap message in the transmitter must be configured to the target system interface. In receiver 7VE632x an external metered value is required from the information catalog for detection of the external transformer tap.

This metered value must be configured to source system interface. The "link" between transmitter and receiver is effected in the station configuration (see Manual „"Ethernet & IEC 61850, Start Up"“).

The external metered value can now be selected in the synchronization function in the transformer-tap tab. The settings for the transformer taps must be set as set out above.

Note:

- In case of an termination of the communication link between transmitter and receiver, the value of the transformer tap is marked “invalid“ and a running synchronization is terminated. **Tracking of the external transformer tap is not possible!**
- An invalid transformer tap setting is transmitted by GOOSE as „63“. This is detected by 7VE632x, which marks all measured values as „invalid“.
- In accordance with IEC 61850, the transformer taps only transmit integers. The transmission of intervals is thus not possible.

Frequency and Voltage Balancing

Balancing commands can be output only by the device variants 7VE6***-*****-***C** or **D**. This functionality can be also used if at least one of the parameters 6170 **U BALANCING** and 6180 **f BALANCING** in contrast to the delivery setting is not set to ***OFF***, but one of the alternatives offered is selected. For actuator pulses to a voltage controller **U BALANCING** = ***Pulse*** is selected for control of a transformer tap switch = ***Tap changer***.

For adaptation of the balancing commands to the characteristic of the voltage controller, in addresses6171 to 6174 the actuator, the pause times and the rate of voltage change are set.

Voltage Balancing Pulses

With the parameters 6130 **dU ASYN U2>U1** and 6131 **dU ASYN U2<U1** for a synchronous parallel connection a range is extended for the admissible voltage difference whose average value is adopted as a target value for the balancing commands.

The parameter 6171 **T U PULS MIN** establishes the duration of the minimum actuator pulse, with parameter 6172 **T U PULS MAX** that of the maximum actuator pulse. The latter establishes also the duration of the (constant) actuator pulses for the transformer tap switches.

The minimum actuator pulse is set by the reaction of the controller or of the entire system and is to be established on commissioning.

The maximum actuator time is intended to avoid excessive overshoot on large ΔU. The appropriate setting value is to be established on commissioning.

The parameter 6173 **dU2 / dt** informs the device of the rate of change of the controller. The following formula results from this:

$$t_{act} = \frac{\Delta f_{act}}{df/dt} = \frac{\Delta f_{act}}{\text{Parameter 6x83}}$$

Example:

Setting value 6130 dU ASYN U2>U1	= 2 V
Setting value 6131dU ASYN U2<U1	= 2 V
Setting value 6173 dU2 / dt	= 2 V/s
actually measured dU	= -4 V

These setting values and the measure value result in the following actuator time:

ΔUact = I dU – 0,5 · (Parameter 6130 – Parameter 6131) I =

I –4 V–0.5 · (2 V – 2 V) I = 4 V

$$t_{act} = \frac{4\ V}{2\ V/s} = 2\ s$$

Depending on the sign i.e. whether U2 is smaller or larger than U1, the actuator direction („higher“ or „lower“) is established. In the example „higher“ pulses are output. The resulting times are checked against the parameters for minimum (6171) and maximum (6172) pulse time. If the calculated time for the actuator pulse is less than the minimum pulse time, a pulse with minimum pulse time is output. If the time for the actuator pulse is greater than the maximum pulse time, the actuator pulse is limited to the maximum pulse time. For this the long actuator pulse is divided into multiple shorter pulses, which are interrupted by the pause time 6174 **T U PAUSE**. Using the numerical values of the example and a setting of the parameter 6172 **T U PULS MAX** = ***1 s*** a division on two one second pulses resulted. If the parameter 6172 **T U PULS MAX** is set to ∞ there is no time restriction and a continuous pulse is output until the calculated time has expired.

In case of very unsettled power system conditions it may be advantageous to filter the measured values. With parameter 6175 **SMOOTHING U**, which is only accessible under DIGSI, a smoothing mean value formation can be selected with the stages ***1*** (weak smoothing) to ***10*** (strong smoothing). Normally, the default setting (***1***) is sufficient. With setting ***0*** no smoothing is required.

Overexcitation Limitation

In combination with the frequency adjustment the overexcitation (U/f) is continually monitored. In case of exceeding parameter 6176 **(U/Un) / (f/fn)**, which is accessible under DIGSI, the target voltage for the voltage adjustment of side 2 (U_2) is reduced or limited to the maximum permissible value. The voltage adjustment value is derived from the limitation of $\Delta U_{adjust} = U_{2,max} - U_2$.

The maximum permissible secondary voltage $U_{2,max}$ can be

$$U_{2,\ max} = \frac{U/U_n}{f/f_n} \cdot \frac{U_{nom,\ sec}}{\text{Factor U1/U2}} \cdot \frac{f_2}{f_{nom}}$$

derived from the relation.

For an estimation of $U_{2,max}$ the following example applies the factory settings (see table).

Address	Parameter	Default Setting
6176	(U/Un) / (f/fn)	1,1
6126	$U_{Nom,sec}$	100 V
6121	Balancing U1/U2	1
270	f_{Nom}	e.g. 50 Hz

If, for example, at the moment of synchronization, the generator frequency f_2 = 50,05 Hz, then the following applies: f_2/f_{Nom} = 50,05 Hz/50 Hz = 1,001. The limit of the maximum permissible generator voltage $U_{2,max}$ is 110,11 V as secondary voltage. The voltage adjustment commands are performed in such manner that such voltage is not exceeded. If the voltage is U2 > $U_{2,max}$, adjustment commands are performed to reduce U2 until meeting the condition again.

Usually, the preset parameter 6176 **(U/Un) / (f/fn)** = does not need to be changed. If a change is implemented, it should be noted that monitoring applies to secondary values exclusively. If the generator voltage and the primary transformer voltage differ from each other, such deviation should be taken into consideration in parameter at address 6176.

Setting example: The following are default settings:

$U_{N,G}$ = 6.3 kV

$U_{N,Transformer\ prim}$ = 6 kV

$U_{N,Transformer\ sec}$ = 100 V

U/f = 1,1

The overexcitation limit shall be calculated as follows:

Parameter 6176 **(U/Un) / (f/fn)** = U / f * $U_{N,G}$ / $U_{N,Transformer\ prim}$ = 1.1 (6.3 kV / 6 kV) = 1.1 * 1.05 = **1.15**.

Together with the factory settings and considering that $f_2 = f_{Nom}$, the maximum permissible voltage $U_{2,max}$ = 115 V.

Frequency Balancing Pulses

With the parameters 6132 **df ASYN f2>f1** and 6133 **df ASYN f2<f1** for asynchronous parallel switching a range is set up for the admissible frequency difference. As a target value for at the actuator commands, the center value is not used as for voltage balancing commands, but established by the parameter 6185 **Δf SET POINT** (see figure2-37). Since it is preferred to parallel generators in over-synchronism following conditions should be imposed:

Δf SET POINT < 0,5 · **df ASYN f2>f1**

With f2 > f1 a positive sign results.

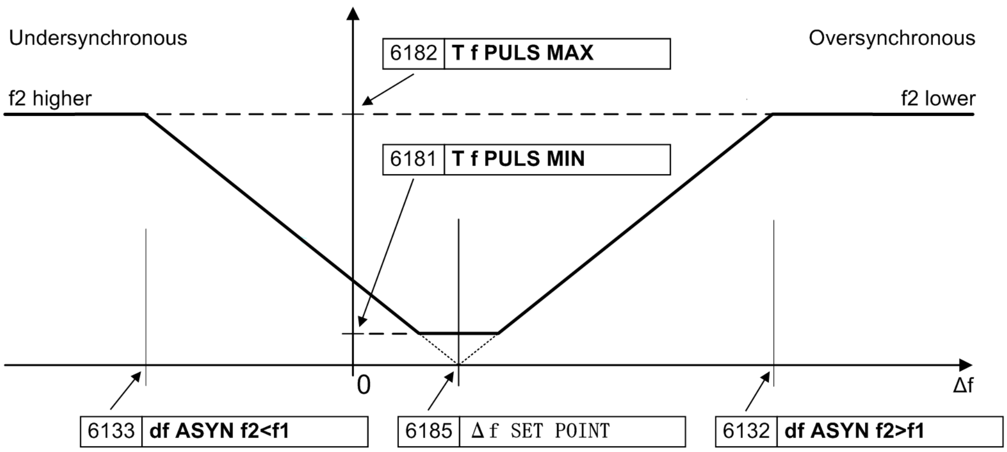


Figure 2-37 Determining frequency balancing pulses

The parameter 6181 **T f PULS MIN** establishes the duration of the minimum actuator pulse, with parameter 6182 **T f PULS MAX** that of the maximum actuator pulse.

The parameter 6183 **df2 / dt** informs the device of the rate of change of the controller. The following formula results from this:

$$t_{act} = \frac{\Delta f_{act}}{df/dt} = \frac{\Delta f_{act}}{\text{parameter 6X83}}$$

<u>Example:</u>

Setting value 6132 df ASYN f2>f1	= 0.1 Hz
Setting value 6183 df2 / dt	= 1 Hz/s
Setting value 6185 Δf SET POINT	= 0.04 Hz
actually measured df	= +0.5 Hz

These setting values and the measure value result in the following actuator time:

Δf SET POINT = 0.5 · 0.1 Hz = + 0.05 Hz

Δfact = I df – Δ**f SET POINT** I = I +0.5 Hz – 0.04 Hz I = 0.46 Hz

$$t_{act} = \frac{0.46\ \text{Hz}}{1\ \text{Hz} / \text{s}} = 0.46\ \text{s}$$

The minimum actuator pulse is set by the reaction of the controller or of the entire system and is to be established on commissioning.

The maximum actuator time is intended to avoid excessive overshoot on large Δf. The appropriate setting value is to be established on commissioning.

Depending on the sign i.e. whether f2 is smaller or larger than f1, the actuator direction („higher“ or „lower“ is established. In the example „higher“ pulses are output. The resulting times are checked against the parameters for minimum (6181) and maximum (6182) pulse time. If the calculated time for the actuator pulse is less than the minimum pulse time, a pulse with minimum pulse time is output. If the time for the actuator pulse is greater than the maximum pulse time, the actuator pulse is limited to the maximum pulse time. For this the long actuator pulse is divided into multiple shorter pulses, which are interrupted by the pause time 6184 **T f PAUSE**. If the parameter 6182 **T U PULS MAX** is set to ∞ there is no time restriction and a continuous pulse is output until the calculated time has expired.

In particular with hydro-electric power stations, generator rotation speed can be subject to fluctuations. Actuator commands established from a current frequency value could thus be incorrect. The option is therefore provided using the parameter 6186 **SMOOTHING f** of subjecting the frequency difference to an averaging with different smoothing factors ***1*** to ***10***.

If the frequency difference is Δf ≈ 0 i.e. the generator runs in synchronism with the power system but the connection conditions are not yet fulfilled, synchronization would not be possible or would take a very long time. In such cases a „Kick impulse“ can be issued if the parameter 6187 **KICK PULSE** = ***ON*** was selected and kick impulses thus enabled. These are issued only if the duration until synchronism exceeds an adjustable time set by parameters 6189.**T SW-ON MIN**. This insures that kick impulses are not issued immediately before synchronism is achieved, but only if the voltage vectors are not coinciding in the immediate future. For the set value of the parameter 6189 applies the formula: **T SW-ON MIN** ≈ 1/(2·Δf). The highest of the both set values of the parameter 6132 **df ASYN f2>f1** and 6133 **df ASYN f2<f1** are selected for Δf.

The kick impulse is initiated in the direction of the parameter setting from Δ**f KICK** (according to the positive or negative signs of the frequency value). Its length is calculated from the frequency change df2/dt and the set value of the parameter 6188 Δ**f KICK**.

2.2.2.2 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
6101	Synchronizing	ON OFF	OFF	Synchronizing Function
6102	SyncSD	(Setting options depend on configuration)	None	synchronizable switching device
6103	Umin	20 .. 125 V	90 V	Minimum voltage limit: Umin
6104	Umax	20 .. 140 V	110 V	Maximum voltage limit: Umax
6105	U<	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6106	U>	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6107	SYNC U1<U2>	YES NO	NO	ON-Command at U1< and U2>
6108	SYNC U1>U2<	YES NO	NO	ON-Command at U1> and U2<

Addr.	Parameter	Setting Options	Default Setting	Comments
6109	SYNC U1<U2<	YES NO	NO	ON-Command at U1< and U2<
6111A	TSUP VOLTAGE	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6112	T-SYN. DURATION	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchro-nism-check
6113	PHASE SEQUENCE	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6120	T-CB close	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6121	Balancing U1/U2	0.50 .. 2.00	1.00	Balancing factor U1/U2
6122A	ANGLE ADJUSTM.	0 .. 359 °	0 °	Angle adjustment (transformer)
6124	VT Un1, primary	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6125	VT Un2, primary	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6126	Unom SECONDARY	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6127	T CLS CMD MIN	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6130	dU ASYN U2>U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6131	dU ASYN U2<U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6132	df ASYN f2>f1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6133	df ASYN f2<f1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6140	SYNC PERMIS.	NO YES	NO	Switching at synchronous condi-tions
6141	F SYNCHRON	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6142	dU SYN U2>U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6143	dU SYN U2<U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6144	dα SYN α2>α1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6145	dα SYN α2<α1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6146	T SYNC-DELAY	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6150	dU SYNC U2>U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6151	dU SYNC U2<U1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6152	df SYNC f2>f1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1

Addr.	Parameter	Setting Options	Default Setting	Comments
6153	df SYNC f2<f1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNC α2> α1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNC α2< α1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6160	TAP CHG. OBJ.	(Setting options depend on configuration)	None	Tap changer object
6161	#STEP NOM. VOLT	-62 .. 62	0	# of tap changer at nom. voltage
6162	TAP STEP	0.00 .. 20.00 %	0.00 %	Step size tap changer
6170	U BALANCING	OFF Tap changer Pulse	OFF	Voltage balancing
6171	T U PULS MIN	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6172	T U PULS MAX	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6173	dU2 / dt	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6174	T U PAUSE	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6175A	SMOOTHING U	1 .. 100	1	Smoothing factor for the voltage
6176A	(U/Un) / (f/fn)	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6180	f BALANCING	OFF Pulse	OFF	Frequency balancing
6181	T f PULS MIN	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6182	T f PULS MAX	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6183	df2 / dt	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6184	T f PAUSE	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6185	Δf SET POINT	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6186A	SMOOTHING f	1 .. 100	1	Smoothing factor for the frequency
6187	KICK PULSE	OFF ON	ON	Release of kick pulses
6188A	Δf KICK	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6189A	T SW-ON MIN	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing

2.2.2.3 Information List

No.	Information	Type of Information	Comments
170.0001	>Sy1 activ	SP	>Sync-group 1 activate
170.0050	Sy1 Error	OUT	Sync-group 1: Error
170.0051	Sy1 BLOCK	OUT	Sync-group 1 is BLOCKED
170.2007	Sy1 Ctrl	SP	Sync-group 1 Measuring req. of Control
170.2008	>BLOCK Sy1	SP	>BLOCK Sync-group 1
170.2022	Sy1 measu.	OUT	Sync-group 1: measurement in progress
170.2050	U1 =	MV	U1
170.2051	f1 =	MV	f1
170.2052	U2 =	MV	U2
170.2053	f2 =	MV	f2
170.2054	dU =	MV	dU
170.2055	df =	MV	df
170.2056	dα =	MV	dalpha
170.2101	Sy1 OFF	OUT	Sync-group 1 is switched OFF
170.2300	Sync CloseRel 1	OUT	Sync. Release of Close Command 1
170.2301	Sync CloseRel 2	OUT	Sync. Release of Close Command 2
170.2311	Sy1 active	OUT	Sync. Function group 1 is active
170.2312	Sy1 on	OUT	Sync-group 1 is switched on

2.2.3 SYNC General

2.2.3.1 Setting Notes

Functional Description

In the following tables are shown parameter and messages which are not specially assigned to one of the 8 synchronization groups but they apply for the synchronization function in general.

2.2.3.2 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
6001	COM. TESTSYNC.	OFF ON	OFF	Test synchronization (Commisioning)

2.2.3.3 Information List

No.	Information	Type of Information	Comments
222.0043	>Sync. MeasOnly	SP	>Sync. Measurement Only
222.2011	>Sync Start	SP	>Sync. Start of Synchronization
222.2012	>Sync Stop	SP	>Sync. Stop of Synchronization

No.	Information	Type of Information	Comments
222.2013	>Sync U1>U2<	SP	>Sync. Switch to U1> and U2<
222.2014	>Sync U1<U2>	SP	>Sync. Switch to U1< and U2>
222.2015	>Sync U1<U2<	SP	>Sync. Switch to U1< and U2<
222.2027	Sync. U1> U2<	OUT	Sync. Condition U1>U2< fulfilled
222.2028	Sync. U1< U2>	OUT	Sync. Condition U1<U2> fulfilled
222.2029	Sync. U1< U2<	OUT	Sync. Condition U1<U2< fulfilled
222.2030	Sync. Udiff ok	OUT	Sync. Voltage difference (Udiff) okay
222.2031	Sync. fdiff ok	OUT	Sync. Frequency difference (fdiff) okay
222.2032	Sync. α ok	OUT	Sync. Angle difference (adiff) okay
222.2033	Sync. f1>>	OUT	Sync. Frequency f1 > fmax permissible
222.2034	Sync. f1<<	OUT	Sync. Frequency f1 < fmin permissible
222.2035	Sync. f2>>	OUT	Sync. Frequency f2 > fmax permissible
222.2036	Sync. f2<<	OUT	Sync. Frequency f2 < fmin permissible
222.2037	Sync. U1>>	OUT	Sync. Voltage U1 > Umax permissible
222.2038	Sync. U1<<	OUT	Sync. Voltage U1 < Umin permissible
222.2039	Sync. U2>>	OUT	Sync. Voltage U2 > Umax permissible
222.2040	Sync. U2<<	OUT	Sync. Voltage U2 < Umin permissible
222.2090	Sync U2>U1	OUT	Sync. Udiff too large (U2>U1)
222.2091	Sync U2<U1	OUT	Sync. Udiff too large (U2<U1)
222.2092	Sync f2>f1	OUT	Sync. fdiff too large (f2>f1)
222.2093	Sync f2<f1	OUT	Sync. fdiff too large (f2<f1)
222.2094	Sync α2>α1	OUT	Sync. alphadiff too large (a2>a1)
222.2095	Sync α2<α1	OUT	Sync. alphadiff too large (a2<a1)
222.2102	>BLK Sync CLOSE	SP	>BLOCK Sync. CLOSE command
222.2103	Sync. CLOSE BLK	OUT	Sync. CLOSE command is BLOCKED
222.2302	Sync synchron 1	OUT	Sync. Synchronization condition 1 okay
222.2303	Sync synchron 2	OUT	Sync. Synchronization condition 2 okay
222.2309	Sync sup.asym.	OUT	Sync-supervision U1,U2 asymmetrical
222.2310	Sync sup. α	OUT	Sync-supervision Alpha>
222.2332	Sync f syn 1	OUT	Sync:Synchronization cond. f1
222.2333	Sync f syn 2	OUT	Sync:Synchronization cond. f2
222.2334	Sync Stop TS	OUT	Sync:Stop by invalid TapChangerVal.
222.2335	SyncSEQ U1 123	OUT	Sync: U1 phase sequence is L1 L2 L3
222.2336	SyncSEQ U1 132	OUT	Sync: U1 phase sequence is L1 L3 L2
222.2337	SyncSEQ U2 123	OUT	Sync: U2 phase sequence is L1 L2 L3
222.2338	SyncSEQ U2 132	OUT	Sync: U2 phase sequence is L1 L3 L2
222.2340	>COM Test sync.	SP	>Commisioning test synchronization
222.2341	Test CloseRel 1	OUT	Comm: Release of Close Command 1
222.2342	Test CloseRel 2	OUT	Comm: Release of Close Command 2
223.2320	>BLK Balancing	SP	>BLOCK Balancing commands
223.2321	>BLK U Balanc.	SP	>BLOCK Voltage balancing commands
223.2322	>BLK f Balanc.	SP	>BLOCK Frequency balancing commands
223.2323	>Start Balanc.	SP	>Start balancing sequence
223.2324	Sync U2 down	OUT	Sync: decrease voltage U2
223.2325	Sync U2 up	OUT	Sync: increase voltage U2
223.2326	Sync f2 down	OUT	Sync: decrease frequency f2

No.	Information	Type of Information	Comments
223.2327	Sync f2 up	OUT	Sync: increase frequency f2
223.2339	Balanc. activ	OUT	Balancing commands are activ
25064	Sync ON-Sig	OUT	Sync: ON - Signal
25065	Sync ON 1-Sig	OUT	Sync: ON 1 - Signal
25066	Sync ON 2-Sig	OUT	Sync: ON 2 - Signal

2.3 Protection and Automation Functions

The many of measured values at the analog inputs of the device can be made accessible to other applications, in addition to the synchronizing functions. Here the voltage or frequency protection or the threshold supervision are used for these values. A further application involves power system decoupling.

In the device variants 7VE6***-****B***- with supplementary functionality, the following functions are available:

- Undervoltage protection (ANSI 27)
- Overvoltage protection (ANSI 59)
- Frequency protection (ANSI 81)
- Rate of frequency change protection (ANSI 81R)
- Vector Jump
- Threshold Supervisions
- External trip commands

2.3.1 Undervoltage Protection

Undervoltage protection detects voltage dips in electrical machines and devices and avoids inadmissible operating states and possible loss of stability. In order to achieve all applications, a selected voltage is pulled over to one of the 6 voltage transformers for the undervoltage protection.

The undervoltage protection together with the overvoltage protection, the vector jump relay, the frequency change protection and the frequency protection forms a criterion for the network decoupling.

2.3.1.1 Functional Description

Mode of Operation

Undervoltage protection consists of two stages. A pickup is signalled as soon as selectable voltage thresholds are undershot. A trip signal is transmitted if a voltage pickup exists for a selectable time.

In order to ensure that the protection does not accidentally pick up due to a secondary voltage failure, each stage can be blocked individually or both stages together, via binary input(s), e.g. using a voltage transformer mcb.

The protection is active via a wide frequency range. The full sensitivity is ensured in the range in which the frequency response is corrected ($0,5 \cdot f_N$ to $1,5 \cdot f_N$). The input signal is attenuated outside this frequency correction range in such way that the undervoltage protection as well as the sensitive tend to overreact.

The following figure shows the logic diagram for undervoltage protection.

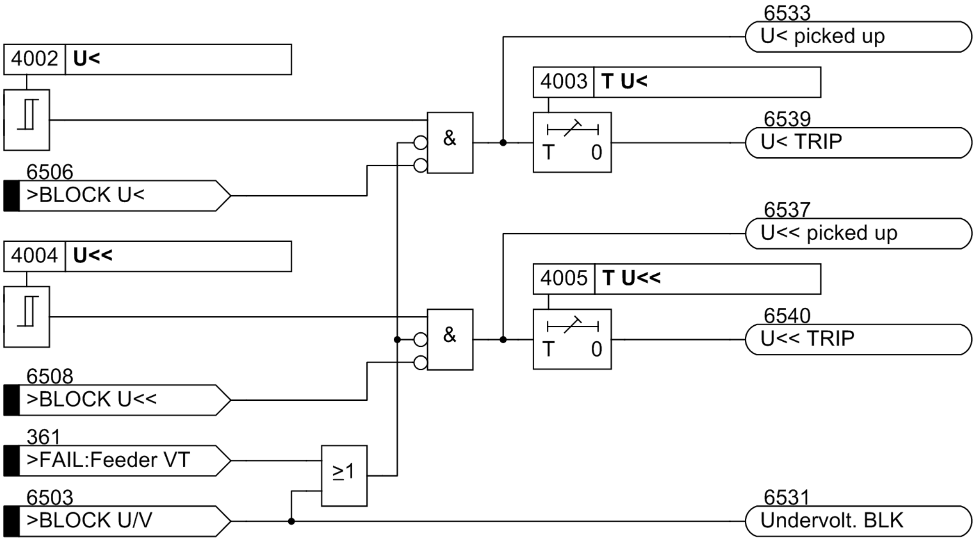


Figure 2-38 Logic Diagram of the Undervoltage Protection

2.3.1.2 Setting Notes

General

The undervoltage protection is only effective and available if this function was set during protective function configuration (Section 2.1.1, address 140, **UNDERVOLTAGE** is set to ***Enabled***). If the function is not required ***Disabled*** is set. Address 4001 **UNDERVOLTAGE** serves to switch the function ***ON*** or ***OFF*** or to block only the trip command (***Block relay***).

Setting Values

Using the parameter 4007 **MEAS. INPUT** one of the 6 voltage inputs (***Ua*** to ***Uf***) is allocated to the overvoltage protection. The following allocation applies between voltage input and device connections:

Voltage input	Device connections
Ua	Q1, Q2
Ub	Q3, Q4
Uc	Q5, Q6
Ud	Q7, Q8
Ue	Q9, Q10
Uf	Q11, Q12

Typically a phase-to-phase voltage is connected, a phase-earth voltage may also be used however. In the latter case the pickup thresholds must be matched accordingly.

The first undervoltage protection stage is typically set to about 75% of the nominal machine voltage, i.e. address 4002 **U<** = ***75 V*** is set. The user must select a value for the 4003 **T U<** time setting that ensures that voltage dips which would affect operating stability are disconnected. On the other hand, the time delay must be large enough to avoid disconnections during admissible short-time voltage dips.

For the second stage, a lower pickup threshold4004 **U<<** e.g. = ***65 V*** should be combined with a shorter trip time 4005 **T U<<** e.g. = ***0.5 s*** to perform an approximate adaptation to the stability behaviour of the consumers.

All setting times are additional time delays which do not include the operating times (measuring time, dropout time) of the protective function.

The drop-out ratio can be adapted in small steps to the operating conditions at address 4006 **U< DOUT RATIO**.

2.3.1.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
4001	UNDERVOLTAGE	OFF ON Block relay	OFF	Undervoltage Protection
4002	U<	10.0 .. 125.0 V	75.0 V	U< Pickup
4003	T U<	0.00 .. 60.00 sec; ∞	3.00 sec	T U< Time Delay
4004	U<<	10.0 .. 125.0 V	65.0 V	U<< Pickup
4005	T U<<	0.00 .. 60.00 sec; ∞	0.50 sec	T U<< Time Delay
4006A	U< DOUT RATIO	1.01 .. 1.20	1.05	U<, U<< Drop Out Ratio
4007	MEAS. INPUT	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input

2.3.1.4 Information List

No.	Information	Type of Information	Comments
6503	>BLOCK U/V	SP	>BLOCK undervoltage protection
6506	>BLOCK U<	SP	>BLOCK Undervoltage protection U<
6508	>BLOCK U<<	SP	>BLOCK Undervoltage protection U<<
6530	Undervolt. OFF	OUT	Undervoltage protection switched OFF
6531	Undervolt. BLK	OUT	Undervoltage protection is BLOCKED
6532	Undervolt. ACT	OUT	Undervoltage protection is ACTIVE
6533	U< picked up	OUT	Undervoltage U< picked up
6537	U<< picked up	OUT	Undervoltage U<< picked up
6539	U< TRIP	OUT	Undervoltage U< TRIP
6540	U<< TRIP	OUT	Undervoltage U<< TRIP

2.3.2 Overvoltage Protection

Overvoltage protection serves to protect the electrical machine and connected electrical plant components from the effects of inadmissible voltage increases. Overvoltages can be caused by incorrect manual operation of the excitation system, faulty operation of the automatic voltage regulator, (full) load shedding of a generator, separation of the generator from the system or during island operation.

2.3.2.1 Functional Description

Mode of Operation

The overvoltage protection monitors one of the 6 voltage inputs of the device 7VE61 and 7VE63. A phase-to-phase voltage is usually connected. In case of a high overvoltage, tripping switchoff is performed with a short-time delay, whereas in case of less severe overvoltages, the switchoff is performed with a longer time delay. Voltage thresholds and time delays can be set individually for both elements.

Each stage can be blocked individually and/or for both stages can be blocked, via binary input(s).

The following figure shows the logic diagram for the overvoltage protection function.

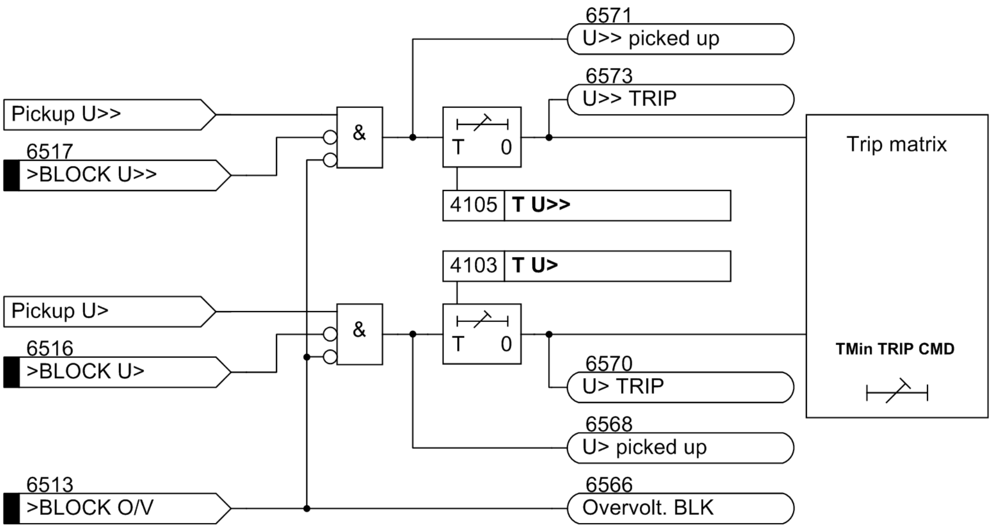


Figure 2-39 Logic Diagram of the Overvoltage Protection

2.3.2.2 Setting Notes

General

Overvoltage protection is only effective and available if this function was set during protective function configuration (Section 2.1.1, address 141, **OVERVOLTAGE** is set to ***Enabled***. If the function is not required ***Disabled*** is set. Address 4101 **OVERVOLTAGE** serves to switch the function ***ON*** or ***OFF*** or to block only the trip command (***Block relay***).

Setting Values

Using the parameter **MEAS. INPUT** one of the 6 voltage inputs (***Ua*** to ***Uf***) is allocated to the overvoltage protection. The following allocation applies between voltage input and device connections:

Voltage input	Device connections
Ua	Q1, Q2
Ub	Q3, Q4
Uc	Q5, Q6
Ud	Q7, Q8
Ue	Q9, Q10
Uf	Q11, Q12

Typically a phase-to-phase voltage is connected, a phase-earth voltage may also be used however. In the latter case the pickup thresholds must be matched accordingly.

The setting of limit values and time delays of the overvoltage protection depends on the speed with which the voltage regulator can regulate voltage variations. The protection must not intervene in the regulation process of the faultlessly functioning voltage regulator. For this reason, the two-stage characteristic must always be above the voltage time characteristic of the regulation procedure.

The long-time stage 4102 **U>** and 4103 **T U>** must intervene in case of steady-state overvoltages. It is set to approximately 110 % to 115 % U_N and, depending on the regulator speed, to a range between 1.5 s and 5 s.

In case of a full-load rejection of the generator, the voltage increases first in relation to the transient voltage. Only then does the voltage regulator reduce it again to its nominal value. The U>> stage is set generally as a short-time stage in a way that the transient procedure for a full-load rejection does not lead to a tripping. Usual are e.g. for 4104 **U>>** about 130 % U_N with a delay 4105 **T U>>** from zero to 0.5 s.

All setting times are additional time delays which do not include the operating times (measuring time, dropout time) of the protective function.

The dropout ratio can be adapted at the address 4106 **U> DOUT RATIO** in small stages to the operating conditions and used for highly precise signalizations (e.g. network infeed of wind power stations).

2.3.2.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
4101	OVERVOLTAGE	OFF ON Block relay	OFF	Overvoltage Protection
4102	U>	30.0 .. 200.0 V	115.0 V	U> Pickup
4103	T U>	0.00 .. 60.00 sec; ∞	3.00 sec	T U> Time Delay
4104	U>>	30.0 .. 200.0 V	130.0 V	U>> Pickup
4105	T U>>	0.00 .. 60.00 sec; ∞	0.50 sec	T U>> Time Delay
4106A	U> DOUT RATIO	0.90 .. 0.99	0.95	U>, U>> Drop Out Ratio
4107	MEAS. INPUT	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input

2.3.2.4 Information List

No.	Information	Type of Information	Comments
6513	>BLOCK O/V	SP	>BLOCK overvoltage protection
6516	>BLOCK U>	SP	>BLOCK overvoltage protection U>
6517	>BLOCK U>>	SP	>BLOCK overvoltage protection U>>
6565	Overvolt. OFF	OUT	Overvoltage protection switched OFF
6566	Overvolt. BLK	OUT	Overvoltage protection is BLOCKED
6567	Overvolt. ACT	OUT	Overvoltage protection is ACTIVE

No.	Information	Type of Information	Comments
6568	U> picked up	OUT	Overvoltage U> picked up
6570	U> TRIP	OUT	Overvoltage U> TRIP
6571	U>> picked up	OUT	Overvoltage U>> picked up
6573	U>> TRIP	OUT	Overvoltage U>> TRIP

2.3.3 Frequency Protection

The frequency protection function detects abnormally high and low frequencies in the generator. If the frequency lies outside the permissible range, appropriate switching actions are initiated, e.g. separating the generator from the system.

A decrease in system frequency occurs when the system experiences an increase in real power demand, or when a malfunction occurs with a generator governor or automatic generation control (AGC) system. The frequency protection function is also used for generators which (for a certain time) operator to an island network. This is due to the fact that the reverse power protection cannot operate in case of drive power failure. The generator can be disconnected from the power system by means of the frequency decrease protection.

An increase in system frequency occurs e.g. when large loads (island network) are removed from the system, or on frequency control malfunction. This entails risk of self-excitation for generators feeding long lines under no-load conditions.

Due to the use of filter functions, the frequency evaluation is free from harmonic influences and very accurate.

2.3.3.1 Functional Description

Frequency Increase and Decrease

Frequency protection consists of the four frequency elements f1 to f4. To make protection flexible for different power system conditions, theses stages can be used alternatively for frequency decrease or increase separately, and can be independently set to perform different control functions. The setting decides on the purpose of the individual frequency stage. For the f4 frequency stage, the user can specify independently of the parameterized limit value if this stage shall function as decrease or increase stage. For this reason, it can also be used for special applications, if, for example, frequency undershoot below the nominal frequency is to be signaled.

Operating Range

The frequency can be determined as long as there is a sufficiently high voltage at the selected input. If the measurement voltage drops below a settable value **Umin**, frequency protection is disabled because precise frequency values can no longer be calculated from the signal.

Time Delays/Logic

Trippings can be delayed each using an added time stage. When the time delay expires, a trip signal is generated. After pickup dropout the tripping command is immediately reset, but not before the minimum command duration has expired.

Each of the four frequency stages can be blocked individually by binary inputs.

The following figure shows the logic diagram for the frequency protection function.

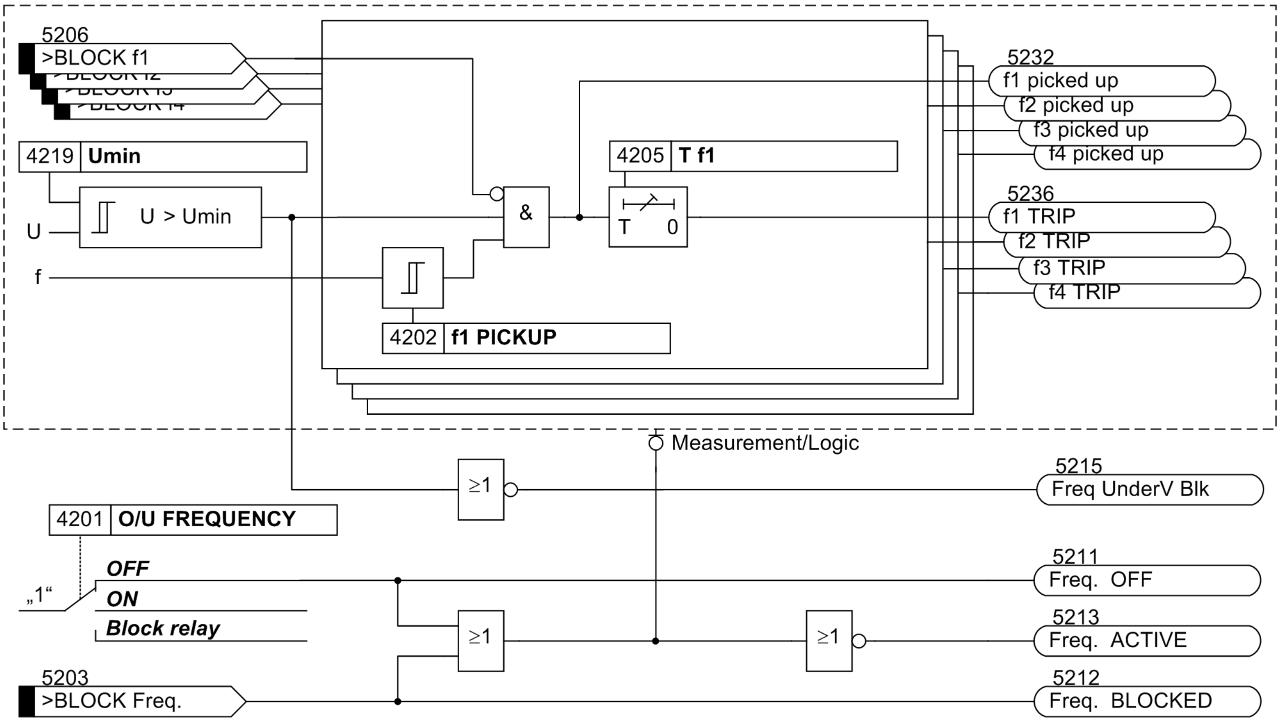


Figure 2-40 Logic diagram of the frequency protection

2.3.3.2 Setting Notes

General

Frequency protection is only in effect and accessible if address 142 **FREQUENCY Prot.** is set to ***Enabled*** during configuration of protective functions. If the function is not required ***Disabled*** is set. Address 4201 **O/U FREQUENCY** serves to switch the function ***ON*** or ***OFF*** or to block only the trip command (***Block relay***).

Pickup Values

By configuring the rated frequency of the power system and the frequency threshold for each of the stages **f1 PICKUP** to **f4 PICKUP** in each case the function is established as either overvoltage or undervoltage protection. Set the pickup threshold lower than nominal frequency if the element is to be used for underfrequency protection. Set the pickup threshold higher than nominal frequency if the element is to be used for overfrequency protection.

Note

If the threshold is set equal to the nominal frequency, the element is inactive.

For the f4 frequency stage, the former applies only if the parameter 4218 **THRESHOLD f4** is set to ***automatic*** (default setting). If desired, this parameter can also be set to ***f>*** or ***f<***, in which case the evaluation direction (increase or decrease detection) can be specified independent of the parametrized **f4 PICKUP** threshold.

If frequency protection is used for network decoupling and load shedding purposes, settings depend on the actual network conditions. Normally a graded load shedding is strived for that takes into account priorities of consumers or consumer groups.

Further application examples are covered under power stations. The frequency values to be set mainly depend, also in these cases, on power system/power station operator specifications. In this context, frequency decrease protection ensures the power station's own demand by disconnecting it from the power system on time. The turbo regulator regulates the machine set to the nominal speed. Consequently, the station's own demands can be continuously supplied at nominal frequency.

Under the assumption that apparent power is reduced to the same degree, turbine-driven generators can, as a rule, be continuously operated down to 95 % of nominal frequency. However, for inductive consumers, the frequency reduction not only means greater current consumption but also endangers stable operation. For this reason, only a short-time frequency reduction down to about 48 Hz (for f_N = 50 Hz) or 58 Hz (for f_N = 60 Hz) is permissible.

A frequency increase can, for example, occur due to a load shedding or malfunction of the speed regulation (e.g. in a stand-alone system). In this way, the frequency increase protection can, for example, be used as over-speed protection.

Setting example:

Stage	Cause	Settings		
		for f_N = 50 Hz	for f_N = 60 Hz	Delay
f1	Disconnection from the network	48.00 Hz	58.00 Hz	1.00 sec
f2	Shutdown	47.00 Hz	57.00 Hz	6.00 sec
f3	Warning	49.50 Hz	59.50 Hz	20.00 sec
f4	Alarm or tripping	52.00 Hz	62.00 Hz	10.00 sec

Time Delays

The delay times **T f1** to **T f4** entered at addresses 4205, 4209, 4213 and 4217) allow the frequency stages to be graded. The set times are additional delay times not including the operating times (measuring time, dropout time) of the protective function.

Minimum Voltage

Address 4219 **Umin** is used to set the minimum voltage which if undershot, frequency protection is blocked. A value of approx. 65 % U_N is recommended. The parameter value is based on phase-to-phase voltages. The minimum voltage threshold can be deactivated by setting this address to **0**.

Measurement Input

The parameter 4220 **MEAS. INPUT** establishes which of the 6 voltage inputs (***Ua*** to ***Uf***) of the device the frequency measurement is to refer to. The following allocation applies between voltage input and device connections:

Voltage input	Device connections
Ua	Q1, Q2
Ub	Q3, Q4
Uc	Q5, Q6
Ud	Q7, Q8
Ue	Q9, Q10
Uf	Q11, Q12

2.3.3.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
4201	O/U FREQUENCY	OFF ON Block relay	OFF	Over / Under Frequency Protection
4202	f1 PICKUP	40.00 .. 65.00 Hz	48.00 Hz	f1 Pickup
4203	f1 PICKUP	40.00 .. 65.00 Hz	58.00 Hz	f1 Pickup
4204	f1 PICKUP	12.00 .. 20.00 Hz	16.10 Hz	f1 PICKUP
4205	T f1	0.00 .. 600.00 sec; ∞	1.00 sec	T f1 Time Delay
4206	f2 PICKUP	40.00 .. 65.00 Hz	47.00 Hz	f2 Pickup
4207	f2 PICKUP	40.00 .. 65.00 Hz	57.00 Hz	f2 Pickup
4208	f2 PICKUP	12.00 .. 20.00 Hz	15.80 Hz	f2 PICKUP
4209	T f2	0.00 .. 100.00 sec; ∞	6.00 sec	T f2 Time Delay
4210	f3 PICKUP	40.00 .. 65.00 Hz	49.50 Hz	f3 Pickup
4211	f3 PICKUP	40.00 .. 65.00 Hz	59.50 Hz	f3 Pickup
4212	f3 PICKUP	12.00 .. 20.00 Hz	16.50 Hz	f3 PICKUP
4213	T f3	0.00 .. 100.00 sec; ∞	20.00 sec	T f3 Time Delay
4214	f4 PICKUP	40.00 .. 65.00 Hz	52.00 Hz	f4 Pickup
4215	f4 PICKUP	40.00 .. 65.00 Hz	62.00 Hz	f4 Pickup
4216	f4 PICKUP	12.00 .. 20.00 Hz	17.20 Hz	f4 PICKUP
4217	T f4	0.00 .. 100.00 sec; ∞	10.00 sec	T f4 Time Delay
4218	THRESHOLD f4	automatic f> f<	automatic	Handling of Threshold Stage f4
4219	Umin	10.0 .. 125.0 V; 0	65.0 V	Minimum Required Voltage for Operation
4220	MEAS. INPUT	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input

2.3.3.4 Information List

No.	Information	Type of Information	Comments
5203	>BLOCK Freq.	SP	>BLOCK frequency protection
5206	>BLOCK f1	SP	>BLOCK frequency protection stage f1
5207	>BLOCK f2	SP	>BLOCK frequency protection stage f2
5208	>BLOCK f3	SP	>BLOCK frequency protection stage f3
5209	>BLOCK f4	SP	>BLOCK frequency protection stage f4
5211	Freq. OFF	OUT	Frequency protection is switched OFF

No.	Information	Type of Information	Comments
5212	Freq. BLOCKED	OUT	Frequency protection is BLOCKED
5213	Freq. ACTIVE	OUT	Frequency protection is ACTIVE
5215	Freq UnderV Blk	OUT	Frequency protection undervoltage Blk
5232	f1 picked up	OUT	Frequency protection: f1 picked up
5233	f2 picked up	OUT	Frequency protection: f2 picked up
5234	f3 picked up	OUT	Frequency protection: f3 picked up
5235	f4 picked up	OUT	Frequency protection: f4 picked up
5236	f1 TRIP	OUT	Frequency protection: f1 TRIP
5237	f2 TRIP	OUT	Frequency protection: f2 TRIP
5238	f3 TRIP	OUT	Frequency protection: f3 TRIP
5239	f4 TRIP	OUT	Frequency protection: f4 TRIP

2.3.4 Rate-of-frequency-change protection

With the rate-of-frequency-change protection, frequency changes can be quickly detected. This allows a prompt response to frequency dips or frequency rises. A trip command can be issued even before the pickup threshold of the frequency protection (see Section 2.3.3) is reached.

Frequency changes occur for instance when there is an imbalance between the generated and the required active power. They call for control measures on the one hand and for switching actions on the other hand. These can be unburdening measures, such as network decoupling, or disconnection of loads (load shedding). The sooner these measures are taken after malfunctioning, the more effective they will be.

The two main applications for this protection function are thus network decoupling and load shedding.

2.3.4.1 Function Description

Measuring Principle

From the voltage at the selected input, the frequency is determined once per cycle over a measuring window of 3 cycles, and a mean value of two consecutive frequency measurements is formed. The frequency difference is then determined over a settable time interval (default setting 5 cycles). The ratio between frequency difference and time difference corresponds to the frequency change; it can be positive or negative. The measurement is performed continuously (per cycle). Monitoring functions such as undervoltage monitoring, check for phase angle jumps etc. to avoid overfunctioning.

Frequency Increase/ Decrease

The rate-of-frequency-change protection has four stages, from df1/dt to df4/dt. This allows the function to be adapted variably to all power system conditions. The stages can be set to detect either frequency decreases (-df/dt) or frequency increases (+df/dt). The -df/dt stage is only active for frequencies below the rated frequency, or less if the underfrequency enabling is activated. Likewise, the df/dt stage is active for frequencies above the rated frequency, or higher, if the overfrequency enabling is activated. The parameter setting decides for what purpose the particular stage will be used.

To avoid a proliferation of setting parameters, the settable measuring window for the frequency difference formation and the dropout difference are each valid for two stages.

Operating Ranges

The frequency can be determined as long as there is a sufficiently strong voltage at the selected input. If the measurement voltage drops below a settable value **U MIN**, frequency protection is disabled because precise frequency values can no longer be calculated from the signal.

Time Delays/Logic

Tripping can be delayed by a set time delay associated with each applied time stage. This is recommended for monitoring of small gradients. When the time delay expires, a trip signal is generated. After pickup dropout the tripping command is immediately reset, but not before the minimum command duration has expired.

Each of the four frequency change stages can be blocked individually by binary input. The undervoltage blocking acts on all stages simultaneously.

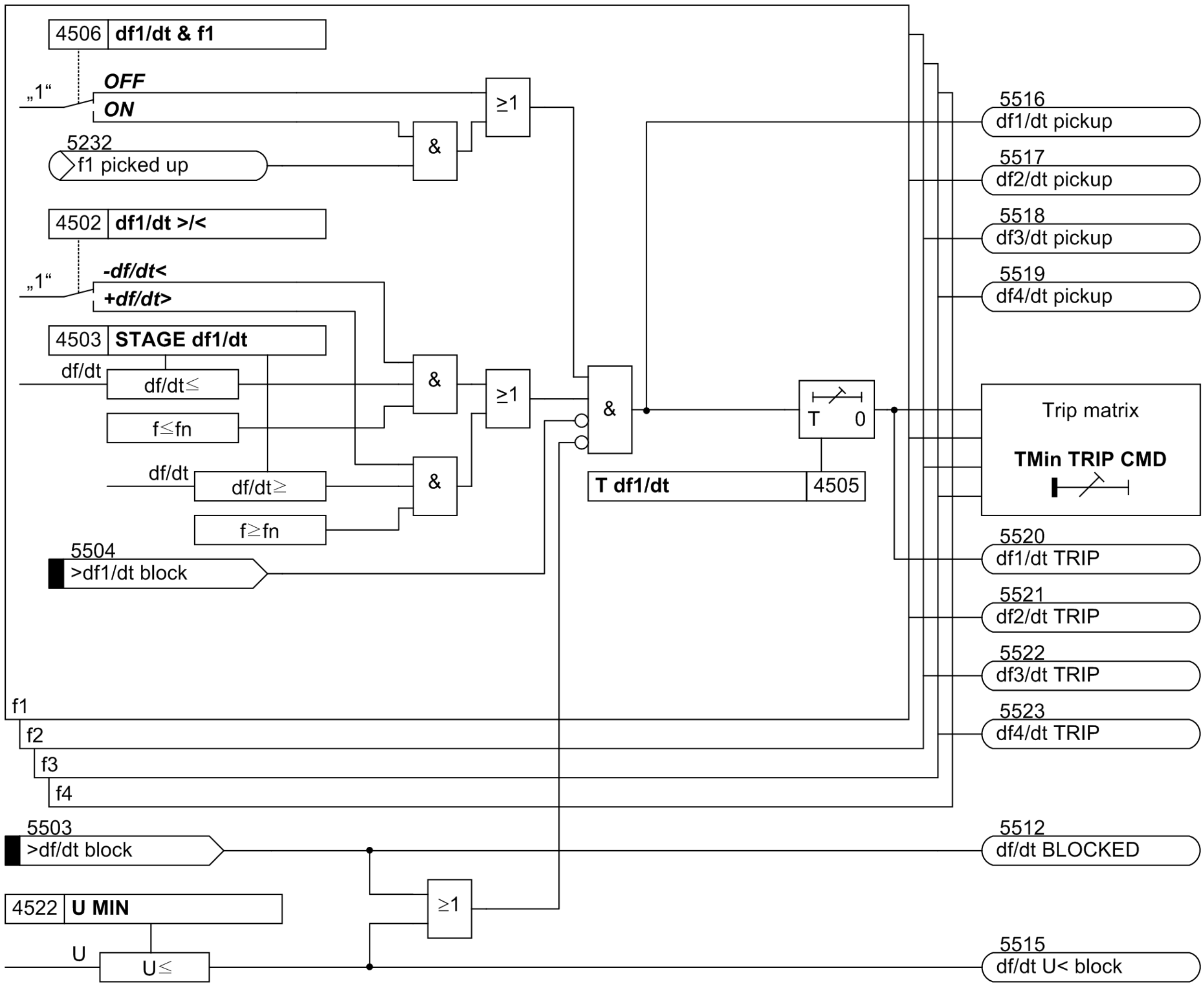


Figure 2-41 Logic diagram of the rate-of-frequency-change protection

2.3.4.2 Setting Notes

General

The rate-of-frequency-change protection is only effective and accessible if during the configuration address 145 **df/dt Protect.** has been set accordingly. 2 or 4 stages can be selected. The default setting is ***2 df/dt stages***.

At address 4501 **df/dt Protect.**, the function ***ON*** or ***OFF*** can be set, or only the trip command can be blocked (***Block relay***).

Pickup Values

The setting procedure is the same for all stages. In a first step, it must be determined whether the stage is to monitor a frequency rise at $f>f_N$ or a frequency drop at $f<f_N$. For stage 1, for instance, this setting is made at address 4502 **df1/dt >/<**. The pickup value is set as an absolute value at address 4503 **STAGE df1/dt**. The setting of address 4502 informs the protection function of the applicable sign.

The pickup value depends on the application and is determined by power system conditions. In most cases, a network analysis will be necessary. A sudden disconnection of loads leads to a surplus of active power. The frequency rises and causes a positive frequency change. A failure of generators, on the other hand, leads to a deficit of active power. The frequency drops and leads to a negative frequency change.

The following relations can be used as an example for estimation. They apply for the change rate at the beginning of a frequency change (approx. 1 second).

$$\frac{df}{dt} = -\frac{f_N}{2H} \cdot \frac{\Delta P}{S_N}$$

Significance:

f_N	Nominal Frequency
ΔP	Active power change
	$\Delta P = P_{Consumption} - P_{Generation}$
S_N	Nominal apparent power of the machines
H	Inertia constant

Typical values for H are:

for hydro-electric generators (salient-pole machines)	H = 1.5 s to 6 s
for turbine-driven generators (cylindrical-rotor machines)	H = 2 s to 10 s
for industrial turbine-generators	H = 3 s to 4 s

Example:

$f_N = 50$ Hz

H = 3 s

Case 1: $\Delta P/S_N = 0.12$

Case 2: $\Delta P/S_N = 0.48$

Case 1: df/dt = -1 Hz/s

Case 2: df/dt = -4 Hz/s

The default settings are based on the above example. The four stages have been set symmetrically.

Time Delays

The delay time should be set to zero wherever the protection function is supposed to respond very quickly. This will be the case with high setting values. For the monitoring of small changes (< 1Hz/s), on the other hand, a small delay time can be useful to avoid overfunctioning. The delay time for stage 1 is set at address 4505 **T df1/dt**, and the time set there is added to the protection operating time.

Release by the Frequency Protection

The parameter **df1/dt & f1** (Address 4506) is used to set the release of the stage from a certain frequency threshold on. For this the pertinent frequency stage of the frequency protection is queried. In the setting example this is stage f1. To exclude coupling of the two functions, the parameter can be set to ***OFF*** (default setting).

Advanced Parameters

The advanced parameters allow setting each for two stages (e.g. df1/dt and df2/dt) the dropout difference and the measuring window. This setting can only be done with the DIGSI communication software.

Setting changes are necessary e.g. to obtain a large dropout difference. For the detection of very small frequency changes (< 0.5 Hz/s), the default setting of the measuring window should be extended. This is to improve the measuring accuracy.

Setting value Stage df_n/dt	**df/dt HYSTERES.** (Addr. 4523, 4525)	**dfx/dt M-WINDOW** (Addr. 4524, 4526)
0.1...0.5 Hz/s	≈ 0.05	25...10
0.5...1 Hz/s	≈ 0.1	10...5
1...0.5 Hz/s	≈ 0.2	10...5
5...00.20 Hz/s	≈ 0.5	5...1

Minimum Voltage

Address 4522 **U MIN** is used to set the minimum voltage below which the frequency change protection will be blocked. A value of approx. 65 % U_N is recommended. The minimum voltage threshold can be deactivated by setting this address to „0“.

2.3.4.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
4501	df/dt Protect.	OFF ON Block relay	OFF	Rate-of-frequency-change protection
4502	df1/dt >/<	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df1/dt >/<)
4503	STAGE df1/dt	0.1 .. 10.0 Hz/s; ∞	1.0 Hz/s	Pickup Value of df1/dt Stage
4504	STAGE df1/dt	0.1 .. 3.0 Hz/s; ∞	0.3 Hz/s	Pickup Value of df1/dt Stage
4505	T df1/dt	0.00 .. 60.00 sec; ∞	0.50 sec	Time Delay of df1/dt Stage
4506	df1/dt & f1	OFF ON	OFF	AND logic with pickup of stage f1

Addr.	Parameter	Setting Options	Default Setting	Comments
4507	df2/dt >/<	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df2/dt >/<)
4508	STAGE df2/dt	0.1 .. 10.0 Hz/s; ∞	1.0 Hz/s	Pickup Value of df2/dt Stage
4509	STAGE df2/dt	0.1 .. 3.0 Hz/s; ∞	0.3 Hz/s	Pickup Value of df2/dt Stage
4510	T df2/dt	0.00 .. 60.00 sec; ∞	0.50 sec	Time Delay of df2/dt Stage
4511	df2/dt & f2	OFF ON	OFF	AND logic with pickup of stage f2
4512	df3/dt >/<	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df3/dt >/<)
4513	STAGE df3/dt	0.1 .. 10.0 Hz/s; ∞	4.0 Hz/s	Pickup Value of df3/dt Stage
4514	STAGE df3/dt	0.1 .. 3.0 Hz/s; ∞	1.3 Hz/s	Pickup Value of df3/dt Stage
4515	T df3/dt	0.00 .. 60.00 sec; ∞	0.00 sec	Time Delay of df3/dt Stage
4516	df3/dt & f3	OFF ON	OFF	AND logic with pickup of stage f3
4517	df4/dt >/<	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df4/dt >/<)
4518	STAGE df4/dt	0.1 .. 10.0 Hz/s; ∞	4.0 Hz/s	Pickup Value of df4/dt Stage
4519	STAGE df4/dt	0.1 .. 3.0 Hz/s; ∞	1.3 Hz/s	Pickup Value of df4/dt Stage
4520	T df4/dt	0.00 .. 60.00 sec; ∞	0.00 sec	Time Delay of df4/dt Stage
4521	df4/dt & f4	OFF ON	OFF	AND logic with pickup of stage f4
4522	U MIN	10.0 .. 125.0 V; 0	65.0 V	Minimum Operating Voltage Umin
4523A	df1/2 HYSTERES.	0.02 .. 0.99 Hz/s	0.10 Hz/s	Reset Hysteresis for df1/dt & df2/dt
4524A	df1/2 M-WINDOW	1 .. 25 Cycle	5 Cycle	Measuring Window for df1/dt & df2/dt
4525A	df3/4 HYSTERES.	0.02 .. 0.99 Hz/s	0.40 Hz/s	Reset Hysteresis for df3/dt & df4/dt
4526A	df3/4 M-WINDOW	1 .. 25 Cycle	5 Cycle	Measuring Window for df3/dt & df4/dt
4527	MEAS. INPUT	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input

2.3.4.4 Information List

No.	Information	Type of Information	Comments
5503	>df/dt block	SP	>BLOCK Rate-of-frequency-change prot.
5504	>df1/dt block	SP	>BLOCK df1/dt stage
5505	>df2/dt block	SP	>BLOCK df2/dt stage

No.	Information	Type of Information	Comments
5506	>df3/dt block	SP	>BLOCK df3/dt stage
5507	>df4/dt block	SP	>BLOCK df4/dt stage
5511	df/dt OFF	OUT	df/dt is switched OFF
5512	df/dt BLOCKED	OUT	df/dt is BLOCKED
5513	df/dt ACTIVE	OUT	df/dt is ACTIVE
5515	df/dt U< block	OUT	df/dt is blocked by undervoltage
5516	df1/dt pickup	OUT	Stage df1/dt picked up
5517	df2/dt pickup	OUT	Stage df2/dt picked up
5518	df3/dt pickup	OUT	Stage df3/dt picked up
5519	df4/dt pickup	OUT	Stage df4/dt picked up
5520	df1/dt TRIP	OUT	Stage df1/dt TRIP
5521	df2/dt TRIP	OUT	Stage df2/dt TRIP
5522	df3/dt TRIP	OUT	Stage df3/dt TRIP
5523	df4/dt TRIP	OUT	Stage df4/dt TRIP

2.3.5 Jump of Voltage Vector

Sometimes consumers with their own generating plant feed power directly into a network. The incoming feeder line is usually the ownership boundary between the network utility and these consumers/producers. A failure of the input feeder line, for example, due to a three-pole automatic reclosure, can result in a deviation of the voltage or frequency at the feeding generator which is a function of the overall power balance. When the incoming feeder line is switched on again after the dead time, asynchronous conditions may prevail that cause damage to the generator or the gear train between generator and drive.

One way to identify an interruption of the incoming feeder is to monitor the phase angle in the voltage. If the incoming feeder fails, the abrupt current interruption causes a phase angle jump in the voltage. This jump is detected by means of a delta process. As soon as a preset threshold is exceeded, an opening command for the generator or bus-tie coupler circuit-breaker is issued.

