WOODWARD

Combined protection and control system

CSP2-T Transformer Differential Protection

Table of contents

Appendix

1 Introduction

1.1 Signs and abbreviations used

AC	**A**lternating **C**urrent
Ag	*Silver (Lat. agentum, see periodic system of elements)*
AR	**A**uto **R**eclosing
Au	*Gold (Lat. aurum, see periodic system of elements)*
avg	*average*
B	**B**ackward: *Index for current protection functions for backward device*
BB	**B**us **B**ar
BFOC	**B**ayonet **F**ibre **O**ptic **C**onnector
BS	**B**ritish **S**tandard
C	**C**ommissioning: *putting systems or parts of systems into operation*
CAN H	**CAN**-BUS line: **H** = High
CAN L	**CAN**-BUS line: **L** = Low
CB	**C**ircuit **B**reaker
CBF	**C**ircuit **B**reaker **F**ailure: *protective function*
CHAR	*Tripping characteristic curve*
CHP	**C**ombined **H**eat and **P**ower Station
CMP1	**C**ontrol **M**onitor **P**rotection: *Operation and control unit for CSP1 and CSP2*
COM	*Serial interface*
COS	**COS**INE: *angle of the earthing direction with compensated mains star point*
CSP1-B	*Basic unit for bus bar differential protection system*
CSP2	**C**ontrol **S**ystem **P**rotection: *Combined protection and control system*
CSP2-F3	*Basic unit for feeder and control system (Type of device: 3 controllable switching elements)*
CSP2-F5	*Basic unit for feeder and control system (Type of device: 5 controllable switching elements)*
CSP2-L	*Basic unit for line differential protection system (Type of device: 3 controllable switching elements)*
CSP2-T25	*Basic unit for transformator differential protection and control system (Type of device: 5 controllable switching elements)*
CT	**C**urrent **T**ransformer
DC	**D**irect **C**urrent
DEFT	**DEF**INITE **T**IME: *Tripping after a definite set time*
DFFT	**D**igital **F**ast **F**ourier **T**ransformation
DI	**D**igital **I**nput
DIN	**D**eutsches **I**nstitut für **N**ormung: *German Norming Institute*
DSS	Double bus-bar system
EINV	**E**XTREMELY **INV**ERSE: *IDMT characteristic (current-dependent tripping curve) according to IEC Norm*
EN	**E**uropean **N**orm
e-n	*Former designation for the transformer winding to determine the residual voltage Ue*
ESD	**E**lectro-**S**tatic **D**ischarge
ESS	Single bus-bar system
EVT	**E**arth **V**oltage **T**ransformer: *da-dn windings (formerly: e-n windings) of the voltage transformers*
F	**F**orward: *Index for current protection functions for forward direction*
FB	**F**ield **B**us
FF	**F**use **F**ailure (Voltage Transformer Supervision)
FO	**F**ibre **O**ptic
FT	**F**ast **T**rip: *Index in the AR function*
GND	**G**ROU**ND**: *joint return line*
IEC	**I**nternational **E**lectrotechnical **C**ommission
INV	**INV**ERSE: *current-dependent tripping characteristic*
IP 54	Type of enclosure

L	*Formula abbreviation for inductivity*
LCD	**L**iquid **C**rystal **D**isplay
LED	**L**ight **E**mitting **D**iode
LINV	**L**ONG TIME **INV**ERSE: Inverse *characteristic (current-dependent tripping characteristic) to IEC norm*
max	*Index for "Maximum figure" in the statistical data*
MMI	**M**an **M**achine **I**nterface
MTA	**M**aximum **T**orque **A**ngle
MV	**M**edium **V**oltage
Ni	**Ni**ckel
NINV	**N**ORMAL **INV**ERSE: *Inverse characteristic (current-dependent tripping characteristic) to IEC norm*
OL	**O**utput **L**: *power output for winding drive*
OM	**O**utput **M**: *power output for motor drive*
PC	**P**ersonal **C**omputer
PE	**P**rotective **E**arth
PLC	**P**rogrammable **L**ogics **C**ontroller
Q	*Identification of operating equipment for switchgear in the mean voltage to IEC norm*
RESI	*Angle at resistance-earthed mains star point (mean voltage)*
RxD	Signal line (Receive)
SCADA	**S**ubstation **C**ontrol **A**nd **D**ata **A**cquisition System
SCI	**S**erial **C**ommunication **I**nterface: *Communication to the counter-station in CSP2-L*
SG	**S**witch **G**ear
SIN	**SIN**US: *Angle in isolated mains star point (mean voltage)*
SL-SOFT	**S**YSTEM **L**INE **SOFT**: *operation and evaluation software for the SYSTEM LINE devices*
SOLI	*Angle with rigidly earthed mains star point (mean voltage)*
SOTF	**S**witch **O**n **T**o **F**ault: *Switch-on protection in current protection functions*
SRAM	**S**tatic **R**ead **A**ccess **M**emory: *voltage fail-safe memory*
TCS	**T**rip **C**ircuit **S**upervision
TxD	**T**ransmission to **D**evice
VBG	**V**ereinigte **B**erufs-**G**enossenschaften (United Professional Associations): *Accident Prevention Directives*
VDE	**V**erband **D**eutscher **E**lektrotechniker (Association of German Electrical Engineers)
VDEW	**V**ereinigung **D**eutscher **E**lektrizitäts-**W**erke (Association Of German Electricity Companies)
VINV	**V**ERY **INV**ERSE: *IDMT characteristic (current-dependent tripping characteristic) to IEC norm*
VT	**V**oltage **T**ransformer

1.2 Concept of the *SYSTEM LINE*

The task of the protecting technique is to guarantee safe operation of the electrical energy systems by use of protective equipment specific to the operating plant, which quickly and selectively separates the operating device affected from the electric mains if dangerous states occur.

However, higher demands are increasingly being made of the protective systems in use today and based on digital technique. Although the protection of the operating device continues to be in the foreground, the course of centralisation has made it necessary to expand the individual protective systems to form communicating units of an overall system (system technique). This means that each switchboard of a switchgear can be monitored and operated from the central station control technique via the protective system with specific communications systems.

> The *SYSTEM LINE (SL)* is a product line for *high-quality digital protection of electrical equipment* in combination *with extended functions* for complex applications in the medium-voltage area!

System idea and history
In medium-voltage engineering, there are typical applications such as feeder protection, line differential protection, bus bar protection etc. Each of these applications has a variety of specific functions, which were only covered in the past by the combination of a number of devices with individual functions. These solutions were cost-intensive and demand with considerable technical efforts.
The objective in the development of the *SYSTEM LINE* was to generate a high-quality protection and control system integrating numerous functions in one system and thus taking over practically all the tasks for a specific application, e.g. for feeder protection, cable-/line differential protection or transformer differential protection

The devices of the *SYSTEM LINE* combine all the benefits provided by modern digital technique to fulfil the variety of complex demands made of it on the part of the electrical supply utilities and industry.
Tasks entailing the protection of operating plant, supervision of the system, detection and provision of measured values and messages for cases of operation, recording and evaluating measured values and messages for disturbances, control and locking functions as well as various possibilities of communication are to be mentioned here as being of great importance.
The internal modular set-up of hardware and software permits flexible inclusion of extensions and customers' requirements according to needs.

Alongside the consistent use of digital technique, high availability thanks to permanent self supervision of the devices, high functionality and flexibility as well as ergonomically designed user interfaces (MMI) are in the foreground as the system idea. In this way, the *SYSTEM LINE* is not only used in new systems, but is also outstandingly suitable for existing switchgear (retrofitting), as the connection of the protection and control systems can be done independent of the manufacturers of switchboards and switchgear.

The systems of the *SYSTEM LINE* thus have a high cost-reducing potential as a central unit. For operators of MV systems, this leads to a reduction of costs in planning, material, installation and in commissioning of the switchgear.

Realisation
The protection and control systems of the *SYSTEM LINE* have been implemented as "two-device solutions". Such a system comprises, on the one hand, a *CSP* basic device, in which all the functions and interfaces necessary for operation have been integrated, on the other hand a *CMP* display and operating unit, *which is used as a "man-machine interface" (MMI).*
The communication between the two devices is done via a CAN field bus system.
The *CSP* basic device can be fitted directly in the low-voltage niche of a cubicle without a further auxiliary relay thanks to the robust and protected construction, thus reducing the wiring to a minimum. Stand alone operation of the *CSP* without the *CMP* display and monitoring unit is equally as possible as connection of SCADA-system via optical or electrical interfaces.

The communication ability is increased by the coupling of the *CSP* devices via the internal CAN system bus (multi-device communication). Access to the *CSP/CMP* systems via a centrally arranged PC, making use of the *SL-SOFT* application software, thus enables comfortable operation (reading of data, saving of disturbance records as well as [remote] parameterisation of the connected devices).

The *local* operation of the protection and control system is done via the separate *CMP1* display and operating unit, which is installed in the cubicle door. Here, quick access to the operating data of the switchgear, local parameterisation of the *SYSTEM LINE* devices and the local control of switchgear is in the foreground. Due to the high type of enclosure (IP 54) of the front (foil keyboard) of the display and operating unit, the *CMP1* can even be used in an environment with a high degree of pollution.

1.2.1 Basic unit *CSP2*

The *CSP2* basic device is an integrated protection and control system for installation in the low-voltage compartment of the circuit breaker (mounting plate construction). The basic module, which is autarkically ready for operation, contains the entire protection and control technique.

The *CSP2* is offered for various applications (several types of devices). For each type of devices, there are corresponding output classes to match individual requirements or necessities:

- *feeder protection and control system*: *CSP2-F3* and *CSP2-F5*
- *trafo differential protection and control system* *CSP2-T25*
- *cable /line differential protection and control system*: *CSP2-L1* and *CSP2-L2*

After selection of the scope of performance for the application in question, each of these devices can be adapted individually to the primary and secondary technique of the field in question (configuration).

Figure 1.1: Basic device of the trafo differential system ***CSP2-T25***

The CSP2 basic unit excel thanks to the following particular properties:

- compact construction in robust plastic housing with IP 50 type of enclosure,
- extensive protection and control functions,
- intuitive menu guidance,
- wide-range power pack for auxiliary voltage supply to the device (AC or DC)
- wide-range power pack for auxiliary voltage supply for digital inputs (AC or DC)
- wide-range power pack for auxiliary voltage supply (DC),
- various working ranges (high/low voltage area) for digital inputs,
- flexible administration of the inputs and outputs,
- galvanic de-coupling of the power circuits,
- stand-alone operation without display and operating unit *CMP1* possible,
- connection of control technique with various types of protocols via optical or electrical interfaces
- various PC communication interfaces: CAN-BUS; RS232,
- various SCADA communication interfaces: FO; RS485,
- disturbance recorder with many features for PC/laptop; optionally with extended non-volatile memory,
- extensive self-supervision (hardware and software),
- maintenance free.

1.2.2 *CMP1* display and operating unit

The *CMP1* display and operating unit is integrated into the front door of the cubicle as a complete and favourably priced user interface (MMI). It informs the operating personnel about the current status of the switchboard by displaying all the relevant measured data, messages and parameters. There is the possibility of reading out data, making parameterisations and also controlling switchgears of the field.

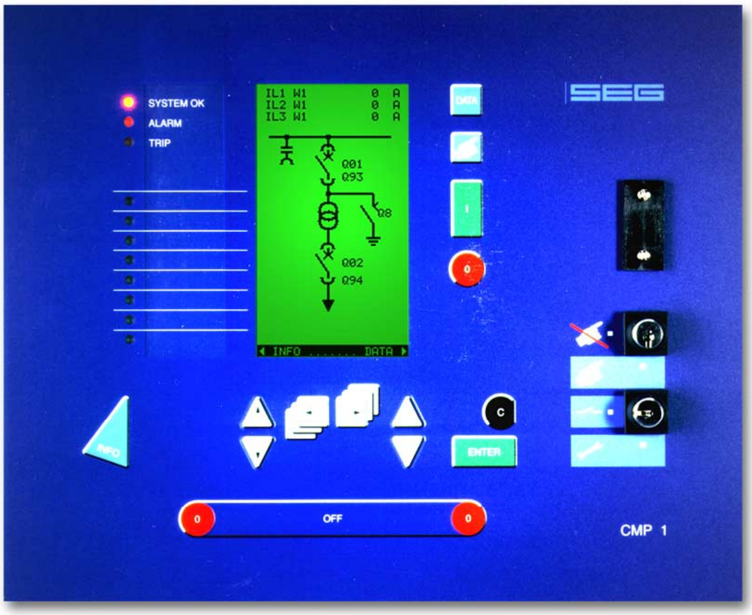


*Figure 1.2: **CMP1-1** display and operating unit*

The CMP1 excels thanks to the following properties:

- flat and compact design,
- wide-range power pack (AC or DC),
- large, automatically background-illuminated LCD graphic display (128 x 240 pixel) with:
  - display of a configurable feeder single line,
  - display of switch positions, measured values and operating information,
  - protocolling of events with real-time stamp,
  - protocolling of fault events with effective values,
  - extensive commissioning support and
  - varied test possibilities.
- foil keyboard with IP 54 type of enclosure for the front side,
- multi-coloured function keys for menu guidance, control and in "danger off function"
- two key-operated switches to stipulate the modes of operation:
  - local/remote operation and
  - standard operation/parameterisation
- 11 multi-coloured LED's (parameterisable)
- integrated message relays for system error indication
- CAN interface for connection with the *CSP2* and
- 2 x RS 232 interfaces for operation via PC/Laptop (front side and bottom edge of the device).

The connection to the *CSP2* basic module is done via a three-cored, screened CAN-BUS line, which is easy to wire together with the voltage supply.
The *CMP1* has a large *graphic display*, on which a *single line diagram* informs you about the state of the field at all times.
All the *settings and switching actions* can also be carried out via the *CMP1 display and operating unit.*

1.3 *SYSTEM LINE* - Overview

In the following overview, the individual performance classes of the devices available in the *SYSTEM LINE* are explained according to their application.

Transformator differential protection and control system CSP2-T	
Performance class	*Description*
CSP2-T25	The combined transformer differential protection and control system CSP2-T25 is especially developed for two winding transformers and is able to control up to 5 switching devices (2 circuit breakers, disconnectors and earthing switch). The number of measuring inputs comprises 4 voltage inputs (UL1, UL2, UL3, Ue), 7 current inputs (IL1W1, IL2W1, IL3W1, IL1W2, IL2W2, IL3W2, Ie) and 2 inputs for temperature sensors.
Feeder protection and control system CSP2-F	
Performance class	*Description*
CSP2-F3	The combined protection and control system *CSP2-F* is for all feeder applications with single and double busbar systems, which call for extended protection and control functions. The number of measuring inputs comprises 4 voltage inputs (U_{L1}, U_{L2}, U_{L3}, U_E) and 4 current inputs (I_{L1}, I_{L2}, I_{L3}, I_E) which are needed to realise extensive protection and measuring functions. *CSP2-F3* is intended for control of up to 3 switching devices (1 circuit breaker, disconnectors and earhting switches) and are for recognizing up to 5 switching devices.
CSP2-F5	*CSP2-F5* represents the most capable variant of the *CSP2*-System. Compared to *CSP2-F3* it is possible to control and recognize 5 switching devices (2 circuit breakers, disconnectors and earthing switches). The number of measuring inputs is equal to *CSP2-F3*.
Cable/Line differential protection and control system CSP2-L	
Performance class	*Description*
CSP2-L1	The digital Cabel-/Line differential protection and control system is used as main protection for cables and lines. Accordingly, faults have to be cleared fast and phase selectively so that operating devices will be disconnected at both ends. Therefore it is necessary to connect a protection unit at both ends of the cable/line. Communication between the two protection units will be done by optical fibres. One complete cable/line differential protection system consists of two basic units *(CSP2)* and two operating units *(CMP)* which will be used for local control of switching devices (per system: 1 circuit breaker, disconnectors and earthing switches) The maximum length of a protected cable/line is about 2 km.
CSP2-L2	With both categories of the *CSP2-L* it is possible to recognize up to 5 and to control up to 3 switching devices. (1 circuit breaker, disconnectors and earthing switches).
Busbar differential protection CSP1-B	
Performance class	*Description*
CSP1-B06	*CSP1-B* is a central busbar differential protection system which is used as main protection for single busbar systems. The protection device provides phase-selective detection and tripping within the shortest possible time. Single busbar systems with up to 6 feeders will be protected by the *CSP1-B06* system which consists of one basic unit *(CSP1)* and one operating unit *(CMP1)*. For applications including more than 6 feeders (18 feeders as maximum) there is a need for the *CSP1-B18* system.
CSP1-B18	The *CSP1-B18* system consists of three basic units and one operating unit. Phase-selective current measurement will be provided by the use of one *CSP1-B* each per phase. Communication between the *CSP1* devices will be carried out by fibre optic connetion.

Table 1.1: Overview of the SYSTEM LINE product line

1.3.1 Overview of functions, *CSP2*

No.	Protection functions	ANSI	CSP2-F3	CSP2-F5	CSP2-L1	CSP2-L2	CSP2-T25
1	Overcurrent directional/non-directional	51/67	●	●	●	●	●
2	Short-circuit current directional/non-directional	50/67	●	●	●	●	●
3	Earth current directional/non-directional	50N/51N/67N	●	●	●	●	●
4	Restricted Earth Fault	64REF	-	-	-	-	●
5	Differential	87	-	-	Cable	Cable	Transformer
6	Overload protection with thermal replica	49	●	●	●	●	●
7	Overload protection with temperature sensors	49	-	-	-	-	●
8	Residual voltage	59N	●	●	●	●	●
9	Over-/Undervoltage	27/59	●	●	●	●	●
10	Over-/Underfrequency	81	●	●	-	-	●
11	Automatic Reclosing (AR)	79	●	●	●	●	●
12	Power/Reverse Power	32F/B	●	●	-	-	*
13	Negative phase sequence current (I_2)	46	●	●	-	-	-
14	Control circuit supervision (incl. trip circuit)	74TC	●	●	●	●	●
15	Circuit breaker failure (CBF)	50/62BF	●	●	●	●	●
16	Lock out function	86	●	●	●	●	●
17	Reverse interlocking	-	●	●	●	●	●
18	Voltage transformer supervision (fuse failure)	-	●	●	●	●	●
19	Switch on to fault (SOTF)	-	●	●	●	●	●
20	AR fast trip	-	●	●	●	●	●
21	AR-Start by Non-Corresponding of CB	-	●	●	●	●	●
22	Programmable protection logic (i.e. function/blocking/trip blocking)	-	●	●	●	●	●
23	Parameter switch	-	●	●	●	●	●
24	Disturbace recorder (Optionally with extended memory	-	●	●	●	●	●

Table 1.2: Overview of functions of the **CSP2** *types of devices*

No.	Control functions	CSP2-F3	CSP2-F5	CSP2-L1	CSP2-L2	CSP2-T25
1	No. of controllable switching devices	3	5	3	3	5
2	No. of switching devices that can be shown on the graphic display	5	5	5	5	5
3	No. of power outputs for control of circiut breakers (Contol coils of circuit breakers)	2	3 (4)	2	2	4
4	No. of power outputs for control of motor-driven switching devices (i.e earthing isolators and disconectors)	2	4 (3)	2	2	3
5	No. of signal relays	6	10	6	6	6
6	No. of configurable digital inputs	22	26	22	22	26
7	Command outputs with defined switching and operation times	●	●	●	●	●
No.	**Supervision functions**	**CSP2-F3**	**CSP2-F5**	**CSP2-L1**	**CSP2-L2**	**CSP2-T25**
1	Fault/differential position	●	●	●	●	●
2	Withdrawal of the circuit breaker	●	●	●	●	●
3	Circuit breaker ready	●	●	●	●	●
4	Programmable interlocking conditions at feeder level	●	●	●	●	●
5	Interlocking of switching devices at station level by SCADA system	●	●	●	●	●
No.	**Programmable logic functions**	**CSP2-F3**	**CSP2-F5**	**CSP2-L1**	**CSP2-L2**	**CSP2-T25**
1	32 programmable logic equations	●	●	●	●	●
2	32 input variables per logic function	●	●	●	●	●
3	1 time element per logic output	●	●	●	●	●

Table 1.1: Outline CSP2 control, monitoring and programmable logic functions

The *CSP2* is a *combined protection and control system* with various integrated functions for use in medium-voltage cubicles. Alongside the most important protective functions, this system has also combined extended functions such as:

- measurement,
- supervision,
- switchgear control/interlocking and
- communication

in a way suitable for use in a medium-voltage panel.

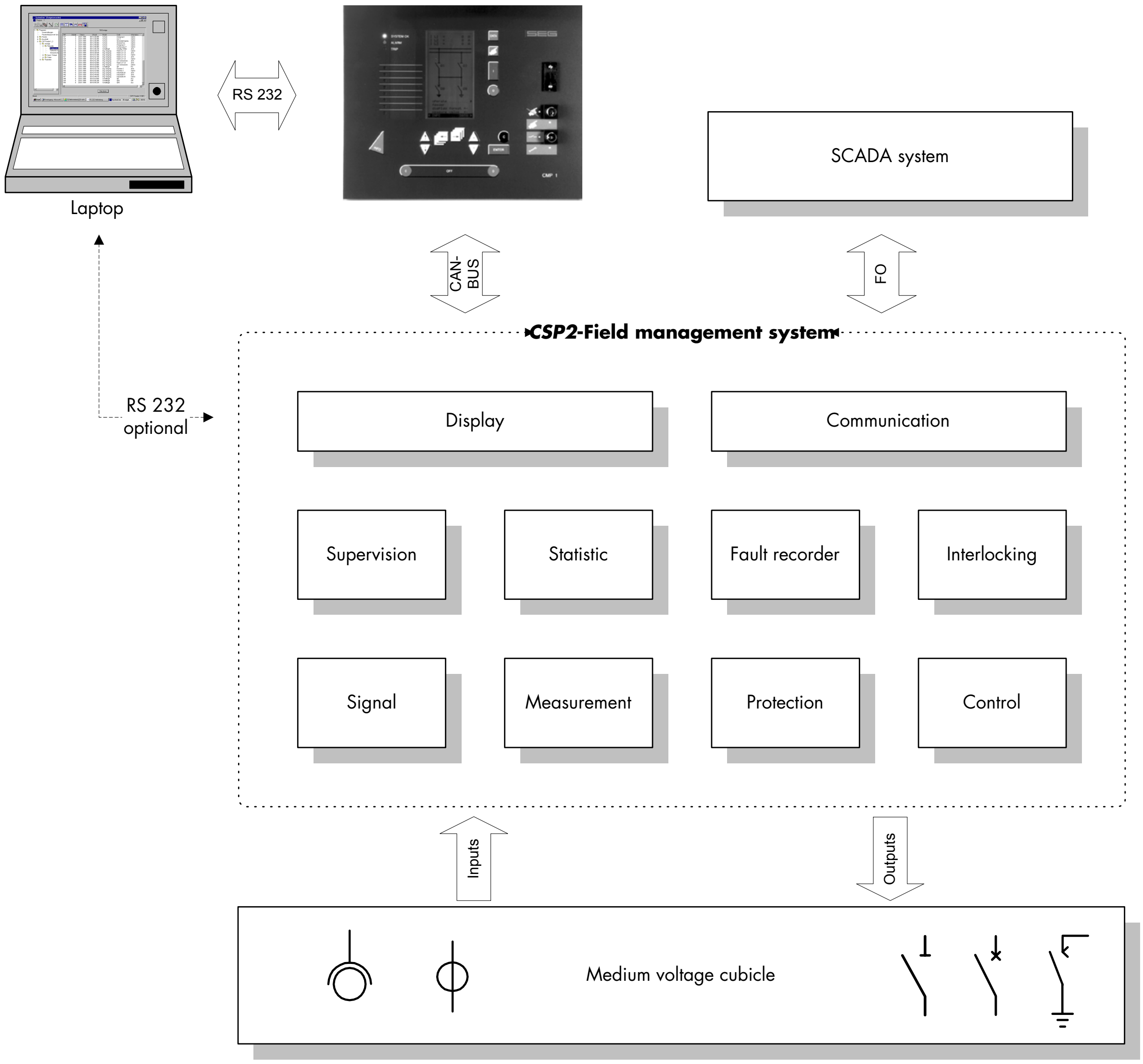


Figure 1.3: CSP2 as a field management system

With regard to operational safety and immunity from disturbance, the *SYSTEM LINE* corresponds to the high requirements of protective systems for the energy distribution.

The *CSP2* system is used in systems of energy distribution (electricity supply utilities, node stations, sub-stations), energy generation (hydroelectric power plants, wind-driven power stations, combined heat and power stations (CHP) and industrial systems. As a field management system, this system can be used as a component part of fully automated systems.

The *CSP2/CMP1* systems can be connected to a SCADA system or automation systems via optional interfaces (electrical or optical). The data transmission is optionally via the IEC 60870-5-103 types of protocol or PROFIBUS DP. Through connection of a PC/laptop, the *SL-SOFT* application software can be used to build up a second communication level. The connection of the individual systems via a field bus system makes device log-in from one central place possible (*CSP2* multi-device communication).

1.3.2 *CSP2-F* as field management system for feeder protection

Feeder *protection* is a partial discipline of the overall mains protection technique, as its main task comprises the *protection of the feeders* to the operating equipment connected to the mains such as transformers, motors, generators and bus-bars. Depending on the value and the importance, these electrical equipments is protected by separate systems specifically tailor made to match them (e.g. generator protection, bus bar differential protection), with *feeder protection* being able to take on certain backup protection functions as a rule.

With the various expansion levels (output classes) of the *CSP2-F* the protection requirements and control tasks of simple feeders right down to double bus bar systems are covered.

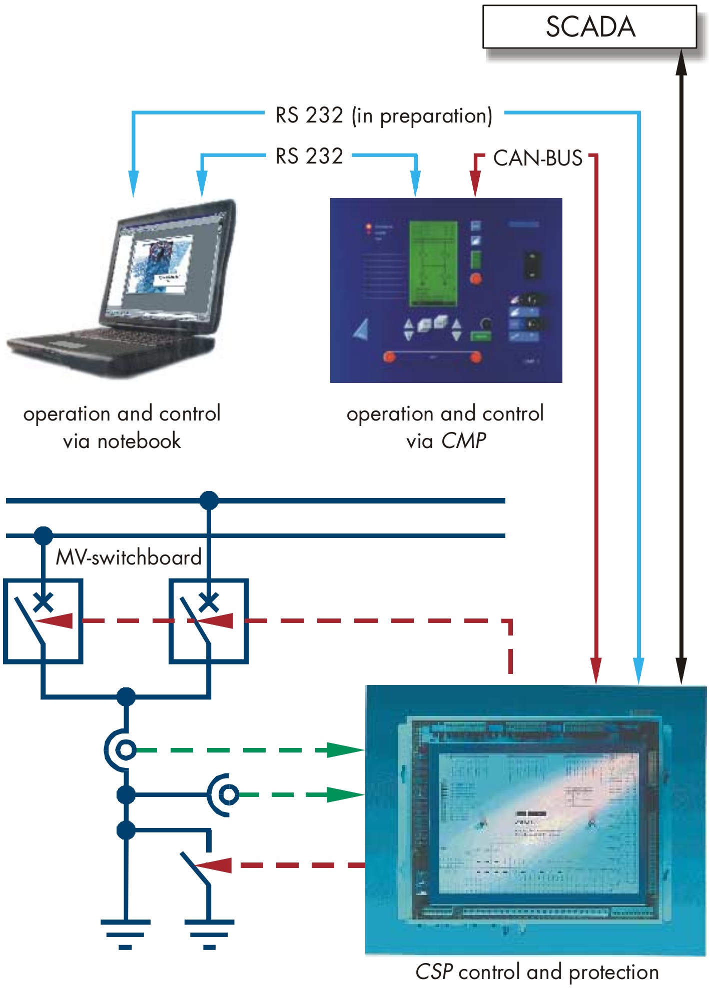


Figure 1.4: Feeder protection and control system, CSP2-F

1.3.3 *CSP2-L* as a field management system for line differential protection

To protect important feeder cables and overhead lines, the *CSP2-L* two-end differential protection is used.

A complete differential protection system comprises one *CSP2-L* basic unit and one *CMP1* operating unit at each end of the cable or overhead line to be protected. The communication between the *CSP2-L* partner devices of the stations is done by fibre optic. The integrated control, interlocking and monitoring functions extend the *CSP2-L/CMP1* system to form a combined protection and control system with which up to three switchgears can be controlled.
In addition to the differential protection as the main protection function, the *CSP2-L* has these backup protection functions: directional/non directional overcurrent time protection, directional/non directional earth overcurrent protection, overload protection with thermal replica, supervision of the residual voltage, under/over voltage protection, voltage transformer supervision, control circuit supervision, switch-on to fault protection (SOTF), backward interlocking and automatic reclosing (AR).

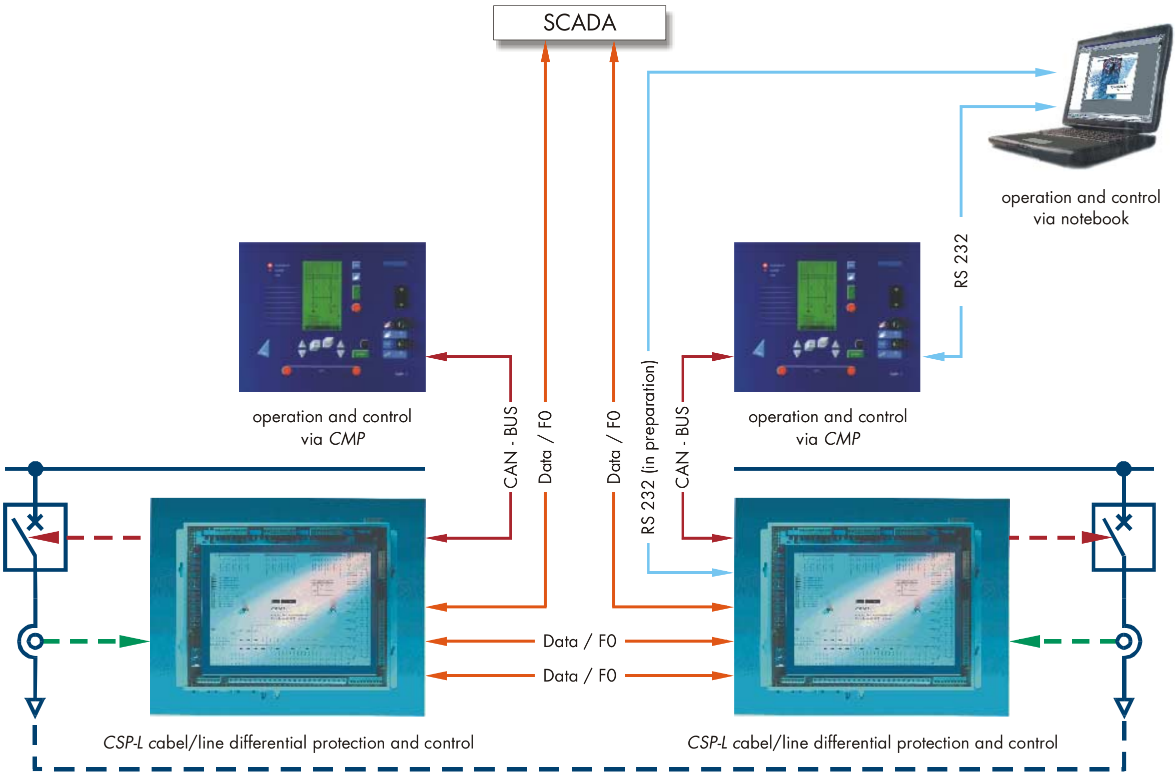


Figure 1.5: Cable/line differential protection and control system ***CSP2-L***

1.3.4 *CSP2-T25* as a field management system for transformer differential protection

With the high performance management system, two-winding transformers can be protected and operated completely.

A complete differential protection system comprises one *CSP2-T25* basic unit and one operating unit *CMP1*. The integrated control, interlocking and monitoring functions extend the *CSP2-T25/CMP1* system to form a combined protection and control system with which up to 5 switchgears can be controlled.
In addition to the transformer differential protection as the main protection function, the ***CSP2-T*** has the following backup protection functions: directional/non directional overcurrent time protection, directional/non directional earth overcurrent protection, overload protection with thermal replica, supervision of the residual voltage, under/over voltage protection, voltage transformer supervision, control circuit supervision, switch-on to fault protection (SOTF), backward interlocking and automatic reclosing (AR).

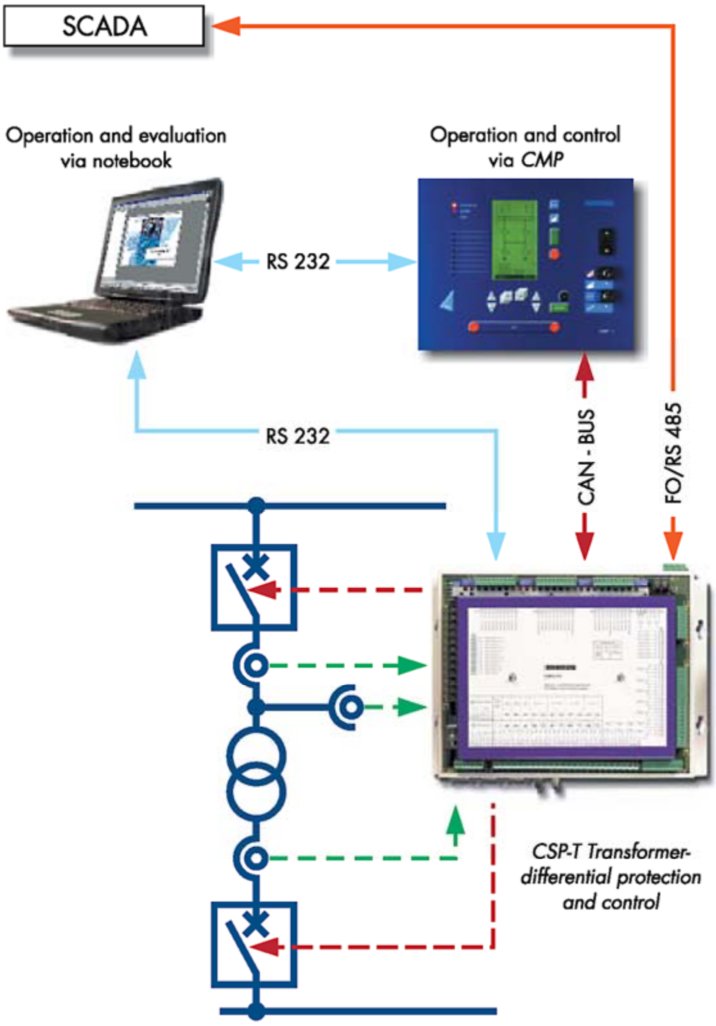


Figure 1.6: CSP2-T25 transformer differential protection and control

1.4 Information on the manual

Scope of function
This manual entails the complete scope of all versions of the *CSP2-T.*

Structure of the manual

- *Chapter 1 "Introduction"*
  Explanation of the general alignment of the *SYSTEM LINE*.

- *Chapter 2 "Hardware – set-up and connections"*
  Here, there is an extensive description of the hardware of the *CSP2* basic device and the *CMP1* display and operation unit with important information on installation and connection of the devices. Reference is merely made to relevant parameter settings and software functions are only explained to the extent necessary for understanding with regard to the hardware.
  Extensive explanations on the software functions are given in Chapter 5 "Main menu of the *CSP2*"!

- Chapter 3 "Operation via CMP1" and Chapter 4 "Operation via SL-SOFT application software"
  In these chapters, the operation of the *CSP2* basic unit via the *CMP1* on the one hand and via the *SL-SOFT* operating software on the other hand is described.
  In *Chapter 3*, the functions of the individual operation element keys are extensively described and the meaning of the operation modes are explained. As an example, the mode of procedure for the operation, control and parameter setting via the *CMP1* is presented and visualised via screenshots/display shots.
  Chapter 4 contains a rough description of the *SL-SOFT* operating and evaluating software for the operation and parameter setting of the *CSP2* basic device. An extensive description of this application software is available in the form of a separate document, which can be demanded if required.

- *Chapter 5 "Main menu of the CSP2"*
  The structure of this chapter is analogous to the structure of the menus in the *CSP2*. Here, all the software functions are extensively described on the basis of the parameters listed and their settings.

- *Chapter 6 "Control" and Chapter 7 "Interlocking of switchgears"*
  These chapters extensively concern themselves with the control and interlocking functions in the *CSP2*. Information on existing norms and general directives supplement this important subject!

- *Chapter* 8 "Communication"
  The various possibilities of communication with the protection and control systems of the *SYSTEM LINE* make this chapter necessary. Here, general information on the individual data protocol types for connection of station control techniques and on PC communication are in the foreground. Examples of connections round this chapter off. The variants for physical connection (interfaces) of the *CSP2* to the communication systems have been described in Chapter 2.
  Detailed information is also available in separate documents. They contain general descriptions as well as the data point lists on the individual types of protocol corresponding to the *CSP2*.

- Chapter 9 "Project engineering" and Chapter10 "Commissioning"
  These chapters contain information on the handling and realisation of *SYSTEM LINE* projects. Tools are presented as projecting assistance and plant documentation, as are specific applications and general information on commissioning.

- *Chapter 11 "Technical Data"*
  Important information on the hardware of the *CSP2* and *CMP1*

General

- In general, contexts covering more than one area and information on plausibility are stated as ***ATTENTION***, ***NOTE*** or ***REMARK*** in each chapter!
- The graphical quick user guides used in this manual are to increase the user-friendliness and facilitate orientation. The graphical quick user guides stop on the third menu level at the latest and are therefore not always complete. As individual graphical quick user guides cannot be produced for each type of device. The device with the most features is portrayed as a rule. Not every functionality portrayed in the graphical quick user guides is therefore always available in every device type. The precise possibilities of setting can be seen from the enclosed tables.
- **The appendix** contains
  - Checklist for the *CSP2-T25*
  - Setting lists of the system and protection parameters
  - Fax template addressed to Woodward. With this, you can send us your suggestions for supplements and optimisation of this manual!
  - Type key for the order form of the SL systems

2 Hardware – Construction and Connections

2.1 Basic unit *CSP2*

In the following the hardware components of the connection of the basic device *CSP2* to the periphery are described and the function of the LEDs explained.

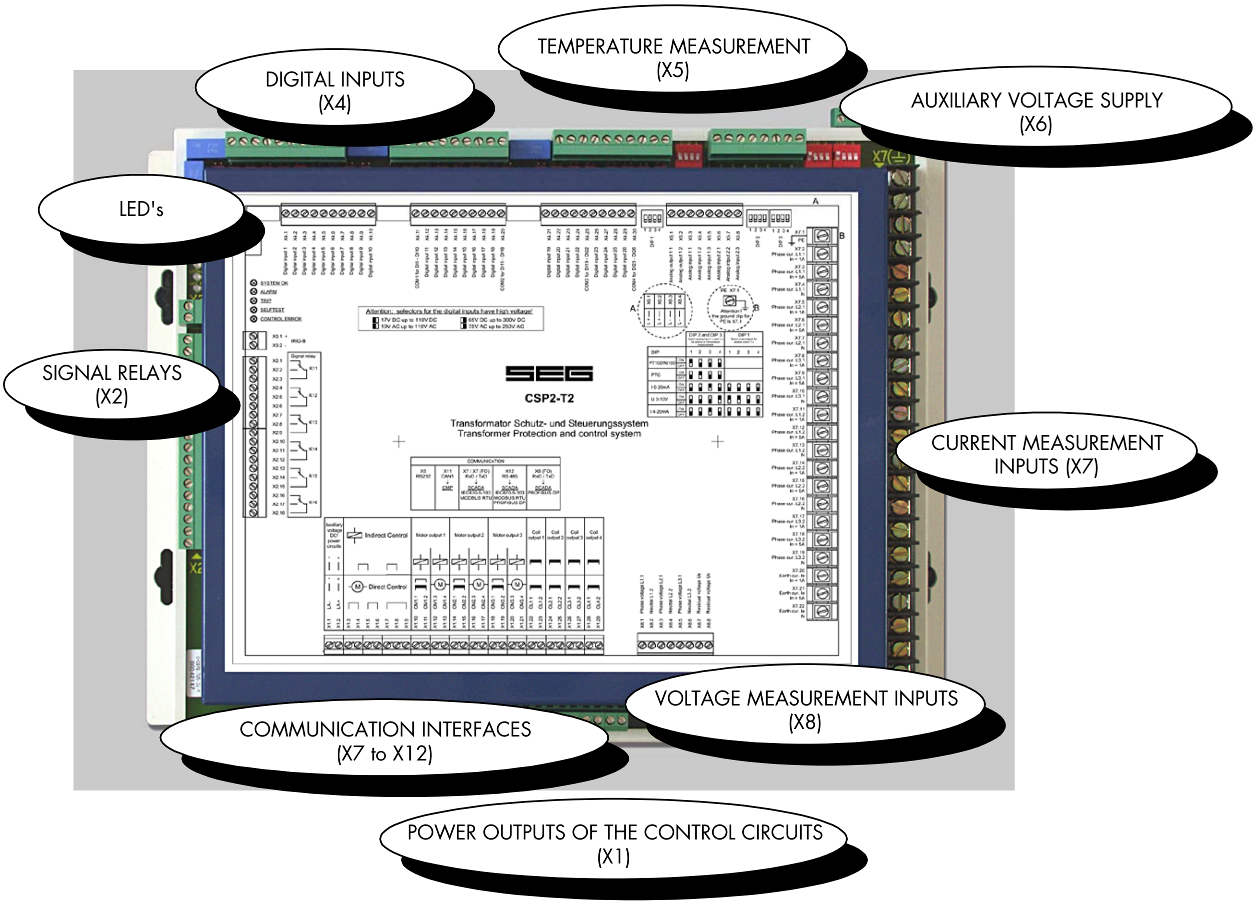


Figure 2.1: Top view ***CSP2-T25***

Line-cross sections of the measurement inputs

- Terminals of the current measurement inputs: max. 2 × 2.5 mm², bzw. 1 × 4 mm²
- All other terminals: max. 1 × 2.5 mm²

2.1.1 Dimensions and Connection diagrams

(Dimensions in mm)

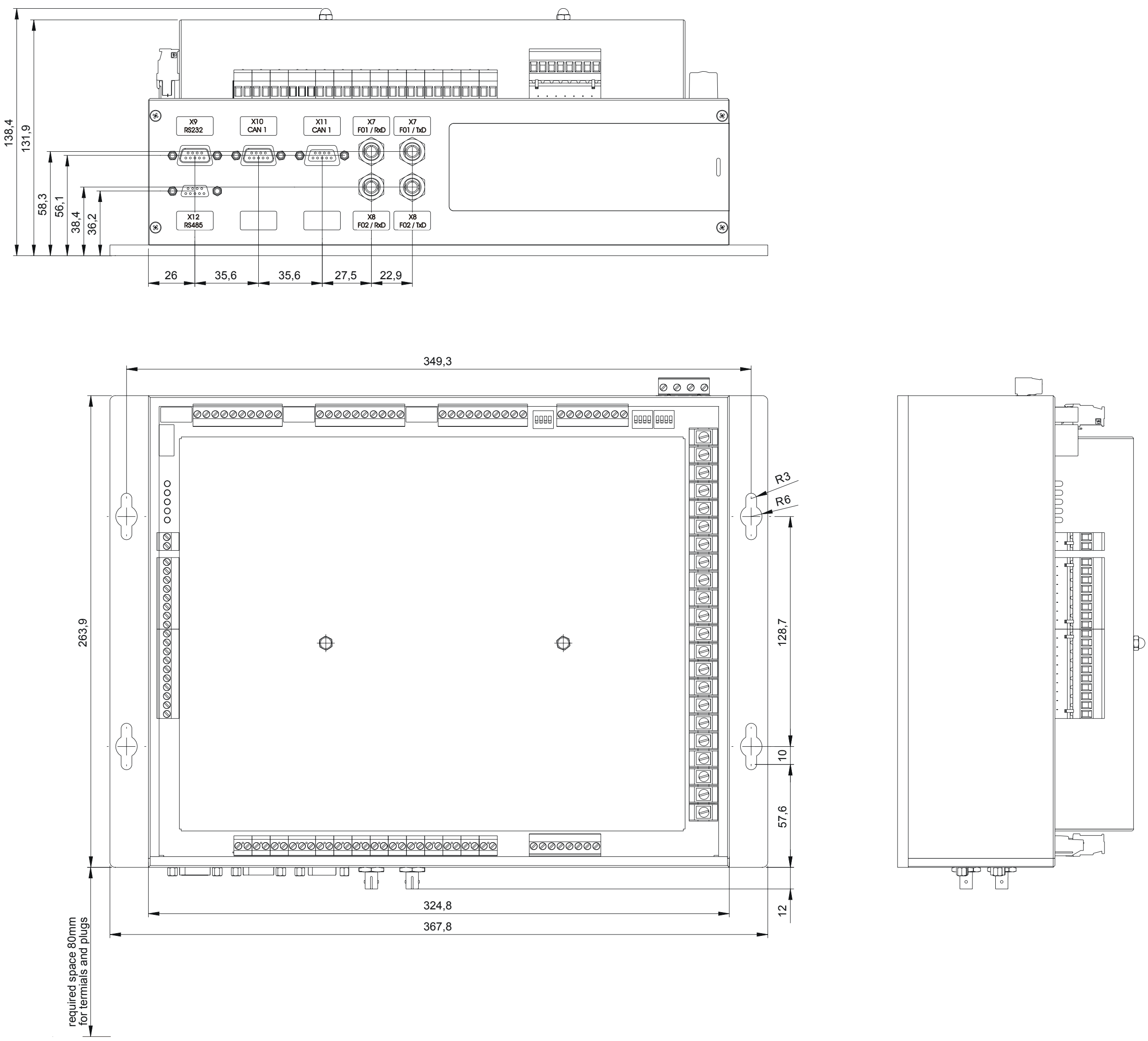


*Figure 2.2: Dimensions of the **CSP2-T25***

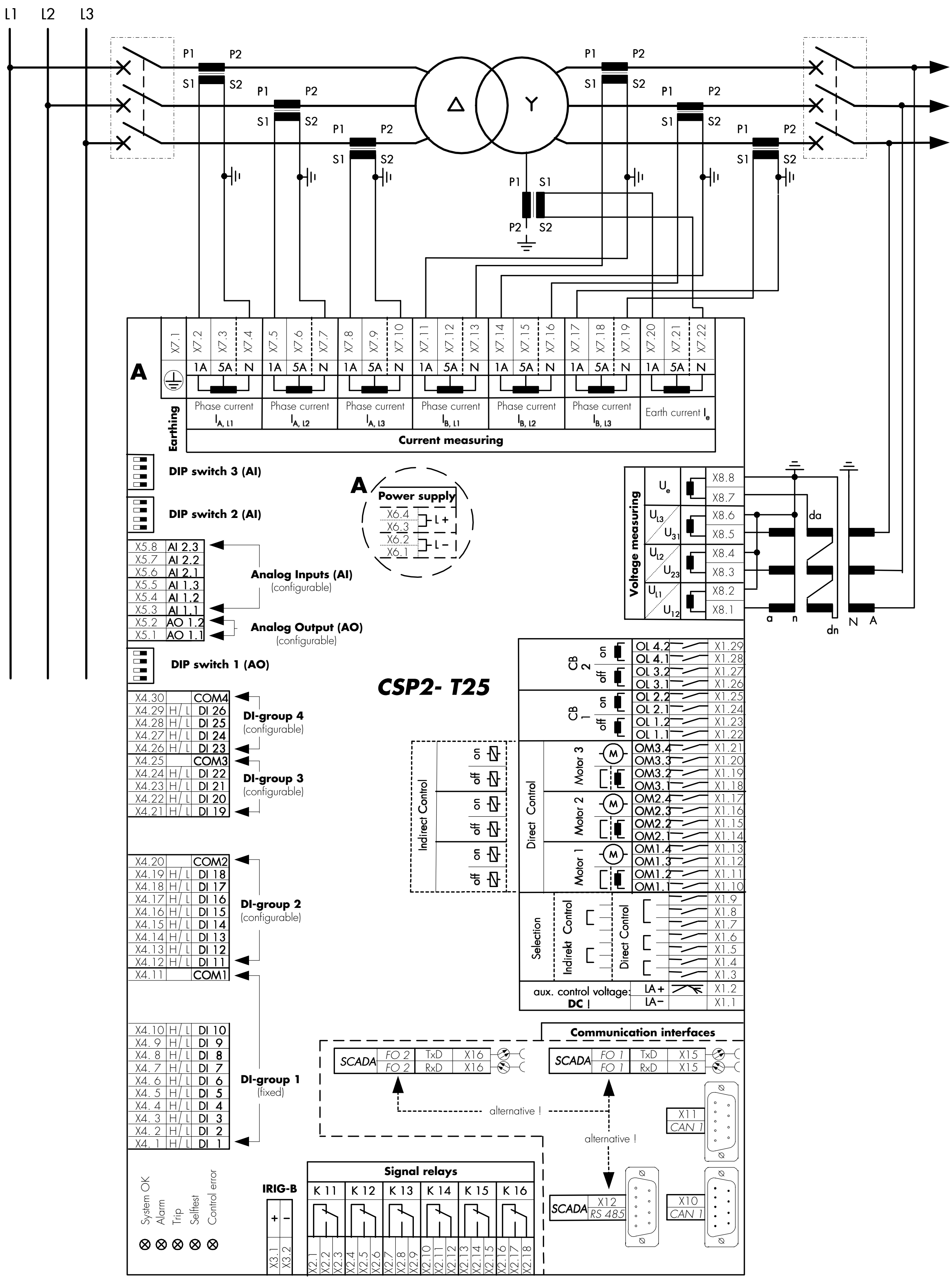


Figure 2.3: Connection diagram CSP2-T25

2.1.2 LED-displays of the CSP2

Description

The *CSP2* has five LEDs on the case top side by which important system operation and multiple messages can be displayed. The LEDs of the *CSP2* are principally independent of the LEDs of the *CMP1* and cannot be configured!

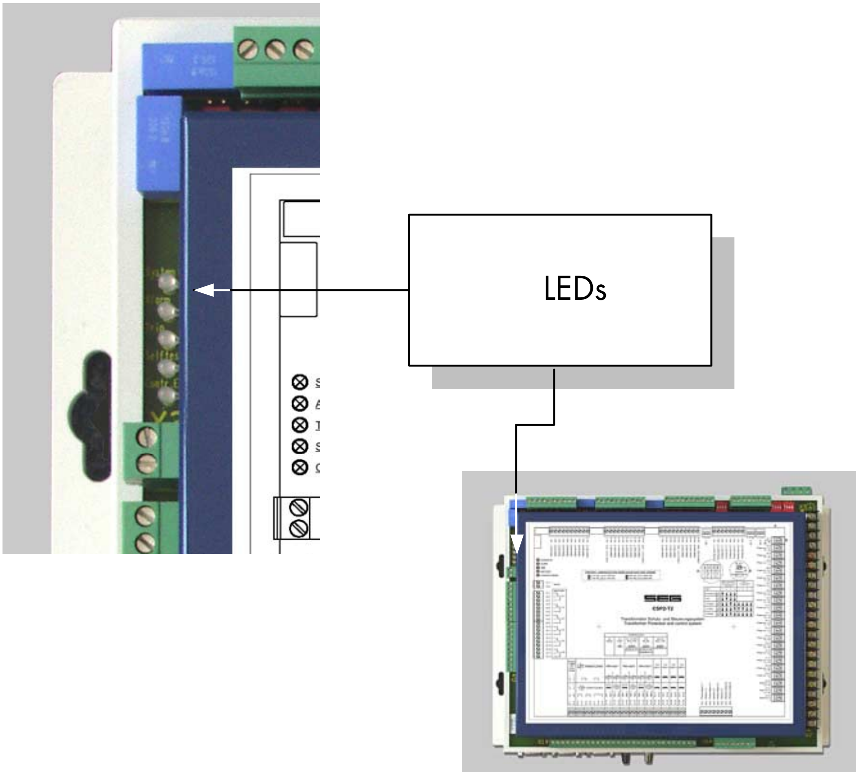


Figure 2.4: LEDs of the CSP2

LEDs of the CSP2			
Function	*Description*	*LED Display*	
		Colour Code	*Acknowledge.*
System OK.	No internal fault, *CSP2* is in operating mode	green	-
	System fault	red	-
Alarm	General activation (general protective activation or alarm signal by a supervision function)	red	-
Trip	General trip (general protective trip)	red	●
Selftest	Initialisation phase : Signals the start-up phase of the *CSP2* (system restart) after voltage connection at terminal strip X6.	green	-
Contr. Error	Signals fault of a switching device (e.g. exceeding of the control time) can be reset via the *CMP1*	red	●

Table 2.1: Overview LEDs

Attention

The LED *"System OK"* of the *CSP2* relates exclusively to the self-supervision of the protection and control system *CSP2*!

The LED *"System OK"* of the *CMP1* relates to the self-supervision of the protection and control system *CSP2* and/or the display and operation unit *CMP1*.

Note

In case of a system fault message via the LED "*System OK"* of the *CMP1*, a check has to be carried out at any rate to find out if the LED of the *CSP2* also reports the system fault! If this is not the case, disturbed communication between *CSP2* and *CMP1* or a defect in *CMP1* can be assumed. Protection and supervision functions as well as remote-control and communications functions thus continue to be fully operational!

2.1.3 Control outputs of the power circuit (X1)

Description
As a combined protection and control system, the *CSP2* is able to switch MV-switchgears. The control wires for the drives of the switchgears can in this case either be directly connected to terminal board X1 ("Direct control") or switched by the corresponding auxiliary relays which are driven by *CSP2* ("indirect control").

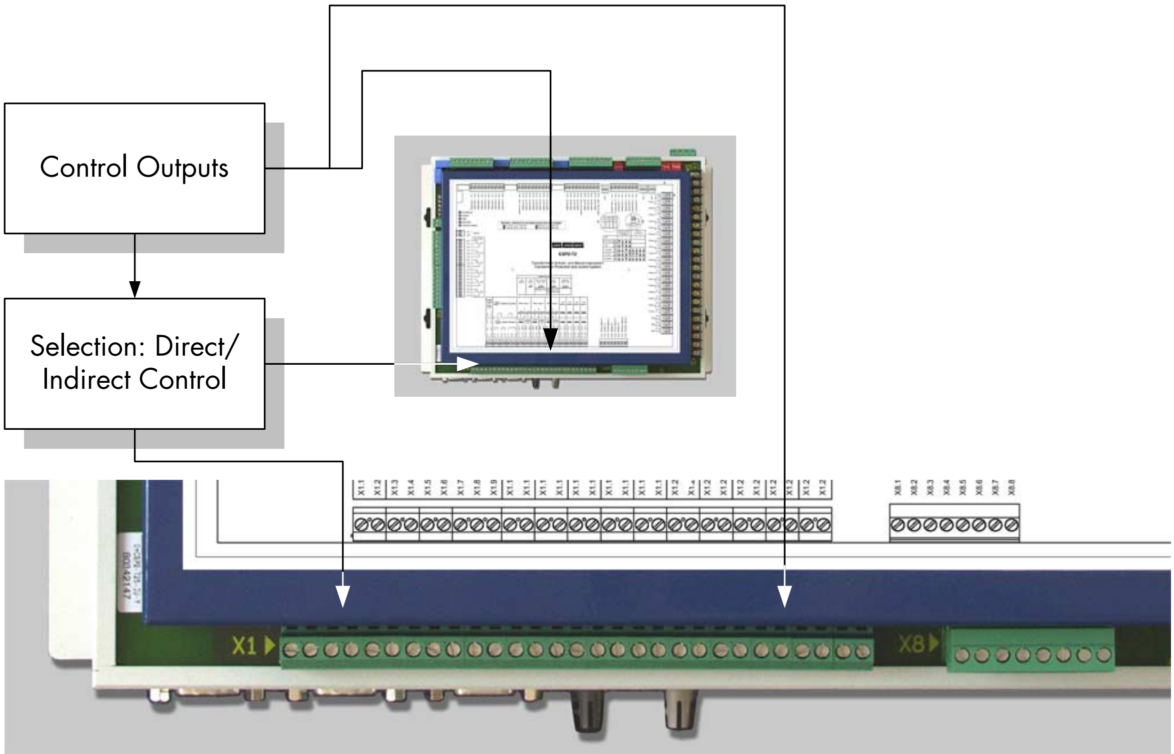


Figure 2.5: Detail view control outputs

Voltage supply of the power circuit
The power circuit of the *CSP2* disposes of several control output OM (Output *motor type*) and OL (Output coil type), which have been constructed as short-circuit-proof relay contacts. Thus a galvanic decoupling to the periphery is guaranteed for the unswitched state.
For the control of the switchgears, the *CSP2* requires an auxiliary voltage supply (auxiliary control voltage), which is connected to terminals X1.1 and X1.2. This auxiliary control voltage will be switched through when sending a control command (or trip command) via the power circuit of the *CSP2* on the contact-terminals of the corresponding control outputs. Direct voltages in the range of 18 – 280V DC may be used (see Chapter *"Technical Data"*). In this way the electrically controllable switchgears can be connected directly and without additional decoupling levels.

Attention

If there is only an *AC voltage* at disposal, it is absolutely necessary that a rectifier is connected ahead!
Should a smoothing capacitor additionally be used for rectifying the alternating voltage, the smoothed voltage, in accordance with the characteristics of he capacitor, may be at the level of he alternating voltage amplitude. Thus the peak value of the alternating voltage used *must not exceed 280V*!
The cable line of the power outputs from and to the switchgear must not exceed 30 m.

Drive variants for MV-switchgears
According to the switchgears of the medium voltage panel there are two different types regarding the *drive type of the switchgears:*

- *L-type*: switchgears with "coil drive" (e.g. circuit breakers)
- *M-type*:switchgears with "motor drive" (e.g. disconnecting switches, earthing switches)

Switchgears with coil drive (L-type)
For the control of a circuit breaker (CB1 and CB2) four control outputs (OL) are required in each case.

CB1
- The control output OL1 serves for giving the "CB1-OFF-command",
- the control output OL2 for giving the "CB1-ON-command".

CB2
- The control output OL3 serves for giving the "CB2-OFF-command",
- the control output OL4 serves for giving the "CB2-ON-command".

Definition of terms

A "CB OFF-command" for a circuit breaker may be sent as a *trip command* from a protection function or as a controlled *OFF control command* from ***CMP1***, a SCADA-System or via an active digital input! An "ON-command" for a circuit breaker can be sent as *an auto reclosing command* of an effective AR-function or as a *controlled ON-command* from *CMP1*, of the SCADA system, of the programmable logic (SL-Logic)

or via an active digital input!

Attention

"OFF-Command" from *effective protection functions* can only be given at the control outputs OL1 and OL3!

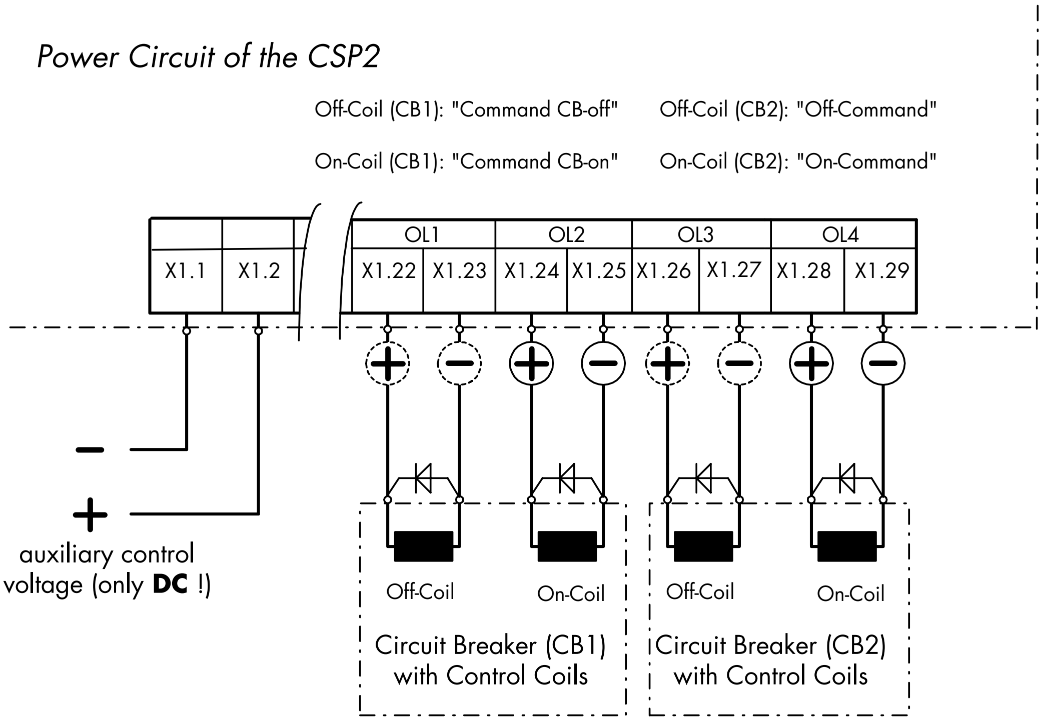


Figure 2.6: Power circuit breaker control (L-type))

Note

When resetting the power outputs for the control coils of circuit breakers, *high induction voltages* are created at the terminals. These might have negative influences on the power circuit of the ***CSP2***. In order to eliminate these disturbing influences, the control coils of the power circuit breakers must be provided with corresponding relief measures. *State of the art* is the use of *free wheeling diodes*, which shortens the developing induction voltages immediately (free-wheeling circuit).
Relief measured must in general always be provided at the location of occurrence of the disturbing influences, in this case, therefore, directly at the terminals of he control coils.

Switchgears with motor drive (M-type)
The motor drives of MV-switchgears are as a rule constructed as *direct current series-wound machine*. For the connection of these *series wound* motors to the ***CSP2***, three terminals per control output (OM) are provided:

- *The field winding (excitation)* is generally connected to terminals OMx.1 and OMx.2.
- *The armature coil* is connected to terminals OMx.3 and OMx.4(!).

(Example see Figure 2.7*: field winding: X1.10 and X1.11; armature winding: X1.12 and X1.13)!*

Note

If the drive motor has only *two terminals*, the motor will only be connected to the terminals of "armature winding" (OMx.3 and OMx.4) of the ***CSP2***. The "series circuit terminals" OMx.1 and OMx.2) in this case must be bridged at the ***CSP2***.

Variants of switchgear control for motor driven switchgears (M-type)
The ***CSP2*** makes possible via an easily makeable bridging connection of the additional terminal X1.3 up to X1.9 a selection between direct *and* indirect controlling for motor-driven switchgears (M-Type).

Direct switchgear controlling
For switchgears (M-type) whose motor drives are controlled directly from ***CSP2***, the rotation change-over of the motor (anti-clockwise, clockwise) must be taken into account. For this, the polarity inversion at the armature winding of the drive motor (rotation change-over for the closing or opening of the MV-switchgear) will be carried out automatically at the corresponding terminals of the ***CSP2*** (OMx.3 and OMx.4) when the next control command is given!

Note

The *polarity* present at the terminals (OMx.3/OMx.4) is dependent on the activated control commands ON or OFF!

If e.g. a *control command for switching on* of the connected switchgear in Figure 2.7 is activated, terminal X1.11 has the negative potential of the auxiliary control voltage. In this case, an internal auxiliary relay contact bridges the terminals X1.11 with X1.12 and thus provides for the series connection of the field winding with the armature winding. Here the motor must be connected in such a way, that the switchgear moves at the indicated polarity to the "ON-Position" (clockwise rotation of motor: closing of the switchgear).

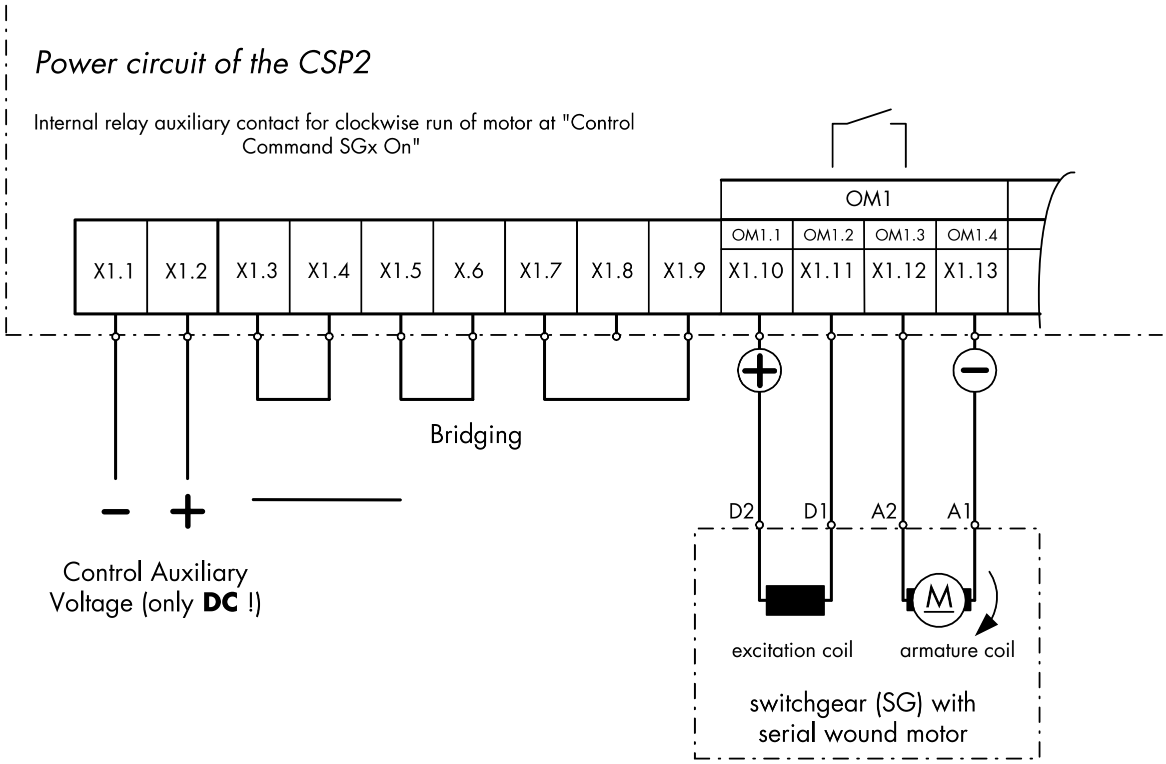


Figure 2.7: Direct switchgear control (M-type) – switching-on of switchgear

When thereupon an OFF-control command occurs, the negative potential changes from terminal X1.13 to X1.12 and an internal relay contact now bridges the terminals X1.11 with X1.13 (anti-clockwise motor run: opening of the switchgear)

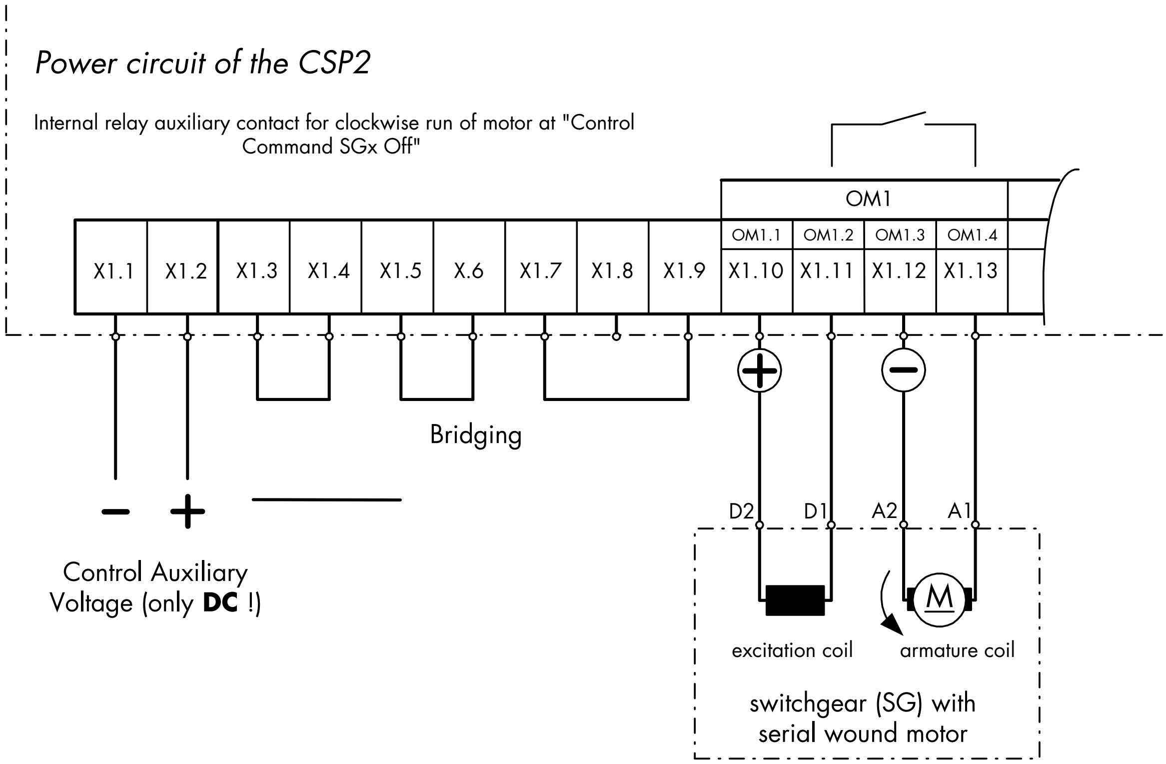


Figure 2.8: Direct switchgear control (M-type) – switching-OFF of switchgear

The polarity inversion applies only for the control circuits (OM1 to OM3) provided for the motor drives. At the control outputs for the circuit breaker (OL1 to OL4) in general no polarity inversion is carried out!

Indirect switchgear controlling
This variant is provided for switchgears whose motor drives are controlled via auxiliary relays and thus are 'indirectly' controlled *(see* Figure 2.9*).*
Therefore, a polarity inversion at the terminals OMx.3 and OMx.4 must not occur! When giving the control commands ON/OFF, thus *no* polarity inversion occurs at the terminals of the ***CSP2***.
The anticlockwise or clockwise rotation of the motor for closing or opening the switchgear is carried out by the corresponding controlling of the motor (e.g. "H-circuit connection") via the auxiliary relays K1 for OFF or K2 for ON.

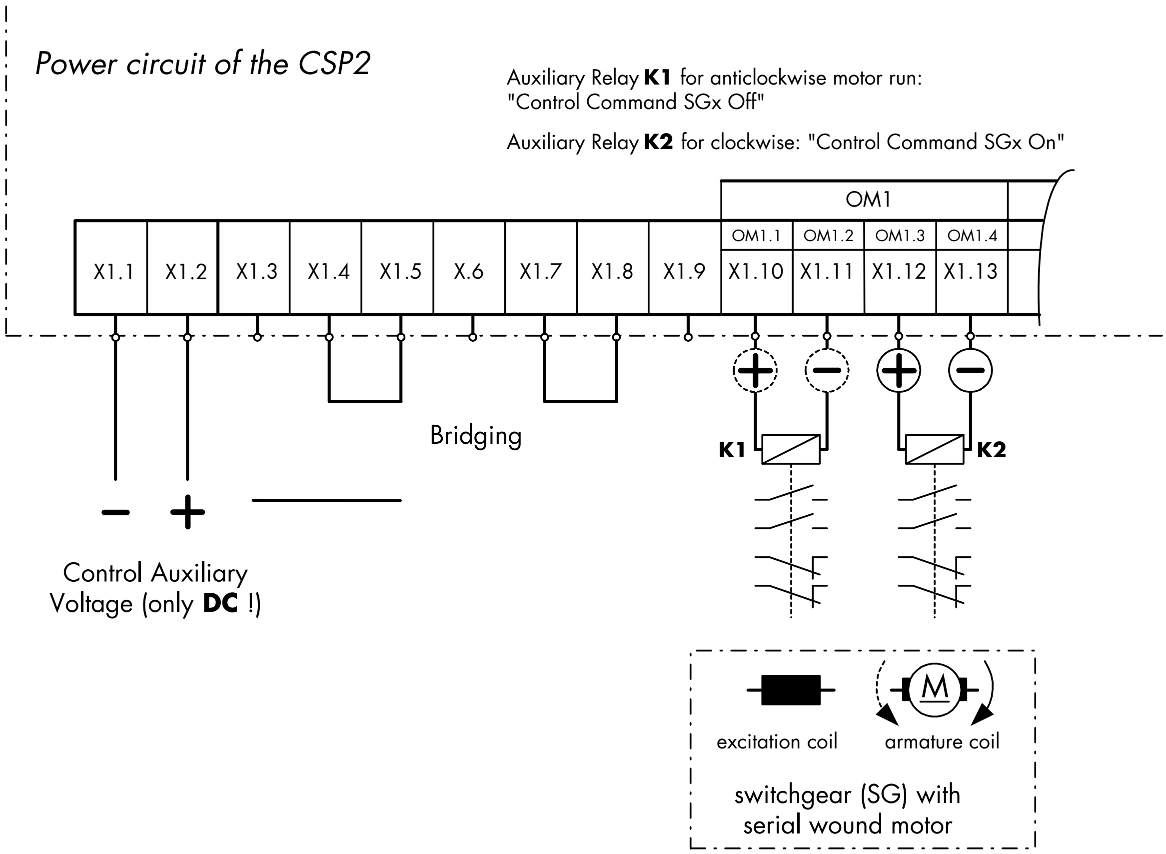


Figure 2.9: Indirect switchgear control (M-type))

Note

The indirect control must principally be applied too, when the switchgear to be controlled is driven via the control coils, however does not possess a *trip coil* and thus is no intended for a trip-off by protective functions *(example: disconnector with compressed air cylinders).*

Overview: Variants of the switchgear control (direct/indirect)

According to the control of motor-driven switchgears (M-type) used, corresponding terminals are to be bridged in terminal row XA1. By this terminal connection the required polarity inversion occurs at *direct* switchgear control for the M-type – not at *indirect* control. For the control of circuit breakers (L-type) the connections of terminal board XA1 are without significance.

Choice of the Control Method for Control Outputs OM1 to OM4			
Terminal Strip X1	*Direct Control*	*Indirect Control*	Note
X1.3	┐		Bridge wiring : Terminal bridges to be wired from external !
X1.4	┘	┐	
X1.5	┐	┘	
X1.6	┘		
X1.7	┐	┐	
X1.8	│	┘	
X1.9	┘		

Table 2.2: Choice of switchgear Control Direct/Indirect

Direct Control of the Control Outputs OL1 to OL4 and OM1 to OM3					
Terminal Strip X1	*Internal Name*	*Switchgear Type*	*Description*	*Polarity*	*Polarity inversion*
X1.1	LA-	U_H	Aux. Control Voltage (DC !)	–	–
X1.2	LA+			+	–
X…					
X1.10	OM 1.1	Motor Drive (M-Type)	Series Winding (or bridged)	+	–
X1.11	OM 1.2			–	–
X1.12	OM 1.3		Armature *	+ (–)	●
X1.13	OM 1.4			– (+)	●
X1.14	OM 2.1	Motor Drive (M-Type)	Series Winding (or bridged)	+	–
X1.15	OM 2.2			–	–
X1.16	OM 2.3		Rotor *	+ (–)	●
X1.17	OM 2.4			– (+)	●
X1.18	OM 3.1	Motor Drive (M-Type)	Series Winding (or bridged)	+	–
X1.19	OM 3.2			–	–
X1.20	OM 3.3		Rotor *	+ (–)	●
X1.21	OM 3.4			– (+)	●
X1.22	OL1.1	OFF Coil (L-Type)	OFF Command for CB1	+	
X1.23	OL1.2			–	
X1.24	OL2.1	ON Coil (L-Type)	ON Command for CB1	+	
X1.25	OL2.2			–	
X1.26	OL3.1	OFF Coil (L-Type	OFF Command for CB2	+	
X1.27	OL3.2			–	
X1.28	OL4.1	ON Coil (L-Type)	ON Command for CB2	+	
X1.29	Ol4.2			–	

Table 2.3: Terminal Assignment of the Control Outputs for Direct Control

*) The drive motor must be so connected that the switchgear is driven to the ON position at the indicated polarity. At these terminals the *CSP2* changes the polarity internally when the switchgear is to be driven into the OFF position.

Indirect Control of the Control Outputs OL1 to OL4 and OM1 to OM3				
Terminal Strip X1	*Internal Name*	*Switchgear Type*	*Description*	*Polarity*
X1.1	LA-	U_H	Aux. Control Voltage (DC !)	–
X1.2	LA+			+
X…				
X1.10	OM 1.1	Motor Drive (M-Type)	Aux. Relay for SGX OFF	+
X1.11	OM 1.2			–
X1.12	OM 1.3		Aux. Relay for SGX ON	+
X1.13	OM 1.4			–
X1.14	OM 2.1	Motor Drive (M-Type)	Aux. Relay for SGX OFF	+
X1.15	OM 2.2			–
X1.16	OM 2.3		Aux. Relay for SGX ON	+
X1.17	OM 2.4			–
X1.18	OM 3.1	Motor Drive (M-Type)	Aux. Relay for SGX OFF	+
X1.19	OM 3.2			–
X1.20	OM 3.3		Aux. Relay for SGX ON	+
X1.21	OM 3.4			–
X1.22	OL1.1	OFF Coil (L-Type)	OFF Command for CB1	+
X1.23	OL1.2			–
X1.24	OL2.1	ON Coil (L-Type)	ON Command for CB1	+
X1.25	OL2.2			–
X1.26	OL3.1	OFF Coil (L-Type	OFF Command for CB2	+
X1.27	OL3.2			–
X1.28	OL4.1	ON Coil (L-Type)	ON Command for CB2	+
X1.29	Ol4.2			–

Table 2.4: Terminal Assignment of the control outputs for indirect control

Assignment: Switchgears – control outputs
According to the application (field configuration), the electrically controllable switchgears must be assigned to corresponding control outputs. For this, the succession as shown by the following examples must be adhered to:

Examples *CSP2-T25*:

1. In case of applications with 2 *circuit breakers, 1 disconnector and 1 earth switch:*
    - switchgear 1 (SG1): circuit breaker 1 (control outputs OL1, OL2)
    - switchgear 2 (SG2): circuit breaker 2 (control outputs OL3, OL4)
    - switchgear 3 (SG3): disconnect (control output OM1)
    - switchgear 4 (SG4): earthing switch (control output OM2)

2. In case of applications with 2 *circuit breakers (withdrawable truck):*
    - switchgear 1 (SG1): circuit breaker 1 (control outputs OL1, OL2)
    - switchgear 2 (SG2): circuit breaker 2 (control outputs OL3, OL4)
    - switchgear 3 (SG3): withdrawable truck of a CB1 (control output OM1)
    - switchgear 4 (SG4): withdrawable truck of a CB2 (control output OM2)
    - switchgear 5 (SG5): earthing switch (control output OM3)

3. In case of applications with 2 *circuit breakers, 2 disconnectors and 1 earth switch:*
    - switchgear 1 (SG1): circuit breaker 1 (control outputs OL1, OL2)
    - switchgear 2 (SG2): circuit breaker 2 (control outputs OL3, OL4)
    - switchgear 3 (SG3): disconnect (control output OM1)
    - switchgear 4 (SG4): withdrawable truck of a CB2 (control output OM2)
    - switchgear 5 (SG5): earthing switch (control output OM3)

Supervision functions for the power circuit

- Short-circuit supervision of the control outputs.
- Protection from destruction of the power circuit due to wrong polarization of the auxiliary control voltage (in this case, however, no output of a control command is possible).
- Supervision for presence of auxiliary control voltage.
- Supervision of the control outputs *(see chapter. „Control circuit supervision CCS")*
- Supervision for internal semiconductor short circuit

Heeding the protective function "Control Circuit Supervision (CCS)"
This protective function serves to increase the availability of swichgears. Here the control circuits of the switchgears connected to the *CSP2* are cyclically tested for disconnection. When a disturbance is detected, it will immediately be reported by the *CSP2*.
For the *Control Circuit Supervision (CCS)* to be able to monitor the control circuits efficiently, attention must be paid while projecting that no auxiliary contacts whatsoever of the switchgears can disconnect the control circuits! Some switchgear manufacturers, however, insert disconnector contacts into the control circuits of the switchgears (e.g. in the case of power circuit breakers) in order to prevent repeated trip of the control coils (anti-pumping) when a faulty check back signal of the switchgear occurs.

Note
The *CSP2* prevents an "anti-pumping" behaviour by a consequent supervision of each individual switching operation *(see chapter "Control Times")*! Consequently, the above mentioned disconnector contacts may in general be omitted when connecting switchgears to the *CSP2*!

Should disconnector contacts be present after all, they have to be bridged over by a resistance (approx. 1kΩ, 2W) so that the supervision current generated by *CSP2* (5 mA) can flow when executing the control circuit supervision.

(For more details see chapter "Control Circuit Supervision")

2.1.4 Current measuring (X7)

Description

The *CSP2* disposes of *seven current measurement inputs*: Three for measuring the phase currents *IL1.W1, IL2.W1, IL3.W1,* three for measuring the phase currents for transformer side winding W2, *IL1.W2, IL2.W2, IL3.W2* and one for the earth current measurement *Ie*. Each current measurement input is provided with three terminals. Thereby it is possible to connect current transformers with a secondary nominal current of 1A or 5A. The adaptation of the secondary nominal value can be done by parameter setting.

Note

For *phase current measurement* all phase current transformers must have the same secondary nominal current!

The *earth current input* can either be used as measurement input for a separate earth current transformer (*ring core transformer)* or is switched into the sum path of the phase current transformers *(Holmgreen circuit).*

- *ring core transformer:* for the earth current path another nominal current can be selected than for the phase current paths.
- The settings of the field parameter "*CT sec"* and *"ECT sec"* for the secondary nominal current (1 A or 5 A) of phase and earth current path must be equal!

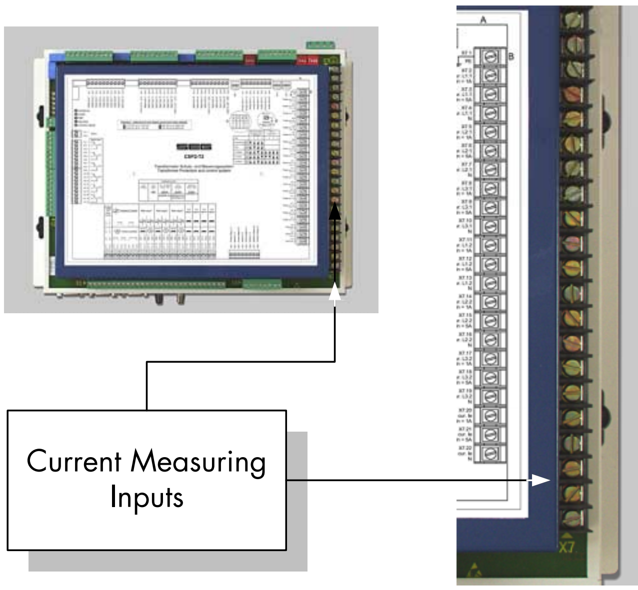


Figure 2.10: *Detail of current measurement inputs*

Current Measuring Inputs			
Terminal No.	*Secondary Rated Transformer current*	*Primary Measured Quantity*	*Measuring Range*
X7.2	1A	Phase currrent IL1.W1	0…40 × I_N
X7.3	5A		
X7.4	N		
X7.5	1A	Phase current IL2. W1	0…40 × I_N
X7.6	5A		
X7.7	N		
X7.8	1A	Phase current IL3. W1	0…40 × I_N
X7.9	5A		
X7.10	N		
X7.11	1A	Phase currrent IL1. W2	0…40 × I_N
X7.12	5A		
X7.13	N		
X7.14	1A	Phase current IL2. W2	0…40 × I_N
X7.15	5A		
X7.16	N		
X7.17	1A	Phase current IL3. W2	0…40 × I_N
X7.18	5A		
X7.19	N		
X7.20	1A	Earth current Ie	0…20 × I_N
X7.21	5A		
X7.22	N		

Table 2.5: Connection of the current measuring inputs

In the following, different connection modes for phase as well as earth current transformers are shown and explained.

Heeding the power direction when connecting the current transformers
In many applications of the *CSP2* direction-dependent protective functions are of vital importance. Here, it is necessary to define the power direction definitely in or to use them as a criterion for protection tripping in the case of a fault.

Wrongly interpreted power direction by the *CSP2* has also consequences for the signs of the displayed measurement values and the protection functions!

Note

In order to correct a *wrongly interpreted power direction* without a time and money consuming change of wiring, the *CSP2* disposes of two field parameters independent of each other (see chapter "*Field Parameters")*:

- "*CT dir*": three-pole correction (three measurement inputs) of the phase position for the phase current paths
- *"ECT dir"*: one-pole correction (one measurement input) of the phase position for the earth current path.

via which the power direction for the *CSP2* can be adapted equipment-internally.

Attention

The *CSP2* interprets a *power direction* as positive when:

- *the secondary current of a current transformer "flows in"* at the terminals of the measurement input for 1A or 5A and *"flows out"* at terminal *"N"* and
- the field parameter *"CT dir"* and *"ECT dir"* have the settings *0°* (default settings)!

The *primary power direction* supposed in the following illustrations (reference-arrow direction of the primary phase current *IL1*) a *corresponding secondary power* direction will result, which is depicted by the reference-arrow direction of the secondary phase current *IL1'*.

Note

The circuits for connecting the current transformer have in each case been so arranged that the *primary power direction* on the secondary side of *CSP2* will be interpreted as positive with the settings *"CT dir = 0°"*as well as *"ECT dir = 0°"*

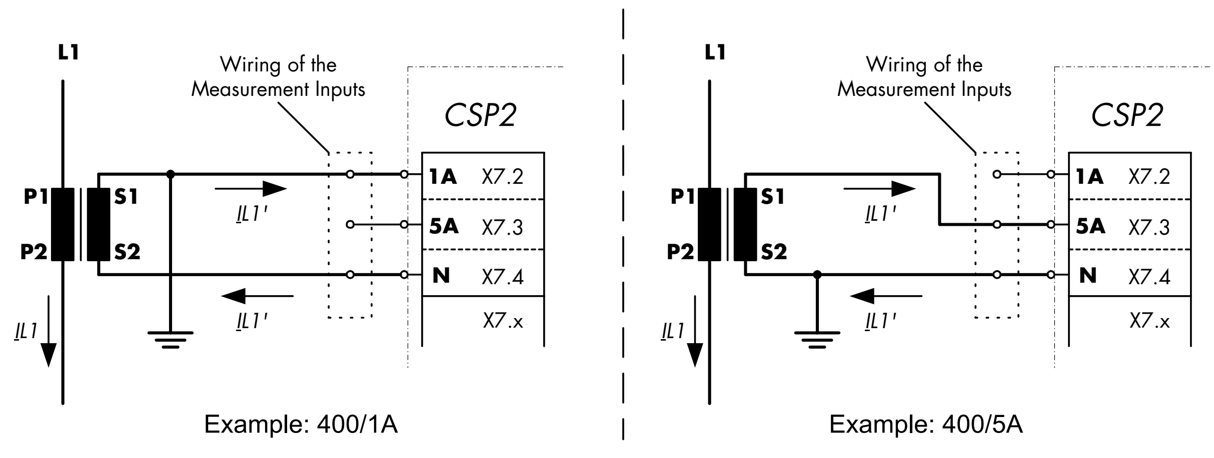


Figure 2.11: Connection of current transformers with different secondary nominal currents and earthing of the secondary terminal S1 or S2

Earthing of the secondary coils of current transformers
The secondary coil of a current transformer must be earthed one-sided according to Standard IEC60044. This serves on the one hand as a *measure of protection*, as in the case of a breakdown of the coil insulation between the primary and the secondary side the mains-side voltage would occur at the secondary side. Consequently, the operation personnel would be endangered. On the other hand, a *defined reference point* for the measurable quantities is created and inductive interference voltages are conducted to earth.
The *secondary terminals S1* or *S2* can be earthed optionally (see Figure 2.12). However, this depends on the standards of the different switchboard manufactorers!

Note

When using the *Holmgreen circuit* as well as *the V-circuit* and selecting the current transformer secondary terminals (S1 or S2), the right polarity must be chosen when connecting the current transformer to the *CSP2*.

Three-phase measurement of the phase currents (without earth current measurement)
The three-phase measurement of the phase currents *I̲L1, I̲L2 and I̲L3* is carried out via three separate current transformers. Depending on the secondary nominal current of the current transformer, the transformer secondary terminals must be connected to the measurement inputs for 1A or 5A.

The *earthing of the secondary winding* can optionally be carried out at *S1* or *S2*. The secondary power direction will not be changed thereby.

Example:
Current transformers with secondary nominal current of 1A and earthing of the transformer secondary terminals S2.

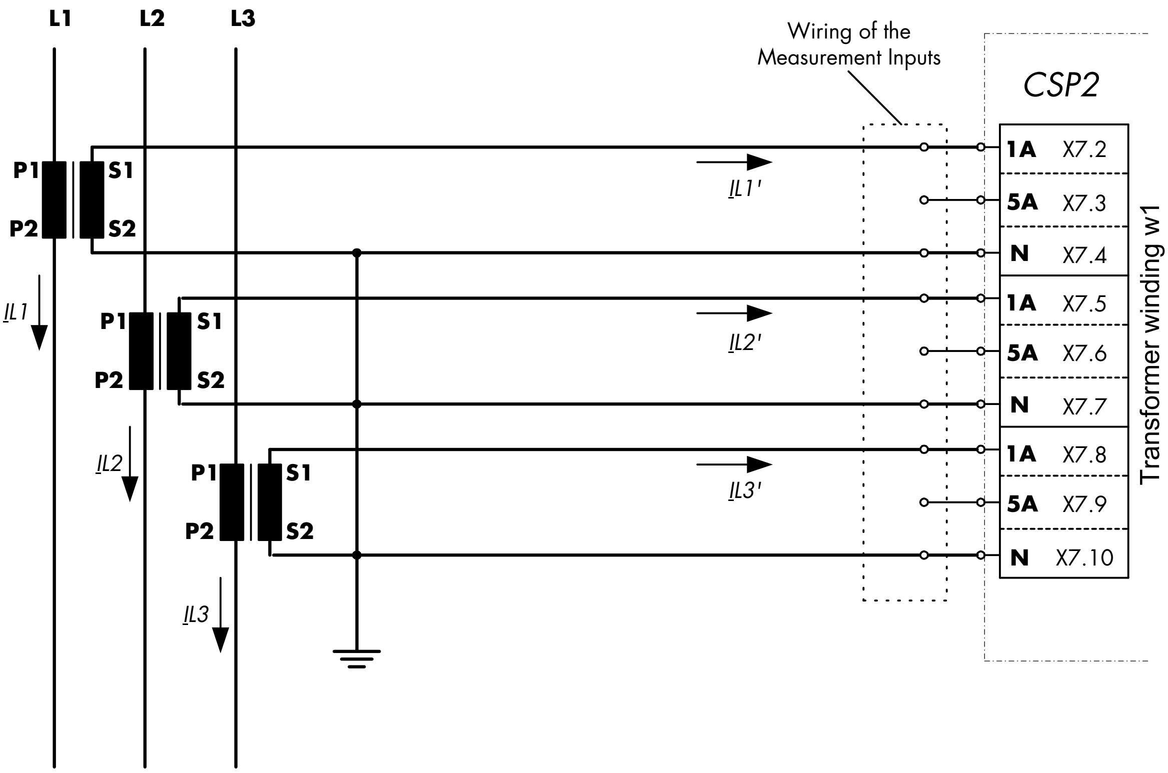


Figure 2.12: Three-phase current measurement winding 1: *- current transformer with secondary nominal current of 1A*
- without earth current measurement
- with earthing of the current transformer secondary terminals S2

Three-phase measurement of the phase currents (with earth current measurement: ring core transformer)
For applications in which also the *earthing current Ie* must be regarded as a criterion, the earth current detection can occur via a direct measurement by a ring core transformer (high precision). The secondary terminals of the ring core transformer must be connected according to the secondary nominal value (1A/5A) to the terminals of the fourth current measurement input of the *CSP2*.

Note

The *earth current measurement via ring core transformer* is based on the detection of the sum current resulting from the phase currents in the line: *IL1+IL2+IL3 = Ie*. In the case of an earth fault, this sum is *unequal* zero! Thus, when using a ring core transformer, attention must be paid that the shielding of the line at the open end will again be returned by the ring core transformer, as otherwise the sum formation would also consider the current in the shielding. Due to this, however, earth faults, in which the error current flows through the shielding, would not be discovered by the ring core transformer!

The earthing of the secondary terminals can also here be carried out optionally at S1 or S2. The secondary power direction is not changed thereby.

Example:
Current transformers with secondary nominal current of 1A and earthing of the transformer secondary terminals S1

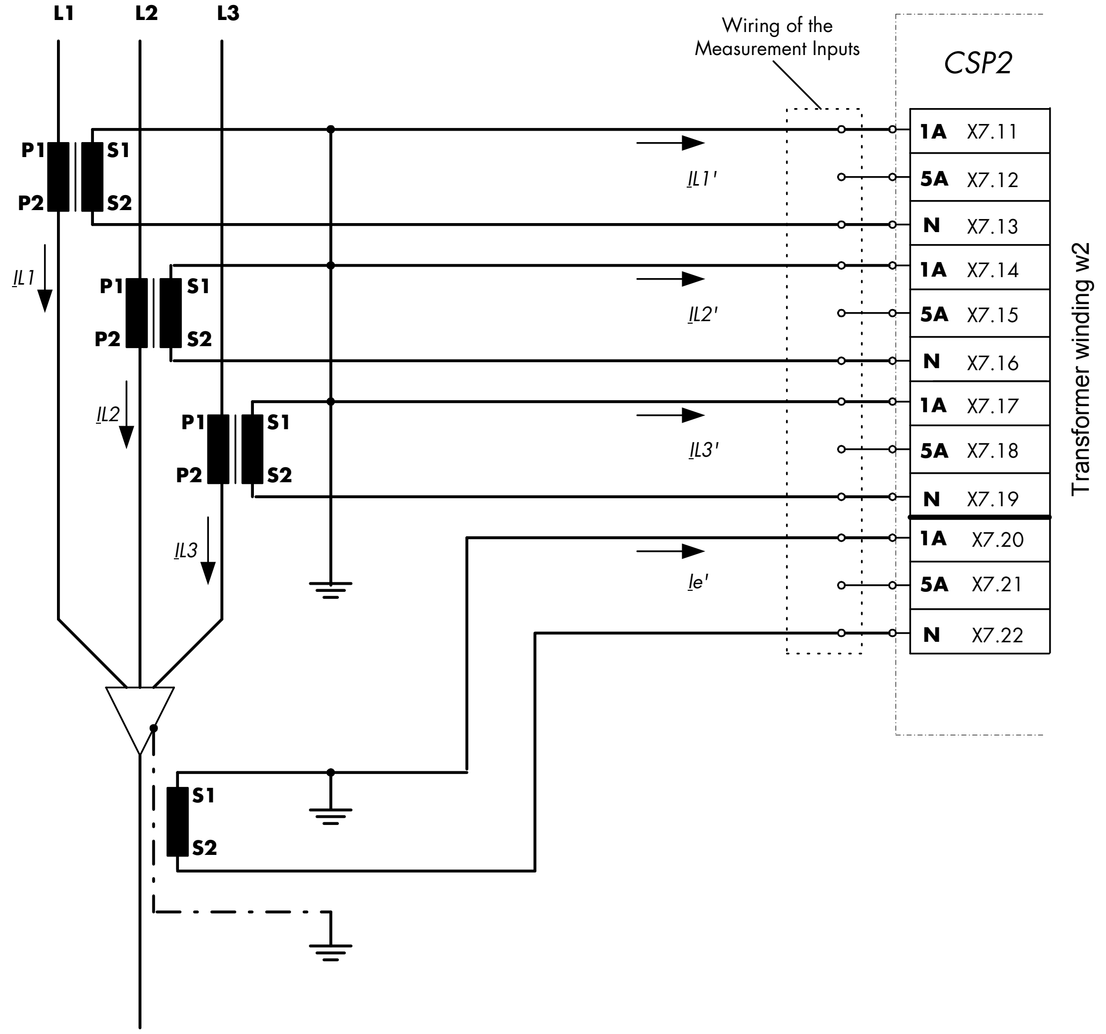


Figure 2.13: Three-phase current measurement winding 2:
- current transformer with secondary nominal current of 1A
- with earth current detection by ring core transformer
- with earthing of the current transformer secondary terminals S1

Three-phase measurement of the phase currents (with earth current measurement: Holmgreen circuit)
If no ring core transformer is available for the detection of the earth current, the fourth current measurement input can be placed in the sum path of the phase currents by simple wiring of the measurement inputs of the *CSP2*. The geometrical addition formation occurs here by the creation of a sum current path of the phase currents.

Remark

In comparison to the ring core transformer, the measurement of the earth current via the Holmgreen circuit is a little less precise, as here the transfer errors of all three phase current converters add up unfavourably. When using a ring core transformer, however, only its own tolerances have an influence on the measurement.

When using the Holmgreen circuit, the *earthing of the current transformer secondary side* can on principle also be carried out at the secondary terminals S1 or S2. However, if the not earthed secondary terminals (correspondingly S2 or S1) are connected with the wrong polarity to the current measurement inputs (1A or 5A) of the *CSP2*, the *CSP2* will interpret a *reverse power direction*. This will influence *direction-dependent protective functions* and *the polarity signs of the measurement values displayed.*

Attention

In order to correct a wrongly interpreted power direction without a costly and time consuming wiring change, the ***CSP2*** disposes of two field parameters independent from one another:

- *"CT dir"*: three-pole correction of the phase position for the phase current paths and
- *"ECT dir":* one-pole correction of the phase position for the earth current path.

via which the power direction can be adapted in the CSP device internally.

Also the following *examples for the Holmgreen circuit* show wiring for connection of the current transformer where the ***CSP2*** interprets as positive the *power directions* for the field parameter settings *"CT dir = 0°"* as well as *"ECT dir = 0°"*.

Example a):
Current transformer with secondary nominal current of 5A and earthing of the transformer secondary terminals S1.

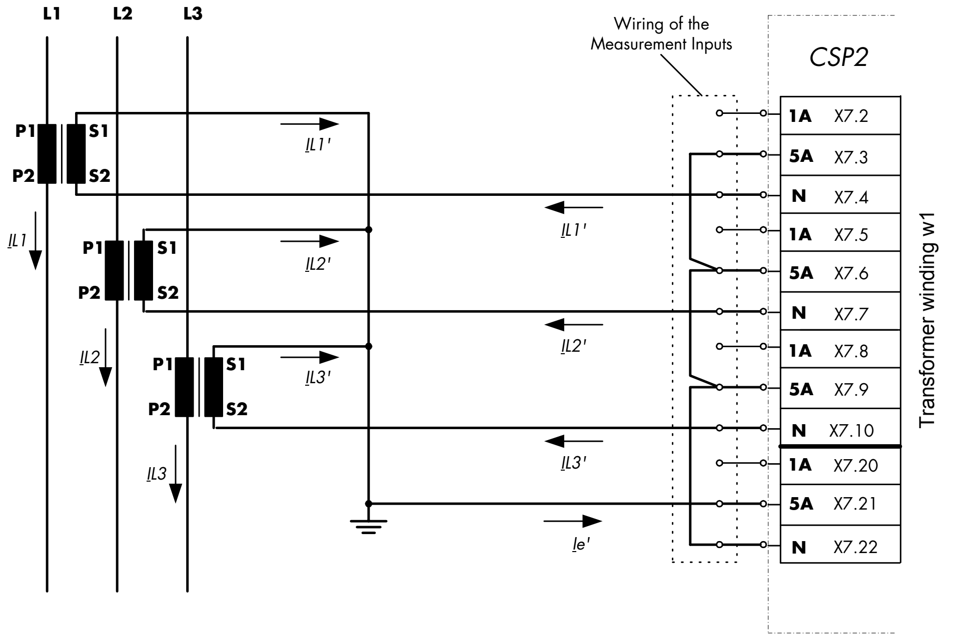


Figure 2.14: Three-phase current measurement winding 1:
- current transformer with secondary nominal current of 5A
- with earth current detection by Holmgreen circuit
- with earthing of the current transformer secondary terminals S1

Example b):
Current transformer with secondary nominal current of 5A and earthing of the transformer secondary terminals S2.

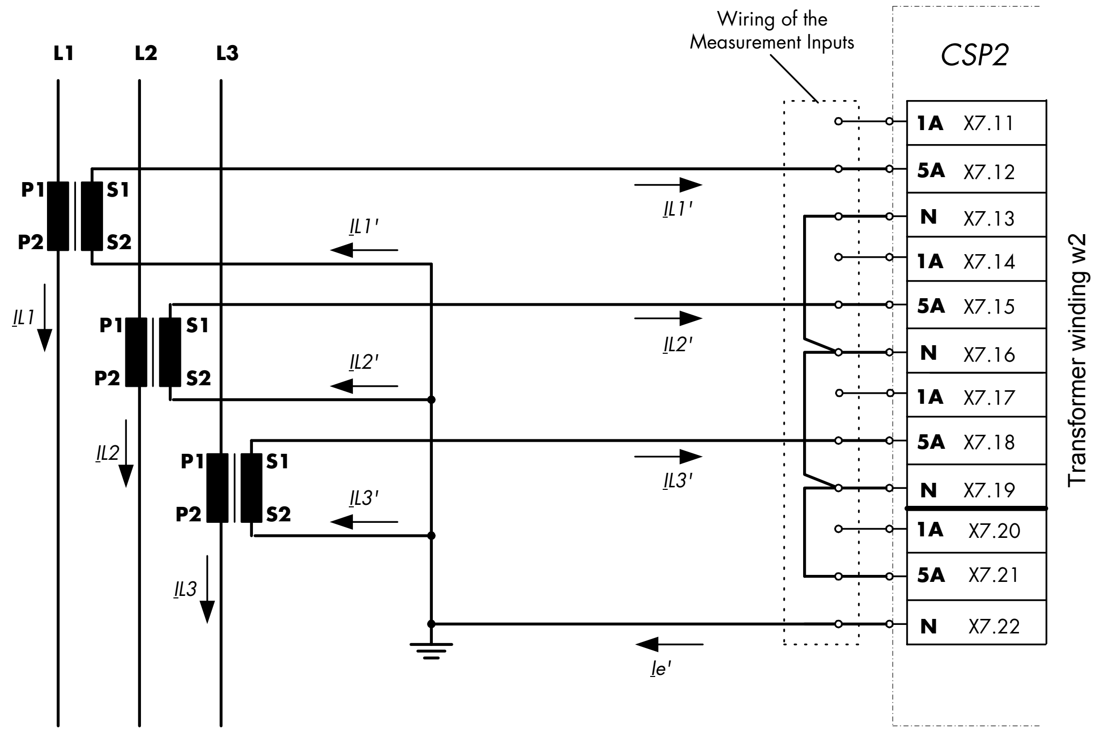


Figure 2.15: Three-phase current measurement winding 2:
- current transformer with secondary nominal current of 5A
- with earth current detection by Holmgreen circuit
- with earthing of the current transformer secondary terminals S2

Two-phase measurement of the phase currents (V-circuit)
Applications where only two current transformers are available for current detection require the so called "V-circuit", in which two of the three phase currents are directly measured via the transform ers. The measurement of the third phase current results from the *geometrical addition of the two other phase currents.*

Example:
Measurement of the phase currents $\underline{I}L1$ and $\underline{I}L3$ with calculation of the phase current $\underline{I}L2$ via the V-circuit

For a *three wire system* with a *balanced* or *unbalanced load* applies that the geometrical addition of the phase currents

$$\underline{I}L1+\underline{I}L2+\underline{I}L3 = 0$$

at any time equals zero! Thus results for the phase current $\underline{I}L2$

$$\underline{I}L1 + \underline{I}L3 = -\underline{I}L2$$

a) View of the primary side *b) view of the secondary side*

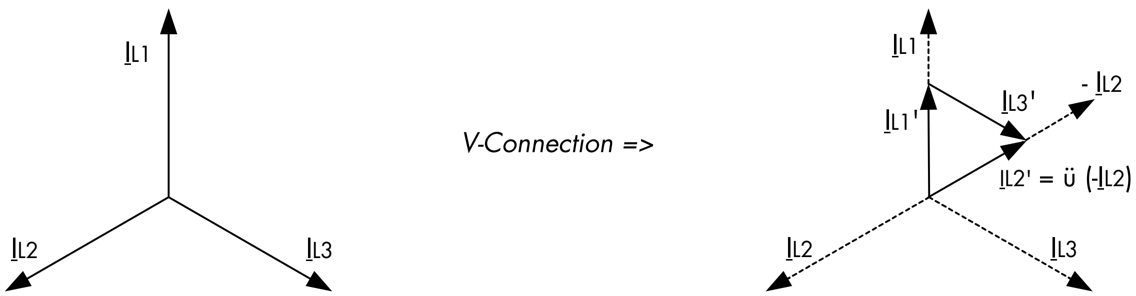


Figure 2.16: a) primary phase currents IL1, IL2, IL3 according to amount and phase position
b) secondary phase currents IL1', IL2', IL3' according to amount and phase position

On the secondary side there are only *two secondary phase currents* available (here *$\underline{I}L1'$ and $\underline{I}L3'$*) whose phase position is in conformity with the corresponding *primary currents.* By the connection of the secondary circuits of both current transformers (V-circuit) a current path (*$\underline{I}L2'$*) is formed which conducts the geometrical addition of the two secondary phase currents *$\underline{I}L1'$ and $\underline{I}L3'$* (*see* Figure 2.16):

$$\underline{I}L2' = \underline{I}L1' + \underline{I}L3'$$

$$= \ddot{u}_1\, \underline{I}L1 + \ddot{u}_3\, \underline{I}L3 \qquad \text{with: } \ddot{u}_1 = \ddot{u}_3 = \ddot{u} : \text{current transformation ratio of the current transformers}$$

$$= \ddot{u}\,(\underline{I}L1 + \underline{I}L3) \qquad \text{with: } \underline{I}L1 + \underline{I}L3 = -\underline{I}L2$$

$$= -\ddot{u}\,\underline{I}L2$$

and represents the available value of the *primary phase current $\underline{I}L2$* correctly according to the amount.

Concerning the phase position, however, the sum current path $\underline{I}L2$ formed in this way shows a phase shift of 180° ! The correction of this phase shift must be carried out by a corresponding wiring of the measurement inputs of the *CSP2* so that the *CSP2* detects the correct phase position of the primary phase current $\underline{I}L2$ (for this, see the following illustration for the V-circuit).

Attention

The V-circuit can only be used under the condition that the mains can be considered earth *faultless*. Provided that, the protective functions as e.g. *power direction protection (P>, P>>, Pr>, Pr>>) and unbalanced load protection (I2>, I2>>)* can be applied. According to the setting of the *pickup value of the unbalanced load protection* this protective function could also create an alarm at *an earth fault* and perhaps lead to trip, as then the sum of the phase currents does not equal zero!
As with the V-circuit *no real* but only a *simulated mains star point* exists, also the *earth over current time functions Ie> and Ie>>* are only usable via a separate *earth current detection with a ring core transformer (see* Figure 2.18*)!*

The *earthing of the current transformer secondary side* can entail the same problems in the V-circuit regarding the detection of the power direction as with the Holmgreen circuit. Also in this respect two circuits are given as examples for which the *CSP2* recognizes the *positive power direction* when the field parameter *"CT dir = 0°"* has been set.

Example a):
Current transformer with secondary nominal current of 5A and earthing of the transformer secondary terminals S1.

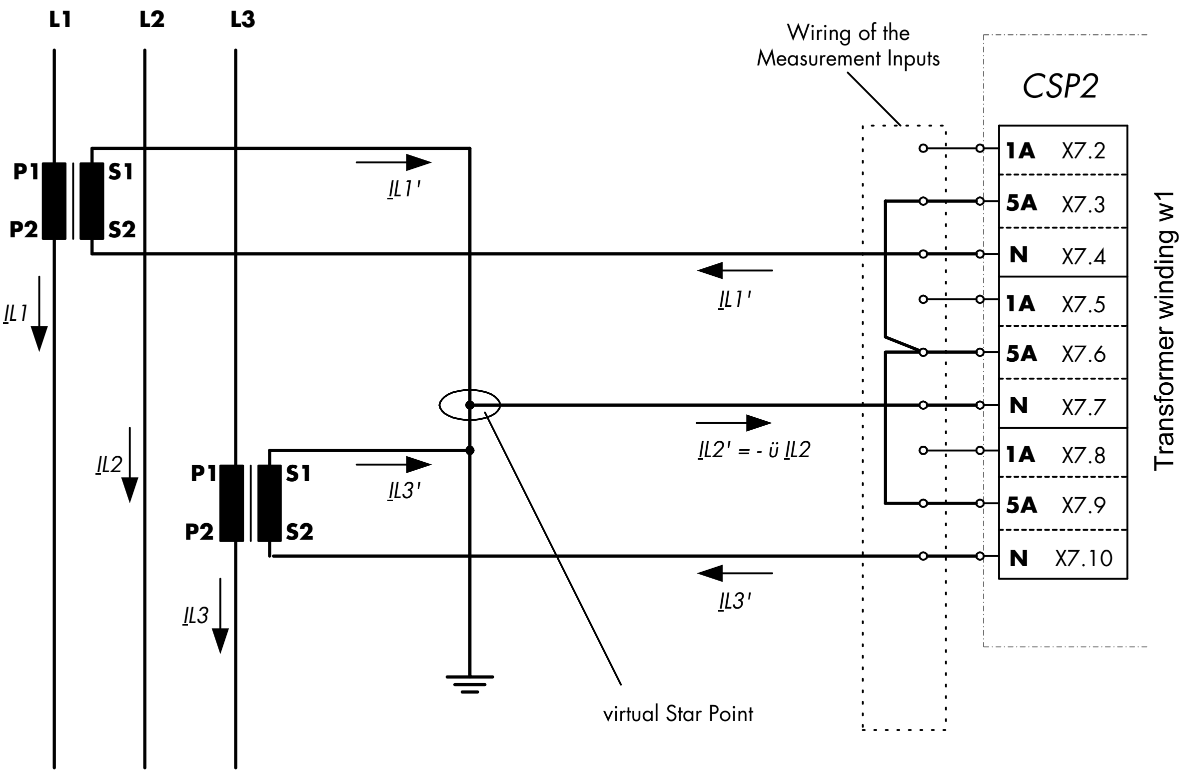


Figure 2.17: Two-phase current measurement winding 1: *- current transformer with secondary nominal current of 5A*
- without earth current detection
- with earthing of the current transformer secondary terminals S1

When using the V–circuit, an *earth current detection* is only possible via a direct measurement by a ring core transformer. The definition of the earth current via the phase conductors (see Holmgreen circuit) is not possible! The connection of a ring core transformer occurs independently of the V-circuit.

Example b):
Current converter with secondary nominal current of 5A and earthing of the transformer secondary terminals S2.

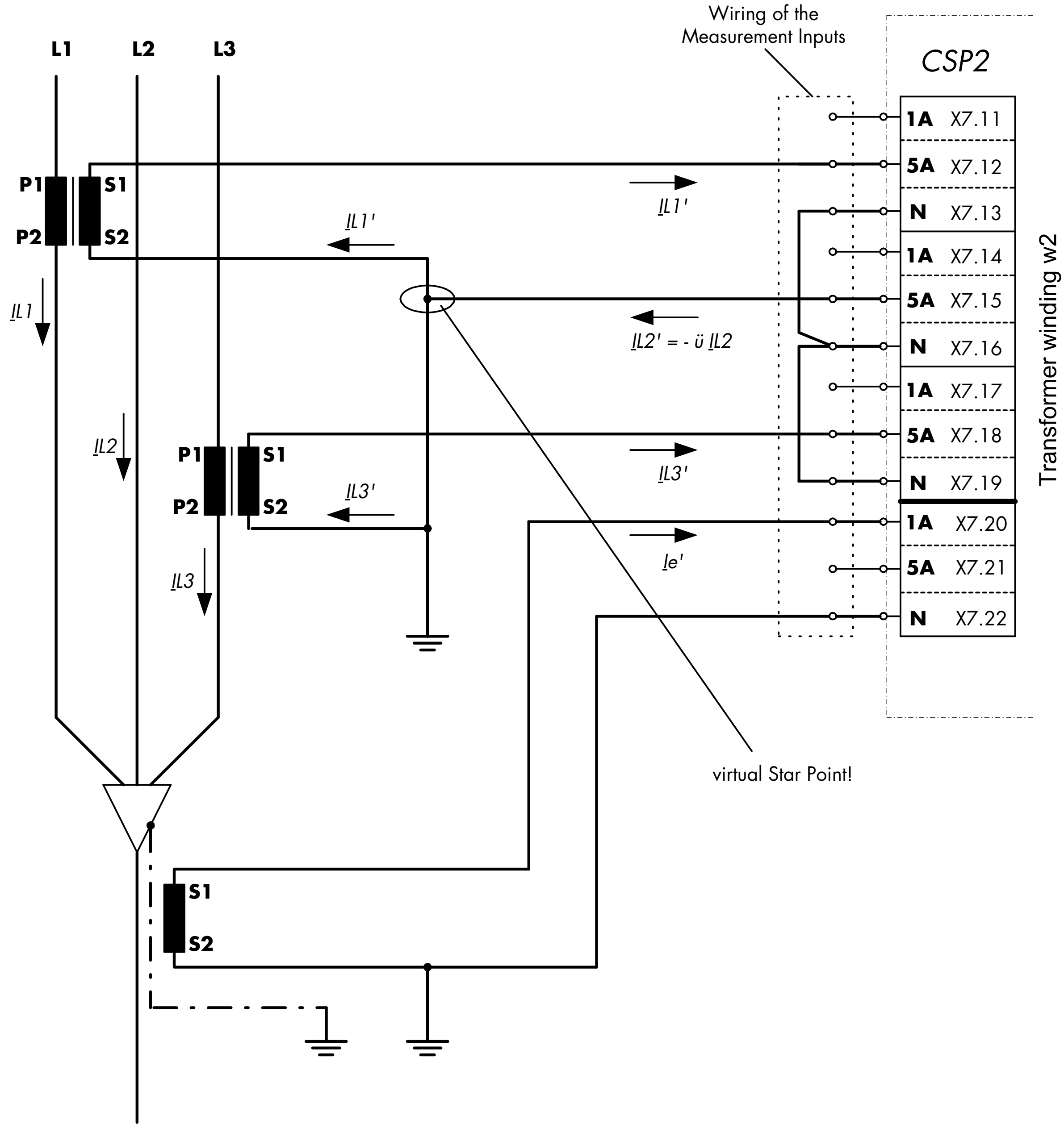


Figure 2.18: Two-phase current measurement by V-circuit winding 2: - current transformer with secondary nominal current of 5A - with earth current detection via wire ring core transformer - with earthing of the current transformer secondary terminals S2

2.1.5 Digital Inputs (X4)

Description
The *CSP2* disposes of optic decoupled inputs with own return lines. These inputs serve for the detection of switchgear positions, further cubicle messages or signals from external protective functions (e.g. Buchholz relays at the transformer, backward interlocking etc.). The number of the inputs depends on the extension level of the *CSP2* used. The inputs are provided with bridge rectifiers for all specified auxiliary voltage ranges of AC and DC *(see chapter "Technical Data")*. A bounce control of the input signals is realized by software. The debounce control time can be set for each input separately from 0 to 60,000 ms. Changes in the logic states are recorded with real-time stamps in the non-volatile *event recorder*.

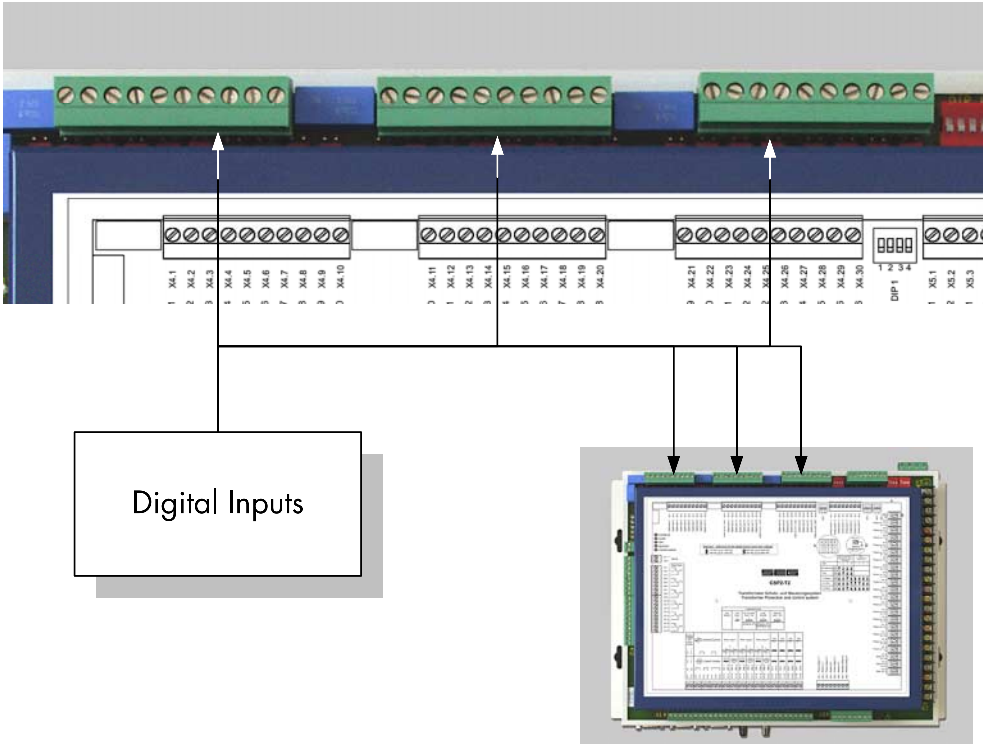


Figure 2.19: Detail digital inputs

Detection of the switchgear positions
For each switchgear which is to be monitored by the *CSP2*, there are at least two digital inputs provided, one as check back signal for the position ON and the other for the position OFF. This makes possible the detection and display of a fault or an intermediate position. For switchgears like circuit breakers additionally further digital inputs can be used for the states i.e. »circuit breaker ready« »spring charged« »circuit breaker removed«.

Switching mode of operation the digital inputs
The switching mode of operation (open/closed current principle) can be parameterized individually for each input. In this case it will be parameterized if the input shall be recognized as active with or without voltage applied. *(For more details see chapter "Digital Inputs).*

Operation ranges – response thresholds
Moreover, it is possible to set the response threshold for each of the inputs in two operation ranges (high/low) (*For precise threshold values see chapter "Technical Data").*

Attention Danger!

For changing the pick-up threshold of a digital input, the cover plate must be removed off. Due to this, there is the danger of getting an electric shock as live parts are no longer protected against touch.

The opening of the device for changing the thresholds of the digital inputs must only be carried out if the device is free of voltage (dead bar) by specialized/trained personel.

Attention has to be paid that all voltage sources that are connected to the *CSP2* are switched off.

- Measurement voltage,
- Auxiliary voltage (power supply)
- Auxiliary voltage of the digital inputs,
- Auxiliary voltage of the power outputs and
- Auxiliary voltages of the signal relay circuits.

The corresponding safety regulations must be observed under any circumstances!

The digital inputs must be connected to the plug-in terminals of row X4. All inputs are combined in several groups. Each group disposes of a common return wire (COM) so that messages fom several voltage sources with different potentials can be processed separately. All inputs are galvanically uncoupled from the CSP device.

The position messages of the switchgears SG1 to SG5 are firmly assigned to the inputs of the first group (DI 1 to DI 10). The definition of the switchgears SG1 to SG5 as e.g. circuit breakers, disconnectors, switch disconnectors or earthing switches depends on the field configuration in each case. All further digital inputs can be assigned with *"input functions"*, which start the function defined for them, when they are activated.

Examples:

- Assignable field messages (MCB trip, spring charged etc.),
- External protective functions (backward interlocking, blocking etc.,
- Messages from external protective gears (TRIP, Alarm) and
- User-defined messages *("Function 1"* to *"Function 10")*

Digital Input				
DI Groups	*Terminal No.*	*DI-No.*	*Function Assignment*	*Description*
Group 1 (fixed)	X4.1	DI1	„SG1 Signal 0"	Position Switching Device 1: OFF
	X4.2	DI2	„SG1 Signal I"	Position Switching Device 1: ON
	X4.3	DI3	„SG2 Signal 0"	Position Switching Device 2: OFF
	X4.4	DI4	„SG2 Signal I"	Position Switching Device 2: ON
	X4.5	DI5	„SG3 Signal 0"	Position Switching Device 3: OFF
	X4.6	DI6	„SG3 Signal I"	Position Switching Device 3: ON
	X4.7	DI7	„SG4 Signal 0"	Position Switching Device 4: OFF
	X4.8	DI8	„SG4 Signal I"	Position Switching Device 4: ON
	X4.9	DI9	„SG5 Signal 0"	Position Switching Device 5: OFF
	X4.10	DI10	„SG5 Signal I"	Position Switching Device 5: ON
	X4.11	COM1	-	Common return wire of group 1
Group 2	X4.12	DI11	„Input Function"	assignable
	X4.13	DI12	„Input Function"	assignable
	X4.14	DI13	„Input Function"	assignable
	X4.15	DI14	„Input Function"	assignable
	X4.16	DI15	„Input Function"	assignable
	X4.17	DI16	„Input Function"	assignable
	X4.18	DI17	„Input Function"	assignable
	X4.19	DI18	„Input Function"	assignable
	X4.20	COM2	-	Common return wire of group 2
Group 3	X4.21	DI19	„Input Function "	assignable
	X4.22	DI20	„Input Function"	assignable
	X4.23	DI21	„Input Function"	assignable
	X4.24	DI22	„Input Function"	assignable
	X4.25	COM3	-	Common return wire of group 3
Group 4	X4.26	DI23	„Input Function "	assignable
	X4.27	DI24	„Input Function"	assignable
	X4.28	DI25	„Input Function"	assignable
	X4.29	DI26	„Input Function"	assignable
	X4.30	COM4	-	Common return wire of group 4

Table 2.6: Connection list of the digital inputs at ***CSP2-T5***

COM: Common return wire of a DI-group.

Group 1: The digital inputs of this DI-group (DI1 to DI10) are reserved for the check back signals (ON/OFF position) of the switchgear to be detected and are not available for variable configuration. The allocation is firmly fixed by the field configuration.

Group 2…4: The allocation is variably configurable for user-defined additional functions ("Input functions")

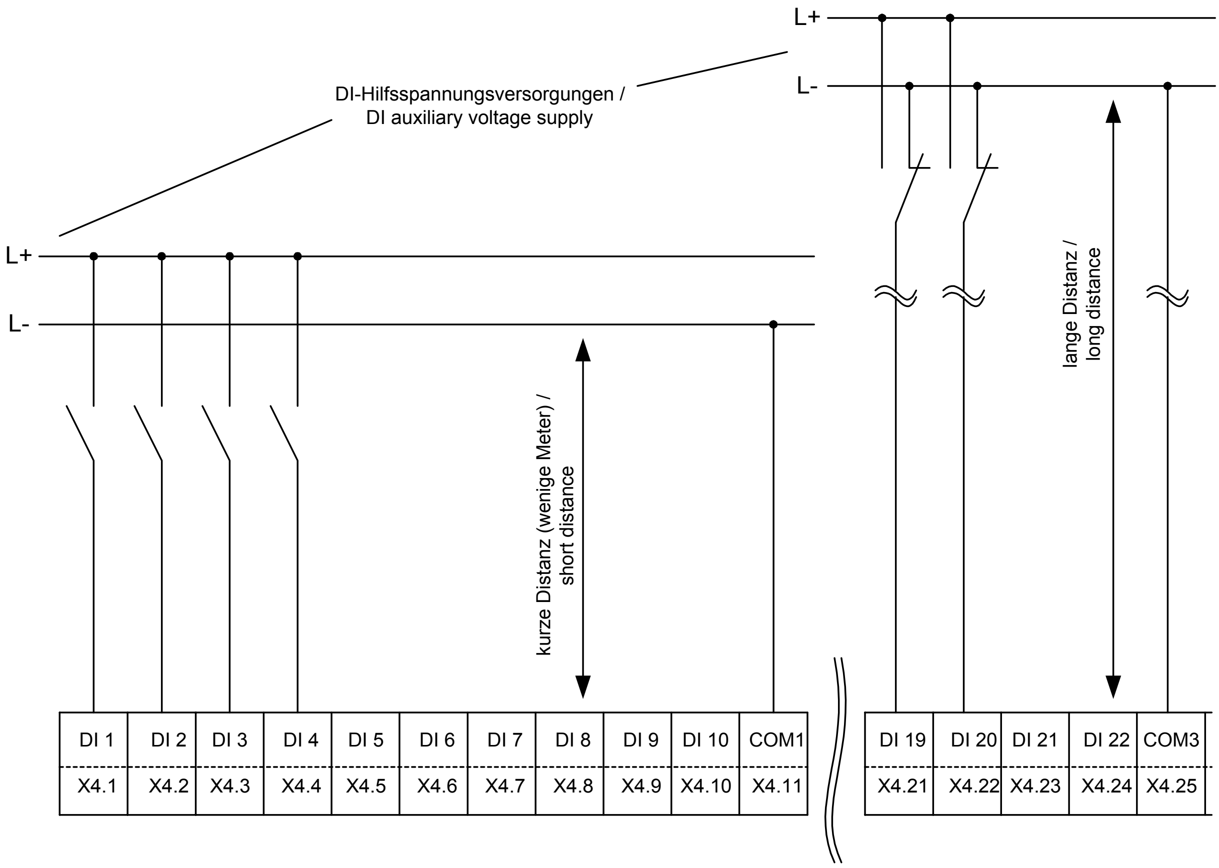


Figure 2.20: Connection of the digital inputs of a group

Each digital input provides *two voltage ranges* for the activation:

- *Low-range*: 17 to 110 V DC/19 to 110V AC
- *High-range*: 65 to 300 V DC or 75 to 250 V AC

The change onto the other range in each case is done by a jumper, which is placed on the top side of the device and is accessible after removal of a cover plate (default: open = high). In this way each input can be switched individually insensitive to interference voltages.

Attention

Especially when using applications with long unshielded signal wires which are led from the periphery to the digital input, inductive or capacitive coupling can cause undesired activation of the digital input. Thus the default setting is always preset at the high range (jumper).
In general, when projecting there should be paid attention to the fact that only shielded wires are used for long signal lines in order to avoid the antenna effect, which otherwise would be created!
Should only unshielded lines be available (specially in old systems), the following measures are to be taken to eliminate the above mentioned EMC problems:

- The contacts for signals to the digital inputs must be available as changeover contact (periphery) so that in the unswitched state the normally closed contact conducts the signal line to the same potential as that of the common return wire *(see* Figure 2.20*)*. Thereby the arising antenna effect will be eliminated.
- Use of a decoupling relay
- Wiring of the digital inputs with corresponding RC-elements

2.1.6 Analogue Inputs (X5)

Description

Differing physical quantities can be acquired via *analogue inputs*. Constant measuring of the temperature is very significant for the transformer protection. There are three different types of resistance thermometers (sensors) Pt100, Ni100 or PTC for measuring the temperature directly via analogue inputs. For this, however, it is necessary to adapt the internal wiring of the respective analogue inputs (hardware) to the used temperature sensor by *DIP switches* as well as a software adjustment to the effect that the measuring signals can be correctly interpreted over the reference characteristic defined in the software. (see Chapter „Temperature Supervision ϑ1 and ϑ2“).

Very often temperature sensors are embedded in the secondary winding, especially where dry-type transformers are used, and their screened wires are brought out for further processing of the measuring value.

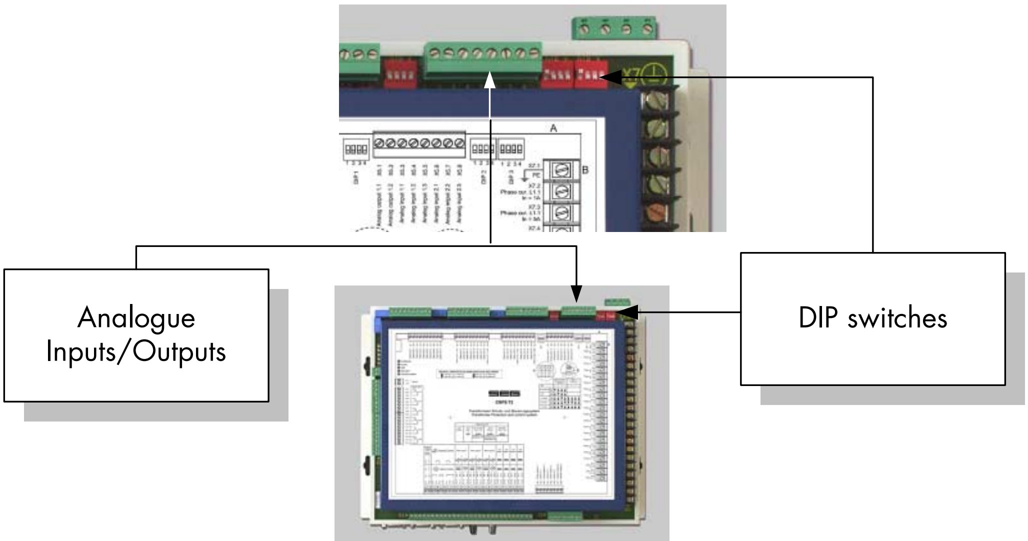


Figure 2.21: Detail of analogue inputs with DIP switches

Choice of the measuring function

Analogue Input	*Type of Sensor*	*Option*	*DIP Switch 2.1*	*DIP Switch 2.2*	*DIP Switch 2.3*	*DIP Switch 2.4*
AI 2	PT100 / Ni100	❑	ON	OFF	OFF	OFF
	PTC (0 – 30 kOhm)	❑	OFF	ON	OFF	OFF
	[0 – 20 mA DC / 4 – 20 mA DC]	❑	OFF	OFF	ON	OFF
	[0 – 10 V DC]	❑	OFF	OFF	OFF	ON
	Type of Sensor	*Option*	*DIP Switch 3.1*	*DIP Switch 3.2*	*DIP Switch 3.3*	*DIP Switch 3.4*
AI 3	PT100 / Ni100	❑	ON	OFF	OFF	OFF
	PTC (0 – 30 kOhm)	❑	OFF	ON	OFF	OFF
	[0 – 20 mA DC / 4 – 20 mA DC]	❑	OFF	OFF	ON	OFF
	[0 – 10 V DC]	❑	OFF	OFF	OFF	ON

Figure 2.22.: Assignment of the hardware function per DIP Switch

Note

The current measuring ranges 0 – 20 mA or 4 – 20 mA and the voltage measuring range 0 – 10 V for detection of customer-side measuring quantities are not yet available in the *CSP2-T*!

Connecting method

Temperature-dependent resistors are used for measuring the temperature by the *CSP2-T*, but here it is possible that the measuring result is distorted by the specific wire resistance when longer connecting wires are used. In order to compensate for this effect, the temperature sensors Pt100 and Ni100 are to be connected to the analogue inputs by the so called *three-wire method*. For that purpose an additional measuring line is to be led from a sensor contact to the *CSP2-T* so that two measuring circuits are formed. Provided all three measuring lines have an identical resistance value, the effect of the wire resistance is compensated for.

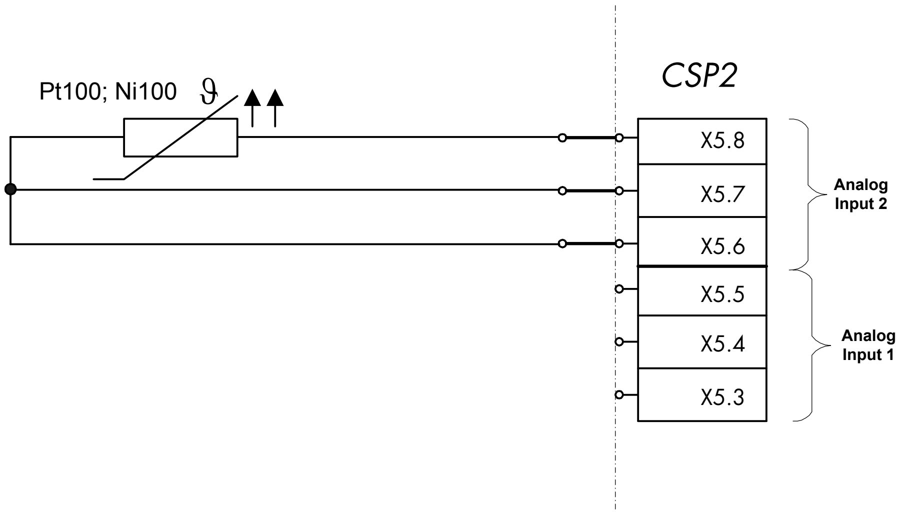


Fig.: Three-wire connecting method Pt100 and Ni100

Due to the fact that the resistance temperature characteristic (R-T Characteristic) of *PTC sensors* runs through a relatively high-impedance resistance range, the resistance losses of the connection wires can be considered insignificantly small and thus a compensation circuit is not needed. The sensor is to be connected to terminals X5.8 and X5.6 or to X5.5 and X5.3.

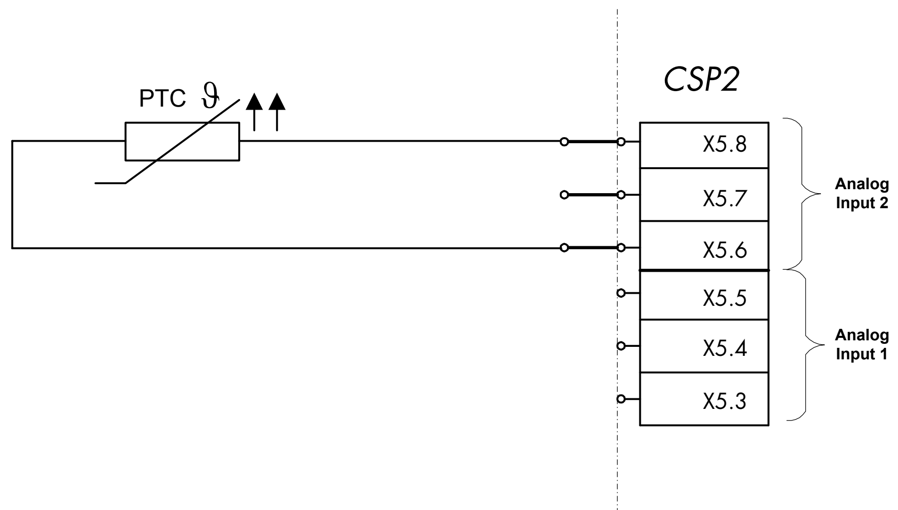


Fig.: Two-wire connecting method PTC

Important

The analogue inputs in the *CSP2-T* are to be connected to *screened wires* only. This is the only way to prevent distortion of the measuring values due to coupled interference quantities.

Pt100 and *Ni100 as well as PTC temperature sensors* are resistors with positive temperature coefficient (so called PTC resistors); i.e. when the temperature is rising, the internal resistance is increasing. Dependent on the application, the *PTC temperature sensors* have different "rated turn-off temperatures ϑ_{NAT} ". The rated turn-off temperature is defined by the manufacturer and it is the temperature where the sensor has the highest resistance variation.

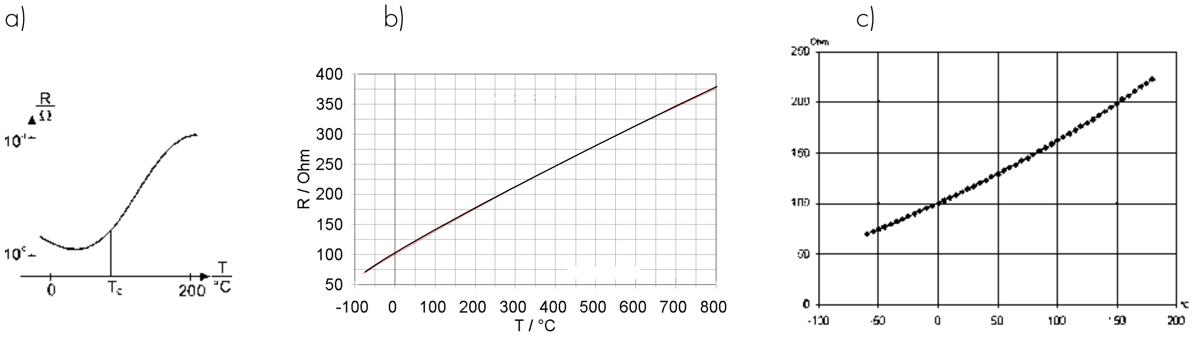


Fig.: a) Resistance temperature characteristic *PTC*
b) Resistance temperature characteristic *Pt100*
c) Resistance temperature characteristic *Ni100*

2.1.7 Auxiliary Voltage Supply (X6)

Voltage supply

The auxiliary voltage supply for the *CSP2* has to be connected to the plug-in terminals X6. The wide-range power pack of the *CSP2* as well as of the *CMP1* makes a special setting of the voltage level not necessary. The auxiliary voltage must only be in the admissible range of

- 19 to 395 V DC or
- 22 to 280 V AC.

The auxiliary voltage input is provided with its own rectifier so that polarity faults are impossible. The terminals X6.1 and X6.2 as well as X6.3 and X6.4 are internally bridged. Therefore the terminal block X6 can also serve as power supply connection for the *CMP1*.

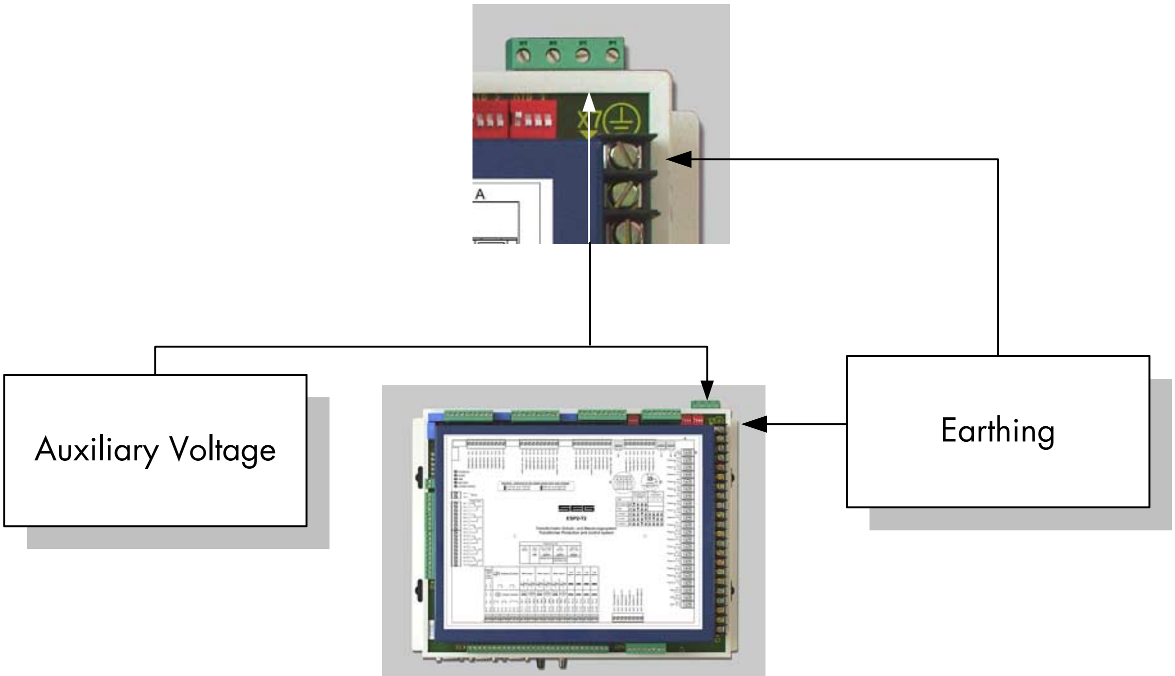


Figure 2.23: Detail equipment auxiliary voltage supply

Earthing

The separately constructed screw-type terminals X7.1 serve for reliable earthing of the system. It is recommended to lead a conductor of 4 to 6 mm^2 cross section from the earthing screw on a possibly direct way to a common earth connection point.

Note

With regard to the earthing connection as well as the connection of the auxiliary supply voltage, the corresponding regulations must be observed.

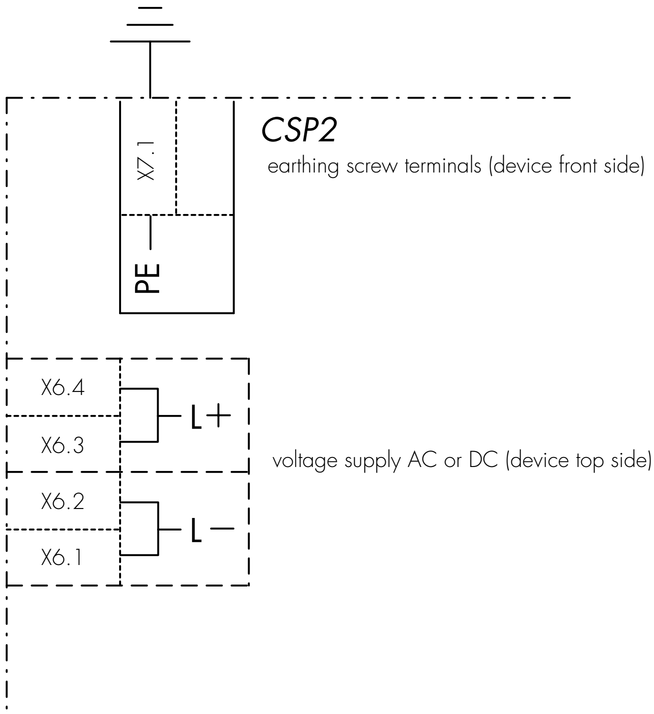


Figure 2.24: Connection of auxiliary voltage/earthing

Auxiliary Voltage Supply of the CSP2			
Terminal No.	*Connection of Supply Voltage*	*Description*	*Note*
X6.1	L–	Aux. voltage +/≈ for the CSP2	Internally bridged: Parallel Supply for the CMP1
X6.2	L–	Aux. voltage +/≈ for the CMP1	
X6.3	L+	Aux. voltage −/≈ for the CSP2	Internally bridged: Parallel Supply for the CMP1
X6.4	L+	Aux. voltage −/≈ for the CMP1	
X7.1	PE	Earthing terminal for the CSP2/CMP1	Internally bridged: Parallel Supply for the CMP1

Table 2.7: Terminal allocation of the auxiliary voltage supply

2.1.8 Voltage measurement (X8)

Description
The *CSP2* is equipped with four voltage measurement inputs. Three are for the detection of the *line-to-line voltages* U12, U23, U31 *or of the phase voltages* UL1, UL2, UL3 and one for the detection of the residual voltage Ue.
Each measurement channel is completely galvanically decoupled and equipped with two connections which are connected to the plug-in terminal strip X5.

Note

For measurement of *line-to-line voltages* all phase voltage transformers must possess the same secondary nominal voltage! The *residual voltage Ue* can either be measured directly by the series connection of the three e-n-windings of the phase voltage transformer or be calculated from the measured phase voltages.

- *Direct measurement (e-n-windings)*: for the residual voltage measurement channel other nominal voltages can be selected than for the phase voltage measurement channels.
- *Calculatory determination:* The fourth voltage measurement channel is not necessary!

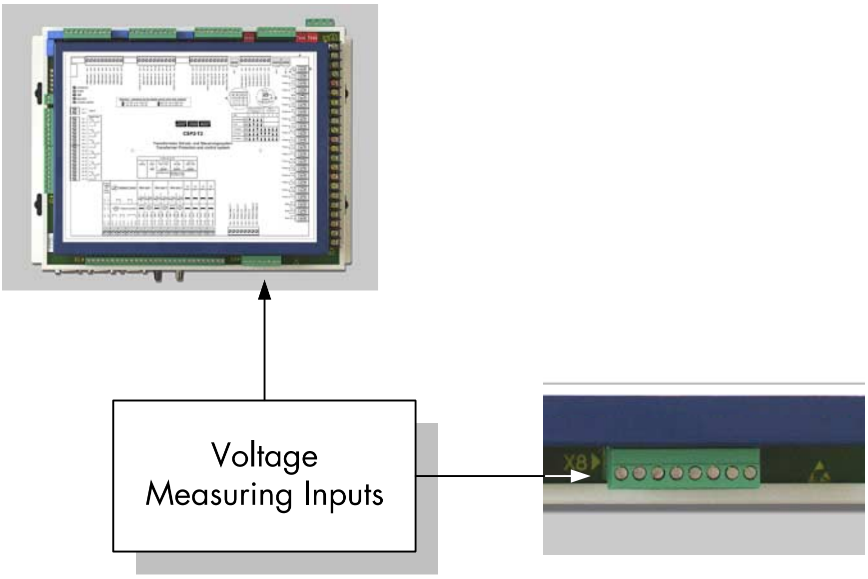


Figure 2.25: Voltage measurement inputs

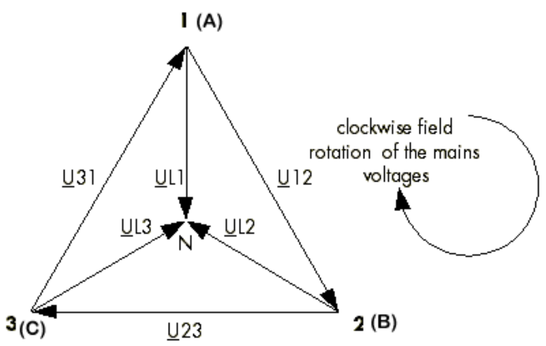
Voltage measuring inputs					
Terminal No.	*Measurement LN*		*Measurement LL*		*Measuring range*
	Wiring of the measuring inputs	*Primary measured quantity*	*Wiring of the measuring inputs*	*Primary measured quantity*	
X8.1	Line Conductor L1	Phase voltage UL1	Line Conductor L1	Line-to-line voltage U12	0…230 V
X8.2	Neutral Conductor		Line Conductor L2		
X8.3	Line Conductor L2	Phase voltage UL2	Line Conductor L2	Line-to-line voltage U23	0…230 V
X8.4	Neutral Conductor		Line Conductor L3		
X8.5	Line Conductor L3	Phase voltage UL3	Line Conductor L3	Line-to-line voltage U31	0…230 V
X8.6	Neutral Conductor		Line Conductor L1		
X8.7	da (formerly „e“)	Residual Voltage Ue			0…230 V
X8.8	dn (formerly „n“)				

Table 2.8: Terminal allocation for voltage measurement

Earthing of the secondary windings of voltage transformers;
The secondary winding of a voltage transformer must be earthed one-sided according to the standard of IE60044-2. On one hand, this serves as a protective measure, as in case of a breakdown of the coil insulation between the primary and the secondary side, the mains-side voltage would occur at the secondary side. Consequently, the operating personnel would be endangered. On the other hand, a *defined reference point* for the measurable quantities will be created from the measurement technique standpoint by the earthing of the secondary windings, and inductive interference voltages will be earthed. The earthing of the *secondary terminals* must be carried out, as a rule, according to the circuit examples as follows:

Considerations of the rotation field direction of the impressed mains voltage
The mains voltages provided by energy supply utilities have a constant amplitude in normal operation as well as a fixed frequency (mains quality) and carry as a rule a *clockwise rotation field.* However, there are regions in which the mains field rotates anti-clockwise.
Depending on the rotation field direction of the mains voltages, *the phase voltages UL1, UL2, UL3 as well as the line-to-line voltages U12, U23, U31* (line to line voltages) thus have the following *phase positions*:

a) b)



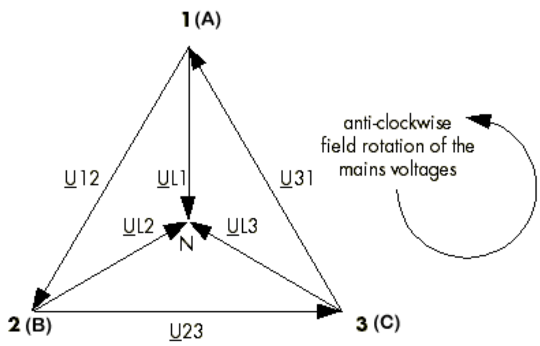


Figure 2.26: Phase position of the phase and line-to-line voltages in a) the clockwise rotation field (ABC) b) the anti-clockwise rotation field (ACB)

The *phasor diagram* in general presents a *time snap-shot of the rotating voltage vectors*. Here the position of the voltage vectors corresponds to the phase displacements of the individual voltages in relation to each other. The rotation direction of the voltage vectors proceeds in electrical engineering *anti-clockwise* and is defined as *"mathematically positive"*.
The *sinusoidal wave form* of the phase voltages $u_{LN}(t)$ and line-to-line voltages $u_{LL}(t)$ result from the phasor diagram of the voltage vectors.

A comparison of both systems shows that in the *anti-clockwise rotation field* the *wave form* of the phase voltages *UL2, UL3* (and thus also their *line-to-line voltages U23, U31*) in relation to the clockwise rotation field (phase sequence: (phase sequence: *L1 → L2 → L3) result in the phase sequence*: *L1 → L3 → L2*.

Note

In the case of the *anti-clockwise rotation field* of the mains voltages the *changed phase sequence* has an effect on certain protective functions and the display of measurement values! Therefore it is necessary to adapt the CSP2 system to the actual rotation field direction. This can be done by the system parameter Rt.field of the submenue “field settings”.