This means that the vector jump function is mainly used for network decoupling.

2.3.5.1 Functional Description

Frequency Behaviour on Load Shedding

The following figure shows the evolution of the frequency when a load is disconnected from a generator. Opening of the generator circuit breaker causes a phase angle jump that can be observed in the frequency measurement as a frequency jump. The generator is accelerated in accordance with the power system conditions (see also Section 2.3.4 „Rate-of-Frequency-Change Protection“).

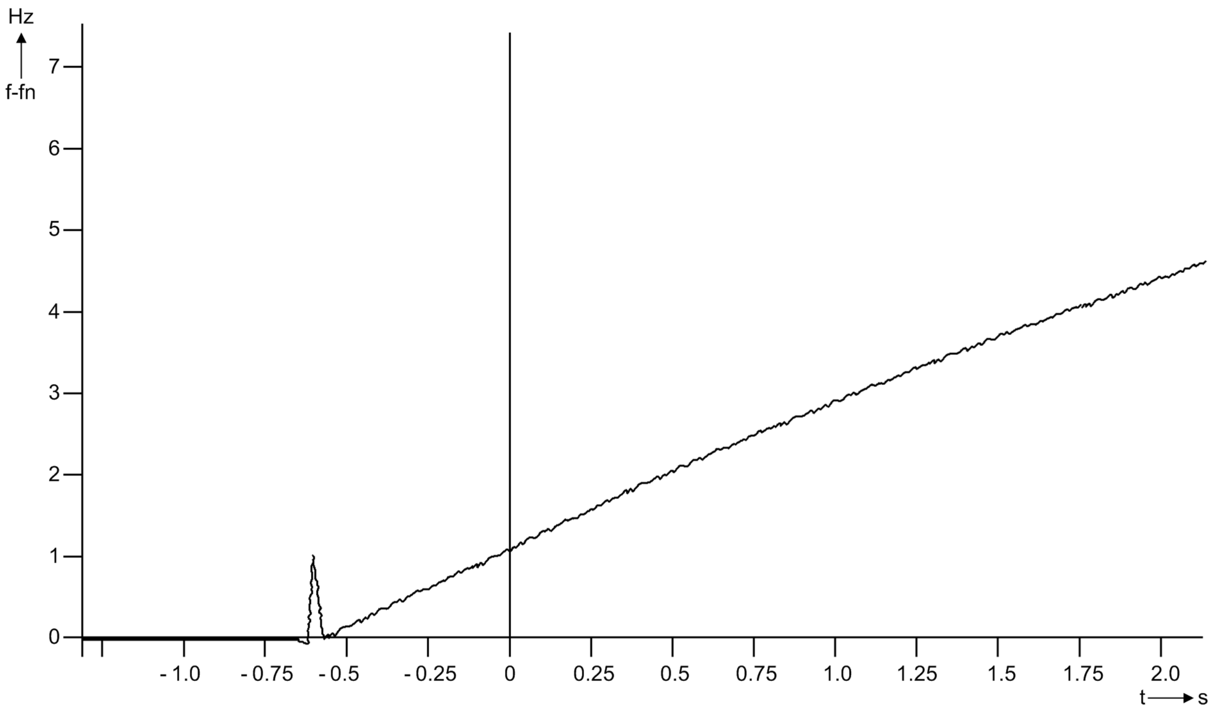


Figure 2-42 Change of the Frequency after Disconnection of a Load (Fault recording with the SIPROTEC 4 device- the figure shows the deviation from the nominal frequency)

Measuring Principle

The voltage vector is calculated from the voltage at the selected input, and the phase angle change is determined over a delta interval of 2 cycles. The presence of a phase angle jump indicates an abrupt change of current flow. The basic principle is shown in the following figure. The diagram on the left shows the steady state, and the diagram on the right the vector change following a load shedding. The vector jump is clearly visible.

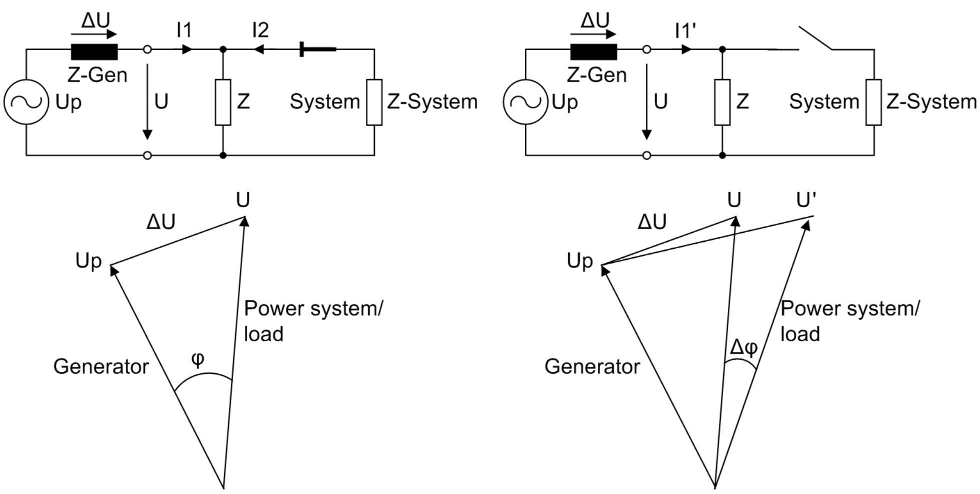


Figure 2-43 Voltage Vector Following Load Shedding

The function features a number of additional measures to avoid spurious tripping, such as:

- Correction of steady-state deviations from rated frequency
- Frequency operating range limited to $f_N \pm 3$ Hz
- Minimum voltage for enabling
- Blocking on voltage connection or disconnection

Logic

The logic is shown in Figure 2-44. The phase angle comparison determines the angle difference, and compares it with the set value. If this value is exceeded, the vector jump is stored in a RS flip-flop. Trippings can be delayed by the associated time delay.

The stored pickup can be reset via a binary input, or automatically by a timer (address 4604 **T RESET**).

The vector jump function becomes ineffective on exiting the admissible frequency band. The same applies for the voltage. In such a case the limiting parameters are **U MIN** and **U MAX**.

If the frequency or voltage range is not maintained, the logic generates a logical 1, and the reset input is continuously active. The result of the vector jump measurement is suppressed. If, for instance, the voltage is connected, and the frequency range is correct, the logical 1 changes to 0. The timer **T BLOCK** with reset delay keeps the reset input active for a certain time, thus preventing a pickup caused by the vector jump function.

If a short-circuit causes the voltage to drop abruptly to a low value, the reset input is immediately activated to block the function. The vector jump function is thus prevented from causing a trip.

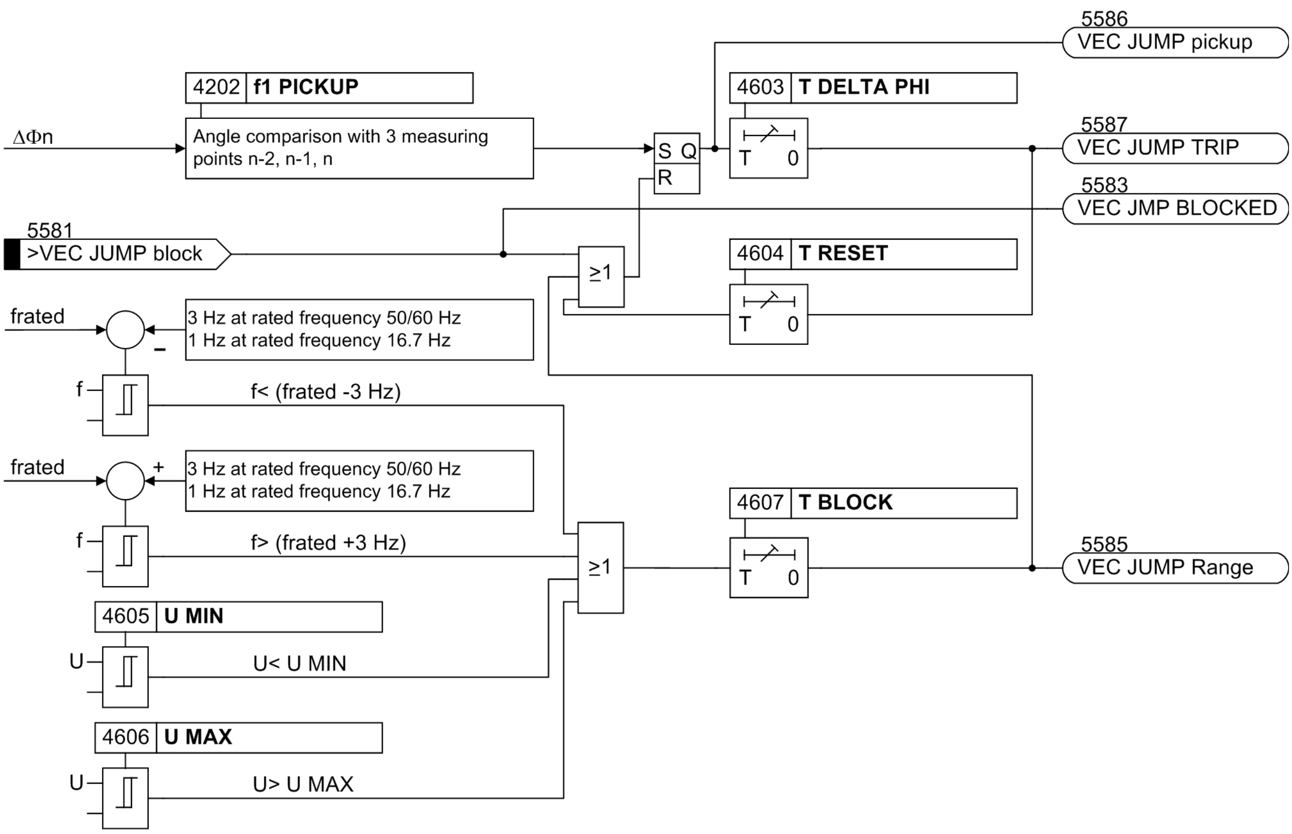


Figure 2-44 Logic Diagram of the Vector Jump Detection

2.3.5.2 Setting Notes

General

The vector jump protection is only effective and available if address 146 **VECTOR JUMP** is set to ***Enabled*** during configuration.

Address 4601 **VECTOR JUMP** serves to switch the function ***ON*** or ***OFF*** or to block only the trip command (***Block relay***).

Pickup Values

The value to be set for the vector jump (address 4602 **DELTA PHI**) depends on the feed and load conditions. Abrupt active power changes cause a jump of the voltage vector. The value to be set must be established in accordance with the particular power system. This can be done on the basis of the simplified equivalent circuit of the diagram „Voltage Vector after a Load Shedding“ in the Functional Description section, or using network calculation software.

If a setting is too sensitive, the protection function is likely to perform a network decoupling every time loads are connected or disconnected. Therefore the default setting is **10°**.

The admissible voltage operating range can be set at addresses 4605 for **U MIN** and 4606 for **U MAX**. Setting range limits are to some extent a matter of the utility's policy. The value for **U MIN** should be below the admissible level of short voltage dips for which network decoupling is desired. The default setting is ***80 %*** of the nominal voltage. For **U MAX** the maximum admissible voltage must be selected. This will be in most cases ***130 %*** of the nominal voltage

Time Delays

The time delay **T DELTA PHI** (address 4603) should be left at zero, unless you wish to transmit the trip indication with a delay to a logic (CFC), or to leave enough time for an external blocking to take effect.

After expiry of the timer **T RESET** (address 4604), the protection function is automatically reset. The reset time depends on the decoupling policy. It must have expired before the circuit breaker is reclosed. Where the automatic reset function is not used, the timer is set to ∞. The reset signal must come in this case from the binary input (circuit breaker auxiliary contact).

The timer **T BLOCK** with reset delay (address 4607) helps to avoid overfunctioning when voltages are connected or disconnected. Normally the default setting need not be changed. Any change can be performed with the DIGSI communication software (advanced parameters). It must be kept in mind that **T BLOCK** should always be set to more than the measuring window for vector jump measurement (2 cycles).

2.3.5.3 Settings

Addresses which have an appended "A" can only be changed with DIGSI, under Additional Settings.

Addr.	Parameter	Setting Options	Default Setting	Comments
4601	VECTOR JUMP	OFF ON Block relay	OFF	Jump of Voltage Vector
4602	DELTA PHI	2 .. 30 °	10 °	Jump of Phasor DELTA PHI
4603	T DELTA PHI	0.00 .. 60.00 sec; ∞	0.00 sec	T DELTA PHI Time Delay
4604	T RESET	0.10 .. 60.00 sec; ∞	5.00 sec	Reset Time after Trip
4605A	U MIN	10.0 .. 125.0 V	80.0 V	Minimal Operation Voltage U MIN

Addr.	Parameter	Setting Options	Default Setting	Comments
4606A	U MAX	10.0 .. 170.0 V	130.0 V	Maximal Operation Voltage U MAX
4607A	T BLOCK	0.00 .. 60.00 sec; ∞	0.10 sec	Time Delay of Blocking
4609	MEAS. INPUT	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input

2.3.5.4 Information List

No.	Information	Type of Information	Comments
5581	>VEC JUMP block	SP	>BLOCK Vector Jump
5582	VEC JUMP OFF	OUT	Vector Jump is switched OFF
5583	VEC JMP BLOCKED	OUT	Vector Jump is BLOCKED
5584	VEC JUMP ACTIVE	OUT	Vector Jump is ACTIVE
5585	VEC JUMP Range	OUT	Vector Jump not in measurement range
5586	VEC JUMP pickup	OUT	Vector Jump picked up
5587	VEC JUMP TRIP	OUT	Vector Jump TRIP

2.3.6 Threshold supervision

The threshold monitoring checks selected measured values for overshoot or undershoot of an adjustable threshold. The processing speed of this function is so high that it can be used for protection applications. The necessary logical combinations can be implemented by means of CFC.

Applications

- For high-speed monitorings, automatic functions and application-specific protection functions.
- Together with direct coupling functions with time delay can be said, which also open a fault condition and a fault record.
- Application as a simple two-point controller is possible by extending from a smaller stage and a larger stage an admissible range for these measures values. On exiting this range the particular indication is issued which then can instigate a corresponding reaction in the process.

2.3.6.1 Function Description

Measured Values

There are 6 threshold supervision blocks, 3 each for overshoot and undershoot of the threshold. As result a logical indication is output that can be further processed by the CFC.

The voltage values of the 6 inputs of the device are available as measured values for threshold monitoring. Just as the protection functions, the threshold monitoring is also always active. Outside the frequency correction range (0,5· f_N to 1,5· f_N) undervoltage functions tend to overreact, all the functions on the other hand to underreact.

The following figure shows an overview of the threshold monitoring logic.

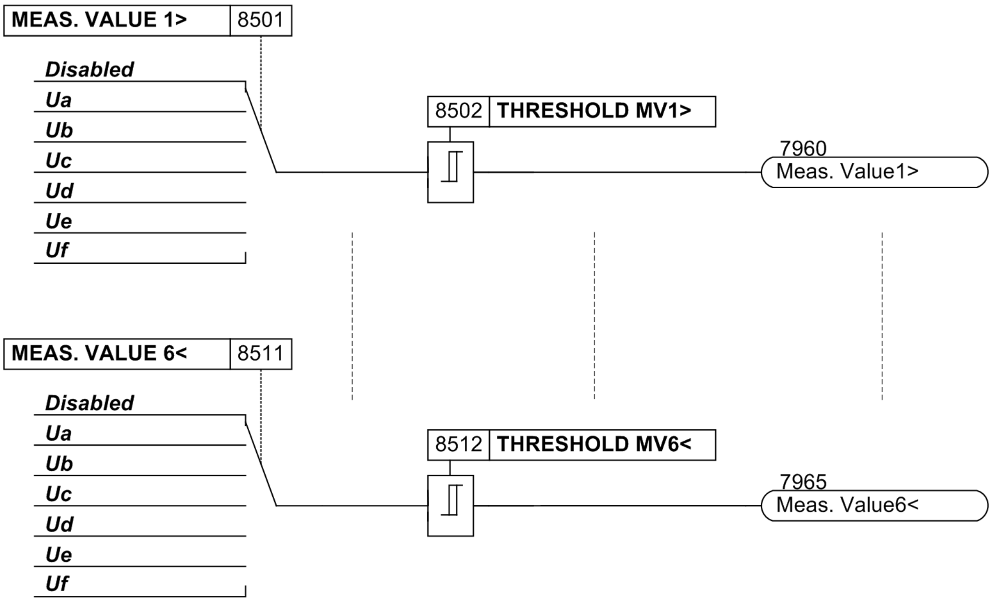


Figure 2-45 Logic of the Threshold Supervision

The figure shows that the measured values can be freely allocated to the threshold supervision blocks. The dropout ratio for the MVx> stages is 0.95 or 1 %. Accordingly, it is 1.05 or 1 % for the MVx< stages.

2.3.6.2 Setting Notes

General

The threshold supervision function is only effective and accessible if address 185 **THRESHOLD** has been set to ***Enabled*** during the configuration of the protection functions.

Pickup Values

The pickup valuers are set as percentage values referred to100 V, as secondary values.

At addresses 8501, 8505 and 8509 you select the measured values to be used for the larger stages, under 8503, 8507 and 8511 for the smaller stages.

With the parameters 8502, 8504, 8506, 8508 , 8510 and 8512 you establish the individual threshold values.

Processing of Indications

The indications of the 6 measured value monitoring blocks (see information list) are available in the configuration matrix for further logical processing by the CFC.

2.3.6.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8501	MEAS. VALUE 1>	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV1>
8502	THRESHOLD MV1>	2 .. 200 %	100 %	Pickup Value of Measured Value MV1>
8503	MEAS. VALUE 2<	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV2<
8504	THRESHOLD MV2<	2 .. 200 %	100 %	Pickup Value of Measured Value MV2<
8505	MEAS. VALUE 3>	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV3>
8506	THRESHOLD MV3>	2 .. 200 %	100 %	Pickup Value of Measured Value MV3>
8507	MEAS. VALUE 4<	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV4<
8508	THRESHOLD MV4<	2 .. 200 %	100 %	Pickup Value of Measured Value MV4<
8509	MEAS. VALUE 5>	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV5>
8510	THRESHOLD MV5>	2 .. 200 %	100 %	Pickup Value of Measured Value MV5>

Addr.	Parameter	Setting Options	Default Setting	Comments
8511	MEAS. VALUE 6<	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV6<
8512	THRESHOLD MV6<	2 .. 200 %	100 %	Pickup Value of Measured Value MV6<

2.3.6.4 Information List

No.	Information	Type of Information	Comments
7960	Meas. Value1>	OUT	Measured Value MV1> picked up
7961	Meas. Value2<	OUT	Measured Value MV2< picked up
7962	Meas. Value3>	OUT	Measured Value MV3> picked up
7963	Meas. Value4<	OUT	Measured Value MV4< picked up
7964	Meas. Value5>	OUT	Measured Value MV5> picked up
7965	Meas. Value6<	OUT	Measured Value MV6< picked up

2.3.7 External Trip Functions

Any signals from external protection or supervision units can be incorporated and processed in the digital multifunctional parallel switch devices 7VE61 and 7VE63 via binary inputs. Like the internal signals, they can be signaled, time delayed, transmitted to the trip matrix, and also individually blocked. This way it is possible to include mechanical protection equipment, e.g. Buchholz protection, into the processing of indications and trip commands of the parallel switch devices. Furthermore, interaction between protection functions of different devices is possible.

2.3.7.1 Functional Description

Mode of Operation

The logic status of the corresponding assigned binary inputs is checked at cyclic intervals. Change of input status is considered only if at least two consecutive status checks have the same result. An additional time delay 8602 **T DELAY** is available for the trip command.

The following figure shows the logic diagram for direct input trippings. This logic is implemented in all four times in the same manner, the function numbers of the indications are each specified for the first external trip command channel.

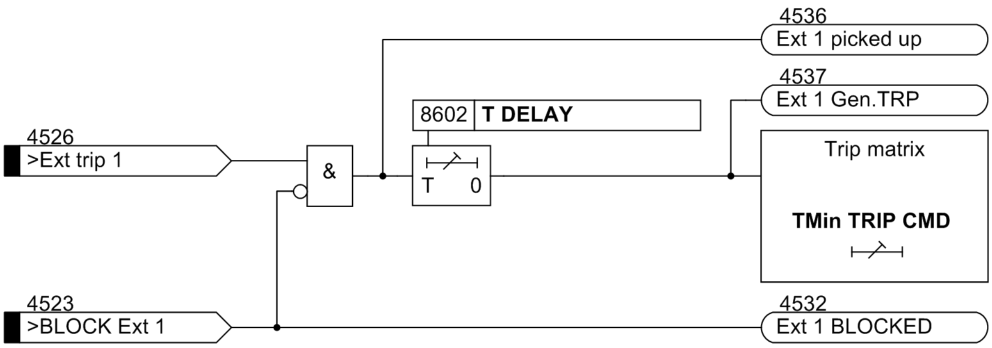


Figure 2-46 Logic Diagram of Direct Input Trippings

2.3.7.2 Setting Notes

General

External trip command via binary inputs is only effective and available if configured at addresses 186 **EXT. TRIP 1** to 189 **EXT. TRIP 4** as ***Enabled***. ***Disabled*** is set if the functions are not required. Addresses 8601 **EXTERN TRIP 1** to 8901 **EXTERN TRIP 4** are used to switch the functions individually ***ON*** or ***OFF***, or to block only the trip command (***Block relay***).

Like the internal signals, they can be indicated as external trippings, time delayed and transmitted to the trip matrix. The delay times are set at addresses 8602 **T DELAY** through 8902 **T DELAY**. Like for the protective functions, the dropout of the direct input trippings is extended by the parametrized minimum duration **TMin TRIP CMD**.

2.3.7.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
8601	EXTERN TRIP 1	OFF ON Block relay	OFF	External Trip Function 1
8602	T DELAY	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 1 Time Delay
8701	EXTERN TRIP 2	OFF ON Block relay	OFF	External Trip Function 2
8702	T DELAY	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 2 Time Delay
8801	EXTERN TRIP 3	OFF ON Block relay	OFF	External Trip Function 3
8802	T DELAY	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 3 Time Delay
8901	EXTERN TRIP 4	OFF ON Block relay	OFF	External Trip Function 4
8902	T DELAY	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 4 Time Delay

2.3.7.4 Information List

No.	Information	Type of Information	Comments
4523	>BLOCK Ext 1	SP	>Block external trip 1
4526	>Ext trip 1	SP	>Trigger external trip 1
4531	Ext 1 OFF	OUT	External trip 1 is switched OFF
4532	Ext 1 BLOCKED	OUT	External trip 1 is BLOCKED
4533	Ext 1 ACTIVE	OUT	External trip 1 is ACTIVE
4536	Ext 1 picked up	OUT	External trip 1: General picked up
4537	Ext 1 Gen. TRIP	OUT	External trip 1: General TRIP
4543	>BLOCK Ext 2	SP	>BLOCK external trip 2
4546	>Ext trip 2	SP	>Trigger external trip 2
4551	Ext 2 OFF	OUT	External trip 2 is switched OFF
4552	Ext 2 BLOCKED	OUT	External trip 2 is BLOCKED
4553	Ext 2 ACTIVE	OUT	External trip 2 is ACTIVE
4556	Ext 2 picked up	OUT	External trip 2: General picked up
4557	Ext 2 Gen. TRIP	OUT	External trip 2: General TRIP
4563	>BLOCK Ext 3	SP	>BLOCK external trip 3
4566	>Ext trip 3	SP	>Trigger external trip 3
4571	Ext 3 OFF	OUT	External trip 3 is switched OFF
4572	Ext 3 BLOCKED	OUT	External trip 3 is BLOCKED
4573	Ext 3 ACTIVE	OUT	External trip 3 is ACTIVE
4576	Ext 3 picked up	OUT	External trip 3: General picked up
4577	Ext 3 Gen. TRIP	OUT	External trip 3: General TRIP
4583	>BLOCK Ext 4	SP	>BLOCK external trip 4
4586	>Ext trip 4	SP	>Trigger external trip 4
4591	Ext 4 OFF	OUT	External trip 4 is switched OFF
4592	Ext 4 BLOCKED	OUT	External trip 4 is BLOCKED
4593	Ext 4 ACTIVE	OUT	External trip 4 is ACTIVE
4596	Ext 4 picked up	OUT	External trip 4: General picked up
4597	Ext 4 Gen. TRIP	OUT	External trip 4: General TRIP

2.4 Analog Outputs

Depending on the variant ordered, the 7VE61 and 7VE63 parallel switching devices can have up to four analog outputs (plug-in modules on ports B and D). The analog outputs determine the output of percentage measured values which are made available by the synchronization function.

2.4.1 Functional Description

Application

The synchronizing function measured values to be transmitted via these analog outputs have been specified during function scope configuration (see Section 2.1.1.2). Up to four of the following analog outputs are available:

- Masure value ΔU as a percentage of the operational rated voltage U_{nom},
- Measured value Δf as a percentage of the rated frequency f_{nom},
- Measured value $\Delta\alpha$ as a percentage of 180°,
- Measure value $|\Delta U|$ as a percentage of the operational rated voltage U_{nom},
- Measured value $|\Delta f|$ as a percentage of the rated frequency f_{nom},
- Measured value $|\Delta\alpha|$ as a percentage of 180°,
- Measured value U1 as a percentage of the operational rated voltage U_{nom},
- Measured value U2 as a percentage of the operational rated voltage U_{nom},
- Measured value f1 as a percentage of the rated frequency f_{nom},
- Measured value f2 as a percentage of the rated frequency f_{nom}

Analog values are output as injected currents. The analog outputs have a nominal range between 0 mA and 20 mA, their operating range can be up to 22.5 mA. The conversion factor and the validity range can be set.

If measured values are transmitted, they are cyclically updated 1× per cycle.

2.4.2 Setting Notes

General

You have specified during configuration of the analog outputs (Section 2.1.1.2, addresses 173 to 176), which of the analog inputs available in the device are to be used. If a function is not needed, ***Disabled*** is set. The other parameters associated with this analog output are masked out in such a case.

Note

The measured values are produced by the synchronizing function. If no synchronizing function group is activated or if all synchronizing function groups are set to ***Disabled*** or ***OFF*** no measured values are generated.

Measured Values

Once the measured values are selected for the analog outputs (Section 2.1.1.2, addresses 173 to 176), set the conversion factors for the available outputs under addresses 7301 to 7305, as follows:

- Scaling factor U:

  Address 7301 **SCAL. U** = value in V, which corresponds to 100 %,
- Scaling factor frequency:

  Address 7302 **SCAL. f** = value in Hz, which corresponds to 100 %,
- Scaling factor ΔU:

  Address 7303 **SCAL. ΔU** = value in V, which corresponds to 100 %,
- Scaling factor ΔU:

  Address 7304 **SCAL. Δf** = value in Hz, which corresponds to 100 %,
- Scaling factorΔα:

  Address 7305 **SCAL. Δα** = value in °, which corresponds to 100 %.

Under addresses 7311, 7321, 7331 and 7341 you specify which of the analog outputs (B1, B2, D1 and D2) will be used for the measured values (U1, f1, U2, f2, ΔU, Δf, Δα, I ΔU I, I Δf I, I Δα I).

Once the measured values are selected for the analog outputs, set the conversion factor and the validity range for the available outputs, as follows:

- For analog output 1 at mounting location „B“ (Port B1):

  Address 7312 **MIN. VALUE(B1)** the smallest reference value in %.

  Address 7313 **MIN. OUTPUT(B1)** of the minimum current output value in mA,

  Address 7314 **MAX. VALUE(B1)** the smallest reference value in %.

  Address 7315 **MAX. OUTPUT(B1)** the maximum current output value in mA,
- For analog output 2 at mounting location „B“ (Port B2):

  Address 7322 **MIN. VALUE(B2)** the smallest reference value in %.

  Address 7323 **MIN. OUTPUT(B2)** the minimal current output value in mA,

  Address 7324 **MAX. VALUE(B2)** the smallest reference value in %.

  Address 7325 **MAX. OUTPUT(B2)** the maximum current output value in mA.
- For analog output 3 at mounting location „D“ (Port D1):

  Address 7332 **MIN. VALUE(D1)** the smallest reference value in %.

  Address 7333 **MIN. OUTPUT(D1)** the minimal current output value in mA,

  Address 7334 **MAX. VALUE(D1)** the maximum reference value in %.

  Address 7335 **MAX. OUTPUT(D1)** the maximum current output value in mA,
- For analog output 4 at mounting location „D“ (Port D2):

  Address 7342 **MIN. VALUE(D2)** the smallest reference value in %.

  Address 7343 **MIN. OUTPUT(D2)** the minimal current output value in mA,

  Address 7344 **MAX. VALUE(D2)** the maximum reference value in %.

  Address 7345 **MAX. OUTPUT(D2)** the maximum current output value in mA,

The maximum possible value is 22.0 mA; in case of an overflow (value outside the maximum admissible range) 22.5 mA is output. For measured values below the minimum reference value the parametrized mimimum output value is output. The setting ranges are such that both positive as well as negative values can be represented over the output range, as is necessary for display of ΔU, Δf, Δα.

The following diagram illustrates the relationships.

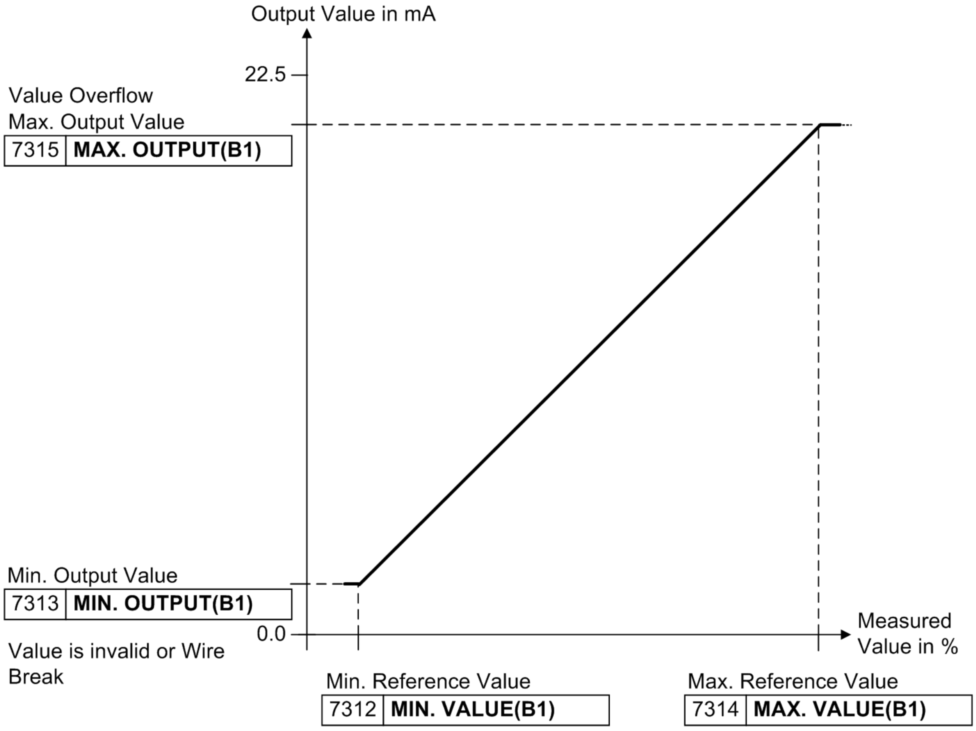


Figure 2-47 Definition of output range representation

Example:

The difference voltage ΔU of the synchronizing function is to be output as analog output 1 for positive and negative values at the mounting location „B“. For this a 4–20 mA output is implemented. A current below 4 mA (recommended monitoring threshold ≈ 2 mA) is to take it at the reception side as a wire break.

As a scaling value for the difference voltage 5 V is selected. Via the analog output voltage of ± 2.5 V is to be output.

The following setting values result:

Scaling factor U for 100 %: address 7303 **SCAL. ΔU** = ***5.0 V***

Minimum reference value in %: Address 7312 **MIN. VALUE(B1)** = ***–50 %***

Minimum current output value in mA: Address 7313 **MIN. OUTPUT(B1)** = ***4 mA***

Maximum reference value in %: Address 7314 **MAX. VALUE(B1)** = ***50.00 %***

Maximum current output value in mA: Address 7315 **MAX. OUTPUT(B1)** = ***20.0 mA***

The relation between measured values and output values is illustrated in the following table as well as in Figure 2-48.

Table 2-6 Example output for measured value ΔU

Measured value	percentage value	output value
invalid value (wire break)		0.0 mA
–5.0 V	–100 %	4.0 mA
–2.5 V	–50 %	4.0 mA
–1.25 V	–25 %	8.0 mA
0.0 V	0 %	12.0 mA

Measured value	percentage value	output value
1.25 V	25 %	16.0 mA
2.5 V	50 %	20.0 mA
5.0 V	100 %	20.0 mA

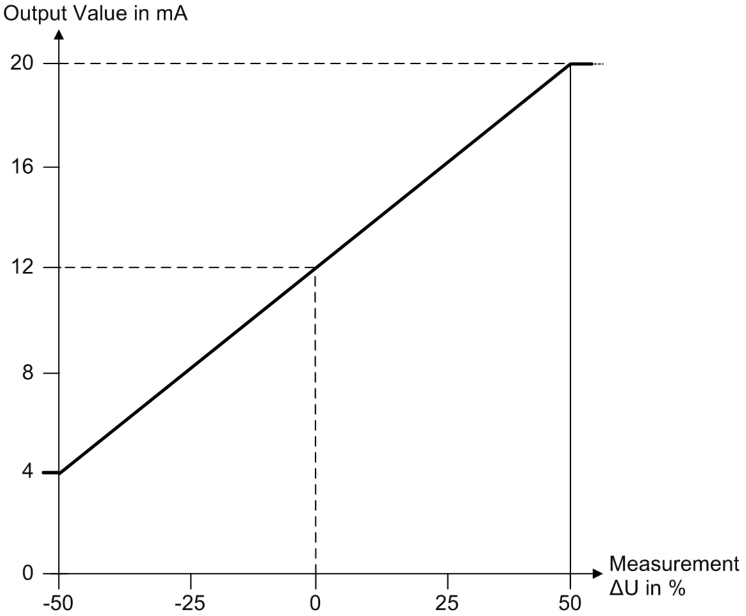


Figure 2-48 Example of an output of the measured value ΔV

2.4.3 Settings

Addr.	Parameter	Setting Options	Default Setting	Comments
7301	SCAL. U	10.0 .. 180.0 V	100.0 V	Scaling factor U for 100%
7302	SCAL. f	10.00 .. 200.00 Hz	100.00 Hz	Scaling factor f for 100%
7303	SCAL. ΔU	1.0 .. 180.0 V	5.0 V	Scaling factor DELTA U for 100%
7304	SCAL. Δf	1.00 .. 200.00 Hz	10.00 Hz	Scaling factor DELTA f for 100%
7305	SCAL. Δα	1.0 .. 180.0 °	10.0 °	Scaling factor DELTA ALPHA for 100%
7311	ANALOGOUTPUT B1	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output B1 (Port B)
7312	MIN. VALUE(B1)	-200.00 .. 100.00 %	-50.00 %	Minimum Percentage Output Value (B1)

Addr.	Parameter	Setting Options	Default Setting	Comments
7313	MIN. OUTPUT(B1)	0 .. 10 mA	4 mA	Minimum Current Output Value (B1)
7314	MAX. VALUE(B1)	10.00 .. 200.00 %	50.00 %	Maximum Percentage Output Value (B1)
7315	MAX. OUTPUT(B1)	10 .. 22 mA	20 mA	Maximum Current Output Value (B1)
7321	ANALOGOUTPUT B2	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output B2 (Port B)
7322	MIN. VALUE(B2)	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (B2)
7323	MIN. OUTPUT(B2)	0 .. 10 mA	4 mA	Minimum Current Output Value (B2)
7324	MAX. VALUE(B2)	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (B2)
7325	MAX. OUTPUT(B2)	10 .. 22 mA	20 mA	Maximum Current Output Value (B2)
7331	ANALOGOUTPUT D1	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output D1 (Port D)
7332	MIN. VALUE(D1)	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (D1)
7333	MIN. OUTPUT(D1)	0 .. 10 mA	4 mA	Minimum Current Output Value (D1)
7334	MAX. VALUE(D1)	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (D1)
7335	MAX. OUTPUT(D1)	10 .. 22 mA	20 mA	Maximum Current Output Value (D1)

Addr.	Parameter	Setting Options	Default Setting	Comments
7341	ANALOGOUTPUT D2	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output D2 (Port D)
7342	MIN. VALUE(D2)	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (D2)
7343	MIN. OUTPUT(D2)	0 .. 10 mA	4 mA	Minimum Current Output Value (D2)
7344	MAX. VALUE(D2)	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (D2)
7345	MAX. OUTPUT(D2)	10 .. 22 mA	20 mA	Maximum Current Output Value (D2)

2.5 Supervision

The device incorporates comprehensive monitoring functions which cover both hardware and software; the measured values are continuously checked for plausibility, so that the voltage transformer circuits are also included in the monitoring system to a large extent.Special monitoring functions are integrated, in particular for the synchronizing function.

2.5.1 Function Description

Hardware Monitoring

The device monitoring extends from the measuring inputs to the binary outputs. Monitoring circuits and processor check the hardware for malfunctions and inadmissible conditions (see also Table 2-7).

Auxiliary and Reference Voltages

The processor voltage of 5 VDC is monitored by the hardware since if it goes below the minimum value, the processor is no longer functional. In that case the device is put out of operation. When the normal voltage returns, the processor system is restarted.

Failure or switching off the supply voltage removes the device from operation and a message is immediately generated by the "life contact" (an alternatively NO or NC contact). Brief auxiliary voltage interruptions of less than 50 ms do not disturb the operational readiness of the device (for nominal auxiliary voltage ≥ 110 VDC).

The processor monitors the reference voltage of the ADC (analog-to-digital converter). In case of inadmissible deviations the protection is blocked; persistent faults are signalled (indication: „`Error A/D-conv.`“).

Buffer Battery

The buffer battery, which ensures operation of the internal clock and storage of counters and messages if the auxiliary voltage fails, is periodically checked for charge status. If it is less than an allowed minimum voltage, then the „`Fail Battery`“ message is issued.

If the device is isolated from the auxiliary voltage for several hours, the internal back-up battery is switched off automatically, i.e. the time is not registered any more. Messages and fault recordings however are kept stored.

Memory Components

All working memories (RAMs) are checked during start-up. If a fault occurs in this process, the start is aborted and an LED starts flashing. During operation the memories are checked by means of their checksum.

For the program memory (EPROM), the cross-check sum is cyclically generated and compared to a stored reference program cross-check sum.

For the settings memory, the cross-check sum is formed cyclically and compared to the cross-check sum that is freshly generated each time a setting process takes place.

If a fault occurs the processor system is restarted.

Probing

The sampling frequency and the synchronism between the internal buffer modules is continuously monitored. If any deviations cannot be removed by renewed synchronisation, then the processor system is restarted.

Software Monitoring

Watchdog

For continuous monitoring of the program sequences, a watchdog timer is provided in the hardware (hardware watchdog) which will reset and completely restart the processor system in the event of processor failure or if a program falls out of step.

A further software watchdog ensures that any error in the processing of the programs will be recognized. This also initiates a restart of the processor system.

If such a malfunction is not cleared by the restart, an additional restart attempt is begun. After three unsuccessful restarts within a 30 second window of time, the device automatically removes itself from service and the red "Error" LED lights up. The operational readiness relay ("Life contact") opens and issues an alarm (alternatively as NO or NC contact).

Offset Monitoring

This monitoring checks all data channels in the ring buffer by using offset filters, for faulty offset formation of the analog/digital converters and the analog input paths. Any offset errors are detected by a use of DC voltage filters and the associated scan values corrected up to a particular limit. If this is exceeded an indication is issued (191 „`Error Offset`“) the one which flows in the warn group annunciation (annunciation 160).

Monitorings of the Synchronizing Function

Channel Monitoring

This monitoring has the task of examining measurement signals and the associated negated signals of the synchronizing function in the paralleling device operating mode, for consistency. By numerical check of instantaneous values and summation formation (normally ≈ zero must result), the input transformers, analog/digital converters, sampling and the ring buffer are checked. If the data of the negated and nonnegated voltage for a voltage channel are detected as inadmissible, the particular indication „`Sync Fail Ch U1`“ or „`Sync Fail Ch U2`“ is issued and the synchronizing function blocked.

Monitoring of the Analog/Digital Converter

For analog/digital conversion of a maximum total of 6 measurement signals, two ADC converters are available each with four channels. The two remaining channels are used for monitoring purposes with one channel of the other converter in each case. The output values of the redundant channels are checked for consistency with the those of the original channels. If deviations are detected here an indication „`Error ADC`“ is generated and both synchronizing function and all protection functions are blocked.

Phase Sequence Supervision

The phase sequence direction of both voltage sides is monitored for consistency of parameterisation. A requirement for phase sequence monitoring is connection of an additional phase-to-phase voltage on the two sides U1 and U2 and the enabling of the phase sequence check using parameter **`6x13 PHASE SEQUENCE`**. In addition the voltages at all inputs must exceed a paramerizable minimum voltage.

Phase rotation is checked by supervising the phase sequence of the voltages. This is established from the time difference between the zero transitions of the individual phases If measured and parametrized phase sequence direction differ an indication „`SyncSeq U1 fail`“ or „`SyncSeq U2 fail`“ is output and the synchronizing function blocked.

Check of Data Current State and Continuity

The measurement voltages are continually entered as numerical values in a ring buffer. For each of the measured values a corresponding sequence of numerical scan values exist in the ring buffers, which reflect the chronological course of the analog values. To ensure that actually current values are available an internal counter queries the sampling values and monitors their progress. If the monitoring detects a current state fault, the indication „`Fail. Sampling`“ is issued and as long as this prevails a closure command by the synchronizing function is suppressed.

If transient disturbances lead to unsteady changes in the sampling values, errors can occur in the frequency and angle calculations leading to wrong connections. The continuity supervision evaluates the difference of consecutive sampling values for each measured value, and on detection of an unsteady state blocks connection for a defined time period. A corresponding indication „`Sync Fail Data`“ is produced. Since this involves a transient error, the protection functions of the device are not blocked.

Monitoring of the Function Group Selection

A particular group of parameters is provided for each synchronizing point which are designated as a function group. Each of these function groups applies to one synchronising point and must be therefore clearly selected. This is done via the binary inputs „`>Sy1 activ`“ to „`>Sy8 activ`“. The selection uniqueness is checked by a „1-out of-n“ decision. An incorrect function group selection is signalled by the indication „`Sync FG-Error`“.

Relay Monitoring

The relays R1 (BO1) and R2 (BO2) in the devices 7VE61 and 7VE63 are activated by 2 command channels and an additional enabling channel. Open circuits and short-circuits in the relay activation are detected and indicated (annunciations „`Error Relay R1`“ or „`Error Relay R2`“). If this monitoring responds the synchronizing function is blocked and reset.

Plausibility of Parameter Settings

In principle simultaneous parametrization and synchronization is not permitted. A start pulse is not accepted during a parametrization or a current synchronisation is aborted by a reparametrization.

On plausibility errors in configuration of the synchronizing function the indication „`Sync Fail.Conf.`“ is issued and the synchronizing function blocked. The check is done already on startup of the device/on arriving measured request to the synchronizing function. All switching actions which operate with the synchronizing function are acknowledged in the error case with a negative command execution (CO-).

Further monitoring is specific to function group i.e. it monitors the parameters within a function group. In the event of plausibility errors the indication „SyX ParErr“ (with X = 1 to 8) is issued and the faulty parametrized functional group is blocked. The following monitoring functions are carried out:

<table>
<tr><th>Addr.</th><th>Parameter</th><th>Description</th><th>Condition</th></tr>
<tr><td>6 x 05</td><td>U<</td><td>Threshold U1, U2 dead line</td><td rowspan="4">6 x 05 < 6 x 06 ≤ 6 x 03 < 6 x 04</td></tr>
<tr><td>6 x 06</td><td>U></td><td>Threshold U1, U2 energized</td></tr>
<tr><td>6 x 03</td><td>Umin</td><td>Lower voltage limit: Umin</td></tr>
<tr><td>6 x 04</td><td>Umax</td><td>Upper voltage limit: Umax</td></tr>
<tr><td>6 x 30</td><td>dU ASYN U2>U1</td><td>Perm. Voltage Difference U2>U1</td><td rowspan="4">6 x 30 ≤ I 6 x 03–6 x 04 I
6 x 31 ≤ I 6 x 03–6 x 04 I</td></tr>
<tr><td>6 x 31</td><td>dU ASYN U2<U1</td><td>Perm. Voltage Difference U2<U1</td></tr>
<tr><td>6 x 03</td><td>Umin</td><td>Lower voltage limit: Umin</td></tr>
<tr><td>6 x 04</td><td>Umax</td><td>Upper voltage limit: Umax</td></tr>
<tr><td>6 x 42</td><td>dU SYN U2>U1</td><td>Perm. Voltage Difference U2>U1</td><td rowspan="4">6 x 42 ≤ I 6 x 03–6 x 04 I
6 x 43 ≤ I 6 x 03–6 x 04 I</td></tr>
<tr><td>6 x 43</td><td>dU SYN U2<U1</td><td>Perm. Voltage Difference U2<U1</td></tr>
<tr><td>6 x 03</td><td>Umin</td><td>Lower voltage limit: Umin</td></tr>
<tr><td>6 x 04</td><td>Umax</td><td>Upper voltage limit: Umax</td></tr>
</table>

Addr.	Parameter	Description	Condition
6 x 71	T U PULS MIN	minimum position impulse for U comparison	6 x 71 < 6 x 72
6 x 72	T U PULS MAX	maximum position impulse for U comparison	
6 x 81	T f PULS MIN	minimum position impulse for f comparison	6 x 81 < 6 x 82
6 x 82	T f PULS MAX	maximum position impulse for f comparison	
6 x 20	T-CB close	Operating Time of the Circuit Breaker	6 x 20 != ∞
6 x 33	df ASYN f2<f1	Perm. Frequency Difference f2<f1	(-1·6 x 33) < 6 x 85 < 6 x 32
6 x 85	Δf SET POINT	Target value for the frequency balance	
6 x 32	df ASYN f2>f1	Perm. Frequency Difference f2>f1	

Malfunction Responses of the Monitoring Functions

Depending on the type of malfunction detected, an indication is sent, a restart of the processor system initiated, the synchronism function is blocked and reset or the whole device is taken out of service. After three unsuccessful restart attempts, the device is also taken out of service. The device healthy relay (live) also resets and alarms the failure state of the relay with its normally closed contact. Also, the red LED "ERROR" lights up on the front cover, if the internal auxiliary voltage is present, and the green RUN "LED" goes out. If the internal auxiliary supply also fails all LEDs are extinguished. The following table summarises the monitoring functions and the malfunction responses of the device.

Table 2-7 Summary of Malfunction Responses of the Device

Monitoring	possible causes	Malfunction Response	Indication (No.)	Output
Auxiliary supply voltage loss	External (aux. voltage) internal (converter)	Device not in operation	All LEDs dark	DOK[2)] drops out
Internal supply voltages	Internal (converter) or reference voltage	Device not in operation	LED ”ERROR" „Error A/D-conv.“ (181)	DOK[2)] drops out
Battery	Internal (Buffer battery)	Indication	„Fail Battery“ (177)	„Alarm Sum Event“ (160)
Hardware Watchdog	Internal (processor failure)	Device not in operation [1)]	LED ”ERROR"	DOK[2)] drops out
Software watchdog	Internal (processor failure)	Restart attempt [1)]	LED ”ERROR"	DOK[2)] drops out
Working memory ROM	Internal (hardware)	Abortion of restart, Device out of service	LED flashes	DOK[2)] drops out
Program memory RAM	Internal (hardware)	during boot sequence	LED flashes	DOK[2)] drops out
		detection during operation: Restart attempt [1)]	LED ”ERROR"	
Settings memory	Internal (hardware)	Restart attempt [1)]	LED ”ERROR"	DOK[2)] drops out
Sampling frequency	Internal (hardware)	Device not in operation	„Fail. Sampling“ (25043) LED ”ERROR"	DOK[2)] drops out
Channel monitoring U1	Internal (hardware)	Indication	„Sync Fail Ch U1“ (25037)	Synchronizing function is blocked
Channel monitoring U2	Internal (hardware)	Indication	„Sync Fail Ch U2“ (25038)	Synchronizing function is blocked

Monitoring	possible causes	Malfunction Response	Indication (No.)	Output
ADC monitoring	Internal (hardware)	Indication	„Error ADC“ (25036)	DOK[2] drops out
Phase sequence for voltage side 1	External (power system or connection)	Indication	„SyncSeq U1 fail“ (25039)	Synchronizing function is blocked
Phase sequence for voltage side 2	External (power system or connection)	Indication	„SyncSeq U2 fail“ (25040)	Synchronizing function is blocked
Data current state	internal (software) or external influenced by disturbance	Indication	„Fail. Sampling“ (25043)	Protection and synchronizing function are blocked
Data continuity	Disturbance influencing	Indication	„Sync Fail Data“ (25054)	Delay of the synchronizing function
Function group selection	External (power system or connection) or parametrizing error	Indication	„Sync FG-Error“ (222.2096)	Synchronizing function is blocked
Relay monitoring	Internal (hardware)	Indication	„Error Relay R1“ (25041) „Error Relay R2“ (25042)	Synchronizing function is blocked
Plausibility monitorings	Configuration errors Parametrization errors	Indication	„Sync Fail.Conf.“ (222.2331) „Sy1 ParErr“ (170.2097)	Synchronizing function is blocked
Offset monitoring	Internal (hardware)	Indication	„Error Offset“ (191)	Synchronizing function is blocked

[1] After three unsuccessful restarts, the device is taken out of service.

[2] DOK = "Device Okay" = Ready for service relay drops off, synchronizing protection and control functions are blocked. Operator communication is still possible

Group indications

Certain indications of the monitoring functions are combined as group indications. These group indications (disturbance group indication 140, warning group indication 160 and disturbance measured value 181) and their composition are described in the appendix A.9.

2.5.2 Information List

No.	Information	Type of In-formation	Comments
68	Clock SyncError	OUT	Clock Synchronization Error
140	Error Sum Alarm	OUT	Error with a summary alarm
160	Alarm Sum Event	OUT	Alarm Summary Event
170.2097	Sy1 ParErr	OUT	Sync-group 1: Parameter not plausible
170.2097	Sy2 ParErr	OUT	Sync-group 2: Parameter not plausible
170.2097	Sy3 ParErr	OUT	Sync-group 3: Parameter not plausible
170.2097	Sy4 ParErr	OUT	Sync-group 4: Parameter not plausible
170.2097	Sy5 ParErr	OUT	Sync-group 5: Parameter not plausible
170.2097	Sy6 ParErr	OUT	Sync-group 6: Parameter not plausible
170.2097	Sy7 ParErr	OUT	Sync-group 7: Parameter not plausible
170.2097	Sy8 ParErr	OUT	Sync-group 8: Parameter not plausible
177	Fail Battery	OUT	Failure: Battery empty
181	Error A/D-conv.	OUT	Error: A/D converter
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
190	Error Board 0	OUT	Error Board 0
191	Error Offset	OUT	Error: Offset
193	Alarm adjustm.	OUT	Alarm: Analog input adjustment invalid
222.2096	Sync FG-Error	OUT	Sync. Multiple selection of func-groups
222.2331	Sync Fail.Conf.	OUT	Sync. Failure in Configuration
25036	Error ADC	OUT	Error Analog/Digital converter
25037	Sync Fail Ch U1	OUT	Sync. Failure Channel supervision U1
25038	Sync Fail Ch U2	OUT	Sync. Failure Channel supervision U2
25039	SyncSeq U1 fail	OUT	Sync: Failure phase sequence U1
25040	SyncSeq U2 fail	OUT	Sync: Failure phase sequence U2
25041	Error Relay R1	OUT	Error Relay R1
25042	Error Relay R2	OUT	Error Relay R2
25043	Fail. Sampling	OUT	Failure Sampling
25054	Sync Fail Data	OUT	Sync: Failure data continuity

2.6 Protection Function Control

The function logic coordinates the sequence of both the protective and ancillary functions, processes the functional decisions, and data received from the system.

2.6.1 Pickup Logic of Device

This section describes the general pickup and spontaneous messages in the device display.

2.6.1.1 Function Description

General Device Pickup

The pickup signals for all protection functions in the device are logically OR-combined, and lead to the general device pickup. It is initiated by the first incoming pickup, ends when the last function drops out and is indicated as general device pickup.

The general pickup is a prerequisite for a number of internal and external consequential functions. These functions, which are controlled by the general pickup, include:

- Start of Trip Log: From start of the general device pickup to device drop out, all fault indications are entered in the trip log.
- Initialization of fault recording: The storage and maintenance of fault values can also be made dependent on the occurrence of a trip command.
- Generation of Spontaneous indications in the device display: Certain fault indications are displayed in the device display as so-called spontaneous indications (see below "Display—Spontaneous Indications"). This display can also be made dependent on a general device trip.

Display–Spontaneous Messages

Spontaneous indications are fault indications that appear in the display automatically when general device pickup has occurred. In the case of 7VE61 and 7VE63 they are the following:

"Protection Pickup":	the protection function that last picked up
"Protection Trip":	the protection function that last initiated a trip signal;
"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;

2.6.2 Tripping Logic of Device

This section comprises a description regarding the general trip and termination of the trip command.

2.6.2.1 Functional Description

General Trip

The tripping signals for all protective functions are connected by ”OR” and generate a message „`Relay TRIP`“.

This annunciation, like individual trip indications, can be allocated to an LED or an output relay. It can also be used as a sum event.

Control of the Trip Command

For controlling the trip command the following applies:

- If a protective function is set to ***`Block. Relay`***, it is blocked for the activation of the output relay. The other protective functions are not affected by this.
- A trip command once transmitted is stored (see Figure 2-49). At the same time, the minimum trip command duration **`T TRIPCOM MIN`** is started. This trip signal duration timer ensures the trip signal is transmitted to the circuit breaker for a sufficient amount of time, even if the function which issued the trip signal drops out quickly. The trip signal is only terminated after all protection Functions drop out AND the minimum trip signal duration expires.
- Finally, it is possible to latch the trip signal until it is manually reset (lockout function). This allows interlocking the circuit breaker against reclosing until the cause of the malfunction has been clarified and the interlock has been manually reset. The reset takes place either by pressing the LED reset key or by activating an appropriately masked binary input („`>Reset LED`“). A precondition, of course, is that the circuit breaker trip coil – as usual – remains blocked as long as the trip signal is present, and the trip coil current is interrupted by the auxiliary contact of the circuit breaker.

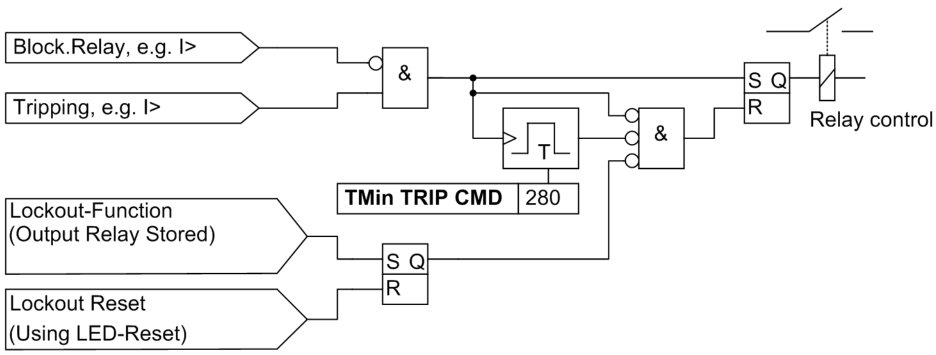


Figure 2-49 Terminating the Trip Signal, Example of a Protective Function

2.6.2.2 Setting Notes

Command Duration

The minimum trip command duration `280` **`TMin TRIP CMD`** was described already in Section 2.1.2. It is valid for all protection functions which can issue a trip command.

2.6.3 Fault Display on the LEDs/LCD

The indication of messages masked to LEDs, and the maintenance of spontaneous messages, can be made dependent on whether the device has issued a trip command. In this situation, messages are not reported, if one or more protective functions have picked up on a fault, but a trip signal has not been issued yet by the 7VE61 and 7VE63, because the fault was cleared by another device (for example, outside the own protection range). These messages are then limited to faults in the line to be protected.

2.6.3.1 Functional Description

Creating a Reset Command

The following figure illustrates the creation of the reset command for stored messages. By the moment of the device dropout, the stationary conditions (fault indication with excitation/with trip signal; tripping/no tripping) decide whether the new fault remains stored or is reset.

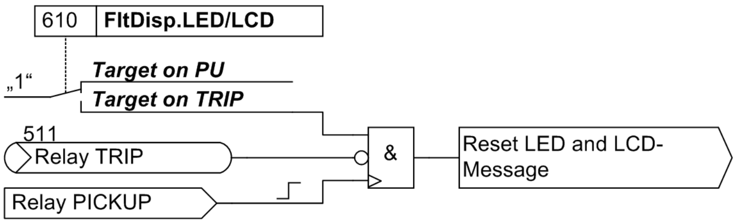


Figure 2-50 Creation of the reset command for the memory of LED and LCD messages

2.6.3.2 Setting Notes

Fault Display on the LEDs/LCD

Pickup of a new protective function generally turns off any previously lit LEDs, so that only the latest fault is displayed at any time. It can be selected whether the stored LED displays and the spontaneous indications on the display appear upon renewed pickup, or only after a renewed trip signal is issued. In order to enter the desired type of display, select in menu **PARAMETER** the submenu **Device**. Address 610 **FltDisp.LED/LCD** offers the two alternatives ***Target on PU*** and ***Target on TRIP***.

2.7 Additional Functions

The auxiliary functions of the 7VE61 and 7VE63 relay include:

- Processing of indications
- Measurements (including acquisition of minimum and maximum values)
- Setting of Limit Values for Measured Values and Statistic Values
- Date and Time Management
- Commissioning Tools

2.7.1 Message Processing

After the occurrence of a system fault, data regarding the response of the relay and the measured values are saved for future analysis. For this purpose, the device is designed to perform message processing:

– LED display and binary outputs (output relays)

– Information via display field or personal computer

– Information to a control center

2.7.1.1 Functional Description

LED Display and Binary Outputs (output relays)

Important events and conditions are displayed, using LEDs at the front panel of the relay. The device furthermore has output relays for remote indication. All LEDs and binary outputs indicating specific messages can be freely configured. The relay is delivered with a default setting. The SIPROTEC 4 System Description provides a detailed description of the configuration procedure (see /1/). The default settings on delivery are listed in the Appendix of this manual.

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

- locally by pressing the LED key on the relay,
- remotely using a binary input configured for that purpose,
- using one of the serial interfaces,
- automatically at the beginning of a new pickup (please observe the LED minimum hold time).

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

A green LED displays operational readiness of the relay („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.

Information on the Integrated Display (LCD) or to a Personal Computer

Events and statuses can be read out on the display panel on the device front panel. Using the front operator interface or the rear service interface, for instance, a personal computer can be connected, to which the information can be sent.

In the quiescent condition, as long as no system fault is present, the display panel can display selected operating information (overview of operating measurement values). In the event of a system fault, fault information, so-called spontaneous display messages, appear instead. After the fault messages have been acknowledged, the quiescent data are shown again. Acknowledgement can be performed by pressing the LED buttons on the front panel (see above).