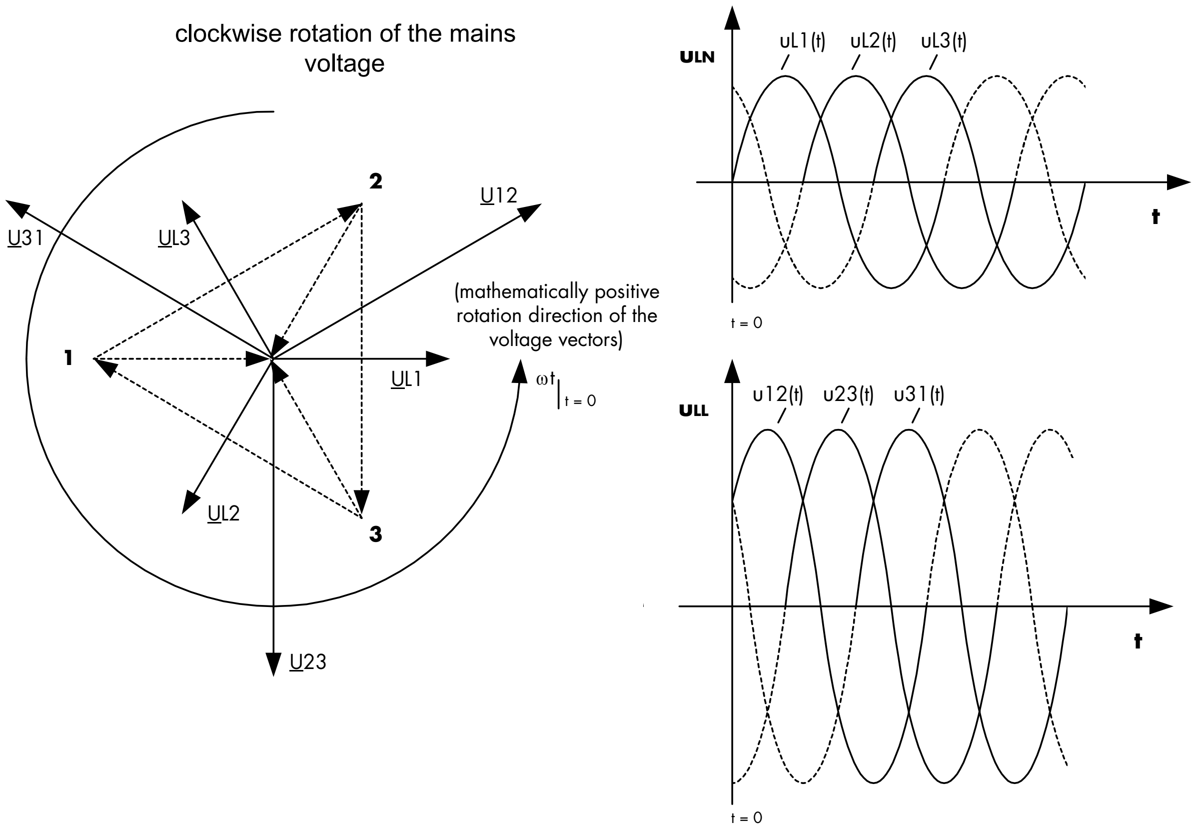


Figure 2.27: a) clockwise rotation field vector diagram: - instantaneous display of the rotating voltage vectors for t = 0- wave form of the phase and line-to-line voltages.

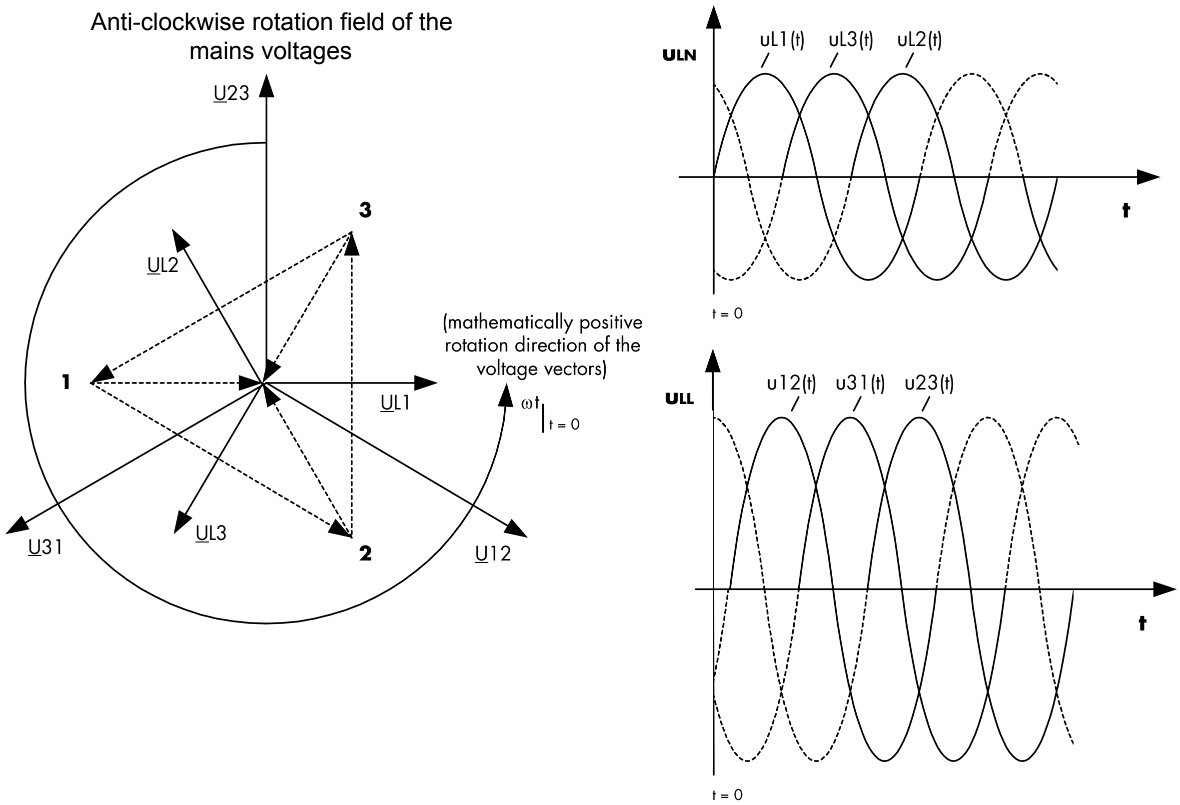


Figure 2.28: a) anti-clockwise rotation field vector diagram: - instantaneous display of the rotating voltage vectors for t = 0 - wave form of the phase and line-to-line voltages

"Measurement of the phase-to-neutral voltage LN" or "Measurement of the line-to-line voltage LL" at the measurement location

Medium voltage systems are in general configured as *three-wire systems*. According to quantity and type of the voltage transformers used, either a *secondary four-wire system* or *three-wire system* can develop at the measurement location (mounting point of the voltage transformers).

A *secondary four-wire system* can only be constructed with three single-pole insulated *phase voltage transformers,* in which the secondary measurement coils (a – n) are earthed at the terminals n *so that an* image of the star point results. *This serves for direct measurement of the* phase voltages *U̲L1, U̲L2, U̲L3 (measurement LN).*

A secondary *three-wire system* can either be derived from the four-wire system (no connection of the n-wire to the ***CSP2***) or be realized by use of two double-pole insulated *line-to-line voltage tranformers* in V-circuit. In case of the three-wire system, the *line-to-line voltages U̲12, U̲23, U̲31 are measured directly* (measurement LL).

Remark

In case of *unearthed systems* (three-wire system with star point not neutral earthed) the *"Measurement LN"* is not to be recommended, as the secondary-side star point is no image of the primary-side star point. Due to this degree of liberty of the measurement system the phase voltages can turn into any values although the line-to-line voltages are fully in the normal range. False tripping by over- or undervoltages as well as inconsistent measurement values due to a high harmonics content by the circling star point could be the consequence.

Setting of the voltage transformer ratios in the ***CSP2***
For a correct calculation of the secondary voltage measurement values by their corresponding primary values, it is necessary to set the *transformation ratio of the voltage transformer in the* ***CSP2***.
The setting of the (always the same) transformation ratio of the phase voltage transformer is carried out *in the three-pole method* (three measurement inputs) via the common field parameter *"VT pri."* for the *primary line-to-line nominal voltages, and "VT sec."* for the *secondary* nominal line-to-line voltages.

The setting of the (always the same) transformation ratio of the voltage transformer for earth fault detection (earth voltage transformer) is carried out in single-pole method (one measurement input) via the field parameter *"EVT pri"* for the *primary* nominal line-to-line voltages, and *"EVT sec"* for the *secondary* nominal voltages of the auxiliary windings for earth fault detection (da – dn).

Attention

Usually transformer manufacturers indicate the transformation ratios of a voltage transformer with two secondary measurement windings in the following way:

prim. line-to-line voltage / √3: sec. line-to-line voltage (da-/ √3 : sec. line-to-line voltage (da – dn)/3

Example: *voltage transformer with two secondary auxiliary windings with different transformation ratios concerning* the secondary measurement windings

10kV/ √3 : sec. 100V/ √3 : 115V/3

When setting the *primary nominal voltage* as well as the *secondary nominal voltages* of the voltage transformer, the factors *„1/ √3"* and *„3"* must not be included!
These factors are taken into account automatically via the software of the ***CSP2*** according to the setting of the field parameter *"VT con"* for the measurement circuit of the phase voltage transformers *(measurement LN or LL)* as well as the field parameters *"EVT con"* depending on the processes for detecting the residual voltage *(direct measurement* or *calculatory determination based on the measured phase voltages).*

Example: *Settings of the field parameter for the above mentioned voltage transformers*

„VT prim	*= 10000"*	*„EVT prim*	*= 10000"*
„VT sec	*= 100"*	*„EVT sec*	*= 115"*
„VT con	*= Y/Δ/ V/no VT"*	*„EVT con*	*= calculate/open Δ/no EVT"*
„VT loc	*= W1 busbar*	*„EVT loc*	*= W1*
	= W1 Tr.		*= W2"*
	= W2 Tr.		
	= W2 busbar"		

Attention

The measurement ranges of the voltage measurement inputs lie in each case between 0 and 230 V. Should e.g. voltage transformers with a secondary nominal voltage of 230 V be used, the setting of the field parameters *"EVT sec"* would have to be 230 V! This means, however, that overvoltages will not be detected any more by the *CSP2*!
For the application of the voltage protection functions U> and U>> this signifies a reduction of the maximum setting of the response values on 1 x Un! Would the response values be selected higher, the active protective steps would never be able to trip!

As a rule, the voltage transformers possess, however, secondary nominal voltages of 100 respectively 110 V so that a detection of overvoltages is possible without problems.

Detection of the residual voltage Ue

Direct measurement of the residual voltage Ue
For a direct measurement of the residual voltage Ue, three voltage transformers must be present which dispose each of an additional measurement coil (da – dn, former designation: e – n) for earth fault detection. These auxiliary windings are connected in series *(open delta connection)* and led to the fourth voltage measurement input of the *CSP2*. The direct measurement of the residual voltage is thus independent from the measurement of the phase or line-to-line voltages *(measurement LN respecively measurement LL)*!

Calculatory determination of the residual voltage Ue
When using voltage transformers with only one measurement winding (a – n) each, the residual voltage cannot be measured directly! However, there is the possibility to calculate the residual voltage *Ue* from the *measured phase voltages* $\underline{U}$*L1*, $\underline{U}$*L2*, $\underline{U}$*L3*. This requires, however, a *secondary four-wire system (measurement LN) to which the voltage measurement inputs of the* ***CSP2*** *will have to be connected in star connection*!

Secondary four-wire system (measurement LN): three-phase measurement of the primary phase voltages
The three-phase measurement of the *phase voltages* *UL1*, *UL2*, *UL3* occurs via three single-pole insulated phase voltage transformers whose measurement windings (a –n) are connected to the corresponding measurement inputs of the *CSP2*.
The *line-to-line voltages* *U12*, *U23*, *U31* in this case are calculated from the phase voltages!

Wiring of the measurement inputs of the CSP2
For a three-phase measurement of the phase voltages, the measurement inputs of the *CSP2* must be connected in *"star connection"* to the four *wire secondary system*.

Example a):
Three-phase voltage transformer with only one secondary measurement winding (a – n) each

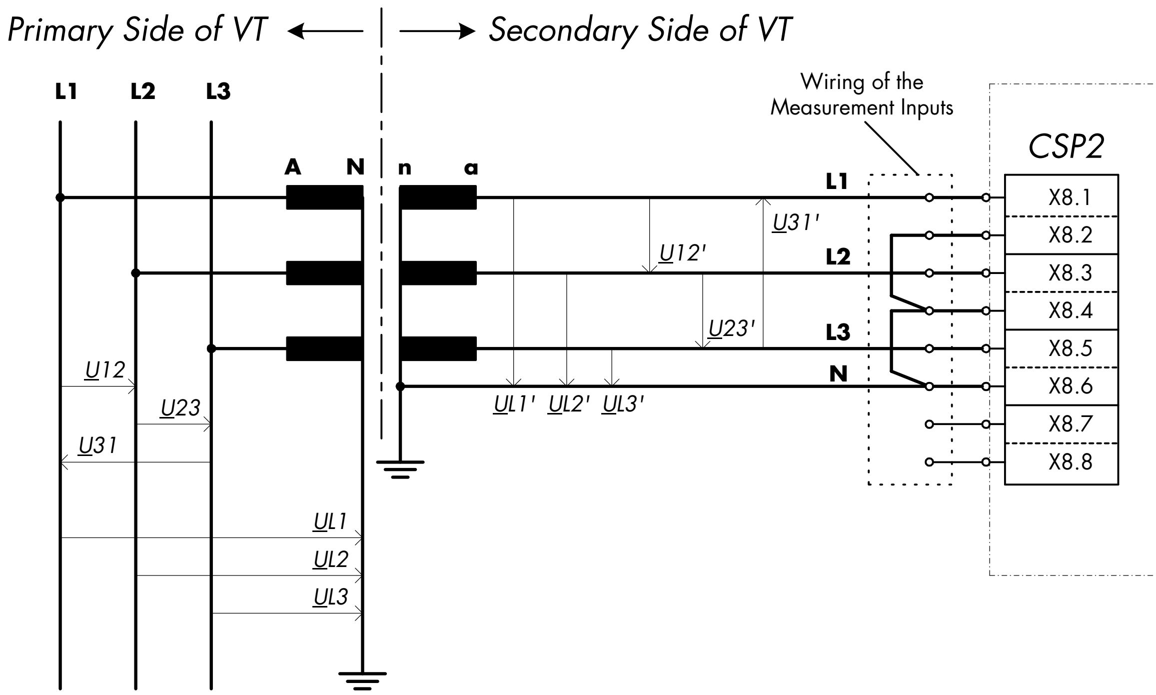


Figure 2.29: Three-phase voltage measurement
- three single-pole insulated voltage transformers: four wire secondary system
- wiring of the measurement inputs: "star connection"
- no auxiliary windings (da-dn) for earth fault detection!

Detection of the residual voltage Ue
With this circuit *no direct measurement* of the residual voltage Ue is possible, as here the voltage transformers do not have secondary measurement windings (da – dn) for earth fault detection! However, the *CSP2* can determine the residual voltage by calculation of the geometrical addition of the measured phase voltages.

Required settings of the field parameters and protective parameters (should the latter be necessary):

Four wire secondary system				
Parameter		*Adjustment*	*Note*	*Classed as*
Field Parameter	VT con	„Y“	Measuring of phase voltages	Compulsory!
	EVT con	„geometrical addition“	Computation of Ue	Compulsory!
Protection Parameters (U>, U>>, U<, U<<)	evaluate	„Voltage LN“	Pick-up value of active protection function, refers to phase voltages	Optionally
		„Voltage LL“	Pick-up value of active protection function, refers to line-to-line voltages	Recommend.

Table 2.9: Parameter settings in "star connection" without measurement of the residual voltage Ue

Example b):
Three-phase voltage transformer with two secondary measurement windings (a – n and da - dn) each

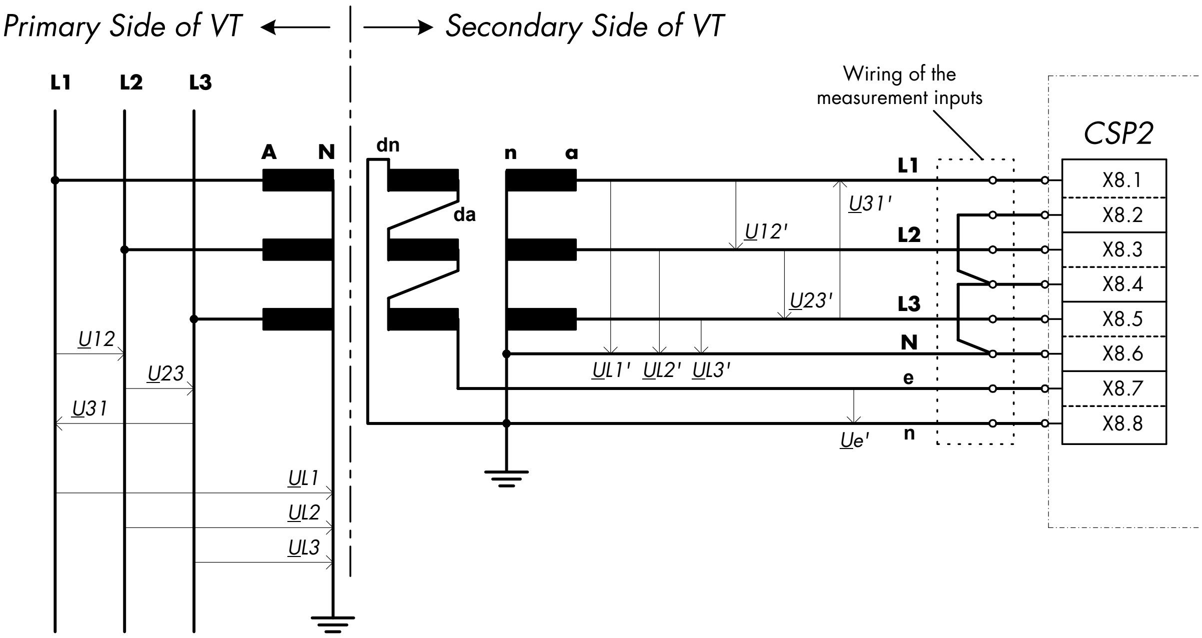


Figure 2.30: Three-phase voltage measurement: *- three single-pole insulated voltage transformers: four wire secondary system*
- wiring of the measurement inputs: "star connection"
- with auxiliary windings (da-dn) for earth fault detection

Detection of the residual voltage Ue
With this circuit the residual voltage *Ue* is measured directly via the *open delta connection* of the auxiliary windings (da – dn). However, alternatively the *CSP2* can determine the residual voltage by calculation of the geometrical addition of the measured phase voltages.

Required settings of the field parameters and if necessary protective parameters:

Four wire secondary system (measurement of Ue)				
Parameter		*Adjustment*	*Note*	*Classed as*
Field parameter	VT con	„Y"	Measurement of phase voltages	Compulsory!
	EVT con	„Open Delta"	Direct measurement of Ue	Recommend.
		„geometr. in addition"	Calculation of Ue	Alternatively
Prot. parameter (U>, U>>, U<, U<<)	evaluate	„Voltage LN"	Pick-up value of the active protection function refers to phase voltages	Optionally
		„Voltage LL"	Pick-up value of the active protection function refers to line-to-line voltages	Recommend.

Table 2.10: Parameter settings in "star connection" with measurement/calculation of the residual voltage Ue

Secondary three-wire system (measurement LL): three-phase measurement of the primary line-to-line voltages
The three-phase measurement of the *line-to-line voltages U12, U23, U31* occurs via three single-pole insulated phase voltage transformers whose measurement windings (a–n) are connected to the corresponding measurement inputs of the *CSP2*.
The *phase voltages UL1, UL2, UL3* in this case cannot be calculated from the *line-to-line voltages U12, U23, U31, as here the CSP2 has no reference point for the phase voltages!*

Wiring of the measurement inputs of the CSP2
For a three-phase measurement of the phase voltages, the measurement inputs of the *CSP2* must be connected in *"delta connection"* to the *secondary three-wire system*.

Example a): Three-phase voltage transformer with only one secondary measurement winding (a – n) each

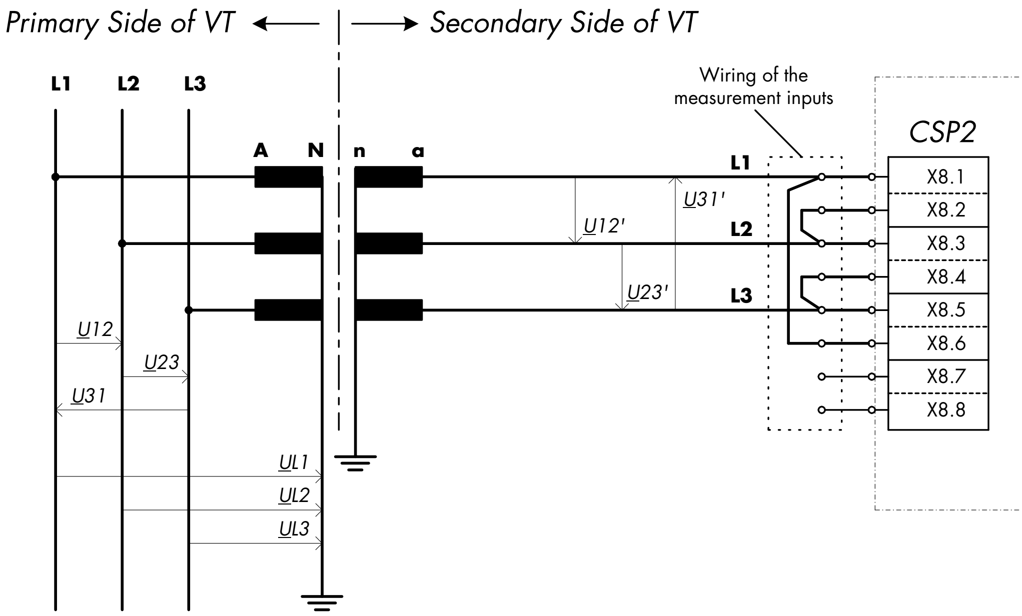


Figure 2.31: Three-phase voltage measurement:
- three single-pole insulated voltage transformers: three-wire secondary system
- wiring of the measurement inputs: "star connection"
- no auxiliary windings (da-dn) for earth fault detection!

Detection of the residual voltage Ue
A calculation of the residual voltage *Ue* is *not* possible here!

Required settings of the field parameters and if necessary protective parameters:

Three wire secondary system				
Parameter		*Adjustment*	*Note*	*Classed as*
Field Parameters	VT con	„Δ“	Measurement of line-to-line voltages	Compulsory!
Protect. Parameters (U>, U>>, U<, U<<)	evaluate	„Voltage LL“	Pick-up value of the active protection function refers to line-to-line voltages	Compulsory!
Protect. Parameters Ue>, Ue>>)	Function	„inactive“	Protection elements must not be activated, they are ineffective !	Compulsory!
Protect. Parameters (non-direct.: Ie>, Ie>>)	Ue Block	„inactive“	Ue must not be used as additional trip criterion because Ue cannot be identified !	Compulsory!
Protect. Parameters (directional: Ie>, Ie>>)	Direction	„inactive“	Ue must not be used as criterion for defining the direction, because Ue cannot be identified !	Compulsory!

Table 2.11: Parameter settings in "delta connection" without measurement/calculation of the residual voltage Ue

Example b) *Three-phase voltage transformer with two secondary measurement windings (a–n and da-dn) each*

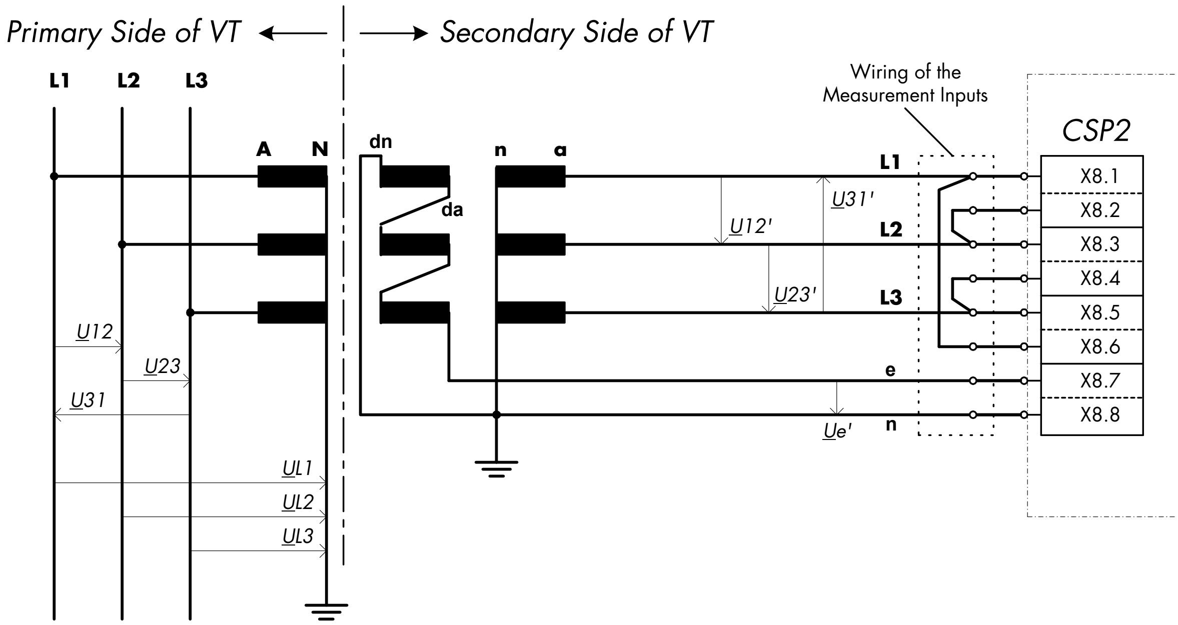


Figure 2.32: Three-phase voltage measurement: - three single-pole insulated voltage transformers: three-wire secondary system
- wiring of the measurement inputs: "delta connection"
- no auxiliary windings (da-dn) for earth fault detection!

Detection of the residual voltage Ue

With this circuit the residual voltage *Ue* is measured directly via the *open delta connection* of the auxiliary windings (da – dn)!

A calculation of the residual voltage *Ue* from the phase voltages is *not* possible here!

Required settings of field parameters and protective parameters

Three wire secondary system (measurement of Ue)				
Parameter		*Adjustment*	*Note*	*Classed as*
Field Parameters	VT con	„Δ“	Measurement of line-to-line voltages	Compulsory!
	EVT con	„Open Delta“	Direct measurement of Ue	Compulsory!
Protect. Parameters (U>, U>>, U<, U<<)	evaluate	„Voltage LL“	Pick-up value of the active protect. function refers to line-to-line voltages	Compulsory!

Table 2.12: Parameter setting for „Delta Connection“ with measurement of the residual voltage Ue

Secondary three-wire system (measurement LL): two-phase measurement of the primary line-to-line voltages
In this case the secondary *three-wire system* is formed only by two two-pole insulated voltage transformers, in which the secondary measurement windings (a-b) are connected in *"V-connection"* to the corresponding measurement inputs of the ***CSP2***! In this way *the line-to-line voltages U12 and U23 can be measured directly*. The calculation of the third *line-to-line* voltage *U31* is carried out *indirectly* via the measurement of the *geometrical addition of the line-to-line voltages U12 and U23*, which has been formed by the two (V-circuit) measurement windings.
The *phase voltages UL1*, *UL2*, *UL3* also in this case cannot be calculated from the *line-to-line voltages U12*, *U23*, *U31*, as here the ***CSP2*** has no reference point for the phase voltages!

*Wiring of the measurement inputs of the **CSP2***
For a two-phase measurement of the line-to-line voltages, the measurement inputs of the ***CSP2*** must be connected in *"delta connection"* to the three wire *secondary system*.

Example: Two line-to-line voltage transformers with only one secondary measurement winding (a-b) in V-connection each

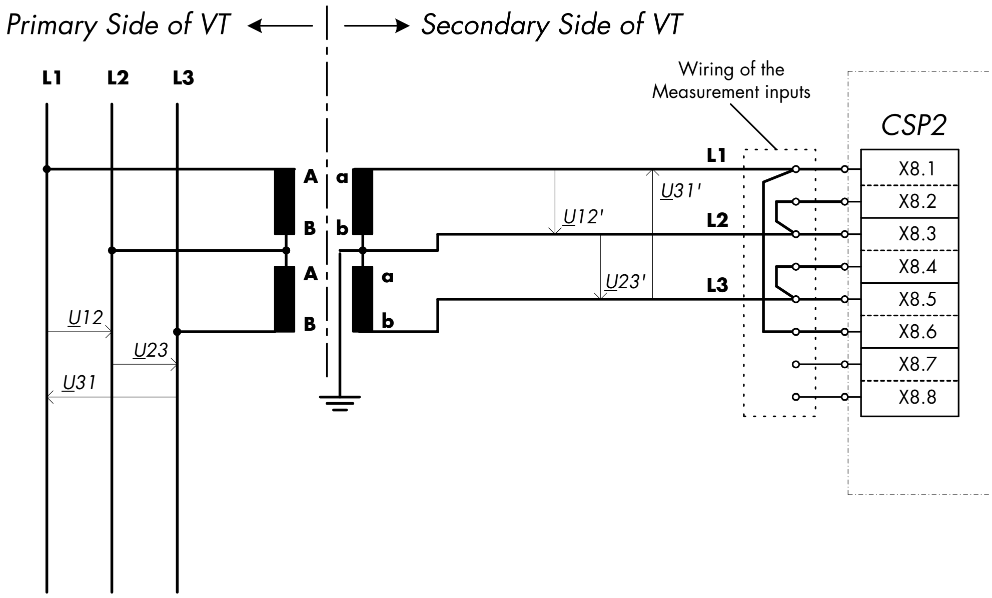


Figure 2.33: Two-phase voltage measurement:
- two two-pole insulated voltage transformers: three wire secondary system
- wiring of the measurement inputs: "delta connection"
- no auxiliary windings (da-dn) for earth fault detection!

Detection of the residual voltage Ue
A calculation of the residual voltage *Ue* is *not* possible here!

Required settings of the field parameters and protective parameters:

Three wire secondary system (V-connection)				
Parameter		*Setting*	*Remark*	*Classed as*
Field Parameters	VT con	„V"	Measurement of the line-to-line voltages	Compulsory!
Protect. Parameters (U>, U>>, U<, U<<)	evaluate	„Voltage LL"	Pick-up value of the active protect. function refers to the line-to-line voltages	Compulsory!
Protect. Parameters (Ue>, Ue>>)	Function	„inactive"	Protection steps must not be activated, they are ineffective !	Compulsory!
Protect. Parameters (non-direct.: Ie>, Ie>>)	Ue block	„inactive"	Ue must not be used as additional trip criterion because Ue cannot be identified !	Compulsory!
Protect. Parameters (directional: Ie>, Ie>>)	Direction	„inactive"	Ue must not be used as criterion for defining the direction, because Ue cannot be identified !	Compulsory!

Table 2.13: Parameter settings in "delta connection" without measurement/calculation of the residual voltage Ue

2.1.9 Signal relay outputs (X2)

Description

The signal relays serve for further processing (parallel wiring) of messages or protective functions *(e.g. backward interlocking).* Each signal relay is provided with a potential-free changeover contact, i.e. a further processing as normal closed contact or normal open contact only depends on the connecting.

All signal relays can be parameterised variably with up to 16 defined output messages. The output messages connected to a signal relay are linked by OR-operation, i.e. if one of these functions becomes active, the relay switches the contacts.

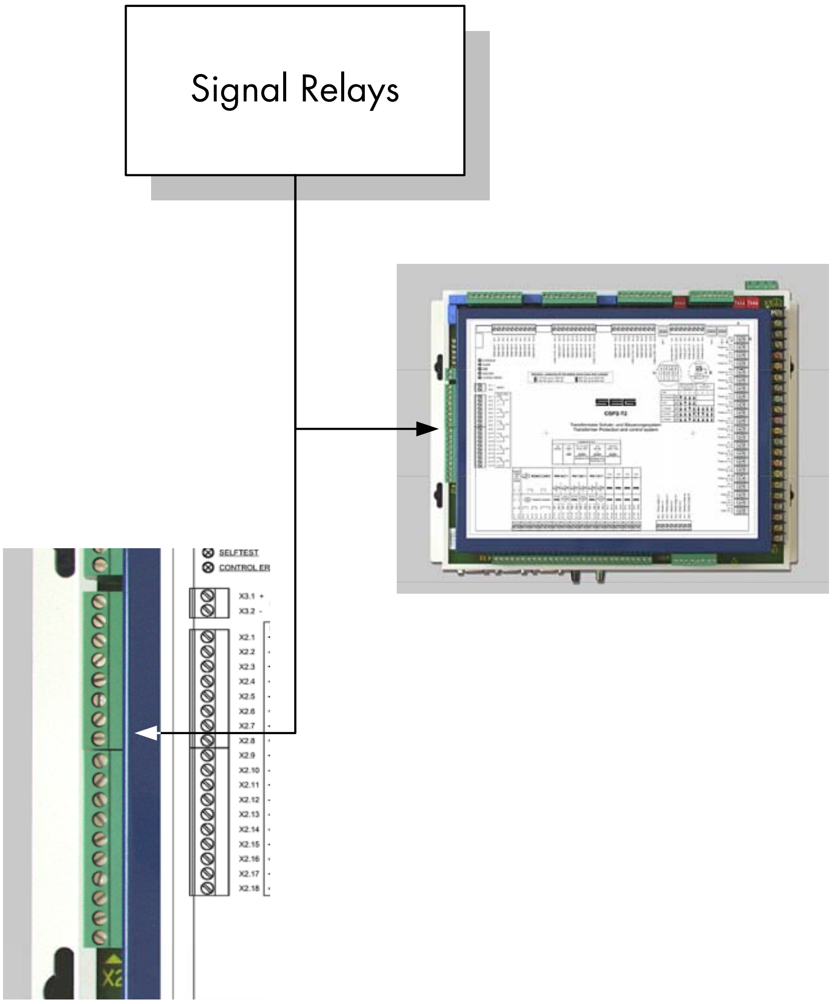


Figure 2.34: Detail view of signal relays

The following illustration shows the signal relays with their contact assignment:

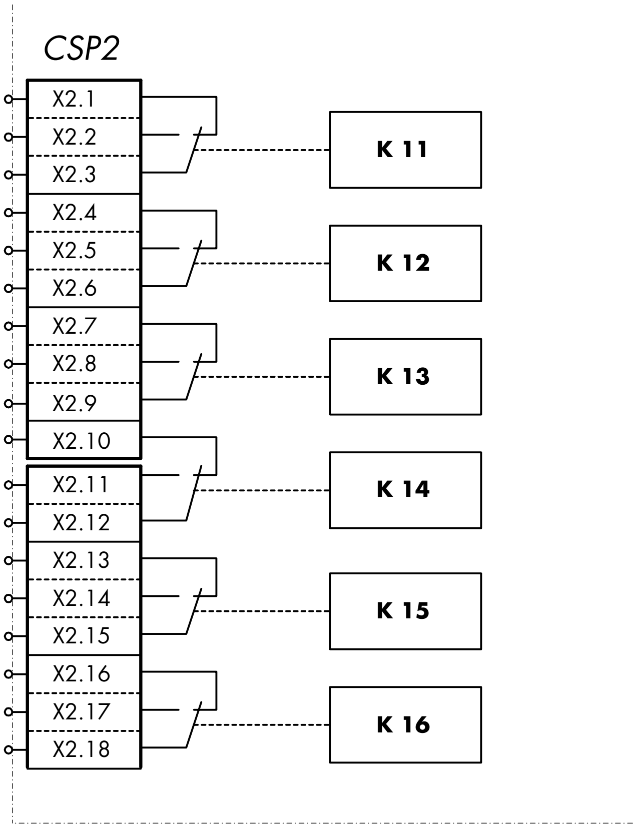


Figure 2.35: Connections of the signal relay of CSP2-T25

Attention

A direct controlling of switchgears (e.g. trip of a circuit breaker) via the signal relay contacts should be avoided because of the electrical dimensioning of the changeover contacts (pay attention to max. switching capacity of the signal relay contacts!) and the longer response time of the signal relay!

Signal Relays			
Terminal No.	*Potential free Contacts*	*Name of the signal relay*	*Assignment of the Output Function*
X2.1	NO Contact	K11	„System OK“ (Default Setting Woodward) (can be configurated with up to 16 output messages: OR-operation (logic))
X2.2	NC Contact		
X2.3	Floor Contact		
X2.4	NO Contact	K12	„General Alarm (Default Setting Woodward) (can be configurated with up to 16 output messages: OR-operation (logic))
X2.5	NC Contact		
X2.6	Floor Contact		
X2.7	NO Contact	K13	„General Trip“ (Default Setting Woodward) (can be configurated with up to 16 output messages: OR-operation (logic))
X2.8	NC Contact		
X2.9	Floor Contact		
X2.10	NO Contact	K14	(can be configurated with up to 16 output messages: OR-operation (logic))
X2.11	NC Contact		
X2.12	Floor Contact		
X2.13	NO Contact	K15	(can be configurated with up to 16 output messages: OR-operation (logic))
X2.14	NC Contact		
X2.15	Floor Contact		
X2.16	NO Contact	K16	(can be configurated with up to 16 output messages: OR-operation (logic))
X2.17	NC Contact		
X2.18	Floor Contact		

Table 2.14: Contact assignment of the signal relays

2.1.10 Communication interfaces

Overview

The *SYSTEM LINE* disposes of a high compatibility for connection of the different communication levels (SCADA respectively multi-device communication). For this purpose the basic unit *CSP2* offers a number of different (partly optional) communication interfaces via which data can be exchanged with the periphery.

Communication Options: Interfaces and Data Protocols				
Interface	*Name*	*Phys. Properties*	*Design of Plug Connection*	*Protocol Type*
				CSP2-T
X15	F01/TxD F01/RxD	FOC up to 2 km (*CSP2-L*: optionally up to 20 km)	BFOC 2,5 (ST®)	IEC 60870-5-103
				MODBUS RTU
X16	F02/TxD F02/RxD	FOC up to 2km	BFOC 2,5 (ST®)	PROFIBUS DP
X9	RS232*	Electrical	9-pole D-SUB	SEG Protocol
X10	CAN1	Electrical	9-pole D-SUB	Internal System Bus
X11	CAN1	Electrical	9-pole D-SUB	Internal System Bus
X12	RS485	Electrical	9-pole D-SUB	IEC 60870-5-103
				MODBUS RTU
				PROFIBUS DP

Table 2.15: Summary of Communication Options in the ***CSP2***

* = optional

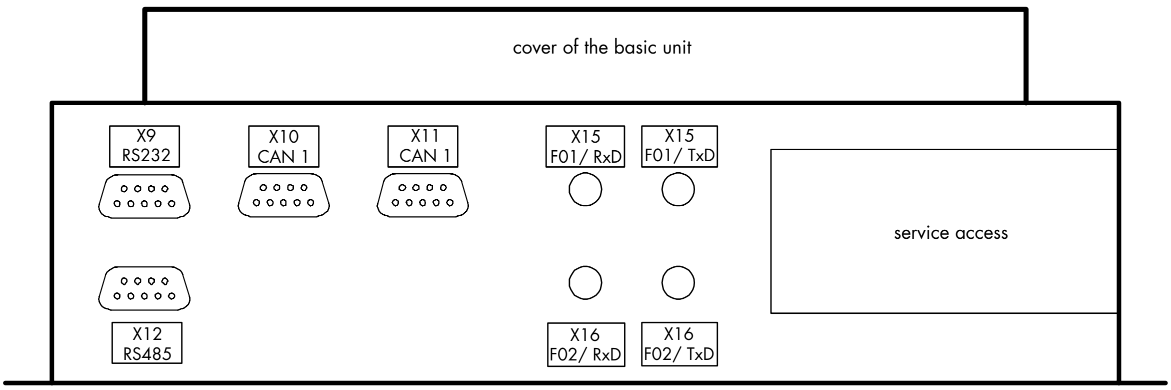


Figure 2.36: Communication interfaces for the ***CSP2***

Primary communication level: CSP2 – SCADA
At the primary communication level the SCADA is in the foreground. According to region and application there exist at present different philosophies for data exchange which with respect to the degree of demand for safety, data redundancy and information content require different types of protocol.

In the *CSP2 three types of data protocol* are provided at present:

- IEC 60870-5-103
- PROFIBUS DP
- MODBUS RTU

Note

The devices of the *SYSEM LINE* contain only the communication interface (hardware) ordered on the basis of according to the order form as well as an adapted software of the *CSP2* adjusted to the desired data protocol for connection to the SCADA-system. The SCADA-system is *not included in the scope of delivery.*

Physical connection of the CSP2 to the computer of the SCADA-system
For the *physical connection (interfaces)* of the devices to the computer of the SCADA-system the customer either desires electrical or fibre optic communications. In order to fulfill both requirements here too, the *CSP2* can either be equipped with an electrical RS485 interface or alternatively with a transmit and receive module for the connection of two fibre optics (FO).

Attention

Depending on the desired type of protocol and the physical interface variant, the data transfer to the SCADA occurs either via the interfaces X15, X16 or X12 *(see* Table 2.15*)*!

Remarks to the communication variant "Profibus DP/RS485 respectively FO"
By opening the cover of the service access, three LED-displays become visible which give information about the status of communication between master and slave. This is e.g. very useful at the commissioning of *CSP2/CMP1-systems* in order to control the communication to the connected automatization system.

Functions of the LED-displays in the inspection access
Only after recognizing a connected PROFIBUS-Master, the two green LEDs (1 and 2) light up. If an internal disturbance occurs, the LED "Error" (3) lights up red.

- *LED1*: This LED is permanently lit green when the communication connection between the *CSP2* (slave) and the automatisation system (master) has been established.

- *LED2*: This is a temporary display. The LED only lights up green when master and slave have exchanged data.

- *LED 3*: When the auxiliary supply voltage is switched to the *CSP2*, the LED "Error" begins to light, as the communication has not yet been established. Only when the boot phase of the *CSP2* has been finished and the communication to the automatisation system functions correctly, the LED "Error" goes off.

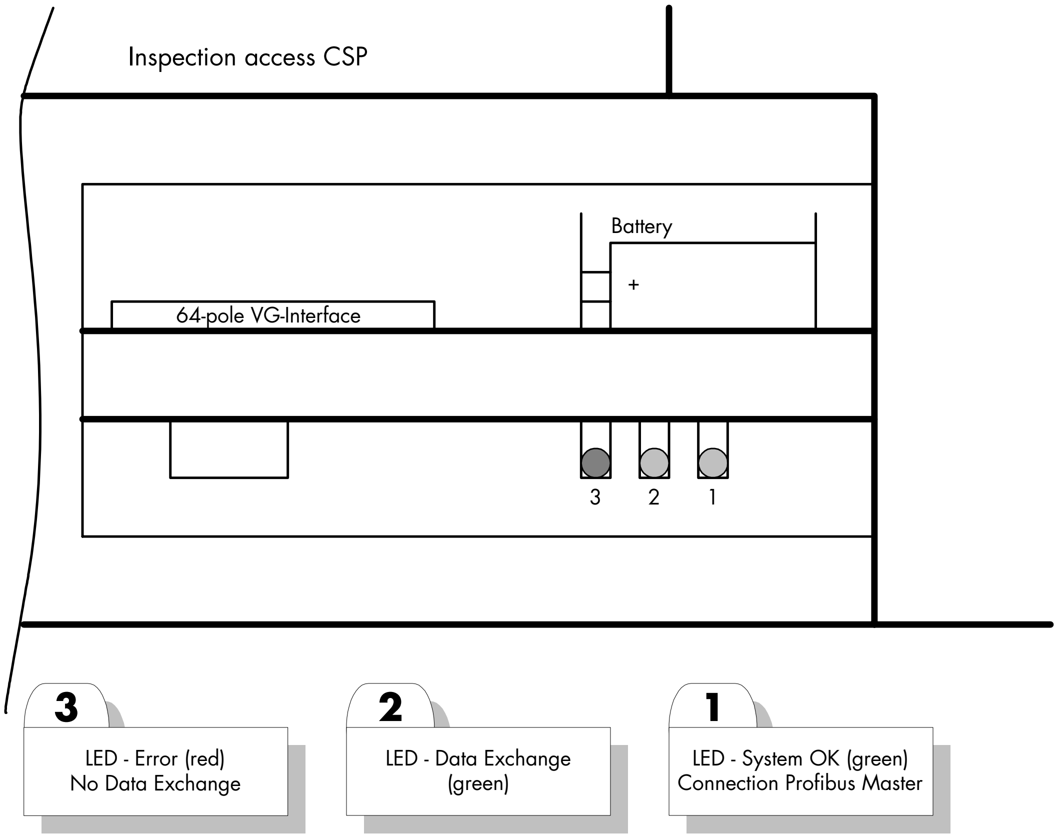


Figure 2.37: Opened service access CSP2

Secondary communication level: CSP2/CMP1 - PC/Notebook.
On the secondary communication level operation of the *CSP2/CMP1*-systems can be carried out via the PC-software *SL-SOFT*. For this, the PC/notebook can be directly connected to the correspondingly provided R232-interface of the *CSP2* via a zero-modem cable.

Note

The *required parameter settings* for the different *communication variants* are treated in detail in chapter *"Main menu of the CSP2".*

2.1.10.1 FO-Interface (X15)

Description
The optional interface X15 is provided for connecting two fibre optics (FO) to the ***CSP2***, one of which serves as a transmission line (FO1/TxD), the other as a receiving line (FO1/RxD):

FO1: „Fibre Optic 1" (identification of the upper FO-module *(see* Figure 2.38*)*)
RxD: „Receive of Data"
TxD: „Transmission of Data"

Attention

According to the different types of devices, interface X15 is used

- transformer protection ***CSP2-T*** for the *communication to SCADA-system*

(see Table 2.15*)* !

Interface X15 for SCADA communication in transformer protection ***CSP2-T***
In the transformer protection system the interface X15 serves for connecting the ***CSP2*** to a central computer of the SCADA-system via fibre optic (FO).
Table 1.5 *"Overview of the communication option in* ***CSP2****"* shows that via interface X15 only the data telegrams of the following protocol types can be processed:

- IEC 60870-5-103
- MODBUS RTU

(communication option PROFIBUS DP: *see chapter. „FO-interface X16"* !)

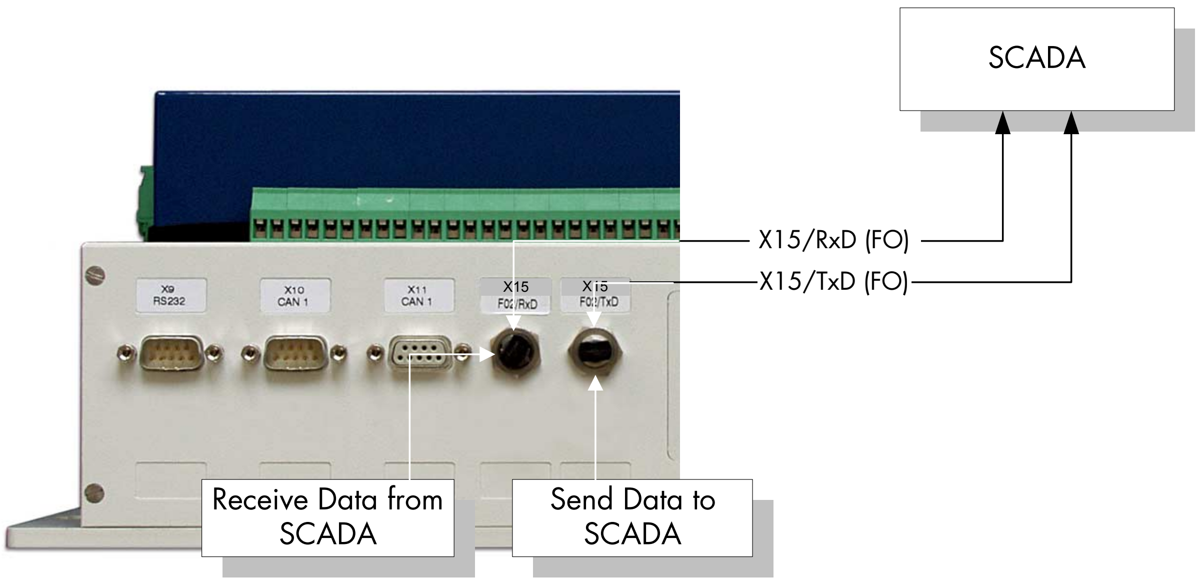


Figure 2.38: CSP2 interface X15

Range of the FO (fibre optic*)-module and max. FO-length*
In general the maximum range depends on the minimum transmission and reception power of the FO-module at which the input or output signals can still be detected. As the minimum transmission and reception power is in a reciprocal relationship to the *total attenuation of the communication distance*, it results in a *maximum line attenuation* from which the maximum *FO-length* (single length) can be calculated via the specific fibre optic attenuation.

The *maximum total attenuation* (κ_{GES}) *of the communication distance depends on:*

- the specific attenuation *(Θ)* and the length of the line fibre used (the technical data (in dB/km) of the manufacture has to be taken into account),
- the transmission method of the fibre optic signals and thus the kind of line fibre used (multimode or monomode),
- the *attenuation of the connection plugs* (κ_1 = max. 1 dB for a plug connection),
- the attentuation (κ_2 = max. 0.3 dB) due to aging of LED
- the *attenuation* (κ_3) *due to the number* (N) *of the splices* on the fibre optic distance (depending on the quality of the implementation, an additional attenuation of up to 1 dB per splice must be taken into account).

For determining the *max. FO-length* for each *distance*, the following formula can be used as an approximation:

$$l_{FOmax} = (\kappa_{Total} - \kappa_1 - \kappa_2 - N \times \kappa_3) \,/\, \Theta$$

Max. FO-length
From the minimum transmission and reception performance, a maximum total attenuation of the communication distance of 10 dB results for his FO-module.

Example:

Supposing the FOs have been mounted without splices, and without taking into account the attenuation for the end plug connections (e.g. 2 x 0.85 dB) and the attenuation by LED-aging effects (e.g. 0,3 dB), a *maximum line attenuation of 8 dB* exists.
Commercial fibre optics (multi-mode fibers) in general show a specific attenuation between 3 and 4 dB so that the *max. line length of the FOs* is between 2.7 and 2.0 km.

2.1.10.2 FO-Interface (X16)

Fibre optic (SCADA)
The optional interface X16 is also provided for connecting two fibre optics (FO) to the ***CSP2***, one of which serves for transmission (FO2/TxD), the other for receiving data (FO2/RxD):

FO2: „Fibre Optic 2" (identification of the upper module *(see* Figure 2.38*)*)
RxD: „Receive of Data"
TxD: „Transmission of Data"

Via interface X16 only data protocols for the *SCADA communication* can be transmitted. (see Table 2.15)!

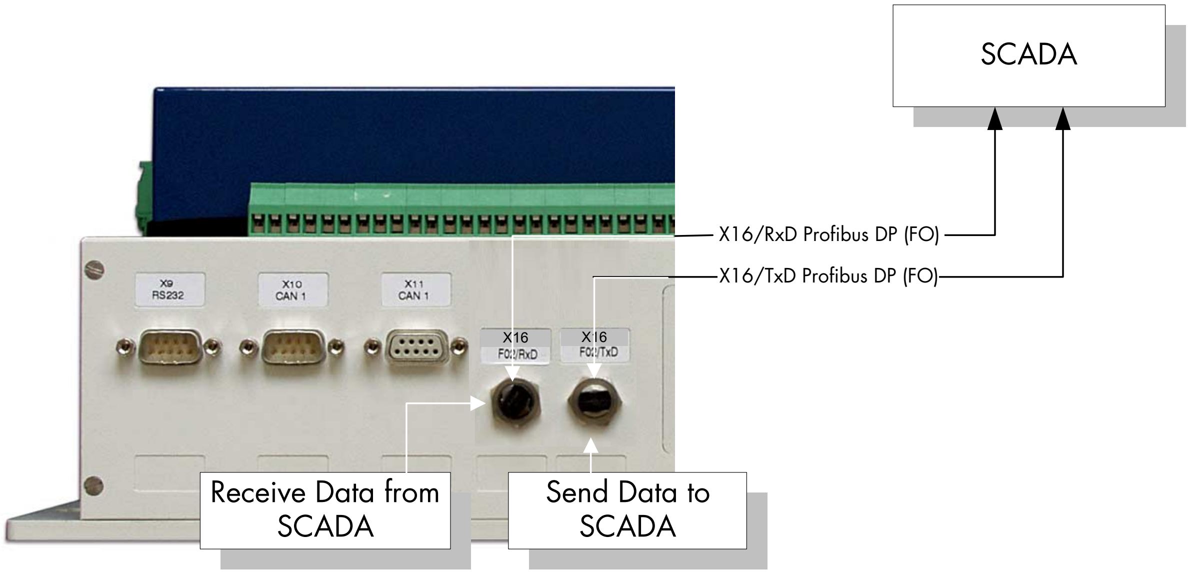


Figure 2.39: CSP2: SCADA communication X16

Attention

- *Transformer protection **CSP2-T***: Due to special hardware prerequisites for using PROFIBUS DP as data protocol, the SCADA communication can only be realized via interface X16!

Note

The FO-module used for interface X16 is the same as the FO-module of the interface.

2.1.10.3 RS232 PC-interface (X9) (in preparation)

PC-interface with RS232 protocol
With the 9-pole D-sub-plug a PC/laptop can directly be connected via a zero-modem cable. For exchange of data with the ***CSP2***, the operation software *SL-SOFT* (parameter setting and evaluation software) is required.

PIN	*Function*
2	TxD
3	RxD
5	Ground
Socket housing	Shielding

Attention

The maximum line length of the zero-modem cable is 5 m! The line should in any case dispose of a shielding in order to avoid interference effects.

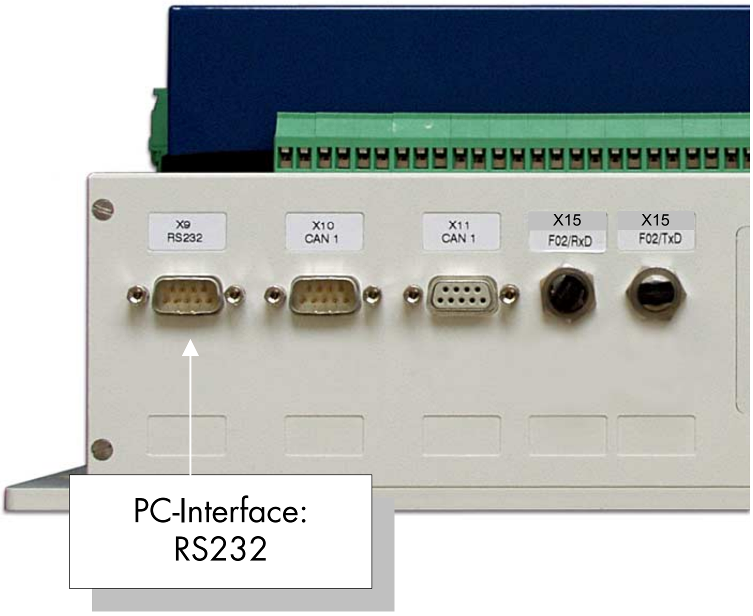


Figure 2.40: ***CSP2****: PC-interface RS232 (in preparation)*

2.1.10.4 CAN-BUS-interfaces (X10/X11)

*CAN-BUS communication between **CSP2** and **CMP1***
Two 9-pole D-sub-sockets are provided for communication between ***CMP1*** and ***CSP2***. Both connectors of the CAN-BUS are internally feeded through so that the ***CSP2*** can be connected without any problem to a bus system (multi-device communication).
Optionally both sockets (interfaces can be used as input or output.

PIN	*Function*
2	CAN – „Low"-level
7	CAN – „High"-level
6	Ground and shielding
Socket housing	Shielding

CAN-BUS multi-device communication for PC attachment
In order to be able to attach a stationary PC to the ***CSP/CMP*** systems, a CAN-fieldbus network can be constructed, in which up to 16 ***CSP/CMP*** systems can be included in. When the ***CSP2*** is the last device in a CAN-BUS system, the bus must be terminated with a resistance of 120 Ω at the plug left free across the terminals 2 and 7. The can bus cables that are delivered with the ***CSP*** devices (for the communication between ***CSP2*** and ***CMP1***) are equipped with the terminating resistor at each end.
For building a multi-device communication according to *variant 1* or *variant 2 (see chapter "**CSP2** multi–device communication),* the resistances must be removed from the corresponding spots of the cases so that they are still only existent at the start and at the end of the CAN-BUS.

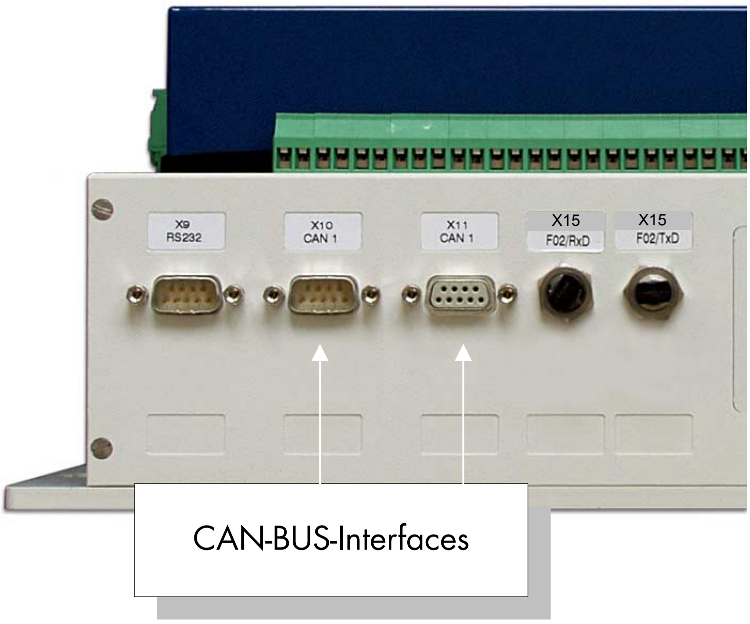


Figure 2.41: CSP2: CAN-BUS-interfaces (internal system bus)

Note

When using only one ***CMP1*** within the CAN-BUS system, a corresponding setting via the parameter "single ***CMP***" (*single **CMP**) in the* ***CSP2*** must be carried out (for details see chapter "CAN-BUS").

2.1.10.5 RS485-interface (X12)

SCADA-interface
The physical connection of the *CSP2/CMP1 systems* to a SCADA system can optionally (use order form) also be carried out in an electrical version via an RS485-bus system. For this, the *optional interface X12* is provided at the *CSP2*. Independent of the unit type of the *CSP2* all available data protocol types can be transmitted.

PIN	*Function*	
1 and plug housing	Earthing/Shielding	
3	RxD/TxD – P	(„High"-level)
(5)	DGND (Ground)	(neg. potential of the supply voltage)
(6)	VP	(pos. potential of the supply voltage)
8	RxD/TxD – N	(„Low"-level)

Due to its simple wiring and *the high transmission rates* the communication via RS485 is used most.

Construction of the bus system
The communication to a higher level control system (e.g. automation system with PLC) is carried out here via a shielded twisted pair cable with 9-pole SUB-D plugs. For the multi-device communication, the can-bus is feed-through (parallel wiring) in order to ensure that the communication to SCADA still works if one device is faulty

Attention

The *implementation of the wiring must* correspond to the valid recommendations and regulations in order to prevent transmission problems already in the beginning!

It is possible to buy can-bus cables that offer the possibility to switch the terminal resistors on and off (please refer to (please refer to the illustration on the next page).

Data protocol	*Terminal Resistances*	
	R1	*R2*
IEC 60807-5-103	120 Ω	750 Ω
MODBUS RTU	120 Ω	750 Ω
PROFIBUS DP	220 Ω	390 Ω

Table 2.16: Wiring and bus termination for the RS 485 transmission

Up to 31 *CSP2* devices can be included into one bus system. The line used for data transmission should be shielded in order to prevent disturbance interferences.

Data transmission rates and maximum line length
The *maximum length* (range) of an RS 485 bus system is dependent on the transmission rate *(see* Table 2.17*)*:

Transmission rate of a RS485 bus-system					
Transmission rate (Kbaud)	9.6 – 93.75	187.5	500	1500	12000
Range of transmission (m)	1200	1000	400	200	100

Table 2.17: Range of transmission depending on the transmission rate

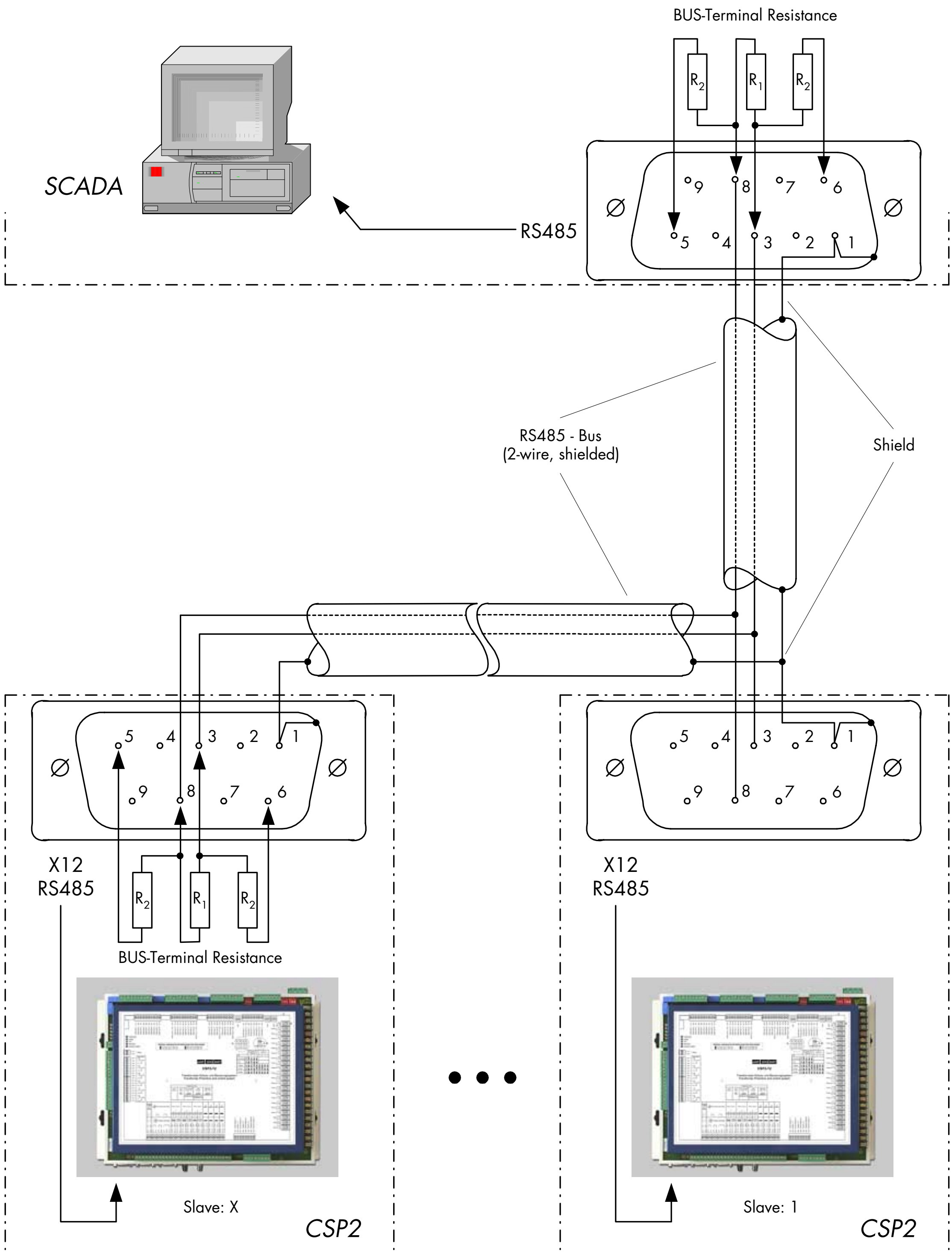


Figure 2.42: Wiring and bus termination for the RS-485 communication

Attention

The *installation and wiring must* correspond to the valid recommendations and regulations in order to prevent transmission problems!

2.2 Operating and display unit *CMP1*

In the following the connections and communication interfaces of the operation and display unit *CMP1* will be explained.

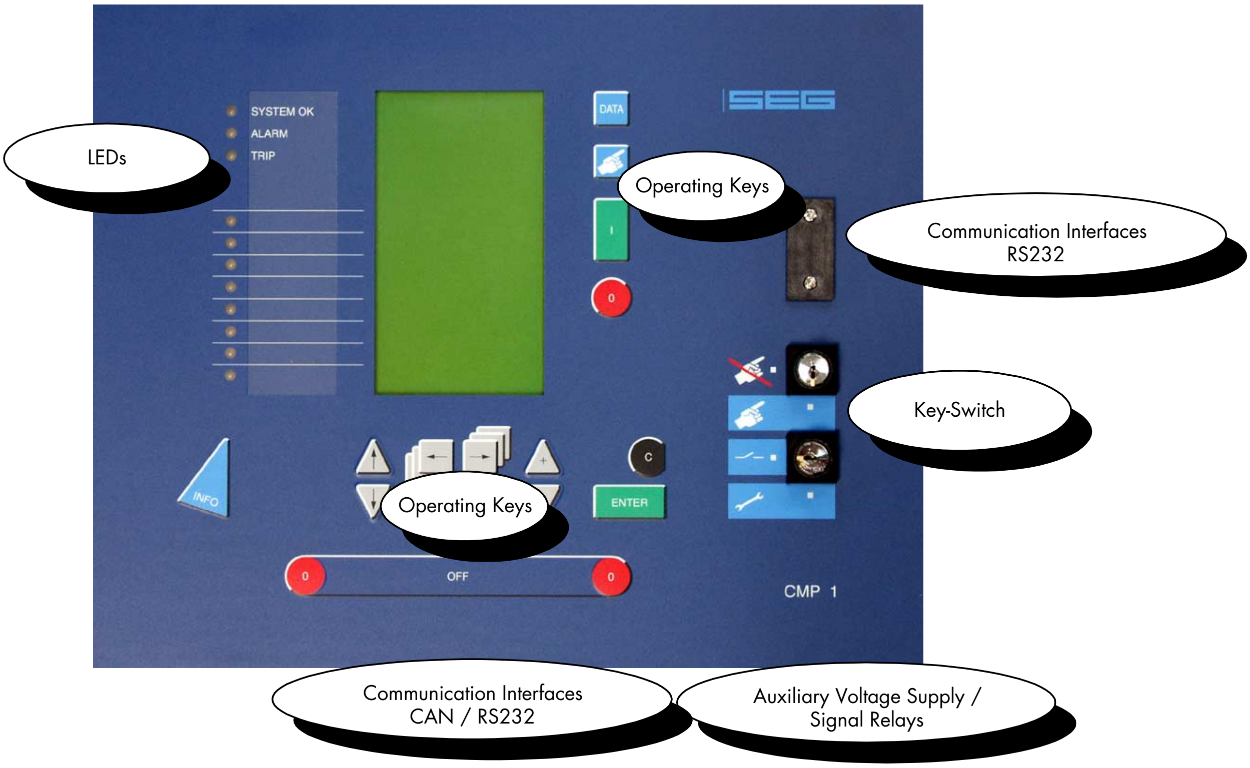


Figure 2.43: Front plate ***CMP1-120***

2.2.1 CMP dimensions

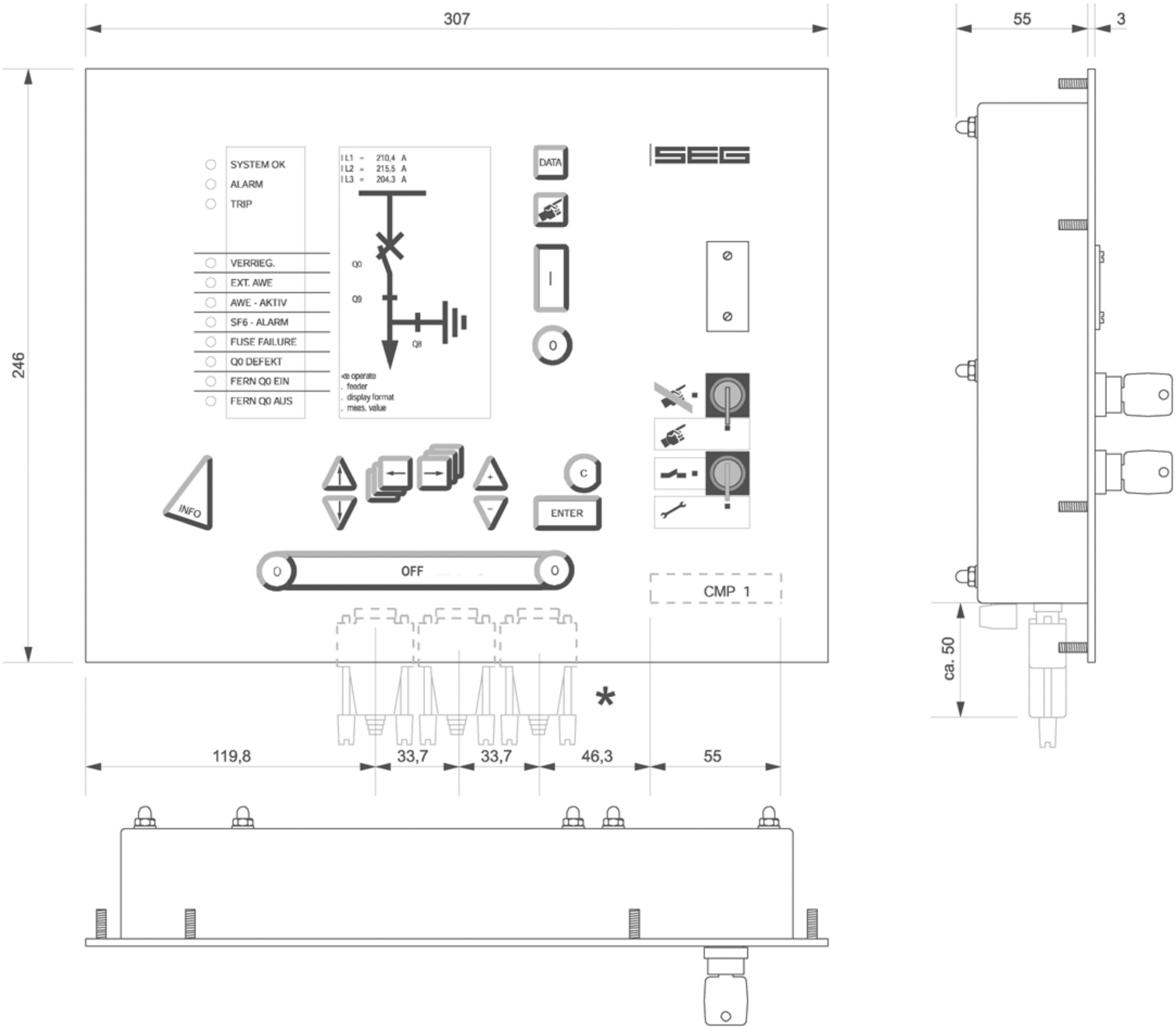


Figure 2.44: Dimensional drawing of CMP1-1 for feeder protection (all dimensions in mm)

* When using a cable channel, approx. 50 mm space must be left at the cabinet bottom for the sub-D plug

2.2.2 Dimensional drawing of the front door cut-out

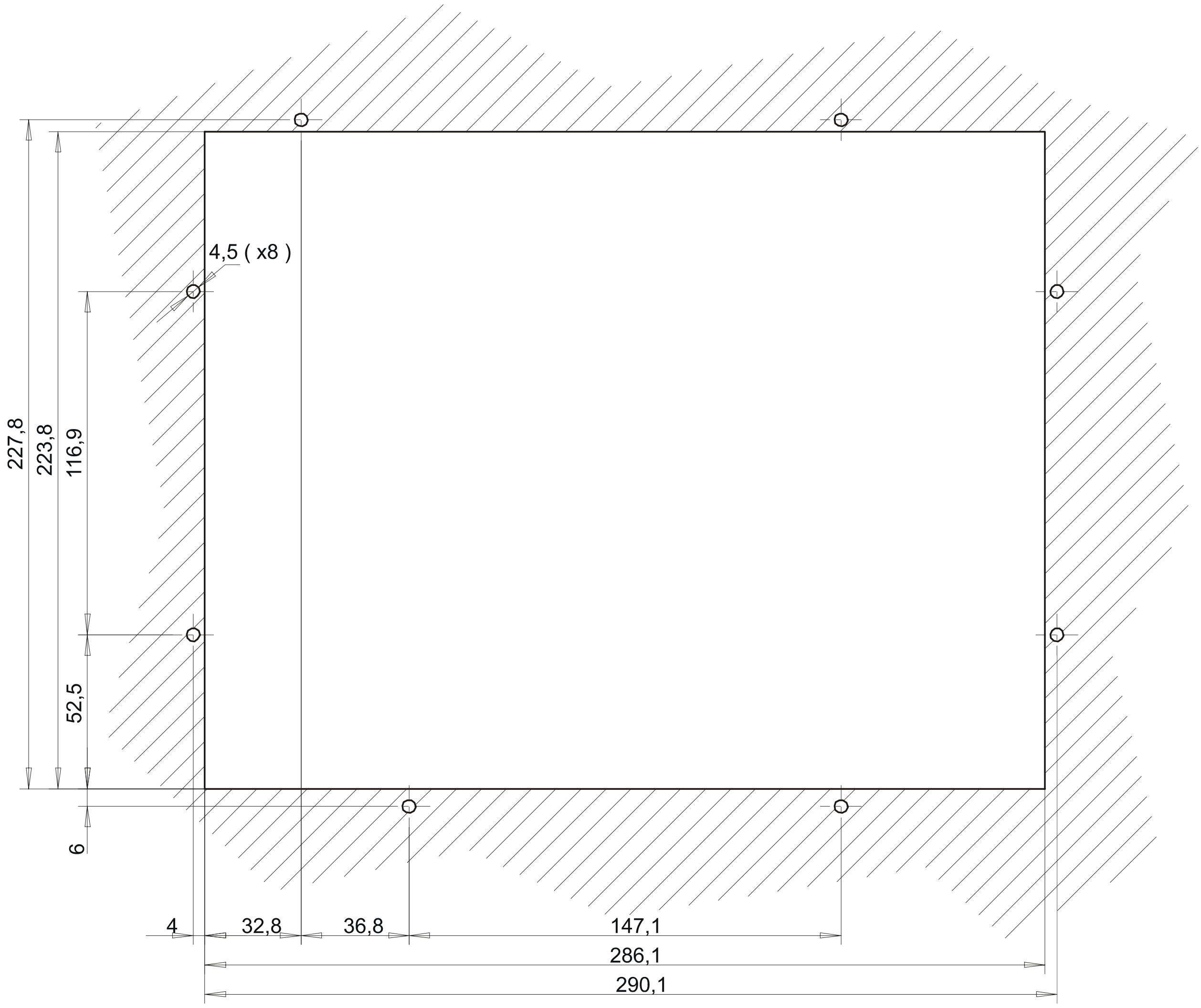


*Figure 2.45: Dimensional drawing of the front door cutout for **CMP1** (all dimensions in mm)*

2.2.3 LED-displays of the *CMP1*

Description
At the front of the *CMP1* there are 11 two-coloured (red/green) light emitting diodes (LEDs) for display of messages at the disposal of the operator.
These LEDs are separated into two blocks: the upper block consisting of 3 LEDs, and the lower block consisting of 8 LEDs. On one LED up to 5 functions can be assigned (parameterized). They can be selected from the lists of input and output messages according to requirements.

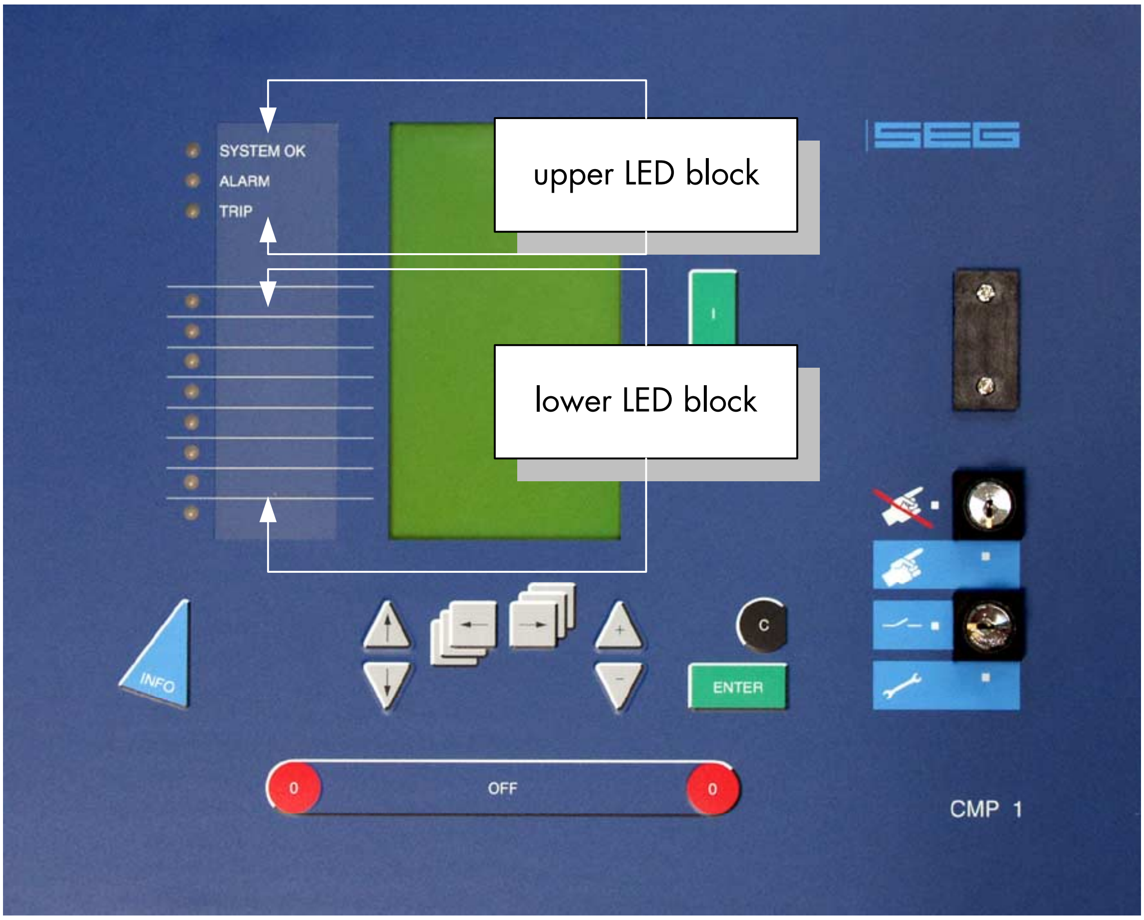


Figure 2.46: LEDs of the CMP1

Upper LED block
For these three LEDs there is no clear text available. The *CMP1*, however, is provided with a slide-in strip (foil), which in the default version of the *CMP1* shows the following explanations texts for the LEDs of the upper block concerning the standard configuration:

LED 1: „SYSTEM OK“
LED 2: „ALARM“
LED 3: „TRIP“

Attention

The message "SYSTEM OK" refers to the self-supervision of the protection and control systems *CSP2* and/or to the display and operation unit *CMP1*.

In the case of alteration of the standard configuration of these LEDs and the explanations required therefore, this slide-in strip can be replaced or labled by the user.

Lower LED block

By pressing the hot key "INFO", the clear text information for the functions (input and/or output messages) assigned on the LEDs of the lower block appears on the display. The clear text shown on the display always refers to the last activated or still active function.

LED acknowledgment

According to the parameterizing, the LED displays can be defined as "status display" or as "acknowledgeable". An acknowledgeable LED lights up until it is acknowledged by the operator (via key "C" of the ***CMP1***, via DI or the SCADA system). If the LED is defined as "status display", the LED goes off at the moment the status of the function changes from active to inactive.

(For more details see chapter "LED assignment")

2.2.4 Auxiliary voltage supply for *CMP1*

Auxiliary voltage/relay output
The connection to the *CMP1* has to be realized via a plug whose terminals provide the device with the *auxiliary voltage supply (L+, L-)* and the *earthing (PE)*. Via the terminal board there is, moreover, the possibility to process further (parallel wiring) the message "System ok" for the *CMP1*.

Figure 2.47: Connections of the CMP1

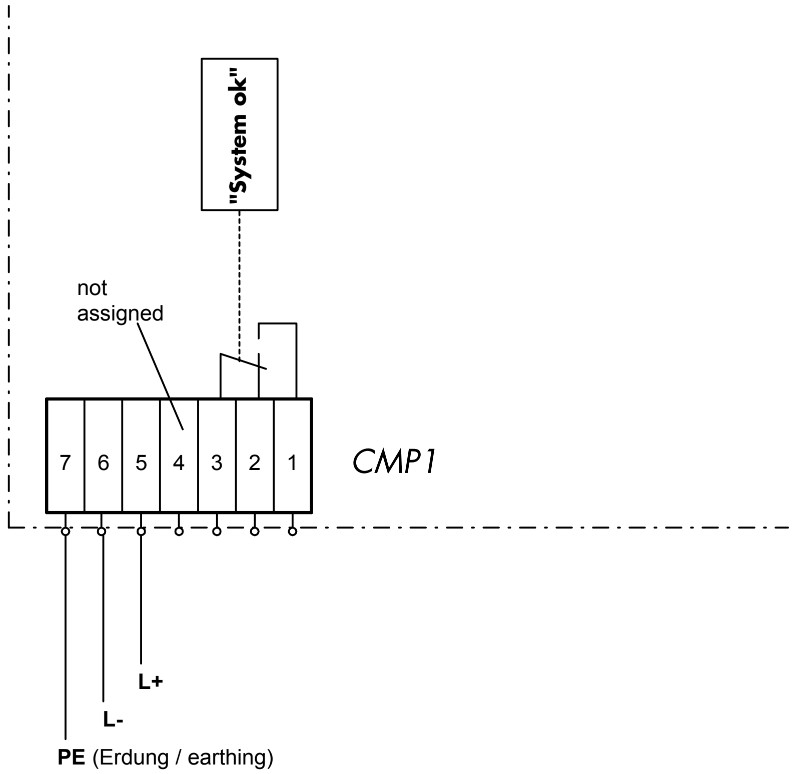


Figure 2.48: Plug in terminal strip of the CMP1

Assignment of the terminal strip CMP1				Available in **CMP1-**	
Terminal No.	*Contacts*	*Note*	*Description*	***12X***	***22X***
1	NO	Normally open	Signal relay output : »System OK« *	●	●
2	NC	Normally closed			
3	COM	Common			
4			Not used	●	●
5	L +		Connection of aux. voltage supply (wide-range : AC or DC)	●	●
6	L -				
7	PE		Earthing/Shielding	●	●

Table 2.18: Auxiliary voltage/earthing/signal relay output

* The *CMP1* message *"System ok"* refers either to the total system *CSP2/CMP1* or only to the *CMP1*. Should the signal relay output be set or if the LED at the *CMP1* lights up red for "System ok", the user must at any rate ascertain whether also the LED at the *CSP2* lights up red for "System ok".

Example: *disturbed communication between CSP2 and CMP1*
In this case the LED at the *CMP1* lights up *red* (the signal relay output is set). The LED at the *CSP2*, however, still lights up *green*. This means that the *CSP2* continues to function correctly.

2.2.5 CAN-communication connection between ***CMP1*** **and** ***CSP2***

The PIN assignment of the CAN interface of the *CMP1* corresponds to the CAN interfaces at the *CSP2 (see chapter "CAN BUS Interfaces (X10/X11)")*. At both ends of the built up CAN BUS cables there is a terminal resistance firmly soldered (at the case of the connectors).

Attention

The CAN connection cable for communication between *CMP1* and *CSP2* must not exceed 100m

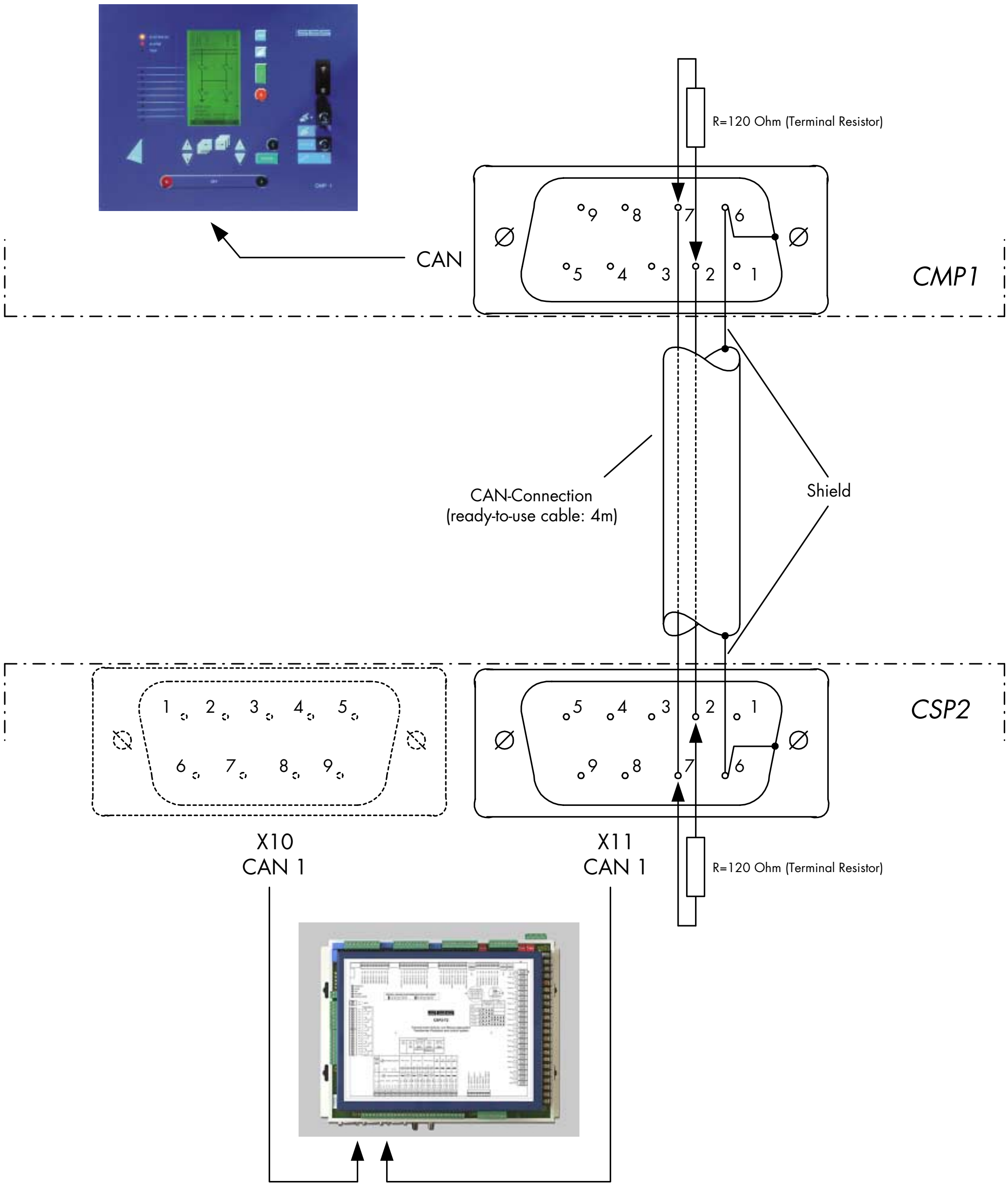


Figure 2.49: CAN connection between CSP2 and CMP1

Note

The CAN connection cable for communication between *CMP1* and *CSP2* is contained in the scope of delivery, but not the cable for a multi device connection.

2.2.6 RS232-Communication connections between *PC (Laptop)* and *CMP1*

The PIN assignment of the RS232 interface of the *CMP1* corresponds to that of the *CSP2 (see chapter "R232 interface (X9)(in preparation)").*

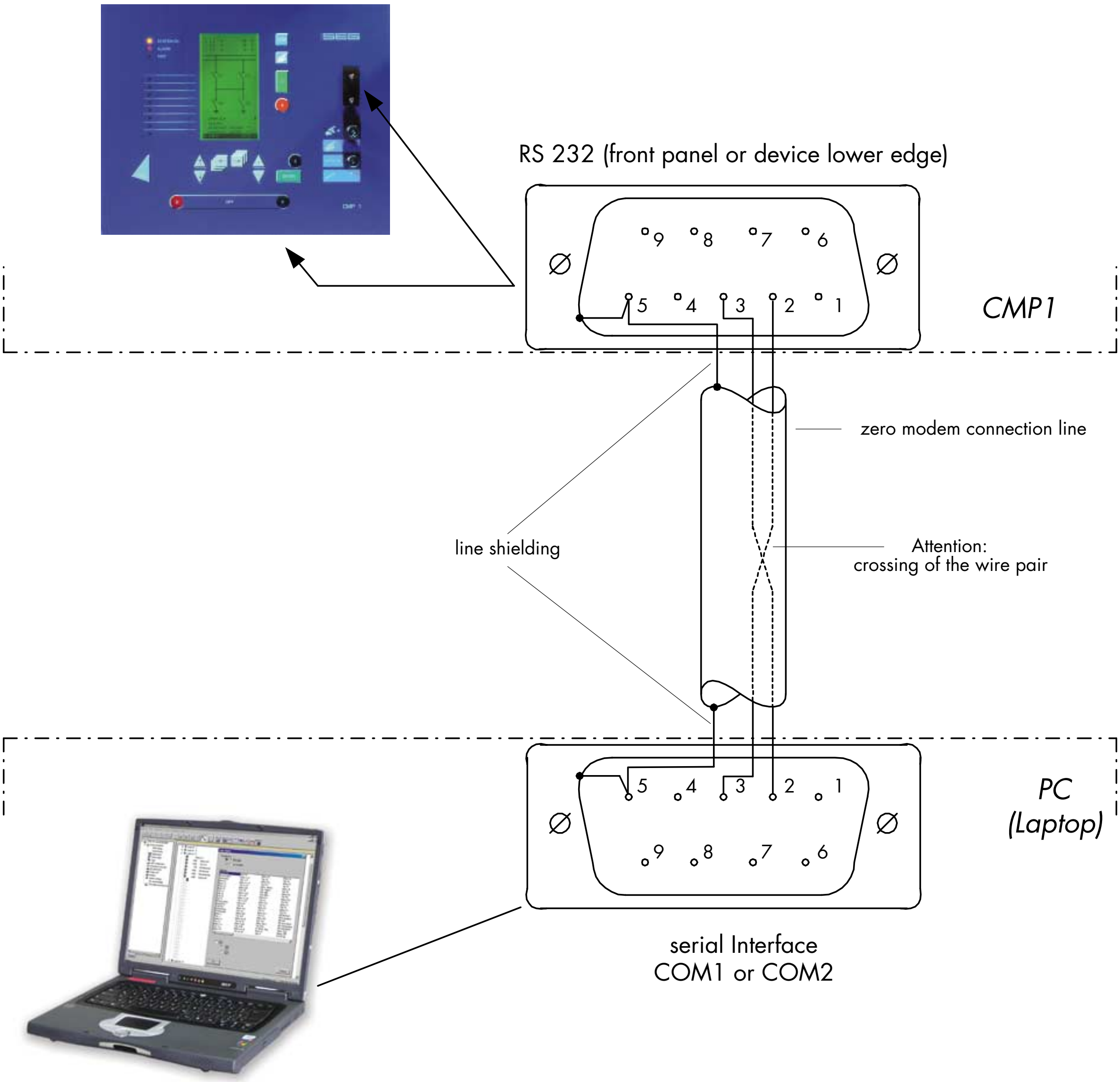


Figure 2.50: Serial connection between PC (Laptop) and CMP1

Note

For connection of a PC or laptop to the ***CMP1***, a *zero modem cable* is required, which, however, is not included in the scope of delivery.

3 Operation via *CMP1*

The operation of the switchboard and all inputs which are necessary for the local operation can be carried out via the *CMP1*. The user entries are carried out via the keys of the CMP. Check-back signals and status displays are visible on the large and background-illuminated LC-display. The display shows the position of the switchgears in graphical form, messages as text and parameters and measurement values in tabular form.

3.1 Key elements on the *CMP1* front plate

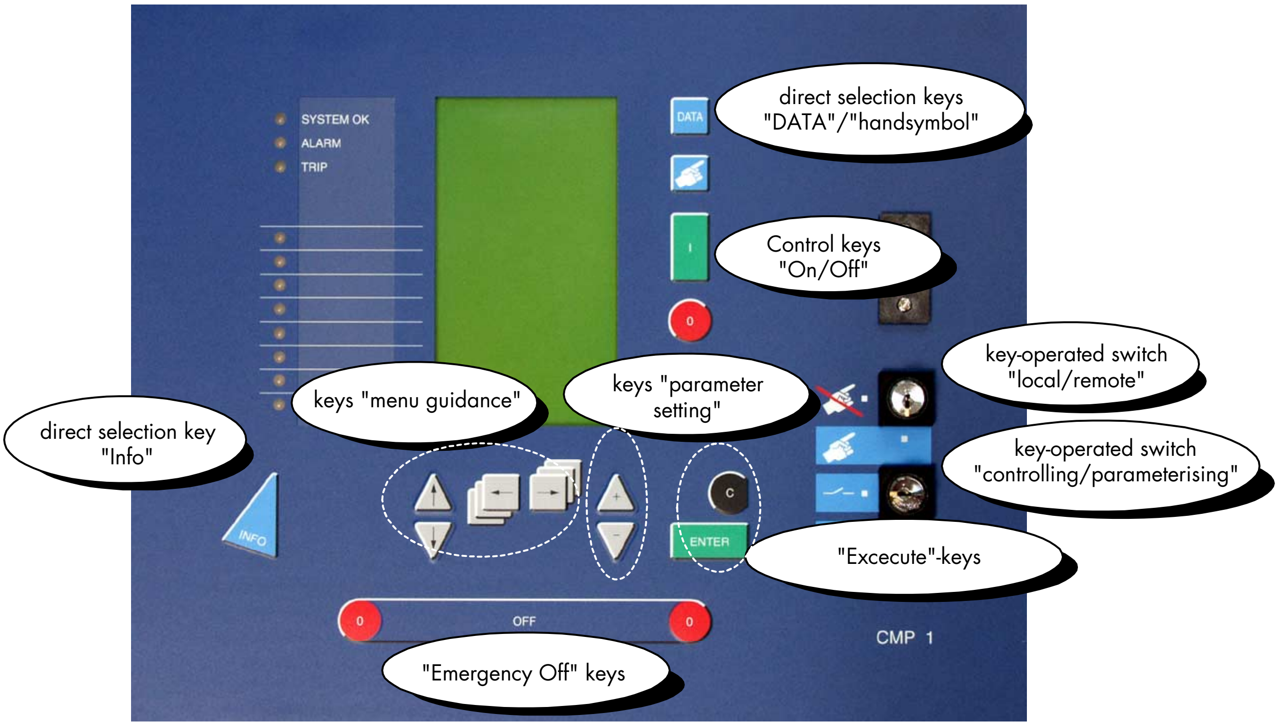


Figure 3.1: Front plate ***CMP1-1***

3.2 Functions of the keys and key switches

The CMP1 disposes of several control elements for the control and parameter setting of the basic unit *CSP2*. With the help of the *key-operated switches* a selection can be made between the different operational modes. The *direct selection keys* make a direct jump to certain menu pages possible. The navigation through the menu is carried out via corresponding menu guidance keys (arrow keys) with which the cursor is moved and subsequent pages can be called up. Changes of parameter settings can be carried out via two separate keys (+/- keys).
For the *local control*, control keys (I/0) are available with which the switchgears in the control mode can be switched on and off. For danger off/emergency off (please refer to figure 3.1) of the power circuit breaker(s) in an emergency, two separate keys are provided, which have to be pressed at the same time.

3.2.1 Key-operated switches and mode of operations

With the two key switches the operation mode of the *CSP2*-system is selected. According to the key switch position, they enable or lock the access to data and parameters or controlling switchgears and thereby secure the system against unauthorized access and controlling.
Four different position combinations can be set. Three of those will be used to set the individual mode of operations (MODE). The key switch combination "Remote control/parameter setting" is *no* operation mode and thus functionless. If it is set unintentionally, a message pops up in the display with the request for correction.

Meaning of the key switch positions

Operating Element	*Key Position*	*MODE 1* (Local Operation/ Controlling)	*MODE 2* (Local Operation/ Param.Setting)	*MODE 3* (Remot.Operation/ Controlling)	*No Operating Modes (No Function)*
Key Switch 1 (upper one)	Vertical	●	●	-	-
	Horizontal	-	-	●	●
Key Switch 2 (lower one)	Vertical	-	●	-	●
	Horizontal	●	-	●	-

Table 3.1: Overview of the operating modes

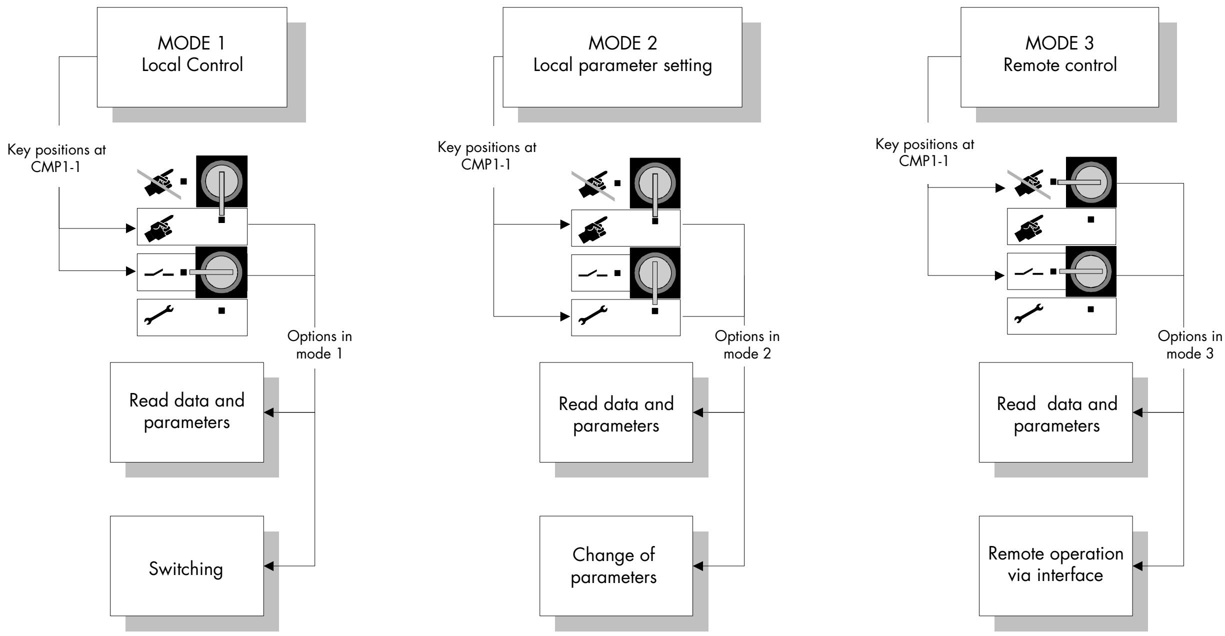


Figure 3.2: Overview over operation modes

3.2.1.1 MODE 1 (local operation/control)

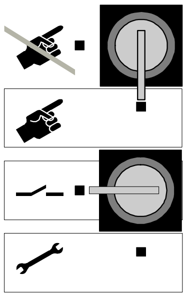


Figure 3.3: local operation/control

In order to control switchgears from the local side, MODE 1 has to be selected (for the key switch position please refer to fig. 3.3). Only in MODE 1 the menu item "control" appears at the bottom of the display. Via the navigation (arrow keys) keys the control menu has to be entered. Within the control mode switchgears can be selected and switched.

Caution

Extern control commands which are sent via a SCADA or received via digital inputs of the *CSP2*, will not be processed in MODE 1!

Note

Extern locking commands which are sent via SCADA or received via digital inputs of the *CSP2*, will in MODE 1 be taken in account by the *CSP2* and could possibly block the local control command!

The *principle steps of carrying out a control command* is described in detail in chapter "Example of carrying out control command".

3.2.1.2 MODE 2 (local operation/parameterising)

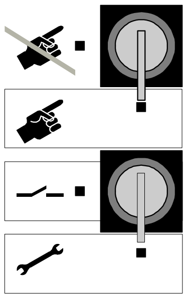


Figure 3.4: Local operation/parameterising

In order to read out and change parameters, MODE 2 has to be selected (for the key switch position please refer to Fig. 3.4).

Note

In MODE 2 switchgears can not be switched via the CMP (in MODE 2 there is no menu item "control" visible!).

Note

The "How to do" of Parameter changings is shown in form of examples in chapter "Example of a control process" and "Example: Setting of system parameters".
If the lower key-switch is set into the "control = horizontal" position before the parameter changes are saved/confirmed, all changes are rejected.

3.2.1.3 MODE 3 (remote operation/control)

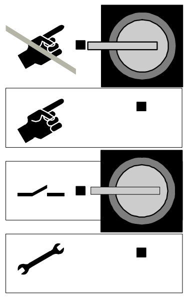


Figure 3.5: Remote operation/control

In MODE 3 the reading of data is in principle possible via the menu keys of the *CMP1*. Locally, parameters and switchgear positions can only be read out but not changed. The only exception thereto is the function "Emergency off", which is always permitted and does no take into account any field and system locking field and system lockings.

MODE 3 must be selected when switchgears have to be controlled (switched) remotely, e.g. SCADA system or via digital inputs.
If no SCADA system is connected, this key switch position for this can be used to lock *CSP2/CMP1* against an unauthorized changes of parameters or switchgear positions.

3.2.2 Direct selection keys of the *CMP1*

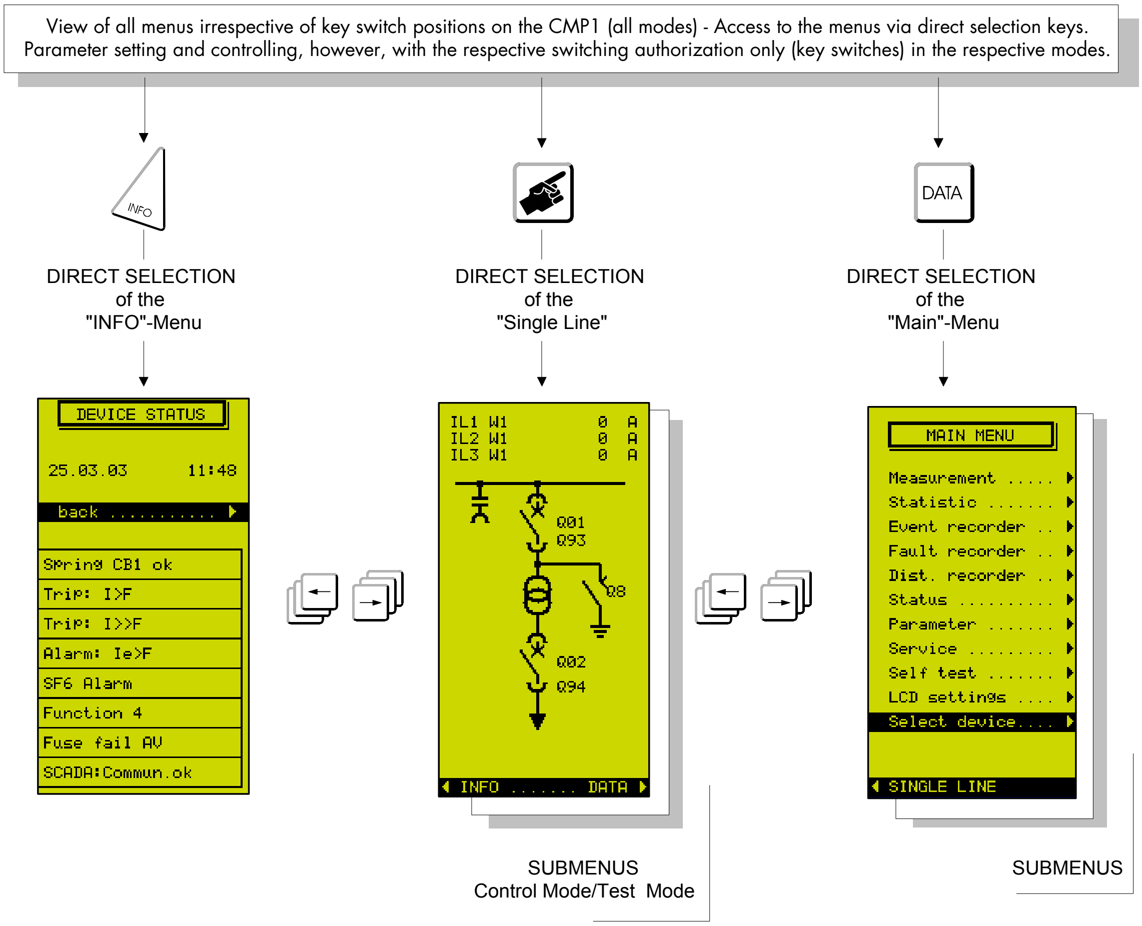


Figure 3.6: Direct selection keys of the CMP1

There is also the possibility to change between these main pages by using the keys "RIGHT/LEFT" arrow key. However, a corresponding note always appears at the bottom of the display of the present menu page.

3.2.2.1 Key »DATA« (main menu)

Main menu

By pressing key “DATA” the page of the main menu pops up in the display of the *CMP1*. The main menu consists of multiple sub-menus. There functions can be divided in principle in the following four groups:

1. *Display/recording of data and events* during the operation of the system (e.g. "Measurement values").
2. *Display of status parameters* during the operation of the plant (e.g. I/O status "Dis").
3. *Action parameters for functions* to initiate certain processes (e.g. reset function: "Event recorder" and
4. *Configuration of the* ***CSP2/CMP1*** systems via setting parameters (system parameters and protection parameters).

The following assignment of the sub-menus to their functions makes clear that some sub-menus can fulfill several of the above mentioned functions:

Sub-menus for display/recording of operational and measurement data

- „MEASUREMENT VALUES“ , in which the present measurement values can be read,
- „STATISTICS“ , in which the present (calculated) statistical measurement values can be read
- „EVENT RECORDER“ , in which the last 50 operation events have been stored,
- „FAULT RECORDER“ , in which the last 5 *faults* (activations) with the according measurement values have been saved,
- „SERVICE“ for display of date, time, the operational hours of the *CSP2* as well as the pre sent software versions of *CSP2* and *CMP1*.

Sub-menus with status displays

- „STATUS“ , which the status (active/inactive) of the individual digital inputs with indication of the assigned input function, the status of the signal relay and the logic are displayed.

- „DISTURBANCE RECORDER“ , in which the information on the recording data generated for *disturbances* are shown with indication of the status of the present action (e.g. "wait" or "saving",
- „SELECT DEVICE“ (device selection) in which in a multi-device communication (with only one *CMP1* and several *CSP2*) the connection with the selected *CSP2* is displayed.

Sub-menus with action parameters for functions

- „DISTURBANCE RECORDER“ , in which the information on the disturbance data generated for *disturbances* are saved with the possibility to start recording the *disturbance* values manually via the *action parameter "man.trigger"*.
- „SELF TEST“ , in which the hardware components of the *CSP2* and *CMP1* can be tested,
- „DEVICE SELECTION“ , in which in case of a multi-device communication the connection to the *CSP2* to be selected can be carried out via CAN-BUS.

Sub-menus with setting parameters for ***CSP2*** *configuration*

- „SERVICE“ , in which the date as well as the time of the internal clock of the *CSP2* can be seen and the device name and the software version number.
- „PARAMETER“ , in which further sub-menus with settings for system parameters and protection parameters are displayed.

Note

In chapter "Structure of the main menu" the complete menu tree of the main menu is shown. A detailed description of the functions of the individual sub-menus is contained in chapter *"Main menu of the* ***CSP2****"*.

Foot line of the main menu

Change to the *start page "SINGLE LINE"* can be effected via the foot line of the main menu.

3.2.2.2 Key »Hand-Symbol« (start page SINGLE LINE)

Start page „SINGLE LINE"
Independent of the operation mode setting, the activation of the key, on which the hand symbol is shown, calls up the single line. In the upper quarter of the display the start page shows the *present measurement values for the phase currents*, among them the *feeder control picture* of the field configuration with the present switchgear positions.
If operational mode MODE 1 is set, the menu item *"operate"* (appears below the single line), via which the CONTROL MODE is accessable.

Note

> If the keys of the *CMP1* are not actuated for approx. 10 min., the SINGLE LINE appears automatically in the display and serves as a permanent message! At the same time the background illuminated display is darkened.

Single Line
The *single line* is a *single-pole illustration of the present cubicle* and shows its field configuration. All connected switchgears are shown with their titles and the present switch position. The following *switch positions* can be shown:

- switchgear is „OFF",
- switchgear is „ON",
- switchgear is in „INTERMEDIATE POSITION" switching operation not terminated or simultaneous missing of the positions check back signals for OFF and ON, and
- switchgear in „FAULTY POSITION" simultaneous reporting of the switch positions for OFF and ON.

a) b) c) d)

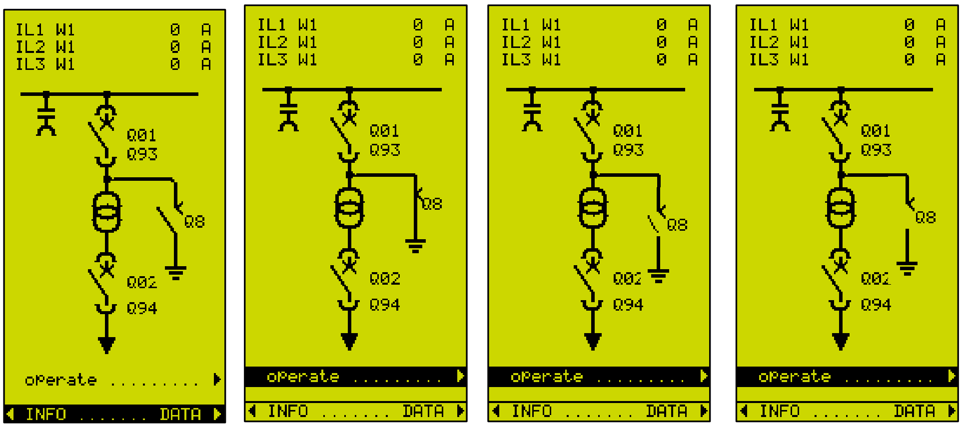
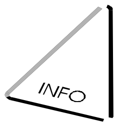


Figure 3.7: Single lines for the four different switch positions:
a) earthing open
b) earthing closed
c) earthing switch in intermediate position
d) earthing switch in faulty position

Menu item "operate"
By calling up this page, one access the CONTROL MODE in which the switchgears can be locally (ie. via the control keys of the *CMP1*) controlled (*for more details see chapter "CONTROL MODE"*)!

Foot line of the start page SINGLE LINE
Change to the page INFO or to the main menu (DATA) can be effected via the foot line of the main menu.

3.2.2.3 Key »INFO« (non-coded display text for LED displays)



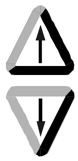
Device status
Via key "INFO" it is possible to jump from any submenu in the menu tree to the page INFO. The INFO page shows on the display the text information of the input functions or messages assigned to LEDs 4 to 11 (lower LED block). The corresponding text information appears in each case at the same height at which the LED has been placed *(for more details see chaper* "LED placement"*).*

Menu item" (return)
Via this line it is possible to jump back to the menu item of the menus from which the key INFO was pressed.

3.2.3 Menu guidance

For navigation the the menu structure of the *CSP2* the *CMP1* disposes of the keys »UP/DOWN«-arrow keys and the keys »RIGHT/LEFT«-arrow keys.
Dependend on the different mode of operations, the keys, however, continue to take over important tasks (examples hereto can be found in *chapter "Example: control in the CONTROL MODE* as well as in the chapters for example parameter setting).

3.2.3.1 Keys »UP/DOWN«



These two triangular keys with arrows on them serve for

- *up and down movement* of the dark *cursor bar* for selection of menu items,
- *call-up* of the different *event messages* in the menu "Event recorder",
- *call-up* of the different fault *messages* in the menu "Fault recorder" and
- *call-up* of the switchgears to be controlled in the CONTROL MODE, and also TEST MODE. Here the selected switchgear is marked by a *circle marker* which surrounds the symbol of the switchgear.

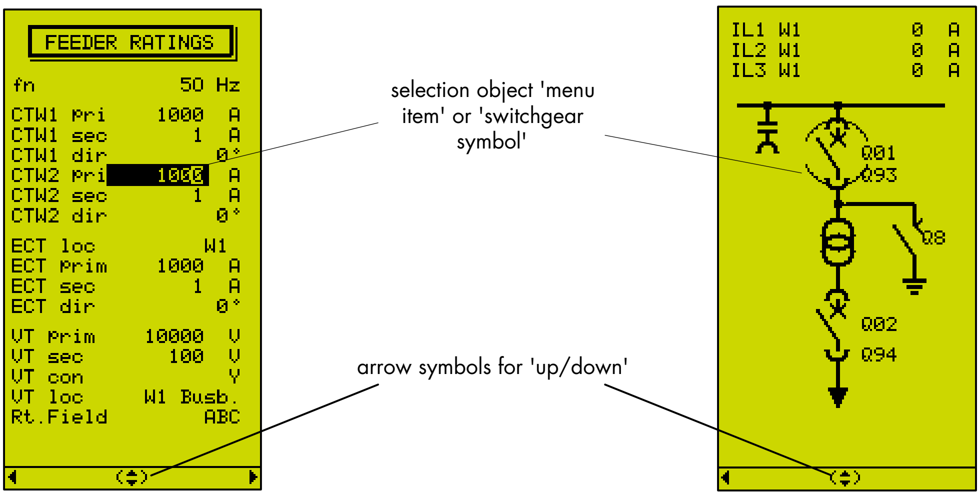
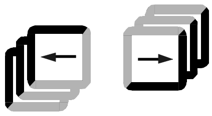


Figure 3.8: Examples for selection objects via keys »UP/DOWN« arrow keys"

Note

- The *selection possibility* of *menu items* or *switchgear symbols* is partly dependent on the operation mode!
  If a selection via the keys »UP/DOWN« is possible, a corresponding symbol (two arrows pointing up and down) appears in the middle of the foot line. If e.g. in MODE 1 a parameter page of the sub-menu "OVERCURRENT I>" is called up, the different parameter lines can only be selected when change to MODE 2 is carried out via the lower key-operated switch. Only then the corresponding symbol appears in the foot line.
- If these keys are pressed only *temporarily*, the *cursor bar* or the *circle marker* jumps from the present menu item or *switchgear symbol* to the next (by key »UP«) or the previous item (by key »DOWN«). If the keys are held pressed, the cursor bar or the circle marker surround the symbols of the subsequent or previous line or switchgear at a cycle of one second.

3.2.3.2 Keys »RIGHT/LEFT«



Also the »RIGHT/LEFT« arrow keys" serve on the one hand as *call-up* and *selection keys* of the menu guidance and on the other hand, however, also as *execution key* for certain functions.

The key »RIGHT« is used for

- *call-up* of the subsequent menu page (if available)
- *call-up* of a sub-menu or for
- *selection of decimal digits in a parameter setting process* or as
- *execution key for action parameters.*

The key »LEFT« serves either for

- *call-up* of the previous menu page or for
- *selection of decimal digits in a parameter setting process.*

Call-up of the subsequent or the previous menu page
The foot line indicates principally if the menu offers further pages for call-up. For this, a symbol in the form of a little arrow point directed to the »RIGHT« appears in the »RIGHT« part of the foot line. Consequently, this symbol is not shown in the foot line of each last page of a sub-menu. By moving the cursor bar to the foot line (key UP) and pressing key »RIGHT« the selected sub-menu is opened.

The *call-up of the previous page* is effected in the same way, only that here the key »LEFT« must be pressed. The arrow point directed to the left in the foot line indicates the possibility of leafing back.

Call-up of sub-menus
If on one menu page sub-menus are displayed, in each case a symbol (small arrow point to the right) in the sub-menu item indicates that a call-up is possible via pressing the key »RIGHT«.

Selection of decimal digits in the parameter setting process
If in MODE 2 a parameter is changed, the setting of which is indicated as a number value, the keys »RIGHT/LEFT« are required to select the decimal digit to be changed *(see chapter "Example: parameter setting of protection parameters").*

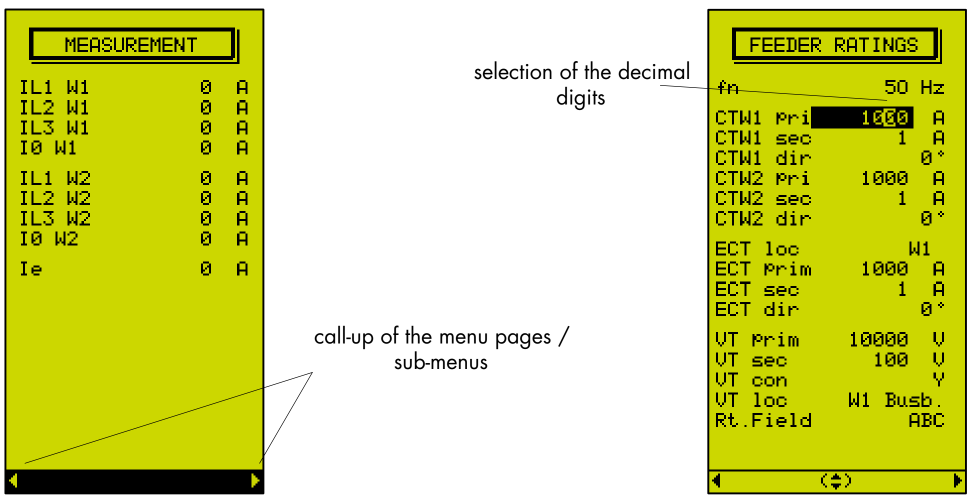


Figure 3.9: Examples for call-up and selection functions of the keys »RIGHT/LEFT«

Executing keys for action parameters
Dependent on the operating mode set and the selected *action parameters*, the ***CSP2*** carries out the corresponding action when pressing the key »RIGHT«. In MODE 1, such an action can be e.g. the manual starting of a data recording with the "DISTURBANCE RECORDER". In MODE 2 the function of key »RIGHT« changes when e.g. after a parameter change in the sub-menu "SAVE FUNKTION" has to be stored. The storing is then effected by pressing key »RIGHT«, when then serves as execution key *(see chapter "Example; setting of system parameters.*

Examples: "Reset functions" or "man. trigger" for manual starting of a data recording with the "Disturbance recorder".

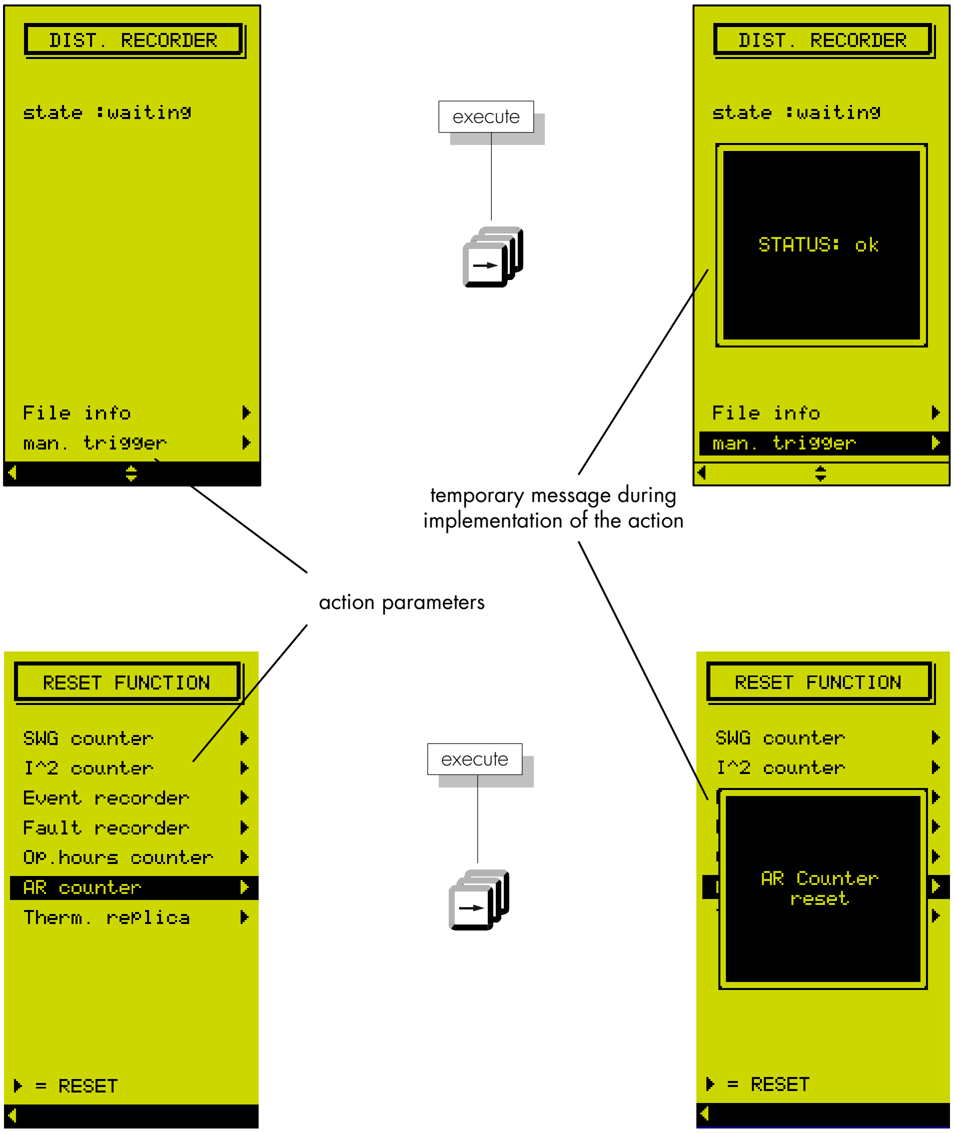
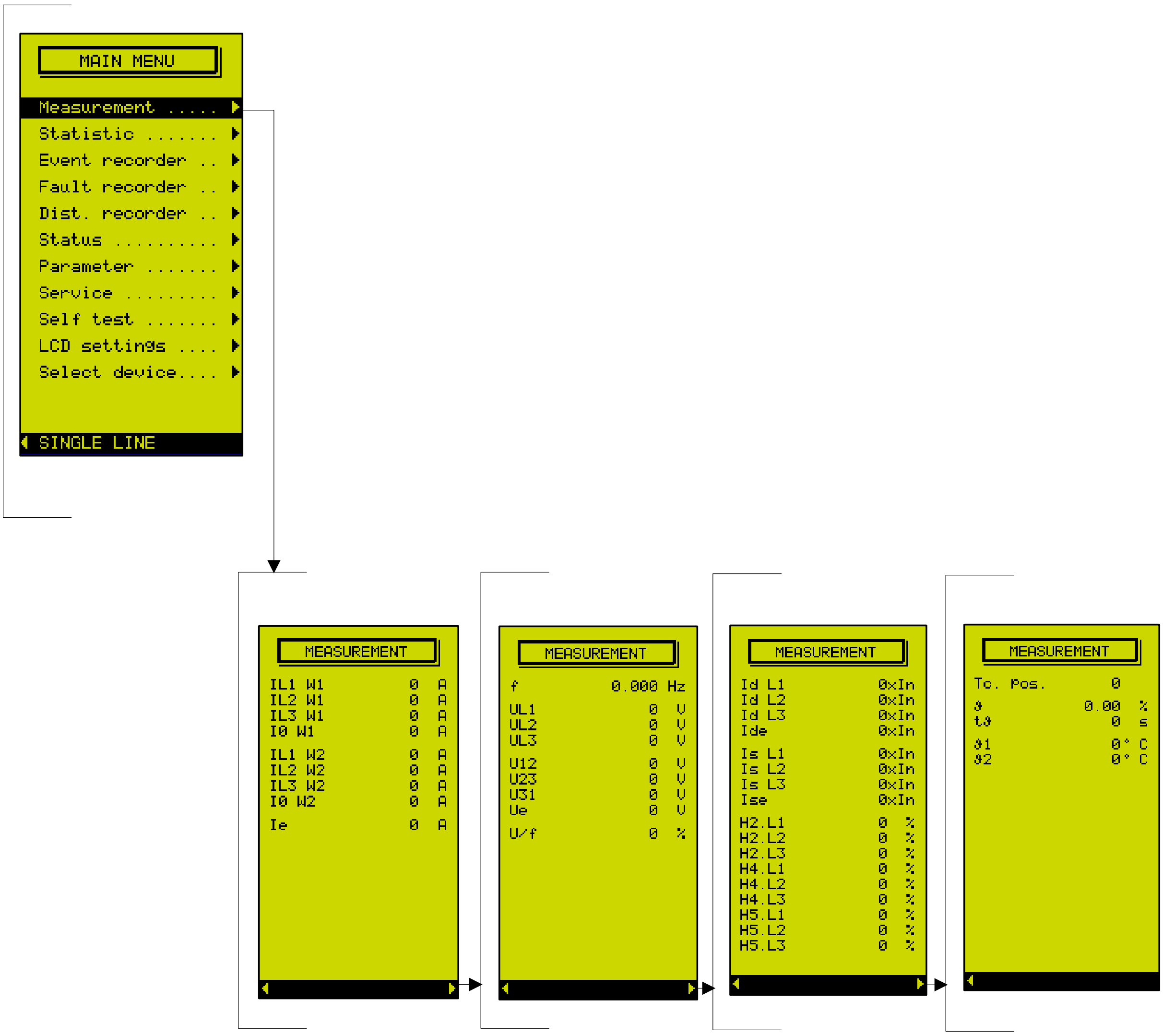


Figure 3.10: Examples for execution pressing the arrow key »RIGHT«

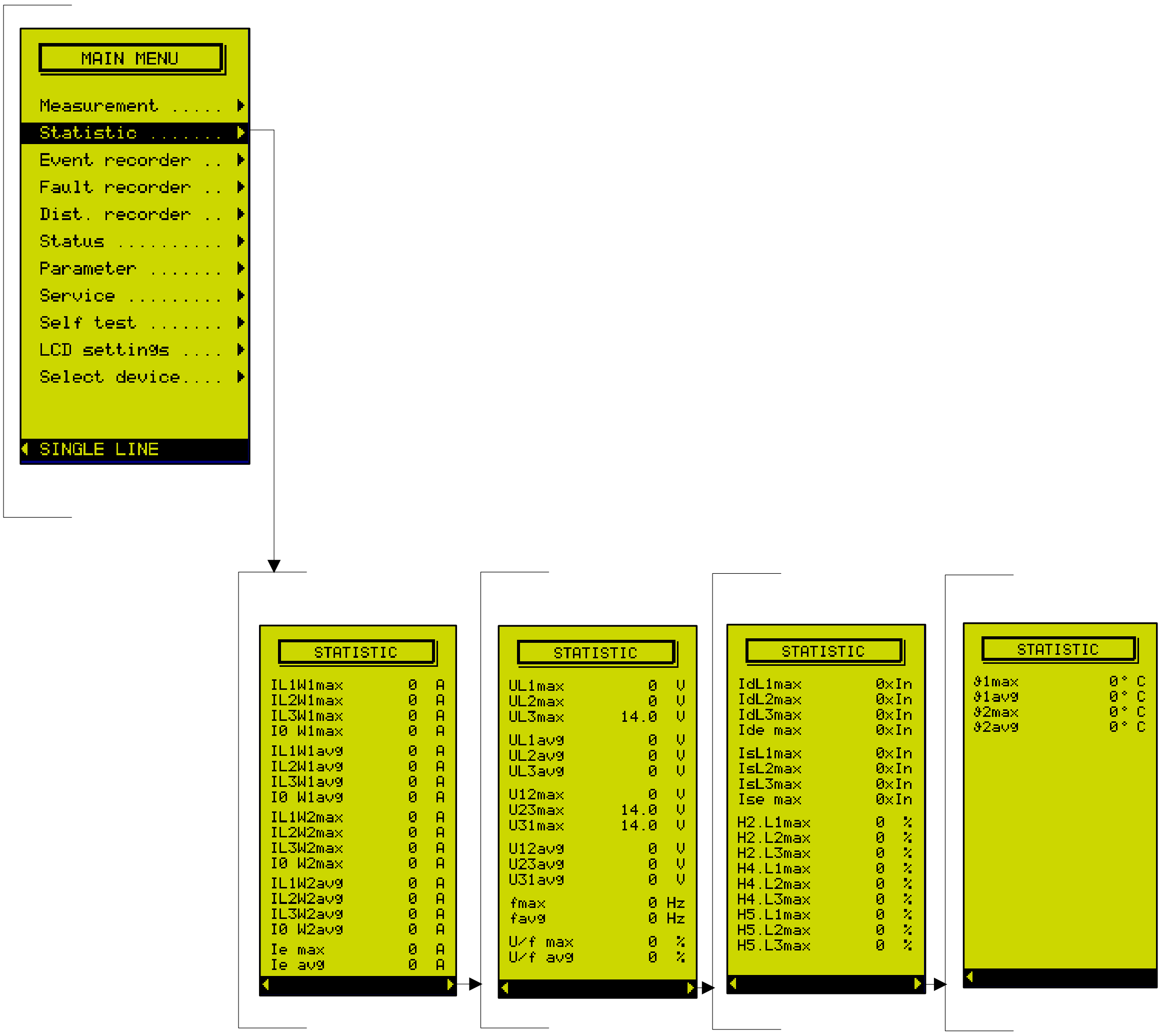
3.2.3.3 Structure of the main menu

The following screenshots show the sub-menues of the main menu. Via the »UP/DOWN« arrow keys and »RIGHT/LEFT« arrow keys any menu page independent of the operational modes set can be called up (read data).