The relay is equipped with several event buffers, for operational messages, circuit breaker statistics, etc., which are protected against loss of the auxiliary voltage by a buffer battery. These messages can be displayed on the LCD at any time by selection via the keypad or transferred to a personal computer via the serial service or PC interface. Readout of messages during operation is described in detail in the SIPROTEC 4 System Description /1/.

Information to a Control Center

If the device has a serial system interface, stored information may additionally be transferred via this interface to a centralized control and storage device. Transmission is possible via different transmission protocols.

Classification of Messages

The messages are categorized as follows:

- Operational messages (event log); messages generated while the device is operating: information on the status of device functions, measurement data, system data, recording of control commands, and similar information regarding the synchronization function
- Fault messages (trip log): messages from the last 8 network faults that were processed by the device. When starting a synchronization, a new fault message is displayed and the corresponding messages of the synchronization conditions are entered.
- Messages of "Statistics": they include a counter for the trip commands initiated by the device, i.e. reclose commands as well as values of interrupted currents and accumulated fault currents.

A complete list of all message and output functions that can be generated by the device with the maximum functional scope can be found in the Appendix. All functions are associated with an information number. The lists also indicate where each message can be sent to. If functions are not present in the specific version of the device, or if they are set to ***Disabled***, then the associated messages cannot appear.

Operational Messages (Buffer: Event Log)

Operational messages contain information that the device generates during operation and about operational conditions. Up to 200 operational messages are stored in chronological order in the device. New messages are added at the end of the list. When the maximum capacity of the memory is exhausted, the oldest message is lost.

General Interrogation

The general interrogation which can be retrieved via DIGSI enables the current status of the SIPROTEC 4 device to be read out. All messages requiring general interrogation are displayed with their present value.

Spontaneous Messages

The spontaneous messages displayed using DIGSI reflect the present status of incoming information. Each new incoming message appears immediately, i.e. the user does not have to wait for an update or initiate one.

Fault Annunciations (Buffer: Trip Log)

After a fault on the system, for example, important information about the progression of the fault can be retrieved, such as the pickup or initiation of a trip signal. The start of the fault is time stamped with the absolute time of the internal system clock. The course of the disturbance is output with a relative time referred to the pickup instant, so that the duration until tripping and up to reset of the trip command can be ascertained. The resolution of the time information is 1 ms.

Spontaneous Displays on the Device Front

After occurrence of a fault, the most important fault data appear in the display automatically after a general pickup of the device, without further operating actions.

When a graphical display is used, spontaneous messages can also be set in parameters .

Retrievable Annunciations

The annunciations of the last eight network faults can be retrieved and output. Where a generator fault causes several protective functions to pick up, the fault is considered to include all that occurred between pickup of the first protective function and dropout of the last protective function.

In total 600 annuncations can be recorded. Oldest data are erased for newest data when the buffer is full.

2.7.2 Measurement

A series of measured values and the values derived from them are constantly available for call up on site, or for data transfer (see Tables 2-8 and 2-9).

2.7.2.1 Functional Description

Display of Measured Values of the Voltage Inputs:

The operational measured values of the voltages at the 6 voltage inputs are displayed as secondary values. Primary and percentage values are not displayed.

Table 2-8 Operational Measured Values

Measured Values	secondary	primary	%
U_a, U_b, U_c, $U_{d,}$ U_e, $U_{f,}$	$U_{sec.}$	no primary values	no percentage values
f_a, f_b, f_c, f_d, f_e, f_f	f in Hz	—	—

Synchronization Measured Values

The measured values derived from the synchronization function (see Table 2-9) can be read out in secondary, primary or percentage values. Such measured values can only be displayed if a group has been selected. A prerequisite for a correct display of primary and percentage values is the complete and correct input of the nominal values of the transformers. Table 2-9 shows the formulas which form the basis for the conversion from secondary values into primary values and percentages.

Table 2-9 Conversion formulae between secondary values and primary/percentage values of the synchronizing function

Measured values	second-ary	primary	%
U1	$U1_{sec.}$	$\frac{\text{VT Un1, primary}}{\text{Unom SECONDARY}} \cdot U1_{sec}$	$\frac{\text{VT Un2, primary}}{\text{Unom SECONDARY}} \cdot \text{FAC}$
U2	$U2_{sec.}$	$\frac{\text{VT Un2, prim}}{\text{Unom SEC}} \cdot \text{Balancing U1/U2} \cdot U2_{sec}$	$\frac{U2_{sec}}{\text{Unom SEC}} \cdot \text{Balancing U1/U2} \cdot 100$
ΔU	$\Delta U_{sec.}$	$\frac{\text{VT Un1, primary}}{\text{Unom SECONDARY}} \cdot U1_{sec}$	20 $V_{sec.}$ corresponds to 100 %
Frequencies f1 f2 Δf	f in Hz f2 – f1	f in Hz f2 – f1	$\frac{f}{f_{Nom}} \cdot 100$ 1 Hz corresponds to 100 %
Angle difference Δα	°el. α2 – α1	°el. α2 – α1	 45 ° corresponds to 100 %

with

Parameter	Address
Balancing U1/U2	6121
VT Un1, primary	6124
VT Un2, primary	6125
Unom SECONDARY	6126

The calculation of the operational measured values is also performed during a fault. The values are updated at intervals of approx.0.6 s.

Transfer of Measured Values

Measured values can be retrieved by a central control system (SCADA).

2.7.2.2 Information List

No.	Information	Type of Information	Comments
-	Meter res	IntSP_Ev	Reset meter
5594	Ua =	MV	Voltage Ua
5595	Ub =	MV	Voltage Ub
5596	Uc =	MV	Voltage Uc

No.	Information	Type of Information	Comments
5597	Ud =	MV	Voltage Ud
5598	Ue =	MV	Voltage Ue
5599	Uf =	MV	Voltage Uf
25001	fa =	MV	Frequency fa
25002	fb =	MV	Frequency fb
25003	fc =	MV	Frequency fc
25004	fd =	MV	Frequency fd
25005	fe =	MV	Frequency fe
25006	ff =	MV	Frequency ff
25044	U1 =	MV	Voltage U1
25045	U2 =	MV	Voltage U2
25046	f1 =	MV	Frequency f1
25047	f2 =	MV	Frequency f2
25048	dU =	MV	Voltage difference dU
25049	df =	MV	Frequency difference df
25050	dα =	MV	Phase difference dalpha
25051	|dU| =	MV	Amount of voltage difference |dU|
25052	|df| =	MV	Amount of frequency difference |df|
25053	|dα| =	MV	Amount of phase difference |dalpha|

2.7.3 Commissioning

To support commissioning the directions of field rotation of both voltages U1 and U2 are presented in the measured values display window, as well as the currently active synchronizing fucntion group.

2.7.3.1 Information List

No.	Information	Type of Information	Comments
25033	Seq U1 =	MV	Phase Sequence U1
25034	Seq U2 =	MV	Phase Sequence U2
25035	SG =	MV	Active Sync-group
25060	t On =	MV	Time to next possible switch-on

2.7.4 Min/Max Measurement Setup

Minimum and maximum values are calculated by the 7VE61 and 7VE63 and can be read out with the point of time (date and time of the last update).

2.7.4.1 Description

Minimum and Maximum Values

Minimum and maximum values of voltages U1, U2 and ΔU as primary values, of frequencies f1, f2 and Δf, and the angle difference $\Delta\alpha$, each with last update date and time designation. The selected group values are calculated and displayed. The resetting of the minimum/maximum values takes place automatically for each successfully starting of a synchronization. Additionally, the minimum/maximum values can be reset via binary inputs or, in the delivery status of the device, also via the F4 function key.

2.7.4.2 Information List

No.	Information	Type of Information	Comments
-	ResMinMax	IntSP_Ev	Reset Minimum and Maximum counter
399	>U1 MiMa Reset	SP	>U1 MIN/MAX Buffer Reset
874	U1 Min =	MVT	U1 (positive sequence) Voltage Minimum
875	U1 Max =	MVT	U1 (positive sequence) Voltage Maximum
25014	U2min =	MVT	Voltage U2 Minimum
25015	U2max =	MVT	Voltage U2 Maximum
25016	f1min =	MVT	Frequency f1 Minimum
25017	f1max =	MVT	Frequency f1 Maximum
25018	f2min =	MVT	Frequency f2 Minimum
25019	f2max =	MVT	Frequency f2 Maximum
25020	dUmin =	MVT	Voltage difference dU Minimum
25021	dUmax =	MVT	Voltage difference dU Maximum
25022	dfmin =	MVT	Frequency difference df Minimum
25023	dfmax =	MVT	Frequency difference df Maximum
25024	dαmin =	MVT	Angel difference dalpha Minimum
25025	dαmax =	MVT	Angel difference dalpha Maximum
25027	>f1 MiMa Reset	SP	>f1 MIN/MAX Buffer Reset
25028	>U2 MiMa Reset	SP	>U2 MIN/MAX Buffer Reset
25029	>f2 MiMa Reset	SP	>f2 MIN/MAX Buffer Reset
25030	>dU MiMa Reset	SP	>dU MIN/MAX Buffer Reset
25031	>df MiMa Reset	SP	>df MIN/MAX Buffer Reset
25032	>dα MiMa Reset	SP	>dalpha MIN/MAX Buffer Reset

2.7.5 Limit-Measured Values

To recognize extraordinary operational conditions, specific warning levels can be programmed. If a preset limit is overshot or undershot, an indication is generated. This indication can also be allocated to output relays and LEDs.

The user can thus defining warning levels in accordance with his application, which he can freely logically allocate to measured or average values supplied by the device.

On delivery of the 7VE61 and 7VE63 no limit levels are configured:

Applications

- The limit values for measured values work with multiple measurement repetitions and lower priority than the synchronization and the protection functions. For that reason, this limit value detection may not respond to fast measured value changes before protection functions are started and tripped. Thus this functionality is not suitable for blocking protection functions. In such cases, threshold supervisions are suitable (see Section 2.3.6).

2.7.5.1 Setting Notes

Set Points for Measured Values

Setting is performed in the DIGSI Configuration Matrix under **Settings**, **Masking I/O (Configuration Matrix)**. Set the filter "Measured and Metered Values Only" and select the configuration group "Set Points (MV)". Here, default settings may be changed or new set points defined.

Settings must be applied in percent and usually refer to nominal values of the device.

2.7.6 Statistics

2.7.6.1 Functional Description

Number of Trips

The number of trips initiated by the 7VE61 and 7VE63 is counted, as long as the position of the circuit breaker is monitored via breaker auxiliary contacts and binary inputs. To use this function, the internal pulse counter „#of TRIPs=“ is masked in the matrix to a binary input that is controlled by the circuit breaker OPEN position. The pulse metered value „#of TRIPs=“ can be found in the "**Statistics**" group if the option "Measured and Metered Values Only" was enabled in the configuration matrix.

Operating Hours

In addition operating hours are summed (device runtime).

Number of Closures

The number of closures instigated by the synchronising function is counted.

2.7.6.2 Setting Notes

Reading/Setting/Resetting the Counter

The SIPROTEC 4 System Description provides a description of how to read out the statistical counters via the device front panel or DIGSI. Setting or resetting of these statistical counters takes place under the menu item **MESSAGES** —> **STATISTICS** by overwriting the counter values displayed.

2.7.6.3 Information List

No.	Information	Type of Information	Comments
-	#of ONs=	PMV	Number of switch ONs
-	#of TRIPs=	PMV	Number of TRIPs
409	>BLOCK Op Count	SP	>BLOCK Op Counter
1020	Op.Hours=	VI	Counter of operating hours

2.7.7 Set Points (Statistic)

2.7.7.1 Description

For the statistical counters, limit values may be entered and an indication is generated as soon as they are reached. The indication can be allocated to both output relays and LEDs.

2.7.7.2 Setting Notes

Reading/Setting/Resetting the Counter

The SIPROTEC 4 System Description provides a description of how to read out the statistical counters via the device front panel or DIGSI. Setting or resetting of these statistical counters takes place under the menu item **MESSAGES** —> **STATISTICS** by overwriting the counter values displayed.

2.7.7.3 Information List

No.	Information	Type of Information	Comments
-	OpHour>	LV	Operating hours greater than
272	SP. Op Hours>	OUT	Set Point Operating Hours

2.7.8 Time Setup

The integrated date/clock management enables the exact timely assignment of events e.g., those in the operational messages and fault messages or in the lists of the minimum/maximum values.

2.7.8.1 Functional Description

Mode of Operation

The time can be influenced by

- internal RTC (Real Time Clock),
- external synchronization sources (e.g. DCF77, IRIG B),
- external minute pulses via binary input.

Note

Upon delivery of the device the internal clock RTC is always set by default as synchronization source, regardless of whether the device is equipped with a system interface or not. If the time synchronization is to use an external source, this must be selected.

The procedure for changing the synchronization source is described in detail in the SIPROTEC 4- System Description.

The following operating modes can be selected :

No.	Operating Mode	Comments
1	Internal	Internal synchronization using RTC (default)
2	IEC 60870-5-103	External synchronization via system interface (IEC 60870-5-103)
3	PROFIBUS DP	External synchronization using PROFIBUS interface
4	IRIG B Time signal	External synchronization using IRIG B (telegram format IRIG-B000)
5	DCF77 Time signal	External synchronization using DCF 77
6	Sync. Box Time signal	External synchronization using the SIMEAS-Synch.Box time signal
7	Pulse via binary input	External synchronization with pulse via binary input
8	Field bus (DNP, Modbus)	External synchronization using field bus
9	NTP (IEC 61850)	External synchronization using system interface (IEC 61850)

Either the European time format (DD.MM.YYYY) or the US format (MM/DD/YYYY) can be specified for the device display

To preserve the internal battery, this switches off automatically after some hours in the absence of an auxiliary voltage supply.

2.7.9 Commissioning Aids

Device data sent to a central or master computer system during test mode or commissioning can be influenced. There are tools for testing the system interface and the binary inputs and outputs of the device.

Applications

- Test Mode
- Commissioning

Prerequisites

The following applies to the utilization of the commissioning aids as described below:

The device must be equipped with an interface.

The device has to be connected to a control center.

2.7.9.1 Description

Test Messages to the SCADA Interface during Test Operation

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.

Depending on the type of protocol, all messages and measured values transferred to the central control system can be identified with an added message "test operation"-bit while the device is being tested on site (test mode). This identification prevents the messages from being incorrectly interpreted as resulting from an actual power system disturbance or event. As another option, all messages and measured values normally transferred via the system interface can be blocked during the testing ("block data transmission").

Data transmission block can be accomplished by controlling binary inputs, by using the operating panel on the device, or with a PC and DIGSI via the operator interface.

The SIPROTEC 4 System Description describes how to activate and deactivate test mode and blocked data transmission.

Checking the System Interface

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 indications are transmitted correctly.

A dialog box displays the texts of all annunciations that have been masked to the system interface in the matrix. In another column of the dialog box you can specify a value for the annunciations that you want to test (e.g. coming/ going)to generate an annunciation as soon as you have entered password no. 6 (for hardware test menus). The annunciation is output and can now be read both in the operational annunciations of the SIPROTEC 4 device and in the station control center.

The procedure is described in detail in Chapter "Mounting and Commissioning".

Checking the Binary Inputs and Outputs

The binary inputs, outputs, and LEDs of a SIPROTEC 4 device can be individually controlled. This feature can be, for example, to verify control wiring from the device to substation equipment (operational checks), during commissioning.

A dialog box displays all binary inputs and outputs existing in the device, and the LEDs with their current state. It also shows which commands or annunciations are masked to which hardware component. In another column of the dialog box you can switch each item to the opposite state after entering password no. 6 (for hardware test menus). Thus, you can energize every single output relay to check the wiring between protected device and the system without having to create the alarm allocated to it.

The procedure is described in detail in Chapter "Mounting and Commissioning".

Creating a Test Fault Record

During commissioning energization sequences should be carried out, to check the stability of the protection also during closing operations. Oscillographic event recordings contain the maximum information about the behaviour of the protection.

Along with the capability of storing fault recordings via pickup of the protection function, the 7VE61 and 7VE63 also has the capability of initiating a measured value recording using the operator control 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 energized.

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 log buffer in the display, as they are not network fault events.

The procedure is described in detail in Chapter "Mounting and Commissioning".

2.8 Command Processing

Apart from the synchronization and protection functions as set out above, a control command process is integrated in the SIPROTEC 7VE61 and 7VE63 to coordinate the operation of circuit breakers and other equipment in the power system. Control commands can originate from four command sources:

- Local operation using the keypad on the local user interface of the device,
- Operation using DIGSI,
- Remote operation via network control center or substation controller (e.g. SICAM)
- Automatic functions (e.g. using a binary inputs).

The number of switchgear devices that can be controlled is basically limited by the number of available and required binary inputs and outputs. Therefore, the variant 7VE63 should be the preferred version. For control purposes it has to be ensured that the corresponding binary inputs and outputs are configured and provided with the correct properties.

If specific interlocking conditions are needed for the execution of commands, the user can program the device with bay interlocking by means of the user-defined logic functions (CFC) in the device. The interlocking conditions of the system can be injected via the system interface and must be allocated accordingly.

The procedure for switching resources is described in the SIPROTEC 4 System Description under „Control of Switchgear“.

2.8.1 Control Device

In the parallel switch devices 7VE61 and 7VE63 the switchgear can be controlled via the operator panel of the device. Furthermore, control can be executed via the operator interface using a personal computer and via the serial interface with a link to the substation control equipment.

Prerequisites

The variant 7VE63 is preferred since the number of resources being controlled is limited by the:

– binary inputs present

– binary outputs present

2.8.1.1 Description

Operation Using the Keypad with Text Display

Using the navigation keys ▲, ▼, ◀, ▶, the control menu can be accessed and the switching device to be operated can be selected. After having entered a password, a new window is displayed in which multiple control actions (e.g. close, open, cancel) are available and can be selected using the ▼ and ▲ keys. Thereafter, a query for security reasons appears. After the security check is completed, the ENTER key must be pressed again to carry out the command. If this release does not occur within one minute, the process is aborted. Cancellation via the ESC key is possible at any time before the control command is issued.

Operation Using the Keypad with Graphic Display

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. Controlling of switchgears is only possible within this control display, 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 switching operation via the ENTER key. Then a safety query appears. After the security check is completed, the ENTER key must be pressed again to carry out the command. 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.

During normal processing, the control display indicates the new actual status after the control command was executed and the message “command end” appears at the lower display edge. In case of control commands with feedback, the message “FB reached” is displayed for a short time before this.

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

Operation using DIGSI

Switchgear devices can be controlled via the operator control interface with a PC using the DIGSI operating program. The procedure to do so is described in the SIPROTEC 4 System Description (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 switchgear control and protection system. Please check MLFB order number to ensure that your individual relay has a SCADA interface module that supports this. Furthermore, certain settings for the serial interface in the device need to be carried out (see SIPROTEC 4 System Description).

2.8.2 Types of Commands

In conjunction with the power system control several command types can be distinguished for the device:

2.8.2.1 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 (not synchronized), disconnectors and earth electrodes,
- Step commands, e.g. raising and lowering transformer LTCs
- Set-point commands with configurable time settings, e.g. to control Petersen coils

Internal / Pseudo Commands

They do not directly operate binary outputs. They serve to initiate internal functions, simulate changes of state, or to acknowledge changes of state.

- Manual overriding commands to manually update information on process-dependent objects such as annunciations 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 are issued to establish internal settings, e.g. deleting / presetting the switching authority (remote vs. local), a parameter set changeover, data transmission block to the SCADA interface, and measured value set-points.
- Acknowledgment and resetting commands for setting and resetting internal buffers or data states.
- Information status command to set/reset the additional information "information status" of a process object, such as:
  - Input blocking
  - Output Blocking

2.8.3 Command Processing

Safety mechanisms in the command sequence ensure that a command can only be released after a thorough check of preset criteria has been successfully concluded. Standard Interlocking checks are provided for each individual control command. Additionally, user-defined interlocking conditions can be programmed separately for each command. The actual execution of the command is also monitored afterwards. The overall command task procedure is described in brief in the following list:

2.8.3.1 Description

Check Sequence

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 Recognition.
- User configurable interlocking checks
  - Switching Authority
  - Device Position Check (set vs. actual comparison)
  - Interlocking, Zone Controlled (logic using CFC)
  - System Interlocking (centrally, using SCADA system or substation controller)
  - Double Operation (interlocking against parallel switching operation)
  - Protection Blocking (blocking of switching operations by protective functions)
- 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)
  - Setting Modification in Process (if setting modification is in process, commands are denied or delayed)
  - Operating equipment enabled as output (if an operating equipment component was configured, but not configured to a binary input, the command is denied)

– Output Block (if an output block has been programmed for the circuit breaker, and is active at the moment the command is processed, then the command is denied)

– Board Hardware Error

– Command in Progress (only one command can be processed at a time for one operating equipment, object-related Double Operation Block)

– 1-of-n-check (for schemes with multiple assignments, such as relays contact sharing a common terminal a check is made if a command is already active for this set of output relays).

Monitoring the Command Execution

The following is monitored:

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

2.8.4 Interlocking

System interlocking is executed by the user-defined logic (CFC).

2.8.4.1 Description

Switchgear interlocking checks in a SICAM/SIPROTEC 4 system are normally divided in the following groups:

- System interlocking relies on the system data base in the substation or central control system.
- Bay interlocking relies on the object data base (feedbacks) of the bay unit.
- cross-bay interlocking via GOOSE messages directly between bay units and protection relays (with IEC61850: The inter-relay communication with GOOSE is performed via the EN100 module)

The extent of the interlocking checks is determined by the configuration of the relay. For more information on GOOSE, please refer to the SIPROTEC 4 System Description /1/.

Switching objects that require system interlocking in a central control system are assigned to a specific parameter inside the bay unit (via configuration matrix).

For all commands, operation with interlocking (normal mode) or without interlocking (Interlocking OFF) can be selected:

- for local commands, by activation of "Normal/Test"-key switch,
- for automatic commands, via command processing by CFC and deactivated interlocking recognition,
- for local / remote commands, using an additional interlocking disable command, via Profibus.

Interlocked/Non-interlocked Switching

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

Deactivated interlock switching means the configured interlocking conditions are not checked in the relay.

Interlocked switching means that all configured interlocking conditions are checked within the command processing. If a condition is not fulfilled, the command will be rejected by a message with a minus added to it (e.g. "„CO–“"), immediately followed by a message.

The following table shows the possible types of commands to a breaker and associated indications. For the device the messages designated with *) are displayed in the event logs, for DIGSI 4 they appear in spontaneous messages.

Type of Command	Control	Cause	Message
Control issued	Switching	CO	CO+/–
Manual tagging (positive / negative)	Manual tagging	MT	MT+/–
Information state command, Input blocking	Input blocking	ST	ST+/– *)
Information state command, Output blocking	Output Blocking	ST	ST+/– *)
Cancel command	Cancel	CA	CA+/–

The "plus" appearing in the message is a confirmation of the command execution. The command execution was as expected, in other words positive. The minus sign means a negative confirmation, the command was rejected. Possible command feedbacks and their causes are dealt with in the SIPROTEC 4 System Description. The following figure shows operational indications relating to command execution and operation response information for successful switching of the circuit breaker.

The check of interlocking can be programmed separately for all switching devices and tags that were set with a tagging command. Other internal commands such as manual entry or abort are not checked, i.e. carried out independent of the interlocking.

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

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

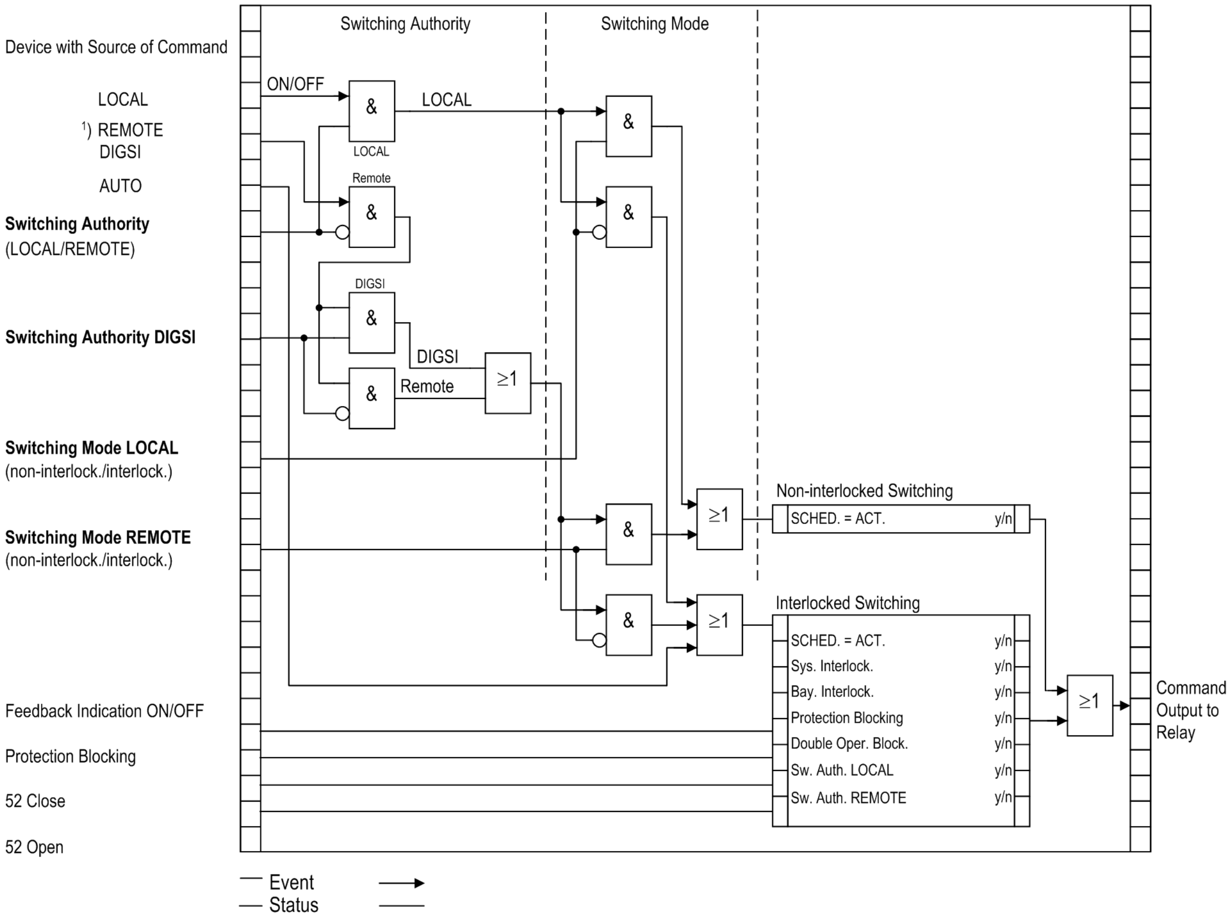
Figure 2-51 Example of an operational indication for switching circuit breaker 52

Standard Interlocking (default)

The following fixed checks are programmed for each switchgear with the standard interlocking function. These can be individually enabled or disabled via parameters:

- Switching Status Check (set = 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 both for interlocked as well as noninterlocked switching.
- System Interlocking: To check the power system interlocking, a local command is transmitted to the central unit with Switching Authority = LOCAL. A switching device that is subject to system interlocking cannot be switched by DIGSI.
- Zone Controlled / Bay Interlocking: Logic links in the device which were created via CFC are interrogated and considered during interlocked switching.
- Blocked by Protection: A CLOSE-command is rejected as soon as one of the protective functions of the device establishes a fault case. The OPEN-command, in contrast, can always be executed.
- Double Operation Block: Parallel switching operations are interlocked against one another; while one command is processed, a second one cannot be carried out.
- Switching Authority LOCAL: A switch command from local control (command with command source LOCAL) is only allowed if local control is admissible for the device (via key switch or configuration).

- Switching authority DIGSI: Switching commands that are issued locally or remotely via DIGSI (command with command source DIGSI) are only allowed if remote control is admissible for the device (by key switch or configuration. If a DIGSI-computer logs in at the device, it leaves a Virtual Device Number (VD). Only commands with this VD (when Switching Authority = REMOTE) will be accepted by the device. Remote switching commands will be rejected.
- Switching Authority REMOTE: A remote control command (command with command source REMOTE) is only allowed if remote control is admissible for the device (by key switch or configuration).



[1]) Source REMOTE also includes SAS.
(LOCAL Command using substation controller
REMOTE Command using remote source such as SCADA through controller to device.)

Figure 2-52 Standard interlockings

The following figure shows the configuration of the interlocking conditions using DIGSI.

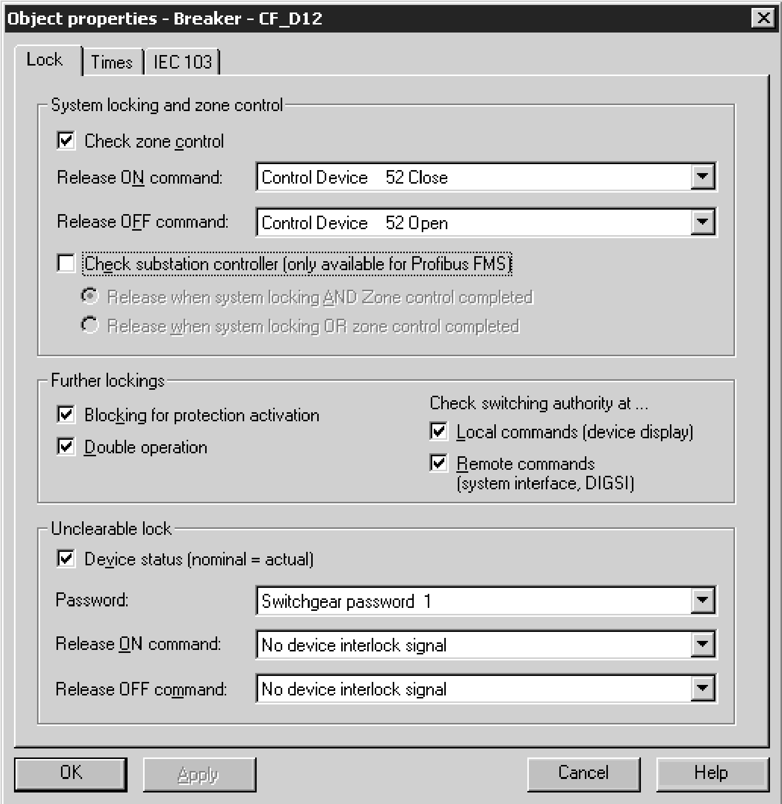


Figure 2-53 DIGSI-Dialog Box for Setting the Interlocking Conditions

The display shows the configured interlocking reasons. They are marked by letters explained in the following table.

Table 2-10 Command types and corresponding messages

Interlocking Commands	Abbrev.	Message
Switching Authority	L	L
System interlocking	S	A
Zone controlled	Z	Z
SET = ACTUAL (switch direction check)	P	P
Protection blockage	B	B

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 2-54 Example of configured interlocking conditions

Control Logic using CFC

For the bay interlocking a control logic can be structured via the CFC. Via specific release conditions the information “released” or “bay interlocked” are available (e.g. object "52 Close" and "52 Open" with the data values: ON / OFF).

Switching Authority

The interlocking condition "Switching Authority" serves to determine the switching authorization. It enables the user to select the authorized command source. 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 devices in housing of size $^{1}/_{2}$ (7VE63) are equipped with key switches on the front panel. The top switch is reserved for switching authority. The position "Local" enables local control, the position "Remote" enables remote control. For devices in housing of size $^{1}/_{3}$ (7VE61) the switching authority can be changed between "REMOTE" and "LOCAL" in the operator panel after having entered the password or by means of CFC also via binary input and function key.

The "Switching authority DIGSI" 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 SC 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 available DIGSI	y/n (create appropriate object)
Specific device (e.g. switching device)	Switching authority LOCAL (check for Local status): y/n
Specific device (e.g. switching device)	Switching authority REMOTE (check for LOCAL, REMOTE or DIGSI commands: y/n

Table 2-11 Interlocking logic

Current Switching Authority Status	Switching Authority DIGSI	Command Issued with SC[3)]=LOCAL	Command Issued from SC=LOCAL or REMOTE	Command issued from SC=DIGSI
LOCAL	not registered	Allowed	Interlocked [2)] - "switching authority LOCAL"	Interlocked "DIGSI not registered"
LOCAL	Checked	Allowed	Interlocked [2)] - "switching authority LOCAL"	Interlocked [2)] - "switching authority LOCAL"
REMOTE	Not checked	Interlocked [1)] - "switching authority REMOTE"	Allowed	Interlocked "DIGSI not registered"
REMOTE	Checked	Interlocked [1)] - "switching authority DIGSI"	Interlocked [2)] - "switching authority DIGSI"	Allowed

[1)] also "Allowed" for: ”switching authority LOCAL (check for Local status): is not marked
[2)] also "Allowed" for: ”Switching authority REMOTE (check for LOCAL, REMOTE, or DIGSI status): is not marked"
[3)] SC = 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 Mode

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 devices in housing of size $^1/_2$ (7VE63) are equipped with two key switches. The bottom switch is reserved for the switching mode. The "Normal" position of the law key switch allows interlocked switching while the "Interlocking OFF" position allows non-interlocked switching. For devices in housing of size $^1/_3$ (7VE61) the switching mode can be changed between "interlocked (latched)" and "non-interlocked (unlatched)" in the operator panel after having entered the password or by means of CFC also via binary input and function key.

The following switching modes (remote) are defined:

- Remote or DIGSI commands (SC = LOCAL, REMOTE, or DIGSI)
  - interlocked, or
  - non-interlocked switching. Here, deactivation of interlocking is accomplished via a separate command. The position of the key-switch is irrelevant.
  - For commands from CFC (SC = AUTO SICAM), please observe the notes in the CFC manual (component: BOOL to command).

Zone Controlled / Field Interlocking

Zone controlled / field interlocking (e.g. via CFC) includes the verification that predetermined switchgear position conditions are satisfied to prevent switching errors (e.g. disconnector vs. ground switch, ground switch 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).

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

The enable information with the data "switching device 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.

When a switching command is initiated, the actual status is scanned cyclically. The assignment is done via "Release object CLOSE/OPEN".

System Interlocking

Substation Controller (System interlocking) involves switchgear conditions of other bays evaluated by a central control system.

Double Activation Blockage

Parallel switching operations are interlocked. As soon as the command has arrived all command objects subject to the interlocking are checked to know whether a command is being processed. While the command is being executed, interlocking is enabled for other commands.

Blocking by Protection

The pickup of protective elements blocks switching operations. Protective elements are configured, separately for each switching component, to block specific switching commands sent in CLOSE and TRIP direction.

When enabled, "Block CLOSE commands" blocks CLOSE commands, whereas "Block TRIP commands" blocks TRIP signals. Switching operations in progress will immediately be aborted by the pickup of a protective element.

Device Status Check (set = actual)

For switching commands, a check takes place whether the selected switching device is already in the set/desired position (set/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 "set condition equals actual condition". If the circuit breaker/switchgear device is in the intermediate position, then this check is not performed.

Bypassing Interlocking

Bypassing configured interlocks at the time of the switching action happens device-internal via interlocking recognition in the command job or globally via so-called switching modes.

- SC=LOCAL
  - The switching modes "interlocked (latched)" or "non-interlocked (unlatched)" can be set in housing sizes $^1/_2$ (7VE63) via the key switch. The position "Interlocking OFF" corresponds to non-interlocked switching and serves the special purpose of unlocking the standard interlocks. For devices in housing of size $^1/_3$ (7VE61) the switching mode can be changed between "interlocked (latched)" and "non-interlocked (unlatched)" in the operator panel after having entered the password or by means of CFC also via binary input and function key.
- REMOTE and DIGSI
  - Commands issued by SICAM or DIGSI are unlocked via a global switching mode REMOTE. A separate job order must be sent for the unlocking. The unlocking applies only for one switching operation and for command caused by the same source.
  - Job order: command to object "Switching mode REMOTE", ON
  - Job order: switching command to "switching device"
- Derived command via CFC (automatic command, SC=Auto SICAM):
  - Behaviour configured in the CFC block ("BOOL to command").

2.8.5 Command Logging / Acknowledgement

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.

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 4 System Description.

2.8.5.1 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.

Command Output and Switching Relays

The command types needed for tripping and closing of the switchgear or for raising and lowering of transformer taps are described in the configuration section of the SIPROTEC 4 System Description /1/ .

■

Mounting and Commissioning 3

This chapter is intended for experienced commissioning staff. They should be familiar with the commissioning of protection and control equipment, with operation of the power system network and with the safety rules and regulations. Certain adaptations of the hardware to the power system specifications may be necessary. For primary testing, the object to be protected (generator, motor, transformer) must be started up and in put into service.

3.1 Mounting and Connections

General

WARNING!

Warning of improper transport, storage, installation or erection of the device.

Failure to observe these precautions can result in death, personal injury or substantial property damage.

Unproblematic and safe use of this device depends on proper transport, storage, installation and erection of the device taking into account the warnings and instructions of the device manual.

In particular the general installation and safety regulations for working in power current installations (for example, ANSI, IEC, EN, DIN, or other national and international regulations) must be observed.

3.1.1 Configuration Information

Prerequisites

For mounting and connection the following requirements and conditions must be met:

The rated device data has been tested as recommended in the SIPROTEC 4 System Description /1/ and their compliance with these data is verified with the Power System Data.

Connection Options

General diagrams are shown in Appendix A.2. Connection examples for voltage transformer circuits are provided in A.3. The configuration of the synchronization function (Section 2.2.2.1) must be checked to ensure it corresponds with the connections to the device.

Binary Inputs and Outputs

Allocation possibilities of binary inputs and outputs, i.e. the individual matching to the system are described in the SIPROTEC 4 System Description /1/. The presettings of the device are listed in Appendix A, Section A.4. Check also whether the labelling corresponds to the allocated message functions.

Changing Setting Groups

If binary inputs are used to switch setting groups, please observe the following:

- Two binary inputs must be dedicated to the purpose of changing setting groups when four groups are to be switched. One binary input must be set for „`>Set Group Bit0`“, the other input for „`>Set Group Bit1`“. If either of these input functions is not assigned, then it is considered as not controlled.
- To control two setting groups, one binary input set for „`>Set Group Bit0`“ is sufficient since the binary input „`>Set Group Bit1`“, which is not assigned, is considered to be not controlled.
- The status of the signals controlling the binary inputs to activate a particular setting group must remain constant as long as that particular group is to remain active.

The following table shows the allocation of the binary inputs to the setting groups A to D and a simplified connection diagram for the two binary inputs is illustrated in the following figure. The figure illustrates an example in which both Set Group Bits 0 and 1 are configured to be controlled (actuated) when the associated binary input is energized (high).

Where:

no = not triggered

yes = triggered

Table 3-1 Changing setting groups using binary inputs

Binary Input		Active Group
>Set Group Bit 0	>Set Group Bit 1	
No	No	Group A
Yes	No	Group B
No	Yes	Group C
Yes	Yes	Group D

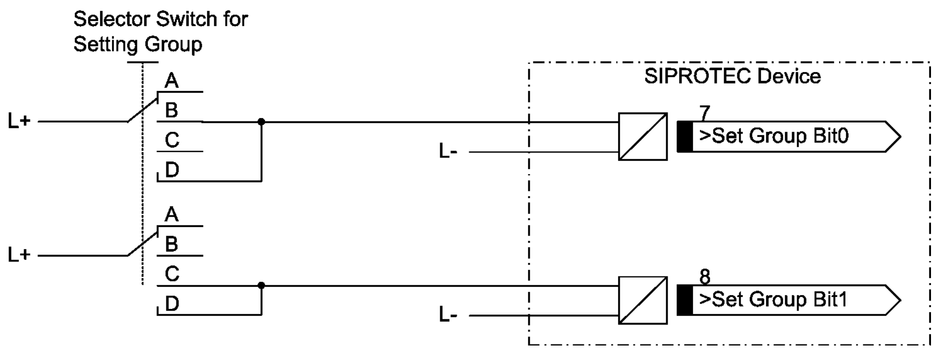


Figure 3-1 Connection diagram (example) for setting group switching using binary inputs

3.1.2 Hardware Modifications

3.1.2.1 General

General

A subsequent adaptation of the hardware to the power system conditions can, for example, become necessary with regard to the control voltage for binary inputs or the termination of bus-capable interfaces. Follow the procedure described in this section, whenever hardware modifications are done.

Auxiliary Voltage

There are different power supply voltage ranges for the auxiliary voltage (refer to the Ordering Information in Appendix A.1). The variants for DC 60/110/125 V and DC 110/125/220 V, AC 115/230 V are interchangeable by modifying the position of the jumpers. Jumper setting allocation for the rated voltage ranges, and their location on the PCB are described in this Section under the margin title „Processor Board C-CPU-2“. Location and ratings of the miniature fuse and the buffer battery are also given. When the device is delivered, these jumpers are set according to the name-plate sticker, and they do not need to be altered.

Live Contact

The life contact of the device is a changeover contact from which either the NC contact or the NO contact can be connected to the device terminals via a plug-in jumper (X40). Assignments of the jumpers to the contact type and the spatial layout of the jumpers are described in the following Section at margin heading „Processor Board C-CPU-2“.

Control Voltage for Binary Inputs

When the device is delivered the binary inputs are set to operate with a voltage that corresponds to the rated voltage of the power supply. 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, one jumper must be changed for each input. The allocation of the plug-in jumpers to the binary inputs and their actual positioning are described in this Section.

Note

If binary inputs are used for trip circuit monitoring, note that two binary inputs (or one binary input and an equivalent resistor) are connected in series. The switching threshold must be significantly less than one half of the rated control voltage.

Contact Mode for Binary Outputs

Input/output modules can have relays with changeover contacts which can be set either as NO or NC. Therefore it is necessary to rearrange a jumper. For which relay on which board this applies is described in this Section under "Input/Output Board C–I/O -1" and "Input/Output Board C–I/O -8".

Replacing Interfaces

The serial interfaces can only be exchanged in the versions for panel flush mounting and cubicle mounting. Which interfaces can be exchanged, and how this is done, is described in this Section under the margin title „Replacing Interface Modules“.

Terminating Resistors for RS485 and Profibus DP (electrical)

For reliable data transmission the RS485 bus or the electrical Profibus DP must be terminated with resistors at the respective last device on the bus. For this purpose termination resistors are provided on the PCB of the C-CPU-2 processor board and on the RS485 or PROFIBUS interface module which can be connected via jumpers. Only one of the three options may be used. The physical location of the jumpers on the PCB is described in this Section under the margin title „Processor Board C–CPU-2“, and under the margin title „Bus-Capable Serial Interfaces“ for the interface modules. Both jumpers must always be plugged in the same way.

The terminating resistors are disabled on unit delivery.

Spare Parts

Spare parts can be the battery for storage of data in the battery-buffered RAM in case of a power failure, and the internal power supply miniature fuse. Their spatial arrangement is shown in the figure of the processor board. The ratings of the fuse are printed on the board next to the fuse itself. When replacing the fuse, please observe the guidelines given in the SIPROTEC 4 System Description in the chapter „Maintenance“ and „Corrective Maintenance“.

3.1.2.2 Disassembly

Disassembly of the Device

Note

It is assumed for the following steps that the device is not in operation.

Caution!

Caution when changing jumper settings that affect nominal values of the device

As a consequence, the order number (MLFB) and the ratings on the nameplate no longer match the actual device properties.

If changes are necessary under exceptional circumstances, the changes should be clearly and fully marked on the device. Self adhesive stickers are available that can be used as replacement nameplates.

To perform work on the printed circuit boards, such as checking or moving switching elements or exchanging modules, proceed as follows:

- Prepare area of work: Preparing a surface appropriate to electrostatic sensitive devices (EGB). In addition to this, the following tools are required:
  - screwdriver with a 5 to 6 mm wide tip,
  - a Philips screwdriver size 1,
  - 5 mm socket or nut driver.
- Unfasten the screw-posts of the D-subminiature connectors on the back panel at location „A“ and „C“. This activity does not apply if the device is for surface mounting.
- If the device has additional communication interfaces at locations „A“, „C“ and/or „B“ „D“ on the rear, the screws located diagonally to the interfaces must be removed. This activity does not apply if the device is for surface mounting.
- Remove the caps on the front cover and loosen the screws that become accessible.
- Remove the front panel and tilt it to the side.

Work on the Plug Connectors

Caution!

Mind electrostatic discharges

Non–observance can result in minor personal injury or material damage.

Electrostatic discharges over connections of components, conductor paths or pins are to be avoided by prior touching of grounded metal parts at any circumstances.

Do not plug or withdraw interface connections under power!

The following must be observed:

- Disconnect the ribbon cable between the front cover and the C-CPU-2 board (No. 1 in Figures and) at the front cover side. To disconnect the cable, push up the top latch of the plug connector and push down the bottom latch of the plug connector. Carefully set aside the front cover.
- Disconnect the ribbon cables between the C-CPU-2 board (1) and the I/O boards ((2) and (3), (depending on the variant ordered).

- Remove the boards and set them on the grounded mat to protect them from ESD damage. In the case of the device variant for panel surface mounting, please be aware of the fact that a certain amount of force is required in order to remove the C-CPU-2 module due to the existing plug connectors.
- Check the jumpers according to Figures 3-4 to 3-7 and the following information, and as the case may be change or remove them.

The allocation of the boards for housing size $^1/_3$ is shown in Figure 3-2 and for housing size $^1/_2$ in Figure 3-3.

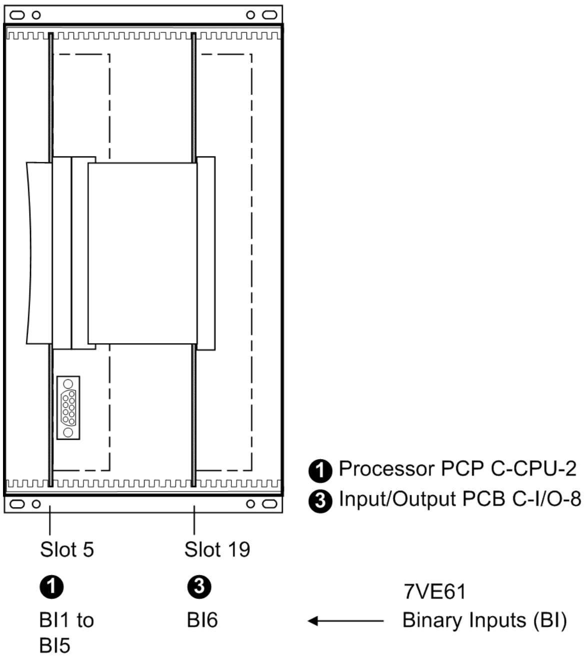


Figure 3-2 Front view with housing size $^1/_3$ after removal of the front cover (simplified and scaled down)

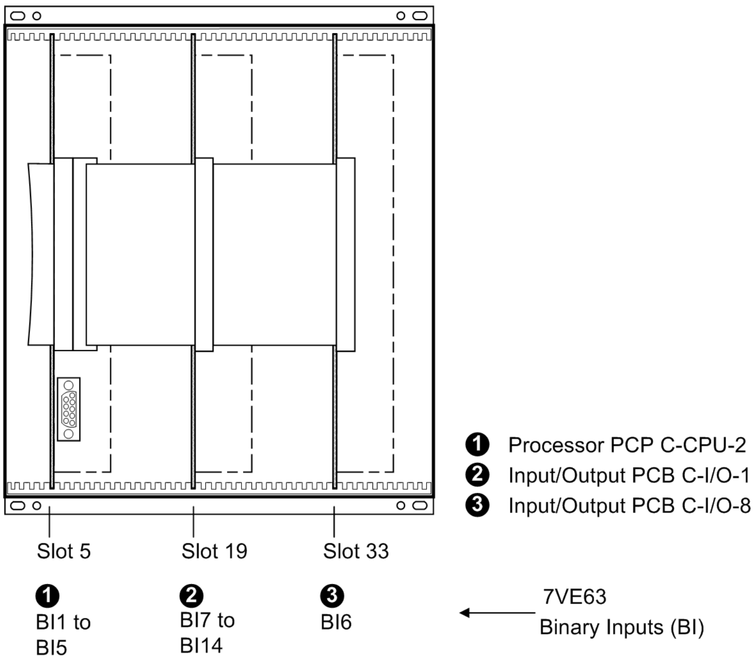


Figure 3-3 Front view with housing size $^1/_2$ after removal of the front cover (simplified and scaled down)

3.1.2.3 Switching Elements on the Printed Circuit Boards

Processor Printed Circuit Board C–CPU–2

The layout of the printed circuit board for the C-CPU-2 board is illustrated in the following figure. The location and ratings of the miniature fuse (F1) and of the buffer battery (G1) are shown in the following figure.

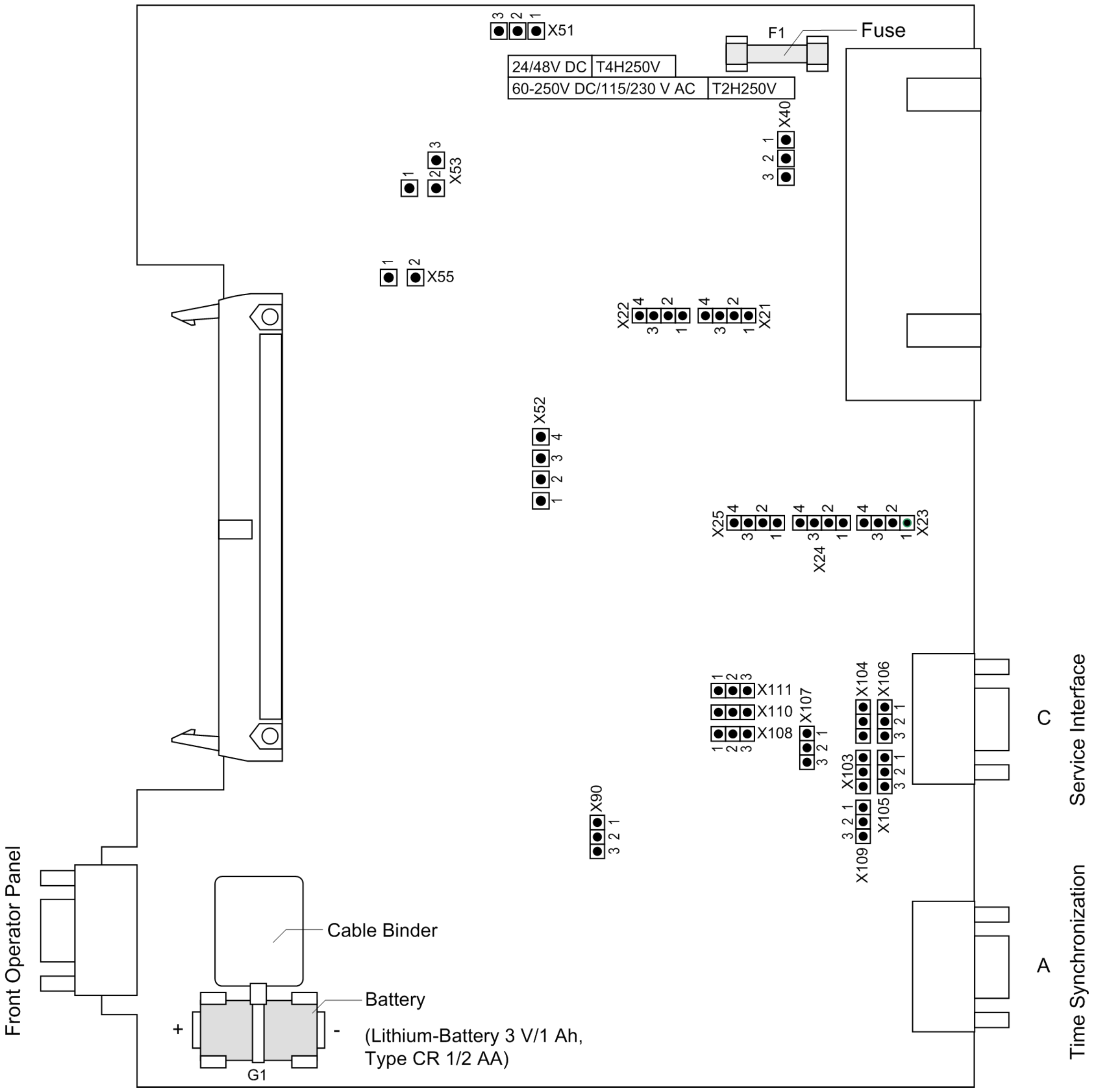


Figure 3-4 Processor printed circuit board C-CPU-2 with jumpers settings required for the board configuration

The set rated voltage of the integrated power supply is checked according to Table 3-2, the quiescent state of the life contact according to Table 3-3 and the selected control voltages of the binary inputs BI1 to BI5 according to Table 3-4 and the integrated interface RS232 / RS485 according to Table 3-5 to 3-7.

Power Supply

Table 3-2 Jumper settings of the rated voltage of the integrated **Power Supply** on the C-CPU-2 processor board

Jumper	Rated Voltage		
	24 to 48 VDC	**60 to 125 VDC**	**110 to 250 VDC, 115 to 230 VAC**
X51	Not used	1–2	2–3
X52	Not used	1–2 and 3–4	2–3
X53	Not used	1–2	2–3
X55	Not used	Not used	1–2
	Cannot be changed	Interchangeable	

Live Status Contact

Table 3-3 Jumper position of the quiescent state of the **live status contact** on the C-CPU-2 processor printed circuit board

Jumper	Open in the quiescent state	Closed in the quiescent state	Presetting
X40	1-2	2-3	2-3

Pickup Voltages of BI1 to BI5

Table 3-4 Jumper settings of the **Voltage Thresholds** (DC voltage) of the binary inputs BI1 to BI5 on the C-CPU-2 processor board

Binary Inputs	Jumper	19 V Threshold 1)	88 V Threshold 2)	176 V Threshold 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 power supply voltages of 24 VDC to 125 VDC
2) Factory settings for devices with power supply voltages of 110 to 250 VDC and 115 VAC or 115 to 230 VAC
3) Use only with pickup voltages 220 or 250 VDC

RS232/RS485

The service interface (**Port C**) can be converted into an **RS232 or RS485** interface by modifying the setting of the appropriate jumpers.

Jumpers X105 to X110 must be set to the same position !

The presetting of the jumpers corresponds to the configuration ordered.

Table 3-5 Jumper settings of the integrated **RS232/RS485 Interface** on the C–CPU-2 board

Jumper	RS232	RS485
X103 and X104	1-2	1-2
X105 to X110	1-2	2-3

With interface RS232 jumper X111 is needed to activate CTS which enables the communication with the modem.

CTS (Clear to Send)

Table 3-6 Jumper setting for **CTS** on the C-CPU-2 board

Jumper	/CTS from Interface RS232	/CTS triggered by /RTS
X111	1-2	2-3 [1)]

1) Presetting

Jumper setting 2-3: The connection to the modem is usually established with a star coupler or fibre-optic converter. Therefore the modem control signals according to RS232 standard DIN 66020 are not available. Modem signals are not required since the connection to the SIPROTEC® 4 devices is always operated in the half-duplex mode. Please use the connection cable with order number 7XV5100-4.

The jumper setting 2-3 is also necessary when using the RTD-box in half duplex operation.

Jumper setting 1-2: This setting makes the modem signals available, i. e. for a direct RS232-connection between the SIPROTEC® 4 device and the modem this setting can be selected optionally. We recommend to use a standard RS232 modem connection cable (converter 9-pin to 25-pin).

Note

For a direct connection to DIGSI with interface RS232 jumper X111 must be plugged in position 2-3.

If there are no external matching resistors in the system, the last devices on a RS485 bus must be configured using jumpers X103 and X104.

Terminating Resistors

Table 3-7 Jumper settings of the **Terminating Resistors** of interface RS485 on the C-CPU-2 processor board

Jumper	Terminating Resistor enabled	Terminating resistor disabled	Presetting
X103	2-3	1-2	1-2
X104	2-3	1-2	1-2

Note: Both jumpers must always be plugged in the same way !

Jumper X90 has currently no function. The factory setting is 1-2.

The terminating resistors can also be connected externally (e.g. to the connection module). In this case, the terminating resistors located on the RS485 or PROFIBUS interface module or directly on the PCB of the processor board C–CPU–2 of 7VE61 and 7VE63 must be disabled.

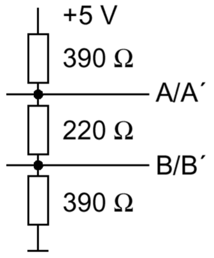


Figure 3-5 Termination of the RS485 interface (external)

Input/Output Board C–I/O-1

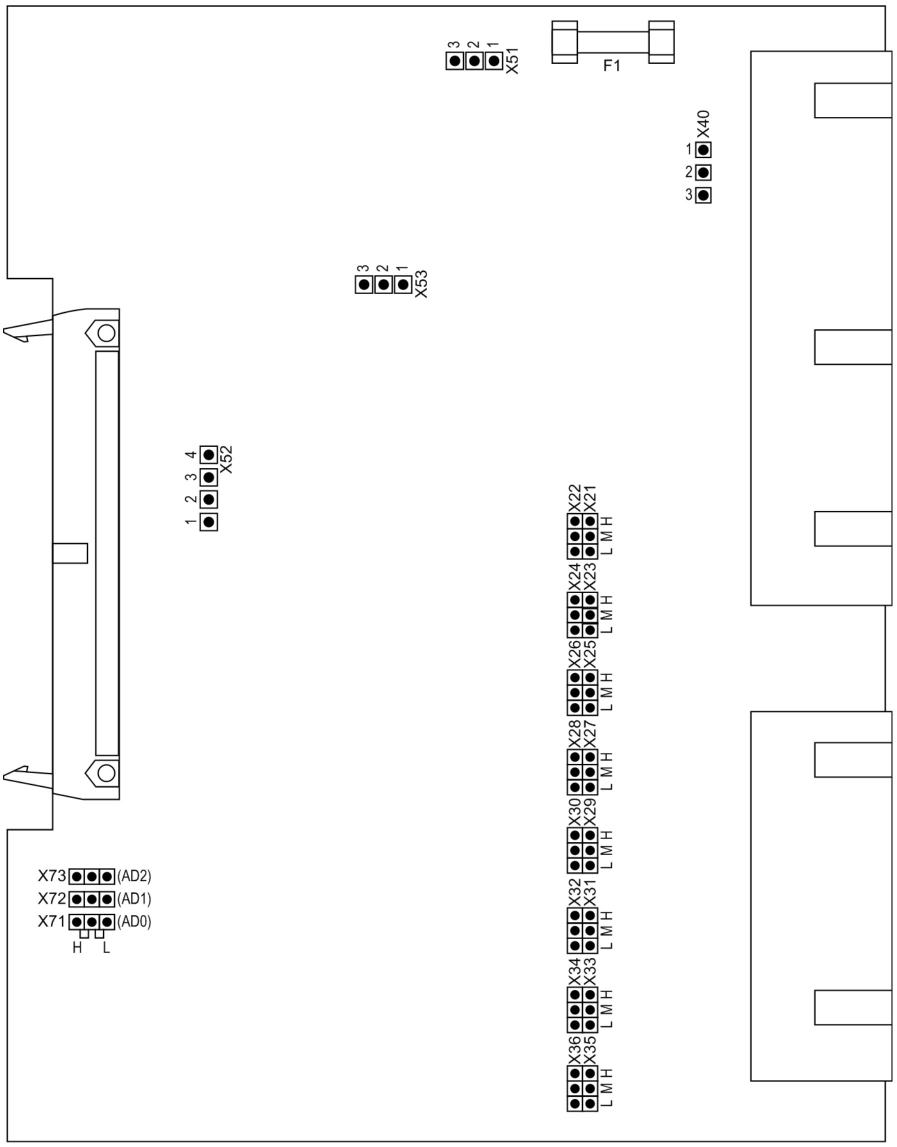


Figure 3-6 Input/output board C-I/O-1 with representation of the jumper settings required for the board configuration

The selected control voltages of binary inputs BI7 to BI14 are checked according to Table 3-8. Jumper settings for the contact mode of binary output BO10 are checked according to Table 3-9.