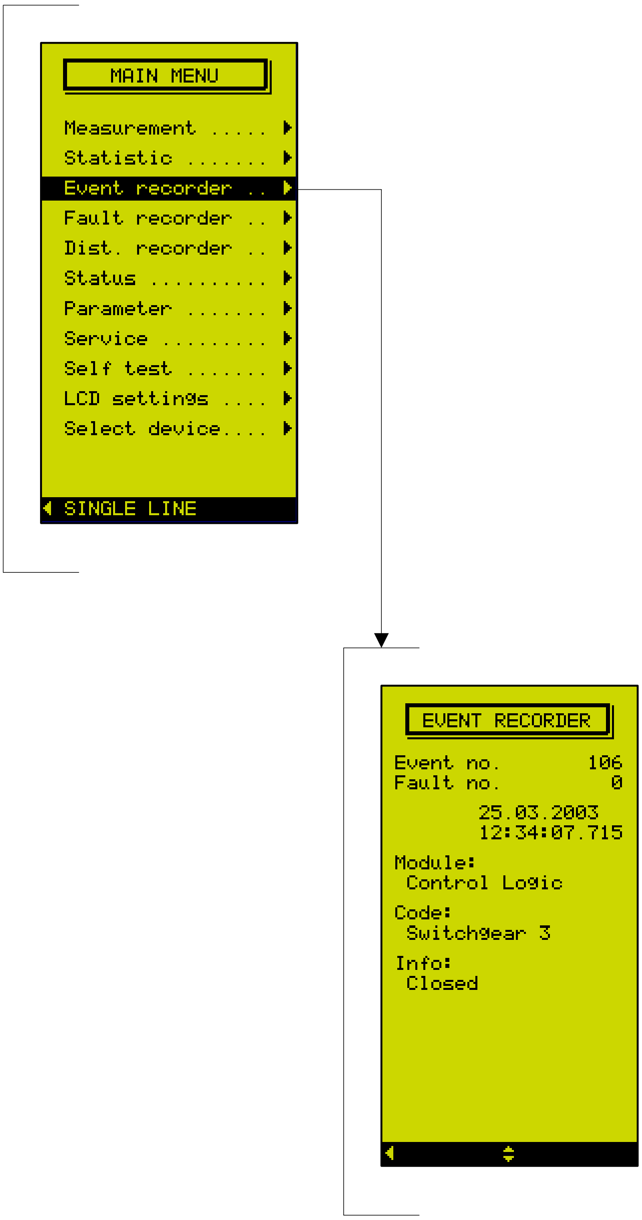
Menu tree of the sub-menu ""MEASUREMENT"



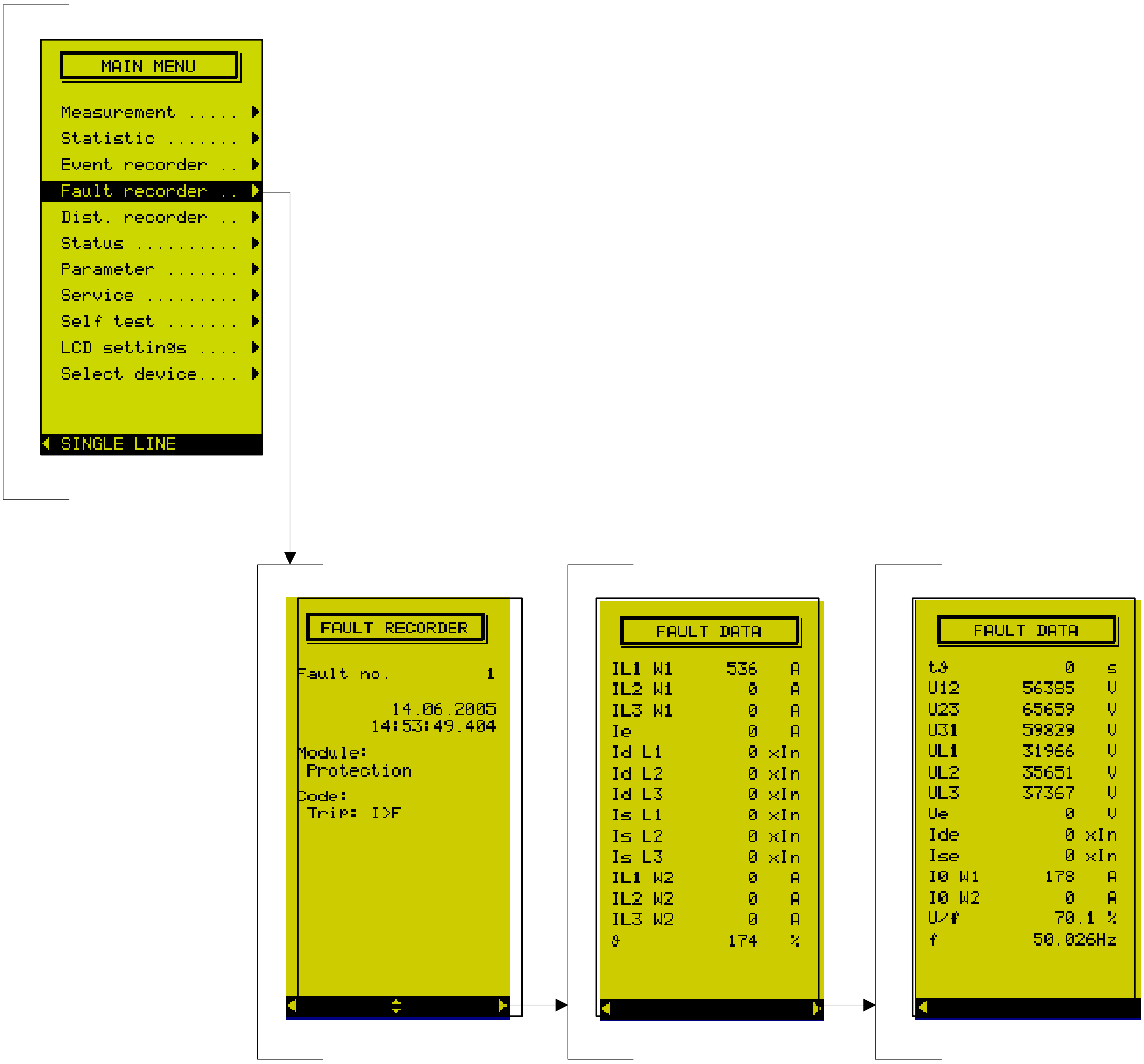
Menu tree of the sub-menu "STATISTIC"



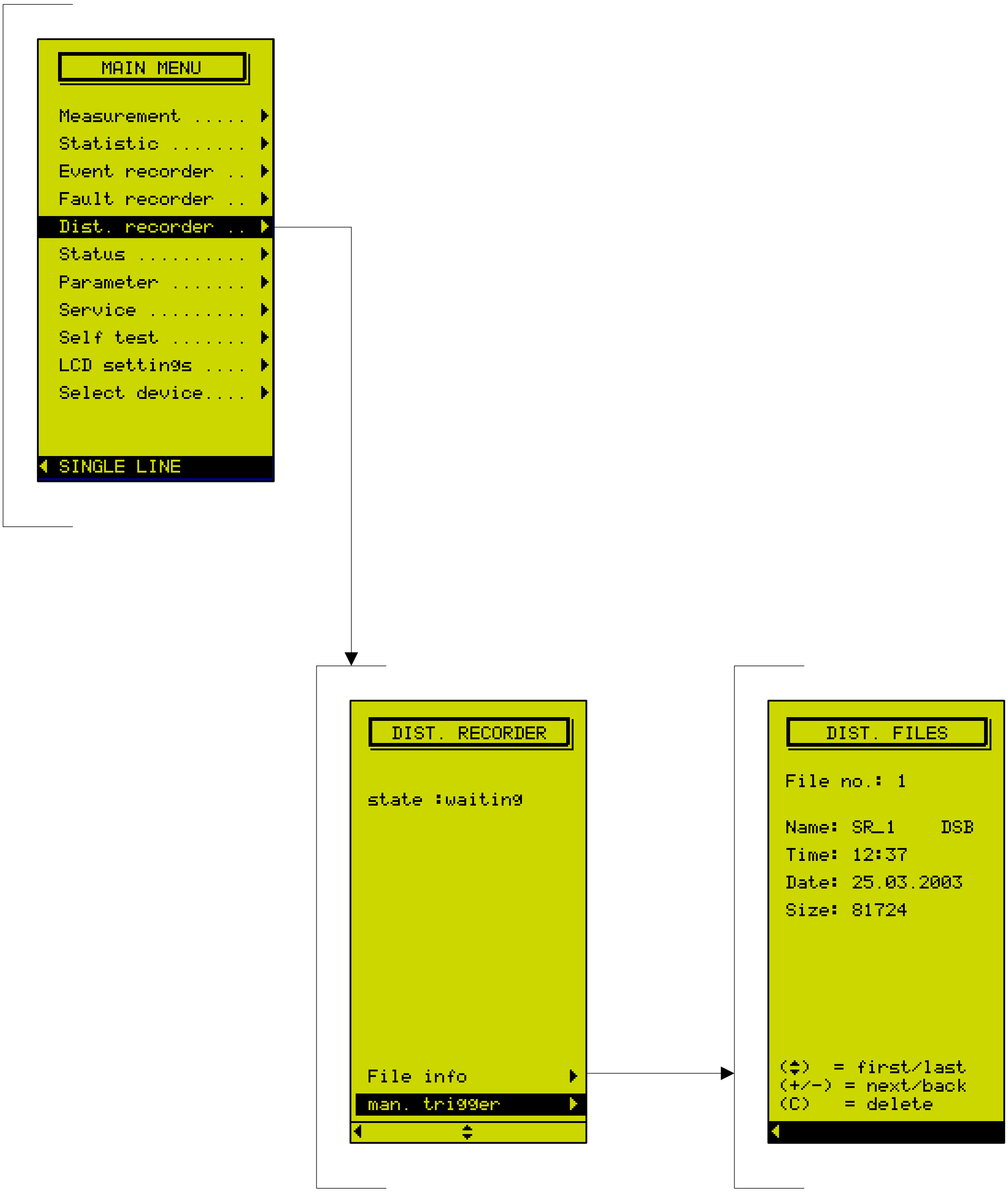
Menu tree of the sub-menu "EVENT RECORDER"



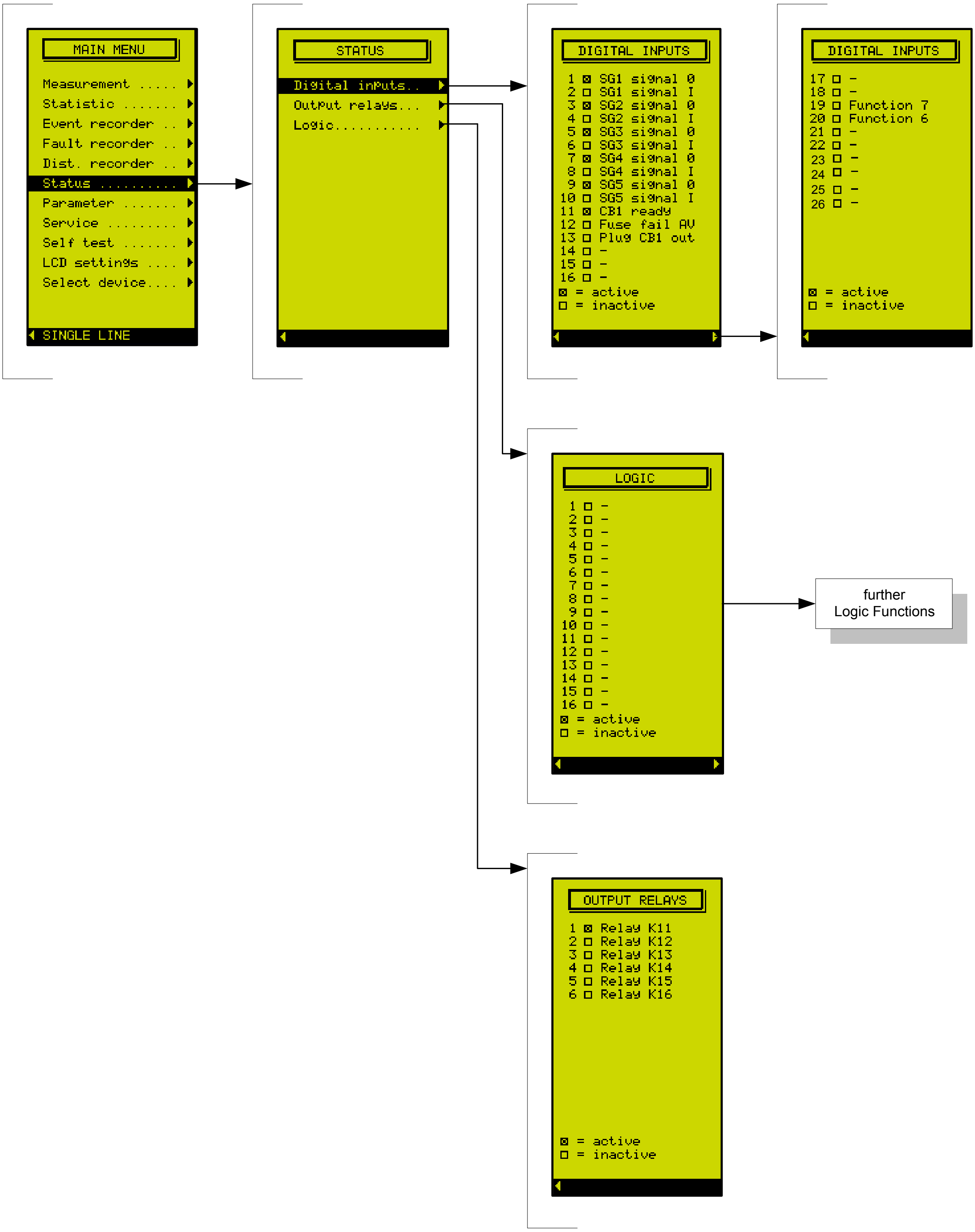
Menu tree of the sub-menu "FAULT RECORDER"



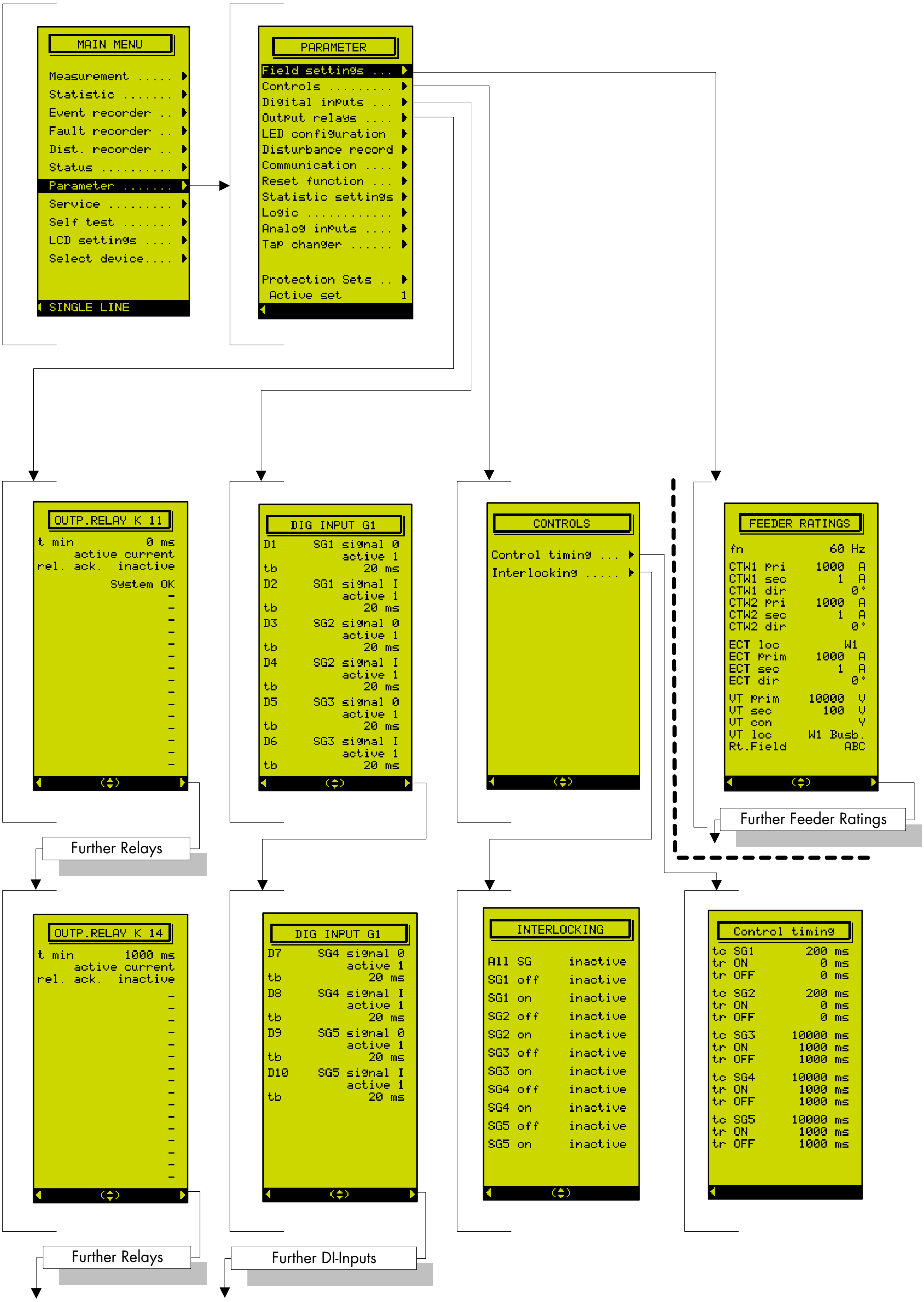
Menu tree of the sub-menu „DISTURBANCE RECORDER“



Menu tree of the sub-menu „STATUS“

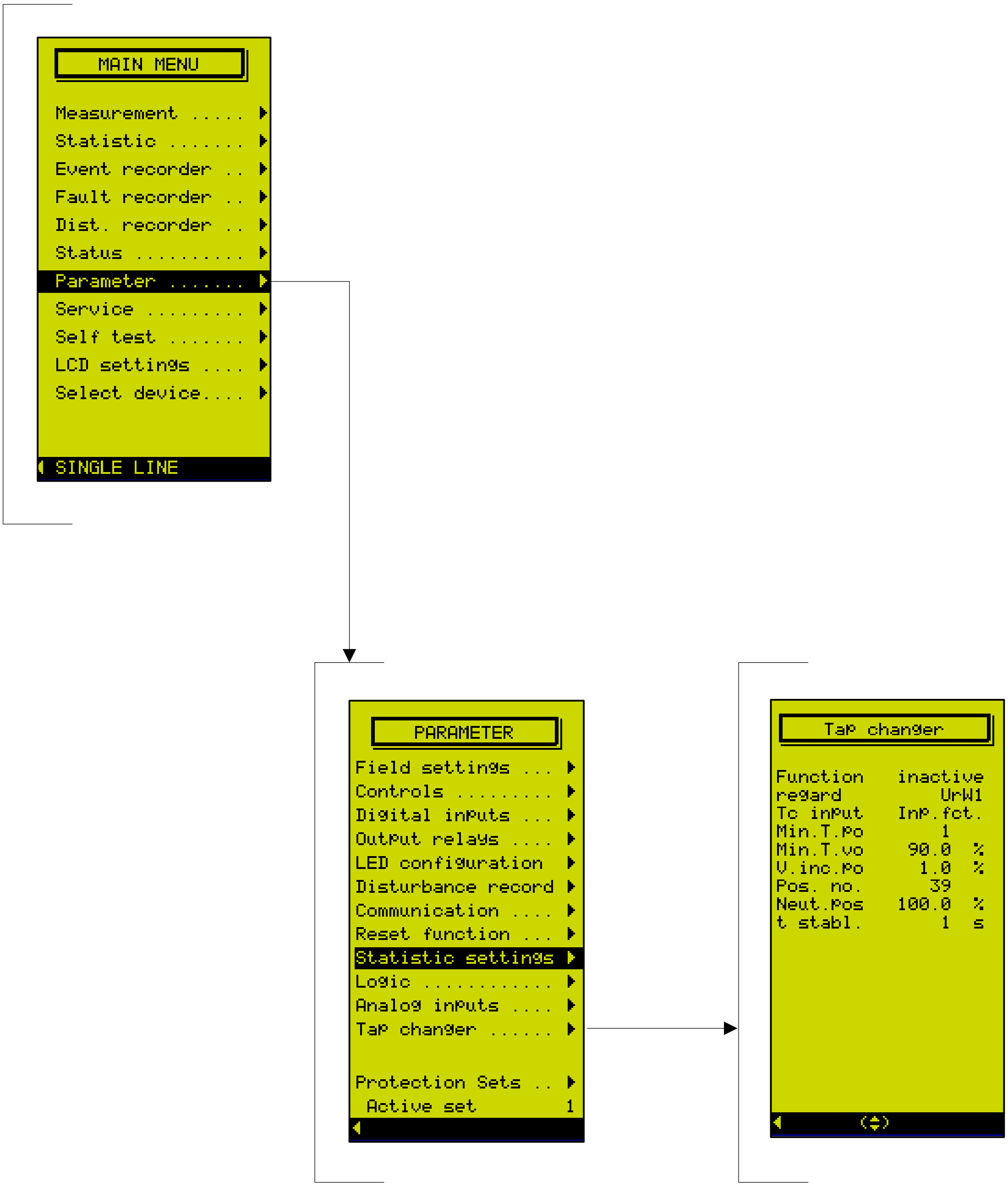


Menu tree of the sub-menu "PARAMETER" (Part 1)

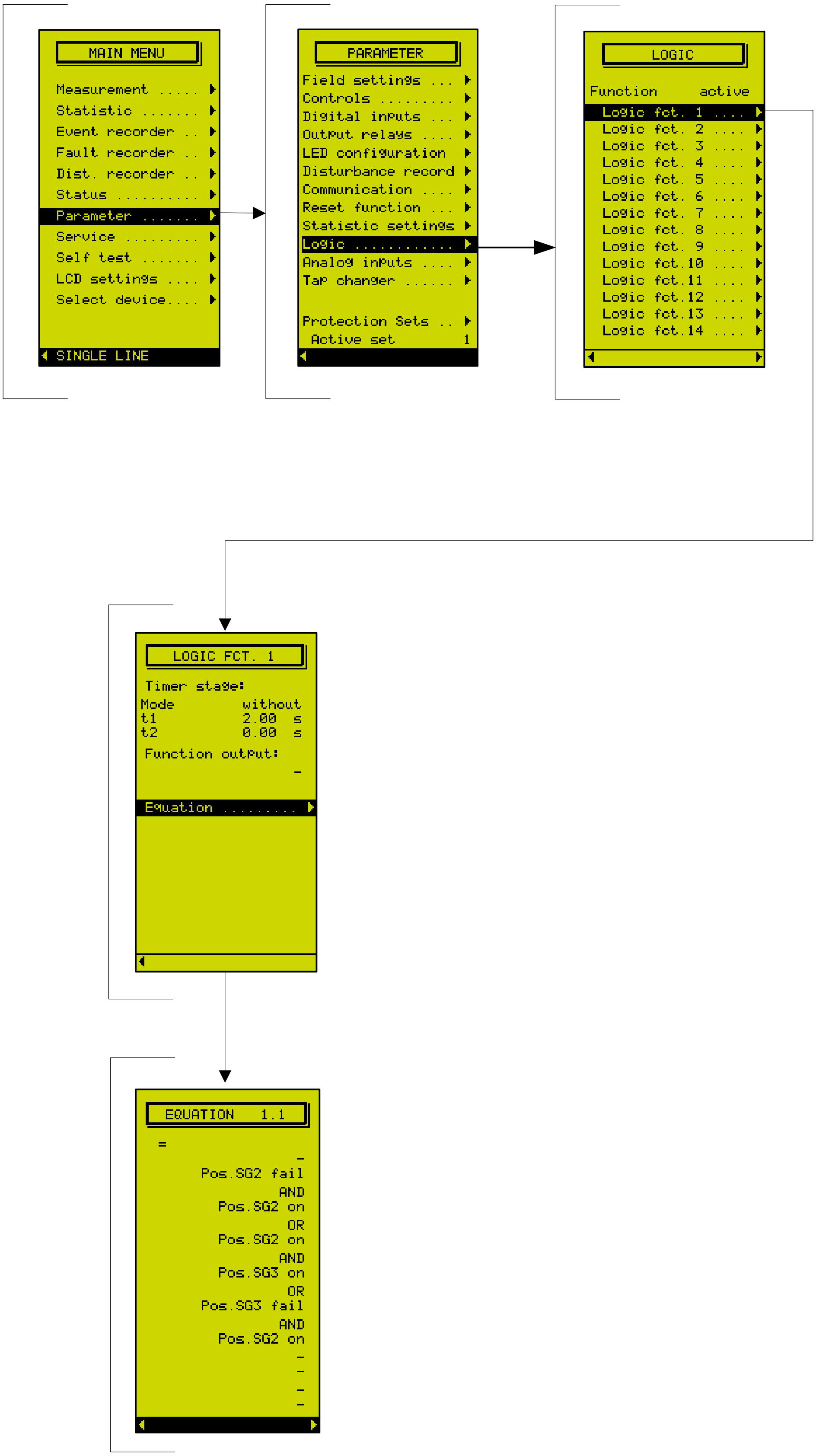


Menu tree of the sub-menu "PARAMETER" (Part 2)

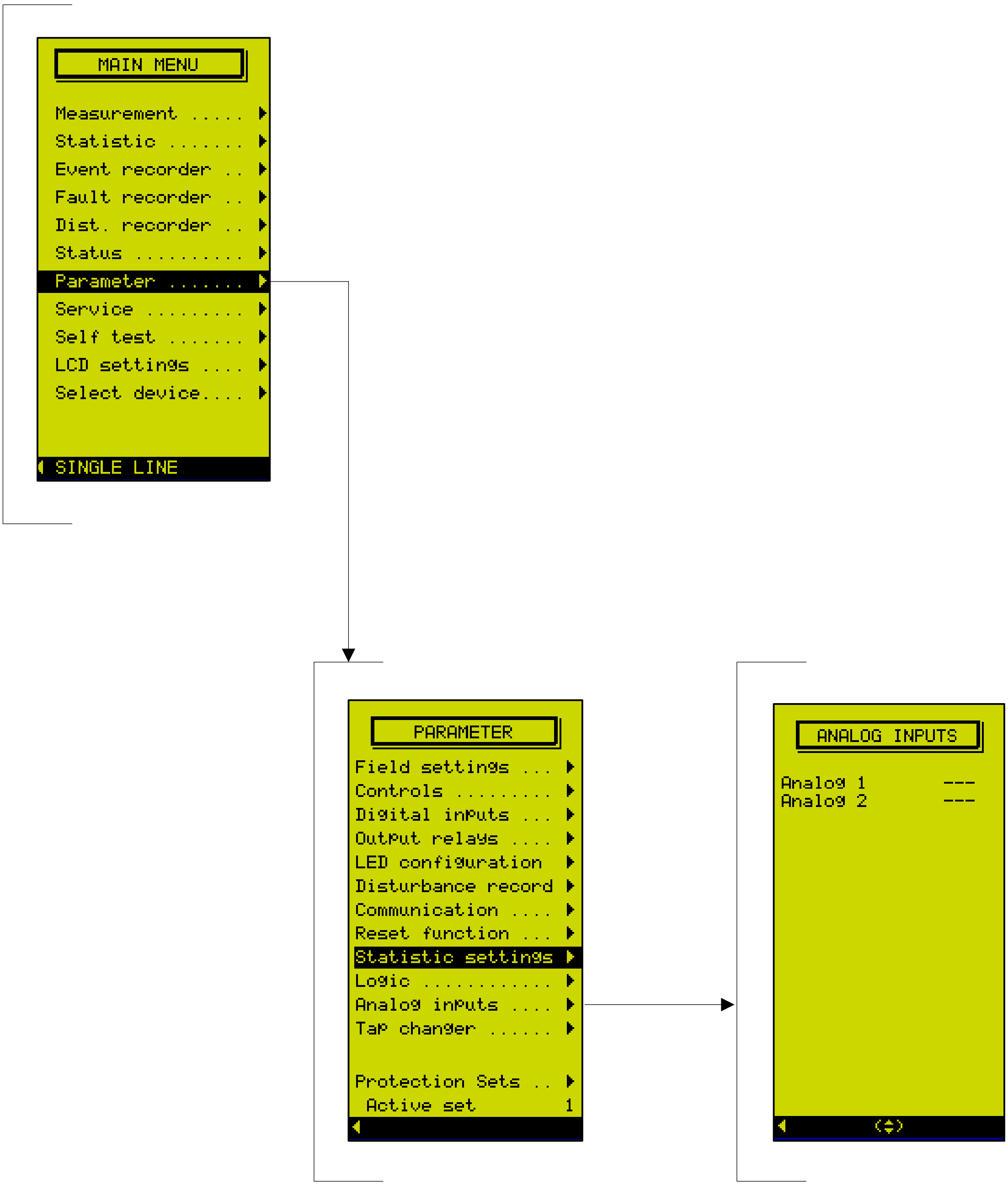
Menu tree of the sub-menu "PARAMETER" (Part 3a)



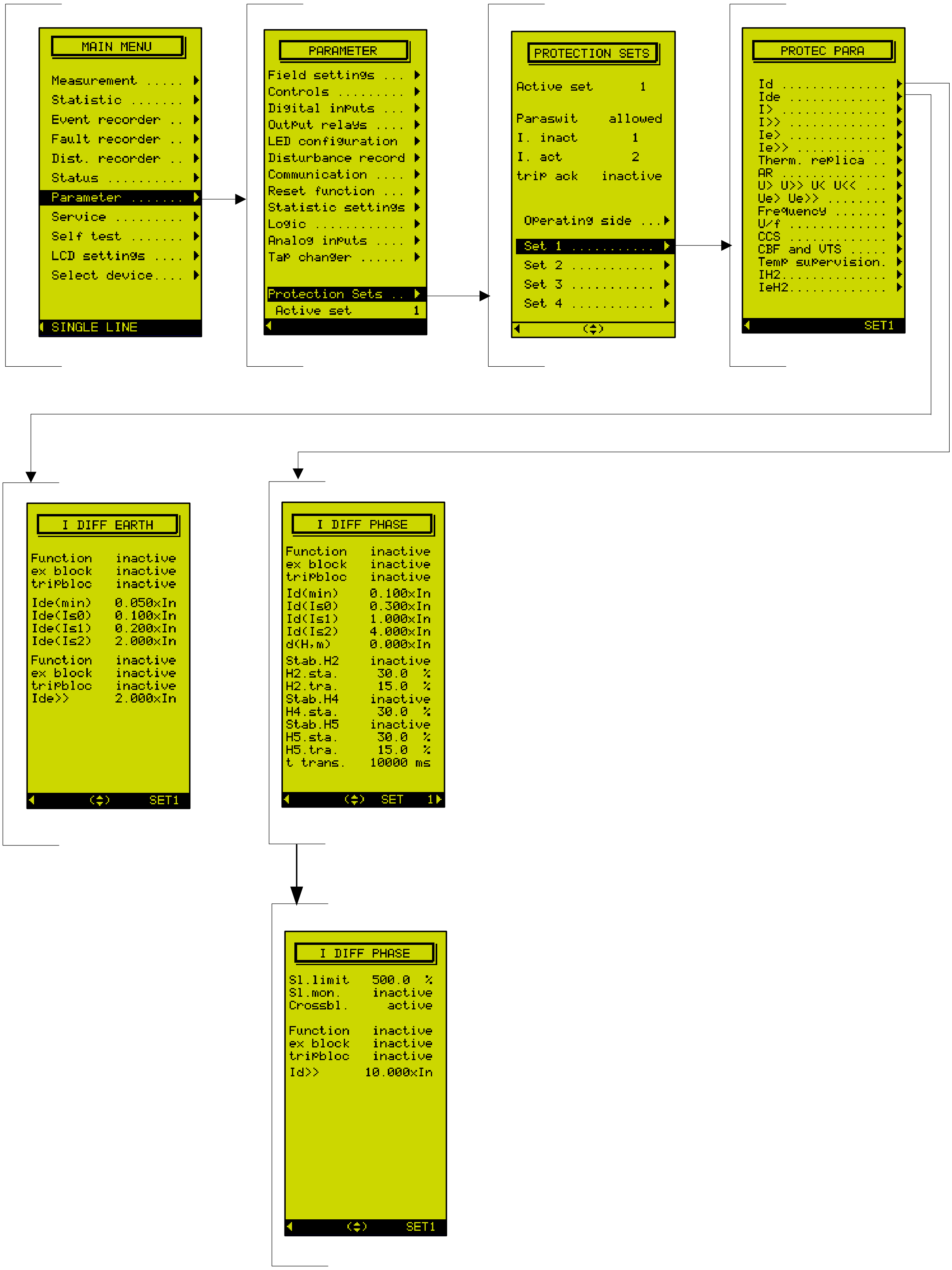
Menu tree of the sub-menu "PARAMETER" (Part 3b)



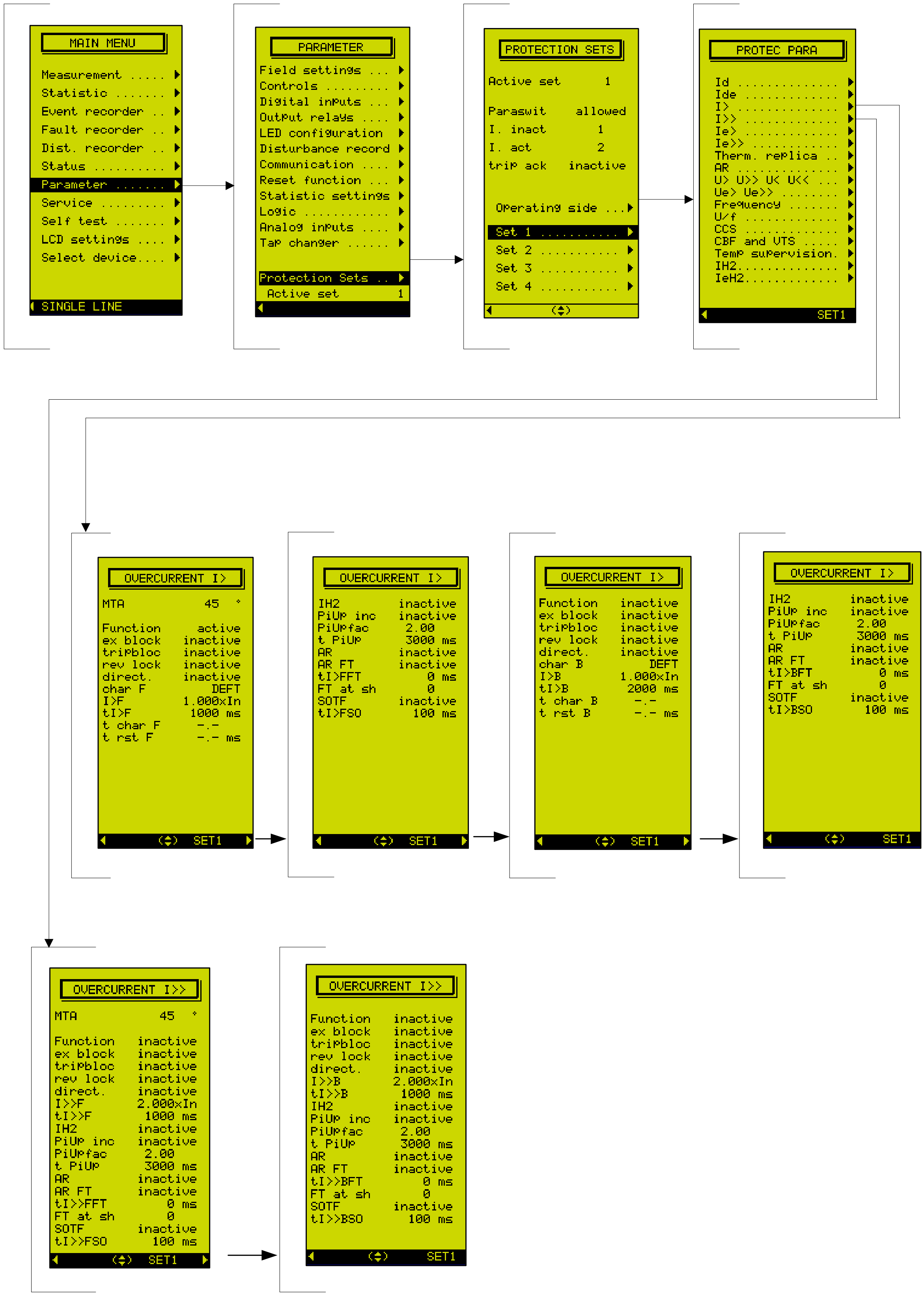
Menu tree of the sub-menu "PARAMETER"



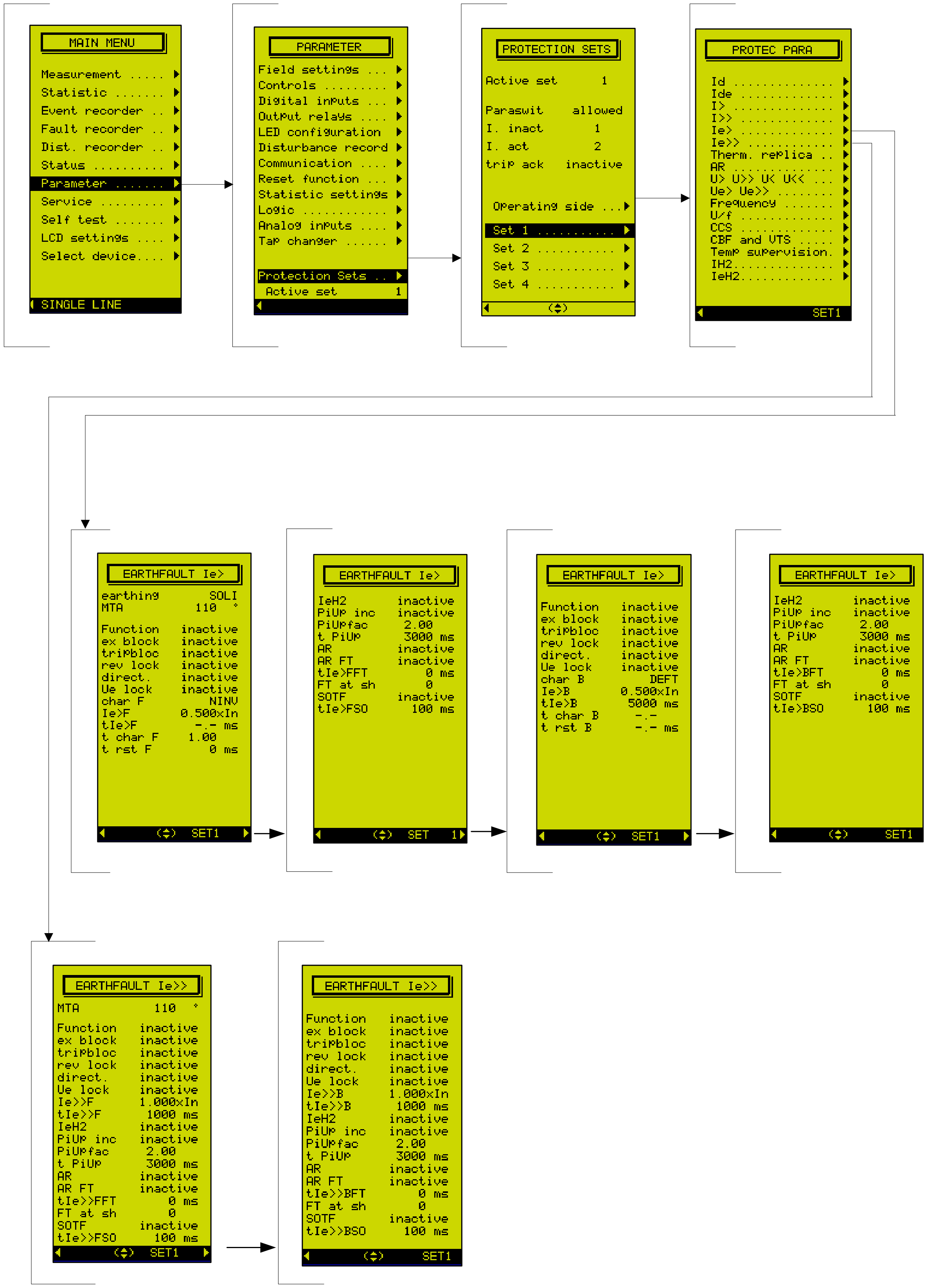
Menu tree of the sub-menu "PARAMETER" (Part 4a)



Menu tree of the sub-menu "PARAMETER" (Part 4b)

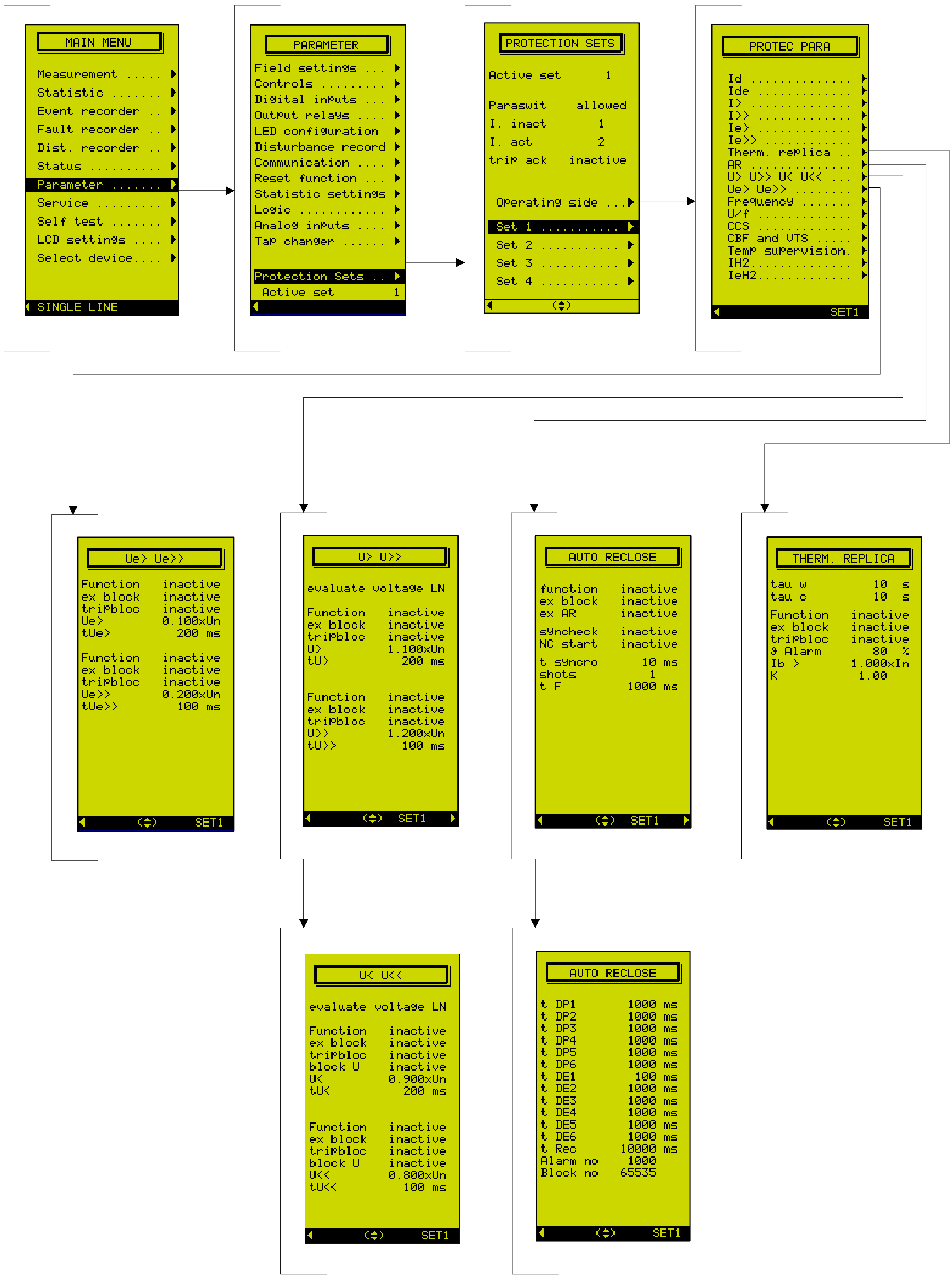


Menu tree of the sub-menu "PARAMETER" (Part 4c)

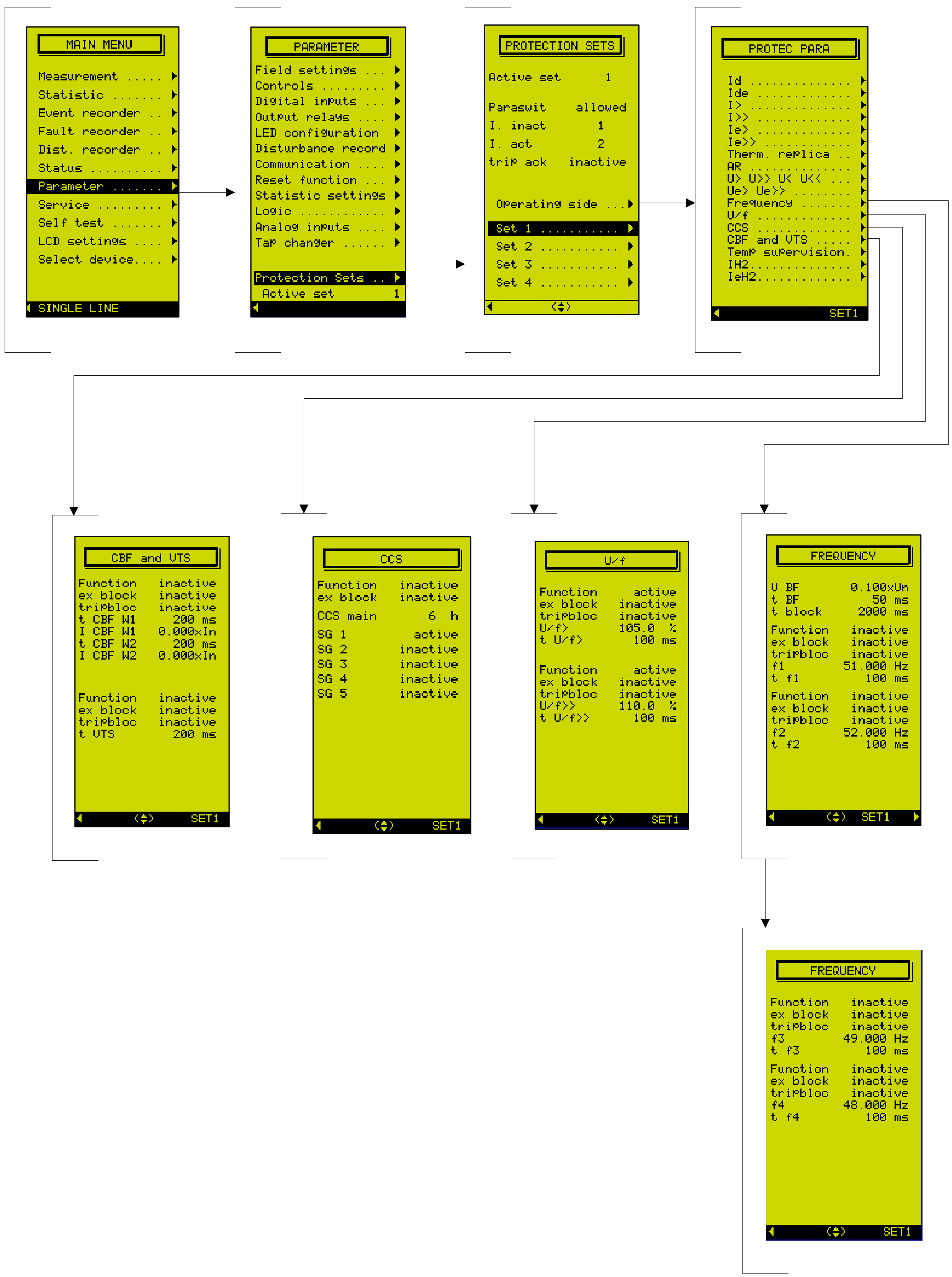


Menu tree of the sub-menu "PARAMETER" (Part 4d)

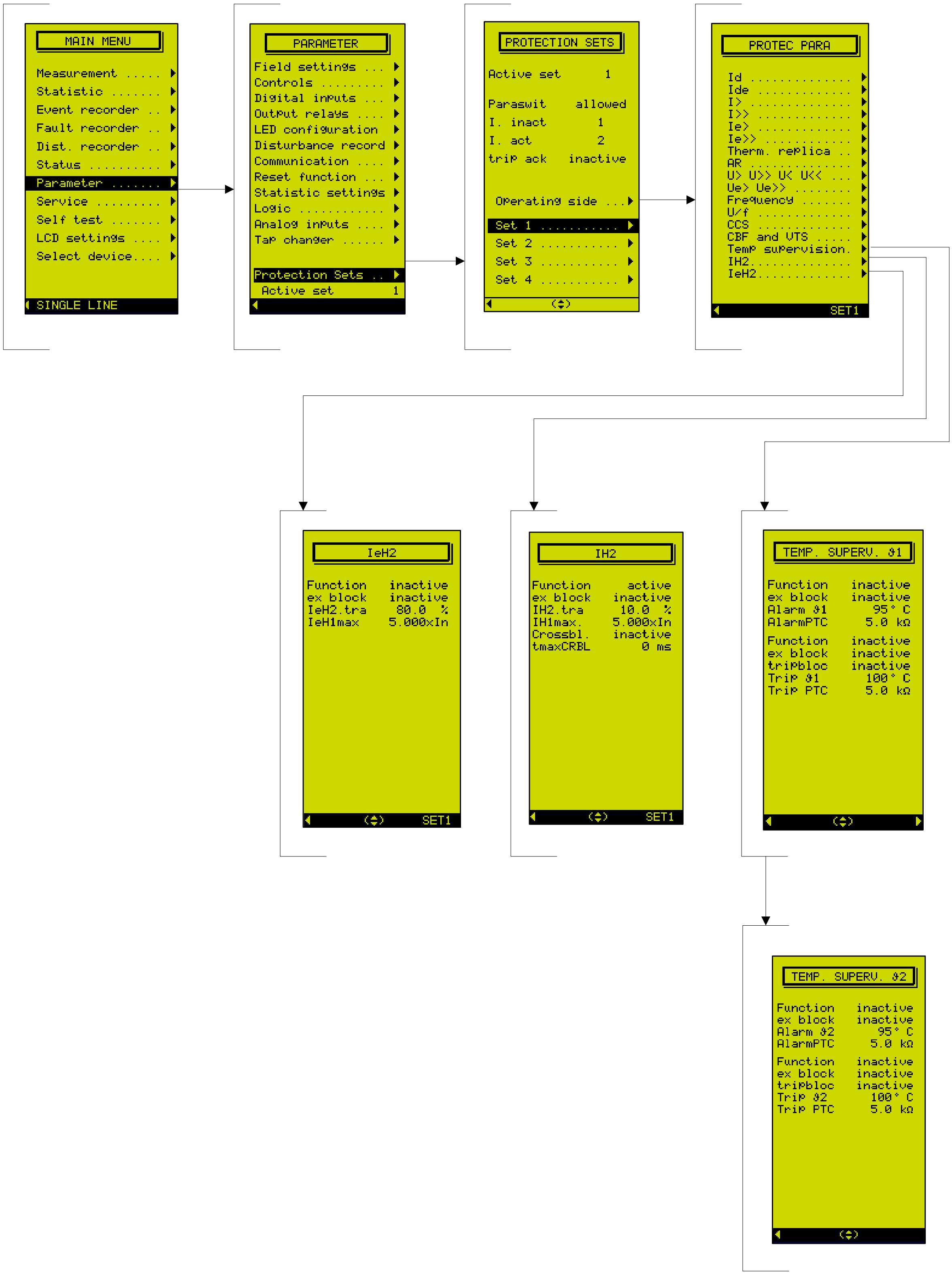
Menu tree of the sub-menu "PARAMETER" (Part 5)



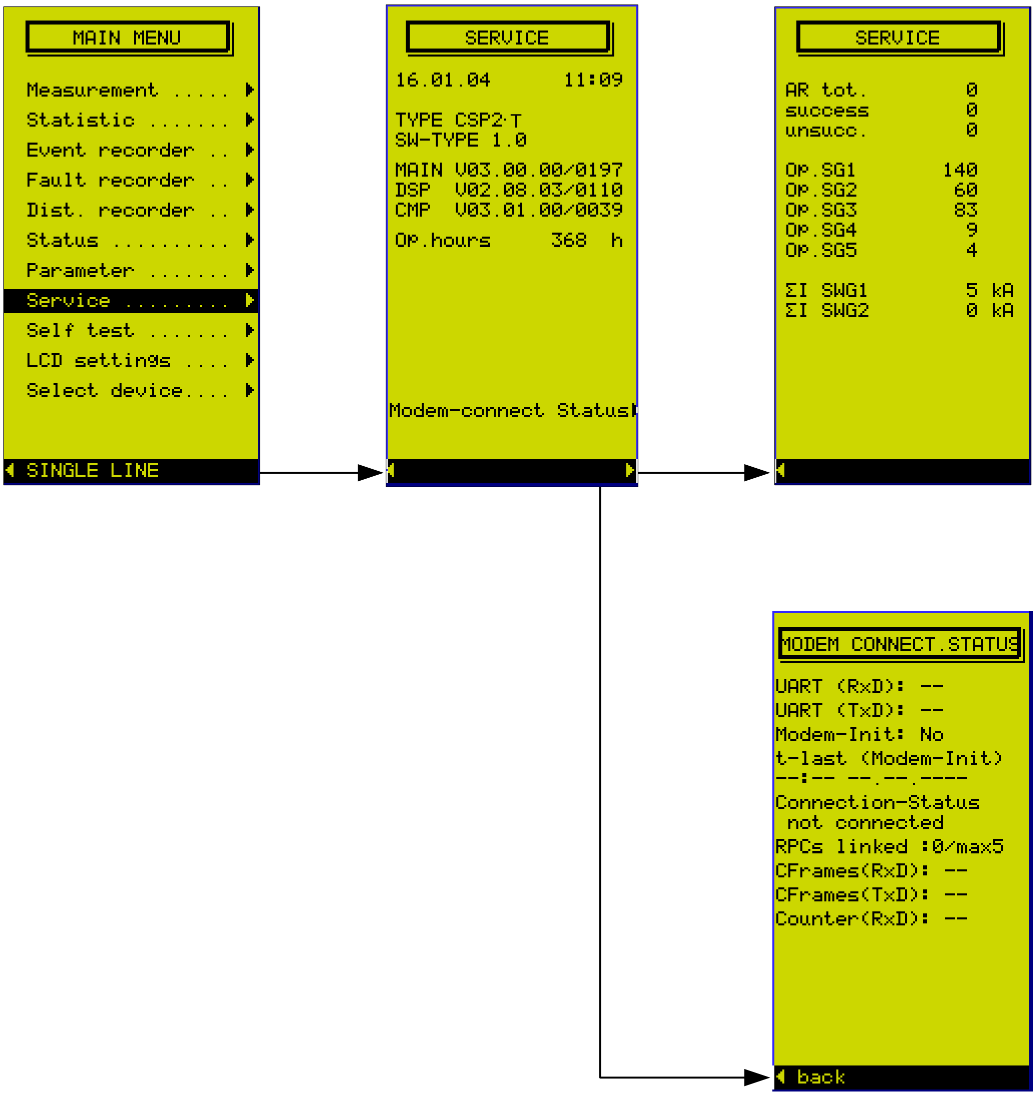
Menu tree of the sub-menu "PARAMETER" (Part 5a)



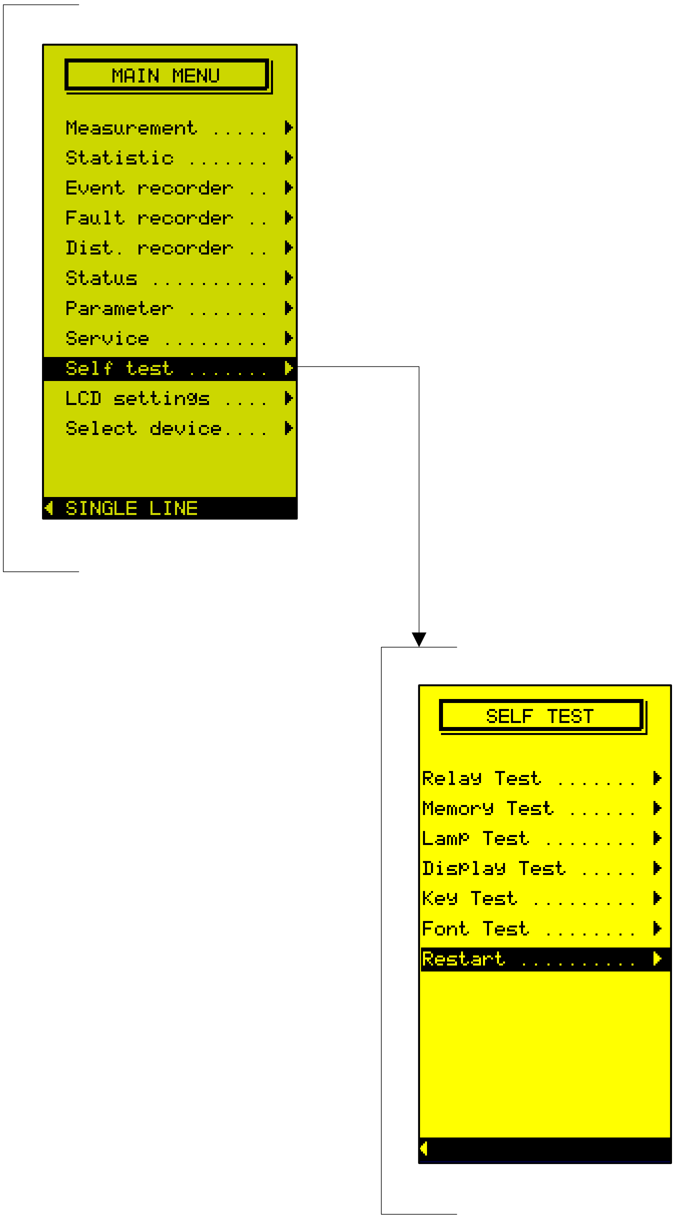
Menu tree of the sub-menu "PARAMETER" (Part 6)



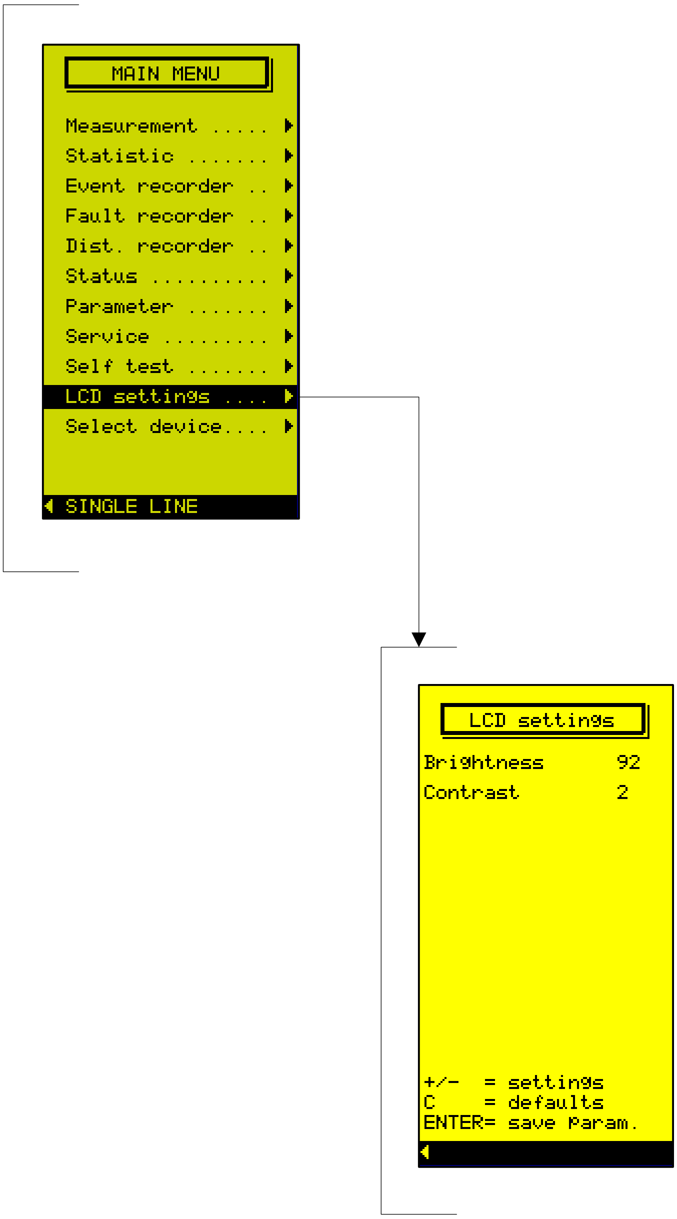
Menu tree of the sub-menu „SERVICE"



Menu tree of the sub-menu „SELF TEST“



Menu tree of sub-menu "LCD – SETTINGS"



3.2.4 Parameter setting via *CMP1*

Parameter setting means the *change of parameters* and can be carried out locally via the operating keys of the *CMP1*. As parameters there are at disposal in the *CSP2*

- *system parameters* as well as
- *protection parameters*

(see chapter "main menu of the CSP2" for more details).

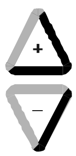
Before a parameter setting process can be carried out, first the corresponding operating mode (MODE 2) must be set. Subsequently, the parameter to be changed must be called up via the keys for menu guidance (keys »UP/DOWN« and »RIGHT/LEFT«). By pressing the keys »+/-« the desired setting can then be effected. However, the *CSP2* only works with the new settings when these have been saved. The activation of the saving process is carried out in the sub-menu "Save function" which must be called up by the key "ENTER". Here are still other possibilities available for the handling of parameter changes beside the storage option.

Depending on the present menu page, the keys »RIGHT/LEFT«, »ENTER« and »C« take over continuation tasks.

Attention

- In case of *system parameter changes* (e.g. digital inputs or signal relays), the *CSP2* reboot due to the configuration alteration of the hardware. This means that the system is not ready for operation for the run-up time of 10 s.
- The *saving of parameter changes* requires time. Thus it is sensible to first enter all changes and then store them jointly. During the saving process the LED "System OK" can go off or light up red. The saving process is finished when the LED lights up green again.
- If no keys are actuated for 10 min, all unsaved changes will be automatically rejected. This time corresponds to the "Screensaver-time" after which the background illumination of the display goes off when none of the *control elements* have been activated.

3.2.4.1 Keys »+/–«



If a parameter is selected by the keys for menu guidance (MODE 2), its setting can be changed via the keys »+/«. The settings themselves can be values or *functions*.

Thus the activation of

- key »+« results in the *increase of a numerical value* or in the selection of the next function from a list of functions.
- key »-« in the *decrease of the numerical value* or in the selection of the immediately *previous function from a list of functions*.

(See chapter "Example: Setting of protection parameters")

3.2.4.2 Key »ENTER«

The key »ENTER« is an action key with which different functions are assigned. The functions to be executed depend on the operation mode as well as on the present menu page shown in the display.

Functions of key »ENTER«:

- *Call-up of the sub-menu* "SAVE FUNCTION" for saving a parameter change (MODE 2).
- *Back* to the parameter that has been changed in the sub-menu for handling a parameter change in MODE 2)
- *Call-up* of the *CMP1* menus "CAN DEV. NO. CONFIG", in which by using the CAN-BUS *multi-device communication* the necessary settings are carried out *(see chapter "Bus capability of the operation and display unit CMP1"),*
- *Executing key* for saving the *changed settings (see chapter "Bus capability of the operation and display unit CMP1") and*
- *Call-up* of the main menu (only in MODE 1 and MODE 3)

3.2.4.3 Sub-menu »Save functions«

After finishing of all parameter changes, these have to be saved in the ***CSP2***. For this, the sub-menu "SAVE FUNCTION" is called up by pressing key »ENTER«. The called up menu page offers the possibility to:

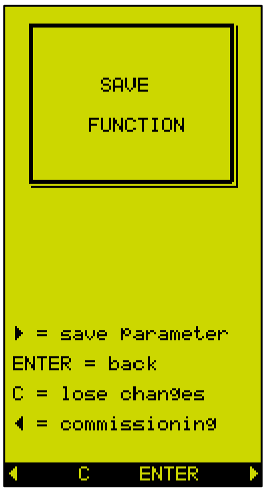
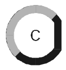


Figure 3.11: Sub-menu "SAVE FUNCTION" for handling of parameter changes

- *Save changes* → press key »RIGHT«
- *Return, discard changes* → press key »ENTER«
- *Discarding all changes* → press key »C«
- *Access to the internal service menu (password required)* → press key »LEFT«

3.2.4.4 Key »C«



The key »C« serves for:

- *Discarding of parameter changes* and re-establishes the originally saved numerical value or function (see sub-menu "SAVE FUNCTION" for handling the parameter changes in MODE 2").
- *Execution key for deleting* of saved *disturbance files data* and
- *Resetting of acknowledgeable LEDs and signal relays* (not in sub-menu "SAVE FUNCTION".

3.2.4.5 Example: Setting of protection parameters

In the following example a *parameter setting process* for the protection function "OVERCURRENT I>>" in the protection parameter set 1 is carried out. Therein are changed a *numerical value* of a parameter as well as a parameter which is to be set via a *function selection.* Subseqently the changes in *CSP2* are saved.

The individual steps of the entire parameter setting process are explained step by step by images of the required keys and the results shown by screenshots.

How to change a parameter

1st step
Setting of MODE 2 (operation mode: Local/Parameter setting) via the key switches of the *CMP1*.

2nd step
Call-up of the main menu via the direct selection key »DATA«. The page of the main menu shows a list of sub-menus that can be called up from here. At the call-up of this page, the last called-up sub-menu is automatically preselected by the cursor bar.

Note

At each call-up of a sub-menu or a new page, the symbol of an hour-glass appears (in order to indicate that the system is busy) in the right lower corner of the display (this also applies to all activated *action parameters*).

3rd step
Move cursor bar via the keys »UP/DOWN« to the menu line "Parameters".

4th step
Call up sub-menu "Parameter" by pressing key »RIGHT«.

5th step
After call-up of sub-menu "Parameter", the cursor bar is positioned into the menu line "Parameter set" by pressing keys »UP/DOWN«. By pressing key »RIGHT« the sub-menu "Para. switch" is called up.

6th step
Move cursor bar to menu line "Parameter set 1" by pressing keys »UP/DOWN«.

7th step
Call up sub-menu "Prot. para." by pressing key »RIGHT«.

8th step
By pressing keys »UP/DOWN« move cursor to menu item "I>>".

9th step
By pressing key »RIGHT« call up sub-menu "High set overcurrent I>>".

10th step
By pressing keys »UP/DOWN« move cursor bar to menu item "Function".

11th step
Now the first element (foward) of the protection function I>> shall be configured as "active". Therefore, the parameter "Function" must be set from at present "inactive" to "active"!

The present setting of the parameter "Function" shows at first the setting "inactive". By pressing key »+«, the next following setting from the function list for the setting of this parameter is shown. This is the setting "active".

12th step
Now the parameter for the triggering delay time "tI>>F" shall be set!

By pressing key »DOWN« move the cursor bar to the menu item "tI>>F".

13th step
When preselecting parameters by numerical value settings, always the 3rd decimal digit is preselected automatically. By pressing keys »RIGHT/LEFT«, the corresponding decimal digits of the numerical value indication can be preselected.
By pressing key »+«, the numerical value of the preselected decimal digit is increased; decreased by key »-«. If key »+« or key »-« is held pressed, the numerical value is increased/decreased automatically by "1" at the rhythm of half a second. An increase of the numerical value to more than "9" leads automatically to an incremental overrun into the next higher decimal digit, and a decrease of the number value to under "0" to a decremental overflow.

The change of the numerical value from 1000 to 450 has to be carried out in two steps. At first, the 3rd decimal digit is set to the value "4" by pressing key »-«. The decremental overflow results automatically in a "disappearance" of the 4th decimal digit in the display.

14th step
Now the second decimal digit must be set to the value "5". Thus, at first, it is preselected by pressing key »RIGHT«.

15th step
The desired numerical value is set by operating key »+« accordingly.

16th step
Now the parameter changes must be saved! For this, at first the sub-menu "SAVE FUNCTION" is called up by pressing key »ENTER«.

17th step
In order to carry out the savings, now key »RIGHT« must be pressed. After approx. 1.5 seconds a "pop-up window" *(see chapter "Pop-up messages"*) appears with the message *"Parameter set switched"*.

Now the changed settings of both parameters are save and the ***CSP2*** works with the new settings!

18th step

The pop-up window "Parameter set switched" remains in the display either as long as MODE 2 is left or until any operating key element of *CMP1* is pressed!

By switch-over of the lower key-operated switch to the horizontal position a change from MODE 2 to MODE 1 is effected again (only then MODE 3 can be set, if required).

The parameter setting process is completed now. If no further keys are actuated for 10 min, the display changes automatically to the *start page* SINGLE LINE.

Attention

If a parameterising process is interrupted, i.e. if for 10 min no operating key is pressed, all changes effected up to then and not stored yet will be discarded!

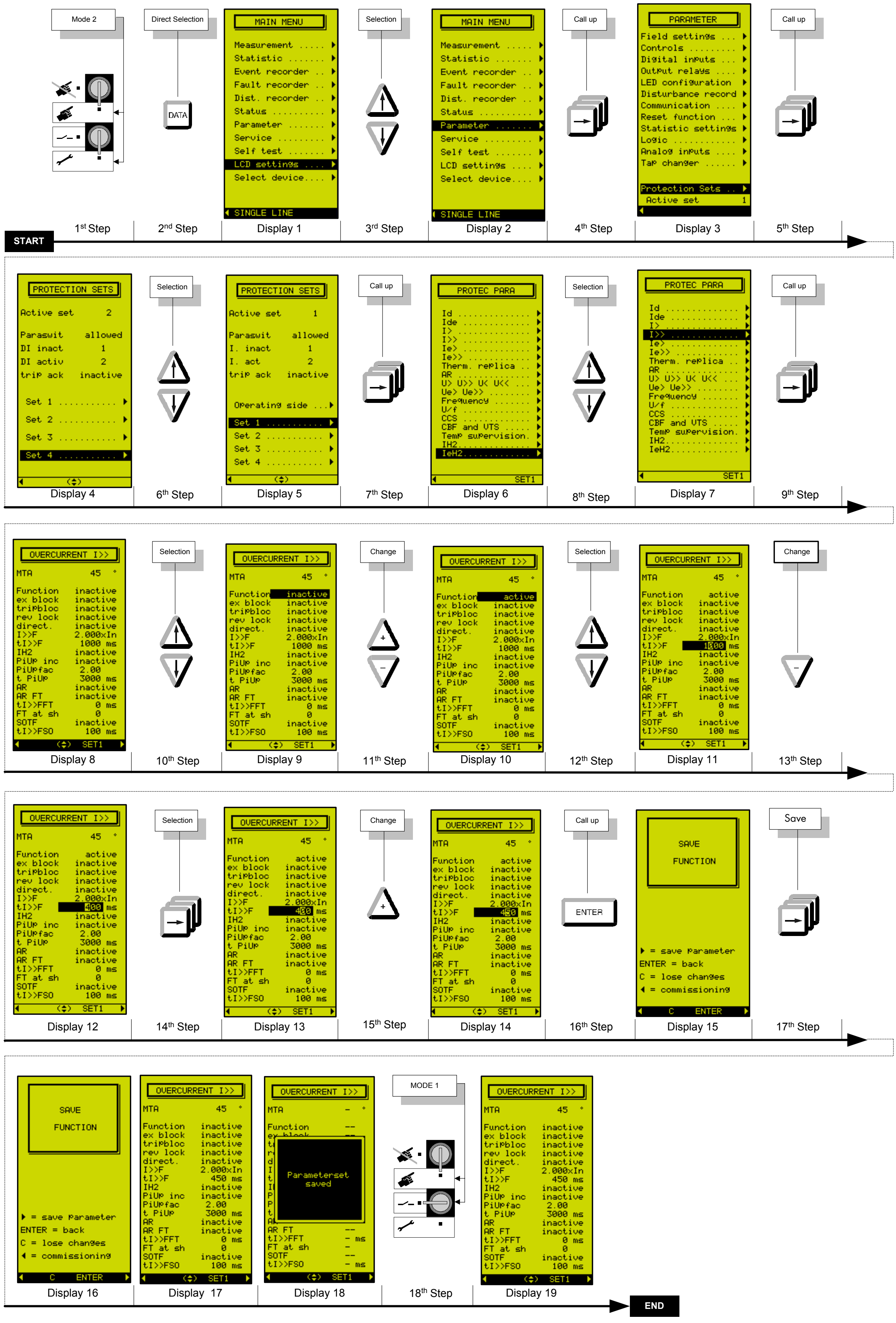


Figure 3.12: Example: Changing a protection parameter: Protection function I>>

3.2.4.6 Example: Setting of system parameters

In the now following example, a *setting procedure* for the "Field settings" in the system parameter set is carried out. Also here a *numerical value* of a parameter is changed as well as a parameter which must be set via a *function selection* is changed. Subsequently, the changes are saved in the *CSP2*.

The different steps of the entire parameter setting procedure will be explained and shown by help of screenshots of the required keys and of the resulting indications of the display.

Procedure for parameter setting

1st step to 4th step
Same as procedure for "Setting of protection parameters"

5th step
By pressing key »UP« move cursor bar to the menu item *"Field settings).*

6th step
By pressing key »RIGHT« call up sub-menu "Feeder ratings".

7st step
By pressing key »UP« accordingly, move cursor bar to parameter line "VT pri".

8th step and 9th step
By pressing key »LEFT« several times, the cursor moves to the first decimal digit.

10th step
By pressing key »+« accordingly, set the desired numerical value for the primary nominal value of the voltage transformer, here: from 10000 to 20000.

11th step
Now the measuring circuit for voltage measurements shall be set from "Y" to „Δ".

For this, at first parameter "VT con" is preselected by pressing key »DOWN«.

12th step
By pressing key »+«, the setting "Δ" is selected from the function selection for this parameter.

13th step
Now the parameter changes must be saved. For this, the sub-menu "SAVE FUNCTION" is called up via key »ENTER«.

14th step
In order to execute the saving process, key »RIGHT« must be pressed now. After about 1.5 seconds a pop-up window appears (see chapter 3.2.6) with the message "rebooting System".

Note

Contrary to the saving action during the setting of protection parameters, the system will reboot, as the change of system parameters has an influence on the hardware configuration of the *CSP2* and thus requires an initialisation of the systems. The system restart is initiated automactically.

15th step
The pop-up window message "rebooting System" remains in the display until the booting procedure is completed!

By switching of the lower key switch into the horizontal position, MODE 2 is left and MODE 1 is activated (only then also MODE 3 can be set, if necessary).

The parameter setting procedure is now completed.

Attention

If a parameter setting procedure is aborted, i.e. if for10 minutes none of the operating keys is pressed, all changes previously made and which have not been saved yet will be discarded.

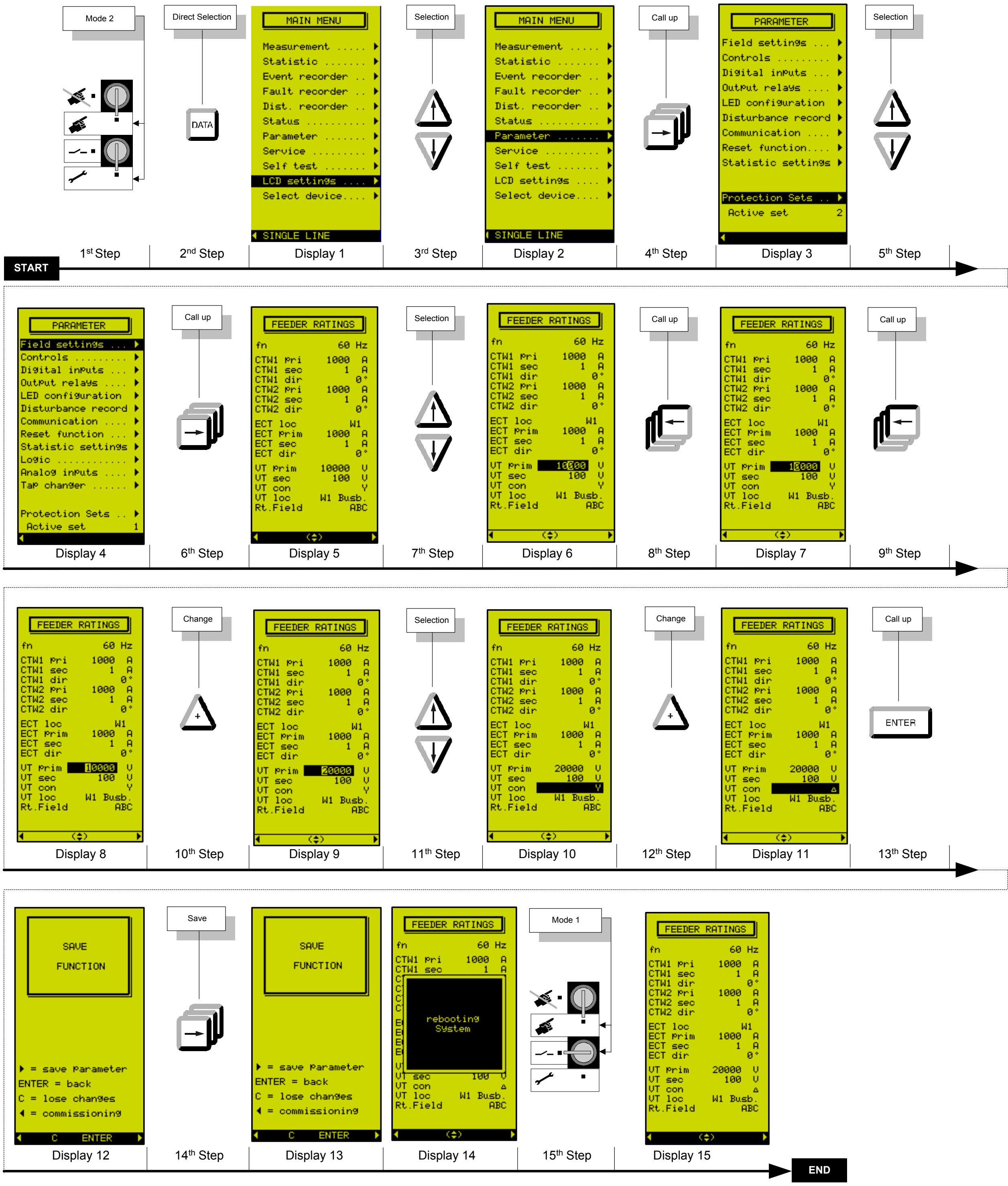


Figure 3.13: Example of setting system parameters, field settings

3.2.5 Controlling switchgear via *CMP1*

The *control of a switchgear* signifies a *controlled initiated switching action* which may be executed locally via the *CMP1*.

The *execution of a control action* can either be carried out in the CONTROL MODE (by taking into account all on feeder- and station-level interlockings) or ongoing in the TEST MODE (without interlockings).

3.2.5.1 CONTROL MODE

For security reasons the execution of a switch action can only be executed in the CONTROL MODE so that *no unintended switch actions* can be done. The CONTROL MODE itself is only accessible in MODE 1 via call-up of menu item "operate". Only then switchgears can be preselected and switched.

Taking into account the field interlockings
Switching actiones will only be executed if no internal interlocking conditions have been violated. The internal interlockings (field interlockings) are separately determined depending on the field configuration of each controllable switchgear and are deposited in the data file "sline.sl" for the single line image. Interlocking conditions can be determined separately for switching on and/or switching off of a switchgear.

Attention

If a switching command is invalid or violates an interlocking condition, the switching action will not be executed.

Note

When assigning *LEDs,* one LED should principally be assigned to interlocking violations with the output function "Interlock" *(see chapter "interlocking techniques").*
Additionally, an entry in the *event recorder* is generated (same message text as that of the output function) which protocols this switching attempt.

3.2.5.2 TEST MODE (without interlocking)

In the CONTROL MODE the TEST MODE can be called up by placing the lower key switches into the vertical position.
The TEST MODE is provided for a test of the controllable switchgears. For the commissioning, it is sometimes necessary to switch the switchgears without interlocking. This is especially useful when the plant is still not energized (dead bar) or not yet completely equipped with switchgears.

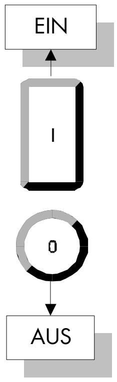
Attention: Danger to life!

- In this test mode all switch positions can be changed without any interlocking.
- These switching actions are completely free and are not subject to any interlocking!

Due to the special danger it must be emphasized again here that in the TEST MODE no interlockings are active any more. Then it is e.g. possible to switch the earthing switch when the circuit breaker is in the on position. Switching actions in this mode may only be carried out by authorized personnel with exact knowledge of the plant environment and under consideration of all relevant safety measures.

The TEST MODE can be left with one *change of the key switch position* or by *pressing a direct selection key.* Thereafter, the interlockings will become active again. Moreover, the switchgears must not be left in a position that violates an interlocking condition when leaving the TEST MODE.

3.2.5.3 Keys »ON/OFF«



By pressing the keys »ON/OFF« the controllable switchgears can be switched on and off in the CONTROL MODE (and TEST MODE).

3.2.5.4 Keys »Emergency OFF«

The two keys »EMERGENCY OFF« serve for switching off the circuit breakers) in case of emergency. For this, both keys must, however, be actuated at the same time. The switching off occurs independently of the set mode of operation and without taking into account possible active interlockings for the power circuit breakers.

3.2.5.5 Example: controlling in CONTROL MODE

In the following example the fundamental procedure for controlling a switchgear is shown. All necessary steps for switching an earthing switch are shown and explained.

Procedures for controlling switchgears

1st step
Calling up MODE 1 (operation mode: Local/Control) via the key switches of the *CMP1*.

2nd step
Setting of the *start page* SINGLE LINE via the direction selection key »SINGLE-LINE«.

3rd step
In MODE 1 the menu item "operate" is displayed on the display which serves for the call-up of the CONTROL MODE. This menu item is first to be selected by actuating key »UP«.

4th step
The CONTROL MODE is now entered by pressing key »RIGHT«.

5th step

The selection of the switchgear to be controlled is carried out by pressing the keys »UP/DOWN«. Here the cursor, which is in the foot line changes to a circle marker which surrounds the switchgear.

If in a *cubicle* several *switchgears* are controllable, the circle marker jumps to the next *switchgear symbol* when the key *»UP« is pressed anew.*

6th step

When key »ON« is pressed, the earthing switch is switched on. Here the switch leaves the defined position »OFF«, and changes over in to the intermediate position which is signified by an unclosed thin centre line (display indication 5). When reaching the end position »ON« (display screenshot 6) the switch action is completed.

7th step

If all switch actions to be executed are completed, the CONTROL MODE should be left again for reasons of security protection against unauthorized switching. This can be effected by pressing of the direct selection keys »SINGLE-LINE« or »DATA«.

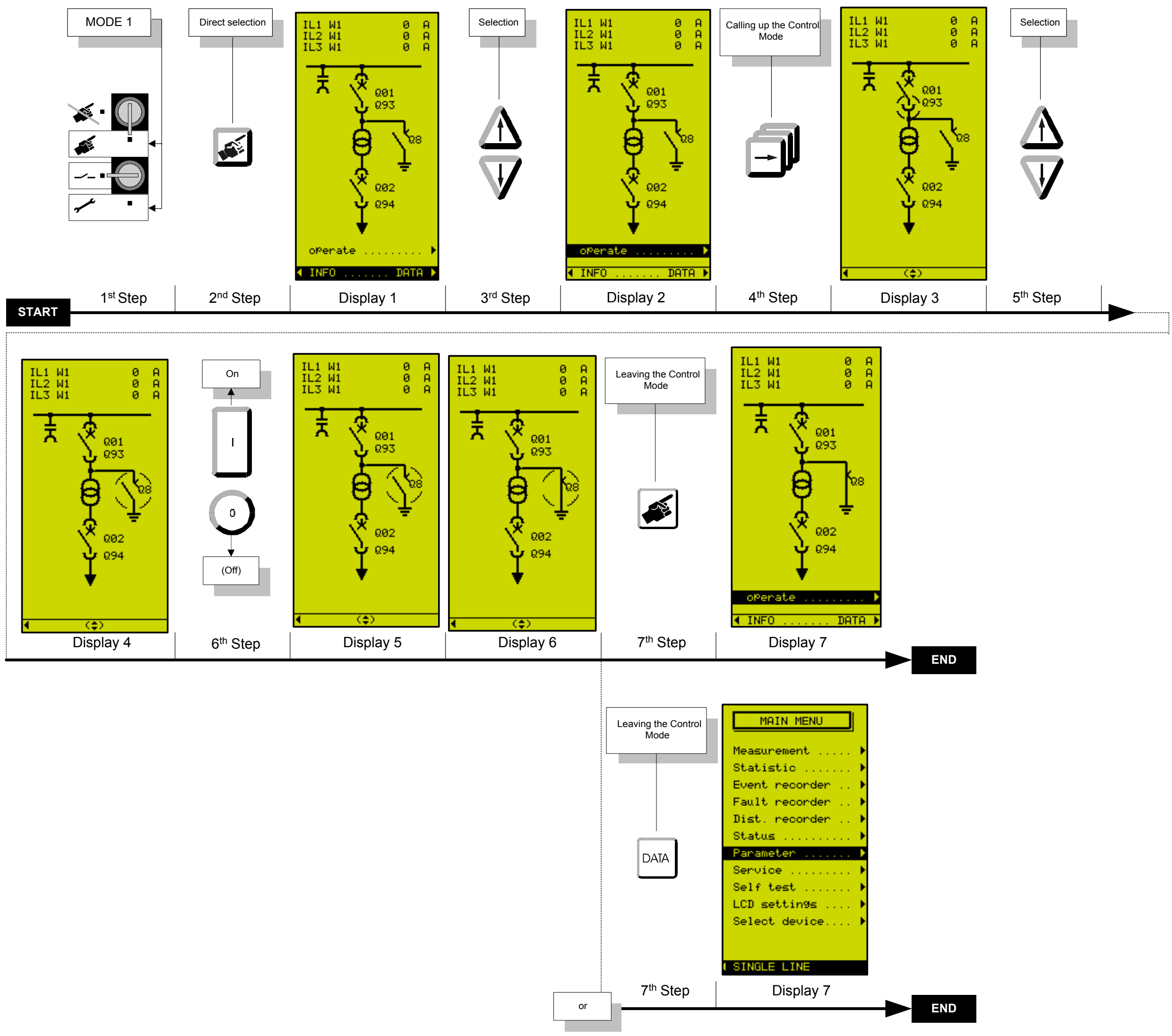


Figure 3.14: Example of a control procedure via CMP1 in CONTROL MODE

3.2.5.6 Example: controlling in TEST MODE – Caution: Danger to Life

the following example shows the controlling of switchgears for test purposes (without interlockings):

Procedure for switchgear controlling without interlockings

1st step to 4th step
Are executed *in the same* way as the switchgear controlling in CONTROL MODE!

5th step
As soon as the CONTROL MODE is called up, the lower key switch is moved to the vertical position in order to call up the TEST MODE.

In the display there appears automatically the information "COMMISSIONING MODE, no interlock!" in order to show that all switch actions from now on are effected without taking account of the interlockings.

Caution: Danger to life

6th step to 10th step
The switching on and off of the switchgears is carried out in the same way as control in CONTROL MODE and can be executed at will.

Attention

Before TEST MODE is left, it is imperative to see to it that the switchgears are not in a position that violates interlockings!

Step „y"
The TEST MODE will be left and turned back into the CONTROL MODE by switching over of the lower key switch into the horizontal position.

Step „z"
The CONTROL MODE again can be left in the usual way via the direct selection keys »SINGLE-LINE« or »DATA«.

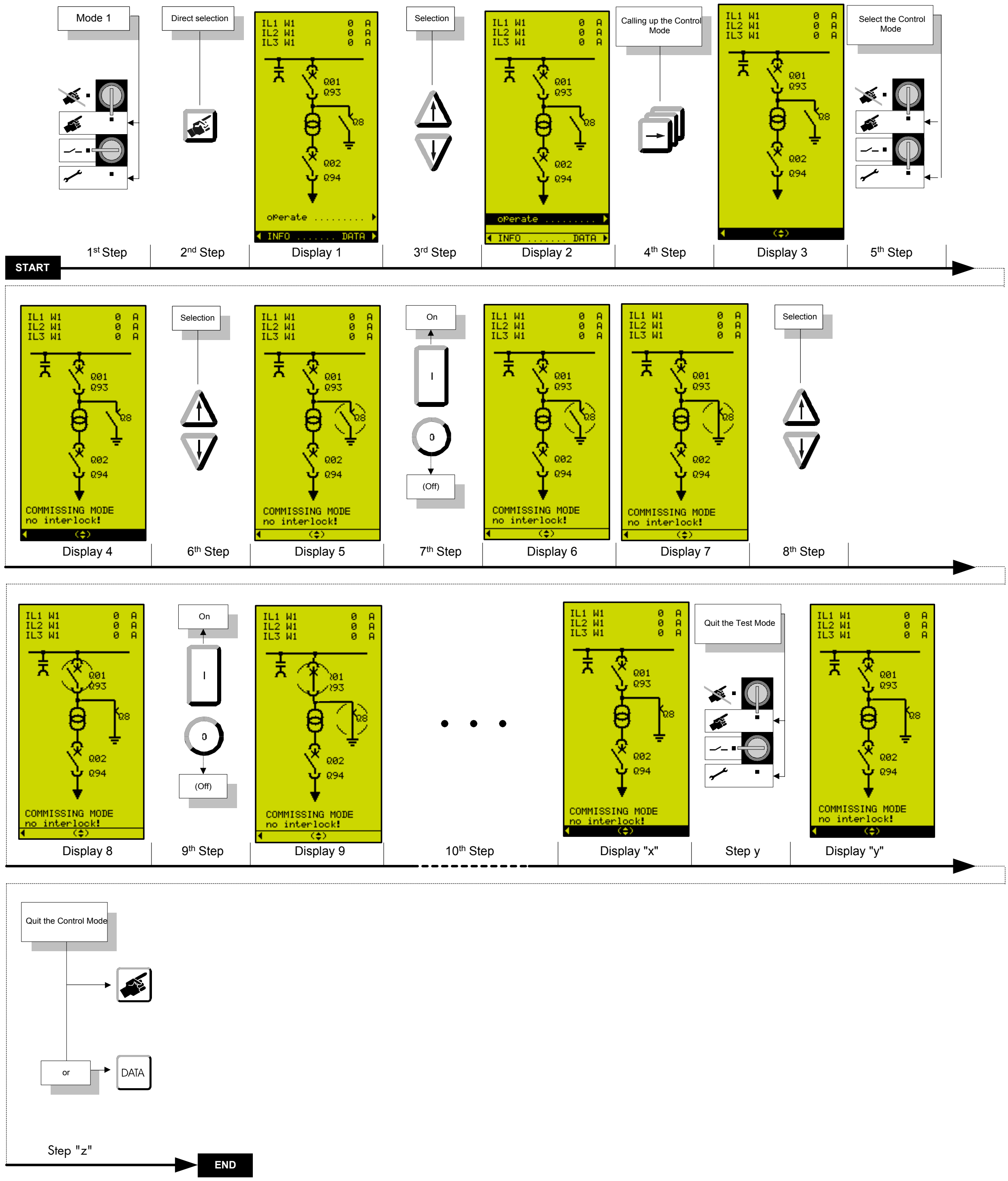


Figure 3.15: Example of a control procedure via CMP1 in TEST MODE (without interlockings)

3.2.6 Pop-up window

Pop-up windows show *system messages* which are popped up in for certain processes in order to inform the user about the status or the further action for operating the *CSP2*. In this case, each time a black back-grounded window appears on the present menu page with the text of the corresponding system message. *Pop-up* windows appear at the following system messages:

- *Set up of the communication between CSP2 and CMP1*
  During the *boot phase (system restart)* of the *CSP2/CMP1* systems, the pop-up windows appear in the as shown in Fig. 3.16. The second and third windows appear alternatively until the communication between *CSP2* and *CMP1* is established. Thereafter, the *CMP1* reads the data from the *CSP2*.

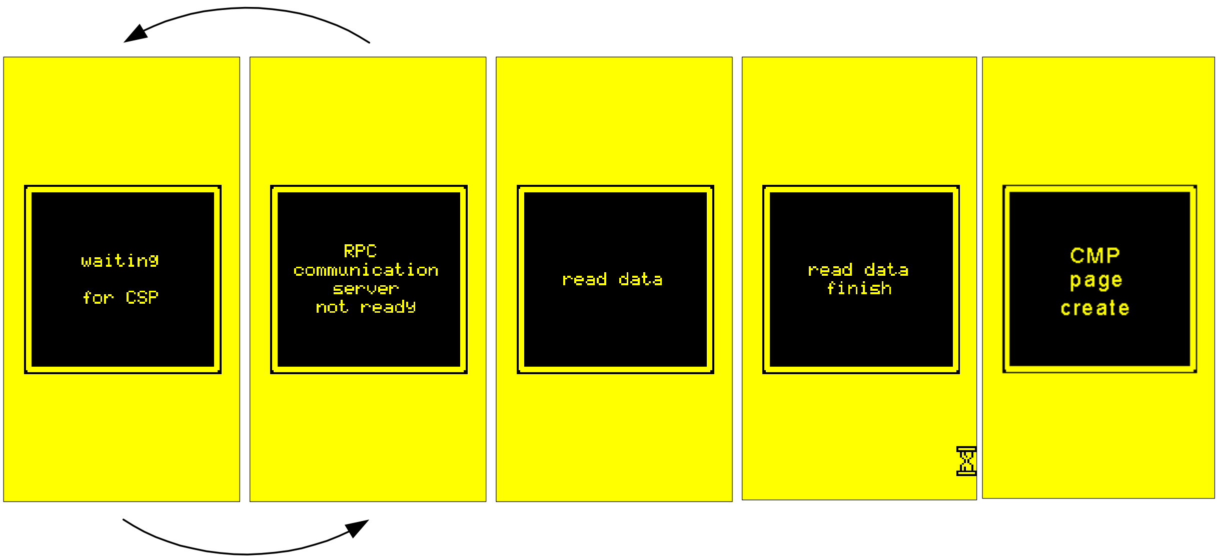


Figure 3.16: Pop-up windows at setup of communication

- *Interruption of the communication between CSP2 and CMP1*
  In case of a communication interruption between *CSP2* and *CMP1* during the operation, the following two windows are shown alternatively.

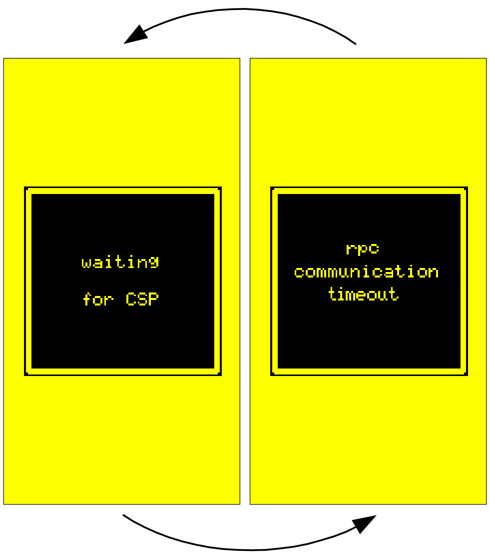


Figure 3.17: Pop-up windows at communication interruption

- *Activation of the action parameters, e.g. when resetting counter:*

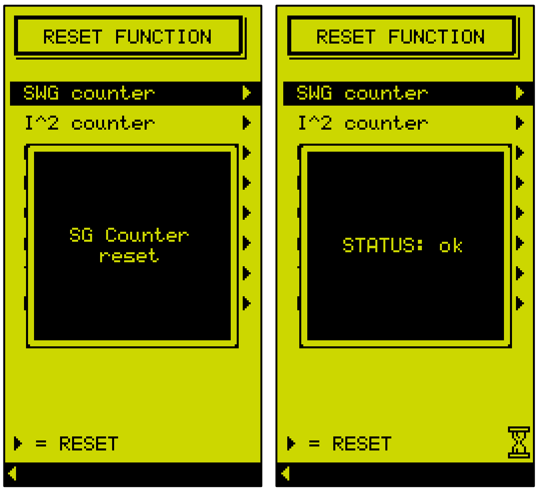


Figure 3.18: Pop-up windows at handling of parameter changes

- *Handling of parameter changes: e.g. Discarding or saving protection parameters and system parameters (rebooting system)*

Figure 3.19: Pop-up windows at abort of the parameter setting procedure

- *Abort of a parameter setting process*
  A parameter setting process is aborted, when e.g. during the parameter setting the mode of operation is changed from MODE 2 to MODE 1 or when for about 10 min no operating key has been pressed any more.

Figure 3.20: Pop-up windows e.g. at setting of undefined mode of operations

- *Prompting for aborting*
  If a non-defined mode of operation (e.g. remote control/parameter setting) is set, this will be brought to the attention of the user by the following message:

Figure 3.21: Pop-up windows e.g. at setting of undefined mode of operations

4 Operation via *SL-SOFT*

The objective of the *SL-SOFT* parameter setting and evaluation software is to give the user a quick and comfortable access to parameters and data of the combined protection and control system *CSP2/CMP1*. Underlying tasks such as the *read-out of data, parameter setting* and the *preparation and treatment of data/parameter sets records* can be implemented with the *standard version*.
Optional additional functions take on further tasks such as the evaluation of disturbance recorder (*.dsb files).

Note

For the detailed description of the *SL-SOFT* a separate manual *"SLS 2.0 SYSTEM LINE SOFT" parameterisation and evaluation"* is available.

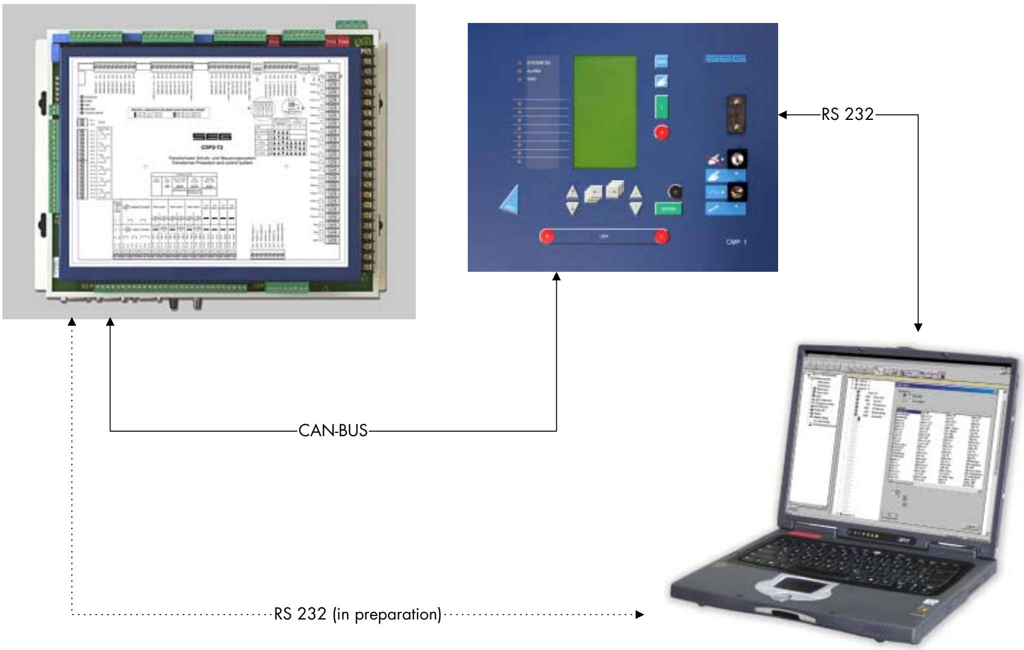


Figure 4.1: Connection example CSP2/CMP - PC via RS 232

4.1 File handling of the *CSP2* with *SL-SOFT*

The data sets of the *CSP2* principally comprise two files, on which the device configuration is based with regard to the application:

- *"sline.sl"* or *"*.sl"*
- *"parameter.csp"*

The *file names "sline"* and *"parameter"* are factory designations, which can be adapted individually by the user. The *data endings "*.sl"* and *"*.csp"* must however be kept.

"sline.sl"
On the one hand, this file contains data for the *Single-Line* for the display of the field configuration on the LCD of the *CMP1*; on the other hand, the *field interlocking conditions* stipulated by an internal locking matrix.
The ending "*.sl" must be kept. It´s allowed to use eight characters, letters or numbers for the name of the file.

Note

When logging into a *CSP2* with *SL-SOFT* the file *"sline.sl"* can merely be copied or overwritten by loading a different *"*.sl"* file. *Opening and editing* this file is possible with the *SL-Soft/SL-Draw* (full version).

"parameter.csp"

In this file, the *four protection parameter sets* and the *system parameter set* have been put together into one *parameter file*. This parameter file is dependent on the type of device (e.g. *CSP2-F3*, *CSP2-F5* or *CSP2-L*) and on the *CSP2* device software version. Loading of a parameter file into a *CSP* type of device not provided for it is prevented by a *plausibility check*.

Note

In the *processing of protection* and *system parameters*, it is necessary to open the file *"parameter.csp"* to start with. The corresponding parameter set can then be called and changed via a selection. This process is the same for ONLINE MODE as for OFFLINE MODE, in which either a parameter file which has already been stored is called or a new record is generated.

Individual parameter records cannot be stored separately or loaded into the *CSP2* for security reasons, but always only via the complete parameter file!

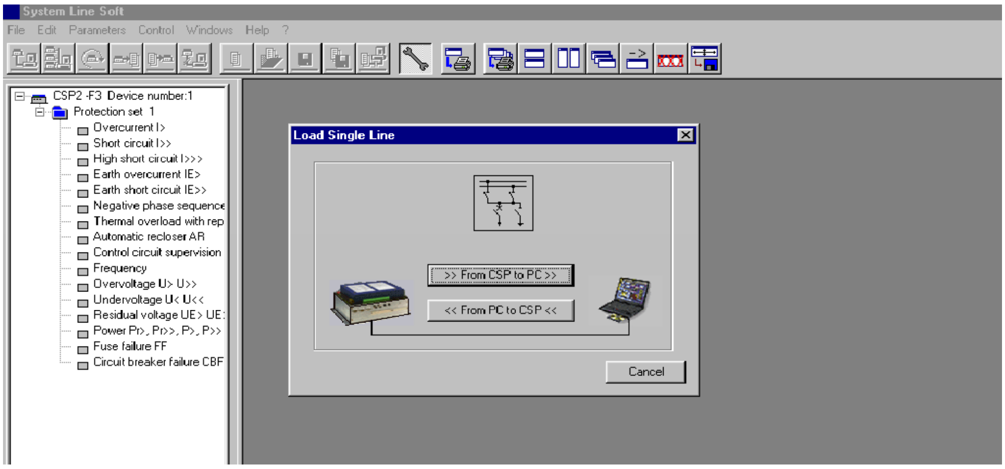


Figure 4.2: Copying the "sline.sl" file

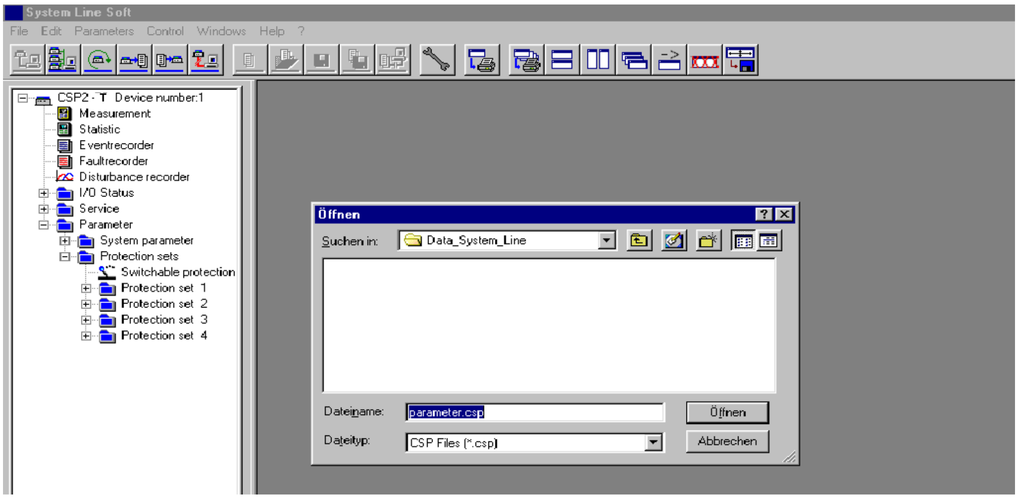


Figure 4.3: Opening the parameter file "parameter.csp" in OFFLINE MODE

4.2 Basic version SL-Soft

The *standard version* of the *SL-SOFT* (»*SYSTEM LINE SOFT*«) permits simple menu-controlled evaluation and parameter setting of the *CSP2* devices and runs on every IBM compatible PC/notebook with the Windows 95/98/ME/XP or Windows NT/2000 operating systems.
Communication to the *CSP2/CMP1 system* (online operation) is done via the RS232 interface or via the internal CAN BUS.
SL-SOFT permits operation by mouse (Windows standard/surface) and has a user-guided window technique. The menu tree of *SL-SOFT* is based on the menu structure of the *CSP2/CMP1*, in order to simplify navigation through the various menus.

The *SL-SOFT* can be switched-over between german and english language.

Features of the basic version (SL-Soft without Data Recording)

- Available for all *CSP2* devices (not CSP1-B) of the *SYSTEM LINE*,
- Online/offline operation
- Integrated language selection (German/English)
- Device log-in via individual and multiple device communication
- Comfortable data access by window technique,
- Menu-guided surface,
- Read-out of all available data,
- Cyclic read-out of the measuring values,
- Read out of the status of the inputs and outputs,
- Parameter setting of all device-specific configuration data,
- Plausibility checks,
- Copying and deletion of the data sets,
- Preparation of parameters in offline mode,
- Archiving of records,
- Print-out of parameters and data with various print options,
- Further processing of the measuring values (recording, display),
- Commissioning support (e.g. differential and stabilisation values in the *CSP2-T*) and function support,
- Triggering off disturbancy records (manual triggering)
- Synchronization with PC time.

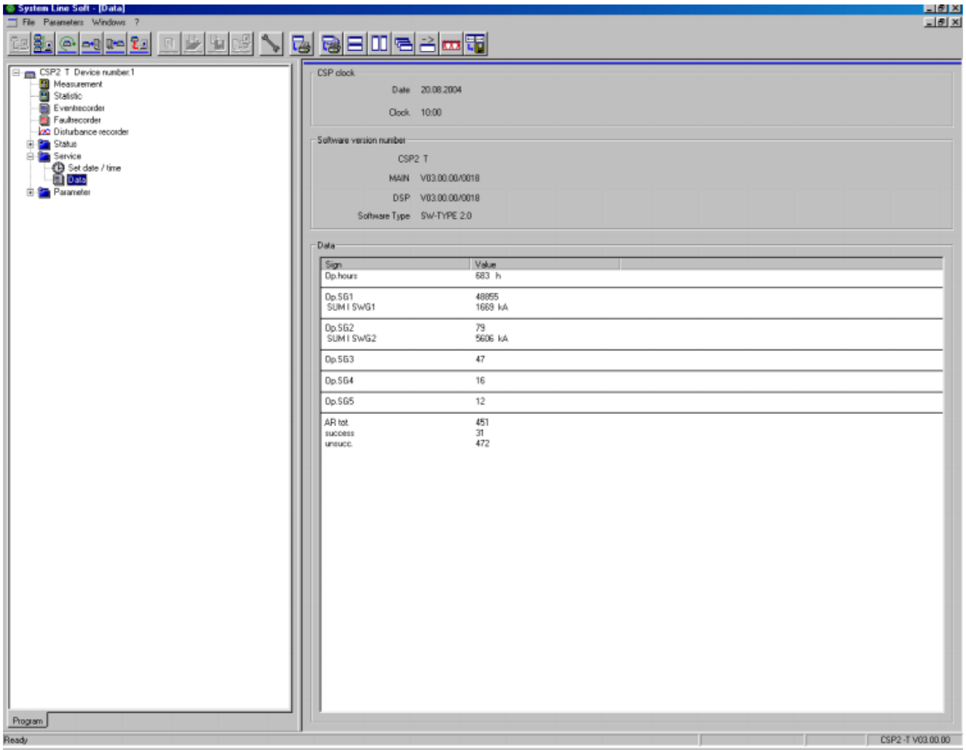


Figure 4.4: Overview in ONLINE MODE (Example: Menu "Data")

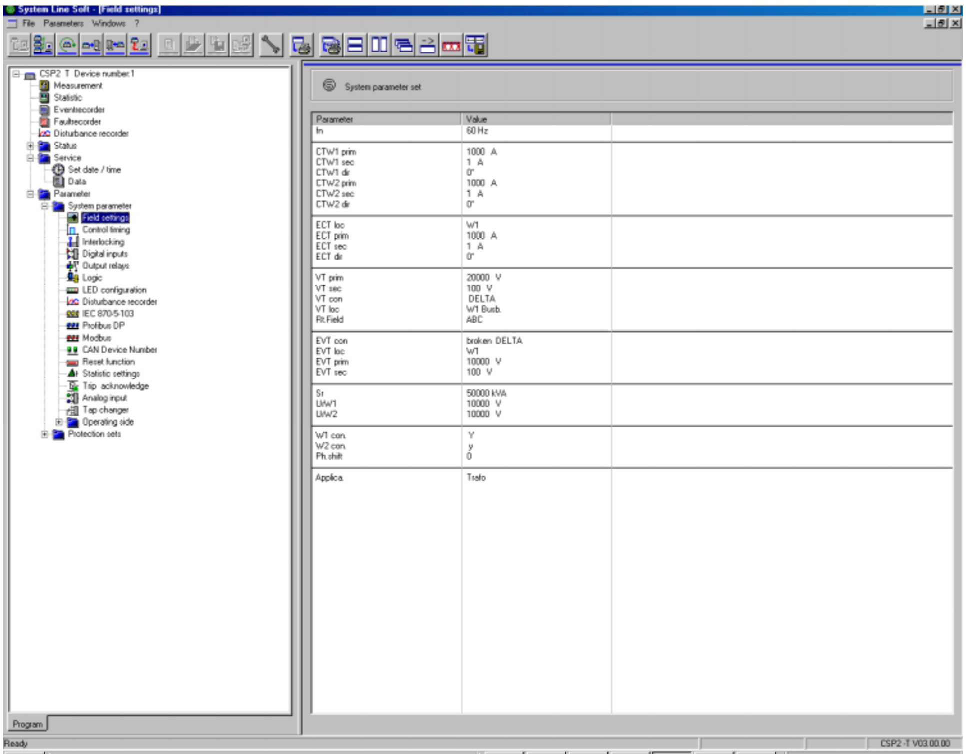


Figure 4.5: Overview in OFFLINE MODE (Example: Menu "Field settings" in the system parameter set)

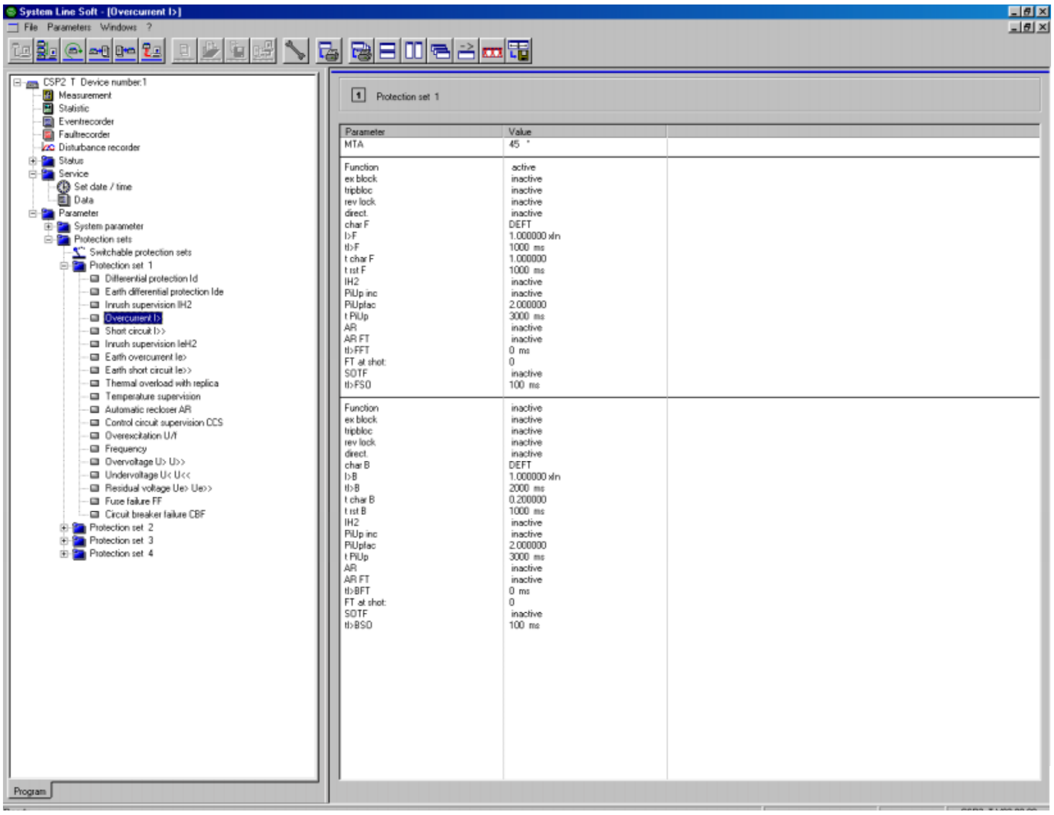


Figure 4.6: Overview in OFFLINE MODE (Example: Menu "Overcurrent I>" in protection parameter set 1)

4.3 Full version SL-SOFT

In addition to the standard version, *SL-SOFT* (full version) provides optional additional features, which increase the functionality of the overall system. This includes the "data visualizer" as well as the configuration programmes *"SL-DRAW"* (production of single lines incl. field interlocking logic).
The additional functions can be taken into consideration on the basis of the type key of *SL-SOFT* in ordering.

4.3.1 Evaluation of disturbancy records (Data visualizer)

The *"data recorder"* is a software tool (programme), with which the disturbancy records generated by the disturbancy recorder of the *CSP2* can be evaluated.
In order to be able to evaluate the disturbancy records saved in the *CSP2* via the data recorder, they must be copied onto a hard drive or floppy disk (PC/laptop) in the online mode of the *SL-SOFT* by the single *"Drag and Drop"* method.

When a stored disturbance record file is called up, all the analogue channels (measured values) and all the digital channels detected during the recording can be shown as oscillographic curves. The resolution of the analogue measured values is automatically adapted to the maximum values detected, with the result that complicated calibration is not necessary.

In order to use the Data visualizer, an extended version (optional) of the *SL-SOFT* has to be installed. This means, the data recorder is not a separate programme. If the extended version of the *SL-SOFT* (optional) is installed the data recorder can be called up via the "Data recorder icon" within the *SL-SOFT* start menu. (Start → Programme → System Line_V2 → Data Visualizer)

Scope of function and output of the "data visualizer"

- Evaluation of the disturbance records, oscillographic curves, editing-capability
- Extensive functions for evaluation (zoom, display of individual measuring values with time stamp etc.)
- Import and export of data records in ASCII and COMTRADE format

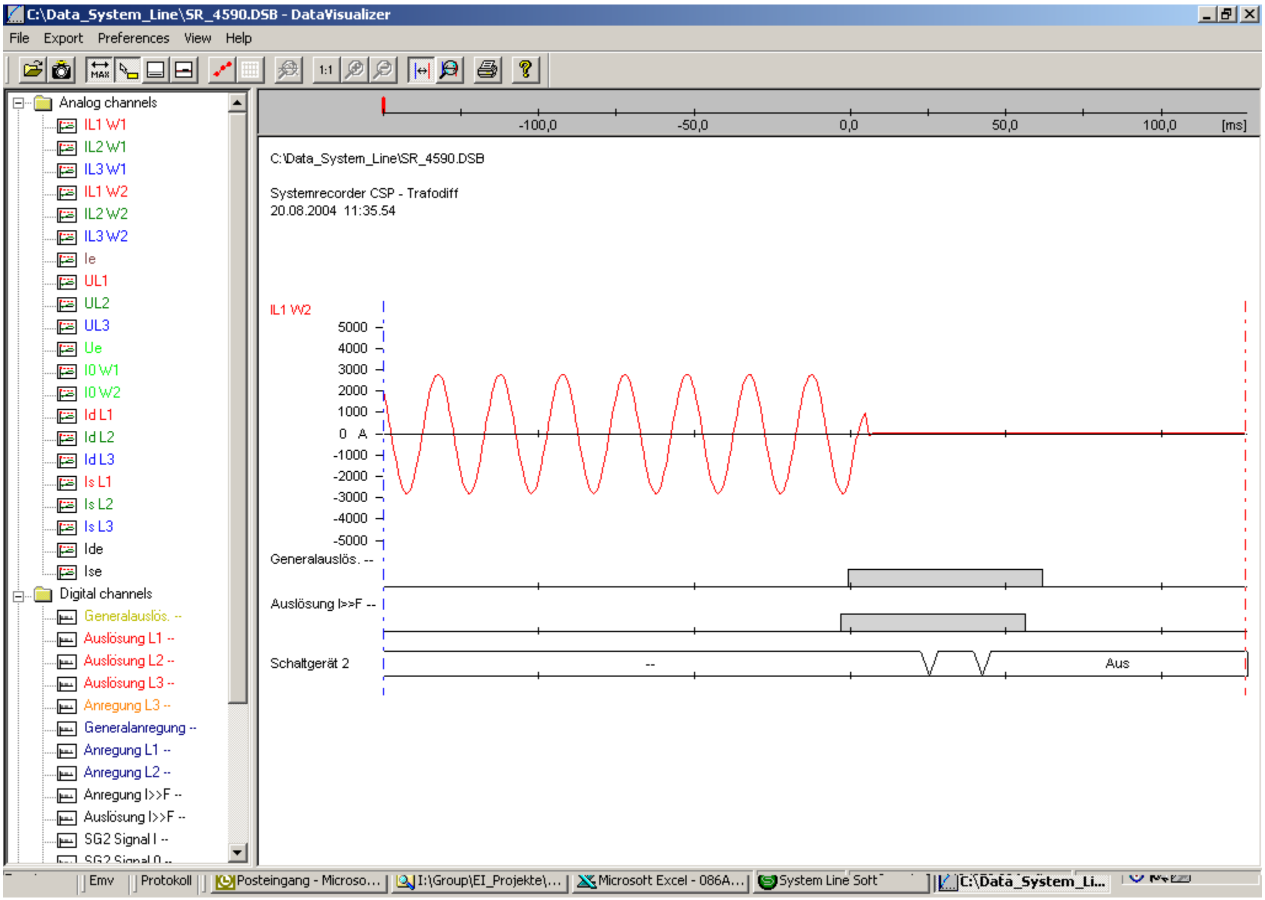


Figure 4.7: Optional additional function: data visualizer

4.3.2 SL-LOGIC

By using the *SL-LOGIC* up to 32 customer specific logic functions are programmable. By this the functionality of the *CSP* devices is widely extended. For additional information please refer to the *SL-SOFT* manual.

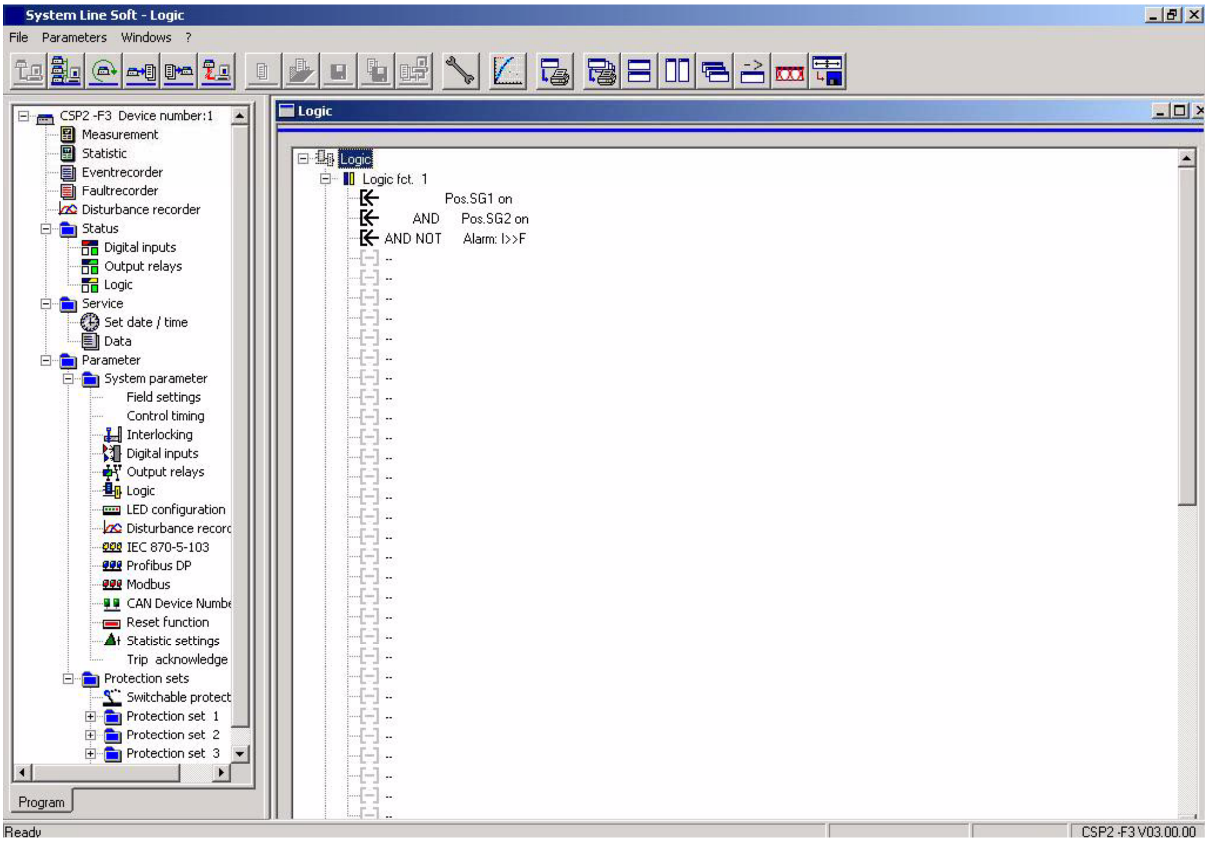


Figure 4.8: SL LOGIC

4.3.3 Configuration of Single-Line-Diagrams via *SL-DRAW*

The full version of the *SL-SOFT* contains a sub-menu called *SL-DRAW*. This is intended to be used for the configuration of the graphic representation of a single-line diagram as well as for programming the field interlockings. A database provides a number of various symbols for creating individual graphics for single-line diagrams. For that purpose standardized symbols of the switching devices and also a toolbox with usual elements for drawing are available.
Special configuration menus make the assignment of the switching symbols used, and plausibility checks which inhibit false parameter assignments. Once all the switching devices have been assigned, the field interlocking conditions can be programmed.

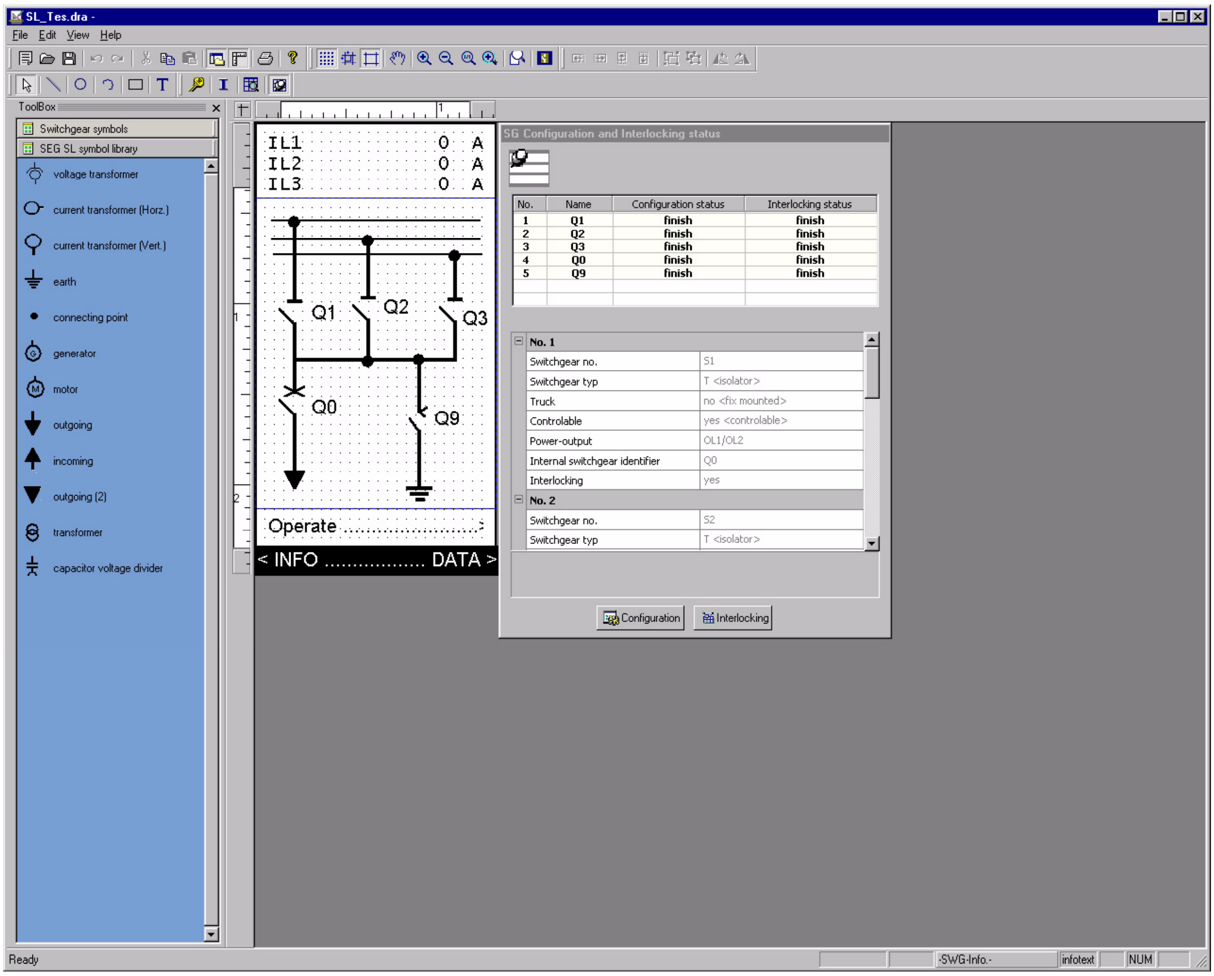


Figure 4.9: SL Draw

5 Main menu of the *CSP2*

Main menu of the CSP2
The main menu of the combined protection and control system *CSP2/CMP1* offers the following sub-menus:

- measurement
- statistics
- event recorder
- fault recorder
- disturbance recorder
- status
- service
- parameter
- self test
- LCD setting and
- device selection

Within these sub menus only *data* can be read out or certain *menu items (action parameter) be activated* in order to execute certain procedures.

Additionally to the *read-out of data,* within the sub-menu

- parameters

Settings of parameters of the protection, control and other functions can be changed. This menu accesses the parameter file *"parameter.csp" (see chapter "operation via SL-SOFT")* which contains the *system parameter set* and the four *protection parameter sets.*

In the following chapters the individual menus including their sub-menus are presented and their functions explained. A detailed listing of all parameters as well as their setting possibilities, in conjunction with general explanations for certain conditions, shall contribute to the understanding of the functions of the *CSP2*.

5.1 Menu measurement values

The *CSP2* offers to the user measurement values which inform about the *operational status of the MV-panel*. Measurement values can be locally shown and read out at the display of the operation and display unit *CMP1*. The *measurement* values made available by the *CSP2* are on the one hand based on the

- *measurement and on the other hand*
- *on calculation.*

Measuring Values						
Quantity measured (Indication)	*Description*	*Range of Values*	*Unit*	*Detection* *Direct Measuring*	*Detection* *Calculation*	*Note*
IL1 W1	Phase Currents		A	●	-	Instant.value (Effective value)
IL2 W1			A			
IL3 W1			A			
IL1 W2			A			
IL2 W2			A			
IL3 W2			A			
Ie	Earth Current		A			
I0 W1	Earth Current		A	●	-	Instant.value (Effective valuet)
I0 W2						
UL1	Phase Voltages		V	●	-	Instant.value (Effective value)
UL2			V			
UL3			V			
U12	Line-to-Line Voltages (Interlinked Voltages)		V	●	●	Instant.value (Effective value)
U23			V			
U31			V			
Ue	Residual Voltage		V	●	●	Instant.value (Effective value)
U/f	Overexcitation		%		●	
f	Frequency		Hz	-	●	Instant.value (Effective value)
ϑ	Thermal Capacity	0…200 %	%		●	Instantaneous value
tϑ	Time until trip of protective function ϑ>		s		●	Instantaneous value
ϑ1	Temperature supervision		°C	●		
ϑ2				●		
IdL1	Differential Currents		x IN		●	Instant.value (Effective value)
IdL2			x IN		●	
IdL3			x IN		●	
Ide	Differential earth current		x IN		●	
IsL1	Stabilising Currents		x IN		●	Instant.value (Effective value)
IsL2			x IN		●	
IsL3			x IN		●	
Ise	Stabilisation earth current		x IN		●	
Tc pos.	Tap changer position		0-39	●		
H2. L1	Second harmonics		%		●	
H2. L2			%		●	
H2. L3			%		●	
H4. L1	Fourth harmonics		%		●	

Measuring Values						
Quantity measured (Indication)	Description	Range of Values	Unit	Detection: Direct Measuring	Detection: Calculation	Note
H4. L2			%		●	
H4. L3			%		●	
H5. L1	Fifth harmonics		%		●	
H5. L2			%		●	
H5. L3			%		●	

Table 5.1: Overview of Measuring Values

Direct measuring of measurement values
Via the *analogous measurement value* (measurement channel) of the *CSP2*, the measurement value for *phase currents and phase- or line-to-line voltages are directly measured*. According to the measurement circuit used, the *CSP2* receives corresponding analogous measurable values. These *time continuous measurement signals digitalized by the CSP2 (via Sample & Hold) in order to:*

- calculation of the protection algorithms (protection functions),
- display oscillographic curves within the data recorder (disturbance recorder),
- record in the fault recorder (instantaneous fault recording at the time of a protection trip),
- digital indication at the display of the *CMP1*,
- data exchange with the SCADA-system,
- calculate measuring values based on measured values.

Remark

The determination of the *time intervals for sampling the analogous measurement values is designated as "sampling frequency" and dependent on the type of device of the CSP2* (*see chapter "Disturbance recorder")*.

The following quantities can be measured directly dependent on the measuring circuit used.

Direct Detection of Measuring Quantities

Quatity Measured (Indication)	*Description*	*Unit*	*Analogue Quantity Measured (Input Variable)*	*Measuring Circuit – Current: Three-Phase*	*Current: Holmgreen*	*Current: V- Connection*	*Current: Ring Core CT*	*Voltage: Star Connection*	*Voltage: Delta Connection / V-Connection*	*Voltage: Open Delta*
IL1W1	Phase Current	A	$i_{L1W1}(t)$	●	●	●	-	-	-	-
IL2W1		A	$i_{L2W1}(t)$							
IL3W1		A	$i_{L3W1}(t)$							
IL1W2		A	$i_{L1W2}(t)$							
IL2W2		A	$i_{L2W2}(t)$							
IL3W2		A	$i_{L3W2}(t)$							
Ie	Earth Current	A	$i_{Le}(t)$	-	●	-	●	-	-	-
UL1	Phase Voltages	V	$u_{L1}(t)$	-	-	-	-	●	-	-
UL2		V	$u_{L2}(t)$	-	-	-	-		-	-
UL3		V	$u_{L3}(t)$	-	-	-	-		-	-
U12	Line-to-Line Voltages	V	$u_{12}(t)$	-	-	-	-		●	-
U23		V	$u_{23}(t)$	-	-	-	-			-
U31		V	$u_{31}(t)$	-	-	-	-			-
Ue	Residual Voltage	V	$u_e(t)$	-	-	-	-	-	-	●
f	Frequency	Hz								
ϑ1	Temperature supervision									
ϑ2										
Tc pos.	Tap changer position									

Table 5.2: Direct Measured Values

Calculated measuring values
Additionally to the directly measured values for *current and voltage,* further operational values/signals are of importance for operation and supervision of an MV (medium voltage) system *(e.g. input/output of active*

power, power factor etc.). Such measurement values, however, *cannot* be measured *directly* but must be derived (calculated) from the *directly measured* quantities with appropriate formulas.

The calculation method used depends on the configuration of the voltage measurement circuits. The belonging parameter has to be set accordingly.

Calculation of Derived Quantities										
	Measuring Circuit									
	Current				*Voltage*					
Quantity Measured (Indication) Display	*Three-Pole*	*Holmgreen*	*V-Connection*	*Ring Core CT*	*Star Connection*	*Delta Connection / V-Connection*	*Open Delta*	*Analogue Quantities Measured (Input Variable)*	*Calculation Formula*	*Note*
U12	-	-	-	-		-	-	$u_{L1}(t)$	$U_{12} = U_{L1}\ \sqrt{3}$	
U23	-	-	-	-	●	-	-	$u_{L2}(t)$	$U_{23} = U_{L2}\ \sqrt{3}$	
U31	-	-	-	-		-	-	$u_{L3}(t)$	$U_{31} = U_{L3}\ \sqrt{3}$	
Ue	-	-	-	-	●	-	-	$u_{L1}(t)$, $u_{L2}(t)$, $u_{L3}(t)$	$\underline{U}_e = \underline{U}_{L1} + \underline{U}_{L2} + \underline{U}_{L3}$	
U/f										
ϑ	●	●	●	-	-	-	-	$i_{L1}(t)$, $i_{L2}(t)$, $i_{L3}(t)$		For calculation always the highest measured phase current is used
tϑ	●	●	●	-	-	-	-	$i_{L1}(t)$, $i_{L2}(t)$, $i_{L3}(t)$	Internal Algorithm	
I0W1										
I0W2										
IdL1	●	●	●	-	-	-	-	$i_{L1\,A}(t)$, $i_{L1\,B}(t)$	Operat.: $I_{d\,L1} = \|\|I_{L1\,A}\| - \|I_{L1\,B}\|\|$ Fault: $I_{d\,L1} = \|I_{L1\,A} - I_{L1\,B}\|$	$\underline{I}_{L1\,B}$: Information from Opposite Station
IdL2	●	●	●	-	-	-	-	$i_{L2\,A}(t)$, $i_{L2\,B}(t)$	Operation: $I_{d\,L2} = \|\|I_{L2\,A}\| - \|I_{L2\,B}\|\|$ Fault: $I_{d\,L2} = \|I_{L2\,A} - I_{L2\,B}\|$	$\underline{I}_{L2\,B}$: Information from Partner Device
IdL3	●	●	●	-	-	-	-	$i_{L3\,A}(t)$, $i_{L3\,B}(t)$	Operation: $I_{d\,L3} = \|\|I_{L3\,A}\| - \|I_{L3\,B}\|\|$ Fault: $I_{d\,L3} = \|I_{L3\,A} - I_{L3\,B}\|$	$\underline{I}_{L3B}$: Information from Partner Device
Ide										
IsL1	●	●	●	-	-	-	-	$i_{L1\,A}(t)$, $i_{L1\,B}(t)$	Operation: $I_{S\,L1} = \sqrt{(I_{L1\,A} \times I_{L1\,B})} \times \cos\varphi$ Fault: $I_{S\,L1} := 0$	$\underline{I}_{L1\,B}$: Information from Partner Device
IsL2	●	●	●	-	-		-	$i_{L2\,A}(t)$, $i_{L2\,B}(t)$	Operation: $I_{S\,L2} = \sqrt{(I_{L2\,A} \times I_{L2\,B})} \times \cos\varphi$ Fault: $I_{S\,L2} := 0$	$\underline{I}_{L2\,B}$: Information from Partner Device
IsL3	●	●	●	-	-	–	-	$i_{L3\,A}(t)$, $i_{L3\,B}(t)$	Operation: $I_{S\,L3} = \sqrt{(I_{L3\,A} \times I_{L3\,B})} \times \cos\varphi$ Fault: $I_{S\,L3} := 0$	$\underline{I}_{L3\,B}$: Information from Partner Device
Ise										

Table 5.3: Derived Quantities (Computed)

The display of the *CMP1* shows the measurement values as *absolute values*:

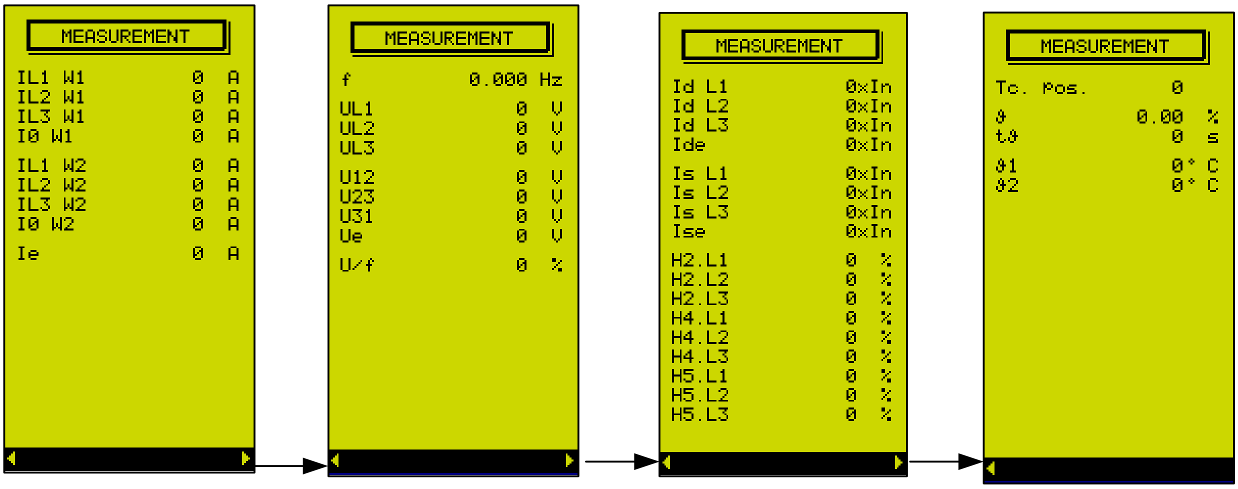


Figure 5.1: Menu „Measurement values" in the display of the CMP1 (Example CSP2-T)

When using the *SL-SOFT*, the *measurement values* can either be displayed as *absolute values* or as *relative values*.

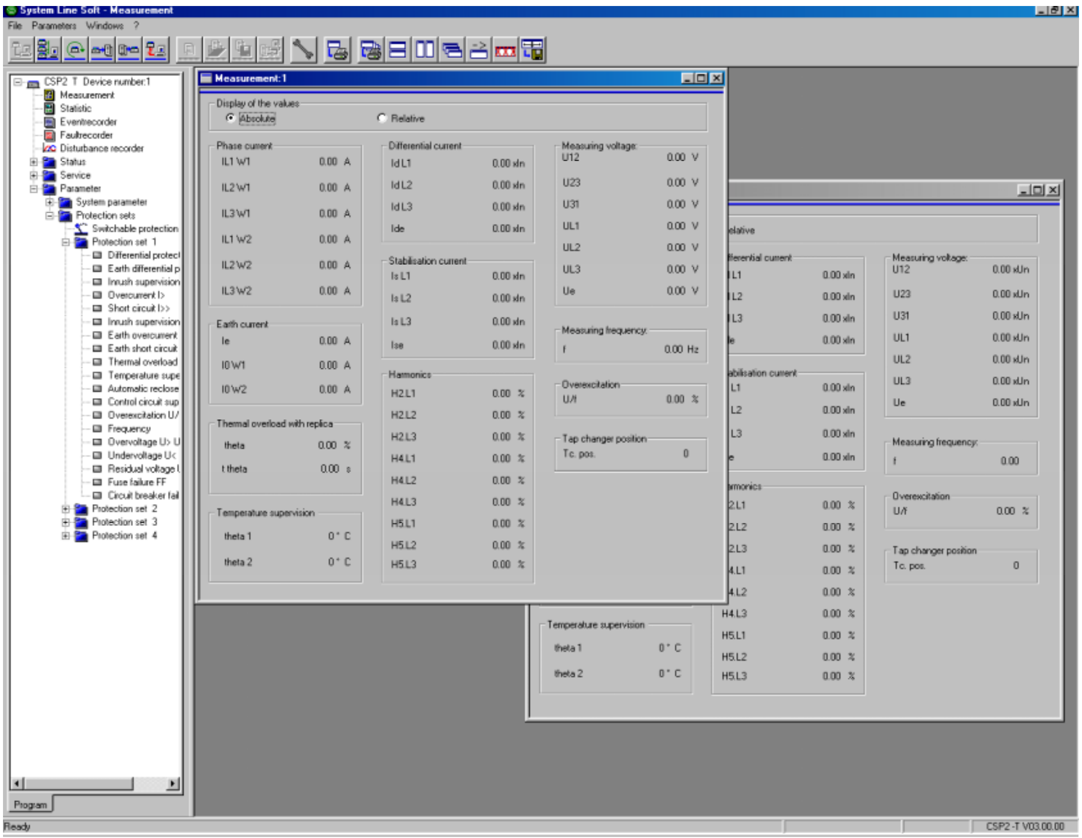


Figure 5.2: Menu „Measurement values" – SL-SOFT (Example CSP2-T)

5.2 Menu statistics

In this menu the *"statistical data"* can be read out which give information about the *load flow for defined periods of time during the operation of the MS-panel.*

Statistical data are cyclically calculated *maximum* and *medium values* of directly measured and calculated *measurement values*. The calculation of statistical data occurs each time after a *settable time interval "Δt"*. If the time interval is e.g. set to 60 minutes, the calculation and display of the statistical values occurs each time after 60 min, i.e. the individual statistical values are updated every 60 minutes.

Additionally, within a day (24 h) a so-called *synchronization instant "hh:mm:ss"* can be defined at which the calculation of the statistical data can be restarted. By the definition of a *synchronization instant* it is possible to calculate and display the maximum or medium load flow *per calendar day* from 00:00 to 24:00.

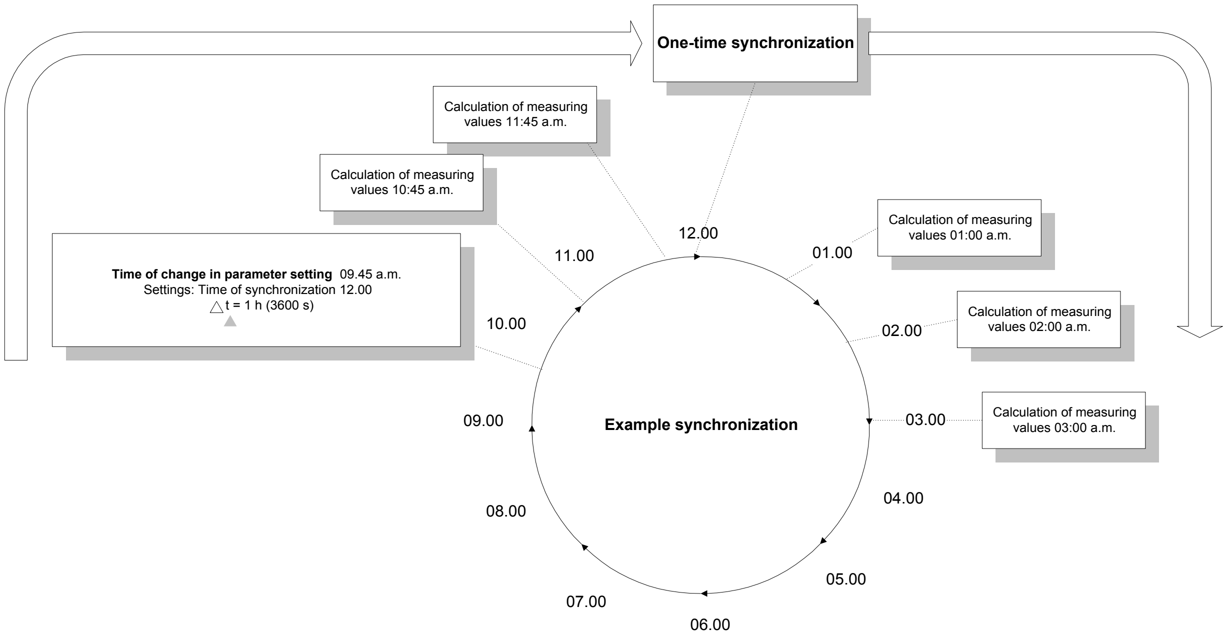


Figure 5.3: Example synchronization instant

(The setting of the corresponding parameters can be implemented as described in chapter *"Statistical Data").*

The set *time interval* and the defined *synchronization instant* are valid for all statistical quantities.

The statistical measurement values are also available as *data points* in the *different protocol types* and can be send to the SCADA-system.

Example: transmitted information in the data point of the protocol IEC 60870-5-103, Modbus or Profibus DP

- measurement value,
- time intervals in minutes (period of time which was used as basis for the calculation of the maximum and medium values),
- serial cycle number (e.g. all values designated Nr. 30 belong to a block)
- time stamp of the measurement (standardized).

The measurement value detection in this way makes possible the reduction of the measurement values via the protocol and thus increases the effectivity of the data transfer.

The display indication of the *CMP1* shows *the statistical values* as *absolute values* of the *CSP2-T*

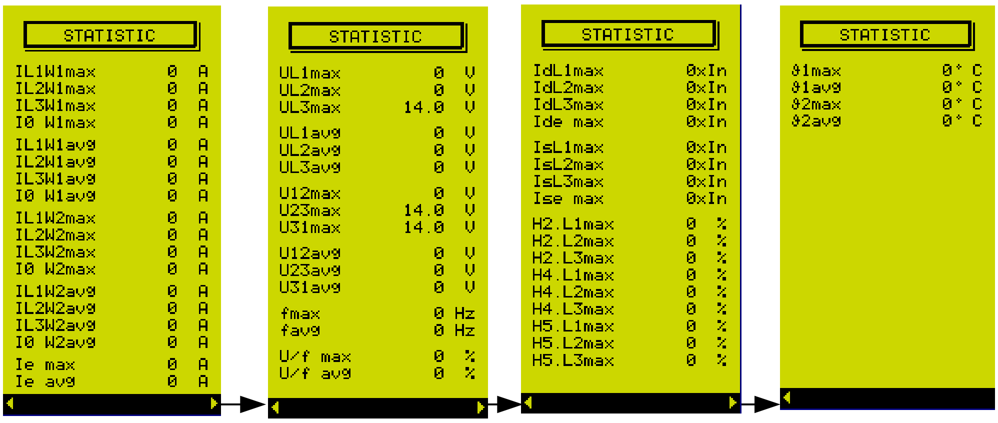


Figure 5.4: Menu „Statistic" in the display of the CMP1 (Example CSP2-F)

When using the operation software *SL-SOFT*, the *statistical values* can either be displayed as *absolute values* or as *relative values*.

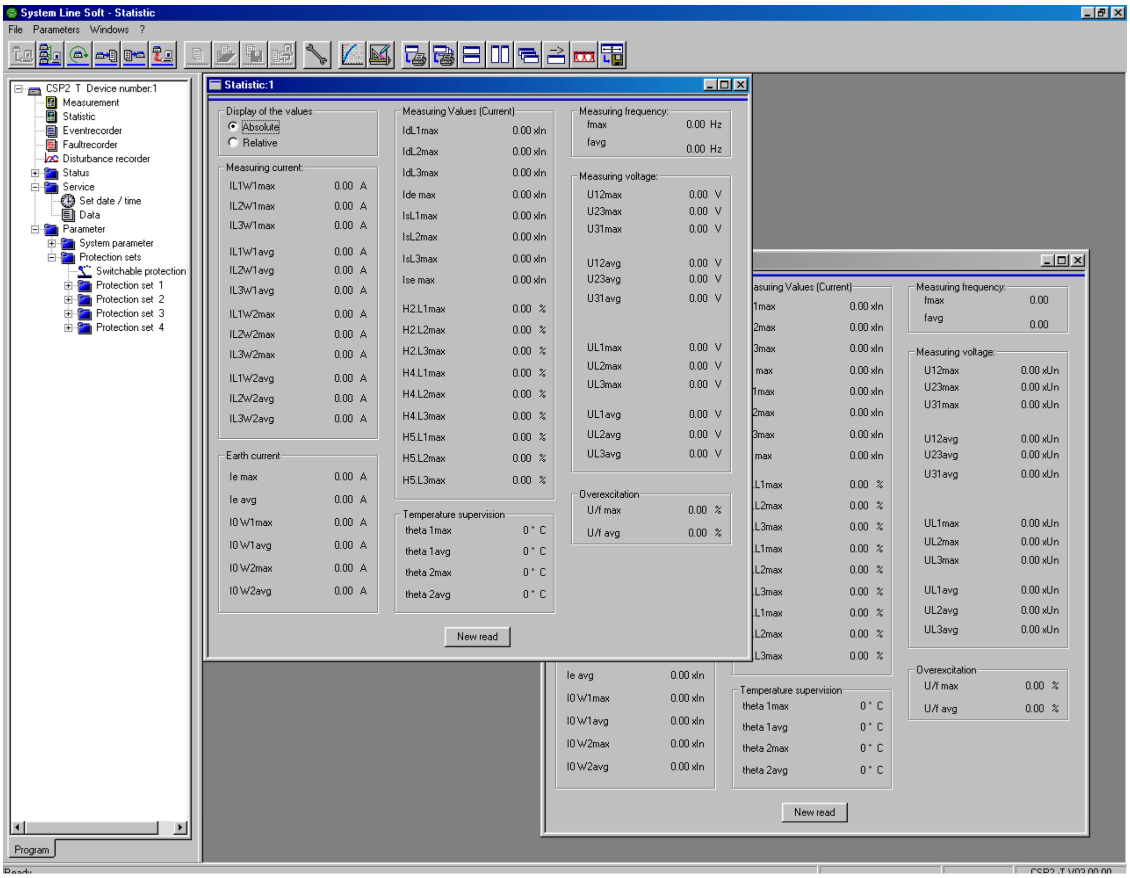


Figure 5.5: Menu „Statistic" – SL-SOFT (Example CSP2-T)

Statistical Data			
Statistic Quantity	Description	Unit	Calculation (Update)
UL1 max	Max. value phase neutral voltage L1-N	V	Cyclic via „Δt“ or „Synchronizsation Instant “
UL2 max	Max. value phase neutral voltage L2-N	V	
UL3 max	Max. value phase neutral voltage L3-N	V	
UL1 avg	Average value phase neutral voltage L1-N	V	
UL2 avg	Average value phase neutral voltage L2-N	V	
UL3 avg	Average value phase neutral voltage L3-N	V	
U12 max	Max. value phase phase voltage L1-L2	V	
U23 max	Max. value phase phase voltage L2-L3	V	
U31 max	Max. value phase phase voltage L3-L1	V	
U12 avg	Average value phase phase voltage L1-L2	V	
U23 avg	Average value phase phase voltage L2-L3	V	
U31 avg	Average value phase phase voltage L3-L1	V	
f max	Max. value frequency	Hz	
f avg	Average value frequency	Hz	
U/f max	Max. value overexcitation	%	
U/f avg	Average value overexcitation	%	
Id L1max	Max. value differential current Id L1	A	
Id L2max	Max. value differential current Id L2	A	
Id L3max	Max. value differential current Id L3	A	
Is L1max	Max. value stabilisation current Is L1	A	
Is L2max	Max. value stabilisation current Is L2	A	
Is L3max	Max. value stabilisation current Is L3	A	
IL1 W1max	Max. value phase current L1 at winding 1	A	
IL2 W1max	Max. value phase current L2 at winding 1	A	
IL3 W1max	Max. value phase current L3 at winding 1	A	
IL1 W1avg	Max. value phase current L1 at winding 1	A	
IL2 W1avg	Avg. value phase current L2 at winding 1	A	
IL3 W1avg	Avg. value phase current L3 at winding 1	A	
IL1 W2max	Max. value phase current L1 at winding 2	A	
IL2 W2max	Max. value phase current L2 at winding 2	A	
IL3 W2max	Max. value phase current L3 at winding 2	A	
IL1 W2avg	Max. value phase current L3 at winding 2	A	
IL2 W2avg	Avg. value phase current L2 at winding 2	A	
IL3 W2avg	Avg. value phase current L3 at winding 2	A	
Ie avg	Avg. value, measured earth current	A	
I0 W1avg	Avg. value, calculated earth current at W1	A	
I0 W2avg	Avg. value, calculated earth current at W2	A	
Ie max	Max. value, measured earth current	A	
I0 W1max	Max. value, calculated earth current at W1	A	
I0 W2max	Max. value, calculated earth current at W2	A	
Ide max	Max. differential earth current	A	
Ise max	Max. stabilisation earth current	A	
ϑ1 max	Max. temperature supervision 1 unit °C	°C	
ϑ1 avg	Avg. temperature supervision 1 unit °C	°C	
ϑ2 max	Max. temperature supervision 2 unit °C	°C	
ϑ2 avg	Avg. temperature supervision 2 unit °C	°C	

Table 5.4: Statistical Data

5.3 Menu event recorder

The *event recorder* records up to 50 events monitored by *CSP2*. These include protection, control, parameter setting and self-test events. Beside the name of an event also further data are saved which permit more exact conclusions from the event. The event recorder works according to the FIFO-principle (First-In-Fist-Out). This means that the first 50 events are saved into the memory of the event recorder. The 51st event then overwrites the oldest event in the memory. Thus it is guaranteed that always the last 50 events are fail-safely ready to be called up.

Scope of saved information
Each event is recorded in the event recorder according to a certain structure, i.e. additionally to the message ("what" happened) information is delivered which enables an assignation of the message to the total context.

Structure of an event				
Event Data	*Messages*	*Description*	*Example*	*N o t e*
Serial number	„XXXXXXX“	Serial number of the event from commissioning onwards	„1111“	
Fault No.	„X“	Fault number = Event assignment to a specific fault	„4“	Event message is to assign to fault no. “4” (protective trip)
(Time stamp)	„XX.XX.XXXX“ „XX:XX:XX,XXX“	Date and time (accuracy in the millisecond range) of the event	28.03.2002 15:43:22,333	dd.mm.yyyy hh:mm:ss,sss
Module (Cause of the event massage)	„Control Logic“	Messages from the control and	»Digital Input«	Event message was generated via a digital input
	»Digital Input	interlocking of incoming messages from digital inputs		
	„Parametrising“	Change of a parameter setting		
	„IEC 870-5-103“	Messages from the SCADA-system with protocol type IEC 60870-5-103)		
	„Recorder“	Messages from the fault recorder (fault recorder function)		
	System	Internal device messages		
	Protection	Messages from internal and external protective functions		
	Supervision Logic	Messages from programmable Logic functions		
Code	See table „Messages in the Event Recorder“	Event message	»Control Interlocking 1«	Interlocking of control via the active digital input (DI function : „Control Interlocking1“)
Info (State of the event)	„coming“		»inactive«	Interlocking has been inactivated by de-activating the digital input (DI function: „Control Interlocking1“)
	„going“			
	„send“	Signal „Temporary Line Fault“ : wipe signal		
	„Parameter set 1“			
	„Parameter set 2“			
	„Parameter set 3“			
	„Parameter set 4“			
	„active“			
	„inactive“			
	„OFF“			
	„ON“			
	„DIFF“			
	„Fault“			
	„Removed“			
	„Blocked“			
	„Unblocked“			

Table 5.5: Structure event messages

The *event recorder* can be read out via the display and operation unit *CMP1* or the parameter setting and evaluation software *SL-SOFT*. both displays are equivalent and show the same contents.