Figure 3-3 illustrates the assignment of the binary inputs to the mounting location.

Pickup voltages of BI7 to BI14

Table 3-8 Jumper settings for **pickup voltages** (DC voltage) of the binary inputs BI7 and BI14 on the C–I/O-1 board

Binary Inputs	Jumper	19 V Threshold 1)	88 V Threshold 2)	176 V Threshold 3)
BI7	X21/X22	L	M	H
BI8	X23/X24	L	M	H
BI9	X25/X26	L	M	H
BI10	X27/X28	L	M	H
BI11	X29/X30	L	M	H
BI12	X31/X32	L	M	H
BI13	X33/X34	L	M	H
BI14	X35/X36	L	M	H

1) Factory settings for devices with rated power supply voltages of 24 VDC to 125 VDC
2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115 to 230 VAC
3) Use only with control voltages 220 or 250 VDC

Contact Mode

With models 7VE6**3** binary output BO12 can be changed from normally open to normally closed operation. The following table shows the setting of jumper X40 regarding the contact mode.

Table 3-9 Jumper settings for **contact mode** of the binary output BO12 on the C–I/O-1 board

Jumper	Normally open contactor	Normally closed contactor	Presetting
X40	1–2	2–3	1–2

Board Addresses

Jumpers X71, X72 and X73 on the Input/Output C-I/O-1 board are used to set the bus address and may not be changed. The following Table shows the factory setting of the jumpers.

The mounting location of the board is shown in Figure 3-3.

Table 3-10 Jumper settings for **Board Addresses** on the C–I/O–1 board for 7VE63

Jumper	Factory Setting
X71	H
X72	L
X73	H

Input/Output Board C–I/O-8

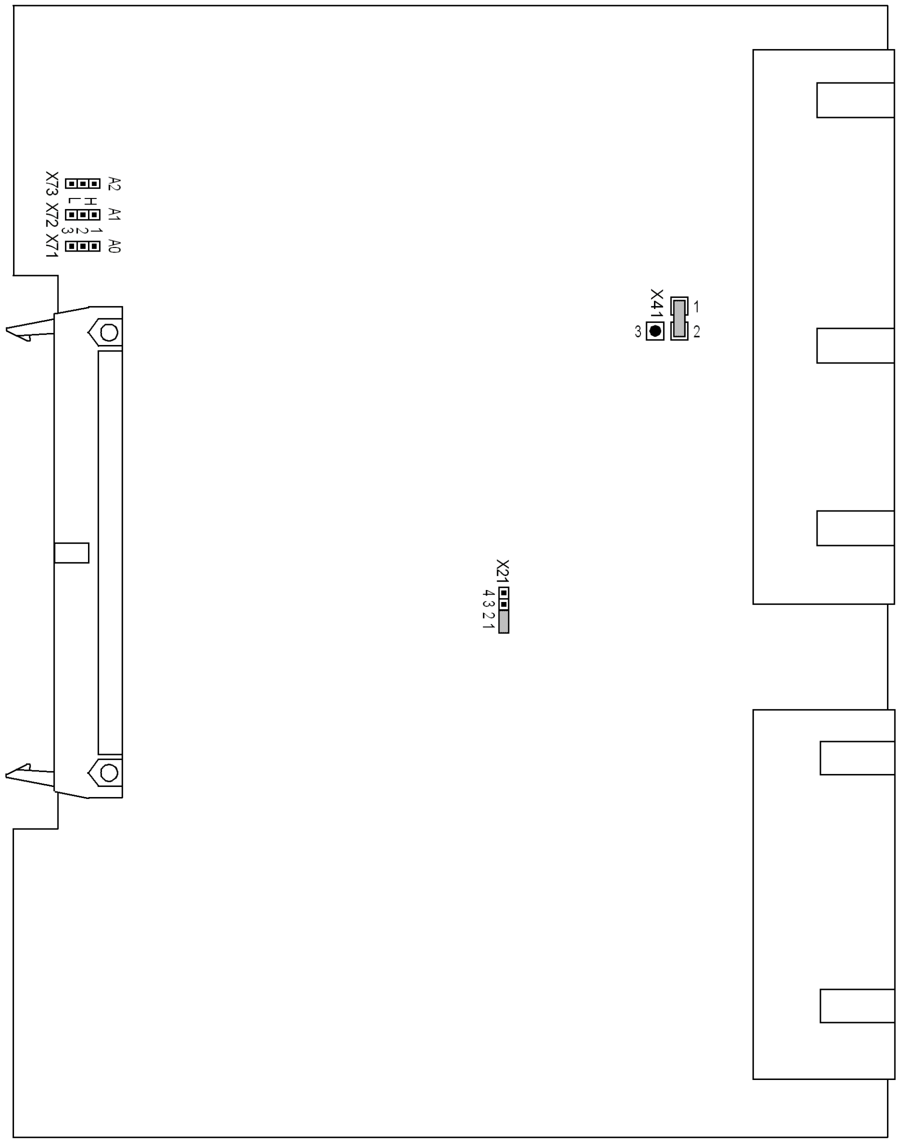


Figure 3-7 Input/output board C-I/O-8 with representation of the jumper settings required for the board configuration

The selected control voltages of the binary input BI6 are checked according to Table 3-12. Jumper settings for the contact mode of binary output BO5 are checked according to Table 3-11.

Figures 3-2 and 3-3 illustrate the assignment of the binary inputs to the mounting location of the board.

Contact Mode

The contacts can be changed from normally open to normally closed with the output relay BO5. The following table shows the setting of jumper X41 in dependance with the contact mode.

Table 3-11 Jumper settings for the **contact mode** of the relays BO5 on the C–I/O-8 board

Jumper	Normally open contactor	Normally closed contactor	Presetting
X41	1–2	2–3	1–2

Pickup voltages of the BI6

Table 3-12 Jumper setting for the **pickup voltages** (DC voltage) of the binary inputs BI6 on the C–I/O-8 board

Binary Input	Jumper	19 V Threshold 1)	88 V Threshold 2)	176 V Threshold 3)
BI6	X21	1–2	2–3	3–4

1) Factory settings for devices with rated power supply voltages of 24 VDC to 125 VDC
2) Factory settings for devices with power supply voltages of 110 VDC to 220 VDC and 115 to 230 VAC
3) Use only with control voltages 220 to 250 VDC

Jumpers X71, X72 and X73 on the C–I/O-8 board serve to set the bus address. The jumpers must not be changed. The following table lists the jumper presettings.

Board Address

Table 3-13 Jumper settings of the **Board Addresses** on the input/output board C-I/O-8

Jumper	Housing size $^1/_3$	Housing size $^1/_2$
X71	2–3 (L)	2–3 (L)
X72	2–3 (L)	2–3 (L)
X73	1–2 (H)	1–2 (H)

3.1.2.4 Interface Modules

Replacing Interface Modules

The interface modules are located on the processor printed circuit boards C–CPU (1) in Figures 3-2 and 3-3

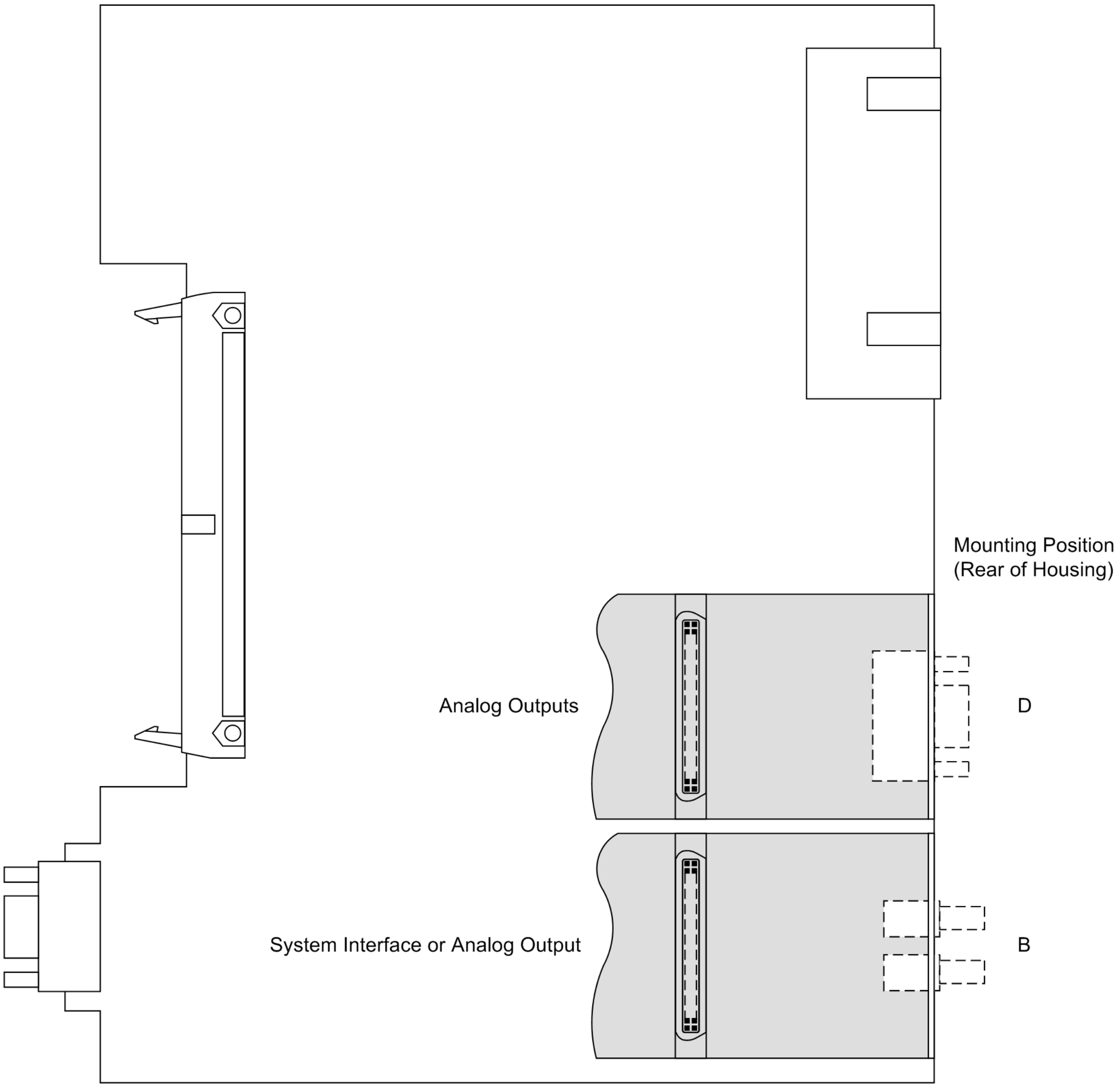


Figure 3-8 Processor printed circuit board C–CPU-2 with interface modules

Please note the following:

- The interface modules can only be replaced in devices for panel flush mounting and cubicle mounting.

  Devices in surface mounting housings with double-level terminals can be changed only in our manufacturing centre.
- Only interface modules can be used with which the device can be ordered from the factory also in accordance with the order number (see also Appendix A.1).

Table 3-14 Replacement modules for interfaces

Interface	Mounting Location / Port	Replacement Module
System Interface	B	RS232
		RS485
		FO 820 nm
		Profibus DP RS485
		Profibus DP double ring
		Modbus RS485
		Modbus 820 nm
		DNP 3.0, RS485
		DNP 3.0 820 nm
		Ethernet electrical (EN100)
		Ethernet optical (EN100)
Analog interface		2 x 0 to 20 mA
Analog interface	D	2 x 0 to 20 mA

The order numbers of the replacement modules can be found in the Appendix in Section A.1.

EN100 Ethernet Module (IEC 61850)

The Ethernet interface module has no jumpers. No hardware modifications are required to use it.

Termination

For bus-capable interfaces a termination is necessary at the bus for each last device, i.e. terminating resistors must be connected. With the 7VE61 and 7VE63 device, this concerns the variants with RS485 or PROFIBUS interfaces.

The terminating resistors are located on the RS485 or Profibus interface module, which is on the C–CPU–2 board ((1) in Figures 3-2 and 3-3), or directly on the PCB of the C-CPU-2 board (see margin title "C-CPU-2 Processor Board", Table 3-7).

Figure 3-8 shows the printed circuit board C–CPU–2 and the interface modules.

The module for the RS485 interface is shown in Figure 3-9, the module for the Profibus interface in Figure 3-10.

On delivery the jumpers are set so that the terminating resistor are disconnected. Both jumpers of a module must always be plugged in the same way.

Jumper	Terminating Resistors	
	Connected	Disconnected
X3	2-3	1-2 *)
X4	2-3	1-2 *)

*) Default Setting

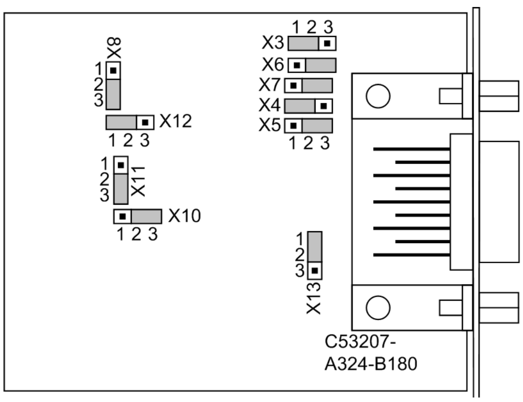


Figure 3-9 Position of terminating resistors and the plug-in jumpers for configuration of the RS485 interface

Jumper	Terminating Resistors	
	Connected	Disconnected
X3	1-2	2-3 *)
X4	1-2	2-3 *)

*) Default Setting

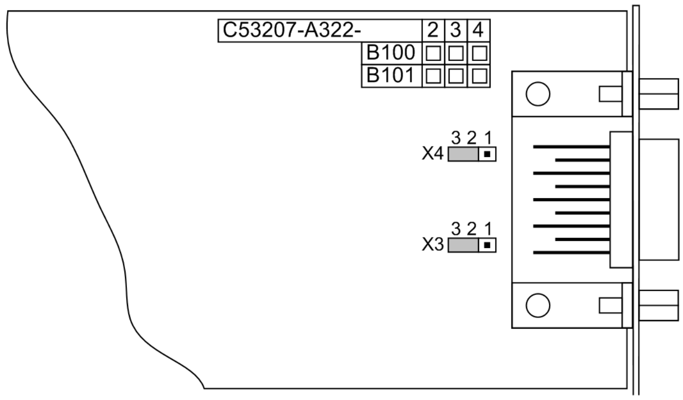


Figure 3-10 Position of the plug-in jumpers for the configuration of the terminating resistors at the Profibus (FMS and DP), DNP 3.0 and Modbus interfaces

The terminating resistors can also be connected externally (e.g. to the terminal block), see Figure 3-5. In this case, the matching resistors located on the RS485 or PROFIBUS interface module or directly on the PCB of the C-CPU-2 board of must be disabled.

It is possible to convert the R485 interface to a RS232 interface by changing the jumper positions and vice-versa.

The jumper positions for the alternatives RS232 or RS485 (as in Figure 3-9) are derived from the following Table.

Table 3-15 Configuration for RS232 or RS485 on the interface module

Jumper	X5	X6	X7	X8	X10	X11	X12	X13
RS232	1-2	1-2	1-2	1-2	1-2	2-3	1-2	1-2
RS 485	2-3	2-3	2-3	2-3	2-3	2-3	1-2	1-2

The jumpers X5 to X10 must be plugged in the same way!

The jumpers are preset at the factory according to the configuration ordered.

Analog Output

The AN20 analog output interface module (see Figure 3-11) has 2 floating channels with a current range of 0 to 20 mA (unipolar, max. 350 Ω). The location on the C–CPU–2 board is "B" and/or "D" depending on the variant ordered (see Figure 3-8).

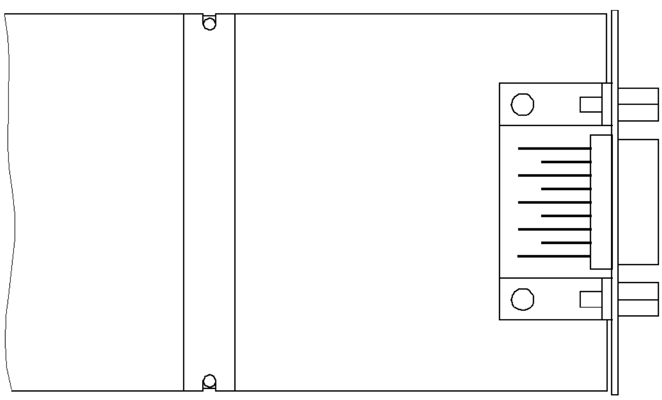


Figure 3-11 AN20 analog output interface board

3.1.2.5 Reassembly

The device is assembled in the following steps:

- Insert the boards carefully in the housing. The mounting locations of the modules are shown in Figures 3-2 and 3-3. For the surface mounting device variant, it is recommended to press the metal lever of the module when inserting the C-CPU-2 processor board. This eases plug connector insertion.
- Plug in the plug connectors of the ribbon cable onto the input/output modules I/O and then onto the processor module C-CPU-2. Be careful not to bend any connector pins! Do not apply force!
- Connect the plug connectors of the ribbon cable between the C-CPU-2 board and the front panel to the front panel plug connector.
- Press the plug connector interlocks together.
- Replace the front panel and screw it tightly to the housing.
- Replace the covers again.
- Screw the interfaces on the rear panel of the device tight again.

  This activity does not apply if the device is for surface mounting.

3.1.3 Mounting

3.1.3.1 Panel Flush Mounting

For installation proceed as follows:

- Remove the 4 covers on the corners of the front plate Thus, 4 elongated holes in the mounting bracket are revealed and can be accessed.
- Insert the device into the control panel section and tighten it with 4 screws. For dimension drawing see section 4.13.
- Mount the four covers.
- Connect the earth on the rear plate of the device to the protective earth of the panel. Use at least one M4 screw for the device earth. The cross-sectional area of the earth wire must be equal to the cross-sectional area of any other control conductor connected to the device. The cross-section of the earth 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 centered in the connection chamber, in such a way that the screw thread fits in the hole of the lug. The SIPROTEC 4 System Description provides information regarding maximum wire size, torque, bending radius and cable relief and must be observed.

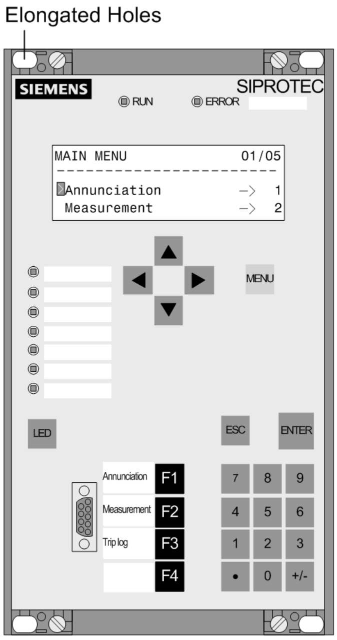


Figure 3-12 Panel flush mounting of a device (housing size $^1/_3$)

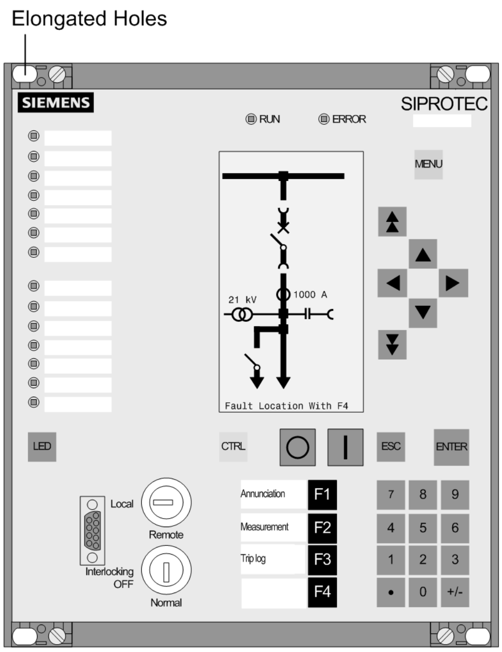


Figure 3-13 Panel flush mounting of a device (housing size $^1/_2$)

3.1.3.2 Rack and Cubicle Mounting

To install the device in a rack or cubicle, two mounting brackets are required. The order numbers can be found in the Appendix under Section A 1.

- Loosely screw the two mounting brackets in the rack or cubicle with four screws.
- Remove the 4 covers on the corners of the front plate Thus, 4 respectively elongated holes in the mounting bracket are revealed and can be accessed.

- Fasten the device to the mounting brackets with 4 screws.
- Mount the four covers.
- Tighten the mounting brackets to the rack or cubicle using eight screws.
- Connect the low-resistance operational and protective earth on the rear plate of the device. Using at least one M4 screw for the device earthing. Make connections at the device rear using plug or screw terminals in accordance with the circuit diagram. When using spade lugs or directly connecting wires to threaded terminals, before cable insertion the screws must be tightened so that the heads are flush with the outside of the terminal block. The cross-section of the earth 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 manner that the screw heads are even with the terminal block. A ring lug must be centered in the connection chamber in such a way that the screw thread fits in the hole of the lug. The SIPROTEC 4 System Description provides information regarding maximum wire size, torque, bending radius and cable relief and must be observed.

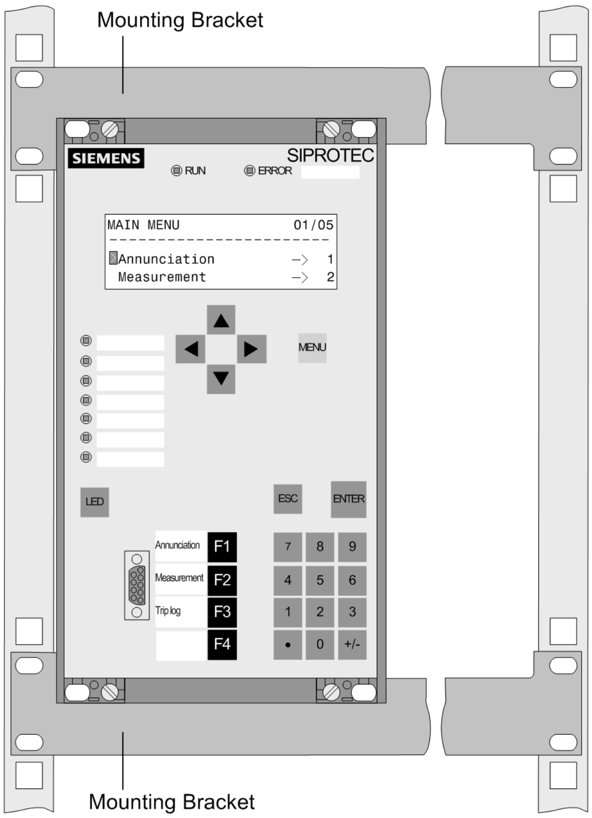


Figure 3-14 Installing a device in a rack or cubicle (housing size $^1/_3$)

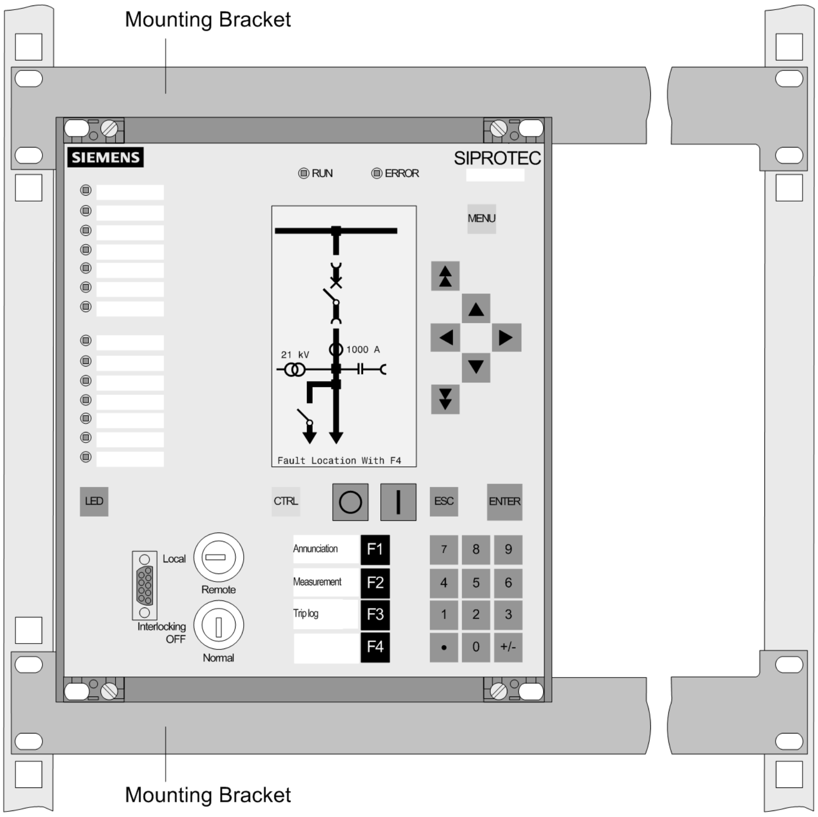


Figure 3-15 Installing a device in a rack or cubicle (housing size $^1/_2$)

3.2 Checking Connections

3.2.1 Checking Data Connections of Interfaces

Pin assignments

The following tables illustrate the pin assignment of the various serial device interfaces and of the time synchronisation interface and the Ethernet interface. The position of the connections can be seen in the following figure.

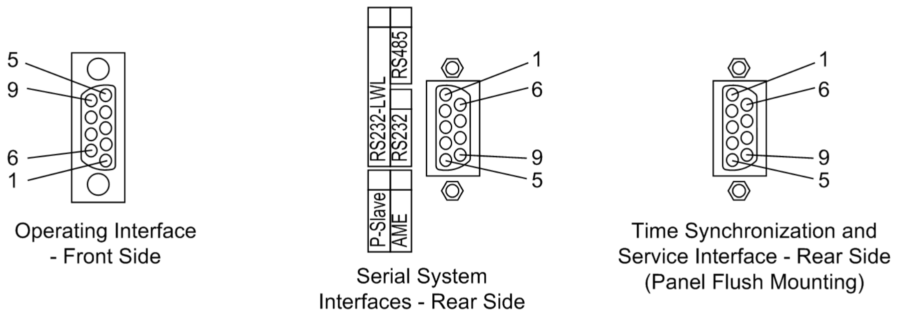


Figure 3-16 9-pin D-subminiature female connectors

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 for an ordering description of the cable.

Service Interface

Check the data connection if the service interface (Port C) for communication with the device via fix wiring or a modem.

System Interface

When a serial interface of the device is connected to a central substation control system, the data connection must be checked. 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 grounded at **both ends**. For extremely EMC-prone environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Table 3-16 Assignment of the connectors for the various serial interfaces

Pin No.	RS232	RS485	Profibus FMS Slave, RS485	Modbus RS485	EN 100 electr.
			Profibus DP Slave, RS485	**DNP 3.0 RS485**	**RJ45**
1	Shield (with shield ends electrically connected)				Tx+
2	RxD	–	–	–	Tx–
3	TxD	A/A' (RxD/TxD-N)	B/B' (RxD/TxD-P)	A	Rx+
4	–	–	CNTR-A (TTL)	RTS (TTL level)	–
5	GND	C/C' (GND)	C/C' (GND)	GND1	–
6	–	–	+5 V (max. load < 100 mA)	VCC1	Rx–
7	$\overline{\text{RTS}}$	– [1)]	–	–	–
8	$\overline{\text{CTS}}$	B/B' (RxD/TxD-P)	A/A' (RxD/TxD-N)	B	–
9	–	–	–	–	not available

1) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 Interface. Pin 7 must therefore not be connected!

Termination

The RS485 interface is capable of half-duplex operation with signals A/A' and B/B' with the common reference potential C/C' (EARTH). Verify that only the last device on the bus has the terminating resistors connected, and that the other devices on the bus do not. The jumpers for the terminating resistors are on the interface module RS485 (see Figure 3-9) or on the Profibus RS485 (see Figure 3-10). or directly on the C–CPU–2 (see Figure 3-4 and Table 3-7). The terminating resistors can also be connected externally (e.g. to the connection module as illustrated in Figure 3-5). In this case, the terminating resistors located on the module must be disabled.

If the bus is extended, make sure again that only the last device on the bus has the terminating resistors enabled, and that all other devices on the bus do not.

Analog Output

The two analog values are output as currents on a 9-pin DSUB socket. The outputs are isolated.

The cable shield is to be grounded at **both ends**. For extremely EMC environments, the GND may be connected via a separate individually shielded wire pair to improve immunity to interference.

Table 3-17 Pin assignment of DSUB socket for analog output

Pin No.	Code
1	Channel 1 positive
2	–
3	–
4	–
5	Channel 2 positive
6	Channel 1 negative
7	–
8	–
9	Channel 2 negative

Time Synchronization Interface

It is optionally possible to process 5 V-, 12 V- or 24 V- time synchronization signals, provided that they are carried to the inputs named in the following table.

Table 3-18 D-SUB socket assignment of the time synchronization interface

Pin No.	Description	Signal Meaning
1	P24_TSIG	Input 24 V
2	P5_TSIG	Input 5 V
3	M_TSIG	Return Line
4	– [1)]	– [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

Fibre-optic Cables

WARNING!

Laser rays!

Do not look directly into the fiber-optic elements!

Signals transmitted via optical fibers are unaffected by interference. The fibers guarantee electrical isolation between the connections. Transmit and receive connections are represented by symbols.

The character idle state for the optical fibre interface is „Light off“. If the character idle state is to be changed, use the operating program DIGSI, as described in the SIPROTEC 4 System Description.

3.2.2 Checking the Device Connections

General

By checking the device connections the correct installation of the protection device e.g. in the cubicle must be tested and ensured. This includes wiring check and functionality as per drawings, visual assessment of the protection system, and a simplified functional check of the protection device.

Auxiliary Power Supply

Before the device is connected for the first time to voltage, it should be have been at least 2 hours in its operating room, in order to attain temperature equilibrium and to avoid dampness and condensation.

Note

If a redundant supply is used, there must be a permanent, i.e. uninterruptible connection between the minus polarity connectors of system 1 and system 2 of the DC voltage supply (no switching device, no fuse), because otherwise there is a risk of voltage doubling in case of a double earth fault.

Switch on the auxiliary voltage circuit breaker (supply protection), check voltage polarity and amplitude at the device terminals or at the connection modules.

Visual Check

Check the cubicle and the devices for damage, condition of the connections etc., and device earthing.

Wiring

It is particularly important to check the correct wiring and allocation of all device interfaces. The margin heading titled„Test function for checking the binary inputs and outputs“ provides additional information to this end.

For analog inputs a plausibility check can be controlled as described above under the margin title „Secondary Testing“

Secondary Check of the Synchronization Function

To minimize the cost at the primary check, a secondary check is recommended. This test has as main purpose to prove the proper wiring including allocation and to prove the main function for the single synchronizers. In association with the test equipment Omicron CMC 56 for manual and automatic test, the software module "paralleling device" can be used as software test for example. The tests are supported by the software of the device. Here are also very important the operational measured values, the event puffer entry, the fault record function and the Web browser.

The following test steps are recommended:

- Control of the voltage connections (anti-parallel connection of Ua and Ub or Ud and Ue, as well as the right phase rotation; the faults show the operational measured values or the operational indication buffer, an exception is the one-phase synchrocheck).
- Proper allocation and wiring of the CLOSE commands (these must be strictly configured to the relays R1 (BO1) and R2 (BO2), an exception is the one-phase synchrocheck)
- Proper allocation and wiring of the synchronization groups (control of the binary inputs including the pickup thresholds)
- Proper allocation and wiring of the start and stop commands
- Proper allocation and wiring of the circuit breaker for the voltage transformer (they can operate to a binary input)
- Proper allocation and wiring of the voltage and frequency control output (checking of the direction adjustment)
- Proper allocation and wiring of the remaining binary information according to the project (for example, running, stopped, CLOSE command as annunciation, synchronization test via binary inputs and others)
- Checking the allocation on LED
- Synchronization test for the individual synchronization groups (checking of the proper functions including the settings parameters, the control of the direction adjustment for voltage and frequency, the annunciations and the synchronization record can be used for the documentation)
- Project-specific tests such as analog outputs, serial interface (if it must be controlled via these) and others (please refer also to the following instructions)

Secondary Checks of the Protective Functions

The only functional test required for protective relays is a plausibility check of the operational measured values by means of some secondary test equipment; this is to ensure that no damage has occurred during transport. A possible three-phase test equipment is recommended for the secondary checks (e.g. Omicron CMC 56 for manual and automatic checking).

The measurement accuracy to be achieved depends on the electrical data of the test sources used. The accuracies specified in the technical specifications can be expected only if the reference conditions in accordance with VDE 0435/Part 303 or IEC 60255 are adhered to, and precision measurement instruments are used.

Tests can be done with the current setting values or with the preset values.

LEDs

After tests where the displays appear on the LEDs, these should be reset in order that they present information only on the currently executed test. This should be done at least once each using the reset button on the front panel and via the binary input for remote reset (if allocated). Observe that an independent reset occurs also on the arrival of a new fault and that setting of new indications can be optionally made dependent on the pickup or a trip command (parameter 610 **FltDisp.LED/LCD**).

3.2.3 Checking System Incorporation

General Information

WARNING!

Warning of hazardous voltages

Non–observance of the following measures can result in death, personal injury or substantial property damage.

Only qualified people who are familiar with and observe the safety procedures and precautionary measures shall perform the inspection steps.

With this check of the parallel switching device, the correctness incorporation into the power system is tested and ensured.

Checking of parametrization (allocations and settings) in accordance with the power system requirements, is an important test step here.

The interface-wide incorporation check in the power system results on the one hand in testing of cubicle wiring and drawing records in accordance with functionality, and on the other hand the correctness of cabling between transducer or transformer and protection device.

Auxiliary Power Supply

Check the voltage magnitude and polarity at the input terminals.

Note

If a redundant supply is used, there must be a permanent, i.e. uninterruptible connection between the minus polarity connectors of system 1 and system 2 of the DC voltage supply (no switching device, no fuse), because otherwise there is a risk of voltage doubling in case of a double earth fault.

Caution!

Be careful when operating the device connected to a battery charger without a battery

Non-observance of the following measure can lead to unusually high voltages and thus the destruction of the device.

Do not operate the device on a battery charger without a connected battery. (For limit values see also Technical Data, Section 4.1).

Visual Check

During the visual check the following must be considered:

- Check of the cubicle and the devices for damage;
- Check of earthing of the cabinet and the device;
- Check the external cabling for condition and completeness.

Acquisition of Technical Power System Data

For checking synchronization and protection parameterization (allocation and settings) in accordance with power system requirements, recording of technical data of the individual components is necessary in the primary system. This includes, among others, the generator and voltage transformer.

On deviations from the planned data the settings values at the device must be corrected accordingly.

Analog Inputs

Checking of the voltage transformer circuits includes the following items:

- Acquisition of technical data
- Visual check of transformers, e.g. for damage, assembly position, connections
- Check cabling in accordance with circuit diagram

Further tests are under certain circumstances necessary in accordance with contract:

- Insulation measurement of cable
- Measurement of transformation ratio and polarity
- Burden measurement
- So far test switches are used for the secondary check, their function must also be checked.

Binary Inputs and Outputs

For more information see also Section 3.3.

- Setting of binary inputs:
  - Check and match jumper allocation for pickup thresholds (see Section 3.1)
  - Check the pickup threshold – if possible – with a variable DC voltage source
- Check the tripping circuits from the command relays and the tripping lines down to the various components (circuit breakers, excitation circuit, emergency tripping, switchover devices etc.)
- Check the signal processing from the signal relays and the signal lines down to the station control and protection system; to do so, energize the signal contacts of the parallel switching device and check the texts in the station control and protection system
- Check the control circuits from the output relays and the control lines down to the circuit breakers and disconnectors etc.
- Check the binary input signals from the signal lines down to the paralleling device by activating the external contacts

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 and close circuits to the circuit breakers and other primary switches are disconnected from the device.

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

Activation and Deactivation

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 set ON, 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. In addition to this, the user can determine by activating the **transmission block** that no indications at all are transferred via the system interface during a test operation.

The SIPROTEC 4 System Manual 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 Interfaces

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 messages 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 system interface 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 interface test is carried out 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 on **Generate Annunciations** shown in the list view. The dialog box **Generate Annunciations** opens (refer to the following figure).

Structure of the Test Dialog Box

The **Indication** column shows the display texts of all indications configured in the matrix to the system interface. The **SETPOINT** column serves to specify a value for the indications to be tested. Depending on annunciation type, several input fields are offered (e.g.annunciation „`coming`“/ annunciation „`going`“). By clicking on one of the fields you can select the desired value from the pull-down menu.

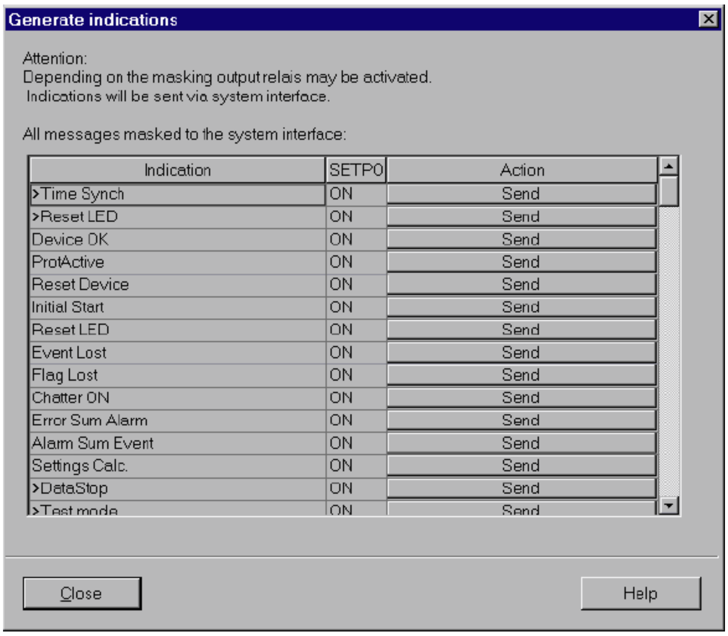


Figure 3-17 System interface test with dialog box: Generating indications – Example

Changing the Operating State

On clicking one of the buttons in the column **Action** you will be prompted for the password No. 6 (for hardware test menus). After correct entry of the password, individual annunciations can be initiated. To do so, click on the button **Send** in the corresponding line. The corresponding annunciation is issued and can be read out either from the event log of the SIPROTEC 4 device or from the substation control center.

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 power system 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 dialog 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 in DIGSI. This feature is used to verify control wiring from the device to plant equipment (operational checks) 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 finishing the hardware test, the device will make an initial startup. Thereby, all annunciation buffers are erased. If required, these buffers should be extracted with DIGSI prior to the test.

The hardware test can be carried out 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 **Device Inputs / Outputs**. The dialog box of the same name opens (see the following figure).

Structure of the Test Dialog Box

The dialog box is classified into three groups: **BI** for binary inputs, **BO** for output relays, and **LED** for light-emitting diodes. On the left of each group is an accordingly labelled button. By double-clicking a button, information regarding the associated group can be shown or hidden.

In the column **Actual** the present (physical) state of the hardware component is displayed. Indication is made by symbols. The physical scheduled states of the binary inputs and outputs are indicated by an open or closed switch symbol, the LEDs by a dark or illuminated LED symbol.

The opposite state of each element is displayed in the column **Setpoint**. The display is made in plain text.

The right-most column indicates the commands or messages that are configured (masked) to the hardware components.

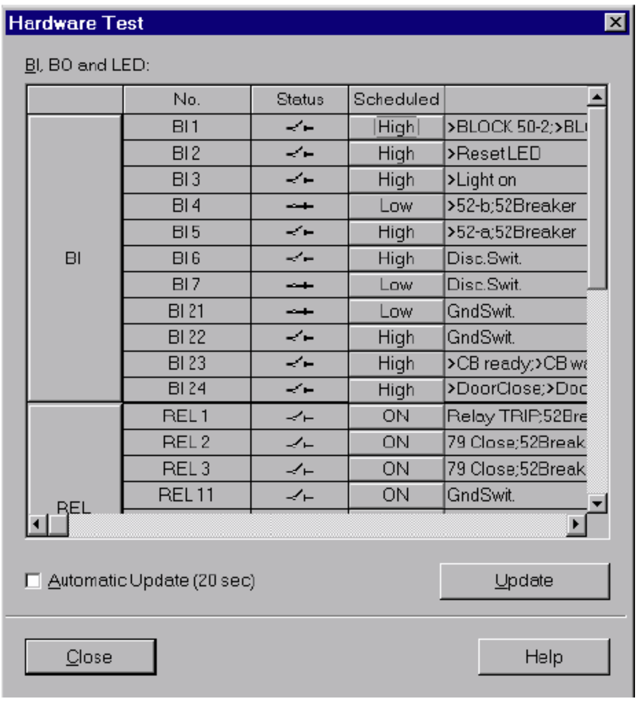


Figure 3-18 Test of the Binary Inputs and Outputs — Example

Changing the Operating State

To change the condition of a hardware component, click on the associated button 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 Output Relays

Each individual output relay can be energized allowing a check of the wiring between the output relay of the 7VE61 and 7VE63 and the system, without having to generate the messages that are assigned to the relay. However, this does not apply for both CLOSE relays BO1 and BO2 with configuration of a $1^1/_2$ channel operation with 7VE61 or a two-channel with 7VE63, because these relays must be controlled via a cross of both measurement procedures.

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 protection function or 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.
- Finish the testing (see margin title below „Exiting the Procedure“), so that during further testings no unwanted switchings are initiated.

Test of the Binary Inputs

To test the wiring between the plant and the binary inputs of the 7VE61 and 7VE63 the condition in the plant which initiates the binary input must be generated and the response of the device checked.

To do so, the dialogue 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:

- Each state in the plant which causes a binary input to pick up must be generated.
- Check the reaction in the **Actual** column of the dialog box. To do this, the dialog box must be updated. The options may be found below under the margin title „Updating the Display“.
- Finish the testing (see margin title below „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

The LEDs may be tested in a similar manner to the other input/output components. As soon as the first state change of any LED has been triggered, all LEDs are separated from the internal device functionality and can only be controlled via the hardware test function. This means e.g. that no LED is illuminated anymore by a protection 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 is made:

- 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 Testing Analog Output

The SIPROTEC devices 7VE61 and 7VE63 can be equipped with up to 2x2 analog outputs. Where analog outputs are provided and used, their functioning should be tested.

Since various types of measured values or events can be output, the test to be performed depends on the values involved. These values must be generated (e.g. with secondary test equipment).

Make sure that the proper values are correctly output at their destination.

3.3.5 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.

A general procedure cannot in the nature of things be specified. Configuration of these functions and the set value conditions must be actually known beforehand and tested. Possible interlocking conditions of switching devices (circuit breakers, disconnectors, earth switch) are of particular importance. They must be considered and tested.

3.3.6 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. For devices with graphic display this is easy to do with the control display.

The switching procedure is described in the SIPROTEC 4 System Description. The switching authority must be set in correspondence with the source of commands used. With the switching mode, you can choose between locked and unlocked switching. In this case, you must be aware that unlocked switching is a safety risk.

Switching from a Remote Control Centre

If the device is connected to a control centre via a system interface, the corresponding switching tests may also be checked from the control centre. Please also take into consideration that the switching authority is set in accordance with the source of commands used.

3.3.7 Commissioning Check

Factory Setting

When the protection device is delivered from the factory, all protective functions have been switched off. This has the advantage that each function can be separately tested without being influenced by other functions. The required functions must be activated for testing and commissioning.

Commissioning Tool Using a WEB Browser

The 7VE61 and 7VE63 features a Web-based commissioning tool to assist during commissioning, and to perform routine tests. With this tool all indications and measured values can be easily read out. For testing purposes vector diagrams and selected characteristics can be visualized.

If you want to use the „IBS tool“, please refer to the help files to „IBS tool“.

The IP address required for the browser depends on the port used for connecting the PC:

- Connection to the front **operator interface:**
  IP-Address 192.168.1.1 (Standard Setting)
- Connection to the rear **service interface** (port C):
  IP-Address 192.168.1.1 (Standard Setting)
- Connection via **EN100**:
  IP-address according to setting

3.3.8 Checking the Control and Measured Voltages Circuits

General

The voltage circuits are checked to ensure the correct cabling, polarity, phase sequence, transformer ratio etc. of the voltage transformers - not to check individual protection functions of the device.

Earthing of the Voltage Transformers

When checking the voltage transformers, particular attention should be paid to the broken delta windings because these windings may only be earthed in one phase.

Preparation

Set the overvoltage protection function to about 110 % of the rated generator voltage with trip on excitation.

Frequency protection (address 4201) to ***Block relay***.

Check in the unexcited condition of the machine with the help of remanent voltages, that all short-circuit bridges are removed.

Control Circuits

When checking the circuit breaker, the neighbouring isolating switches are opened. It is controlled, that the circuit breaker itself in position „Manual“ of the synchronizing switch (if it exists) can only be closed by pressing the control discrepancy switch and in position „Automatic“ only by 7VE61 and 7VE63.

When using the variants with frequency and voltage balance, the correct reaction of the voltage regulator and the speed controller on the setpoint commands (higher/lower) is checked from the7VE61 and 7VE63. In case of more parallel switching, the before mentioned checking are executed for each synchronizer. Here all possible questionable circuit breakers are separated at both ends, in order to control the allocation between the selected synchronizer and the circuit breaker.

Protection Switches for the Voltage Transformers

Since it is very important for the undervoltage protection and the synchronization function that these functions are blocked automatically if the circuit breaker for the voltage transformers has tripped, the blocking should be checked along with the voltage circuits. Each of the 6 voltage inputs of a binary input „>FAIL: VT Ua“ to „>FAIL: VT Uf“ can be specified.

Disconnect one voltage transformer miniature circuit breaker of each binary input.

One should check in the Event Log that the VT mcb trip annunciation was detected (e.g "„>FAIL: VT Ua“ „ON“). A requirement for this is that the auxiliary contact of the VT mcb is connected and correspondingly allocated.

Close the VT mcb again: The above annunciations appear under the "going" operational annunciations, i.e. with the comment "OFF“ (e.g. "„>FAIL: VT Ua“ „OFF“).

If one of the indications does not appear, check the connection and allocation of these signals.

If the „ON“ and „OFF“ annunciations are exchanged, then the breaker auxiliary contact type should be checked and corrected if necessary.

Measured Voltage Circuits, General

The connections of the voltage transformer are tested with primary quantities.

WARNING!

Warning of dangers evolving from improper primary tests

Non–observance of the following measure 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 the synchronizing device and protection systems, the operation of the plant and the safety rules and regulations (switching, earthing, etc.).

With proper connections of the measuring circuits, none of the measured-values supervision elements should pick up in the device. If an element detects a problem, the causes which provoked it may be viewed in the Event Log.

The frequency protection function is verified by a plausibility check of the instantaneous machine speed and the operational measured value indicated.

The absolute value and the phase sequence of the connected values have to be controlled. The voltages and the phase sequence voltage can be read on the display in the front display panel, or called up via a PC, and compared with the actual measured quantities. If the measured quantities are not plausible, the connections must be checked and revised after switching off the line. The measurements must then be repeated.

Measured Voltage Circuits, Synchronization Function

With regard to the synchronization function, the control of the voltage transformer via the primary switch through is an imperative test to be carried out.

The tests can differ depending on the arrangement of the voltage transformer. The following examples contain the example of condition and describe typical applications. More tests have to be autonomously decided.

If the generator, for example, is not yet ready for operation, the preliminary test can be executed with the system voltage. Here if necessary, the starpoint of the generator has to open.

If the synchronizers have via the Voltage Transformers at both sides of the circuit breaker (see the following figure), in this way the voltage transformers can be simply executed to the voltage check:

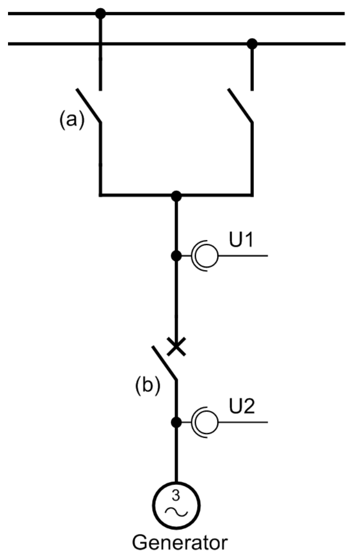


Figure 3-19 Measuring voltages for synchronization

Checking with Side Connection Voltage Transformer

With open circuit breaker (b) , the busbar voltage transformer from the system is set under voltage: Isolator (a) CLOSE

With the 7VE61 and 7VE63 the voltage for the operational measured values is read out as voltage U1 and compared with the actual voltage.

For three-phase systems the phase sequence is checked. If each of the two phase-to-phase voltages or three phase-to-earth voltages are connected to the device and the parameter 6113 **PHASE SEQUENCE** is set to clockwise rotation (***L1 L2 L3***) or set to anti-clockwise rotation (***L1 L3 L2***), the phase sequence voltage can be read out in the operational measured values. If there is no conformity with the parameterized phase sequence voltage, the corresponding annunciations are indicated. Thus, the secondary wiring mode to the device is checked. If monophase systems or two phase-to-phase voltages are not connected , the parameter 6113 **PHASE SEQUENCE** is set to ***NO***.

Busbar - Line Isolator Open (a)

After starting up the generator, the generator voltage is read out in the operational measured values as voltage U2 and compared with the actual voltage. It has to be taken into consideration that the operational measured value of the voltage U2 is influenced by the adaptation factor 6121**Balancing U1/U2**. Normally, however, this factor is set to ***1*** and if necessary, first when the checking of the secondary voltage circuits is finished, the deviating values can be set.

Now, with three-phase systems the phase rotation check is executed with the generator voltage: The phase rotation of the generator voltage must be equal to the phase rotation of the system voltage. In this case the phase rotation can be read out in the operational measured values. If there is no conformity with the parameterized phase sequence voltage, the corresponding annunciations are indicated. Thus, the secondary wiring mode to the device is checked.

The final testing of the secondary voltage circuits takes place by the fact that the both voltage transformers receive the identical voltage. In addition, the generator feeder has to be separated from the busbar. The circuit breaker (b) is closed, so that both voltages U1 and U2 are identical.

By reading the operational measured values one should check that within the framework of the measuring tolerances

- Both voltages U1 and U2 are equal
- Both frequencies f1 and f2 are equal

If the secondary voltages are not equal due to different voltage transformer, an appropriate correction can be performed with the help of the adaptation factor 6121 **Balancing U1/U2**. The same applies for the phase angle deviation tolerance, which can be adapted with the help of the parameter 6122 **ANGLE ADJUSTM.**.

In the operational measured values of the 7VE61 and 7VE63 one should check also that within the framework of the measuring tolerances

- The difference voltage dU is zero,
- The difference frequency df is zero,
- The difference angle dα is zero.

Note

If for three-phase systems from the 7VE61 and 7VE63 the phase rotation checks are executed, the same phase rotation has to be displayed for both voltages in the operational measured values.

In case of several synchronizing points, each of the synchronizing points has to be tested.

Checking with Busbar Voltage Transformer

With busbar voltage transformers, it may be necessary to check for each busbar the applied voltage via the isolator auxiliary contacts by reading the operational measured values and comparing them with the actual voltage. Each of the busbar voltages on the measurement location has to be switched one by one by switching the isolators or the temporary bridging of the isolator auxiliary contacts.

The voltage checks for the system voltage as well as for generator voltage in the measuring field can be performed with an arrangement as shown in Figure 3-20. **Only one of the circuit breakers (a) or (b) may be closed!** With the opened generator switch (b) and the closed section switch (a) the system voltage is applied in the measuring field. After opening of the section switch (a) and closing the generator switch (b) the voltage of the generator voltage can be checked.

First execute the voltage check with the network voltage (b) open, (a) closed. In the 7VE61 and 7VE63 the voltage U1 is read out and compared with the actual voltage.

Now, the phase rotation is checked. if for three-phase systems two phase-to-phase voltages are connected to the device and the parameter 6113 **PHASE SEQUENCE** is set to clockwise rotation (***L1 L2 L3***) or set to anti-clockwise rotation (***L1 L3 L2***) the phase sequence voltage can be read out in the operational measured values. Thus, the secondary wiring mode to the device is checked.

Finally open the **section switch opens again (a).**

After starting up the generator, the phase rotation check is executed with the generator voltage, (a) open, (b) closed. The voltage U2 in the 7VE61 and 7VE63 can be read out in the operational measured values and compared with the actual voltage. It has to be taken into consideration that the operational measured value of the voltage U2 is influenced by the adaptation factor 6121 **Balancing U1/U2**.

The phase rotation of the generator voltage must be equal to the phase rotation of the system voltage. If two phase-to-phase voltages are connected to the device and the parameter 6113 **PHASE SEQUENCE** is set to clockwise rotation (***L1 L2 L3***) or set to anti-clockwise rotation (***L1 L3 L2***) the phase sequence voltage can be read out in the operational measured values. Thus, the secondary wiring mode to the device is checked.

The final testing of the secondary voltage circuits takes place by the fact that the both voltage transformers receive the identical voltage. In addition, the section switch (a) is open, no network voltage is available. The generator circuit breaker (b) is closed, so that both voltages U1 and U2 are identical.

By reading the operational measured values one should check that within the framework of the measuring tolerances

- Both voltages U1 and U2 are equal
- Both frequencies f1 and f2 are equal

If the secondary voltages are not equal due to different voltage transformer, an appropriate correction can be performed with the help of the adaptation factor 6121 **Balancing U1/U2**.

In the operational measured values of the 7VE61 and 7VE63 one should check also that within the framework of the measuring tolerances

- The difference voltage dU is zero,
- The difference frequency df is zero,
- The difference angle dα is zero.

If for three-phase systems from the 7VE61 and 7VE63 the phase rotation checks are executed, the same phase rotation has to be displayed for both voltages in the operational measured values.

With multiple busbars, the attempt for each busbar voltage has to be checked.

In case of several synchronizing points, each of the synchronizing points has to be tested.

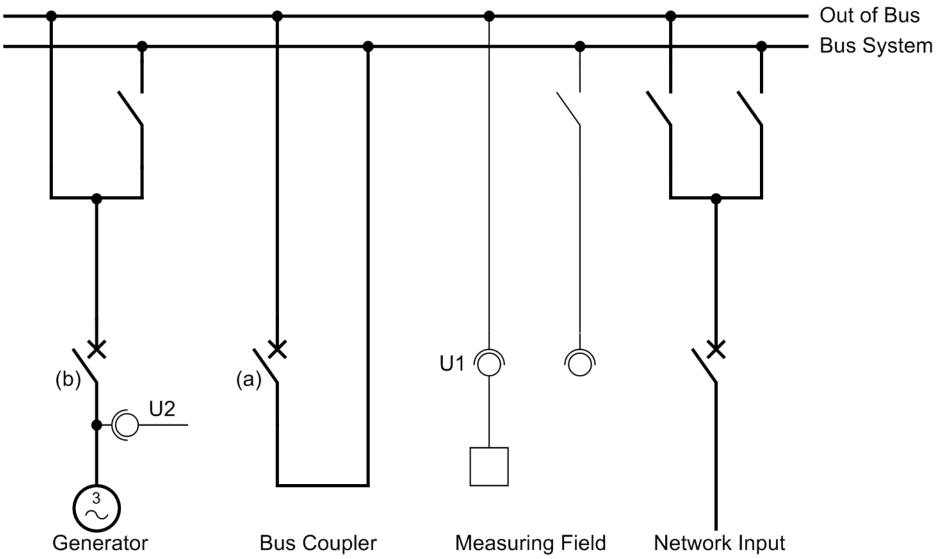


Figure 3-20 Testing the measuring voltages in the measuring field — Example 1

Synchronization of Networks

The previous rules apply for the synchronization of systems. The following figure shows a possible switching arrangement. Identical tests are executed as for the „checking with busbar voltage transformer “. For details, see above.

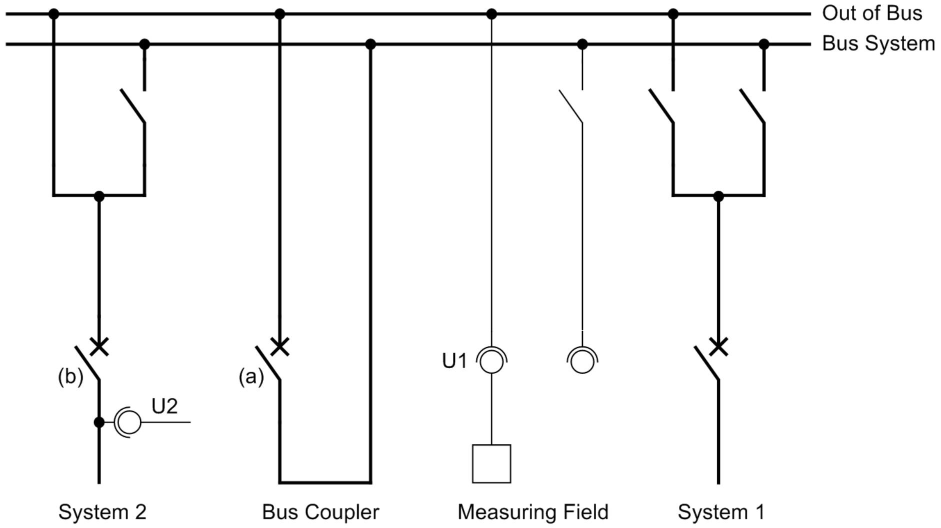


Figure 3-21 Testing the measuring voltages in the measuring field — Example 2

If there is no transformer between the two measuring points – as shown in the above examples – address 6122 **ANGLE ADJUSTM.** must be set to ***0***°.

If the measurement is made across a transformer, this angle setting must correspond to the phase rotation through which the vector group of the transformer (as seen from the feeder in the direction of the busbar) rotates the voltage. There is an example in the setting notes of the synchronization function.

Checking with the Power Transformer

In the synchronization range, it is included a power transformer with tap changers is included as shown in Figure 3-22. There are different methods to perform a test. The method without having the generator in operation is described. The generator circuit breaker including the isolator is continuously open and it is secured against switching.