Figure 5.6: Screenshot of the information to be called up out of the "EVENT RECORDER"

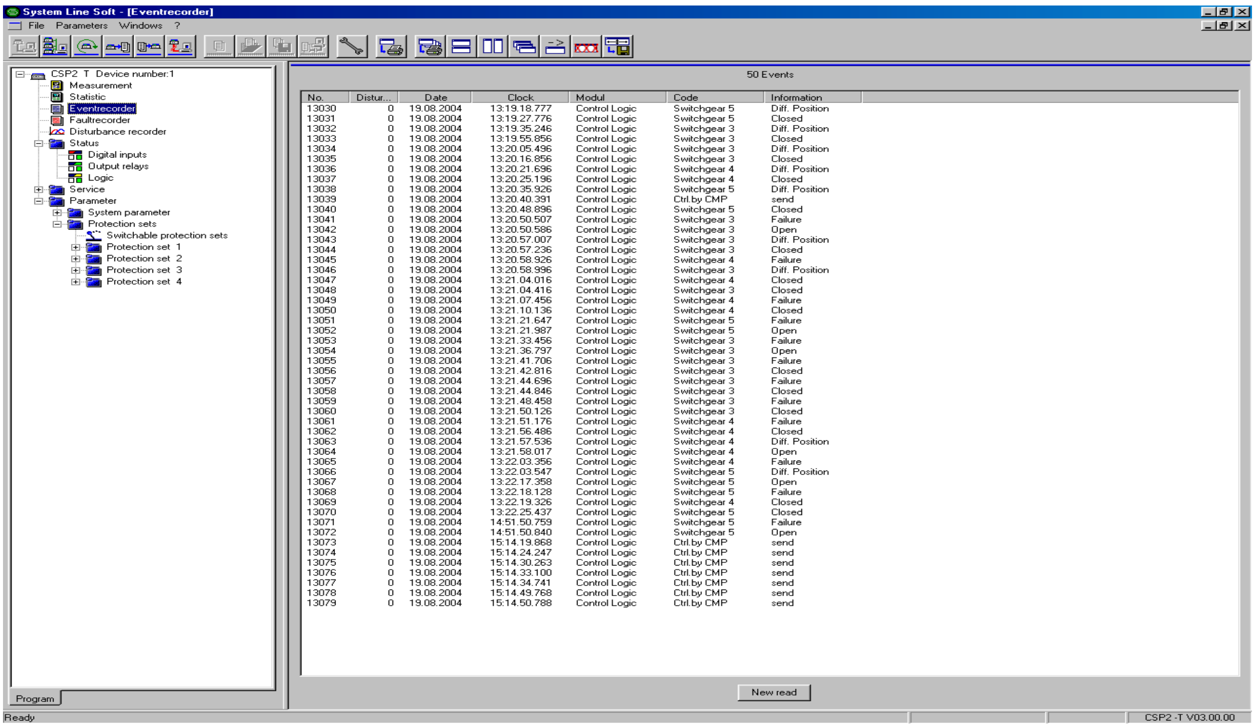


Figure 5.7: Informations to be called up from the event recorder by means of the SL-Soft

Event Messages									
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)							Assignable as message
		Status (of the Event)				Dual Message	Single Message	Wipe signal	
Param. on Site	Parameterizing	coming		going		-	●	-	
Plausibility	Parameterizing	coming							
Act.Parameters.	Parameterizing	Param. Set 1	Param. Set 2	Param. Set 3	Param. Set 4				
Defaultparamet.	Parameterizing	coming		going			●		
Monitor Block.	IEC 870-5-103	coming		going			●		
Fault Recorder	Recorder	coming		going			●		
System Start	System	coming		going			●		
Device Reset	System	coming		going			●		
Calibrat. Mode	System	coming		going			●		
Commiss. Mode	System	coming		going			●		
Test Mode	System	coming		going			●		
Selftest Alarm	System	coming		going			●		
Selftest Failure	System	coming		going			●		
Current Superv.	System	coming		going			●		
Voltage Superv.	System	coming		going			●		
Field rotating	System	coming		going			●		
Selfsupervision	System	coming		going			●		
LED Test	System	coming		going			●		
Relay Test	System	coming		going			●		
Protection, active	Protection	coming		going			●		●
General Alarm:	Protection	coming		going			●		●
Alarm: L1	Protection	coming		going			●		●
Alarm: L2	Protection	coming		going			●		●
Alarm: L3	Protection	coming		going			●		●
Alarm: N	Protection	coming		going			●		●
General Trip:	Protection	coming		going			●		●
Trip: L1	Protection	coming		going			●		●
Trip: L2	Protection	coming		going			●		●
Trip: L3	Protection	coming		going			●		●
Trip: N	Protection	coming		going			●		●
Ph fault forward	Protection	coming		going			●		
Ph fault backward	Protection	coming		going			●		
Earth fault forward	Protection	coming		going			●		
Earth fault backward	Protection	coming		going			●		
Function I>F	Protection	active		inactive			●		
Function I>>F	Protection	active		inactive			●		
Function I>B	Protection	active		inactive			●		
Function I>>B	Protection	active		inactive			●		
Function Ie>F	Protection	active		inactive			●		
Function Ie>>F	Protection	active		inactive			●		
Function Ie>B	Protection	active		inactive			●		
Function Ie>>B	Protection	active		inactive			●		
Alarm: I>F	Protection	coming		going			●		●
Alarm: I>>F	Protection	coming		going			●		●
Alarm: I>B	Protection	coming		going			●		●

Event Messages

CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)						Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal		
Alarm: I>>B	Protection	coming	going		●			●
Alarm: Ie>F	Protection	coming	going		●			●
Alarm: Ie>>F	Protection	coming	going		●			●
Alarm: Ie>B	Protection	coming	going		●			●
Alarm: Ie>>B	Protection	coming	going		●			●
Trip: I>F	Protection	coming	going		●			●
Trip: I>>F	Protection	coming	going		●			●
Trip: I>B	Protection	coming	going		●			●
Trip: I>>B	Protection	coming	going		●			●
Trip: Ie>F	Protection	coming	going		●			●
Trip: Ie>>F	Protection	coming	going		●			●
Trip: Ie>B	Protection	coming	going		●			●
Trip: Ie>>B	Protection	coming	going		●			●
I>F blocked	Protection	coming	going		●			-
I>>F blocked	Protection	coming	going		●			-
I>B blocked	Protection	coming	going		●			-
I>>B blocked	Protection	coming	going		●			-
Ie>F blocked	Protection	coming	going		●			-
Ie>>F blocked	Protection	coming	going		●			-
Ie>B blocked	Protection	coming	going		●			-
Ie>>B blocked	Protection	coming	going		●			-
Function IH2	Protection	active	inactive		●			-
IH2 blocked	Protection	coming	going		●			-
Alarm: IH2	Protection	coming	going		●			-
IH2 blocked L1	Protection	coming	going		●			●
IH2 blocked L2	Protection	coming	going		●			●
IH2 blocked L3	Protection	coming	going		●			●
IH2 X blocked	Protection	coming	going		●			-
Function IeH2	Protection	active	inactive		●			-
IeH2 blocked	Protection	coming	going		●			-
IeH2 blocked E	Protection	coming	going		●			●
Function υ>	Protection	active	inactive		●			-
Alarm: υ>	Protection	coming	going		●			●
Trip: υ>	Protection	coming	going		●			●
υ> blocked	Protection	coming	going		●			-
Function U>	Protection	active	inactive		●			-
Function U>>	Protection	active	inactive		●			-
Function U<	Protection	active	inactive		●			-
Function U<<	Protection	active	inactive		●			-
Alarm: U>	Protection	coming	going		●			●
Alarm: U>>	Protection	coming	going		●			●
Alarm: U<	Protection	coming	going		●			●
Alarm: U<<	Protection	coming	going		●			●
Trip: U>	Protection	coming	going		●			●
Trip: U>>	Protection	coming	going		●			●
Trip: U<	Protection	coming	going		●			●

CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
Trip: U<<	Protection	coming	going		●		●
U> blocked	Protection	coming	going		●		-
U>> blocked	Protection	coming	going		●		-
U< blocked	Protection	coming	going		●		-
U<< blocked	Protection	coming	going		●		-
Function Ue>	Protection	active	inactive		●		
Function Ue>>	Protection	active	inactive		●		
Alarm: Ue>	Protection	coming	going		●		
Alarm: Ue>>	Protection	coming	going		●		
Trip: Ue>	Protection	coming	going		●		●
Trip: Ue>>	Protection	coming	going		●		●
Ue> blocked	Protection	coming	going		●		-
Ue>> blocked	Protection	coming	going		●		-
Function f1	Protection	active	inactive		●		
Function f2	Protection	active	inactive		●		
Function f3	Protection	active	inactive		●		
Function f4	Protection	active	inactive		●		
Alarm: f1	Protection	coming	going		●		●
Alarm: f2	Protection	coming	going		●		●
Alarm: f3	Protection	coming	going		●		●
Alarm: f4	Protection	coming	going		●		●
Trip: f1	Protection	coming	going		●		●
Trip: f2	Protection	coming	going		●		●
Trip: f3	Protection	coming	going		●		●
Trip: f4	Protection	coming	going		●		●
f1 blocked	Protection	coming	going		●		-
f2 blocked	Protection	coming	going		●		-
f3 blocked	Protection	coming	going		●		-
f4 blocked	Protection	coming	going		●		-
Function U/f>	Protection	active	inactive		●		-
Function U/f>>	Protection	active	inactive		●		-
Alarm: U/f>	Protection	coming	going		●		●
Alarm: U/f>>	Protection	coming	going		●		●
Trip: U/f>	Protection	coming	going		●		●
Trip: U/f>>	Protection	coming	going		●		●
U/f> blocked	Protection	coming	going		●		-
U/f>> blocked	Protection	coming	going		●		-
Fct. local CBF	Protection	active	inactive		●		-
Local CBF	Protection	coming	going		●		●
Loc. CBF block	Protection	coming	going		●		-
Alarm: CBF W1	Protection	coming	going		●		●
Alarm: CBF W2	Protection	coming	going		●		●
Fct. ext. CBF	Protection	active	inactive		●		-
Trip:: Ext.CBF	Protection	coming	going		●		●
Function CCS	Protection	active	inactive		●		-
Alarm: CCS	Protection	coming	going		●		●

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event) Status (of the Event)		Dual Message	Single Message	Wipe signal	Assignable as message
Alarm: CCS V	Protection	coming	going		●		-
Alarm: CCS int	Protection	coming	going		●		-
Alarm: CCS SC	Protection	coming	going		●		-
CCS blocked	Protection	coming	going		●		-
CCS:fault CB1	Protection	coming	going		●		-
CCS:fault CB2	Protection	coming	going		●		-
CCS:fault OM1	Protection	coming	going		●		-
CCS:fault OM2	Protection	coming	going		●		-
CCS:fault OM3	Protection	coming	going		●		-
CCS:fault OM4	Protection	coming	going		●		-
CCS:bridge def.	Protection	coming	going		●		-
CCS:broken line	Protection	coming	going		●		-
CCS:rel.closed	Protection	coming	going		●		-
CCS:fault IGBT	Protection	coming	going		●		-
Function VTS	Protection	active	inactive		●		
Alarm: VTS	Protection	coming	going		●		●
Trip: VTS	Protection	coming	going		●		●
VTS blocked	Protection	coming	going		●		-
Function AR	Protection	active	inactive		●		●
AR(ST):CB on	Protection	coming				●	-
AR(LT):CB on	Protection	coming				●	-
AR:blocked	Protection	coming	going		●		-
AR:successful	Protection	coming				●	-
AR:unsuccessful	Protection	coming				●	-
AR NC:start	Protection	coming				●	-
AR NC:CB on	Protection	send				●	-
Function Id>	Protection	active	inactive		●		
Function Id>>	Protection	active	inactive		●		
Alarm: Id>	Protection	coming	going		●		●
Alarm: Id>>	Protection	coming	going		●		●
Trip:Id>	Protection	coming	going		●		●
Trip:Id>>	Protection	coming	going		●		●
Id> block	Protection	coming	going		●		-
Id>> block	Protection	coming	going		●		-
IdH2 Sta	Protection	coming	going		●		●
IdH4 Sta	Protection	coming	going		●		●
IdH5 Sta	Protection	coming	going		●		●
IdCrossb	Protection	coming	going		●		●
Function Ide>	Protection	active	inactive		●		
Function Ide>>	Protection	active	inactive		●		
Alarm: Ide>	Protection	coming	going		●		●
Alarm: Ide>>	Protection	coming	going		●		●
Trip: Ide>	Protection	coming	going		●		●
Trip: Ide>>	Protection	coming	going		●		●
Ide> blocked	Protection	coming	going		●		-
Ide>> blocked	Protection	coming	going		●		-

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
Fct. ϑ1 Alarm	Protection	active	inactive		●		
Fct. ϑ1 Trip	Protection	active	inactive		●		
Alarm: ϑ1	Protection	coming	going		●		●
Trip: ϑ1	Protection	coming	going		●		●
ϑ1 Alarm block	Protection	coming	going		●		-
ϑ1 Trip block	Protection	coming	going		●		-
Broken wire ϑ1	Protection	coming	going		●		-
Fct. ϑ2 Alarm	Protection	active	inactive		●		
Fct. ϑ2 Trip	Protection	active	inactive		●		
Alarm: ϑ2	Protection	coming	going		●		●
Trip: ϑ2	Protection	coming	going		●		●
ϑ2 Alarm block	Protection	coming	going		●		-
ϑ2 Trip block	Protection	coming	going		●		-
Broken wire ϑ2	Protection	coming	going		●		-
Function Prot.1	Protection	active	inactive		●		
Function Temp.	Protection	active	inactive		●		
Function Buchh.	Protection	active	inactive		●		
Function Diff.	Protection	active	inactive		●		
Function Imped.	Protection	active	inactive		●		
Function Motor	Protection	active	inactive		●		
Function Prot.2	Protection	active	inactive		●		
Function Prot.3	Protection	active	inactive		●		
Function Prot.4	Protection	active	inactive		●		
Function Prot.5	Protection	active	inactive		●		
Function Prot.6	Protection	active	inactive		●		
Alarm:Prot.1	Protection	coming	going		●		●
Alarm:Temp.	Protection	coming	going		●		●
Alarm:Buchh.	Protection	coming	going		●		●
Alarm:Diff.	Protection	coming	going		●		●
Alarm:Imped.	Protection	coming	going		●		●
Alarm:Motor	Protection	coming	going		●		●
Alarm:Prot.2	Protection	coming	going		●		●
Alarm:Prot.3	Protection	coming	going		●		●
Alarm:Prot.4	Protection	coming	going		●		●
Alarm:Prot.5	Protection	coming	going		●		●
Alarm:Prot.6	Protection	coming	going		●		●
Trip:Prot.1	Protection	coming	going		●		●
Trip:Temp.	Protection	coming	going		●		●
Trip:Buchh.	Protection	coming	going		●		●
Trip:Diff.	Protection	coming	going		●		●
Trip:Imped.	Protection	coming	going		●		●
Trip:Motor	Protection	coming	going		●		●
Trip:Prot.2	Protection	coming	going		●		●
Trip:Prot.3	Protection	coming	going		●		●
Trip:Prot.4	Protection	coming	going		●		●
Trip:Prot.5	Protection	coming	going		●		●

Event Messages										
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)								Assignable as message
		Status (of the Event)					Dual Message	Single Message	Wipe signal	
Trip:Prot.6	Protection	coming		going				●		●
Switchgear 1	Control Logic	Open	Closed	Diff. Position	Failure	Removed	●			-
Switchgear 2	Control Logic	Open	Closed	Diff. Position	Failure	Removed	●			-
Switchgear 3	Control Logic	Open	Closed	Diff. Position	Failure	Removed	●			-
Switchgear 4	Control Logic	Open	Closed	Diff. Position	Failure	Removed	●			-
Switchgear 5	Control Logic	Open	Closed	Diff. Position	Failure	Removed	●			-
Local control	Control Logic	coming		going				●		-
Emergency off	Control Logic	coming		going				●		●
Interlocking	Control Logic	coming		going				●		●
Switchgea.fail	Control Logic	coming		going				●		●
SCADA:Cmd out1	Control Logic	coming		going				●		●
SCADA:Cmd out2	Control Logic	coming		going				●		●
SCADA:Cmd out3	Control Logic	coming		going				●		●
SCADA:Cmd out4	Control Logic	coming		going				●		●
SCADA:Cmd out5	Control Logic	coming		going				●		●
SCADA:Cmd out6	Control Logic	coming		going				●		●
SCADA:Cmd out7	Control Logic	coming		going				●		●
Rel:Ext CB1 on	Control Logic	coming		going				●		●
Fct:Ext CB1 off	Control Logic	coming		going				●		●
Ctrl.by CMP	Control Logic			Send					●	-
CB off by Prot.	Control Logic			Send					●	-
CB on by AR	Control Logic			Send					●	-
Ctrl.by SCADA	Control Logic			send					●	-
Ctrl. by I. fct.	Control Logic			send					●	-
Interlock:CMP	Control Logic	coming		going				●		-
Interlock:SCADA	Control Logic	coming		going				●		-
All SG	Control Logic	coming		going				●		-
SG1 off	Control Logic	coming		going				●		-
SG1 on	Control Logic	coming		going				●		-
SG2 off	Control Logic	coming		going				●		-
SG2 on	Control Logic	coming		going				●		-
SG3 off	Control Logic	coming		going				●		-
SG3 on	Control Logic	coming		going				●		-
SG4 off	Control Logic	coming		going				●		-
SG4 on	Control Logic	coming		going				●		-
SG5 off	Control Logic	coming		going				●		-
SG5 on	Control Logic	coming		going				●		-
Fct:Ext CB2 off	Control Logic	coming		going				●		-
Rel:Ext CB2 on	Control Logic	coming		going				●		-
Fct:Ext CB off	Control Logic	coming		going				●		-
Function Tc.	Supervision	active		inactive				●		
Malfunc. Tc.	Supervision	coming		going				●		●
Tc.pos.0	Supervision	coming		going				●		●
Tc.pos.1	Supervision	coming		going				●		●
Tc.pos.2	Supervision	coming		going				●		●
Tc.pos.3	Supervision	coming		going				●		●

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
Tc.pos.4	Supervision	coming	going		●		●
Tc.pos.5	Supervision	coming	going		●		●
Tc.pos.6	Supervision	coming	going		●		●
Tc.pos.7	Supervision	coming	going		●		●
Tc.pos.8	Supervision	coming	going		●		●
Tc.pos.9	Supervision	coming	going		●		●
Tc.pos.10	Supervision	coming	going		●		●
Tc.pos.11	Supervision	coming	going		●		●
Tc.pos.12	Supervision	coming	going		●		●
Tc.pos.13	Supervision	coming	going		●		●
Tc.pos.14	Supervision	coming	going		●		●
Tc.pos.15	Supervision	coming	going		●		●
Tc.pos.16	Supervision	coming	going		●		●
Tc.pos.17	Supervision	coming	going		●		●
Tc.pos.18	Supervision	coming	going		●		●
Tc.pos.19	Supervision	coming	going		●		●
Tc.pos.20	Supervision	coming	going		●		●
Tc.pos.21	Supervision	coming	going		●		●
Tc.pos.22	Supervision	coming	going		●		●
Tc.pos.23	Supervision	coming	going		●		●
Tc.pos.24	Supervision	coming	going		●		●
Tc.pos.25	Supervision	coming	going		●		●
Tc.pos.26	Supervision	coming	going		●		●
Tc.pos.27	Supervision	coming	going		●		●
Tc.pos.28	Supervision	coming	going		●		●
Tc.pos.29	Supervision	coming	going		●		●
Tc.pos.30	Supervision	coming	going		●		●
Tc.pos.31	Supervision	coming	going		●		●
Tc.pos.32	Supervision	coming	going		●		●
Tc.pos.33	Supervision	coming	going		●		●
Tc.pos.34	Supervision	coming	going		●		●
Tc.pos.35	Supervision	coming	going		●		●
Tc.pos.36	Supervision	coming	going		●		●
Tc.pos.37	Supervision	coming	going		●		●
Tc.pos.38	Supervision	coming	going		●		●
Tc.pos.39	Supervision	coming	going		●		●
Prot.blocked	Digital Input or Logic	coming	going		●		●
AR blocked	Digital Input or Logic	coming	going		●		●
AR start	Digital Input or Logic	coming	going		●		●
AR sync.check	Digital Input or Logic	coming	going		●		●
Ext CB fail	Digital Input or Logic	coming	going		●		●
Alarm:Prot.1	Digital Input or Logic	coming	going		●		●
Trip:Prot.1	Digital Input or Logic	coming	going		●		●
Device reset	Digital Input or Logic	coming	going		●		●
Fuse fail VT	Digital Input or Logic	coming	going		●		●
Fuse fail AV	Digital Input or Logic	coming	going		●		●

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
Alarm:CCS	Digital Input or Logic	coming	going		●		●
Switch p.-set	Digital Input or Logic	coming	going		●		●
Trigg.dist.rec	Digital Input or Logic	coming	going		●		●
CB1 ready	Digital Input or Logic	coming	going		●		●
CB2 ready	Digital Input or Logic	coming	going		●		●
SF6 Alarm	Digital Input or Logic	coming	going		●		●
Cmd1 SG1 on	Digital Input or Logic	coming	going		●		●
Cmd1 SG1 off	Digital Input or Logic	coming	going		●		●
Cmd2 SG1 on	Digital Input or Logic	coming	going		●		●
Cmd2 SG1 off	Digital Input or Logic	coming	going		●		●
Cmd SG2 on	Digital Input or Logic	coming	going		●		●
Cmd SG2 off	Digital Input or Logic	coming	going		●		●
Cmd SG3 on	Digital Input or Logic	coming	going		●		●
Cmd SG3 off	Digital Input or Logic	coming	going		●		●
Cmd SG4 on	Digital Input or Logic	coming	going		●		●
Cmd SG4 off	Digital Input or Logic	coming	going		●		●
Cmd SG5 on	Digital Input or Logic	coming	going		●		●
Cmd SG5 off	Digital Input or Logic	coming	going		●		●
Plug CB1 out	Digital Input or Logic	coming	going		●		●
Plug CB2 out	Digital Input or Logic	coming	going		●		●
Ctrl.blocked1	Digital Input or Logic	coming	going		●		●
Function 1	Digital Input or Logic	coming	going		●		●
Function 2	Digital Input or Logic	coming	going		●		●
Function 3	Digital Input or Logic	coming	going		●		●
Function 4	Digital Input or Logic	coming	going		●		●
Function 5	Digital Input or Logic	coming	going		●		●
Function 6	Digital Input or Logic	coming	going		●		●
Function 7	Digital Input or Logic	coming	going		●		●
Function 8	Digital Input or Logic	coming	going		●		●
Function 9	Digital Input or Logic	coming	going		●		●
Function 10	Digital Input or Logic	coming	going		●		●
Ext prot.act.	Digital Input or Logic	coming	going		●		●
Alarm:Temp.	Digital Input or Logic	coming	going		●		●
Trip:Temp.	Digital Input or Logic	coming	going		●		●
Alarm:Buchh.	Digital Input or Logic	coming	going		●		●
Trip:Buchh.	Digital Input or Logic	coming	going		●		●
Trip:Diff.	Digital Input or Logic	coming	going		●		●
Alarm:Imped.	Digital Input or Logic	coming	going		●		●
Trip:Imped.	Digital Input or Logic	coming	going		●		●
Fuse fail VC	Digital Input or Logic	coming	going		●		●
Fuse fail Ven	Digital Input or Logic	coming	going		●		●
HH-fuse trip	Digital Input or Logic	coming	going		●		●
Ext. CB trip	Digital Input or Logic	coming	going		●		●
SG1 block.	Digital Input or Logic	coming	going		●		●
SG2 block.	Digital Input or Logic	coming	going		●		●
SG3 block.	Digital Input or Logic	coming	going		●		●

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
SG4 block.	Digital Input or Logic	coming	going		●		●
SG5 block.	Digital Input or Logic	coming	going		●		●
SG23 block.	Digital Input or Logic	coming	going		●		●
SG234 block.	Digital Input or Logic	coming	going		●		●
SG2345 block.	Digital Input or Logic	coming	going		●		●
Alarm:Motor	Digital Input or Logic	coming	going		●		●
Trip:Motor	Digital Input or Logic	coming	going		●		●
Ctrl.blocked2	Digital Input or Logic	coming	going		●		●
Ext CB1 off	Digital Input or Logic	coming	going		●		●
Ext CB1 on	Digital Input or Logic	coming	going		●		●
SG1on block.1	Digital Input or Logic	coming	going		●		●
SG1on block.2	Digital Input or Logic	coming	going		●		●
Alarm:Prot.2	Digital Input or Logic	coming	going		●		●
Trip:Prot.2	Digital Input or Logic	coming	going		●		●
Alarm:Prot.3	Digital Input or Logic	coming	going		●		●
Trip:Prot.3	Digital Input or Logic	coming	going		●		●
Alarm:Prot.4	Digital Input or Logic	coming	going		●		●
Trip:Prot.4	Digital Input or Logic	coming	going		●		●
Alarm:Prot.5	Digital Input or Logic	coming	going		●		●
Trip:Prot.5	Digital Input or Logic	coming	going		●		●
Alarm:Prot.6	Digital Input or Logic	coming	going		●		●
Trip:Prot.6	Digital Input or Logic	coming	going		●		●
Bypath1 Cboff	Digital Input or Logic	coming	going		●		●
Bypath1 Cbon	Digital Input or Logic	coming	going		●		●
Bypath2 Cboff	Digital Input or Logic	coming	going		●		●
Bypath2 Cbon	Digital Input or Logic	coming	going		●		●
Load shedding	Digital Input or Logic	coming	going		●		●
U</U<< Block	Digital Input or Logic	coming	going		●		●
PiUp inc	Digital Input or Logic	coming	going		●		●
Ext CB2 off	Digital Input or Logic	coming	going		●		●
Ext CB2 on	Digital Input or Logic	coming	going		●		●
Ext CB off	Digital Input or Logic	coming	going		●		●
SG2on block.	Digital Input or Logic	coming	going		●		●
Tc.po.change	Digital Input or Logic	coming	going		●		●
Tc.BCD0	Digital Input or Logic	coming	going		●		-
Tc.BCD1	Digital Input or Logic	coming	going		●		-
Tc.BCD2	Digital Input or Logic	coming	going		●		-
Tc.BCD3	Digital Input or Logic	coming	going		●		-
Tc.BCD4	Digital Input or Logic	coming	going		●		-
Tc.BCD5	Digital Input or Logic	coming	going		●		-
Logic fct. 1	Logic	coming	going		●		●
Logic fct. 2	Logic	coming	going		●		●
Logic fct. 3	Logic	coming	going		●		●
Logic fct. 4	Logic	coming	going		●		●
Logic fct. 5	Logic	coming	going		●		●
Logic fct. 6	Logic	coming	going		●		●

Event Messages							
CODE (Event Messages)	MODULE (Event Source)	INFO (Information on the Event)					Assignable as message
		Status (of the Event)		Dual Message	Single Message	Wipe signal	
Logic fct. 7	Logic	coming	going		●		●
Logic fct. 8	Logic	coming	going		●		●
Logic fct. 9	Logic	coming	going		●		●
Logic fct. 10	Logic	coming	going		●		●
Logic fct. 11	Logic	coming	going		●		●
Logic fct. 12	Logic	coming	going		●		●
Logic fct. 13	Logic	coming	going		●		●
Logic fct. 14	Logic	coming	going		●		●
Logic fct. 15	Logic	coming	going		●		●
Logic fct. 16	Logic	coming	going		●		●
Logic fct. 17	Logic	coming	going		●		●
Logic fct. 18	Logic	coming	going		●		●
Logic fct. 19	Logic	coming	going		●		●
Logic fct. 20	Logic	coming	going		●		●
Logic fct. 21	Logic	coming	going		●		●
Logic fct. 22	Logic	coming	going		●		●
Logic fct. 23	Logic	coming	going		●		●
Logic fct. 24	Logic	coming	going		●		●
Logic fct. 25	Logic	coming	going		●		●
Logic fct. 26	Logic	coming	going		●		●
Logic fct. 27	Logic	coming	going		●		●
Logic fct. 28	Logic	coming	going		●		●
Logic fct. 29	Logic	coming	going		●		●
Logic fct. 30	Logic	coming	going		●		●
Logic fct. 31	Logic	coming	going		●		●
Logic fct. 32	Logic	coming	going		●		●
Log.bounce sv1	Logic	coming	going		●		●
Log.bounce sv2	Logic	coming	going		●		●
Fct. Logic	Logic	coming	going		●		●

Table 5.6: Messages in the event recorder

5.4 Menu fault recorder

The "Fault recorder" saves data which are related to a trip. The memory of the fault recorder guarantees the recording of up to 5 disturbances.
At first the protective trip is recorded in the fault recorder as a *fault event.* For each disturbance event the measurement values at the time of the tripping (instantaneous recording of the fault values) are additionally recorded in form of absolute values.

For the duration of the recording and saving of disturbance events in the fault recorder is blocked. Incoming fault event during a recording will, however, not be rejected but sequentially processed (recorded) so that also in case of several disturbance events in sequence a complete documentation is guaranteed.

Structure of a Fault Event Message			
Data of the fault event	*Description*	*Example*	*N o t e*
Serial number	Serial number of the fault from commissioning onwards	„24“	
Fault number		„3“	
(Time stamp)	Date and and time (accuracy in the millisecond range) of the event	23.02.2002 11:35:44.556	dd.mm.yyyy hh:mm:ss,sss
Module	Source of the fault	„Protection“	
Code	Fault event	„Trip I>F“	

Table 5.7: Structure of a Fault Event Message

Instantaneous Fault Values		
Fault Data	*Description*	*Display*
UL1	Phase neutral voltage L1-N	V
UL2	Phase neutral voltage L2-N	V
UL3	Phase neutral voltage L3-N	V
U12	Phase phase Voltage L1-L2	V
U23	Phase phase voltage L2-L3	V
U31	Phase phase voltage L3-L1	V
Ue	Earth voltage	V
f	Frequency	Hz
U/f	Overexcitation	%
Id L1	Differential current Id L1	In
Id L2	Differential current Id L2	In
Id L3	Differential current Id L3	In
Is L1	Stabilisation current Is L1	In
Is L2	Stabilisation current Is L2	In
Is L3	Stabilisation current Is L3	In
IL1 W1	Phase current L1 at winding 1	A
IL2 W1	Phase current L2 at winding 1	A
IL3 W1	Phase current L3 at winding 1	A
IL1 W2	Phase current L1 at winding 2	A
IL2 W2	Phase current L2 at winding 2	A
IL3 W2	Phase current L3 at winding 2	A
Ie	Measured earth current	A
I0 W1	Calculated earth current W1	A
I0 W2	Calculated earth current W2	A
Ide	Differential earth current	In
Ise	Stabilisation earth current	In
ϑ	Thermal overload	%
tϑ	Time until trip by thermal overload	s

Table 5.8: Measurement value instantaneous recording of the fault recorder

The *FAULT RECORDER* can either be read out via the display and operation unit *CMP1* or via the *SL-SOFT*. Both displays are equivalent and show the same contents.

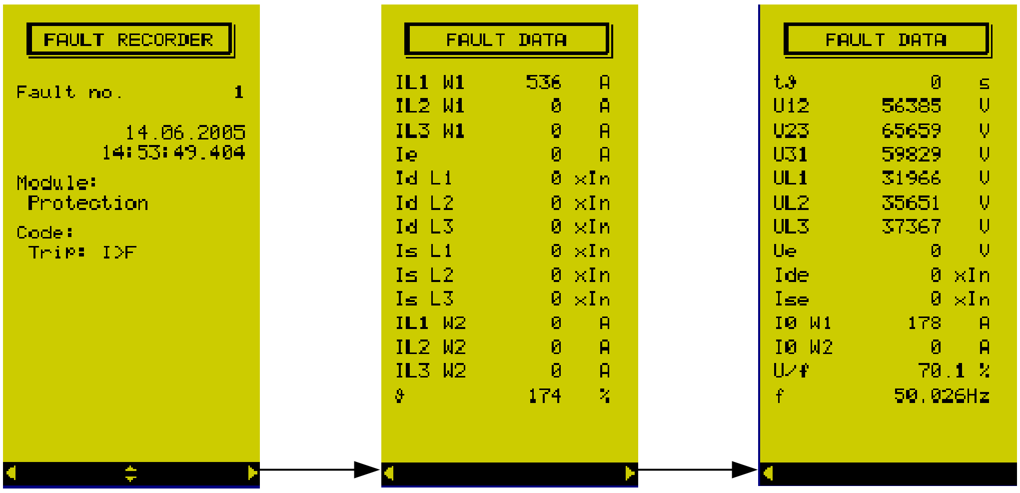


Figure 5.8: Screenshots of the Fault Recorder Displayed at the CMP1 (Example: CSP2-F)

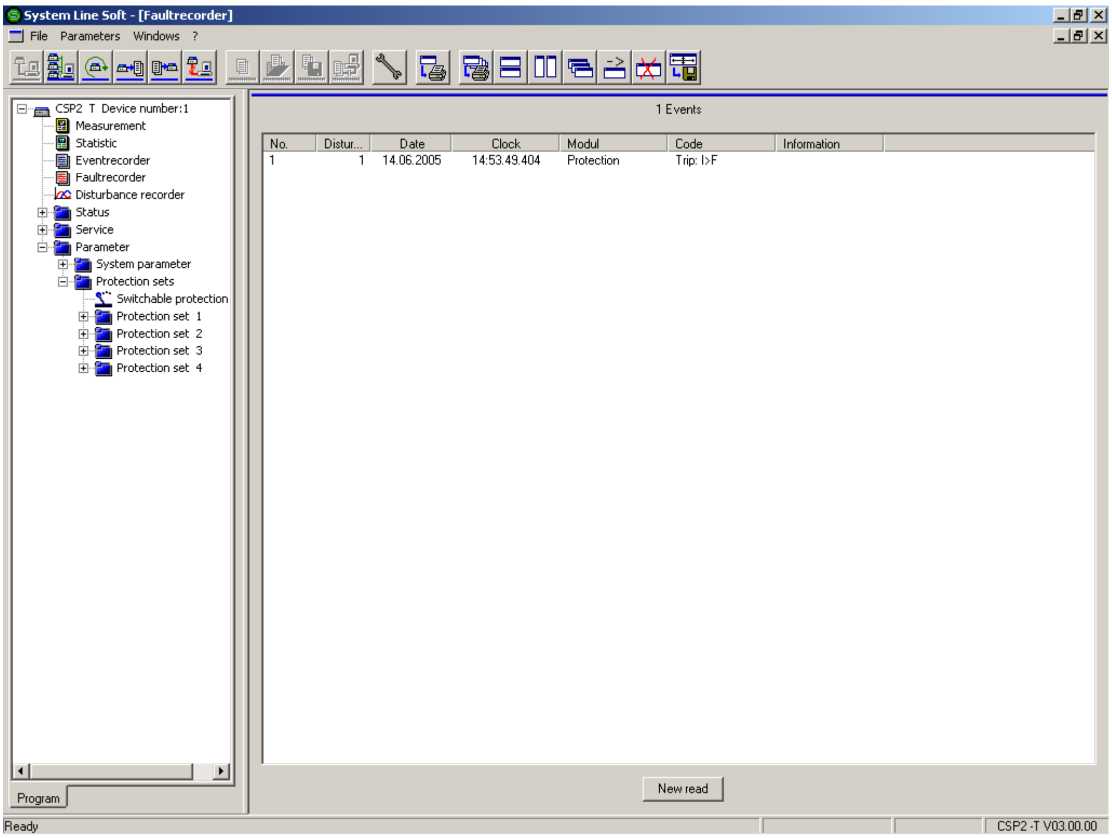


Figure 5.9: Screenshots of the Fault Recorder (SL-SOFT)

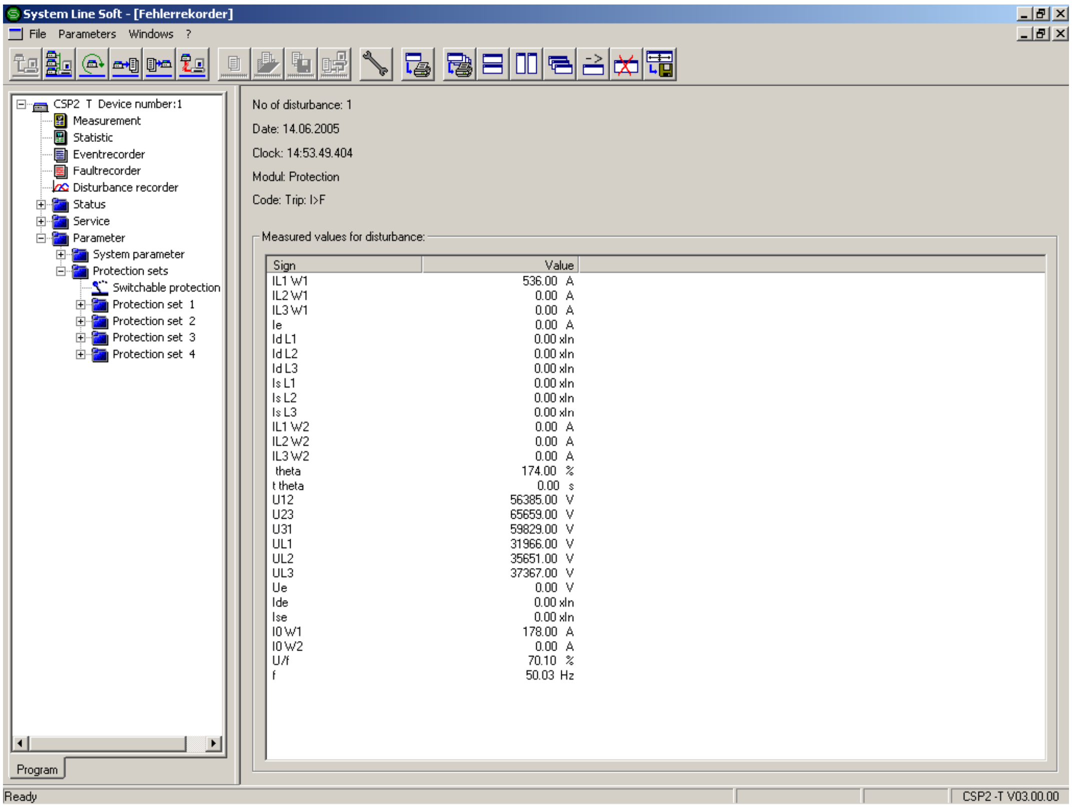


Figure 5.10: Screenshots of the instantaneous fault values responding to the disturbance event (SL-Soft)

Remark

The menu "FAULT RECORDER" is a separate menu and thus detached from the menu *"Disturbance recorder"*. The differences are explained in the next chapter.

5.5 Menu „Disturbance recorder“

In contrary to the *fault recorder*, which only saves the fault events and records the relevant measurement values at the time of tripping (instantaneous fault recording), the *disturbance recorder function* makes possible the recording of limited time histories of analogous and digital channels.

For each protection trip on the one hand there occurs a recording in the *fault recorder*. Additionally, in case of an *active disturbance recorder function*, the *CSP2* generates a *disturbance record file*. The *standard version* of the *CSP2* disposes of a memory with a total recording length of 10 s. As an *optional additional function* an extended non-volatile memory area with a total recording length of 50 s can be provided.

Remark

The function of the disturbance recorder can be adapted individually to each application. For this, there is a separate sub-menu provided in the menu "Parameter", in which the settings can be done *(see chapter "disturbance recorder")*.

Statusdisplay and action parameter

The menu "Disturbance recorder" disposes on the one hand of a *status display* which informs about the present status of the function and on the other hand it disposes of a *menu item* by which the recording can be restarted manually.

"File info"

Here all relevant data *("File no. xy"/"Name"/"Time"/"Date"/"Size")* for each of the stored disturbance record files are contained. The file size is shown in Bytes.

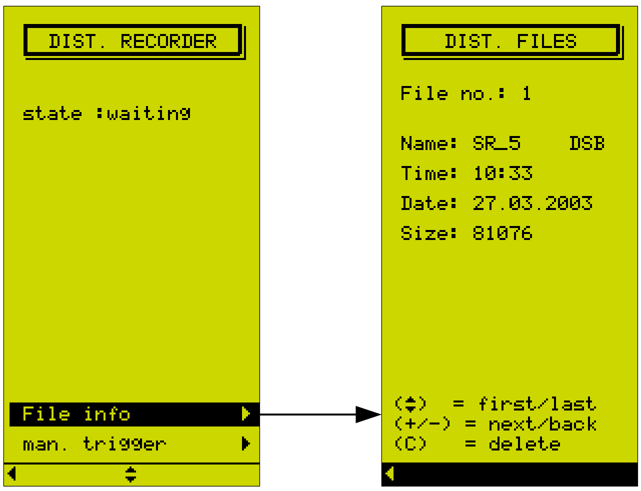


Figure 5.11: Menu „Disturbance recorder“

"State: waiting/start/saving" (status parameters)
this is a *status display* of the disturbance value recording. The display "State: waiting" signalizes, that the disturbance recorder is ready to be started. When the disturbance value recorder is started (activation of the menu "man trigger"), the display changes for about 1.5 s to *"State: Start"*. Thereafter, the *CSP2* starts saving the disturbance record file into the storage medium provided. During the storing, this is signalized by the display "State: saving". After termination of the saving process, the display of the *CMP* changes again to the readiness status *"State waiting")*.

"Man. trigger" (menu item)
By activation of this *menu item*, the disturbance recording is started *manually*. This can either be executed via the menu guidance of the *CMP1* or via *SL-SOFT*.

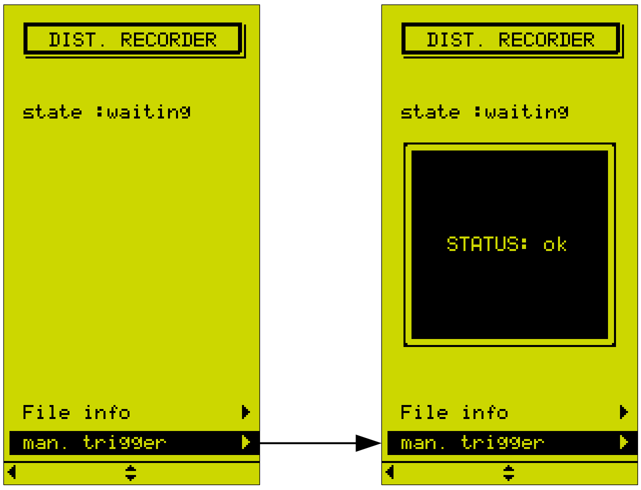


Figure 5.12: Manual trigger of the disturbance recorder via CMP1

The menu "Disturbance Recorder" can also be accessed via the *SL-SOFT*.

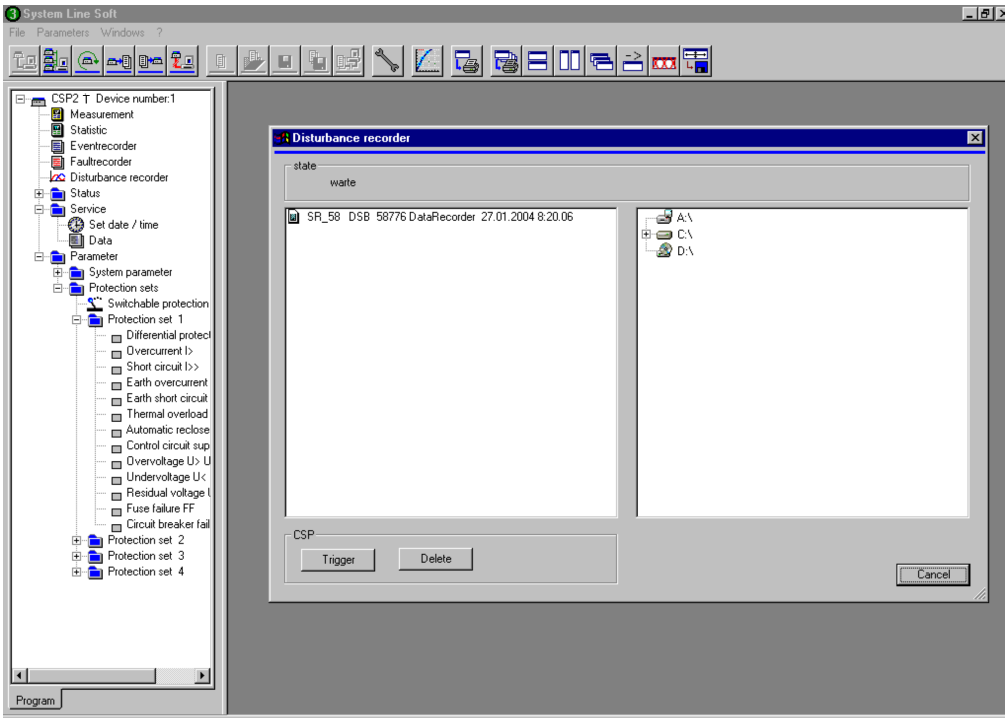


Figure 5.13: Screenshot of the „Disturbance Recorder" (SL-SOFT)

A manual trigger can be started (within the *SL-SOFT*) by clicking the button "Trigger" with the left hand mouse key.

Deleting of a disturbance record file is also possible. The pop-up window "Delete OK" informs that the deleting procedure was executed successfully.

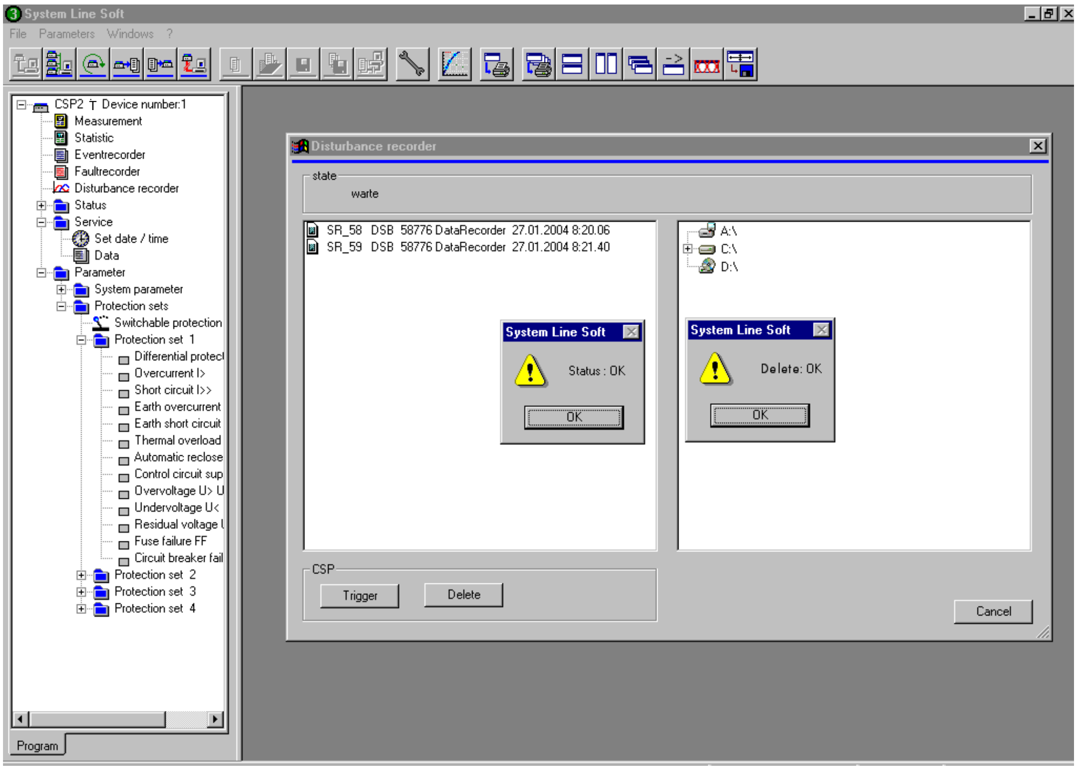


Figure 5.14: Manual trigger of the disturbance recorder via the „SL-SOFT"

Saving of disturbance recorder files

The disturbance record files saved in the *CSP2* can only be evaluated by the optionally available *data recorder* of the *SL-SOFT*. For this, the data files, however, must be saved (copied) beforehand by the *CSP2* on a hard drive or floppy disk of the local PC/laptop. The copying is carried out by simple "drag & drop" of the *.dsb-file from the left part of the "Disturbance recorder" – window into the right part of the window (your local hard drive) with the left mouse key as shown in Fig. 5.15.

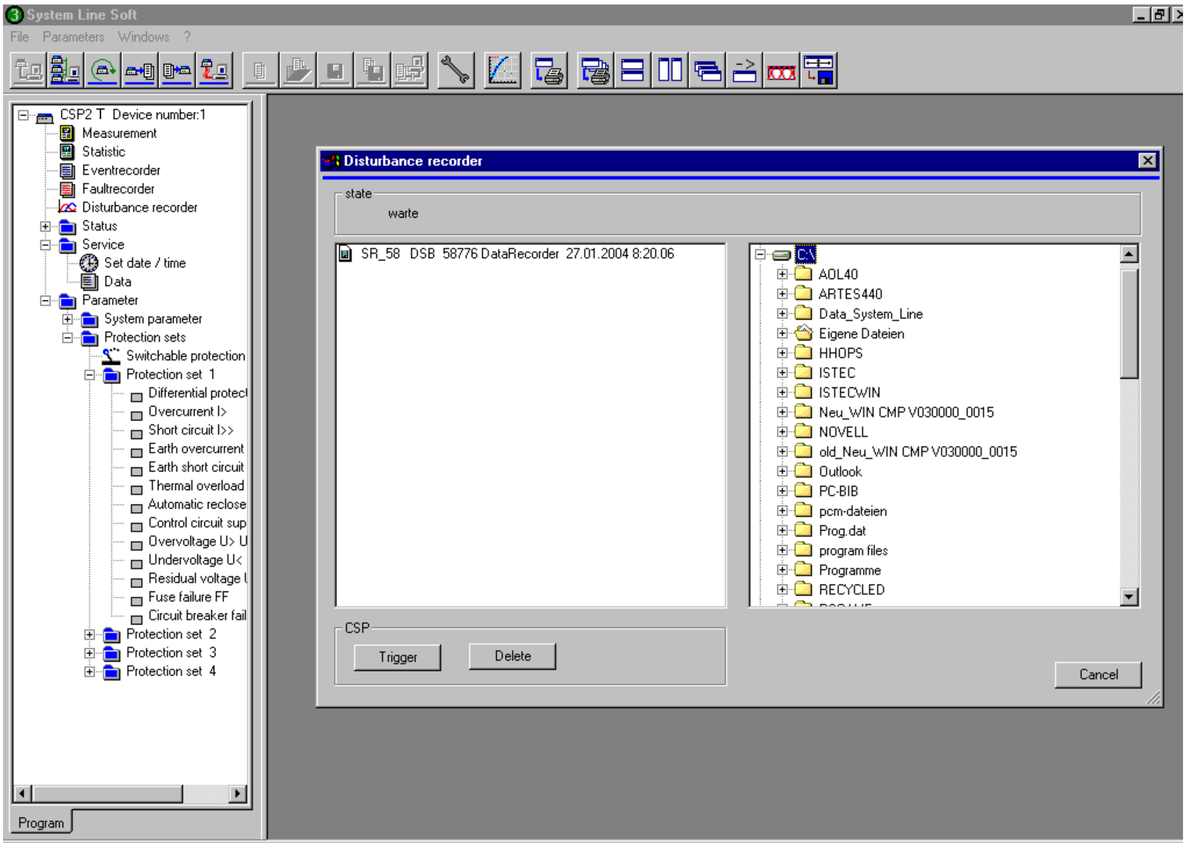


Figure 5.15: Storing of disturbance recorder data via SL-SOFT

Remark

The *size of a disturbance record file* depends on the setting parameters of "Sample n" and "Pre-trigger" (*see chapter "disturbance recorder"),* which define the duration of the recording. Thus the saving of a disturbance record file on the PC/notebook can take several seconds. A status bar in the foot line of the SL-SOFT shows the progress of the file transfer.

5.6 Menu status

Within the status menu, the status of the signal outputs (signal relays), function inputs (digital inputs) and logic outputs are shown within the corresponding sub-menus.

In this way on the one hand the *wiring* can be checked without great effort during the mounting of the cubicle, and on the other hand the *function tests* can be checked in the scope of a *commissioning*.

Input status
Each digital input is displayed with its assigned No. and input function. The actual state of each input is indicated within the corresponding check box.

Output Status
The No. and actual state (Relay closed/not closed) of each signal relay is shown within the submenu Signal Relays.

Logic
Each output state of a logic equation is shown and in addition to that the assigned functions.

Remark

As up to 16 output messages can be assigned on each signal relay, for reasons of clarity the display of these output messages in the display of the *CMP1* is renounced. When using the operation software *SL-SOFT*, however, the assigned output messages can be displayed!

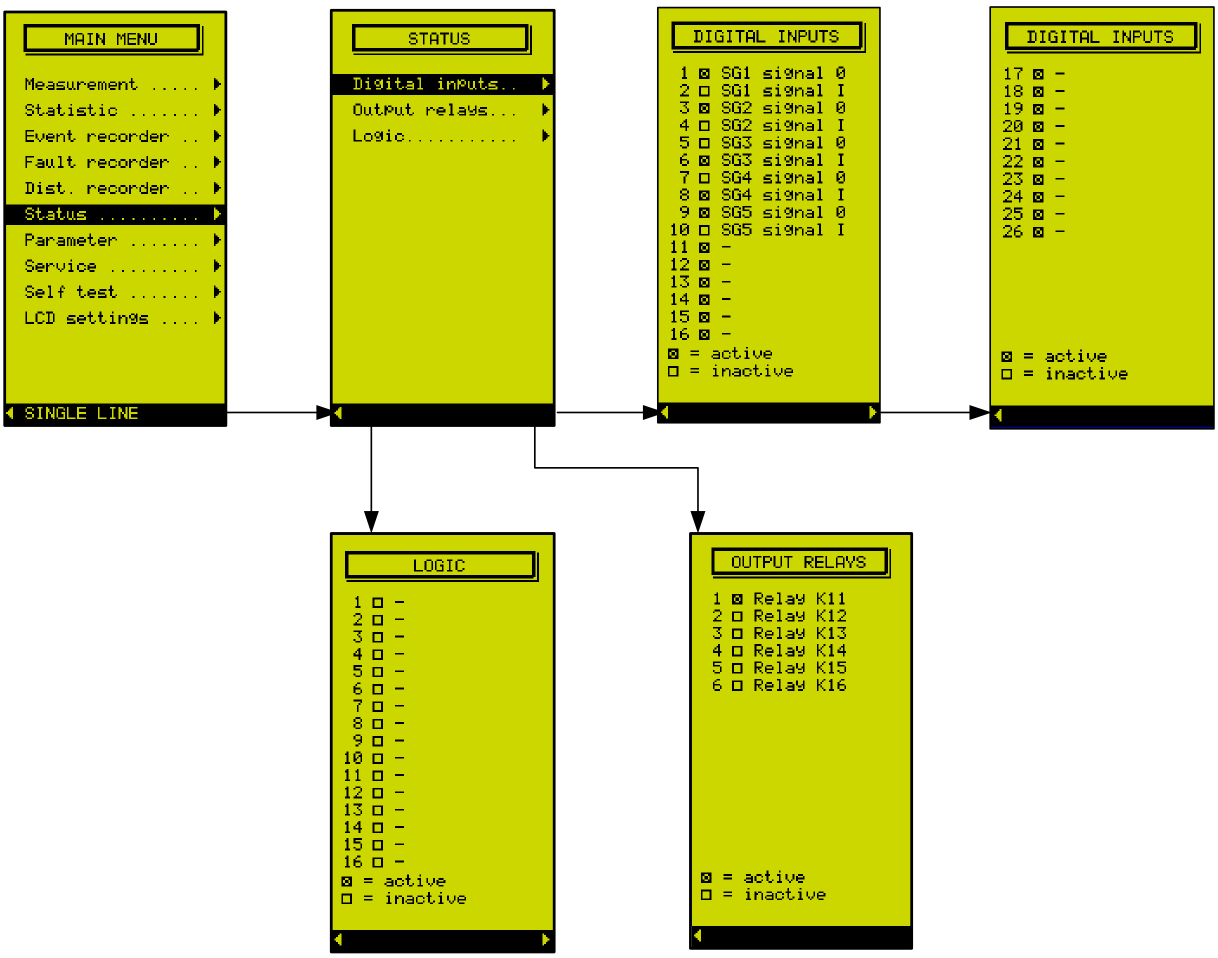


Figure 5.16: Menu „I/O status" in the display of the CMP1

Operation via SL-SOFT

The menu "I/O Status" of *SL-SOFT* enables a more detailed *display of the digital inputs* and the signal relays. Additionally to the data that can be shown in the display of the *CMP1*, the window of the *SL-SOFT* shows also the parameterized *DI-logic* as well as the *rebounce time* set for each of the digital inputs.

For the signal relays the same is valid, as for each of them additional parameters like *Relay Logic, Minimum holding time* and *Acknowledgement* are displayed.

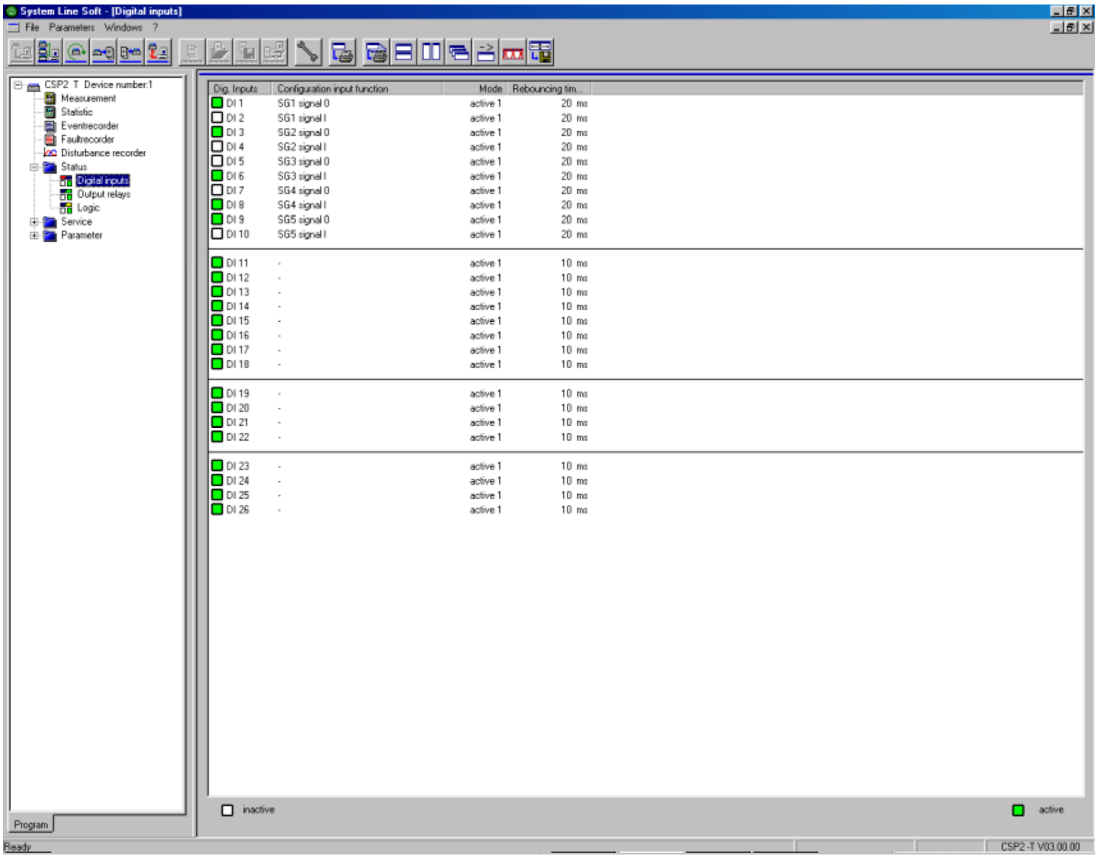


Figure 5.17: Menu „Status" (Digital Inputs) - SL-SOFT

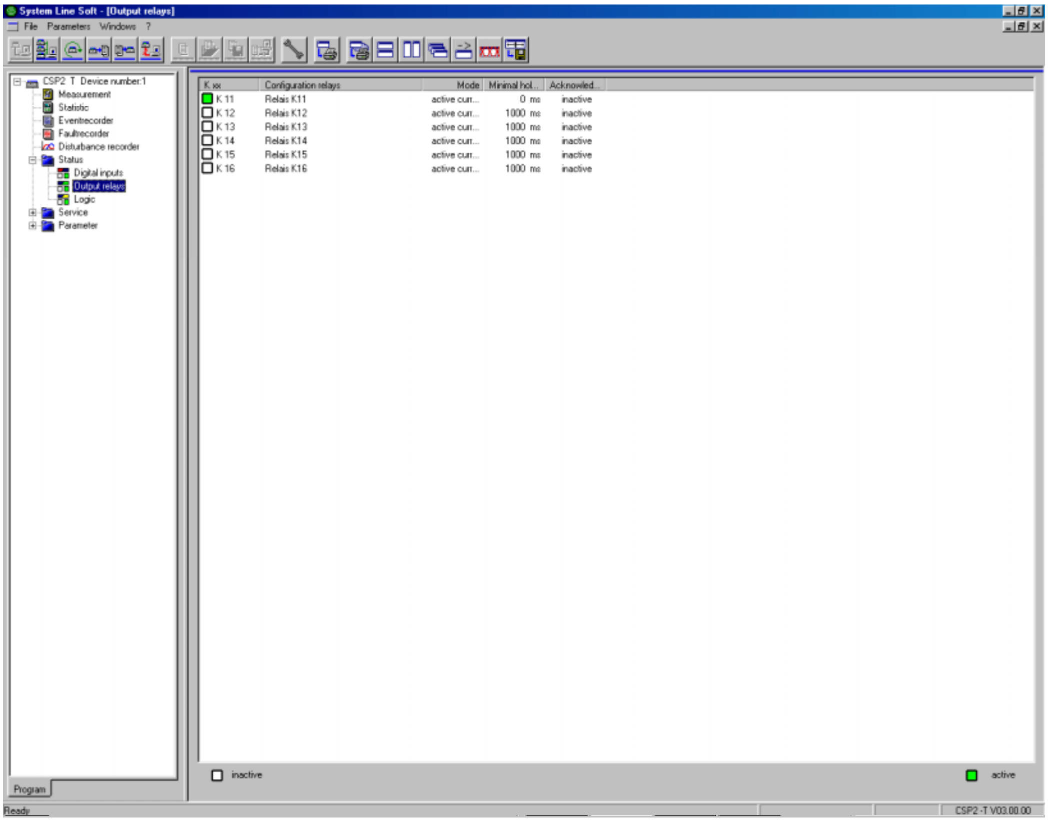


Figure 5.18: Menu „Status“ (Signal (Output) relays) - SL-SOFT

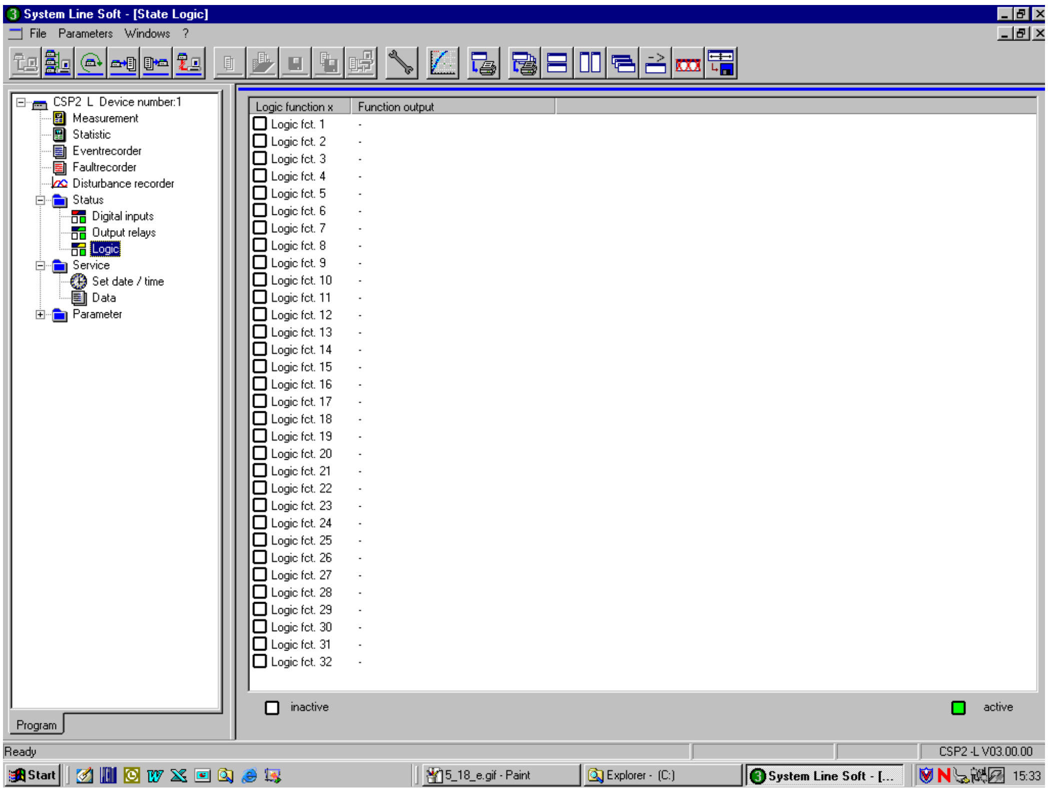


Figure 5.19: Menu „Status“ (Logic) - SL-SOFT

5.7 Menu Parameter

Description
In this chapter, the individual parameters and their settings are explained with their effects on the total system. All the parameters belonging to a function are put together in a parameter group. The tabular list of the individual parameters within the parameter group has been matched to the menus of the *CMP1*.
A parameter group belongs either to the *system parameter set* or to a *protection parameter set*. The *CSP2* has 4 switchable protection parameter sets, each of which entails the complete scope of the protection functions designated for the corresponding type of appliance.
This means that depending on the type of appliance differing parameters can partly be available in the *CSP2*.

Explanations of the table set-up

Example

field settings [1]					
Parameter [2]	*Description* [3]	*Settings/Setting Range* [4]	*Description* [5]	*Pre-setting.* [6]	*Step range* [7]
CT pri	Rated primary current of the phase CTs	1...50,000 A		1000 A	1 A
VT con	Connection mode (treatment) of the phase VTs	Y	Star	Y	-
		Δ	Delta		
		no VTs	no U-measuring		
		V	V-connection		

Table 5.9: Example of a Parameter Table

[1] Name of the parameter group
[2] Short designation of the parameter as it appears in the *CMP1* display
[3] Parameter description
[4] Setting range and/or term of the selection available
[5] Description of setting range or selection
[6] Default setting
[7] Step range within the setting range for numerical values

5.7.1 System parameters

The *System parameters* entail settings with regard to:

- field settings,
- controls: switch control times, interlockings (via SCADA and *CMP1*),
- assignment of the digital inputs,
- assignment of the logic,
- assignment of the signal relays,
- assignment of the LED's,
- fault recorder,
- communication: IEC 60870-5-103; PROFIBUS-DP and CAN-BUS,
- resetting of functions,
- statistical parameters,
- analog inputs,
- tap changer and
- operating side

Note

When *saving amended system parameters,* there is automatically a *re-boot* of the *CSP/CMP system*!

5.7.1.1 Field settings

Description

This parameter group contains all the principal settings concerned with the measurement of current, voltage and frequency and depend on the transmission ratio of the transformers, their physical arrangement and measurement circuits and on the existing mains frequency.

Parameters

„f_N“ (nominal frequency)

The setting of the nominal frequency can be *"50 Hz“* or *"60 Hz“*. It defines the reference value for a measured over- or under-frequency in the "Frequency protection" protection parameter group.

„CTW1 pri“ (Primary nominal value of the current transformer)

This parameter defines the nominal current of the primary side W1 of the existing current transformers.

„CTW1 sec“ (Secondary nominal value of the current transformer)

This parameter defines the nominal current of the secondary side W1 of the existing current tranformers to 1 A or 5 A.

„CTW1 dir“ (Polarity of the current transformer – important for directional protection!)

With the settings *"0°"* or *"180°"* the user has the possibility of joint alteration of direction for the phase currents. An amendment of the default setting, *"0°“* can become necessary if protective functions with a directional feature are used and all three current transformers have erroneously been connected with the wrong polarity. The current indicators determined are calculatorily turned 180° by the *CSP2*.

„CTW2 pri“ (Primary nominal value of the current transformer)

This parameter defines the nominal current of the primary side W2 of the existing current transformers.

„CTW2 sec" (Secondary nominal value of the current transformer)
This parameter defines the nominal current of the secondary side W2 of the existing current tranformers to 1 A or 5 A.

„CTW2 dir" (Polarity of the current transformer – important for directional protection!)
With the settings *"0°"* or *"180°"* the user has the possibility of joint alteration of direction for the phase currents. An amendment of the default setting, *"0°"* can become necessary if protective functions with a directional feature are used and all three current transformers have erroneously been connected with the wrong polarity. The current indicators determined are calculatorily turned 180° by the *CSP2*.

Remark

If the *Holmgreen circuit* is used to detect the earth current, the parameter *"ECT dir"* must be selected according to the setting of the parameter *"CT dir"*!

If the phase currents are detected via the *V connection* (2-phased current measurement), the determination of the earth current is only possible via a direct measurement with a *ring core transformer*!

„ECT prim" (Primary nominal value of the earth current transformer)
This parameter defines the primary nominal current of the existing earth current transformer (ring core transformer). If the earth current detection is done via the *Holmgreen connection*, the primary value of the phase current transformer (*CT pri*) must also be entered here.

„ECT sec" (Secondary nominal value of the earth current transformer)
This parameter defines the secondary nominal current of the existing earth current transformer (*ring core transformer*) to 1 A or 5 A. If the earth current detection is done via the *Holmgreen connection*, the secondary value of the phase current transformer (*CT sec*) must be entered here.

„ECT dir" (polarity of the earth current transformer – important for directional protection!)
With the settings *"0°"* or *"180°"* the operator has the possibility of turning the current vector by 180 degrees (change of sign), without modification of the wiring. This means, the current indicator determined is calculatorily turned 180° by the *CSP2*.
A modification of the default setting *"0"* can become necessary in earth current detection via:

- *Ring core transformers*: and connection with polarity the wrong way round
- *Holmgreen connection*: and connection of all phase current converters with polarity the wrong way round

„VT pri" (primary nominal value of the voltage transformers)
This parameter defines the primary nominal voltage of the existing voltage transformer.

„VT sec" (secondary nominal value of the voltage transformers)
This parameter defines the secondary nominal voltage of the existing voltage converters.

„VT con" (kind of connection of the voltage transformers)
This parameter has to be set in order to ensure the correct assignment of the voltage measurement channels in the *CSP2* to the secondary terminals of the transformer (*Y, Δ or V connection*). With the setting »*no VT*« there is no voltage measurement.

„VT loc" (measurement location of the voltage transformers)
This parameter considers the physical arrangement (measurement location) of the voltage transformers, which can be fit on the bus bar side (*"VT loc = W1 BB or W2 BB ":* above the CB) or on the transformer (winding) side (*"VT loc = W1 Tr or W2 Tr ":* underneath the CB).

Settings:

„W1 busb.": The voltage transformers are located at the busbar side (1) – above the circuit breaker (1).

„W1 Tr": The voltage transformers are located at the transformer (winding) side (1) – below the circuit breaker (1).

„W2 busb.": The voltage transformers are located at the busbar side (2) – above the circuit breaker (2).

„W2 Tr": The voltage transformers are located at the transformer (winding) side (2) – below the circuit breaker (2).

Remark

The voltage measurement by CSP2-T is dependend on the VT location as well as on the CB position at both ends of the transformer (see tabulated form at chapter "Tripping location")

Attention

Please be aware of active under-voltage protective function U< and U<<. In dependence of the VT location and position states of CBs the conditioning for the effectiveness of U< and U<< is different. To realize customer-specific requirements CSP2-T provides the input function "U<, U<< Block" can be applied by the programmable logic functions.

„EVT con" (measurement of the residual voltage)
The parameter »*EVT con*« stipulates the way in which the residual voltage is to be detected:

Settings:

„geometr.SUM": The detection of the residual voltage *Ue* is done calculatorily via the formation of the geometrical sum: $\sum \underline{U}_{L-N} = \underline{U}_{L1}+\underline{U}_{L2}+\underline{U}_{L3}$ of the measured phase voltages $\underline{U}_{L1}$ ($\underline{U}_{L1-N}$), $\underline{U}_{L2}$ ($\underline{U}_{L2-N}$) and $\underline{U}_{L3}$ ($\underline{U}_{L3-N}$), which must be connected in *star connection* (*VT con = Y*) to the voltage measurement inputs for this purpose. The residual voltage Ue can only be calculated from the phase voltages.

„broken delta": This setting can be selected if the residual voltage Ue is measured directly. The prerequisite is the existence of three phase voltage transformers, each of which has an e-n winding. The e-n windings are connected in series to the measurement input for the residual voltage (*open delta*). In this, the primary and secondary nominal values of the phase voltage transformers are to be considered *(EVT pri/EVT sec)* with regard to the e-n winding.

Remark

If the *V-connection* is used (2-phased voltage measurement) neither the direct measurement nor the calculatory determination of the residual voltage Ue are possible!

„no EVT.": There is no detection of the residual voltage Ue.

„EVT pri" (Primary nominal value of the voltage transformers)
This parameter defines the primary nominal voltage of the existing voltage transformers, which is only to be taken into account in the direct measurement of the residual voltage Ue ("*EVT con = open delta*").

„EVT sec" (Secondary nominal value of the e-n winding of the voltage transformers)
This parameter defines the secondary nominal voltage from the e-n windings of the existing voltage transformers, which is only to be taken into account in the direct measurement of the residual voltage ("*EVT con = open delta*").

Field settings					
Parameter	*Description of the parameter*	*Setting/ Setting Range*	*Description of the parameter setting*	*Pre-Setting*	*Step Range*
f_N	Nominal frequency	50 Hz 60 Hz		50 Hz	-
Parameter CT (phase current transformer)					
CTW1 pri	primary side W1; primary nom. current CT1	1...50,000 A		1000 A	1 A
CTW1 sec	primary side W1; secondary rated current CT1	1 A 5 A		1 A	-
CTW1 dir	Polarity (direction) of the phase CTs	0° 180°		0°	180°
CTW2 pri	secondary side W2; primary rated current CT2	1...50,000 A		1000 A	1 A
CTW2 sec	secondary side W2; secondary rated current CT2	1 A 5 A		1 A	
CTW2 dir	Polarity (direction) of the phase CTs	0° 180°		0°	180°
Parameter ECT (earth current transformer)					
ECT loc	location of the ECT, winding1 or winding2 or Cauldron protection or no ECT W1: Ie loc W1 measured, Ie W2 calculated; W2: Ie loc W2 measured, Ie W1 calculated; CP (Cauldron protection), Ie W1 and W2 calculated; No ECT: Ie loc W1 calculated, Ie loc W2 calculated	W1 W2 Caldron no ECT		W1	
ECT prim.	Rated primary current of the earth CTs	1...50,000 A	*	1000 A	1 A
ECT sec	Rated secondary current of the earth CTs	1 A 5 A	**	1 A	-
ECT dir	Polarity (Direction) of the earth CT	0° 180°		0°	180°
Parameter VT					
VT prim.	Rated primary voltage of the VTs	1...500,000 V		110,000 V	1 V
VT sec	Rated secondary of the VTs	1...230 V		1 V	1 V
VT con	Connection mode (treatment) of the phase VTs	Y Δ no VT V	Star Connection Delta Connection No U-Measurement V-Connection	Y	-
VT loc	location from voltage measurement W1 busbar, see position VT Loc1 in figure transformerstation W2 Tr (winding1 = prim Tr) see position VT Loc2 in figure transformerstation W2 Tr (winding2 = sec. Tr) see position VT Loc3 in figure transformerstation W2 busbar see position VT Loc4 in figure transformerstation	W1 Busb. W1 Tr W2 Tr W2 Busb.		W1	-

Field settings					
Parameter	*Description of the parameter*	*Setting/ Setting Range*	*Description of the parameter setting*	*Pre-Setting*	*Step Range*
Rt.field	ABC right rotating field ACB left rotating field to take into account a left rotating field it is possible to use the parameter "Rotating field".	ABC ACB		ABC	
Parameter EVT (earth voltage transformer)					
EVT con	broken delta (via separate voltage input), If -broken Δ- is selected, the location for the earth voltage measuring will be select with the parameter -EVT loc-. (EVT con -broken Δ- and select EVT loc -W1- or -W2-) If -geometr. Σ- is select, the parameter -EVT loc- will be ignored and the measuring location is the same as the phase voltage location, VT loc. In this case VT con must be set to –star- if -no EVT- is select, the earth voltage can´t be measured.	broken Δ geometr.SUM none	Series Connection of the e-n Wndings $\sum \underline{U}_{L-N} = \underline{U}_{L1}+\underline{U}_{L2}+\underline{U}_{L3}$, only for setting : „VT = Y" No Ue Measurement	broken Δ	-
EVT loc	W1 (winding1 = prim TR) see position VT Loc2 in figure transformerstation W2 (winding2 = sec. TR) see position VT Loc3 in figure transformerstation	W1 W2		W1	
EVT prim.	Rate primary voltage of the VT e-n winding	1…500000 V	Only relevant for setting: „EVT con = open Δ"	10000 V	1 V
EVT sec	Rated secondary voltage of the VT e-n winding	1…230 V	Only relevant for setting: „EVT con = open Δ"	1 V	1 V
Parameter transformer (TR)					
Applica.	Device assortment			10,000 kVA	
Sr	power capacity transformer	1...800,000 kVA			
UrW1	rated voltage winding1 (prim. side)	1…500000 V			
UrW2	rated voltage winding2 (sec. side)	1…500000 V			
W1 con.	connection groups winding1 (primary side). YN or ZN are connection groups with earth connection	y d z yn zn		y	
W2 con.	connection groups winding2 (secondary side) yn or zn are connection groups with earth connection	y d z yn zn		y	
Ph.shift	phase shift between primary and secondary side. The phase shift angle is factor (1,2,3…11) multiplied with 30 degrees.	0 1 2 3 …11		0	

Table 5.10: Field parameters

5.7.1.2 Controls

Description
The parameter menu "Controls" contains the two sub-menus "Control Timing" and "Interlocking". The sub-menu "control times" is used to parameter the control times for the individual switchgears. In the sub-menu "Interlocking", blocking commands for individual or all switchgear can be set or cancelled by parameter setting.

5.7.1.2.1 Control times

Description
The *control times* are supervision times for the executing of switching actions and are composed of the *switching times* and *follow-up times*.
As a function of the field configuration and the assignment of the switchgears to the control outputs, the control times can be set accordingly.
Switchgear 1 (SG1) and switchgear 2 (SG2) are circuit breakers as a rule, with the disconnector (e.g. SG2, SG3, SG4) and the earthing switch (e.g. SG5) being defined as switchgear below. The circuit breaker 1 is actuated via the control outputs (coil outputs) OL1 »OFF« and OL2 »ON«, circuit breaker 2 is actuated via controled outputs, coil OL3 »OFF« and OL4 »ON«. The set control time *ts* for SG1 and SG2 acts directly on the circuit breaker via the control outputs.

Switchgears SG3, SG4 and SG5 (disconnector or earthing switch) are actuated via the control outputs (motor outputs) OM1, OM2 and OM3 and activated for the period set in each case with a corresponding control command.

Parameters

Switch time „ts SGX"
All the control commands issued are limited as regards time. If a control command is not positively acknowledged after the time set (i.e. check back signal for the position of the switchgear to be controlled is not received within the set switching time), the switchgear in question is recognised as being in a faulty position and the command is terminated. The control times can be set separately from 80 to 50,000 ms for the individual control outputs.

Follow-up times „tr ON" and „tr OFF"
A switch command with follow-up time is used to conclude a switching process safely or to fix a switchgear in its final position. For this, the disconnector/earthing switch is »pushed on« a little after the receipt of the new check back signal if a follow-up time has been set. This means that the drive motor remains switched on after the check back signal is present (check-back signals are present due to imprecise adjustment of the limit switch, but the contacts of the switchgear are not yet in the required final position) for the duration of the set follow-up time.
In this, *"tr ON "* is the follow-up time for the command issue SGX to switch on and *"tr OFF "* the follow-up time for the command issue SGX to switch off. The follow-up times can be set separately from 0 to 5,000 ms for the individual control outputs.

Control Times						
Switching time/ follow up time		*Description*	*Setting range*	*Possibly Application*	*Control output*	*Default*
SG1	tc SG1	Switching time for SG1	80 – 50,000ms	Circuit breaker	OL1, OL2	200ms
	tr ON	Follow up time ON for SG1	0 - 5000ms			5000 ms
	tr OFF	Follow up time OFF for SG1	0 - 5000ms			5000 ms
SG2	tc SG2	Switching time for SG2	80 – 50,000ms	circuit breaker	OL3, OL4	200 ms
	tr ON	Follow up time ON for SG2	0 - 5000ms			5000 ms
	tr OFF	Follow up time OFF for SG2	0 - 5000ms			5000 ms
SG3	tc SG3	Switching time for SG3	80 – 50,000ms	isolator or earthing switch	OM1	10,000 ms
	tr ON	Follow up time ON for SG3	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG3	0 - 5000ms			1000 ms
SG4	ts SG4	Switching time for SG4	80 – 50,000ms	isolator or earthing switch	OM2	10,000 ms
	tr ON	Follow up time ON for SG4	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG4	0 - 5000ms			1000 ms
SG5	ts SG5	Switching time for SG5	80 – 50,000ms	isolator or earthing switch	OM3	10,000 ms
	tr ON	Follow up time ON for SG5	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG5	0 - 5000ms			1000 ms

Table 5.11: Control Times and follow up times

5.7.1.2.2 Interlocking

Description
The control of switchgears can be prevented by certain interlocking commands. These interlocking commands (interlocking markers) can be sent or cancelled either by SCADA via the data telegrams of the various types of protocols or directly by a *CMP* parameter setting (further details in Chap. 5.7.1.2.2 "Interlocking"). The set interlocking markers block control commands made either by the *CMP1* via digital inputs or by the SCADA-system. The status of an interlocking marker is displayed by the displays "active" or "inactive".

Important

> When the *communication* between *CSP2* and the *SCADA-system is interrupted,* it is possible to reset "active" interlocking markers via the *CMP1*. Precondition for this, however, is that MODE 3 (Local Operation/Parameter Setting) is selected.

Parameter

„All SG"
All the control commands are blocked (if the function is set to active).

„SG1 off"
Only the control command for *switching off switchgear* 1 (SG1) are blocked (if the function is set to active).

„SG1 on"
Only the control commands for *switching on switchgear* 1 (SG1) are blocked (if the function is set to active).

„SG2 off"
Only the control commands for *switching off switchgear* 1 (SG2) are blocked (if the function is set to active).

„SG2 on"
Only the control commands for *switching on switchgear* 2 (SG2) are blocked (if the function is set to active).

„SG3 off"
Only the control commands for *switching off switchgear* 2 (SG3) are blocked (if the function is set to active).

„SG3 on"
Only the control commands for *switching on switchgear* 3 (SG3) are blocked (if the function is set to active).

„SG4 off"
Only the control commands for *switching off switchgear* 3 (SG4) are blocked (if the function is set to active).

„SG4 on"
Only the control commands for *switching on switchgear* 4 (SG4) are blocked (if the function is set to active).

„SG5 off"
Only the control commands for *switching off switchgear* 4 (SG5) are blocked (if the function is set to active).

„SG5 on"
Only the control commands for *switching on switchgear 5* (SG5) are blocked (if the function is set to active).

Interlocking				
Parameter	*Setting/Setting Range*	*Description of Parameter Setting*	*Pre-setting*	*Step range*
All SG	active	Any issued control command will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG1 off	active	Every OFF command for SG1 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG1 on	active	Every ON command for SG1 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG2 off	active	Every OFF command for SG2 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG2 on	active	Every ON command for SG2 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG3 off	active	Every OFF command for SG3 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG3 on	active	Every ON command for SG3 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG4 off	active	Every OFF command for SG4 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG4 on	active	Every ON command for SG4 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG5 off	active	Every OFF command for SG5 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG5 on	active	Every ON command for SG5 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	

Table 5.12: Interlocking: Blocking via SCADA and CMP1

5.7.1.3 Digital inputs

Description
Depending on the type of device and capability, the *CSP2* provides a certain number of digital inputs. They are used to monitor processes in the periphery via signal lines and to initiate certain actions on the part of the *CSP2* that have the input functions assigned to the digital inputs.
The digtial functions can be assigned to digital inputs (input functions):

- protection functions,
- check back signals,
- field and
- supervision messages as well as
- remote control and interlocking functions for switchgears.

Parameters

„DI x" (fixed or assigned input functions)
The digital inputs are divided into firmly assigned (group 1) and freely (from the catalogue of the input functions – see Annex) assignable inputs (remaining groups). By means of the *CMP1*, the input functions can be assigned to the digital inputs.

A digital input can be activated according to two (parameter setting) principles:

1st setting: "active 1" (working current principle)
A digital input becomes active if a potential difference above the pick-up threshold of the digital input exists at its terminal compared with the "COMx" return line. The pick-up threshold can be set separately for each DI via a coding plug.

2nd setting: "active 0" (idle current principle)
If necessary, the logics of each digital input can be inverted. The input would accordingly be active if no potential difference between the terminal of the digital input and its return line "COMx" exists (example of application: »Fuse fail AV«).

Debouncing time
The debouncing time states the interval of time after which the input accepts a new change of status at the earliest. An individual anti-beat time can be set for each input if the incoming signal shows a bouncing behaviour. This function is sensible if the input source does not supply a defined status transition. In the use of an debouncing time, the reaction time of the system is extended, as quick sequences of real alterations of state at an input are recognised more slowly as a function of the set debouncing time.
For applications with a time delay, debouncing times of up to 60,000 ms can be set. The minimum reaction time of the digital inputs amounts to 50 ms.

Note

A set debouncing time acts on the one hand as a delay time for the activation, on the other hand as a delay time for the deactivation of a digital input!
Example: set debouncing time = 5000 ms
Activation of the DI: The signal must exist on the terminal for at least 5000 ms in order to activate the DI!
Deactivating the DI: If the signal goes off, the DI is only deactivated after 5000 ms.

Digital Inputs *(DI-Group1 - fixed allocation)*				
DI-Gruppe	*DI-No*	*Parameters*	*Setting/ Setting Range*	*Description*
Group 1 (fixed)	DI 1	DI 1 (fixed function)	„SG1 Signal 0"	Position switch. device 1: OFF
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000ms	Debouncing time
	DI 2	DI 2 (fixed function)	„SG1 Signal I"	Position switch. Device 1: ON
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000 ms	Debouncing time
	DI 3	DI 3 (fixed function)	„SG2 Signal 0"	Position switch. Device 2: OFF
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000 ms	Debouncing time
	DI 4	DI 4 (fixed function)	„SG2 Signal I"	Position switch. device 2: ON
			„active 1"	Open circuit principle
			„aktiv 0"	Closed circuit principle
			„inaktiv"	Out of function
			0…60,000 ms	Debouncing time
	DI 5	DI 5 (fixed function)	„SG3 Signal 0"	Position switch. device 3: OFF
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000 ms	Debouncing time
	DI 6	DI 6 (fixed function)	„SG3 Signal I"	Position switch. device 3: ON
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000 ms	Debouncing time
	DI 7	DI 7 (fixed function)	„SG4 Signal 0"	Position switch. device 4: OFF
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60,000 ms	Debouncing time t
	DI 8	DI 8 (fixed function)	„SG4 Signal I"	Position switch. device 4: ON
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60.000 ms	Debouncing time
	DI 9	DI 9 (fixed function)	„SG5 Signal 0"	Position switch. device 5: OFF
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60.000 ms	Debouncing time
	DI 10	DI 10 (fixed function)	„SG5 Signal I"	Position switch. Device 5: ON
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0…60.000 ms	Debouncing time

Table 5.13: Fixed Allocation of digital inputs – DI Group 1

Digital Inputs *(Variable Allocation for DI Groups 2 to 4 — Here: Exemplarily for Group2)*				
DI-Group	*DI-No.*	*Parameters*	*Setting/Setting Range*	*Description*
Group 2 (variabel)	DI 11	DI 11 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000 ms	Debouncing time
	DI 12	DI 12 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000 ms	Debouncing time
	DI 13	DI 13 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000ms	Debouncing time
	DI 14	DI 14 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000 ms	Debouncing time
	DI 15	DI 15 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000ms	Debouncing time
	DI 16	DI 16 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000 ms	Debouncing time
	DI 17	DI 17 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000ms	Debouncing time
	DI 18	DI 18 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1"	Open circuit principle
			„active 0"	Closed circuit principle
			„inactive"	Out of function
			0...60.000 ms	Debouncing time

Table 5.14: Variable assignment of digital inputs – DI Group 2 (by way of example)

Assignable input functions (DI functions)
In order to increase the functionality of the *CSP/CMP* system, the user has a variety of input functions at his disposal. For this, one input function is to be assigned to one digital input (DI) (parameter setting). The activation of such an input function is done via the activation of the corresponding digital input (DI) which this function has been assigned to.

Note

- Each DI can only be assigned to one input function
- Input functions can be multiply assigned.
- If the same input function is used by two or more DI's, the result is an "or" equation of all states.

Description (input functions in case of activation)!
Depending on the type of the input function, certain processes are initiated by the *CSP2*.

Processing (module)
Each activated input function is followed by a certain action, the effects of which refer to the various modules of the *CSP2*. These are modules for control/locking functions, monitoring/reports or protective functions etc.

Assignment
The input functions for the detection of the switch position feedbacks (»SG1 Signal I« to »SG5 Signal 0«) have been firmly assigned to the first 10 digital inputs (DI group 1), i.e. the first 10 DI's cannot be assigned with other input functions. (Examples of switchgear assignment can be found in the "*Field configuration*" chapter). From DI 11, the digital inputs can be assigned with each of the assignable input functions.

Contents of display
The momentary switchgear positions (»SG1 Signal I« to »SG2 Signal 0«) are shown in the display of the *CMP1*. If a switchgear position changes, the check back signals are transmitted into the *CSP* via the firmly assigned digital inputs (»SG1 Signal I« to »SG2 Signal 0«). The single line (single-pole graph) of the *CMP* is actuated on the base of the first ten digital inputs.
In this, two position check back signals independent of one another must be provided for each switchgear (e.g. for switchgear 1: »SG1 Signal I« and »SG1 Signal 0«. Consequently, there are four possible states for the switchgear positions of each switchgear:

1. „*Switchgear closed*": »SG1 Signal I« = *active*, »SG1 Signal 0« = *inactive*«
2. „*Switchgear open*": »SG1 Signal I« = *inactive*, »SG1 Signal 0« = *active*«
3. „*Differential position*": »SG1 Signal I« = *inactive*, »SG1 Signal 0« = *inactive*«
4. „*Failure position*": »SG1 Signal I« = *active*, »SG1 Signal 0« = *active*«

In addition, only the »CB1 removed« (or. »CB2 removed«) input functions influence the display of the symbols for the power switch(es):

5. *»CB1 removed« = active*: symbol for CB1 goes off
6. *»CB2 removed« = active*: symbol for CB2 goes off

All the other input functions cannot be shown graphically on the display of the *CMP*!

LED (acknowledgement, flashing code)

Flashing code
Each input function can be displayed by assignment to a LED of the *CMP* and possesses its functionality according to a certain colour or flashing code:
r = red
rb = blinking red
g = green
gb = blinking green

Acknowledgement
Each input function is only active as long as the corresponding digital input is active. An *acknowledgeability* therefore does not refer to the input function itself, but merely to the LED to which the input function is assigned. Further, an LED cannot be acknowledged as long as the input function and thus the digital input is still active.

If the acknowledgement (LED Quit) is set to:
trip: This means that only trips have to be acknowledged.
alarm: This means that trips and alarms have to be acknowledged.
all: This means that the LED has to be acknowledged for all input functions (even those who are not acknowledgeable like "SG1 on")
none: not assigned

For *non-acknowledgeable* input functions, the LED goes off or changes its colour when the function is no longer active.
If the output function is *acknowledgeable*, the LED continues to light up even after deactivation of the function. Resetting the LED can be done with the »C« key on the *CMP1*, via a digital input with the assigned input function »Acknowledgement« or via an acknowledgement command from the SCADA-system.

Example: Acknowledgeable input function "Fuse fail AV"

Digital Input Functions							
Input Function (Displayed Text)	*Description*	*Processing (Module)*	*Assignable*	*Shown in Display*	*LED-Anzeige*		
					LED-Reset	*Blink Code*	*Note*
„Fuse fail AV"	Message signalling failure of the MCB for the supply voltage (aux. voltage) of external devices.	Supervision	●	-	-	r	DI active
					●	-	DI inactive

When this input function becomes active (column *Remark:* "DI active"), the LED onto which this input function has been placed lights up red. As long as the DI activating this input function is still active, the LED cannot be acknowledged. If the DI and thus the input function becomes inactive, the LED can now be acknowledged. The LED goes off after the acknowledgement.
In addition, the *LED acknowledgeability* for this input function depends on the setting of the LED parameter *"LED-Quit"*.

Input Functions (for Digital Inputs and Function Outputs Logic)

Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED-Display		
					LED Reset	Blink Code	Note
„n.a.“	Not assigned (i.e.without function)	-	●	-	-	-	-
„SG1 Signal I“	Position check-back signal for „Switchgear 1 ON“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG1 Signal 0“	Position check-back signal for „ Switchgear 1 OFF“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG2 Signal I“	Position check-back signal for „ Switchgear 2 ON“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG2 Signal 0“	Position check-back signal for „ Switchgear 2 OFF“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG3 Signal I“	Position check-back signal for „ Switchgear 3 ON“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG3 Signal 0“	Position check-back signal for „ Switchgear 3 OFF“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG4 Signal I“	Position check-back signal for „ Switchgear 4 ON“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG4 Signal 0“	Position check-back signal for „ Switchgear 4 OFF“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG5 Signal I“	Position check-back signal for „ Switchgear 5 ON“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„SG5 Signal 0“	Position check-back signal for „ Switchgear 5 OFF“	Interlocking/ Supervision	-	●	-	- -	DI active DI inactive
„Prot. blocked“	Blocking of those protective functions which have the »Ex Block« parameter in position »active«	Protection	●	-	-	fr -	DI active DI inactive
„AR blocked“	External blocking of the AR function In case that the AR cycle will be blocked by the input function „AR blocked“ the AR function is to be stopped by means of resetting relevant timers and counters affecting the AR cycle.	Protection	●	-	-	fr -	DI active DI inactive
„AR Start“	Start of the AR function triggered by an external protect. trip via a DI function (e.g. „Protective Trip 1“).	Protection	●	-	-	fr -	DI active DI inactive
„AR sync.check“	For connection of an external synchronisation check relay. If the related setting is activated in the AR parameter group, the CB is only re-connected within an AR sequence if this digital input is in »active« position.	Protection	●	-	-	fr -	DI active DI inactive
„Rev interlock“	Signal input for setting up a protection concept with „Rear Interlocking“. This input is connected with output „Protective Activation X“ of a lower-level protection facility. When the input is active, individual steps of the overcurrent protection functions can be interlocked if their parameters »Rear Interlock. «are set to »active«.	Protection	●	-	-	fg -	DI active DI inactive
„Ext CB fail“	Trip signal of external protective facilities (lower-level protective facilities which signal »Circuit Breaker Failure«) incl. OFF command to the local CB.	Protection	●	-	- ●	r -	DI active DI inactive
„Alarm: Prot.1“	External protective signal: Activation of an external protective facility (for any protective facility).	Protection	●	-	-	fr -	DI active DI inactive
„Trip: Prot.1“	Trip signal of external protective facilities (for any protective facility) incl.OFF command to the local CB.	Protection	●	-	-	r	DI active

Input Functions (for Digital Inputs and Function Outputs Logic)							
Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED-Display: LED Reset	LED-Display: Blink Code	LED-Display: Note
	(Activation of the AR function only if a digital input with „AR Start" has been assigned and was activated).				●	-	DI inactive
„Device Reset"	External resetting signal for resetable LED indications and signal relays.	LED Display/ Signal Relay	●	-	-	fg	DI active
						-	DI inactive
„Fuse fail VT"	Failure indication of a single-pole autom. fuse for external VTs. Voltage measuring is recognized of being interrupted and all active protective functions for voltage, frequency and power are blocked (ineffective).	Supervision/ Protection	●	-	-	r	DI active
					●	-	DI inactive
„Fuse fail AV"	Message signalling failure of the autom. fuse for the supply voltage (aux. voltage) of external devices.	Supervision	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: CCS"	Signal coming from an external control circuit supervision.	Supervision	●	-	-	fr	DI active
						-	DI inactive
„Switch p.-set"	Remote switching between two protective parameter sets (see chapter „Parameter/Protective Parameter")	Protection	●	-	-	fg	DI active
						-	DI inactive
„Trigg.dist.rec"	Start of the fault recorder from external	Data Recording	●	-	-	fg	DI active
						-	DI inactive
„CB1 ready"	CB1 is ready for operation. If this function is »inactive«, connection of CB1 is blocked.	Interlocking	●	-	-	g	DI acive
						r	DI inactive
„CB2 ready"	CB2 is ready for operation. If this function is »inactive«, connection of CB2 is blocked.	Interlocking	●	-	-	g	DI active
						r	DI inactive
„SF6 Alarm"	Message indicating pressure decrease in the gas tank	Supervision	●	-	-	r	DI active
					●	-	DI inactive
„Cmd1 SG1 ON"	Remote ON command for switching device 1 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd1 SG1 OFF"	Remote OFF command for switching device 1 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd2 SG1 ON"	Remote ON command for switching device 1 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd2 SG1 OFF"	Remote OFF command for switching device 1 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG2 ON"	Remote ON command for switching device 2 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG2 OFF"	Remote OFF command for switching device 2 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG3 ON"	Remote ON command for switching device 3 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG3 OFF"	Remote OFF command for switching device 3 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG4 ON"	Remote ON command for switching device 4 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG4 OFF"	Remote OFF command for switching device 4 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG5 ON"	Remote ON command for switching device 5 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive
„Cmd SG5 OFF"	Remote OFF command for switching device 5 incl. field interlocking (key switch position at the CMP: „Remote Operation")	Control	●	-	-	fg	DI active
						-	DI inactive

Input Functions (for Digital Inputs and Function Outputs Logic)							
					LED-Display		
Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED Reset	Blink Code	Note
„Plug CB1 out“	CB1 or first CB (Duplex) is removed (or the plug is removed). CB1 symbol in the display disappears, CB1 cannot be controlled any longer.	Interlocking	●	●	-	fg	DI active
						-	DI inactive
„Plug CB2 out“	Second CB (Duplex only) is removed (or the plug is removed). CB2 symbol in the display disappears, CB2 cannot be controlled any longer.	Interlocking	●	●	-	fg	DI active
						-	DI inactive
„Ctrl. blocked 1“	Blocking of the ON/OFF control for all electrical controllable switching devices	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„Function 1“	Message of user defined „Function 1“	Message	●	-	-	r	DI active
					●	-	DI inactive
„Function 2“	Message of user defined „Function 2“	Message	●	-	-	r	DI active
					●	-	DI inactive
„Function 3“	Message of user defined „Function 3“	Message	●	-	-	r	DI active
					●	-	DI inactive
„Function 4“	Message of user defined „Function 4“	Message	●	-	-	r	DI active
						-	DI inactive
„Function 5“	Message of user defined „Function 5“	Message	●	-	-	r	DI active
						-	DI inactive
„Function 6“	Message of user defined „Function 6“	Message	●	-	-	r	DI active
						-	DI inactive
„Function 7“	Message of user defined „Function 7“	Message	●	-	-	g	DI active
						-	DI inactive
„Function 8“	Message of user defined „Function 8“	Message	●	-	-	g	DI active
						-	DI inactive
„Function 9“	Message of user defined „Function 9“	Message	●	-	-	g	DI active
						-	DI inactive
„Function 10“	Message of user defined „Function 10“	Message	●	-	-	g	DI active
						-	DI inactive
„Ext prot.act“	Indication as to supervision of external protective devices	Supervision	●	-	-	g	DI active
						r	DI inactive
„Alarm: Temp.“	External protection signal: Activation of an external protection device (mainly for temperature monitoring facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Temp.“	Trip signal of external protection devices (mainly for temperature monitoring facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: Buchh.“	External protection signal: Activation of an external protection device (mainly for Buchholz protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Buchh.“	Trip signal of external protection devices (mainly for Buchholz protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Trip: Diff.“	Trip signal of external protection devices (mainly for differential protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: Imped.“	External protection signal: Activation of an external protection device (mainly for distance protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive

Input Functions (for Digital Inputs and Function Outputs Logic)							
Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED-Display: LED Reset	LED-Display: Blink Code	LED-Display: Note
„Trip: Imped."	Trip signal of external protection devices (mainly for distance protection facility) incl. an OFF command to the local CB.	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Fuse fail VC"	Message signalling failure of the autom. fuse for the control voltage (e.g. of the power circuits)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Fuse fail Ven"	Message signalling failure of the autom. fuse for the residual voltage	Protection	●	-	-	r	DI active
					●	-	DI inactive
„HH-fuse trip"	Message signalling HH-fuse trip	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Ext. CB trip."	Message signalling failure of external circuit breaker	Protection	●	-	-	r	DI active
					●	-	DI inactive
„SG1block."	Blocking of the ON/OFF control for switching device 1 (Exception: „EMERGENCY OFF"/AR/Protective trip function for the CB)	Interlocking	●	-	-	fr	DI active
						-	DI inactive
„SG2 block."	Blocking of the ON/OFF control for switching device 2	Interlocking	●	-	-	fr	DI active
						-	DI inactive
„SG3 block."	Blocking of the ON/OFF control for switching device 3	Interlocking	●	-	-	fr	DI active
						-	DI inactive
„SG4 block."	Blocking of the ON/OFF control for switching device 4	Interlocking	●	-	-	fr	DI active
						-	DI inactive
„SG5 block."	Blocking of the ON/OFF control for switching device 5	Interlocking	●	-	-	fr	DI active
						-	DI inactive
„SG23 block."	Blocking of the ON/OFF control for switching devices 2 and 3	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„SG234 block."	Blocking of the ON/OFF control for switching devices 2, 3 and 4	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„SG2345 block."	Blocking of the ON/OFF control for switching devices 2, 3, 4, and 5	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„Alarm: Motor"	External protection signal: Activation of an external protection device (mainly for motor protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Motor"	Trip signal of external protection devices (mainly for motor protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with "AR Start")	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Ctrl blocked 2"	Blocking of the ON/OFF control for all electrical controllable switching devices	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„Ext CB1 off"	External disconnection of CB1, irrespectively of the CMP key switch position: Local Operation/Remote Operation. When function „Ext CB1 OFF" is active, the control commands for reconnection of CB1 are blocked.	Control	●	-	-	r	DI active
					●	-	DI inactive
„Ext CB1 on"	External connection of CB1. Condition for this: Release command from the SCADA system „Rel:Ext CB2 on" has been issued and the CMP key switch is in position "Remote Operation".	Control	●	-	-	fg	DI active
						-	DI inactive
„SG1on block.1"	Blocking of the ON control for switching device 1	Interlocking	●	-	-	fg	DI active
						-	DI inactive
„SG1on block.2"	Blocking of the ON control for switching device 1	Interlocking	●	-	-	fg	DI active
						-	DI inactive

Input Functions (for Digital Inputs and Function Outputs Logic)							
Input Function (Displayed Text)	*Description*	*Processing (Module)*	*Assignable*	*Shown in Display*	*LED-Display*		
					LED Reset	*Blink Code*	*Note*
„Alarm: Prot.2“	External protection signal: Activation of an external protection device (for any protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Prot.2“	Trip signal of external protection devices (for any protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: Prot.3“	External protection signal: Activation of an external protection device (for any protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Prot.3“	Trip signal of external protection devices (for any protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: Prot.4“	External protection signal: Activation of an external protection device (for any protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Prot.4“	Trip signal of external protection devices (for any protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-		r	DI active
					●	-	DI inactive
„Alarm: Prot.5“	External protection signal : Activation of an external protection device (for any protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Prot.5“	Trip signal of external protection devices (for any protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Alarm: Prot.6“	External protection signal : Activation of an external protection device (for any protection facility)	Protection	●	-	-	fr	DI active
						-	DI inactive
„Trip: Prot.6“	Trip signal of external protection devices (for any protection facility) incl. an OFF command to the local CB. (Activation of the AR function only with additional assignment and activation of a digital input with “AR Start”)	Protection	●	-	-	r	DI active
					●	-	DI inactive
„Bypath1 CB off“	Information to the CSP that the CB has been operated directly by an external OFF command (i.e. independently of the *CSP2*). (This message is necessary to prevent reconnection by the active AR function when “NC-Start = active”)	Protection/ Supervision	●	-	-	fr	DI active
					●	-	DI inactive
„Bypath1 CB on“	Information to the CSP that the CB has been operated directly by an external ON command (i.e. independently of the *CSP2*). (This message is necessary to activate the SOTF function and for blocking the AR function temporarily.)	Protection/ Supervision	●	-	-	fg	DI active
					●		DI inactive
„Bypath2 CB off“	Information to the CSP that the CB has been operated directly by an external OFF command (i.e. independently of the *CSP2*). (This message is necessary to prevent reconnection by the active AR function when “NC-Start = active”)	Protection/ Supervision	●	-	-	fr	DI active
					●	-	DI inactive

Input Functions (for Digital Inputs and Function Outputs Logic)							
Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED-Display: LED Reset	LED-Display: Blink Code	LED-Display: Note
„Bypath2 CB on“	Information to the CSP that the CB has been operated directly by an external ON command (i.e. independently of the *CSP2*).	Protection / Supervision	●	-	-	fg	DI active
					●	-	DI inactive
„Load-Shedding“	Information to the CSP that the CB has been operated directly by an external OFF command (i.e. independently of the *CSP2*). (This message is necessary to block the active AR function during load-shedding. When the „Load-Shedding“ function is active, control commands for reconnection of the CB are blocked).	Protection / Supervision	●	-	-	r	DI active
					●	-	DI inactive
„S-Cmd SG1 on“	On-Command for switchgear 1 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-		DI inactive
„S-Cmd SG1 off“	Off-Command for switchgear 1 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG2 on“	On-Command for switchgear 2 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG2 off“	Off-Command for switchgear 2 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG3 on“	On-Command for switchgear 3 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG3 off““	Off-Command for switchgear 3 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG4 on“	On-Command for switchgear 4 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG4 off“	Off-Command for switchgear 4 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG5 on“	On-Command for switchgear 5 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„S-Cmd SG5 off“	Off-Command for switchgear 5 – inclusive of the field interlockings (key switch position at the CMP “local operation” or “remote operation”)	Control	●	-	-	fg	DI active
					-	-	DI inactive
„ Ext CB2 off “	External disconnection of CB2, irrespectively of the CMP key switch position: Local Operation/Remote Operation. When function „Ext CB2 OFF“ is active, the control commands for reconnection of CB2 are blocked.	Control	●	-	-	r	DI active
					●	-	DI inactive
„Ext CB2 on“	External connection of CB2. Condition for this: Release command from the SCADA system „Rel:Ext CB2 on “ has been issued and the CMP key switch is in position “Remote Operation”.	Control	●	-	-	fg	DI active
					-	-	DI inactive
„ Ext CB off“	External disconnection of CB1 and CB2, irrespectively of the CMP key switch position: Local Operation/Remote Operation. When function „Ext CB OFF“ is active, the control commands for reconnection of CB1 and CB2 are blocked.	Control	●	-	-	r	DI active
					●	-	DI inactive

Input Functions (for Digital Inputs and Function Outputs Logic)							
Input Function (Displayed Text)	Description	Processing (Module)	Assignable	Shown in Display	LED-Display		
					LED Reset	Blink Code	Note
„SG2on block."	Blocking of the ON control for switching device 2	Interlocking	●	-	-	fg	DI active
					-	-	DI inactive
„Tc.BCD0"	BCD information for tap changer position, valency "1"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.BCD1"	BCD information for tap changer position, valency "2"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.BCD2"	BCD information for tap changer position, valency "4"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.BCD3"	BCD information for tap changer position, valency "8"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.BCD4"	BCD information for tap changer position, valency "10"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.BCD5"	BCD information for tap changer position, valency "20"	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„Tc.po.change"	Tc.po.change has "high" potential, the CSP device store the last tap changer position. All changes on the BCD— informations will be ignored, so long as the potential on the Tc.po.change has "high". When the potential is "low", the new position will be accepted.	Supervision	●	-	-	g	DI active
					-	-	DI inactive
„U</U<<Block"	Depent to the state of the input function the voltage protection function U<,U<< can be blocked, if the parameter from the protection function U< or U<< "Block U" is active.	Protection / Supervision	●	-	-	r	DI active
					-	-	DI inactive
„PiUp inc "	With the pick up increase function it is possible to increase the threshold of the protection steps I>F/B, I>>F/B, Ie>F/B, Ie>>F/B	Supervision	●	-	-	r	DI active
					-	-	DI inactive

Table 5.15: Digital input functions - overview

Caution

* Due to the standardized software, the *CSP* shows also input functions which are not supported by the device.

5.7.1.4 Signal relay (output relays)

Description
Depending on the type of device, the *CSP2* provides a certain number of signal relays. Signals and processes which can be detected by the *CSP2* are available to the user via the potential-free contacts of the signal relays for further processing (parallel wiring).

Parameters

"(assignable functions)"
Up to 16 output messages can be assigned to each of the signal relays (terminal row X6). A relay picks up when at least one of the assigned functions is active (OR connection). The required output function(s) is (are) selectable from the catalogue (table) for the assignable output messages.
(Number of signal relays available for the concerned *CSP2* type in question – see 2.1.9.)

Minimum holding time "t min"
If the assigned output function becomes inactive again, the release of the relay is delayed by a settable minimum holding time tmin. The minimum holding time *tmin* is the time for which the relay picks up at least, with the result that wipers can also be detected securely. (see Figure 5.20)

For each signal relay, a separate setting is possible whether it is put out of function (*inactive*), whether it picks up when one of the assigned output messages is active (*working current principle*) or whether it picks up when *none* of the assigned output messages is active (*idle current principle*).

	No active output function	*At least one active output function*
Normal closed	Relay picked-up	Relay released
Normal open	Relay released	Relay picked-up

Table 5.16: Relay position according to the assigned functions and the parameterised operating principle

„Quitt." (relay acknowledgement)
In general, the acknowledgeability of a signal relay depends upon the output messages assigned. The acknow-ledgeability is pre-defined for each individual output message (similar to the colour and flashing code for input or output messages.
With the parameter *"Quitt."* each signal relay can be configured separately as "acknowledgeable"; i.e. even if the assigned output function, which is generally not acknowledgeable, changes back to the "inactive" status, the relay continues to be picked up until it is acknowledged. The acknowledgement can be done via the key »C« on the *CMP1*, a digital input or via SCADA and effects all the signal relays as well as LED's.

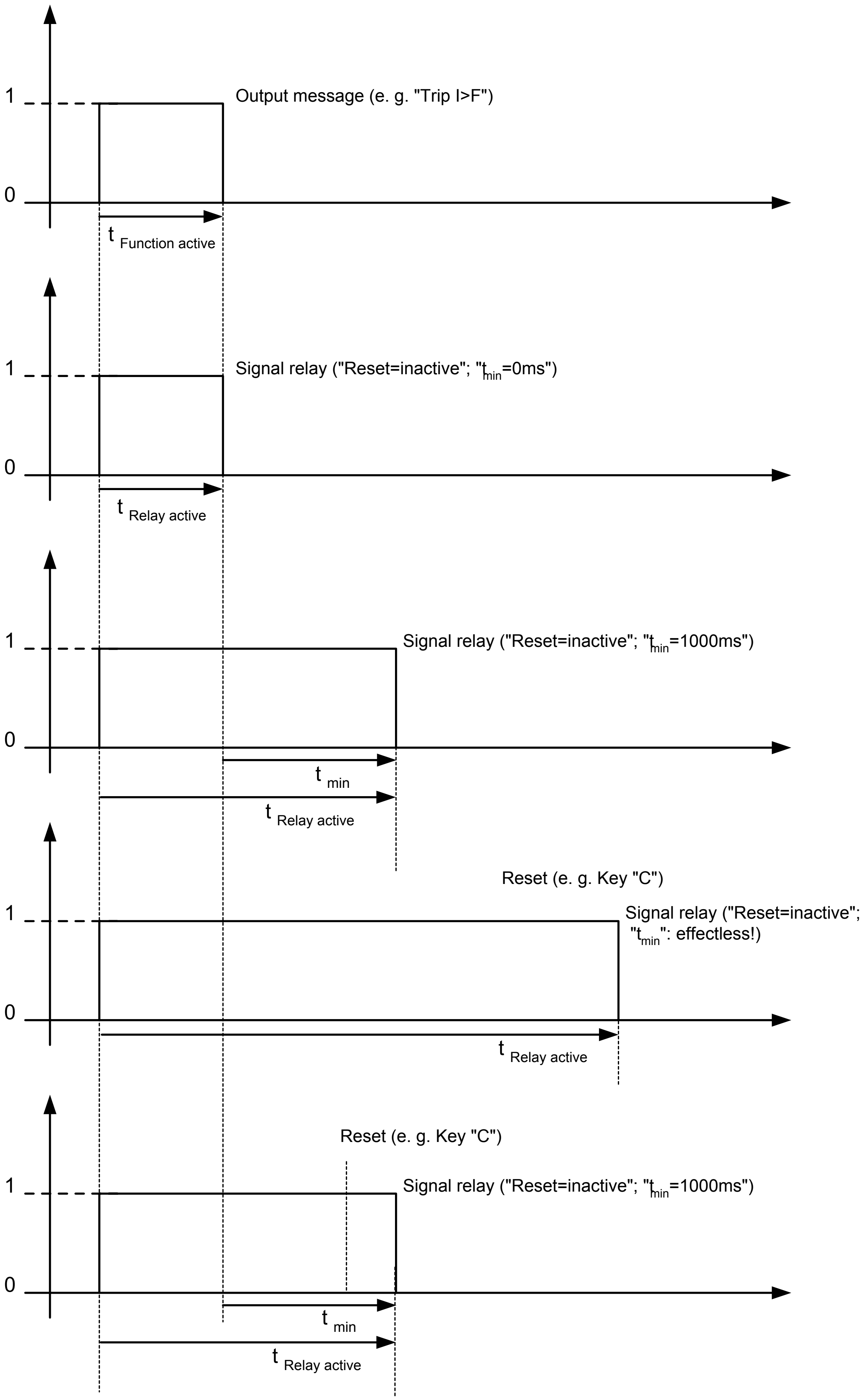


Figure 5.20: Acknowledgement of signal relays and minimum holding time

Default setting of the signal relays (output relays)
The *signal relay K11* has been firmly assigned to the »System OK« output message and designed as a »working current relay«. It picks up if the device shows no internal errors. The »*minimum holding time t min*« is set to zero ("t min = 0 ms"). The relay acknowledgement *"Quitt."* has been set as "inactive".
The *signal relay K12* has been pre-configured with the "General alarm" output message ("working current principle", "t min = 1000 ms"; "Quitt. = inactive).
The *report relay K13* has been pre-configured with the "General trip" output message ("working current principle", "t min = 1000 ms"; "Quitt. = inactive).

No output messages have been assigned on the other signal relays by SEG!

Signal Relay *(Variable Assignment – By Way of Example)*			
Relay Name	*Parameters*	*Setting/Setting Range*	*Description*
K14	t min	0…1000 ms	Minimum relay holding time
		„active 1"	Open circuit principle
		„active 0"	Closed circuit principle
		„inactive"	Out of function
	Reset .	„active"	Relay reset
		„inactive"	
	(Messages can be assigned)	Text of the assigned output message	To be chosen from the List of output messages (see Annex)
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
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		Text of the assigned output message	
		Text of the assigned output message	

Table 5.17: Variable assignment of output messages

Assignable output messages
Output messages are used to display system and operational signals via LED's and on the other hand to provide these signals for external further processing (potential-free contacts for parallel wiring) via signal relays.

It is distinguished between two kinds of output messages:

- *Push-through functions*
  "Push-through" functions are *input functions* (DI functions) which are also available as *output messages*. In this, the input messages are provided as signals in order to be able to further process proceedings in the peripheral devices (e.g. "CB1 ready"). The signal texts of the push-through functions are the same as those of the corresponding input functions.
- *Internal output messages*
  These messages are activated internally by the *CSP2* by evaluation of certain events. For example, such events are connected with the evaluation of measurement variables for application for protection functions (e.g. „Trip: I>F"), with control switchgears concerned with the internal locking logic (e.g. "Interlock") or with the *CSP/CMP* self-supervision (e.g. "System ok").

Description
The *Description* column shows the event that activates the output message. All available output messages are shown into detail in table 5.18. For the *push-through functions*, corresponding references to the description of the input functions are made.

LED (acknowledgement, flashing code)

Blink code
Each output message can be assigned on a LED. In case of its activation it lights up or flashes according to the pre-defined colour that is assigned to the output function.
r = red
fr = blinking red
g = green
fg = blinking green

Acknowledgement
Each output message is only active as long as the conditions for activation are fulfilled. These conditions differ for each output message and are explained in the *Description* column. An *acknowledgeability* therefore does not refer to the output function itself, but merely to the LED (or the signal relay) to which the output message is assigned. Further, a LED or a signal relay cannot be acknowledged as long as the output message is still active.

LED acknowledgement
For the works setting of the LED acknowledgement *"LED-Quit = trip"* some of the output messages also possess the possibility of acknowledgeability corresponding to their functionality. If a different setting of this parameter is selected with regard to the LED acknowledgeability (e.g. *"LED-Quit = all"*), the acknowledgeability of the LED is based on the setting then selected. For *"LED-Quit = all"* for example, this means that all the output messages placed onto this LED can be acknowledged (see Chapter "LED acknowledgement").
For *non-acknowledgeable* output messages, the LED goes off or changes its colour when the message is no longer active.
If the output message is *acknowledgeable*, the LED also continues to light up after deactivation of the function. A resetting of the LED can be done via the »C« key on the *CMP1*, via a digital input with the assigned input function »Acknowledgement« or via an acknowledgement command from the SCADA-systems.

Signal relay acknowledgement
see description of the signal relay parameter *"Quitt."*.

Example 1: Acknowledgeable output message "Trip L1" (*push-through function)*

Output Messages							
Output Message (Text)	*Description*	*Internal output messages*	*Push through function*	*LED-Display*			
				LED Reset	*Blink Code*	*Note*	
„Trip: Prot. 1“	Message of the active input function with the same name (DI function)		●	-	r	DI active	
				●	-	DI inactive	

When this output message (here: *push-through function*) becomes active (Column *remark:* "DI active"), the LED onto which this output message has been assigned lights up red. As long as the DI activating this push-through function is still active, the LED cannot be acknowledged. If the DI and thus the push-through function becomes inactive, the LED can now be acknowledged. After the acknowledgement, the LED goes off.
Over and above this, the *LED acknowledgeability* or *signal relay acknowledgeability* for these output messages (here: *push-through function*) depends on the setting of the LED parameter *"LED-Quit"* and on the setting of the signal relay parameter *"Quitt."*.

Example 2: Acknowledgeable output message "Trip I>F" (*internal output message*)

Output Messages						
Output Message (text)	*Description*	*Internal output messages*	*Push through function*	*LED-Display*		
				LED-Reset	*Blink. Code*	*Note*
„Trip: I>F“	Message of the active input function with the same name (DI function)	●	-	●	r	

When this output message (here: *internal output message*) becomes active (here: via the protection element I>F), the LED onto which this output message has been assigned lights up red. As the output message "Trip I>F" is however only active for the duration of the tripping command for the trigger coil of the CB, the *LED acknowledgeability* or *signal relay acknowledgeability* for these internal output messages depends on the setting of the LED parameter *"LED-Quit"* or on the setting of the signal relay parameter *"Quitt."*.

***Output Messages** (for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display* LED-Reset	Blink. Code	*Note*
„n.a.“	Not assigned	-	-	-	-	-
„System OK“	Message signalling state of the CSP system; at works assigned to signal relay K11 and LED 1 (default) *Note:* »Self-Test Relay« K11 functions normally as »working current relay« and picks-up when function »System OK« is active. This only is seemingly a contradiction to term »normal closed Logic« for a self-test relay which is picked up in released conditions (System OK) and drops in case a fault occurs in the system. In technical respect both versions are operating in the same way.	●	-	-	g	Operation
					r	Failure
„General alarm“	Message signalling protective alarm (internally or via DI); at works assigned to signal relay K12 and LED 2	●	-	-	fr	-
„General trip“	Message signalling a protective trip (internally or via DI); at works assigned to signal relay K13 and LED 3	●	-	●	r	-
„Alarm: L1“	Protective activation in phase L1	●	-	-	fr	-
„Alarm: L2	Protective activation in phase L2	●	-	-	fr	-
„Alarm: L3	Protective activation in phase L3	●	-	-	fr	-
„Alarm: N	Protective activation in phase N	●	-	-	fr	-
„Trip: L1“	Protective trip in phase L1	●	-	●	r	-
„Trip: L2“	Protective trip in phase L2	●	-	●	r	-
„Trip: L3	Protective trip in phase L3	●	-	●	r	-
„Trip: N“	Protective trip in phase N	●	-	●	r	-
„Protect.active“	Message signalling that one of the internal protective functions is set to »active« or an „Input Protection Function“ (e.g. „Protect. Trip 1“) is assigned to a digital input.	●	-	-	g	Protection active
					r	Protection inacive
„Alarm:Prot.1“	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Alarm:Trip.1“	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Prot.blocked“	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Ctrl.blocked 1“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Alarm: I>F“	Overcurrent activation in forward direction or non-directional	●	-	-	fr	-
„Trip: I>F“	Overcurrent trip in forward direction or non-directional	●	-	●	r	-
„Alarm: I>>F“	Short-circuit activation in forward direction or non-directional	●	-	-	fr	-
„Trip: I>>F“	Short-circuit trip in forward direction or non-directional	●	-	●	r	-
„„Alarm: I>B“	Overcurrent activation in backward direction or non-directional	●	-	-	fr	-
„Trip: I>B“	Overcurrent trip in backward direction or non-directional	●	-	●	r	-
„Alarm: I>>B“	Short-circuit activation in backward direction or non-directional	●	-	-	fr	-
„Trip: I>>B“	Short-circuit trip in backward direction or non-directional	●	-	●	r	-
„Alarm: Ie>F“	Earth fault alarm in forward direction or non-directional	●	-	-	fr	-
„Trip: Ie>F“	Earth fault trip in forward direction or non-directional	●	-	●	r	-
„Alarm: Ie>>F“	Short-circuit to earth activation in forward direction or non-directional	●	-	-	fr	-
„Trip: Ie>>F“	Short-circuit to earth trip in forward direction or non-directional	●	-	●	r	-
„Alarm: Ie>B“	Earth fault activation in backward direction or non-directional	●	-	-	fr	-
„Trip: Ie>B“	Earth fault trip in backward direction or non-directional	●	-	●	r	-
„Alarm: Ie>>B“	Short circuit to earth alarm in backward direction or non-directional	●	-	-	fr	-
„Trip: Ie>>B“	Short circuit to earth trip in backward direction or non-directional	●	-	●	r	-
„Alarm: ϑ>“	Overload activation	●	-	-	fr	-

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display* LED-Reset	Blink. Code	*Note*
„Trip: ϑ>“	Overload trip	●	-	●	r	-
„Alarm: Id>“	Differential protection alarm, 1st stage	●	-	-	r	-
„Alarm: Id>>“	Differential protection alarm, 2st stage	●	-	-	r	-
„Trip: Id>“	Differential protection trip, 1st stage	●	-	●	r	-
„Trip: Id>>“	Differential protection trip, 2st stage	●	-	●	r	-
„Alarm: Ide>“	Earth differential protection alarm, 1st stage	●	-	-	r	-
„Alarm: Ide>>“	Earth differential protection alarm, 2st stage	●	-	-	r	-
„Trip: Ide>“	Earth differential protection trip, 1st stage	●	-	●	r	-
„Trip: Ide>>“	Earth differential protection trip, 2st stage	●	-	●	r	-
„Alarm: U>“	Overvoltage alarm, 1st stage	●	-	-	fr	-
„Trip: U>“	Overvoltage trip, 1st stage	●	-	●	r	-
„Alarm: U>>“	Overvoltage alarm, 2nd stage	●	-	-	fr	-
„Trip: U>>“	Overvoltage trip, 2nd stage	●	-	●	r	-
„Alarm: U<“	Undervoltage alarm, 1st stage	●	-	-	fr	-
„Trip: U<“	Undervoltage trip, 1st stage	●	-	●	r	-
„Alarm: U<<“	Undervoltage alarm, 2nd stage	●	-	-	fr	-
„Trip: U<<“	Undervoltage trip, 2nd step	●	-	●	r	-
„Alarm: Ue>“	Residual voltage alarm, 1st stage	●	-	-	fr	-
„Trip: Ue>“	Residual voltage trip, 1st stage	●	-	●	r	-
„Alarm: Ue>>“	Residual voltage alarm, 2nd stage	●	-	-	fr	-
„Trip: Ue>>“	Residual voltage trip, 2nd stage	●	-	●	r	-
„U< block.freq.“	Message signalling blocking of the frequency protection at undervoltage conditions (U < U BF)	●	-	-	fr	-
„Alarm: f1“	Frequency alarm, 1st stage	●	-	-	fr	-
„Trip: f1“	Frequency trip, 1st stage	●	-	●	r	-
„Alarm: f2“	Frequency alarm, 2nd stage	●	-	-	fr	-
„Trip: f2“	Frequency trip, 2nd stage	●	-	●	r	-
„Alarm: f3“	Frequency alarm, 3rd stage	●	-	-	fr	-
„Trip: f3“	Frequency trip, 3rd stage	●	-	●	r	-
„Alarm: f4“	Frequency alarm, 4th stage	●	-	-	fr	-
„Trip: f4“	Frequency trip, 4th stage	●	-	●	r	-
„Alarm: U/f>“	Overexcitation alarm, 1st stage	●	-	-	fr	-
„Trip: U/f>“	Overexcitation trip, 1st stage	●	-	●	r	-
„Alarm: U/f>>“	Overexcitation alarm, 2nd stage	●	-	-	fr	-
„Trip: U/f>>“	Overexcitation trip, 2nd stage	●	-	●	r	-
„AR blocked“	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„AR in progress“	Message signalling that an AR cycle is active	-	-	-	fr	-
„AR Start“	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„AR sync.check“	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„AR maintanance“	Maintenance message when the AR meter has reached the 1st maintenance reading	●	-	-	fr	-
„AR maint.block“	Maintenance message when the AR meter has reached the 2nd maintenance reading	●	-	●	r	-
„Alarm: CCS“	Message signalling that the protective function »CCS (control circuit supervision)« has detected a fault in the control circuits of the controllable switching devices (interruption).	●	-	●	r	-

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display* LED-Reset	Blink. Code	*Note*
„Alarm: CBF“	Message signalling that the protective function »CBF (circuit breaker failure protection)« has recognized trip of the local CB.	●	-	●	r	-
„Ext CB fail“	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Fuse fail VT“	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: VTS“	Message signalling that the protective function »VTS (voltage transformer supervision)« has detected a fault in the VT circuits.	●	-	●	r	-
„Fuse fail AV“	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm:powercirc.“	Message signalling that the CSP has detected an internal fault within the power circuits of the control outputs.	●	-	●	r	-
„Pos.SG1 on“	Position indication message of switching device 1; active when switching device 1 is in ON-Position.	●	-	-	r	On-Pos.
„Pos.SG2 on“	Position indication message of switching device 1; active when switching device 2 is in ON-Position.	●	-	-	r	On-Pos.
„Pos.SG3 on“	Position indication message of switching device 1; active when switching device 3 is in ON-Position	●	-	-	r	On-Pos.
„Pos.SG4 on“	Position indication message of switching device 1; active when switching device 4 is in ON-Position	●	-	-	r	On-Pos.
„Pos.SG5 on“	Position indication message of switching device 1; active when switching device 5 is in ON-Position	●	-	-	r	On-Pos.
„CB1 ready“	Message of the corresponding active input function	-	●	-	g	Fct. active
					r	Fct. inactive
„CB2 ready“	Message of the corresponding active input function	-	●	-	g	Fct. active
					r	Fct. inactive
„Cmd1 SG1 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd1 SG1 off“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd2 SG1 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd2 SG1 off“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG2 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG2 off“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG3 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG3 off“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG4 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG4 off“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Cmd SG5 on“	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display*		
				LED-Reset	*Blink. Code*	*Note*
„Cmd SG5 off"	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Plug CB1 out"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„Plug CB2 out"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„Pos.SG diff"	Message signalling the intermediate position of an electrical controllable switching device during a switching action (both position check-back signals: „SGx Signal I" and „SGx Signal 0" are inactive)	●	-	-	fg	-
„DBB connect."	Message signalling that connection of the main bus bar with the reserve bus bar is permitted when the digital input »DBBSCoupling« is active.	-	●	-	g	Fct. active
					-	Fct. inactive
„Interlock"	Message signalling that an internal interlocking condition was infringed when a control command was issued; the related control function is blocked. (See Chapter "Interlocking Functions of the CSP2")	●	-	●	fr	-
„Switchgear fail"	Collective message for »Switching Device Defective« when a control action of a switching device was not correct. This output function becomes always active if the differential position (exceeding of the control time) or the fault position (position check-back signals for SGx ON and SGx OFF –both are active-) are recognised by the CSP after the fixed control time has elapsed.	●	-	●	r	-
„SF6 Alarm"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Remote Mode"	Indication of the CMP key switch position: »Remote Operation«	●	-	-	g	-
„Test Mode"	Indication for COM mode. For internal use only!	●	-	-	fr	-
„Alarm: CMP"	Signalling a system error in the CMP	●	-	-	fr	-
„Pos.SG1fail"	Message that SG1 is in an intermediate position and both position indicators ("SG1 Signal 1" and "SG1 Signal 0") of SG1 are active.	●	-	●	r	-
„Pos.SG2fail"	Message that SG2 is in an intermediate position and both position indicators ("SG2 Signal 1" and "SG2 Signal 0") of SG2 are active.	●	-	●	r	-
„Pos.SG3fail"	Message that SG3 is in an intermediate position and both position indicators ("SG3 Signal 1" and "SG3 Signal 0") of SG3 are active.	●	-	●	r	-
„Pos.SG4fail"	Message that SG4 is in an intermediate position and both position indicators ("SG4 Signal 1" and "SG4 Signal 0") of SG4 are active.	●	-	●	r	-
„Pos.SG5fail"	Message that SG5 is in an intermediate position and both position indicators ("SG5 Signal 1" and "SG5 Signal 0") of SG5 are active.	●	-	●	r	-
„SG1 timeout"	Message signalling that the control time for SG1 was exceeded during a switching action. This means that after the fixed control time has exceeded, switching device 1 is still in its initial position or in »Intermediate Position« (both position check-back signals: „SG1 Signal I" and „SG1 Signal 0" are inactive)	●	-	●	r	-
„SG2 timeout"	Message signalling that the control time for SG2 was exceeded during a switching action. This means that after the fixed control time has exceeded, switching device 2 is still in its initial position or in »Intermediate Position« (both position check-back signals: „SG2 Signal I" and „SG2 Signal 0" are inactive)	●	-	●	r	-
„SG3 timeout"	Message signalling that the control time for SG3 was exceeded during a switching action. This means that after the fixed control time has exceeded, switching device 3 is still in its initial position or in »Intermediate Position« (both position check-back signals: „SG3 Signal I" and „SG3 Signal 0" are inactive)	●	-	●	r	-

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display*		
				LED-Reset	Blink. Code	*Note*
„SG4 timeout"	Message signalling that the control time for SG4 was exceeded during a switching action. This means that after the fixed control time has exceeded, switching device 4 is still in its initial position or in »Intermediate Position« (both position check-back signals: „SG4 Signal I" and „SG4 Signal 0" are inactive)	●	-	●	r	-
„SG5 timeout"	Message signalling that the control time for SG5 was exceeded during a switching action. This means that after the fixed control time has exceeded, switching device 5 is still in its initial position or in »Intermediate Position« (both position check-back signals: „SG5 Signal I" and „SG5 Signal 0" are inactive)	●	-	●	r	-
„Function 1"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●		Fct. inactive
„Function 2"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Function 3"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Function 4"	Message of the corresponding active input function	-	●	-	r	Fct. active
					-	Fct. inactive
„Function 5"	Message of the corresponding active input function	-	●	-	r	Fct. active
					-	Fct. inactive
„Function 6"	Message of the corresponding active input function	-	●	-	r	Fct. active
					-	Fct. inactive
„Function 7"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„Function 8"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„Function 9"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„Function 10"	Message of the corresponding active input function	-	●	-	g	Fct. active
					-	Fct. inactive
„SCADA: Commun.ok"	Message signalling that communication to the station control system (SCS) is active.	-	-	-	g	Comm. OK
					r	Comm. error
„Device reset"	Message of the corresponding active input function	-	●	-	g	Fct. active
						Fct. inactive
„Ext. prot. act."	Message of the corresponding active input function	-	●	-	g	Fct. active
					r	Fct. inactive
„Alarm: Temp."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Temp:"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Buchh."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Buchh."	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Trip: Diff."	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Imped."	Message of the corresponding active input function	-	●	-	fr	Fct. active
						Fct. inactive
„Trip: Imped:"	Message of the corresponding active input function	-	●	-	r	Fct. active
					-	Fct. inactive

Output Messages (for LED´s, Signal Relays and for Input Elements of the Logic)						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display*		
				LED-Reset	Blink. Code	*Note*
„Fuse fail VC"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Fuse fail Ven"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„HH-fuse trip"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Ext. CB trip"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„SG1 block."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„SG2 block."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„SG3 block."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„SG4 block."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„SG5 block."	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„SG23 block."	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„SG234 block."	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„SG2345 Interl."	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Alarm: Motor"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Motor"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Ctrl.blocked2"	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„SCADA: Cmd out 1"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 2"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 3"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 4"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 5"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 6"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„SCADA: Cmd out 7"	Message signalling an unsafe SCADA command, i.e. the signal relay is controlled by a command issued by the control system (SCADA)	●	-	-	fg	-
„Release CB1 on"	Message signalling the release command from the SCADA for remote connection of CB1 (via input function)	●	-	-	fg	-
„Ext CB1 off"	Message of the corresponding active input function	-	●		r	Fct. active
				●	-	Fct. inactive
„Ext CB1 on"	Message of the corresponding active input function	-	●	-	fg	Fct. active

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display* LED-Reset	Blink. Code	*Note*
					-	Fct. inactive
„SG1 on block.1"	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„SG1 on block.2"	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Alarm: Prot.2"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Prot.2"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Prot.3"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Prot.3"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Prot.4"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Prot.4"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Prot.5"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Prot.5"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Alarm: Prot.6"	Message of the corresponding active input function	-	●	-	fr	Fct. active
					-	Fct. inactive
„Trip: Prot.6"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„All SG blocked"	Message signalling the SCADA command or CMP parameter setting to interlock all control commands	●	-	-	fg	-
„SG1 off block."	Message signalling the SCADA command or CMP parameter setting to interlock the switching OFF command for switching device 1	●	-	-	fg	-
„SG1 on block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching ON command for switching device 1	●	-	-	fg	-
„SG2 off block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching OFF command for switching device 2	●	-	-	fg	-
„SG2 on block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching ON command for switching device 2	●	-	-	fg	-
„SG3 off block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching OFF command for switching device 3	●	-	-	fg	-
„SG3 on block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching ON command for switching device 3	●	-	-	fg	-
„SG4 off block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching OFF command for switching device 4	●	-	-	fg	-
„SG4 on block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching ON command for switching device 4	●	-	-	fg	-
„SG5 off block"	Message signalling the SCADA command or CMP parameter setting to interlock the switching OFF command for switching device 5	●	-	-	fg	-
„SG5 on block"	Message signalling the SCS command or CMP parameter setting to interlock the switching ON command for switching device 5	●	-	-	fg	-
„Bypath1 CB off"	Message of the corresponding active input function	-	●	-	fr	Fct. active
				●	-	Fct. inactive

Output Messages (for LED´s, Signal Relays and for Input Elements of the Logic)						
Output Function (displayed text)	Description	Internal output function	Pass through function	LED-Display LED-Reset	Blink. Code	Note
„Bypath1 CB on"	Message of the corresponding active input function	-	●	-	fg	Fct. active
				●	-	Fct. inactive
„Bypath2 CB off"	Message of the corresponding active input function	-	●	-	fr	Fct. active
				●	-	Fct. inactive
„Bypath2 CB on"	Message of the corresponding active input function	-	●	-	fg	Fct. active
				●	-	Fct. inactive
„Load-Shedding"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Emergency off"	Signal for pressing the „Emergency OFF" button at the CMP for CB1 (and CB2)	●	-	●	r	-
„Logic fct. 1"	Output message of the state logic equation 1	●	-	-	g	
„Logic fct. 2"	Output message of the state logic equation 2	●	-	-	g	-
„Logic fct. 3"	Output message of the state logic equation 3	●	-	-	g	
„Logic fct. 4"	Output message of the state logic equation 4	●	-	-	g	-
„Logic fct. 5"	Output message of the state logic equation 5	●	-	-	g	
„Logic fct. 6"	Output message of the state logic equation 6	●	-	-	g	-
„Logic fct. 7"	Output message of the state logic equation 7	●	-	-	g	
„Logic fct. 8"	Output message of the state logic equation 8	●	-	-	g	-
„Logic fct. 9"	Output message of the state logic equation 9	●	-	-	g	
„Logic fct. 10"	Output message of the state logic equation 10	●	-	-	g	-
„Logic fct. 11"	Output message of the state logic equation 11	●	-	-	g	
„Logic fct. 12"	Output message of the state logic equation 12	●	-	-	g	-
„Logic fct. 13"	Output message of the state logic equation 13	●	-	-	g	
„Logic fct. 14"	Output message of the state logic equation 14	●	-	-	g	-
„Logic fct. 15"	Output message of the state logic equation 15	●	-	-	g	
„Logic fct. 16"	Output message of the state logic equation 16	●	-	-	g	-
„Logic fct. 17"	Output message of the state logic equation 17	●	-	-	g	
„Logic fct. 18"	Output message of the state logic equation 18	●	-	-	g	-
„Logic fct. 19"	Output message of the state logic equation 19	●	-	-	g	
„Logic fct. 20"	Output message of the state logic equation 20	●	-	-	g	-
„Logic fct. 21"	Output message of the state logic equation 21	●	-	-	g	
„Logic fct. 22"	Output message of the state logic equation 22	●	-	-	g	-
„Logic fct. 23"	Output message of the state logic equation 23	●	-	-	g	
„Logic fct. 24"	Output message of the state logic equation 24	●	-	-	g	-
„Logic fct. 25"	Output message of the state logic equation 25	●	-	-	g	
„Logic fct. 26"	Output message of the state logic equation 26	●	-	-	g	-
„Logic fct. 27"	Output message of the state logic equation 27	●	-	-	g	
„Logic fct. 28"	Output message of the state logic equation 28	●	-	-	g	-
„Logic fct. 29"	Output message of the state logic equation 29	●	-	-	g	
„Logic fct. 30"	Output message of the state logic equation 30	●	-	-	g	-
„Logic fct. 31"	Output message of the state logic equation 31	●	-	-	g	
„Logic fct. 32"	Output message of the state logic equation 32	●	-	-	g	-
„Log.bounce sv1"	bouncing supervision of the logic alarm	●	-	-	g	
„Log.bounce sv2"	bouncing supervision of the logic alarm failure	●	-	-	g	-

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display*		
				LED-Reset	Blink. Code	*Note*
„P-Set 1"	Protection parameter set 1 active	●	-	-	g	
„P-Set 2"	Protection parameter set 2 active	●	-	-	g	-
„P-Set 3"	Protection parameter set 3 active	●	-	-	g	
„P-Set 4"	Protection parameter set 4 active	●	-	-	g	-
"Pos.SG1 off"	Off-Position SG1	●	-	-	g	
"Pos.SG2 off"	Off-Position SG2	●	-	-	g	-
"Pos.SG3 off"	Off-Position SG3	●	-	-	g	
"Pos.SG4 off"	Off-Position SG4	●	-	-	g	-
"Pos.SG5 off"	Off-Position SG5	●	-	-	g	
"Pos.SG1 diff"	Intermediate-Position SG1	●	-	-	g	-
"Pos.SG2 diff"	Intermediate-Position SG2	●	-	-	g	
"Pos.SG3 diff"	Intermediate-Position SG3	●	-	-	g	-
"Pos.SG4 diff"	Intermediate-Position SG4	●	-	-	g	
"Pos.SG5 diff"	Intermediate-Position SG5	●	-	-	g	-
„S-Cmd SG1 on"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG1 off"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG2 on"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG2 off"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG3 on"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG3 off"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG4 on"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG4 off"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG5 on"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„S-Cmd SG5 off"	Message of the corresponding active input function	●	-	-	fg	Fct. active
				-	-	Fct. inactive
„Ext CB2 off"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Ext CB2 on"	Message of the corresponding active input function	-	●	-	r	Fct. active
				-	-	Fct. inactive
„Ext CB off"	Message of the corresponding active input function	-	●	-	r	Fct. active
				●	-	Fct. inactive
„Release CB2 on"	Message signalling the release command from the SCADA for remote connection of CB2 (via input function)	●	-	-	fg	-
„SG2on block."	Message of the corresponding active input function	-	●	-	fg	Fct. active
					-	Fct. inactive
„Alarm: ϑ1"	Temperature supervision ϑ1 alarm, 1st stage	●	-	-	fr	-
„Alarm: ϑ2"	Temperature supervision ϑ2 alarm, 2st stage	●	-	-	fr	-

Output Messages (for LED´s, Signal Relays and for Input Elements of the Logic)						
Output Function (displayed text)	Description	Internal output function	Pass through function	LED-Display		
				LED-Reset	Blink. Code	Note
„Trip: ϑ1 "	Temperature supervision ϑ1 trip, 1st stage	●	-	●	r	-
„Trip: ϑ2 "	Temperature supervision ϑ2 trip, 2st stage	●	-	●	r	-
„Broken wire ϑ1"	Temperature supervision ϑ1, broken wire at sensor1, 1st stage	●	-	●	r	-
„Broken wire ϑ2"	Temperature supervision ϑ2, broken wire at sensor2, 2st stage	●	-	●	r	-
„Tc.pos.0"	Tap changer position 0	●	-	-	g	-
„Tc.pos.1"	Tap changer position 1	●	-	-	g	-
„Tc.pos.2"	Tap changer position 2	●	-	-	g	-
„Tc.pos.3"	Tap changer position 3	●	-	-	g	-
„Tc.pos.4"	Tap changer position 4	●	-	-	g	-
„Tc.pos.5"	Tap changer position 5	●	-	-	g	-
„Tc.pos.6"	Tap changer position 6	●	-	-	g	-
„Tc.pos.7"	Tap changer position 7	●	-	-	g	-
„Tc.pos.8"	Tap changer position 8	●	-	-	g	-
„Tc.pos.9"	Tap changer position 9	●	-	-	g	-
„Tc.pos.10"	Tap changer position 10	●	-	-	g	-
„Tc.pos.11"	Tap changer position 11	●	-	-	g	-
„Tc.pos.12"	Tap changer position 12	●	-	-	g	-
„Tc.pos.13"	Tap changer position 13	●	-	-	g	-
„Tc.pos.14"	Tap changer position 14	●	-	-	g	-
„Tc.pos.15"	Tap changer position 15	●	-	-	g	-
„Tc.pos.16"	Tap changer position 16	●	-	-	g	-
„Tc.pos.17"	Tap changer position 17	●	-	-	g	-
„Tc.pos.18"	Tap changer position 18	●	-	-	g	-
„Tc.pos.19"	Tap changer position 19	●	-	-	g	-
„Tc.pos.20"	Tap changer position 20	●	-	-	g	-
„Tc.pos.21"	Tap changer position 21	●	-	-	g	-
„Tc.pos.22"	Tap changer position 22	●	-	-	g	-
„Tc.pos.23"	Tap changer position 23	●	-	-	g	-
„Tc.pos.24"	Tap changer position 24	●	-	-	g	-
„Tc.pos.25"	Tap changer position 25	●	-	-	g	-
„Tc.pos.26"	Tap changer position 26	●	-	-	g	-
„Tc.pos.27"	Tap changer position 27	●	-	-	g	-
„Tc.pos.28"	Tap changer position 28	●	-	-	g	-
„Tc.pos.29"	Tap changer position 29	●	-	-	g	-
„Tc.pos.30"	Tap changer position 30	●	-	-	g	-
„Tc.pos.31"	Tap changer position 31	●	-	-	g	-
„Tc.pos.32"	Tap changer position 32	●	-	-	g	-
„Tc.pos.33"	Tap changer position 33	●	-	-	g	-
„Tc.pos.34"	Tap changer position 34	●	-	-	g	-
„Tc.pos.35"	Tap changer position 35	●	-	-	g	-
„Tc.pos.36"	Tap changer position 36	●	-	-	g	-
„Tc.pos.37"	Tap changer position 37	●	-	-	g	-
„Tc.pos.38"	Tap changer position 38	●	-	-	g	-
„Tc.pos.39"	Tap changer position 39	●	-	-	g	-
„Tc.po.change"	Tap changer position changed, new position is valid when Tc.po.change is inactive.	●	-	-	g	-
„Malfunc. Tc."	Malfunction tap changer, undefined position	●	-	-	r	-
„IH2 blocked L1"	Inrush detection 2-nd harmonics at phase current IL1. Supervision blocked phase current protection L1, if IH2 parameter (I>F / B, I>>F / B) is active	●	-	-	fr	-

Output Messages *(for LED´s, Signal Relays and for Input Elements of the Logic)*						
Output Function (displayed text)	*Description*	*Internal output function*	*Pass through function*	*LED-Display*		
				LED-Reset	Blink. Code	*Note*
„IH2 blocked L2"	Inrush detection 2-nd harmonics at phase current IL2. Supervision blocked phase current protection L2, if IH2 parameter (I>F / B, I>>F / B) is active	●	-	-	fr	-
„IH2 blocked L3"	Inrush detection 2-nd harmonics at phase current IL3. Supervision blocked phase current protection L3, if IH2 parameter (I>F / B, I>>F / B) is active	●	-	-	fr	-
„IeH2 blocked E"	Inrush detection 2-nd harmonics at earth current Ie. Supervision blocked earth current protection, if IeH2 parameter (Ie>F / B, Ie>>F / B) is active	●	-	-	fr	
„ U</U<< Block "	Message of the corresponding active input function	●	-	-	r	Fct. active
				-	-	Fct. inactive
„ PiUp inc "	Message of the corresponding active input function	●	-	-	r	Fct. active
				-	-	Fct. inactive
„Alarm: CBF W1"	Alarm circuit breaker failure at CB1, transformer side W1	●	-	-	fr	-
„Alarm: CBF W2"	Alarm circuit breaker failure at CB2, transformer side W2	●	-	-	fr	-
„IdH2 Sta"	Stationary stabilisation differential current 2-nd harmonics is stimulated at Id>, if parameter Stab.H2 (Id>) is active.	●	-	-	r	-
„IdH4 Sta"	Stationary stabilisation differential current 4-th harmonics at Id>>, if parameter Stab.H4 (Id>) is active.	●	-	-	r	-
„IdH5 Sta"	Stationary stabilisation differential current 5-th harmonics at Id>>, if parameter Stab.H5 (Id>) is active.	●	-	-	r	-
„IdCrossb"	Crossblock stabilisation differential current at Id>, >, if parameter Crossbl. (Id>) is active.	●	-	-	r	-

Table 5.18: List of output messages

* Due to the standardised software, the *CSP* shows also input functions which are not supported by the device.

User-defined functions (»Function 1« to »Function 10«)
User-defined function is used to designate an arbitrary functional process in the MV cubicle, which is merely to be reported or displayed (LED) by the *CSP/CMP* system.
In this, this user-defined function provides a signal (»message/signal X«), via an auxiliary contact, the signal being fed to the *CSP2* via a digital input.

LED display of the user-defined function (message/signal X):

- The input functions must be assigned to one of the digital inputs. Colour or flashing code of the LED's have already been allocated to these input functions (see table above).
- After this, the selected input function must be assigned onto a LED.

Further processing of the user-defined function (Signal X) via signal relay:
Many input functions are also available as output messages (push-through functions). For further parallel processing (in a PLC or a conventional SCADA-system) the *output message corresponding to the input function* (»*Function 1*« to »*Function 10*«) can be assigned to an output relay. In this way, the signal of message X is again available via the potential-free contacts of the signal relay.

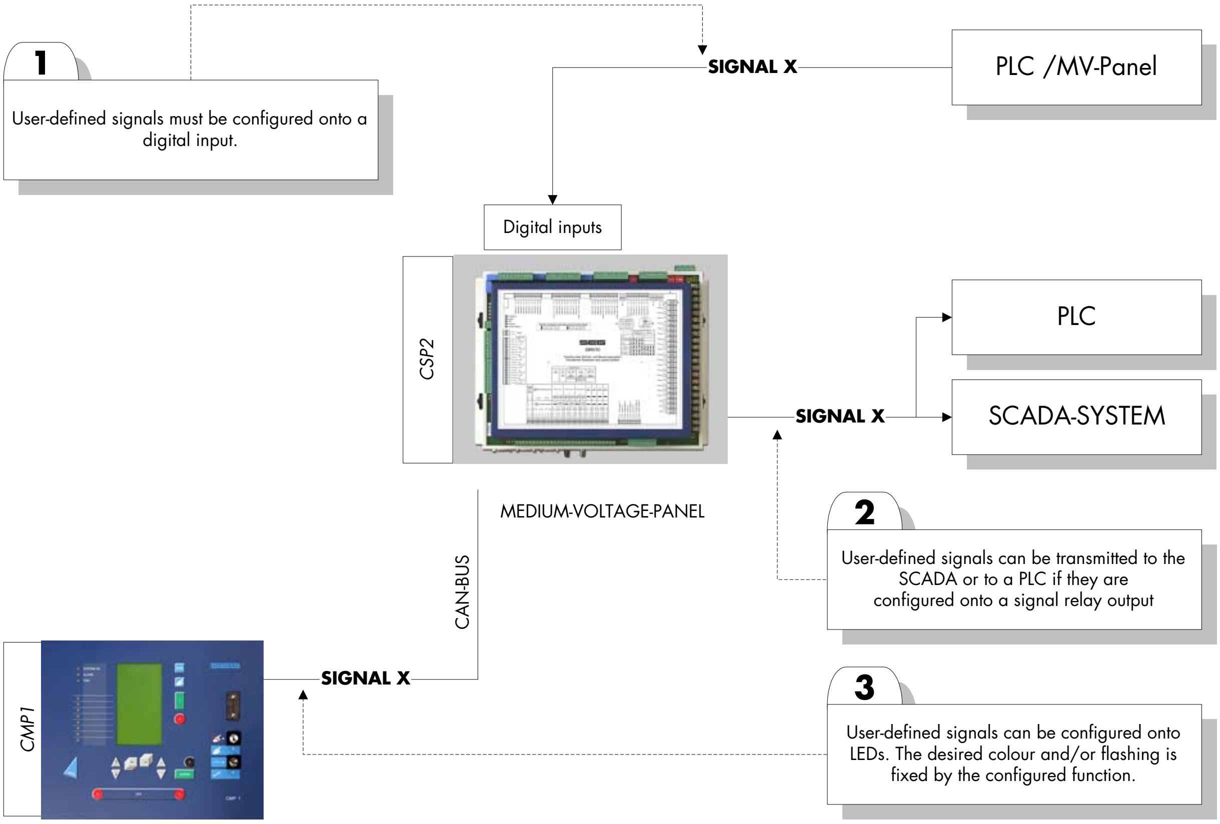


Figure 5.21: User defined functions as output messages.

5.7.1.5 LED assignment

Description

To display important system and operating messages/signals via the display and operating unit *CMP1*, the user has 11 LED's at his disposal. The corresponding signals are available as input functions and output messages and can be selected from the lists (tables) and assigned to the LED's depending on the application.
Up to 5 signals (input functions and/or output messages) can be assigned on each LED. If one of these functions becomes active, the LED in question lights up according to the colour and flashing code which is firmly defined for each input function and output message (see tables on input functions and output messages).

Meaning of the colours

- red: general trip (e.g. trip, fuse fail, spring not charged)
- blinking red: general alarm report (e.g. protective alarm)
- blinking green: interlocking reports (e.g. interlocking from extern)
- green: normal operation signal/message (e.g. spring charged)
- not lighting up: no or normal operation message/signal

Parameters

"Quit LED" (LED acknowledgement)

Generally, the acknowledgeability of a LED depends on the assigned output or input message. The acknowledgeability is firmly pre-defined for each individual output message and input function (similar to the colour and flashing code for an input or output message).
With the parameter *"Quit LED"* the LED's can be set as "acknowledgeable", i.e. even if the assigned output function, which is generally not acknowledgeable, changes back to the "inactive" status, the LED lights up (flashes) until it is acknowledged.
Acknowledgement can be done via the key »C« on the *CMP1*, a digital input or via the SCADA-system and effects equally on all LED's and also on signal relays.

„(Assignment of function)"

Here, you state whether the required LED function is to be taken from the input or output list. Up to 5 signals can be assigned to each of the 11 variably configurable LED's. However, in assignment, you ought to consider that only the last of a number of signals incoming onto an LED is displayed. When called up by the "INFO" key (on the *CMP1*) the plain information signal text) of the current function at the time is shown on the display. If no function is active, the first assigned function is shown (on the display).

Attention

In the assignment of a number of different signals on a joint LED, ensure that there are no functional overlaps depending on the colour/flashing code and function of the input function or output message to be placed. For this reason, some functions should be assigned separately.
This particularly applies for the "CBx removed" and " CBx ready" input functions.

LEDs (variable assignment – by way of example)			
LED Names	Parameters	Setting	Description
LED 5	Quit LED	„None"	There is no reset of the LED indication necessary for messages
		„All"	LED indications have to be reset for all messages after change of status
		„Alarm"	Reset of LED indication for trip and alarm signals (e.g. „Trip: I>F" or „Alarm: I>F")
		„Trip"	Reset of LED indications for trip signals (e.g. "Trip: I>F")
	(Functions/Messages can be assigned)	„Input"	These settings define whether an input or output function is to be assigned
		„Output"	
		„Text of assigned function/message"	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message "	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message "	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message "	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input"	These settings define whether an input or output function is to be assigned
		„Output"	
		„Text of assigned function/message "	To be chosen from the catalogue (Annex)

Table 5.19: LEDs which can be configurated variably with max. 5 user specific assignments

The remaining LED's are configured according to the same scheme.

5.7.1.6 Disturbance recorder

Description

The function of the disturbance recording interpolates the oscillographic curves of the analog channels (currents/voltages) on the basis of recorded sample points and saves them as a file in an internal memory of the *CSP2*. Alongside the analog channels, digital channels are recorded. The evaluation is done via the optional available"data visualizer" of the *SL-SOFT*.

The duration of recording of a disturbance sequence depends on the type of device (*CSP2-F* or *CSP2-L*), the mains frequency used f_{Mains} (*fn = 50/60Hz*) and the set quantity of samples (*„sample n/duration"*) for the entire recording.

Sample points – duration of disturbance recording

As a matter of principle, the sample rate per mains period T_{Mains} for the device variants of the *SYSTEM LINE* is defined as follows:

- *CSP2-T*: 32 sample points per line period

$$32/T_{Mains} = n/T_{Rec.}$$

The period of recording $T_{Rec.}$ of a disturbance record in *CSP2-T* generally results in:

$$\begin{aligned} T_{Rec.} &= (n/32) \times T_{Mains} \\ &= (n/32) \times 1/f_{Mains} \\ &= (n/32) \times 1/fn \\ &= \text{sample } n/(32 \times fn) \end{aligned}$$

With n:overall number of sample points = sample n (duration)
fn: set nominal frequency

Total recording time, fn = 50Hz, $T_{Rec.\ max}$ =2.75 s
Total recording time, fn = 60Hz, $T_{Rec.\ max}$ =2.3 s

Parameters

"Sample n/duration" (number of sample points for total period of recording)

This parameter states the total number of sample points which are to apply for the recording of a disturbance record. The overall duration of the individual disturbance records then results from the above mentioned formula for $T_{Rec.}$

If the duration for the disturbance records is stated by the user, the sampling rate to be set is calculated from:

"Pre-trig" (number of sample points for the pre-history of the trigger event)
Here, the number of sample points for the recording of the pre-history is set, i.e. incidents before the *trigger event ("T. source")*. The duration of the recording for the pre-history then results as:

$$T_{pre\text{-}trig} = \text{pre-trig}/(32 \times fn)$$

Attention

The set number of sample points for the recording of the pre-history (*pre-trig*) is always a subset of the total number of sample points (*sample n/duration*)! For this reason, the following must be observed in setting:

!!! T $_{Pre\ trig}$ **<** *Duration n* **!!!**

Example: *CSP2-T* at *fn = 50 Hz*: *sample n = 3,000*; *pre trigger = 400*
The overall period of recording according to the formula above is: $T_{Rec.}$ = 1,875 ms. The period of the recording of the pre-history results as $T_{pre\text{-}trig}$ = 250 ms. This means that of the overall recording period of 1,875 ms a recording period of 250 ms is used for the pre-history, with the result that only 1,625 ms remain for the recording from the trigger incident up to the end of the recording.

"Trigger" (Trigger event)
This parameter states the event for which the disturbance recording is to be started. The trigger incident can be a protective alarm or a protective trip, in which their downward or upward slope (e.g. *"pi.up on"* or *"pi-up re"*) can additionally be selected for the start of the disturbance recording.
As an alternative to the internal trigger events, the disturbance recording can also be externally started via an active digital input (external trigger event) or a logic output with the assigned input function *"Trigg. dist.rec"*. Only recognition of an upward slope of the digital input or the logic output starts the disturbance recording.

The disturbance recording can also be started manually, in addition to other trigger events. This is done by activation of the menu parameter *"Man. trigger"* (see *Main menu/disturbance recorder*) via the *CMP1* or via the
SL-SOFT.
If the disturbance recording is exclusively to be done manually, the setting *"Trigger = inactive"* must be set.

"Storage" (memory medium)
Standard versions of the *CSP2-T* is provided with an internal memory (*Int.RAM*) the storage sizes of which are designed for a max. total recording time $T_{Rec\ max}$:

It is, however, also possible to save several fault recordings of shorter recording time but the sum of the respective total recording time, i.e. 2,750 ms or 2,300 ms, cannot be exceeded.
An extended fail-safe memory area is available as option for the *CSP2* standard version (option "K" in the Order form). Here the memory is designed for several disturbance recordings with a total recording time of about 13,750 ms.
For this option, the setting *"Storage =ROM Card"* must be selected.

"auto del" (treatment of the saving of disturbance records)
Each memory medium only has a limited storage capacity. If the storage medium is full, no more disturbance records can be saved. This applies for the setting *"auto del = inactive"*.
However, in order always to be able to save the current record, the setting *"auto del = aktiv"* must be selected. Storage of the disturbance record files is now done with the FIFO principle (First In – First Out). The storage of the current disturbance record overwrites the oldest disturbance record files still stored.

Disturbance Recorder				
Parameters	*Setting/ Setting Range*	*Description*	*Presetting.*	*Step Range*
Sample n	160…4400	Number of measuring points, starting from the trigger event	1800	1
Pre-trig	0…4400	Number of measuring points prior to the trigger event	240	1
T. Source	„pi.up on"	Start of fault value recording with incoming message for „Protective Alarm" (pick up value)	„trip on"	-
	„pi.up re"	Start of fault value recording with outgoing message for „Protective Alarm" (pick up value)		
	„trip on"	Start of fault value recording with incoming message for „Protective Trip"		
	„trip rel"	Start of fault value recording with outgoing message for „Protective Trip"		
	„Input fct."	External start of fault value recording (no internal trigger events) via active digital input (DI) „Fault Recorder ON"		
	„inactive"	Start of the fault value recording *only* possible via menu parameter „Man. Tigger" (*CMP1* or *SL SOFT*)		
Storage	„Int. RAM"	Internal volatile storage of the *CSP2* (Standard Version)	„Int. RAM"	-
	„RAM Card"	Internal non-volatile extended storage of the *CSP2* (optional)		
	„FLASHRAM"	(for use in Woodward only)		
auto del	„active"	Storing of fault recording files until store is full, afterwards the FIFO principle applies!	„active"	-
	„inactive"	Storing of fault recording files until store is full, afterwards there is no recording possible!		

Table 5.20: Parameters for function of the fault recorder

5.7.1.7 Communication

5.7.1.7.1 IEC 60870-5-103

Description
The *CSP2* optionally has a standardized serial interface to the SCADA-system matching the VDEW recommendation. Communication to a SCADA-system is done either via a fibre optic connection or alternatively via an electrical RS 485 interface and is based on the normed transmission protocol IEC 60870-5-103.
This transmission contains normed telegrams such as general protection alarms, measured values and disturbance records in the "compatible area". In addition, a freely definable transmission area ("private range") exists for non-normed signals (messages), in which information, e.g. on controls and measured values, can be transmitted.

Note

Upon request, a data protocol list (data point list) of all telegrams is available. As to the *General Protocol Description* the IEC Norm 60870-5-103 refers.

Efficient data transmission
The IEC 60870-5-103 protocol is an "event-controlled" transmission protocol in which the individual data points do not have to be addressed directly by the host computer. The host computer merely requests that the *CSP2* transmits data. The *CSP2* then decides which data it transmits to the host computer.
If the complete number of data points were always transmitted with each inquiry of the host computer, this would overburden the host computer and the bus system and would additionally be inefficient.

In order to guarantee a quick and efficient data exchange, the protocol provides the following mechanism, which is anchored in the norm:

Classification of the data points to avoid redundant telegrams on the data bus!

„Data of Class 1": This category entails all the data points of the "Signals" list and certain data points of the "Measurement" list (measured figures belonging to a trip). Such data have a high transmission priority, as they give decisive information about the operating status of the switchgear. The transmission of these data points is however only done in the change of status of a signal as soon as the host computer inquires it.