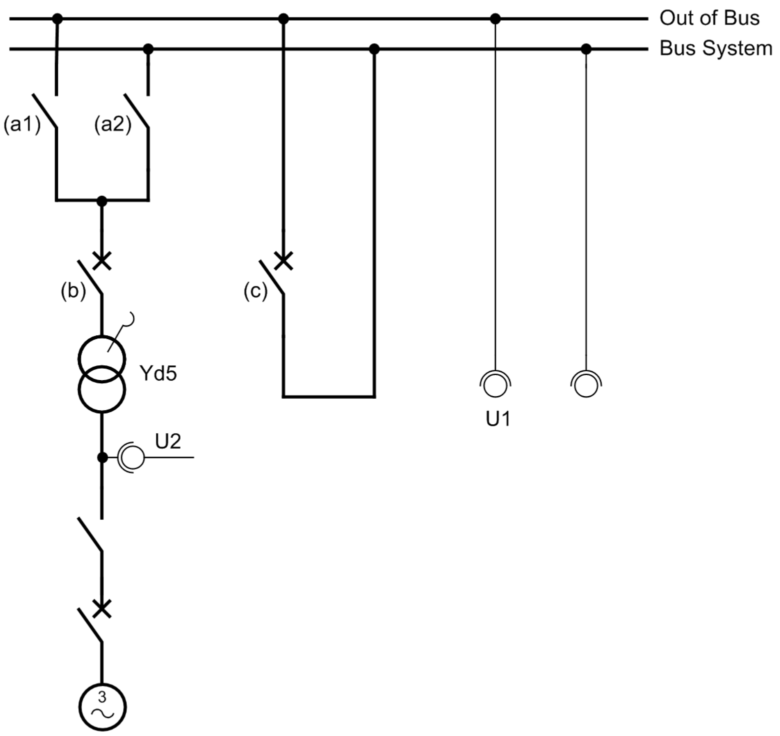


Figure 3-22 Measuring voltages with synchronization via the transformer

The following checking steps have to be executed analogically to the previous checkings:

- Set the tap changer of the transformator to the nominal position
- Circuit breaker (b) is open and section switch (c) closed
- Check the measured values on side U1 (U1, f1, phase rotation)
- Check that the transformer differential protection is ready for operation
- Close isolator (a1) and then close the circuit breaker (b)
- Check the measured values on side U2 (U1, f1, phase rotation)
- Compared the measured values on side 1 and on side 2:
  - Voltage equality U1 = U2
  - Frequency equality f1 = f2
  - The difference voltage dU is zero
  - The difference frequency df is zero
  - The difference angle dα is zero

Note

If dU and dα are unequal to zero, then wiring or setting error exist.

– Activate the tap changer and check again the measured values. The measured values on the side 2 have to remain the same and all differential quantities must be equal to zero.

After the test has been completed, you can reestablish the output switching condition.

Testing the Synchrocheck

The same test steps have to be executed as for the synchronization function (see above). In the version ***1ph Sync check***, only one voltage is used for each side. Thus, the phase rotation check is not required.

3.3.9 Measuring the Operating Time of the Circuit Breaker

General

In order to achieved an exact parallel switching with a zero phase angle, it is necessary – under asynchronous system conditions – that the operating time of the circuit breaker is measured and set correctly when closing. If it is switched exclusively with synchronism systems conditions, this section can be skipped.

With External Timer

For measuring the operating time a setup as shown in Figure 3-23 is recommended. The timer is set to a range of 1 s and a graduation of 1 ms.

The circuit breaker is connected manually. At the same time the timer is started. After closing the poles of the circuit breaker, the voltage U_{Line} appears and the timer is stopped.

If the timer is not stopped due to an unfavourable closing moment, the attempt will be repeated.

It is particularly favourable to calculate the mean value from several (3 to 5) successful switching attempts.

Note

You may add to the measured value the operating time of the parallel switching device (22 ms at f_N = 50 or 60 Hz; 42 ms at f_N = 16.7 Hz) and set the total length of time under address 6120 as **T-CB close**. Round off to the next lower settable value. Proceed for all used synchronizing functions 2 to 8 in the same way.

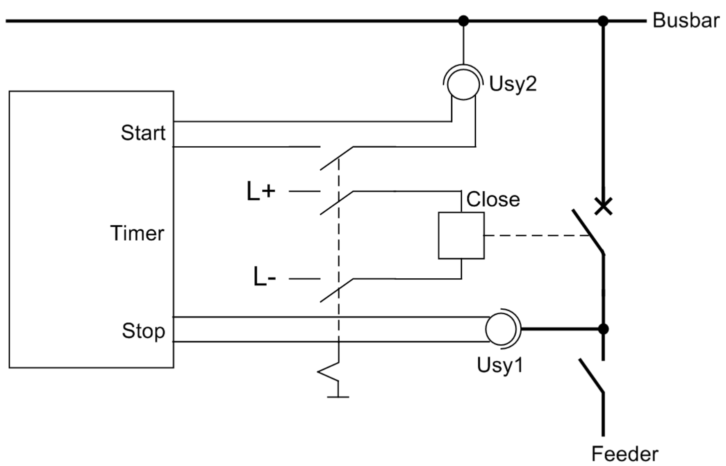


Figure 3-23 Measuring the circuit breaker closing time

By Reading Out from Fault Records

The circuit breaker closing time can be also determined by reading out fault records in respect to the time delay between the CLOSE command to the circuit breaker and the closing of the circuit breaker poles. In such case, the obtained time from the fault record is the real circuit breaker closing time.

To do so, the following procedure is recommended:

- Set a similar state which can be switched with no danger of the circuit breaker.
- Activate the parameter 6107 **SYNC U1<U2>** in the synchronization functional group 1 setting to ***YES***, if U2 is switched. The setting for the parameter 6108 **SYNC U1>U2<** = ***YES*** applies when switching through to U1.
- Set the fault record in the functional scope to instantaneous values record and trigger with parameter 401 **WAVEFORMTRIGGER** to ***Save w. TRIP***.
- Select the synchronization functional group and start the synchronism. The paralleling device is immediately started.
- Read the fault record out and measure the closing time with SIGRA (see Figure 3-24). Use both cursors and the time measurement function for that purpose. The occurrence of the 2nd voltage signals the closed poles.
- Set the calculated time under address 6120 as **T-CB close**. Round off to the next lower settable value. Proceed for all used synchronizing functions 2 to 8 in the same way.
- Set again the parameter 6x07 or 6x08 to the original value.

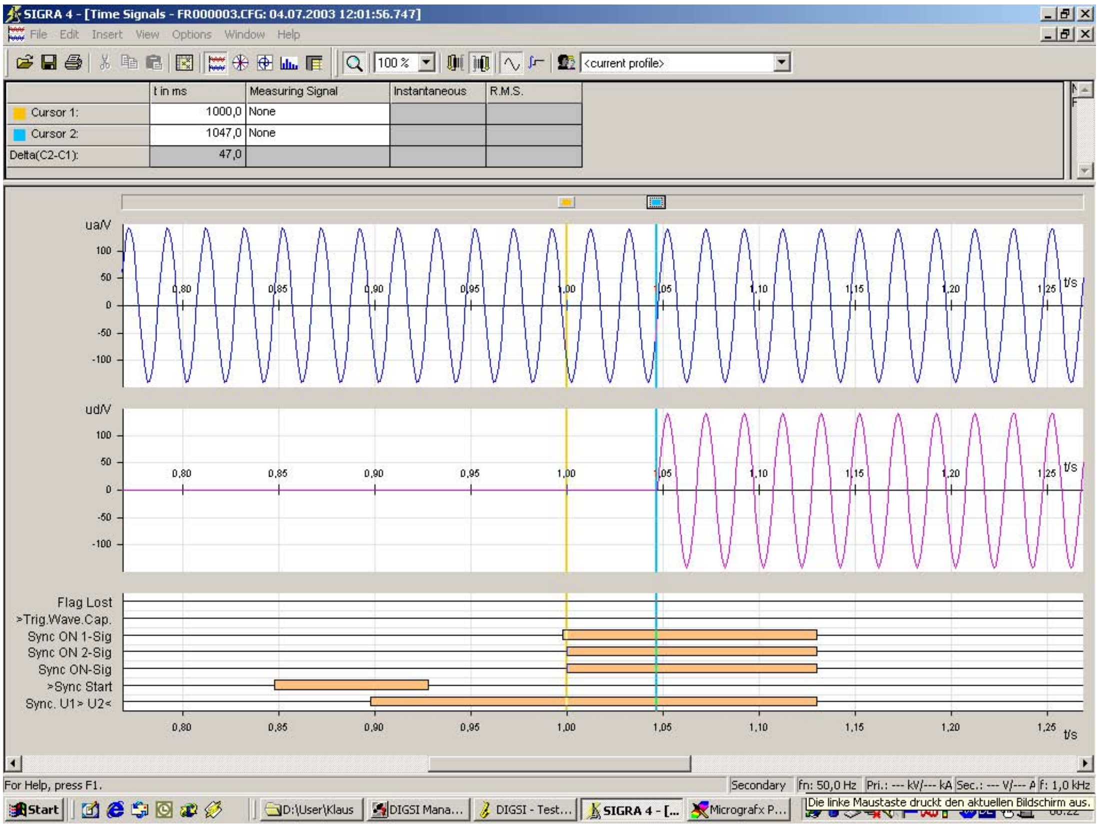


Figure 3-24 Web Tool — Measurement of the circuit breaker closing time

3.3.10 Test Operation with the Synchronization Function

Prerequisites

The setting values are checked again (see Subsection „setting notes“ of the synchronization function in Chapter 2).

The circuit breaker is disconnected. The close command for the circuit breaker as well as some setpoint commands are interrupted (disconnect the close and setpoint command). The system voltage is switched through the measurement.

Asynchronous Systems

The generator is placed to a speed below the permissible frequency difference via manual control according to 6132 **df ASYN f2>f1** or 6133 **df ASYN f2<f1**. The generator is activated to the system voltage. The values can be read out in the operational measured values in the 7VE61 and 7VE63.

The synchronization function is initiated in the 7VE61 and 7VE63 (e.g. per start input or measurement request via the integrated control using the control keys). If there is a synchroscope available, initiation takes place approximately by synchronism , thus „12 o´clock“; then the duration is equivalent command to a revolution for a duration of 1/Δf until the parallel switching command (with a frequency difference of 0.1 Hz therefore 10 s).

This attempt is several times executed for oversynchronous switching and for undersynchronous switching — if it is permissible for both — .

The switching on behaviour is checked with an external recorder or with the integrated fault record function. Additionally both procedures must have issued the CLOSE command briefly before the synchronous instant, with offset to the close time of the circuit breaker. Figure 3-25 shows an example of an instantaneous value recording. The envelope curve and the synchronous instance are clearly visible as well as the binary tracks traces with the CLOSE commands of the two measuring procedures. The track with the difference angle $\Delta\alpha$ is to be used for the evaluation of the switching on behaviour. The distance between the CLOSE command and $\Delta\alpha = 0$ must correspond to the circuit breaker closing time. The circuit breaker closing time of the circuit breaker runs in the example to 420 ms. In case of long time, there was an interlocking switched in between.

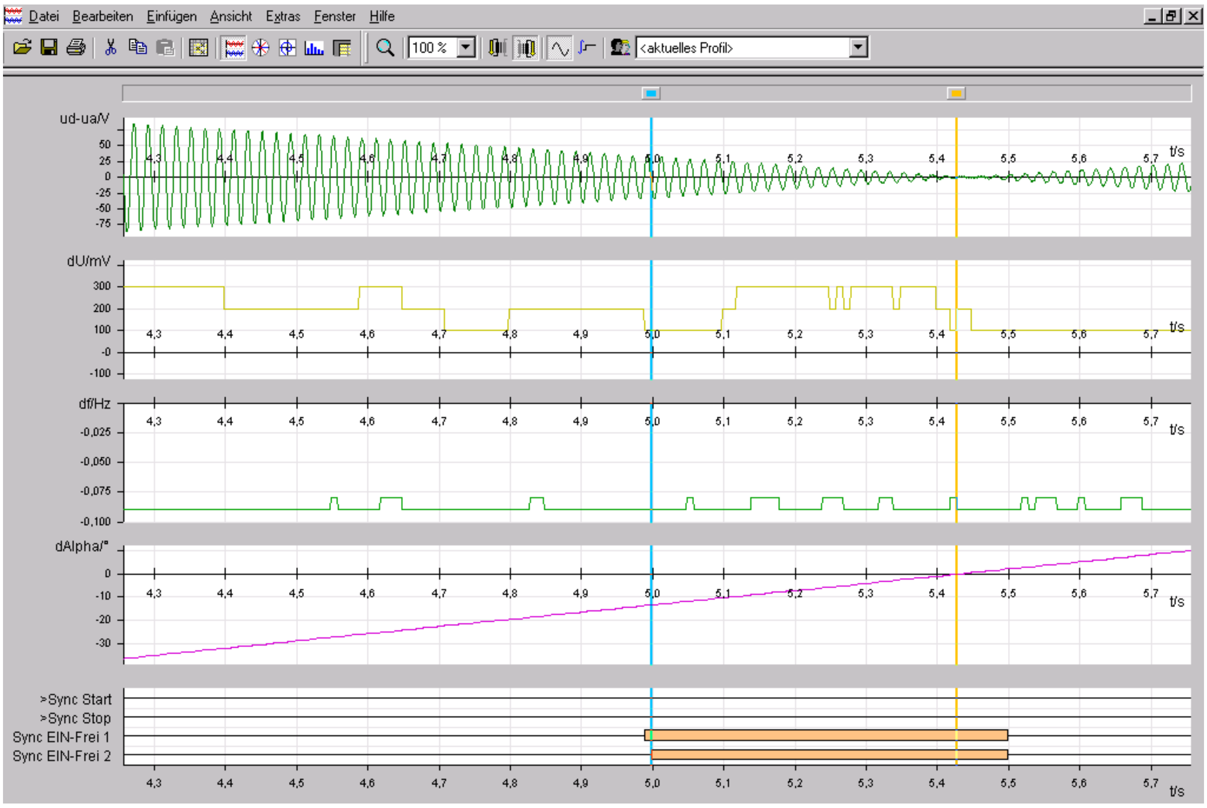


Figure 3-25 Record of instantaneous values from a generator synchronization (asynchronous conditions)

The test operation with the synchronization function can be repeated at the limits of the permissible voltage difference.

The correct function of the setpoint commands is then checked for devices with frequency and voltage balancer. In addition the setpoint command circuits can be switched active (connected again); the close command remains interrupted.

The generator is started with a speed outside the area for the asynchronous switching. The synchronization function is initiated.

It must be checked that the speed of the 7VE61 and 7VE63 is influenced in the correct sense.

WARNING!

Warning of faulty speed adjustment!

Non-observance of the following measures can result in death, personal injury or substantial property damage.

If the speed adjustment is not carried out as you planned:

Abort immediately synchronization pressing the stop-input,

Switch to manual operation,

Shut down generator,

Set up the recommended setpoint commands.

If the adjustment direction is correct, the command duration and the command intervals as well as the setting parameters (e.g. df/dt) can be optimized. Here the RMS fault record is helpful, which shows very good the transient condition behaviour due to the long recording time. If the main setting parameters are found, the synchronization attempts are executed.

Synchronization attempts (dummy) are executed for over-frequency as well a for under-frequency in accordance with the values of the parameters 6132 **df ASYN f2>f1** and 6133 **df ASYN f2<f1**.

After successful checking of the frequency balance, the voltage balance is executed. The generator is brought to approx. rated speed, the excitation is brought to a voltage outside the permissible synchronization voltage. The synchronization function is initiated in the 7VE61 and 7VE63.

It must be checked that the voltage of the 7VE61 and 7VE63 is influenced in the correct sense.

WARNING!

Warning of faulty voltage adjustment!

Non-observance of the following measures can result in death, personal injury or substantial property damage.

If the voltage adjustment is not carried out as you planned:

Abort immediately synchronization pressing the stop-input,

Switch to manual operation,

Shut down generator,

Set up the recommended setpoint commands.

If the adjustment direction is correct, the command duration and the command intervals as well as the setting parameters (e.g. dU/dt) can be optimized.

Synchronization attempts (dummy) are executed for overvoltage as well as for undervoltage in accordance with the values of the parameters 6130 **dU ASYN U2>U1** and 6131 **dU ASYN U2<U1**.

The RMS value record is particularly suitable for checking the control behaviour. To do so, the fault recording is to be set (parameter 401 **WAVEFORMTRIGGER**) to ***Save w. Pickup***.

Figure 3-26 shows a record of a test operation with the synchronization function. The functioning of the operating time can be seen very well.

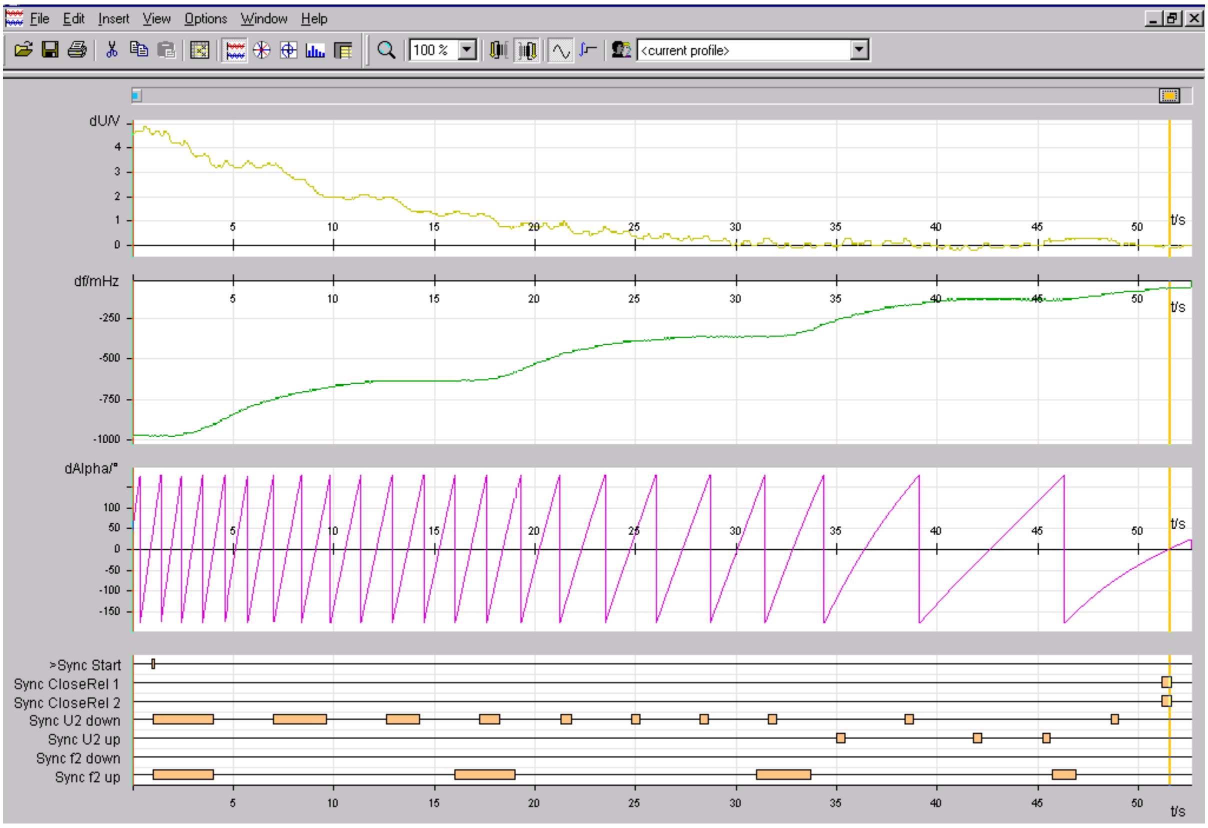


Figure 3-26 Instantaneous fault record of a test operation with synchronization attempt for testing the balancing

Synchronous Systems

The parallel switching device is started and the creation of close command is checked. The operational measured values provide also additional information. The synchronous conditions must be fulfilled within this time 6146 **T SYNC-DELAY**. If it a change between the asynchronous and the synchronous conditions is observed, the threshold 6141 **F SYNCHRON** is slightly increased. The behaviour is checkable with the fault record accordingly. The effective value record can be used via the effective enable time (approx. 10 s). The actual r.m.s values can be read at first switching from the measured value track.

Synchrocheck

If this function is used in context with the manual synchronization function, the proper enabling has to be checked. The execution of commands for the circuit breaker is interrupted in this attempt via disconnection. The generator is then synchronized manually and the proper enabling is checked with the fault record function. As described in the Description of the synchronization function (Section 2.2.1), the manual ON command issues a measurement request. This initiates the release of the internal logic. The envelope curve of the differential voltage can be seen in the instantaneous values record according to Figure 3-27. The coming edge of the binary track „`>Sync. MeasOnly`“ shows the operating manual ON. The time difference for the synchronous instance shows the quality of the manual close mode. If the measured values during measurement request are in the set limits, the synchrocheck function issues the release. This is visible in the binary track „`Sync CloseRel 1`“.

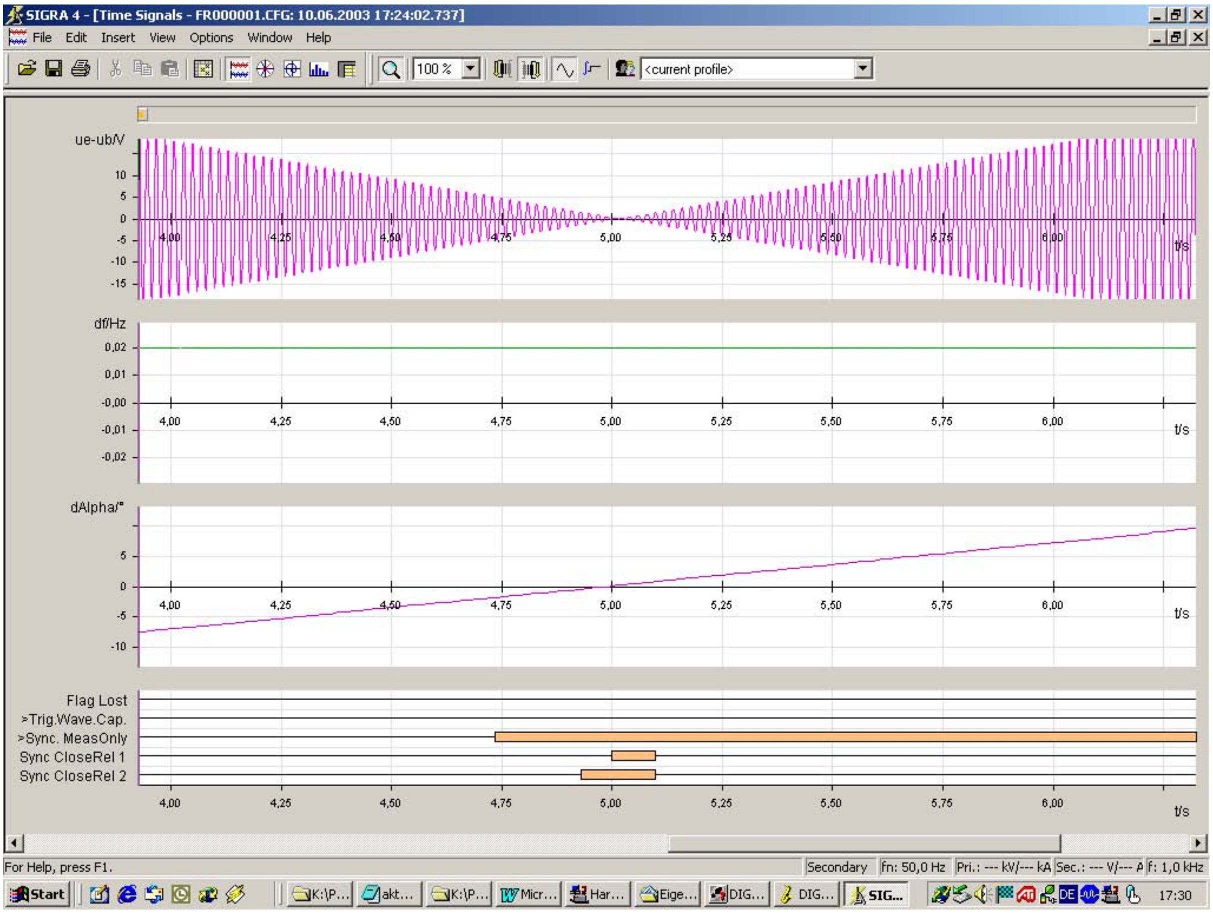


Figure 3-27 Instantaneous fault record of a test operation attempt with manual synchronization

3.3.11 Synchronization Test

In order to test the parameter setting of the synchronization function, it is possible to make a synchronization test. The IBS-Mode is here connected and the IBS-mode is set to **Sync. Test**. The synchronization test is started as a completely normal synchronization. If the synchronization function operates successfully, so it is issued an ON command „`Test CloseRel 1`“ and/or „`Test CloseRel 2`“ is generated. The annunciations „`Sync CloseRel 1`“ and „`Sync CloseRel 2`“ are suppressed. A synchronization record is created for checking.

3.3.12 Commissioning-Help using the Web-Tool

The IP address required for the browser depends on the port used for connecting the PC:

- Connection to the front **operator interface:**

  IP-Address 192.168.1.1 (Standard Setting)

- Connection to the rear **service interface** (port C):

  IP-Address 192.168.1.1 (Standard Setting)

When the Tool is started and a connection to the device is established, the view for the remote control appears in the browser (see Figure).

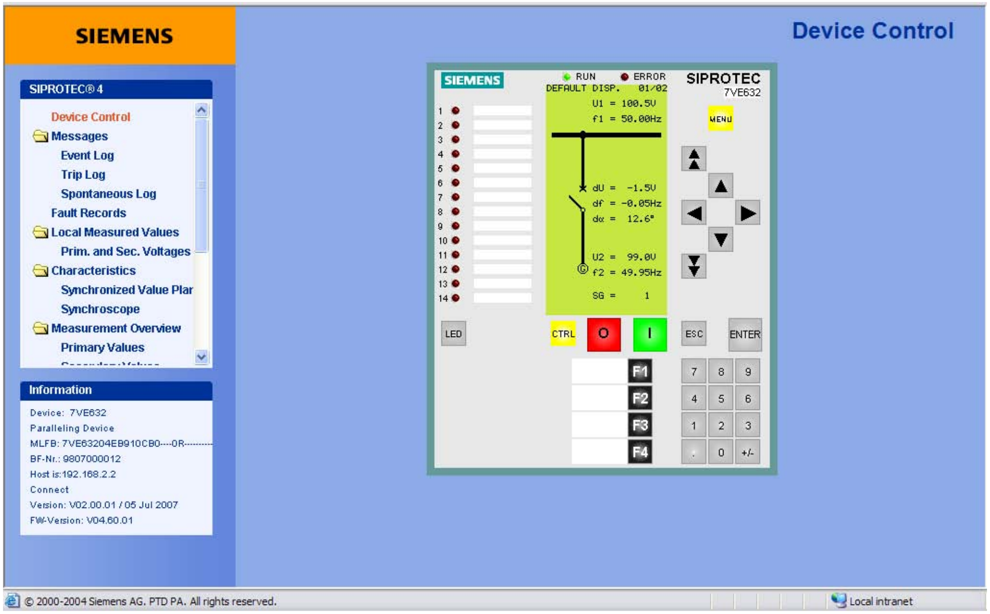


Figure 3-28 Web-Tool – remote control by means of virtual device 7VE6

On the start page are displayed all the data to identify the device. All the parameter settings can be used directly at the device via the view of the **Control Remote**.

With more selection fields the measured. values and the parameterized operating ranges of the synchronization function can be visualized. Also, a running synchronization by visualization of the rotating vector (U2) is dynamically illustrated via the option **synchroscope** (see the following Figure).

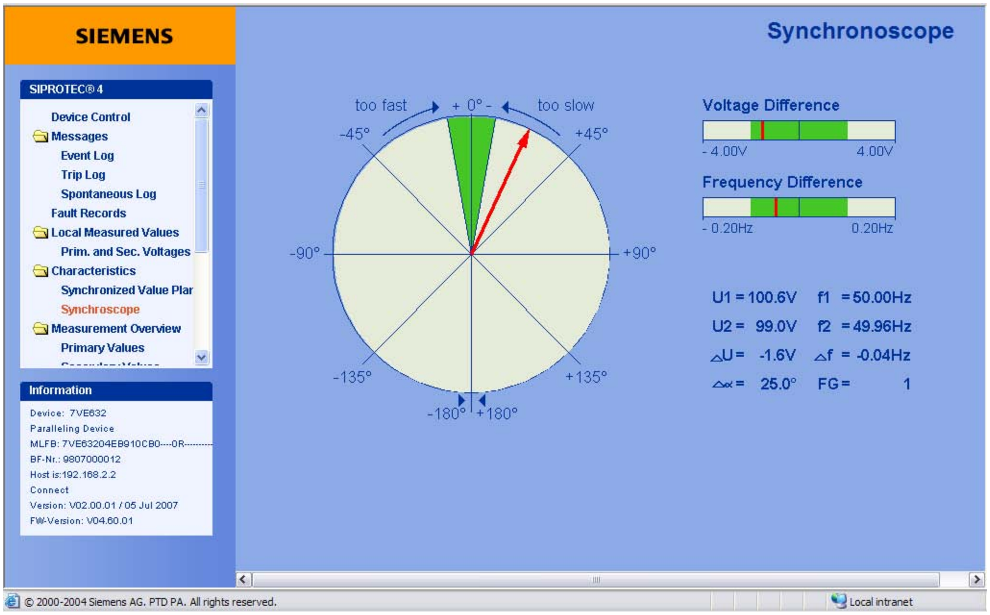


Figure 3-29 Browser control – Visualisation of the synchronisation values (Synchroscope)

3.3.13 1st Parallel Switching with the Synchronization Function

Prerequisites

After all tests are completed, the first „hot“ synchronization occurs.

At least one of the 8 synchronization function groups must be configured as available under address 161 to 168 (see Section 2.1.1.2). The operation mode is thereby already preselected. In addition the used SYNC function group must be switched on under the address **6X01** ***ON***. It is communicated to the device with the selection of the synchronizers which parameter block and thus which message from the setting values are valid. If no parameter block or more than one is selected, the device is automatically blocked. If asynchronous systems should be connected , the previously determined time must be entered under parameter 6120**T-CB close** in Section „ Measuring the Operating Time of the Circuit Breaker“.

Important Test Steps

- The initiation of the device via the start input occurs after selection of the synchronizers.
- Observe the device during the synchronization (measured values, LEDs, annunciations)
- After CLOSE command, the following final checks have to be carried out:
  - Correct indication via LED, signal contacts and if necessary Bus
  - Reading out the event puffer (operational messages, disturbance indications) and checking on plausibility
  - Reading out the fault record and evaluate the connection

Additional information regarding the individual synchronization conditions is given below.

Asynchronous Systems

The generator in general is here positioned via the corresponding automatic operating mode approximated to the synchronization conditions and afterwards the parallel switching device is started. The fine adjustment is performed via the control output. If the measured values are within the setting limits, the device determines the next instant at which the two systems are in phase from the angle difference and the frequency difference. The close command is issued at a time before synchronization corresponding to the operating time of the circuit breaker. The duration of the close command is set in address 6127**T CLS CMD MIN**.

The device performs the checks until the switching conditions are fulfilled, the maximum duration is 6112 **T-SYN. DURATION**.

If you are not satisfied with the fine adjustment of the control outputs, a modification of the setting parameters and a repeated synchronization take place.

In order to make more checks is advised to read out again the synchronization record and to evaluate. In contrast to Figure 3-25, the „hot“ synchronization after closing the circuit breaker poles has a zero differential voltage.

Synchronous Systems

As soon as all synchronism conditions after the starting are fulfilled, the messages „Sync synchron 1“ and „Sync synchron 2“ are issued and the CLOSE command is provided after release of time delay **T SYNC-DELAY**. The duration of the close command is set in address 6127.**T CLS CMD MIN**.

If not all synchronization conditions are fulfilled, the device continues checking until the monitoring time 6112 **T-SYN. DURATION** expires. The device then starts itself automatically.

The behaviour of the device can be checked in the operational measured values. If necessary a correction of the setting parameters can be carried out in the event of switching status and systems conditional deviations.

Synchrocheck

The interaction with the manual synchronization is checked: The generator is manually synchronized and the behaviour with the fault record is documented. The record can be compared with the figure3-27. The switching poles close delayed by the closing time after release and manual CLOSE. All differential quantities are now zero.

Consider when selecting ***1ph Sync check*** under address 161 to 168, that this selection has a fixed allocation between SYNC function groups and voltage channels (see the setting notes of the synchronization function). An additional aid for the connection check are the messages „Sync U2<U1“, „Sync U2>U1“, and „Sync α2<α1“, „Sync α2>α1“ (see „spontaneous messages“.

If not all synchronization conditions are fulfilled, the device continues checking until the monitoring time 6112 **T-SYN. DURATION** expires. The device then stops itself automatically.

3.3.14 Creating Oscillographic Recordings for Test

Prerequisite

Along with the capability of storing fault recordings via pickup of the protection function, the 7VE61 and 7VE63 also has the capability of capturing the same data when commands are given to the device via the service program DIGSI, the serial interface, or a binary input. 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 energised.

Such externally started test fault recordings (that is, without a protection pickup) are handled by the device as normal fault recordings, i.e. for each measurement record a fault log is opened with its own number, for unequivocal allocation. However, these recordings are not displayed in the fault indication buffer, as they are not fault events.

Triggering Oscillographic Recording

To trigger test measurement recording with DIGSI, click on **Test** in the left part of the window. Double click the entry **Test Wave Form** in the list of the window.

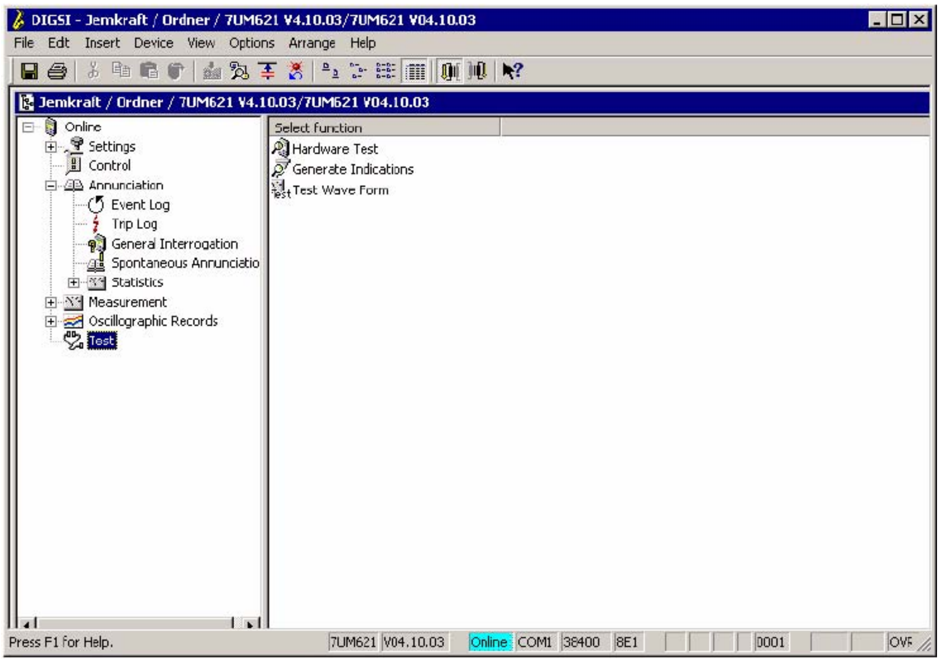


Figure 3-30 Triggering oscillographic recording with DIGSI — Example

A test measurement record is immediately started. During recording, an indication is given in the left part of the status bar. Bar segments additionally indicate the progress of the procedure.

For display and evaluation of the recording you require one of the programs SIGRA or ComtradeViewer.

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!

The setting values should be checked again, if they were changed during the tests. Check if protection, control and auxiliary functions to be found with the configuration parameters are set correctly (Section 2.1.1, Functional Scope). All desired elements and functions must be set ***ON***. Keep a copy of all of the in-service settings on a PC.

Check the internal clock of the device. If necessary, set the clock or synchronize the clock if the element is not automatically synchronized. For assistance, refer to the SIPROTEC 4 System Description.

The annunciation buffers are deleted under **MAIN MENU** → **Annunciation** → **Set/Reset**, so that future information will only apply for actual events and states (see also SIPROTEC 4 System Description). The counters in the switching statistics should be reset to the values that were existing prior to the testing (see also SIPROTEC 4 System Description).

Reset the counter of the operational measured values (e.g. operating hours counter) under **MAIN MENU** → **Measured Values** → **Reset** (also see SIPROTEC 4 System Description).

Press the Esc key (several times if necessary), to return to the default display. The default display appears in the display box (e.g. the display of operational measured values).

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, saved output relays are reset, too. 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 pressed. Any LEDs that are lit after the clearing attempt are displaying actual conditions.

The green „RUN“ LED must light up, whereas the red „ERROR“ must not light up.

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 presents the technical data of the SIPROTEC 4 7VE61 and 7VE63 device and its individual functions, including the limit values that must not be exceeded under any circumstances. The electrical and functional data for devices equipped with all options are followed by the mechanical data with dimensional drawings.

4.1 General

4.1.1 Analog Inputs/Outputs

Voltage Inputs

Nominal Frequency	f_N	50 Hz or 60 Hz (adjustable) 16,7 Hz with version 7VE6***-*****-*****1**
Secondary nominal voltage		80 V to 125 V
Measuring range		0 V to 200 V
Burden	at 100 V	Approx. 0.3 VA
Voltage path overload capacity		
– Thermal (rms)		230 V continuous

Analog output (for operational measured values)

Nominal Range	0 to 20 mA–
Operating Range	0 to 22.5 mA–
Connection for flush-mounted case	Rear panel, mounting location "B" or/and "D" 9-pin DSUB female connector
For Panel Surface-Mounted Case	At the terminal on the case bottom or/and at the housing top
Max. Burden	350 Ω

4.1.2 Auxiliary Voltage

DC Voltage

Voltage supply using integrated converter		
Rated auxiliary V_{Aux}DC	24/48 VDC	60/110/125 VDC
Permissible Voltage Ranges	19 to 58 VDC	48 to 150 VDC
Rated auxiliary V_{Aux}DC	110/125/220/250 VDC	
Permissible Voltage Ranges	88 to 300 VDC	
Permissible AC ripple voltage, Peak to peak, IEC 60 255–11	≤15 % of the auxiliary voltage	
Power Input	Quiescent	energized
7VE61	Approx. 5 W	Approx. 9.5 W
7VE63	Approx. 5.5 W	Approx. 14 W
Bridging time for failure/short circuit (not in energized operation)	≥ 50 ms at U ≥ 48 VDC ($U_{A,N}$ = 24/48 V)	
	≥ 50 ms at U ≥ 110 VDC ($U_{A,N}$ = 60..125 V)	
	≥ 20 ms at U ≥ 24 VDC($U_{A,N}$ = 24/48 V)	
	≥ 20 ms at U ≥ 60 VDC($U_{A,N}$ = 60..125 V)	

Alternating Voltage

Voltage supply using integrated converter		
Nominal Auxiliary Voltage U_{Aux} AC	115 to 230 VAC (50/60 Hz)	
Permissible voltage range	92 to 276 VAC	
Power Input	Quiescent	energized
7VE61	Approx. 9 VA	Approx. 21 VA
7VE63	Approx. 12 VA	Approx. 25 VA
Bridging time for failure/short circuit (not in energized operation)	≥ 200 ms	

4.1.3 Binary Inputs and Outputs

Binary Inputs

Variant	Quantity	
7VE61**–	6 (configurable)	
7VE63**–	14 (configurable)	
Rated Voltage Range	24 VDC to 250 VDC, bipolar	
Current Consumption, Energized	Approx. 1.8 mA, independent of control voltage	
Secured Switching Threshold	Changeable via jumpers	
For Nominal Voltages	24/48/ 60/110/125 VDC	U_{high} ≥ 19 V– U_{low} ≤ 10 V–
For nominal voltages	110/125/ 220.250 VDC and 115/230 VDC	U_{high} ≥ 88 V– U_{low} ≤ 44 VDC
For Nominal Voltages	220/250 VDC	U_{high} ≥ 176 VDC U_{low} ≤ 88 VDC
Maximum admissible voltage	300 VDC	
Impulse filter on input	220 nF coupling capacity at 220 V with recovery time > 60 ms	

Binary Outputs

Flag / Command Relay		
Number:	7VE61**–	9 (1 NO contact each, 1 of them optionally as NC contacts) + 1 life contact (NC or NO contact, selectable)
	7VE63**–	17 (1 NO contact each, 2 of them optionally as NC contacts) + 1 life contact (NC or NO contact, selectable)
Switching capability	CLOSE	1000 W/VA
	BREAK	30 VA 40 W resistive 25 W at L/R ≤ 50 ms
Switching voltage	250 V	

adm. current per contact (continuous)	5 A
adm. current per contact (close and hold)	30 A for 0.5 s (NO contact)
admissible total current on common path contacts	5 A continuous 30 A ≤ 0.5 s

4.1.4 Communication Interfaces

Operating Interface

Connection	Front side, non-isolated, RS232, 9-pin DSUB port for connection of a PC
Operation	With DIGSI
Transmission Speed	min. 4 800 Baud; max. 115 200 Baud Factory setting: 38,400 Baud Parity: 8E1
bridgeable distance	15 m

Service / Modem Interface

	Connection	isolated interface for data transfer
	Operation	With DIGSI
	Transmission Speed	min. 4,800 Baud to 115,200 Baud Factory setting: 38,400 Baud Parity: 8E1
RS232/RS485		RS232/RS485 according to the ordering variant
	Connection for flush-mounted case	Rear panel, mounting location "C" 9-pole DSUB port
	Surface-mounting case	At the console housing mounted case on the case bottom; Shielded data cable
	Test voltage	500 VAC, 50 Hz
RS232		
	bridgeable distance	15 m
RS485		
	bridgeable distance	1,000 m

System Interface

IEC 60870-5-103		
	RS232/RS485 Acc. to ordered variant	Isolated interface for data transfer to a master terminal

RS232		
	Connection for flush mounted case	Rear panel, mounting location "B" 9-pole DSUB port
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 4,800 Bd, max. 115,200 Bd Factory setting 38,400 Bd
	Bridgeable distance	15 m / 50 feet
RS485		
	Connection for flush mounted case	Rear panel, mounting location "B" 9-pin DSUB port
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
	Transmission speed	min. 4,800 Bd, max. 115,200 Bd Factory setting 38,400 Bd
	Bridgeable distance	Max. 1,000 m / 3,280 feet
Fibre optic cable (FO)		
	FO connector type	ST connector
	Connection for flush mounted case	Rear panel, mounting location "B"
	For panel surface-mounted case	in console housing at case bottom side
	Optical wavelength	λ = 820 nm
	Laser class 1 acc. to EN 60825-1/-2	Using glass fiber 50/125 µm or Using glass fiber 62.5/125 µm
	Permissible optical link signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Bridgeable distance	Max. 1,500 m
	Character idle state	Configurable; factory setting: “Light off”
Profibus RS485 (DP)		
	Connection for flush mounted case	Rear panel, mounting location "B"
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
	Transmission speed	up to 12 MBd
	Bridgeable distance	1,000 m / 3,280 feet at ≤ 93.75 kBd 500 m / 1,640 feet at ≤ 187.5 kBd 200 m / 656 feet at ≤ 1.5 MBd 100 m / 328 feet at ≤ 12 MBd

DNP 3.0 RS485		
	Connection for flush mounted case	Rear panel, mounting location "B" 9-pin DSUB port
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
	Transmission speed	up to 19,200 Bd
	Bridgeable distance	Max. 1,000 m / 3,280 feet
MODBUS RS485		
	Connection for flush mounted case	Rear panel, mounting location "B" 9-pin DSUB port
	for surface-mounting case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
	Transmission speed	up to 19,200 Bd
	Bridgeable distance	Max. 1,000 m / 3,280 feet
Profibus FO (DP)		
	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 "B"
	For panel surface-mounted case	Please use version with Profibus RS485 in the console housing as well as separate electrical/optical converter.
	Transmission speed	up to 1.5 MBd
	Recommended	> 500 kBd
	Optical wavelength	λ = 820 nm
	Laser class 1 acc. to EN 60825-1/-2	Using glass fiber 50/125 µm or Using glass fiber 62.5/125 µm
	Permissible optical link signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Bridgeable distance	Max. 1,500 m / 0.93 miles
DNP 3.0 FO		
	FO connector type	ST connector receiver/transmitter
	Connection for flush mounted case	Rear panel, mounting location "B"
	For panel surface-mounted case	Please use version with DNP 3.0 RS485 in the console housing as well as separate electrical/optical converter.
	Transmission speed	up to 19,200 Bd
	Optical wavelength	λ = 820 nm
	Laser class 1 acc. to EN 60825-1/-2	Using glass fiber 50/125 µm or Using glass fiber 62.5/125 µm
	Permissible optical link signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Bridgeable distance	Max. 1,500 m / 0.93 miles

MODBUS FO		
	FO connector type	ST connector receiver/transmitter
	Connection for flush mounted case	Rear panel, mounting location "B"
	For panel surface-mounted case	Please use version with MODBUS RS485 in the console housing as well as separate electrical/optical converter.
	Transmission speed	up to 19,200 Bd
	Optical wavelength	λ = 820 nm
	Laser class 1 acc. to EN 60825-1/-2	Using glass fiber 50/125 µm or Using glass fiber 62.5/125 µm
	Permissible optical link signal attenuation	Max. 8 dB, with glass fibre 62.5/125 µm
	Bridgeable distance	Max. 1,500 m / 0.93 miles
Analog output module (electrical)	2 ports with 0 mA to 20 mA	
	Connection for flush mounted case	Rear panel, mounting location "B" and "D" 9-pin DSUB port
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage	500 V; 50 Hz
Ethernet electrical (EN 100) for IEC 61850 and DIGSI		
	Connection for flush mounted case	Rear panel, mounting location "B" 2 x RJ45 female connector 100BaseT acc. to IEEE802.3
	For panel surface-mounted case	in console housing at case bottom side
	Test voltage (female connector)	500 V; 50 Hz
	Transmission speed	100 Mbits/s
	Bridgeable distance	20 m / 66 feet
Ethernet optical (EN 100) for IEC 61850 and DIGSI		
	FO connector type	ST connector receiver/transmitter
	Connection for flush mounted case	Rear panel, mounting location "B"
	For panel surface-mounted case	Not available
	Optical wavelength	λ = 1350 nm
	Transmission speed	100 Mbits/s
	Laser class 1 acc. to EN 60825-1/-2	Using glass fiber 50/125 µm or Using glass fiber 62.5/125 µm
	Permissible optical link signal attenuation	Max. 5 dB, with glass fibre 62.5/125 µm
	Bridgeable distance	Max. 800 m / 0.5 mile

Time Synchronization Interface

Time synchronization	DCF 77 / IRIG B Signal (telegram format IRIG-B000)
Connection for flush-mounted case	rear panel, mounting location "A"; 9-pole D-subminiature Female Connector

for surface-mounted case	at two-tier terminals on case bottom
Signal nominal voltages	selectable 5 V, 12 V or 24 V
Test voltage	500 V; 50 Hz

Signal levels and burdens			
	Nominal signal voltage		
	5 V	12 V	24 V
U_{IHigh}	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

Standards

Standards:	IEC 60255 (product standards) IEEE Std C37.90.0/.1 VDE 0435 See also standards for individual tests

Insulation Test

Standards:	IEC 60255–5 and IEC 60870–2–1
High voltage test (routine test) current inputs, voltage inputs, output relays	2.5 kV (rms), 50 Hz
Voltage Test (routine test) Auxiliary Voltage and Binary Inputs	3.5 kV DC
Impulse voltage test (piece test) only isolated communication and time synchronisation interfaces or analog outputs (port A –D)	500 V (rms), 50 Hz
Impulse voltage test (type test) all circuits except communication and time synchronisation interfaces, analog outputs class III	5 kV (peak value); 1.2/50 µs; 0.5 J; 3 positive and 3 negative shots in intervals of 1 s

EMC Tests for Immunity (type tests)

Standards:	IEC 60 255-6 and -22, (product standards) EN 61000-6-2 (generic standard) VDE 0435 Part 301 DIN VDE 0435-110
High-frequency test IEC 60255-22-1, Class III and VDE 0435 Part 303, Class III	2.5 kV (Peak); 1 MHz; τ = 15 µs; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Electrostatic discharge IEC 6055-22-2, 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
Radio frequency electromagnetic field, frequency sweep IEC 60255-22-3, Class III IEC 61000-4-3, Class III	10 V/m: 80 MHz to 1000 MHz; 10 V/m: 800 MHz to 960 MHz; 20 V/m: 1.4 GHz to 2.0 GHz; 80 % AM; 1 kHz

Radio frequency electromagnetic field, individual frequencies IEC 60255-22-3, IEC 61000-4-3, Amplitude-modulated		Class III: 10 V/m 80/160/450/900 MHz 80 % AM 1 kHz; duty cycle > 10 s
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		Impulse: 1.2/50 µs
	Auxiliary voltage	Common mode: 2 kV; 12 Ω; 9 µF diff. mode:1 kV; 2 Ω; 18 µF
	Measuring inputs, binary inputs and relay outputs	Common mode: 2 kV; 42 Ω; 0.5 µF diff. mode: 1 kV; 42 Ω; 0.5 µF
Line conducted HF, amplitude module. 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 IEEE Std C37.90.1		2.5 kV (Peak); 1 MHz; τ = 15 µs; 400 Surges per s; Test duration 2 s; R_i = 200 Ω
Fast Transient Surge Withstand Cap. IEEE Std C37.90.1		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
Radiated electromagnetic interference IEEE Std 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 61000-6-3 (generic standard)
Radio Noise Voltage to Lines, Only Power Supply Voltage IEC-CISPR 22	150 kHz to 30 MHz Limit Class B
Radio Noise Field Strength IEC-CISPR 11	30 MHz to 1000 MHz Limit Class A

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: 1g 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, each 3 shocks (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 in each direction of 3 orthogonal axes

4.1.7 Climatic Stress Tests

Temperatures

Standards:	IEC 60255–6
Type tested (acc. IEC 60086-2-1 and -2, Test Bd, for 16 h)	-25 °C to +85 °C
Admissible temporary operating temperature (tested for 96 h)	–20 °C to +70 °C or –4 °F to +158 °F (legibility of display may be restricted from +55 °C or 131 °F)
Recommended for permanent operation (according to IEC 60255-6)	-5 °C to +55 °C
Limit Temperatures for Storage	-25 °C to +55 °C
Limit Temperatures during Transport	-25 °C to +70 °C
STORE AND TRANSPORT OF THE DEVICE WITH FACTORY PACKAGING!	
Limit Temperatures for Normal Operation (i.e. output relays not energized)	-20 °C to +70 °C
Limit temperatures under maximum load (max. cont. admissible input and output values)	–5 °C to +55 °C for 7VE61 –5 °C to +40 °C for 7VE63

Humidity

admissible humidity	yearly average ≤ 75 % relative humidity; On 56 days of the year up to 93% relative humidity. Condensation must be avoided in operation!
Siemens recommends that all devices be installed so 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 protection device is designed for installation in normal relay rooms and plants, so that electromagnetic compatibility (EMC) is ensured if installation is done properly.

In addition the following is recommended:

- Contactors and relays operating within the same cubicle or on the same relay board with digital protection equipment should always be provided with suitable quenching equipment.
- 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. When handling the modules or the boards outside of the case, standards for components sensitive to electrostatic discharge (**E**lectrostatic **S**ensitive **D**evices) must be observed. They are not endangered when inserted into the case.

4.1.9 Design

Housing	7XP20
Dimensions	See dimensional drawings, Section 4.13

Weight (mass) approx.	
In flush mounted housing	
7VE61** (Housing size $^1/_3$)	Approx 5.2 Kg (11.4 Ib)
7VE63** (Housing size $^1/_2$)	Approx 7.0 kg (15.4 Ib)
in surface mounted case	
7VE61** (Housing size $^1/_3$)	Approx 9.2 kg (19.8 Ib)
7VE63** (Housing size $^1/_2$)	Approx 12 kg (26.4 Ib)

Protection class acc. to IEC 60 529		
For surface mounting housing equipment		IP 51
In flush mounted housing		
	Front	IP 51
	Rear	IP 50
For personal protection		IP 2x with cover cap

4.2 Synchronization Function (25)

Operating Modes

Synchrocheck	Synchronism check
	dead-line / live-bus.
	Dead-bus / live-line
	dead bus and dead line
	bypassing
	or combination of the above
Switching Synchronous Systems	Switching at frequence equal
Switching Asynchronous Systems	Closing the circuit breaker under asynchronous power conditions taking into consideration the circuit breaker operating time

Voltages

Maximum operating voltage U_{max}	20 V to 140 V	Increments 1 V
Minimum operating voltage U_{min}	20 V to 125 V	Increments 1 V
U1, U2 (U<, for de-energization)	1 V to 60 V	Increments 1 V
U1, U2 (U<, for live-line)	20 V to 140 V	Increments 1 V
Tolerances	1 % of pickup value or 0.5 V	
Drop-off to pick-up ratio	approx. 0.9 (U>) or 1.1 (U<)	

ΔU-Measurement

Voltage difference ΔU	0.0 V to 40.0 V	Increments 0.1 V
Tolerance	max. 0,5 V; typical 0,2 V	
Drop-off to pick-up ratio	Approx. 1.05	

Matching

Angle Correction of the Vector group	0° to 359°	Increments 1°
Matching of the voltage transformers U1/U2	0.50 to 2.00	Increments 0.01

Synchronous Power Conditions

Δα-measurement	2° to 80°	Increments 1°
Tolerance	0,5° at nominal frequency and small frequency difference	
Dropout difference of the phase values	1°	
Δf-measurement	0.00 Hz to 2.00 Hz	Increments 0.01 Hz
Tolerance	10 mHz	
Dropout Value Frequency	20 mHz	
Release delay	0.00 s to 60.00 s	Increments 0.01 s

Asynchronous Power Conditions

Δf measurement	0.00 Hz to 2.00 Hz	Increments 0.01 Hz
Tolerance	10 mHz	

Max. angle error	3° for $\Delta f \leq 1$ Hz at f_N = 50/60 Hz 3° for $\Delta f \leq 0.3$ Hz at f_N = 16.7 Hz	
	5° for $\Delta f \geq 1$ Hz at f_N = 50/60 Hz 5° for $\Delta f \geq 0.3$ Hz at f_N = 16.7 Hz	
Synchronous/asynchronous thresholds	0.01 Hz to 0.04 Hz	
Tolerance	5 mHz	
Circuit breaker operating time	10 ms to 1000 ms	Increments 1 ms

Times

Minimal measuring time for the already selected function groups	Approx. 10 ms at f_N = 50/60 Hz approx. 30 ms at f_N = 16.7 Hz	
Minimal measuring time without previous selected function groups	approx. 80 s at f_N = 50/60 Hz approx. 240 ms at f_N = 16,7 Hz	
Maximum transmission time after starting	0.01 s to 1200.00 s; ∞	Increments 0.01 s
Closing time of the circuit breaker	10 ms to 1000 ms; ∞	Step 1 ms
Minimum switching order duration	0.01 s to 10.00 s	Increments 0.01 s
Voltages monitoring time	0.0 s to 60.0 s	Increments 0.1 s
Tolerance of all timers	1 % of setting value or 10 ms	

Consideration of the Transformer Tapping

Tap number for secondary nominal voltage	-62 to 62	Increments 1
Difference between 2 increments in percentage	0.00 % to 20.00 %	Increments 0.01 %

4.3 Balancing Commands for the Synchronizing Function

Frequency Balancing

Minimum control impulse	10 ms to 1000 ms	Increments 1 ms
Maximum control impulse	0.00 s to 32.00 s; ∞	Increments 0.01 s
Frequency change of the control system	0.05 Hz/s bis 5.00 Hz/s	Increments 0.01 Hz/s
Response time of the control system	0.00 s to 32.00 s	Increments 0.01 s
Target value for frequency balancing	-1.00 Hz to +1.00 Hz	Increments 0.01 Hz
Kick impulse	ON/OFF	
Frequency change for kick impulse	0.01 Hz/s bis 0.10 Hz/s	Increments 0.01 Hz/s
Wait time for kick impulse	0.2 s to 1000.0 s	Increments 0.1 s

Voltage Balancing

Minimum control impulse	10 ms to 1000 ms	Increments 1 ms
Maximum control impulse	1.00 s to 32.00 s; ∞	Increments 0.01 s
Voltage change of the control system	0.1 V/s to 50.0 V/s	Increments 0.1 V/s
Response time of the controller	0.00 s to 32.00 s	Increments 0.01 s
Smoothing factor for the voltage	1 to 10	Increments 1
Maximum permissible overexcitation $(U/U_N)/(f/f_N)$	1.00 to 1.40	Increments 0.01

Tolerances

Minimum position impulse	10 ms
Position impulse / actuator times	5 % ± 30 ms
Other operating times	1 % or 10 ms

4.4 Undervoltage Protection (27)

Setting Ranges/Resolutions

Measured Quantity	Fundamental component of one of the undervoltage voltages connected to the measuring inputs (selectable)	
Pickup thresholds U<, U<<	10.0 V to 125.0 V	Increments 0.1 V
U<, U<< Dropout ratio	1.01 to 1.20	Increments 0.01
Time Delays T U<, T U<<	0.00 s to 60.00 s or ∞ (ineffective)	Increments 0.01 s
The set times are pure delay times.		

Operating Times

Pickup times/dropout times	approx. 55 ms at f_N = 50 Hz approx. 48 ms at f_N = 60 Hz approx. 145 ms at f_N = 16.7 Hz

Tolerances

Pickup voltages U<, U<<	1 % of setting value, or 0.5 V
Delay times T	1 % of setting value or 10 ms

Influencing Variables

Power supply DC voltage in range $0.8 \leq U_{PS}/U_{PSN} \leq 1.15$	≤ 1 %
Temperature in range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	≤ 0.5 % / 10 K
Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 1 %
Harmonics –up to 10 % 3rd harmonic –up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.5 Overvoltage Protection (59)

Setting Ranges/Resolutions

Measured quantity	Fundamental component of one of the undervoltage voltages connected to the measuring inputs (selectable)	
Pickup thresholds U>, U>>	30.0 V to 200.0 V	Increments 0.1 V
U>, U>> Dropout ratio	0.90 to 0.99	Increments 0.01
Time Delays T U>, T U>>	0.00 s to 60.00 s or ∞ (ineffective)	Increments 0.01 s
The set times are pure delay times.		

Operating Times

Pickup times/dropout times	approx. 55 ms at f_N = 50 Hz approx. 48 ms at f_N = 60 Hz approx. 145 ms at f_N = 16.7 Hz

Tolerances

Pickup voltages U<, U<<	1 % of setting value, or 0.5 V
Delay times T	1 % of setting value or 10 ms

Influencing Variables

Power supply DC voltage in range $0.8 \le U_{PS}/U_{PSN} \le 1.15$	≤ 1 %
Temperature in range –5 °C ≤ Θ_{amb}≤ 55 °C, 23 °F ≤ Θ_{amb}≤ 131 °F	≤ 0.5 % / 10 K
Frequency in range $0.95 \le f/f_N \le 1.05$	≤ 1 %
Harmonics –up to 10 % 3rd harmonic –up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.6 Frequency Protection (81)

Setting Ranges/Resolutions

Number of frequency elements	4; can be set to f> or f<	
Pickup Frequency f> or f<	40.00 Hz to 65.00 Hz at f_N = 50/60 Hz	Increments 0.01 Hz
	12.00 Hz to 20,00 Hz at f_N = 16.7 Hz	
Time Delays T f1 T f2 to T f4	 0.00 s to 600.00 s 0.00 s to 100.00 s	 Increments 0.01 s Increments 0.01 s
Undervoltage Blocking	10.0 V to 125.0 V and 0 V (no blocking)	Increments 0.1 V
The set times are pure delay times.		

Times

	f_N = 50/60 Hz	f_N = 16.7 Hz
Pickup times f>, f< Dropout Times f>, f<	approx. 100 ms approx. 150 ms	approx. 400 ms approx. 450 ms

Dropout Difference

Δf = | Pickup Value – Dropout Value |	approx. 20 mHz

Dropout Ratio

Dropout ratio for undervoltage blocking	approx. 1.05

Tolerances

Frequencies f>, f< Undervoltage blocking Time Delays T(f<, f<)	10 mHz (at $U = U_N$, $f = f_N$) 15 mHz (at $U = U_N$, $f = f_N \pm 10$ %) 1 % of setting value or 0.5 V 1 % of setting value or 10 ms

Influencing Variables

Power Supply DC Voltage in Range $0,8 \leq U_{Aux}/U_{Aux,N} \leq 1.15$	1 %
Temperature in Range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	0.5 %/10 K
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 1 % 1 %

4.7 Rate-of-Frequency Change Protection df/dt (81R)

Setting Ranges/Resolutions

Stages, can be +df/dt> or –df/dt	4	
Pickup values df/dt	0.1 to 10 Hz/s and ∞ (ineffective)	Increments 0.1 Hz/s
Delay times T	0.00 to 60.00 s or ∞ (ineffective)	Increments 0.01 s
Undervoltage blocking U_{MIN}	10.0 to 125.0 V	Increments 0.1 V
Length of the measuring window	1 to 25 cycles	Increments 1 cycle
Dropout Difference Δf/dt	0.02 to 0.99 Hz/s	Increments 0.01 Hz/s

Times

Pickup and Dropout Time df/dt	approx. 200 s to 700 ms at f_N = 50/60 H (dep. on window frequency and length)
	approx. 600 s to 2100 ms at f_N = 16.7 Hz (dep. on window frequency and length)

Dropout Ratio

Dropout ratio U_{MIN}	Approx. 1.05

Tolerances

Frequency Rise	
–Measuring Window < 5	Approx. 5 % or 0.15 Hz/s at U > 0,5 U_N
– Measuring Window ≥ 5	Approx. 3 % or 0.1 Hz/s at U > 0,5 U_N
Undervoltage Blocking	1 % of setting value or 0.5 V
Delay Times	1 % or 10 ms

Influencing Variables for Pickup Values

Power Supply DC Voltage in Range 0,8 ≤ $U_{Aux}/U_{Aux,N}$ ≤ 1.15	≤ 1 %
Temperature in Range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	≤ 0.5 % / 10 K
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.8 Vector Jump

Setting Ranges/Resolutions

Angle jump $\Delta\varphi$	2° to 30°	Increments 1°
Delay Time $T_{\Delta\varphi}$ Inhibit time $T_{INHIBIT}$	0.00 to 60.00 s or ∞ ineffective	Increments 0.01 s
Reset Time T_{Reset}	0.10 to 60.00 s or ∞ ineffective	Increments 0.01 s
Minimum voltage U_{MIN}	10.0 to 125.0 V	Increments 0.1 V
Maximum voltage U_{MAX}	10.0 to 170.0 V	Increments 0.1 V

Times

	f_N = 50/60 Hz	f_N = 16.7 Hz
Pickup times $\Delta\varphi$	approx. 75 ms	approx. 200 ms
Dropout times $\Delta\varphi$	approx. 75 ms	approx. 200 ms

Dropout Ratios

–	–

Tolerances

Angle Jump	0.5° at U > 0.5 U_N
Undervoltage Blocking	1 % of setting value or 0.5 V
Delay times T	1 % or 10 ms

Influencing Variables

Power Supply DC Voltage in Range $0,8 \leq U_{Aux}/U_{Aux,N} \leq 1.15$	≤ 1 %
Temperature in Range 23.00 °F (–5 °C) ≤ Θ_{amb} ≤ 131.00 °F (55 °C)	≤ 0.5 % / 10 K
Frequency in Range $0.95 \leq f/f_N \leq 1.05$	≤ 1 %
Harmonics - Up to 10 % 3rd harmonic - Up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.9 Threshold Supervision

Setting Ranges/Resolutions

Number of increments	6 (3 higher and 3 lower)	
Measured Quantity:	U_a, U_b, U_c, U_d, U_e, U_f (selectable)	
Setting range	2 % to 200 %	Increments 1 %

Times

Pickup and Dropout Time	approx. 25 s to 55 ms at f_N = 50/60 Hz
Drop-off times	approx. 70 s to 145 ms at f_N = 16.7 Hz

Dropout ratio

Dropout ratio	0.95 or 1 % or 1.05 or 1 %

Tolerances

Pickup voltages	1 % of setting value, or 0.5 V
Delay times T	1 % of setting value or 10 ms

Influencing variables

Power supply DC voltage in range $0.8 \leq U_{PS}/U_{PSN} \leq 1.15$	≤ 1 %
Temperature in range $-5\ °C \leq \Theta_{amb} \leq 55\ °C$	≤ 0.5 % / 10 K
Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 1 %
Harmonics –up to 10 % 3rd harmonic –up to 10 % 5th harmonic	 ≤ 1 % ≤ 1 %

4.10 Coupling of External Tripping via Binary Inputs

Setting Ranges/Resolutions

Number of binary couplings	4	
Delay Time $T_{delay\ time}$	0.00 s to 60.00 s or ∞ (ineffective)	Increments 0.01 s

Times

Pickup times	approx. 20 ms
Drop-off times	approx. 20 ms

Tolerances

Delay times T	1 % of setting value or 10 ms

Influencing variables

Power supply DC voltage in range $0.8 \leq U_{PS}/U_{PSN} \leq 1.15$	≤ 1 %
Temperature in range $-5\ °C \leq \Theta_{amb} \leq 55\ °C$	≤ 0.5 % / 10 K
Frequency in range $0.95 \leq f/f_N \leq 1.05$	≤ 1 %

4.11 User-defined functions (CFC)

Function Modules and Possible Assignments to Task Levels

Function module	Explanation	Run-time level			
		MW_ PROC	PLC1_ PROC	PLC_ PROC	SFS_ PROC
ABSVALUE	Magnitude calculation	X	—	—	—
ADD	Addition	X	X	X	X
AND	AND–Gate	—	X	X	X
BOOL_TO_CO	Boolean to command, (conversion)	—	X	X	—
BOOL_TO_DI	Boolean to double point indication (conversion)	—	X	X	X
BOOL_TO_IC	Boolean to internal single point indication (conversion)	—	X	X	X
BUILD_DI	Create double point indication	—	X	X	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
DI_TO_BOOL	Double point indication to Boolean (conversion)	—	X	X	X
DIV	Division	X	—	—	—
DM_DECODE	Decode double point indication	X	X	X	X
DYN_OR	Dynamic Or	X	X	X	X
LIVE_ZERO	Live–zero monitoring, non-linear characteristic	X	—	—	—
LONG_TIMER	Timer (max. 1193 h)	X	X	X	X
LOOP	Signal feedback	—	X	—	—
LOWER_SETPOINT	Lower limit	X	—	—	—
MUL	Multiplication	X	—	—	—
NAND	NAND-gate	—	X	X	X
NEG	Negator	—	X	X	X
NOR	NOR NOR-gate	—	X	X	X
OR	OR-gate	—	X	X	X
RS_FF	RS-Flipflop	—	X	X	X
SQUARE_ROOT	Root extractor	X	—	—	—
SR_FF	SR-Flipflop	—	X	X	X
SUB	Subtraction	X	—	—	—
TIMER	universal timer	—	X	X	—
UPPER_SETPOINT	Upper limit	X	—	—	—
X_OR	XOR-gate	—	X	X	X
ZERO_POINT	Zero suppression	X	—	—	—

General Limits

Description	Limit	Comments
Maximum number of all CFC charts considering all task levels	32	When the limit is exceeded, the device rejects the parameter set with an error message, restores the last valid parameter set and performs a new startup with it.
Maximum number of all CFC charts considering one task level	16	When the limit is exceeded, an error message is output by the device and the device is put into monitoring mode. The red ERROR-LED lights up.
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 starts monitoring. The red ERROR-LED lights up.
Maximum number of reset-resistant flipflops D_FF_MEMO	350	When the limit is exceeded, an error message is output by the device and the device is put into monitoring mode. The red ERROR-LED lights up.

Device-specific Limits

Description	Limit	Comments
Maximum number of synchronous changes of chart inputs per task level	165	When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.
Maximum number of chart outputs per task level	150	

Additional Limits

Additional Limits [1] for the following CFC blocks		
Task Level	**Maximum Number of Modules in the Task Levels**	
	TIMER[2] [3]	TIMER_SHORT[2] [3]
MW_BEARB	—	—
PLC1_BEARB 15		30
PLC_BEARB		
SFS_BEARB —		—

1) When the limit is exceeded, an error message is output by the device. Consequently, the device starts monitoring. The red ERROR-LED lights up.

2) For the maximum number of timers that can be used, the following constraint applies: (2 · number of TIMERs + number of TIMER_SHORTs) < 30. TIMER and TIMER_SHORT thus share the available timer resources in the framework of this inequality. The LONG_TIMER is not subject to this limit.

3) The time values for the blocks TIMER and TIMER_SHORT must not be smaller than the time resolution of the device, i.e. 10 ms, otherwise the blocks will not start with the start pulse.

Maximum number of TICKS in the task levels

Task Level	Limit in TICKS [1]
MW_BEARB (Measured Value Processing)	10000
PLC1_BEARB (Slow PLC processing)	2000
PLC_BEARB (Fast PLC Processing)	400
SFS_BEARB (Interlocking)	10000

[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

Individual 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
Arithmetic	ABS_VALUE	5
	ADD	26
	SUB	26
	MUL	26
	DIV	54
	SQUARE_ROOT	83
Basis logic	AND	5
	CONNECT	4
	DYN_OR	6
	NAND	5
	NEG	4
	NOR	5
	OR	5
	RISE_DETECT	4
	X_OR	5
Information status	SI_GET_STATUS	5
	CV_GET_STATUS	5
	DI_GET_STATUS	5
	MV_GET_STATUS	5
	SI_SET_STATUS	5
	DI_SET_STATUS	5
	MV_SET_STATUS	5
	ST_AND	5
	ST_OR	5
	ST_NOT	5

Individual Element		Number of TICKS
Memory	D_FF	5
	D_FF_MEMO	6
	RS_FF	4
	RS_FF_MEMO	4
	SR_FF	4
	SR_FF_MEMO	4
Control commands	BOOL_TO_CO	5
	BOOL_TO_IC	5
	CMD_INF	4
	CMD_CHAIN	34
	CMD_CANCEL	3
	LOOP	8
Type converter	BOOL_TO_DI	5
	BUILD_DI	5
	DI_TO_BOOL	5
	DM_DECODE	8
	DINT_TO_REAL	5
	DIST_DECODE	8
	UINT_TO_REAL	5
	REAL_TO_DINT	10
	REAL_TO_UINT	10
Comparison	COMPARE	12
	LOWER_SETPOINT	5
	UPPER_SETPOINT	5
	LIVE_ZERO	5
	ZERO_POINT	5
Metered value	COUNTER	6
Time and cycle	TIMER	5
	TIMER_LONG	5
	TIMER_SHORT	8
	ALARM	21
	FLASH	11

4.12 Additional Functions

Operational Measured Values

Operational measured values for voltages	U_a, U_b, U_c, U_d, U_e, U_f in V secondary,
Range	10 % to 120 % of U_N
Tolerance	0.2 % of measured value, or ±0.2 V ±1 digit
Power Angle	$\Delta\alpha$
Range	–180° to +180°
Tolerance	0,5°
Range	8 $^1/_2$ digits (28 Bit) for VDEW protocol 9 $^1/_2$ digits (31 Bit) in the unit
Tolerance	1 % ± 1 Digit
Operating measured values for frequency	f1, f2, Δf in Hz
Range	40 Hz < f < 65 Hz at f_N = 50/60 Hz 12 Hz < f < 20 Hz at f_N = 16,7 Hz
Tolerance	10 mHz (at U = U_N , f = f_N ± 10 %)

Analog Outputs (optional)

Quantity	Max. 2
possible measured values	ΔU; Δf; Δα of the synchronism function in % IΔUI; IΔfI; IΔαI of the synchronism function in % U1 of the synchronism function in % U2 of the synchronism function in % f1 of the synchronism function in Hz f2 of the synchronism function in Hz
Range	0.0 mA to 22.5 mA or 4.0 mA to 22.5 mA
Minimum limits(valid from:)	0.0 mA to 5.0 mA (increments 0.1 mA)
Maximum Threshold	22.0 mA (fixed)
Configurable reference value 20 mA	10.0 % to 1.000.0 % (0.1 % increments)

Local Measured Values Monitoring

Voltage Sums	U1 +(–$\overline{U1}$) = 0 U2 +(–U2) = 0
Voltage Phase Sequence	Clockwise (L1L2L3)/ counter-clockwise (L1L3L2)

Fault Event Recording

Indications memory for the last 8 fault cases (max. 600 indications)

Operational Messages (Buffer: Event Log)

Maximal memorization of 200 messages, time resolution 1 ms

Time Allocation

Resolution for Event Log (Operational Indications)	1 ms
Resolution for Fault Log (Fault Indications)	1 ms
Maximum Time Deviation (Internal Clock)	0.01 %
Battery	Lithium battery 3 V/1 Ah, type CR 1/2 AA "Flt. Battery" on low battery charge

Fault Recording

Number of slides	Maximum 8 fault records saved by buffer battery also through auxiliary voltage failure
Instantaneous values:	
Recording time	total 10 s Pre-event and post-event recording and memory time adjustable
Scanning rate with 50 Hz Scanning rate with 60 Hz	1 sample/1 ms each 1 sample/0.83 ms each
Channels	U_a, U_b, U_c, U_d, U_e, U_f $U_d – U_a$ $U_e – U_b$ $U_f – U_C$ ΔU Δfa $\Delta\alpha$
RMS values:	
Recording time	total 100 s Pre-event and post-event recording and memory time adjustable
Scanning rate with 50 Hz Scanning rate with 60 Hz	1 sample/10 ms 1 sample/8.33 ms
Channels	U1, U2, f1, f2, ΔU, Δf and $\Delta\alpha$

Statistics

Stored number of trips via protection	up to 9 digits
Number of Closures	up to 9 digits

Operating Hours Counter

Criterion	
Countering	up to 6 digits

Commissioning Aids

	Phase Rotation Field Check Operational measured values Switching device test Creation of a Test Measurement Report

Clock

Time Synchronization	DCF 77/ IRIG B-Signal (telegram format IRIG-B000) Binary Inputs Communication
Deviation of the time synchronization	approx. 3 ms

Group Switchover of the Function Parameters

Number of Available Setting Groups	4 (parameter group A, B, C and D)
Switchover Performed	Using the keypad DIGSI using the front PC port with protocol via system (SCADA) interface Binary Input

4.13 Dimensions

4.13.1 Panel Flush and Cubicle Mounting (Housing Size $^1/_3$)

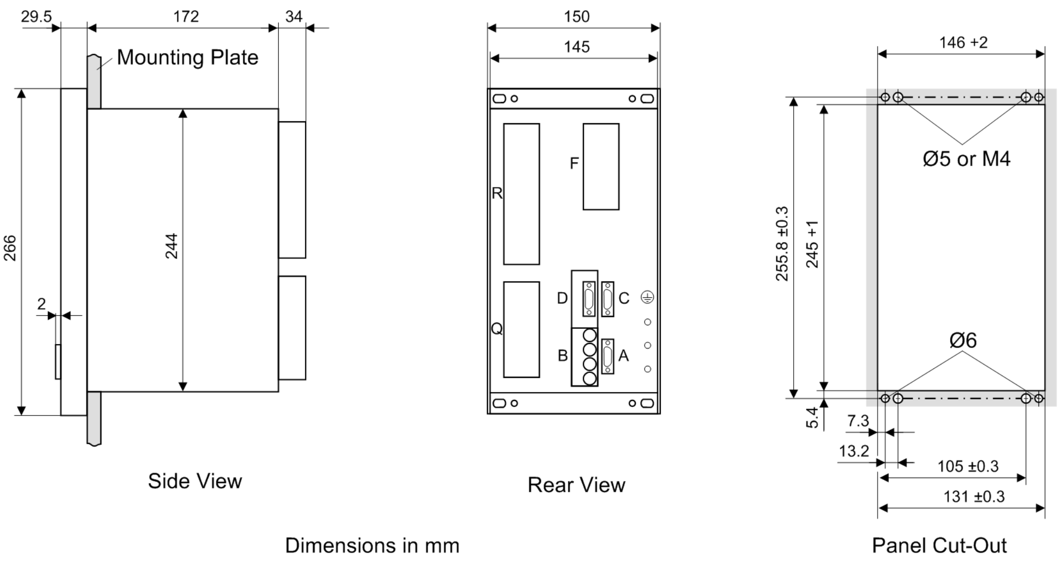


Figure 4-1 Dimensions of a device for panel flush mounting or cubicle installation (size $^1/_3$)

4.13.2 Panel Flush and Cubicle Mounting (Housing Size $^1/_2$)

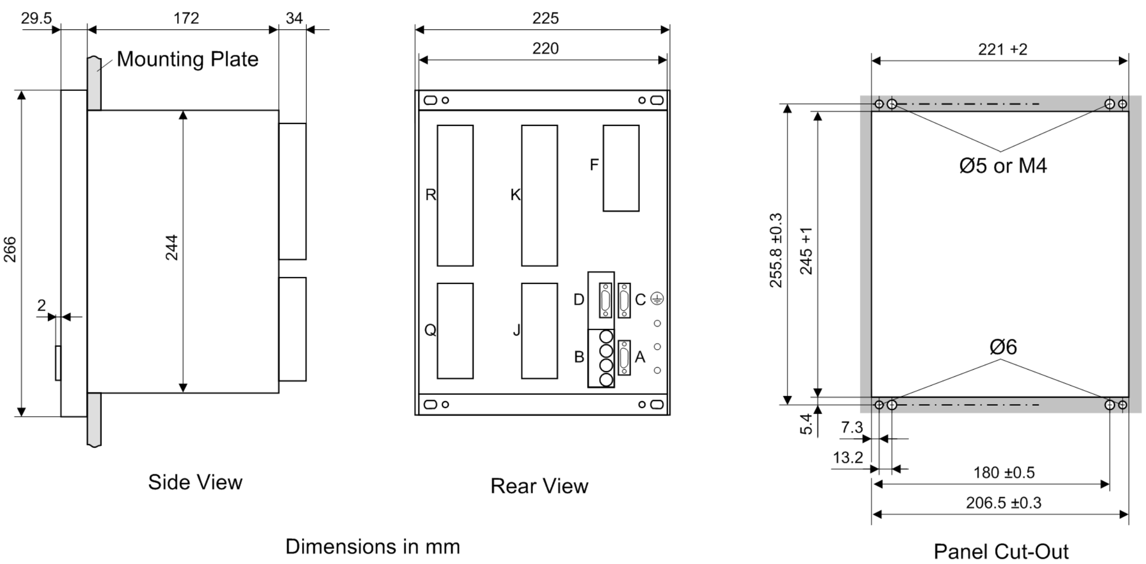


Figure 4-2 Dimensions of a device for panel flush mounting or cubicle installation (size $^1/_2$)

4.13.3 Panel Flush Mounting (Housing Size $^1/_3$)

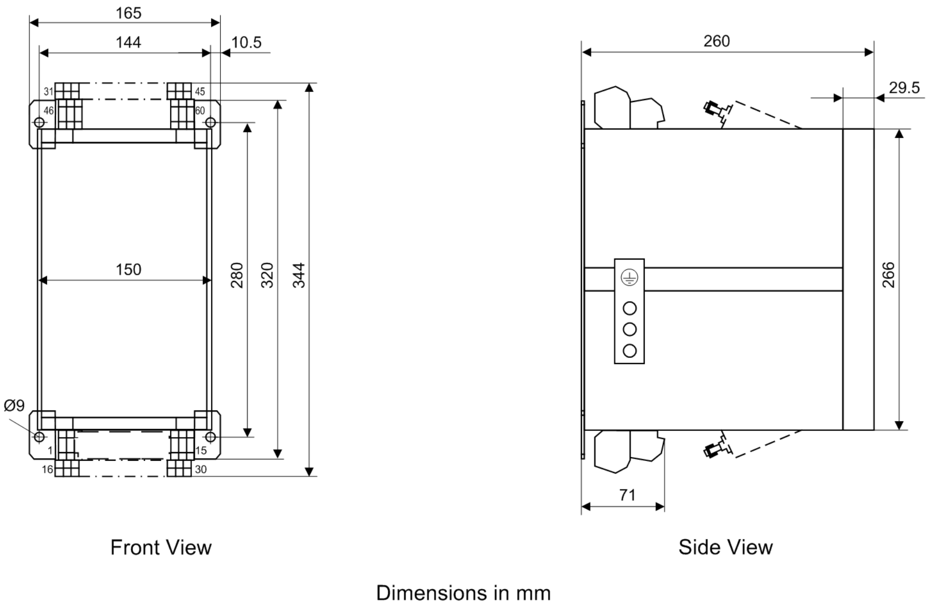


Figure 4-3 Dimensions of a device for panel surface mounting (size $^1/_3$)

4.13.4 Panel Flush Mounting (Housing Size $^1/_2$)

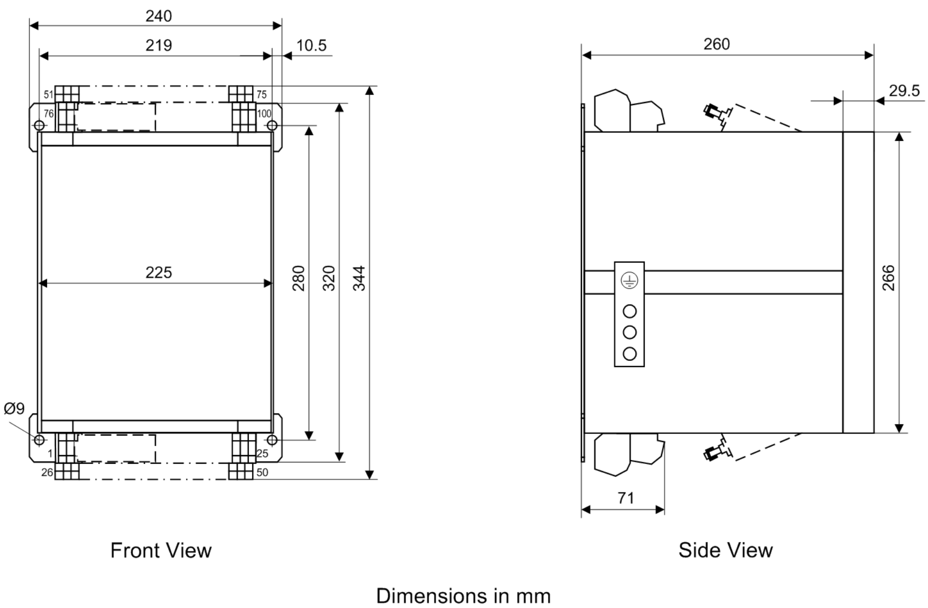


Figure 4-4 Dimensions of a device for panel surface mounting (size $^1/_2$)

■

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 7VE61

						6	7		8	9	10	11	12		13	14	15	16		Supplemen-tary		
Multifunctional Paralleling Device	7	V	E	6	1			—						—	0				+			

Housing, Binary Inputs and Outputs	Position 6
Housing $^1/_3$ 19”, 6 BI, 9 BO, 1 live status contact	1

Nominal Device Current	Position 7
without	0

Auxiliary Voltage (Power Supply, Pickup Threshold of Binary Inputs)	Position 8
24 to 48 VDC, Binary Input Threshold 17°VDC [2)]	2
60 to 125 VDC [1)], Binary Input Threshold 19 VDC [2)]	4
110 to 250 VDC [1)], 115 to 230 VAC, Binary Input Threshold 88 VDC [2)]	5
220 to 250 VDC [1)], 115 to 230 VAC, Binary Input Threshold 176 VDC [2)]	6

Construction	Position 9
Surface-mounting case for panel, 2-tier terminals top / bottom	B
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E

Region-specific default / language settings and function versions	Position 10
Region DE, 50 Hz, IEC, German Language (language can be changed)	A
Region World, 50 / 60 Hz, IEC / ANSI, Language English (language can be changed)	B
Region US, 60 Hz, ANSI, American English Language (language can be changed)	C
Region World, 50 / 60 Hz, IEC / ANSI, Spanish Language (language can be changed)	E

1) with plug-in jumper one of the 2 voltage ranges can be selected
2) for each binary input the pickup threshold ranges are interchangeable via plug-in jumpers

System interfaces (Port B)	Position 11
None	0
System port, IEC protocol, electrical RS232	1
System port, IEC protocol, electrical RS485	2
System port, IEC protocol, optical 820 nm, ST-connector 820 nm	3

System interfaces (Port B)	Position 11
Analog Outputs 2 x 0 to 20 mA or 4 to 20 mA	7
For further protocols see Additional Information in the following **L**	9

Additional information L for further protocols (port B)	Supple-mentary
System port, Profibus DP slave, electrical RS485	+ L 0 A
System port, Profibus DP slave, optical 820 nm, twin ring, ST-connector [1]	+ L 0 B
System port, Modbus RTU, electrical RS485	+ L 0 D
System port, Modbus RTU, optical 820 nm, twin ring, ST-connector [1]	+ L 0 E
System Port, DNP 3.0, electrical RS485	+ L 0 G
System Port, DNP 3.0, optical 820 nm, ST-connector [1]	+ L 0 H
IEC 61850, electrical with EN100, with RJ45-connector	+L 0 R
IEC 61850, optical with EN100, with ST-connector [2]	+L 0 S

1) If the 9th position is = „B“ (panel surface mounting), then the device must be ordered with the RS485–Interface and a separate Optical Fibre-converter

2) Cannot be delivered in connection with 9th digit = B. Only EN100 electrical possible (see Table A-1)

For surface mounting cases optical interfaces are not possible. In this case, please order a device with the appropriate electrical RS485 interface, and the additional converters listed in Table .

Table A-1 Additional device/module for surface-mounted case

Protocol	Converter/ Module	Order Number	Comments
Profibus DP	SIEMENS OLM[1]	6GK1502-2CB10	for single ring
		6GK1502-3CB10	for twin ring
Modbus	RS485/FO	7XV5651-0BA00	–
DNP 3.0 820 nm	RS485/FO		

1) The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810-0BA00 is required.

Port C (Service Interface)	Position 12
DIGSI / Modem, electrical RS232	1
DIGSI / Modem, electrical RS485	2
For further interface options see Additional Information **M**	9

Additional Information M, Service and Additional Interface (Port C and Port D) (Port C , Service Interface)	
DIGSI 4, Modem RS232	+M 1 *
DIGSI 4, Modem RS485	+M 2 *
(Port D, Additional Interface)	
Analog Outputs 2 x 0 to 20 mA or 4 to 20 mA	+M * K

Functional Scope of the Device	Position 14
Synchrocheck for up to 3 synchronizing points (with switching to dead line / bus)	A
Paralleling function for 2 synchronizing points without balancing commands ($1^{1}/_{2}$-channel – Synchrocheck in the 2nd channel)	B
Paralleling function for 2 synchronizing points with balancing commands ($1^{1}/_{2}$-channel – Synchrocheck in the 2nd channel)	C
Paralleling function for 4 synchronizing points with balancing commands ($1^{1}/_{2}$-channel – Synchrocheck in the 2nd channel)	D

Additional Functions	Position 15
without	A
Protection and Network Decoupling Function (Voltage and frequency protection, rate-of-frequency change protection and vector jump)	B

Additional Applications	Position 16
without	0
Application for Traction Systems (f_N = 16.7 Hz)	1

A.1.1.2 7VE63

						6	7		8	9	10	11	12		13	14	15	16		Supplemen-tary		
Multifunctional Paralleling Device	7	V	E	6	3			—						—	0				+			

Housing, Binary Inputs and Outputs	Position 6
Housing $^{1}/_{2}$ 19”, 14 BI, 17 BO, 1 Live Status Contact	2

Nominal Device Current	Position 7
without	0

Auxiliary Voltage (Power Supply, Pickup Threshold of Binary Inputs)	Position 8
24 to 48 VDC, Binary Input Threshold 19°VDC [2]	2
60 to 125 VDC [1], Binary Input Threshold 19 VDC [2]	4
110 to 250 VDC [1], 115 to 230 VAC, Binary Input Threshold 88 VDC [2]	5
220 to 250 VDC [1], 115 to 230 VAC, Binary Input Threshold 176 VDC [2]	6

Construction	Position 9
Surface-mounting case for panel, 2-tier terminals top / bottom	B
Flush mounting case, screw-type terminals (direct connection / ring and spade lugs)	E

Region-specific default / language settings and function versions	Position 10
Region DE, 50 Hz, IEC, German Language (language can be changed)	A
Region World, 50 / 60 Hz, IEC / ANSI, Language English (language can be changed)	B
Region US, 60 Hz, ANSI, American English Language (language can be changed)	C
Region World, 50 / 60 Hz, IEC / ANSI, Spanish Language (language can be changed)	E

1) with plug-in jumper one of the 2 voltage ranges can be selected
2) for each binary input the pickup threshold ranges are interchangeable via plug-in jumpers

System interfaces (Port B)	Position 11
None	0
System port, IEC protocol, electrical RS232	1
System port, IEC protocol, electrical RS485	2
System port, IEC protocol, optical 820 nm, ST-connector	3
Analog Outputs 2 x 0 to 20 mA (4 to 20 mA)	7
For further protocols see Additional Information in the following **L**	9

Additional information L for further protocols (port B)	Supple-mentary
System port, Profibus DP slave, electrical RS485	+ L 0 A
System port, Profibus DP slave, optical 820 nm, twin ring, ST-connector [1)]	+ L 0 B
System port, Modbus RTU, electrical RS485	+ L 0 D
System port, Modbus RTU, optical 820 nm, twin ring, ST-connector [1)]	+ L 0 E
System Port, DNP 3.0, electrical RS485	+ L 0 G
System Port, DNP 3.0, optical 820 nm, ST-connector [1)]	+ L 0 H
IEC 61850, electrical with EN100, with RJ45-connector	+L 0 R
IEC 61850, optical with EN100, with ST-connector [2)]	+L 0 S

1) if the 9. position is = „B“ (panel surface mounting), then the device must be ordered with the RS485–Interface and a separate Optical Fibre-converter
2) Cannot be delivered in connection with 9th digit = B. Only EN100 electrical possible (see Table A-2)

For surface mounting cases optical interfaces are not possible. In this case, please order a device with the appropriate electrical RS485 interface, and the additional converters listed in Table .

Table A-2 Additional Device/Module for Surface-mounted Case

Protocol	Converter/ Module	Order Number	Comments
Profibus DP	SIEMENS OLM[1)]	6GK1502-2CB10	for single ring
		6GK1502-3CB10	for twin ring
Modbus	RS485/FO	7XV5651-0BA00	–
DNP 3.0 820 nm	RS485/FO		

1) The converter requires an operating voltage of 24 VDC. If the available operating voltage is > 24 VDC the additional power supply 7XV5810-0BA00 is required.

Port C (Service Interface)	**Position 12**
DIGSI / Modem, electrical RS232	1
DIGSI / Modem, electrical RS485	2
For further interface options see Additional Information **M**	9

Additional Information M, Service and Additional Interface (Port C and Port D)	
(Port C , Service Interface)	
DIGSI 4, Modem RS232	+M 1 *
DIGSI 4, Modem RS485	+M 2 *
(Port D, Additional Interface)	
Analog Outputs 2 x 0 to 20 mA or 4 to 20 mA	+M * K

Functional Scope of the Device	**Position 14**
Synchrocheck for up to 3 synchronizing points (with switching to dead line / bus)	A
Paralleling function for 2 synchronizing points without balancing commands (2 channels – independent procedures)	B
Paralleling function for 2 synchronizing points with balancing commands (2 channels – independent procedures)	C
Paralleling function for 8 synchronizing points with balancing commands (2 channels – independent procedures)	D

Additional Functions	**Position 15**
without	A
Protection and Network Decoupling Function (Voltage and frequency protection, rate-of-frequency change protection and vector jump)	B

Additional Applications	**Position 16**
without	0
Application for Traction Systems (f_N = 16.7 Hz)	1

A.1.2 Accessories

Replacing interface modules

Name	Order number
RS232	C53207-A351-D641-1
RS485	C73207-A351-D642-1
FO 820 nm	C53207-A351-D643-1
Profibus DP RS485	C53207-A351-D611-1
Profibus DP double ring	C53207-A351-D613-1
Modbus RS485	C53207-A351-D621-1
Modbus opt. 820 nm	C53207-A351-D623-1
DNP 3.0 RS485	C53207-A351-D631-1
DNP 3.0 820 nm	C53207-A351-D633-1
Ethernet electrical (EN100)	C53207-A351-D675-1
Ethernet optical (EN100)	C53207-A322-B150-1

Terminal Block Covering Caps

Covering cap for terminal block type	Order number
18-pin voltage terminal, 12-current terminal	C73334-A1-C31-1
12 terminal voltage, 8 terminal current block	C73334-A1-C32-1

Short-Circuit Links

Short circuit links for terminal block type	Order number
Voltage connections (18 terminal or 12 terminal)	C73334-A1-C34-1
Current connections (12 terminal or 8 terminal)	C73334-A1-C33-1

Connector Type

Connector Type	Order number
2-pin	C73334-A1-C35-1
3-pin	C73334-A1-C36-1

Mounting Rail for 19"- Racks

Name	Order number
Angle strip (mounting rail)	C73165-A63-C200-3

Battery

Lithium battery 3 V/1 Ah, type CR 1/2 AA	Order number
VARTA	6127 101 501

Interface Cable

Interface cable between PC and SIPROTEC device	Order number
Cable with 9-pole male / female connector	7XV5100–4

Operating Software DIGSI 4

DIGSI 4 Protection Operation and Configuration Software	Order number
DIGSI 4, basic version with licenses for 10 PCs	7XS5400-0AA00
DIGSI 4, complete version with all option packages	7XS5402-0AA0

Graphical Analysis Program SIGRA

SIGRA Evaluation Program	Order number
Full version with license for 10 PCs	7XS5410-0AA0

Graphic Tools

Graphic Tools 4	Order number
Full version with license for 10 PCs	7XS5430-0AA0

DIGSI REMOTE 4

Software for remotely operating protective devices via a modem (and possibly a star connector) using DIGSI 4 (optional package of the complete version of DIGSI 4)	Order number
DIGSI REMOTE 4; Full version with license for 10 PCs; Language: German	7XS5440-1AA0

SIMATIC CFC 4

Graphical software for setting interlocking (latching) control conditions and creating additional functions (optional package of the complete version of DIGSI 4)	Order number
SIMATIC CFC 4; Full version with license for 10 PCs	7XS5450-0AA0

A.2 Terminal Assignments

A.2.1 Housing for Panel Flush and Cubicle Mounting

7VE61–*E**

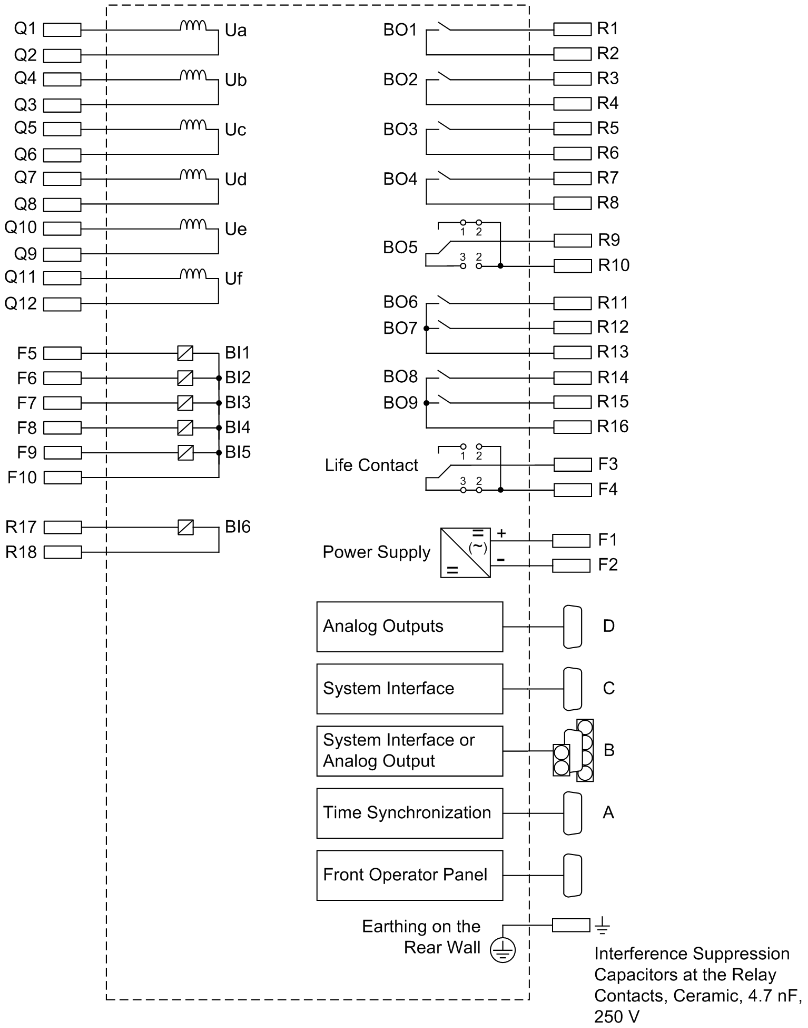


Figure A-1 General diagram for 7VE61**-*E (panel flush mounted or cubicle mounted)

7VE63**-*E

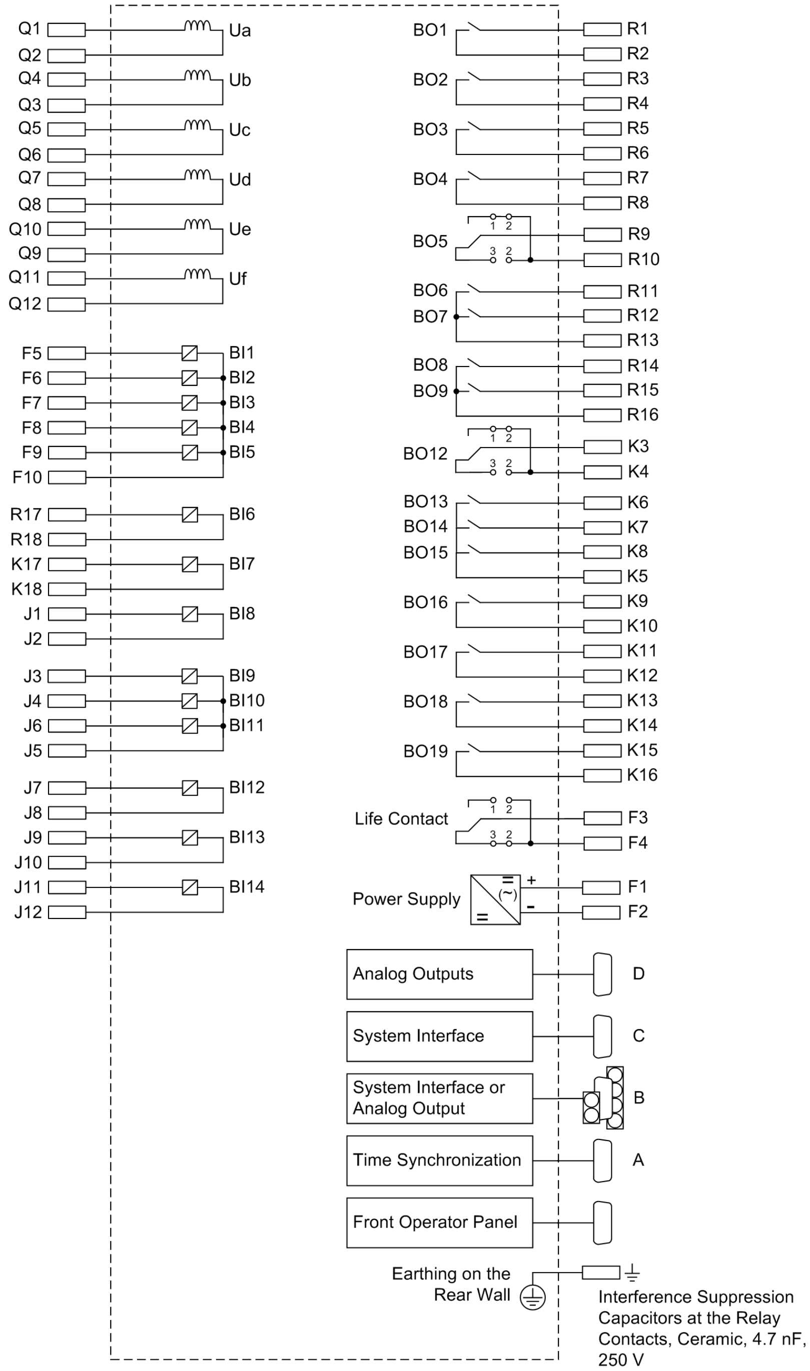


Figure A-2 General diagram of a 7VE63**-*E (panel flush mounted or cubicle mounted)

A.2.2 Housing for Panel Surface Mounting

7VE61–*B**

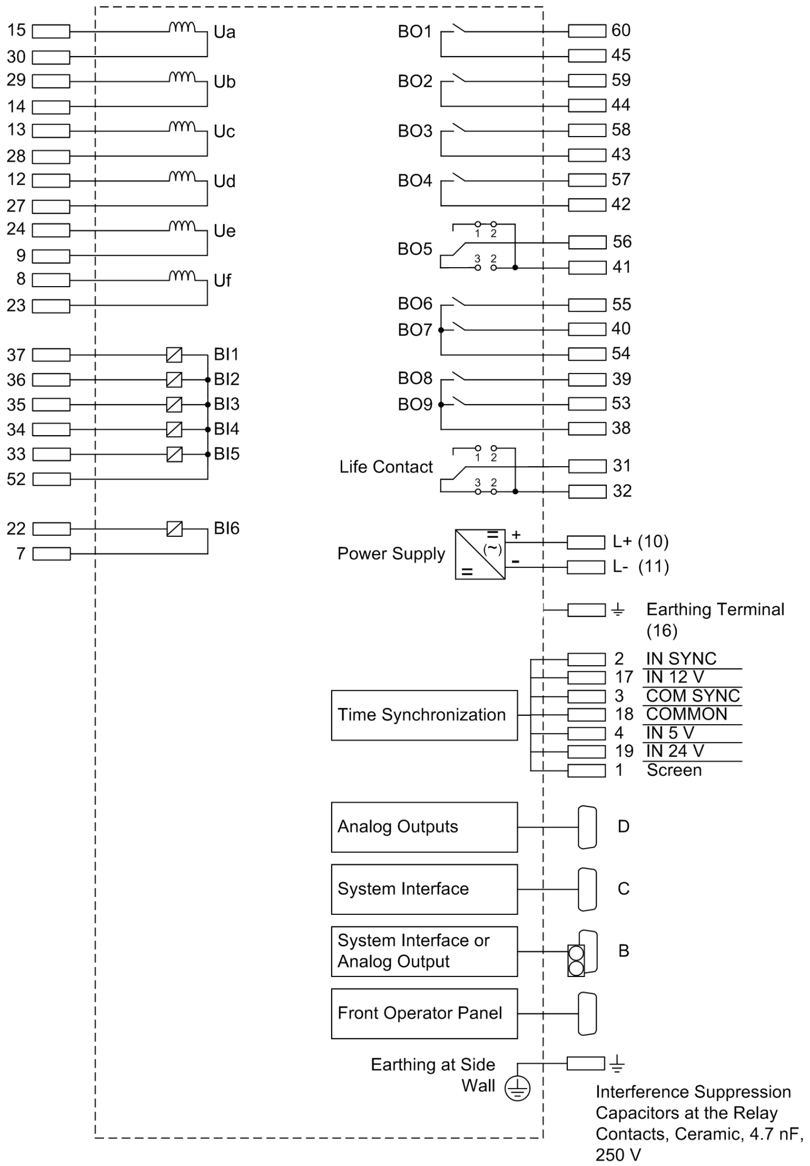


Figure A-3 General diagram of a 7VE61**-B (panel surface mounting)

7VE63-*B**

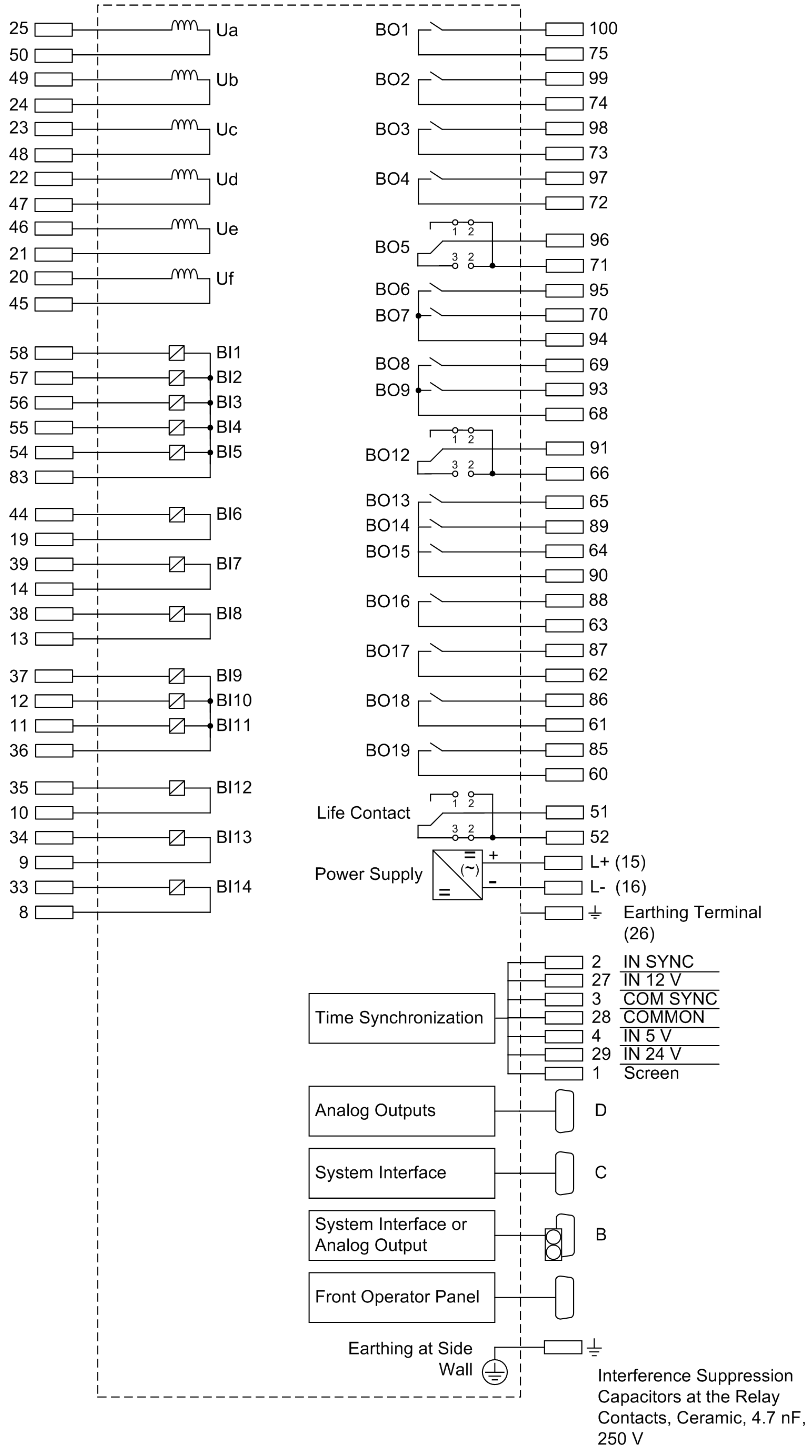


Figure A-4 General diagram of a 7VE63**-*B (panel surface mounting)

A.2.3 Assignment of the D-subminiature Connectors

to the interfaces

Pin no.	Operating Interface	RS232	RS485	Profibus FMS Slave, RS485 Profibus DP Slave, RS485	Modbus, RS485 DNP3.0, RS485
1		Shield (electrically connected with shield end)			
2	RxD	RxD	—	—	—
3	TxD	TxD	A/A’ (RxD/TxD-N)	B/B’ (RxD/TxD-P)	A
4	—	—	—	CNTR-A (TTL)	RTS (TTL level)
5	GND	GND	C/C’ (GND)	C/C’ (GND)	GND1
6	—	—	—	+5 V (max. load <100 mA)	VCC1
7	RTS	RTS	—*)	—	—
8	CTS	CTS	B/B’ (RxD/TxD-P)	A/A’ (RxD/TxD-N)	B
9	—	—	—	—	—

*) Pin 7 also carries the RTS signal with RS232 level when operated as RS485 interface.
Pin 7 must therefore not be connected!

On 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	—*)	—*)
5	Screen	Screen Potential
6	—	—
7	P12_TSIG	Input 12 V
8	P_TSYNC*)	Input 24 V*)
9	Screen	Screen Potential

*) assigned, but not available

A.3 Connection Examples

A.3.1 7VE61 complete connection examples

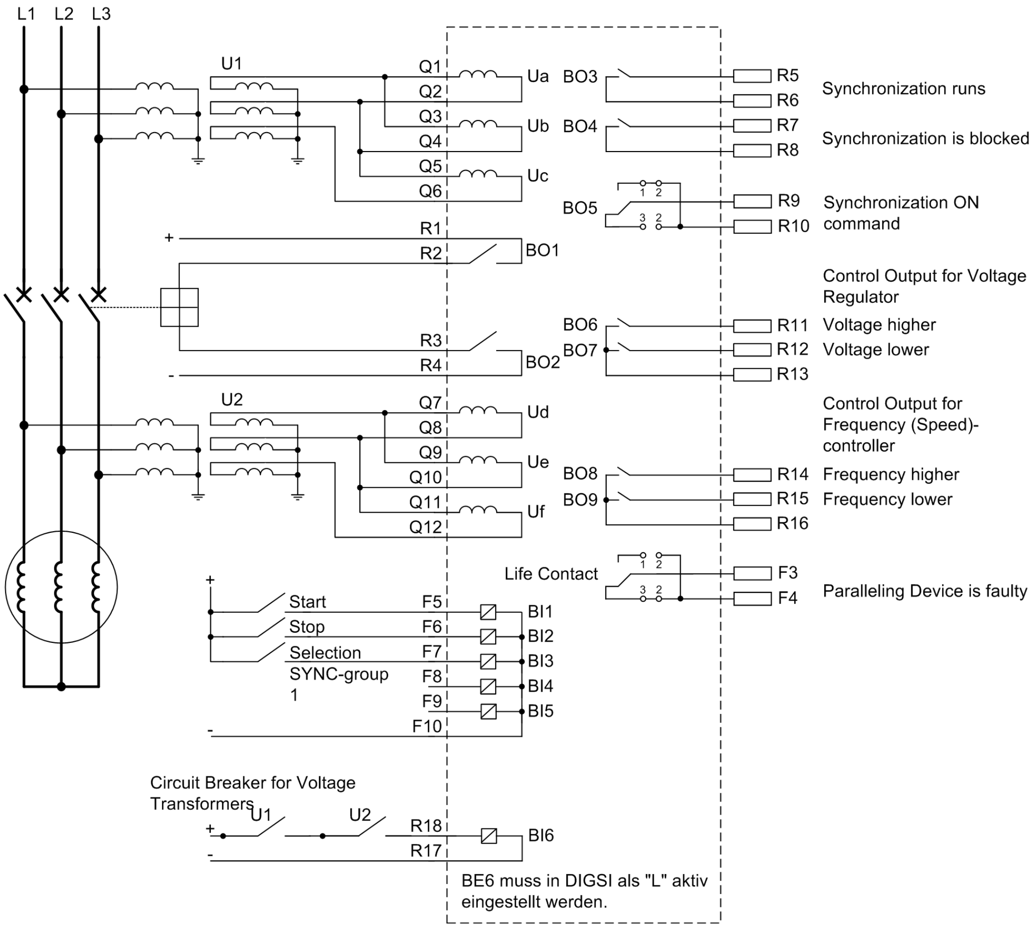


Figure A-5 Connection circuit for the synchronization of a generator — Example 7VE61**-*E in flush mounted case

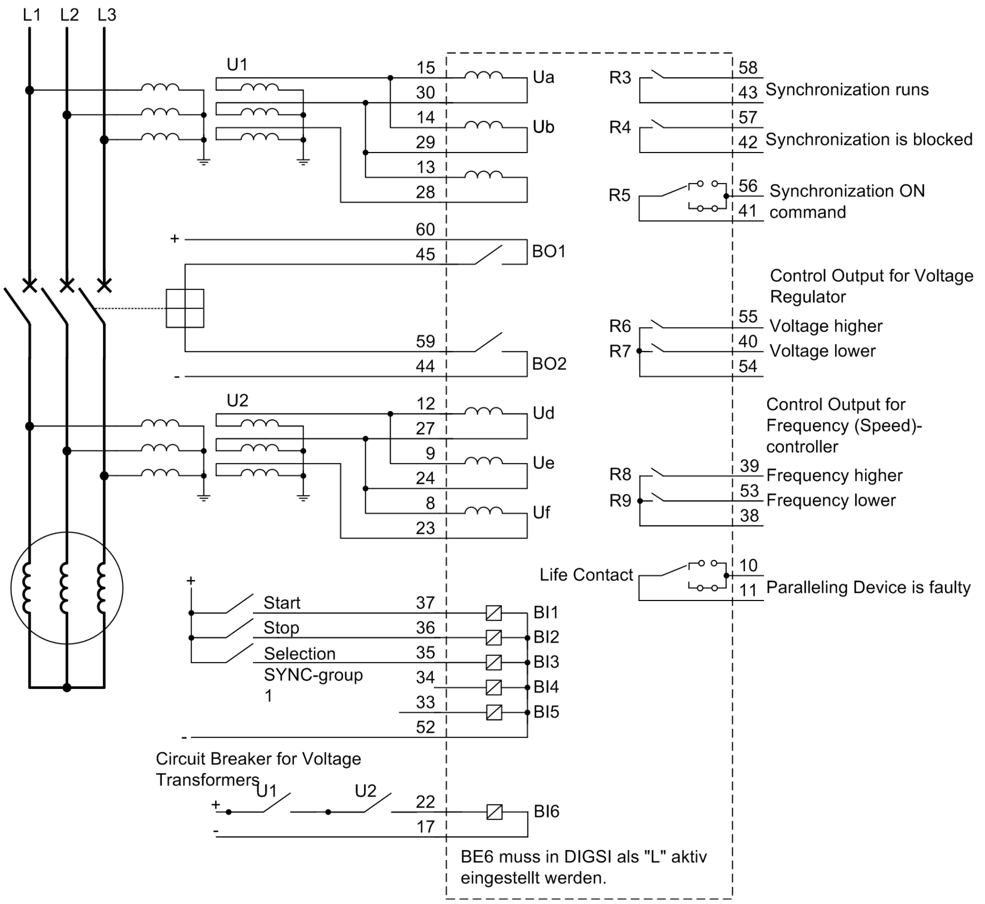


Figure A-6 Connection circuit for the synchronization of a generator — Example 7VE61**-*E in surface mounting case (panel surface mounting)

A.3.2 Voltage Connectors

If three-phase voltage transformers are available, the following connection is recommended. It represents the standard connection, because it offers a high measuring for the paralleling function. So it is additionally queried the phase rotation check, and when connecting to a dead bus several voltages are checked, so that an interruption in the voltage connection cannot lead to an unwanted operation.

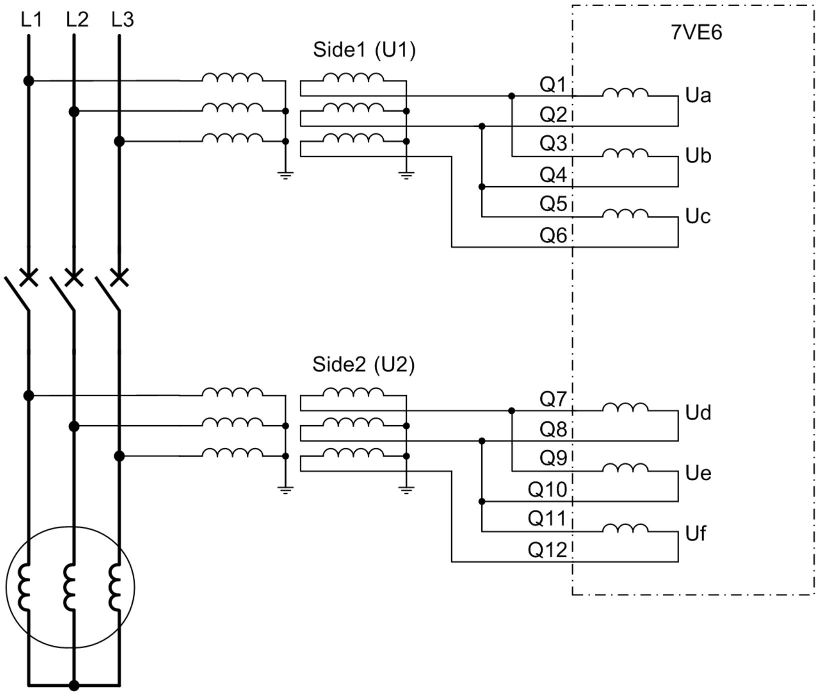


Figure A-7 Connection to a three-phase voltage transformer – standard connection

If plant conditions of the voltage transformers connected in open delta connection (V-connection) are available, it is recommended the following connection. In terms of electricity, there is no difference for the synchronization function to be connected to a three-phase voltage transformer. Essentially, it is also possible a mixed connection. On the one side three-phase isolated voltage transformer and on the other side V-connection. If synchroscope is additionally connected, it is necessary a galvanically isolation via an interposing transformer.

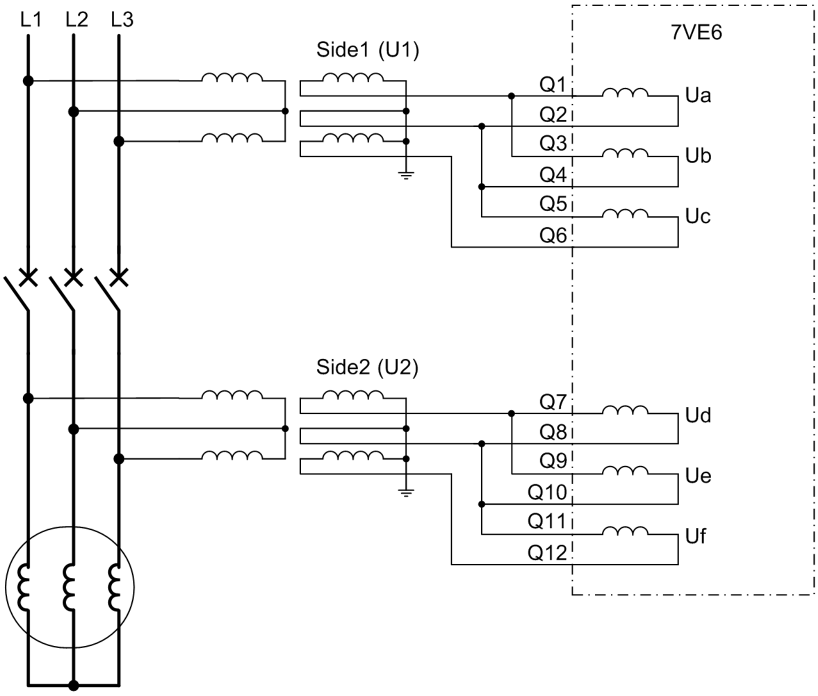


Figure A-8 Connection to a voltage transformer in open delta connection (V-connection)

In order to save costs, it can be often used a two-phase isolated voltage transformer, which are connected to a phase-to-phase voltage. In this case the phase sequence supervision is inactive and reliability restrictions when connecting to the dead busbar must be accepted. Full two-channel redundancy is ensured.