„Data of Class 2": This category contains data points of the "Measurement" list. They change frequently, but only possess a low transmission priority. A transmission to the host computer takes place cyclically if no higher-priority data ("signals") are ready for transmission. A transmission cycle is completed when all the data ready for transmission have been transmitted by the *CSP2*.

Parameters

"I.-block" (Information blocking)
With this, a blocking of the transmission is possible if e.g. the SCADA is not to be burdened with redundant information during commissioning or testing. The *CSP2* replies to the cyclic inquiry telegrams of the host computer with a reply telegram, which merely signalizes intact communication of the *CSP2*.

"t respo" (Supervision time: reply cycle of the CSP2 to the host computer)
With this, the maximum break time *t respo*. is stated in which the *CSP2* must react to an inquiry telegram of the host computer. If there is no reply telegram from the device within this period, the *CSP2* rejects the inquiry. In this case, the host computer recognizes a communication disturbance on the part of the *CSP2* and must inquire again.

"t call" (Supervision time: inquiry cycle of the host computer to CSP2)
Transmission disturbances are only reported by the device after the expiry of a supervision time *t call*. If there is no inquiry telegram from the host computer within this period, the host computer recognizes a communication disturbance on the part of the host computer. The SCADA computer has to start a new inquiry.

"Baud rate" (data transmission rate to the host computer)
The data transmission rate can be changed between the two fixed values 9,600 or 19,200 Baud. The data transmission rate to be set depends upon the hardware of the host computer and is stated by the manufacturer of the SCADA-system.

"Slave-ID" (Device number)
The device ID with which the SCADA-system identifies each device must be assigned once per station, as otherwise no unambiguous assignment of the signals in the overall system is possible. Assignment of the device address can only be done in cooperation with the SCADA-system.

" t wait" (Idle period between transmission and receipt)
In particular bus systems with RS 485 hardware expect an idle time on the bus after each transmission of a telegram. This idle time is needed as the *CSP2* must switch from the "transmit" to the "receive" direction after each transmission and must guarantee an idle time between the receipt of a telegram from the host computer and the reply telegram of the *CSP2*.
If this idle time is not parameterized, this can lead to communication disturbances (data collision) between the *CSP2* and the SCADA used.

Parameters for transmission reduction for "Class 2" data":
Data of "Class 2" are divided into three groups: "cyclic measured values", values with regard to "revision data" and "statistical data". For each group, a separate parameter is provided, via which the transmission frequency can be set with regard to the inquiry cycles.

"pr VCPQF" (transmission priority for cyclic measured values)
This parameter states the frequency (priority) with regard to the inquiry cycles with which the cyclically recorded measured values are to be transmitted to the host computer.

"pr com" (transmission priority for revision data)
This parameter states the frequency (priority) with regard to the inquiry cycles with which the figures for the revision data (e.g. number of switching cycles) are to be transmitted to the host computer.

"pr stat" (transmission priority for statistical data)
This parameter states the frequency (priority) with regard to the inquiry cycles with which the statistical measured values are to be transmitted to the host computer. The statistical measured values are calculated cyclically as a function of the calculation interval *"Δt"* (see parameter: "Statistical data") and can only be transmitted again after the expiry of the calculation interval.

"DataRed." (data reduction)

Depending on the setting of this parameter, the quantity of "Class 2" data to be transmitted (only "cyclic measured values", "statistical measured values" and "counters for revision data") can additionally be reduced.

Settings:

„active": This means a supervision of the data changes. Merely the data which have changed since the last transmission cycle are transmitted. This supervision is effective for the " cyclic measured values", the "statistical measured values" and the "counters for revision data". If the data are unaltered, the *CSP2* transmits individual values upon inquiry.

„inactive": With this setting, the data are transmitted with each inquiry cycle, regardless of whether their value has changed or not.

Example 1:

„pr VCPQF = 1": The cyclically measured values are transmitted with each inquiry cycle

„pr coun = 3": The counters for the revision data are only transferred with every third inquiry cycle!

„pr stat = 0": The statistical measured figures are not transmitted at all!

„DataRed = active": Only the data of the "cyclic measurement values" and the "counters for revision data" which have changed since the last inquiry cycle are transmitted!

Example 2:

„pr VCPQF = 1": The cyclically recorded measured values are transmitted with each inquiry cycle!

„pr coun = 3": The counters for the revision data are only transferred with every third inquiry cycle!

„pr stat = 2": The statistical measured values are only transmitted with every other inquiry cycle and after the expiry of the calculation interval *"Δt"*!

„DataRed = inaktiv": data of the "cyclic measurement values" and the "counters for revision data" are transmitted regardless of an alteration, but depending on the transmission priority parameterized in each case.

Protocol Type IEC 60870-5-103				
Parameters	*Setting / Setting Range*	*Beschreibung*	*Presetting*	*Step Range*
I.-block	„active"	Information blockade is effective		-
	„inactive"	Information blockade is out of function	„inactive"	
t respo.	10…1000ms	Max. hold time before the CSP2 sends a response telegram to the host computer	500ms	1ms
t call	200…600000ms	Max. hold time before the host computer sends an inquiry telegram to the CSP2	240000ms	1ms
Baud Rate	„9600"	Used data transmission rate [bit/s]		-
	„19200"		19200	
Slave Id.	1…254	Device address which can be issued individually	1	1
t wait	4…150ms	Hold time before each newly sent telegram	4ms	1ms
pr VIPQF	0…100	Transmission priority of „Cyclic Measuring Values"	1	1
pr coun.	0…100	Transmission priority of „Counting Values for Revision Data"	3	1
pr stat.	0…100	Transmission priority of „Statistical Data"	2	1
Datared.	„active"	Data transmission only when changing the „Cyclic Measuring Values", „Statistical Measuring Values" or „Counting Values for Revision Data"		-
	„inaktiv"	Data is transmitted at each inquiry cycle, independent of changing the „Cyclic Measuring Values" or „Counting Values for Revision Data"	„inactive"	

Table 5.21: Parameters for configuration of the IEC 60870-5-103 data protocol

5.7.1.7.2 PROFIBUS DP

Description

Communication of the *CSP2/CMP1* system and the *Protocol Profile* PROFIBUS DP to a SCADA (Master) system is realized either via fibre optic (FO) or alternatively via an electrical interface *RS 485;* this is based on standard EN 50170/2.

Note

On request a *General Protocol Description* and a *Data Protocol List* (data point list) are available as separate manuals.

Parameter

„P_DP_No"

This parameter defines the id (slave no.) for the slave device connected (*CSP2*).

„t call" (Supervision time: Inquiry cycle of the automation system to the CSP2)

Disruptions of communication are only signalled by the *CSP2* after the monitoring time *t call.* has elapsed. If the automation system does not send an inquiry telegram during this time, the *CSP2* concludes that the automation system is the source for the communication failure. The signal "SCADA Comm. Active" is then reset.

Protocol type PROFIBUS DP				
Parameters	*Setting Range*	*Description*	*Presetting*	*Step Range*
P_DP_No.	0…126	ID number of the Slave (CSP2) connected	„1"	1
t call	200…240000 ms	Max. hold time before the automation system sends an inquiry telegram to the CSP2	„24000 ms"	1 ms

Table 5.22: Parameters for configuration of the Data Protocol PROFIBUS DP

5.7.1.7.3 MODBUS RTU

Description
Communication of the *CSP2/CMP1* system and the *protocol profile* MODBUS RTU to a SCADA (Master) system is realized either via fibre optic (FO) or alternatively via an electrical interface *RS 485*.

Note

On request a *General Protocol Description* and a *Data Protocol List* (data point list) are available as separate manuals.

Parameter

„Parity" (Recognition of communication errors)
It is possible that the last data bit is followed by a parity bit which is used for recognition of communication errors. The paraty bit ensures that with even parity ("EVEN") always an even number of bits with valency "1" or with odd parity ("ODD") an odd number of „1" valency bits are transmitted. But it is also possible to transmit no parity bits (here the setting is "*Parity = None"*).

„Stop Bit" (End identification feature of the data byte)
The end of a data byte is terminated optionally by one or two Stop-Bits.

„Baudrate" (Data transmission rate to the host computer)
The data transmission rate can be chosen from the five given values [bit/s]. Adjustment of the data transmission rate depends on the hardware of the host computer and is stated by the manufacturer of the control system.

„timeout" (Supervision time: Reply cycle of the CSP2 to the host computer)
Here the max. hold time "*timeout"* is stated during which the *CSP2* has to response after receipt of an inquiry telegram from the host computer. If there is no reply telegram from the device sent within this time, the *CSP2* discards the inquiry. In this case the host computer concludes that the *CSP2* is the source for the communication failure and has to repeat the inquiry.

„t call" (Supervision time: Inquiry cycle of the Host computer to the CSP2)
Communication errors are only signalled by the *CSP2* after the supervision time *t call* has elapsed.
If the host computer does not send an inquiry telegram during this time, the *CSP2* concludes that the host computer is the source for the communication failure. The signal "SCADA Comm.Active" is then reset.

„Dev.-Addr" (Device address)
The device address by which the SCADA-system (Master) identifies each of the devices (Slave) ought to be assigned only once per bus system because otherwise a clear assignment of messages within the entire system is not possible. The device address can only be allocated together with the SCADA-system.

Protocol type MODBUS RTU				
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*
Parity	„Even“	In the data byte an even number of bits is transmitted with valence "1"	„Even“	-
	„odd“	In the data byte an odd number of bits is transmitted with valence "1".		
	„None“	There is no parity bit transmitted in the data byte		
Stop Bit	„1“	Number of Stop-Bits in the data byte is 1	„1“	-
	„2“	Number of Stop-Bits in the data byte is 2		
Baud Rate	„1200“	Used data transmission rate [bit/s]		-
	„2400“			
	„4800“			
	„9600“			
	„19200“		„9600“	
timeout	50… 1000 ms	Max. idle time before the *CSP2* sends a response telegram to the host computer	„900 ms“	1 ms
t call	200…600000 ms	Max. idle time before the host computer sends an inquiry telegram to the *CSP2*	„240000 ms“	1 ms
slave ID	1…247	Device address (Slave) in the bus system	„1“	1

Table 5.23: Parameters for Configuration of the Data Protocol MODBUS RTU

5.7.1.7.4 CAN-BUS (Variant configuration to the *CSP2*-multi device communication)

Description
Multi device communication means, that the *CSP* basic units are connected via CAN-Bus (for details please refer to chapter *CSP*-multi-device communication). This way it is possible to change parameters and to read out values from a central point respectively PC/Notebook. For this the PC/Notebook has to be connected only to one *CMP* of the bus systems via the "multi device communication" a secondary communication level, beside the primary (communication to SCADA) can be established.

The "multi device communication" can be realised in two different ways:

- *Variant 1*: Each of the *CSP's* has its own operation and control unit *CMP1* (within the bus-system)
- *Variant 2*: There is only one operation and control unit *CMP1* but multiple basic units "*CSP*" within the bus-system

Variant 1
Here each *CSP2* has its own display- and operating unit *CMP1*. Because the *CSP* (basic units) are connected among one another via can-bus, it is possible to access via "System Line Soft" each of the basic units (*CSPs*) by establishing a RS232 connection (zero modem connection) to any of the operation and control units (*CMP*) (Please refer to chapter "Multi device communication" for details). The entire span of the *SL-SOFT* can now be used for operation of the *CSP2* devices.

Variant 2
Consequence for local operaton via *CMP*: Because there is only one operation and control unit *CMP1* available within the bus system, operation and control – as a consequence of that – can be carried out only sequential. Thus it is necessary to log into the device that is to be accessed via the menu item "Select device" (Please refer to chapter "Select device"/Variant 2 of the "Multi device communication").
Even though there is only one *CMP* within the bus-system it is also possible to establish a "Multi device communication" that is a secondary communication level.

Important

The *CMP1* always communicates with one *CSP2* only! Log in into another *CSP2* is only possible via the *CMP1* menu and hence it is time consuming. Therefore attention has to be paid during the projecting phase that vital functions, such as "Emergency Off", are redundant (e.g. an additional separate button for the CB).

For logging the *CMP1* into any of the *CSP2* devices of the CAN-BUS track the menu "*Device Selection*" is to be used. Access to menu "*Device Selection*" is only possible if the multi device communication is configurated as described under "Variant 2".

Note

The menu item *„Act. CAN Dev. No.:"* shows the *existing* CAN device number of the *CSP2* or of the *CSP2/CMP1* system-. This ID is only updated after changes of the parameter "*CAN Device No.*" have been stored.

Parameter

„CAN Device-No."
In the CAN-BUS track of the multi device communication up to 16 *CSP2/CMP1* systems can be embedded. This parameter is used for adjusting the "CAN ID" in the *CSP2*.

Note

If a *CMP1* communicates with the *CSP2* during a parameter setting, then the CAN Device No. of the *CMP1* is automatically updated to the new CAN Device No. of the *CSP2*.

„Single CMP"
If there is only one operaton and control unit CMP1 within the entire bus system, this parameter is to be set to "Single CMP = Yes" else to "Single CMP = No".
For going into detail:

- Setting *„Single CMP = No"* refers to variant 1, where each of the *CSP's* has its own *CMP1*.
- Setting *„Single CMP = Yes"* refers to variant 2, where is only a common operation and control unit for all *CSP's*.

CAN-BUS				
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*
CAN Device No.	1…16	ID number of the *CSP2* or the *CSP2/CMP1* system	1	1
single CMP	„yes"	Setting for version 2 of the multi-device communication	„no"	-
	„no"	Setting for version 1 of the multi-device communication		

Table 5.24: CSP2 Parameters for Configuration of the CSP2 Multi-Device Communication

5.7.1.8 Resetting functions (counters)

Description
The reset function enables the operator to reset the counters to zero or to delete records after commissioning or maintenance.

Parameters

„SWG counter"
The number of counted switching cycles of the electrically controlled switchgears is reset to zero.

„I^2 counter"
The added short-circuit currents of the circuit breaker(s) are reset to zero.

„Event Recorder"
With this, the saved event list is deleted.

„Fault Recorder"
With this, the saved fault record log file is deleted.

„Operating Hour Counter"
Here, the operating hours counter of the *CSP2* is reset to zero.

„AR Counter"
The AR counter is reset to zero).

„Thermal Replica"
By resetting the »thermal replica« function, the interpolated temperature is set to the starting value (first start). In this way, for example, a motor in emergency operation can be restarted after an overload trip.

5.7.1.9 Statistical Data

Description
The statistical data include the calculated maximum and average values of the measured values. They are cyclic calculated after a settable interval. In addition to that a starting point (starting point of the synchronisation) can be parametrized.
The starting point of the synchronisation (please refer to Table 5.2.5 – hour, minute, second) determines the moment at which the calculation of the maximum and average values is started independent of the set time interval Δt. Hence forward recalculation of the stastical data is done according to the set time interval Δt. The synchronisation (hour, minute second) is executed daily. (after 24 hours)

Parameter

Calculation interval „Δt"
The setting of this parameter defines the duration of the interval of time in which the statistical measured values are to be calculated.
Recommendation: Quarters of hours (900 s).

Synchronisation time „hour : minute : second"
These parameters state the point in time of the first synchronisation. This synchronisation is done once a day after the point in time firstly set for the parameterisation. For a daily average value, for example, it could be imaginable that the synchronisation time is placed at 12:00:00 midday or midnight.

Statistical Parameters					
Parameters	*Setting Range*	*Description*	*Note*	*Presetting*	*Step Range*
Δt [s]	1...86400 s	Computation interval for maximum values and average values	Recommend. 900	60 s	1 s
Hour [h]	0...24 h	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 h	1 h
Minute [min]	0...60 min	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 min	1 min
Second [s]	0 ...60 s	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 s	1 s

Table 5.25: Setting of statistical parameters

5.7.1.10 Logic

5.7.1.10.1 Performance Description - General Product Outline

By using the *SL-LOGIC* up to 32 logic functions can be realized via the logic modules specified in chapter 3 limiting value detection and counting functions are in the planning stage as an extension, that will be available as input elements.

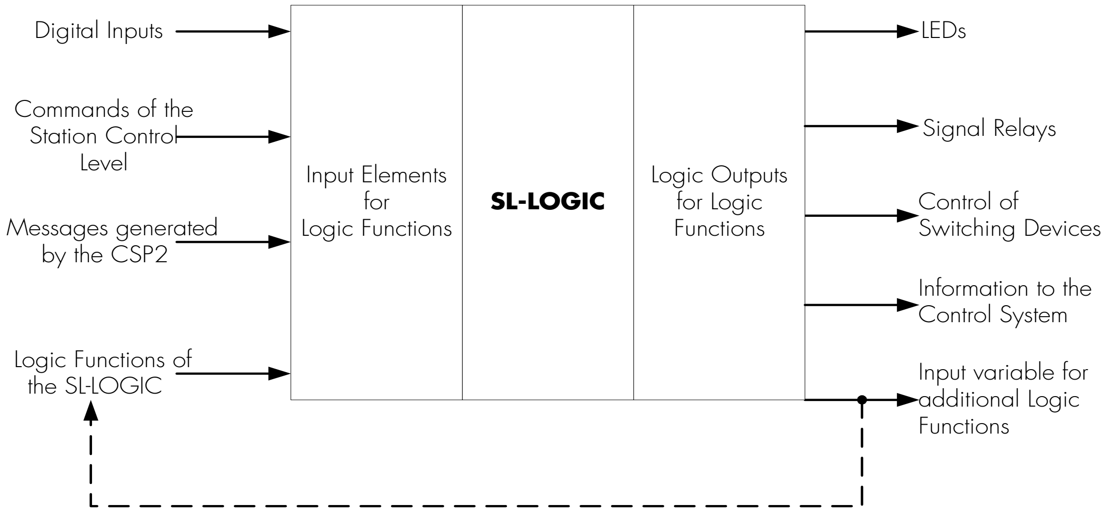


Figure 5.22: SL-LOGIC Performance Outline

Note

An Example for an »Programmable Switch Over Sequence« can be seen in chapter »Projecting«.

The following illustration shows in detail the performance range and the interaction between control unit and the logic. For further explanations and more specified information please see the following chapters of this description.

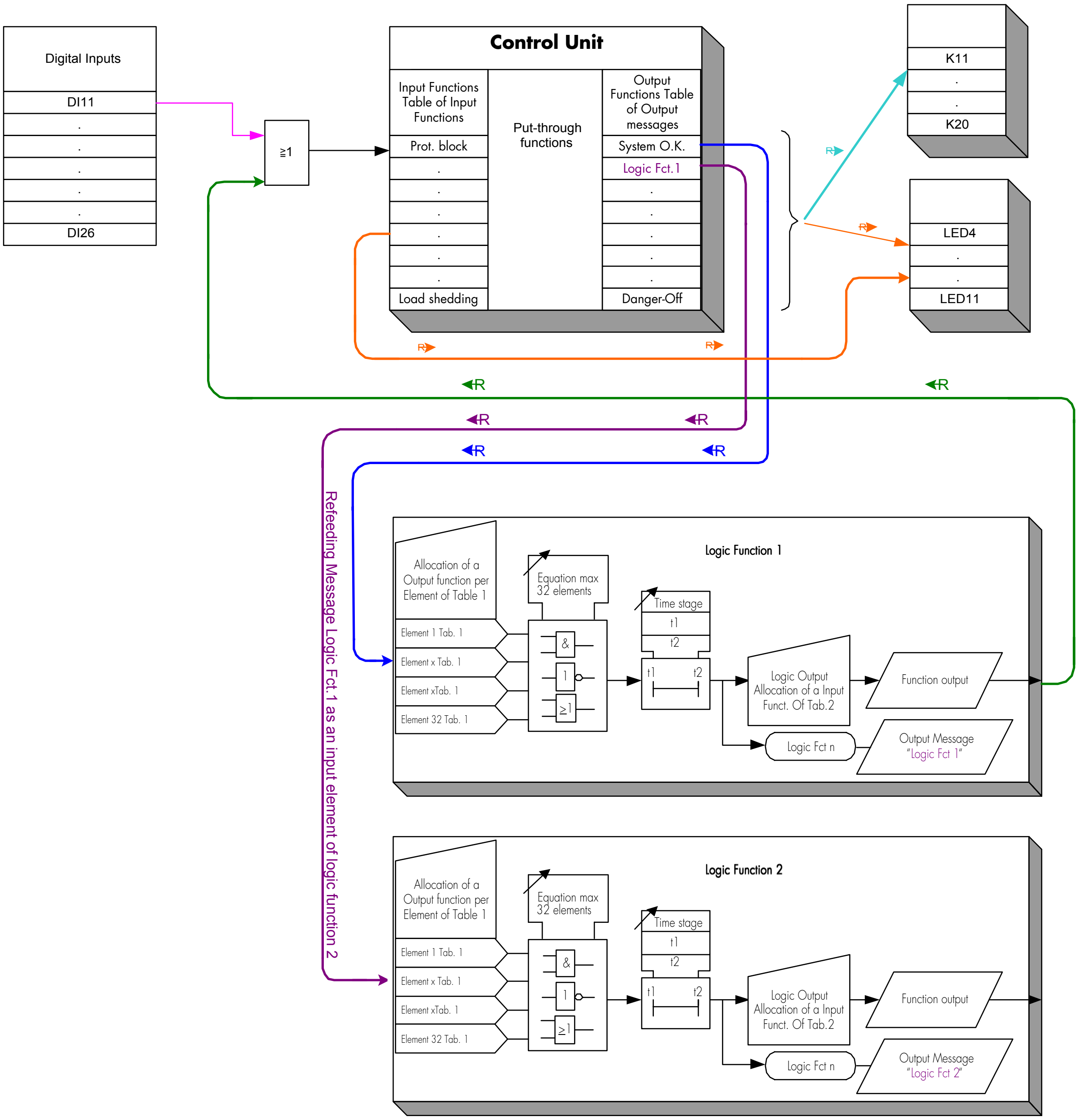


Figure 5.23: SL-LOGIC Detailed Overview

Important

- Do not refeed any output signal back into the associated (the same) logic equation as input element.

5.7.1.10.2 Definition of Terms

For all the circuits shown in this Manual applies: All switches and contacts are shown in neutral position. Circuit inputs are marked with the letters E1,E2,…,En logic-/circuit outputs are marked with "Y" (Y1,Y2,…Yn).

The switching states are defined as follows:

"1"or "H" High): is related to a closed switch (=positive logic)
"0" or "L" (Low): is related to an open switch (=positive logic)

The correlation between input and output variables is described in *Truth Tables*

A (Switch)	Y
0 (L) (open) 1 (H) (closed)	0 (L) (Off) 1 (H) (On)

Table 5.26: Positive Logic

Term	Meaning
/	Negation (NOT)
*	Conjunction (AND)
+	Disjunction (OR)
Input Elements - E1, E2,... En	Circuit Inputs
Logic Equation	Circuit Equation
Output Elements Y1, Y2,…Yn	Circuit Outputs

Table 5.27: Definition of Terms

5.7.1.10.3 SL-LOGIC Modules

The functional range covers the logic functions "AND", "OR" and "NOT" (only for negation of the input elements), with downstream timer.

Further functions, such as *Limiting Value Monitoring* or *Counter* might be realized in future software versions in additional function blocks, i.e. they are not included in the "Programmable Logic".

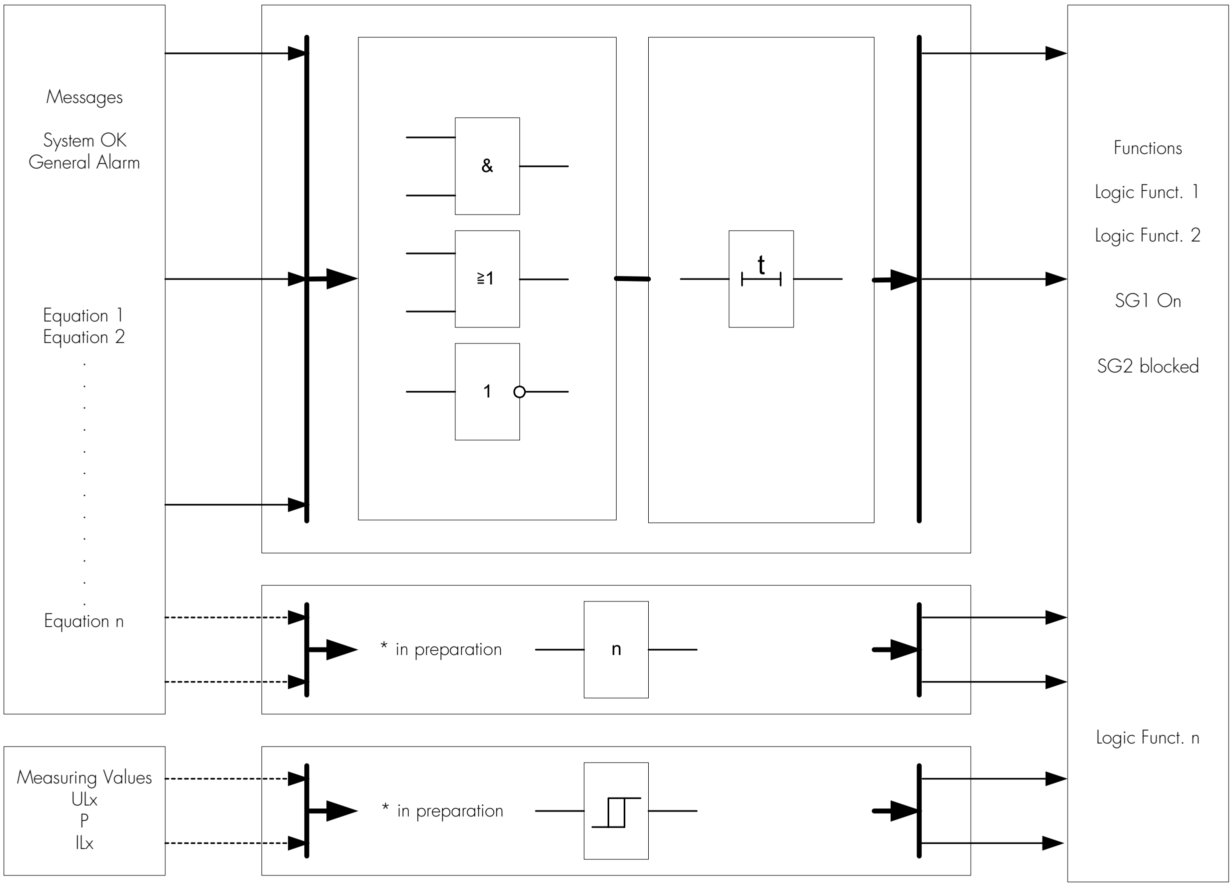


Figure 5.24: Logic Concept

Negation (NOT)

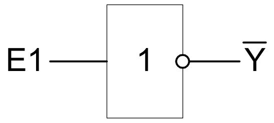


Fig 3.5.1: Logic Symbol Negation

E1	Y
1 (H)	0 (L)

Table 5.28: Truth Table Negation

Conjunction (AND)

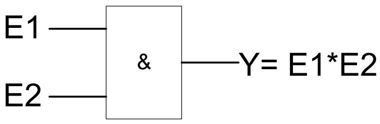


Figure 5.25: Logic Symbol Conjunction

E1	E2	Y
0 (L)	0 (L)	0 (L)
0 (L)	1 (H)	0 (L)
1 (H)	0 (L)	0 (L)
1 (H)	1 (H)	1 (H)

Table 5.29: Truth Table Conjunction

Disjunction (OR)

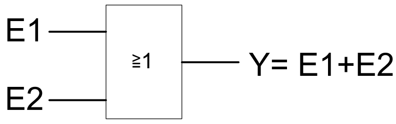


Figure 5.26: Logic Symbol Disjunction

E1	E2	Y
0 (L)	0 (L)	0 (L)
0 (L)	1 (H)	1 (H)
1 (H)	0 (L)	1 (H)
1 (H)	1 (H)	1 (H)

Table 5.30: Truth Table Disjunction

5.7.1.10.4 Ascertaining of Logic Functions (Circuit Equations)

Before setting up a logic function (circuit equation), the function definition (mostly available in text form) has to be analized thoroughly. In order to convert the task required into a logic function (circuit equation) there are three different methods possible:

The logic function (circuit equation) can be set up either based on

- the circuit diagram (variant 1) or
- the logic flow chart (variant 2) or
- the truth table (variant 3)

The ascertained logic function (circuit equation) has now to be converted into the *Disjunctive Normal Form* (DNF), (the exception is variant 3, where the *Disjunctive Normal Form* can be directly read off from the *Function-/Truth table*.

Important

When logic functions (circuit equation) are being set up it is essential to put the *associated disjunctions* into brackets, because *disjunctive* connections (AND) have a higher priority than *conjunctive* connections (OR).

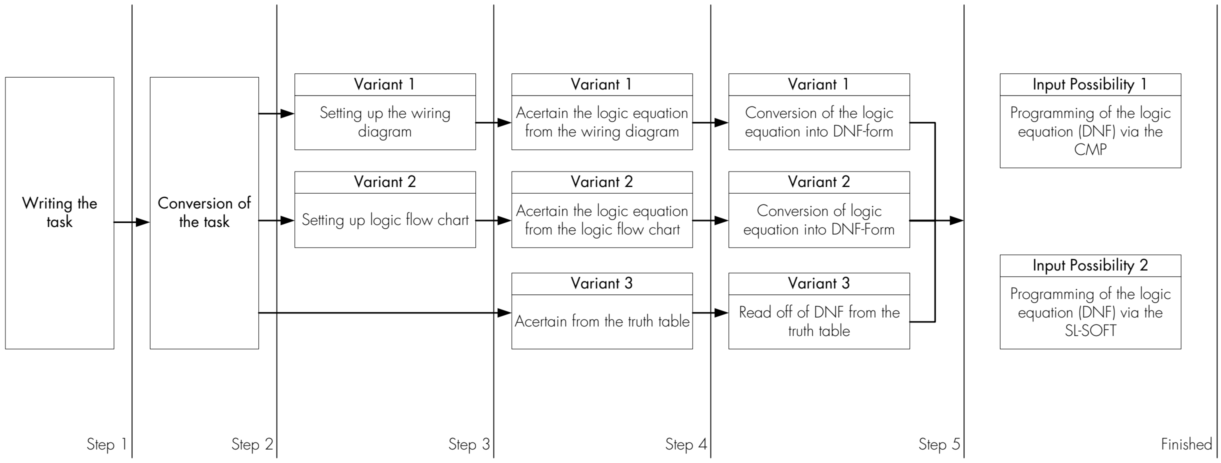


Figure 5.27: Ascertaining and Input of Logic Functions (Circuit Equation)

Variant 1: Setting up a logic function based on the wiring diagram

When the wiring diagram is used for setting up a logic function (circuit equation), the following basic principles have to be considered:

- *Series connection* of contacts means *conjunction* (AND)
- *Parallel connection* of contacts means *disjunction* (OR)

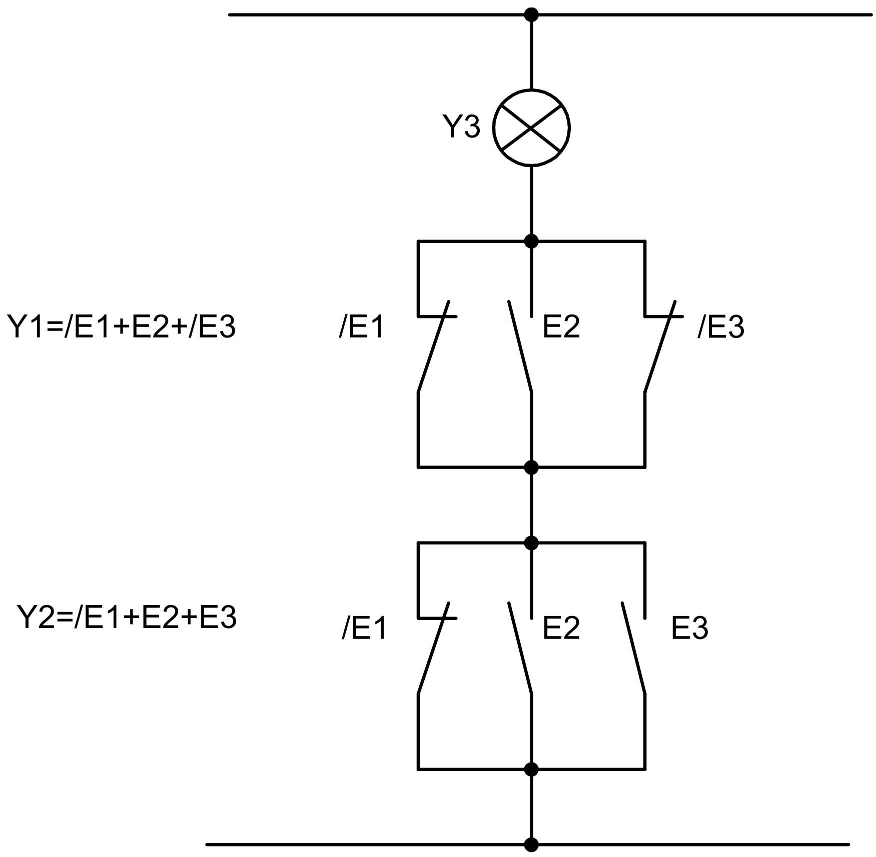


Figure 5.28: Wiring Diagram

The logic function (circuit equation) results from the series connection of the two circuitries "*Y1*" and "*Y2*" (see Figure 5.28)

Y3=Y1*Y2 = (/E1+E2+/E3)*(/E1+E2+E3)

Variant 2: Setting up a logic function base on the logic flow chart

If a required function is converted into a *logic flow chart*, the logic or circuit equation can be read off directly from this plan and by using the suitable means it is then to be converted into the *Disjunctive Normal Form* (see 5.7.1.10.5)

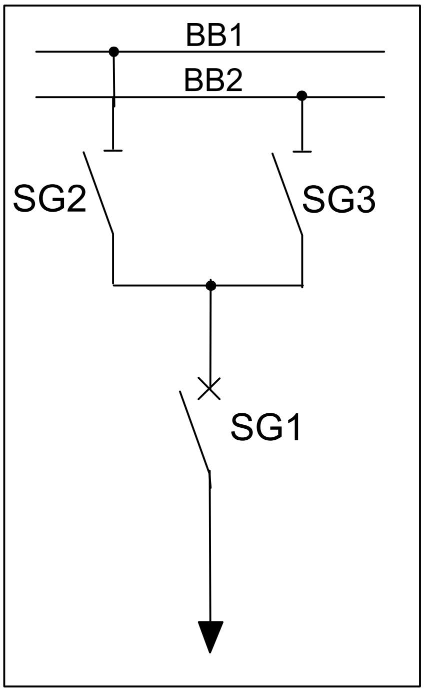


Figure 5.29: Single Line diagram

Note

For this example the logic equation is available in the *Disjunctive Normal Form* (DNF).

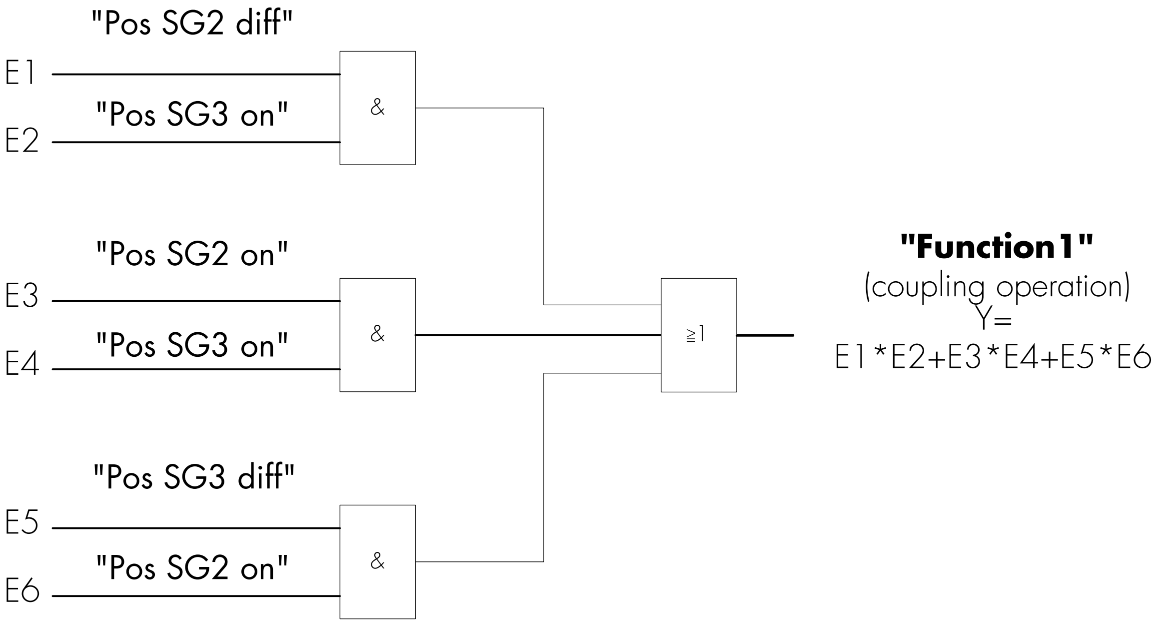


Figure 5.30: Logic Plan „Coupling Operation"

Variant 3: Setting up the Logic function based on the truth table

Line	E1	E2	E3	Y
1	0 (L)	0 (L)	0 (L)	0 (L)
2	0 (L)	0 (L)	1 (H)	0 (L)
3	0 (L)	1 (H)	0 (L)	0 (L)
4	1 (H)	0 (L)	0 (L)	0 (L)
5	0 (L)	1 (H)	1 (H)	1 (H)
6	1 (H)	0 (L)	1 (H)	1 (H)
7	1 (H)	1 (H)	0 (L)	1 (H)
8	1 (H)	1 (H)	1 (H)	1 (H)

Table 5.31: Example For Setting Up The Logic Function (Wiring Equation)

Basically applies that the *columns* have to be gated *conjunctively* (AND) and the *rows disjunctively* (OR)

5.7.1.10.5 Ascertaining of the logic function for the pickup condition(s) - DNF

If the logic function (circuit equation) shall be ascertained for the *Pickup Condition(s),* then

- the terms for the lines have to be determined firstly (AND conjunctions)
- and the result, the finished logic equation, is obtained by
    - AND-gating in the truth table all the elements of a line for which the output is marked by an "H" (logical state "1"). Elements that have the logical state "0" have to be negated and Elements that have the logical state "1" must not be negated.
    - And then these lines (with output marking H respectively "1") to be OR-gated.

Line 5: Y = /E1*E2*E3
Line 6: Y = E1*/E2*E3
Line 7: Y = E1*E2*/E3
Line 8: Y = E1*E2*E3

And so the logic function (circuit equation) for the *Pickup Condition* is as follows :

Y = (/E1*E2*E3)+(E1*/E2*E3)+(E1*E2*/E3)+(E1*E2*E3)

5.7.1.10.6 The Disjunctive Normal Form (DNF)

If a complete *Truth/Function Table* is available then the *Disjunctive Normal Form* (DNF) of the logic function (circuit equation) can be directly read off (see 5.7.1.10.4)

Optimization of the logic functions by way of the Quine-MC Cluskey Method

There are two methods for minimizing the logic functions (circuit equations):

- The *Karnaugh Veitch diagram*. (A graphic method which, however, can only be used for a few input elements)
- The Quine-McCluskey method. This method can be used both manually and with suitable software tools.

Note

For the Quine-McCluskey method there are software tools available and with these tools optimization of logic functions (circuit equation) can be carried out over the PC.

5.7.1.10.7 Debouncing Supervision

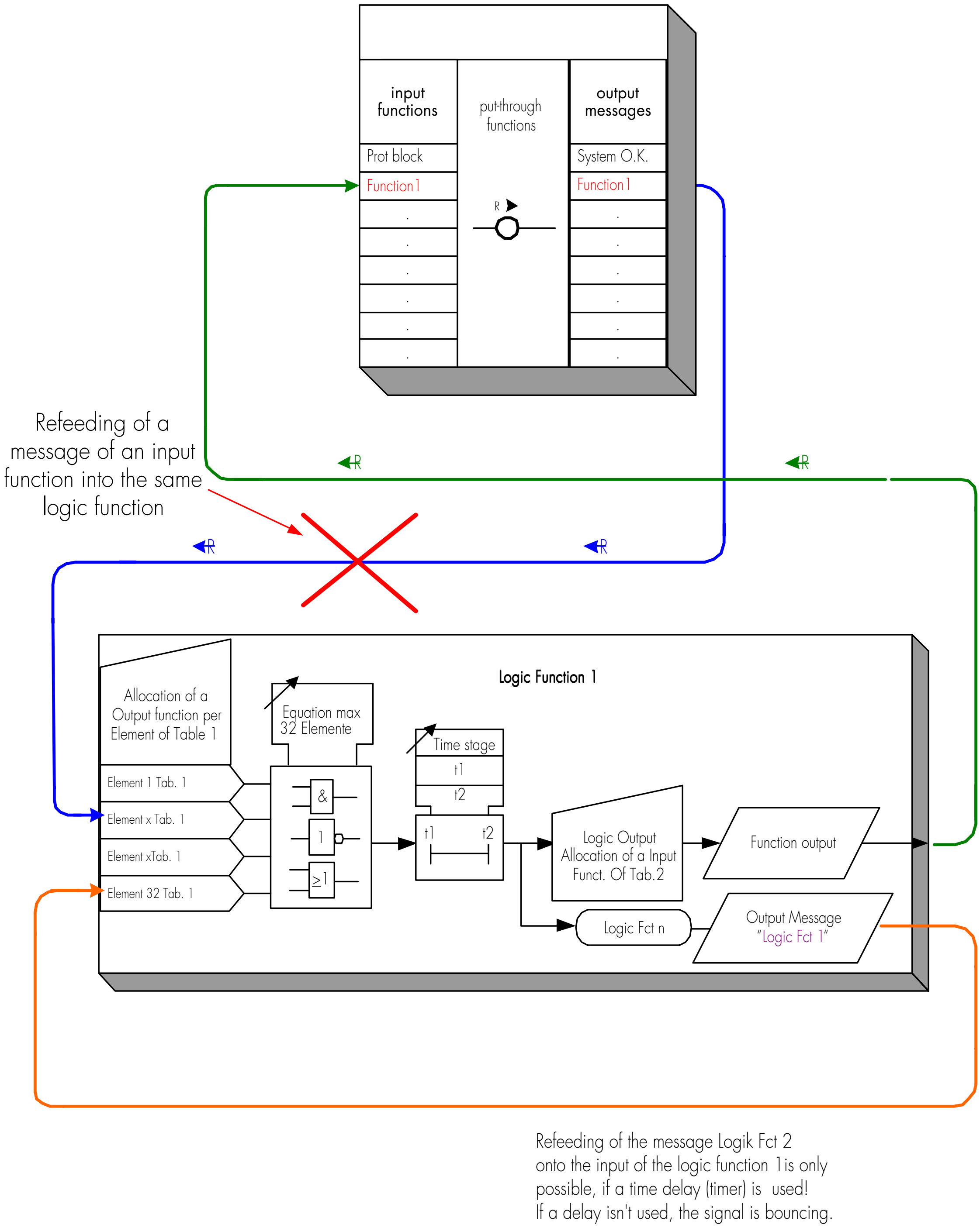


Figure 5.31: Debouncing Supervision

Important (see Figure 5.31)

- Do not feed back any output messages as input elements to the associated (the same) logic equation.

The logic function enables to generate many events with only very short intervals (direct feedback without significant time delay and assignment of input functions to the output of logic functions).

A continuous, rapid event generation stresses the system inadmissible and is monitored by an integrated two-step monitoring function, the debouncing supervision.

Normally the logic operates in a 10 ms-cycle. If the number of signal changes exceeds the threshold of 125 Hz, the first step of the debouncing supervision is responding and reduces the cycle to 100 ms. If now the number of signal changes exceeds the threshold of 125 Hz, the second step of the debouncing supervision is responding (Logic debouncing supervision 2) and reduces further the cycle to 500 ms.

Reductions of the cycle times are reset if the thresholds are undershot (10% hysteresis) .

Activating of the debouncing supervision is signalled through respective messages. Additionally a pop-up window appears on the *CMP*.

Merely with regard to the time accuracy the duly function is impaired.

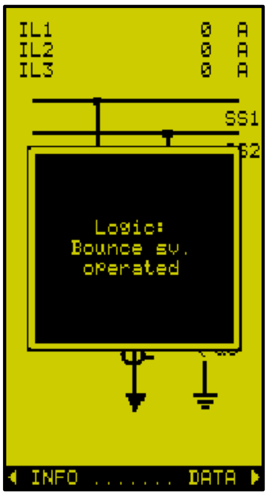


Figure 5.32: Debouncing Supervision

5.7.1.10.8 Input Functions and Output Signals

In order to utilize the entire performance range of the *SL-LOGIC* we have updated and extended the list of input functions and output messages (e.g. by further functions for the detection of switching device positions). The individual functions are specified in the related tables, chapter »Digital Inputs« (input functions) or chapter »Signal Relays« (output signals) of the *CSP2*-Manual.

Important Note

- Maximal *one* free selectable input function can be assigned to each function output of a logic function.
- Logic outputs can also be used as input elements for logic equations. Therefore the messages (output messages) "Logicfct.xy" are available.
- Together with the newly implemented logic some new *Input Functions* to the related list and existing input functions have been modified accordingly (e.g. new input functions for detection of switching device positions).

For controlling the switching devices via the logic, new *Control Functions* have been implemented for the control of SG1 to SG5. As input functions these control functions do not depend on the »LOCAL/REMOTE« switching position. The switching authorization »REMOTE«, can still be realized via the input functions "Cmd1 SGx ON" respectively "Cmdx SGx Off".

Note

- For the List of Input functions please refer to chapter "Digitale Inputs".
- For the List of Output messages please refer to chapter "Signal Relays".

5.7.1.10.9 Parameter

Note

Modifying the Logic (system parameters) will result in a rebooting of the system.

„Function“
For activating or deactivating the entire logic, the logic parameter “*Function=Active/Inactive*” can be used. After the activating process the system is rebooted (about 10 s).

„Mode“
The logic output of each logic equation can be influenced by a preceding time step. Via parameter “*Mode*” the following functions are available:

- "Op./Rel.d": Pickup- and Release time delay (can be retriggered) or:
- "Op.d/Pulse.d": Impulse time (cannot be retriggered)

„t1“
The pickup delay of a logic output of a logic equation is determined by this *time stage parameter*.

„t2“
Within the mode "Op./Rel.d" the release delay of a logic output of a logic equation is determined by this *time stage parameter*. Within the mode "Op.d/Pulse.d" this parameter determines the *impulse time* (pulse duration).

„Function output“

- Maximal *one* free selectable input function can be assigned to each function output of a logic function. " The assignment of a function is not mandatory.
- Logic outputs can be used as input elements for further logic equations. For this purpose the output messages “Logicf fct.xy” are available.

„Equation“
Within the Submenu »Equation« the input elements of the logic equations and the way of gating are parmetrizeable.

SL-LOGIC					
Parameters	*Setting/Setting Range*	*Description*	*Presetting.*	*Step Range*	*Tolerance*
Function	„active“	LOGIC activated		-	
	„inactive“	LOGIC deactivated	„inactive“		

Table 5.32: Setting parameters SL-LOGIC

LOGICAL EQUATION					
Mode	„ Op./Rel.d “	pickup/release delay (can be retriggerd)		-	
	„ Op.d/Pulse.d “	impulse time (cannot be retriggerd)			
	“without”		none		
t1	0…500 s	pickup time delay		10 ms	
t2	0…500 s	Mode "Op./Rel.d": release time delay Mode "Op.d/Pulse.d": Impulse time (pulse duration)		10 ms	
Function output		one input function can be assigned			
Equation		max. 32 input elements and the way of gating			

5.7.1.10.10 Programming of Logic Functions via the CMP

For activating or deactivating the entire logic, the logic parameter “Function Active/Inactive” can be used. This parameter can be activated via the *CMP*.

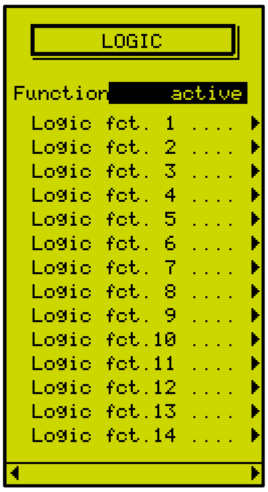


Figure 5.33: Menu Logic

Menu structure of the SL-LOGIC

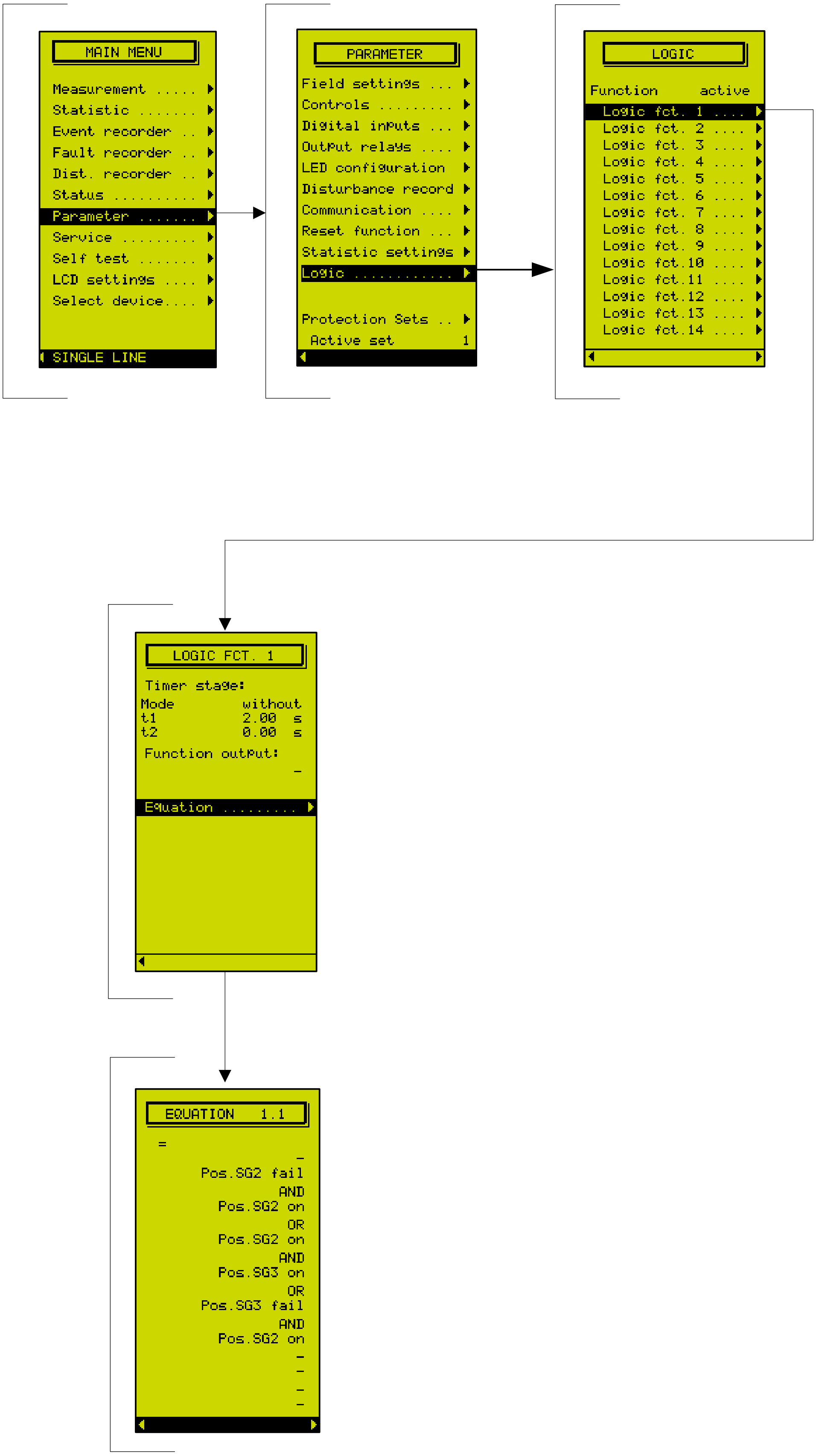


Figure 5.34: Menu Tree SL-LOGIC

Input of the logic function (circuit equation) via the CMP

Firstly the circuit/logic equations have to be ascertained and then to be converted into the *Disjunctive Normal Form* (DNF). See chapters 5.7.1.10.4 and 5.7.1.10.5.

Function »Local Operation/Parameter Assignment« in »MODE 2« is to be selected by using the key switch of the *CMP*.

Now the circuit/logic equations can be entered in menu »LOGIC« according to Figure 5.34.

By pressing keys »ENTER« and »RIGHT« the information is stored and only after this process is completed, the equations are accepted by the system. Thereafter the system is restarted.

Time stages

The logic output of each logic equation can be influenced by a preceding time step. Via parameter "*Mode*" the following functions are available:

- Pickup- and Release time delay (can be retriggered) or:
- Pulse duration (cannot be retriggered)

Pickup- and Release time delay (can be retriggered) (mode „Op./Rel.d")

Time step parameter:
Pickup time : t1= 0 – 500 s step range: 10 ms
Release time: t2= 0 – 500 s step time: 10 ms

- o Change of status from „0" to „1" (Low to High) of a logic output becomes only effective after time delay "*t1*" (= pickup delay).
- o Change of status from „1" to „0" (High to Low) of a logic output becomes only effective after time delay "*t2*" (= release delay).

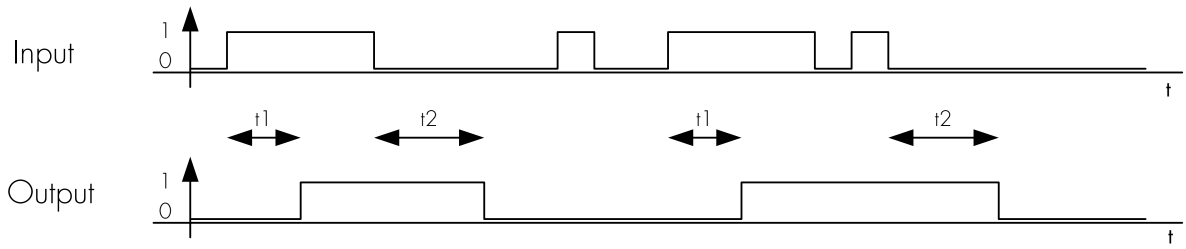


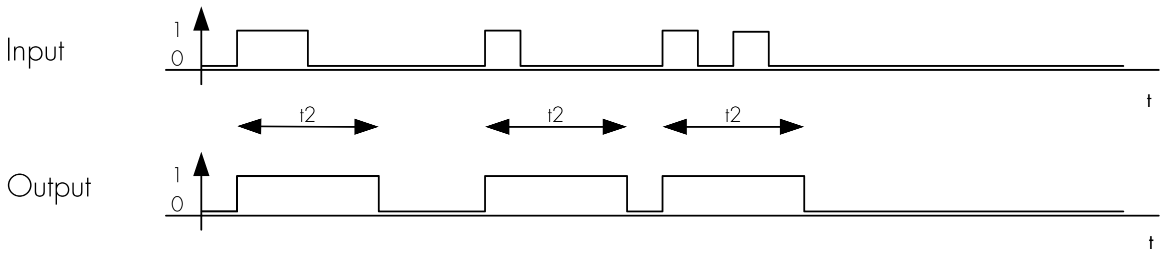
Figure 5.35: Pickup- and Release Time Delay

In mode „Pulse duration“ (cannot be retriggered) (Mode "Op.d/Pulse.d") the following applies

Time stage parameter:
Pickup time: t1= 0 – 500 s step range: 10 ms
Impulse time: t2= 0 – 500 s step range: 10 ms

- o If the pickup requirement for a logic output is met, the signal „1“- (High) is applied <u>after</u> the time defined by “t1” <u>for</u> the time defined by t2

Setting t1 = 0 ms, t2 > 0 ms



Setting t1 > 0 ms, t2 > 0 ms

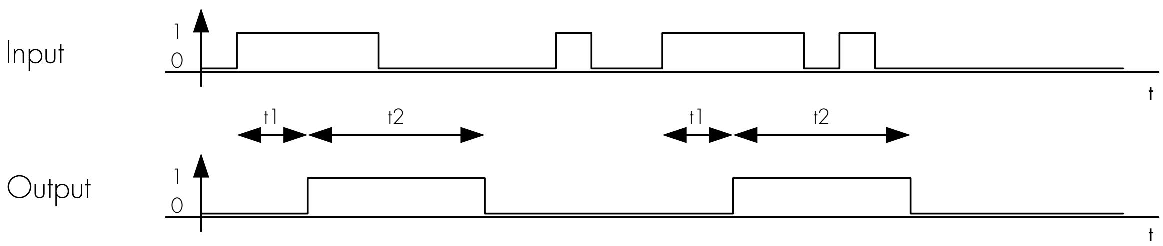


Figure 5.36: Impulse

Plausibility

During the *input/parameterization* of the logic functions they are checked for their plausibility. The following has to be strictly observed:

- There must be no *empty elements* between the input elements.
- An equation is considered plausible when all elements used are entered completely and there are no blanks

If there is an infraction of the plausibility then the setting data is rejected.

Example 1: Plausibility check OK

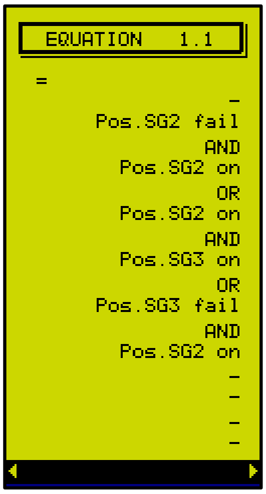


Figure 5.37: Plausibility OK

Example 2: Implausible data - There are blanks between the elements

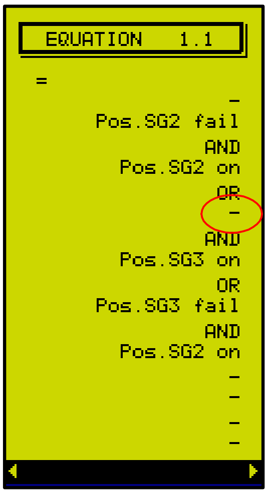


Figure 5.38: Plausibility Blanks

Example 3: Implausible data - Incomplete logic equation

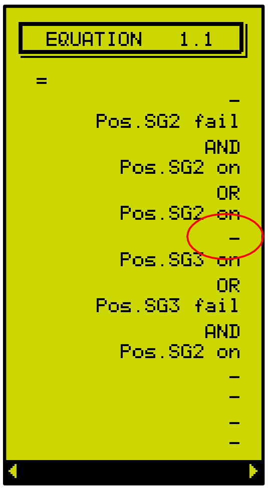


Figure 5.39: Plausibility - Incomplete Logic Equation

Any implausible data is rejected by the *CSP2*.

Figure 5.40: Message About Plausibility Error

The initial status of the logic can be viewed over the *CMP*. The »STATUS« menu includes three submenus : »Digital Inputs«, »Relays« and »Logic«.

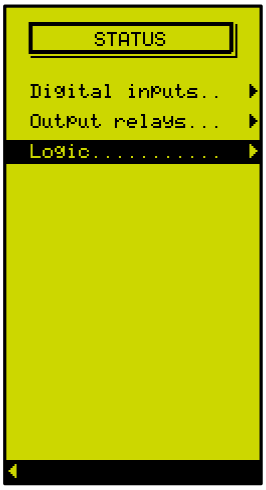


Figure 5.41: CMP Status Menu

The present status “active/inactive” of each logic output of a logic function can be viewed in the menu »LOGIC«. The input function allocated to the specific logic output is also displayed.

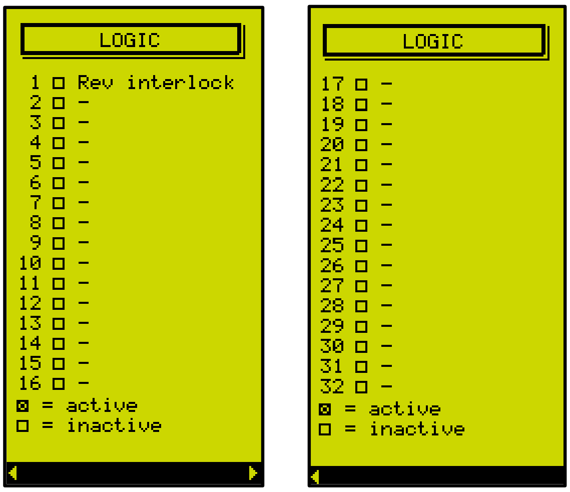


Figure 5.42: CMP Status of the Logic Outputs

5.7.2 Tap Changer Supervision

Description

The *transformer tap changer* is used for regulating the value of the transformers transformation ratio. Dependent upon the load, current and voltage relations for the operating state could be deviated according to the complete transformer equivalent electric diagram.

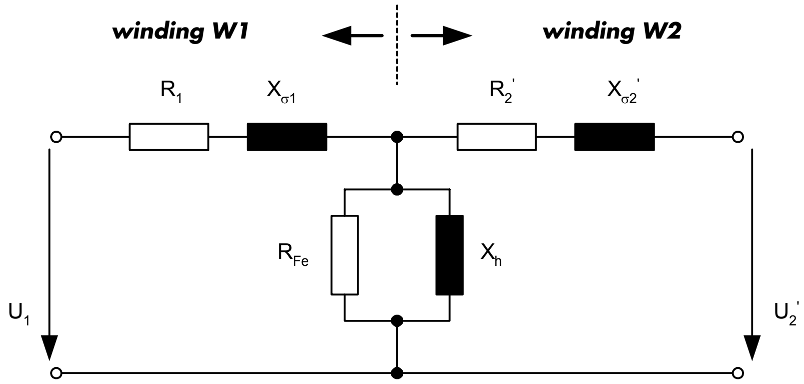


Figure 5.43: Complete transformer equivalent electric diagram

With:

	R_1:	*Winding resistance W1*
	R_2:	*Winding resistance W2, referring to winding end W1*
	$X\sigma 1$:	*Leakage induction W1*
	$X\sigma 2$:	*Leakage induction W2, referring to winding end W1*
	R_{FE}:	*Iron core losses*
	Xh:	*Main induction*

For the loading states the following approximations are permissible :

- The *copper losses* and the *leakage induction* of winding end W2 are neglectable low when compared to the load impedance connected.
- The *iron core losses* and the *main induction* are to be assumed infinite high when compared to the load impedance.

This results in the so called *equivalent short-circuit diagram of the transformer* with a *short-circuit impedance* which serves as calculation basis for the different loading states.

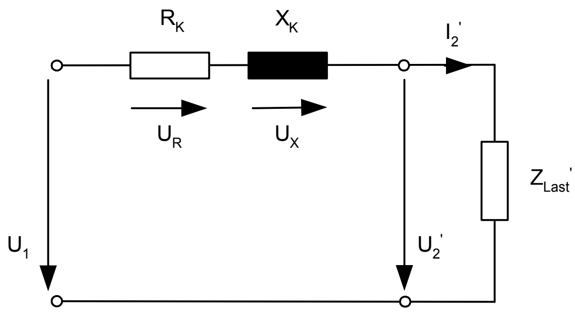


Figure 5.44: Equivalent short-circuit diagram of the transformer

With:

	R_K:	*Short-circuit winding resistance W1 + W2*
	X_K:	*Short-circuit reactance W1 + W2*
	I_2:	*Load current referring to winding end W1*
	Z_{last}:	*Load impedance referring to winding end W1*

The voltage change on the output side of the transformer is defined as the difference between *no-load voltage and full load voltage* (at rated load) and with flowing rated current. During *ohmic* and *inductive* loads the transformer voltage drops but it is increased with *capacitive* loads.

When assuming an identical current for the different loading states this results in a voltage drop U_R at the *short-circuit resistance* R_K and a voltage drop U_X at the *short-circuit reactance* X_K (Kapp'sche triangle).

Voltage drop U_K is caused when the voltage drops across the entire short-circuit impedance range and represents the difference between voltage U_1 at the input side and voltage U_2' at the output side of the transformer.

$\underline{U}_K = \underline{U}_1 - \underline{U}_2'$

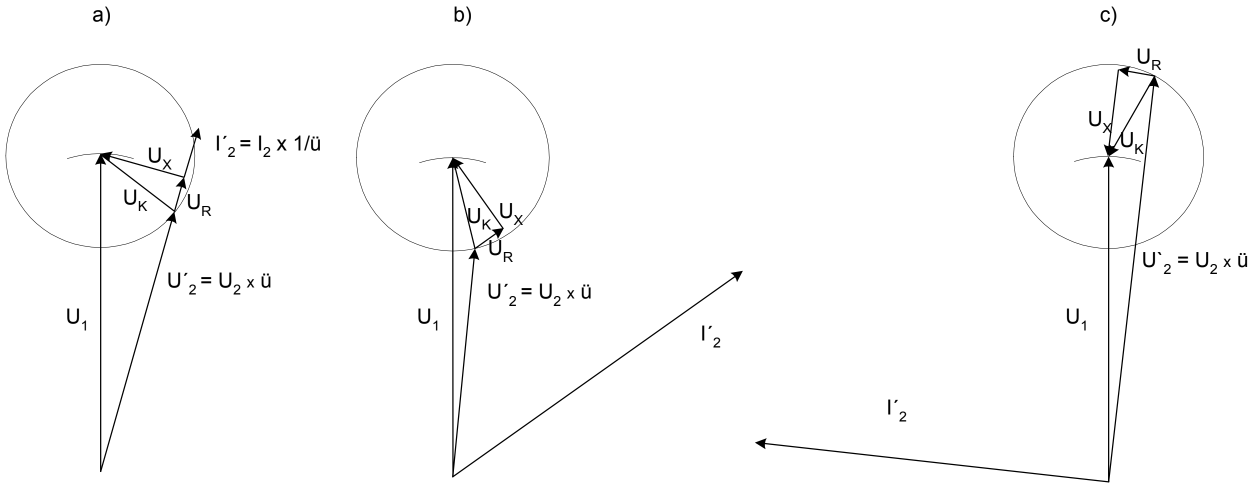


Figure 5.45: Load types of the transformer: a) ohmic load
b) inductive load
c) capacitive load

The *"short-circuit voltage U_K"* is a criterion for the extent of the voltage reduction at applied load and depends on the design rating as well as the construction type of the transformer.

$$u_k = \frac{U_k}{U_{1N}} 100\%$$

with: *U_K : voltage to be applied at the input side up to the transformer rated current and with short-circuited output side*
U_{1N} : rated voltage at the input side
U_K : relative short-circuit voltage referring to the rated voltage

The smaller the short-circuit impedance of the transformer and consequently the voltage reduction at the output side at applied load, the smaller the *relative short-circuit voltage U_K*. Since the quantity of the short-circuit impedance is proportional to the transformer capacity, the short-circuit voltage increases for the higher transformer voltage levels at high loading conditions.
The relative transformer short-circuit voltage in supply systems can be within the range of 4 to 14 %. The resulting voltage reduction during loading can become impermissibly high.

Transformer tap changer for transformer ratio adaption
In order to keep the amount of the voltage profile constant during load changes it is possible to adapt the transformation ratio in such a way that the voltage at the output side is correspondingly increased. The ratio change is realized by altering the number of windings by way of different winding tappings. Such voltage regulation is enabled by the so called transformer tap changer which is connected to the winding tappings of one winding end.

For constructional reasons the tap changer is normally assigned to the winding end with the higher voltage level; also the phase currents are smaller at this winding end, which means that tapping of the winding is possible with far less losses.

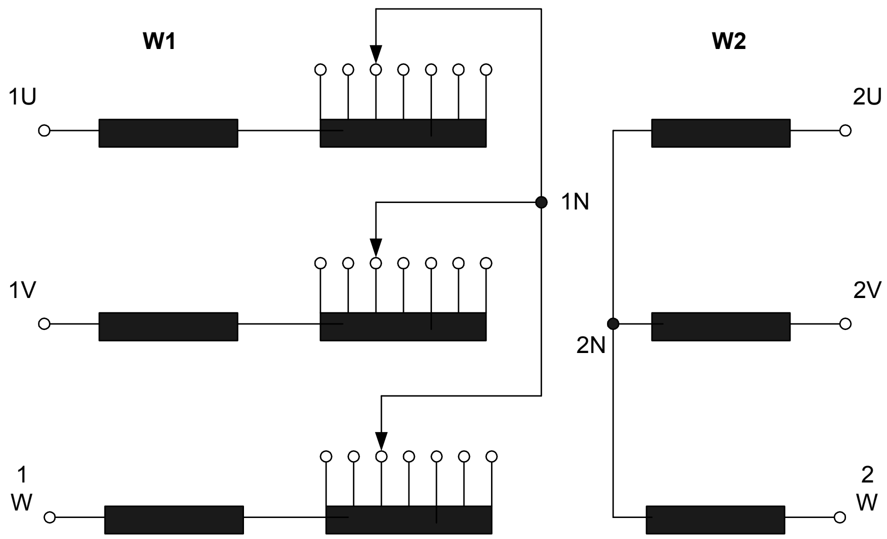


Figure 5.46: Transformer tap changer

Dependent on the brand, the tap changer can indicate its actual position either over a *changeable resistor* – connected to the tap changer – or via *BCD-coded signal lines.* Dependent on the kind of grading there is a certain number of winding tappings and hence tap changer positions to be detected (normally up to ± 16 steps). The voltage is controlled in direction higher or lower and mostly proceeds from a neutral position (to be defined).

BCD-coding of the tap changer position

Each decimal place of a decimal number is presented in the BCD-code by 4 Bit ("Tetrade" or "Nibble") of the dual number system (e.g. decimal "22" = BCD-code: "0001 0110") Since the max. number of tap changer positions to be detected are confined to 39 (± 19 plus "Neutral Position"), the CSP2-T needs only 6 Bits to process the decimal numbers up to "39" inclusively. Therefore the BCD-coded position detection is realized by *6 input functions* which have to be allocated to the digital inputs:

- „*Tc*.BCD 1"
- „*Tc*.BCD 2"
- „*Tc*.BCD 3"
- „*Tc*.BCD 4"
- „*Tc*.BCD 5"
- „*Tc*.BCD 6"

Important

- For the reliable detection of all *available tap changer positions* it must be ensured that all *6 input functions* are allocated to the digital inputs!
- With regard to the used logic (operating principle) for the digital inputs it is recommended to adjust to "active 1" ("Open Circuit Principle" of the digital inputs) so that the right tap changer position can be detected by means of the BCD-coding. When the inverted logic "active 0" (Closed Circuit Principle) is used, 6 additional logic equations have to be used in order to re-invert the individual input functions "Stf.BCDx" and so the correct BCD-coding can be maintained.
- All codings which do not reflect the decimal numbers between "0" and "39" are ignored by the *CSP2-T*.

The *table* shown below comprises the *BCD-coding* for the decimal numbers (1-39) which are allocated to the individual tap changer positions. The *input functions* are allocated to the relevant valency and have to be activated according to the table via the digital inputs to signal the tap changer position.

BCD-Coding of the Tap Changer Positions Via Input Functions							
Position	Output Message for Tap Changer Position (Message Text)	Decimal Position "Unit"		Decimal Position "Unit"			
		Valency					
		2^5	2^4	2^3	2^2	2^1	2^0
		Input Function					
		« *Tc.BCD 5* »	« *Tc.BCD 4* »	« *Tc.BCD 3* »	« *Tc.BCD 2* »	« *Tc.BCD 1* »	« *Tc.BCD 0* »
0	« *Tc.*Pos.0 »	0	0	0	0	0	0
1	« *Tc.*Pos.1 »	0	0	0	0	0	1
2	« *Tc.*Pos.2 »	0	0	0	0	1	0
3	« *Tc.*Pos.3 »	0	0	0	0	1	1
4	« *Tc.*Pos.4 »	0	0	0	1	0	0
5	« *Tc.*Pos.5 »	0	0	0	1	0	1
6	« *Tc.*Pos.6 »	0	0	0	1	1	0
7	« *Tc.*Pos.7 »	0	0	0	1	1	1
8	« *Tc.*Pos.8 »	0	0	1	0	0	0
9	« *Tc.*Pos.9 »	0	0	1	0	0	1
—	P*	0	0	1	0	1	0
—		0	0	1	0	1	1
—		0	0	1	1	0	0
—		0	0	1	1	0	1
—		0	0	1	1	1	0
—		0	0	1	1	1	1
10	« *Tc.*Pos.10 »	0	1	0	0	0	0
11	« *Tc.*Pos.11 »	0	1	0	0	0	1
12	« *Tc.*Pos.12 »	0	1	0	0	1	0
13	« *Tc.*Pos.13 »	0	1	0	0	1	1
14	« *Tc.*Pos.14 »	0	1	0	1	0	0
15	« *Tc.*Pos.15 »	0	1	0	1	0	1
16	« *Tc.*Pos.16 »	0	1	0	1	1	0
17	« *Tc.*Pos.17 »	0	1	0	1	1	1
18	« *Tc.*Pos.18 »	0	1	1	0	0	0
19	« *Tc.*Pos.19 »	0	1	1	0	0	1
—«	P*	0	1	1	0	1	0
—		0	1	1	0	1	1
—		0	1	1	1	0	0
—		0	1	1	1	0	1
—		0	1	1	1	1	0
—		0	1	1	1	1	1
20	« *Tc.*Pos.20 »	1	0	0	0	0	0
21	« *Tc.*Pos.21 »	1	0	0	0	0	1

BCD-Coding of the Tap Changer Positions Via Input Functions							
22	« *Tc*.Pos.22 »	1	0	0	0	1	0
23	« *Tc*.Pos.23 »	1	0	0	0	1	1
24	« *Tc*.Pos.24 »	1	0	0	0	0	1
25	« *Tc*.Pos.25 »	1	0	0	0	1	0
26	« *Tc*.Pos.26 »	1	0	0	0	1	1
27	« *Tc*.Pos.27 »	1	0	0	0	1	1
28	« *Tc*.Pos.28 »	1	0	0	0	1	0
29	« *Tc*.Pos.29 »	1	0	0	0	1	1
—		1	0	0	0	1	1
—		1	0	0	0	1	0
—	P*	1	0	0	0	1	1
—		1	0	0	0	1	1
—		1	0	0	0	1	1
—		1	0	0	0	1	1
30	« *Tc*.Pos.30 »	1	1	0	0	0	0
31	« *Tc*.Pos.31 »	1	1	0	0	0	1
32	« *Tc*.Pos.32 »	1	1	0	0	1	0
33	« *Tc*.Pos.33 »	1	1	0	0	1	1
34	« *Tc*.Pos.34 »	1	1	0	1	0	0
35	« *Tc*.Pos.35 »	1	1	0	1	0	1
36	« *Tc*.Pos.36 »	1	1	0	1	1	0
37	« *Tc*.Pos.37 »	1	1	0	1	1	1
38	« *Tc*.Pos.38 »	1	1	1	0	0	0
39	" *Tc*.Pos.39"	1	1	1	0	0	1

Table 5.33: BCD-coding of tap changer positions

* *Pseudo Tetrades:* Codings which do not represent a decimal number for the BCD-coding and are consequently redundant.

Parameters

„Function"
With setting "*Function = active*" the supervision of the tap changer position is activated.

"regard" (allocation of the winding end for the tap changer)
By the setting of this parameter the CSP2-T is informed to which of the winding ends the tap changer is connected.

"Tc input" (method of tap changer detection)
By the setting of this parameter the CSP2-T is informed about the method the tap changer position is being detected. This can either be realized by voltage measurment (analogue input) at a changeable resistance of the tap changer (in preparation) or by BCD-coded signal detection via the digital inputs.

Note

At the moment detection of the tap changer position is only possible via the digital inputs, i.e. by BCD-coding of the respective input functions.

"Min.T.po" (decimal coding of the lowest tap changer position)
Coding for indication of the lowest step of the voltage control is specifically defined by the manufacturer. Some of the tap changers furnish a *decimal "0"*, others a *decimal "1"* for the BCD-coded signals detected by

the digital input functions. By parameter *"Min.Pos."* the CSP2-T is informed whether the decimal "1" or the decimal "0" is to evaluated for detection of the lowest step.

"Min.T.vo" (voltage value for the lowest tap changer position)
For voltage control the tap changer furnishes a certain voltage value for the lowest step. The setting value is stated in % and refers to the rated voltage of the winding end to be changed.

„V.inc.po" (voltage value per tap changer position)
This is the parameter for defining the voltage value by which the voltage at the winding end connected to the tap changer is increased or decreased *per tap changer position*

"Pos.no." (number of possible tap changer positions)
This is the parameter for fixing the max. number of tap changer positions to be detected by the ***CSP2-T.***

"Neut.pos" (neutral position of the tap changer)
A *neutral position* has to be defined for counting the tap changes, but this is only possible when the voltage adjustment via the tap changer can be effected in both directions *voltage increase* as well as *voltage de-crease*.

"t stabl" (time delay for tap changes)
In order to ensure that during tap changing the change of position is clearly detected, it is imperative to prevent *"bouncing of the BCD-coding"*. "Bouncing" means that a repeated and fast status change ("active"/"inactive"), of, for instance, one of the 6 input functions, would be like a change between two decimal numbers. Consequently the ***CSP2-T*** would constantly adjust the transformation ratio which does not apply any more to the actual tap changer position.
In order to avoid such misinterpretations the time delay *"t stabl"* can be set. The time is started as soon as one of the 6 input functions changes its status and only after the set time has elapsed the actual tap changer position will be read-in.

Tap Changer Supervision				
Parameter	Setting / Setting Range	Description	Pre-Setting	Step Range
Function	"active"	The tap changer supervision is activated		-
	"inactive"	The tap changer supervision is de-activated	"inactive"	
regard	„Ur W1"	Adjustment of winding number at winding end W1	„Ur W1"	
	„Ur W2"	Adjustment of winding number at winding end W2		
Tc input	„Inp.fct."	(Detection of tap changer position via digital input) (BCD).	„Inp.fct."	-
	(not available)	(Detection of tap changer position via analogue input 1)	-	
	(not available)	(Detection of tap changer position via analogue input 2)	-	
Min.T.pos	„0"	BCD-coding: Decimal "0" is allocated to the lowest step of the tap changer.		-
	„1"	BCD-coding: Decimal "1" is allocated to the lowest step of the tap changer.	„1"	
Min.T.vo	80…100 %	Allocation of the voltage value for the lowest step position (in % refers to the rated voltage of the winding end to be changed).	„100 %"	0,1 %
V.inc.po	0…10 %	Voltage value change per tap changer position (in % refers to the rated voltage of the winding end to be changed).	„1"	0,1 %
Pos.no.	1…39	Number of tap changer positions to be detected	„39"	1
Neut.Pos	80…200 %	Defining the neutral position of the tap changer.	„100 %"	0,1 %
T stabl	0…50 s	BCD-coding: Delay time ranging from status change of the digital inputs to read-in of the new tap changer position.	„1 s"	1 s

Table: Parameters for tap changer supervision

5.7.3 Protection parameter (protection parameter sets)

By the *protection parameters* all settings are considered:

- for *protection functions* available for the specific *CSP2* type.

Note

For saving of changed protection parameters the system will not automatically reboot! After about 3 s the changed parameters are taken over by the *CSP2* (saved).

The *CSP2* has 4 protection parameter sets. Each protection parameter set contains the complete number of protection functions for the type of device in question.
All the protection functions work according to the parameters set in the active protective parameter set. If needed, a switch-over to a different protection parameter set is possible. In this way, four different protection sets can be saved in the memory of the *CSP2*.
Each protection parameter set can be modificated in the background without influencing the running protection and control functions. A modificated parameter set, even if only one single parameter has been altered, only becomes active when the alteration of the parameter set has been confirmed (saved) at the end of the processing.

Further down the protection functions and their operating principle are explained and there are terms used like "active", "inactive", "effective"and "ineffective". We would like to explain those terms in detail to ensure a proper understanding.

Each *stage* of a *protection function* can be put into function by setting the parameter "Function" to "active"! This guarantees that in the event of a fault the protection stage recognizes an activation, i.e. it is *effective*, provided that, of course, all *necessary requirements* for the protection functions are met. For instance, in case of blocking the entire protection via an active digital input (DI function : "Prot. Block."),. e.g.the protection function *I>>F* cannot recognize any activation – so it is *"ineffective"*!
The *frequency protection* set to "active" is another example. This protection function can only become "effective", i.e. recognize an activation, as long as the voltage at the measuring inputs *does not* drop below the adjusted threshold (parameter *„U BF"* of the *frequency protection*).

Definition of terms:

- *„inactive":* *Generally* this protection function is *put out of function*. For that purpose the parameter in the protective stage has to be set to *„Function = inactive"*. The protective function cannot recognize *any* activation ! It is a static state, depending on parameters.
- *„active":* *Generally* this protective function is *put into function*. For that purpose the parameter in the protective stage(s) has to be set to *„Function = active"*.Whether the protection function is able to recognize an activation depends on its specific requirements. It is a static state, depending on parameters.
- *„effective":* By using the setting *„Function = active*" of the protection stage the function has firstly to be energized and only then after all essential requirements of the protection function have been met, this function is able to recognize an activation, i.e. it is "*effective*".
- *„ineffective":* At first this protective function is *put into function* by the setting „Function = active" of the protection stage. The protection function, however, cannot recognize any activation be cause it is either blocked (by, for instant, an active digital input with DI function "*Prot. Block.*") or, perhaps, another applying requirement is not met (e.g. lacking measuring quantities). Effective / ineffective are dynamic states depending on several other states.

Blocking of the protection via digital input (input function "Prot. Block.")
Via the active digital input *"Prot. Block".* only those protective stages are blocked which parameters "*ex Block.*" are set to "*active*" !

Important

It is essential that activation of a *temporarily protection blocking* is displayed on the *CMP1*. For this the output function "*Prot. Active*" has to be assigned to a LED (LED "green" = *activated* protection and "red" = "*blocked*" protection).
When this output function is allocated it has to be considered that with an assigned input (protection) function, as for instance, "*Trip. Prot 1*", the output function *"Protect.active"* is still activated, despite the activated digital input "*Prot. Block.*".

5.7.3.1 (Protection-) parameter set switch-over and trigger acknowledgement

Description

For applications in which the protection parameters of active protection functions must be adapted to temporarily amended operational conditions, four protection parameter sets can be parameterized and be used as active parameter set if need be.

The protection parameter set switch-over can be done in three different ways (see Figure 5.47):

- Local switching over via the *CMP1* in MODE 2,
- Remote switching over via a digital input (DI function: „P-Set Sw. Over") in MODE 3 or via
- Remote switching over via a data telegram of the SCADA-system in MODE 3 or
- By using the *SL-SOFT*.

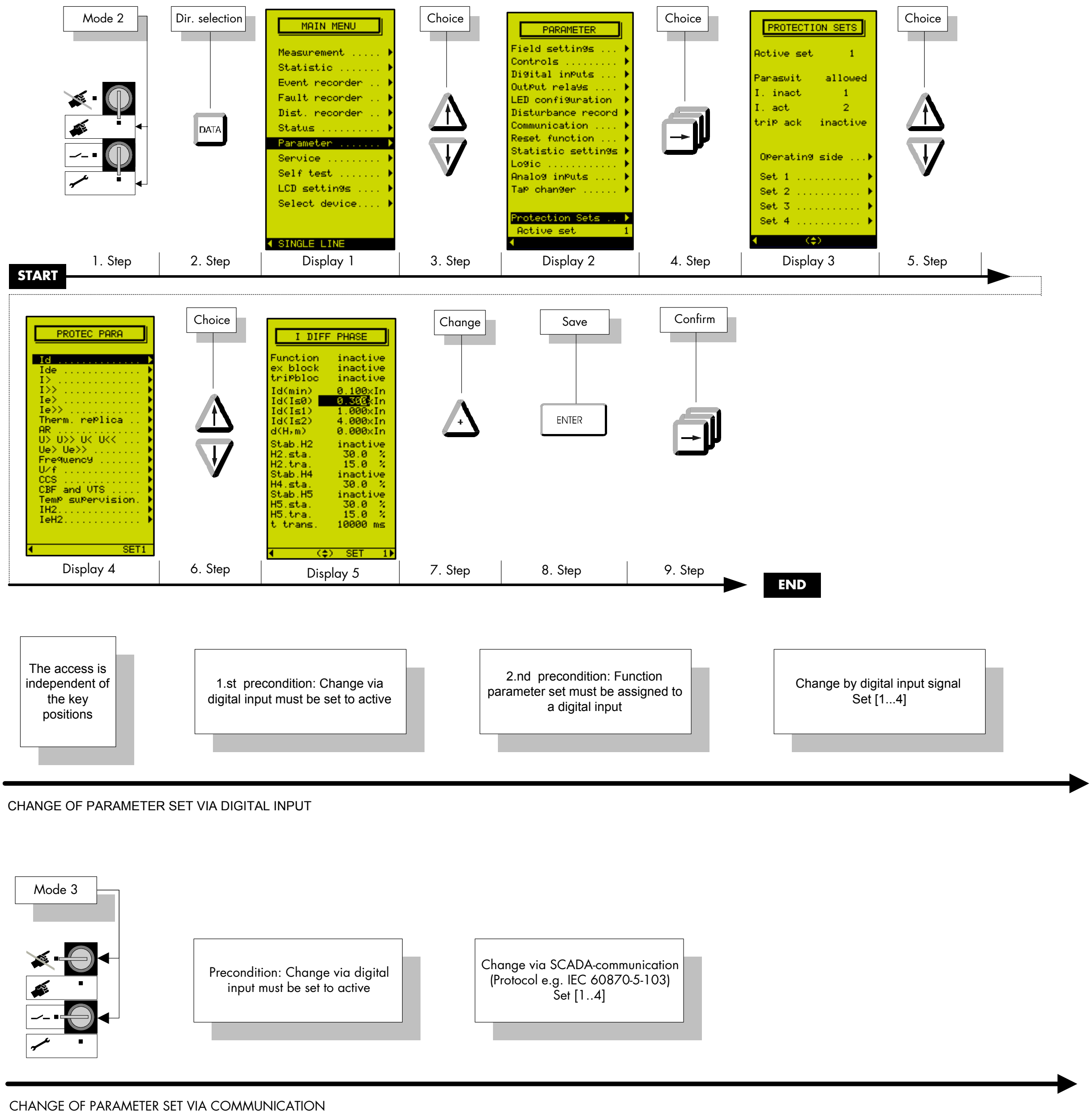


Figure 5.47: Possibilities of switching over the protection parameter set

Parameters

„Active Set"
This parameter displays the number of the currently active protection parameter set (1, 2, 3 or 4). It is further used for protective parameter set switch-over via the *CMP1*. However, the setting of the parameter *"Paraswitch = allowed"* must be selected and saved beforehand.

Note

The number shown in the display of the *CMP1* for the current protection parameter set is only updated after the switch-over of the protection parameter set or when the page is called up again (this can be carried out by scrolling backwards and forwards). On the other hand, the *CSP2* is already working with the new parameter set!

„Paraswitch"
This parameter stipulates whether a switch-over of the protection parameter sets is to be made possible or not. In addition, a separation of the way in which the switch-over of the protection parameter sets is to take place can be done.
Settings:
„not allowed": a switch-over of the protection parameter set is not possible!

„allowed": In this setting, a *switch-over of the protection parameter set* via

- The *CMP1* key switch: ("local/parameter setting") MODE 2 or via
- SCADA is possible (*CMP* key switch: "Remote operation"): MODE 3.

„Input fct.": A switch-over of the protection parameter set is only possible via a digital input placed with the "Switch p-set" input function (prerequisite: CMP key switch "Remote operation").
A manual switch-over is not possible in the active status of the digital input.
From the four existing protective parameter sets, two between which switching over is possible depending upon the status of the digital input can be selected.
For this, the respective code number (1 to 4) for the protection parameter sets to be switched over is to be set in the following parameters:

„Input fct. active"
Here, the number of the protection parameter set which is valid (active) with an *inactive* input function *"Switch p-set"* is entered.

„ Input fct. inactive "
Here, the code of the protection parameter set which is valid (active) with an *active* input function "Switch p-set" is entered.

„trip ack." (Trip acknowledgement)
A trip acknowledgement can be activated via this parameter. If the parameter is parameterized with *"trip ack = active"*, the circuit breaker can only be switched on again after a trip following an acknowledgement via the key "C" on the *CMP*, the digital input "quit" or via the SCADA.

With the setting *"trip ack =inactive"* the circuit breaker can be switched on again directly (i.e. without an acknowledgement) after a protection trip.

Parameter sets				
Parameters	*Settings*	*Description*	*Presetting*	*Step Range*
Active Set	„1“ „2“ „3“ „4“	ID number display of active parameter set and input field for switching over via *CMP1*	„1“	1
Paraswitch	„Not Permitted“	No switch-over action possible	„Not Permitted“	-
	„ Not Permitted “	Switching over: Possible via*CMP1* or control system		
	„Input fct“	Switching over: Possible via digital input only (DI-function „Switch. Over P-Set“)		
Input fct. active	„1“	„Protect. Parameter Set 1“ is active, if DI is *inactive*	„1“	1
	„2“	„Protect. Parameter Set 2“ is active, if DI is *inactive*		
	„3“	„Protect. Parameter Set 3“ is active, if DI is *inactive*		
	„4“	„Protect. Parameter Set 4“ is active, if DI is *inactive*		
nput fct. inactive	„1“	„Protect. Parameter Set 1“ is active, if DI is active	„2“	1
	„2“	„Protect. Parameter Set 2“ is active, if DI is active		
	„3“	„Protect. Parameter Set 3“ is active, if DI is active		
	„4“	„Protect. Parameter Set 4“ is active, if DI is active		
Trip ack.	„active“	A protection trip has to be reset either via button „C“ at the CMP, the DI „Reset“ or via SCADA before the CB can be reconnected	„inactive“	-
	„inactive“	After a protection trip the CB can be re connected without reset		

Table 5.34: Switching over of parameter sets and trip acknowledge

5.7.3.2 Tripping processing

Description
In the course of time different philosophies have been developed for transformers and the application of protective functions and the correlated possibilities with regard to *measuring locations* as well as the *issue of tripping commands (tripping processing)* to one or more CT(s). In the *CSP2-T* the different alternatives for a separate adjustment of each of the protective functions are considered under menu "*Tripping processing"*

Measuring locations
Due to the available winding ends W1 and W2 of the two-winding transformer and the number of CTs there are several possibilities to measure currents and voltages (see Chapter "Field Parameters")

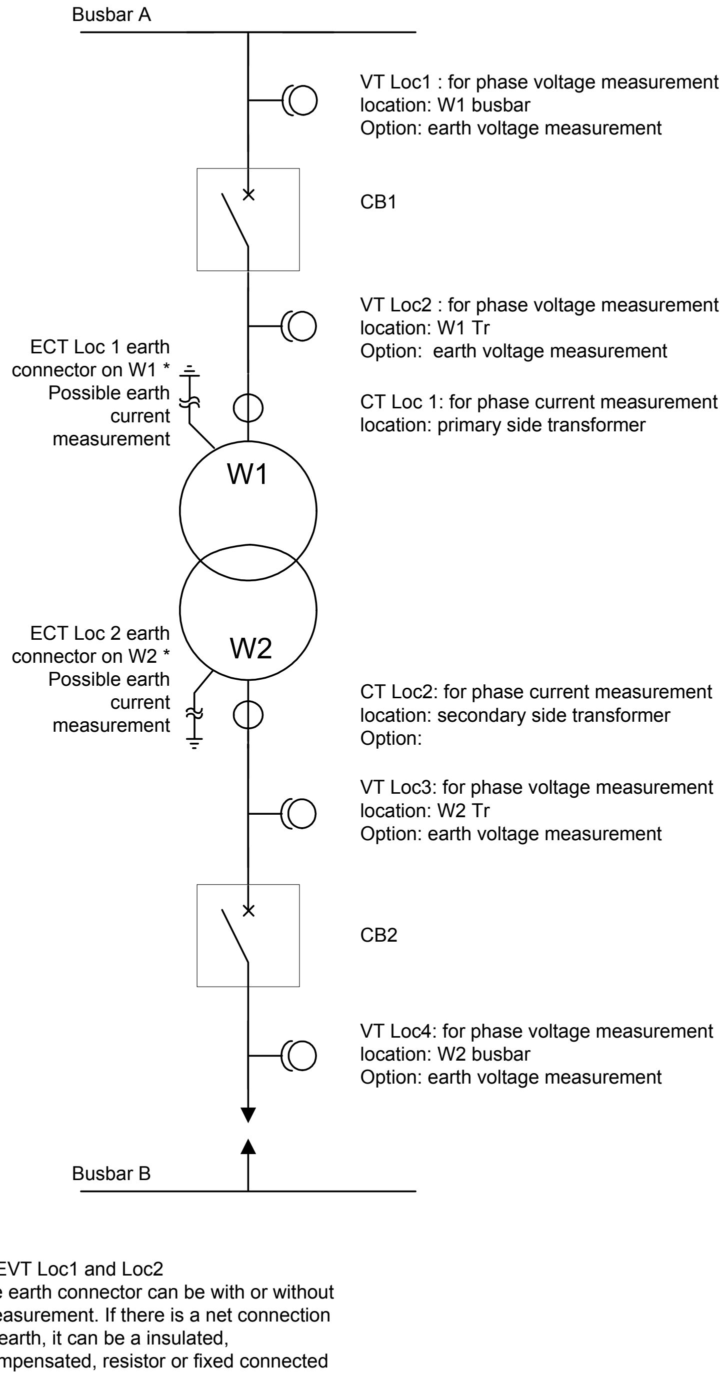


Figure 5.48: Different alternatives for current and voltage measurement

For *current measuring* there are always the phase currents to both of the winding ends acquired. For the use of directional current protection functions such as *I>, I>>, Ie> and Ie>>* it is necessary to provide an adequate voltage measurement as reference values.

Note

Thus the voltage and current measurement values has to be taken from the same winding side of the transformer.

Attention

According to the parameter setting of the current protection functions it is necessary to reference both the current protection function and the voltage measurement to the same winding side.

- *Voltage protection functions refer to the measurement location which is to be adjusted by the parameter „VT loc".*
- *Current protection functions refer to the measurement location which is to be adjusted by the parameter „Meas.loc".*

Measuring of the voltage is subjected to:

the *measuring location of the VTs („W1 Busb.", "W1 Tr", „W2 Busb." and „W2 Tr"),*
the *switching positions of the circuit breakers* and
the *availability of the voltages ($U_{W1\ BB}$ and $U_{W2\ BB}$)* at the bus bars of the two winding ends

In the table below the *measuring voltages* resulting from the different combinations are outlined.

Voltage Measuring						
Parameter	Setting	Combination				Measurement
		Position CB1	$U_{W1\ BB}$	Position CB2	$U_{W2\ BB}$	
VT Loc.	"W1 Busb."	OFF	Not available	OFF	Not available	-
		ON	Not available	OFF	Not available	-
		OFF	Available	OFF	Not available	$U_{W1\ BB}$
		ON	Available	OFF	Not available	$U_{W1\ BB}$
		OFF	Not available	ON	Not available	-
		ON	Not available	ON	Not available	-
		OFF	Available.	ON	Not available	$U_{W1\ BB}$
		ON	Available	ON	Not available	$U_{W1\ BB}$
		OFF	Not available	OFF	Available	-
		ON	Not available	OFF	Available	-
		OFF	Available	OFF	Available	$U_{W1\ BB}$
		ON	Available	OFF	Available	$U_{W1\ BB}$
		OFF	Not available	ON	Available	-
		ON	Not available	ON	Available	$U_{W1\ BB}$
		OFF	Available	ON	Available	$U_{W1\ BB}$
		ON	Available	ON	Available	$U_{W1\ BB}$
	"W1 Tr	OFF	Not available	OFF	Not available	-
		ON	Not available	OFF	Not available	-
		OFF	Available	OFF	Not available	-
		ON	Available	OFF	Not available	$U_{W1\ Tr}$
		OFF	Not available	ON	Not available	-

Voltage Measuring						
Parameter	Setting	Combination				Measurement
		Position CB1	$U_{W1\ BB}$	Position CB2	$U_{W2\ BB}$	
		ON	Not available	ON	Not available	-
		OFF	Available	ON	Not available	-
		ON	Available	ON	Not available	$U_{W1\ Tr}$
		OFF	Not available	OFF	Available	-
		ON	Not available	OFF	Available	-
		OFF	Available	OFF	Available	-
		ON	Available	OFF	Available	$U_{W1\ Tr}$
		OFF	Not available	ON	Available	$U_{W1\ Tr}$
		ON	Not available	ON	Available	$U_{W1\ Tr}$
		OFF	Available	ON	Available	$U_{W1\ Tr}$
		ON	Available	ON	Available	$U_{W1\ Tr}$
	"W2 Tr"	OFF	Not available	OFF	Not available	-
		ON	Not available	OFF	Not available	-
		OFF	Available	OFF	Not available	-
		ON	Available	OFF	Not available	$U_{W2\ Tr}$
		OFF	Not available	ON	Not available	-
		ON	Not available	ON	Not available	-
		OFF	Available	ON	Not available	-
		ON	Available	ON	Not available	$U_{W2\ Tr}$
		OFF	Not available	OFF	Available	-
		ON	Not available	OFF	Available	-
		OFF	Available	OFF	Available	-
		ON	Available	OFF	Available	$U_{W2\ Tr}$
		OFF	Not available	ON	Available	$U_{W2\ Tr}$
		ON	Not available	ON	Available	$U_{W2\ Tr}$
		OFF	Not available	ON	Available	$U_{W2\ Tr}$
		ON	Available	ON	Available	$U_{W2\ Tr}$
	"W2 Busb."	OFF	Not available	OFF	Not available	-
		ON	Not available	OFF	Not available	-
		OFF	Available	OFF	Not available	-
		ON	Available	OFF	Not available	-
		OFF	Not available	ON	Not available	-
		ON	Not available	ON	Not available	-
		OFF	Available	ON	Not available	-
		ON	Available	ON	Not available	$U_{W2\ BB}$
		OFF	Not available	OFF	Available	$U_{W2\ BB}$
		ON	Not available	OFF	Available	$U_{W2\ BB}$
		OFF	Available	OFF	Available	$U_{W2\ BB}$
		ON	Available	OFF	Available	$U_{W2\ BB}$
		OFF	Not available	ON	Available	$U_{W2\ BB}$
		ON	Not available	ON	Available	$U_{W2\ BB}$
		OFF	Not available	ON	Available	$U_{W2\ BB}$
		ON	Available	ON	Available	$U_{W2\ BB}$

Table 5.35: Measurable voltages

Tripping processing
Where two-winding transformers are use with e.g. single bus bar systems (SBB) and with one circuit breaker on each winding end, there are four basic ways to issue the OFF command(s):

Tripping of the *circuit breaker 1 (CB1)* for winding end 1 (W1) or
Tripping of the *circuit breaker 2 (CB2)* for winding end 2 (W2) or
Tripping of *both circuit breakers (CB1 and CB2)* of both winding ends (W1 and W2) or
(*Blocking of the tripping command*)

Note

Blocking of the tripping command can be separately adjusted for each of the protection steps. Although the tripping command is not applied to the power outputs, the related output message „Tripping XY" is activated. This also applies to the message in the communication records for the control system or Scada system.

In addition to the *internal protective functions* the *CSP2-T* has also *digital input functions.* The latter can be activated either via digital inputs or by the internal, freely programmable logic functions (SL-LOGIC). Therefore it is also possible to assign input functions to tripping commands

Tripping Processing and Measuring Location

Parameters	*Assignment*	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Internal protect.funct.*	*Input function*
I>	Measuring location	W1	Measuring at winding end W1	W1	•	
		W2	Measuring at winding end W2			
	Trip loc	W1	Trip command to CB1 of the winding end W1 only			
		W2	Trip command to CB2of the winding end W2 only			
		W1 & W2	Trip command to both CBs	W1 & W2		
I>>	Measuring location	W1	See above (s.a.)	W1	•	
		W2	s.a.			
	Tripping	W1	s.a.			
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
I H2	Measuring location	W1	s.a.	W1		
		W2	s.a.			
Ie>	Measuring location	W1	s.a.	W1	•	
		W2	s.a.			
	Trip loc	W1	s.a.			
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ie>>	Measuring location	W1	s.a.	W1	•	
		W2	s.a.			
	Trip loc	W1	s.a.			
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ie H2	Measuring location	W1	s.a.	W1	•	
		W2	s.a.			
Id>	Trip loc	W1	s.a.	W1	•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Id>>	Trip loc	W1	s.a.	W1	•	
		W2	s.a			
			s.a.			
Ide>	Trip loc	W1	s.a.	W1	•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ide>>	Trip loc	W1	s.a.	W1	•	
		W2	s.a.			
			s.a.			
Thermal replica ϑ>	Measuring location	W1	s.a.	W1	•	
		W2	s.a.			
	Trip loc	W1	s.a.			
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
U/f>	Trip loc	W1	s.o.	W1	•	
		W2	s.o.			
			s.a.			
U/f>>	Trip loc	W1	s.o.	W1	•	

Tripping Processing and Measuring Location

		W2	s.o.			
			s.a.			
Temperature supervision ϑ1>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
		W1 & W2	s.a.	W1 & W2		
Temperature supervision ϑ2>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
		W1 & W2	s.a.	W1 & W2		
U>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
U>>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
U<	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
U<<	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
Ue>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
Ue>>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
FF supervision	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
f1	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
f2	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
f3	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
f4	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
Protect.trip.1	Trip loc	W1	s.a.	W1		
		W2	s.a.			•
			s.a.			
Protect.trip.2	Trip loc	W1	s.a.	W1		
		W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
Protect.trip.3	Trip loc	W1	s.a.	W1		
		W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
Protect.trip.4	Trip loc	W1	s.a.	W1		
		W2	s.a.			•
			s.a.			
Protect.trip.5	Trip loc	W1	s.a.	W1		•
		W2	s.a.			

Tripping Processing and Measuring Location

		W1 & W2	s.a.	W1 & W2		
Protect.trip.6	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Tripp.temp.	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Tripp.Buchh.	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Tripp.Diff	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Tripp.Imped	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Tripp.Motor	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ext CT off	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		

Figure 5.49: Tripping assignment for protective functions

5.7.3.3 Phase current differential protection Id>

Description

The *phase current differential protection function Id>in the CSP2-T* is used for a selectively and quick disconnection of faulty *two-winding transformers*. The protection principle *"Phase Current Differential Protection"* is based on the balance of the *phase currents* flowing between the primary side and the secondary side.
This protection principle is realised by a central protection system comparing the measured values of the phase currents. Through this comparison method a protection can be realized with *CSP2-T* by which a two-winding transformer is only disconnected if this transformer is the source of the fault. By this the zone of protection is exactly limited – ranging from ct to ct - and provides a really fast protection with a min. tripping time of 25 ms.

In some cases it will be necessary to reduce the pick-up sensitivity of the differential protection function. Operational based interference effects, which are considered not to be faults within the zone of protection, but are observed as such and can be suppressed by suitable *stabilising measures*.

Definitions of Terms

Term	Explanation
Through Current I_D	The through current I_D represents physically the current flowing through the object being protected during operation and in the event of failure. I_D cannot be measured directly.
Stabilising Current I_S	The stabilising current I_S is a calculated auxiliary quantity, which detects the current flowing through the object being protected in a calculatory way and is used as X-component for fixing the operating point in the diagram of the pick-up characteristic (I_S: X-axis).
Differential Current I_d	The differential current I_d is the current resulting from the on- and off flowing currents measured on both ends of the line. I_d is used as Y-component for fixing the operating point in the diagram of the pick-up characteristic (I_d: Y-axis).
Operational Based Fault Current	The operational based fault current reflects the portion of the measured differential current which is not caused by a fault of the object being protected, but by systematic faults (e.g. different transformer properties).
Pick-Up Current I_a	The pick-up current I_a is defined by the course of the pick-up characteristic and is increased temporarily by stabilising measures due to the dynamic rise of the characteristic.
Static Tripping Characteristic	The static tripping characteristic segregates the operating section from the section the trip has occurred and it is the dependence criteria between pick-up current and stabilising current. This interdependence can be adjusted.
Stabilisation	The general term "Stabilisation" covers all those measures by which the differential protection is made more resistant to false tripping. Thus „Stabilisation" means to lower the activation sensitivity of the protection function without blocking it completely. Stabilisation measures have to be taken against systematic faults (parameter settings of the basic pick-up characteristic) and against faults caused by transient processes (temporary dynamic rise of the basic pick-up characteristic). The stabilising factors d[H,m] serve for a temporary rise of the basic pick-up characteristic during transient processes.
Stabilising Factor d[H,m]	The absolute quantity for rising the basic pick-up characteristic dependent on the transient stabilising factor m (condition: $m \neq 0$) as well as the harmonic analysis.
Transient Stabilising Factor m	The transient stabilising factor is the indicator for detection of transients by the transient monitor and is computed by the degree of detected transients.
Sensitivity	Ability of a protection facility to react on relatively insignificant disturbances (activation).

Table 5.36: Definition of Terms Regarding Phase Current Differential Protection Id

Principle of the phase current differential protection

Electrical items to be protected as, for instance, *transformers,* are classed as *passive quadripoles*.

The energy conducted through the object to be protected is very significant when considering the discrimination *balance* between *operational based faults and actual faults*. When viewing the *power balance of passive quadripoles*, reduction of a (phase) c*urrent balance* in relation to the impressed mains voltage is feasible.

The protection principle *Phase Current Differential Protection* is founded on the selective phase comparison between the measured phase currents $\underline{I}_{L1,W1}$; $\underline{I}_{L2,W1}$ and $\underline{I}_{L3,W1}$ at the primary side (Index „*W1*") with the measured phase currents $\underline{I}_{L1,W2}$; $\underline{I}_{L2,W2}$ and $\underline{I}_{L3,W2}$ at the secondary side (Index „*W2*") of the transformer.

The isochronously acquired measuring values serve as reference information and are transmitted to the *CSP2-T* via the CT. They are then compared by taking into account

- the CT transmission ratio,
- the transformer transmission ratio,
- the transformer vector group and
- (if existing) the position of the transformer tap changer

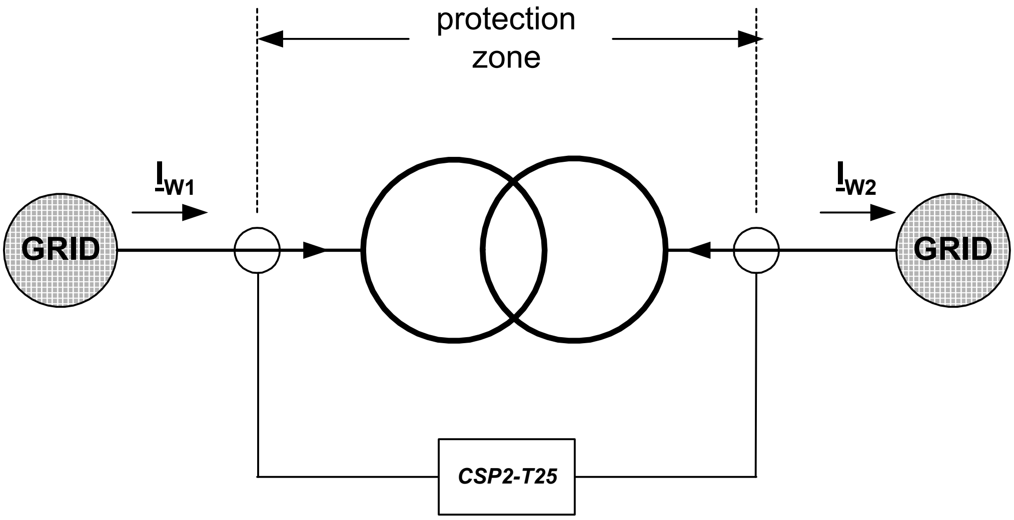


Figure 5.50: Protection principle of the current differential protection by example of a two-sided fed transformer

Comparison is carried out by me*asuri*ng the absolute value and angle of the differential current I_d criteria

The outcome of the analysis is the calculation of the time curve of a *stabilising current* I_S and of a respective *differential current* I_d the values of which forming a dynamic operating point in the static tripping *characteristic diagram* (separating the *operating range* from the *tripping range*) (X-axis: *stabilising current*, Y-axis: *differential current*). A *pick-up current* value I_a is related to each *stabilising current* I_S ; the pick-up current value is defined by the *course* of the *static tripping characteristic*.

Note

The tripping characteristic and its purpose is explained in detail later on in this chapter (under *stabilising measures*).

Operational based faults

When referring to *operational based faults* it is assumed that nearly all the energy (or the phase currents $\underline{I}_{L1,W1}$; $\underline{I}_{L2,W1}$ and $\underline{I}_{L3,W1}$), fed at the *primary side* – minus the minor electrical losses caused by systematic faults – "flows off" at the *secondary side* (phase currents $\underline{I}_{L1,W2}$; $\underline{I}_{L2,W2}$ and $\underline{I}_{L3,W2}$). The energy flowing through is *physically* represented by *the through-current* $I_{D.}$

Actual fault

In case of an *actual fault* only some of the high-level (fault-) energy (or short-circuit current I_K) fed at the primary side flows to the *secondary side,* most of it flows to the point where the fault occurred within the zone of protection. Compared to normal operation, the *through-current* I_D is then far smaller or even zero.

In both cases the *through-current* I_D represents merely the physical value of the energy flowing through the protected object and thus I_D cannot be measured directly. For the *tripping characteristic*, however, an auxiliary quantity is needed by which the through flowing energy (current) is calculated and so contributes to an *exact definition* of the *operating point* in the characteristic diagram (X-axis). This auxiliary quantity is known as *stabilising current* $I_{S.}$

Definition of the stabilising current I_S

The current pointers $\underline{I}_{W1}$ and $\underline{I}_{W2}$ at both ends of the transformer show only *little* deviations of their phase position and their values due to the systematic faults. In physical respect this means a high *through-current* I_D. The stabilising current I_S , as calculatory equivalent to *the through-current,* is computed according to the following formula :

⇒ Calculation of the stabilizing current I_S:

$$i_S(t) = \frac{1}{2}\left[i_{W1}(t) - i_{W2}(t)\right]$$

$$I_S = \frac{1}{\sqrt{2}} \times \hat{I}_S$$

Algorithm for calculating the protective criterion „Differential Current I_d"
By calculation of the *differential current I_d* and the *stabilising current I_S* at both ends of the transformer an operating point in the characteristic diagram is formed (see Figure 5.53). If this operating point is within the tripping range (fault), the *differential current element* Id> picks-up. In case the operating point is within the operating range (normal operation), the protection system is not activated.

Calculation is done by *geometrical addition* of the phase currents $\underline{I}_{W1}$ and $\underline{I}_{W2}$:

⇒ Calculation of the *differential current I_d*:

$$i_d(t) = \left[i_{W1}(t) + i_{W2}(t)\right]$$
$$I_d = \left|DFT\left\{i_d(t)\right\}\right|$$

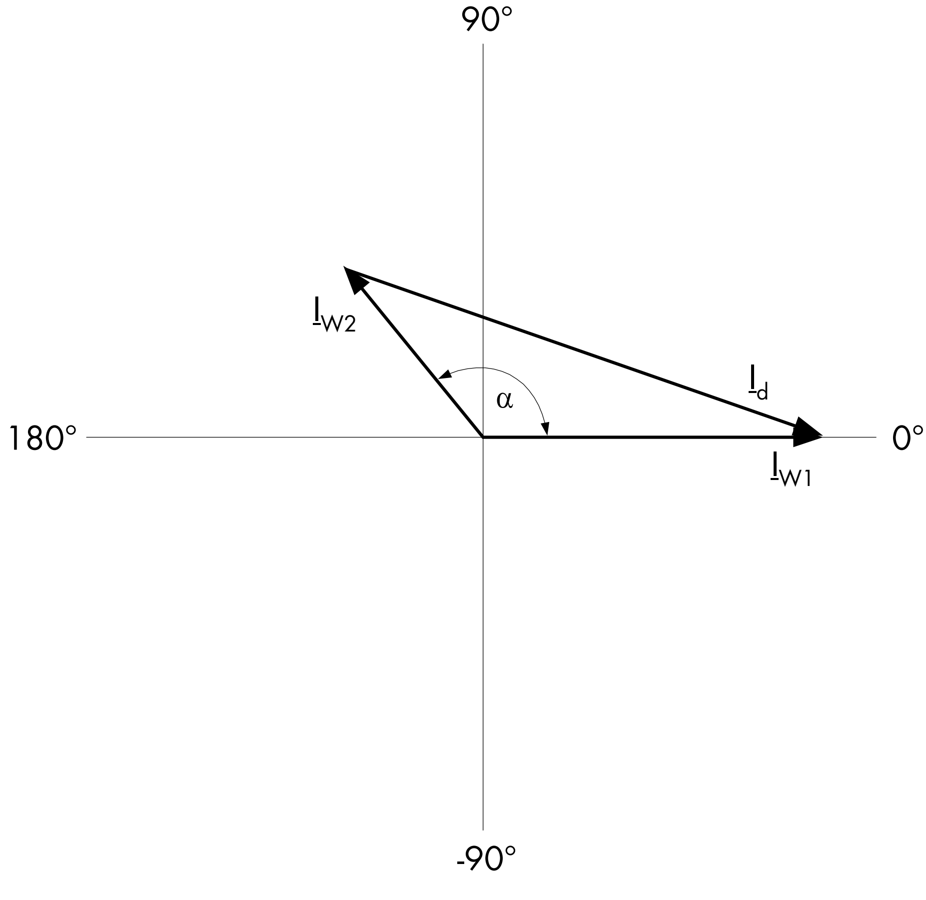


Figure 5.51: Geometrical addition of the phase currents during normal operation and fault conditions

The formulas shown above are based on the sampled values, and the respective graph is based on the basic wave (50 or 60 Hz vector) of the current $\underline{I}_{W1}$, $\underline{I}_{W2}$ or I_d. The indications "*W1*" and "*W2*" represent the primary side and secondary side of the transformer.

The trip function is triggered as soon as a pick-up current I_a , defined by the trip characteristic, (range above the static tripping characteristic) is exceeded by the *differential current I_d* of the related stabilising current I_S .

Stabilising
In order to secure a max. selectivity, i.e. to prevent *false tripping* during normal operation, the *differential protection* has to be stabilised against

- *Systematic faults*
- *Static faults* outside the zone of protection as well as
- *Faults caused by transient processes* (e.g. CT saturation, start-up of the transformer)

Measurement of the *differential current* is *falsified* by these *faults*, i.e that at times a considerable differential current is measured within the secondary measuring circuit which does not exist at the primary side.
Stabililisation against systematic faults is realized by an appropriate *adjustment of the static characteristic*.
Stabililisation against *transient processes* or static faults outside the zone of protection is achieved by a *temporary dynamic rise* of the *static characteristic*.

Important

By *stabilisation measures* the *CSP2-T* is always made *insensitive* against nuisance protection trippings!

Stabilisation against systematic faults
In practice, *systematic faults* can lead to fault currents (differential current I_d) also at normal operation conditions. Such a fault current is measured as *differential current* I_d , although there has no *transformer fault occurred*.
Systematic faults can result of *sources* like

- *Wrong values of the phase currents* caused by single-sided *no-load currents (magnetising currents)*,
- *Wrong angles and values caused by different tolerances* of the CTs used,
- *Wrong values caused by inaccurate adaption of the main CT (*nominal CT data) to the transmission ratio of the transformer,
- Sometimes additional *wrong values* can be the cause, when the *voltage transmission ratio* is changed due to the use of a *tap changer*. Here it is possible that tolerances of the transmission ratio can lead to deviations between the *reference value and the actual value* of the *existing voltage transmission ratio*. The position of the tap changer can be identified either via BCD encoded *wiring of the digital inputs* or via an *analogues input*.

The *pick-up current* I_a of such interference effects has to be duly considered. Thus the quantity of the resulting *fault current* depends on the *operational conditions* and so basically on the *through-current* I_D.

A thorough study of the individual interferences and their effects as fault current is represented in the *typical tripping characteristic (real fault current characteristic)* of a transformer. In the diagram (s. fig. 5.26) the *real fault current (differential current* I_d *) to be expected* is shown above the *stabilising current* I_S.

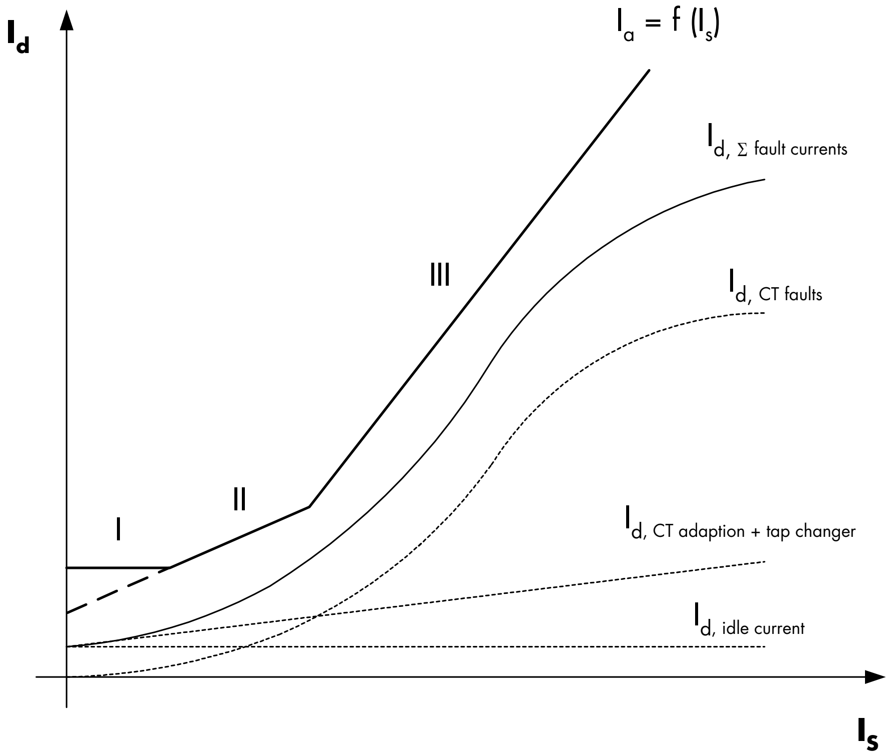


Figure 5.52: Typical tripping curve in comparison to a physical caused primary fault current line

When a fault occurs *within the protection zone*, the measured *differential current* I_d accumulates beyond the *operationally caused fault current*. Therefore the tripping curve has to be above the real fault current curve by the ratio of the desired sensitivity. This course of the tripping curve can be approximated by a simplified curve consisting of *three linear sections (I, II and III)*.
The higher the tripping curve is adjusted, the higher the permissible *differential current* I_d , whereas a *low adjusted characteristic* means an increased *sensitivity*. If the values set in the tripping characteristic lie *below the real fault current characteristic*, then the *systematic faults* stated before can cause *false trippings*.

The *static tripping characteristic* of the differential protection function in the *CSP2-T* defines the *segregation* between *tripping range* and *operating range* and is represented by three lined-up straight-line sections with different gradients.

The *initial point* and *end point* of the straight-line sections are defined by the following *setting parameters*:

- *Id(min)*: *line* — defines the value of a constant tripping current I_a up to the *crossing with the II. or III. straight-section* of the static tripping characteristic
- *Id(Is0)*: defines the tripping current I_a for a stabilising current $I_S = 0$ (if Id_{min} *is set to "0"*)
- *Id(Is1)*: defines the tripping current I_a for a stabilising current $I_S = 2 \times In$ and
- *Id(Is2)*: defines the tripping current I_a for a stabilising current $I_S = 10 \times In$

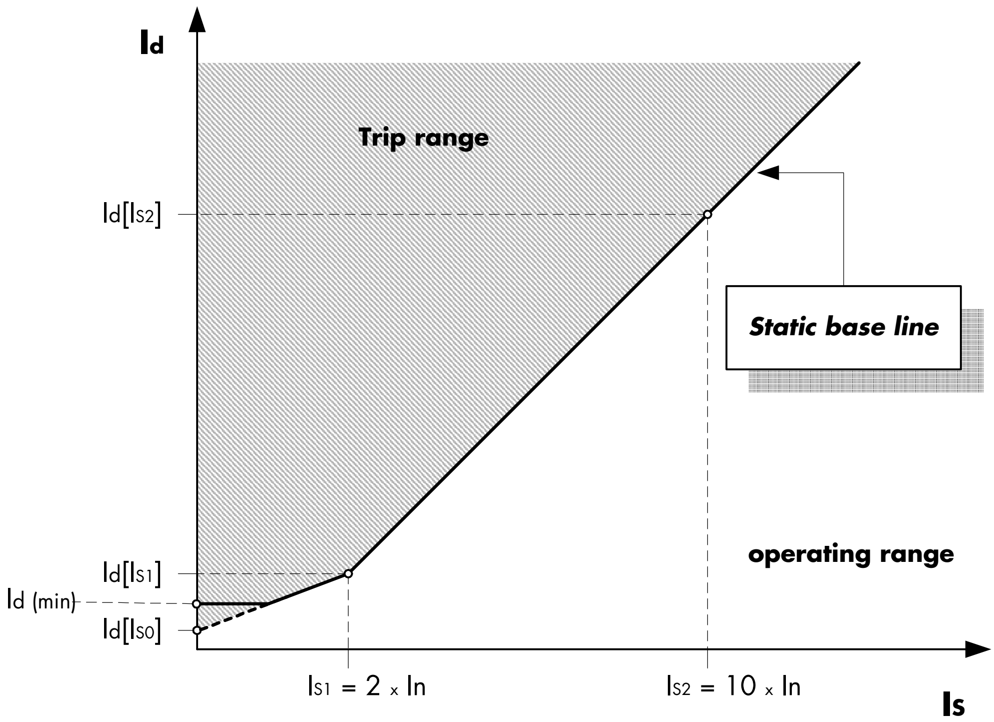


Figure 5.53: Static tripping characteristic

If the *tripping current* I_a would be set very sensitively, nuisance tripping could be caused by merely *systematic interference effects*. Hence with increasing *through-current* I_D the *tripping current* I_a has to be changed to a higher value. This correction is realized by adjusting the static tripping characteristic above the Id[I_{S0}]; Id[I_{S1}]; Id[I_{S2}] parameters which determine the *gradients in the characteristic sections* (see Figure 5.53).

Stabilisation against harmonics
The three straight lines/gradient sections (I, II and III) are to be considered as an interpolation for static states and so they represent an *idealised* approach. In reality, however, *transient effects* and *static harmonics* can be caused by

- certain *transient effects* as well as
- certain *operational conditions of the mains* (caused by static and rotating components)

By certain transient processes, as for instance *CT saturation,* the current difference as well as the harmonics can be increased without a fault having occurred in the protection zone. Consequently it is necessary to employ *stabilising measures* also against harmonics which may lead to false trippings. By these stabilising measures the protection function in the ***CSP2-T*** is *not blocked* but merely *de-sensitised* in correlation with the detected occurrences. High current faults cause the protection function to trip in any case.
In the *CSP2-T* harmonics are detected by a *harmonic analysis.* Transient occurrences are recognized via the *transient monitor*

Harmonics analysis
In the ***CSP2-T*** the *differential current* I_d is formed directly out of the analogue tracks of the current measurement at the line ends. Hence the *differential current* I_d measured this way contains all the harmonics generated by these occurrences. By the following "*Discrete Fourier Transformation (DFT)",* in the frequency range the harmonic portions are filtered out of the *differential current,* their quantity defined and then comparison of the threshold value defined by the relevant protection parameters with regard to stabilisation against harmonics is carried out.

Detection of transients by the transients monitor (gradient monitor)
The t*ransients monitor* of the *CSP2-T* monitors the transformer to be protected and the CT circuits for *transient behaviour* of the phase currents. This *transient behaviour* can be evoked by

- *line circuit closing* at the high-voltage side of the transformer *(rush effect)*
- *line circuit closing* at a parallel, idle running transformer and
- *saturation of the CT.*

The procedure for *detection of transients* is as follows: In the course of the phase currents <u>I</u>dL1', <u>Id</u>L2', <u>Id</u>L3', the max. *gradient factor Δi/Δt* is defined within a half-wave and its *peak value (phase current amplitude)* i_{max} is measured. For valuation purposes both quantities are put into relation and are then evaluated together with the sign of the max absolute slope. For an *all sinusoidal phase current* (first harmonic without higher-frequent components), the ratio from *max. gradient factor* to *phase current amplitude of the half-wave* is:

$$\frac{\left|-\Delta i / \Delta t\right|_{max}}{i_{max}} = 1$$

The chronological course of the phase current is *distorted* by its higher-frequent components, caused by transient processes (e.g. circuit-closing). Consequently there is a *higher value* for the *max. gradient factor* in a half-wave than for a relevant all sinusoidal first harmonic with identical amplitude:

$$\frac{\left|-\Delta i / \Delta t\right|_{max}}{i_{max}} > 1$$

When a „rush current" occurs there is a corresponding negative gradient factor in the positive half-wave and vice versa. An inrush peak is stabilised by the 2^{nd} harmonic. Stabilising measures, e.g. in rising the tripping characteristic by the set value of *d[H,m],* are only employed if an excessive positive gradient factor is detected in the positive half-wave or an excessive negative gradient factor in the negative halve-wave. By these indicators it can be distinguished between an internal or external fault current with CT saturation.

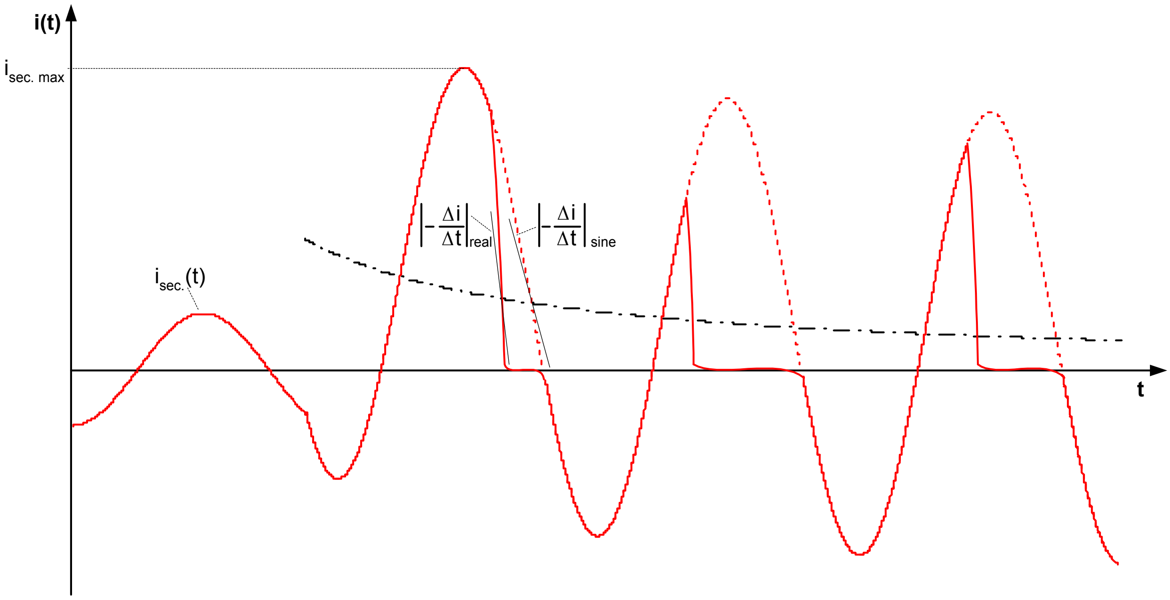


Figure 5.54: Example: Detection of CT saturation by means of the transients monitor

Note

The critaria *"Gradient Factor Δi/Δt"* for *positive* and *negative half-waves* is evaluated in a sign corrected manner by the absolute value.

For evaluation of the criterion *Gradient Factor Δi/Δt* an auxiliary quantity *m* is ascertained, which is in proportion to the ratio of the *max. gradient factor* to *the phase current amplitude of the half-wave*

$$m \sim \frac{\left| -\Delta i / \Delta t \right|_{max}}{i_{max}}$$

and, dependent on the transient process, may take on different values.

Based on the ascertained ratio of the *gradient factor Δi/Δt* to the *phase current amplitude of the half-wave* a relevant value is calculated for *m* which is known as *transient stabilisation factor.*

For the *all sinusoidal phase current* the result is:

$$\left| -\frac{\Delta i}{\Delta t} \right|_{max} = i_{max} \Rightarrow m = 0\,!$$

For a *phase current with higher-frequent components* the result is :

$$\left| -\frac{\Delta i}{\Delta t} \right|_{max} > i_{max} \Rightarrow m > 0\,!$$

Note

The *transient stabilising factor m* is the *indicator for detection of transients* and is a *calculated quantity*! The value of the *transient stabilising factor m* is entered into the calculation algorithm for the dynamic increase of the static tripping characteristic, by which the *sensitivity* of the differential protection function is reduced temporarily.

For: m ≠ 0 ⇒ *temporary dynamic rise of the static tripping characteristic*!

Dynamic rise of the static tripping characteristic by means of stabilising factors (transient characteristic)

In order to prevent false tripping caused by transient processes, a *stabilising factor* is provided in the *CSP2-T*. By this factor the *tripping characteristic* is *temporarily risen dynamically* when harmonics are detected so that the operational range is extended. This refers to the *stabilising factor d[H,m] which can be parameterised:*

- *d[H,m]*: absolute rise of the static tripping characteristic for m ≠ 0 by the value set for *d[H,m]* or when harmonics are detected (2nd, 4th or 5th harmonic).

Hence if, for instance, a *transient process* is detected (m > 0), it is switched over to the *transient characteristic* by the *CSP2-T*, i.e. the static tripping characteristic is shifted in direction *higher trip values* in correlation with the intensity of the transient processes which falsify the measurement.
The static tripping characteristic = f(Id min; Id[Is0]; Id[Is1]; Id[Is2]) is then risen by the absolute value adjusted by *d[H,m]* : Characteristic = f(Id min'; Id[Is0]'; Id[Is1]'; Id[Is2]').

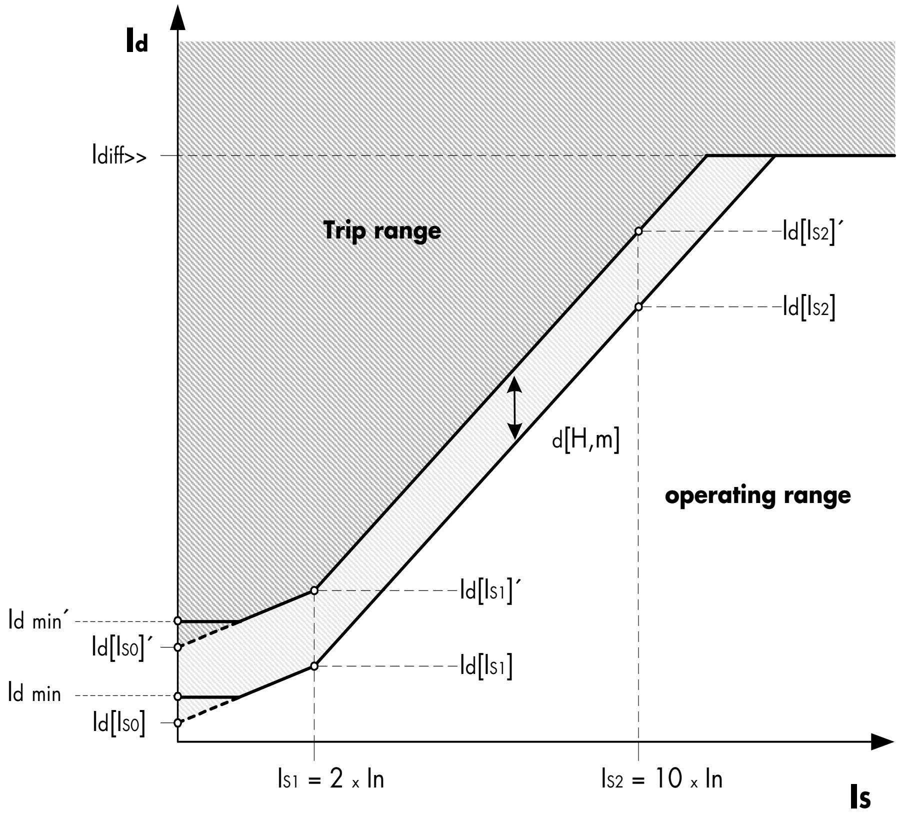


Figure 5.55: Dynamic rise of the static tripping characteristic

Note

Rise of the static tripping characteristic by the stabilising factor *d[H,m]* is only temporary, i.e. if the transient stabilising factor drops to the value *m = 0* for instance, then the dynamic characteristic changes back to the static tripping characteristic.
In case of stabilization by harmonics this stabilization will occurfor at least 4 periods, in case of stabilization by slope detection this stabilization will occur for at least 5 periods.

Unstabilised high-set differential current protection step Idiff>>
Irrespectively of the set static tripping characteristic and stabilising factors *d[H,m],* a pick-up value for a max. differential current *Idiff>>* can be adjusted and results in *undelayed tripping* when exceeded. This protection step is referred to as *high-current differential step Idiff>>* and only trips upon faults within the protection zone.

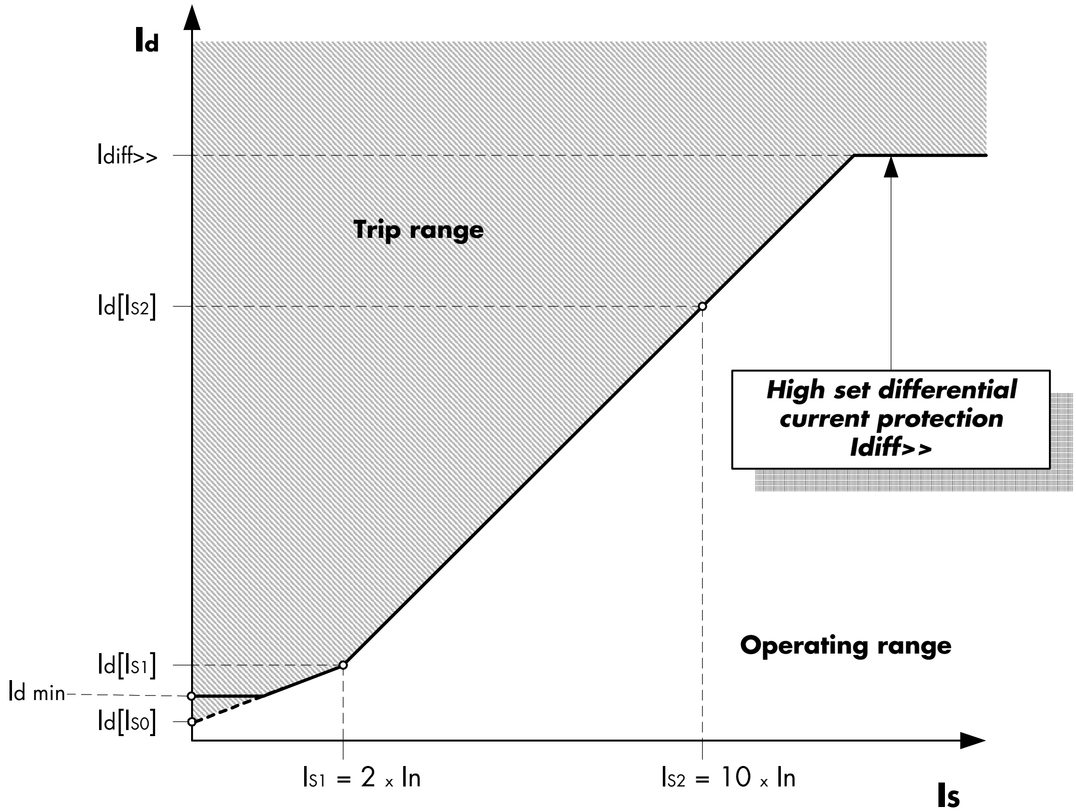


Figure 5.56: Unstabilised high set differential protection step *Idiff>>*

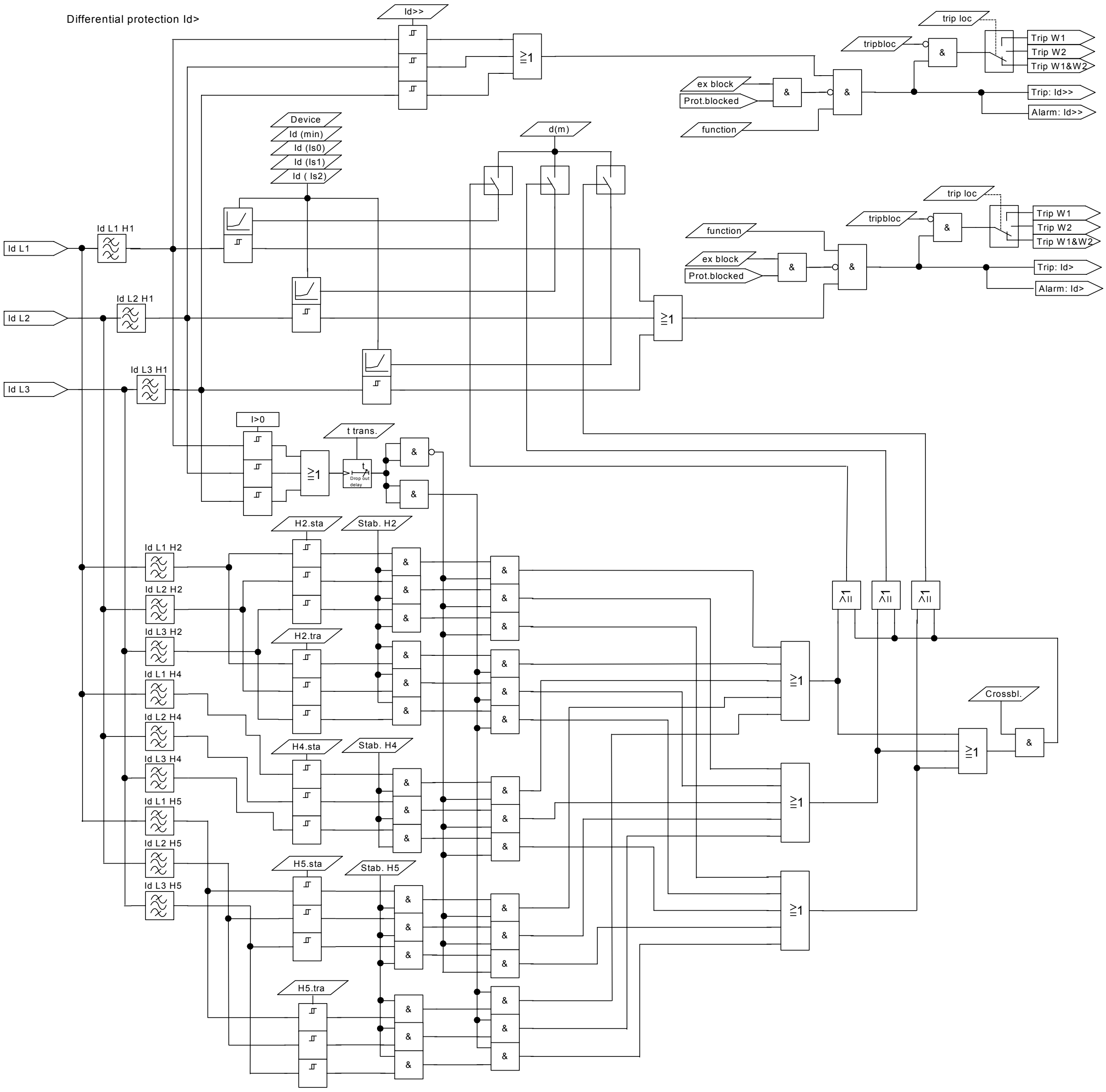


Figure 5.57 Logic diagram of the phase current differential protection function Id>

Parameters

„Function"
The *differential protection function* is generally activated with the setting *„Function = Active"*. But this *differential protection function* can only become active if it is not blocked.

„ex Block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *differential protection* which are set to *„ex block = aktive"* are blocked.

„tripbloc" (Blocking the circuit breaker (CB) OFF command)
Here only the OFF command for the CB is blocked. The signals *"Trip XY"* and *"General Trip"* are, however, generated after the tripping delay time has elapsed. These messages are available as output messages for LED indication, for processing via signal relay or as signals (data points) for communication with the control system.

„Applications" (selection of equipment to be protected)
The *CSP2-T* can be employed for tansformators as well as for generators in one respect and also for short lines and short couplings (bus bar short links). Because the transformer vector group is not taken into account when used as generator differential protection, line differential protection or as differential protection for short links, the protection algorithm has to be adapted to the equipment to be protected.

Adjustments:

„Transformer": Used as transformer differential protection. For this application the transformer vector group is taken into account in the protection algorithm.

„Line" : This adjustment is used for the protection of equipment where the transformer vector group is not to be considered. This applies to generators, short lines or short links.

"Id min", "Id(Is0)", "Id(Is1)" and "Id(Is2) "" (Parameters for definition of the static tripping characteristic)
As to the *differential protection function* the static tripping characteristic is defined by four points:

"Id min": this parameter defines the *constant pick-up value for the differential current* I_d for a stabilising current between $I_S = 0$ (initial point of the first straight line section of the static tripping characteristic) and $I_S = 2 \times In$.

"Id(Is0)": this parameter defines the *pick-up value for the differential current Id* if the *stabilising current is zero:* *"*$I_S = 0$*"* (initial point of the first straight line section of the static tripping characteristic).

"Id(Is1)": this parameter defines the *pick-up value for the differential current Id* if the *stabilising current is twice the rated current: "* $I_S = 2 \times In$*"* (break point of the pick-up characteristic).

"Id(Is2)": this parameter defines the *pick-up value for the differential current Id* if the *stabilising current is ten times the rated current: "* $I_S = 10 \times In$*"* (second point for defining the second straight line section of the pick-up characteristic).

„d[H,m]" (stabilising offset)
When *harmonics* are detected which were caused by *transient* or *static processes*, such as *circuit closings* or *CT saturation,* the static tripping characteristic is risen by the absolute quantity of the set factor *d[H,m]* for stabilising purposes. This is either realized by the harmonics analysis where the component of ultra-harmonics is measured *d[**H**,m]*, or by means of the transients monitor, where the *transient stabilising factor m* is the criterion for the component of the harmonics; *d[H,**m**]*.

"Stab.H2." (stabilisation against the 2nd harmonic)
The function of the phase current differential protection *Id*> can be stabilised against *stationary* and *transient* components of the 2nd harmonic at the differential current (e.g. rush effect). For this purpose parameter *„Stab.H2" is* either set to *"active"* or *"inactive"*.

„H2.sta." (stabilisation against stationary components of the 2^{nd} harmonic)
If the general stabilisation against the 2^{nd} harmonic is activated,there are two different thresholds per two different timespans *t tra* (after energizing) and *t > t tra* per stationary operation. The *pick-up threshold for stabilisation against stationary components* of the 2^{nd} harmonic is set with parameter *„H2.sta"*.

„H2.tra." (stabilisation against transient components of the 2^{nd} harmonic)
If the general stabilisation against the 2^{nd} harmonic was activated, it can be segregated whether the stabilisation should apply to stationary, transient or stationary and transient components. The *pick-up threshold for temporary stabilisation against transient components* of the 2^{nd} harmonic is set with parameter *„H2.tra".*

"Stab.H4." (stabilisation against the 4th harmonic)
The function of the phase current differential protection *Id>* can be stabilised against *stationary* and *transient* components of the 4^{th} harmonic at the differential current (e.g. rush effect). For this purpose parameter *"Stab.H4."* is either set to *"active"* or "*inactive"*.

"H4.sta." (stabilisation against stationary components of the 4^{th} harmonic)
If the general stabilisation against the 4^{th} harmonic was activated, it can be segregated whether the stabilisation should apply to stationary, transient or stationary and transient components. The *pick-up threshold for stabilisation against stationary components* of the 4^{th} harmonic is set with parameter *"H4.sta"*.

"Stab.H5." (stabilisation against the 5th harmonic)
The function of the phase current differential protection *Id>* can be stabilised against *stationary* and *transient* components of the 5^{th} harmonic at the differential current (e.g. rush effect). For this purpose parameter *"Stab.H5."* is either set to *"active"* or "*inactive"*.

„H5.sta." (stabilisation against stationary components of the 5th harmonic)
If the general stabilisation against the 5^{th} harmonic was activated, it can be segregated whether the stabilisation should apply to stationary, transient or stationary and transient components. The *pick-up threshold for stabilisation against stationary components* of the 5^{th} harmonic is set with parameter *"H5.sta"*.

"H5.tra." (stabilisation against transient components of the 5th harmonic)
If the general stabilisation against the 5^{th} harmonic was activated, it can be segregated whether the stabilisation should apply to stationary, transient or stationary and transient components. The *pick-up threshold for temporary stabilisation against transient components* of the 5th harmonic is set with parameter *"H5.tra".*

"t trans" (stabilisation against transient components of the 2nd and 5th harmonic)
With parameter *„t trans"* the *time for temporary transient stabilisation* of the differential protection function *Id>* is defined to indicate when the threshold value for „H2.tra" and „H5.tra" is exceeded.
During "*t trans"* the harmonics contents monitored a value against the transient threshold.

"Crossbl." ("Crossblock" function)
With this function it is possible to use a different technique for stabilisation *of the phase-selective differential protection function Id>*.

Adjustments:

"active": When this function is selected and harmonics are detected in only one of the line conductors, the phase-selective differential protection function *Id>* is also *jointly* stabilised for the other two line conductors, i.e the characteristics for the two other line conductors are *also* risen.

"inactive": When this function is selected and harmonics are detected in only one of the line conductors, the phase-selective differential protection function *Id>* is just temporarily stabilised for that line conductor where the harmonics have been discovered. The characteristics for the other two line conductors will *not* be risen.

"Sl.mon" (gradient monitor or transients monitor)
The transients monitor does not only serve for the analysis of harmonics according to the *„Discrete Fourier Transformation (DFT)"* but also for detection of transient processes and recognition of their internal or external sources. The function of the transients monitor can be activated or deactivated by the parameter *„Sl.mon."*.

„Sl.limit" (gradient limit)
When the transients monitor is set to "active", the degree of the gradient which serves as reference value for initiation of the stabilisation is set by parameter *"Sl.limit"*. The setting *"Sl.limit = 100%"* indicates that the setting for stabilisation is very sensitive. The higher the selected percentage, the more insensitive the *CSP2-T* becomes as to stabilisation by the transients monitor.

Phase Current Differential Protection Id>				
Parameter	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	„active“	Differential protection function is activated	„inactive“	-
	„inactive“	Differential protection function is de-activated		
ex block	„active“	Differential protection function is ineffective when the input function “Protect.Block” is active		-
	„inactive“	Differential protection function is effectife irrespectively of the input function “Protect.Block” state	„inactive“	
trip bloc	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
Applic.	Trafo	Application for ”Transformer“ as object to be protected	Trafo	-
	Cable	Application for short “Lines/Cabel/Bus Bar“ as object to be protected		
Id min	0.1…1 x In	Constant minimum pick-up current(differential current) for a stabilising current up to Is = 2 x In	0.1 x In	0.001 x In
Id(Is0)	0.1…1 x In	Starting point of the static tripping characteristic when Is = 0	0.3 x In	0.001 x In
Id(Is1)	0.2…2 x In	Breaking point of the static tripping characteristic when Is = 2 x In	1.0 x In	0.001 x In
Id(Is2)	2.0…8 x In	Value of the static tripping characteristic when Is = 10 x In	4.0 x In	0.001 x In
d(H, m)	0…8 x In	Stabilising factor for rising the static tripping characteristic in case of stationary or transient harmonic components, which are ascertained by Fourier analysis (H) or transients monitor (m).	0.0 x In	0.001 x In
Stab.H2	Active	Stabilising of differential protection function Id> against stationary or transient components of the 2nd harmonic at the phase current (e.g. rush-effect)	inactive	-
	Inactive			
H2.sta	10…50 %	Threshold (2^{nd} harmonic - basic wave ratio) for stabilising the protection function Id> against *stationary* 2^{nd} harmonic.	30	0.1
H2.tra	10…25 %	Threshold (2nd harmonic – basic wave ratio) for temporary stabilisation of the protection function Id> against *transient* 2^{nd} harmonic.	15	0.1
Stab.H4	Active	Stabilisation of the differential protection function Id> against stationary or transient components of the 4^{th} harmonic at the phase current (e.g. CT saturation).	inactive	-
	Inactive			
H4.sta	10…50 %	Threshold (4th harmonic – basic wave ratio) for stabilising the protection function Id> against *stationary* 4^{th} harmonic.	30	0.1
Stab.H5	Active	Stabilisation of differential protection function Id> against stationary or transient components of the 5^{th} harmonic at the phase current (e.g. transformer overexcitation).	inactive	-
	Inactive		C	
H5.sta	10…50 %	Threshold (5th harmonic – basic wave ratio) for stabilising the protection function Id> against *stationary 5^{th} harmonic.*	30	0.1
H5.tra	10…25 %	Threshold (5th harmonic – basic wave ratio) for temporary stabilisation of the protection function Id> against *transient* 5th harmonic.	15	0.1
t trans	50…120000 ms	Time of temporary stabilisation of the differential protection function Id> when thresholds for „H2.tra“ and „H5.tra“ (*transient* harmonic) are exceeded.	1000 ms	1 ms
Crossbl.	Active	Phase overlapping stabilisation of the differential protection function Id>	active	
	Inactive	Phase selective stabilisation of the differential protection function Id>		

High Phase Current Differential Protection Id>>				
Function	„active“	Differential protection function is activated	„inactive“	-
	„inactive“	Differential protection function is de-activated		
ex block	„active“	Differential protection function is ineffective when the input function „Protect. Block.“ is active	„inactive“	-
	„inactive“	Differential protection function is effective irrespectively of the input function „Protect. Block.“ state.		
Tripbloc.	„active“	OFF command to the local CB is blocked	„inactive“	-
	„inactive“	OFF command to the local CB is issued		
Id>>	2.0...30 x In	Unstabilised high phase differential step: Pick-up value of the differential current based on the rated current	10 x In	0.001 x In
Sl.mon.	„active“	Transients monitor is activated	„active“	-
	„inactive“	Transients monitor is de-activated		
Sl.limit	100 … 500%	Gradient limit when the transients monitor (gradient monitor) initiates stabilisation against CT saturation (temporary rise of the static characteristic by the value adjusted at d[H,m]).	500%	1%

Table 5.37: Phase current differential protection Id

5.7.3.4 Restricted earth fault (REF) *Ide>*

Description
This protection principle is based on a restricted earth fault scheme which only can be used in systems with an earthed star-point. Here the measured *earth current Ie* is compared to the *zero current Io* (cumulative current) formed by the acquired phase currents. The protection facility reacts when a defined threshold value is exceeded.
This way an earth-fault detection is provided for a defined winding end and so the section where the earth fault has occurred can be disconnected very quickly and selectively.

Principle of the restricted earth-fault function
Measured by the *CSP2-T* are the earth current, e.g. via a cable-type CT, at the star point of the selected winding end and the phase current via separate CT's. Firstly the measured phase currents are used to calculate the *zero current Io*.

Important

The *accuracy* of the *zero current Io* determination depends significantly on the *tolerances of the phase current CT.*
This correspondingly applies to the *Holmgreen Connection for measuring the earth current Ie* (instead by using the cable-type CT), but because of its higher accuracy the cable-type CT is to be preferred to the use of the *Holmgreen Connection.*

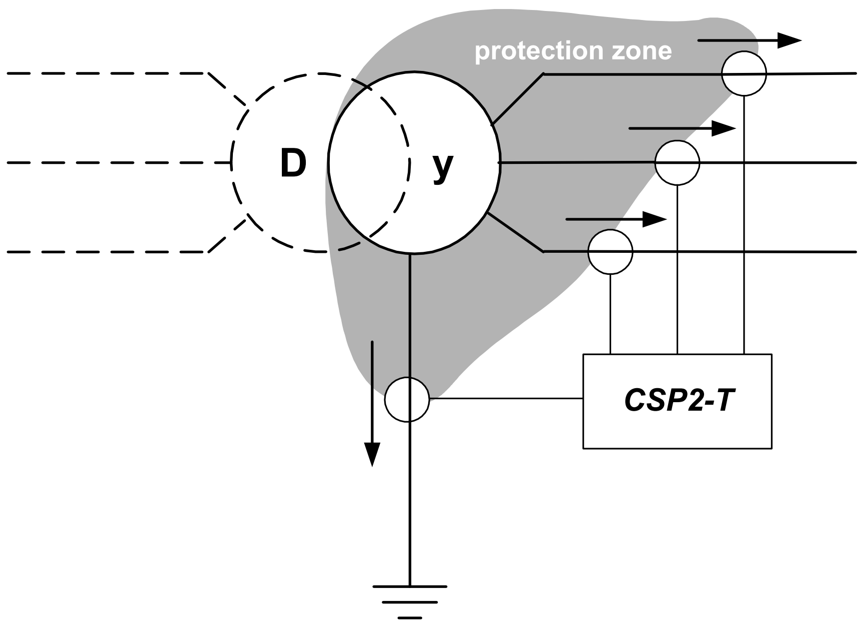


Figure 5.58: Principle of the restricted earth fault function

Resulting from the measured earth current Ie and the calculated zero current Io, the *earth current difference ΔIde* is calculated in the *CSP2-T* and is then compared to the threshold value of the *protective function Ide>*. The criteria

- value and
- phase angle

of the earth differential current are considered as trippping decision.

Attention

- The necessary measuring values for the protective function *Restricted earth fault Ide>* can either be obtained from the *winding end W1 or W2* (see parameter „Meas.loc" of chapter „Tripping processing").

- The trip command generated by the protective function *Restricted earth fault Ide>* can either be given to both CBs (W1 & W2) or to only one CB (W1 or W2) of the winding ends (see parameter *„Trip loc"* of chapter „Tripping processing").

Note

Please be aware that the protective function *Restricted earth fault Ide>* solely can be applied to the winding end which builts the earthed neutral point.

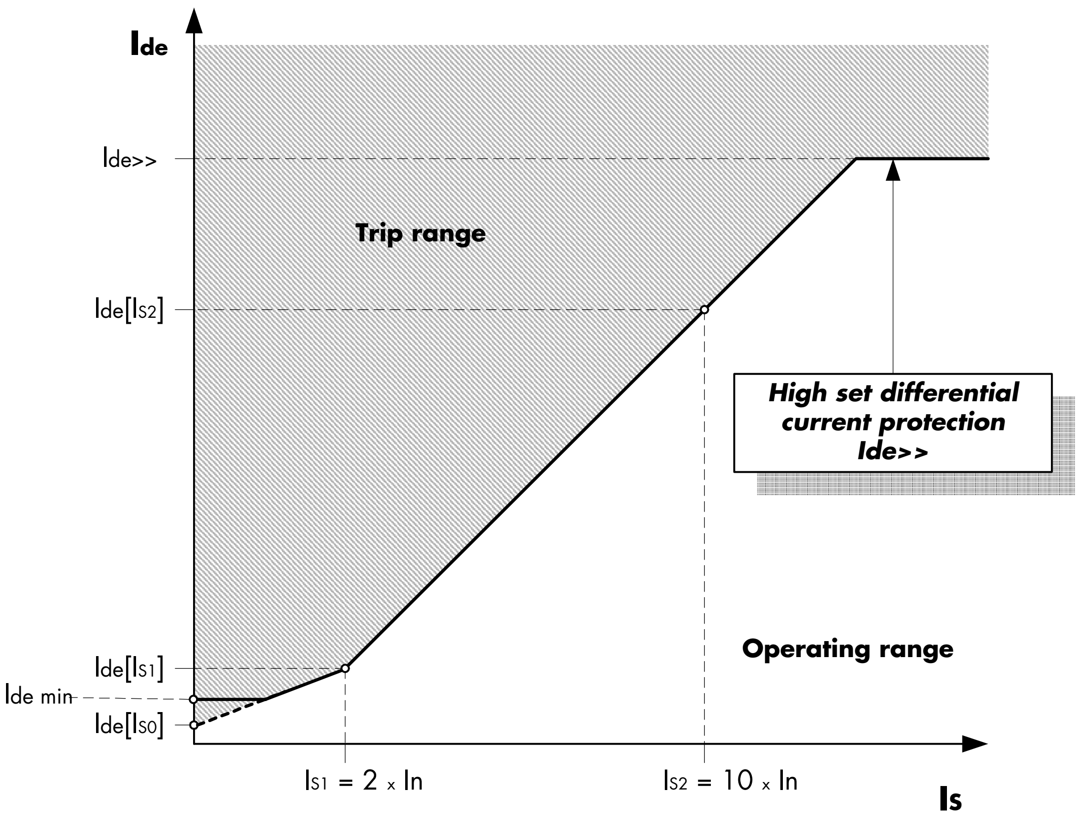


Figure 5.59: Unstabilised high set differential protection step *Ide>*

Parameters

„ex block"

This parameter can only become effective in cooperation with the digital input function *„Prot. blocked"*. With an active status of this input function, the levels of the *restricted earth fault function* which are set to *„ex block = aktive"* are blocked.

"tripbloc" (blockage of the OFF command for the power switch)

Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay, a *"Trip: XY"* message and the message *"General trip"* are nevertheless generated and are available for the communication to the SCADA as output messages of the LED display, the further processing via signal relays or as messages (data points).

The tripping blockage can, for example, be used for detection of direction without a tripping command to the circuit breaker (only display).

"Ide min", "Ide(s0)", "Ide(s1)" and "Ide(s2)" (Parameters to define the static tripping characteristic)
As to the restricted earth fault function the static tripping characteristic is defined by the following points:

"Ide min": this parameter defines a constant *pick-up value for the earth differential current* I_{de} for a stabilizing current between $I_S = 0$ (initial point of the first straight line section) and $I_S = 2 \times In$.

"Ide(Is0)": this parameter defines a *pick-up value for the earth differential current* I_{de}, if the *stabilizing current* is *zero*: *"$I_S = 0$"* (initial point of the first straight line section of the static tripping characteristic).

"Ide(Is1)": this parameter defines the *pick-up value* for the *earth differential current* I_{de}, if the *stabilizing current* is *twice* the *rated current*: *"$I_S = 2 \times In$"*. (inflexion point of the static tripping characteristic).

"Ide(Is2)": this parameter defines the *pick-up value* for the *earth differential current* I_{de}, if the *stabilizing current* is *ten times the rated current*: *"$I_S = 10 \times In$"*. (second point for defining the second straight line section of the static tripping characteristic).

„Ide>>"
When this *pick-up value* for the *earth differential current Ide* is exceeded, an instantaneously operating *high-set tripping* is activated, irrespectively of the stabilizing current.

Restricted Earth Fault Ide>				
Parameter	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	„active	The restricted earth fault function is activated	„inactive“	-
	„inactive“	The restricted earth fault function is de-activated		
ex block	„active“	The restricted earth fault function is ineffective when the input function “Protec.Block” is active“		-
	„inactive“	The restricted earth fault function is effective irrespectively of the state of the input function “Protec.Block”	„inactive“	
Tripblock	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inaktive“	
Ide min	0.05…1 x In	Constant minimum pick-up current (differential current) for a stabilizing current up to Is = 2 x In	0.05 x In	0.001 x In
Ide(Is0)	0.05…1 x In	Starting point of the static tripping characteristic when Is = 0	0.1 x In	0.001 x In
Ide(Is1)	0.2…2 x In	Breaking point of the static tripping characteristic when Is = 2 x In	0.2 x In	0.001 x In
Ide(Is2)	2.0….8 x In	Value of the static tripping characteristic when Is = 8 x In	2.0 x In	0.001 x In
High-Phase Restricted Earth Fault Ide>>				
Function	„active“	The high-phase restricted earth fault function is activated		-
	„inactive“	The high-phase restricted earth fault function is de-activated	„inactive“	
ex block	„active“	The high-phase restricted earth fault function is ineffective when the input function “Protec.Block” is active		-
	„inactive“	The high-phase restricted earth fault is effective irrespectively of the state of the input function “Protec.Block”	„inactive“	
Tripblock	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
Ide>>	2.0…20 x In	Unstabilized high-phase restricted earth fault: Pick-up value of the earth differential current based on the rated current	2.0 x In	0.001 x In

Table 5.38: Restricted earth fault protection

5.7.3.5 Phase current Inrush supervision IH2

Description

When a transformer is connected to a power supply system this normally causes a high current inrush (rush effect) which can be very different in the individual line conductors in terms of time behaviour and quantity. An increased portion of the 2nd harmonic in the phase currents is a typical sign for a current inrush. Dependent on the adjusted threshold value, the time-overcurrent protection (back-up protection), for instance, can be started by such a high current inrush and cause the circuit breaker(s) to trip. But these conditions should absolutely be prevented to have the power supply not unnecessarily interrupted.

In order to distinguish between an *current inrush* and a *fault current*, the relation of the 2nd harmonic to the basic wave (1st harmonic) *I H2/I H1* is used as protection criterion in the *CSP2-T*. When the adjusted value is exceeded, the *time-overcurrent protection functions I> and I>> a*re blocked until the threshold value of *I H2/I H1* is undershot again. Only the line conductor the 2nd harmonic was detected in will be blocked; but it is also possible to adjust a 3phase blocking if a temporary phase overlapping blockade of all three line conductors is required.

The time-overcurrent protection is blocked irrespectively whether the blocking was intended to be phase selective or phase overlapping, but this applies only up to a certain adjustable maximum current value of the basic wave. Should the adjusted value be exceeded, it is likely that a powerful fault current has occurred in the transformer.

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

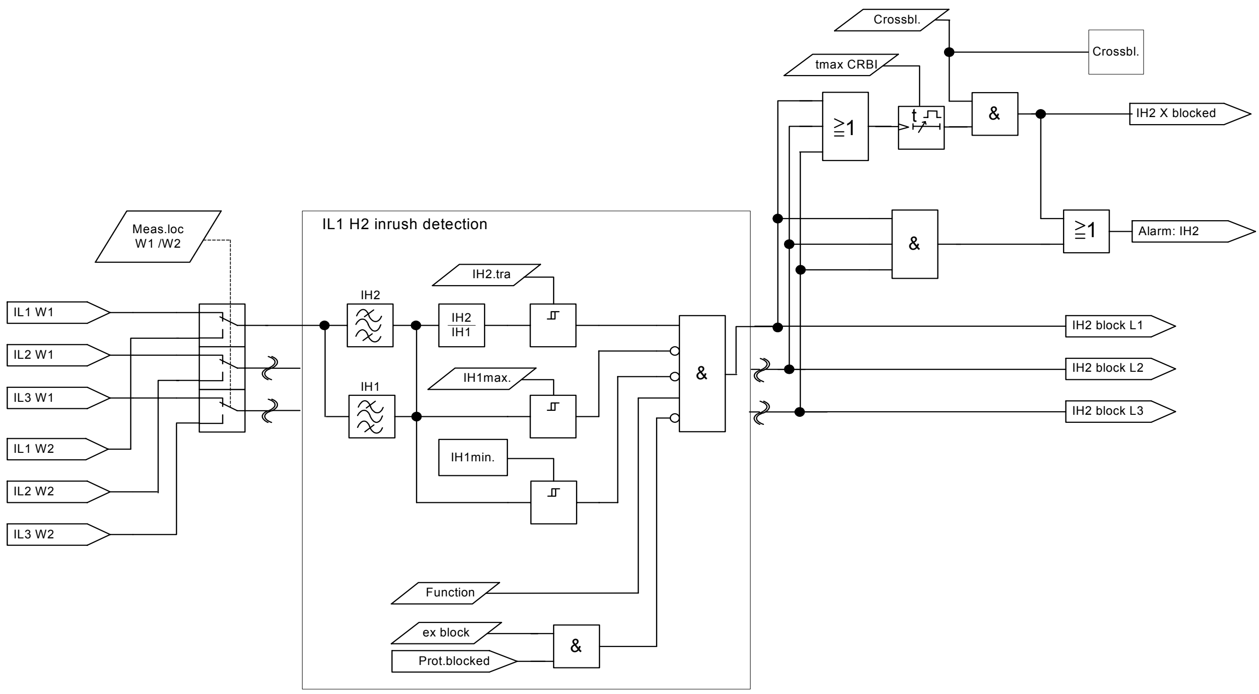


Figure 5.60: Block diagram of inrush phase current supervision I H2

Important

- For the function *phase current inrush supervision I H2* the required phase current measuring values can be obtained either from *winding end W1 or W2. (*Parameter *"Measuring Location,* see chapter "Tripping processing".

Parameters

„Function"
The *phase current inrush supervision I H2* is generally activated with the setting *"Function = active"*. But the *supervision I H2* can only become effective if it is not blocked.

„ex block"
This parameter is only effective together with the digital input function *„Protection blocked"*. If the protection parameter *„ex block. = active"* is set and the digital input function is activated, the *inrush phase current supervision I H2* is blocked!

„I H2 tra" (threshold value for blocking of I> and I>>)
This is the parameter for setting the *limiting value for the relation of the 2nd harmonic to the basic wave (1st harmonic) I H2/I H1* which applies for blocking the tripping of the overcurrent time protection functions *I> and I>>.*

„I H1 max" (Maximum value of the basic wave for blocking of I> and I>>)
This parameter is used to define the *maximum value of the phase current basic wave* up to which the *inrush phase current supervision I H2* is to be effective. When this limiting value is exceeded the overcurrent time protection functions *I> and I>>* trip in spite of the *inrush phase current supervision I H2.*

„Crossbl." (phase-overlapping, temporary blocking of I> and I>>)
This function enables a different approach for blocking the phase-selective overcurrent time protection functions I> and I>> when phase-specific transient harmonics (2^{nd} harmonic) occur in the phase current whilst the start-up is in progress.

Adjustments:

„active": When this function is selected and parts of the 2nd harmonics are detected in only one of the line conductors, the other two line conductors are also temporarily blocked by tripping of the *phase-selective overcurrent time protection functions I> and I>>.*

„inactive": When this function is selected and parts of 2nd harmonics are detected in only one of the line conductors, the *phase-selective overcurrent time protection functions I> and I>>* are only temporarily blocked for that line conductor the harmonics were found in, the other two line conductors remain unblocked.

„tmax CRBL" (time of phase-overlapping blocking of I> and I>>)
By this adjustment the *time of the phase-overlapping blocking of I>* and *I>>* is defined.

Phase Current Inrush supervision I H2				
Parameter	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	„active“	The phase current inrush supervision I H2 is activated	„inactive“	-
	„inactive“	The phase current inrush supervision I H2 is de-activated		
ex block	„active“	The phase current inrush supervision I H2 is ineffective when the input function „Protect.Block.“ is active	„inactive“	-
	„inactive“	The phase current inrush supervision I H2 is effective, irrespectively of the input function „Protect.Block.“ state		
I H2. tra	5…40 %	Threshold value for trip blocking by the protection functions I> and I>> with reference to the relation of I H2/I H1.	10 %	0.1 %
I H1 max.	0.2…20 x In	Maximum value of the basic wave of the phase current, based on the rated transformer current up to which trip blocking for the protection functions I> and I>> is effective.	5 x In	0.001 x In
Crossbl.	„active“	Phase-overlapping blocking of I> and I>> is activated.		-
	„inactive“	Phase-overlapping blocking of I> and I>> is de-activated.		
tmax CRBL	0…30000 ms	Time for phase-overlapping blocking of I> and I>> by function „3-P Block“.	0 ms	1 ms

Table 5.39: Parameters for phase current inrush supervision I H2

5.7.3.6 Earth current inrush supervision IeH2

Description

When a transformer is connected to a power supply system this normally causes a high inrush current (rush effect) which can be very different in terms of time behaviour and quantity in the individual conductors. If a star point is connected at the winding end, a cumulative current (earth current) will be formed by the unbalanced current inrush; this cumulative current can be detected by a core-type transformer. An increased portion of the 2nd harmonic in the phase current is a typical sign for such an current inrush. Dependent on the adjusted threshold value, the earth time-overcurrent protection (e.g. as back-up protection) can be started when an earth current inrush is comparatively high and cause the circuit breaker(s) to trip. But these conditions should absolutely be prevented so that the power supply is not unnecessarily interrupted.

In order to distinguish between an *earth current inrush* and a *fault current*, the relation of the 2nd harmonic to the basic wave (1st harmonic) IeH2/IeH1 is used as protection criterion in the CSP2-T. When the adjusted value is exceeded, the earth time-overcurrent protection functions Ie> and Ie>> are blocked until the threshold value of IeH2/IeH1 is undershot again.

Block diagram

The block diagram shown below represents the functional correlation between data acquisition, parameters and the subsequent issue of messages and the OFF command.

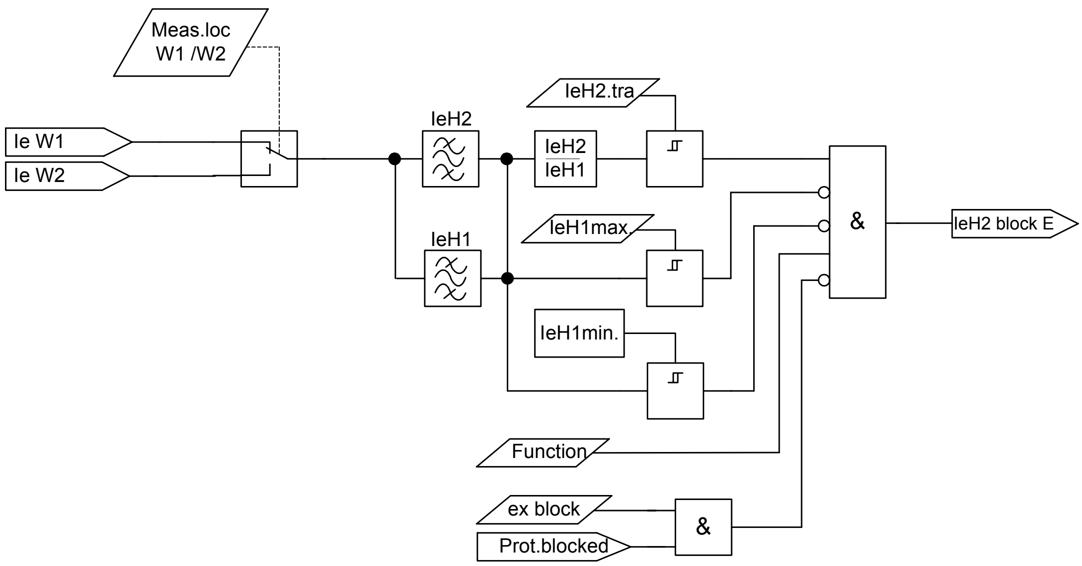


Figure 5.61: Block diagram earth current inrush supervision

Important

- For the function *earth current inrush supervision IeH2* the required phase current measuring values can be obtained either from the winding end W1 or W2. (Parameter *Measuring Location;* see Chapter "Tripping Assignment".

Parameters

„Function"
The earth current inrush supervision IeH2 is generally activated with the setting "*Function = active*". But the supervision IeH2 can only become effective if it is not blocked.

„ex block"
This parameter is only effective together with the digital input function "Protection blocked". If the protection parameter "ex block = active" is set and the digital input function is activated, the *earth current inrush protection IeH2* is blocked!

"IeH2 tra" (threshold value for blocking of Ie> and Ie>>)
This is the parameter for setting the limiting value for the relation of the 2^{nd} harmonic to the basic wave (1^{st} harmonic) which applies for blocking the tripping of the earth current time protective functions Ie> and Ie>>.

„Ie H1 max" (maximum value of the phase current basic wave for blocking of Ie> und Ie>>)
This parameter is used to define the maximum value of the phase current basic wave up to which the *earth current inrush supervision IeH2* is to be effective. When this limiting value is exceeded, the earth current time protective functions Ie> and Ie>> trip in spite of the *earth current inrush supervision IeH2*.

Earth Current Inrush Supervision IeH2				
Parameter	*Setting/Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	"active"	The earth current inrush supervision IeH2 is activated		-
	"inactive"	The earth current inrush supervision IeH2 is de-activated	"inactive"	
ex block	"active"	The earth current inrush supervision IeH2 is ineffective when the input function "Protec.Block." is active		-
	"inactive"	The earth current inrush supervision IeH2 is effective, irrespectively of the status of the input function "Protec.Block"	„inaktive"	
Ie H2 tra	5…100 %	Threshold value Ie H2/Ie H1 for trip blocking by the protective functions Ie> und Ie>>	10 %	0,1 %
IeH1 max	0,2…10 x In	Maximum value of the phase current basic wave, based on the rated transformer current up to which trip blocking for the protective functions Ie> and Ie>> is effective.	5 x In	0,001 x In

Table 5.40: Parameters for earth current inrush supervision IeH2

5.7.3.7 Phase time-overcurrent protection I>, I>>

Description

The *phase time-overcurrent protection in the CSP2-T* can be used as backup protection for the main protection function i.e. the differential protection, but can also be utilized to protect downstream incoming feeders. The *phase time-overcurrent protection* in the *CSP2-T* is divided into the following two phase current protection functions:

- Phase overcurrent protection I>
- Phase short-circuit protection I>>

In the following table are shown: the number of protective elements of the phase overcurrent protection functions, the possibility for adjusting the directional control of the tripping function for the circuit breaker(s) and the tripping characteristics available.

Functions Of The Phase Time-Overcurrent Protection			
Protection Function	*Protective Step*	*Directional Tripping Control*	*Tripping Characteristic*
Phase Overcurrent Protection	I>F	Forward or non-directional	DMT/IDMT
	I>B	Backward or non-directional	
Phase Short-Circuit Protection	I>>F	Forward or non-directional	IDMT
	I>>B	Backward or non-directional	

Table 5.41: Overview of the phase time-overcurrent protection functions

Phase current inrush supervision I H2

This function can be used to distinguish between an current inrush and a fault current *in the component* (see Chapter "Phase current inrush supervision I H2"). *The portion of the 2nd harmonic in relation to the basic wave of the phase current which is typical for circuit closing is monitored by this protective function. Each element of the phase time-overcurrent protection can be blocked if the adjusted threshold value is exceeded. Dependent on adjustment of the* phase current inrush supervision I H2, *the blocking can be either* phase-selective (*i.e. for the line conductor the* phase current inrush protection I H2 *became active*) *or* phase-overlapping *(meaning jointly for all three line conductors).*

For *each element* of the phase time-overcurrent protection *I>F, I>B, I>>F and I>>B* a relevant *parameter* is available for activating the *phase current inrush supervision* I H2.

Dynamic elevation of the tripping characteristic

Another possibility to prevent false tripping of the CB during circuit closing is to temporarily elevate the tripping characteristic of the activating time-overcurrent protection element *dynamically*. This function is integrated in *each element* of the time-overcurrent protection *I>F, I>B, I>>F and I>>B.*

The dynamic elevation of the characteristic can only become effective together with the *input function „dyn.PiUp"*. This input function can be activated either via a digital input or by the adjustable logic functions (SL-LOGIC).

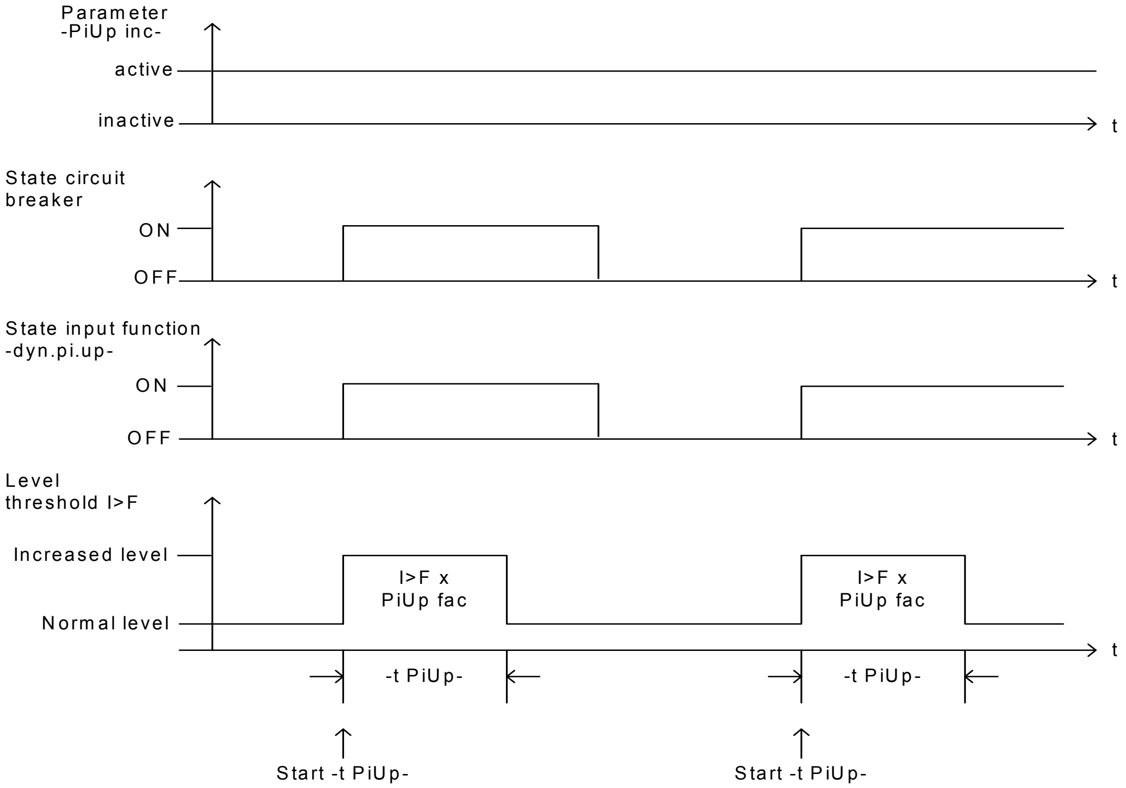


Figure 5.62: Block diagram of dynamic elevation of the tripping characteristic

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

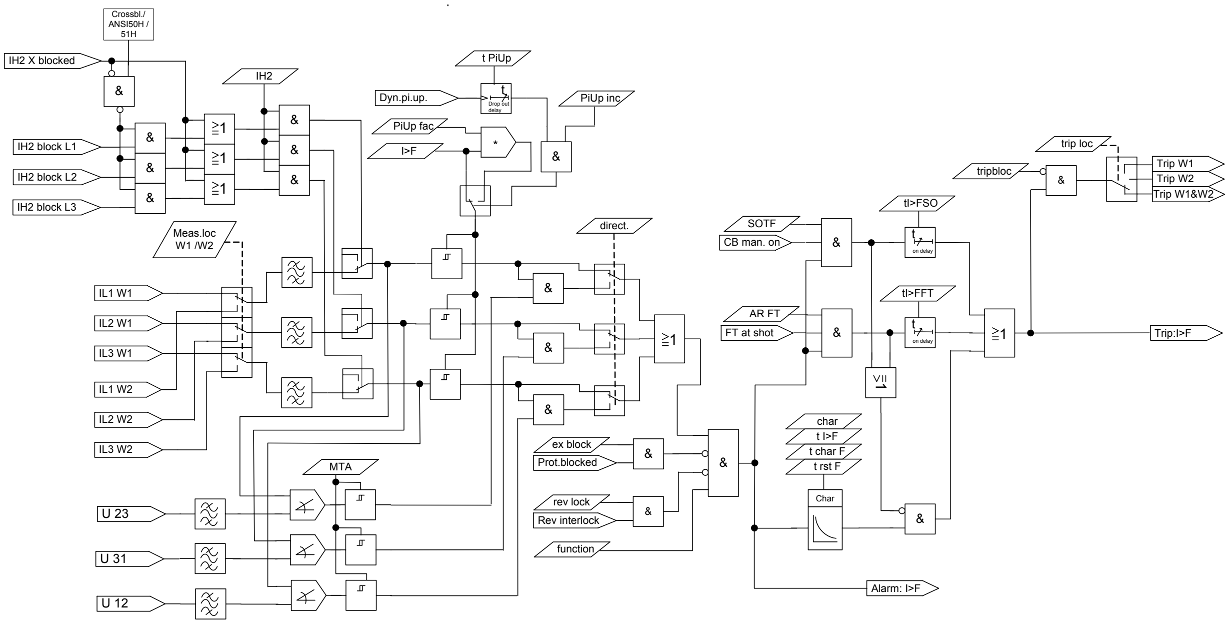


Figure 5.63: Block diagram phase time-overcurrent proetection I>, I>>

Attention
For the *phase time-overcurrent protection I> and I>>* the required phase current measuring values can be obtained either from *winding end W1 or W2* . (Parameter *„Measuring Location"*; see Chapter „Trip Processing").
For the *phase time-overcurrent protection I> and I>>* applies that the OFF command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Locat."*; see Chapter „Trip Processing").

Parameters

In the parameter setting of the time overcurrent protection a large possibility of variation of the setting parameters results. After the selection of the tripping characteristic and determination of the direction, only the relevant parameters appear in the display.

Note

- If the fault is close to the measurement point, the reference voltage can collapse and a direction decision is thus no longer possible. In this case, the *CSP2* has recourse to the last measured value of the corresponding reference voltages, which is available for 10 s.
- If the measured angle deviates from the set characteristic angle by more than ± 90°, the protection detects a reverse direction. For each of the three protective functions, a separate angle can be set.

Characteristic „MTA" ("Maximum Torque Angle" for directional phase overcurrent time protection)
The angle between phase current and the reference voltage which applies to the normal forward direction can be specified with this entry. For tracing the direction of the energy flow, the *CSP2-T* always uses the following reference quantities, irrespectively of the voltage transformer connection.

Reference Quantities for the Directional Feature			
Phase Current	*Winding*	*Reference Voltage*	*Description*
IL1 W1	W1	U 23 W1	Line conductor voltage between phase L2 and phase L3 at winding end W1
IL2 W1		U 31 W1	Line conductor voltage between phase L3 and phase L1 at winding end W1
IL3 W1		U 12 W1	Line conductor voltage between phase L1 and phase L2 at winding end W1
IL1 W2	W2	U 23 W2	Line conductor voltage between phase L2 and phase L3 at winding end W2
IL2 W2		U 31 W2	Line conductor voltage between phase L3 and phase L1 at winding end W2
IL3 W2		U 12 W2	Line conductor voltage between phase L1 and phase L2 at winding end W2

Table 5.42: Overview of the phase overcurrent time protection functions

Important
When the p*hase time-overcurrent protection is directional* it is important that the *measuring values of the phase current a*nd the necessary measuring values of the r*eference voltage* are acquired at the same *winding end,* otherwise a *distinct* directional decision is not possible. *Acquisition* of the reference voltages is based on the setting of parameter *„VT Loct."* (see Chapter „Field Parameter").

Options for directional determination of the energy flow
For the *directional phase time-overcurrent protection* the correlation between the voltage measuring location (system parameter *„VT Loct."* in menu „Field Parameter"), the measuring location of the phase currents (system parameter *„Measuring Location"* in menu „Trip Processing") and the CB positions is explained in the following table. Furthermore it is assumed that the two bus bars („$U_{W1\ BB}$" and „$U_{W2\ BB}$") are live (application as coupling transformer).

Directional Feature					
Setting of Parameter «VT Loct.» in Menu: «Field Parameter»	*Setting of System Parameter «Meas.Loc.» in Menu : «Trip Processing»*	*Setting of Protect.Parameter «Direction»*	*CB1 Position*	*CB2 Position*	*Directional Determination*
"W1 Busb."	"W1"	"active"	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Not possible
			ON	ON	Possible
	"W2"	"inactive"	ON/OFF	ON/OFF	Not possibleh
"W1 Tr"	"W1"	"active"	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Possible
			ON	ON	Possible
	"W2"	"inactive"	ON/OFF	ON/OFF	Not possible
"W2 Busb."	"W1"	"inactive"	ON/OFF	ON/OFF	Not possible
	"W2"	"active"	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Possible
			ON	ON	Possible
"W2 Tr"	"W1"	"inactive"	ON/OFF	ON/OFF	Not possible
	"W2"	"active"	OFF	OFF	Not possible
			ON	OFF	Not possible
			OFF	ON	Possible
			ON	ON	Possible

Table 5.43: Directional feature for the phase overcurrent protection

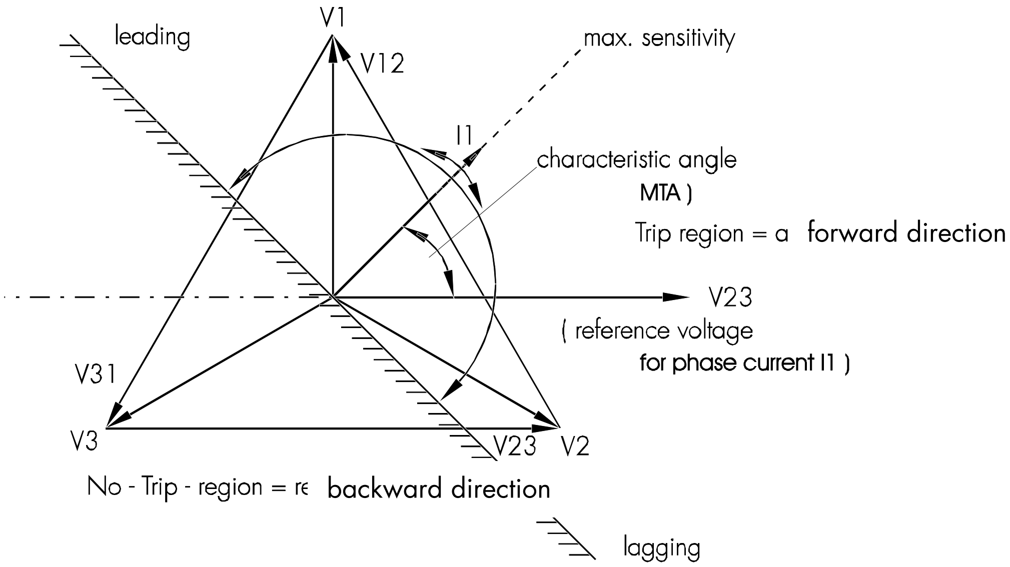


Figure 5.64: Characteristic angle MTA

„Function"
With the setting *"Function = active"* the corresponding *level of the time-overcurrent protection functions* is generally set into function. The protection stage can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the input function „Prot. blocked". With an active status of this input function, the levels of the *time-overcurrent protection* which are set to *„ex block = aktive"* are blocked.

"tripbloc" (blockage of the OFF command for the circuit breaker)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay time, a *"Trip:XY"* message and the message *"General trip"* are nevertheless generated and are available for the communication to the SCADA as output messages of the LED display, the further processing via signal relays or as reports (data points).
The trip blockage can, for example, be used for detection of direction without a trip command to the circuit breaker (only display).

"rev lock" (backward locking)
Each element can be temporarily blocked from external via a joint digital input (DI) with the assigned input function »rev lock«. That is to say, as long as the digital input is active, all the protection stages with parameters set to *"rev lock = active"* are blocked (ineffective).

"direct." (direction decision: with/without)
With this parameter the direction decision for a protection tripping can be activated separately for each level in the event of a fault.
Settings:
„active": The protective stages marked with the index *"F" only* trip in a *forward direction*!
The protective stages marked with the index *"B" only* trip in a *backward direction*!
„inactive": The protection stages are tripping without directional feature (undirected protection)

Note

If all six parameters "direct." are set to »inactive«, the *CSP2-T* has six time overcurrent stages independent of one another without a directional feature.

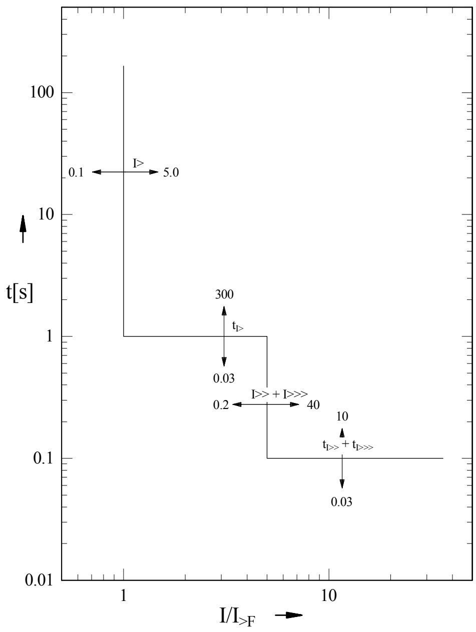
"char X" (tripping characteristic)
For the protective functions of the time overcurrent protection the following tripping characteristics are available (classification to BS 142/ DIN EN 60255-3):

DEFT (Definite Time Characteristic): available for all stages of time overcurrent protection I>F, I>B, I>>F and I>>B

„DEFT": current-independent tripping delay after a defined time.

t I>F

(t I>B)
(t I>>F)
(t I>>B)



(I/I>B)
(I/I>>F)
(I/I>>B)

Figure 5.65: Independent tripping characteristic (DEFT)

INV *(Inverse Time Characteristic): only available for time overcurrent protection I>F and I>B*
For current-dependent tripping delay *(INV)* the *CSP2* calculates the tripping time in the normed inverse tripping characteristics as a function of the amount of overcurrent.

- *„NINV"*: Normal Inverse (Type A)
- *„VINV"*: Very Inverse (Type B)
- *„EINV"*: Extremely Inverse (Type C)
- *„LINV"*: Long Time Inverse (Type D)

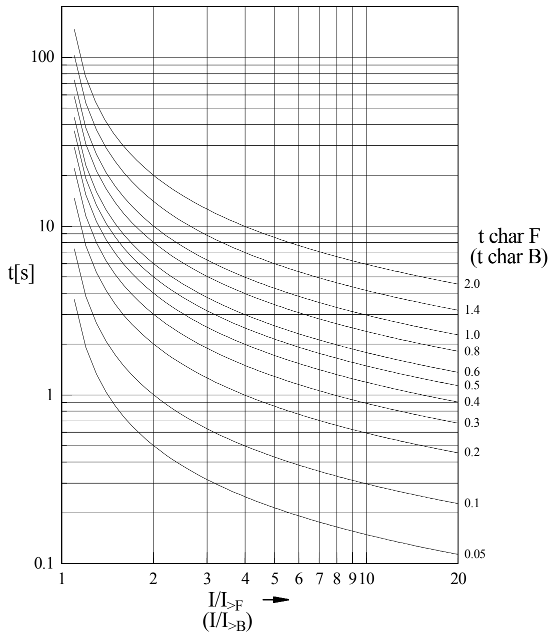


Figure 5.66: Normal inverse (NINV)

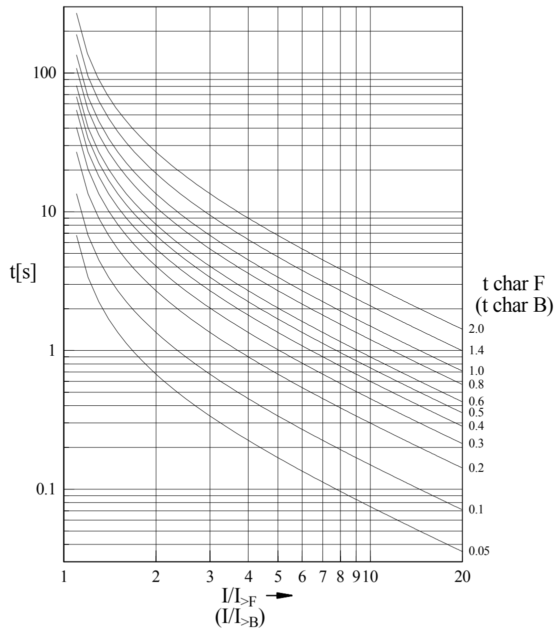


Figure 5.67: Very Inverse (VINV)

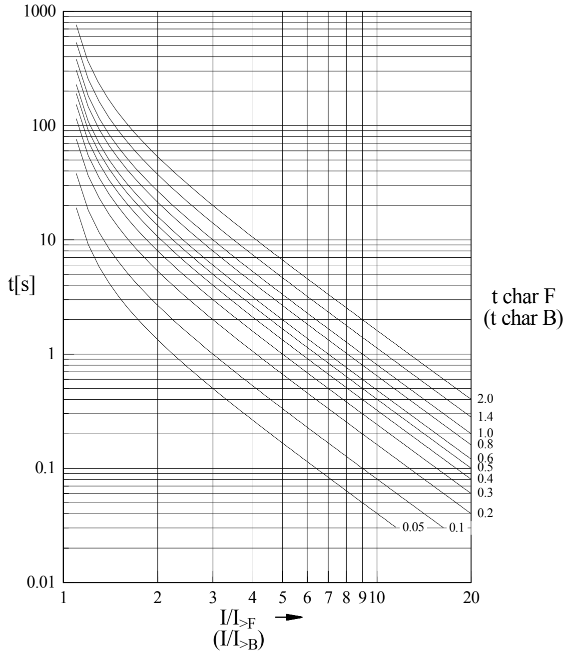


Figure 5.68: Extremly Inverse (EINV)

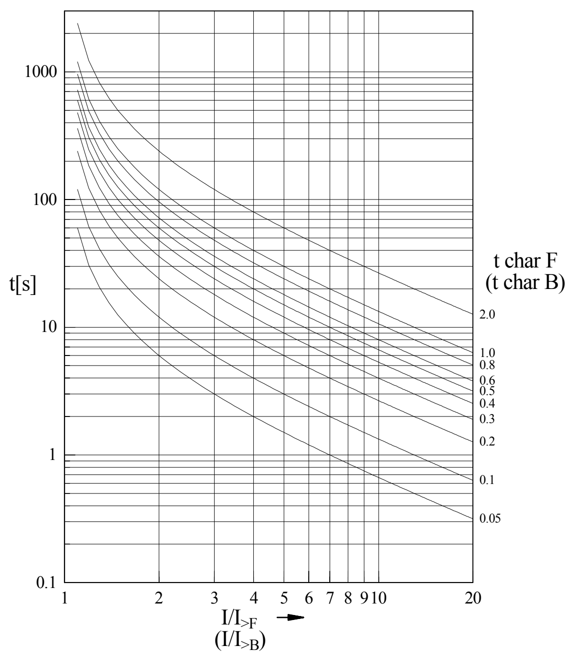


Figure 5.69: Long Time Inverse (LINV)

The protection can be adapted to the specific mains conditions and applications with these characteristics. The adjustable tripping delay *(e.g. "t I>F")* in the *DEFT characteristic* as well as the characteristic factor (time multiplier, e.g. *"t char F"*) for the *INV characteristics* can be adjusted in wide ranges with fine pitches.

Phase current threshold of the protection element (e.g. "I>F")
In the *current-independent tripping characteristic (DEFT)* and also in the *current-dependent tripping characteristic (INV)* the protection stage stimulates as soon as the measured current exceeds this set value in at least one phase. The tripping delay in the *DEFT* characteristics depends on the excess of current in the event of a fault. It is calculated by the *CSP2* via the characteristic as a function of the amount of overcurrent. The tripping delay in the *DEFT* characteristic is not based on the amount of the overcurrent, but on an adjustable time, e.g. *"t I>F"*.
In protection stages with direction detection and active directional function, the protection only trips if the current flows in the corresponding direction and is larger than the set threshold.

Tripping delay of the protection stage for DEFT characteristic (e.g. "t I>F")
For the tripping characteristic according to the *DEFT* characteristic, this parameter determines the tripping delay time of the protection stage by a defined time requirement (independent of current).

Characteristic factor – only for INV characteristics (e.g. "t char F")
With the characteristic factor the required characteristic is determined from the group of curves of the *INV* characteristic (NINV, VINV, EINV or LINV), according to which the current-dependent tripping delay of the protective stage is to be calculated.

Reset time – only for INV characteristics (e.g. "t rst F")
The tripping time calculation always considers the highest of the measured phase currents and is permanently adapted to the current measured current values. That is to say, if the set current threshold is exceeded, a dynamic timer is started for the tripping delay time, the counting speed of which depends on the overcurrent. So that the dynamic tripping time is not restarted every time the current fluctuates around the threshold point (*"pecking fault"*), a *reset time* can be set. In this case, the tripping timer is stopped when the current drops below the pick-up value. If it rises above the threshold shortly after, the tripping timer continues with the counter reading recorded. The *CSP2* only deletes the tripping timer when the current is lower than the threshold time for longer than the set reset time.
With an independent characteristic (INV) no reset time can be set. Here, the tripping time is always reset when the current drops below the threshold in all three phases.

„I H2" (phase current inrush supervision)
This is the parameter to activate the *phase current inrush supervision I H2* for the relevant element of the phase time-overcurrent protection I>F, I>B, I>>F and I>>B.

„PiUp inc" (dynamic characteristic elevation)
This is the parameter to activate the *dynamic elevation of the characteristic temporarily* for the relevant element of the phase time-overcurrent protection I>F, I>B, I>>F and I>>B.

„PiUp fac" (dynamic characteristic elevation)
The level of the dynamic characteristic elevation is defined by factor *„Dyn.Fac."* For this purpose the tripping characteristic (IDMT trip. characteristic) or the threshold value (DMT trip. characteristic) is multiplied by the adjusted value of *„PiUp fac"*.

„t PiUp " (time of the dynamic characteristic elevation)
The dynamic elevation of the characteristic shall only last for the time of the CB circuit closing process. This time period is adjusted with parameter *„t PiUp"*.

„AR" (Automatic Reclosing)
Each threshold of the time overcurrent protection can activate the *"automatic reclosing"* after a protection tripping. For this, the setting *"AR = active"* must be selected. With the default setting *"AR = inactive"* no AR is carried out after the protective tripping.

„AR-FT" (AR fast trip)
This parameter is used to activate a fast trip of the CB if the AR has been started in the event of a permanent fault, without the set general delay time of the protection stage that gives an alarm *(e.g. "t I>F")* being considered.
Settings:
„active": The AR fast trip can become effective. The delay time of the activated protection element is not considered.
„inactive": The AR fast trip is ineffective. In the event of a permanent fault, the CB is tripped taking the delay time of the activated protection element into account.

Tripping delay of the AR fast trip (e.g. "t I>FFT")
Via this parameter, a delay time for the AR fast trip can be set separately for each current protection stage.

Note

If a *tripping delay time for the AR fast trip "t I>FFT"* is used, ensure that this setting is selected smaller than the general delay time of the protection stage *(e.g. "t I>F")*, as otherwise the CB would react according to the general delay, the tripping delay time for the CB conforms to the *„t I>BFT"* for the time the AR fast trip is effective, it does *not* conform to the tripping delay time (e.g. *„t I>F")* of the activating protection stage!

!!! *t I>FFT t I>F* !!!

„FT at sh" (temporal position of the AR fast trip)
This parameter determines after how many auto reclosing attempts the fast trip is carried out.

Settings:
„0": (Fast trigger after stimulation of an AR-capable protection function
In the event of a fault, the first tripping of the CB is after the set delay time for the AR fast tripping *t I>FFT*. If the fault still exists during the first automatic reclosing attempt (1st shot), the CB trippings after the general delay time of the protection stage *(e.g. "t I>F")*.

„1": (*Fast tripping in the first automatic repeat switch-on attempt*)
In the event of a fault, the first trigger of the CB is after the general delay time of the protection stage *(e.g. "t I>F")*. After the expiry of the first break time (e.g. for a phase error: *t DP1*) there is the first automatic reclosing attempt. If the fault continues to exist, the CB now trippings after the set tripping delay time for the AR fast tripping *t I>FFT*.

„2": (Fast tripping in the second automatic reclosing attempt)
In the event of a fault, the first tripping of the CB is after the general delay time of the protection stage *(e.g. "t I>F")*. After the expiry of the first break time (e.g. for a phase error: *t DP1*) there is the first automatic reclosing attempt (1st shot). If the fault continues to exist, the CB now also trippings after the general delay time of the protection stage. After the expiry of the second break time (*t DP2*) there is the second automatic reclosing attempt (2nd shot). If the fault still exists now the CB trips after the set tripping delay time for the AR fast tripping *"t I>FFT"*.

„3" bis *„6":* The fast tripping is analogous to setting "2" only at the automatic reclosing attempt (shot) is carried out after the 3…6 th AR-attempt.

Note

For settings exceeding "1", attention must be paid to the fact that the *AR* function is accordingly set as "multi-shot" that means that the number of shots is to be set within the AR-submenu.
For multi-shot *AR* applications, *specific circuit breakers* must be used, possessing corresponding energy stores in order to guarantee the automatic reclosing in a short time!

„SOTF" (Switch On To Fault – fast trip)
This parameter is used to activate a *fast trip when switching the CB onto a faulty operating electrical equipment*, without the set delay time of the activated protection stage *(e.g. "t I>F")* having to be waited for.
The following block diagram makes the general way of working of the *SOTF function* clear:

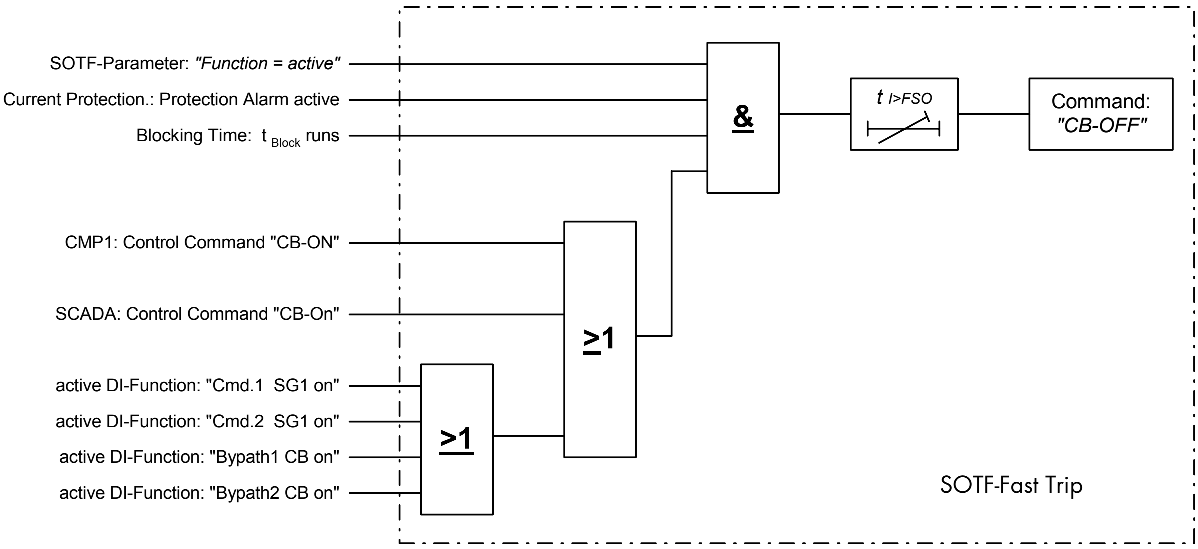


Figure 5.70: Operating principle of the SOTF-Function

Note

The *SOTF fast trip* is not to be confused with the *AR fast trip*! Both functions work independent of one another. Merely the blocking time "*t rec*" the *AR function* has an influence on the function of the *SOTF fast trip*, as the latter is only to become effective when the CB is switched onto a fault via a controlled command and not via an *AR*! If parameterized, a fast trip during a running *AR* is controlled via the *AR fast trip* (see parameter *"AR-FT"* etc.).

Trip delay time of the SOTF fast trip (e.g. "t I>FSO")
For the *SOTF function* a separate tripping delay time can also be set.

Attention

When using a *trip delay time for the SOTF fast trip "t I>FSO"* please ensure that this setting is selected shorter than the general delay time *(e.g. "t I>F")* of the protection level *(e.g. "t I>F")*, as otherwise the CB would trip after the general trip delay time of the activated protection stage.

!!! *t I>FSO* < *t I>F* !!!

Overcurrent protection stage: I>F *(Forward direction or non-direction)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
MTA	0°...355°	Typical angle between phase current and reference voltage	45°	1°	±3°
Function	„active"	I>F stage is put into function	„active"	-	
	„inactive"	I>F stage is put out of function			
ex block	„active"	I>F stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	I>F stage is effective irrespectively of the input function „Protect. Block." state.	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
rev lock	„active"	I>F stage is ineffective when the DI „ Backw. Interl." Is active		-	
	„inactive"	I>F stage is effective irrespectively of the DI "Backw. Interl." state "	„inactive"		
direct.	„active"	I>F stage trips in forward direction only (directional)		-	
	„inactive"	I>F stage trips in both directions (non-directional)	„inactive"		
char F	„DEFT"	DMT characteristic	„DEFT"	-	
	„NINV"	INV characteristic (normal inverse)			
	„VINV"	INV characteristic (very inverse)			
	„EINV"	INV characteristic (extremely inverse)			
	„LINV"	INV characteristic (long time inverse)			
I>F	0.1...40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1 xIn	0.001 x In	±3% of the adjustment value or 1% I_N
t I>F	30...300000 ms	Trip time delay; for DEFT characteristics only	1000 ms	1 ms	DEFT ±1% or ±20 ms
t char F	0.05 2	Characteristic factor; for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV, LINV ±10% EINV
t rst F	0...60000 ms	Reset time for intermittent phase faults; for INV characteristcs only	1000ms	1 ms	only INV ±1% of the adjustment value
IH2	„active"	Activation of phase current inrush protection I H2 for the I>F- element			
	„inactive"	De-activation of phase current inrush protection I H2 for the I>F- element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00...8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0... 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the I>F stage the AR is started		-	
	„inactive"	By trip of the I>F stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		

Overcurrent protection stage: I>F *(Forward direction or non-direction)*					
t I>FFT	0…10000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0“	AR instantaneous trip at the first protect. trip via step I>F	„0“	1	
	„1“	AR instantaneous trip at the first auto. reconnection attempt after a failure has occurred			
	„2“	AR instantaneous trip at the second auto. reconnection attempt after a failure has occurred			
	„3“	AR instantaneous trip at the third auto. reconnection attempt after a failure has occurred			
	„4“	AR instantaneous trip at the fourth auto. reconnection attempt after a failure has occurred			
	„5“	AR instantaneous trip at the fifth auto. reconnection attempt after a failure has occurred			
	„6“	AR instantaneous trip at the sixth auto. reconnection attempt after a failure has occurred			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t I>FSO	30…300,000 ms	Trip time delay for the SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.44: Setting parameters of the I>F stage

Overcurrent protection stage: I>B *(Backward direction or non-direction)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	I>B stage is put into function		-	
	„inactive“	I>B stage is put out of function	„inactive“		
ex block	„active“	I>B stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	I>B stage is effective irrespectively of the input function „Protect. Block.“ state.	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev lock	„active“	I>B stage is ineffective when the DI „Backw. Interl.“ Is active		-	
	„inactive“	I>B stage is effective irrespectively of the DI “Backw. Interl.“ state “	„inactive“		
direct.	„active“	I>B stage trips in backward direction only (directional)		-	
	„inactive“	I>B stage trips in both directions (non-directional)	„inactive“		
char B	„DEFT“	DMT characteristic	„DEFT“	-	
	„NINV“	INV characteristic (normal inverse)			
	„VINV“	INV characteristic (very inverse)			
	„EINV“	INV characteristic (extremely inverse)			
	„LINV“	INV characteristic (long time inverse)			
I>B	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1 x IN	0.001 x In	±3% of the adjustment value or 1% I_N
t I>B	30...300,000 ms	Trip time delay; for DEFT characteristics only	2000 ms	1 ms	DEFT ±1% or ±20 ms
t char B	0.05 2	Characteristic factor; for IMT characteristics only	0.2	0.01	INV ±5% NINV ±7.5% VINV, LINV ±10% EINV
t rst B	0...60,000 ms	Reset time for intermittent phase faults; for IMT characteristcs only	1000 ms	1 ms	only INV ±3% of the adjustment value
IH2	„active“	Activation of inrush phase current protection I H2 for the I>B- element			
	„inactive“	De-activation of inrush phase current protection I H2 for the I>B- element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0…120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the I>B stage the AR is started		-	
	„inactive“	By trip of the I>B stage the AR cannot be started	„inactive“		
AR-FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t I>BFT	0...10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0“	AR instantaneous trip at the first protect. trip via stage I>B	„0“	1	

Overcurrent protection stage: **I>B** (Backward direction or non-direction)					
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t I>BSO	30...300,000 ms	Trip time delay for the SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.45: Setting parameters of the I>B stage

Short-circuit protection stage: I>>F *(Forward direction or non-direction)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
MTA	0°...355°	Typical angle between phase current and reference voltage	45°	1°	±3° of the adjustment value
Function	„active"	I>>F stage is put into function		-	
	„inactive"	I>>F stage is put out of function	„inactive"		
ex block	„active"	I>>F stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	I>>F stage is effective irrespectively of input function "Protect. Block."state	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
rev. lock	„active"	I>>F stage is ineffective when the DI „Backw. Interl." is active		-	
	„inactive"	I>>F stage is effective irrespectively of the DI "Backw. Interl." state	„inactive"		
direct.	„active"	I>>F stage trips in forward direction only (directional)		-	
	„inactive"	I>>F stage trips in both directions (non-directional)	„inactive"		
I>>F	0.1...40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	2 x In	0.001 x In	±3% of the adjustment value or 1% I_N
t I>>F	30...300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IH2	„active"	Activation of the inrush phase current protection I H2 for the I>>F element			
	„inactive"	De-activation of the inrush phase current protection I H2 for the I>>F element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00...8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0... 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the I>>F stage the AR is started		-	
	„inactive"	By trip of the I>>F stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t I>>FFT	0...10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0"	AR instantaneous trip at the first protect. trip via stage I>>F	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state		-	
	„inactive"	SOTF function is put into inactive state	„inactive"		
t I>>FSO	30...300000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.46: Setting parameters of the I>>F stage

Short-circuit protective stage: I>>B *(Backward direction or non-directional)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	I>>B stage is put into function		-	
	„inactive“	I>>B stage is put out of function	„inactive“		
ex block	„active“	I>>B stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	I>>B stage is effective irrespectively of the input function “Protect. Block.” state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local is being issued	„inactive“		
rev lock	„active“	I>>B stage is ineffective when the DI „rev lock“ is active		-	
	„inactive“	I>>B stage is effective irrespectively of the DI “rev lock” state	„inactive“		
direct.	„active“	I>>B stage trips in backward direction only (directional)		-	
	„inactive“	I>>B stage trips in both directions (non-directional)	„inactive“		
I>>B	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	2 x In	0.001 x In	±3% of the adjustment value or 1% I_N
t I>>B	30…300000 ms	Trip time delay for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IH2	„active“	Activation of the phase current inrush protection I H2 for the I>>B element			
	„inactive“	De-activation of the phase current inrush protection I H2 for the I>>B element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0…120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the I>>B stage the AR is started		-	
	„inactive“	By trip of the I>>B stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t I>>BFT	0…10000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0“	AR instantaneous trip at the first protect. trip via stage I>>B	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t I>>BSO	30…300000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.47: Setting parameters of the I>>B stage

5.7.3.8 Earth overcurrent protection Ie>, Ie>>

Description

In the *CSP2-T* the earth overcurrent time protection is divided into the following two earth current protective functions:

- Earth overcurrent protection Ie>
- Earth short-circuit protection Ie>>

In the following table are shown: the number of protective elements of the earth overcurrent time protection functions, the possibility for adjusting the directional feature of the tripping functions for the circuit breaker(s) and the tripping characteristics available:

Functions of the Earth Time-Overcurrent Protection			
Protection Function	*Protection element*	*Directional Tripping Control*	*Tripping Characteristic*
Earth Overcurrent Protection	Ie>F	Forward or non-directional	DMT / IDMT
	Ie>B	Backward or non-directional	
Earth Short-Circuit	Ie>>F	Forward or non-directional	IDMT
	Ie>>B	Backward or non-directional	

Table 5.48: Overview of the earth time-overcurrent protective functions

Attention

For a correct determination of the residual voltage, the correct measurement method (e-n winding or calculatory determination) must be assigned by the parameter "EVT con" in the field "field settings" in the parameter group of the residual voltage supervision.

Earth current Inrush supervision Ie H2
This function can be used to distinguish between an *current inrush* and a *fault current* in the star point when the transformer is asymmetrical loaded (see Chapter „ Earth Current Inrush Supervision Ie H2"). The portion of the 2nd harmonic in relation to the basic wave of the phase current which is typical for circuit closing is monitored by this protective function. Each element of the *time overcurrent protection* can be *blocked* if the adjusted threshold value is exceeded. The blocking function can be phase selective, i.e. for that line conductor the *„ earth current inrush supervision Ie H2"* became active.
For *each element* of the earth time-overcurrent protection *Ie>F, Ie>B, Ie>>F and Ie>>B* a relevant *parameter* is available for activating the *"earth current inrush supervision Ie* H2".

Dynamic elevation of the tripping characteristic
Another possibility to prevent false tripping of the CB during circuit closing is to temporarily elevate the tripping characteristic of the activating earth time-overcurrent protection element *dynamically*. This function is integrated in *each element* of the earth time-overcurrent protection *Ie>F, Ie>B, Ie>>F and Ie>>B*
The dynamic elevation of the characteristic can only become effective together with the *input function „dyn.PiUp"*. This input function can be activated either via a digital input or by the adjustable logic functions (SL-LOGIC).

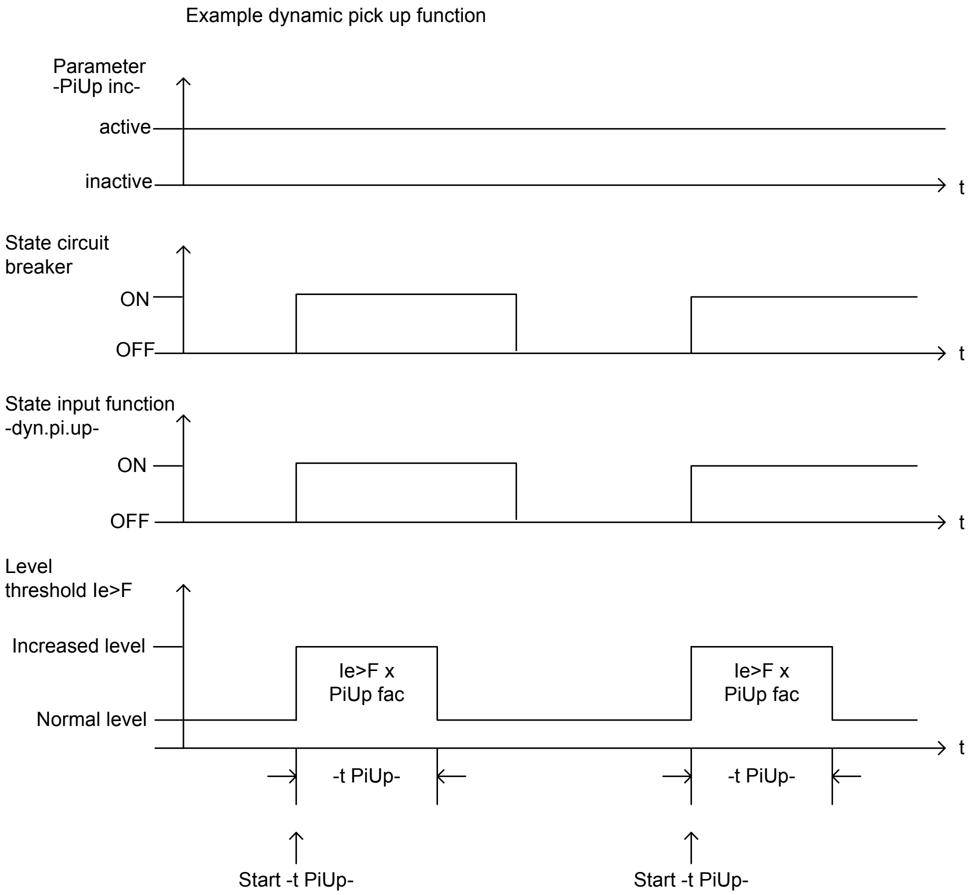


Figure 5.71: Block diagram of dynamic elevation of the tripping characteristic

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

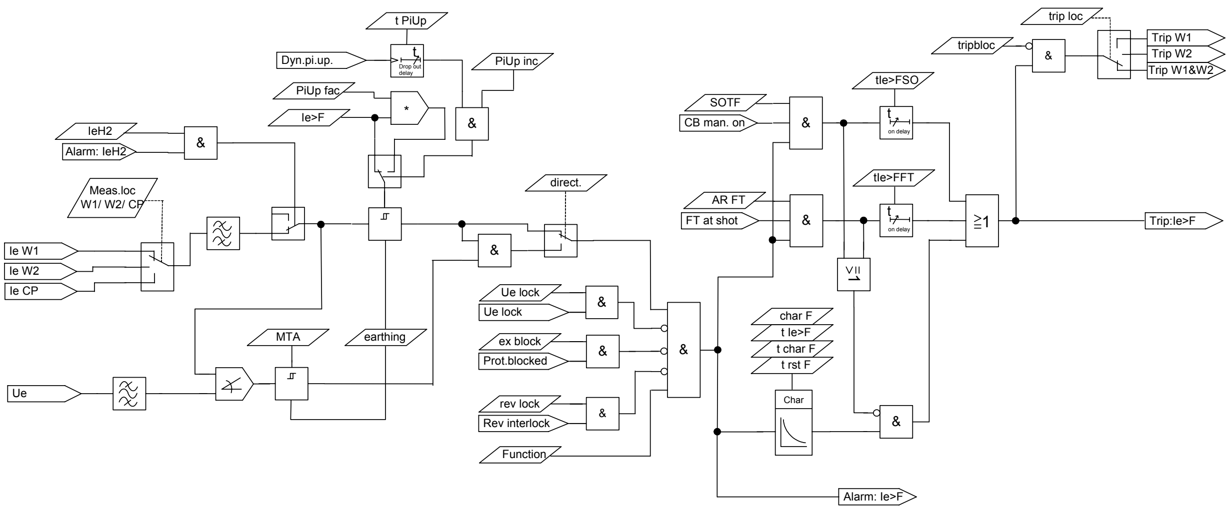


Figure 5.72: Block diagram of the earth overcurrent time protection Ie>, Ie>>

Important

- For the *earth time-overcurrent protection Ie> and Ie>>* the required phase current measuring values can be obtained either from *winding end W1 or W2,* or from the CT used for *tank protection*. (Parameter *„Measuring Location"*; see Chapter „operating side").
- For the *earth overcurrent time protection Ie> and Ie>>* applies that the trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends (Parameter *„Trip.Locat."*; see Chapter "Trip Processing").

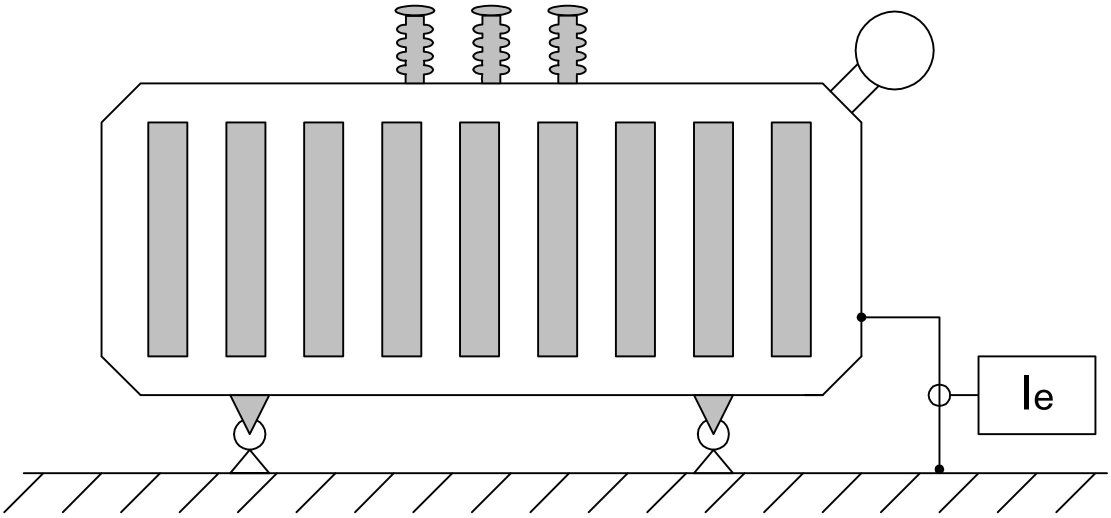


Figure 5.73: Block diagram of the tank protection

Parameters

In parameterizing the earth overcurrent protection a large possibility of variation of the setting parameters results. After the selection of an earthing method directional, determination of direction and the tripping characteristic, only the relevant parameters appear on the display.

„Earthing" (selection of the earthing method for protection)
As in the phase time-overcurrent protection, a pre-setting for direction detection is also necessary in earth excess time-current protection. Two parameters exist in the first stage of the earth overcurrent protection *(Ie>F)* for the detection of the direction of the earth overcurrent protection. Via these parameters, the kind of system (parameter: *"earthing"*), on the other hand the size of the characteristic angle to be set (Parameter: *"MTA"*) can be parametrized.
To start with, the parameter *"earthing"* determines the earthing method existing in the system, i.e. the kind of mains used.

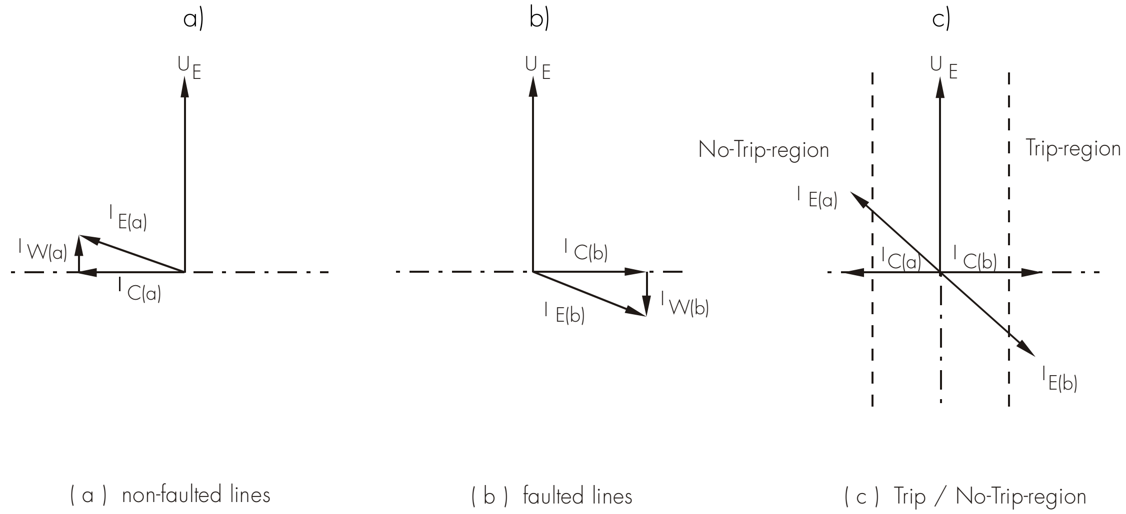
Note

Parameter *„earthing"* is only available once per parameter set and applies jointly for protective functions *Ie>* and *Ie>>*! This parameter ("Earthing") is contained in the parameters of protection function Ie>!

The following four *earthing methods* are distinguished:

- *Mains with isolated star point (SIN)*
- *Mains with earth fault compensation (COS)*
- *Mains with solidly earthed star point (SOLI)*
- *Mains with resistance-earthed star point (RESI)*

1. Mains with isolated star point (setting: "earthing: SIN", "MTA (fixed): -90°")



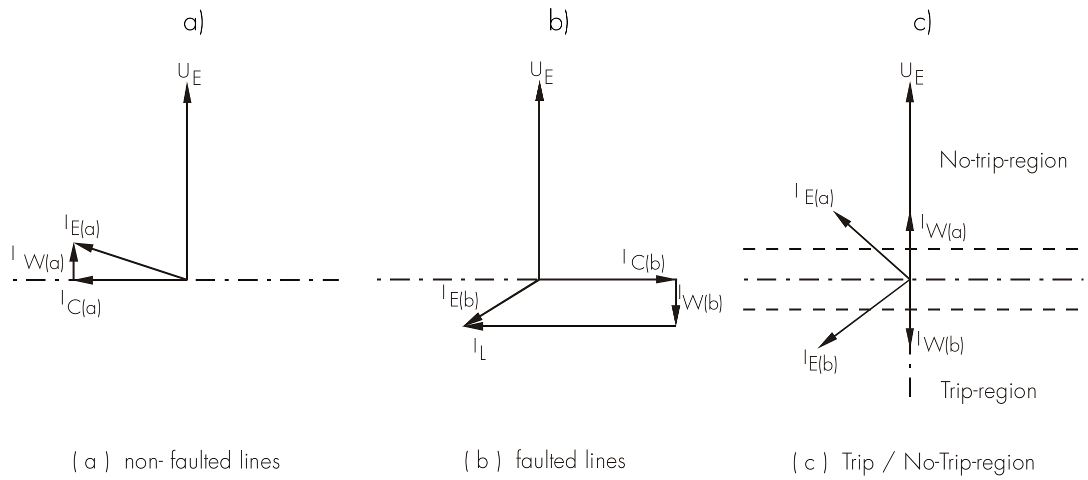
a) Line free of earth faults
b) Line with earth fault
c) Trip region/operating region

with: U_e = residual voltage
I_e = sum current
I_C = capacitive component of the sum current
I_W = ohmic component of the sum current

Figure 5.74: Phase positions of residual voltage and sum currents in isolated grid with short to earth (sin φ)

By determining the reactive current component I_C via the sin φ setting and subsequent comparison with the residual voltage Ue, the *CSP2-F* decides whether the line to be protected has a short to earth. If the line is *free of earth faults* the capacitive component I_C(a) of the sum current is 90° ahead of the residual voltage.
With a line *with a short to earth*, the capacitive component I_C(b) drags behind the residual voltage by 90°.

2. Compensated mains (setting: "earthing: COS", "MTA (fixed): 180°")



a) Line free of earth faults
b) Line with earth fault
c) Trip region/operating region

with Ue = residual voltage
Ie = sum current
I_L = inductive component of the sum current
I_C = capacitive component of the sum current
I_W = ohmic component of the sum current

Figure 5.75: Phase positions of residual voltage and sum currents in compensated grid with short to earth (cos φ)

In compensated mains, no statement about the direction of the short to earth can be made from the reactive current component, as the reactive component of the earth current depends on the degree of compensation of the mains. To determine the direction, the ohmic component of the sum current (cos φ setting) is used.

In lines free of earth faults, active current components and residual voltage are in-phase, while the ohmic component in a line with an earth fault is in the anti-phase to the residual voltage.
Thanks to an efficient digital filtering, all the harmonics are suppressed. In this way, for example, the uneven harmonics in existence in an electrical arc fault do not impair the protective function.

3. Mains with solidly earthed star point (setting: "earthing: SOLI", "MTA: adjustable")

Most faults in a solidly earthed mains mainly have an inductive character. This is why the characteristic angle between current and voltage at which the highest sensitivity of the measurement is achieved has been selected at 110° ahead of the zero voltage U_0.

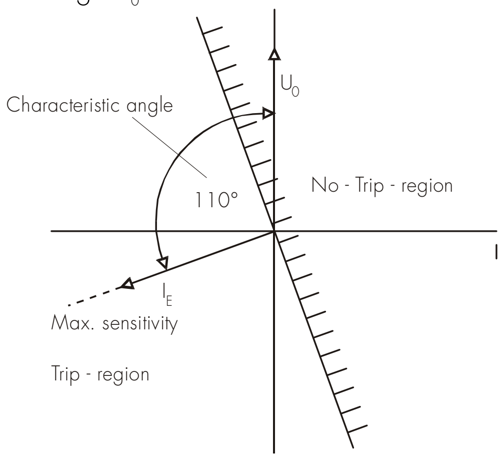


Figure 5.76: Characteristic angle in a solidly earthed mains (SOLI)

4. Mains with resistance-earthed star point (setting: "eathing: RESI", "MTA: adjustable")

In a resistance-earthed mains, most of the faults mainly have an ohmic character with a slight inductive component. This is why the characteristic angle has been set at 170° ahead of the zero voltage U_0 for these kind of mains. The reaction area of the directional element has been set in each case by turning the current vector on the characteristic angle by ± 90°.

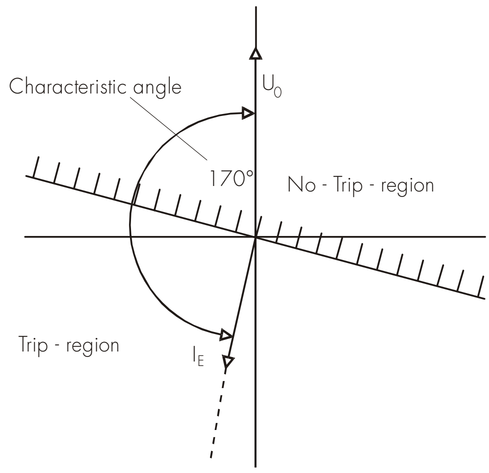


Figure 5.77: Characteristic angle in resistance-earthed mains (RESI)

„MTA" (Characteristic angle for the star point earthing method in directional protection)
The directional determination for the earth current Ie, which is needed for the directional earth time-overcurrent protection, is based on the *measuring principle* for *angle measurement* between the relevant *earth current component* and the *residual voltage Ue*. Dependent on the *vector group* of the transformer used there are different characteristic MTAs due to the star point type at the relevant transformer winding end (either in *Y-connection or Z-connection).*
When function *directional determination* is activated (Parameter: *„Direction = active"*), different setting ranges or fixed values for the characteristic MTA are resulting from the chosen star point type (Parameter: *"Earthing"*):

- When the star point earthing is of *rigid* and *resistance-earthed* type, the size of the characteristic angle can be adjusted.
- When the star point earthing is of *isolated* and *compensated* type, the size of the characteristic MTA is fixed, i.e. the ***CSP2-T*** assumes a fixed angle („SIN = -90°"; „COS = 180°) which states the angle between the earth current component and the residual voltage Ue for the sensitive peak in case a fault occurs with the flowing energy in "forward" direction. If the measured angle deviates from this characteristic angle by more than ± 90°, the protection element detect "backward" flowing energy.

Note

Each protective element of the protection functions Ie> and *Ie*>> has its own „MTA" parameter. Thus each individual protective element operates with the angle specifically adjusted for its „MTA" parameter!

Important

- When the earth *overcurrent time protection is directional* it is important that the *measuring values of the earth current a*nd the necessary measuring value of the r*esidual voltage* are acquired at the same *winding end,* otherwise a *distinct* directional decision is not possible. M*easuring of the* residual voltages is based on the setting of parameter *„EVT Loc"* (see Chapter *„Field Parameter"*).
- But it is also possible to calculate the residual voltage from the *phase voltages* of winding end W1 or W2 (see system parameter *„EVTProc. = geometr.Σ").* In this case the calculation of the residual voltage will be carried out for the winding end the phase VT was allocated to (see system parameter *„VT Loc"* in menu *„Field Parameter"*).

Options for directional determination of the energy flow

For the directional earth overcurrent time protection *the correlation between the voltage measuring location (system parameter „EVT Loc“* - measuring of Ue - *or “VT Loc“* - calculation of Ue - *in menu „Field Parameter“), the measuring location of the earth currents (system parameter „Measuring Location“ in menu „Trip Processing“) and the CB positions are explained in the following table. Furthermore it is assumed that the two bus bars („$U_{W1\ BB}$“ and „$U_{W2\ BB}$“ are live (application as coupling transformer).*

Directional Determination					
Setting of Parameters • *«EVT Loc» (Measuring of Ue)* *or* • *«VT Loc» (Calculation of Ue)*	*Setting of System Parameter «Measuring Locat.» in Menu : «Trip Processing»*	*Setting of Protect.Parameter «Direction»*	*CB1 Position*	*CB2 Position*	*Directional Determination*
“VT Loc = W1 Busb.”	“W1”	“active”	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Not possible
			ON	ON	Possible
	“W2”	“inactive”	ON/OFF	ON/OFF	Not possible
“EVT Loc = W1”	“W1”	“active”	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Possible
			ON	ON	Possible
	“W2”	“inactive”	ON/OFF	ON/OFF	Not possible
“VT Loc = W2 Busb.”	“W1”	“inactive”	ON/OFF	ON/OFF	Not possible
	“W2”	“active”	OFF	OFF	Not possible
			ON	OFF	Possible
			OFF	ON	Possible
			ON	ON	Possible
“EVT Loc = W2”	“W1”	“inactive”	ON/OFF	ON/OFF	Not possible
	“W2”	“active”	OFF	OFF	Not possible
			ON	OFF	Not Possible
			OFF	ON	Possible
			ON	ON	Possible

Table 5.49: Directional determination for the earth overcurrent protection

„Function“
With the setting *"Function = active“* the corresponding *phase of the earth overcurrent protection functions* is generally set into function. The protection element can however only be effective if it is not being blocked.

„ex block“
This parameter can only become effective in cooperation with the digital input function *„Prot. blocked*“. With an active status of this input function, the levels of the *phase of the earth overcurrent protection* which are set to *„ex block = aktive“* are blocked.

"tripbloc“ (blockage of the OFF command for the power switch)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay, a *"Trip: XY“* message and the message "General trip" are nevertheless generated and are available for the communication to the SCADA as output messages of the LED display, the further processing via signal relays or as messages (data points).
The tripping blockage can, for example, be used for detection of direction without a tripping command to the circuit breaker (only display).

„rev lock“ (reverse locking)
Each element can be temporarily blocked from external via a common digital input (DI) with the assigned input function »rev. lock.«. That is to say, as long as the digital input is active, all the protection elements with the setting *"rev lock = active“* are blocked (ineffective).

„direct.“ (direction decision)
With this parameter, the direction decision for a protective tripping can be activated separately for each stage in the event of a fault. For example, the earth overcurrent protection can be set directional, but the earth short-circuit protection can be left non-directional.

Settings:
„active“: The protective stages marked with the index *"F“ only* trip in a *forward direction*!
The protective stages marked with the index *"B“ only* trip in a *backward direction*!
*„inactive“:*The protective stages trigger in the event of a fault without regard for the direction of flow of energy (non-directional)!

Note

If all four direction parameters are set to »inactive«, the *CSP2-F* has four earth overcurrent elements independent of one another without a direction decision.

„Ue lock“ (blocking the protection stage in dependence of the residual voltage Ue)
If this parameter is configured as *active*, this stage of the earth overcurrent time protection only becomes active if a measured residual voltage *Ue* exceeds a certain pick-up value. This pick-up value is to be configured by the parameter *„Ue>“* of the protection stage *Ue>*. For this it is not necessary to activate the *protection stage Ue>*.
The residual voltage *Ue* is thus used as an *additional protection criterion* for the earth time-overcurrent protection.

Tripping characteristic (e.g. "char F“)
(*analogous to time-overcurrent protection*)

Earth current pick-up value of the protection stage (e.g. "Ie>F")
In the *current-independent tripping characteristic (DEFT)* and in the *current-dependent tripping characteristic (INV)* the protection stages pick-up as soon as the measured earth current exceeds this set value. The tripping delay time on the *INV* characteristics is a function of the overcurrent in the event of a fault. It is calculated by the *CSP2* via the characteristic as a function of the size of the earth overcurrent. The tripping delay time in the *DEFT* characteristic is not based on the amount of the overcurrent, but on a settable time e.g. *"t Ie>F"*.
In protection stagess with direction detection and active direction function, the protection only picks-up if the current is flowing in the direction in question and is larger than the threshold.

Tripping delay time of the protection stage for DEFT characteristic (e.g. "t Ie>F")
(analogous to time-overcurrent protection)

Characteristic factor – only for INV characteristics (e.g. "t char F")
(analogous to time-overcurrent protection)

Reset time (e.g. "t rst F")
(analogous to time-overcurrent protection)

„Ie H2" (earth current inrush supervision)
This is the parameter to activate the *earth current inrush supervision Ie H2* for the relevant element of the earth time-overcurrent protection Ie>F, Ie>B, Ie>>F and Ie>>B .

„PiUp inc" (dynamic characteristic factor)
This is the parameter to activate the *dynamic factor of the characteristic temporarily* for the relevant element of the earth time-overcurrent protection Ie>F, Ie>B, Ie>>F and Ie>>B.

„PiUp fac" (dynamic characteristic factor)
The level of of the *dynamic characteristic factor* is defined by *„PiUp fac"*. For this purpose the tripping characteristic (IDMT tripp. characteristic) or the threshold value (DMT tripp. characteristic) is multiplied by the adjusted value of *„PiUp fac"*.

„t PiUp" (time of the dynamic characteristic factor)
The *dynamic factor of the characteristic* shall only last for the time of the CB circuit closing process. This time period is adjusted with parameter *„t PiUp"*

"AR" (Automatic reclosing)
(analogous to time-overcurrent protection)

"AR FT" (AWE fast trip)
(analogous to time-overcurrent protection)

Tripping delay time of the AR fast trip (e.g. "t Ie>FFT")
(analogous to time-overcurrent protection)

"FT at sh" (AR fast trip position)
(analogous to time-overcurrent protection)

"SOTF" (Switch On To Fault – fast trip)
(analogous to time-overcurrent protection)

Trigger delay time of the SOTF fast trip (e.g. "t I>FSO")
(analogous to time-overcurrent protection)

Earth-overcurrent protection stage: Ie>F *(Forward direction or non-directional)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Earthing	„SOLI“	System with solidly earthed star point (MTA = variable)	„SOLI“	1°	±5° of the adjustment value at I_E >1.0*I_N and U_E> 5% U_N
	„RESI“	System with resistance-earthed star point (MTA = variable)		1°	±5° of the adjustment value at I_E >1.0*I_N and U_E> 5% U_N
	„COS“	System with earth fault compensation (MTA = 180°, fixed)			±5° at I_E * cosφ >20% I_N and U_E> 10 V
	„SIN“	System with isolated star point MTA = -90° = 270°, fixed)			±5° at I_E * sinφ >20% I_N and U_E> 10 V
MTA	0°…355°	Typical angle between earth current component and residual voltage (can only be adjusted when earthing = SOLI or RESI“)	110°	1°	
Function	„active“	Ie>F stage put into function		-	
	„inactive“	Ie>F stage put out of function	„inactive“		
ex block	„active“	Ie>F stage is ineffective when input function „Protect.Block.“ is active		-	
	„inactive“	Ie>F stage is effective irrespectively of the input function “Protect. Block.” state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev. lock	„active“	Ie>F stage is ineffective when DI „rev. lock“ Is active		-	
	„inactive“	Ie>F stage is effective irrespectively of the DI “rev. lock” state	„inactive“		
direct.	„active“	Ie>F stage trips in forward direction only (directional)		-	
	„inactive“	Ie>F stage trips in both directions (non-directional)	„inactive“		
Ue lock	„active“	Ie>F stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive“	Ie>F stage is effective no matter whether the residual voltage protection Ue> or Ue>> is activated or not	„inactive“		
char F	„DEFT“	DEFT Definite time characteristic	„DEFT“	-	
	„NINV“	INV characteristic (normal inverse)			
	„VINV“	INV characteristic (very inverse)			
	„EINV“	INV characteristic (extremely inverse)			
	„LINV“	INV characteristic (long time inverse)			
Ie>F	0.01…20 x In	Pickup value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	0.5 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>F	50...300,000 ms	Trip time delay, for DEFT characteristics only	5000 ms	1 ms	DEFT ±1% or ±20 ms

***Earth-overcurrent protection stage: Ie>F** (Forward direction or non-directional)*					
t char F	0.05 2	Characteristic factor, for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV,LINV ±10% EINV
t rst F	0...60,000 ms	Reset time for intermittent phase faults, for INV characteristics only	0 ms	1 ms	only INV ±3% of the adjustment value
IeH2	„active“	Activation of the inrush earth current protection Ie H2 for the Ie>F -element			
	„inactive“	De-activation of the inrush earth current protection Ie H2 for the Ie>F- element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the Ie>F step the AR is started		-	
	„inactive“	By trip of the Ie>F step the AR cannot be started	„inactive“		
AR-FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t Ie>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0“	AR instantaneous trip at the first protect. trip via stage Ie>F	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t Ie>FSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.50: Setting parameters for earth-overcurrent protection Ie>F

Earth-overcurrent protection stage: Ie>B *(Backward direction or non-directional)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active"	Ie>B stage is put into function		-	
	„inactive"	Ie>B stage is put out of function	„inactive"		
ex block	„active"	Ie>B stage ineffective when input function „Protect. Block." is active		-	
	„inactive"	Ie>B stage is effective irrespectively of the input function "Protect. Block." state	„inactive"		
tripbloc.	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
rev. lock	„active"	Ie>B stage is ineffective when the DI „rev. lock" is active		-	
	„inactive"	Ie>B stage is effective irrespectively of the DI "rev. lock" state	„inactive"		
direct.	„active"	Ie>B stage trips in backward direction only (directional)		-	
	„inactive"	Ie>B stage trips in both direction (non-directional)	„inactive"		
Ue lock	„active"	Ie>B stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive"	Ie>B stage is effective no matter whether the residual voltage protection Ue> or Ue>> is activated or not	„inactive"		
char B	„DEFT"	DEFT Definite time characteristic	„DEFT"	-	
	„NINV"	INV characteristic (normal inverse)			
	„VINV"	INV characteristic (very inverse)			
	„EINV"	INV characteristic (extremely inverse)			
	„LINV"	INV characteristic (long time inverse)			
Ie>B	0.01…20 x In	Pickup value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	0.5 x In	0.001 x In	±3% of the adj. value or 0.3% I_N
t Ie>B	50…300,000 ms	Trip time delay, for DEFT characteristics only	5000 ms	1 ms	±1% or ±20 ms
t char B	0.05 2	Characteristic factor, for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV,LINV ±10% EINV
t rst B	0…60,000 ms	Reset time for intermittent phase faults, for INV characteristics only	0 ms	1 ms	only INV ±3% of the adjustment value
IeH2	„active"	Activation of the inrush earth current protection Ie H2 for the Ie>B element			
	„inactive"	De-activation of the inrush earth current protection Ie H2 for the Ie>B-element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the Ie>B stage the AR is started		-	
	„inactive"	By trip of the Ie>B stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t Ie>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0"	AR instantaneous trip at the first protect. trip via stage Ie>B	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			

Earth-overcurrent protection stage: Ie>B *(Backward direction or non-directional)*					
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t Ie>BSO	50...300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.51: Setting parameters for earth-overcurrent protection Ie>B

Earth short-circuit protection stage: Ie>>F *(Forward direction or non-directional)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
MTA	0°…355°	Typical angle between earth current component and residual voltage (can only be adjusted when earthing = SOLI or RESI")	110°	1°	
Function	„active"	Ie>>F stage is put into function		-	
	„inactive"	Ie>>F stage is put out of function	„inactive"		
ex block	„active"	Ie>>F stage ineffective when input function „Protect. Block." is active		-	
	„inactive"	Ie>>F stage effective irrespectively of the input function "Protect. Block." state	„inactive"		
tripbloc.	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
rev. lock	„active"	Ie>>F stage ineffective when DI „rev. lock" is active		-	
	„inactive"	Ie>>F stage effective irrespectively of the DI "rev. lock" state	„inactive"		
direct.	„active"	Ie>>F stage trips in forward direction only (directional)		-	
	„inactive"	Ie>>F stage trips in both directions (non-directional)	„inactive"		
Ue lock	„active"	Ie>>F stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive"	Ie>>F stage is effective no matter whether the residual voltage supervision Ue> or Ue>> is activated or not	„inactive"		
Ie>>F	0.01…20 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1.0 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>>F	50 …300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IeH2	„active"	Activation of the inrush earth current protection Ie H2 for the Ie>>F element			
	„inactive"	De-activation of the inrush earth current protection Ie H2 for the Ie>>F element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the Ie>>F stage the AR is started		-	
	„inactive"	By trip of the Ie>>F stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t Ie>>FFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0"	AR instantaneous trip at the first protect. trip via stage Ie>>F	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state			
	„inactive"	SOTF function is put into inactive state	„inactive"		

Earth short-circuit protection stage: Ie>>F *(Forward direction or non-directional)*					
t Ie>>FSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.52: Setting parameters of the earth short-circuit protection Ie>>F

***Earth short-crcuit protection stage: Ie>>B** (Backward direction or non-directional)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	Ie>>B stage is put into function		-	
	„inactive“	Ie>>B stage is put out of function	„inactive“		
ex block	„active“	Ie>>B stage ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Ie>>F stage effective irrespectively of the input function “Protect. Block.“ state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev. lock	„active“	Ie>>B stage ineffective when DI „rev. lock“ is active		-	
	„inactive“	Ie>>B stage effective irrespectively of the DI “rev. lock“ state	„inactive“		
direct.	„active“	Ie>>B stage trips in backward direction only (directional)		-	
	„inactive“	Ie>>B stage trips in both directions (non-directional)	„inactive“		
Ue lock	„active“	Ie>>B stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive“	Ie>>B stage is effective no matter whether the residual voltage supervision Ue> or Ue>> is activated or not	„inactive“		
Ie>>B	0.01…20 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1.0 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>>B	50 …300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IeH2	„active“	Activation of the inrush earth current protection Ie H2 for the Ie>>B element			
	„inactive“	De-activation of the inrush earth current protection Ie H2 for the Ie>>B element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the Ie>>B stage the AR is started		-	
	„inactive“	By trip of the Ie>>B stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t Ie>>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0“	AR instantaneous trip at the first protect. trip via stage Ie>>B	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	

Earth short-crcuit protection stage: Ie>>B *(Backward direction or non-directional)*					
	„inactive“	SOTF function is put into inactive state	„inactive“		
t Ie>>BSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Table 5.53: Setting parameters of the earth short-circuit protection Ie>>B

5.7.3.9 Overload protection with thermal replica $\vartheta>$

Description
The thermal overload protection in the *CSP2* for transformers, generators and supply lines has been designed according to IEC 255-8 (VDE 435 T301).

In the device, a complete thermal replica function has been implemented as a *single-heat model* of the electrical equipment to be protected, taking the preceeding load into account. The protective function has been designed single-phased with a warning threshold.

For this, the *CSP2* calculates the thermal load of the electrical equipment connected on load side from the existing measurement values and the set parameters. With knowledge of the thermal constants, a deduction can then be made of the temperature of the electrical equipment (interpolated).

Block diagram
The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

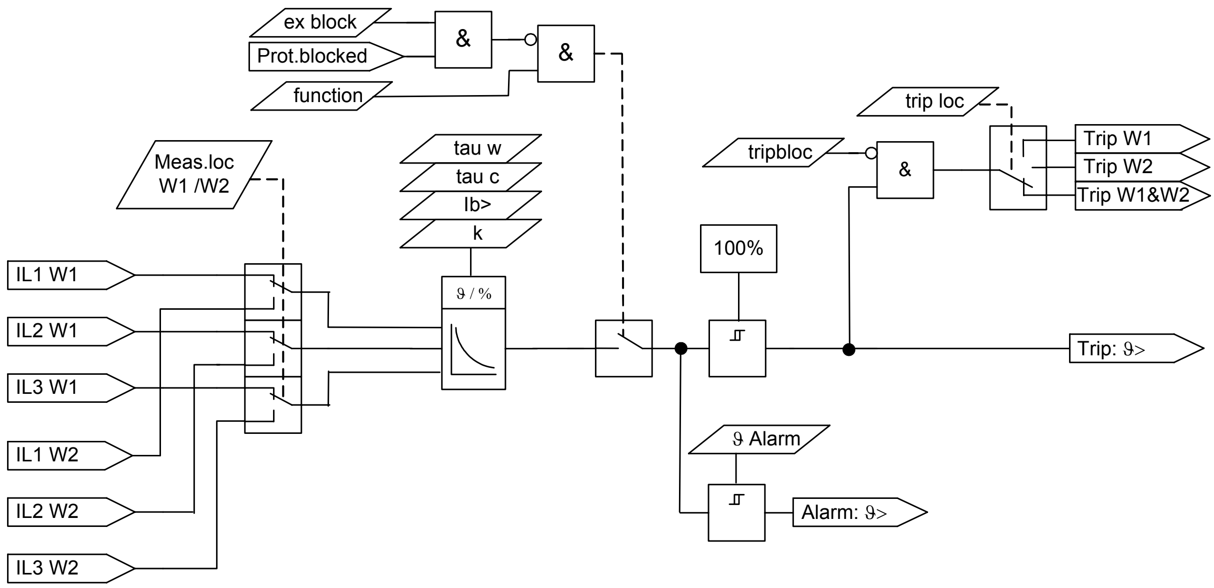


Figure 5.78: Block diagram of overload protection with thermal replica $\vartheta>$

Important

- According to the *overload protection with thermal replica $\vartheta>$* the measuring values of the phase current could either be taken from transformer *winding side W1 or W2* (see chapter „Trip operating" parameter *„Meas.loc"*).

- The tripping command of the *overload protection with thermal replica $\vartheta>$* could either be given to both CBs (W1 & W2) or to only one CB (W1 or W2) of the transformer winding sides (see chapter „Trip operating" parameter *„Trip loc"*).

Parameters

"tau w" (warming time constant)
The time constant sets the heating properties in the thermal model. The rule of thumb is that with constant current the temperature of the behaviour equipment has reached its final value after the time corresponding to 5 times the constant. As heating and cooling normally work with different time constants, they can be set separately. The *CSP2* automatically recognizes whether there is heating or cooling by the current and the temperatures derived from it. In the case of heating, a forecast tripping time *"tϑ"* is displayed in the »Measurement« menu.

"tau c" (cooling time constant)
The time constant sets the cooling properties in the thermal model.

„Function"
With the setting *"Function = active"* the *thermal overload protection* is generally set into function. The protection stage can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function *„Prot. blocked"*. With an active status of this input function, the levels of the *thermal overload protection* which are set to *„ex block = aktive"* are blocked.

"tripbloc" (blocking the OFF command for the circuit breaker)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay, a *"Trip XY"* message and the message *"General trip"* are nevertheless generated and are available for the communication to the SCADA-system as output messages of the LED display, the further processing via signal relays or as messages (data points).

"ϑ Alarm" (overload alarm)
A warning stage, which can be set as a percentage, enables a timely detection of temperature-critical processes. The default setting is *"ϑ Alarm" = 80%"*.

"Ib>" (thermally admissible permanent current - basic current)
The setting of this parameter states the threshold of the overload current at which the *CSP2* must not trip. Generally, this is the maximum admissible operating current for electrical equipment, in which the additional influential variables for the heating have been included (e.g. heat loss by the transformer oil or by air convection).
The product of current and overload factor ($K \cdot I_B$) defines the set threshold of the overload current at which the *CSP2* must not trip. The settings of the overload characteristics refer to this overall factor $K \cdot I_B$.

"K" (overload factor)
This constant is to be multiplied by the basic current. The overload factor is a constant which, multiplied by the basic current I_B, defines the maximum admissible thermal threshold for the electrical equipment. Normally, the admissible heating is 10 % above the basic factor, thus making the overload factor: *K=1.1*.

Remark

To calculate the temperature equivalent, only the basic current I_B is used, with $I^2 \sim \vartheta$. With the constant *K* the activation point *($K \cdot I_B$)* is determined and the tripping time *"tϑ"* calculated. This tripping time is shown in the display as a menu parameter ("DATA/MEASUREMENT") and states the time to the trip of the circuit breaker. The temperature equivalent ϑ [%] is shown as a measured value in percent *"ϑ = X %"* likewise as a menu parameter under ("DATA/Measurement").

Example
A setting of the nominal current with $I_B = 0.8 \cdot I_N$ and selection of an overload factor $K = 1.1$ (10% reserve) results in a activation point of $0.88\ I_N$.

Overload protection with thermal image ϑ>					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
tau w	5…60,000 s	Warming-up time constant of the component (see data sheet of the component)	10 sec	1 s	
tau c	5…60,000 s	Cooling-down time constant of the component (see data sheet of the component)	10 sec	1 s	
Function	„active"	ϑ> stage is put into function		-	
	„inactive"	ϑ>-stage is put out of function	„inactive		
ex block	„active"	ϑ> stage is ineffective when input function "Protect. Block." is active		-	
	„inactive"	ϑ> stage is effective irrespectively of the input function "Protect. Block." State	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked in case of overload		-	
	„inactive"	OFF command to the local CB is being issued in case of overload	„inactive"		
ϑ Alarm	50..100%	Activation value for overload alarm (in per cent)	80%	1%	±1%
Ib>	0.5…2.4 x In	Pick-up value for the max. permissible thermal continuous current (basic current) related to the rated current Disengaging ratio 97% or 1% x In	1 x In	0.001 x In	±3% of the adjustment value or 1% I_N
K	0.8…1.2	Overload factor	1	0.01	

Table 5.54: Setting parameters for thermal overload protection

Heating, cooling constants
τ is the time in which the temperature of the operating equipment to be protected has reached 63% of the stationary operating temperature after switching on. This time constant is stated in the data sheet of the electrical equipment as a rule. If τ is unknown, the following rule of thumb is to be used:

With constant current I about 63% of the final temperature has been reached after $t = \tau$. After a time of $t = 5\tau$ the final temperature has practically been reached (99%).

Attention

The heating time constant and the cooling time constant are equal for cables and transformers without external cooling, whereas they greatly differ from one another for motors!

Tripping characteristic with initial load
Characteristic with complete memory function. The heating caused by the current before the overload happens is taken into account for the thermal replica of the electrical equipment to be protected.

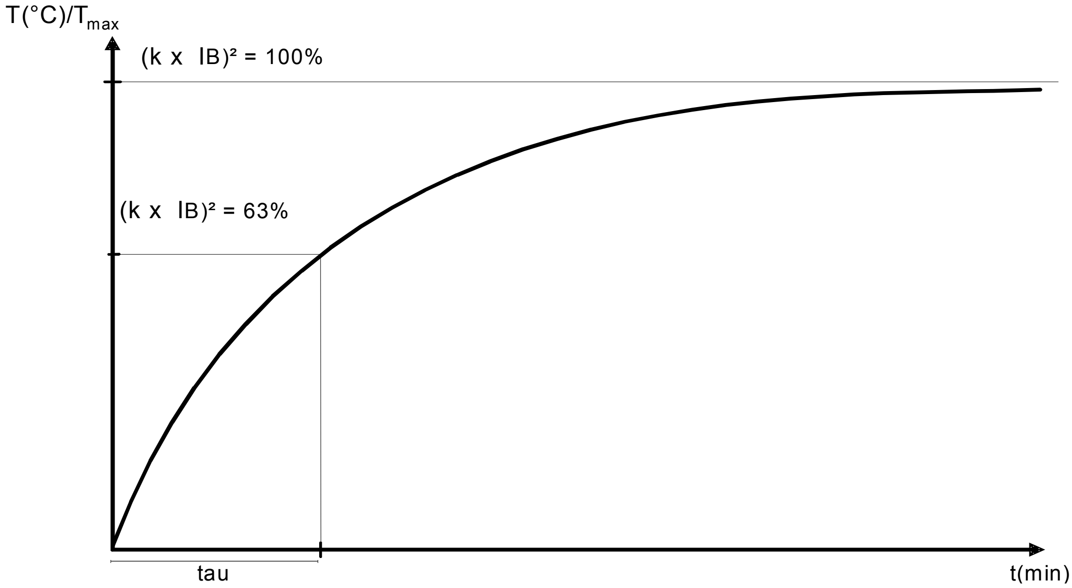


Figure 5.79: Example of a heating with constant current

Note

Further details on the calculation and on the thermal model are listed in the annex. (Calculation, thermal replica)

$$t_{trip} = \mathrm{tau_w} \cdot \ln \frac{\left(\frac{\mathrm{I}}{\mathrm{K} \cdot \mathrm{Ib}>}\right)^2 - \left(\frac{I_{bef}}{K \cdot Ib>}\right)^2}{\left(\frac{I}{K \cdot Ib>}\right)^2 - (K \cdot Ib>)^2}$$

I	= impressed current
Ib>	= refer to table
K	= refer to table
I_{bef}	= load current before

5.7.3.10 Temperature Supervision ϑ1>, ϑ2>

Description

The negative effect of the temperature on the life time of a transformer must not be underestimated. An excessive temperature, e.g. caused by permanent overload operation, can damage the insulation of the transformer and result in faults within the equipment.
Therefore it is essential that the temperature is measured constantly and if the measured value requires, an alarm is generated or the transformer is disconnected from the mains.

The *CSP2-T* has two *separate temperature monitoring functions ϑ1> and ϑ2>* and also *two analogue inputs* for connection of one temperature sensor. This arrangement allows that two different temperature measuring points are monitored in the transformer. Each of the temperature monitoring functions is provided with one *activating element* and one *tripping element* which can be adjusted separately.

The *analogue inputs* can be wired to the usual *temperature sensors, such as Pt100, Ni100 or PTC Sensors.* The necessary hardware adoption is realised via DIP switches (see Chapter „Analogue Inputs"). On the software side the relevant sensors are chosen in menu „Analogue Inputs" by using the respective system parameter.

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command. In this diagram the model of functional diagramm of the *temperature monitoring function ϑ1>* is shown.

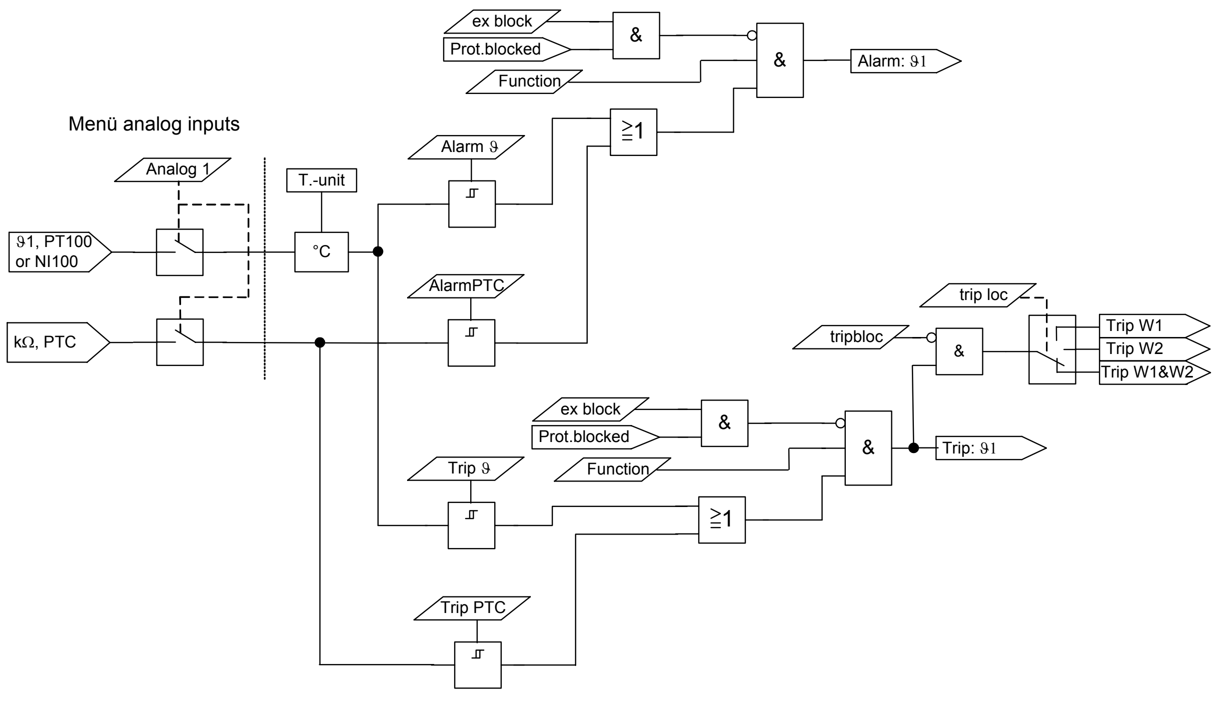


Figure 5.80: Block diagram of temperature supervision ϑ1>

Important

- For each of the two protection functions *temperature supervision ϑ1> and ϑ2>* applies that the trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Locat."*; see chapter „Trip operating").

Parameters

„Function"
The *temperature monitoring function ϑ1> or temperature monitoring function ϑ2>* is generally activated with the setting *Function = "active"*. Parameter *„Function"* is in each of the protection function separately available for the *activating element* and for the *tripping element* and is adjustable. But the *protection functions* can only become effective if they are not blocked.

„ex block"
This parameter is only effective together with the digital input function "*Protection blocked*". If the protection parameter "*ex block." = active"* is set and this digital input function is activated, the *temperature monitoring function ϑ1> or temperature monitoring function ϑ2>* is blocked!

„tripbloc " (Blocking the circuit breaker trip command)
Here only the trip command to the CB is blocked. The signals *„Trip XY"* „ and *„General Trip"* are, however, generated after the tripping delay time has elapsed. These messages are available as output messages for the LED indication, for processing via signal relay or as signals (data points) for communication with the control system.

Threshold value of the alarm element for Platinum-/Nickel-Sensor (e.g. „Alarm ϑ1>")
For generating an alarm in the *CSP2-T* it is possible to adjust a specific temperature value via the activating element for temperature-critical processes. For platinum and nickel sensors the parameter *„Alarm ϑ1>"* applies.

Threshold value of the alarm element for PTC Sensor (e.g. „Alarm PTC)
For generating an alarm in the *CSP2-T* it is possible to adjust a specific temperature value via the activating element for temperature-critical processes. For PTC sensors the parameter *„Alarm PTC"* applies.

Threshold value of the tripping element for Platinum-/Nickel Sensors (e.g. „Trip.ϑ1>")
In order that a signal is issued by the *CSP2-T* for tripping the CB (CBs) it is possible to adjust a specific temperature value via the tripping element for temperature-critical processes. For platinum and nickel sensors the parameter *„Trip. ϑ1>"* applies.

Threshold value of the tripping element for PTC Sensor (e.g. „Trip PTC")
In order that a signal is issued by the *CSP2-T* for tripping the CB (CBs) it is possible to adjust a specific temperature value via the activating element for temperature-critical processes. For PTC sensors the parameter *„Trip PTC"* applies.

Temperature Supervision ϑ1>				
Parameter	Setting/ Setting Range	Description	Pre-Setting.	Step Range
Function	„active"	The temperature supervision ϑ1> is activated		-
	„inactive"	The temperature supervision ϑ1> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ1> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervisionϑ1> is effective irrespectively of the input function „Protect.Block." state	„inactive"	
Alarm ϑ1>	0…200 °C	Temperature threshold value for alarm signal for sensors Pt100 and Ni100	95°C	1 °C
Alarm PTC	0…30.0 kΩ	Temperature threshold value for alarm signal for PTC sensor 1	5.0 kΩ	0.1 kΩ
Function	„active"	The temperature supervision ϑ1> is activated		-
	„inactive"	The temperature supervision ϑ1> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ1> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervision ϑ1> is effective irrespectively of the input function „Protect.Block." state.	„inactive"	
Trip ϑ1>	0…200 °C	Temperatur-e threshold value for tripping (sensors Pt100 and Ni100)	95°C	1 °C
Trip PTC	0…30.0 kΩ	Temperature threshold for tripping (PTC sensor 1)	5.0 kΩ	0.1 kΩ

Temperature Supervision ϑ2>				
Function	„active"	The temperature supervision ϑ2> is activated		-
	„inactive"	The temperature supervision ϑ2> is de-activated	„inactive	
ex Block	„active"	The temperature supervision ϑ2> is ineffective when the input function „Protect.Block" is active		-
	„inacktive"	The temperature supervision ϑ2> is effective irrespectively of the input function „Protect.Block." state	„inactive	
Alarm ϑ2>	0…200 °C	Temperature threshold value for alarm signal for sensors Pt100 and Ni100	95°C	1 °C
Alarm PTC	0…30.0 kΩ	Temperature threshold value for alarm signal for PTC sensor 2	5.0 kΩ	0.1 kΩ
Function	„active"	The temperature supervision ϑ2> is activated		-
	„inactive"	The temperature supervision ϑ2> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ2> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervision ϑ2> is effective irrespectively of the input function „Protect.Block" state	„inactive"	
Trip ϑ2>	0…200 °C	Temperatur-e threshold value for tripping (sensors Pt100 and Ni100)	95°C	1 °C
Trip PTC	0…30.0 kΩ	Temperatur-e threshold value for tripping (PTC-Sensor 2)	5.0 kΩ	0.1 kΩ

Table 5.55: Parameter Temperature Monitoring Functions ϑ1> and ϑ2>

5.7.3.11 Automatic reclosing (AR)

Description

The *automatic reclosing function (AR)* is mainly used for overhead lines so that the power supply can automatically be re-instated in the shortest possible time in case of short-term failure conditions (e.g. short-circuits due to a branch on the transmission line set on fire by an arc).

If the arc finds favourable peripheral conditions (supply of energy, length etc.) it can continue stable burning for a while. As a result of a short interruption of the current supply, the arc quenches. It does not re-ignite when the voltage is switched on again, as the primary source of ignition no longer exists (branch has burnt out in the meantime or fallen). After the reclosing, the line can mainly be operated again without faults. Thanks to a quick auto reclosing, the loss of the supply of energy is minimized.

By the many additional protective functions available in the *CSP2-T* it is also possible that – dependent on the protection philosophy of the user - the following feeder protection can be realized. If there are overheadlines between the transformer and the grid to be supplied, an AR function together with the phase and earth current protection function can distinctively increase the reliability of power supply.

Note

It is not possible to use the AR function also for the phase differential protection.

Explanation of terms

„AR-activating (current-) protection functions"

These are the current protection functions able to activate the AR function in line with the related parameter setting. The individual protection elements are as follows:

- *CSP2-T: I>F, I>B, I>>F, I>>B, Ie>F, Ie>B, Ie>>F and Ie>>B*

„AR cycle"

The AR cycle starts as soon as the AR function is activated and stops when the blocking time $t_{rec.}$ has elapsed.

Activation of the automatic reclosing function can be done in the *CSP2* by

- each step of the AR-activating current protection functions *I>, I>>, Ie> und Ie>>* or
- an external signal (active digital input: *"AR Start"*) or
- an undefined circuit breaker trip event (non-correspondence function).

AR ON command to the circuit breaker (CB)

When the AR function was activated by one of the AR-activating current protection functions, then only that CB is switched on again by the AR function which previously was tripped by the current protection function.

Important

It must be ensured that the *tripping* processing of the AR activating current protection function which activates the AR function is configured such in away, that **never** both CBs are being tripped. This means the parameter *"Trip.Loc"* in menu *"Trip operating"* must not be set to „W1 & W2" , but only to *„W1"* or *„W2"*! Otherwise the AR function for this protection function is automatically blocked.

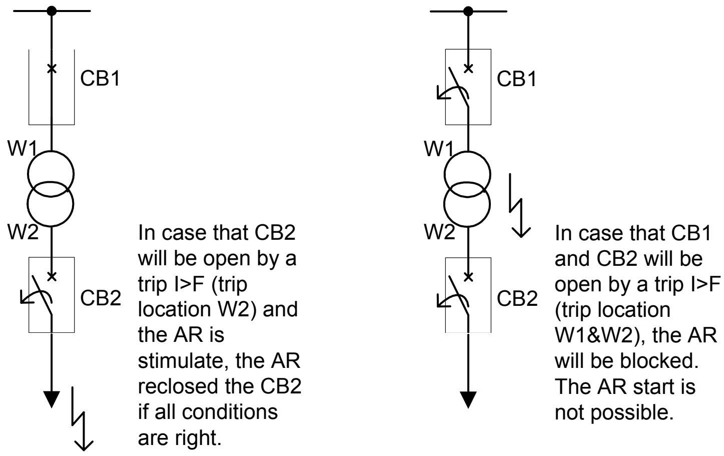


Figure 5.81: Tripping processing for the AR function

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

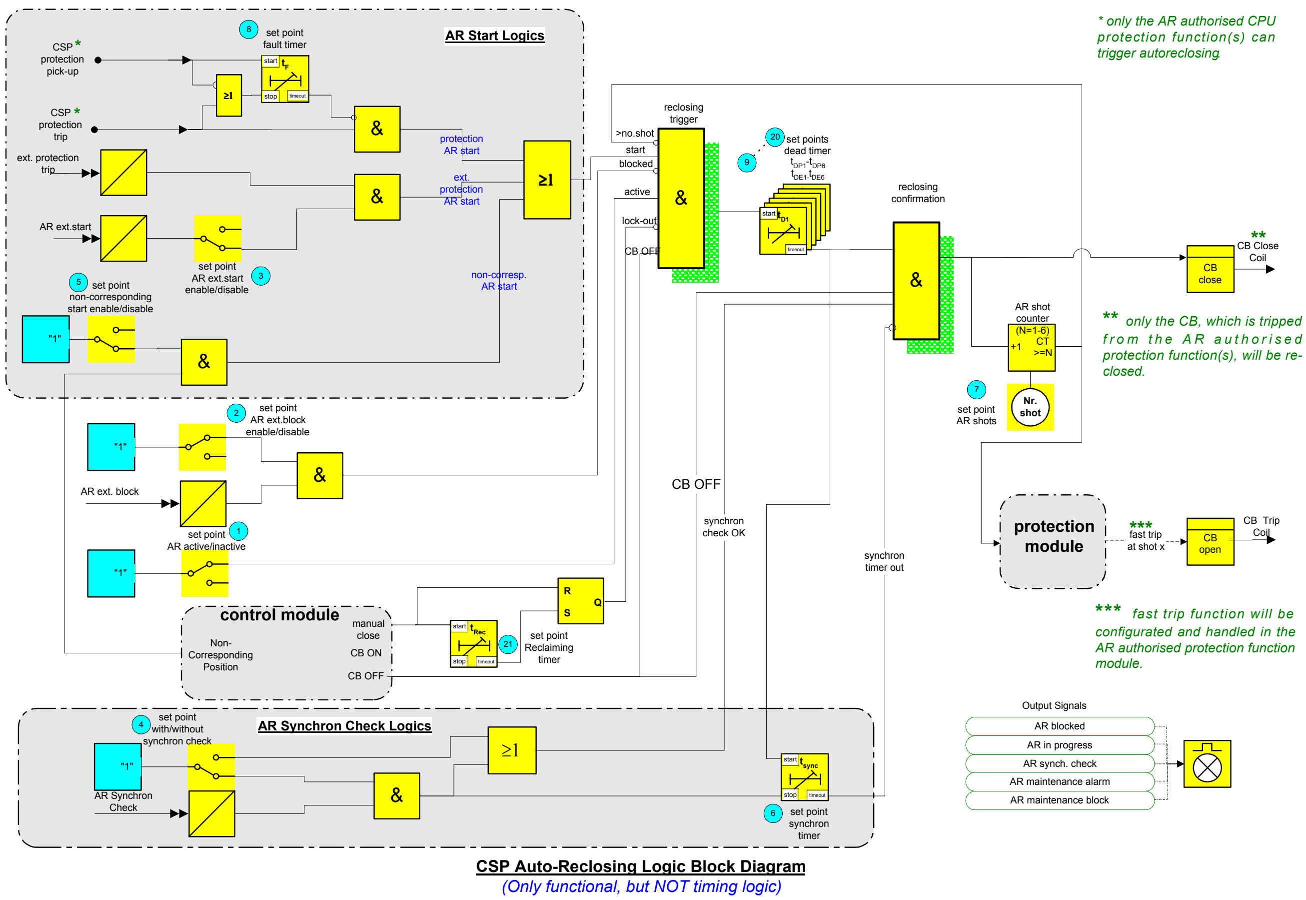


Figure 5.82: Block Diagram AR Function

Parameters

„Function"
With the setting *"Function = active"* the *AR function* is generally set into function. The *AR function* can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *AR function* which are set to *„ex block = aktive"* are blocked.

„ex AR"
If this parameter is set as active, the *AR* function can also be started from externally. The prerequisite is that the trip signal of the external protection system is connected to a digital input and has been assigned to a corresponding input function which results in a trip via the *CSP2* if it is activated. A series of input functions is available for this purpose e.g. *"Trip: Prot. 1 (to 6)"*, *"Trip: Temp."*, *"Trip: Diff."* etc.
Parallel to the trigger signal of the external protection device, a further signal which is to effect the start of the *AR* must be assigned onto a digital input with the input function *"AR-Start"*.

Attention

- Only if *both* signals activate the digital inputs *at the same time* the *AR* can be executed!
- In case that the AR cycle will be blocked by the input function „AR blocked" the AR function is to be stopped by means of resetting relevant timers and counters affecting the AR cycle.

"syncheck" (Synchronity check)
After the start of an *AR* cycle (complete time from start to blockage of the *AR* function via the blocking time *t rec*) a synchronity check can be set as an additional condition for the attempt at auto reclosing of the *AR* function in the *CSP2*. For this, the parameter *"syncheck"* must be active. A release of the switch-on command after the expiry of the break time t_{DP} or t_{DE} is then only given with an active status of the digital input *"AR-Syncheck"* and taking the set synchronisation time *t Syncheck* into account. The signal for the digital input is generated by an external synchronicity control relay e.g. if:

- the voltages in front of and behind LS are synchronous (synchronicity control) or
- no voltage exists in front of and behind the CB (dead bar).

"t syncro" (Synchronization time)
After the expiry of each break time t_{DP} or t_{DE} a timer is started, the time window "*t syncro"* of which can be parametered. Within this set time, the synchronicity signal must have been generated and have activated the digital input *"AR-Syncheck"*. As soon as the digital input has been set, the timer is stopped and the switch-on command released. In the most unfavourable case (synchro check signal only arrives shortly before the expiry of the time) the time is extended up to the auto reclosing by the set synchronization time "*t syncro"*. If the timer nevertheless stops, i.e. if the synchro check signal does not exist within the time window "*t syncro"*, the release for the issue of the switch-on command is blocked and the blocking time "*t rec"* starts.

"NC start" (non-correspondence function: undefined circuit breaker trip)
If the CB switched on is not switched off on the basis of a controlled command (either via the *CMP*, the control technique or a digital input), but goes to the "Off position" by a so-called undefined CB event (non-correspondence position, e.g. tripping by strong vibrations, failure of the mechanics etc.), there is the possibility of starting the *AR* function automatically. For this, the *"NC start"* parameter must be set as active.

Note

In cases in which the CB can additionally be switched off by external switches, protective relays etc. directly and thus independent of the *CSP2*, the *CSP2* would interpret this process as an undefined CB event (NC position) and immediately initiate an *AR*. In order to avoid this, the *CSP2* must be given the information that this is not an undefined CB incident and a start of the *AWE* function is blocked via an active digital input *"Bypass CB off"*. This information can be an auxiliary contact of the external switch or a trip signal of the external protection relay connected onto the above mentioned digital input.

Attention

The digital input *"Bypass X CB off"* must be activated at least simultaneously with the digital input for the position check-back signal *"SG1 Signal 0"* (CB OFF position).

"shots" (auto reclosing attempts)

With this parameter the maximum number of shots for auto reclosing in each start of the *AR* function is to be set. I.e. in the event of a permanent fault, the *AR* module will execute the set number of attempts for auto reclosing before the *AR* function is blocked via the blocking time *t rec*. Maximum 6 shots are possible via the *CSP2*.

"*t F" (fault time)*

The fault time t_F states a period of time in which an *AR* start can become effective at all via the stages of the *AR*-capable (current) protection functions. The timer starts at the same time as the exceeding of the threshold (protection alarm). As soon as the tripping is done, the timer is stopped and the *AR* function is started. The time is reset if the protection alarm is so short that it does not lead to a trip. If the timer does stop, i.e. if the trip signal is not available within the time window *t wirk*, the *AR* function is not even started.
A reason for this can be that the fault time t_F has been set shorter than the tripping delay time of the activated protection function!

Attention

This reason inevitably leads to the fact that the time t_F must always be selected longer than the longest tripping delay time of the active protection functions which can start the *AR* function!

Dead times (e.g. "t DP1" or "t DE1")

After the start of the AR function the timer starts for the first dead time *t DP1* or *t DE1* before the first switch-on command is issued. If the fault still exists, this leads to a repeated protection tripping, after whitch the timer is started immediately for the second dead time *DP2* or *DE2*. Thus, the dead times defines the waiting period between a protection trip and the following attempt to initiate switching-on by the AR.
If the AR function has been started by a level of the protection functions *I>, I>>* or *I>>>* or also by an undefined CB incident, the dead time is based on t *DP* (phase error dead time); if the start is done by one of the protection levels of *Ie>* or *Ie>>*, accordingly to *t DE* (earth fault dead time).
In accordance with the maximum number of attempts at auto reclosing, there are 6 dead timer, which can be parameterized individually.

Attention

The *release of a auto reclosing command* by the *AR-function* depends, amongst other things, on the check back signal (OFF position) of the circuit breaker. I.e. the auto reclosing command can only be executed protection if the *CSP2* has recognized the *"SG1 Signal 0"* check back signal after the protection trip!
As a result, the dead times must be selected in such a way that they are larger that the control time of the circuit breaker needed for the change of position from "CB ON" to "CB OFF"!

!!! Dead time t_{DP} or t_{DE} > control time $t_{s\ SG1}$!!!

"t rec" (reclaim time)
The end of the *AR* cycle is initiated by the reclaim time *t rec*. While the timer for the reclaim time is running, a repeated start of the *AR* function is blocked.
The timer is started if:

- the set number of auto reclosing attempts *("Shots")* has been reached and the *AR* was unsuccessful
- or after a successful *AR*
- or if a ON or OFF control command is issued (either via the *CMP*, SCADA or a digital input) to the circuit breaker.
- other active protection functions such as U<, U> etc. during an AR cycle lead to a trip.

Attention

- During a permanent fault, only <u>one</u> *AR* cycle should be started so that the mechanics of the circuit breaker are not overstressed.The operating time "*t F*" has to be set longer than the reclaim time "*t rec*" and thus longer than the longest delay time of the AR-capable current protection stage in order to prevent a (further/second) AR-cycle (after the first has failed that could be initiated by a controlled command.
- According to implemented stabilizing function *„Dynamic pick-up"* or blocking functions such as *„Crossblock"* and *„Inrush supervision I H2 bzw. I eH2"* the tripping time related to the protective functions (which are able to start the AR) will be extended. The additional delay of the trip time has to be taken into account for parameter setting of the *fault time* t_f as well as the *reclaim time* t_{rec}. Otherwise a further AR cycle would be started if the protective function have excited again.

!!! Reclaim time t_{rec} > fault time t_F > longest tripping delay time $t_{I>}$!!!

"Alarm No." (counter)
This counter counts all the auto reclosing attempts (shots) of all *AR* cycles and outputs an alarm report (first warning stage) when the set final counter value has been reached.
Resetting of this counter is not automatic, but must be done manually by parameter setting (MODE 2) "DATA/Parameter/Reset Functions/*AR Counter*".

"Block No." (counter)
This counter also counts all the auto reclosing attempts (shots) of all *AR* cycles and outputs an alarm message (second warning level) when the set final counter value has been reached.
Resetting of this counter is simultaneous with the resetting of the counter *"Alarm No."*.

Automatic reclosing (AR)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	AR is put into function		-	
	„inactive“	AR is put out of function	„inactive“		
ex block	„active“	AR is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	AR is effective irrespectively of the input function „AR Protect. Block“ state	„inactive“		
ex AR	„active“	AR start if the DI „AR Start“ is active and at the same time a protective trip occurs via an active digital input, e.g. “Protect. Trip 1”).		-	
	„inactive“	AR start via digital input „AR Start“ is out of function	„inactive“		
syncheck	„active“	AR start only if DI „AR Sy. Check“ (synchronizing check signal) is within time frame „t syncheck“		-	
	„inactive“	AR start without synchronisation check signal	„inactive“		
NC start	„active“	AR start when CB is in non-correspondence position		-	
	„inactive“	No AR start when CB is in non-correspondence position	„inactive“		
t syncro	10…100,000 ms	Synchronizing time (-frame) for a synchronized AR start	100,000 ms	1 ms	±1% of the adjustment value or ±20 ms
shots	1…6	Maximum number of reclosing attempts which could be carried out	1	1	
t F	10…10,000 ms	Fault time (fault definition time) for start of the AR function (for AR start via internal current protective functions only)	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP1	100...200,000 ms	Dead time between 1st protect. trip and the first reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP2	100...200,000 ms	Dead time between 2nd protect. trip and the second reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP3	100...200,000 ms	Dead time between 3rd protect. trip and the third reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP4	100...200,000 ms	Dead time between 4th protect. trip and the fourth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP5	100...200,000 ms	Dead time between 5th protect. trip and the fifth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP6	100...200,000 ms	Dead time between 6th protect. trip and the sixth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE1	100...200,000 ms	Dead time between 1st protect. trip and the first reclosing attempt in case of earth faults	100 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE2	100...200,000 ms	Dead time between 2nd protect. trip and the second reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms

t DE3	100...200,000 ms	Dead time between 3rd protect. trip and the third reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE4	100...200,000 ms	Dead time between 4th protect. trip and the fourth reclosing attempt in case of eartzh faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE5	100...200,000 ms	Dead time between 5th protect. trip and the fifth reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE6	100...200,000 ms	Dead time between 6th protect. trip and the sixth reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t block	100...300,000 ms	Blocking time for AR start	10,000 ms	1 ms	±1% of the adjustment value or ±20 ms
Alarm no.	1...65,535	AR counter as first alarm stage when inspection work at the CB is done	1000	1	1
Block. no.	1...65,535	AR counter as second alarm stage when inspection work at the CB is done	65,535	1	1

Table 5.56: Parameter setting „Automatic Reclosing"

5.7.3.12 Control circuit supervision (CCS)

Description

The *control circuit supervision* entails not only the supervision of the tripping circuit of a connected circuit breaker, but all the control outputs of the circuit breaker from the *CSP2* (internal) as well as the control circuits of the connected switchgears (external). The supervision is done according to the closed circuit principle and for normal operation presupposes closed control circuits for switching the electrically controlled switchgears on and off. For the control circuit to be tested, the relay contacts are closed to start with. Then, a current impulse of 5 mA is fed into the control circuit from a separate source of energy.

If an interrupted control circuit is detected, there is a corresponding alarm generated, which is available for display and evaluation via the *CMP/CSP* system or the SCADA. A detected *CCS* fault remains active as a signal until eliminated and is not overwritten by the testing of the other control circuits.

Initiation of the control circuit supervision in fault-free operation:

- The supervision of the entire control circuits is done cyclically as a function of the setting of the time interval via the parameter "*CCS main"*.
- After a control command has been given, the control circuit assigned to this control command is tested before switching, i.e. switching of the corresponding relay contacts of the power circuit.
- Before an ON control command is issued to the circuit breaker, the tripping circuit of the CB is tested in order to guarantee that the CB can also trip in the event of switching onto a fault.

Initiation of the control circuit supervision in operation with faults:

- If the control time set for a switchgear is exceeded in a switching action, a *CCS* test is initiated straight away.
- If the *CCS* is activated (parameter setting), an *CCS* test is initiated immediately.
- In acknowledgement of an *CCS* alarm, the control circuit determined to be faulty is examined again.
- When a fault found in the CB trip circuit is eliminated and acknowledged, a complete CCS test is held before the next switch-on command for the circuit breaker.

Switching capacity of the switchgears

In the switchgear control by the *CSP2* please ensure that the consumpted switching capacity of the drives (ON/OFF coils of the circuit breakers, motors) does not exceed the maximum switching capacity of the control outputs of the *CSP2* (see Chapter "Technical Data").

Supervision functions of the control circuit supervision (CCS)

- Loss of control auxiliary voltage
- The control auxiliary voltage LA+/LA- for the power circuits is permanently supervised for failure. A failure of this auxiliary voltage is detected immediately as a signal and processed accordingly (message to host computer and display via *CMP1*).
- Cable break in control circuit and
- Short-circuit in control circuit.

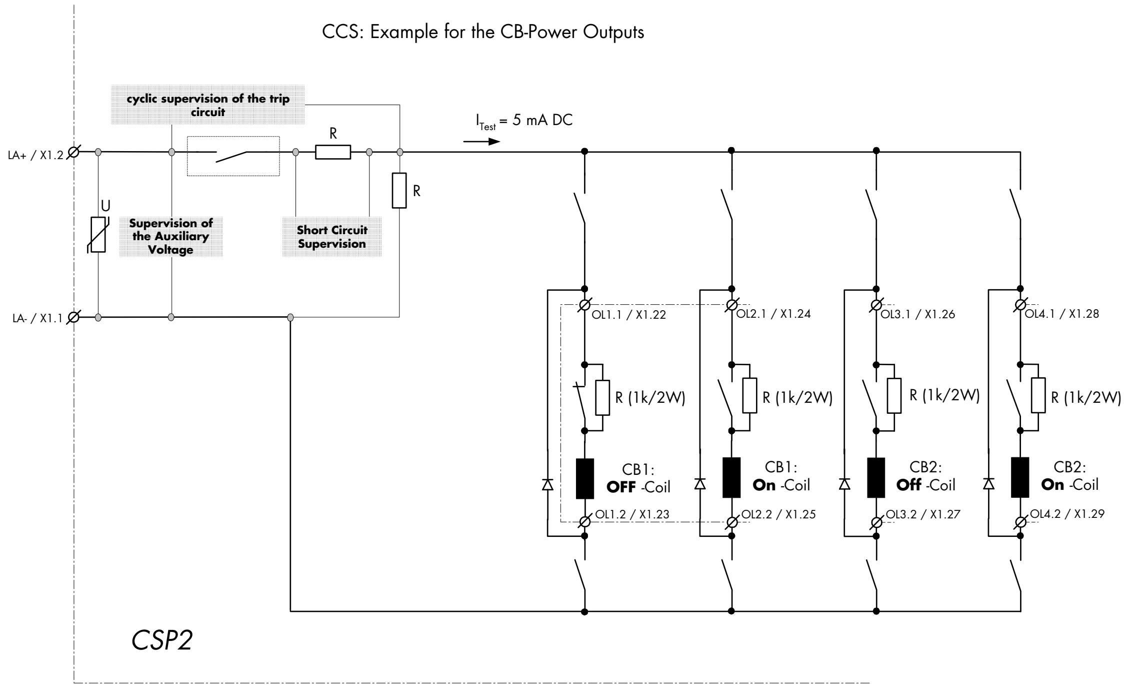


Figure 5.83: Principle of control circuit supervision (CCS)

Breaking contacts in the control circuits

In order to be able to make use of the control circuit supervision for the circuit breaker in the use of CB auxiliary contacts in front of the tripping coil, a resistor must be arranged on the feed-in side of the auxiliary contacts -see Figure 5.83. This auxiliary contact interrupts the feed of energy to the tripping coil if the CB has been switched off successfully and protects the coil against thermal overload in permanently available switch-off commands. After this interruption, no closed circuit (principle) supervision would be possible any more. Here, the projected resistor however permits a small test current. In this way, it is possible to examine the tripping coil for breakage even if the CB has been switched off. The resistor must be surge voltage resistant, as the switch-off voltage

$$u = U_V + L_A \, di/dt$$

with: U_V: supply voltage of the power outputs
L_A: inductivity of the tripping coil

drops via it.

Attention

The resistor must be sufficiently dimensioned for this voltage! As a rule, a resistor with 1 kΩ/2 W is sufficient.

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

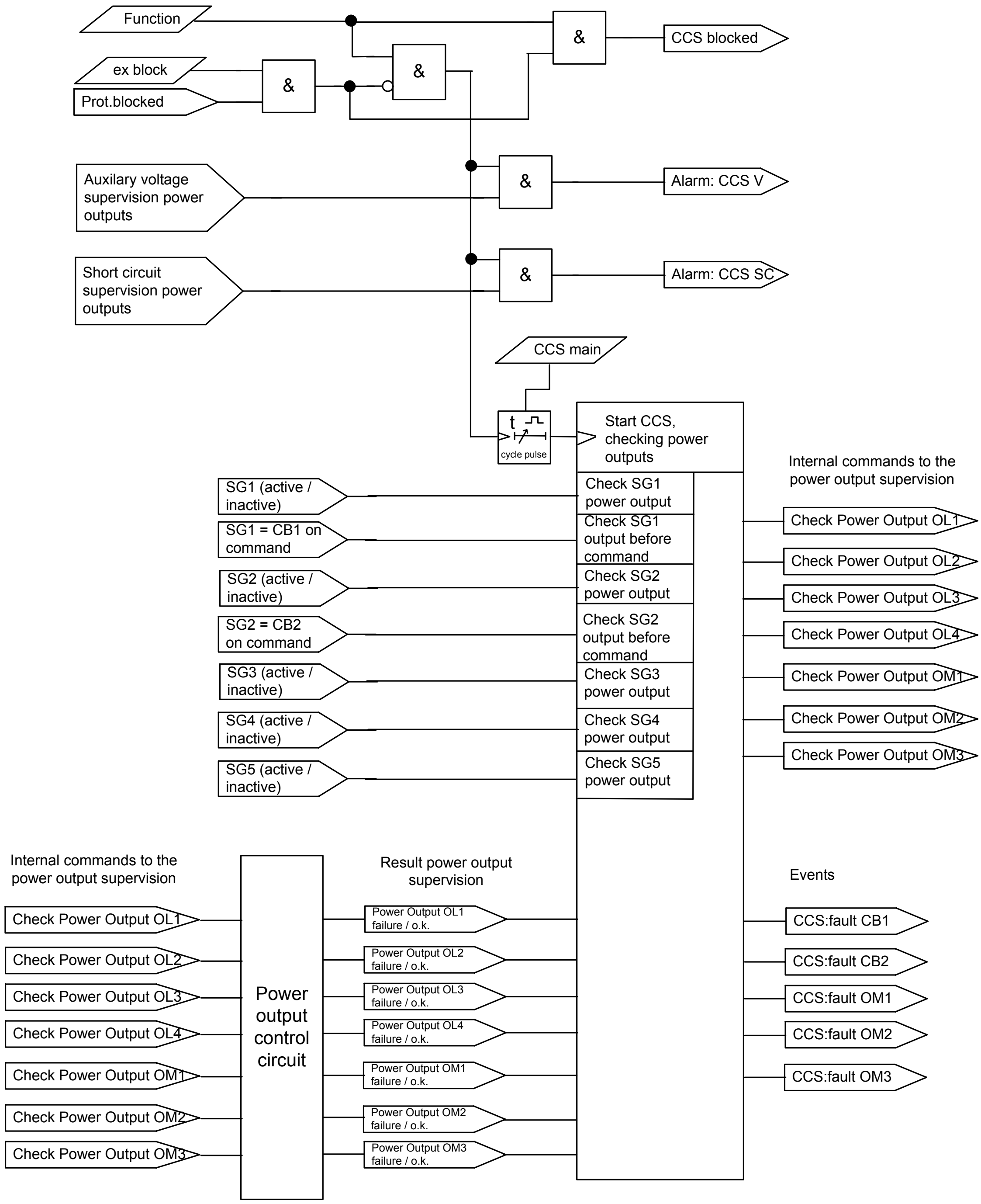


Figure 5.84: Block diagram of the control circuit supervision (CCS)

Parameters

„Function"
With the setting *"Function = active"* the *control circuit supervision (CCS)* is generally set into function. The *CCS* function can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *control circuit supervision (CCS)* which are set to *„ex block = aktive"* are blocked.

„CCS main"
In the *CCS* main test, all the control circuits are checked cyclically. With the parameter "CCS main " the time interval after which the main test is to be done is set.

„SGX"
Depending on the type of device and application (field configuration) of the *CSP2* device, a varying number of switchgears can be electrically controlled via the *CSP2* and thus monitored by the *CCS*. The parameters *"SG1"* to *"SG5"* can be used for separate setting of whether the *CCS* is to act on the individual control outputs or not.

Note

Of the parameters *"SG1"* to *"SG5"* only those which have been defined for electrically controllable switchgears are displayed as parameterizable.

Control Circuit Supervision (CCS)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active"	CCS is put into function		-	
	„inactive"	CCS is put out of function	„inactive"		
Ex Block	„active"	CCS function is ineffective when input function „Protect. Block." is active		-	
	„inactive"	CCS function is effective irrespectively of the input function "Protect. Block." state	„inactive"		
CCS main	3…200 h	Setting of the time interval for a cyclic CCS test of all control outputs	„6 h"	1 h	± 2min per h
SG1	„active"	CCS function checks the SG1 control output	„active"	-	
	„inactive"	CCS function does not check the SG1 control output			
SG2	„active"	CCS function checks the SG2 control output		-	
	„inactive"	CCS function does not check the SG2 control output	„inactive"		
SG3	„active"	CCS function checks the SG3 control output		-	
	„inactive"	CCS function does not check the SG3 control output	„inactive"		
SG4	„active"	CCS function checks the SG4 control output		-	
	„inactive"	CCS function does not check the SG4 control output	„inactive"		
SG5	„active"	CCS function checks the SG5 control output		-	
	„inactive"	CCS function does not check the SD5 control output	„inactive"		

Table 5.57: Setting parameters of the control circuit supervision (CCS)

5.7.3.13 Overexcitation protection U/f>, U/f>>

Description
Certain operational conditions can have an effect on transformers and generators and may cause an increase of voltage or decrease of frequency. An impermissible high induction is the result which can increase the iron losses up to saturation of the iron core (overexcitation).

$$B \sim \frac{U}{f}.$$

Due to these conditions it is possible that the *transformer temperature* rises to values able to damage the insulation of the transformer and which can reduce the service life considerably as a result; the magnetic flux also induces other components of the transformer and causes additional *eddy-current losses,* provoking the temperature to rise as well.

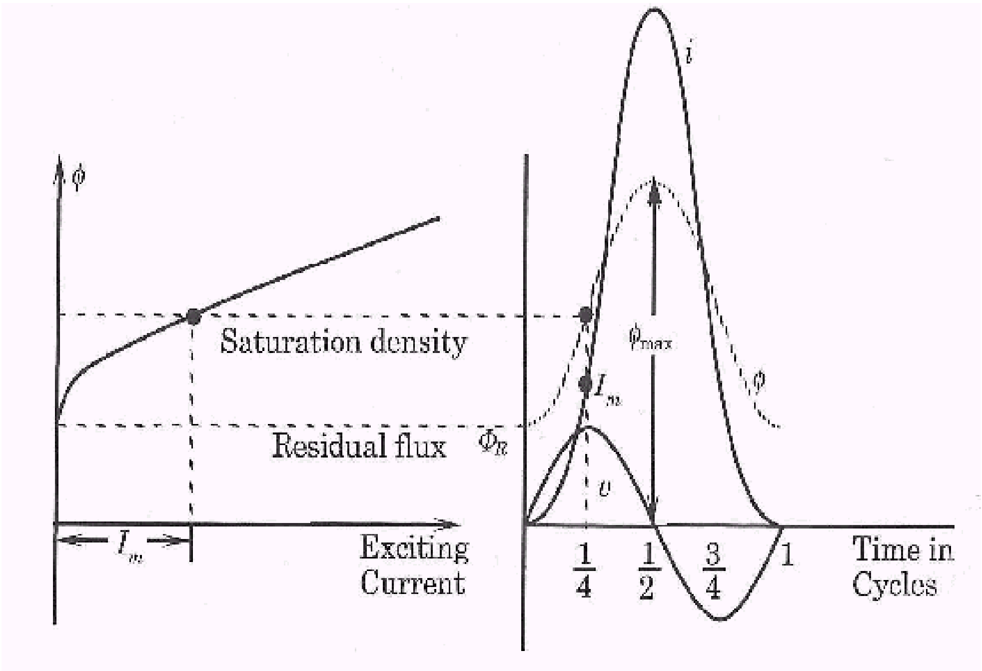


Figure 5.85: Diagram showing the overexcitation protective function U/f>, U/f>>

Overexcitation *operation* of transformers with the effects shown above can, for instance, occur:

- load sheding
- when *transformers are connected in parallel* (transient processes) or
- with *unit-connected transformers* (one winding end at the generator, the other disconnected from the mains; or during an impaired start-up of a generator-/transformer set)

Note

Additional harmonic contents of the 5th harmonic in the differential currents of the components are generated by saturation *of the transformers*. In the ***CSP2-T*** the 5^{th} harmonic is evaluated and can be displayed through the data acquisition.

A *two-step overflux protection* is incorporated in the ***CSP2-T*** with a definite maximum time (DMT) property.

Functional block diagram
The functional correlation between data acquisition, parameters and the subsequent output of messages and the trip command are shown on the functional block diagram below.

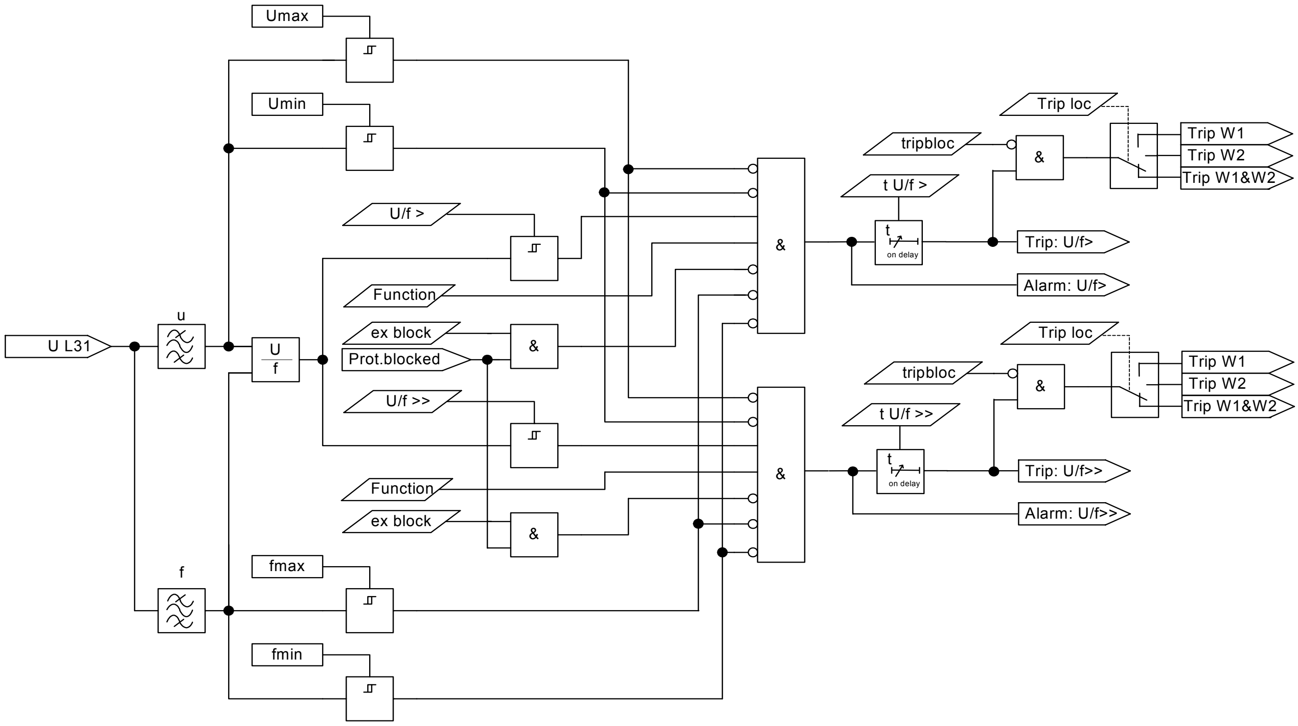


Figure 5.86: Functional block diagram showing the overflux protective function U/f>, U/f>>

Important

- By taking into account the VT location (parameter *VTLocation;* see chapter "Field Parameters"), the used voltage measuring values are the criteria for the function *overflux protection U/f>, U/f>>*. Based on the *winding ends W1 and* W2 and the *circuit breakers CB1and CB2,* there are four different options for placing the VT in the ***CSP2-T***. (Parameter *„meas. loc";* see Chapter *„Trip operating"*).
- With regard to the function *overflux protection U/f>, U/f>>*, the trip command can be issued either to both CTs (at W1 & W2) or optionally to one CB only (at W1 or W2) of the two winding ends. (Parameter *„Triploc"*; see Chapter *„Trip operating"*).