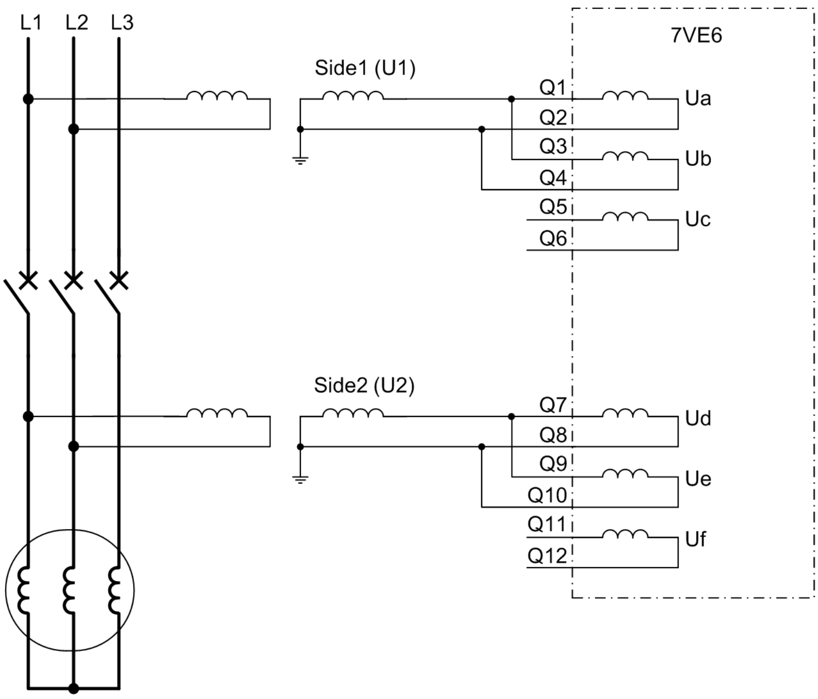


Figure A-9 Connection to a two-phase isolated voltage transformer (unearthed voltage transformer)

A connection to a single-phase isolated voltage transformer should be avoided, if possible. Particularly, in isolated or resonant-starpoint-earthed networks an earth fault leads to a voltage value of zero. Thus, on the one hand you cannot synchronized and on the other hand the bus is identified as dead bus (zero voltage). If the connection U1< and U2> is allowed, there is a high risk of incorrect synchronization. If the earth fault is located for example in phase L1, phase L2 is rotated by 30°. Thus, the device synchronizes with a larger angle error.

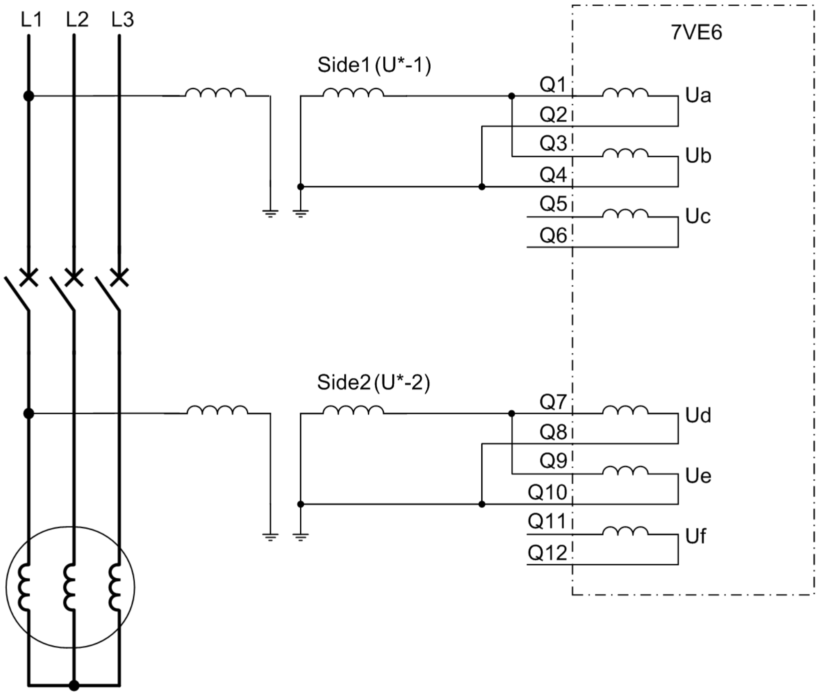


Figure A-10 Connection to a single-phase isolated voltage transformer

A.3.3 Traction Power Systems in 16.7 Hz

The following connection has to be selected for 16.7 Hz traction power systems. With this system structure, there is no phase rotation check. The two-channel feature is fully ensured. Wire break in external voltage transformer circuits is not detected when connecting on a dead busbar. Here it is recommended an additional query from a further voltage transformer.

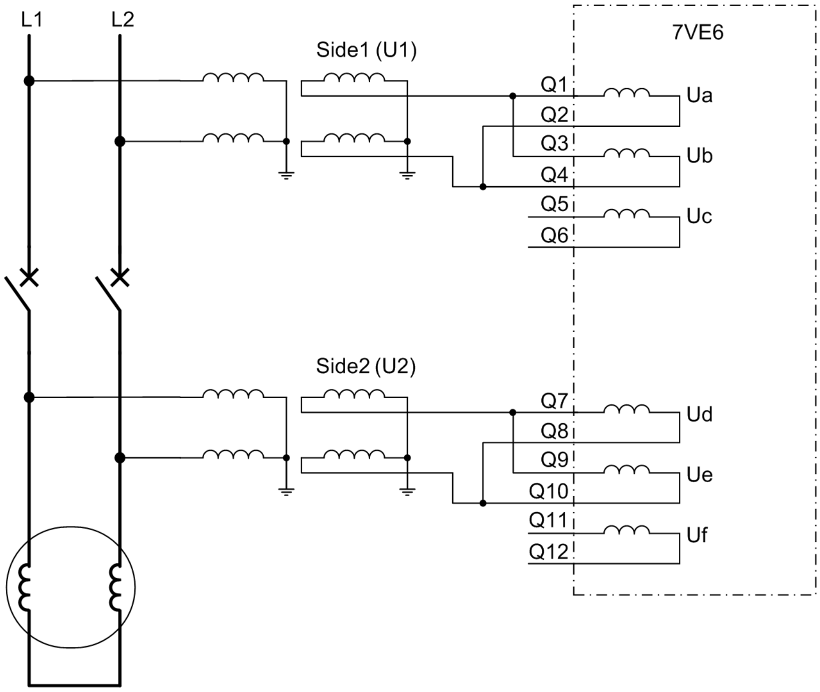


Figure A-11 Connection with traction power application in 16.7 Hz network

A.3.4 Special for Synchrocheck Applications

In the ordering option „Synchrocheck" the synchronization function provides the possibility to monitor up to 3 circuit breaker quasi parallel. In this way save wiring switching and test expenditure can be saved. In particular this is an application in the $1^1/_2$–circuit breaker technique. Also, for smaller power plants of a device can be used up to 3 generators and it helps to save costs.

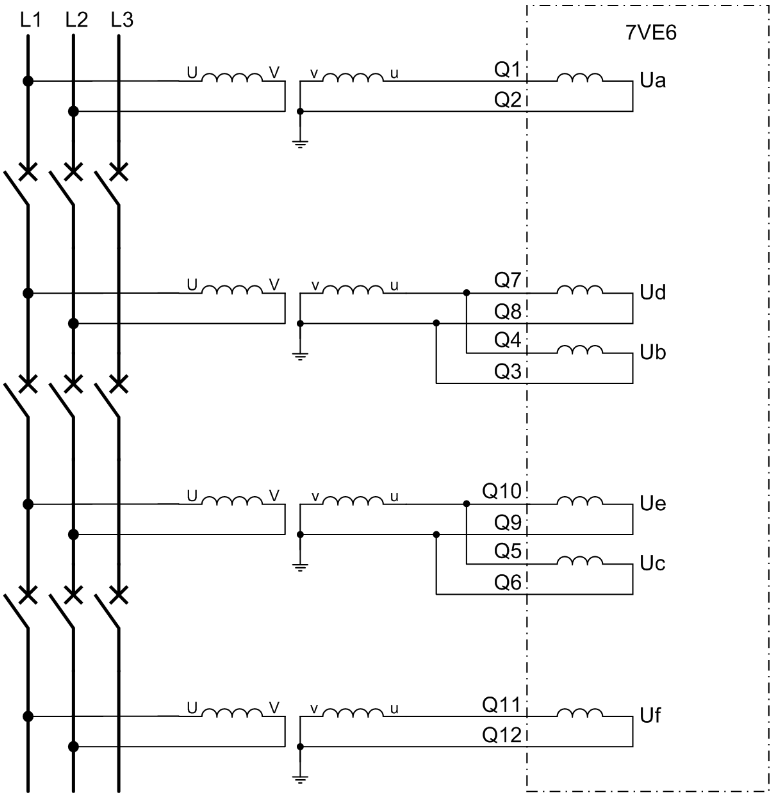


Figure A-12 Synchrocheck for several line ends

In the ordering option „Synchrocheck“ the synchronization function can be set in the following way for two switching devices. The two voltage inputs can be then used for monitoring purpose.

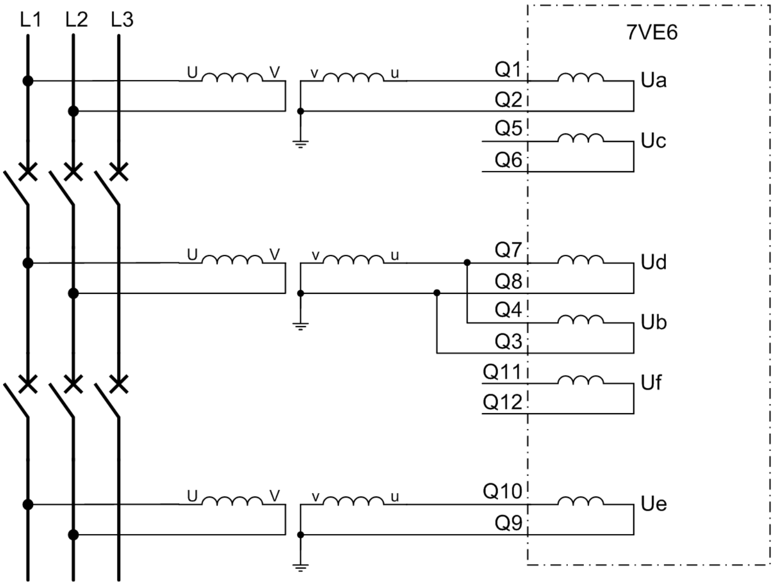


Figure A-13 Synchrocheck for two synchronizing points

A.4 Default Settings

When the device leaves the factory, a large number of LED indicators, binary inputs and outputs as well as function keys are already preset. They are summarized in the following table.

A.4.1 LEDs

Table A-3 LED Indication Presettings

LEDs	Allocated Function	Function No.	Description
LED1	Sync CloseRel 1	170.2300	Sync. Release of Close Command 1
LED2	Sync CloseRel 2	170.2301	Sync. Release of Close Command 2
LED3	Sy1 measu. Sy2 measu. Sy3 measu. Sy4 measu. Sy5 measu. Sy6 measu. Sy7 measu. Sy8 measu.	170.2022 170.2022 170.2022 170.2022 170.2022 170.2022 170.2022 170.2022	Sync-group 1: measurement in progress Sync-group 2: measurement in progress Sync-group 3: measurement in progress Sync-group 4: measurement in progress Sync-group 5: measurement in progress Sync-group 6: measurement in progress Sync-group 7: measurement in progress Sync-group 8: measurement in progress
LED4	Sy1 Error Sy2 Error Sy3 Error Sy4 Error Sy5 Error Sy6 Error Sy7 Error Sy8 Error	170.0050 170.0050 170.0050 170.0050 170.0050 170.0050 170.0050 170.0050	Sync-group 1: Error Sync-group 2: Error Sync-group 3: Error Sync-group 4: Error Sync-group 5: Error Sync-group 6: Error Sync-group 7: Error Sync-group 8: Error
LED5	Sync. fdiff ok	222.2031	Sync. Frequency difference (fdiff) okay
LED6	Sync. Udiff ok	222.2030	Sync. Voltage difference (Udiff) okay
LED7	Sync. α ok	222.2032	Sync. Angle difference (adiff) okay

Table A-4 Additional preset LED displays for 7VE63

LEDs	Allocated Function	Function No.	Description
LED8	Sync U2 up	223.2325	Sync: increase voltage U2
LED9	Sync U2 down	223.2324	Sync: decrease voltage U2
LED10	Sync f2 up	223.2327	Sync: increase frequency f2
LED11	Sync f2 down	223.2326	Sync: decrease frequency f2
LED12	Sync f syn 1 Sync f syn 2	222.2332 222.2333	Sync:Synchronization cond. f1 Sync:Synchronization cond. f2
LED13	SyncSeq U1 fail SyncSeq U2 fail	25039 25040	Sync: Failure phase sequence U1 Sync: Failure phase sequence U2

LEDs	Allocated Function	Function No.	Description
LED14	Error Sum Alarm Alarm Sum Event	140 160	Error with a summary alarm Alarm Summary Event

A.4.2 Binary Input

Table A-5 Binary input presettings for all devices and ordering variants

Binary Input	Allocated Function	Function No.	Description
BI1	>Sync Start	222.2011	>Sync. Start of Synchronization
BI2	>Sync Stop	222.2012	>Sync. Stop of Synchronization
BI3	>Sy1 activ	170.0001	>Sync-group 1 activate
BI4	>Sy2 activ	170.0001	>Sync-group 2 activate
BI5	>Sy3 activ	170.0001	>Sync-group 3 activate
BI6	>FAIL: VT Ua >FAIL: VT Ub >FAIL: VT Uc >FAIL: VT Ud >FAIL: VT Ue >FAIL: VT Uf	5588 5589 5590 5591 5592 5593	>Failure: VT Ua (MCB tripped) >Failure: VT Ub (MCB tripped) >Failure: VT Uc (MCB tripped) >Failure: VT Ud (MCB tripped) >Failure: VT Ue (MCB tripped) >Failure: VT Uf (MCB tripped)

Table A-6 Further binary input presettings for 7VE63

Binary Input	Allocated Function	Function No.	Description
BI7	>Sy4 activ	170.0001	>Sync-group 4 activate
BI8	>Sy5 activ	170.0001	>Sync-group 5 activate
BI9	>Sy6 activ	170.0001	>Sync-group 6 activate
BI10	>Sy7 activ	170.0001	>Sync-group 7 activate
BI11	>Sy8 activ	170.0001	>Sync-group 8 activate
BI12	Not configured	1	No Function configured
BI13	Not configured	1	No Function configured
BI14	Not configured	1	No Function configured

A.4.3 Binary Output

Table A-7 Output relay presettings for all devices and ordering variants

Binary Output	Allocated Function	Function No.	Description
BO1	Sync CloseRel 1	170.2300	Sync. Release of Close Command 1
BO2	Sync CloseRel 2	170.2301	Sync. Release of Close Command 2

Binary Output	Allocated Function	Function No.	Description
BO3	Sy1 measu.	170.2022	Sync-group 1: measurement in progress
	Sy2 measu.	170.2022	Sync-group 2: measurement in progress
	Sy3 measu.	170.2022	Sync-group 3: measurement in progress
	Sy4 measu.	170.2022	Sync-group 4: measurement in progress
	Sy5 measu.	170.2022	Sync-group 5: measurement in progress
	Sy6 measu.	170.2022	Sync-group 6: measurement in progress
	Sy7 measu.	170.2022	Sync-group 7: measurement in progress
	Sy8 measu.	170.2022	Sync-group 8: measurement in progress
BO4	Sy1 Error	170.0050	Sync-group 1: Error
	Sy2 Error	170.0050	Sync-group 2: Error
	Sy3 Error	170.0050	Sync-group 3: Error
	Sy4 Error	170.0050	Sync-group 4: Error
	Sy5 Error	170.0050	Sync-group 5: Error
	Sy6 Error	170.0050	Sync-group 6: Error
	Sy7 Error	170.0050	Sync-group 7: Error
	Sy8 Error	170.0050	Sync-group 8: Error
BO5	Sync ON-Sig	25064	Sync: ON - Signal
BO6	Sync U2 up	223.2325	Sync: increase voltage U2
BO7	Sync U2 down	223.2324	Sync: decrease voltage U2
BO8	Sync f2 up	223.2327	Sync: increase frequency f2
BO9	Sync f2 down	223.2326	Sync: decrease frequency f2

Table A-8 Further output relay presettings for 7VE63

Binary Output	Allocated Function	Function No.	Description
BO10 .. 17	Not configured	1	No Function configured

A.4.4 Function Keys

Table A-9 Applies to all devices and ordered variants

Function Keys	Allocated Function	Function No.	Description
F1	Display of Operational Annunciations	-	-
F2	Operating measured values, primary	-	-
F3	Jumping to heading for last eight fault annunciations	-	-
F4	Jumping to the reset menu of the min/max values	-	-

A.4.5 Default Display

Basic Display of a 7VE61 with Text Display

The following selection is available as start page which may be configured:

Default Display 1:

```
U1: 100.0V f1:50.00Hz
U2: 100.0V f2:50.00Hz
dU:   0.0V df: 0.00Hz
dα: 120.0°  SG:     1
```

Functional Group 1 is effective

```
U1: ---     f1: ---
U2: ---     f2: ---
dU: ---     df: ---
dα: ---     SG: ...
```

No Functional Group is effective

Default Display 2:

```
Ua: 100.0V fa:50.00Hz
Ud: 100.0V fd:50.00Hz
SG:      1
SeqU1: 123  SeqU2: 123
```

Functional Group 1 is effective

```
Ua:   0.0V fa: 0.00Hz
Ud:   0.0V fd: 0.00Hz
SG:   ...
SeqU1:---   SeqU2:---
```

No Functional Group is effective

Default Display 3:

```
Ub: 100.0V fb:50.00Hz
Ue: 100.0V fe:50.00Hz
SG:      1
SeqU1: 123  SeqU2: 123
```

Functional Group 1 is effective

```
Ub:   0.0V fb: 0.00Hz
Ue:   0.0V fe: 0.00Hz
SG:   ...
SeqU1:---   SeqU2:---
```

No Functional Group is effective

Default Display 4:

```
Uc: 100.0V fb:50.00Hz
Uf: 100.0V fe:50.00Hz
SG:      1
SeqU1: 123  SeqU2: 123
```

Functional Group 1 is effective

```
Uc:   0.0V fc: 0.00Hz
Uf:   0.0V ff: 0.00Hz
SG:   ...
SeqU1:---   SeqU2:---
```

No Functional Group is effective

Figure A-14 Basic display of a 7VE61 (with text display)

Basic Displays of a 7VE61 with Graphic Display

```
DEFAULT DISPLAY

U1: ---     f1: ---
U2: ---     f2: ---
dU: ---     df: ---
dα: ---     SG: ...

Ua:    0.0V fa: 0.00Hz
Ud:    0.0V fd: 0.00Hz

Ub:    0.0V fb: 0.00Hz
Ue:    0.0V fe: 0.00Hz

Uc:    0.0V fc: 0.00Hz
Uf:    0.0V ff: 0.00Hz

SeqU1:---   SeqU2:---
```

Figure A-15 Basic display of a 7VE63 device with a large number of measured values (with graphic)

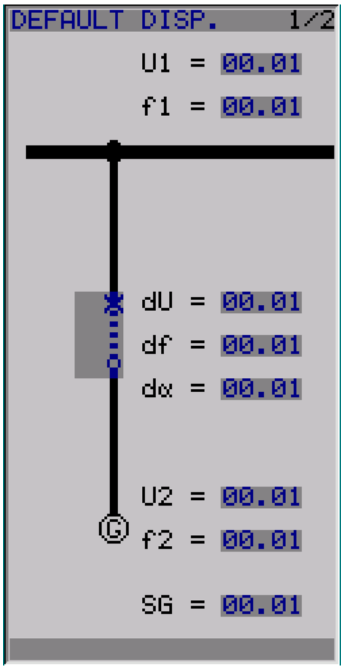


Figure A-16 Basic display of a 7VE63 showing the system (with graphic display)

Spontaneous Fault Message Display

After a fault, automatically and without operator action, the most important fault data from the general device 7VE61 and 7VE63 pickup appears on the display in the sequence shown in the following figure.

S/E/F PICKUP	Protective Function that Picked up First;
S/E/F TRIP	Protective Function that Tripped Last;
PU - Time	Operating Time from General Pickup to Dropout;
TRIP Time	Operating Time from General Pickup to the First Trip Command;

Figure A-17 Display of spontaneous messages in the display – example

A.4.6 Pre-defined CFC Charts

Some CFC charts are already supplied with the SIPROTEC 4 device:

Device and System Logic

The single-point indication „`DataStop`“ that can be injected by binary inputs is converted by means of a NEGATOR block into an indication „`UnlockDT`“ that can be processed internally (internal single point indication, IntSP), and assigned to an output. This would not be possible directly, i.e. without the additional block.

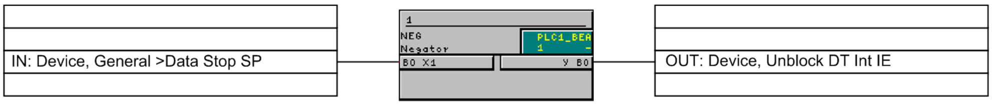


Figure A-18 Link between Input and Output for Transmission Block

A.5 Protocol-dependent Functions

Protocol → Additional service interface (optional)		IEC 60870–5–103	IEC 61850 Ethernet (EN100)	Profibus DP	DNP 3.0	Modbus ASCII/RTU
Function ↓						
Operational measured values yes		Yes (fixed values)	Yes	yes	yes	yes
Metered values yes		yes	Yes	yes	yes	yes
Fault recording yes		yes	Yes	No. Only via additional service interface	No. Only via additional service interface	No. Only via additional service interface
Remote Relay Setting yes		No. Only via additional service interface	No. Only via additional service interface	No. Only via additional service interface	No. Only via additional service interface	No. Only via additional service interface
User-defined alarms and switching objects yes		yes	Yes	yes	yes	yes
Time synchronization —		Via Protocol; DCF77/IRIG B; Interface; Binary Inputs	Via protocol (NTP); DCF77/IRIG B; Interface; Binary Input	Via DCF77/IRIG B; Interface; Binary Inputs Protocol	Via Protocol; DCF77/IRIG B; Interface; Binary Inputs	Via DCF77/IRIG B; Interface; Binary Inputs Protocol
Messages with time stamp yes		yes	Yes	Yes	yes	Yes
Commissioning aids						
Alarm and measured-value blocking	yes	Yes	No.	No.	No.	yes
Test mode	yes	Yes	No.	No.	No.	yes
Physical mode	Asynchronous	Synchronous	Asynchronous	Asynchronous	Asynchronous	—
Transfer mode	Cyclic / Event	cyclically/ Event	Cyclic	cyclically/ Event	Cyclic	—
Baud rate	4800 to 38400	Up to 100 MBaud	Up to 1.5 MBaud	4800 to 19200	2400 to 19200	4800 to 115200
Type	RS232 RS485 Fibre Optic Cable	Ethernet TP	RS485 Fibre Optic Cable; - Double ring	RS485 Fibre Optic Cable	RS485 Fibre Optic Cable	RS232 RS485

A.6 Functional Scope

Addr.	Parameter	Setting Options	Default Setting	Comments
103	Grp Chge OPTION	Disabled Enabled	Disabled	Setting Group Change Option
104	FAULT VALUE	Disabled Instant. values RMS values	RMS values	Fault values
140	UNDERVOLTAGE	Disabled Enabled	Enabled	Undervoltage Protection
141	OVERVOLTAGE	Disabled Enabled	Enabled	Overvoltage Protection
142	FREQUENCY Prot.	Disabled Enabled	Enabled	Over / Underfrequency Protection
145	df/dt Protect.	Disabled 2 df/dt stages 4 df/dt stages	2 df/dt stages	Rate-of-frequency-change protec-tion
146	VECTOR JUMP	Disabled Enabled	Enabled	Jump of Voltage Vector
160	BALANC. (MLFB)	Disabled Enabled	Disabled	Balancing Commands (Siemens only MLFB)
161	SYNC function 1	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 1
162	SYNC function 2	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 2
163	SYNC function 3	Disabled 1ph Sync check 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 3
164	SYNC function 4	Disabled 3ph Sync check 1,5chan.Synchr 2chan.Synchr.	Disabled	SYNC Function group 4
165	SYNC function 5	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 5
166	SYNC function 6	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 6
167	SYNC function 7	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 7
168	SYNC function 8	Disabled 3ph Sync check 2chan.Synchr.	Disabled	SYNC Function group 8
173	ANALOGOUTPUT B1	Disabled Enabled	Disabled	Analog Output B1 (Port B)

Addr.	Parameter	Setting Options	Default Setting	Comments
174	ANALOGOUTPUT B2	Disabled Enabled	Disabled	Analog Output B2 (Port B)
175	ANALOGOUTPUT D1	Disabled Enabled	Disabled	Analog Output D1 (Port D)
176	ANALOGOUTPUT D2	Disabled Enabled	Disabled	Analog Output D2 (Port D)
185	THRESHOLD	Disabled Enabled	Enabled	Threshold Supervision
186	EXT. TRIP 1	Disabled Enabled	Enabled	External Trip Function 1
187	EXT. TRIP 2	Disabled Enabled	Enabled	External Trip Function 2
188	EXT. TRIP 3	Disabled Enabled	Enabled	External Trip Function 3
189	EXT. TRIP 4	Disabled Enabled	Enabled	External Trip Function 4

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
270	Rated Frequency	P.System Data 1	50 Hz 60 Hz 16,7 Hz	50 Hz	Rated Frequency
280	TMin TRIP CMD	P.System Data 1	0.01 .. 32.00 sec	0.15 sec	Minimum TRIP 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	WAVEFORMTRIGGER	Osc. Fault Rec.	Save w. Pickup Save w. TRIP Start w. TRIP	Start w. TRIP	Waveform Capture
403	MAX. LENGTH	Osc. Fault Rec.	0.30 .. 10.00 sec	10.00 sec	Max. length of a Waveform Capture Record
404	PRE. TRIG. TIME	Osc. Fault Rec.	0.05 .. 5.00 sec	5.00 sec	Captured Waveform Prior to Trigger
405	POST REC. TIME	Osc. Fault Rec.	0.05 .. 2.00 sec	2.00 sec	Captured Waveform after Event
406	BinIn CAPT.TIME	Osc. Fault Rec.	0.10 .. 10.00 sec; ∞	10.00 sec	Capture Time via Binary Input
610	FltDisp.LED/LCD	Device	Target on PU Target on TRIP	Target on PU	Fault Display on LED / LCD
615	T MIN LED HOLD	Device	0 .. 60 min	5 min	Minimum hold time of lachted LEDs
640	Start image DD	Device	image 1 image 2 image 3 image 4	image 1	Start image Default Display
4001	UNDERVOLTAGE	Undervoltage	OFF ON Block relay	OFF	Undervoltage Protection
4002	U<	Undervoltage	10.0 .. 125.0 V	75.0 V	U< Pickup
4003	T U<	Undervoltage	0.00 .. 60.00 sec; ∞	3.00 sec	T U< Time Delay
4004	U<<	Undervoltage	10.0 .. 125.0 V	65.0 V	U<< Pickup
4005	T U<<	Undervoltage	0.00 .. 60.00 sec; ∞	0.50 sec	T U<< Time Delay
4006A	U< DOUT RATIO	Undervoltage	1.01 .. 1.20	1.05	U<, U<< Drop Out Ratio
4007	MEAS. INPUT	Undervoltage	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input
4101	OVERVOLTAGE	Overvoltage	OFF ON Block relay	OFF	Overvoltage Protection
4102	U>	Overvoltage	30.0 .. 200.0 V	115.0 V	U> Pickup
4103	T U>	Overvoltage	0.00 .. 60.00 sec; ∞	3.00 sec	T U> Time Delay
4104	U>>	Overvoltage	30.0 .. 200.0 V	130.0 V	U>> Pickup
4105	T U>>	Overvoltage	0.00 .. 60.00 sec; ∞	0.50 sec	T U>> Time Delay
4106A	U> DOUT RATIO	Overvoltage	0.90 .. 0.99	0.95	U>, U>> Drop Out Ratio
4107	MEAS. INPUT	Overvoltage	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input
4201	O/U FREQUENCY	Frequency Prot.	OFF ON Block relay	OFF	Over / Under Frequency Protection
4202	f1 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	48.00 Hz	f1 Pickup
4203	f1 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	58.00 Hz	f1 Pickup
4204	f1 PICKUP	Frequency Prot.	12.00 .. 20.00 Hz	16.10 Hz	f1 PICKUP

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
4205	T f1	Frequency Prot.	0.00 .. 600.00 sec; ∞	1.00 sec	T f1 Time Delay
4206	f2 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	47.00 Hz	f2 Pickup
4207	f2 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	57.00 Hz	f2 Pickup
4208	f2 PICKUP	Frequency Prot.	12.00 .. 20.00 Hz	15.80 Hz	f2 PICKUP
4209	T f2	Frequency Prot.	0.00 .. 100.00 sec; ∞	6.00 sec	T f2 Time Delay
4210	f3 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	49.50 Hz	f3 Pickup
4211	f3 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	59.50 Hz	f3 Pickup
4212	f3 PICKUP	Frequency Prot.	12.00 .. 20.00 Hz	16.50 Hz	f3 PICKUP
4213	T f3	Frequency Prot.	0.00 .. 100.00 sec; ∞	20.00 sec	T f3 Time Delay
4214	f4 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	52.00 Hz	f4 Pickup
4215	f4 PICKUP	Frequency Prot.	40.00 .. 65.00 Hz	62.00 Hz	f4 Pickup
4216	f4 PICKUP	Frequency Prot.	12.00 .. 20.00 Hz	17.20 Hz	f4 PICKUP
4217	T f4	Frequency Prot.	0.00 .. 100.00 sec; ∞	10.00 sec	T f4 Time Delay
4218	THRESHOLD f4	Frequency Prot.	automatic f> f<	automatic	Handling of Threshold Stage f4
4219	Umin	Frequency Prot.	10.0 .. 125.0 V; 0	65.0 V	Minimum Required Voltage for Operation
4220	MEAS. INPUT	Frequency Prot.	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input
4501	df/dt Protect.	df/dt Protect.	OFF ON Block relay	OFF	Rate-of-frequency-change protection
4502	df1/dt >/<	df/dt Protect.	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df1/dt >/<)
4503	STAGE df1/dt	df/dt Protect.	0.1 .. 10.0 Hz/s; ∞	1.0 Hz/s	Pickup Value of df1/dt Stage
4504	STAGE df1/dt	df/dt Protect.	0.1 .. 3.0 Hz/s; ∞	0.3 Hz/s	Pickup Value of df1/dt Stage
4505	T df1/dt	df/dt Protect.	0.00 .. 60.00 sec; ∞	0.50 sec	Time Delay of df1/dt Stage
4506	df1/dt & f1	df/dt Protect.	OFF ON	OFF	AND logic with pickup of stage f1
4507	df2/dt >/<	df/dt Protect.	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df2/dt >/<)
4508	STAGE df2/dt	df/dt Protect.	0.1 .. 10.0 Hz/s; ∞	1.0 Hz/s	Pickup Value of df2/dt Stage
4509	STAGE df2/dt	df/dt Protect.	0.1 .. 3.0 Hz/s; ∞	0.3 Hz/s	Pickup Value of df2/dt Stage
4510	T df2/dt	df/dt Protect.	0.00 .. 60.00 sec; ∞	0.50 sec	Time Delay of df2/dt Stage
4511	df2/dt & f2	df/dt Protect.	OFF ON	OFF	AND logic with pickup of stage f2
4512	df3/dt >/<	df/dt Protect.	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df3/dt >/<)
4513	STAGE df3/dt	df/dt Protect.	0.1 .. 10.0 Hz/s; ∞	4.0 Hz/s	Pickup Value of df3/dt Stage
4514	STAGE df3/dt	df/dt Protect.	0.1 .. 3.0 Hz/s; ∞	1.3 Hz/s	Pickup Value of df3/dt Stage
4515	T df3/dt	df/dt Protect.	0.00 .. 60.00 sec; ∞	0.00 sec	Time Delay of df3/dt Stage
4516	df3/dt & f3	df/dt Protect.	OFF ON	OFF	AND logic with pickup of stage f3
4517	df4/dt >/<	df/dt Protect.	-df/dt< +df/dt>	-df/dt<	Mode of Threshold (df4/dt >/<)
4518	STAGE df4/dt	df/dt Protect.	0.1 .. 10.0 Hz/s; ∞	4.0 Hz/s	Pickup Value of df4/dt Stage
4519	STAGE df4/dt	df/dt Protect.	0.1 .. 3.0 Hz/s; ∞	1.3 Hz/s	Pickup Value of df4/dt Stage
4520	T df4/dt	df/dt Protect.	0.00 .. 60.00 sec; ∞	0.00 sec	Time Delay of df4/dt Stage
4521	df4/dt & f4	df/dt Protect.	OFF ON	OFF	AND logic with pickup of stage f4
4522	U MIN	df/dt Protect.	10.0 .. 125.0 V; 0	65.0 V	Minimum Operating Voltage Umin
4523A	df1/2 HYSTERES.	df/dt Protect.	0.02 .. 0.99 Hz/s	0.10 Hz/s	Reset Hysteresis for df1/dt & df2/dt
4524A	df1/2 M-WINDOW	df/dt Protect.	1 .. 25 Cycle	5 Cycle	Measuring Window for df1/dt & df2/dt
4525A	df3/4 HYSTERES.	df/dt Protect.	0.02 .. 0.99 Hz/s	0.40 Hz/s	Reset Hysteresis for df3/dt & df4/dt

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
4526A	df3/4 M-WINDOW	df/dt Protect.	1 .. 25 Cycle	5 Cycle	Measuring Window for df3/dt & df4/dt
4527	MEAS. INPUT	df/dt Protect.	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input
4601	VECTOR JUMP	Vector Jump	OFF ON Block relay	OFF	Jump of Voltage Vector
4602	DELTA PHI	Vector Jump	2 .. 30 °	10 °	Jump of Phasor DELTA PHI
4603	T DELTA PHI	Vector Jump	0.00 .. 60.00 sec; ∞	0.00 sec	T DELTA PHI Time Delay
4604	T RESET	Vector Jump	0.10 .. 60.00 sec; ∞	5.00 sec	Reset Time after Trip
4605A	U MIN	Vector Jump	10.0 .. 125.0 V	80.0 V	Minimal Operation Voltage U MIN
4606A	U MAX	Vector Jump	10.0 .. 170.0 V	130.0 V	Maximal Operation Voltage U MAX
4607A	T BLOCK	Vector Jump	0.00 .. 60.00 sec; ∞	0.10 sec	Time Delay of Blocking
4609	MEAS. INPUT	Vector Jump	Ua Ub Uc Ud Ue Uf	Ua	Used Measuring Input
6001	COM. TESTSYNC.	SYNC General	OFF ON	OFF	Test synchronization (Commision-ing)
6101	Synchronizing	SYNC function 1	ON OFF	OFF	Synchronizing Function
6102	SyncSD	SYNC function 1	(Setting options depend on configuration)	None	synchronizable switching device
6103	Umin	SYNC function 1	20 .. 125 V	90 V	Minimum voltage limit: Umin
6104	Umax	SYNC function 1	20 .. 140 V	110 V	Maximum voltage limit: Umax
6105	U<	SYNC function 1	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6106	U>	SYNC function 1	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6107	SYNC U1<U2>	SYNC function 1	YES NO	NO	ON-Command at U1< and U2>
6108	SYNC U1>U2<	SYNC function 1	YES NO	NO	ON-Command at U1> and U2<
6109	SYNC U1<U2<	SYNC function 1	YES NO	NO	ON-Command at U1< and U2<
6111A	TSUP VOLTAGE	SYNC function 1	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6112	T-SYN. DURATION	SYNC function 1	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6113	PHASE SEQUENCE	SYNC function 1	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6120	T-CB close	SYNC function 1	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6121	Balancing U1/U2	SYNC function 1	0.50 .. 2.00	1.00	Balancing factor U1/U2
6122A	ANGLE ADJUSTM.	SYNC function 1	0 .. 359 °	0 °	Angle adjustment (transformer)
6124	VT Un1, primary	SYNC function 1	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6125	VT Un2, primary	SYNC function 1	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6126	Unom SECONDARY	SYNC function 1	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6127	T CLS CMD MIN	SYNC function 1	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6130	dU ASYN U2>U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6131	dU ASYN U2<U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6132	df ASYN f2>f1	SYNC function 1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6133	df ASYN f2<f1	SYNC function 1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6140	SYNC PERMIS.	SYNC function 1	NO YES	NO	Switching at synchronous condi-tions
6141	F SYNCHRON	SYNC function 1	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6142	dU SYN U2>U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6143	dU SYN U2<U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6144	dα SYN α2>α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6145	dα SYN α2<α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6146	T SYNC-DELAY	SYNC function 1	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6150	dU SYNC U2>U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6151	dU SYNC U2<U1	SYNC function 1	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6152	df SYNC f2>f1	SYNC function 1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6153	df SYNC f2<f1	SYNC function 1	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6154	dα SYNC α2> α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6155	dα SYNC α2< α1	SYNC function 1	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6160	TAP CHG. OBJ.	SYNC function 1	(Setting options depend on configuration)	None	Tap changer object
6161	#STEP NOM. VOLT	SYNC function 1	-62 .. 62	0	# of tap changer at nom. voltage
6162	TAP STEP	SYNC function 1	0.00 .. 20.00 %	0.00 %	Step size tap changer
6170	U BALANCING	SYNC function 1	OFF Tap changer Pulse	OFF	Voltage balancing
6171	T U PULS MIN	SYNC function 1	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6172	T U PULS MAX	SYNC function 1	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6173	dU2 / dt	SYNC function 1	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6174	T U PAUSE	SYNC function 1	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6175A	SMOOTHING U	SYNC function 1	1 .. 100	1	Smoothing factor for the voltage
6176A	(U/Un) / (f/fn)	SYNC function 1	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6180	f BALANCING	SYNC function 1	OFF Pulse	OFF	Frequency balancing
6181	T f PULS MIN	SYNC function 1	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6182	T f PULS MAX	SYNC function 1	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6183	df2 / dt	SYNC function 1	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6184	T f PAUSE	SYNC function 1	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6185	∆f SET POINT	SYNC function 1	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6186A	SMOOTHING f	SYNC function 1	1 .. 100	1	Smoothing factor for the frequency
6187	KICK PULSE	SYNC function 1	OFF ON	ON	Release of kick pulses
6188A	∆f KICK	SYNC function 1	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6189A	T SW-ON MIN	SYNC function 1	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6201	Synchronizing	SYNC function 2	ON OFF	OFF	Synchronizing Function
6202	SyncSD	SYNC function 2	(Setting options depend on configuration)	None	synchronizable switching device
6203	Umin	SYNC function 2	20 .. 125 V	90 V	Minimum voltage limit: Umin
6204	Umax	SYNC function 2	20 .. 140 V	110 V	Maximum voltage limit: Umax
6205	U<	SYNC function 2	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6206	U>	SYNC function 2	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6207	SYNC U1<U2>	SYNC function 2	YES NO	NO	ON-Command at U1< and U2>
6208	SYNC U1>U2<	SYNC function 2	YES NO	NO	ON-Command at U1> and U2<

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6209	SYNC U1<U2<	SYNC function 2	YES NO	NO	ON-Command at U1< and U2<
6211A	TSUP VOLTAGE	SYNC function 2	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6212	T-SYN. DURATION	SYNC function 2	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6213	PHASE SEQUENCE	SYNC function 2	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6220	T-CB close	SYNC function 2	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6221	Balancing U1/U2	SYNC function 2	0.50 .. 2.00	1.00	Balancing factor U1/U2
6222A	ANGLE ADJUSTM.	SYNC function 2	0 .. 359 °	0 °	Angle adjustment (transformer)
6224	VT Un1, primary	SYNC function 2	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6225	VT Un2, primary	SYNC function 2	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6226	Unom SECONDARY	SYNC function 2	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6227	T CLS CMD MIN	SYNC function 2	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6230	dU ASYN U2>U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6231	dU ASYN U2<U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6232	df ASYN f2>f1	SYNC function 2	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6233	df ASYN f2<f1	SYNC function 2	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6240	SYNC PERMIS.	SYNC function 2	NO YES	NO	Switching at synchronous conditions
6241	F SYNCHRON	SYNC function 2	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6242	dU SYN U2>U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6243	dU SYN U2<U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6244	dα SYN α2>α1	SYNC function 2	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6245	dα SYN α2<α1	SYNC function 2	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6246	T SYNC-DELAY	SYNC function 2	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6250	dU SYNC U2>U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6251	dU SYNC U2<U1	SYNC function 2	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6252	df SYNC f2>f1	SYNC function 2	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6253	df SYNC f2<f1	SYNC function 2	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6254	dα SYNC α2> α1	SYNC function 2	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6255	dα SYNC α2< α1	SYNC function 2	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6260	TAP CHG. OBJ.	SYNC function 2	(Setting options depend on configuration)	None	Tap changer object
6261	#STEP NOM. VOLT	SYNC function 2	-62 .. 62	0	# of tap changer at nom. voltage
6262	TAP STEP	SYNC function 2	0.00 .. 20.00 %	0.00 %	Step size tap changer
6270	U BALANCING	SYNC function 2	OFF Tap changer Pulse	OFF	Voltage balancing
6271	T U PULS MIN	SYNC function 2	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6272	T U PULS MAX	SYNC function 2	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6273	dU2 / dt	SYNC function 2	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6274	T U PAUSE	SYNC function 2	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6275A	SMOOTHING U	SYNC function 2	1 .. 100	1	Smoothing factor for the voltage
6276A	(U/Un) / (f/fn)	SYNC function 2	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6280	f BALANCING	SYNC function 2	OFF Pulse	OFF	Frequency balancing

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6281	T f PULS MIN	SYNC function 2	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6282	T f PULS MAX	SYNC function 2	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6283	df2 / dt	SYNC function 2	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6284	T f PAUSE	SYNC function 2	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6285	∆f SET POINT	SYNC function 2	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6286A	SMOOTHING f	SYNC function 2	1 .. 100	1	Smoothing factor for the frequency
6287	KICK PULSE	SYNC function 2	OFF ON	ON	Release of kick pulses
6288A	∆f KICK	SYNC function 2	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6289A	T SW-ON MIN	SYNC function 2	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6301	Synchronizing	SYNC function 3	ON OFF	OFF	Synchronizing Function
6302	SyncSD	SYNC function 3	(Setting options depend on configuration)	None	synchronizable switching device
6303	Umin	SYNC function 3	20 .. 125 V	90 V	Minimum voltage limit: Umin
6304	Umax	SYNC function 3	20 .. 140 V	110 V	Maximum voltage limit: Umax
6305	U<	SYNC function 3	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6306	U>	SYNC function 3	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6307	SYNC U1<U2>	SYNC function 3	YES NO	NO	ON-Command at U1< and U2>
6308	SYNC U1>U2<	SYNC function 3	YES NO	NO	ON-Command at U1> and U2<
6309	SYNC U1<U2<	SYNC function 3	YES NO	NO	ON-Command at U1< and U2<
6311A	TSUP VOLTAGE	SYNC function 3	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6312	T-SYN. DURATION	SYNC function 3	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6313	PHASE SEQUENCE	SYNC function 3	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6320	T-CB close	SYNC function 3	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6321	Balancing U1/U2	SYNC function 3	0.50 .. 2.00	1.00	Balancing factor U1/U2
6322A	ANGLE ADJUSTM.	SYNC function 3	0 .. 359 °	0 °	Angle adjustment (transformer)
6324	VT Un1, primary	SYNC function 3	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6325	VT Un2, primary	SYNC function 3	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6326	Unom SECONDARY	SYNC function 3	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6327	T CLS CMD MIN	SYNC function 3	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6330	dU ASYN U2>U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6331	dU ASYN U2<U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6332	df ASYN f2>f1	SYNC function 3	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6333	df ASYN f2<f1	SYNC function 3	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6340	SYNC PERMIS.	SYNC function 3	NO YES	NO	Switching at synchronous conditions
6341	F SYNCHRON	SYNC function 3	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6342	dU SYN U2>U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6343	dU SYN U2<U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6344	dα SYN α2>α1	SYNC function 3	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6345	dα SYN α2<α1	SYNC function 3	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6346	T SYNC-DELAY	SYNC function 3	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6350	dU SYNC U2>U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6351	dU SYNC U2<U1	SYNC function 3	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6352	df SYNC f2>f1	SYNC function 3	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6353	df SYNC f2<f1	SYNC function 3	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6354	dα SYNC α2> α1	SYNC function 3	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6355	dα SYNC α2< α1	SYNC function 3	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6360	TAP CHG. OBJ.	SYNC function 3	(Setting options depend on configuration)	None	Tap changer object
6361	#STEP NOM. VOLT	SYNC function 3	-62 .. 62	0	# of tap changer at nom. voltage
6362	TAP STEP	SYNC function 3	0.00 .. 20.00 %	0.00 %	Step size tap changer
6370	U BALANCING	SYNC function 3	OFF Tap changer Pulse	OFF	Voltage balancing
6371	T U PULS MIN	SYNC function 3	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6372	T U PULS MAX	SYNC function 3	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6373	dU2 / dt	SYNC function 3	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6374	T U PAUSE	SYNC function 3	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6375A	SMOOTHING U	SYNC function 3	1 .. 100	1	Smoothing factor for the voltage
6376A	(U/Un) / (f/fn)	SYNC function 3	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6380	f BALANCING	SYNC function 3	OFF Pulse	OFF	Frequency balancing
6381	T f PULS MIN	SYNC function 3	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6382	T f PULS MAX	SYNC function 3	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6383	df2 / dt	SYNC function 3	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6384	T f PAUSE	SYNC function 3	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6385	Δf SET POINT	SYNC function 3	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6386A	SMOOTHING f	SYNC function 3	1 .. 100	1	Smoothing factor for the frequency
6387	KICK PULSE	SYNC function 3	OFF ON	ON	Release of kick pulses
6388A	Δf KICK	SYNC function 3	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6389A	T SW-ON MIN	SYNC function 3	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6401	Synchronizing	SYNC function 4	ON OFF	OFF	Synchronizing Function
6402	SyncSD	SYNC function 4	(Setting options depend on configuration)	None	synchronizable switching device
6403	Umin	SYNC function 4	20 .. 125 V	90 V	Minimum voltage limit: Umin
6404	Umax	SYNC function 4	20 .. 140 V	110 V	Maximum voltage limit: Umax
6405	U<	SYNC function 4	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6406	U>	SYNC function 4	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6407	SYNC U1<U2>	SYNC function 4	YES NO	NO	ON-Command at U1< and U2>
6408	SYNC U1>U2<	SYNC function 4	YES NO	NO	ON-Command at U1> and U2<
6409	SYNC U1<U2<	SYNC function 4	YES NO	NO	ON-Command at U1< and U2<
6411A	TSUP VOLTAGE	SYNC function 4	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6412	T-SYN. DURATION	SYNC function 4	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6413	PHASE SEQUENCE	SYNC function 4	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6420	T-CB close	SYNC function 4	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6421	Balancing U1/U2	SYNC function 4	0.50 .. 2.00	1.00	Balancing factor U1/U2

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6422A	ANGLE ADJUSTM.	SYNC function 4	0 .. 359 °	0 °	Angle adjustment (transformer)
6424	VT Un1, primary	SYNC function 4	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6425	VT Un2, primary	SYNC function 4	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6426	Unom SECONDARY	SYNC function 4	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6427	T CLS CMD MIN	SYNC function 4	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6430	dU ASYN U2>U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6431	dU ASYN U2<U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6432	df ASYN f2>f1	SYNC function 4	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6433	df ASYN f2<f1	SYNC function 4	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6440	SYNC PERMIS.	SYNC function 4	NO YES	NO	Switching at synchronous conditions
6441	F SYNCHRON	SYNC function 4	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6442	dU SYN U2>U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6443	dU SYN U2<U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6444	dα SYN α2>α1	SYNC function 4	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6445	dα SYN α2<α1	SYNC function 4	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6446	T SYNC-DELAY	SYNC function 4	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6450	dU SYNC U2>U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6451	dU SYNC U2<U1	SYNC function 4	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6452	df SYNC f2>f1	SYNC function 4	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6453	df SYNC f2<f1	SYNC function 4	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6454	dα SYNC α2> α1	SYNC function 4	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6455	dα SYNC α2< α1	SYNC function 4	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6460	TAP CHG. OBJ.	SYNC function 4	(Setting options depend on configuration)	None	Tap changer object
6461	#STEP NOM. VOLT	SYNC function 4	-62 .. 62	0	# of tap changer at nom. voltage
6462	TAP STEP	SYNC function 4	0.00 .. 20.00 %	0.00 %	Step size tap changer
6470	U BALANCING	SYNC function 4	OFF Tap changer Pulse	OFF	Voltage balancing
6471	T U PULS MIN	SYNC function 4	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6472	T U PULS MAX	SYNC function 4	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6473	dU2 / dt	SYNC function 4	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6474	T U PAUSE	SYNC function 4	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6475A	SMOOTHING U	SYNC function 4	1 .. 100	1	Smoothing factor for the voltage
6476A	(U/Un) / (f/fn)	SYNC function 4	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6480	f BALANCING	SYNC function 4	OFF Pulse	OFF	Frequency balancing
6481	T f PULS MIN	SYNC function 4	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6482	T f PULS MAX	SYNC function 4	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6483	df2 / dt	SYNC function 4	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6484	T f PAUSE	SYNC function 4	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6485	Δf SET POINT	SYNC function 4	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6486A	SMOOTHING f	SYNC function 4	1 .. 100	1	Smoothing factor for the frequency
6487	KICK PULSE	SYNC function 4	OFF ON	ON	Release of kick pulses

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6488A	Δf KICK	SYNC function 4	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6489A	T SW-ON MIN	SYNC function 4	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6501	Synchronizing	SYNC function 5	ON OFF	OFF	Synchronizing Function
6502	SyncSD	SYNC function 5	(Setting options depend on configuration)	None	synchronizable switching device
6503	Umin	SYNC function 5	20 .. 125 V	90 V	Minimum voltage limit: Umin
6504	Umax	SYNC function 5	20 .. 140 V	110 V	Maximum voltage limit: Umax
6505	U<	SYNC function 5	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6506	U>	SYNC function 5	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6507	SYNC U1<U2>	SYNC function 5	YES NO	NO	ON-Command at U1< and U2>
6508	SYNC U1>U2<	SYNC function 5	YES NO	NO	ON-Command at U1> and U2<
6509	SYNC U1<U2<	SYNC function 5	YES NO	NO	ON-Command at U1< and U2<
6511A	TSUP VOLTAGE	SYNC function 5	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6512	T-SYN. DURATION	SYNC function 5	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6513	PHASE SEQUENCE	SYNC function 5	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6520	T-CB close	SYNC function 5	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6521	Balancing U1/U2	SYNC function 5	0.50 .. 2.00	1.00	Balancing factor U1/U2
6522A	ANGLE ADJUSTM.	SYNC function 5	0 .. 359 °	0 °	Angle adjustment (transformer)
6524	VT Un1, primary	SYNC function 5	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6525	VT Un2, primary	SYNC function 5	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6526	Unom SECONDARY	SYNC function 5	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6527	T CLS CMD MIN	SYNC function 5	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6530	dU ASYN U2>U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6531	dU ASYN U2<U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6532	df ASYN f2>f1	SYNC function 5	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6533	df ASYN f2<f1	SYNC function 5	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6540	SYNC PERMIS.	SYNC function 5	NO YES	NO	Switching at synchronous conditions
6541	F SYNCHRON	SYNC function 5	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6542	dU SYN U2>U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6543	dU SYN U2<U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6544	dα SYN α2>α1	SYNC function 5	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6545	dα SYN α2<α1	SYNC function 5	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6546	T SYNC-DELAY	SYNC function 5	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6550	dU SYNC U2>U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6551	dU SYNC U2<U1	SYNC function 5	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6552	df SYNC f2>f1	SYNC function 5	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6553	df SYNC f2<f1	SYNC function 5	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6554	dα SYNC α2> α1	SYNC function 5	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6555	dα SYNC α2< α1	SYNC function 5	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6560	TAP CHG. OBJ.	SYNC function 5	(Setting options depend on configuration)	None	Tap changer object
6561	#STEP NOM. VOLT	SYNC function 5	-62 .. 62	0	# of tap changer at nom. voltage

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6562	TAP STEP	SYNC function 5	0.00 .. 20.00 %	0.00 %	Step size tap changer
6570	U BALANCING	SYNC function 5	OFF Tap changer Pulse	OFF	Voltage balancing
6571	T U PULS MIN	SYNC function 5	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6572	T U PULS MAX	SYNC function 5	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6573	dU2 / dt	SYNC function 5	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6574	T U PAUSE	SYNC function 5	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6575A	SMOOTHING U	SYNC function 5	1 .. 100	1	Smoothing factor for the voltage
6576A	(U/Un) / (f/fn)	SYNC function 5	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6580	f BALANCING	SYNC function 5	OFF Pulse	OFF	Frequency balancing
6581	T f PULS MIN	SYNC function 5	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6582	T f PULS MAX	SYNC function 5	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6583	df2 / dt	SYNC function 5	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6584	T f PAUSE	SYNC function 5	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6585	Δf SET POINT	SYNC function 5	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6586A	SMOOTHING f	SYNC function 5	1 .. 100	1	Smoothing factor for the frequency
6587	KICK PULSE	SYNC function 5	OFF ON	ON	Release of kick pulses
6588A	Δf KICK	SYNC function 5	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6589A	T SW-ON MIN	SYNC function 5	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6601	Synchronizing	SYNC function 6	ON OFF	OFF	Synchronizing Function
6602	SyncSD	SYNC function 6	(Setting options depend on configuration)	None	synchronizable switching device
6603	Umin	SYNC function 6	20 .. 125 V	90 V	Minimum voltage limit: Umin
6604	Umax	SYNC function 6	20 .. 140 V	110 V	Maximum voltage limit: Umax
6605	U<	SYNC function 6	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6606	U>	SYNC function 6	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6607	SYNC U1<U2>	SYNC function 6	YES NO	NO	ON-Command at U1< and U2>
6608	SYNC U1>U2<	SYNC function 6	YES NO	NO	ON-Command at U1> and U2<
6609	SYNC U1<U2<	SYNC function 6	YES NO	NO	ON-Command at U1< and U2<
6611A	TSUP VOLTAGE	SYNC function 6	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6612	T-SYN. DURATION	SYNC function 6	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6613	PHASE SEQUENCE	SYNC function 6	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6620	T-CB close	SYNC function 6	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6621	Balancing U1/U2	SYNC function 6	0.50 .. 2.00	1.00	Balancing factor U1/U2
6622A	ANGLE ADJUSTM.	SYNC function 6	0 .. 359 °	0 °	Angle adjustment (transformer)
6624	VT Un1, primary	SYNC function 6	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6625	VT Un2, primary	SYNC function 6	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6626	Unom SECONDARY	SYNC function 6	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6627	T CLS CMD MIN	SYNC function 6	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6630	dU ASYN U2>U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6631	dU ASYN U2<U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6632	df ASYN f2>f1	SYNC function 6	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6633	df ASYN f2<f1	SYNC function 6	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6640	SYNC PERMIS.	SYNC function 6	NO YES	NO	Switching at synchronous conditions
6641	F SYNCHRON	SYNC function 6	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6642	dU SYN U2>U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6643	dU SYN U2<U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6644	dα SYN α2>α1	SYNC function 6	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6645	dα SYN α2<α1	SYNC function 6	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6646	T SYNC-DELAY	SYNC function 6	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6650	dU SYNC U2>U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6651	dU SYNC U2<U1	SYNC function 6	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6652	df SYNC f2>f1	SYNC function 6	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6653	df SYNC f2<f1	SYNC function 6	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6654	dα SYNC α2> α1	SYNC function 6	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6655	dα SYNC α2< α1	SYNC function 6	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6660	TAP CHG. OBJ.	SYNC function 6	(Setting options depend on configuration)	None	Tap changer object
6661	#STEP NOM. VOLT	SYNC function 6	-62 .. 62	0	# of tap changer at nom. voltage
6662	TAP STEP	SYNC function 6	0.00 .. 20.00 %	0.00 %	Step size tap changer
6670	U BALANCING	SYNC function 6	OFF Tap changer Pulse	OFF	Voltage balancing
6671	T U PULS MIN	SYNC function 6	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6672	T U PULS MAX	SYNC function 6	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6673	dU2 / dt	SYNC function 6	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6674	T U PAUSE	SYNC function 6	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6675A	SMOOTHING U	SYNC function 6	1 .. 100	1	Smoothing factor for the voltage
6676A	(U/Un) / (f/fn)	SYNC function 6	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6680	f BALANCING	SYNC function 6	OFF Pulse	OFF	Frequency balancing
6681	T f PULS MIN	SYNC function 6	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6682	T f PULS MAX	SYNC function 6	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6683	df2 / dt	SYNC function 6	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6684	T f PAUSE	SYNC function 6	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6685	Δf SET POINT	SYNC function 6	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6686A	SMOOTHING f	SYNC function 6	1 .. 100	1	Smoothing factor for the frequency
6687	KICK PULSE	SYNC function 6	OFF ON	ON	Release of kick pulses
6688A	Δf KICK	SYNC function 6	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6689A	T SW-ON MIN	SYNC function 6	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6701	Synchronizing	SYNC function 7	ON OFF	OFF	Synchronizing Function
6702	SyncSD	SYNC function 7	(Setting options depend on configuration)	None	synchronizable switching device
6703	Umin	SYNC function 7	20 .. 125 V	90 V	Minimum voltage limit: Umin
6704	Umax	SYNC function 7	20 .. 140 V	110 V	Maximum voltage limit: Umax
6705	U<	SYNC function 7	1 .. 60 V	5 V	Threshold U1, U2 without voltage