Parameters

„Function"
The respective step of the *overflux protection* is generally activated with the setting *„Function active"*. But the protective step can only become *active* if it is *not blocked*.

„ex block"
This parameter is only effective together with the digital input function *"Protection blocked"*. If the protective parameter *"ex block = active"* is set and the digital input function is activated, the *overexcitation protection function* is blocked.

„Tripbloc " (Blocking the circuit breaker OFF command)
Here only the "OFF" command for the CB is blocked. The messages *"Trip XY"* and *"General Trip*" are, however, generated after the tripping delay time has elapsed. These messages are available as output functions for the LED indication , for processing via signal relay or as signals (data points) for communication with the control system. The trip blocking function can be used, for example, as directional detection but without OFF command to the CB (indication only).

„Threshold value " (e.g. „U/f>")
There are two steps (U/> and U/f>>) available for the *overflux protection* with separate adjustable operating delay. The adjustments in terms of percentage are based on the ratio between the rated transformer voltage and rated frequency (for setting parameter for *Un* and *fn* see chapter „Field Parameters").

„Tripping delay" (e.g. „t U/f>")
When the threshold value of at least one phase is exceeded and after elapse of the related time delay, the trip function is activated or a message issued.

Overexcitation Protection U/f> *(1st step)*				
Parameters	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*StepRange*
Function	„active"	U/f>-step is activated		-
	„inactive"	U/f>-step is de-activated	„inactive"	
ex block	„active"	U/f>-step is ineffective when the input function „Protect.Block" is active		-
	„inactive"	U/f>-step is effective irrespectively of the state of the input function „Protect.Block."	„inactive"	
Tripbloc	„active"	OFF command to the local CB is blocked		-
	„inactive"	OFF command to the local CB is issued	„inactive"	
U/f>	100...150 %	Threshold value of the 1st overflux step, based on the Un/fn [%] ratio	105 %	0.1 %
t U/f>	30...300000 ms	Tripping delay time	„100 ms"	1 ms
Overexcitation Protection U/f>> *(2nd step)*				
Function	„active"	U/f>>-step is activated		-
	„inactive"	U/f>>-step is de-activated	„inactive"	
ex block	„active"	U/f>>-step is ineffective when the input function „Protect.Block." is active		-
	„inactive"	U/f>>-step is effective irrespectively of the state of the input function "Protect.Block."	„inactive"	
Tripbloc	„active"	OFF command to the local CB is blocked		-
	„inactive"	OFF command to the local CB is issued	„inactive"	
U/f>>	100...150 %	Threshold value of the 2nd overflux step, based on Un/fn [%] ratio	110 %	0.1 %
t U/f>>	30...300000 ms	Tripping delay time	„100 ms"	1 ms

Table 5.58: Parameter „Overexcitation Protection U/f>, U/F>>"

5.7.3.14 Over/under-frequency protection f1>/<, f2>/<, f3>/<, f4>/<

Description
The frequency measurement is based on a time measurement between the zero crossings of the recorded voltage functions of the first and third measurement channel (X5.5, X5.6). As a function of the voltage measurement circuit selected (Y-connection or Δ or V-connection), the recorded voltage is then either the phase voltage U_{L3} (Y-connection) or the line to line voltage U_{31} (Δ or V-connection). The frequency is calculated on base of the period interval. In order to suppress transient disturbances and fluctuations in the display, the frequency measurement is carried out with a quadruple measurement repetition.
The frequency protection has been designed four-staged, and each stage can be set as an under-frequency or over-frequency stage.

Block diagram
The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

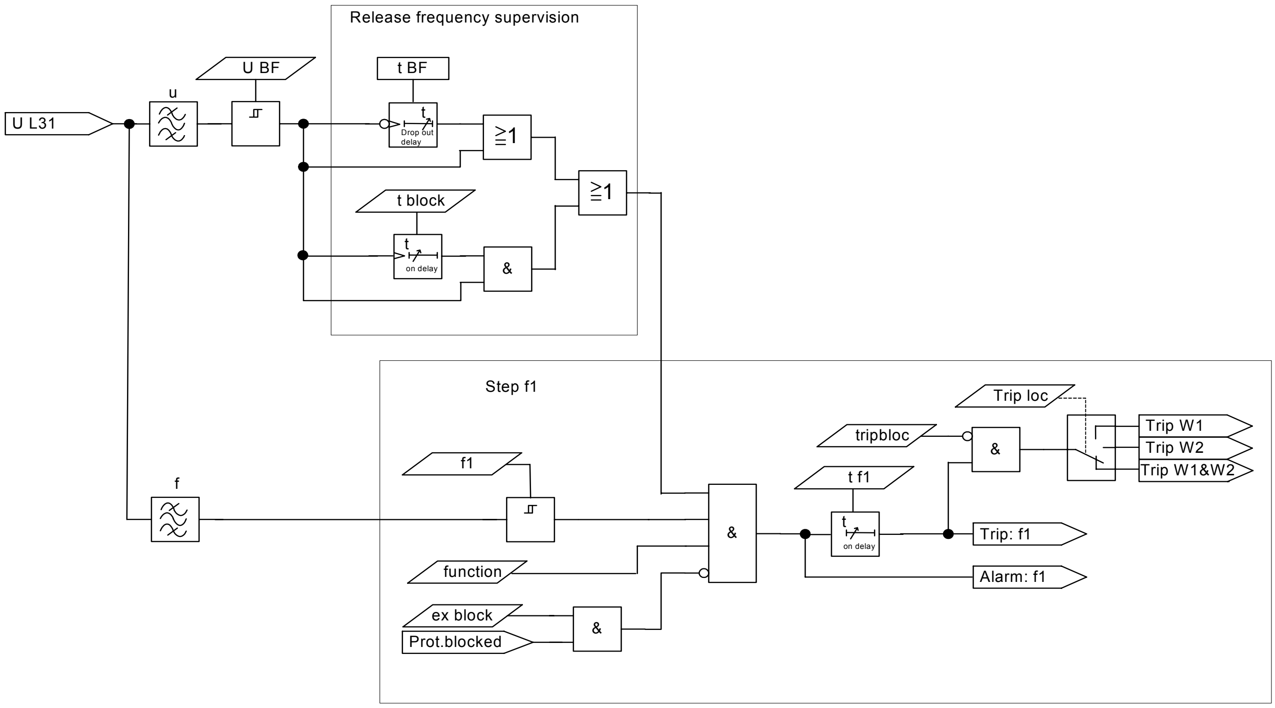


Figure 5.87: Block diagram of the frequency protection f1, f2, f3, f4

Important

- For the function *frequency protection* applies that a trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Loc“*; see Chapter „Trip operating“).

Parameters

"U BF" (measurement voltage threshold to the blockade of the frequency protection)
As the determination of the existing mains frequency results from the measurement of the mains voltage, it may not exceed a threshold, as otherwise no unambiguous frequency determination is guaranteed and this can lead to faulty trips (e.g. when starting a generator). This threshold is set via the parameter "*U BF*". So if this threshold is fallen short of in one of the phases L1, L2 or L3 or if one (or more) phases fail, the frequency protection is blocked (ineffective) as a function of the parameters "*U BF*" and "*t BF*".

"t BF" (blockade delay time of the frequency protection)
If a measurement voltage drops below the threshold defined by *"U BF"*, the frequency protection is only blocked after the expiry of a blockade delay time *t BF* (ineffective).
The blockade delay time *t BF* must be faster than the activation time of the frequency protection. For this reason, the parameter *"t BF"* is fixed at 50 ms and cannot be altered.

"t block" (blockade persistence duration of the frequency protection)
The blockade persistence period states how long the frequency stages are to be blocked after the measurement voltage has been switched (mains recovering time). In this way, a pre-activation of the frequency protection after switching the measurement voltage is to be prevented. However, this period is only started when all three measurement voltages exceed the threshold *U BF*.

Note

The settings of the parameters:

- *„U BF"*: measurement voltage threshold for blocking the frequency protection
- *„t BF"*: delay time until the blockade of the frequency protection and
- *„t block"*: blockade persistence period of the frequency protection

apply for all four stages of the frequency protection together!

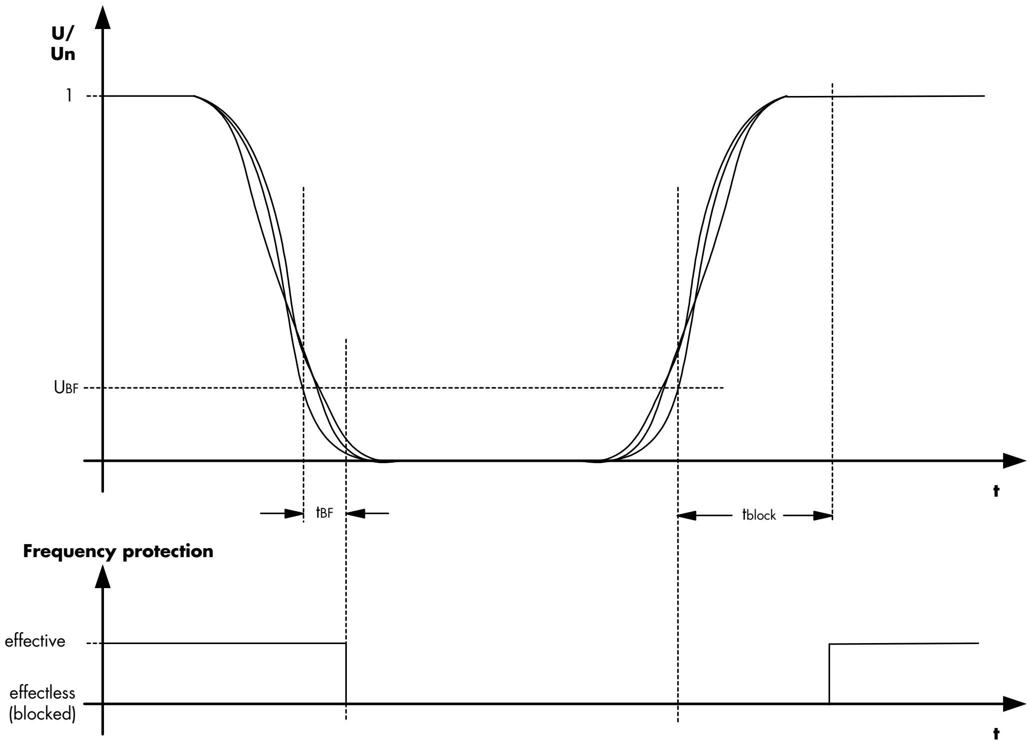


Figure 5.88: Blocking of the frequency protection

„Function"
With the setting *"Function = active"* the corresponding *stage of the frequency protection* is generally set into function. The protection stage can however only be effective if it is not blocked.

„ex block“
This parameter can only become effective in cooperation with the digital input function „Prot. blocked“. With an active status of this input function, the levels of the *frequency protection* which are set to *„ex block = aktive“* are blocked.

„tripbloc“ (blockage of the OFF command for the circuit breaker)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the trip delay, a “Trip: XY” signal and the signal "General Trip" are nevertheless generated and are available for the communication to SCADA as output messages of the LED display, the further processing via signal relays or as messages (data points).

Threshold of the protection stage (e.g. "f1“)
Four protection stages (switching points) are available for the frequency protection. Each stage can be set either as an *over-frequency (f>)* or *under-frequency supervision (f<)*. Whether a level acts as *f>* or as *f<* depends on whether the set value is above or below the selected nominal frequency *fn*. For this, the nominal frequency must be set in the "DATA\Parameter\Field settings" pre-settings: *"fn“*. A separate delay time exists for all the stages.
In order to avoid false tripping and false interpretations of the frequency stages, no values can be set in a blocked area ranging to ±0.2% of f_N.

Tripping delay time of the protective stage (e.g. "t f1“)
A separate trip delay time can be set for each of the four protection stages. This parameter determines the trip delay of the protection stage through setting a defined time.

Frequency protection *(Common parameters for all stages)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
U BF	0.1…1 x Un	Lower threshold value of the measuring voltage for blocking the frequency protection	0.1 x Un	0.001 x Un	±1% of the adjustment value or 0.5% U_N
t BF	50 ms	Delay time for blocking the frequency protection	Fixed	-	
t block	100… 20,000 ms	Persistance duration for blocking the frequency protection	2000 ms		±1% of the adjustment value or ±20 ms
Frequency Protection – 1st stage					
Function	„active“	1st frequency stage is put into function		-	
	„inactive“	1st frequency stage is put out of function	„inactive“		
ex block	„active“	Function of 1st frequency stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Function of 1st frequency stage is effective irrespectively of the input function „Protect. Block.“ state	„inactive“		
tripbloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
f1	40…70 Hz	Pick-up value of the 1st frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	51 Hz	0.01 Hz	< 0.05 of rated f_N
t f1	100… 300,000 ms	Trip time delay of the 1st frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 ms
Frequency Protection – 2nd stage					
Function	„active“	2nd frequency stage is put into function		-	
	„inactive“	2nd frequency stage is put out of function	„inactive“		
ex block	„active“	Function of 2nd frequency stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Function of 2nd frequency stage is effective irrespectively of the input function „Protect. Block.“ state	„inactive“		
tripbloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
f2	40…70 Hz	Pick-up value of the 2nd frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	52 Hz	0.001 Hz	< 0.05 of rated f_N
t f2	100… 300,000 ms	Trip time delay of the 2nd frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m
Frequency Protection – 3rd stage					
Function	„active“	3rd frequency stage is put into function		-	
	„inactive“	3rd frequency stage is put out of function	„inactive“		
ex block	„active“	Function of 3rd frequency stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Function of 3rd frequency stage is effective irrespectively of the DI „Protect. Block.“ state	„inactive“		
tripbloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		

f3	40…70 Hz	Pick-up value of the 3rd frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	49 Hz	0.001 Hz	< 0.05 of rated f_N
t f3	100… 300,000 ms	Trip time delay of the 3rd frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m
		Frequency Protection – 4th stage			
Function	„active"	4th frequency stage is put into function		-	
	„inactive"	4th frequency stage is put out of function	„inactive"		
ex block	„active"	Function of 4th frequency stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	Function of 4th frequency stage is effective irrespectively of the input function „Protect. Block." state	„inactive"		
tripbloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
f4	40…70 Hz	Pick-up value of the 4th frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	48 Hz	0.001 Hz	< 0.05 of rated f_N
t f4	100… 300,000 ms	Trip time delay of the 4th frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m

Table 5.59: Setting parameters for frequency protection (over-/under-frequency)

5.7.3.15 Overvoltage protection U>, U>> / undervoltage protection U<, U<<

Description
The voltage protection functions in the *CSP2*, which are phase selective, are designed as *two-stage overvoltage- and undervoltage protection*. If the *CSP2* system is connected to a four-wire system with star point, the line conductor or phase voltages can optionally be set as threshold for the voltage protection. If the voltage measurement circuits of the *CSP2* are switched in delta connection, only the line conductor voltage can be evaluated in the protection.

The effectiveness of the *undervoltage protection function U<, U<<* depends on

- the *measuring location of the voltage transformers(VT) (Parameter: „VT Loc“: “W1 Busb.”, “W1 Tr”, „W2 Busb.“ or „W2 Tr“),*
- the *circuit breaker positions* and
- the *voltage available at the bus bars of the two winding ends ($U_{W1\ BB}$ and $U_{W2\ BB}$)*
- the *input function „U<, U<< Block*“ together with the parameter of the undervoltage steps*„block U“*.

The t*able* below shows the *effectiveness* or *ineffectiveness of the undervoltage protection* when voltage is available at the bus bar *(BB)* of winding end 1 *(W1)*.
The discreminating criteria are:

Effectiveness Undervoltage Protection U<, U<<							
Parameters	*Setting*	*CB1 Position*	*CB2 Position*	*$U_{W2\ BB}$ not available (e.g. outgoing transf. feeder panel)*		*$U_{W2\ BB}$ available (e.g.coupling transformer panel)*	
				U<, U<< effective	*U<, U<< inefecctive*	*U<, U<< effective*	*U<, U<< ineffective*
VT Loc	“W1 Busb.”	OFF	OFF	•	-	•	-
		ON	OFF	•	-	•	-
		OFF	ON	•	-	•	-
		ON	ON	•	-	•	-
	“W1 Tr”	OFF	OFF	-	•	-	•
		ON	OFF	•	-	•	-
		OFF	ON	-	•	•	-
		ON	ON	•	-	•	-
	“W2 Tr”	OFF	OFF	-	•	-	•
		ON	OFF	•	-	•	-
		OFF	ON	-	•	•	-
		ON	ON	•	-	•	-
	“W2 Busb.”	OFF	OFF	-	•	•	-
		ON	OFF	-	•	•	-
		OFF	ON	-	•	•	-
		ON	ON	•	-	•	-

Table 5.60: Effectiveness of the undervoltage protection

Block diagram
The block diagram shown below represents the functional correlation between data acquisition, parameters and the subsequent issue of messages and the OFF command.

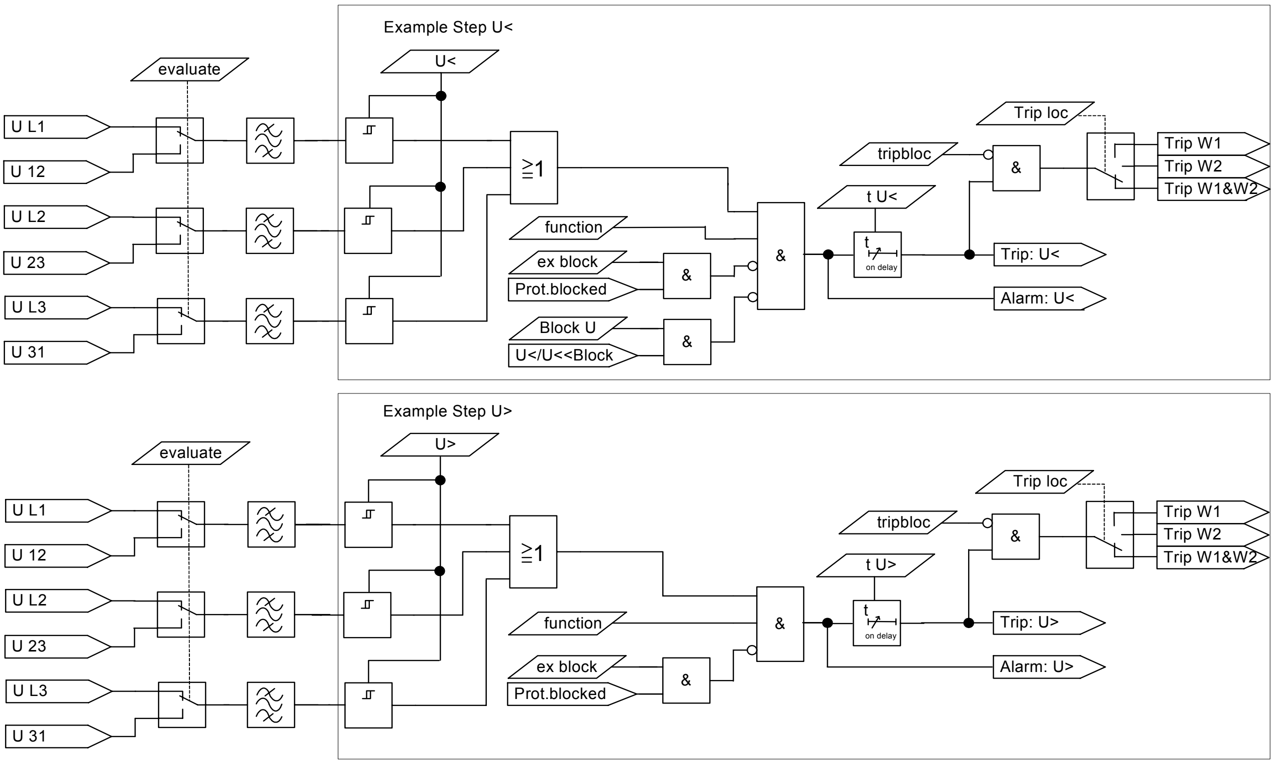


Figure 5.89: Block diagram of the overvoltage and undervoltage protection U>, U>>, U<, U<<

Important

- The used voltage measuring values for the *overvoltage/undervoltage protection functions U>, U>>, U< and U<<* can be measured either at the *winding end W1* or *W2*. (Parameter *„VT Loc“*; see Chapter „Field Parameters“).
- For the *overvoltage/undervoltage protection functions U>, U>>, U< and U<<* applies that the trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Loc“*; see Chapter „Trip operating“).

Parameters

"Evaluate" (selection of the voltage protection criterion)
As a function of the *kind of voltage measurement circuit (Y, Δ or V-connection)* the line conductor or the phase voltage can be selected as a protection criterion for both the *over-voltage* as also for the *under-voltage protection*. The *pick-up values* of the individual protection stages are adjusted as relative values, related to the *rated quantity Un*. Dependent on the setting of parameter "*evaluate*", the *rated quantity Un* is either defined as *line conductor "voltage LL" (line-to-line voltage)* or *phase "voltage LN"*.

Settings:
„Voltage LN": The pick-up value is related to the phase voltages. In this case the factor to be adjusted is also put in without considering factor *„√3"*.

„Voltage LL": The *pick-up value* is related to the *line-to-line voltages*. In this case the factor to be adjusted is also put in without considering factor *„√3"* .

„Function"
With the setting *"Function = active"* the corresponding *stage of the voltage protection functions* is generally set into function. The protection stage can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *voltage protection* which are set to *„ex block = active"* are blocked.

„tripbloc" (blockage of the OFF command for the circuit breaker)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay, a "Trip XY" signal and the signal "General trip" are nevertheless generated and are available for the communication to SCADA as output messages of the LED display, the further processing via report relays or as reports (data points).

„block U"
This parameter can only become effective together with the *input function „U<, U<< Block"* which can be activated via a digital input or a programmable logic function. When the input function „U<, U<< Block" is active then those steps of the undervoltage protection function are blocked with parameter setting *„block U = active"*.

„Pick-Up Value" (e.g. „U>")
Two stages (U>/U>>, U</U<<) with separately set tripping delays are available for each of the over and under-voltage protection.

„Tripping delay time" (e.g. „t U>")
If a threshold is exceeded in at least one phase and after the expiry of the tripping delay, the trip or signal takes place.

Remark on the voltage monitoring

The kind of connection of the voltage transformers is selected in the "Field settings parameter *"VT con"* menu. Depending on the measuring circuit, a selection can be made between star, delta, V-connection and no measurement (Voltage Measurement). The primary nominal voltage *"VT prim"* and the secondary nominal voltage *"VT sec"* are likewise set in the "Feeder ratings" menu.

Examples for setting of the threshold for voltage protection functions

Attention

All *adjustable thresholds U<, U<<, U> and U>>* of the voltage protection functions are related to the adjustments of the parameter "*Measurement*" in the menus "Overvoltage U> U>>" and "Overvoltage U< U<<"!

1st Measuring of the voltage in *star connection (Y):*

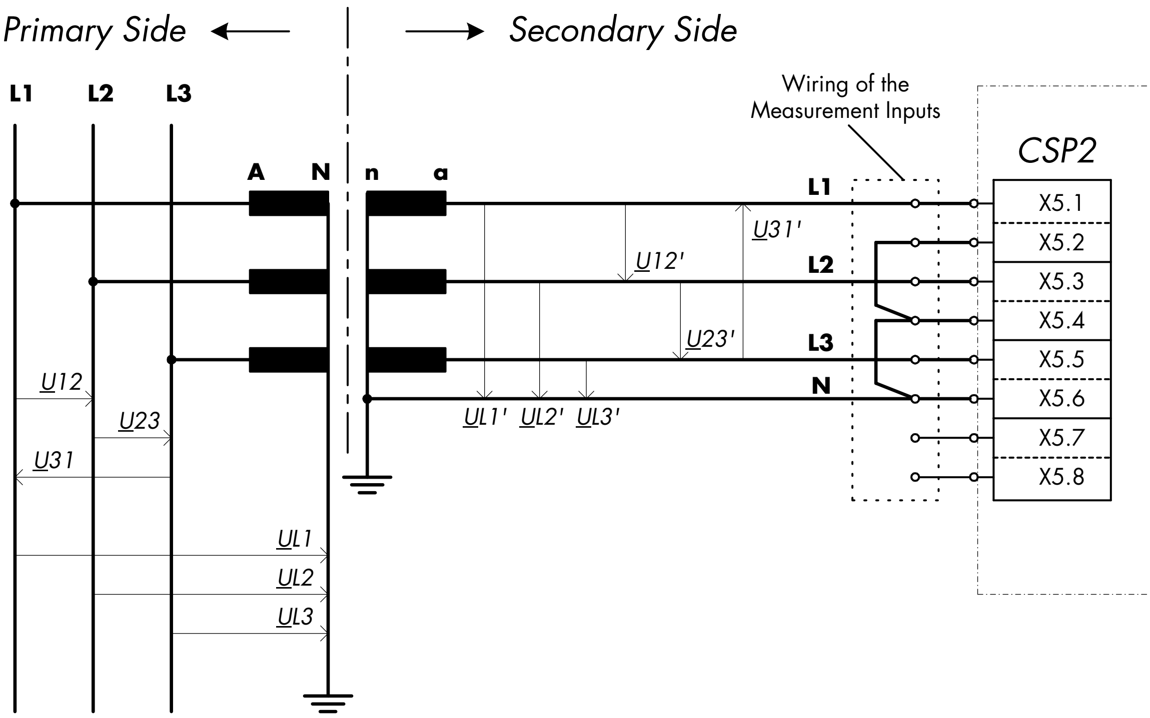


Figure 5.90: Star Connection („Y")

Example I : If the *default setting of the pick up refers to line-to-line-voltage ULL* I
Field parameter: *„VT con = Y"* (Star connection: Measuring of the line-to-line voltages)
"VT prim = 6000 V" (primary line-to-line voltage)
„VT sec = 100 V" (secondary line-to-line voltage)
Protect.parameter: *„Measuring = Voltage LL"* (Un = *VT sec*)

The *pick-up value* for the first stage of the *undervoltage protection function U<* is to be set to *50%* of the *line-to-line voltage ULL!*

⇒ Setting of the pick-up value: *„U< = 0.5 x Un"*

Example 2: If the *default setting of the pick-up value refers to the phase voltage ULN*
Field parameter: *„VT con = Y"* (Star connection: Measuring of the phase voltages)
„VT prim = 6000 V" (primary phase voltage)
„VT sec = 100 V" (secondary phase voltage)
Protect.parameter: *„Measuring = Voltage LN"* (Un = VT sec/√3)

The *pick-up value* for the first stage of the *undervoltage protection function U<* is to be set to *50%* of the phase voltage *ULN !*

⇒ Setting of the pick-up value: *„U< = 0,5 x Un"*

2nd Measuring of the voltage in delta connection *(Δ):*

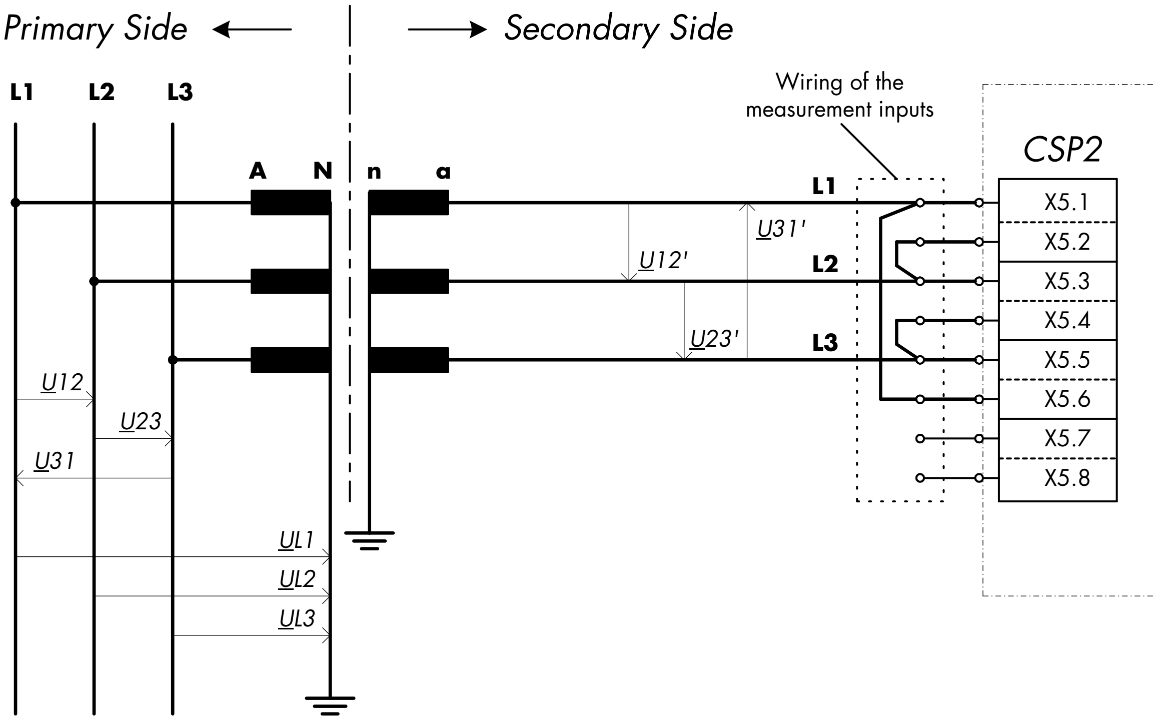


Figure 5.91: Delta connection („Δ")

Example: If the *default setting of the pick-up value refers to line-to-line-voltage ULL*

Field parameter: *„VT Treatm. = Δ"* (Delta connection: Measuring of the line-to-line voltages)
"VT prim. = 6000 V" (primary line-to-line voltag)
„VT sec = 100 V" (secondary line-to-line voltage)

Protect.parameter: *„Measuring = Voltage LL"* (Un = *VT sec*)

The *pick-up value* for the first stage of the *undervoltage protection function U<* is to be set to *50%* of the *line-to-line voltage ULL!*

⇒ Setting of the pick-up value: *„U< = 0.5 x Un"*

Note

The setting *„Measuring = Voltage LN"* is not permitted in *delta connection* because in this connection only line-to-line voltages can be measured!

Overvoltage protection U> (1st stage)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
evaluate (Measuring)	Inactive	No voltage measuring			
	Voltage LN	Measuring of the phase voltages	„Measuring LL"		
	Voltage LL	Measuring of the line-to-line voltages			
Function	„active"	U> stage is put into function		-	
	„inactive"	U> stage is put out of function	„inactive"		
ex block	„active"	U> stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	U> stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
U>	0.01…2 x Un	Pick-up value of the 1st overvoltage stage related to the rated voltage Disengaging ratio 97% of the adjustment value or 0.5%xUn	„1.1 x Un"	0.001 x Un	±2% of the adjustment value or 1.5% U_N
t U>	30...300,000 ms	Trip time delay	„200 ms"	1 ms	±1% of the adjustment value or ±20 ms
Overvoltage protection U>> *(2nd stage)*					
Function	„active"	U>> stage is put into function		-	
	„inactive"	U>> stage is put out of function	„inactive"		
ex block	„active"	U>> stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	U>> stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
U>>	0.01…2 x Un	Pick-up value of the 2nd overvoltage stage related to the rated voltage Disengaging ratio 97% of the adjustment value or 0.5%xUn	„1.2 x Un"	0.001 x Un	±2% of the adjustment value or 1.5% U_N
t U>>	30...300,000 ms	Trip time delay	„100 ms"	1 ms	±1% of the adjustment value or ±20 ms

Table 5.61: Setting parameters for overvoltage protection

Undervoltage protection U< *(1st step)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
evaluate (Measur-ing)	Inactive	No voltage measuring	„Measuring LL“		
	Voltage LN	Measuring of the phase voltages			
	Voltage LL	Measuring of the line-to-line voltages			
Function	„active“	U< stage is put into function		-	
	„inactive“	U< stage is put out of function	„inactive“		
ex block	„active“	U< stage is ineffective when the input function „Protect. Block.“ Is active		-	
	„inactive“	U< stage is effective irrespectively of the input function “Protect. Block” state	„inactive“		
tripbloc	„active“	Trip blocked, all events will be coming, but no CB will be excited		-	
	„inactive“		„inactive“		
block U	„active“	Blocking via input function (from the SG pos.)			
	„inactive“		„inactive“		
U<	0.01…2 x Un	Pick-up value of the 1st undervoltage stage related to the rated voltage Disengaging ratio 103% of the adjustment value or 0.5%xUn	„0.9 x Un“	0.001 x Un	±2% of the adjustment value or 1.5% U_N
t U<	30…300000 ms	Trip time delay	„200 ms“	1 ms	±1% of the adjustment value or ±20 ms

Undervoltage Protection U<< *(2nd step)*					
Function	„active“	U<< stage is put into function		-	
	„inactive“	U<< stage is put out of function	„inactive“		
ex block	„active“	U<< stage is ineffective when the input function „Protect. Block.“ is active		-	
	„inactive“	U<< stage is effective irrespectively of the input function “Protect. Block” state	„inactive“		
tripbloc	„active“	Off command to the local CB is being blocked		-	
	„inactive“	Off command to the local CB is being issued	„inactive“		
U<<	0.1…2 x Un	Pick-up value of the 2nd undervoltage stage related to the rated voltage Disengaging ratio 103% of the adjustment value or 0.5%xUn	„0.8 x Un“	0.001 x Un	±2% of the adjustment value or 1.5% U_N
t U<<	30…300000 ms	Trip time delay	„100 ms“	1 ms	±1% of the adjustment value or ±20 ms

Table 5.62: Setting parameters for undervoltage protection

5.7.3.16 Residual voltage monitoring Ue>, Ue>>

Description

The residual voltage *Ue* (also called star-point voltage) is a measure for the displacement of the star point from its normal position in a symmetrical system (earth potential). In *isolated mains* the residual voltage is a variable for recognition of shorts to earth. Although a defined star point does not physically exist in such a system, this "fictitious" point can be monitored. The residual voltage determined is compared with the set threshold. The function is two-staged.

Important

- For the *protection function residual voltage supervision Ue>, Ue>>* applies that the trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Loc"*; see Chapter „Trip operation").

Block diagram

The block diagram shown below represents the functional correlation between measurement , parameters and the subsequent issue of messages and the trip command.

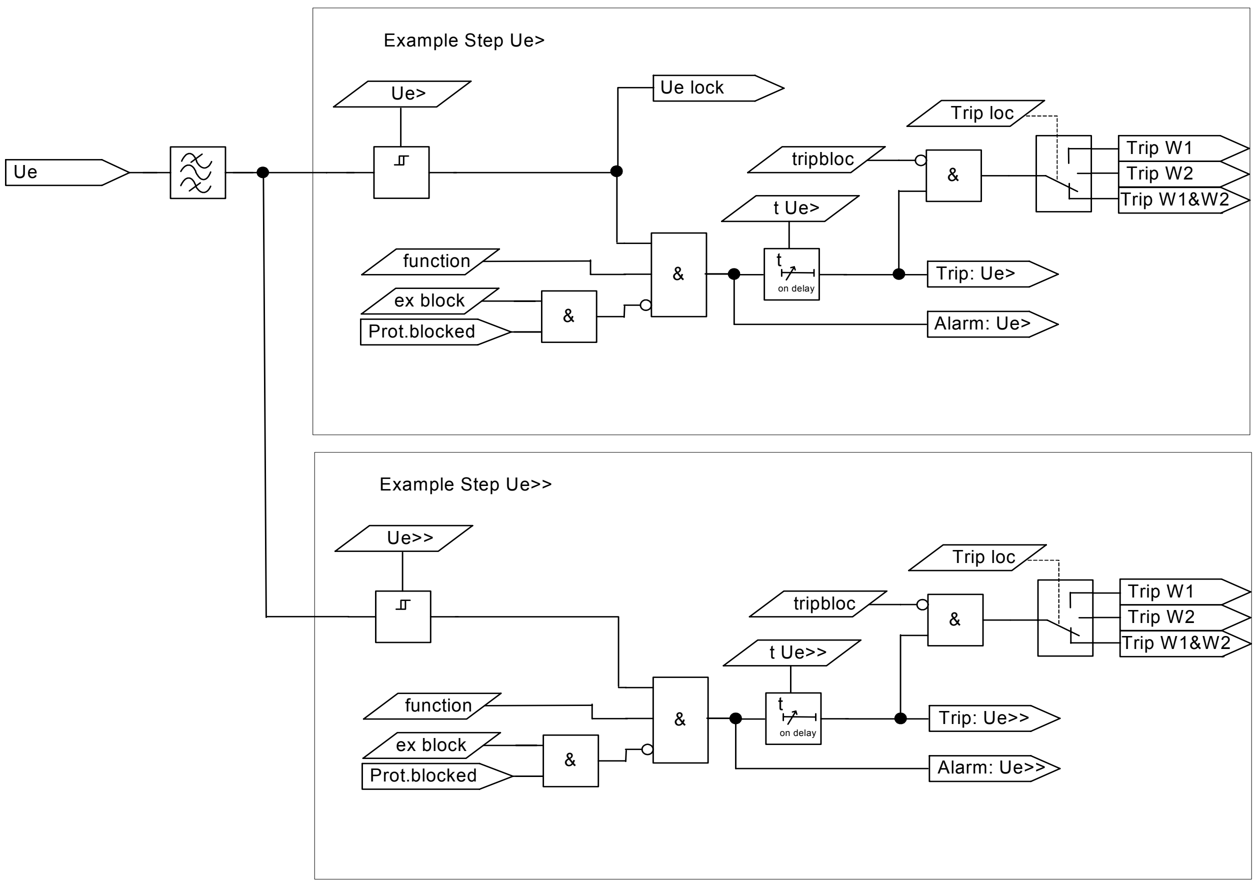


Figure 5.92: Block diagram residual voltage supervision Ue>, Ue>>

Parameters

„Function"
With the setting *"Function = active"* the corresponding *stage of the residual voltage protection functions* is generally set into function. The protection level can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *residual voltage protection* which are set to *„ex block = aktive"* are blocked.

"tripbloc" (blockage of the OFF command for the circuit breaker)
Only the switch-off command to the circuit breaker is blocked. After the expiry of the tripping delay time, a "trip XY" signal and the signal "General trip" are nevertheless generated and are available for the communication to SCADA as output messages of the LED display, the further processing via signal relays or as messages (data points).

Residual voltage threshold of the protection stage (e.g. „Ue>")
For the residual voltage supervision, two stages *(UE>, UE>>)* with separately set delay times are available. If the set value is exceeded *(e.g. "Ue>")* the protection stage is activated.

Trip delay of the protection stage (e.g. „t Ue>")
After the expiry of the set delay time *(e.g. "t Ue>")* a trip command is issued to the circuit breaker. The residual voltage supervision is however merely used as a warning as a rule and is not planned for the tripping of the circuit breaker. Separate settings are possible for both stages.

Residual voltage supervision: Ue> *(1st stage)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	Ue> stage is put into function		-	
	„inactive“	Ue> stage is put out of function	„inactive“		
ex block	„active“	Ue> stage is ineffective when the input function „Protect. Block.“ is active		-	
	„inactive“	Ue> stage is effective irrespectively of the input function “Protect. Block” state	„inactive“		
tripbloc	„active“	Off command to the local CB is being blocked		-	
	„inactive“	Off command to the local CB is being issued	„inactive“		
Ue>	0.01...2 x Un	Pick-up value of the residual voltage related to its rated value which is defined by the rated field data Disengaging ratio 97% of the adjustment value or 0.5%xUn	0.1 x Un	0.001	±2% of the adjustment value or 0.5% U_N
t Ue>	30 ...300,000 ms	Trip time delay	200 ms	1 ms	±1% of the adjustment value or ±20 ms
Residual voltage supervision: Ue>> *(2nd stage)*					
Function	„active“	Ue>> stage is put into function		-	
	„inactive“	Ue>> stage is put out of function	„inactive“		
ex block	„active“	Ue>> stage is ineffective when the input function „Protect. Block.“ is active		-	
	„inactive“	Ue>> stage is effective irrespectively of the input function “Protect. Block” state	„inactive“		
tripbloc	„active“	Off command to the local CB is being blocked		-	
	„inactive“	Off command to the local CB is being issued	„inactive“		
Ue>>	0.01...2 x Un	Pick-up value of the residual voltage related to its rated value which is defined by the rated field data Disengaging ratio 97% of the adjustment value or 0.5%xUn	0.2 x Un	0.001	±2% of the adjustment value or 0.5% U_N
t Ue>>	30 ...300,000 ms	Trip time delay	100 ms	1 ms	±1% of the adjustment value or ±20 ms

Table 5.63: Setting parameters for residual voltage

5.7.3.17 Voltage transformer supervision (VTS)

Description

Faults on the secondary side circuit of voltage transformers (e.g. wire break to the secondary or e-n winding of a voltage transformer or MCB trip of a voltage transformer or fuse etc.) cause faults in the protective functions, in which the voltage is used as an (additional) decision criterion for a tripping of the circuit breaker. For this reason, a supervision of the voltage transformer circuits has been integrated in the *CSP2-F*, in order to give alarm messages *"General Alarm"* and e.g *"Alarm: VTS")* under the above mentioned circumstances and, if parameterized, to switch the circuit breaker off and to block *affected active protection functions*.

Blockage of concerned effective protection functions

Phase-selective protection functions in which the failure of a phase would lead to a faulty tripping of the circuit breaker are blocked in activating of the voltage transformer supervision function (*VTS*). In the *CSP2-F*, this applies to the under-voltage protection (*U<, U<<*) as well as the frequency protection, as the frequency protection results from the measurement of voltage.
In protection functions which make use of the voltage as a decision criterion, but in which the failure of only one phase does not impair the function, there is no blocking. This applies e.g. for over current time protection with directional feature, earth over current time protection with directional feature, as the direction decision in the event of a fault is done via the phase voltages still in existence, from which the necessary reference variables are determined, when the *VTS* is activated (e.g. over current).
Protective functions which generally only trip when a threshold is exceeded are also not blocked. This applies e.g. for power and reverse power protection, over voltage protection, residual voltage protection and over-frequency protection.

Preconditions and operating principle

The *voltage transformer supervision (VTS)* compares the *measured residual voltage Ue* from the e-n coil with the *calculated residual voltage Ue* from the three phase voltages measured directly. However, the *following prerequisites* must be fulfilled for this:

- Measurement connection for phase voltages: in star connection (field parameter: *„VTcon = Y")*
- Measurement connection for residual voltage: open delta connection (field parameter: *„EVTcon = open Δ"*)

If a difference of

- more than 30 % between the p*hase voltages UL1, UL2 and UL3* or
- 10 % *√3 between the *calculated and measured residual voltage Uen*
  is detected, it is assumed that this is caused either by a *fuse failure* or a *line interruption*.

Limitations with regard to the use of the voltage transformer monitoring (FF)

- cannot be used for voltage transformers with primary high-voltage fuses.
- cannot be used if no e-n coil is connected, as then no comparison between measured and calculated residual voltage Ue is possible.
- in use of a three-poled MCB in the voltage measurement circuits. In this case, there cannot be a one-pole fuse trip, as all three phases are switched off at the same time due to the mechanical coupling and the complete measurement voltage drops to zero. The best thing possible is a conductor breakage supervision. For this, the auxiliary contact of the three-poled MCB can be connected directly to a *digital input* to the *CSP2*, in order to signalize the fuse trip. This digital input is then to be configured with the input function *"Fuse Fail VT"*.

Note

The input function *"Fuse Fail VT"* works independent of the internal protection function *"Voltage Transformer Supervision (VTS)"*!

Block diagram
The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

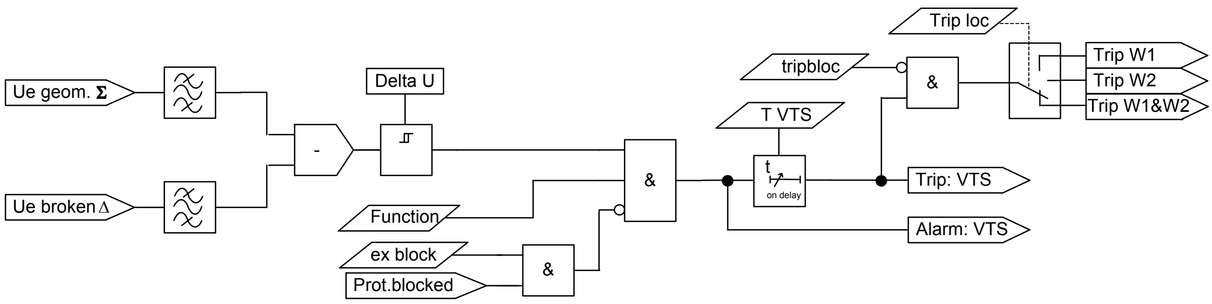


Figure 5.93: Block diagram of the voltage transformer supervision VTS

Important

- For the function *voltage transformer supervision (VTS)* applies that the trip command can be issued either to both of the CBs (at W1 & W2) or alternatively to only one of the two CBs (at W1 or W2) at the two winding ends. (Parameter *„Trip.Loc"*; see Chapter „Trip operation").

Parameters

„Function"
With the setting *"Function = active" the voltage transformer monitoring (FF)* is generally set into function. The CCS function can however only be effective if it is not blocked.

„ex block"
This parameter can only become effective in cooperation with the digital input function „Prot. blocked". With an active status of this input function, the levels of the *voltage transformer monitoring (FF)* which are set to *„ex block = aktive"* are blocked.

"tripbloc" (blockage of active protection functions)
In the parameterising *"tripbloc = active "* the switch-off command for the circuit breaker which would be issued after the expiry of the set tripping delay time *t FF* is blocked. Nevertheless, the "General trip" signal is generated and is available for the communication to SCADA as an output function of the LED display, the further processing via signal relays or as messages (data points).

"t VTS" (tripping delay time)
Via the parameter *"t VTS"*a delay time until the issue of an OFF command to the circuit breaker can be adjusted. Only after the expiry of the set trip delay time *"t VTS"* are the other effective protection functions concerned by the voltage measurement (under-voltage protection and frequency protection) blocked.

Voltage Transformer Supervision (VTS)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active"	VTS is put into function		-	
	„inactive"	VTS is put out of function	„inactive"		
ex block	„active"	VTS stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	VTS stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
t VTS	10…20,000 ms	Trip time delay	„200 ms"	1 ms	±1% of the adjustment value or ±20 ms

Table 5.64: Setting parameters for voltage transformer supervision

5.7.3.18 Circuit Breaker Failure (CBF) protection

Description

The protection and control system ***CSP2*** is provided with a separate circuit breaker failure protection CBF W1 and CBF W2 for each winding end of the transformer (W1 and W2).
The »current flow zero« principle is used as the criterion for a circuit breaker failure.
After a protection trip, the ***CSP2*** expects the current to have dropped below a set zero current threshold *"I CBF"* within the parameterized switch-off time *"t CBF"* for the power switch.
At the expiry of half of the set switch-off time *"t CBF"* the ***CSP2*** compares the measured current with the set zero-current threshold *"I CBF"*. If the current value is above the zero-current threshold at this time, a second OFF command is issued to the circuit breaker. After expiry of the complete switch-off time, the measured current is again compared with the zero-current threshold. If the measured current value is then again higher than the set zero-current threshold, the ***CSP2*** reports a *local circuit breaker failure* ("CBF alarm")! The protection therefore detects if a switch-off command to a local circuit breaker has not been performed correctly.

In order to protect the switchgear according, a command can now be given to the circuit breaker of the superior protection device (***CSP2***). For this, a signal relay with the output messages "CBF-Alarm" is to be assigned. The contact of this signal relay is then to be wired to a digital input (which is assigned to the input function "CB-failure"). If a circuit breaker failure of the local protective device is detected, the circuit breaker of the superior protection device is switched off without a delay via its digital input.
Accordingly a digital input for processing of an external circuit breaker failure signal from an inferior circuit breaker can be provided in the local ***CSP2***. In such a case, there is an undelayed trip command to the local circuit breaker from the local ***CSP2***.

Block diagram

The block diagram shown below represents the functional correlation between measurement, parameters and the subsequent issue of messages and the trip command.

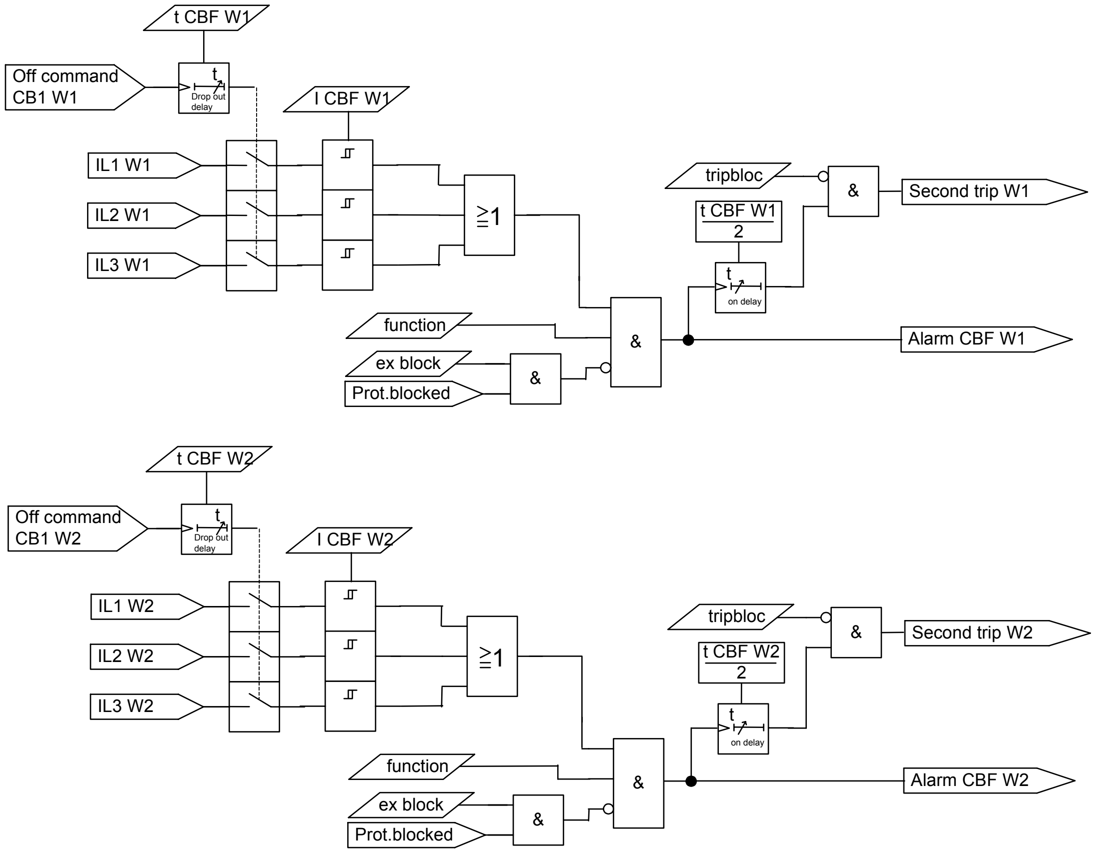


Figure 5.94: Block diagram Circuit Breaker Failure Protection CBF W1 and CBF W2

Parameters

„Function“
With the setting *"Function = active“* the *Circuit Breaker Failure (CBF)* is generally set into function. The protection stage can however only be effective if it is not blocked.

„ex block“
This parameter can only become effective in connection with a digital input onto which the input function *"Protection block."* has been assigned to. With an active status of this digital input, the levels of the protection functions which are set to *"ex Block = active“* are blocked!

"tripbloc“ (blockage of the OFF command for the circuit breaker)
The CBF-module reports the circuit breaker failure, but there is no second OFF command to the circuit breaker.

Switch-off time (e.g. „t CBF W1“)
If the current flowing through the CB is not below the zero current limit *(CBF W1) (or CBF W2) when this time has elapsed,* the message *“Alarm CBF W1” (or “Alarm CBF W2”)* is issued by the CSP2.

Note

The monitoring time “*t CBF*" should always be selected longer than twice the parameterable control time of the power switch:

!!! *t CBF* > 2 x *ts* !!!

In this way, a second trip impulse onto the circuit breaker is guaranteed!

Zero-current threshold (e.g. „I CBF W1“)
If the current falls below the set threshold *“I CBF“* within the time interval “*t CBF W1* (or *t CBF W2*) “ the ***CSP2*** detects a faultless trip of the circuit breaker.

***Circuit breaker failure protection** (CBF W1)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	CBF W1 is put into function		-	
	„inactive“	CBF W1 is put out of function	„inactive“		
ex block	„active“	CBF W1 is ineffective when the DI „Protect. Block.“ is active		-	
	„inactive“	CBF W1 is effective irrespectively of the DI “Protect. Block” state	„inactive“		
tripbloc	„active“	Second OFF command to the local CB1 is being blocked		-	
	„inactive“	Second Off command to the local CB1 is being issued	„inactive“		
t CBF W1	100…10000 ms	Time delay until alarm message „Alarm: CBF W1“ is issued	„200 ms“	1 ms	±1% of the adjustment value or ±20 ms
I CBF W1	0 … 0.1xIn	Threshold value for detection of the zero current when a CBF W1 occurs	0.0 x In	0.001 x In	±3% of the adjustment value bzw 1% I_N

***Circuit breaker failure protection** (CBF W2)*					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	CBF W2 is put into function		-	
	„inactive“	CBF W2 is put out of function	„inactive“		
ex block	„active“	CBF W2 is ineffective when the DI „Protect. Block.“ is active		-	
	„inactive“	CBF W2 is effective irrespectively of the DI “Protect. Block” state	„inactive“		
tripbloc	„active“	Second OFF command to the local CB2 is being blocked		-	
	„inactive“	Second Off command to the local CB2 is being is-sued	„inactive“		
t CBF W2	100…10000 ms	Time delay until alarm message „Alarm: CBF W2“ is issued	„200 ms“	1 ms	±1% of the adjustment value or ±20 ms
I CBF W2	0 … 0.1xIn	Threshold value for detection of the zero current when a CBF W2 occurs	0.0 x In	0.001 x In	±3% of the adjustment value bzw 1% I_N

Table 5.65: Setting parameters for the crcuit breaker failure protection

5.8 Service Menu

In the "Service" menu, important device data for the *CSP2/CMP1* system and revision data for the MV switchgears of the cubicle are displayed. These data entail:

- Date and time,
- Type of device and software version and
- Revision data for switchgears (counters).

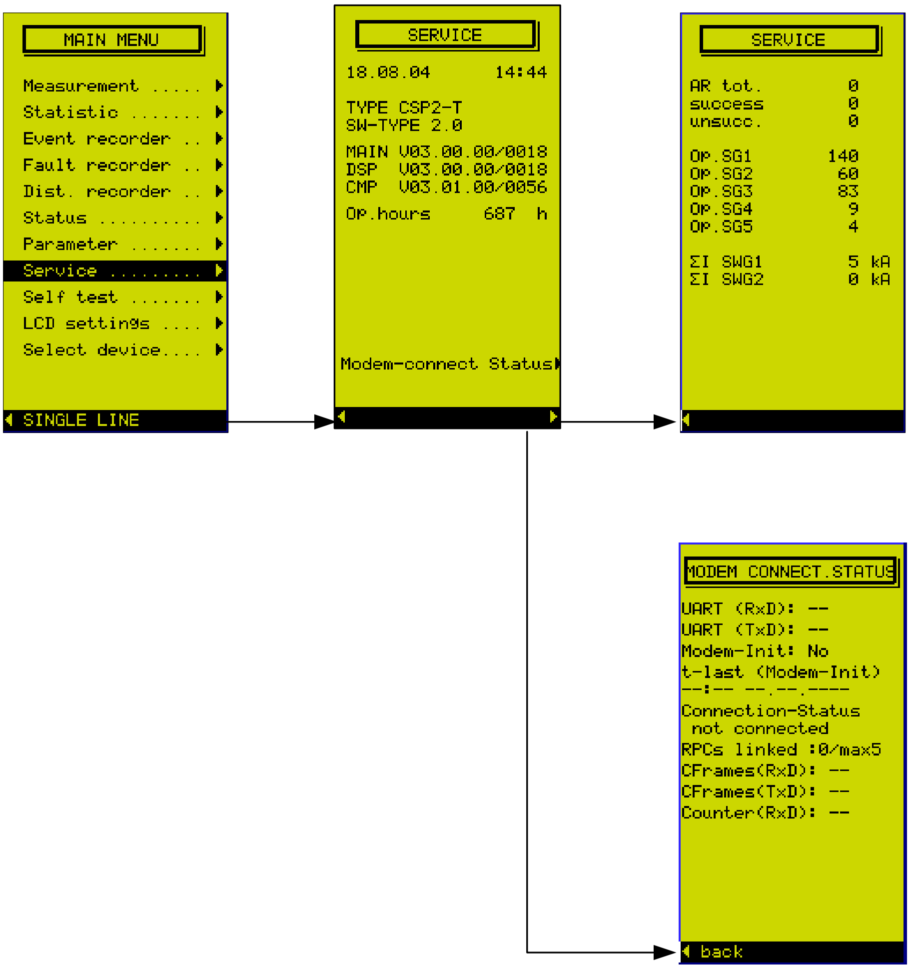


Figure 5.95: "Service data" on the display of the CMP1

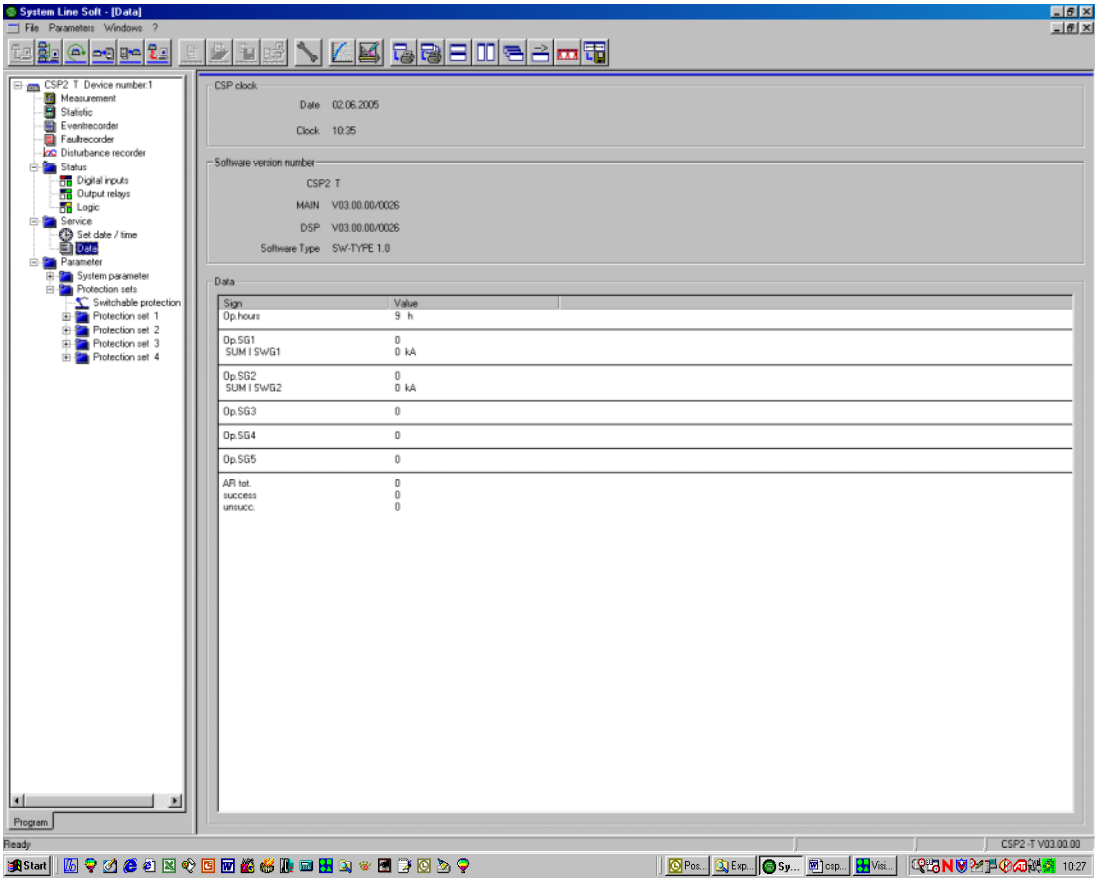


Figure 5.96: "Service data" SL-SOFT

The following table gives information about the available *service data in the menu service*.

Service-Data				
Data	*Display/Unit*	*Description*	*Update*	*Note*
Date	jj.mm.tt	Year, month, day	Daily	Adjustable
Time	hh:mm	Hours and minutes	Every minute	Adjustable
TYPE	CSP2-XX	Type of CSP2-device	When software is upgraded	Type of communication protocol provided by CSP2 device
SW-TYPE	1.0	IEC, Profibus	When software is upgraded	Type of communication protocol provided by CSP2 device
	2.0	Modbus	When software is upgraded	
MAIN	V.xx.xx.xx/xxxx	Software Version standard of the CSP2 main program	When software is upgraded	Main processor (CSP2)
DSP	V.xx.xx.xx/xxxx	Software Version standard of the CSP2-protection programs	When software is upgraded	Digital signal-processor (CSP2)
CMP	V.xx.xx.xx/xxxx	Software Version standard of the CMP1 processors	When software is upgraded	Main processor (CMP1)
Modem-connect	-	Data of the modems used	-	Remote communication via modem
Op. Hours	H	Counter of the CSP2 operating hours	Every hour	Operating data of the CSP2 (can be reset)
AR tot.	Serial No.	Total of all AR attempts since commissioning or since the latest reset of the counter	After each AR attempt	Counter values of ARs (can be reset)
success.		Total of the successful AR attempts since commissioning or since the latest reset of the counter	After an AR cycle has finished	
unsuccess.		Total of the unsuccessful AR attempts since commissioning or since the latest reset of the counter		
Op SG 1	Serial No.	Number of operating cycles of switching device 1	After each complete switching action of the respective switching device	Revision data for switching devices (can be reset)
Op SG 2		Number of operating cycles of switching device 2		
Op SG 3		Number of operating cycles of switching device 3		
Op SG 4		Number of operating cycles of switching device 4		
Op SG 5		Number of operating cycles of switching device 5		
ΣI SWG1	kA	Sum of short-circuit currents switched by the CB1 (SG1)	Protective trip by CB1 (SG1)	Revision data for circuit breakers (can be reset)
ΣI SWG2	kA	Sum of short-circuit currents switched by the CB2 (SG2)	Protective trip by CB2 (SG2)	

Table 5.1: Detailed View – Service Data

"Date" and "Time"
The *CSP2* has a *clock module*, which generates the date and time display. The date is displayed in the "Year.Month.Day" format; the time in the "Hours : Minutes" format.

Note

The clock module is fed by a *lithium battery*, which has a service life of about 10 to 15 years. Replacement of the battery is quick and simple via the review shaft.

The displays for date and time can be changed as follows:

- *Display and operating unit CMP1*: Each individual decimal place of the date and time display in MODE 2 (local operation/parameterization),
- *SL-SOFT*: Synchronization of the date and time of the *CSP2* to the time of the *connected PC/laptop* and
- *SCADA*: Synchronization of the date and the time of the *CSP2* to the time of the *connected host computer*.

Alteration of the date and time display via the CMP1

Via the *CMP1* operating and display unit, *each value of the date and time display* can be changed individually. However, this is only possible in MODE 2 (local operation/parameterization). In comparison with the other parameter setting processes, it is not necessary to save the changes, as the clock module of the *CSP2* takes on each new setting immediately. (A storage process could possibly take too long, meaning that the "new" setting would no longer be up to date.)

The following illustration shows the mode of procedure with the example of *setting the time (minutes)* (setting of the date is analogous).

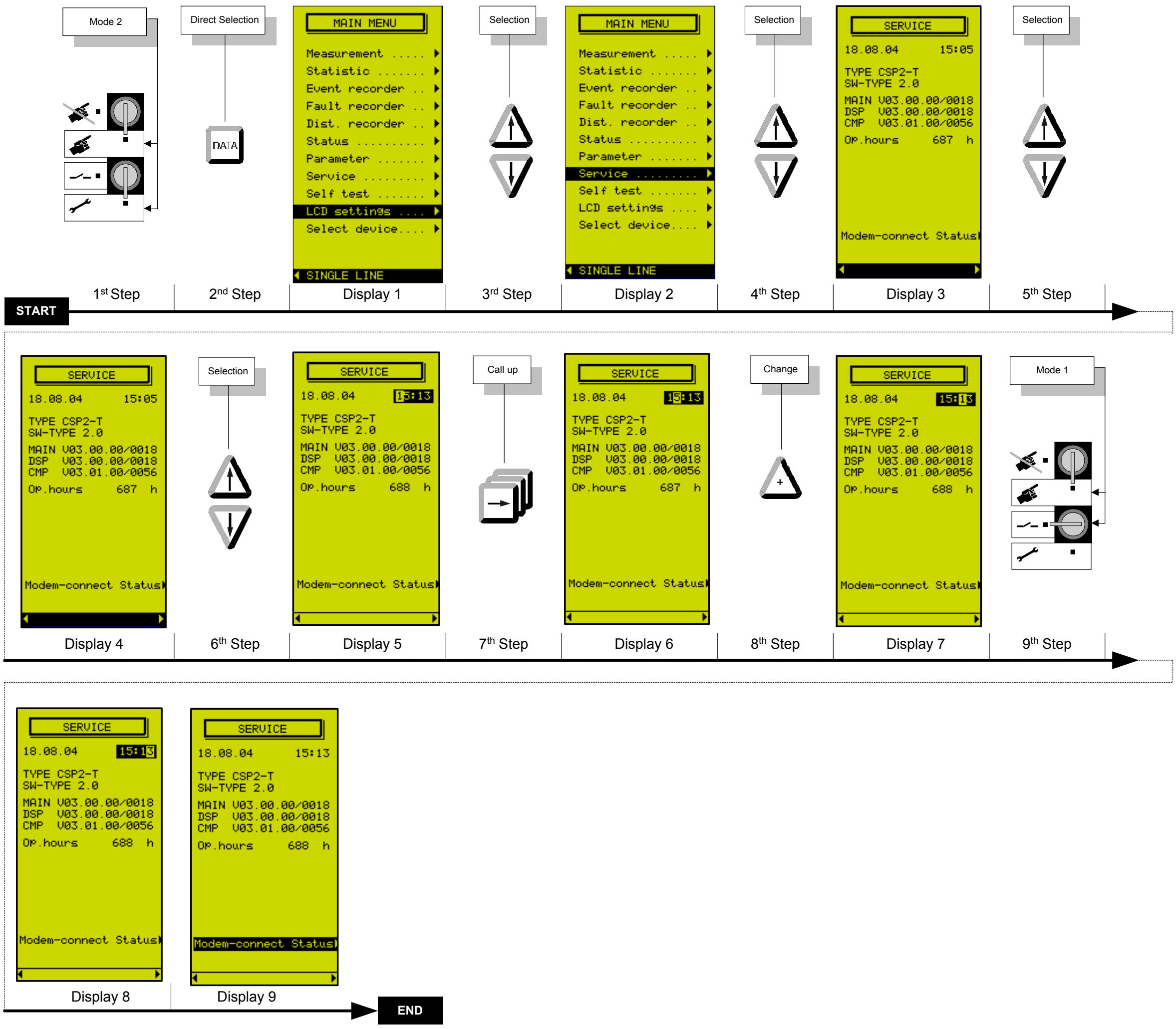


Figure 5.97: Setting the time (minutes) via CMP1

Synchronization of date and time via the SL-SOFT
Using *SL-SOFT*, it is possible to synchronize the date and time of the *CSP2* to the corresponding values of the connected PC/notebook. The *CSP2* takes over the current values of the PC or laptop. The synchronization is carried out in the menu ""Service" under "Set date/time".

Remark

Date and time are *not* saved in the data sets (parameter file "parameter.csp") of the *CSP2*. For this reason, the synchronisation is *not* done in the parameter setting mode of the *SL-SOFT*, but in the normal operation mode in the sub-menu " Set date/time", within the menu service.

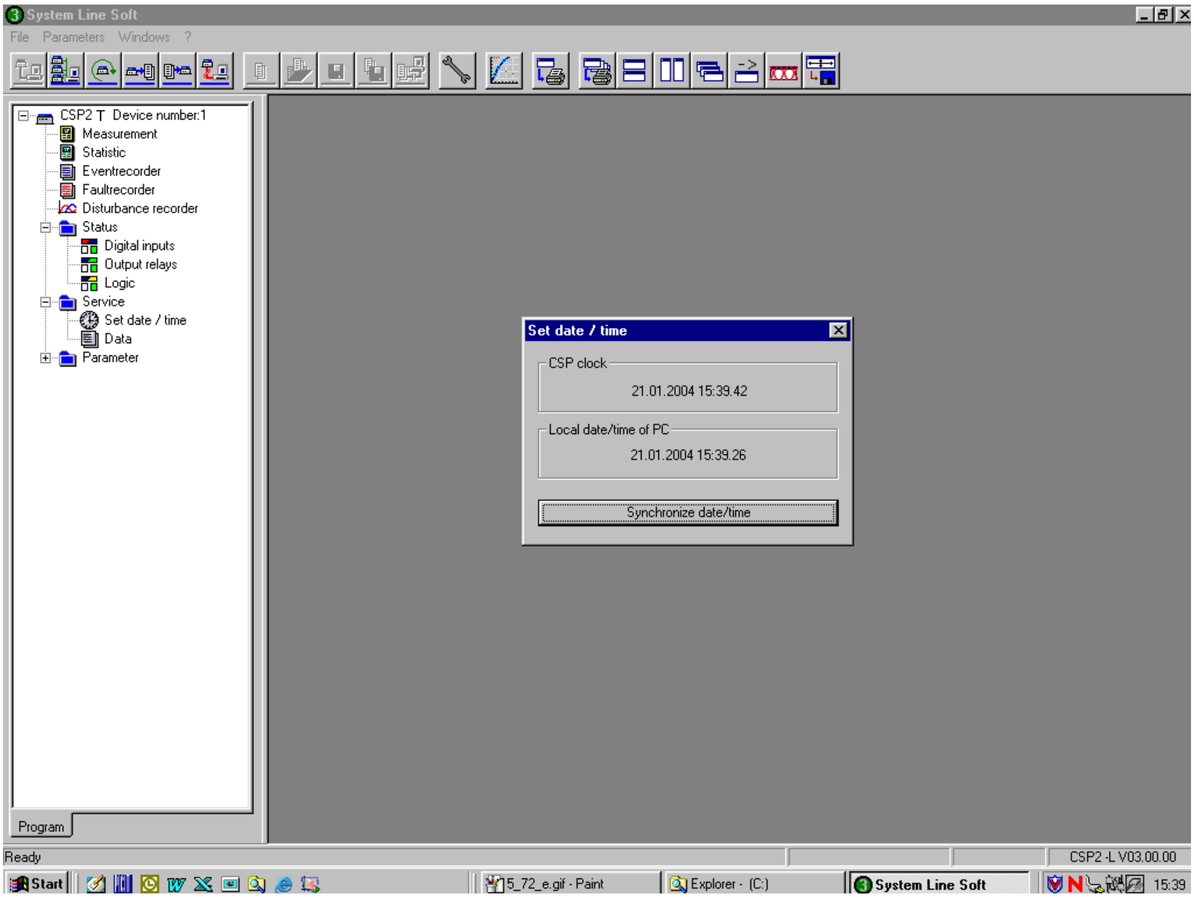


Figure 5.98: Synchronization of date and time via SL-SOFT

Synchronization of date and time via SCADA
The various types of protocol for communication with SCADA possess specific data telegrams which are transmitted cyclically in order to synchronize the date and time of the *CSP2* devices connected to the SCADA.
Such a data telegram contains the *new date* as well as the *new time* as a date set to be transmitted.

Further information about the *time synchronization* can be seen from the *data point lists* for the *protocol types* in question (separate documentation).

"Type" (type of device) and "MAIN", "DSP", "CMP" (status of software version)
The identification of the *type of device* and the display of the *software version status* of *CSP2* and *CMP1*. This identification should be stated in *inquiries*.

"Op.hours" (operation hours counter)
This display refers to the sum total of hours in which the *CSP2* was in operation. In interruptions of the supply of auxiliary voltage for the *CSP2*, the current counter value is saved. The operation hours counter is therefore not automatically reset, but continues counting with the saved value in a subsequent commissioning.
A *reset of the operation hours counter* can however be done manually either via the *CMP1* or via the *SL-SOFT*:

1) *Display and operation unit CMP1*: Menu *"Parameter/Reset Functions"* in MODE 2 (local operation/parameter setting).

For this, the *parameter "Operation hours counter"* is available in the *"Parameter/Reset Functions"* menu and resets the counter by selection and subsequent pressing of the key "RIGHT" (here as an execution key).

2) *Operating software SL-SOFT*: Menu *"Parameter/Reset Functions"* in parameter setting mode of *SL-SOFT* (log into the system parameter set)

In the menu "Reset functions" the operating hours meter can be reset by the *(SL-SOFT) parameter "Op.hours"*.

Revision data
The counter values are used as revision data and permit a deduction of the functional stress of the switch-gears, thus enabling a revision of the switch devices as required. The revision data are generated by the following counters:

- "AR tot"
- *"success"*
- *"unsucc"*
- *"Op. SG1 to "Op. SG5"*
- **Σ***I SG1* and **Σ***I SG2*

(Resetting is done in the menu "Reset functions" analogous to the reset of other counters and functions).

"AR tot." (Total AR value)
This counter totals the AR attempts (*shots*) held regardless of whether they were successful or not.

"success" (number of successful AR attempts per AR cycle)
Here, only the number of AR attempts *(shots)* needed for successful *switching on again* are totalled, i.e. the circuit breaker remains switched on (short-term fault).

Example: *Parameter "Shots = 4"; successful auto reclosing at the 4th AR attempt.*
The counter consequently shows:

- *"AR tot = 4"*
- *"success = 1"*
- *"unsucc = 3"*

"unsucc." (number of unsuccessful AR attempts per AR cycle)
Here, only the number of AR attempts *(shots)* implemented with unsuccessful *AR* is totalled, i.e. in which the last auto reclosing attempt of an AR cycle did not lead to a permanent switch-on of the circuit breaker (longer-term or permanent fault).

Example: *Parameter "Shots = 5"; no auto reclosing after the 5th AR attempt*
The counter consequently shows:

- *"AR tot = 5"*
- *"success = 0"*
- *"unsucc = 5"*

"Op. SG1 to "Op. SG5" (counter for switching cycles)
For each of the *five detectable switchgears, a separate counter* is available, counting the *switching cycles implemented* in each case. It is of no importance whether the switchgears are controlled electrically or mechanically.

Σ*I SG1* and Σ*I SG2 (counters for summation of the currents in protection tripping)*
These two counters total the *short-circuit currents switched by the circuit breaker* in each case at the time of any protection tripping (also DI functions).
The main contacts of a circuit breaker are particularly highly stressed by the switch off of high short circuit currents in protective tripping (contact burn by arcing). This means that circuit breakers must be maintained and revisioned more frequently as a rule than other switchgears. The value of counters ΣI SG1 and ΣI SG2 are therefore of great importance as revision data.

Remark
The counter values of ΣI SG1 and ΣI SG2 should be reset *after each revision*.

5.9 Self-test menu

With the self-test, functions the *CSP2* and *CMP1* can be tested. Each test function is shown on the display during its execution via *Pop up windows*. These test functions are executable at any time with the exception of the *relay test* without *switching authorization* (change of the mode of operation to MODE 2).

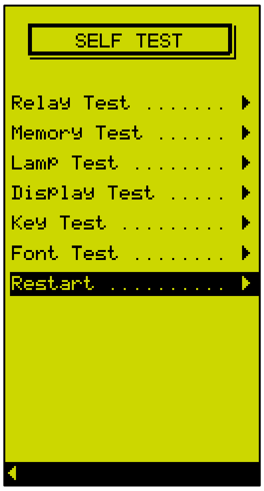


Figure 5.99: Menu "Self-test" in the display of the CMP1

Below, the *displays* are shown and commented separately in the order of their appearance for *each test function*.

Relay test
With the *"Relay test"*, the function of the *signal relays* of the *CSP2* can be checked. All the signal relays are put into alarm state in order. In the *automatic test sequence* the signal relay for the "System OK" system message (works setting) opens first. After this, all the other output relays pick up in the correct order and then open jointly after this. At the end of the test, the "System OK" signal relay picks up again.

Attention

Before the execution of a relay test, ensure that *no external functions such as circuit breaker failure* or *"CB transfer trip" take-on* are forwarded by the *activation of the report relay*!

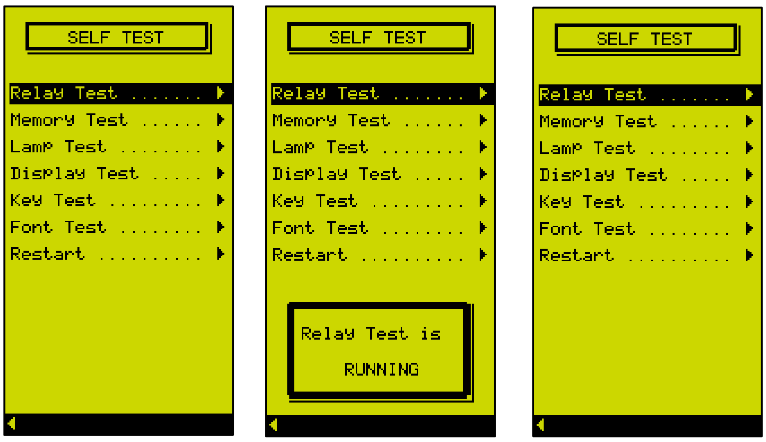


Figure 5.100: Implementation of the "relay test"

Memory test

The *CMP1* display and operating unit has *RAM* and *ROM* memories, the capacity and function of which can be checked by a memory test. The result is displayed.

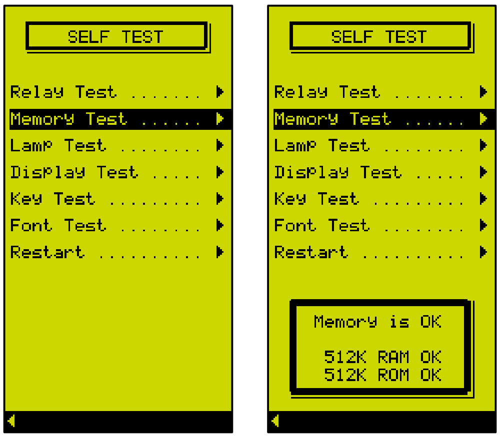


Figure 5.101: Execution of the "memory test"

Lamp test

The *two-colour light-emitting diodes (LED)* on the *CMP1* are lighted up *red* and *green* if they are activated accordingly. After the end of the LED test, the displays return to the menu from which the self test was started.

Figure 5.102: Execution of the "lamp test"

Display test
The display of the *CMP1* is illuminated alternately *light* and *dark*, with the result that faulty pixels become visible immediately.

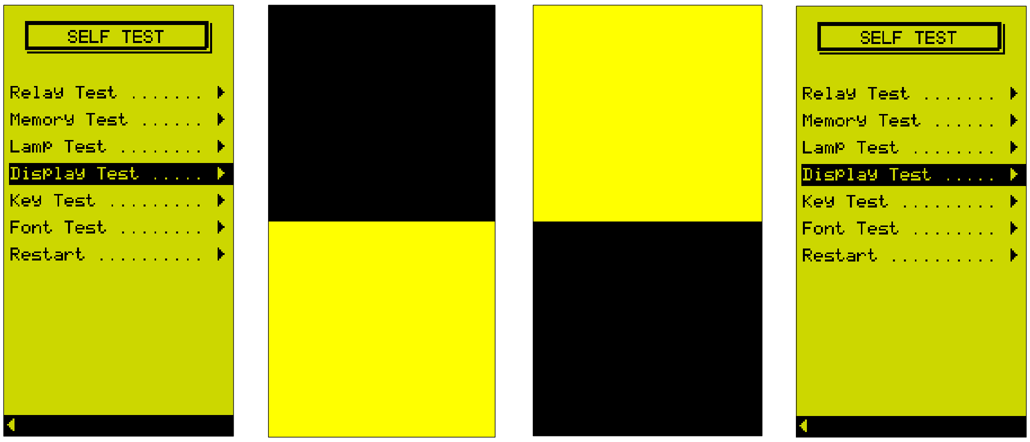


Figure 5.103: Execution of the "display test"

Keyboard test
With the *keyboard test* all the *operating element (keys and key switches)* of the *CMP1* can be tested. The test is done by sequential pressing of the individual operating keys and the key switches. After each pressing of an operating element, the result of the test can be seen on the display. By operating the elements during the test, *no* functions are executed. The operating keys for the "*Emergency OFF*" function can also be tested in this way.

Attention
The function *"Emergency OFF"* is *not* in function during the test!

Operating the key "LEFT (arrow)" ends the *keyboard test* (which is why this key should be checked at the end). If the operation mode is changed (via the key switches) during the test process, a corresponding message pops up and requests for correction; only then can the test be ended and a different MODE set.

Figure 5.104: Execution of the "keyboard test"

Font test

All the displayable fonts are shown.

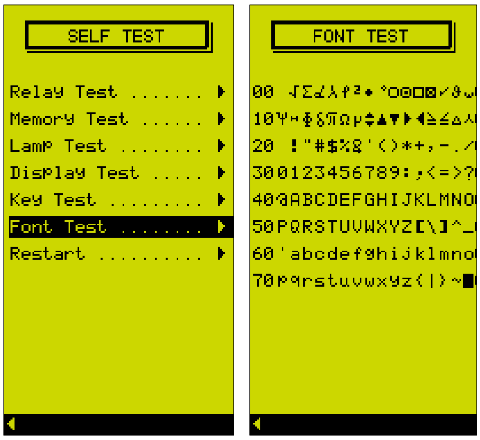


Figure 5.105: Execution of the "font tests"

Restart

The *CMP1* is reset, i.e. it interrupts the communication to the *CSP2* and reconnects again. If the connection is successfully brought about, the SINGLE LINE *start page*, in which *the current single line* is displayed, pops up.

Figure 5.106: Execution of the "restart"

Note

The “Self-Test” functions can not be carried out via the *SL-SOFT*. (The “Self-Test” menu is not part of the *SL-SOFT*)

5.10 Set LCD menu

Display backlight

The *CMP1* display and operating unit has a *background-illuminated LC display*. The backlight can be adapted to the situation with regard to the *light conditions in the cubicle surrounding*. For this, the *Brightness* and *Contrast* settings of the display can be altered.

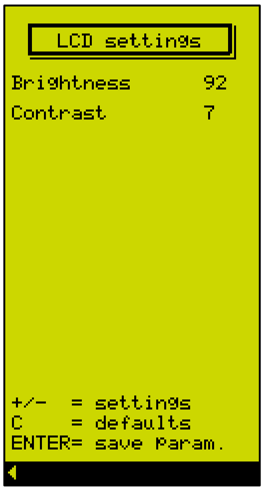


Figure 5.107: "Set LCD" menu in the display of the CMP1

The display backlight automatically goes on when the first key is pressed and goes off if no operating key is used for a duration of about 10 min.

Parameters

Display Adjustments				
Parameters	*Description*	*Setting Range*	*Presetting*	*Step Range*
Brightness	Change of the display backlight	0...100	92	1
Contrast	Contrast Change	0...100	2	1

Table 5.2: Setting parameters of the Display

Remark

The parameter settings are changes in the "LCD-settings" CMP menu.

Note

The *"LCD-settings"* menu is *not* part of the *SL-SOFT*. The *parameters* of this menu therefore can *not* be set via *SL-SOFT*.

5.11 Device selection menu (Variant 2 of multi-device communication)

The term "*Multi-device communication"* describes the connection of the *CSP2* devices amongst one another via the internal CAN-BUS to a bus-system line *(see Chap. "CSP2 Multi-device communication").*

The *CSP2/CMP1* system offers *two variants of multi-device communication*, which can be realized and used in different ways:

- *Variant 1*: the CAN-BUS system entails the same number of *CSP2* as *CMP1* devices
- *Variant 2*: the CAN-BUS system contains only one *CMP1* for the whole quantity of *CSP2* devices

The *local operation of the CSP2* devices in the CAN-BUS system is done in *Variant 2* of the multi-device communication merely via *a common CMP1* display and operating unit. As the *CMP1* can always only communicate with a single *CSP2*, operation of the *CSP2* devices can only be done sequentially.

Attention

The *CMP1* always only communicates with one *CSP2*! Log-in to another *CSP2* is only done via the menu control of the *CMP1* and therefore requires time. In projecting, please therefore ensure that important functions such as "Emergency OFF" are implemented redundantly (e.g. additional separate key for the power circuit breaker).

The log-in of the *CMP1* into an arbitrary *CSP2* of the CAN-BUS line is done via the "Select device" menu. Access to the "Select device" menu for its part is only possible if multi-device communication-system has been correctly installed and parameterized as *Variant 2*. This setting is done in the *CSP2* in the "CAN-BUS" menu via the parameter: *"single CMP = yes" (see Chap. "CAN-BUS").*

Note

The "Select device" menu item is *not* shown on the display if the corresponding *CSP2* has been parameterized for *Variant 1* (Parameter: *"single CMP = no"*)!

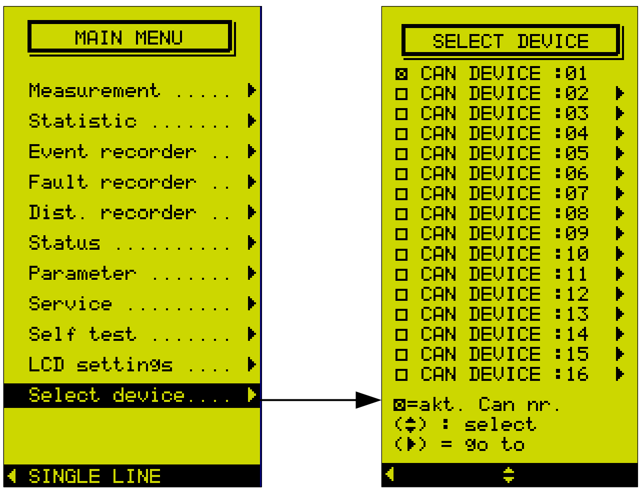


Figure 5.108: "Select device" menu in the display of the CMP1 (Variant 2)

Connecting a CSP2 of the CAN-BUS system

The following screenshots describe the *mode of procedure for logging into* any *CSP2* of the CAN-BUS system via the common *CMP1*. The change of communication is done in the MODE 1 mode of operation.

1st step:

Call up the "MAIN MENU"

2nd step:

Select and call up the "Select device" menu via the keys of the menu guidance.

3rd step:

Select the corresponding menu item which marks the *CSP2* to be selected on the basis of the CAN device number stated.

4th step:

Push the "RIGHT (arrow)" key as the execution key in order to initiate the change in communication.

5th step:

The change in communication to the selected *CSP2* requires a few seconds. During this time, the customer pop-up windows appear in the display. After a successful build-up of the communication, the SINGLE LINE start page of the selected *CSP2* device appears. The process has been completed.

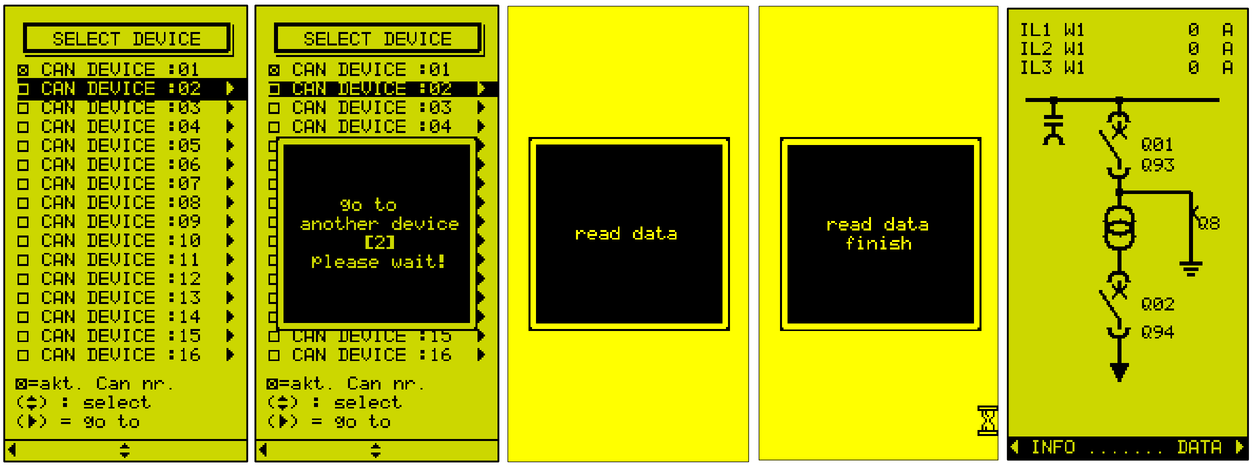


Figure 5.109: Logging into another CSP-system via the "Select device"-menu (Variant 2)

6 Control Technique

To the ongoing tasks of protection devices belong increasingly also the control functions for the MV-switchgears, which include in general circuit breakers, switch disconnectors, disconnectors as well as earthing switches.

MV switchgears can be switched *mechanically* locally. If the MV switchgears moreover dispose of electrically controllable drives, an operation (control) can also be carried out via a combined protection and control system. Depending on the switching and interlocking scheme, it is then possible to execute the control from different control locations. Frequently, several control sites are used in parallel for the operation of plants:

- "locally" (on site) via CMP or
- switching station (SCADA/remote control system or via a
- conventional remote-control stand (conventional wiring)

According to the needs, a *control system* can be composed of simple switches as e.g. push-button switches or acknowledgement switches or is constructed as a complex control system. These systems contain an extensive logic which examines the switching command for admissibility before each passing of a command. At the control site, the *switching state* of the corresponding switchgear must be perfectly recognizable at any time. For this, optical and electro-mechanical position indicators (checkback signals) are used. Signal lamps as optical position indicators could also be combined to one device, the acknowledgement switch.

In order to prevent faulty operations, *locking functions* have to be provided, which can be constructed mechanically or electrically. Electrical lockings can either be regulated via the interrupter contacts in the control circuits (hardware) or, when using combined protection and control systems, by the *SYSTEM LINE* via the software *(see chapter 7: "Interlocking"* (interlocking technique).

6.1 Basics

Switching actions on the MV-level constitute important interventions into the energy supply, and faulty operations could entail considerable danger conditions for humans and electrical equipment. Thus the regulations for switching actions are subject to standards and directives to guarantee the plant safety.

Standards and directives:

• DIN EN 50110-1/VDE 0105 part 1:	„Operation of electrical power installations“
• DIN EN 50179/VDE 0101:	„Erection of heavy-current installations with rated voltage of more than 1 kV“
• DIN VDE 0670:	„A.c. switchgears voltages of more than 1 kV“
DIN 40719:	„Switching documentation“ (
• VBG 4:	„Electrical installations and equipment“

Safety in switching systems
Clearing, earthing and short circuiting according to DIN 57105/VDE 0105 are prerequisites for permission to work near live parts. Here, the following *5 rules* must imperatively be adhered to:

- Clearing!
- Safeguarding against switching on again!
- Ascertaining that no voltage is present!
- Earthing!
- Safeguarding live parts in proximity against touch!

Switchgears must on the one hand be provided with disconnect points and on the other hand be equipped with earthing switches in order to lead off to earth immediately possibly resulting voltage potentials in the cleared means of operation.
Faulty operations in switchgears constitute a special danger for the personnel and the electrical equipment. This is especially true for the opening of a current-conducting circuit by a disconnector or for switching on an earthing switch onto live system parts.

6.2 Switchgear control via *CSP2*

The *CSP2* of the *SYSTEM LINE* takes over multiple control and interlocking tasks according to device type and application. Additionally to the mere control functions, the *CSP2* disposes of further extensive functions for display, message, supervision and safeguarding of switching actions. Moreover, each switching action is logged into the *event recorder* so that conclusions can be drawn to past operation events.

The *drive components of the switchgears* (motors, control coils) can directly (or indirectly via auxiliary relays) be connected to the control outputs of the *CSP2 (see chapter "Control outputs of the power circuit (X1A, X1").*

The switchgear positions are shown within the display of the *CMP* (single line). Extensive supervision functions deliver information about the state and positions of the switchgears and thus maximum operational availability of the electrical equipment is guaranteed.

The ability of executing of control and interlocking-commands depends on the switching authorization and can be carried out optionally via the operation and display unit *CMP1* via SCADA or via digital inputs.

Remark

Also the "automatic reclosing" of the circuit breaker via the *AR function* is to be interpreted as a control process. The AR is also subject to all active locking and supervision functions!

6.2.1 Functions of the *CSP2* switchgear control

For switchgear control, additionally to the *mere control functions,* the *CSP2* disposes of *additional functions* for guarantee of the safety of switch actions as well as for increasing the availability of MV switchgears:

- detection of switchgears,
- display and signalizing of switchgear states,
- control of switchgears,
- supervision of swichgears and switch actions,
- logging in of the switching action in the event recorder
- locking of switchgears on the field and/or station levels.

Control Functions			
Function	*Description*	*Note*	*Available in CSP2-T*
Detection and visual display of switchgears	Number of switchgears which can be detected	Detection of the switch positions via two aux. contacts (ON/OFF) of the switchgears (Signal lines of the individual messages)	5
	Number of switching devices which can be displayed	OFF position of the switchgears shown as symbol	•
		ON position of the switchgears shown as symbol	•
		»Switching Device in Intermediate Position«	•
		»Switching Device in Fault Position«	•
Control of switchgears	Number of switchgears which are controlled via the *CSP2*		5
	Power outputs for control coil	ON/OFF - separate controllable	2
	Power outputs for motor control (earthing switch disconnector: M-Type)	Clockwise/Anticlockwise running is separate controllable	3
	Signal relay	*„non-confirmed command (no check-back-signal)" via the SCADA-system; e.g. for release purposes etc.*	6
	Digital inputs	„Remote" control by means of parallel wiring	26
	SCADA (optionally): visually: FO (fibre optic) electrically: RS485	„Remote" control via SCADA	•

Table 6.1: Indicating and Control Functions in the CSP2

6.2.2 Recognition of switchgears and display indications

The *recognition of switchgears* (SG) occurs by the *messages about their switch positions* at the *CSP2*. By this information, the *CSP2* is e.g. able to show symbolically the available switchgears on the display of the operation and display unit *CMP1* and to generate messages about the state of the individual switchgears (output messages for LEDs and signal relays, messages to SCADA).

Note

Detected switchgears must not imperatively be controllable via the *CSP2*. Controllable switchgears, however, must in each case also be detected!

Detection of switch positions
For safe detection of the switch position, always two auxiliary contacts of a switchgear are required.
One auxiliary contact closes at switch position "OFF", the other closes at switch position "ON". The signal lines of the auxiliary contacts must be wired to the *CSP2* in each case via a digital input as *single messages*. The digital inputs themselves have been assigned corresponding *input functions* which are necessary for the further processing of the single messages.

Single-messages:
- *Digital input* "SGX signal O": Signal line of the auxiliary contact for message "Switchgear X open".
- *Digital input* "SGX signal I": Signal line of the auxiliary contact for message "Switchgear X closed".

Out of the two *separate single messages* in the *CSP2* now results a so-called *double message* which has a higher information content than a single message. The status evaluation (active/inactive) results in four possibilities which are interpreted by the *CSP2* accordingly. In this way, additionally to the defined switching states "ON" and "OFF" also the intermediate positions:

- »Intermediate position« (both check back signals ON and OFF missing) as well as the
- »Faulty position« (position check back signals ON and OFF will be reported at the same time)

of the switch are supervized and separately reported.

Consequently, here are four possible states for the position messages of a switchgear:

- *„Switch ON“*: "SGX signal I" = active and "SGX signal O" = inactive
- *„Switch OFF“*: "SGX signal I" = inactive and "SGX signal O" = active)
- *„Intermediate position“*: "SGX signal I" = inactive and "SGX signal O" = inactive
- *„Faulty position“*: "SGX signal I" = active and and "SGX signal O" = active

Attention

For the detection of the switch position of a switchgear *always* two separate auxiliary contacts (single messages each) are recommended! When using a single message for detecting the switch positions, no *intermediate positions and faulty positions* can be detected. Supervision of the delay time (time between issue of the command and check back message of the intended switch position), however, can also be effected with a single-pole message.

Example: *Detection of a circuit breaker (CB)*

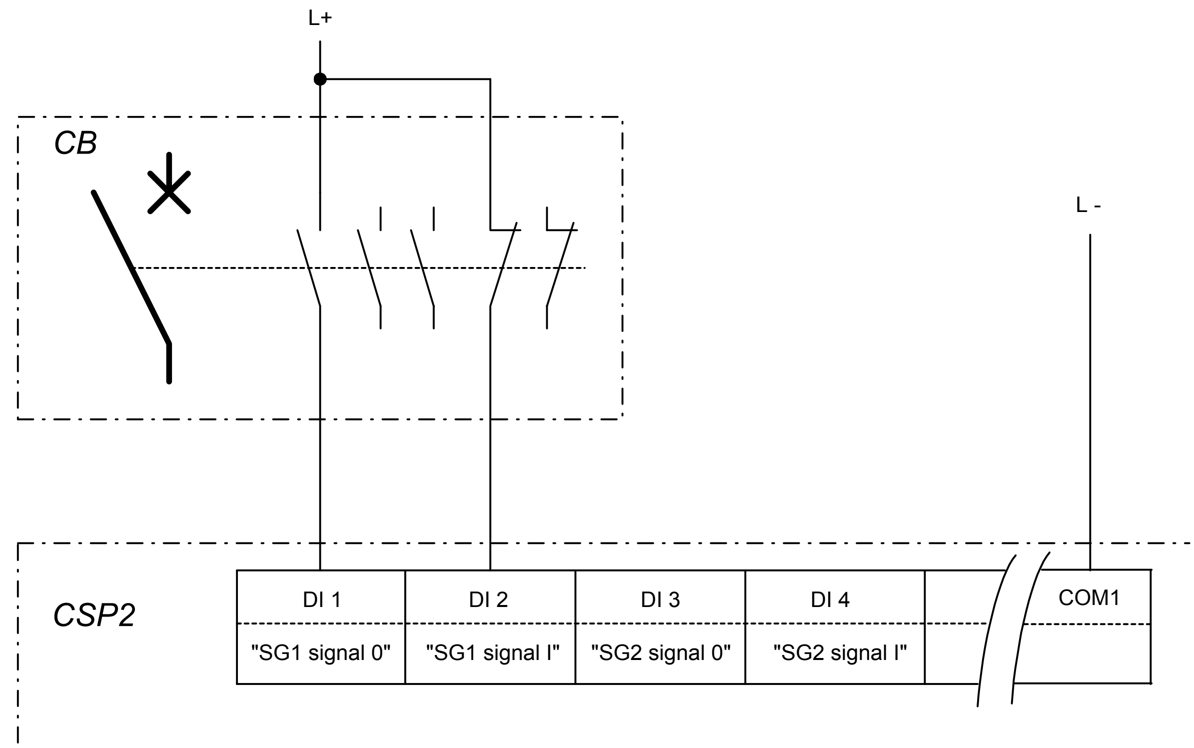


Figure 6.1: Principle for detection of switchgears

Remark

The first block of the digital inputs is provided for the detection of the position messages for switchgears and possesses a common return line *COM1* which conducts the corresponding negative potential. The terminal of this return line is situated on the second terminal board of the *CSP2*.

Graphical indication of the switchgears in the display
The positions backfeed messages of the different switchgears can be displayed on the LC graphic display of the *CMP1* by a single-line diagram.

The graphic symbols of all frequently used switchgears are based on the standard IEC 617 and DIN 40900, and can be selected by configuration from a library. From the individual symbolic switchgears a specific field configuration is established in graphic form. In addition to individual switchgears, also measuring values can be indicated by the state indications of the switchgears on the LC graphic display.

The following table shows a list of the available symbols:

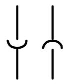
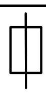
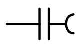
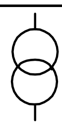
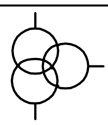
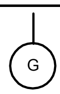
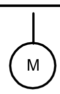
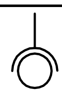
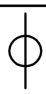
Switching device	*Designation*	*Symbol Representation according to IEC 617, DIN 40900*	*Type of symbol*
Circuit Breaker (CB)	Q0 Q01 Q02		Controllable/detectable switching device
Isolating Switch	Q1,Q2,Q3,Q4 Q9,Q91,Q92 (outgoing)		Controllable/detectable switching device
Earthing Isolator	Q5, Q8 (SBB) Q81, Q82 (DBB)		Controllable/detectable switching device
Load break switch	Q10 Q11		Controllable/detectable switching device
CB Truck	Q93, Q94		Controllable/detectable switching device
Fuse	-		Fixed Symbol
Capacitive Measuring	-		Fixed Symbol
Transformer (2 Winding)	-		Fixed Symbol
Transformer (3 Winding)	-		Fixed Symbol
Generator	-		Fixed Symbol
Motor	-		Fixed Symbol
Feeder	-		Fixed Symbol
Voltage Transformer	-		Fixed Symbol
Current Transformer	-		Fixed Symbol

Table 6.2: Symbols for the single line diagram

Examples of switchgears symbols in the display of the CSP2

Each positon change of the detected switchgears can be observed by a change of the corresponding symbols on the display of the *CMP1*. In the following, the symbol for each displayable switchgear the symbols of the four possible switch positions are shown:

Circuit breaker not withdrawable

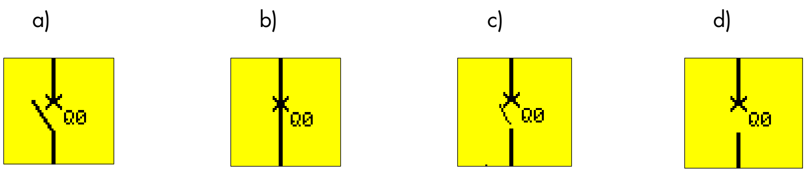


Figure 6.2: Symbols of the four different circuit breaker position messages:

a) CB open
b) CB closed
c) CB in differential position
d) CB in faulty position

Circuit breaker with truck unit (not withdrawn)

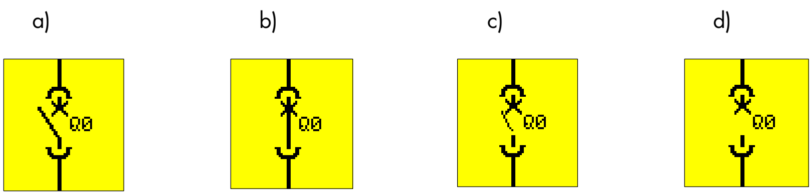


Figure 6.3: Symbols of the four different circuit breaker position messages:

a) CB open
b) CB closed
c) CB in differential position
d) CB in faulty position

Circuit breaker with truck unit (withdrawn)

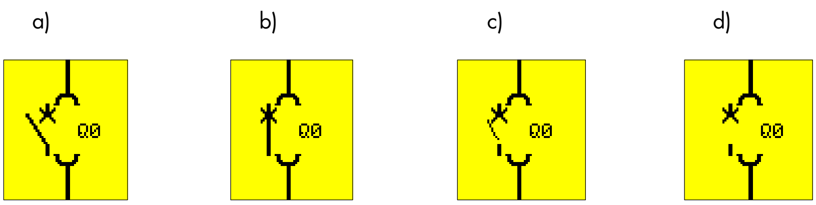


Figure 6.4: Symbols of the four different circuit breaker position messages:

a) CB open
b) CB closed
c) CB in differential position
d) CB in faulty position

Load break switch

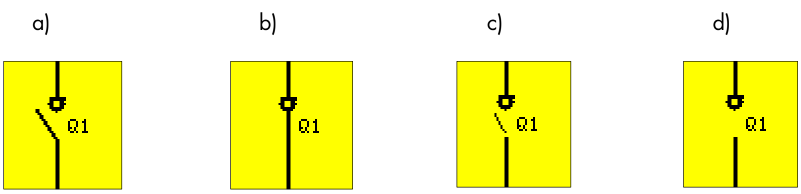


Figure 6.5: Symbols of the four different load-break switch position messages:

a) load-br sw. open
b) load-br sw. closed
c) load-br sw. in differential position
d) load-br sw. in faulty position

Disconnector / Isolator

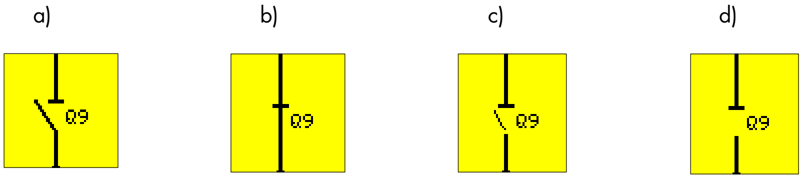


Figure 6.6: Symbols of the four different disconnector switch position messages:

a) disconnector sw. open
b) disconnector sw. closed
c) disconnector sw. in differential position
d) disconnector sw. in faulty position

Withdrawable unit for circuit breaker

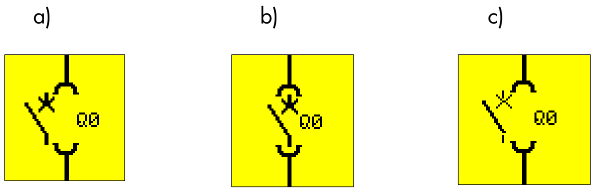


Figure 6.7: Symbols of the four different position messages for wtithdrawable unit:

a) wtithdrawable unit open
b) wtithdrawable unit closed
c) wtithdrawable unit in differential position and wtithdrawable unit in faulty position

Earthing switch

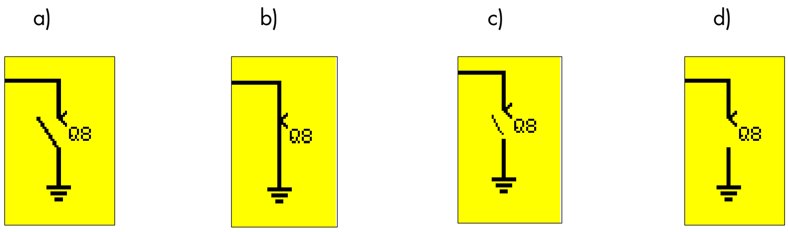


Figure 6.8: Symbols of the four different earthing switch position messages:

a) earthing switch open
b) earthing switch closed
c) earthing switch in differential position
d) earthing switch in faulty position

6.2.3 Controllability of switchgears

MV switches can be detected by the CSP2 via their auxiliary contacts. If suitable drives (coil drives or motor drives) are available, the detected *switches can be additionally controlled.*

Prerequisites: Hardware
Additionally to the detection of the switch position via the check back messages, the drive components for ON and OFF switching must be connected to the control outputs of the *CSP2*. According to the type of switchgear, these can be control coils, servo motors or auxiliary relays. In general, the following allocations of the *CSP2* power outputs to the switchgears are valid:

- OL1 (circuit breaker Q01 switch-off coil),
- OL2 (circuit breaker Q01 switch-on coil),
- OL3 (circuit breaker Q02 switch-off coil),
- OL4 (circuit breaker Q02 switch-on coil),
- OM1 (disconnector switch/earthing switch),
- OM2 (disconnector switch/earthing switch),
- OM3 (disconnector switch/earthing switch),

The control outputs are supplied by a separate control auxiliary voltage (DC) which is connected to the *CSP2* and will be switched through to the corresponding control output at the issue of the command. The wiring expenditure, especially in case of several controllable switches, is considerably reduced thereby. *(Details see in chapter "Control outputs of the power circuit (X1)").*

Prerequisites: configuration software SL-Draw (see instruction manual SL-Draw)
A switchgear controllable via the *CSP2* must be taken into account for the device configuration.

- Determination which type on the switchgear no. (example: *SG1 = power circuit breaker*)
- Determination switch designation (display indication) on the switchgear no. (example: *SG1 = Q01*)
- Determination control output (hardware output) on the switchgear no. (example: *SG1 = OL1, OL2*)
- Establishing the locking conditions (field interlocking) separately for the on and off switching of the controllable switchgear. For this, the position messages of the other detected switches are used for the blocking of commands via AND/OR logic functions.
- Setting of the control time (switching time and, if necessary, press-out times) for running time supervision of the switchgear *(see chapter "Control times" system parameters).*

Attention

The issue of a certain control command as e.g. "Cmd SG1 on" (DI-function) refers always to the switchgear no. (here: SG1). In many applications the switchgear 1 (SG1) is a circuit breaker with the assigned control circuits OL1 and OL2 (hardware outputs). When using a load-break switch instead of the circuit breaker, the switchgear no. SG1 refers to the load-break switch. As this switchgear, however, in general disposes of a motor drive, a control output for motor drives (e.g. OM1) must be assigned when *configuring the switchgear* no. SG1. Consequently, the terminals of the drive motor must be connected to the terminals for the assigned control output (e.g. OM1).

6.2.4 Sequence of a control process

After issuing a control command for a switchgear, at first the switching authorization for the control site will be checked by the *CSP2*:

- checking for switching authorization (set mode of operation)
- checking for *termination of a preceding switching action*
- checking for *active interlocking functions*
- checking of the control circuit by *control circuit supervision CCS* (when active)
- checking of a *defined end position* of the switchgear

Checking the switching authorization
According to the control site from which the command was issued, the *CSP2* checks whether the correct mode of operation was selected via the key switches of the *CMP1*. For remote control via digital inputs or a SCADA-system, the mode of operation MODE 3 is required! (In case of local control, the control command anyway can only be issued if beforehand MODE 1 was set and called up via the menu item "operate" (control) of the CONTROL MODE.

Checking for termination of a preceding switching action
Switching actions will always be carried out sequentially! An issued control command will only be processed by the *CSP2*, if a preceding initiated switching action has been terminated without disturbance. In this way erroneous operation of switchgears are prevented and dangerous conditions avoided!

Checking for active interlocking functions
Issued control commands are blocked by active interlockings. Interlockings can be configured and activated in different ways (see chapter "Interlocking technique"). If a control command is issued for a locked switchgear, it will not be executed. This "interlocking violation" can be displayed by the output message "Interlock") via an LED or processed further via a signal relay.

Checking of the control output by the "control circuit supervision CCS"
Before the execution of a switching action, the control output required for the control process is checked by the protection function "control circuit supervision CCS" for interruption. This occurs only, if this protection function was set to active (see chapter "Control circuit supervision CCS").

Checking for a defined end position of the switchgear
A defined end position of a switchgear describes the position check-back messages "switchgear ON" and "Switchgear OFF". This switching action is, however, ignored by the *CSP2* (without message), if e.g. in case of a circuit breaker in position 'ON' a control command 'on'" is issued.
If the "intermediate differential position exists, it can be assumed that the switchgear either is just performing a switching action or that it is faulty. In case of a reported "faulty position", it must be assumed that a fault of the switchgear exists.
In the cases "intermediate position" and "faulty position", the issued control command is not executed. However, a corresponding entry into the event recorder as well as the activation of the output messages "Interlock" and "swichgear fail" (switchgear faulty as collective messages) occurs.

As far as the above mentioned checks of an execution of the switch action allow, the control process is executed as follows:

- closing of the internal relay contacts
- switching through of the auxiliary control voltage
- start of the running-time supervision (control lines)
- activation of the status message "SG moving" (intermediate position of switchgear)
- feedback message of the intended switch position
- resetting of the power control output
- change of the switch symbol in display (corresponding to the present switch position). According to the actual switchgear position.
- *Resetting the control output*

With the closing of the internal relay contacts, the negative potential (-) of the auxiliary control voltage has already been connected to the corresponding terminal of the control output. Subsequently, the switching through of the positive potential (+) to the control output is carried out.

Attention

For auxiliary control voltage only a direct voltage (DC) can be used! *(see chapter "Technical data")*

Start of the running-time supervision

For the correct execution of a switching action (switching on or off), each switchgear requires a minimum time indicated by the manufacturer's data sheet of the switchgear. With the initiation of the control process, a timer is started in the *CSP2* which supervises the switch running time of the switchgear.

Note

This timer is parameterizable for the switching time tc (and must be adapted to the switch running time (see chapter "control times". The switching time for circuit breakers is in general about
tc=150 ms, so that the default setting of the CSP2 *for the switching time* "tc_{SGx}= 200 ms" *is sufficient.*
In case of motor-driven disconnecting switches, the switch running times vary according to manufacturer, so that the indication on the data sheet must at any rate be taken account of!

For the setting of the switching time *tc* in general the following formula applies:

!!! tc_{SGx}> tc!!!

If the check back message of the intended switch position occurs within the set switching time *ts*, a correct execution of the switching action is assumed.
Should the switching action, however, takes more than the set time *ts*, i.e. if the position feedback message occurs later or even does not arrive at all, a fault in the switchgear can be assumed. Thereupon the *CSP2* carries out an entry into the event recorder, the output message "switchgear fail" is activated and a corresponding message is sent to the SCADA-system.

Activation of the status message "SG moving" (switchgear in intermediate position)

During the switching action the switchgear moves first from the defined switch position (on or off) into intermediate position. As soon as the *CSP2* recognizes the intermediate position, the output message "SG moving" is activated and a corresponding message is sent to the SCADA-system.

Check back signal of the intended switch position

If the switchgear is in the intended end position (ON or OFF), this position is backfeed reported to the *CSP2* via the two digital inputs (check back signals).

Resetting the control outputs
After recognizing the new switch position by the check back signals, the power output is reset. By the deactivation of the power output, the galvanic separation of the switchgear from the *CSP2* is re-established.

Change of the switch symbol in the display
The switch symbol in the display changes as soon as a new status regarding the switch position is recognized. During the switching action the display indication changes first from the"on" or "off" symbol to the symbol of the "intermediate position". When the defined end position of the switchgear is reached, the symbol indicates accordingly position "ON" or "OFF".

The control process for the switching action is now terminated!

6.2.5 Control sites

Under the designation "control site=location" the site is to be understood from which the control commands can be issued. Essentially, here the local and the remote control must be distinguished. In the case of local control, the control site is represented by the operation unit *CMP1* which is situated directly on the cubicle and thus "on site".

Contrary to this is the *remote control*, where there is a longer distance between the control site and the switchgears. The remote-control site can on the one hand be a SCADA-system, and on the other hand also a parallel wired control room (e.g. a motor control stand) in a separate room or building. The parallel wiring requires the use of digital inputs of the *CSP2*.

The switch symbols of the single line diagram in the display always show the present state of the switchgears.

6.2.5.1 Locking between local and remote control

For the different switching authorizations (allocation of the switching authorization), two different operation modes are existing. A conflict between local and remote control is prevented by the position of the upper key-switch.

For the control of the individual switchgears, the following operation modes are available:

- MODE 1  »Local operation and control« control only via operating keys of the *CMP1* possible! Exception: input function S-Cmd SGx on/off (from logic or digital inputs)
- MODE 3  »Remote operation and control« control only possible via *serial* interface to the SCADA-system or via input functions (from logic or digital inputs) of the *CSP2*!

6.2.5.2 Local operation and control via CMP1

Switching actions via the *CMP1* are only possible in “control mode” of the operation MODE 1. Via the menu guidance keys of the display and control unit *CMP1*, the switchgear to be controlled is selected in the single line diagram by a circle marker and switched by the control keys »ON« and »OFF«. These two keys are exclusively reserved for this purpose.

Note

A detailed description of the local control of switchgears is contained in the chapter "switchgear control via *CMP1*".

6.2.5.3 Remote control via digital inputs depending on the switching authorization in Mode 3

Conventional signal lines can be connected to digital inputs of the *CSP* device. Furthermore input functions (DI-functions) have to be assigned to the digital inputs in order to execute the switching actions (from remote site).

Attention

In the case of longer signal lines (>3 m), it is imperative to use shielded conductors to avoid possible voltage coupling which could lead to an uncontrolled activation of the digital inputs.

For the switchgear control via digital inputs or logic equations the following input functions are available:

- "Cmd1 SG1 on"
- "Cmd1 SG1 off"
- "Cmd2 SG1 on"
- "Cmd2 SG1 off"
- "Cmd SG2 on"
- "Cmd SG2 off"
- "Cmd SG3 on"
- "Cmd SG3 off"
- "Cmd SG4 on"
- "Cmd SG4 off"
- "Cmd SG5 on"
- "Cmd SG5 off"
- "Ext CB1 off"
- "Ext CB1 on" (only in connection with SCADA enable command)
- "Ext CB2 off"
- "Ext CB2 on" (only in connection with SCADA enable command)

Attention

Digital inputs for control commands ON are in general processed edge controlled by the *CSP2*!
Digital inputs for control commands OFF are in general processed level controlled by the *CSP2*!
This means that the switch-off of a switchgear has a higher priority than a switch-on.
Example: a circuit breaker is switched on via a digital input with the DI-function "Cmd1 SG1 ON". It is assumed that the signal line for this DI carries potential continually and thus the DI continues to be active. The command ON thus is still present. If now a signal for switch-off is sent via another DI (DI-function "Cmd1 SG1 OFF"), the switch-on command still present is ignored by the *CSP2* and the switch-off of the circuit breaker is executed.

In the opposite case, a switch-on command cannot overwrite a present switch-off command!

6.2.5.4 Control commands via digital inputs independent of switching authorizations

In order to be able to control – independent of the switching authorization (local/remote) – 10 control commands were added to the system. These input functions can also be assigned to digital inputs or logic equations.

- "S-Cmd SG1 on"
- "S-Cmd SG1 off"
- "S-Cmd SG2 on"
- "S-Cmd SG2 off"
- "S-Cmd SG3 on"
- "S-Cmd SG3 off"
- "S-Cmd SG4 on"
- "S-Cmd SG4 off"
- "S-Cmd SG5 on"
- "S-Cmd SG5 off"

6.2.5.5 Remote control via SCADA system

For the remote control of the switchgears via SCADA-system, likewise MODE 3 (remote operation/control) must be selected.
Remote control via SCADA and via the input functions cmd x SG x on/off have equal rights, as both control sites can be considered as remote control sites. The DI-function

- „Ext. CB1 on"

is the only exception, as here the switch-on of the circuit breaker is only executed when beforehand a corresponding enable command was issued by the SCADA-system.

With the above limitation, the control commands can in general be sent and executed either via the serial interface for the SCADA-system (e.g. IEC 60870-5-103-Protocol) or via digital inputs.

Note

In MODE 3, a switchgear control via the *CMP1* is not possible, as the call-up of the CONTROL MODE is prevented by the fade-out of the line "operate".

6.2.6 Supervision functions for switchgear control

Supervision functions serve for the increase of availability of MV-switchgears. The *CSP2* disposes of a group of different functions for status supervision of switchgears as well as for supervision of switching actions.

Monitoring Functions	
Function	*Description*
Supervision of Switch Positions	Supervision of ON/OFF signals for the switching device position check-back messages (display symbols, LED indications)
Digital Monitoring Functions	Processing of signals issued by the switching device or the panel
Control times	Supervision of the CB, isolator or earthing switch operating times
Supervision of Control Circuits CCS	Protective function
Circuit Breaker Failure Protection CBF	Protective function

Table 6.3: Supervision functions in the CSP2

Supervision of the switch positions
The optical display of the present switch positions is effected mainly via the display (see chapter "detection of switchgears").
Additionally, according to the switch position, certain output messages are activated which can be assigned to LEDs or signal relays. The following output messages are available:

- "Pos. SG1 on"
- "Pos. SG2 on"
- "Pos. SG3 on"
- "Pos. SG4 on"
- "Pos. SG5 on"
- "Pos. SG1 off"
- "Pos. SG2 off"
- "Pos. SG3 off"
- "Pos. SG4 off"
- "Pos. SG5 off"
- "Pos. SG1 fail"
- "Pos. SG2 fail "
- "Pos. SG3 fail "
- "Pos. SG4 fail "
- "Pos. SG5 fail "
- "Pos. SG1 diff"
- "Pos. SG2 diff "
- "Pos. SG3 diff "
- "Pos. SG4 diff "
- "Pos. SG5 diff "

For detailed descriptions of these output messages see chapter "Output relays".

supervision functions via digital inputs or logic
Cubicles and switchgears dispose of auxiliary contacts by which certain events can be signalized. The signal lines of the auxiliary contacts can be led to digital inputs which themselves can be assigned to corresponding input functions (DI-functions) in order to initiate suitable processes by the *CSP2*.

The monitoring functions include:

- „SF6 Alarm“
- „Plug CB1 out“
- „Plug CB2 out“
- „CB1 ready“
- „CB2 ready“
- „Fuse fail VT“
- „Fuse fail AV“
- „CSS Alarm“
- „Ext prot. act.“
- „Fuse fail VC“
- „Fuse fail VEN“
- „Fuse fail HH“
- „Ext. CB trip“
- „Bypath1 CB on“
- „Bypath1 CB off“
- „Bypath2 CB on“
- „Bypath2 CB off“
- „Load shedding“

Not each of these input functions when activated leads automatically to the initiation of an action by the *CSP2*.
Some of the supervision functions serve only for messages and can be further processed in conjunction with signal relays and other digital inputs.
(For a detailed description of the above DI-functions see chapter " digital inputs".

Control times
Switch operating times are monitored in the *CSP2* via the set control times (see chapter "control times". These are separately settable for each switchgear and when exceeded, activate the following output messages:

- „Switchgear fail“ (common message)
- "SG1 timeout"
- "SG2 timeout"
- "SG3 timeout"
- "SG4 timeout"
- "SG5 timeout"

If one of these output messages becomes active due to a control time being exceeded, all switching commands are blocked. Only after establishment of the defined end positions (On or Off) for all switchgears of the field and the acknowledgement (key "C", via SCADA or digital input "Quit" (acknowledgement) can a renewed switching attempt be performed again.
(For a detailed description of the above mentioned input functions see chapter "signal relays".

Control circuit supervision CSS
This is a protection function which serves for monitoring the control inputs for interruptions. Here, the internal power circuit of the *CSP2* as well as the external switching circuits of the periphery connected to the *CSP2* are checked (see chapter "control circuit supervision CSS").

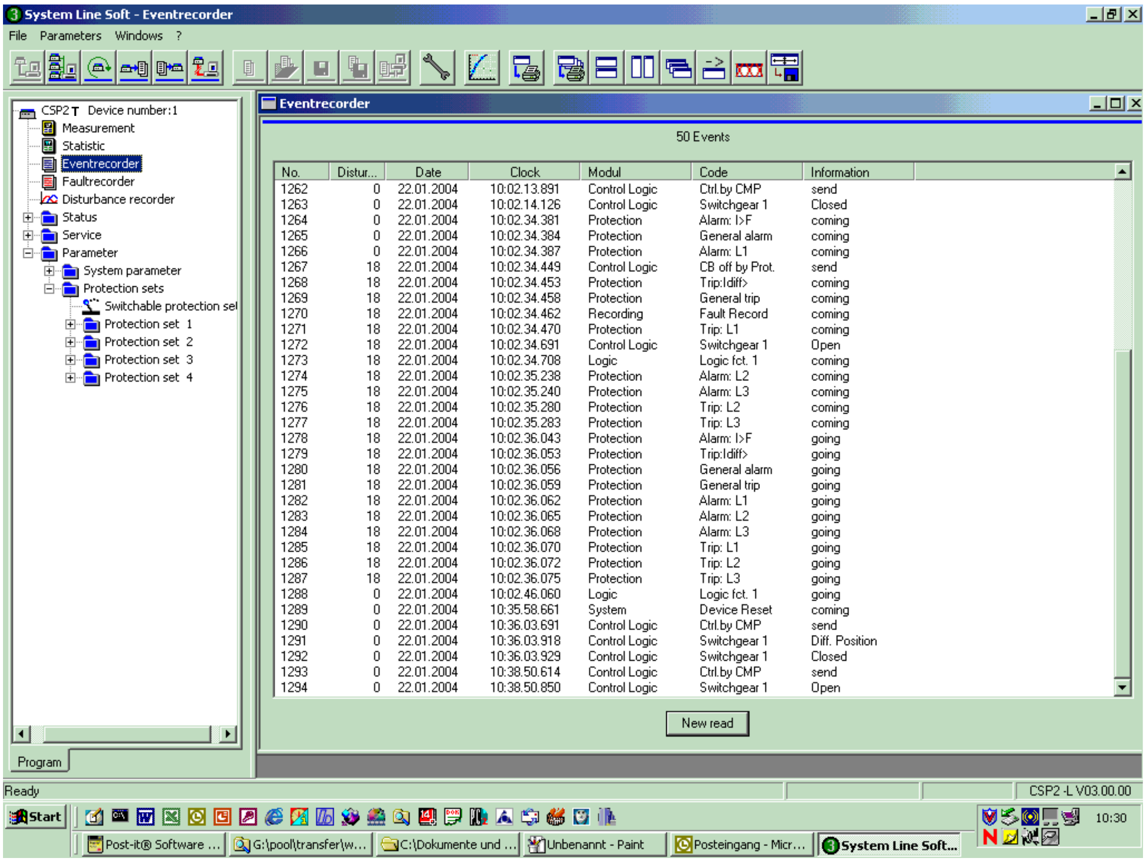
Protection against circuit breaker failure CBF
Also the circuit breaker failure protection is a protective function which in case of an activated protection trip monitors the switch-off of the circuit breaker and the dying down of the fault current related thereto (see chapter "circuit breaker failure protection".

6.2.7 Logging of the switch actions

Each switching action, switch position change or supervision message is logged into the *event recorder* with a storage depth of 50 events (first in, first out) for subsequent analysis and evaluation. Information like e.g. switchgear, switching command source (local/remote), switch result, time stamp etc. is recorded.

Switch actions having an influence on other functions of the *CSP2*, generate corresponding entries in the event recorder which refer to events leading further. If e.g. a switching action for a circuit breaker is carried out, this has an influence on the protection functions. When e.g. switching the CB on or off, the AR-function is temporarily blocked. This AR-blockade is reported by the message "AR blocked" via the event recorder. Information "event on" (info comes) and "event off" (info goes) designates the begin and also the end of the period of active AR-blockade (see examples).
Events related to protective tripping can further give information by the evaluation of disturbance records.

Examples for the logging of switching actions:



No.	Distur...	Date	Clock	Modul	Code	Information
1262	0	22.01.2004	10:02.13.891	Control Logic	Ctrl.by CMP	send
1263	0	22.01.2004	10:02.14.126	Control Logic	Switchgear 1	Closed
1264	0	22.01.2004	10:02.34.381	Protection	Alarm: I>F	coming
1265	0	22.01.2004	10:02.34.384	Protection	General alarm	coming
1266	0	22.01.2004	10:02.34.387	Protection	Alarm: L1	coming
1267	18	22.01.2004	10:02.34.449	Control Logic	CB off by Prot.	send
1268	18	22.01.2004	10:02.34.453	Protection	Trip:Idiff>	coming
1269	18	22.01.2004	10:02.34.458	Protection	General trip	coming
1270	18	22.01.2004	10:02.34.462	Recording	Fault Record	coming
1271	18	22.01.2004	10:02.34.470	Protection	Trip: L1	coming
1272	18	22.01.2004	10:02.34.691	Control Logic	Switchgear 1	Open
1273	18	22.01.2004	10:02.34.708	Logic	Logic fct. 1	coming
1274	18	22.01.2004	10:02.35.238	Protection	Alarm: L2	coming
1275	18	22.01.2004	10:02.35.240	Protection	Alarm: L3	coming
1276	18	22.01.2004	10:02.35.280	Protection	Trip: L2	coming
1277	18	22.01.2004	10:02.35.283	Protection	Trip: L3	coming
1278	18	22.01.2004	10:02.36.043	Protection	Alarm: I>F	going
1279	18	22.01.2004	10:02.36.053	Protection	Trip:Idiff>	going
1280	18	22.01.2004	10:02.36.056	Protection	General alarm	going
1281	18	22.01.2004	10:02.36.059	Protection	General trip	going
1282	18	22.01.2004	10:02.36.062	Protection	Alarm: L1	going
1283	18	22.01.2004	10:02.36.065	Protection	Alarm: L2	going
1284	18	22.01.2004	10:02.36.068	Protection	Alarm: L3	going
1285	18	22.01.2004	10:02.36.070	Protection	Trip: L1	going
1286	18	22.01.2004	10:02.36.072	Protection	Trip: L2	going
1287	18	22.01.2004	10:02.36.075	Protection	Trip: L3	going
1288	0	22.01.2004	10:02.46.060	Logic	Logic fct. 1	going
1289	0	22.01.2004	10:35.58.661	System	Device Reset	coming
1290	0	22.01.2004	10:36.03.691	Control Logic	Ctrl.by CMP	send
1291	0	22.01.2004	10:36.03.918	Control Logic	Switchgear 1	Diff. Position
1292	0	22.01.2004	10:36.03.929	Control Logic	Switchgear 1	Closed
1293	0	22.01.2004	10:38.50.614	Control Logic	Ctrl.by CMP	send
1294	0	22.01.2004	10:38.50.850	Control Logic	Switchgear 1	Open

Figure 6.9: Switch-off of the circuit breaker via key "off" (key with a "zero-symbol" on it) of the CMP1

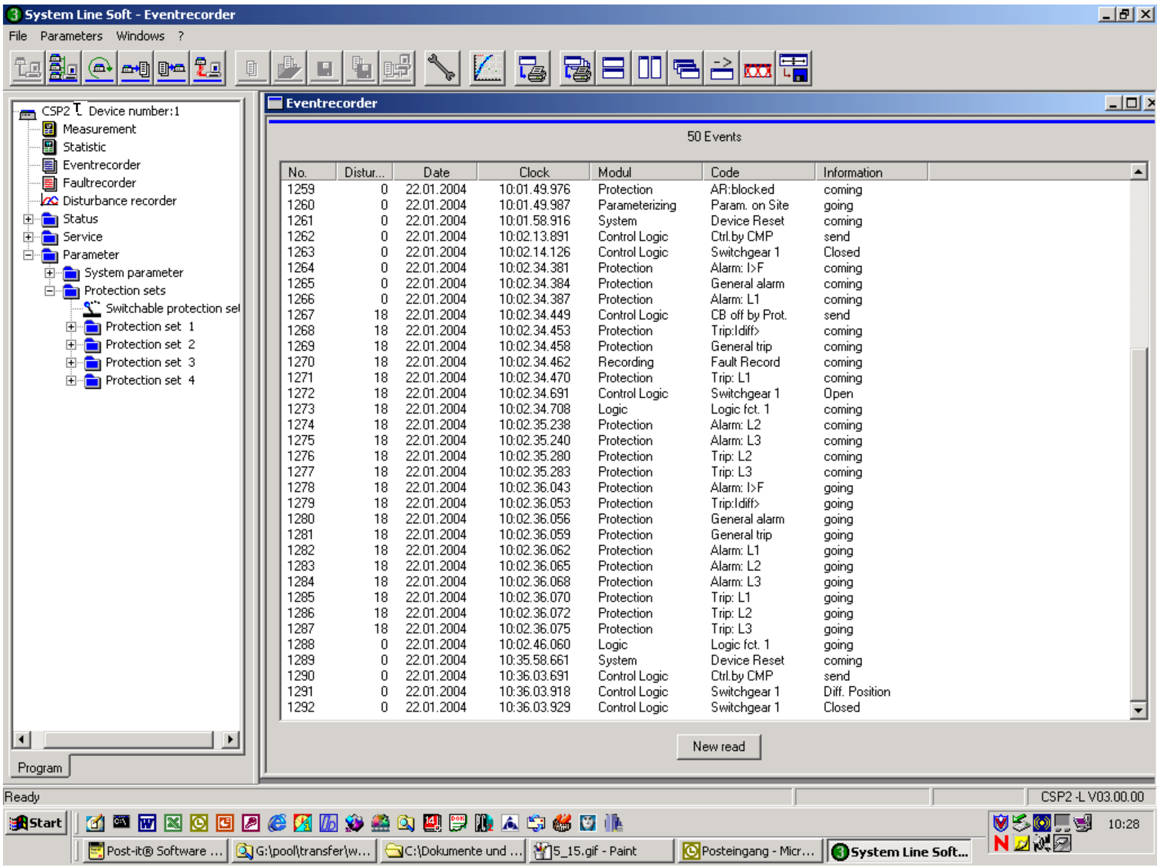


Figure 6.10: Switch-on of the circuit breaker via key "on" (key with a "I-symbol" on it) of the CMP1

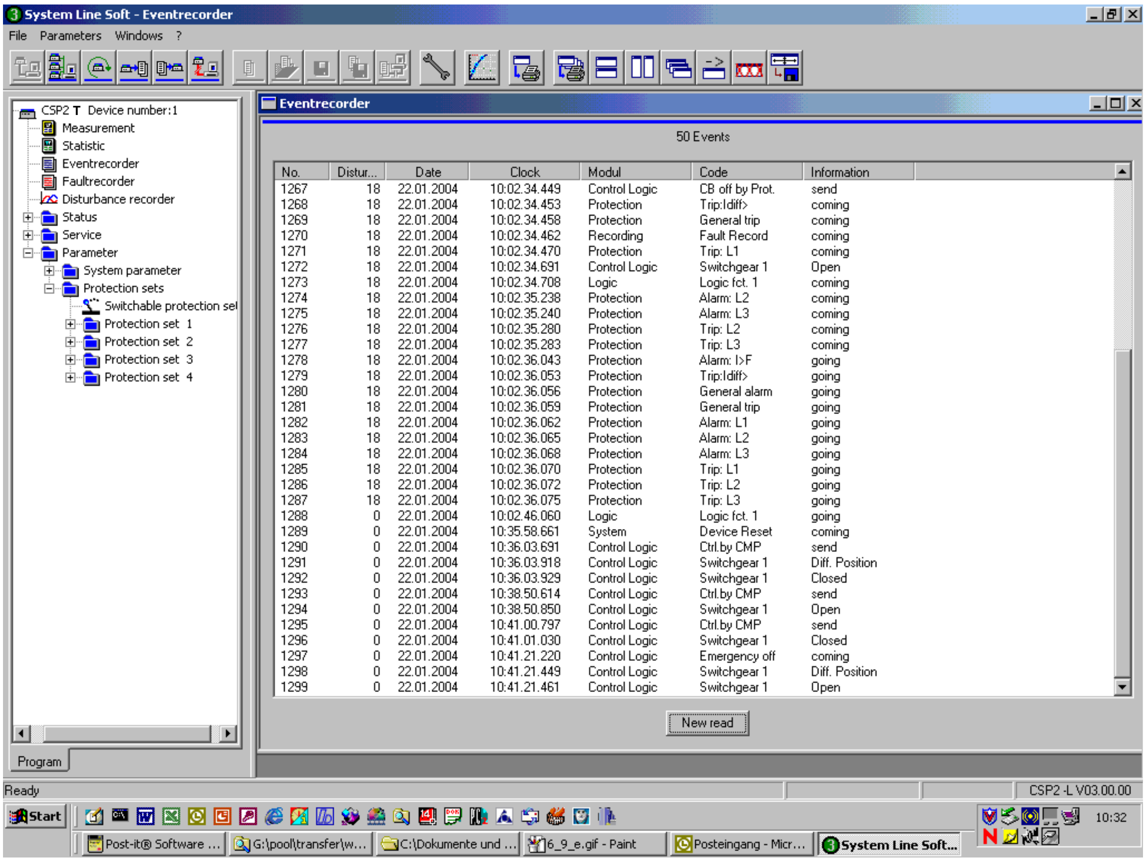


Figure 6.11: Switch-off of the circuit breaker via key "Emergency off" of the CMP1

7 Interlockings

Faulty switching actions which lead to arc short-circuits can be avoided by *interlocking*. The interlocking is to be constructed in such a way that it is effective in all switching actions, regardless of the control position implementing them.
Interlocking of devices prevent inadmissible switching actions. Simple field-related interlockings take into account that, for example, disconnecting switches are not switched with the circuit breaker in on-position or that circuit breakers cannot be switched on if auxiliary energy is missing (spring not changed or low gas pressure). *Plant-related lockings* check across a number of fields, e.g. the coupling position or the position of the bus-bar earthing switch.

Mechanical lockings
Simple interlocking tasks within a switching field interlocking on feeder level can be solved *mechanically* with blocking pawls by, for example, contact of the connecting rod assembly for the earthing switch by cutting off being prevented with the circuit breaker switched on. Combined switchgears such as a disconnecting switch with an integrated earthing switch (three-position switch) are interlocked against one another by their mechanical set-up.

Electrical interlockings
The most variable use, in particular in system interlockings (interlocking on station level), is possible with *electrical interlocking*. It either intervenes into the control circuits directly by interrupting the operating circuits with the help of relays or electronic circuits or locks switching actions via blocking magnets.

7.1 General locking guidelines (extract from VDE 0670-7)

Interlockings between various devices and components are necessary for safety and practicality. The following stipulations are mandatory for main current circuits:

1. *Insulation enclosed switchboards with removable parts:*
   removing or insertion of a circuit breaker, switch disconnector or relay may only be possible if this switching device is switched off. Operation of a circuit breaker, switch disconnector or relay may only be possible if this switching device is in the operating, disconnecting, outer, test or earthing position. It may not be possible to switch a circuit breaker or a relay on in the operating position without this switchgear having been connected to the auxiliary current circuit.

2. *Insulation enclosed switchboards without removable parts, with disconnecting switch:*
   Interlockings prevent disconnecting switches from being operated under inadmissible conditions [see VDE 0670 part 2]. Operation of a disconnecting switch designed for switching only in a current-free condition may only be possible if the circuit breaker, load break switch or the relay in question has been switched off.
   Operation of a circuit breaker, switch or relay may only be possible if the disconnecting switch in question is either in the opened or in the closed position.

The inclusion of additional or other interlockings is to be agreed between manufacturers and operators. The manufacturer shall give all the necessary information about the nature and function of the interlockings.
We recommend interlocking earthing switches with a short-circuit switch-on capability under the nominal surge current of the circuit with the disconnecting switches in question. Devices integrated in the main current circuits, faulty operation of which can cause damage, or which are used to maintain the disconnection during maintenance work, are to be provided with possibilities of blocking (e.g. padlocks).

Note

As far as possible, mechanical interlockings (emergency operability) are to be prefered.

7.2 Interlocking functions of the *CSP2*

Alongside the switchgear control, the interlocking/release of switchgears is an integral component of the control technique in medium voltage.
The interlockings prevent the unauthorized switching of the switches for conditions not safe for operation and thus protect against far-reaching damage to persons and property.

Interlockings are used for:

- safety against unintentional faulty operation
- operational safety
- plant safety and
- personal safety.

In addition to the switching authorizations, the control sovereignty can also be controlled and assigned via switchgears interlockings from "local" or "remote".

Attention

All internal and external protection trippings as well as the "Danger off" function are not subject to any kind of locking commands.
Internal protection functions: external protection blockade and backward interlocking!

Many supervisions and lockings customary in medium-voltage technique are deposited as a default in the *CSP2 (s. Table of the input functions in Chap. "Digital Inputs").*

Each locking violation during the control processes is written in the event recorder as "interlocking coming" and can be displayed by LED or assigned on signal relays for further processing as assignable output messages "Interlock".

In medium voltage, a distinction is made between interlocking at *"Feeder level"* and interlocking at *"Station level"*.

7.2.1 Interlocking at feeder level

The lockings are only subject to the specific signals of the switch field. This includes not only the interlockings of the switchgears amongst one another, but also the consideration of monitoring reports such as "CBx ready" or "Plug CBx out".

7.2.1.1 Internal interlock matrix for interlocking at feeder level (Design with SL-Draw)

With the *internal interlock matrix,* the admissibility and thus the execution of a switch command is checked as a function of the position signals (state information) of the switchgears. The interlock matrix is configured according to customers' requirements. Depending upon the switching command, up to five "OR connected" conditions can be checked. Each "OR connected" condition for its part can contain up to five "AND connected" position check back signals (state information) of the switchgears. If one of the conditions is fulfilled, the switching command is discarded.

7.2.1.2 Interlocking with faulty switch position

As soon as one of the supervised switchgear remains in an inadmissible switch position (intermediate position or faulty position), all the control processes are blocked.

Exception

Tripping commands of internal and external protection trips and "Emergency Off" function.

7.2.1.3 Interlocking in double operation (anti-pumping)

Repeated control commands such as switching a switchgear on twice, are not executed by the *CSP2* (anti-pumping).

Exception

Tripping commands of internal and external protection trips and control commands for "CB OFF" (the OFF commands are also sent if the circuit breaker is in the OFF position.)

7.2.1.4 Interlocking when sending control commands during a control process

In the *CSP2* only one control processes at a time is executed until the check back signals report of the switch-gear are available. Other control commands issued during this time are rejected.

Exception

If a protection trip takes place during a control command issue (e.g. for a disconnector or earthing switch), the command issue for the disconnector or earthing switch is stopped and the protection trip executed.

7.2.1.5 Interlocking with protection trips

Protection trips can be launched by

- internal protection functions of the *CSP2* or by
- external protection trips via digital inputs of the *CSP2*.

As soon as a protective tripping is available as "active", no circuit breaker can be switched on. Disconnectors and earthing switches can be controlled.

The following input functions block, as long as they are active, the switching on of the CB:

- „Trip: Prot.1"
- „Trip: Prot.2"
- „Trip: Prot.3"
- „Trip: Prot.4"
- „Trip: Prot.5"
- „Trip: Prot.6"
- „Trip: Temp"
- „Trip: Buchh"
- „Trip: Diff"
- „Trip: Imped"
- „Trip: Motor"

(please refer to chapter „Digital Inputs" / table of input functions)

7.2.1.6 Interlocking with active parameter "Trip acknowledge"

If the parameter "*trip ack*" (tripping acknowledgement) is parameterized as *"active"*, control is only possible again after acknowledgement of the previous protection tripping which is no longer available.

7.2.1.7 Interlocking through supervision functions (digital input functions)

In the *CSP2* some input functions have been implemented as supervision functions:
In assignment of these functions, their status is automatically considered in intended control processes for the circuit breaker and, if applicable, the plug-in.

- „CB1 ready" (blocking of the control command, if the input function is assigned, but inactive),
- „CB2 ready" (blocking of the control command, if the input function is assigned, but inactive),
- „plug CB1 out" (blocking of the control command, if the input function is active),
- „plug CB2 out" (blocking of the control command, if the input function is active)

(see list of input functions in the Chap. "Digital inputs")

7.2.1.8 Interlockings in remote control via digital inputs or logic

For the external control commands, the switching authorisation (upper *CMP* key switch) can only be granted in the »REMOTE CONTROL« mode. The following *control functions* are available *as input functions*:

- "Cmd1 SG1 on" (taking the interlockings into account)
- "Cmd1 SG1 on" (taking the interlockings into account)
- "Cmd2 SG1 on" (taking the interlockings into account)
- "Cmd2 SG1 on" (taking the interlockings into account)
- "Cmd SG2 on" (taking the interlockings into account)
- "Cmd SG2 on" (taking the interlockings into account)
- "Cmd SG3 on" (taking the interlockings into account)
- "Cmd SG3 on" (taking the interlockings into account)
- "Cmd SG4 on" (taking the interlockings into account)
- "Cmd SG4 on" (taking the interlockings into account)
- "Cmd SG5 on" (taking the interlockings into account)
- "Cmd SG5 on" (taking the interlockings into account)
- "Ext CB1 on" (only implemented with approval command by station control (IEC 60870-5-103) and taking the interlockings into account)
- "Ext CB1 off" (without taking the interlockings into account)
- "Ext CB2 on" (only implemented with approval command by station control (IEC 60870-5-103) and taking the interlockings into account)
- "Ext CB2 off" (without taking the interlockings into account)

(see list of input functions in the Chap. "Digital inputs")

Note

Indices in the function designations (signal message text) permit unambiguous multiple use of a control function.

Attention

The OFF control commands have higher priority than the ON control commands. As long as an OFF control command is available (voltage level detection for DI), ON control commands which have been sent are not processed for the corresponding switchgear by the *CSP2*. An available ON control command (voltage edge detection for DI) can be overwritten by an OFF control command at any time.

7.2.2 Interlockings at station level

For interlocking, signals from other switchboards or common signals are also used. Alongside the detection of bus-bar earthers, the switch positions of coupling and feed switches, for example, can block certain control processes in the individual fields.

7.2.2.1 Interlocking via input functions

The implementation of the plant lockings in conventional technique (parallel wiring) can be implemented across the entire plant by means of contact lines. For this, various input functions are available to the user for the locking of individual or a number of switchgears, blocking the control regardless of the switching sovereignty:

- "Ctrl. blocked 1"
- "Ctrl. blocked 2"
- "SG1 block."
- "SG2 block."
- "SG3 block."
- "SG4 block."
- "SG5 block."
- "SG23 block."
- "SG234 block."
- "SG2345 block."
- "SG1 on block. 1"
- "SG1 on block. 2"

(see list of input functions in the Chap. "Digital inputs"):
Indices in the function designations (signal message text) permit unambiguous multiple use of an interlocking function.

Attention

Interlockings via programmable logic functions are active independent of the switching authorization (Local/Remote).

7.2.3 Interlocking after external load shedding (Input-function)

If the circuit breaker is switched off by an external load shedding, in which the OFF command goes directly from the external source to the circuit breaker and is thus issued parallel to the control circuits of the *CSP2*, additional assignment of the "Load shedding" input function prevents a switch-on of the circuit breaker by a control command (also AR). The switch-on interlocking is active as long as the digital input has been set.

7.2.4 Interlockings via programmable logic functions (SL-LOGIC)

Customer-specific interlockings on station level could be realised by using the programmable logic functions (*SL-LOGIC*) which are in the scope of *CSP2* functionality. The affordable logic equations are to be configured matching the adequate input elements, time delay of the logic output and also the functional configuration of the logical output.

The input elements of the logical equations are to be chosen from the list of output messages.
(see list of output elements of chapter „Alarm relays")

To give an interlocking command, the *logic output* of the equation

- „Logic fct. 1"
- „Logic fct. 2

  .
  .
  .
- „Logic fct. 32"

has to be configured with an *interlocking function* which considers *one* switching device or *several* or *all* devices

- „Ctrl. blocked 1"
- „Ctrl. blocked 2"
- „SG1 block."
- „SG2 block."
- „SG3 block."
- „SG4 block."
- „SG5 block."
- „SG23 block."
- „SG234 block."
- „SG2345 block."
- „SG1 on block. 1"
- „SG1 on block. 2"

(see list of input functions of chapter. „Digital Inputs")

Note

Chapter „Programmable logic functions (*SL-LOGIC*) gives conclusion about the common way of programming the logical equations.

Attention

Interlockings via programmable logic functions are active independent of the switching authorization (Local/Remote).

7.2.5 Interlocking via SCADA system or *CMP1*

As an extension, the *CSP2* has fail-safe stored and device-internal interlock markers for all controllable switchgears, which can be set or reset via SCADA or the parameter setting via the *CMP1*. All the switchgears can be locked separately for each control device or generally for all control processes in this way.
The markers can be changed via the control technique independent of the switching sovereignty. Consideration of the switching sovereignty (*CMP* key switch for local/remote control) can be done within the SCADA system.

In parameterization mode (mode 2, local operation and control, parameter setting), the interlocking markers can be set or deleted via the *CMP1* or via the *SL-SOFT*. In this way, an internal interlocking can be realized if the control technique fails or in certain operating conditions of the plant. In this way, also temporary switchboard interlockings during a construction phase can be realized without wiring being necessary. In this mode, the markers cannot be set via SCADA.

In the sub-menu "Interlocking" of the *CSP2*, the current status of the internal interlock markers is displayed. If the status of an interlock marker is "active", there is an interlocking of the control command(s) for the switchgears in question.

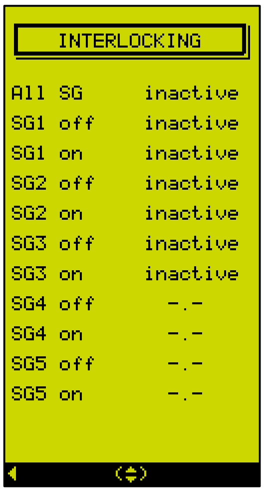


Figure 7.1: status display of the interlocking markers

The set markers are available on the one hand as assignable output messages for the LED display and further processing by signal relays (see list of output messages in Chap. *"Signal relay"*):

- "All SG1"
- "SG1 off"
- "SG2 off"
- "SG2 on"
- "SG3 off"
- "SG3 on"
- "SG4 off"
- "SG4 on"
- "SG5 off"
- "SG5 on"

On the other hand, a corresponding entry is registered in the event recorder if a marker has been set via the *SCADA* or the *local parameter setting* (MODE 2):

- “Interlock: CMP“ (report that a marker has been set via the *CMP1*)
- “Interlock: SCADA“ (report that a marker has been set via the SCADA)

In the "Interlockings" sub-menu of the *CSP2*, the current status of the internal interlock markers is displayed. If the status of an interlock marker is active, there is an interlock of the control command(s) for the switching device(s) in question.

8 Communication

SCADA communication
The *CSP2* is a *high-quality digital protection and control system* for many applications in the *medium voltage* range. Additionally to a multitude of protection functions, it combines the measurement, supervision and control of switchgears in one system. All relevant information of the *medium voltage* panel is processed by the *CSP2/CMP1* system and made available to a master system on mains level.
The *control technique* constitutes the central *subarea of the system technique* and takes over functions like the following at the master level:

- controlling,
- interlocking,
- measurement, displays
- signalizing,
- counters (e.g. operation hours)

SCADA leads via a quick fault detection and high operational safety to a high availability of the switchboard and, moreover, results in cost reductions regarding operation personnel by its simple construction.
The required communication between the master computer of the SCADA-system (station level) and the protection/control system (field level) is effected via different protocol variants (type of the data protocol) and means of transmission (type of the physical connection) the application of which is subject world-wide to different standards.