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6706	U>	SYNC function 7	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6707	SYNC U1<U2>	SYNC function 7	YES NO	NO	ON-Command at U1< and U2>
6708	SYNC U1>U2<	SYNC function 7	YES NO	NO	ON-Command at U1> and U2<
6709	SYNC U1<U2<	SYNC function 7	YES NO	NO	ON-Command at U1< and U2<
6711A	TSUP VOLTAGE	SYNC function 7	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6712	T-SYN. DURATION	SYNC function 7	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6713	PHASE SEQUENCE	SYNC function 7	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6720	T-CB close	SYNC function 7	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6721	Balancing U1/U2	SYNC function 7	0.50 .. 2.00	1.00	Balancing factor U1/U2
6722A	ANGLE ADJUSTM.	SYNC function 7	0 .. 359 °	0 °	Angle adjustment (transformer)
6724	VT Un1, primary	SYNC function 7	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6725	VT Un2, primary	SYNC function 7	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6726	Unom SECONDARY	SYNC function 7	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6727	T CLS CMD MIN	SYNC function 7	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6730	dU ASYN U2>U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6731	dU ASYN U2<U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6732	df ASYN f2>f1	SYNC function 7	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6733	df ASYN f2<f1	SYNC function 7	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6740	SYNC PERMIS.	SYNC function 7	NO YES	NO	Switching at synchronous conditions
6741	F SYNCHRON	SYNC function 7	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6742	dU SYN U2>U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6743	dU SYN U2<U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6744	dα SYN α2>α1	SYNC function 7	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6745	dα SYN α2<α1	SYNC function 7	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6746	T SYNC-DELAY	SYNC function 7	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6750	dU SYNC U2>U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6751	dU SYNC U2<U1	SYNC function 7	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6752	df SYNC f2>f1	SYNC function 7	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6753	df SYNC f2<f1	SYNC function 7	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6754	dα SYNC α2> α1	SYNC function 7	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6755	dα SYNC α2< α1	SYNC function 7	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6760	TAP CHG. OBJ.	SYNC function 7	(Setting options depend on configuration)	None	Tap changer object
6761	#STEP NOM. VOLT	SYNC function 7	-62 .. 62	0	# of tap changer at nom. voltage
6762	TAP STEP	SYNC function 7	0.00 .. 20.00 %	0.00 %	Step size tap changer
6770	U BALANCING	SYNC function 7	OFF Tap changer Pulse	OFF	Voltage balancing
6771	T U PULS MIN	SYNC function 7	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6772	T U PULS MAX	SYNC function 7	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6773	dU2 / dt	SYNC function 7	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6774	T U PAUSE	SYNC function 7	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6775A	SMOOTHING U	SYNC function 7	1 .. 100	1	Smoothing factor for the voltage
6776A	(U/Un) / (f/fn)	SYNC function 7	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6780	f BALANCING	SYNC function 7	OFF Pulse	OFF	Frequency balancing
6781	T f PULS MIN	SYNC function 7	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6782	T f PULS MAX	SYNC function 7	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6783	df2 / dt	SYNC function 7	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6784	T f PAUSE	SYNC function 7	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6785	Δf SET POINT	SYNC function 7	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6786A	SMOOTHING f	SYNC function 7	1 .. 100	1	Smoothing factor for the frequency
6787	KICK PULSE	SYNC function 7	OFF ON	ON	Release of kick pulses
6788A	Δf KICK	SYNC function 7	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6789A	T SW-ON MIN	SYNC function 7	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
6801	Synchronizing	SYNC function 8	ON OFF	OFF	Synchronizing Function
6802	SyncSD	SYNC function 8	(Setting options depend on configuration)	None	synchronizable switching device
6803	Umin	SYNC function 8	20 .. 125 V	90 V	Minimum voltage limit: Umin
6804	Umax	SYNC function 8	20 .. 140 V	110 V	Maximum voltage limit: Umax
6805	U<	SYNC function 8	1 .. 60 V	5 V	Threshold U1, U2 without voltage
6806	U>	SYNC function 8	20 .. 140 V	80 V	Threshold U1, U2 with voltage
6807	SYNC U1<U2>	SYNC function 8	YES NO	NO	ON-Command at U1< and U2>
6808	SYNC U1>U2<	SYNC function 8	YES NO	NO	ON-Command at U1> and U2<
6809	SYNC U1<U2<	SYNC function 8	YES NO	NO	ON-Command at U1< and U2<
6811A	TSUP VOLTAGE	SYNC function 8	0.0 .. 60.0 sec; ∞	0.1 sec	Supervision time Dead Line / Dead Bus
6812	T-SYN. DURATION	SYNC function 8	0.01 .. 1200.00 sec; ∞	1200.00 sec	Maximum duration of synchronism-check
6813	PHASE SEQUENCE	SYNC function 8	NO L1 L2 L3 L1 L3 L2	NO	Phase sequence check
6820	T-CB close	SYNC function 8	10 .. 1000 ms; ∞	∞ ms	Closing (operating) time of CB
6821	Balancing U1/U2	SYNC function 8	0.50 .. 2.00	1.00	Balancing factor U1/U2
6822A	ANGLE ADJUSTM.	SYNC function 8	0 .. 359 °	0 °	Angle adjustment (transformer)
6824	VT Un1, primary	SYNC function 8	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U1, primary
6825	VT Un2, primary	SYNC function 8	0.10 .. 999.99 kV	15.75 kV	VT nominal voltage U2, primary
6826	Unom SECONDARY	SYNC function 8	80 .. 125 V	100 V	Rated Secondary Voltage (Ph-Ph)
6827	T CLS CMD MIN	SYNC function 8	0.01 .. 10.00 sec	0.10 sec	Min close command time of the CB
6830	dU ASYN U2>U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6831	dU ASYN U2<U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6832	df ASYN f2>f1	SYNC function 8	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6833	df ASYN f2<f1	SYNC function 8	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6840	SYNC PERMIS.	SYNC function 8	NO YES	NO	Switching at synchronous conditions
6841	F SYNCHRON	SYNC function 8	0.01 .. 0.04 Hz	0.01 Hz	Frequency threshold ASYN <--> SYN
6842	dU SYN U2>U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6843	dU SYN U2<U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6844	dα SYN α2>α1	SYNC function 8	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
6845	dα SYN α2<α1	SYNC function 8	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6846	T SYNC-DELAY	SYNC function 8	0.00 .. 60.00 sec	10.00 sec	Release delay at synchronous conditions
6850	dU SYNC U2>U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2>U1
6851	dU SYNC U2<U1	SYNC function 8	0.0 .. 40.0 V	2.0 V	Maximum voltage difference U2<U1
6852	df SYNC f2>f1	SYNC function 8	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2>f1
6853	df SYNC f2<f1	SYNC function 8	0.00 .. 2.00 Hz	0.10 Hz	Maximum frequency difference f2<f1
6854	dα SYNC α2> α1	SYNC function 8	2 .. 80 °	10 °	Maximum angle difference alpha2>alpha1
6855	dα SYNC α2< α1	SYNC function 8	2 .. 80 °	10 °	Maximum angle difference alpha2<alpha1
6860	TAP CHG. OBJ.	SYNC function 8	(Setting options depend on configuration)	None	Tap changer object
6861	#STEP NOM. VOLT	SYNC function 8	-62 .. 62	0	# of tap changer at nom. voltage
6862	TAP STEP	SYNC function 8	0.00 .. 20.00 %	0.00 %	Step size tap changer
6870	U BALANCING	SYNC function 8	OFF Tap changer Pulse	OFF	Voltage balancing
6871	T U PULS MIN	SYNC function 8	10 .. 1000 ms	100 ms	Minimum pulse duration for U balancing
6872	T U PULS MAX	SYNC function 8	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for U balancing
6873	dU2 / dt	SYNC function 8	0.1 .. 50.0 V/s	2.0 V/s	dU/dt of the controller
6874	T U PAUSE	SYNC function 8	0.00 .. 32.00 sec	5.00 sec	Transient time of the U-controller
6875A	SMOOTHING U	SYNC function 8	1 .. 100	1	Smoothing factor for the voltage
6876A	(U/Un) / (f/fn)	SYNC function 8	1.00 .. 1.40	1.10	Maximum permissible overexcitation
6880	f BALANCING	SYNC function 8	OFF Pulse	OFF	Frequency balancing
6881	T f PULS MIN	SYNC function 8	10 .. 1000 ms	20 ms	Minimum pulse duration for f balancing
6882	T f PULS MAX	SYNC function 8	1.00 .. 32.00 sec; ∞	1.00 sec	Maximum pulse duration for f balancing
6883	df2 / dt	SYNC function 8	0.05 .. 5.00 Hz/s	1.00 Hz/s	df/dt of the controller
6884	T f PAUSE	SYNC function 8	0.00 .. 32.00 sec	5.00 sec	Transient time of the f-controller
6885	Δf SET POINT	SYNC function 8	-1.00 .. 1.00 Hz; < > 0	0.04 Hz	Set point for frequency balancing
6886A	SMOOTHING f	SYNC function 8	1 .. 100	1	Smoothing factor for the frequency
6887	KICK PULSE	SYNC function 8	OFF ON	ON	Release of kick pulses
6888A	Δf KICK	SYNC function 8	-0.10 .. 0.10 Hz; < > 0	0.04 Hz	df for the kick pulse
6889A	T SW-ON MIN	SYNC function 8	0.2 .. 1000.0 sec; 0	5.0 sec	Min time to switch-on without balancing
7301	SCAL. U	AnalogOutputs	10.0 .. 180.0 V	100.0 V	Scaling factor U for 100%
7302	SCAL. f	AnalogOutputs	10.00 .. 200.00 Hz	100.00 Hz	Scaling factor f for 100%
7303	SCAL. ΔU	AnalogOutputs	1.0 .. 180.0 V	5.0 V	Scaling factor DELTA U for 100%
7304	SCAL. Δf	AnalogOutputs	1.00 .. 200.00 Hz	10.00 Hz	Scaling factor DELTA f for 100%
7305	SCAL. Δα	AnalogOutputs	1.0 .. 180.0 °	10.0 °	Scaling factor DELTA ALPHA for 100%
7311	ANALOGOUTPUT B1	AnalogOutputs	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output B1 (Port B)
7312	MIN. VALUE(B1)	AnalogOutputs	-200.00 .. 100.00 %	-50.00 %	Minimum Percentage Output Value (B1)
7313	MIN. OUTPUT(B1)	AnalogOutputs	0 .. 10 mA	4 mA	Minimum Current Output Value (B1)

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
7314	MAX. VALUE(B1)	AnalogOutputs	10.00 .. 200.00 %	50.00 %	Maximum Percentage Output Value (B1)
7315	MAX. OUTPUT(B1)	AnalogOutputs	10 .. 22 mA	20 mA	Maximum Current Output Value (B1)
7321	ANALOGOUTPUT B2	AnalogOutputs	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output B2 (Port B)
7322	MIN. VALUE(B2)	AnalogOutputs	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (B2)
7323	MIN. OUTPUT(B2)	AnalogOutputs	0 .. 10 mA	4 mA	Minimum Current Output Value (B2)
7324	MAX. VALUE(B2)	AnalogOutputs	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (B2)
7325	MAX. OUTPUT(B2)	AnalogOutputs	10 .. 22 mA	20 mA	Maximum Current Output Value (B2)
7331	ANALOGOUTPUT D1	AnalogOutputs	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output D1 (Port D)
7332	MIN. VALUE(D1)	AnalogOutputs	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (D1)
7333	MIN. OUTPUT(D1)	AnalogOutputs	0 .. 10 mA	4 mA	Minimum Current Output Value (D1)
7334	MAX. VALUE(D1)	AnalogOutputs	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (D1)
7335	MAX. OUTPUT(D1)	AnalogOutputs	10 .. 22 mA	20 mA	Maximum Current Output Value (D1)
7341	ANALOGOUTPUT D2	AnalogOutputs	U1 [%] f1 [%] U2 [%] f2 [%] ΔU [%] Δf [%] Δα [%] |ΔU| [%] |Δf| [%] |Δα| [%]	ΔU [%]	Analog Output D2 (Port D)
7342	MIN. VALUE(D2)	AnalogOutputs	-200.00 .. 100.00 %	0.00 %	Minimum Percentage Output Value (D2)
7343	MIN. OUTPUT(D2)	AnalogOutputs	0 .. 10 mA	4 mA	Minimum Current Output Value (D2)
7344	MAX. VALUE(D2)	AnalogOutputs	10.00 .. 200.00 %	100.00 %	Maximum Percentage Output Value (D2)
7345	MAX. OUTPUT(D2)	AnalogOutputs	10 .. 22 mA	20 mA	Maximum Current Output Value (D2)
8501	MEAS. VALUE 1>	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV1>
8502	THRESHOLD MV1>	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV1>
8503	MEAS. VALUE 2<	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV2<

Addr.	Parameter	Function	Setting Options	Default Setting	Comments
8504	THRESHOLD MV2<	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV2<
8505	MEAS. VALUE 3>	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV3>
8506	THRESHOLD MV3>	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV3>
8507	MEAS. VALUE 4<	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV4<
8508	THRESHOLD MV4<	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV4<
8509	MEAS. VALUE 5>	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV5>
8510	THRESHOLD MV5>	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV5>
8511	MEAS. VALUE 6<	Threshold	Disabled Ua Ub Uc Ud Ue Uf	Disabled	Measured Value for Threshold MV6<
8512	THRESHOLD MV6<	Threshold	2 .. 200 %	100 %	Pickup Value of Measured Value MV6<
8601	EXTERN TRIP 1	External Trips	OFF ON Block relay	OFF	External Trip Function 1
8602	T DELAY	External Trips	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 1 Time Delay
8701	EXTERN TRIP 2	External Trips	OFF ON Block relay	OFF	External Trip Function 2
8702	T DELAY	External Trips	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 2 Time Delay
8801	EXTERN TRIP 3	External Trips	OFF ON Block relay	OFF	External Trip Function 3
8802	T DELAY	External Trips	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 3 Time Delay
8901	EXTERN TRIP 4	External Trips	OFF ON Block relay	OFF	External Trip Function 4
8902	T DELAY	External Trips	0.00 .. 60.00 sec; ∞	1.00 sec	Ext. Trip 4 Time Delay

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 indications 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
-	Reset LED (Reset LED)	Device	IntSP	on	*		*	LED			BO		70	19	1	No
-	Test mode (Test mode)	Device	IntSP	ON OFF	*		*	LED			BO		70	21	1	Yes
-	Stop data transmission (DataStop)	Device	IntSP	ON OFF	*		*	LED			BO		70	20	1	Yes
-	Unlock data transmission via BI (UnlockDT)	Device	IntSP				*									
-	>Back Light on (>Light on)	Device	SP	ON OFF	*		*	LED	BI		BO					
-	Clock Synchronization (SynchClock)	Device	IntSP _Ev	*	*		*	LED			BO					
-	Hardware Test Mode (HWTestMod)	Device	IntSP	ON OFF	*		*	LED			BO					
-	Disturbance CFC (Distur.CFC)	Device	OUT	on off	*			LED			BO					
-	Setting Group A is active (GroupA act)	Change Group	IntSP	ON OFF	*		*	LED			BO		70	23	1	Yes
-	Setting Group B is active (GroupB act)	Change Group	IntSP	ON OFF	*		*	LED			BO		70	24	1	Yes
-	Setting Group C is active (GroupC act)	Change Group	IntSP	ON OFF	*		*	LED			BO		70	25	1	Yes
-	Setting Group D is active (GroupD act)	Change Group	IntSP	ON OFF	*		*	LED			BO		70	26	1	Yes
-	Fault Recording Start (FltRecSta)	Osc. Fault Rec.	IntSP	ON OFF	*		*	LED			BO					
-	Controlmode REMOTE (ModeREMOTE)	Cntrl Authority	IntSP	ON OFF	*			LED								

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
-	Control Authority (Cntrl Auth)	Cntrl Authority	IntSP	ON OFF	*			LED								
-	Controlmode LOCAL (ModeLOCAL)	Cntrl Authority	IntSP	ON OFF	*			LED								
-	Control Authority (Cntrl Auth)	Cntrl Authority	DP	ON OFF	*			LED					101	85	1	Yes
-	Controlmode LOCAL (ModeLOCAL)	Cntrl Authority	DP	ON OFF	*			LED					101	86	1	Yes
-	Reset meter (Meter res)	Measurement	IntSP_Ev	ON	*				BI							
-	Reset Minimum and Maximum counter (ResMinMax)	Min/Max meter	IntSP_Ev	ON	*											
-	Error Systeminterface (SysIntErr.)	Protocol	IntSP	ON OFF	*			LED			BO					
1	No Function configured (Not configured)	Device	SP													
2	Function Not Available (Non Existent)	Device	SP													
3	>Synchronize Internal Real Time Clock (>Time Synch)	Device	SP_Ev	*	*		*	LED	BI		BO		135	48	1	No
4	>Trigger Waveform Capture (>Trig.Wave.Cap.)	Osc. Fault Rec.	SP	*	*		m	LED	BI		BO		135	49	1	Yes
5	>Reset LED (>Reset LED)	Device	SP	*	*		*	LED	BI		BO		135	50	1	Yes
7	>Setting Group Select Bit 0 (>Set Group Bit0)	Change Group	SP	*	*		*	LED	BI		BO		135	51	1	Yes
8	>Setting Group Select Bit 1 (>Set Group Bit1)	Change Group	SP	*	*		*	LED	BI		BO		135	52	1	Yes
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	SP	*	*		*	LED	BI		BO		135	53	1	Yes
16	>Stop data transmission (>DataStop)	Device	SP	*	*		*	LED	BI		BO		135	54	1	Yes
51	Device is Operational and Protecting (Device OK)	Device	OUT	ON OFF	*		*	LED			BO		135	81	1	Yes
52	At Least 1 Protection Funct. is Active (ProtActive)	Device	IntSP	ON OFF	*		*	LED			BO		70	18	1	Yes
55	Reset Device (Reset Device)	Device	OUT	ON	*		*	LED			BO					
56	Initial Start of Device (Initial Start)	Device	OUT	ON	*		*	LED			BO		70	5	1	No
67	Resume (Resume)	Device	OUT	ON	*		*	LED			BO					
68	Clock Synchronization Error (Clock SyncError)	Supervision	OUT	on off	*		*	LED			BO					
69	Daylight Saving Time (DayLightSavTime)	Device	OUT	ON OFF	*		*	LED			BO					
70	Setting calculation is running (Settings Calc.)	Device	OUT	ON OFF	*		*	LED			BO		70	22	1	Yes
71	Settings Check (Settings Check)	Device	OUT	*	*		*	LED			BO					
72	Level-2 change (Level-2 change)	Device	OUT	ON OFF	*		*	LED			BO					
73	Local setting change (Local change)	Device	OUT	*	*		*									

No.	Description	Function	Type of In-for-matio n	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
110	Event lost (Event Lost)	Device	OUT_ Ev	ON	*		*	LED			BO		135	130	1	No
113	Flag Lost (Flag Lost)	Device	OUT	ON	*		m	LED			BO		135	136	1	Yes
125	Chatter ON (Chatter ON)	Device	OUT	ON OFF	*		*	LED			BO		135	145	1	Yes
140	Error with a summary alarm (Error Sum Alarm)	Supervision	OUT	on off	*		*	LED			BO		70	47	1	Yes
160	Alarm Summary Event (Alarm Sum Event)	Supervision	OUT	on off	*		*	LED			BO		70	46	1	Yes
170.0001	>Sync-group 1 activate (>Sy1 activ)	SYNC function 1	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 2 activate (>Sy2 activ)	SYNC function 2	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 3 activate (>Sy3 activ)	SYNC function 3	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 4 activate (>Sy4 activ)	SYNC function 4	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 5 activate (>Sy5 activ)	SYNC function 5	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 6 activate (>Sy6 activ)	SYNC function 6	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 7 activate (>Sy7 activ)	SYNC function 7	SP	on off	*		*	LED	BI		BO					
170.0001	>Sync-group 8 activate (>Sy8 activ)	SYNC function 8	SP	on off	*		*	LED	BI		BO					
170.0050	Sync-group 1: Error (Sy1 Error)	SYNC function 1	OUT	*	on off		*	LED			BO		41	80	2	Yes
170.0050	Sync-group 2: Error (Sy2 Error)	SYNC function 2	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 3: Error (Sy3 Error)	SYNC function 3	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 4: Error (Sy4 Error)	SYNC function 4	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 5: Error (Sy5 Error)	SYNC function 5	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 6: Error (Sy6 Error)	SYNC function 6	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 7: Error (Sy7 Error)	SYNC function 7	OUT	*	on off		*	LED			BO					
170.0050	Sync-group 8: Error (Sy8 Error)	SYNC function 8	OUT	*	on off		*	LED			BO					
170.0051	Sync-group 1 is BLOCKED (Sy1 BLOCK)	SYNC function 1	OUT	on off	on off		*	LED			BO		41	204	1	Yes
170.0051	Sync-group 2 is BLOCKED (Sy2 BLOCK)	SYNC function 2	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 3 is BLOCKED (Sy3 BLOCK)	SYNC function 3	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 4 is BLOCKED (Sy4 BLOCK)	SYNC function 4	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 5 is BLOCKED (Sy5 BLOCK)	SYNC function 5	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 6 is BLOCKED (Sy6 BLOCK)	SYNC function 6	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 7 is BLOCKED (Sy7 BLOCK)	SYNC function 7	OUT	on off	on off		*	LED			BO					
170.0051	Sync-group 8 is BLOCKED (Sy8 BLOCK)	SYNC function 8	OUT	on off	on off		*	LED			BO					
170.2007	Sync-group 1 Measuring req. of Control (Sy1 Ctrl)	SYNC function 1	SP	*	on off		*	LED			BO					
170.2007	Sync-group 2 Measuring req. of Control (Sy2 Ctrl)	SYNC function 2	SP	*	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
170.2007	Sync-group 3 Measuring req. of Control (Sy3 Ctrl)	SYNC function 3	SP	*	on off		*	LED			BO					
170.2007	Sync-group 4 Measuring req. of Control (Sy4 Ctrl)	SYNC function 4	SP	*	on off		*	LED			BO					
170.2007	Sync-group 5 Measuring req. of Control (Sy5 Ctrl)	SYNC function 5	SP	*	on off		*	LED			BO					
170.2007	Sync-group 6 Measuring req. of Control (Sy6 Ctrl)	SYNC function 6	SP	*	on off		*	LED			BO					
170.2007	Sync-group 7 Measuring req. of Control (Sy7 Ctrl)	SYNC function 7	SP	*	on off		*	LED			BO					
170.2007	Sync-group 8 Measuring req. of Control (Sy8 Ctrl)	SYNC function 8	SP	*	on off		*	LED			BO					
170.2008	>BLOCK Sync-group 1 (>BLOCK Sy1)	SYNC function 1	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 2 (>BLOCK Sy2)	SYNC function 2	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 3 (>BLOCK Sy3)	SYNC function 3	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 4 (>BLOCK Sy4)	SYNC function 4	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 5 (>BLOCK Sy5)	SYNC function 5	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 6 (>BLOCK Sy6)	SYNC function 6	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 7 (>BLOCK Sy7)	SYNC function 7	SP	*	*		*	LED	BI		BO					
170.2008	>BLOCK Sync-group 8 (>BLOCK Sy8)	SYNC function 8	SP	*	*		*	LED	BI		BO					
170.2022	Sync-group 1: measurement in progress (Sy1 measu.)	SYNC function 1	OUT	*	on off		*	LED			BO		41	203	2	Yes
170.2022	Sync-group 2: measurement in progress (Sy2 measu.)	SYNC function 2	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 3: measurement in progress (Sy3 measu.)	SYNC function 3	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 4: measurement in progress (Sy4 measu.)	SYNC function 4	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 5: measurement in progress (Sy5 measu.)	SYNC function 5	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 6: measurement in progress (Sy6 measu.)	SYNC function 6	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 7: measurement in progress (Sy7 measu.)	SYNC function 7	OUT	*	on off		*	LED			BO					
170.2022	Sync-group 8: measurement in progress (Sy8 measu.)	SYNC function 8	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 2	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 3	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 4	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 5	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 6	OUT	*	on off		*	LED			BO					
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 7	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
170.2025	Sync. Monitoring time exceeded (Sync.MonTimeExc)	SYNC function 8	OUT	*	on off		*	LED			BO					
170.2097	Sync-group 1: Parameter not plausible (Sy1 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 2: Parameter not plausible (Sy2 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 3: Parameter not plausible (Sy3 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 4: Parameter not plausible (Sy4 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 5: Parameter not plausible (Sy5 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 6: Parameter not plausible (Sy6 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 7: Parameter not plausible (Sy7 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2097	Sync-group 8: Parameter not plausible (Sy8 ParErr)	Supervision	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 1 is switched OFF (Sy1 OFF)	SYNC function 1	OUT	on off	*		*	LED			BO		41	36	1	Yes
170.2101	Sync-group 2 is switched OFF (Sy2 OFF)	SYNC function 2	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 3 is switched OFF (Sy3 OFF)	SYNC function 3	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 4 is switched OFF (Sy4 OFF)	SYNC function 4	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 5 is switched OFF (Sy5 OFF)	SYNC function 5	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 6 is switched OFF (Sy6 OFF)	SYNC function 6	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 7 is switched OFF (Sy7 OFF)	SYNC function 7	OUT	on off	*		*	LED			BO					
170.2101	Sync-group 8 is switched OFF (Sy8 OFF)	SYNC function 8	OUT	on off	*		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 1	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 2	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 3	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 4	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 5	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 6	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 7	OUT	*	on off		*	LED			BO					
170.2300	Sync. Release of Close Command 1 (Sync CloseRel 1)	SYNC function 8	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 1	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 2	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 3	OUT	*	on off		*	LED			BO					

No.	Description	Function	Type of In-for-matio n	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
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 4	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 5	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 6	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 7	OUT	*	on off		*	LED			BO					
170.2301	Sync. Release of Close Command 2 (Sync CloseRel 2)	SYNC function 8	OUT	*	on off		*	LED			BO					
170.2311	Sync. Function group 1 is active (Sy1 active)	SYNC function 1	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 2 is active (Sy2 active)	SYNC function 2	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 3 is active (Sy3 active)	SYNC function 3	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 4 is active (Sy4 active)	SYNC function 4	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 5 is active (Sy5 active)	SYNC function 5	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 6 is active (Sy6 active)	SYNC function 6	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 7 is active (Sy7 active)	SYNC function 7	OUT	on off	*		*	LED			BO					
170.2311	Sync. Function group 8 is active (Sy8 active)	SYNC function 8	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 1 is switched on (Sy1 on)	SYNC function 1	OUT	on off	*		*	LED			BO		41	89	1	Yes
170.2312	Sync-group 2 is switched on (Sy2 on)	SYNC function 2	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 3 is switched on (Sy3 on)	SYNC function 3	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 4 is switched on (Sy4 on)	SYNC function 4	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 5 is switched on (Sy5 on)	SYNC function 5	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 6 is switched on (Sy6 on)	SYNC function 6	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 7 is switched on (Sy7 on)	SYNC function 7	OUT	on off	*		*	LED			BO					
170.2312	Sync-group 8 is switched on (Sy8 on)	SYNC function 8	OUT	on off	*		*	LED			BO					
177	Failure: Battery empty (Fail Bat-tery)	Supervision	OUT	on off	*		*	LED			BO					
181	Error: A/D converter (Error A/D-conv.)	Supervision	OUT	on off	*		*	LED			BO					
183	Error Board 1 (Error Board 1)	Supervision	OUT	on off	*		*	LED			BO					
184	Error Board 2 (Error Board 2)	Supervision	OUT	on off	*		*	LED			BO					
185	Error Board 3 (Error Board 3)	Supervision	OUT	on off	*		*	LED			BO					
186	Error Board 4 (Error Board 4)	Supervision	OUT	on off	*		*	LED			BO					
187	Error Board 5 (Error Board 5)	Supervision	OUT	on off	*		*	LED			BO					

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	Configurable in Matrix: LED	Binary Input	Function Key	Relay	Chatter Suppression	IEC 60870-5-103: Type	Information Number	Data Unit	General Interrogation
188	Error Board 6 (Error Board 6)	Supervision	OUT	on off	*		*	LED			BO					
189	Error Board 7 (Error Board 7)	Supervision	OUT	on off	*		*	LED			BO					
190	Error Board 0 (Error Board 0)	Supervision	OUT	on off	*		*	LED			BO					
191	Error: Offset (Error Offset)	Supervision	OUT	on off	*		*	LED			BO					
193	Alarm: Analog input adjustment invalid (Alarm adjustm.)	Supervision	OUT	on off	*		*	LED			BO					
222.0043	>Sync. Measurement Only (>Sync. MeasOnly)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2011	>Sync. Start of Synchronization (>Sync Start)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2012	>Sync. Stop of Synchronization (>Sync Stop)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2013	>Sync. Switch to U1> and U2< (>Sync U1>U2<)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2014	>Sync. Switch to U1< and U2> (>Sync U1<U2>)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2015	>Sync. Switch to U1< and U2< (>Sync U1<U2<)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2027	Sync. Condition U1>U2< fulfilled (Sync. U1> U2<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2028	Sync. Condition U1<U2> fulfilled (Sync. U1< U2>)	SYNC General	OUT	*	on off		*	LED			BO					
222.2029	Sync. Condition U1<U2< fulfilled (Sync. U1< U2<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2030	Sync. Voltage difference (Udiff) okay (Sync. Udiff ok)	SYNC General	OUT	*	on off		*	LED			BO		41	207	2	Yes
222.2031	Sync. Frequency difference (fdiff) okay (Sync. fdiff ok)	SYNC General	OUT	*	on off		*	LED			BO		41	208	2	Yes
222.2032	Sync. Angle difference (adiff) okay (Sync. α ok)	SYNC General	OUT	*	on off		*	LED			BO		41	209	2	Yes
222.2033	Sync. Frequency f1 > fmax permissible (Sync. f1>>)	SYNC General	OUT	*	on off		*	LED			BO					
222.2034	Sync. Frequency f1 < fmin permissible (Sync. f1<<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2035	Sync. Frequency f2 > fmax permissible (Sync. f2>>)	SYNC General	OUT	*	on off		*	LED			BO					
222.2036	Sync. Frequency f2 < fmin permissible (Sync. f2<<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2037	Sync. Voltage U1 > Umax permissible (Sync. U1>>)	SYNC General	OUT	*	on off		*	LED			BO					
222.2038	Sync. Voltage U1 < Umin permissible (Sync. U1<<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2039	Sync. Voltage U2 > Umax permissible (Sync. U2>>)	SYNC General	OUT	*	on off		*	LED			BO					
222.2040	Sync. Voltage U2 < Umin permissible (Sync. U2<<)	SYNC General	OUT	*	on off		*	LED			BO					
222.2090	Sync. Udiff too large (U2>U1) (Sync U2>U1)	SYNC General	OUT	*	on off		*	LED			BO					
222.2091	Sync. Udiff too large (U2<U1) (Sync U2<U1)	SYNC General	OUT	*	on off		*	LED			BO					
222.2092	Sync. fdiff too large (f2>f1) (Sync f2>f1)	SYNC 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
222.2093	Sync. fdiff too large (f2<f1) (Sync f2<f1)	SYNC General	OUT	*	on off		*	LED			BO					
222.2094	Sync. alphadiff too large (a2>a1) (Sync $\alpha 2>\alpha 1$)	SYNC General	OUT	*	on off		*	LED			BO					
222.2095	Sync. alphadiff too large (a2<a1) (Sync $\alpha 2<\alpha 1$)	SYNC General	OUT	*	on off		*	LED			BO					
222.2096	Sync. Multiple selection of func-groups (Sync FG-Error)	Supervision	OUT	on off	*		*	LED			BO					
222.2102	>BLOCK Sync. CLOSE command (>BLK Sync CLOSE)	SYNC General	SP	*	on off		*	LED	BI		BO					
222.2103	Sync. CLOSE command is BLOCKED (Sync. CLOSE BLK)	SYNC General	OUT	*	on off		*	LED			BO		41	37	2	Yes
222.2302	Sync. Synchronization condition 1 okay (Sync synchron 1)	SYNC General	OUT	*	on off		*	LED			BO		41	81	2	Yes
222.2303	Sync. Synchronization condition 2 okay (Sync synchron 2)	SYNC General	OUT	*	on off		*	LED			BO		41	82	2	Yes
222.2309	Sync-supervision U1,U2 asym-metrical (Sync sup.asym.)	SYNC General	OUT	*	on off		*	LED			BO					
222.2310	Sync-supervision Alpha> (Sync sup. α)	SYNC General	OUT	*	on off		*	LED			BO					
222.2331	Sync. Failure in Configuration (Sync Fail.Conf.)	Supervision	OUT	on off	*		*	LED			BO					
222.2332	Sync:Synchronization cond. f1 (Sync f syn 1)	SYNC General	OUT	*	on off		*	LED			BO					
222.2333	Sync:Synchronization cond. f2 (Sync f syn 2)	SYNC General	OUT	*	on off		*	LED			BO					
222.2334	Sync:Stop by invalid TapChang-erVal. (Sync Stop TS)	SYNC General	OUT	on off	*		*	LED			BO					
222.2335	Sync: U1 phase sequence is L1 L2 L3 (SyncSEQ U1 123)	SYNC General	OUT	on off	*		*	LED			BO					
222.2336	Sync: U1 phase sequence is L1 L3 L2 (SyncSEQ U1 132)	SYNC General	OUT	on off	*		*	LED			BO					
222.2337	Sync: U2 phase sequence is L1 L2 L3 (SyncSEQ U2 123)	SYNC General	OUT	on off	*		*	LED			BO					
222.2338	Sync: U2 phase sequence is L1 L3 L2 (SyncSEQ U2 132)	SYNC General	OUT	on off	*		*	LED			BO					
222.2340	>Commisioning test synchroniza-tion (>COM Test sync.)	SYNC General	SP	on off	on off		*	LED	BI		BO					
222.2341	Comm: Release of Close Command 1 (Test CloseRel 1)	SYNC General	OUT	on off	on off		m	LED			BO					
222.2342	Comm: Release of Close Command 2 (Test CloseRel 2)	SYNC General	OUT	on off	on off		m	LED			BO					
223.2320	>BLOCK Balancing commands (>BLK Balancing)	SYNC General	SP	on off	on off		*	LED	BI		BO		41	70	1	Yes
223.2321	>BLOCK Voltage balancing com-mands (>BLK U Balanc.)	SYNC General	SP	on off	on off		*	LED	BI		BO		41	71	1	Yes
223.2322	>BLOCK Frequency balancing commands (>BLK f Balanc.)	SYNC General	SP	on off	on off		*	LED	BI		BO		41	72	1	Yes
223.2323	>Start balancing sequence (>Start Balanc.)	SYNC General	SP	on off	on off		*	LED	BI		BO		41	73	1	Yes
223.2324	Sync: decrease voltage U2 (Sync U2 down)	SYNC General	OUT	*	*		m	LED			BO		41	74	1	Yes
223.2325	Sync: increase voltage U2 (Sync U2 up)	SYNC General	OUT	*	*		m	LED			BO		41	75	1	Yes
223.2326	Sync: decrease frequency f2 (Sync f2 down)	SYNC General	OUT	*	*		m	LED			BO		41	76	1	Yes

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
223.2327	Sync: increase frequency f2 (Sync f2 up)	SYNC General	OUT	*	*		m	LED			BO		41	77	1	Yes
223.2339	Balancing commands are activ (Balanc. activ)	SYNC General	OUT	on off	on off		*	LED			BO					
272	Set Point Operating Hours (SP. Op Hours>)	SetPoint(Stat)	OUT	ON OFF	*		*	LED			BO		135	229	1	Yes
301	Power System fault (Pow.Sys.Flt.)	Device	OUT	ON OFF	ON OFF		*						135	231	2	Yes
302	Fault Event (Fault Event)	Device	OUT	*	ON		*						135	232	2	Yes
320	Warn: Limit of Memory Data exceeded (Warn Mem. Data)	Device	OUT	on off	*		*	LED			BO					
321	Warn: Limit of Memory Parameter exceeded (Warn Mem. Para.)	Device	OUT	on off	*		*	LED			BO					
322	Warn: Limit of Memory Operation exceeded (Warn Mem. Oper.)	Device	OUT	on off	*		*	LED			BO					
323	Warn: Limit of Memory New exceeded (Warn Mem. New)	Device	OUT	on off	*		*	LED			BO					
361	>Failure: Feeder VT (MCB tripped) (>FAIL:Feeder VT)	P.System Data 1	SP	on off	*		*	LED	BI		BO		150	38	1	Yes
399	>U1 MIN/MAX Buffer Reset (>U1 MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
409	>BLOCK Op Counter (>BLOCK Op Count)	Statistics	SP	ON OFF	*		*	LED	BI		BO					
501	Relay PICKUP (Relay PICKUP)	P.System Data 1	OUT	*	on		m	LED			BO		150	151	2	Yes
511	Relay GENERAL TRIP command (Relay TRIP)	P.System Data 1	OUT	*	on		m	LED			BO		150	161	2	Yes
545	Time from Pickup to drop out (PU Time)	Device	VI													
546	Time from Pickup to TRIP (TRIP Time)	Device	VI													
1020	Counter of operating hours (Op.Hours=)	Statistics	VI													
4523	>Block external trip 1 (>BLOCK Ext 1)	External Trips	SP	*	*		*	LED	BI		BO					
4526	>Trigger external trip 1 (>Ext trip 1)	External Trips	SP	on off	*		*	LED	BI		BO		51	126	1	Yes
4531	External trip 1 is switched OFF (Ext 1 OFF)	External Trips	OUT	on off	*		*	LED			BO		51	131	1	Yes
4532	External trip 1 is BLOCKED (Ext 1 BLOCKED)	External Trips	OUT	on off	on off		*	LED			BO		51	132	1	Yes
4533	External trip 1 is ACTIVE (Ext 1 ACTIVE)	External Trips	OUT	on off	*		*	LED			BO		51	133	1	Yes
4536	External trip 1: General picked up (Ext 1 picked up)	External Trips	OUT	*	on off		*	LED			BO		51	136	2	Yes
4537	External trip 1: General TRIP (Ext 1 Gen. TRIP)	External Trips	OUT	*	on		*	LED			BO		51	137	2	Yes
4543	>BLOCK external trip 2 (>BLOCK Ext 2)	External Trips	SP	*	*		*	LED	BI		BO					
4546	>Trigger external trip 2 (>Ext trip 2)	External Trips	SP	on off	*		*	LED	BI		BO		51	146	1	Yes
4551	External trip 2 is switched OFF (Ext 2 OFF)	External Trips	OUT	on off	*		*	LED			BO		51	151	1	Yes
4552	External trip 2 is BLOCKED (Ext 2 BLOCKED)	External Trips	OUT	on off	on off		*	LED			BO		51	152	1	Yes
4553	External trip 2 is ACTIVE (Ext 2 ACTIVE)	External Trips	OUT	on off	*		*	LED			BO		51	153	1	Yes

No.	Description	Function	Type of Information	Log Buffers: Event Log ON/OFF	Trip (Fault) Log On/Off	Ground Fault Log ON/OFF	Marked in Oscill. Record	Configurable in Matrix: LED	Binary Input	Function Key	Relay	Chatter Suppression	IEC 60870-5-103: Type	Information Number	Data Unit	General Interrogation
4556	External trip 2: General picked up (Ext 2 picked up)	External Trips	OUT	*	on off		*	LED			BO		51	156	2	Yes
4557	External trip 2: General TRIP (Ext 2 Gen. TRIP)	External Trips	OUT	*	on		*	LED			BO		51	157	2	Yes
4563	>BLOCK external trip 3 (>BLOCK Ext 3)	External Trips	SP	*	*		*	LED	BI		BO					
4566	>Trigger external trip 3 (>Ext trip 3)	External Trips	SP	on off	*		*	LED	BI		BO		51	166	1	Yes
4571	External trip 3 is switched OFF (Ext 3 OFF)	External Trips	OUT	on off	*		*	LED			BO		51	171	1	Yes
4572	External trip 3 is BLOCKED (Ext 3 BLOCKED)	External Trips	OUT	on off	on off		*	LED			BO		51	172	1	Yes
4573	External trip 3 is ACTIVE (Ext 3 ACTIVE)	External Trips	OUT	on off	*		*	LED			BO		51	173	1	Yes
4576	External trip 3: General picked up (Ext 3 picked up)	External Trips	OUT	*	on off		*	LED			BO		51	176	2	Yes
4577	External trip 3: General TRIP (Ext 3 Gen. TRIP)	External Trips	OUT	*	on		*	LED			BO		51	177	2	Yes
4583	>BLOCK external trip 4 (>BLOCK Ext 4)	External Trips	SP	*	*		*	LED	BI		BO					
4586	>Trigger external trip 4 (>Ext trip 4)	External Trips	SP	on off	*		*	LED	BI		BO		51	186	1	Yes
4591	External trip 4 is switched OFF (Ext 4 OFF)	External Trips	OUT	on off	*		*	LED			BO		51	191	1	Yes
4592	External trip 4 is BLOCKED (Ext 4 BLOCKED)	External Trips	OUT	on off	on off		*	LED			BO		51	192	1	Yes
4593	External trip 4 is ACTIVE (Ext 4 ACTIVE)	External Trips	OUT	on off	*		*	LED			BO		51	193	1	Yes
4596	External trip 4: General picked up (Ext 4 picked up)	External Trips	OUT	*	on off		*	LED			BO		51	196	2	Yes
4597	External trip 4: General TRIP (Ext 4 Gen. TRIP)	External Trips	OUT	*	on		*	LED			BO		51	197	2	Yes
5203	>BLOCK frequency protection (>BLOCK Freq.)	Frequency Prot.	SP	*	*		*	LED	BI		BO					
5206	>BLOCK frequency protection stage f1 (>BLOCK f1)	Frequency Prot.	SP	on off	*		*	LED	BI		BO		70	177	1	Yes
5207	>BLOCK frequency protection stage f2 (>BLOCK f2)	Frequency Prot.	SP	on off	*		*	LED	BI		BO		70	178	1	Yes
5208	>BLOCK frequency protection stage f3 (>BLOCK f3)	Frequency Prot.	SP	on off	*		*	LED	BI		BO		70	179	1	Yes
5209	>BLOCK frequency protection stage f4 (>BLOCK f4)	Frequency Prot.	SP	on off	*		*	LED	BI		BO		70	180	1	Yes
5211	Frequency protection is switched OFF (Freq. OFF)	Frequency Prot.	OUT	on off	*		*	LED			BO		70	181	1	Yes
5212	Frequency protection is BLOCKED (Freq. BLOCKED)	Frequency Prot.	OUT	on off	on off		*	LED			BO		70	182	1	Yes
5213	Frequency protection is ACTIVE (Freq. ACTIVE)	Frequency Prot.	OUT	on off	*		*	LED			BO		70	183	1	Yes
5215	Frequency protection undervolt-age Blk (Freq UnderV Blk)	Frequency Prot.	OUT	on off	on off		*	LED			BO		70	238	1	Yes
5232	Frequency protection: f1 picked up (f1 picked up)	Frequency Prot.	OUT	*	on off		*	LED			BO		70	230	2	Yes
5233	Frequency protection: f2 picked up (f2 picked up)	Frequency Prot.	OUT	*	on off		*	LED			BO		70	231	2	Yes
5234	Frequency protection: f3 picked up (f3 picked up)	Frequency Prot.	OUT	*	on off		*	LED			BO		70	232	2	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
5235	Frequency protection: f4 picked up (f4 picked up)	Frequency Prot.	OUT	*	on off		*	LED			BO		70	233	2	Yes
5236	Frequency protection: f1 TRIP (f1 TRIP)	Frequency Prot.	OUT	*	on		*	LED			BO		70	234	2	Yes
5237	Frequency protection: f2 TRIP (f2 TRIP)	Frequency Prot.	OUT	*	on		*	LED			BO		70	235	2	Yes
5238	Frequency protection: f3 TRIP (f3 TRIP)	Frequency Prot.	OUT	*	on		*	LED			BO		70	236	2	Yes
5239	Frequency protection: f4 TRIP (f4 TRIP)	Frequency Prot.	OUT	*	on		*	LED			BO		70	237	2	Yes
5503	>BLOCK Rate-of-frequency-change prot. (>df/dt block)	df/dt Protect.	SP	*	*		*	LED	BI		BO					
5504	>BLOCK df1/dt stage (>df1/dt block)	df/dt Protect.	SP	on off	*		*	LED	BI		BO		72	1	1	Yes
5505	>BLOCK df2/dt stage (>df2/dt block)	df/dt Protect.	SP	on off	*		*	LED	BI		BO		72	2	1	Yes
5506	>BLOCK df3/dt stage (>df3/dt block)	df/dt Protect.	SP	on off	*		*	LED	BI		BO		72	3	1	Yes
5507	>BLOCK df4/dt stage (>df4/dt block)	df/dt Protect.	SP	on off	*		*	LED	BI		BO		72	4	1	Yes
5511	df/dt is switched OFF (df/dt OFF)	df/dt Protect.	OUT	on off	*		*	LED			BO		72	5	1	Yes
5512	df/dt is BLOCKED (df/dt BLOCKED)	df/dt Protect.	OUT	on off	on off		*	LED			BO		72	6	1	Yes
5513	df/dt is ACTIVE (df/dt ACTIVE)	df/dt Protect.	OUT	on off	*		*	LED			BO		72	7	1	Yes
5515	df/dt is blocked by undervoltage (df/dt U< block)	df/dt Protect.	OUT	on off	on off		*	LED			BO		72	18	1	Yes
5516	Stage df1/dt picked up (df1/dt pickup)	df/dt Protect.	OUT	*	on off		*	LED			BO		72	9	2	Yes
5517	Stage df2/dt picked up (df2/dt pickup)	df/dt Protect.	OUT	*	on off		*	LED			BO		72	10	2	Yes
5518	Stage df3/dt picked up (df3/dt pickup)	df/dt Protect.	OUT	*	on off		*	LED			BO		72	11	2	Yes
5519	Stage df4/dt picked up (df4/dt pickup)	df/dt Protect.	OUT	*	on off		*	LED			BO		72	12	2	Yes
5520	Stage df1/dt TRIP (df1/dt TRIP)	df/dt Protect.	OUT	*	on		*	LED			BO		72	13	2	Yes
5521	Stage df2/dt TRIP (df2/dt TRIP)	df/dt Protect.	OUT	*	on		*	LED			BO		72	14	2	Yes
5522	Stage df3/dt TRIP (df3/dt TRIP)	df/dt Protect.	OUT	*	on		*	LED			BO		72	15	2	Yes
5523	Stage df4/dt TRIP (df4/dt TRIP)	df/dt Protect.	OUT	*	on		*	LED			BO		72	16	2	Yes
5581	>BLOCK Vector Jump (>VEC JUMP block)	Vector Jump	SP	*	*		*	LED	BI		BO					
5582	Vector Jump is switched OFF (VEC JUMP OFF)	Vector Jump	OUT	on off	*		*	LED			BO		72	72	1	Yes
5583	Vector Jump is BLOCKED (VEC JMP BLOCKED)	Vector Jump	OUT	on off	on off		*	LED			BO		72	73	1	Yes
5584	Vector Jump is ACTIVE (VEC JUMP ACTIVE)	Vector Jump	OUT	on off	*		*	LED			BO		72	74	1	Yes
5585	Vector Jump not in measurement range (VEC JUMP Range)	Vector Jump	OUT	on off	*		*	LED			BO		72	75	1	Yes
5586	Vector Jump picked up (VEC JUMP pickup)	Vector Jump	OUT	*	on off		*	LED			BO		72	76	2	Yes
5587	Vector Jump TRIP (VEC JUMP TRIP)	Vector Jump	OUT	*	on		*	LED			BO		72	77	2	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
5588	>Failure: VT Ua (MCB tripped) (>FAIL: VT Ua)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	83	1	Yes
5589	>Failure: VT Ub (MCB tripped) (>FAIL: VT Ub)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	84	1	Yes
5590	>Failure: VT Uc (MCB tripped) (>FAIL: VT Uc)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	85	1	Yes
5591	>Failure: VT Ud (MCB tripped) (>FAIL: VT Ud)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	86	1	Yes
5592	>Failure: VT Ue (MCB tripped) (>FAIL: VT Ue)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	87	1	Yes
5593	>Failure: VT Uf (MCB tripped) (>FAIL: VT Uf)	P.System Data 1	SP	on off	*		*	LED	BI		BO		41	88	1	Yes
6503	>BLOCK undervoltage protection (>BLOCK U/V)	Undervoltage	SP	*	*		*	LED	BI		BO					
6506	>BLOCK Undervoltage protection U< (>BLOCK U<)	Undervoltage	SP	on off	*		*	LED	BI		BO		74	6	1	Yes
6508	>BLOCK Undervoltage protection U<< (>BLOCK U<<)	Undervoltage	SP	on off	*		*	LED	BI		BO		74	8	1	Yes
6513	>BLOCK overvoltage protection (>BLOCK O/V)	Overvoltage	SP	*	*		*	LED	BI		BO					
6516	>BLOCK overvoltage protection U> (>BLOCK U>)	Overvoltage	SP	on off	*		*	LED	BI		BO		74	20	1	Yes
6517	>BLOCK overvoltage protection U>> (>BLOCK U>>)	Overvoltage	SP	on off	*		*	LED	BI		BO		74	21	1	Yes
6530	Undervoltage protection switched OFF (Undervolt. OFF)	Undervoltage	OUT	on off	*		*	LED			BO		74	30	1	Yes
6531	Undervoltage protection is BLOCKED (Undervolt. BLK)	Undervoltage	OUT	on off	on off		*	LED			BO		74	31	1	Yes
6532	Undervoltage protection is ACTIVE (Undervolt. ACT)	Undervoltage	OUT	on off	*		*	LED			BO		74	32	1	Yes
6533	Undervoltage U< picked up (U< picked up)	Undervoltage	OUT	*	on off		*	LED			BO		74	33	2	Yes
6537	Undervoltage U<< picked up (U<< picked up)	Undervoltage	OUT	*	on off		*	LED			BO		74	37	2	Yes
6539	Undervoltage U< TRIP (U< TRIP)	Undervoltage	OUT	*	on		*	LED			BO		74	39	2	Yes
6540	Undervoltage U<< TRIP (U<< TRIP)	Undervoltage	OUT	*	on		*	LED			BO		74	40	2	Yes
6565	Overvoltage protection switched OFF (Overvolt. OFF)	Overvoltage	OUT	on off	*		*	LED			BO		74	65	1	Yes
6566	Overvoltage protection is BLOCKED (Overvolt. BLK)	Overvoltage	OUT	on off	on off		*	LED			BO		74	66	1	Yes
6567	Overvoltage protection is ACTIVE (Overvolt. ACT)	Overvoltage	OUT	on off	*		*	LED			BO		74	67	1	Yes
6568	Overvoltage U> picked up (U> picked up)	Overvoltage	OUT	*	on off		*	LED			BO		74	68	2	Yes
6570	Overvoltage U> TRIP (U> TRIP)	Overvoltage	OUT	*	on		*	LED			BO		74	70	2	Yes
6571	Overvoltage U>> picked up (U>> picked up)	Overvoltage	OUT	*	on off		*	LED			BO		74	71	2	Yes
6573	Overvoltage U>> TRIP (U>> TRIP)	Overvoltage	OUT	*	on		*	LED			BO		74	73	2	Yes
7960	Measured Value MV1> picked up (Meas. Value1>)	Threshold	OUT	*	*		*	LED			BO					
7961	Measured Value MV2< picked up (Meas. Value2<)	Threshold	OUT	*	*		*	LED			BO					
7962	Measured Value MV3> picked up (Meas. Value3>)	Threshold	OUT	*	*		*	LED			BO					

No.	Description	Function	Type of In-formation	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
7963	Measured Value MV4< picked up (Meas. Value4<)	Threshold	OUT	*	*		*	LED			BO					
7964	Measured Value MV5> picked up (Meas. Value5>)	Threshold	OUT	*	*		*	LED			BO					
7965	Measured Value MV6< picked up (Meas. Value6<)	Threshold	OUT	*	*		*	LED			BO					
25007	Voltage U1 at switch on (U1:)	P.System Data 1	VI	*	on off											
25008	Frequency f1 at switch on (f1:)	P.System Data 1	VI	*	on off											
25009	Voltage U2 at switch on (U2:)	P.System Data 1	VI	*	on off											
25010	Frequency f2 at switch on (f2:)	P.System Data 1	VI	*	on off											
25011	Voltagedifference at switch on (dU:)	P.System Data 1	VI	*	on off											
25012	Frequencydifference at switch on (df:)	P.System Data 1	VI	*	on off											
25013	Angledifference at switch on (dα:)	P.System Data 1	VI	*	on off											
25027	>f1 MIN/MAX Buffer Reset (>f1 MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25028	>U2 MIN/MAX Buffer Reset (>U2 MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25029	>f2 MIN/MAX Buffer Reset (>f2 MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25030	>dU MIN/MAX Buffer Reset (>dU MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25031	>df MIN/MAX Buffer Reset (>df MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25032	>dalpha MIN/MAX Buffer Reset (>dα MiMa Reset)	Min/Max meter	SP	ON	*		*		BI		BO					
25036	Error Analog/Digital converter (Error ADC)	Supervision	OUT	on off	*		*	LED			BO					
25037	Sync. Failure Channel supervision U1 (Sync Fail Ch U1)	Supervision	OUT	on off	*		*	LED			BO					
25038	Sync. Failure Channel supervision U2 (Sync Fail Ch U2)	Supervision	OUT	on off	*		*	LED			BO					
25039	Sync: Failure phase sequence U1 (SyncSeq U1 fail)	Supervision	OUT	on off	*		*	LED			BO					
25040	Sync: Failure phase sequence U2 (SyncSeq U2 fail)	Supervision	OUT	on off	*		*	LED			BO					
25041	Error Relay R1 (Error Relay R1)	Supervision	OUT	on off	*		*	LED			BO					
25042	Error Relay R2 (Error Relay R2)	Supervision	OUT	on off	*		*	LED			BO					
25043	Failure Sampling (Fail. Sampling)	Supervision	OUT	on off	*		*	LED			BO					
25054	Sync: Failure data continuity (Sync Fail Data)	Supervision	OUT	on off	*		*	LED			BO					
25059	>Breaker contacts (>Break. Contact)	P.System Data 1	SP	on off	*		*	LED	BI		BO					
25064	Sync: ON - Signal (Sync ON-Sig)	SYNC General	OUT	*	*		m	LED			BO		41	100	2	Yes
25065	Sync: ON 1 - Signal (Sync ON 1-Sig)	SYNC General	OUT	*	*		m	LED			BO					
25066	Sync: ON 2 - Signal (Sync ON 2-Sig)	SYNC General	OUT	*	*		m	LED			BO					
30053	Fault recording is running (Fault rec. run.)	Osc. Fault Rec.	OUT	*	*		*	LED			BO					

A.9 Group Alarms

No.	Description	Function No.	Description
140	Error Sum Alarm	193 25041 25042 25037 25038 25039 25040 222.2096 170.2097 170.2097 170.2097 170.2097 170.2097 170.2097 170.2097 170.2097 222.2331 181	Alarm adjustm. Error Relay R1 Error Relay R2 Sync Fail Ch U1 Sync Fail Ch U2 SyncSeq U1 fail SyncSeq U2 fail Sync FG-Error Sy1 ParErr Sy2 ParErr Sy3 ParErr Sy4 ParErr Sy5 ParErr Sy6 ParErr Sy7 ParErr Sy8 ParErr Sync Fail.Conf. Error A/D-conv.
160	Alarm Sum Event	177 68 191 25054	Fail Battery Clock SyncError Error Offset Sync Fail Data
181	Error A/D-conv.	25036 25043 183 184 185 186 187 188 189 190	Error ADC Fail. Sampling Error Board 1 Error Board 2 Error Board 3 Error Board 4 Error Board 5 Error Board 6 Error Board 7 Error Board 0

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
-	Control DIGSI (CntrlDIGSI)	Cntrl Authority	-	-	-	-	-	CFC	CD	DD
-	Number of switch ONs (#of ONs=)	Statistics	-	-	-	-	-		CD	DD
-	Number of TRIPs (#of TRIPs=)	Statistics	-	-	-	-	-		CD	DD
-	Operating hours greater than (OpHour>)	SetPoint(Stat)	-	-	-	-	-		CD	DD
170.2050	U1 (U1 =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2050	U1 (U1 =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2051	f1 (f1 =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2052	U2 (U2 =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2053	f2 (f2 =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2054	dU (dU =)	SYNC function 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
170.2055	df (df =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2055	df (df =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 1	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 2	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 3	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 4	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 5	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 6	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 7	-	-	-	-	-	CFC	CD	DD
170.2056	dalpha (dα =)	SYNC function 8	-	-	-	-	-	CFC	CD	DD
874	U1 (positive sequence) Voltage Minimum (U1 Min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
875	U1 (positive sequence) Voltage Maximum (U1 Max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
5594	Voltage Ua (Ua =)	Measurement	134	156	No	9	1	CFC	CD	DD
5595	Voltage Ub (Ub =)	Measurement	134	156	No	9	2	CFC	CD	DD
5596	Voltage Uc (Uc =)	Measurement	134	156	No	9	3	CFC	CD	DD
5597	Voltage Ud (Ud =)	Measurement	134	156	No	9	4	CFC	CD	DD
5598	Voltage Ue (Ue =)	Measurement	134	156	No	9	5	CFC	CD	DD
5599	Voltage Uf (Uf =)	Measurement	134	156	No	9	6	CFC	CD	DD
25001	Frequency fa (fa =)	Measurement	134	156	No	9	7	CFC	CD	DD
25002	Frequency fb (fb =)	Measurement	134	156	No	9	8	CFC	CD	DD
25003	Frequency fc (fc =)	Measurement	134	156	No	9	9	CFC	CD	DD
25004	Frequency fd (fd =)	Measurement	134	156	No	9	10	CFC	CD	DD
25005	Frequency fe (fe =)	Measurement	134	156	No	9	11	CFC	CD	DD
25006	Frequency ff (ff =)	Measurement	134	156	No	9	12	CFC	CD	DD
25014	Voltage U2 Minimum (U2min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25015	Voltage U2 Maximum (U2max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25016	Frequency f1 Minimum (f1min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25017	Frequency f1 Maximum (f1max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25018	Frequency f2 Minimum (f2min =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25019	Frequency f2 Maximum (f2max =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25020	Voltage difference dU Minimum (dUmin =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25021	Voltage difference dU Maximum (dUmax =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25022	Frequency difference df Minimum (dfmin =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25023	Frequency difference df Maximum (dfmax =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25024	Angel difference dalpha Minimum (dαmin =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25025	Angel difference dalpha Maximum (dαmax =)	Min/Max meter	-	-	-	-	-	CFC	CD	DD
25033	Phase Sequence U1 (Seq U1 =)	Commissioning	134	156	No	9	13	CFC	CD	DD
25034	Phase Sequence U2 (Seq U2 =)	Commissioning	134	156	No	9	14	CFC	CD	DD
25035	Active Sync-group (SG =)	Commissioning	134	156	No	9	15	CFC	CD	DD
25044	Voltage U1 (U1 =)	Measurement	130	1	No	9	1	CFC	CD	DD
25045	Voltage U2 (U2 =)	Measurement	130	1	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
25046	Frequency f1 (f1 =)	Measurement	130	1	No	9	3	CFC	CD	DD
25047	Frequency f2 (f2 =)	Measurement	130	1	No	9	4	CFC	CD	DD
25048	Voltage difference dU (dU =)	Measurement	130	1	No	9	5	CFC	CD	DD
25049	Frequency difference df (df =)	Measurement	130	1	No	9	6	CFC	CD	DD
25050	Phase difference dalpha (dα =)	Measurement	130	1	No	9	7	CFC	CD	DD
25051	Amount of voltage difference |dU| (|dU| =)	Measurement	-	-	-	-	-	CFC	CD	DD
25052	Amount of frequency difference |df| (|df| =)	Measurement	-	-	-	-	-	CFC	CD	DD
25053	Amount of phase difference |dalpha| (|dα| =)	Measurement	-	-	-	-	-	CFC	CD	DD
25060	Time to next possible switch-on (t On =)	Commissioning	134	156	No	9	16	CFC	CD	DD

■

Literature

/1/ SIPROTEC 4 System Description; E50417-H1140-C151-A8

/2/ SIPROTEC DIGSI, Start UP; E50417-G1176-C152-A2

/3/ DIGSI CFC, Manual; E50417-H1140-C098-A7

/4/ SIPROTEC SIGRA 4, Manual; E50417-H1100-C070-A4

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 are transferred event-controlled via the Ethernet communication system. They serve for direct information exchange among the relays. This mechanism implements cross-communication between bay units.

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 sub-modules 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.

WM

A WD (Wertmeldung) designates value indication.

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