Operation software for single and multiple-device communication (secondary communication level)
Due to the limited information transmission of the SCADA connection (e.g. via IEC 60870-5-103), a *second information level* is offered by many protection device manufacturers to make possible a redundant evaluation of the devices.
This redundant evaluation is carried out in the *CSP2* by application of the operation software *SL-SOFT*. The required communication distance between the PC/notebook and the *CMP/CSP* systems can either be executed as *single- or multi-device communication*.

The connection of the PC/notebook via the internal system CAN bus, renders this second information level accessible to the user.

In the following, the different communication possibilities are shown and general explanations of the different variants regarding the *primary and secondary communication* levels given.

8.1 Overview

The tabular overview below gives information about the different possibilities of communication of the primary and secondary communication levels of the *CSP2/CMP1* systems

Communication Options of the CSP2/CMP1-Systems		
Protocol Types	*Phys. Lacing (Serial Interface)*	*Applications*
IEC 60870-5-103	FO	SCADA communication
	RS485	
PROFIBUS DP	FO	SCADA communication
	RS485	
MODBUS RTU	FO	SCADA communication
	RS485	
CAN-BUS	CAN1	Single device communication CSP2 – CMP1
	CAN1: Variant 1	Multi device communication: one CMP1 – several CSP2
	CAN1: Variant 2	Multi device communication: several CMP1 – several CSP2

Table 8.1: List of Communication Interfaces

8.2 Protocol type IEC 60870-5-103

This protocol IEC 60870-5-103 is very common in the European region and used predominantly by energy supply utilities.

Structure
This protocol is distinguished from the information transmission in two areas: the standardised "compatible range", in which the type of function is defined according to the protection task of the field management system (e.g. line differential protection, transformer differential protection or time overcurrent protection), and the "private range", in which the individual device functions (control commands), messages and measurement values are defined which exceed the compatible range and cannot be assigned to any single protection task.

8.3 Protocol type PROFIBUS DP

The connection of the combined protection and control systems *CSP2/CMP1* with the SCADA system via the communication variants PROFIBUS DP is based on Standard EN 501702.
The data protocol PROFIBUS DP is the most frequently used communications protocol in industrial bus systems due to its high transmission speed, efficiency and the optimised and thus lower connection costs. It is especially suitable for the communication between the decentralised periphery devices (field level) and the different automation systems (station level).

Note

In case of using the data protocol type PROFIBUS DP it is not possible to apply CSP2 multi device communication

The linking of the *CSP2* systems with PROFIBUS DP enables the inclusion of medium voltage applications in the automation world like building or process control engineering.
By further processing in industrial communication systems, the detected data of the field level are rendered more transparent for the most different applications and can also be processed further e.g. in energy management systems of higher level inter-connected systems.

Extent of the functions of PROFIBUS DP

Output data of the CSP2 slaves:

- information on device version,
- measurement values,
- switch positions,
- device status,
- time and date,
- status of the digital inputs of the device
- protection status messages and
- number of switching cycles.

Input data of the CSP-slaves:

- control of the switch elements,
- switch-over of parameter sets,
- resetting and acknowledging of messages,
- setting of date and time
- control of the signal relay.

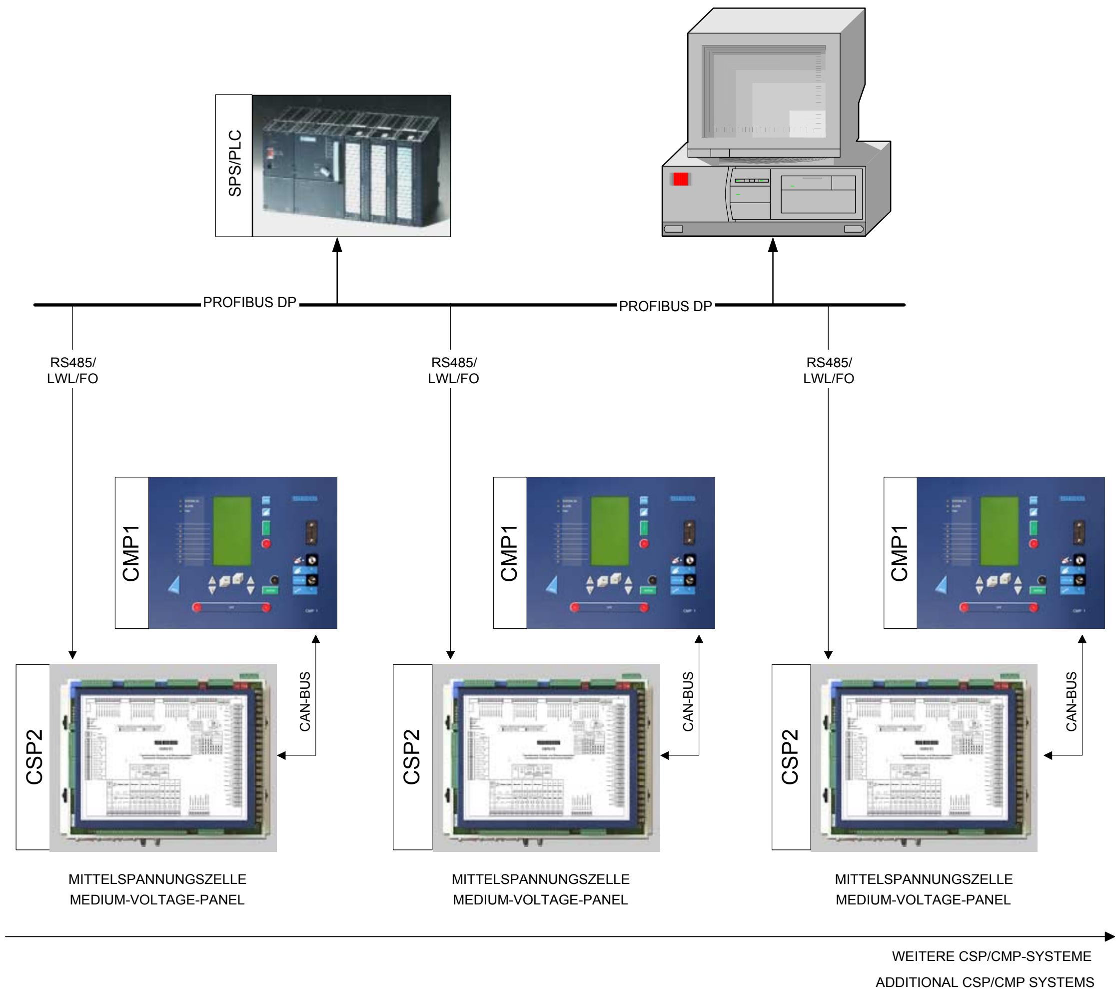


Figure 8.1: Primary communication level with PROFIBUS DP

8.4 MODBUS RTU-Protocol

This data protocol is predominantly used in Far East, Latin America, Eastern Europe as an industial bus-system in order to connect automation-systems.
Usually the automation-system manufactor offers a corresponding driver (library) within the standard scope of delivery.

Structure
Compared to others (e.g. *IEC 60870-5-103*, the *Modbus RTU* Protocol is built up rather simple).

8.5 Communication examples

As shown as follows multiple connection types – field management system *CSP2* to SCADA – can be realized.
The physical connection of the *CSP/CMP*-systems to the SCADA system is flexible. Thus customized communication solutions/connectionscan be realized.

8.5.1 Physical linking via fibre optic FO (star coupler)

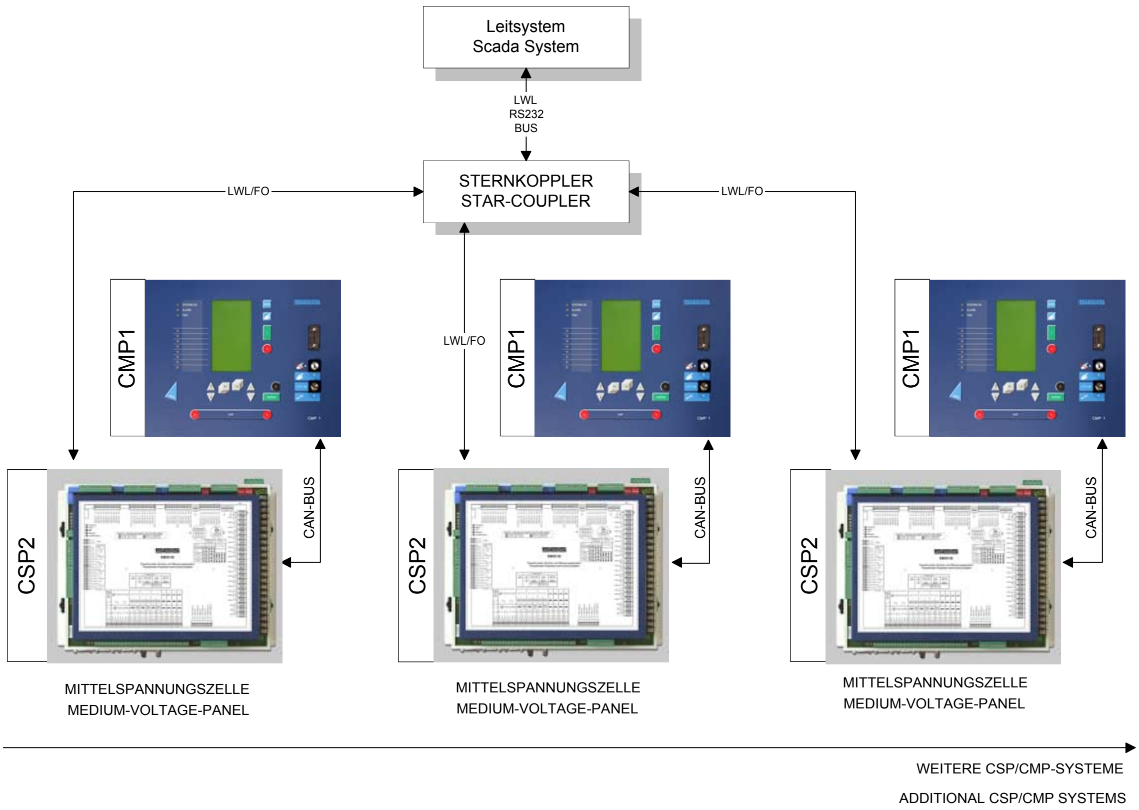


Figure 8.2: Linking via optical waveguide (LWL)

8.5.1.1 Illustration example star-coupler

Figure 8.3: Illustration example 1 – star-coupler

Figure 8.4: Illustration example 2 – star-coupler

8.5.2 Physical connection (link) via RS485

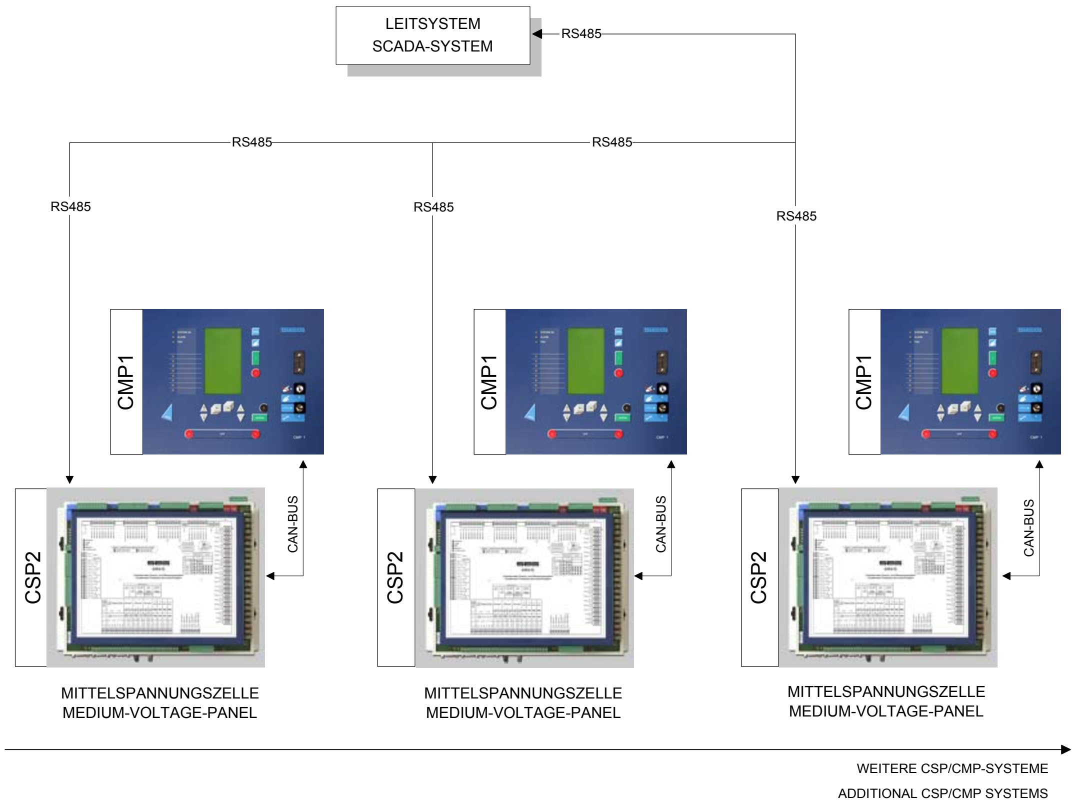


Figure 8.5: Linking via RS 485 (indirectly)

8.5.3 Physical connection (link) via RS232

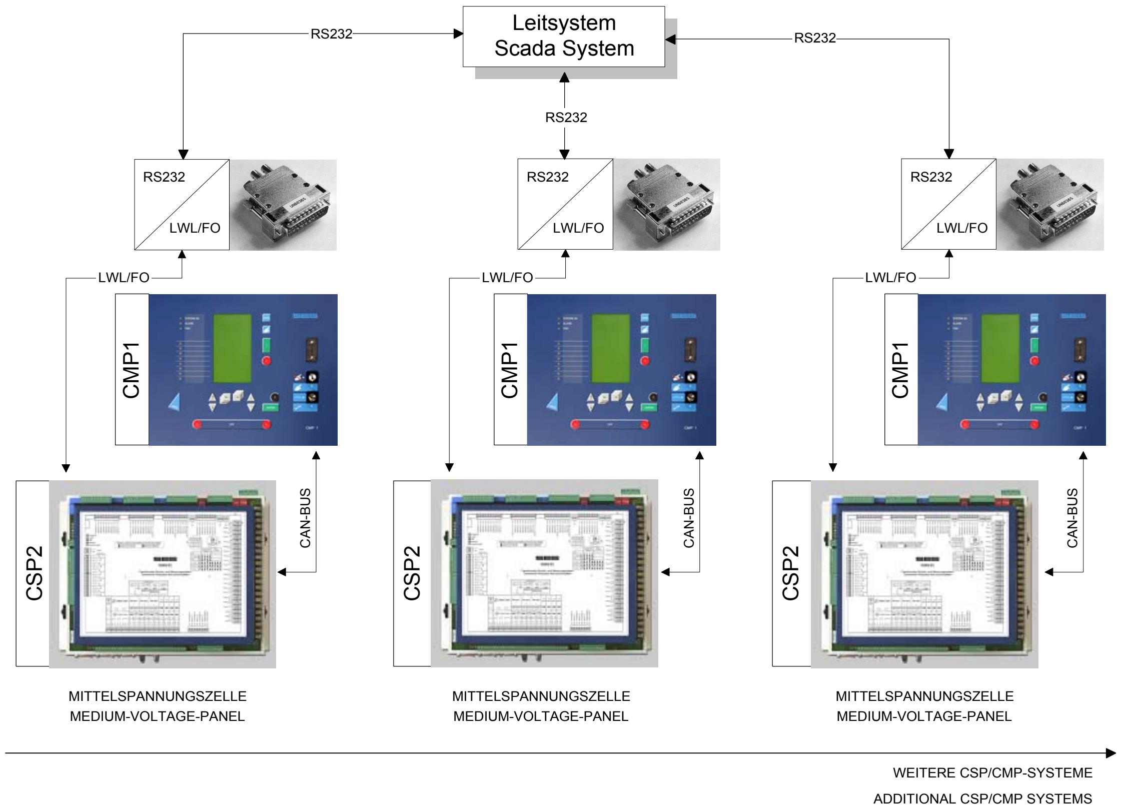


Figure 8.6: Communication via RS232

8.6 *CSP2* Multi-device communication

The term "multi-device communication" means connection of several *CSP2 (CMP1)* systems among each other via a communication bus (CAN) and enables in this way operation of the individual *CSP2*-devices (slaves) from a central site (PC/CMP1).
According to the customer needs, the *CSP/CMP*-system offers two types of multi device communication. For details please refer to the next chapter ("Variants of the *CSP2* multi-device communication").

Note

In case of using the data protocol type PROFIBUS DP it is not possible to apply CSP2 multi device communication

For the realization of a multi-device communication, certain prerequisites must be fulfilled in the construction of the bus-system and in the device configuration to guarantee communication capability of the bus. In general, the *CSP2/CMP1*-systems are correspondingly configured and marked before delivery during the project processing in the scope of the technical pre-clarification, so that the mounting and commissioning can be effected without problems.

Note

Should it become necessary at a later time, however, to exchange individual *CSP2*- or *CMP1*-devices (e.g. due to a construction change of the switching system), the procedures mentioned in the following chapters must be observed.

By using converters or modems, a remote communication can be constructed which e.g. makes possible a remote parameter setting of the individual *CSP2 (CMP1)*-systems.

8.6.1 Variants of the *CSP2* multi-device communication

Possibilities of using the multi-device communication:

- Operation of the *CSP2*-devices via a PC by using the operation software *SL-SOFT* from a central site (variants 1 and 2)
- Operation of the *CSP2*-devices via a single *CMP1* (only variant 2)

Variant 1
Here, each *CSP2* disposes of an own operation and display unit *CMP1*. A PC can be connected with an RS232-interface of any *CMP1* via the constructed CAN BUS system. By using the operation software *SL-SOFT*, the individual *CSP2*-devices can be separately pre-selected when a communication connection between any *CMP1* and a PC/laptop has been established correspondingly. Now the full extent of the *SL-SOFT* is available for operation of the *CSP2*-devices.

Variant 2
The main purpose of this variant is the reduction of the number of *CMP1*-devices. The local access to the *CSP2*-devices in the CAN-BUS distance is effected here by a joint operation and display unit *CMP1* via the menu "Select device".

Attention – danger to life!

The *CMP1* communicates always only with one *CSP2*! The pre-selection (logging into a device) into another *CSP2* occurs only via the menu guidance of the *CMP1* and thus requires time. Hence that it must be ensured during the projecting that important functions such as "Emergency off" are constructed redundantly (e.g. additional separate push button for the circuit breaker).

Also in this variant, a PC/notebook can be connected with the *CMP1* so that the *CSP2*-devices can be operated from a central site.

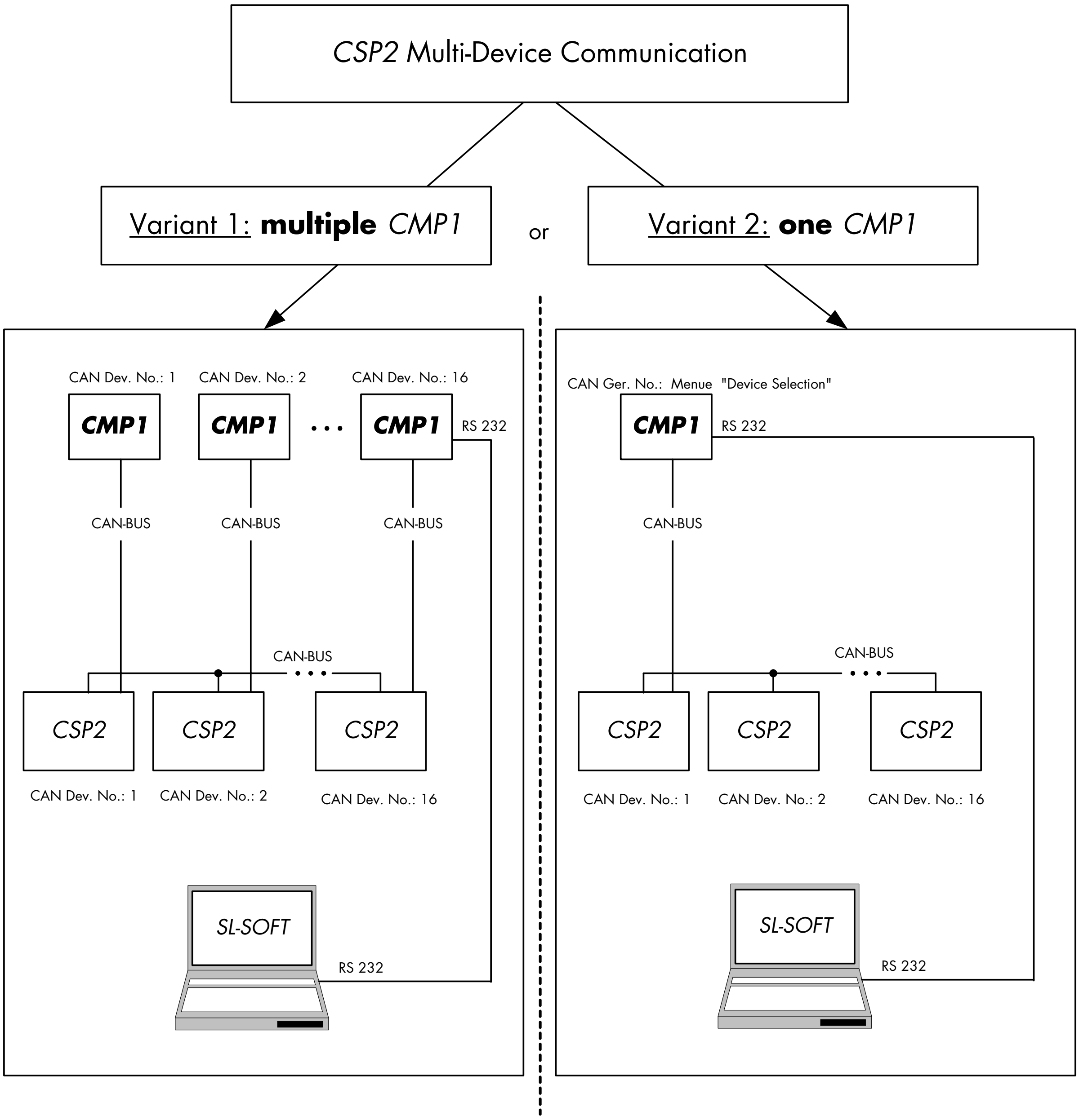


Figure 8.7: Variants of the CSP2 multi-device communication

8.6.2 Prerequisites for multi-device communication

For the multi device communication a corresponding bus-system has to be built up and the devices have to be parametrized accordingly.

Hardware

- Build up the CAN-BUS-system between the *CSP2/(CMP1)*-Systems,
- Build up the connection between the PC/laptop (*SL-SOFT*) and the CAN-Bus-system.

Device configuration

- bus capability of the operation and display unit(s) *CMP1*,
- selection of the variant for multi-device communication,
- assignment of the CAN-device numbers.

8.6.2.1 CAN-BUS System (hardware prequisistes)

The construction of the bus system via the internal CAN-BUS-system can be realized in a simple and cost-effective way.
Each *CSP2* disposes of two parallel CAN-interfaces which are required for the construction of the CAN-BUS system. The interface X10 (socket) is required (as usual) for the communication between *CSP2* and *CMP1*. The second CAN-interface X9 (plug) is in each case connected with the interfaces X9 of the other *CSP2*-device (parallel wiring).

Attention

- The length of the CAN-BUS system must not exceed 100m (inclusively branch lines to the *CMP*)
- During the installation of the bus-system, it has to be assured, that both ends of the bus-line are terminated with a terminal resistor. Otherwise the multi device system doesn´t work due to reflex-ions (signals).

Variant 1: *several CMP1 and several CSP2*

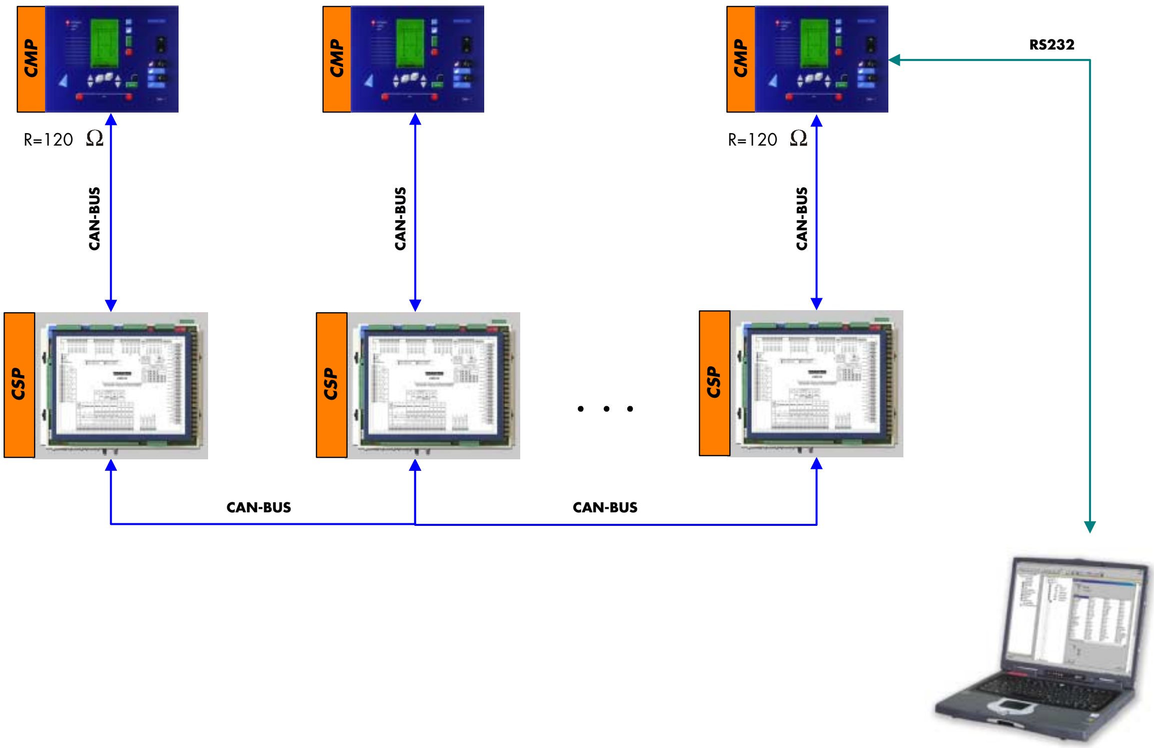


Figure 8.8: CAN-BUS-system variant 1 – CSP2 multi-device communication

Variant 2: *Single CMP1 and multiple CSP2*

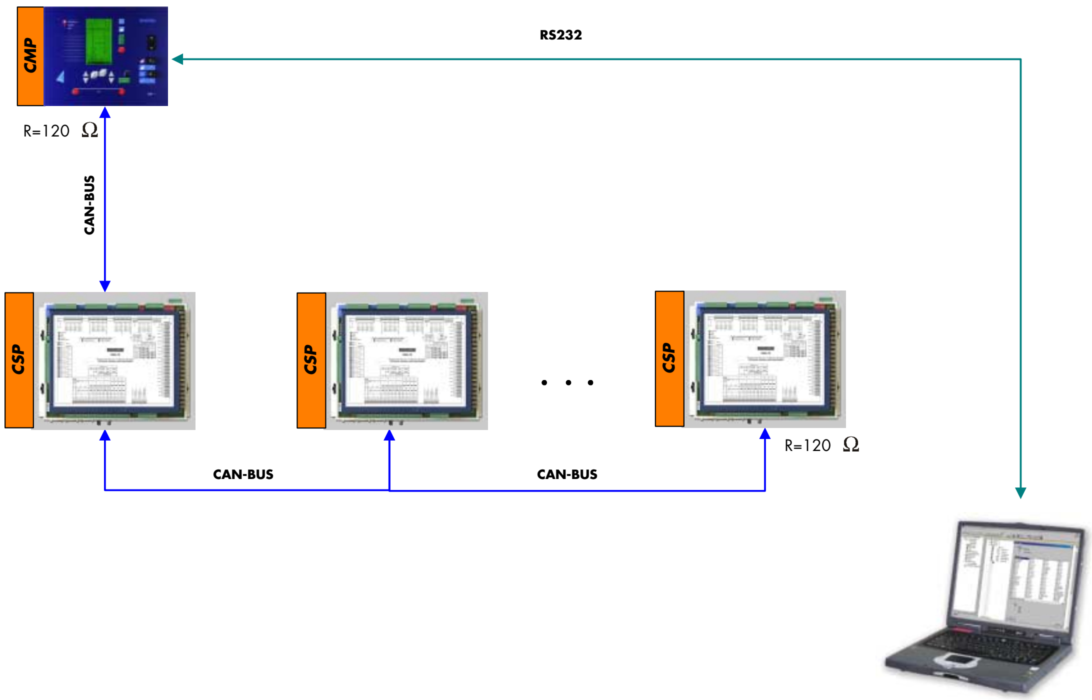


Figure 8.9: CAN-BUS system - variant 2 of the CSP2 multi-device communication

8.6.2.2 Bus capability of the operation and display unit *CMP1*

The connection of the *CSP2/CMP1*-systems via the CAN-BUS requires the adaptation of the individual *CSP2*- and *CMP1*-devices. For the operation and display units *CMP1*, this means that they will become "bus-capable" by parameter setting.

Procedure:

1st step:
The *CMP1* is first separated from the CAN-BUS system.

2nd step:
Rebooting the *CMP1* by switching off and on of the supply voltage of the *CMP1*

3rd step:
As soon as the window "rpc communication timeout" pops up, the CMP-menu "CAN DEV. NO. CONFIG" is to be called up by pressing key "ENTER".

4th step:
Now the setting for parameter "BUS" is to be set to "yes". The parameter setting process is the same as for the parameterizing the *CSP2*-device (see chapter "Parametrizing via *CMP1*" (parameterising via *CMP1*)).

5th step:
The *CMP1* is now to be (again) connected to the CAN-BUS.

Attention

When using *variant 1*, it must be insured before the *CMP1* is reconnected to the CAN-BUS that the set CAN-device number of the *CMP1* matches that of the corresponding *CSP2*-device!
When using *variant 2*, the CAN-device number of the *CMP1*-device must match that of one of the connected *CSP2*-device (see chapter "Assignment of the *CMP1*-CAN device- numbers").

Setting of bus capability of the operation and display unit CMP1:

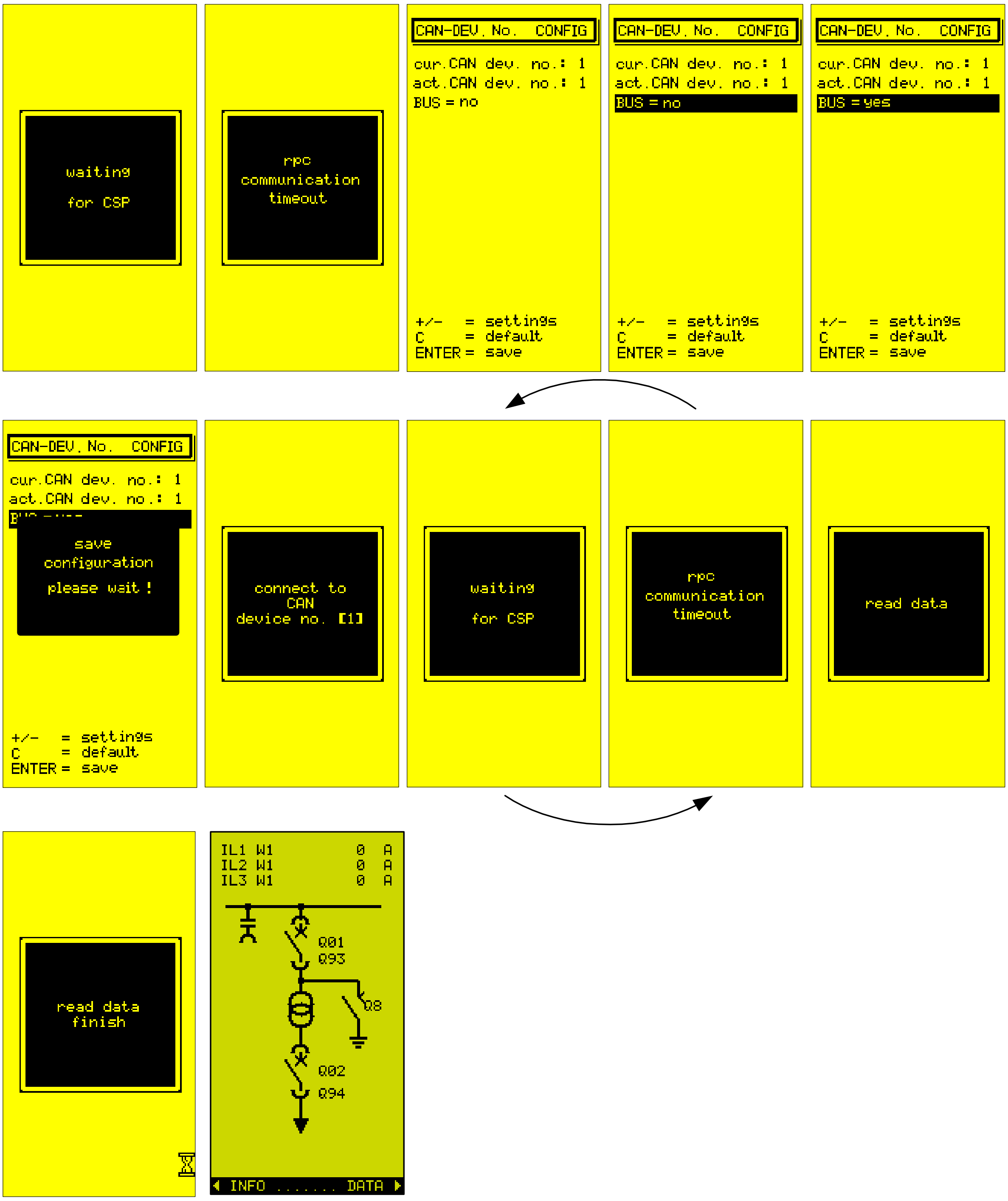


Figure 8.10: Setting of bus capability of the CMP1

8.6.2.3 Selection of the variant via parameter setting of the *CSP2*

The *CSP2*-devices must be adapted to the selected variant for multi-device communication. This occurs via the parameter setting of each *CSP2*-device in the submenu "CAN-BUS".

(For setting the variant, see chapter "CAN-BUS multi-divice communication")

8.6.2.4 Assignment of the CSP2-CAN appliance numbers (ids)

Independent of the variant of the *CSP2*-multi-device communication, different CAN-device numbers must be set for any *CSP2*-devices part of the CAN-BUS system. Maximally 16 *CSP2*-devices can be connected with the CAN-BUS system. Thus only the numbers 1 to 16 can be set as CAN-ids.

(For setting the CAN-device number, see chapter "CAN-BUS multi-appliance communication")

Attention

For the included *CSP2*-device different CAN-devices numbers must be set!

8.6.2.5 Setting of the CMP1-CAN device-numbers (Id)

The connection of the *CSP2/CMP1*-systems via the CAN-BUS requires adaptation of the individual *CSP2*- and *CMP1*-devices. For the operation and display unit(s) *CMP1*, this means that their CAN-device number(s) must be set by parameterizing in dependence of the selected variant for multi-device communication.

Variant 1: The CAN-device number of the *CMP1* must be the same as that of the corresponding *CSP2*-device!

Variant 2: The CAN-device number of the *CMP1* must be the same as that of that *CSP2*-device that it is connected to, within the bus system.

Procedure:

1st step:
The *CMP1* is first to be separated from the CAN-BUS system.

2nd step:
Rebooting the *CMP1* by switching off and on of the supply voltage of the *CMP1*

3rd step:
As soon as the window "rpc communication timeout" pops up, the CMP-menu "CAN DEV. NO. CONFIG" is called up by pressing key »ENTER«.

4th step:
Setting of operation mode MODE 1 (both key switches in vertical position).

5th step:
Now the setting for parameter "act. CAN dev. no." is parameterized to the desired CAN-appliance number. The parameter setting process is the same as for parameterizing the *CSP2*-device *(see chapter "parameterizing via CMP")*

6th step:
By pressing the key »ENTER«, the new setting is saved in the *CMP1*.

7th step:
The *CMP1* is now connected with the CAN-BUS system, and the *CMP1* establishes the connection with the *CSP2* with the same now set CAN-device number of the *CMP1*.

The following illustration shows the procedure for setting the *CMP1* CAN-device number (Id).

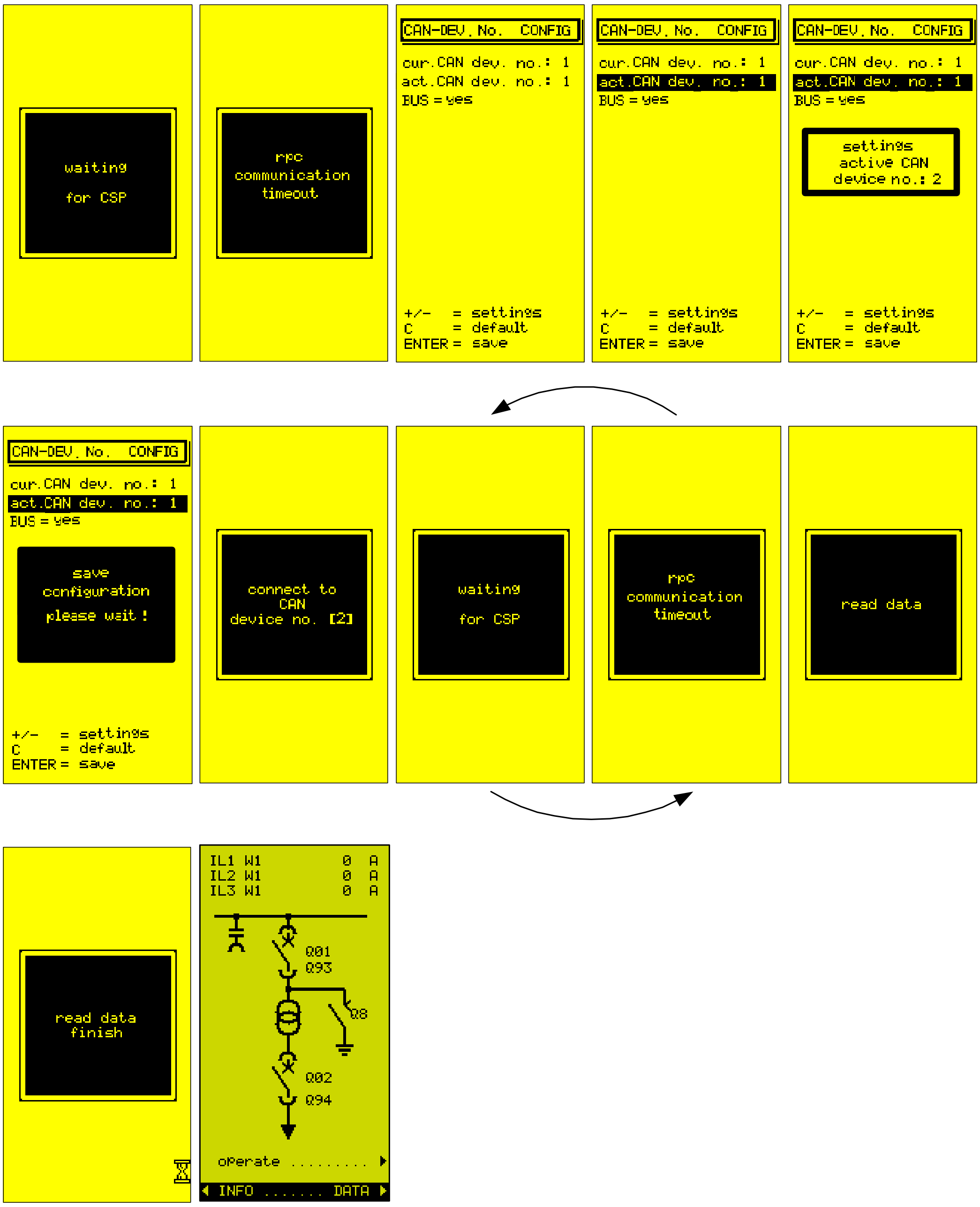


Figure 8.11: Setting of CMP1 CAN device number (id)

Note

The menue item "cur. CAN dev. no.:" shows the actual "CAN-Device Number of the CMP1". This menue item is only updated after saving the parameter changes.

8.6.3 Replace of devices in the CAN-BUS system

Should it become necessary to replace individual *CSP2*- or *CMP1*-device in the CAN-BUS system, e.g. due to modifications of the switchboard, the device to be replaced must first be separated from the CAN-BUS system and from the supply voltage of the devices, and then dismounted.

In the following, the further procedure for exchanging a *CMP1* and a *CSP2* are explained separately.

8.6.3.1 Replace of a CMP1

1st step:
Check respectively setting of the bus capability of the *CMP1*-device.

2nd step:
Check respectively setting of the required CAN-device number (id) of the *CMP1*-device.

Both steps are executed in the *CMP1*-menu "CAN DEV: NO.CONFIG" (see chapter "Bus capability of the operation and display unit *CMP1*")

3rd step:
Connection of the *CMP1* to the *CSP2*.

8.6.3.2 Replace of a ***CSP2***

1st step:
Check respectively setting of the selected variant for *CSP2* multi-device communication.

2nd step:
Check respectively setting of the required CAN-device number of the *CSP2*-device.

Both steps are executed in the submenu "CAN-BUS" of the *CSP2* (see chapter "CAN-BUS").

3rd step:
Connection of the *CSP2* to the CAN-BUS system.

9 Projecting (design)

Applications
As already mentioned in the Chapter *"Introduction"*, there are various applications for the area of protection technique on the medium-voltage level:

- Feeder protection
- Cable/line differential protection
- Bus-bar differential protection
- Transformer differential protection
- Motor protection
- Generator protection
- Distance protection
- Mains decoupling etc.

The *SYSTEM LINE* series of products currently comprises the following types of equipment:

- Transformer differential protection system *CSP2-T*
- Combined feeder protection and control system *CSP2-F*
- Combined cable/line differential protection system *CSP2-L*
- Bus-bar differential protection system *CSP1-B*

Variety of differing demands
Due to the world-wide use of these systems, the devices have been designed with high *flexibility* and *functionality* with regard to integration in *switchboards made by various manufacturers*. The international differences include, for example:

- standards and guidelines with regard to plant safety,
- mains topology (kinds of mains, e.g.: neutral point connection),
- protection concepts,
- concepts for switchgear control and interlocking,
- communication connections to SCADA (types of protocol, phys. interfaces) and
- use of switchboards and switchgears of various manufacturers.

But there are also differing requirements made of the protection and control systems to be used *within one region* on the part of the mains and switchboard operators. Here, the use of various operating equipment and the differing functions for the operation of the switchboard are in the foreground:

- *Type of switchboard* (e.g. gas-insulated or vacuum switchboards, single or double bus-bar systems)
- *Differing protection concepts* (e.g. use of DEFT or INV tripping characteristics, directional or non-directional protection, signal comparison protection etc.)
- *Variety of differing field configurations* (e.g. use of mechanically or electrically controllable switchgears such as circuit breakers, switch disconnector, disconnecting switches and earthing switches).
- Variety of differing functions (e.g. switchgear, field and plant interlockings, signal and supervision functions, measurement functions etc.),
- *Differing SCADA and automation systems* (protocol types, phys. interfaces) for communication with the field level
- and many more besides.

Device selection and configuration
On the basis of the above mentioned variety, we cannot talk of standardized applications in the closer sense of the term. For this reason, there are also no universal devices with generally valid parameter sets, the parameter settings of which match for each application. This is why each application must be engineered specific to the customer, with the result that all the requirements are fulfilled. For this, the correct type and capability of device must be selected to start with.

Project handling
Due to the complexity of projects with combined protection and control systems, Woodward offers project handling for projects of the *SYSTEM LINE* series of devices. The project handling is designed as follows:

- *Assistance in the selection of the* correct type of device and the corresponding capability,
- *technical clarification* in advance to integrate the *CSP/CMP* system into the switching plant (upon request, in a projecting discussion),
- production of a *checklist* with information on the field configuration for each individual type of switchboard,
- configuration of the *CSP* devices before delivery,
- if requested: protection tests and commissioning of the *CSP/CMP* systems on site and also
- if requested: customer coaching for the devices of the *SYSTEM LINE*
- telephone consultancy and after-sales service.

9.1 Design of protection transformers

An important integral part of each protective function is the transformer, which form the foundation for a protection by quick and most precise provision of the measurement values possible. The transformers are to be selected to match the primary values and the load. Mismatches lead to lack of precision and, in the worst case, to malfunctions of the protection.
The protective transformers convert the primary values of current and voltage into physically separated, standardized secondary values (1/5 A, 100/110 V). Thanks to the transmission properties of the transformers, the connected devices are simultaneously and effectively protected against short-circuits and over voltages.

Explanations of terms

Rated current intensity	Matching the primary and secondary current values stated on the rating plate. Examples of standardized primary nominal currents: 50 A, 100 A, 150 A, 200 A, 300 A, 400 A, 600 A, 800 A,1000 A. Standardized secondary nominal currents: 1 A , 5 A
Rated transformation ratio	Ratio between primary and secondary rated current, is stated as an unreduced fraction ki = I1/I2 = N2/N1
Rated power	Product of the square of the secondary nominal current and the nominal burden, unit in VA
Rated burden	Impedance of all secondarily connected devices and lines, unit in Ω with added burden output factor cos β (acc. to VDE 0414: cos β = 1 for nominal output < 5 VA, otherwise cos β = 0,8)
Class precision	Distinction in various classes to match the allocation to measurement or protection transformers Protection transformers with maximum precision: Class 5P Protection transformers with normal precision: Class 10P
Excess current factor	Whole-figured multiple of the primary nominal current in load with nominal burden, the error precision being 5% or 10% at the most. The nominal overcurrent factor is stated together with the identification letter or class sign in question. For protective current converters, the identification letter P (Protection) has been stipulated. Standard application 10P: overall error for overcurrent max. 10% (formerly Class 3) Measurement application 5P: overall error for overcurrent max. 5% (formerly Class 1) The overcurrent factor is stated behind identification letter P. *Example:* 10P10 = 10% overall error with 10 x IN 5P10 = 5% overall error with 10 x IN
Thermal nominal permanent current	1.2 times the nominal current with which the current converter can be permanently loaded without thermal damage.
Thermal threshold current	Value of the primary current which can flow with short-circuited secondary winding and 1 s duration without thermal damage. (see rating plate) Standard design: Ith > 60 x IN
Dynamic threshold current	Value of the first current amplitude, the force effect of which leads to no damage with the secondary coil short-circuited: Idyn = 2.5 x Ith
Terminal designations	Primary terminals: P1, P2 Secondary terminals S1 ,S2 (attention: earth terminal S1 if possible)

For the *design of current transformers,* it holds:

- Adaptation of the primary nominal current of the operating equipment to be protected (e.g. nominal transformer current = 80 A, nominal transformer current = 100 A),
- design of the secondary nominal current 1 A/5 A to match the measurement lines and the input variables of measurement and protection devices,
- calculation of the nominal burden on the basis of the power consumption of the connected devices and the measurement lines and
- class precision and overcurrent factor to the peripheral conditions (e.g. more precise measurement, better determination of distance in the short circuit, costs).

Examples of the power consumption of measurement lines (each 10 m double line, copper):

Cross-section (in mm^2)	*Nominal secondary current 1 A*	*Nominal secondary current 5 A*
1.5	0.24 VA	6 VA
2.5	0.14 VA	3.6 VA
4	0.09 VA	2.2 VA
6	0.06 VA	1.5 VA
10	0.04 VA	0.9 VA

Table 9.1: Examples of power consumption of measurement lines

Attention

The secondary current circuit of a current transformer may never be opened in operation, but always kept short-circuited. Otherwise, there is the risk of overvoltages and inadmissible heating.

9.2 Configuration of the switchboard

Field configuration (Single line diagram and field interlockings)
The graphic display of the field configuration (single line), the diagram assignment of switchgears and the interlocking conditions (field interlocking) are produced with the specific software programme *SL-Draw* and stored in the *CSP2* system *configuration file* "Sline.sl". This configuration file can be loaded or copied into the *CSP2* in online mode of the operating software *SL-SOFT* and copied onto the local storage medium of the PC/notebook.

9.2.1 Examples of field configuration

Most switchboards in medium-voltage have either

- double bus-bar systems (DBB) or
- single bus-bar systems (SBB).

Thus the switchboard configuration depends on the bus-bar system, the number of detectable and, if need be, controllable switchgears and the field interlocking conditions connected with this.

Below, some examples of switching field configurations are shown for the above mentioned bus-bar systems.

9.2.1.1 Feeder configurations for single bus-bar systems (SBB)

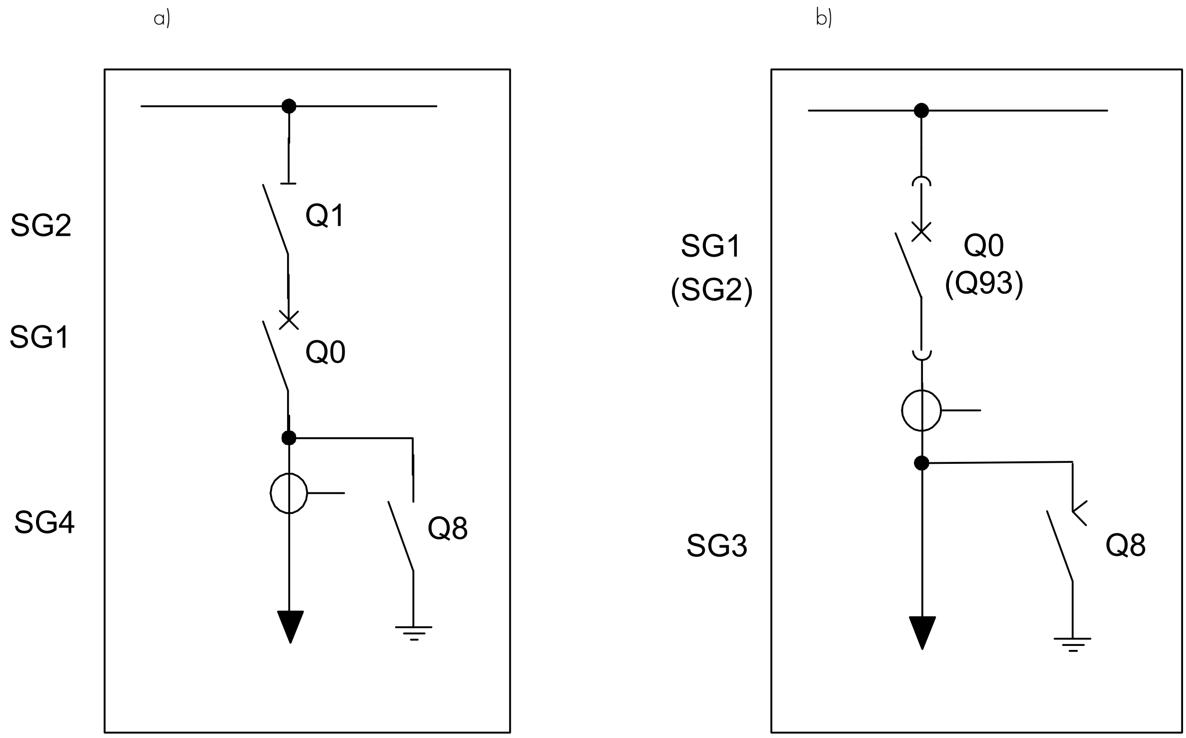


Figure 9.1: a) feeder with CB, isolator and earthing switch
b) feeder with withdrawable CB and earthing switch

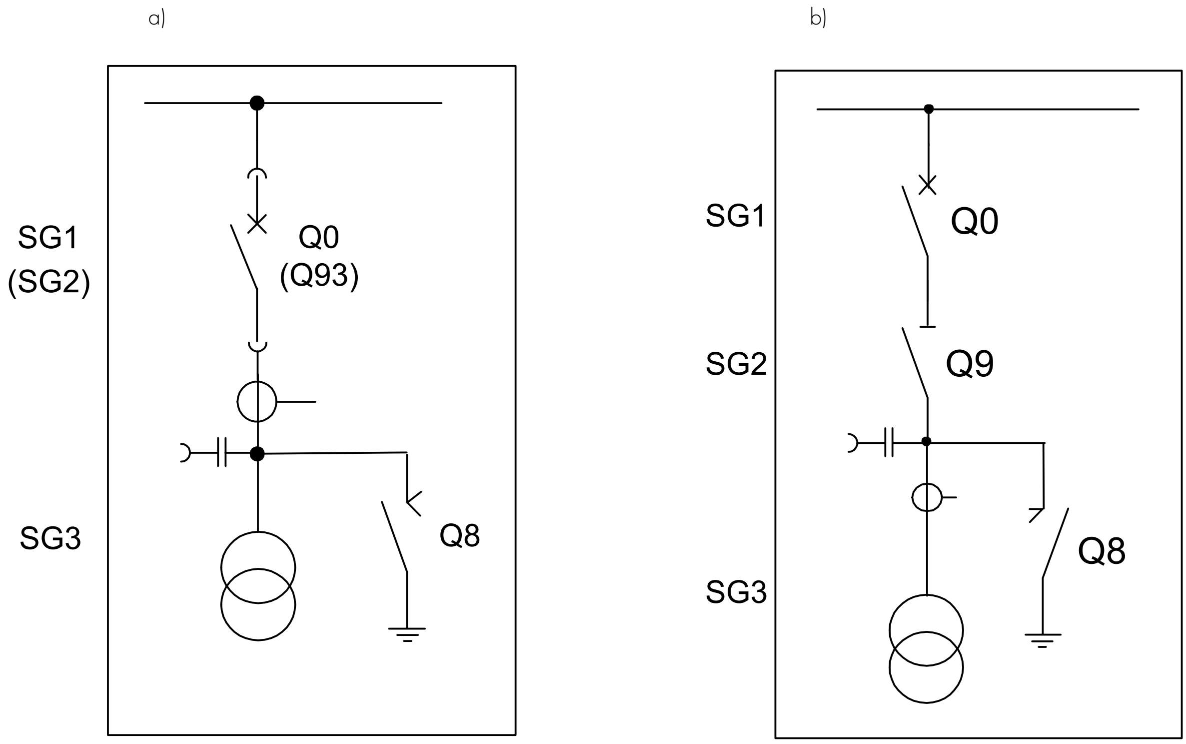


Figure 9.2: *a) Transformer feeder: withdrawable CB and earthing switch*
b) Transformer feeder: CB, isolator and earthing switch

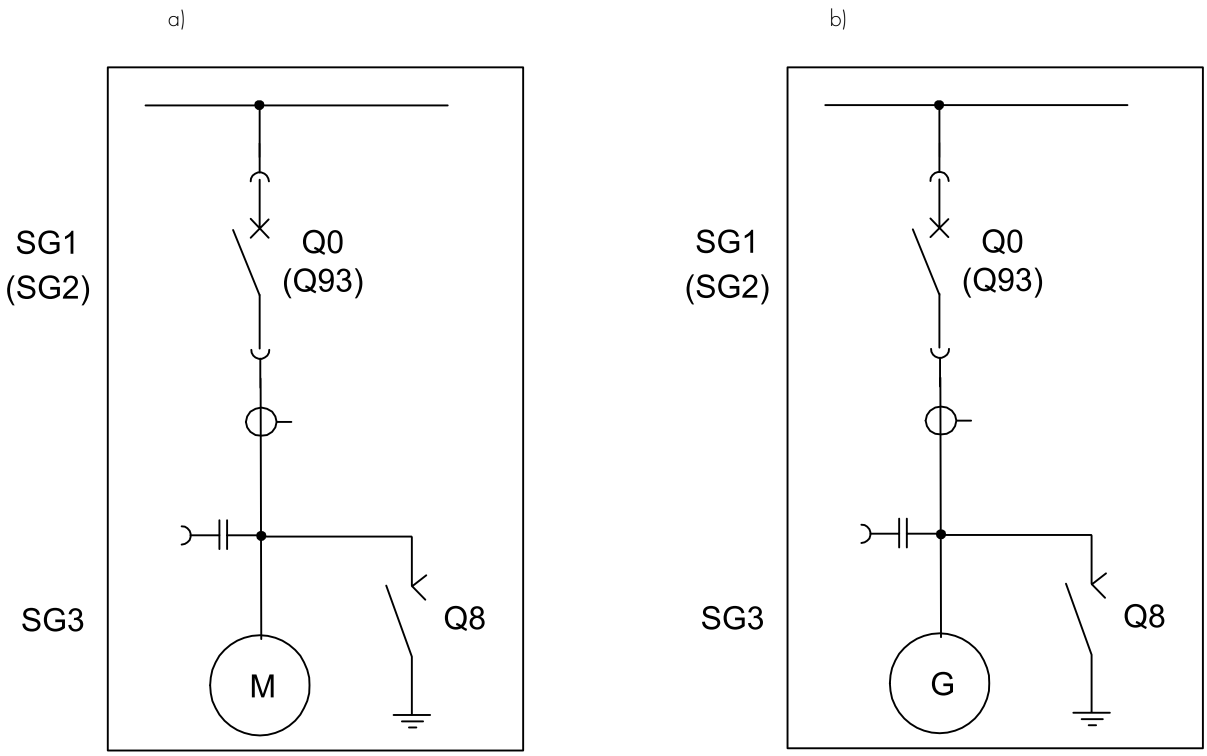
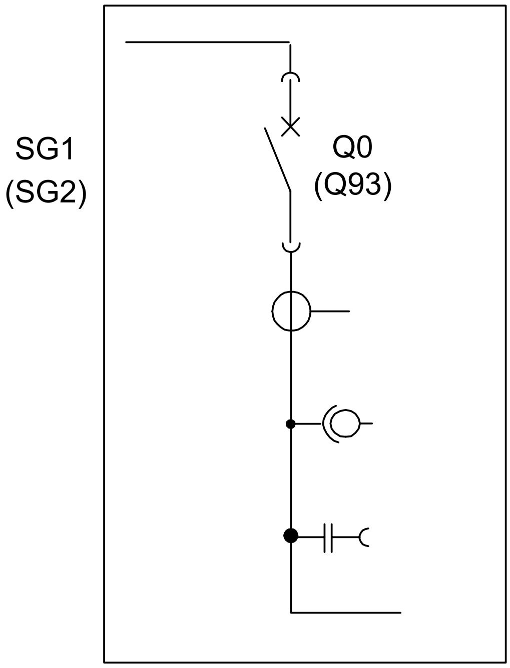


Figure 9.3: *a) Motor feeder: withdrawable CB and earthing switch*
b) Generator feeder withdrawable CB and earthing switch

9.2.1.2 Bus section panel for single bus-bar systems (SBB)

a)



b)

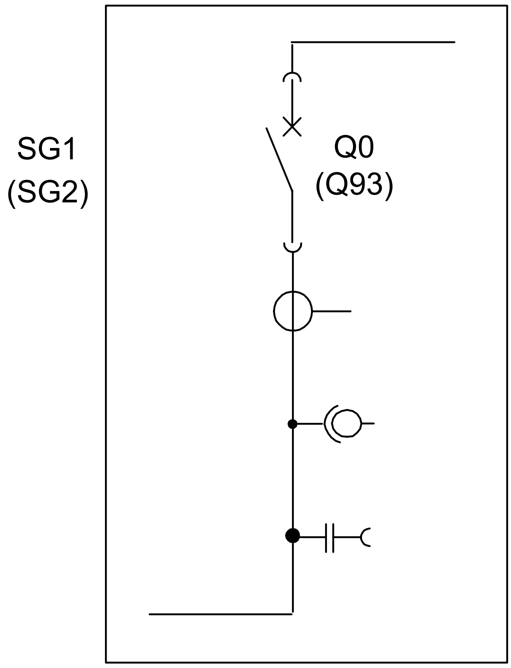
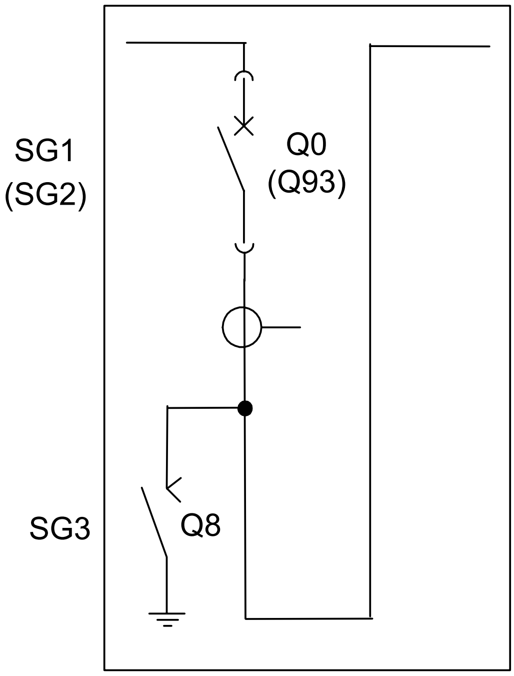


Figure 9.4: *a) Bus section panel: withdrawable CB*
b) Bus section panel: withdrawable CB

a)



b)

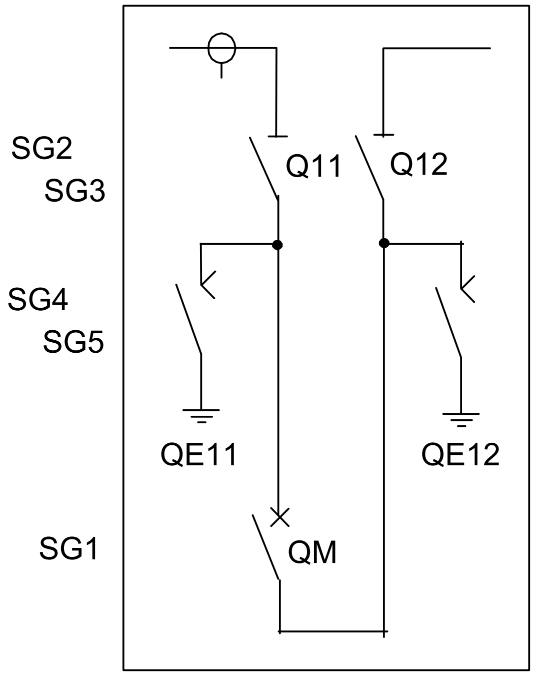


Figure 9.5: *a) Transfer field: withdrawable CB and earthing switch*
b) Bus section panel: CB, isolator and earthing switch (three-position switch)

9.2.1.3 Feeder configurations for double bus-bar system (DBB)

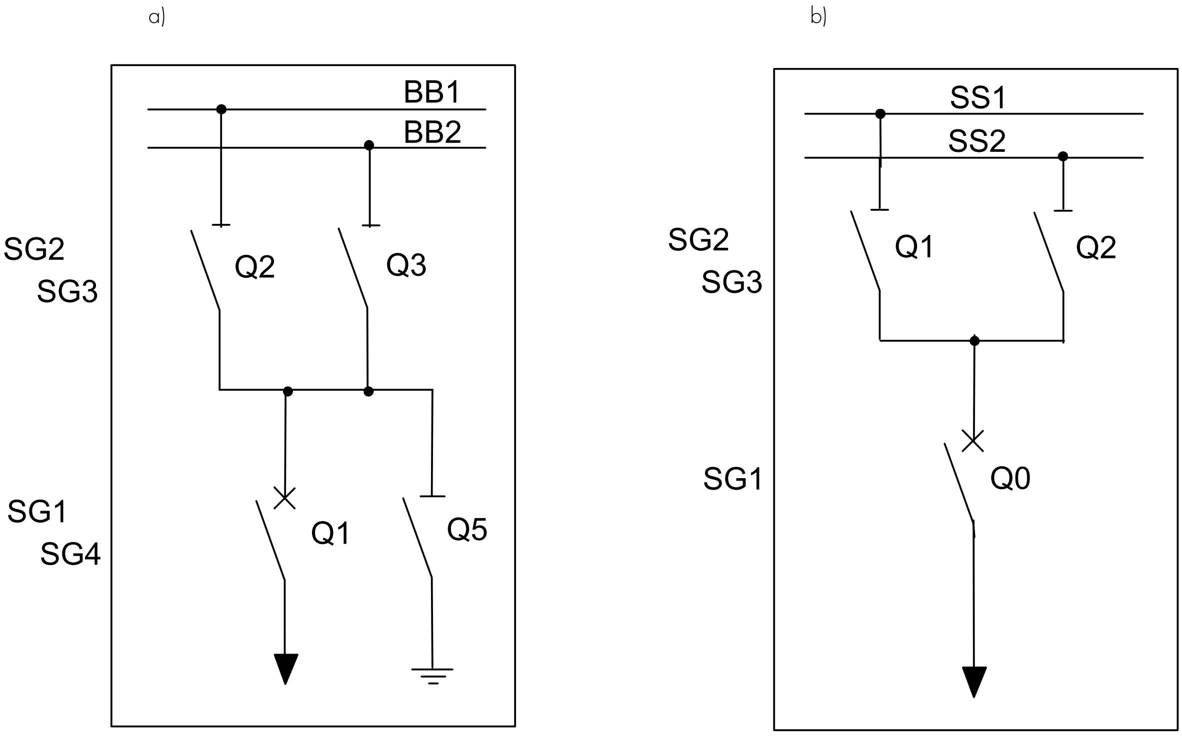


Figure 9.6: *a) Feeder: CB, disconnector and earthing switch*
b) Feed-in field: CB and disconnector

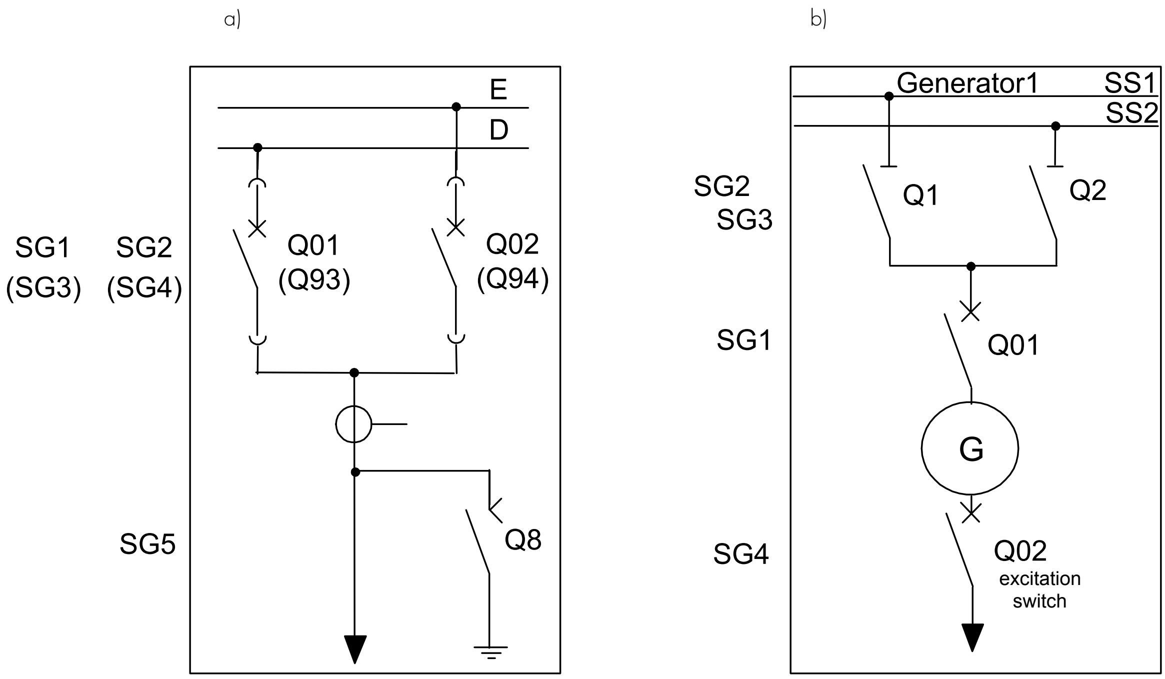


Figure 9.7: *a) Feeder: withdrawable CB´s and earthing switch*
b) Generator Feeder: CB, bus-bar and feeder disconnection

9.2.1.4 Bus coupler panel for double bus-bar systems (DBB)

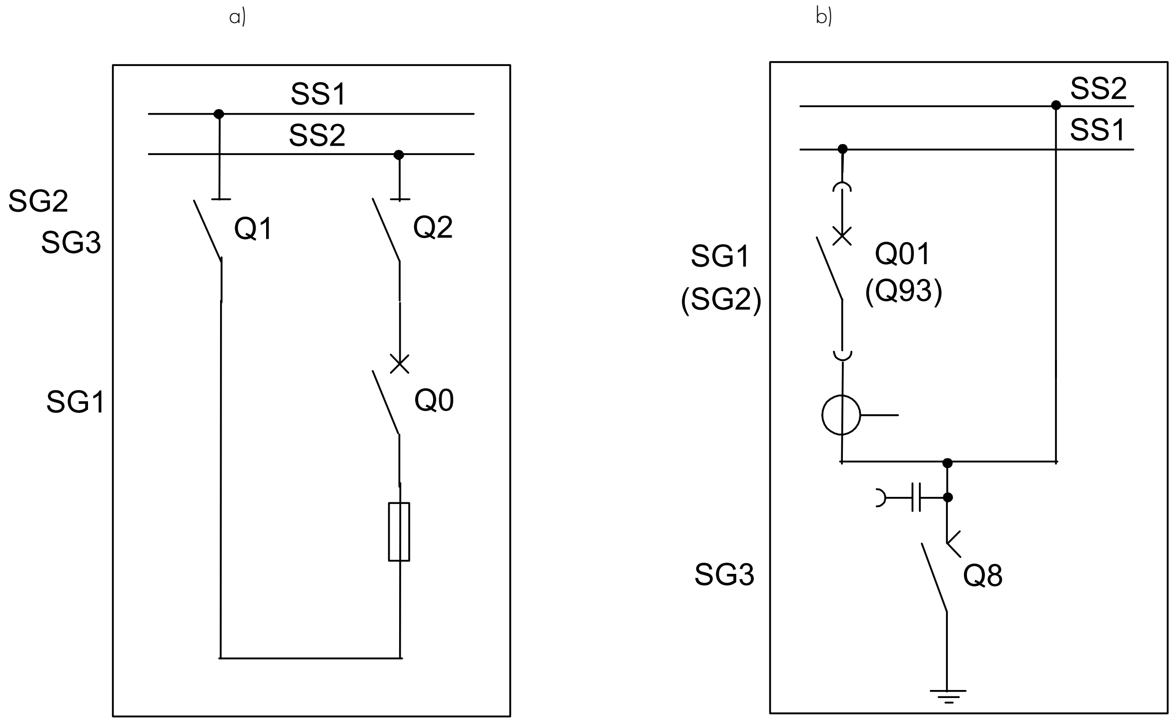


Figure 9.8: *a) Bus coupler panel: CB with HH fuse and disconnector*
b) Bus coupler panel: withdrawable CB and earthing switch

9.2.2 Checklist as projecting assistance and plant documentation

The *checklist* for the devices of the *SYSTEM LINE* is an elementary instrument for projecting of applications in which the *CSP2/CMP1* combined protection and control systems are used. The checklists contain all the relevant information on the *configuration of a type of switchboards* and are used over and above the projecting phase, as *plant documentation*.

For each type of device of the *SYSTEM LINE* there is a separate checklist available:

- Checklist *CSP2-T25*,
- Checklist *CSP2-F3*
- Checklist *CSP2-F5* and
- Checklist *CSP2-L*.

Projecting phase
As a rule, the configuration of the *CSP2/CMP1 systems* is done before delivery of the devices. For this, *technical clarification* is necessary:

- selection of the suitable capability class of the type of device,
- stipulation of the individual ancillary voltages,
- stipulation of the transformer ratios,
- stipulation of the measurement circuits for current and voltage measurement,
- stipulation of the active protective functions,
- if need be, stipulation of the version of the SCADA communication,
- configuration of the individual switchboard types (type of the bus-bar, graphic of the single line, number of detectable and controllable switchgears, field interlockings)
- stipulation of the plant interlockings,
- stipulation of the assignment of switchgears and the control outputs of the *CSP2*,
- stipulation of the direct or indirect control of the switchgears,
- stipulation of the assignment of DI functions onto the digital inputs,
- stipulation of the assignment of output messages onto the signalt relays and
- stipulation of the assignment of input functions (DI functions) and output messages onto the LED's.
- stipulation of the assignment of logic equations.

This information is entered in the checklist, thus forming the basis for the device configuration (parameter setting).

Note

We would recommend doing the technical clarification in a *projecting discussion* between the *user* and the *SYSTEM LINE project manager*. The above mentioned technical information must be subject to being unambiguous.

Plant documentation
The checklists contain not only the detailed technical information, but also general information on:

- order handling,
- switchboards and
- remarks on amendments during the projecting phase.

When the devices are supplied, the checklist generated for each type of switchboard is supplied. In this way, the user is given an extensive documentation on the secondary engineering used in connection with the switchboard.

Note

In the annex, there is a "blank checklist" of a *CSP2-T*.

9.2.3 Example for Programmable Logic Equations (SL-LOGIC)

Specification of the required task – programming example of a customer specific switching - over sequence "The feeder panel of a 10 kV single bus bar system consists of a circuit breaker, an isolating switch and an earthing switch. All three switching devices are electrically controllable by the combined protection and control system CSP2.
It is intended to project a switching-over sequence where the feeder is automatically switched over from the supply mode to earthing of the panel within 20 s. When in remote operation this switching-over process shall either be initiated via a signal line from an external common control room (parallel wiring) or from the station control system (e.g. by using the protocol type acc. to IEC 60870-5-103). Initiation of this process, however, should only be possible upon a release signal from the common control room (signal line). The switching-over sequence shall be stopped/interlocked by an external, conventional »EMERGENCY OFF« input element if a pushbutton is pressed or when the signal line is interrupted. Operating status »Supply« and »Earthing« have to be signalled to the common control room."

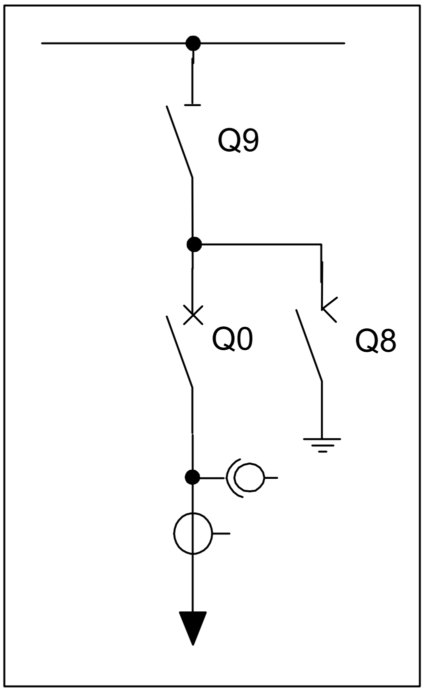


Figure 9.9: Configuration Of The Feeder Panel

Interpretation and realization of the required task
Based on the conventional task description the *Input Elements* and *Logic Outputs* needed for the *SL-LOGIC* function have firstly to be defined i.e. they have to be named and the logic status to be allocated ("0" or "1").
To achieve this the elements available in the *CSP2* have to be assessed first and then co-ordinated to the task required.

Initial situation
The output is fed by the feeder, i.e. the earthing switch is open whereas the isolating switch and the CB are closed. This is indicated by the following *Input Elements* and their allocated logic status ("0" or "1"):

„Pos. SG1 ON"	= 1	(circuit breaker Q0),	=> "*E1*" (input element)
„Pos. SG2 ON"	= 1	(isolating switch Q9),	=> "*E2*" (input element)
„Pos. SG3 OFF"	= 1	(earthing switch Q8)	=> "*E3*" (input element)

By analyzing the respective switching device positions, the signal of the operational status »Supply« is generated. Since such an application-orientated signal is not available in the *CSP2* as predefined output message, it has to be generated by a logic output of a logic equation:
„Logic fct.1" = "1" => "*Y1*" (Logic output without assignment)

Operational mode and release of the switching-over sequence
As basic condition for initiating the process, the feeder should be in mode »Remote Operation«. Hence the upper key switch on the *CMP1* has to be put into the horizontal position. By this the output signal "Remote Operation" – supplied by the *CSP2* - is activated. This signal is used as additional input element. Then the logical status applies to the requirement:
„Remote Operation" = „1" => "*E4*" (input element)

Before the switching-over process is started, a „Release" command from the external common control room is additionally required. A digital input has to be used with an assigned input function which is only processed as signal. For that purpose input function "7", for instance, is available in the *CSP2*. Logic status "1" will be assigned when the necessary condition is met:
„Function 7" = „1" => "*E5*" (input element)

When actuated the external »EMERGENCY OFF« facility is to interlock the switching-over sequence against activation. Over conventional wiring this signal is led to a digital input with signal "function 6" assigned to. The closed circuit principle is used for supervision of cable breaks, and so the logic status "0" is assigned to the input element for the *SL-LOGIC* function:
„Function 6" = „0" => "*E6*" (input element)

Command for activating the switching-over sequence.
The automatic switching-over process (switching sequence) shall either be activated via a digital input, e.g. the input "Function 8" or the station control system (SCS), for example, "SCS Command Output 2". In order to meet the activating conditions the logic statuses and their input elements should be as follows:
„Function 8" = „1" => "*E7*" (input element)
„SCS-Comm.Outp.2 = „1" => "*E8*" (input element)

The commands have to be OR-gated because they can be given optionally. To achieve this, a logic equation is needed with a logic output only used as auxiliary variable for processing:
„Logic fct.2" = „1" => "*Y2*" (logic output without assignment)

Automatic switching-over procedure
As soon as all a/m conditions are met and the switching-over command is issued, the switching-over procedure is initiated. Firstly the circuit breaker (CB) has to be switched off. Then the respective input elements to be linked in a logic equation and the logic output assigned with control function "S-Cmd. SG1 Off" (input function). Taking into account the logic status, this logic output is as follows:
„Logic fct.3" → „S-Cmd. SG1 OFF" = „1"=> "*Y3*" (logic output with assignment) *(Switch-command)*

After the circuit breaker has reached the "OFF position", a timer is started which in terms of time monitors the further process until it is completed (earthing). For this timer, however, a separate equation has to be used because logic output "Logicfct.3" is to induce opening of the circuit breaker without a time component. Therefore the input element of this timer is the logic output "Logicfct.3":
„Logic fct.4" = „1" => "*Y4*" (logic output without assignment)

Now the isolating switch Q9 is to be opened. Its de-activation is generated through a further logic function by linking the input element for the "OFF signal" of the CB:
„Pos. SG1 OFF" = „1" => "*E9*" (input element)
with the output of the logic equation for the monitoring time „Logic fct.4".

This logic equation provides the output where the control function for opening the isolating switch is assigned to:
„Logic fct.5" → „S-Cmd. SG2 OFF" = „1" => "*Y5*" (logic output with assignment) *(Switch-OFF-command for SG2)*

As soon as the isolating switch is opened, the earthing switch shall close and here the related check-back signal of the position is used as input element:
„Pos. SG2 OFF" = „1" => "*E10*" input (element)

Important

When projecting it is essential to consider a minimal dead time of 700 ms between the position check-back signal of a switching device (exception the CB) and the subsequent control command. Should an extra running time "*tn* ON/OFF" be adjusted for the power output of the switching device, then this time has to be added to the minimal dead time:

$$t_P = 700\ ms + t_{n\ ON/OFF}$$

In order to guarantee this dead time, an additional logic equation has to be used. As input elements this equation ought to have the position check-back signal of the isolating switch "Pos. SG2 OFF" as well as the property of the preceding logic output "Logicfct.5". The timer is then to be adjusted according to the mode used for the ON-delayed activation of the logic output. After the dead time has elapsed and the position check-back signal for the open isolating switch was received (AND), the ON- command for the earthing switch should be issued. For this purpose the logic output is assigned with the function "S-Cmd.SG3 ON":
„Logic fct.6" → „S-Cmd. SG3 ON" = „1"> "*Y6*" (logic output with assignment)

As soon as the earthing switch is activated for earthing the feeder, the circuit breaker has to be closed, but only when it is ensured that the earthing switch is in a definite position. As input element for this switching sequence (new logic equation), the position *check-back signal* of the earthing switch is being used:
„Pos. SG3 ON" = „1" => "*E11*" (input element), as well as the preceding logic output „Logic fct.6" (AND).

Here, too, the dead time has to be considered accordingly, i.e. for the timer of logic equation "*Y6*" a time delay has to be set. The output of this logic equation is assigned with the input function „S-Cmd. SG1 ON":
„Logic fct.7" → „S-Cmd. SG1 ON" = „1" => "*Y7*" (logic output with assignment) *(Switch-ON-command for SG3)*

Indication of operating state „Earthing"
After the switching-over sequence is completed, the switching devices of the feeder are in the operational state „Earthing". To enable signalling of this operating state it is necessary to link the following input elements in a further logic equation:
„Pos. SG1 ON" = 1 (CB Q0), => "*E1*" (input element)
„Pos. SG2 OFF" = 1 (Isolating switch Q9), => "*E10*" (input element)
„Pos. SG3 ON" = 1 (Earthing switch Q8) => "*E11*" (input element)

The resulting logic output can then, for instant, be assigned to a signal relay for further processing:
„Logic fct.8" = „1" => "*Y8*" (logic output without assignment)

Preparing the truth table

By using the *input elements* and *output elements* as defined above, a table (truth table) can be set up where the relation between the logic outputs and their input elements is clearly reflected. Based on this truth table it is possible to set up the logic equations in Disjunctive Normal Form (DNF). But these logic equations would include terms in Full Conjunction (i.e. each of the terms comprises the complete number of existing input elements). In order to keep the logic equations as "lean" as possible, only those input elements relevant for the respective logic output should be assigned with the logic state "0" or "1", all other input elements should be assigned with a "x", to be interpreted as an "optional array". Easier still, to leave the relevant square in the truth table vacant.

Note

"*Optional arrays*" mean a higher transparency of the truth table and reduce the number of logic equations.

The truth table should not be set up to the whole extension because the number of combinations possible depends on the input elements and these can be numerous (often >10). The number of possible combinations can be computed as follows :

$$N = 2^n$$

N =Number of combinations (logic equations)

n =Number of input elements

It is advisable to list only combinations of logic outputs with the logic state "1".

For this example the *truth table* is as follows:

Input Elements											*Logic Outputs*							
„Pos. SG1 on“	“Pos. SG2 on“	“Pos. SG3 off“	„remote operation“	„Function 7“	„Function 6“	„Function 8“	„SCADA: Cmf out 2“	„Pos. SG1 off“	„Pos. SG2 off“	„Pos. SG3 on“	„Logic fct.1“ Assignment : None	„Logic fct.2“ Assignment: None	„Logic fct.3“ Assignment: S-Cmd SG1 Off“	„Logic fct.4“ Assignment: None	„Logic fct.5“ Assignment: „ S-Cmd SG2 off“	„Logic fct.6“ Assignment: „S-Cmd SG3 on“	„Logic fct.7“ Assignment: „ S-Cmd SG1 on “	„LLogi c fct.8“ Assignment: None
E1	*E2*	*E3*	*E4*	*E5*	*E6*	*E7*	*E8*	*E9*	*E10*	*E11*	*Y1*	*Y2*	*Y3*	*Y4*	*Y5*	*Y6*	*Y7*	*Y8*
1	1	1									1							
						1						1						
							1					1						
			1	1	0						1	1	1					
													1	1				
								1						1	1			
									1						1	1		
										1						1	1	
1									1	1								1

Table 9.2: Truth Table

Note

- The abbreviations for the *input elements E1…E10* and for the *logic outputs* Y1…Y8 do <u>not</u> exist in the *CSP2*! They are only used for more transparency and as abbreviations when preparing the logic equations and the technical documentation.
- To ensure that an *input element* is recognized and processed by the *CSP2*, it has to be assigned with a signal from the List of *Output messages*.
- Optionally the *Logic Outputs* can either be processed as a mere signal („Logic fct.xy“) or they can be applied with a *Function*. For realizing this a function out of the List of *Input Functions* has to be assigned to a logic output.
- In the double framed squares of the table the results of the individual terms for the respective logic output are stated.
- *Logic Outputs*, too, can be used as *Input elements* for other *logic equations*.
  Timers are always part of the logic outputs and can consequently be considered in the *truth table*.

Setting up of logic equations

The individual logic equations can now be read off of the *truth table*:

Y1 = E1*E2*E3	(Logic equation 1 in DNF)
Y2 = E7 + E8	(Logic equation 2 in DNF)
Y3 = E4*E5*/E6* Y1*Y2	(Logic equation 3 in DNF)
Y4 = Y3	(Logic equation 4 in DNF)
Y5 = E9*Y4	(Logic equation 5 in DNF)
Y6 = E10*Y5	(Logic equation 6 in DNF)
Y7 = E11*Y6	(Logic equation 7 in DNF)
Y8 = E1*E10*E11	(Logic equation 8 in DNF)

Setting up of the logic flow chart based on the logic equations.

A logic flow chart can now be prepared on the ascertained logic equations as listed above.

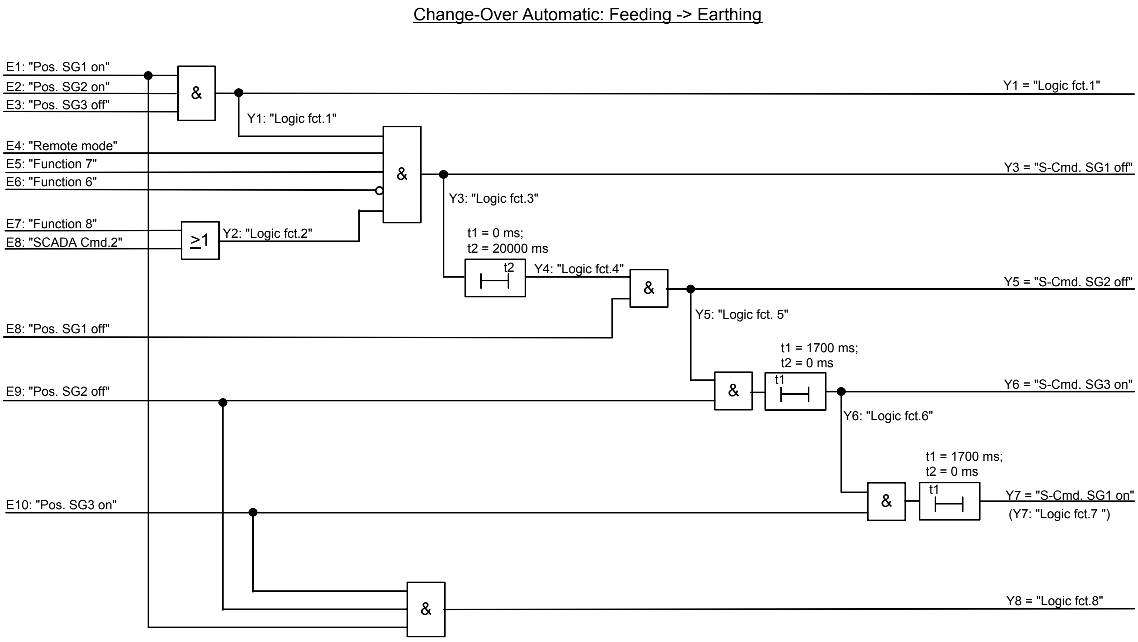


Figure 9.10: Example „Switching-Over Sequence" : Logic Flow Chart

Efficient utilization of the SL-LOGIC reduction with regard to the number of logic equations

The *logic flow chart* is to optimize in such a way that for realisation of the user-specific functions as few as possible logic equations are needed, i.e. certain parts of the circuitry/logic equations shall be eliminated and their input elements then be integrated in the subsequent logic equation.

The example shows that the auxiliary variable "*Y2*", for instance, can be eliminated. This means that the subsequent logic equation "*Y3*" (i.e. the one processed as input element in the internal state variable "Y2") does not receive the internal state variable "*Y2*" as input element, but the input elements "E6" and "E7", from which the internal state variable "*Y2*" was generated. For the logic equation "Y3", the conversion has to be converted ininto the Disjunctive Normal Form (DNF), because a logic equation can only be entered as *DNF* into the *CSP2*. The converted logic equation is then as follows:

Y3 = E4*E5*/E6* Y1*Y2
= E4*E5*/E6*(E7+E8)*Y1
= E4*E5 */E6*E7*Y1+ E4*E5*/E6*E8*Y1 (Logic equation 3 in DNF)

Attention

When *logic equations* can be *cut down* this always means an extension of the whole circuitry! It should be duly taken into account that the number of input elements for the subsequent logic equation(s) (into which the input elements of the eliminated logic equation merge) does not exceed 32, because one logic equation can only process 32 input elements.

Only those logic equations are permitted to be eliminated which were introduced as internal state variables and are not needed as signal („Logicfct.xy") or as function (assignment of an input function).

Optimization of logic equations according to „Quine-McCluskey"

In many cases it is possible to optimize (simplify) the logic equations originated from the functions required. *Especially with regard to a number of input elements >5* it is advisable to have an update carried out automatically. There are different software programs available and some of them can even be obtained free of charge (freeware) from the internet.

For the current example an automatic update is not necessary. It is, for instance, not possible to further simplify the logic equation for "*Y3*".

Adaptation of the logic equations

Due to elimination of the logic equation for "*Y2*" it becomes necessary to change numbering of the logic equations accordingly:

Y1 = E1*E2*E3 (Logic equation 1 in DNF)
Y2 = E4*E5*/E6*E7*Y1+ E4*E5*/E6*E8*Y1 (Logic equation 2 in DNF)
Y3 = Y2 (Logic equation 3 in DNF)
Y4 = E9*Y3 (Logic equation 4 in DNF)
Y5 = E10*Y4 (Logic equation 5 in DNF)
Y6 = E11*Y5 (Logic equation 6 in DNF)
Y7 = E1*E10*E11 (Logic equation 7 in DNF)

Adaptation of the truth table

When logic equations are eliminated it becomes necessary to change truth tables and logic flow charts accordingly. For adapting the truth table, the column of the eliminated logic equation (here: equation Y2) and the lines showing the results of logic output "*Y2*" are to be taken out. Numbering is then simply to be corrected.

Input Elements											*Logic Outputs*						
											Assignment : None	Assignment: S-Cmd SG1 Off"	Assignment: None	Assignment: „ S-Cmd SG1 off"	Assignment: „S-Cmd SG3 on"	Assignment: „ S-Cmd SG1 on "	Assignment : None
„Pos. SG1 onn"	„Pos. SG2 on »	"Pos. SG3 off"	„remote operation"	„Function 7"	„Function 6"	„Function 8"	„SCADA: Cmf out 2"	„Pos. SG1 off"	„Pos. SG2 off"	„Pos. SG3 on"	„Logic fct.1 »	„Logic fct.2 »	„Logic fct.3 »	„Logic fct.4 »	„Logic fct.5 »	„Logic fct.6 »	„Logic fct.7 »
E1	*E2*	*E3*	*E4*	*E5*	*E6*	*E7*	*E8*	*E9*	*E10*	*E11*	*Y1*	*Y2*	*Y3*	*Y4*	*Y5*	*Y6*	*Y7*
1	1	1									1						
			1	1	0	1					1	1					
			1	1	0		1				1	1					
												1	1				
								1						1			
									1					1	1		
										1					1	1	
1									1	1			1			1	1

Table 9.3: Updated Truth Table

Adaptation of the logic flow chart

The logic flow chart, too, has to be updated.

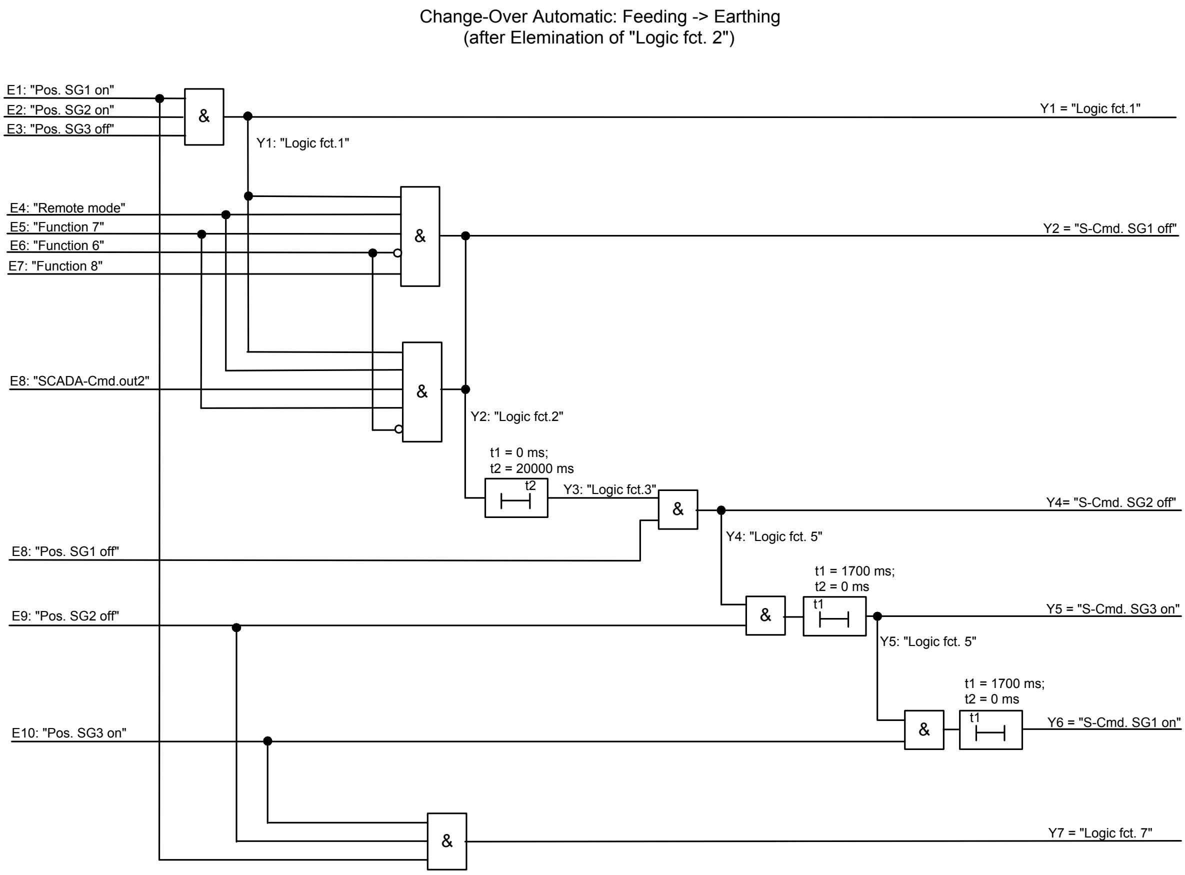


Figure 9.11: Updated Logic Flow Chart

9.3 Specific applications

The combined protection and control system has a number of various protection functions as well as far-reaching functions for digital inputs (DI functions) and signal relays (output messages). The combination of corresponding functions (parallel wiring of digital inputs and signal relays) makes it possible to implement specific applications in feeder protection.

9.3.1 Line protection

Directional overcurrent protection
The detection of direction increases the selectivity of the protection. The signal comparison of two *CSP2* can implement a protection which only disconnects a line fed from both sides free if it is faulty itself.

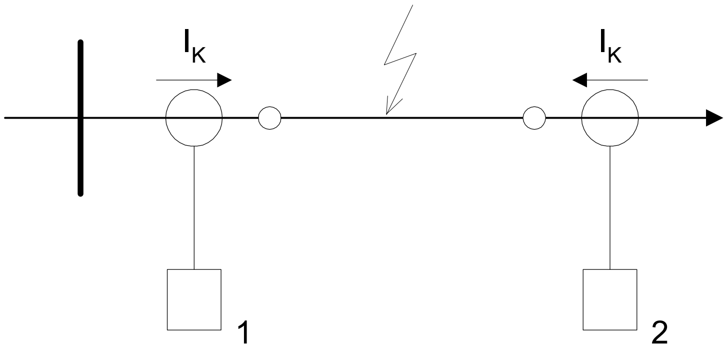


Figure 9.12: Directional dependent protection

In this case, each *CSP2* transmits its direction decision to the partner device. The tripping is only executed if the error on the cable/line is between the two *CSP2* and is therefore recognised as an internal error by both *protective devices*.

Necessary settings

Protection 1:

- I>>F active with protective block (active 0) and
- I>>F alarm on signal relay.

Protection 2:

- I>>F active with protective block (active 0) and
- I>>F alarm on signal relay.

9.3.2 Bus-bar protection with backward interlocking

Backward interlocking
Quick bus-bar protection: in a star network, a quick selective short-circuit protection can be done with a backward interlocking. If an error occurs in feeder 2 in this, protection devices 1 and 2 trip, as both detect the short-circuit current. But here, only protection 2 may trip, in order not to switch the entire bus-bar S off. Alongside a purely time staggering, this requirement can also be fulfilled via a backward interlocking. For this, the subordinate protection device must inform superior protection device 1 of its excitation and block it. This method can be quicker than a time staggering, as, for example with a fault on bus-bar S, relay 1 does not have to wait and see whether a subordinate protection can isolate the error beforehand.

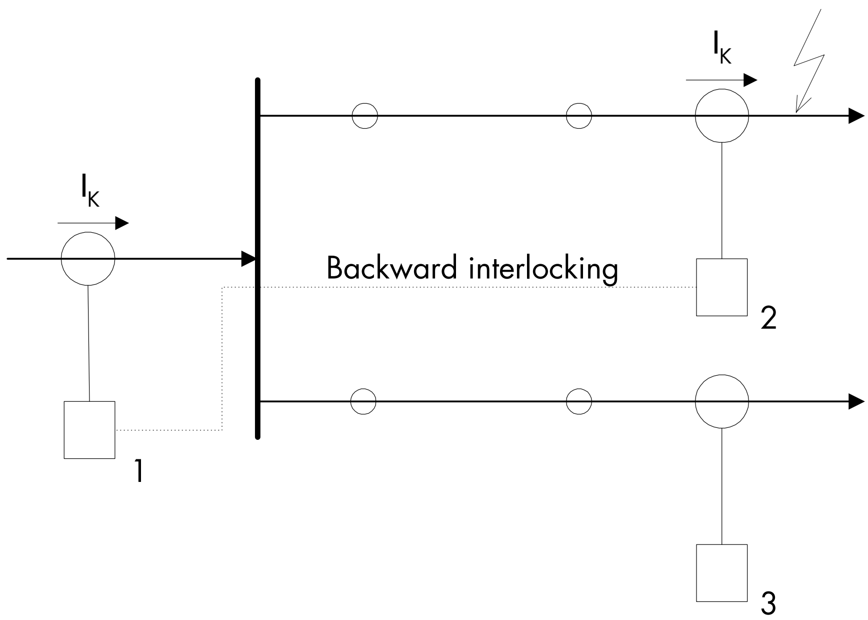


Figure 9.13: backward interlocking

In all *CSP2* device types, a binary input can be pre-programmed as a so-called " backward interlocking " (rev. lock). This input can be used to coordinate the protective functions in one field with those in other fields in order to increase the selectivity and speed of the overall protective system. The backward interlocking input can be regarded as a general external blocking and linked with other integrated protective functions. The cooperation of the backward interlocking with other protective functions can be made clear by the following two typical applications:

- Quick bus-bar protection by backward interlocking: with the backward interlocking, the overcurrent protection or short-circuit protection in the *CSP2* can be used as a quick bus-bar protection in a radial system. In this case, current excitations from all the feeders of a bus-bar section are guided to the overcurrent protection used as a bus-bar protection as blocking signals. In the event of an error directly on a bus-bar and no blockages of other protective systems, the excess current protection can trip with a short tripping time depending on the staggered time.

- Differential protection by signal comparison: signal comparison via the backward interlocking can be used with double-sided feeding for device types *CSP2-T25* and *CSP2-F5* with the functionality of a line differential protection. In this case, each *CSP2* transmits its direction decision to the other. Tripping is only activated if the fault is determined by both *CSP2* as a forward-lying fault (fault is on the line between the two *CSP2*). The overcurrent protection can be used with or without external blocking.

9.3.3 Calculating the tripping times

The tripping times of the (current) dependent tripping curves (INV) are calculated according to the following relationship:

Tripping *characteristics according to IEC 255-3 or BS 142:*

Normal Inverse (NINV): $$t = \frac{0{,}14}{\left(\frac{I}{I>}\right)^{0{,}02} - 1} t\,charF/B\ [s]$$

Very Inverse (VINV): $$t = \frac{13{,}5}{\left(\frac{I}{I>}\right) - 1} t\,charF/B\ [s]$$

Extremely Inverse (EINV): $$t = \frac{80}{\left(\frac{I}{I>}\right)^{2} - 1} t\,charF/B\ [s]$$

Long Time Inverse (LINV): $$t = \frac{120}{\left(\frac{I}{I>}\right) - 1} t\,charF/B\ [s]$$

with:

t	=	tripping time
t char F/B	=	time multiplier
I	=	fault current
I>	=	pick-up value current

9.3.4 Calculations on the thermal replica

Foundations of calculation
On the basis of the underlying homogenous body heating model, deductions can be made for a heat energy Q stored in the electrical equipment. With a constant current load and after a long time, a stationary condition is reached in which the electrical equipment temperature no longer increases. The heat fed per unit of time is equal to the amount of heat emitted by cooling (energy balance).

$$Q_{discharged} = Q_{suppllied}$$

The fed thermal energy and the temperature ϑ of the operating equipment in a stationary condition are proportional to the square of the phase current (e.g. ohmic losses and iron losses in the transformer):

$$Q \sim I^2 \quad \text{or} \quad \vartheta \sim I^2$$

As the alarm value in the *CSP2* is determined from $I_B \cdot k$, the following relationship applies:

$$\vartheta n \cdot k^2 \sim (I_B \cdot k)^2$$

The temperature T actually existing in the operating equipment need not be known in this. The temperature is described in the thermal replica by the temperature equivalent ϑ (in %). For a load with the maximum admissible operating current $k \cdot I_B$ the operating equipment reaches the maximum admissible operating temperature ϑ_B in a stationary condition. For this load, the temperature equivalent to $k^2 \cdot 100\%$ is defined:

$$\vartheta\,(\%) = \frac{I^2}{(k \cdot I_B)^2} \cdot 100\%$$

I.e.: with a load of $I = 0.9 \times (k \cdot I_B)$ and $k\ I_B = 1.2$ the temperature reaches 81% of the maximum admissible operating temperature according to the above definition. For electrical equipment loaded over and above the maximum operating current ($I > k \cdot I_B$) following prior loading, the following course of temperature results:

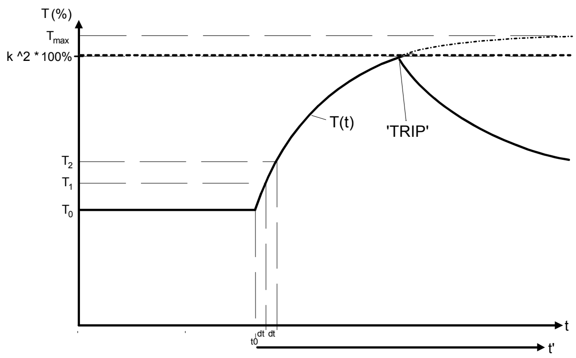


Figure 9.14: Heating of electrical equipment

The temperature equivalent ($T = \vartheta$) runs according to an e-function.
for ($\vartheta > \vartheta_0$) it holds:

$$\vartheta(t') = \vartheta_0 + (\vartheta_{max} - \vartheta_0) \cdot (1 - e^{-\frac{t'}{\tau}})$$

after conversion:

$$\vartheta(t') = \vartheta_{max} + (\vartheta_0 - \vartheta_{max}) \cdot e^{-\frac{t'}{\tau}}$$

if $\vartheta(t') \geq k^2 \cdot 100\%$ an alarm or trippingstage should be activated (trip).

The temperature after the time dt can be determined as:

$$\vartheta_1 = \vartheta_{max} + (\vartheta_0 - \vartheta_{max}) \cdot e^{-\frac{dt}{\tau}}$$

After the time 2·dt:

$$\vartheta_2 = \vartheta_{max} + (\vartheta_0 - \vartheta_{max}) \cdot e^{-\frac{2dt}{\tau}} \quad \text{or} \quad \vartheta_2 = \vartheta_{max} + (\vartheta_1 - \vartheta_{max}) \cdot e^{-\frac{dt}{\tau}}$$

In general:

$$\vartheta_n = \vartheta_{max} + (\vartheta_{n-1} - \vartheta_{max}) \cdot e^{-\frac{dt}{\tau}}$$

In this way, a recursion formula is produced, in which, for a new calculation of the thermal equivalent ϑ_n:

- the last value ϑ_{n-1},
- the stationary final value ϑ_{max} with the present current,
- the set time constant τ and
- the time since the last calculation dt must be known.

Analogously, it holds for the temperature equivalent ϑ_{max}:

$$\vartheta(t') = \frac{I^2}{(k \cdot I_B)^2} \cdot 100\% + \left(\vartheta_0 - \frac{I^2}{(k \cdot I_B)^2} \cdot 100\% \right) \cdot e^{-\frac{t'}{\tau}}$$

with I = largest measured phase current.

In each new calculation step n the current temperature equivalent is determined as follows:

$$\boxed{\vartheta_n = \frac{I_n^2}{(k \cdot I_B)^2} \cdot 100\% + \left(\vartheta_{n-1} - \frac{I_n^2}{(k \cdot I_B)^2} \cdot 100\% \right) \cdot e^{-\frac{dt}{\tau}}}$$

with:

I_n: largest measured phase current in the calculation step.
dt: interval of time between the calculation steps.
ϑ_{n-1}: temperature equivalent of the previous calculation step.

After the start of the protection programme (switching the auxiliary voltage on) no temperature equivalent ϑ_{n-1} has yet been calculated. For this reason, the cold state of the electrical equipment to be protected is presupposed. But if the electrical equipment has already been loaded, it takes about three times as long as τ_{heat} with a constant load until the thermal equivalent corresponds to the actual conditions.

Differing time constants:
After the operating equipment has been switched off ($I_n = 0$) the temperature of the operating equipment, which aims towards $\vartheta_n = 0$ (ambient temperature), drops. As the cooling generally does not happen with the same time constants as the heating (e.g. motors), a separate cooling time constant can be set in the *CSP2*.

For example: $\tau_{cool} = 2 \cdot \tau_{heat}$

The conversion to the cooling or heating time constant therefore depends on the comparison of the measured current with the last current measured:

$I_n \geq I_{n-1} \Rightarrow$ heating
$I_n < I_{n-1} \Rightarrow$ cooling

When the *CSP2* is first switched on, there is a deduction to the cold state of the operating equipment.

The tripping criterion for the alarm or tripping phase of the thermal replica is:

$$\vartheta_{Trip} > k^2 \cdot 100\%$$

Determination of the effective values of the measured phase currents is done via the calculation of the root of the integral of the present current squares of a period. To calculate the thermal replica, the largest of the three phase currents is always used.

10 Commissioning

The following applications are used for *Commissioning* and to *test the device functions*. In order to avoid destruction of the device and to achieve faultless function, attention must be paid to the following:

- The *auxiliary voltage(s)* provided by the switchboard *to supply the devices* must match the nominal values of the auxiliary voltages stated. The auxiliary voltages of the devices include the *supply voltage of CMP1 and CSP2*, the *supply voltage(s) of the digital inputs* and also the auxiliary *control voltage*. Attention must be paid to the stated *nominal ranges of the wide-range power pack*. For the auxiliary control voltage, only one direct voltage may be used, attention being paid to its polarity when connecting to terminals X1.1 and X1.2!

- The nominal field data of the *CSP2* must be adapted to the *primary and secondary nominal data* of the connected transformer by parameter setting.

- The nominal frequency of the *CSP2* must be adapted as a function of the mains frequency.

- The *current and voltage transformer* must be connected correctly.

- All *control and input circuits* must be connected correctly.

- Attention must be paid to a *proper earthing of the device and the measurement circuits*.

- The *current transformer* may not be operated with open secondary winding under any circumstances, but must be operated *short-circuited* in test or mounting.

- The working range of the digital inputs must be adapted to the auxiliary voltage used via the jumpers. The jumpers of the digital inputs may only be changed in a voltage-free and cleared condition.

10.1 Transport

The devices are supplied in *foamed packaging* for a flawless transport. The packaging is to be used for return and further deliveries. The devices are to be removed carefully and the mechanically flawless state is to be checked by a visual check. Specific components (e.g. the optical waveguide connection) are additionally protected by a separate packaging or by a stopper. Pay particular attention to this connection in unpacking and mounting.

10.2 Connection of the auxiliary voltage

After *switching on the* auxiliary *voltage,* all 5 LEDs on the *CSP2* firstly light up green for a short time. During the starting phase, the LED »self-test« lights up. After the start has been completed, the »System Ok« LED lights up green and the corresponding signal relay is activated.

Attention

> Before the device is connected to the auxiliary voltage, you must make sure that it matches the *nominal* auxiliary *device voltage* stated on the rating plate. If the device is bedewed, wait *for at least two hours* before switching on!

10.3 Connection of the measurement circuits

The *current and voltage connections* are to be connected according to the transformer data and the phase position on the device. The corresponding primary values and the type of connection (see "Parameters" chapter) of the converters are to be set In the sub-menu "*Nominal field data*" of the *CSP2*. The current and voltage values can be fed into the *CSP2* with a corresponding test equipment as a secondary figure
(1 or 5 A, 100/110 V) and controlled for a correct display via the overview of measured values. Due to the measurement precision of the *CSP2*, the secondary test device should be designed for this.
The *current phase position and the phase sequence* can be displayed with the help of the unbalanced load current and the power display.

10.4 Connection of the digital inputs and signal relays

By *reading the I/O status*, the *wiring of the digital input and the signal relays* can be checked for correctness of the connection and the signal polarity. After this, the parameterized functions can be displayed and checked via the *event recorder*, on the *CMP1* or PC and also by means of LED's.

10.5 Connection of the control and signal circuits

Attention

> In order to avoid an *undesired switching of switchgears*, the control lines must be interrupted. After completion of the work, the control lines are to be connected again during the tests of the switch appliance control.

After connection of the switchgears to the *CSP2*, each switchgears can have its control function checked on the *CMP1* (call of the CONTROL MODE in MODE 1). If the switchgear does not move or only partly moves after sending of the command and the *CSP2* signalizes a faulty switchgear position, the *control times* in question (see "Parameters" chapter) must be adapted.
If a control command violates the *field-internal or other lockings,* the switching action may not be executed. In such cases, the *CSP2* generates a number of messages. We recommend having such *messages* displayed via the LED's or in the *event recorder*.
If the *control circuit supervision* is used, attention should be paid to the fact that no auxilliary contacts of the switchgears are included in the control circuits.

10.6 Secondary protection tests of the protection functions

For a *precise test of the protection functions*, secondary test equipment of Class 1 with three-phased current and voltage sources as well as integrated timer functions are necessary. For individual protection functions, single-phased current or voltage sources are sufficient.
Due to the large number of protective functions of the *CSP2, only the protective functions to be tested* should be activated for the test in question, as otherwise a multiple alarm can result.

In a *test in the high-current area*, there must be a guarantee that the input circuits are not permanently thermally overloaded.

non-directional current protection
In order to check the non-directional stages of the *protective functions I>, I>> and I>>>,* single or three-phased currents, which activate a protective alarm when the amount of the alarm threshold is reached, are impressed on the secondary side. After the expiry of the *stated tripping delay time,* a tripping must take place. The measurement of the tripping must be done with a time, the measurement precision (measurement resolution) of which is better than 10 ms.

To *check the tripping values,* the current has to be lowered to a value below the alarm threshold until the alarm disappears.

Directional current protection

To *check the directional current protection* you need *current and voltage sources with adjustable phase angle*. During the test, the voltage values are kept constant, the phase currents are varied in *amount and phase angle*. For the test of the directional element in question, the other directional element should be deactivated.

Voltage protection

For this purpose, the *measurement voltage* is connected *three-phased in star or delta connection* depending on the parameters (see Chap. "Field settings"). After a check of the nominal voltage, the *under or over-voltage values* are started up and the delay time is measured. The *setting ratio of the overvoltage* must be larger than 0.97. For *under-voltages,* it must be lower than 1.03.

10.7 Maintenance

As a function of the customer's experience with digital protection devices, the operational safety and the importance of the system, a *cyclic check of the devices* should be done.

Essential *features of the combined protection and control system CSP2/CMP1* are:

- extensive self-test functions,
- cyclic system check,
- parameters are resistant to aging,
- report via LED, signal relay and communication,
- integrated backup protection functions such as *power circuit breaker failure CBF*,
- integrated controls,
- combined measurement functions and
- cyclic control circuit supervision

Maintenance intervals of 2 years are sufficient as a rule. In the maintenance test, all protection and control functions are to be checked with set values and tripping characteristics.

11 Technical data

11.1 Auxiliary voltage

Stipulated auxiliary voltages (EN 60255-6):

Direct voltages (DC): 24 V, 48 V, 60 V, 110 V, 220 V
Alternating voltages (AC): 24 V, 100 V, 110 V, 230 V

Over and above this, the power-pack covers the following customary auxiliary voltages (inter alia England) with a limited tolerance range:

- 240 V AC with the tolerance range -20%/+15%
- 254 V AC with the tolerance range -20%/+10%

The admissible voltage deviations refer to the stipulated nominal auxiliary voltages.

11.1.1 Voltage supply *CMP1*

Voltage range of the supply voltage	*Power consumption in idle state*	*Maximum power consumption (at full load)*
19 - 395 V DC	5 W	8 W
22 - 280 V AC (for frequencies: *40 - 70 Hz*)	5 VA	8 VA

11.1.2 Voltage supply *CSP2*

Voltage supply *CSP2-T*, *CSP2-F* and *CSP2-L*

Voltage range of the supply voltage	*Power consumption in idle state*	*Maximum power consumption (at full load)*
19 - 395 V DC	19 W	27 W
22 - 280 V AC (for frequencies: *40 - 70 Hz*)	19 VA	27 VA

11.1.3 Buffering of the auxiliary voltage supply

Buffering time: *t ≥ 50 ms*, with Ue < Uemin,
i.e. if the auxiliary voltage fails, the function of the device is guaranteed for at least 50 ms!

11.1.4 Fuse Protection

An MCB (miniature circuit breaker) which meets the following demands - min. 4A /slow acting - is to be used for 230 V AC voltage supply.

11.2 Measurement inputs

11.2.1 Current measurement inputs

Number	6 x phase currents , 1 x sum current (for earth, e.g.: ring core converter)	
Measurement technique:	*conventional transformer technique (other sensors in preparation)*	
Nominal currents	1 A and 5 A	(parameter setting)
Measurement range		
Phase currents IL1, IL2, IL3:	0 … 40 x I_N	(only AC),
Earth current Ie:	0 … 20 x I_N	(only AC)
Power consumption in current path:	≤ 0.1 VA	(at $I = I_N$)
Thermal load capacity		
Dimensioning surge current:	250 x I_N	(dynamic half-oscillation)
Dimensioning short-time current:	100 x I_N	(for 1 s)
Long-term load capacity:	4 x I_N	

11.2.2 Voltage measurement inputs

Number	3 × phase voltage (measurement LL or LN) 1 × residual voltage	
Measurement technique:	*conventional transformer technique (other sensors in preparation)*	
Nominal voltages:	100, 110 V AC	
Measurement range:	0…230 V AC	
Power consumption:	≤ 0.1 VA	at $U = U_N$
Thermal load capacity		
Long-term load capacity:	2 x U_N	
Nominal frequencies:	50 Hz; 60 Hz (parameter setting)	

11.2.3 Measurement precision

Phase current measurement (at nominal frequency)

0.1 to 1.5 x I_N:	<0.5% of I_N
1.5 to 40 x I_N:	<1.0% of the measured value

Earth current measurement (at nominal frequency)

0.05 to 0.5 x I_N:	<5.0% of the measured value
0.5 to 20 x I_N:	<2.5% of the measured value

Voltage measurement (at nominal frequency)

10 to 50 V AC:	<1% of U_N
50 to 230 V AC:	<1% of the measured value

Frequency influence

Current/voltage measurement:	<2.0% / Hz

Frequency measurement

40 to 70 Hz:	<0.05% of f_N

Measurement via analogue inputs

PT100	+/- 2% of the end value (200 °C)
NI100	+/- 2% of the end value (200 °C)
PTC	+/- 3% of the measured value or +/- 500 Ohm

11.3 Digital inputs (function/report inputs)

Design: Opto-uncoupled inputs

Number
CSP2-T: 26

Input voltage range: 0 to 350 V DC / 0 to 270 V AC

Threshold recognition

Low range (code plug plugged in)*:*	U_L =	19 to 110 V DC /	19 to 110 V AC
	$U_{L\ on}$ ≥	19 V DC /	22 V AC
	$U_{L\ off}$ ≤	10 V DC /	13 V AC
High range (code plug open)*:*	U_H =	110 to 300 V DC /	110 to 250 V AC
	$U_{H\ on}$ ≥	70 V DC /	85 V AC
	$U_{H\ off}$ ≤	38 V DC /	50 V AC

Input current (function of the input voltage)

Low range (code plug plugged in)*:*	I_{Low}	<4 mA DC/	6 mA AC
High range (code plug open)*:*	I_{High}	<4 mA DC/	14 mA AC

Debouncing time (parameterizable): 10 … 60000 ms (per dig. input)

11.4 Outputs

11.4.1 Power outputs

Number of control outputs

Type of control outputs	*CSP2-T*
Control coils (OL)	4
Motor outputs (OM)	3

The following data apply for the outputs OM and OL

Switching voltage (auxiliary control voltage):	18 to 275 V DC
Max. admissible long-term current:	8 A DC
Max. switch output (function of switch voltage):	17 A, with relief measures (free wheeling circuit)
Current resistance:	short-circuit resistant I > 20A DC break time approx. 700 ms I > 40A DC break time approx. 50 µs
Maximal internal voltage drop	<2V DC by maximal current

11.4.2 Signal relays

Number
CSP2-T: 6

Switch voltages:

Max. alternating current:	250 V AC		
Max. direct current:	220 V DC	with: I_{max} = 0,12 A	with ohmic load
		with: I_{max} = 0,06 A	with inductive load: L/R <50 ms
Direct voltage:	24 V DC	with: I_{max} = 3,0 A	with inductive load

Switch power
Ohmic: 750 VA AC/72 W DC
Inductive: 300 VA AC/45 W DC

Min. switch load: 18 V/2 mA

Max. nominal load: 3 A

Switching current: 12 A (16 ms)

Isolation: 4 kV

Contact material: AgNi + Au

Contact service life: mechanical: 100 x 10^6 switch cycles

11.5 Communication interfaces *CSP2*

PC interface (in preparation)

Number:	1
Type:	RS232
Designation:	X9
Application:	Parameterisation by PC/Laptop
Data transmission rate:	19200 Baud (fixed)
Physical connection:	electric
Plug-in connection:	9-poled SUB-D (plug)
Property:	Galvanic separation via opto-coupler (2.5 kV)

System interfaces

Number:	2
Type:	CAN-BUS
Designations:	X10/CAN 1 (plug), X11/CAN 1 (socket)
Application:	*CMP1/CSP2* communication and *CSP2* multi-device communication
Basis data protocol:	CAN specification V2.0 part B (extended frame)
Processor:	Siemens 80C167C on chip CAN module
Physical connection:	electric
Plug-in connection:	9-poled SUB-D
Property:	Galvanic separation via opto-coupler (2,5 kV)

Optional FO interface (range up to about 2 km)

Number:	1
Type:	Serial communication interface
Designations:	X15(RxD)/X15(TxD) or X16(RxD)/X16(TxD)
Application:	*CSP2-F/T*: communication to SCADA, *CSP2-L*: SCI communication to partner device (*CSP2-L*)
Protocol types:	*CSP2-F/T*: IEC 60870-5-103, PROFIBUS DP or MODBUS RTU, *CSP2-L*: Woodward protocol (SCI communication)
Data transmission rates:	IEC 60870-5-103: 9600 or 19200 baud (adjustable), PROFIBUS DP: max. 5 MBaud (automatic baud rate recognition), MODBUS RTU: 9600 or 19200 baud (adjustable)
Physical connection:	Fibre optic (FO)
Plug-in connection:	BFOC 2.5 (ST®)
Fibre type:	Multi-mode/multi-gradient fibre
Number of fibres:	2 fibres (Transmit[T]/Receive [R])
Core diameter:	62.5 µm
Cladding diameter:	125.0 µm
Wavelength:	820 - 860 nm
max. attenuation:	10 dB (relative to overall attenuation)
max. line length:	approx. 2 km (as a function of the line distance attenuation)

Optional SCADA interface

Number:	1	
Type:	RS 485	
Designation:	X12	
Application:	SCADA communication	
Protocol types:	IEC 60870-5-103, PROFIBUS DP or MODBUS RTU	
Data transmission rates:	IEC 60870-5-103:	9600 or 19200 bps (adjustable),
	PROFIBUS DP:	max. 12 Mbps (automatic baud rate detection),
	MODBUS RTU:	9600 or 19200 bps (adjustable)
Physical connection:	Electric	
Plug-in connection:	9-poled, SUB-D (socket)	
Property:	Galvanic separation via opto-coupler (2.5 kV)	

11.6 System data and test specifications

11.6.1 General provisions

Basic specification norm:	DIN EN 61000-6-2 [03/00] DIN EN 61000-6-3 [12.01]	*Product norm*	DIN EN 60255-6 [11.94] DIN EN 60255-3 [07.98] DIN EN 50178 [04.98]

11.6.2 High-voltage tests (EN 60255-6 [11.94])

Voltage test		
IEC 60255-5 [12/00] DIN EN 50178 [04.98]	All current circuits against other current circuits and touchable surfaces.	2.5 kV (eff.)/50 Hz, 1 min.
Surge voltage test		
IEC 60255-5 [12/00]		5 kV/0.5 J, 1.2/50 µs
High-frequency test		
DIN EN 60255-22-1 [05.91]	Within a current circuit	1 kV/2 s
Class 3	Current circuit against earth	2.5 kV/2 s
	Current circuit against current circuit	2.5 kV/2 s

11.6.3 EMC tests for immunity to interference

Resistance to interference against fast transient disturbance variables (Burst)		
DIN IEC 60255-22-4 [10.93] DIN EN 61000-4-4 [12/01]	Current supply, grid inputs	±4 kV, 2,5 kHz
Class 4	Other inputs and outputs	±2 kV, 5 kHz
Resistance to interference against discharge of static electricity		
DIN EN 60255-22-2 [05.97] DIN EN 61000-4-2 [12/01]	Air discharge	8 kV
Class 3	Contact discharge	6 kV
Resistance to interference against surge voltages		
DIN EN 61000-4-5 [12/01] Class 4	Within a current circuit	2 kV
	Current circuit against earth	4 kV
(only valid for cable lenght < 30 m)		
Resistance to interference against high-frequency electromagnetic fields		
DIN EN 61000-4-3 [12/01] Class 3		10 V/m
Resistance to interference against line-guided disturbance variables induced by high-frequency fields		
DIN EN 61000-4-6 [12/01] Class 3		10 V/m
Resistance to interference against magnetic fields with energy-technical frequencies		
DIN EN 61000-4-8 [12/01]	lasting	100 A/m
Class 5	3 sec.	1000 A/m

11.6.4 EMC tests for disturbance transmission

Radio interference supression DIN EN 55011 [10.97]		Limit value Class B
Radio interference radiation DIN EN 55011 [10.97]		Limit value Class B

11.6.5 Mechanical stress

Oscillation tests DIN EN 60255-21-1[05.96] Class 2	Oscillation test for functionality	0.075 mm, 1.0 gn, 1 run in each direction
	Long-term oscillation test	2.0 gn, 20 runs in each direction
Shock and long-term shock tests DIN EN 60255-21-2 [05.96] Class 1	Shock test for functionality	5 gn, 11 ms, 3 impulses in each direction
	Shock test for resistance capacity	15 gn, 11 ms, 3 impulses in each direction
	Long-term shock test	10 gn, 16 ms, 1000 impulses in each direction and axis
Earthquake oscillation test DIN EN 60255-21-3 [11.95] Class 2	Single-axle earthquake oscillation test	7.5 / 3.5 mm 2.0 / 1.0 gn 1 run in each direction

11.6.6 Type of enclosure

	Front area (CMP)	IP 54
	Protection and control terminals	IP 20

11.6.7 Climatic stress

Temperature range		
	in storage / emergency operation (max. 2 h, device must be in operation)	-25°C - +70°C
	Temperature range in operation	-10°C - +55°C

11.6.8 Environmental tests

Classification		
DIN EN 60068-1[03/95]	Climatic category	10/055/56
DIN EN 60721-3-3[09/95]	Classification of the environmental conditions	3K6/3B1/3C3/3S2/3M4
Test Ad: Cold		
DIN EN 60068-2-1[03/95]	Temperature	-10°C/-25°C
	Duration of load	16h
Test Bd: Dry heat		
DIN EN 60068-2-2[08/94]	Temperature	55°C/70°C
	Relative humidity	<50%
	Duration of load	72 h
Test Cd: Moist heat (constant)		
DIN EN 60068-2-3[12/86]	Temperature	40°C
	Relative humidity	93%
	Duration of load	56
Test Dd: Moist heat (cyclic)		
DIN EN 60068-2-30 [09/86]	Temperature	55°C
	Relative humidity	95%
	Cycles (12 + 12 hours)	2

11.7 Dimensions and weights

device dimensions

Basic device *CSP2-T*:	B 367.8 mm	x	H 263.9 mm	x	T 138.4 mm
Display and operation unit *CMP1*:	B 307.0 mm	x·	H 246.0 mm	x	T 55.0 mm

Weights (net)

Basic device *CSP2-T*:	6.6 kg
Display and operation unit *CMP1*:	2.8 kg

CAN connection line (cable set)

Length: 4 m

Checklist CSP2-T25

Project: *Example*

Feeder: Example

Last state: 09.06.04

Field No.: 00

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1 General information

Project		
Customer		
Street / P.O. Box		
Town		
Responsible		Tel.:
		Fax:
End customer		
Responsible		Tel.:
		Fax:
Responsible	Mr. Th.Hafermann	Tel.: +49 2152 145 636
	Mr. Th.Angenvoort (substitute)	Tel.: +49 2152 145 614
		Fax: +49 2152 145 455

2 Order Processing

Woodward offer-number	
Offer dated	
Order dated	
Order confirmed at	
Woodward job-number	
Delivery date	

Use of types (Order form)	Pieces	Remarks
CSP2-T25		
CMP1-		

3 Information about the switchgear

Manufacturer		
Type of switchgear		
Place of switchgear		
Rated voltage	Ur = KV	
Operating voltage	Ur = kV	
Rated current	Ir = A	
Short circuit current (1 sec.) of busbar	Ik = kA	
Type of elect. network		
Busbar system	Single ❑	Double ❑
Language	English	

4 Field configuration

Name of the feeder:					Voltage DC	Voltage AC	Data of CSP2-F5	Remarks
Number of controllable CBs: 1(2)							I_{max} = 17A (max. steady current)	
CB1, Typ:	Data coil	Ur = V	Sr =		❑	❑		
CB2, Typ:	Data coil	Ur = V	Sr =		❑	❑	$I_{ON\ max}$ = 30A (1sek);	
							$I_{OFF\ max}$ = 24A (with free-wheeling diode)	
Number of controllable switches: 4(3)								
Isolator 1; Type: -	Data motor	Ur = V	Sr =	Ian =	❑	❑		
Isolator 2; Type: -	Data motor	Ur = V	Sr =	Ian =	❑	❑		
Earthing switch 1; Type:	Data motor	Ur = V	Sr =	Ian =	❑	❑		
Earthing switch 2; Type:	Data motor	Ur = V	Sr =	Ian =	❑	❑		
Voltage supply								
CSP2 und CMP1:		Ur = V			❑	❑	U_H = 19–395VDC / 22–280VAC S_{max} = 36VA	
Power outputs:		Ur = V			❑	❑	Auxiliary voltage: U_H = 18–280VDC	
Digital inputs: DI 1 to DI 10:		Ur = V			❑	❑	Low: U_H = 18-110V DC / 18 –110V AC	low operating range:
Digital inputs: DI 11 to DI 18:		Ur = V			❑	❑	U_{ein} ≥ 18V DC / 18V AC	Threshold value detection: on
Digital inputs: DI 19 to DI 22:		Ur = V			❑	❑	U_{aus} ≤ 12V DC / 8V AC	Threshold value detection: off
Digital inputs: DI 23 to DI 26:		Ur = V			❑	❑	High: U_H = 70-300V DC / 68-250V AC	high operating range:
							U_{ein} ≥ 70V DC / 68V AC	Threshold value detection: on
							U_{aus} ≤ 50V DC / 40V AC	Threshold value detection: off
Alarm relays: K11 to K16		Ur = V	Sr =		❑	❑	U_H = 220VDC / 250VAC S_{max} = 1250VAAC / 120WDC	

Measuring				
Current transformer	Type			
W1: Phase current transformer (CT):	Irp = A	Irs =A	Sr = VA	Measuring circuit::
W2: Phase current transformer (CT):	Irp = A	Irs =A	Sr = VA	Measuring circuit::
Earth current transformer (ECT):	Irp = A	Irs =A	Sr = VA	Measuring circuit::
Earth CT location (ECT loc)				
Voltage transformer	Type			
Phase voltage transformer (VT):	Urp = KV/√3	Urs = V/√3	Sr= VA	Measuring circuit::
Phase VT location: (VT loc):				
Earth voltage transformer (EVT):	Urp = KV/√3	Urs = V/3	Sr= VA	Measuring circuit::
Rotating field	ABC ❑	ACB ❑		
Rated frequency	50 Hz ❑	60 Hz ❑		

Note: If the control voltage of the power outputs is an alternating current (AC), it will be necessary to use an external coupling relay!

4.1 Protection functions

ANSI-Code	Protection functions		non-directional	directional	active	inactive	Remarks
51+(67)	Overcurrent protection (UMZ/AMZ)	(I>F/I>B)	❑	❑	❑	❑	
50+(67)	Short circuit protection	(I>>F/I>>B)	❑	❑	❑	❑	
50+(67)	Maximum short circuit protection	(I>>>F/I>>>B)	❑	❑	❑	❑	
51G+(67G)	Earth fault protection	(Ie>F/Ie>B)	❑	❑	❑	❑	
50G+(67G)	Earth short circuit protection	(Ie>>F/Ie>>B)	❑	❑	❑	❑	
64REF	Restricted earth fault	(Ide>, Ide>>)			❑	❑	
49	Overload protection with thermal replica	(ϑ>, ϑ>>)			❑	❑	
27 / 59	Over-/untervoltage	(U>, U>>, U<, U<<)			❑	❑	
24	Overexctation	(U/F>, U/F>>)			❑	❑	
81	Over-/unterfrequency	(f1, f2, f3, f4)			❑	❑	
87T	Phase current differential protection	(Id>, Id>>)			❑	❑	
59N	Residual voltage supervision	(Ue>, Ue>>)			❑	❑	
79	Automatic reclosing	(AR)			❑	❑	
	NON-corresponding CB position	(AR)			❑	❑	
	Fast trip	(AR)			❑	❑	
	Switch on to fault protection	(SOTF)			❑	❑	
50 / 62 BF	CB failure protection	(CBF)			❑	❑	
	Control circuit supervision	(CCS)			❑	❑	
	Voltage transforming supervision	(VTS)			❑	❑	
	Reverse interlocking				❑	❑	
	Temperature measurement				❑		
	Tap changer monitoring				❑		
	Parameter set switching				❑		
	Trip acknowledge				❑		
	<u>External Protection</u> (devices, type and manufacturer)						
	Distance protection				❑		
	Motor protection				❑		
	Generator protection				❑		
	Line differential protection relay				❑		
	Other protection relays:				❑		

4.2 Communication interfaces

Communication interface	Medium: Fibre optic	Medium: RS485	Remarks
IEC 60870-5-103	❑	❑	
PROFIBUS DP	❑	❑	
MODBUS RTU	❑	❑	
CAN-BUS 2	❑		Multi device communication
No communication interface required	❑		

4.3 Assign the switchgears to the application

Switchgear No.	Switchgear	Switchgear controllable	Switchgear recognizable	internal symbol	external symbol	Remarks
SG1	Circuit breaker	☒	❑	Q0		
SG2		❑	❑	Q_		
SG3		❑	❑	Q_		
SG4		❑	❑	Q_		
SG5		❑	❑	Q_		

4.4 Single line diagram and switching conditions

Switching conditions for ON and OFF commands of controllable switchgears (description)		Single Line: Anlage_
Q01 (SG1) ON:	SG1-SG5 in definite position **and** ...	
Q01 (SG1) OFF:	SG1-SG5 in definite position **and** ...	
Q01 (SG1) Trip: Q01 (SG1) Trip blockade: Q01 (SG1) EMERGENCY OFF:		
Q02 (SG2) ON:	SG1-SG5 in definite position **and** ...	
Q02 (SG2) OFF:	SG1-SG5 in definite position **and** ...	
Q0 (SG2) Trip: Q0 (SG2) Trip blockade: Q0 (SG2) EMERGENCY OFF:		
Q2 (SG3) ON:	SG1-SG5 in definite position **and** ...	
Q2 (SG3) ON:	SG1-SG5 in definite position **and** ...	
Q8 (SG4) ON:	SG1-SG5 in definite position **and** ...	
Q8 (SG4) ON:	SG1-SG5 in definite position **and** ...	
Q9 (SG5) ON:	SG1-SG5 in definite position **and** ...	
Q9 (SG5) ON:	SG1-SG5 in definite position **and** ...	

4.5 Terminal plan of CSP-T25

4.5.1 Power supply (only DC!)

Terminal No.	Output No.	Description**	Remarks
X1.1	LA -	Negative voltage supply for power outputs	
X1.2	LA+	Positive voltage supply for power outputs	

4.5.2 Control options of motor-driven switches OM1 to OM3

Terminal No.	Description*		Remarks
	Indirect Control: Coil ☐	Direct Control:Motor ☐	
-	external wire bridge:	external wire bridge:	(external wiring!)
X1.3			
X1.4			
X1.5			
X1.6			
X1.7			
X1.8			
X1.9			

* according to the kind of switchgear control there is a need of wire bridges!

4.5.3 Power outputs

Terminal No.	Output No.	Description**		Remarks
X1.10	OM 1.1	Positive control voltage for ***motor excitation coil*** or ***OFF coil*** SWG3	(Q_)	
X1.11	OM 1.2	Negative control voltage for ***motor excitation coil*** or ***OFF coil*** SWG3	(Q_)	
X1.12	OM 1.3	Positive control voltage for ***ON direction of motor*** or ***ON coil*** SWG3	(Q_)	
X1.13	OM 1.4	Negative control voltage for ***ON direction of motor*** or ***ON coil*** SWG3	(Q_)	
X1.14	OM 2.1	Positive control voltage for ***motor excitation coil*** or ***OFF coil*** SWG4	(Q_)	
X1.15	OM 2.2	Negative control voltage for ***motor excitation coil*** or ***OFF coil*** SWG4	(Q_)	
X1.16	OM 2.3	Positive control voltage for ***ON direction of motor*** or ***ON coil*** SWG4	(Q_)	
X1.17	OM 2.4	Negative control voltage for ***ON direction of motor*** or ***ON coil*** SWG4	(Q_)	
X1.18	OM 3.1	Positive control voltage for ***motor excitation coil*** or ***OFF coil*** SWG5	(Q_)	
X1.19	OM 3.2	Negative control voltage for ***motor excitation coil*** or ***OFF coil*** SWG5	(Q_)	
X1.20	OM 3.3	Positive control voltage for ***ON direction of motor*** or ***ON coil*** SWG5	(Q_)	
X1.21	OM 3.4	Negative control voltage for ***ON direction of motor*** or ***ON coil*** SWG5	(Q_)	
X1.22	OL 1.1	Positive control voltage for ***trip coil*** SWG1	(Q0 / Q01 OFF)	
X1.23	OL 1.2	Negative control voltage for ***trip coil*** SWG1	(Q0 / Q01 OFF)	
X1.24	OL 2.1	Positive control voltage for ***ON coil*** SWG1	(Q0 / Q01 ON)	
X1.25	OL 2.2	Negative control voltage for ***ON coil*** SWG1	(Q0 / Q01 ON)	
X1.26	OL 3.1	Positive control voltage for ***trip coil*** SWG2	(Q02 OFF)	
X1.27	OL 3.2	Negative control voltage for ***trip coil*** SWG2	(Q02 OFF)	
X1.28	OL 4.1	Positive control voltage for ***ON coil*** SWG2	(Q02 ON)	
X1.29	OL 4.2	Negative control voltage for ***ON coil*** SWG2	(Q02 ON)	

** The function of the power outputs depends on the application.

4.5.4 Analog outputs (AO)

Terminal No.	Output No.	Description	Remarks
X5.1	AO 1.1	Not avalable yet!	
X5.2	AO 1.2	Not avalable yet!	

4.5.5 Analog input (AI)

Terminal No.	Output No.	Description	Remarks
X5.3	AI 1.1		
X5.4	AI 1.2		
X5.5	AI 1.3		
X5.6	AI 2.1		
X5.7	AI 2.2		
X5.8	AI 2.3		

Hardware allocation by DIP switches

Input No.	input signal / sensor	optionally available	DIP switch 1.1	DIP switch 1.2	DIP switch 1.3	DIP switch 1.4
AI 1	PT100 / Ni100	❑	ON	OFF	OFF	OFF
	PTC (0 – 30 kOhm)	❑	OFF	ON	OFF	OFF
	0 – 20 mA DC / 4 – 20 mA DC	❑	OFF	OFF	ON	OFF
	0 – 10 V DC	❑	OFF	OFF	OFF	ON
AI 2	PT100 / Ni100	❑	ON	OFF	OFF	OFF
	PTC (0 – 30 kOhm)	❑	OFF	ON	OFF	OFF
	0 – 20 mA DC / 4 – 20 mA DC	❑	OFF	OFF	ON	OFF
	0 – 10 V DC	❑	OFF	OFF	OFF	ON

4.5.6 Current measurement inputs
(Connection see screw cap of CSP)

4.5.7 Voltage measurement inputs
(Connection see screw cap of CSP)

4.5.8 Voltage supply CSP2 and CMP1
(Connection see screw cap of CSP)

4.6 Digital inputs

Terminal No.	Input No.	Telegramm** Fct.-type/Info-No.	Description (of configurated input functions* from DI 11)	Logic	Rebouncing time***	external target	Remarks
X4.1	DI 1	120 / 19	SG1 Signal 0 (switchgear 1: position OFF)		20 ms		
X4.2	DI 2	120 / 19	SG1 Signal I (switchgear 1: position ON)		20 ms		
X4.3	DI 3	120 / 20	SG2 Signal 0 (switchgear 2: position OFF)		20 ms		
X4.4	DI 4	120 / 20	SG2 Signal I (switchgear 2: position ON)		20 ms		
X4.5	DI 5	120 / 21	SG3 Signal 0 (switchgear 3: position OFF)		20 ms		
X4.6	DI 6	120 / 21	SG3 Signal I (switchgear 3: position ON)		20 ms		
X4.7	DI 7	120 / 22	SG4 Signal 0 (switchgear 4: position OFF)		20 ms		
X4.8	DI 8	120 / 22	SG4 Signal I (switchgear 4: position ON)		20 ms		
X4.9	DI 9	120 / 23	SG5 Signal 0 (switchgear 5: position OFF)		20 ms		
X4.10	DI 10	120 / 23	SG5 Signal I (switchgear 5: position ON)		20 ms		
X4.11	COM 1	-	Common wire DI 1 - DI 10	-			-
X4.12	DI 11	160 / 27			10 ms		
X4.13	DI 12	160 / 28			10 ms		
X4.14	DI 13	160 / 29			10 ms		
X4.15	DI 14	160 / 30			10 ms		
X4.16	DI 15	121 / 15			10 ms		
X4.17	DI 16	121 / 16			10 ms		
X4.18	DI 17	121 / 17			10 ms		
X4.19	DI 18	121 / 18			10 ms		
X4.20	COM 2	-	Common wire DI 11 - DI 18	-			-
X4.21	DI 19	121 / 19			10 ms		
X4.22	DI 20	121 / 20			10 ms		
X4.23	DI 21	121 / 21			10 ms		
X4.24	DI 22	121 / 22			10 ms		
X4.25	COM 3	-	Common wire DI 19 - DI 22	-			-
X4.26	DI 23	121 / 23			10 ms		
X4.27	DI 24	121 / 24			10 ms		
X4.28	DI 25	121 / 25			10 ms		
X4.29	DI 26	121 / 26			10 ms		
X4.30	COM 4	-	Common wire DI 23 - DI 26				

* from DI 11 each digital input (DI) could be configurated to one of the input functions(with reference to the choice of input functions)! It is not allowed to configurate an input function twice!

** the configuration of the "Function type" / "Information No." is only related to the digital input; it is independent of the configurated function!

*** Standard value of Woodward

4.7 Signal relays

Alarm relay		Description (of configured output functions* from K 14)	external source	external target	remarks
Termional No.	Free potential contacts				
K11		System OK			System message (pre-setting)
X2.1	opener (nc)	-			
X2.2	shutter (no)	-			
X2.3	pedal contact	-			
K12		General alarm			General protection alarm (pre-setting)
X2.4	opener (nc)	-			
X2.5	shutter (no)	-			
X2.6	pedal contact	-			
K13		General trip			General protection trip (pre-setting)
X2.7	opener (nc)				
X2.8	shutter (no)				
X2.9	pedal contact				
K14					
X2.10	opener (nc)				
X2.11	shutter (no)				
X2.12	pedal contact				
K15					
X2.13	opener (nc)				
X2.14	shutter (no)				
X2.15	pedal contact				
K16					
X2.16	opener (nc)				
X2.17	shutter (no)				
X2.18	pedal contact				

* it is possible to configure up to 16 output functions to one alarm relay! If one of the configured output functions is “active” the relay will work!

4.8 LED configuration

LED	No.	Message text (of the configured functions*)	Configurated as		Flashing-Code		LED Reset	Remarks
			output function	input function	Normal/OK.	Alarm/failure		
1		System OK	•	-	green	red	N	System message (pre-setting)
2	2.1	General alarm	•	•	-	red flashed	N	General protection alarm (pre-setting)
2	2.2							
2	2.3							
2	2.4							
2	2.5							
3	3.1	General trip	•	•	-	red	Y	General protection trip (pre-setting)
3	3.2							
3	3.3							
3	3.4							
3	3.5							
4	4.1							
4	4.2							
4	4.3							
4	4.4							
4	4.5							
5	5.1							
5	5.2							
5	5.3							
5	5.4							
5	5.5							
6	6.1							
6	6.2							
6	6.3							
6	6.4							
6	6.5							
7	7.1							
7	7.2							
7	7.3							
7	7.4							
7	7.5							
8	8.1							
8	8.2							
8	8.3							
8	8.4							
8	8.5							
9	9.1							
9	9.2							

LED	No.	Message text (of the configured functions*)	Configurated as output function	Configurated as input function	Flashing-Code Normal/OK.	Flashing-Code Alarm/failure	LED Reset	Remarks
9	9.3							
9	9.4							
9	9.5							
10	10.1							
10	10.2							
10	10.3							
10	10.4							
10	10.5							
11	11.1							
11	11.2							
11	11.3							
11	11.4							
11	11.5							

* it is possible to configure up to 5 functions (input and output functions) to each LED! If one of the configured functions is “active” the LED will begin to flash!

4.9 Programmable logic functions (SL-Logic)

To realize a customer-specific application with the programmable logic function is it necessary to have a technical description in form of a:

1. text specification or
2. truth table or
3. wiring (connection) diagram or
4. contactless logic diagram or similar

5 Remarks

6 Documentation and drawings

Documentation / Drawings	Date	Send from	Remarks
Checklist of			

Setting lists

Field settings					
Parameter	*Description of the parameter*	*Setting/ Setting Range*	*Description of the parameter setting*	*-Setting*	*Step Range*
f_N	Nominal frequency	50 Hz			-
		60 Hz			
Parameter CT (phase current transformer)					
CTW1 pri	primary side W1; primary nom. current CT1	1...50,000 A			1 A
CTW1 sec	primary side W1; secondary rated current CT1	1 A			-
		5 A			
CTW1 dir	Polarity (direction) of the phase CTs	0°			180°
		180°			
CTW2 pri	secondary side W2; primary rated current CT2	1...50,000 A			1 A
CTW2 sec	secondary side W2; secondary rated current CT2	1 A			
		5 A			
CTW2 dir	Polarity (direction) of the phase CTs	0°			180°
		180°			
Parameter ECT (earth current transformer)					
ECT loc	location of the ECT, winding1 or winding2 or Cauldron protection or no ECT W1: Ie loc W1 measured, Ie W2 calculated; W2: Ie loc W2 measured, Ie W1 calculated; CP (Cauldron protection), Ie W1 and W2 calculated; No ECT: Ie loc W1 calculated, Ie loc W2 calculated	W1			
		W2			
		Caldron			
		no ECT			
ECT prim.	Rated primary current of the earth CTs	1...50,000 A	*		1 A
ECT sec	Rated secondary current of the earth CTs	1 A	**		-
		5 A			
ECT dir	Polarity (Direction) of the earth CT	0°			180°
		180°			
Parameter VT					
VT prim.	Rated primary voltage of the VTs	1...500,000 V			1 V
VT sec	Rated secondary of the VTs	1...230 V			1 V
VT con	Connection mode (treatment) of the phase VTs	Y	Star Connection		-
		Δ	Delta Connection		
		no VT	No U-Measurement		
		V	V-Connection		
VT loc	location from voltage measurement W1 busbar, see position VT Loc1 in figure transformerstation W2 Tr (winding1 = prim Tr) see position VT Loc2 in figure transformerstation W2 Tr (winding2 = sec. Tr) see position VT Loc3 in figure transformerstation W2 busbar see position VT Loc4 in figure transformerstation	W1 Busb.			-
		W1 Tr			
		W2 Tr			
		W2 Busb.			
Rt.field	ABC right rotating field ACB left rotating field	ABC			

Field settings					
Parameter	*Description of the parameter*	*Setting/ Setting Range*	*Description of the parameter setting*	*-Setting*	*Step Range*
	to take into account a left rotating field it is possible to use the parameter "Rotating field".	ACB			
Parameter EVT (earth voltage transformer)					
EVT con	broken delta (via separate voltage input), If -broken Δ- is selected, the location for the earth voltage measuring will be select with the parameter -EVT loc-. (EVT con -broken Δ- and select EVT loc -W1- or -W2-) If -geometr. Σ- is select, the parameter -EVT loc- will be ignored and the measuring location is the same as the phase voltage location, VT loc. In this case VT con must be set to –star- if -no EVT- is select, the earth voltage can´t be measured.	broken Δ	Series Connection of the e-n Wndings	broken Δ	-
		geometr.SUM	$\sum \underline{U}_{L-N} = \underline{U}_{L1}+\underline{U}_{L2}+\underline{U}_{L3}$, only for setting : „VT = Y"		
		none	No Ue Measurement		
EVT loc	W1 (winding1 = prim TR) see position VT Loc2 in figure transformerstation W2 (winding2 = sec. TR) see position VT Loc3 in figure transformerstation	W1		W1	
		W2			
EVT prim.	Rate primary voltage of the VT e-n winding	1…500000 V	Only relevant for setting: „EVT con = open Δ"	10000 V	1 V
EVT sec	Rated secondary voltage of the VT e-n winding	1…230 V	Only relevant for setting: „EVT con = open Δ"	1 V	1 V
Parameter transformer (TR)					
Applica.	Device assortment			10,000 kVA	
Sr	power capacity transformer	1...800,000 kVA			
UrW1	rated voltage winding1 (prim. side)	1…500000 V			
UrW2	rated voltage winding2 (sec. side)	1…500000 V			
W1 con.	connection groups winding1 (primary side). YN or ZN are connection groups with earth connection	y		y	
		d			
		z			
		yn			
		zn			
W2 con.	connection groups winding2 (secondary side) yn or zn are connection groups with earth connection	y		y	
		d			
		z			
		yn			
		zn			
Ph.shift	phase shift between primary and secondary side. The phase shift angle is factor (1,2,3…11) multiplied with 30 degrees.	0		0	
		1			
		2			
		3			
		…11			

Control Times						
Switching time/ follow up time		*Description*	*Setting range*	*Possibly Application*	*Control output*	*Default*
SG1	tc SG1	Switching time for SG1	80 – 50,000ms	Circuit breaker	OL1, OL2	200ms
	tr ON	Follow up time ON for SG1	0 - 5000ms			5000 ms
	tr OFF	Follow up time OFF for SG1	0 - 5000ms			5000 ms
SG2	tc SG2	Switching time for SG2	80 – 50,000ms	circuit breaker	OL3, OL4	200 ms
	tr ON	Follow up time ON for SG2	0 - 5000ms			5000 ms
	tr OFF	Follow up time OFF for SG2	0 - 5000ms			5000 ms
SG3	tc SG3	Switching time for SG3	80 – 50,000ms	isolator or earthing switch	OM1	10,000 ms
	tr ON	Follow up time ON for SG3	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG3	0 - 5000ms			1000 ms
SG4	ts SG4	Switching time for SG4	80 – 50,000ms	isolator or earthing switch	OM2	10,000 ms
	tr ON	Follow up time ON for SG4	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG4	0 - 5000ms			1000 ms
SG5	ts SG5	Switching time for SG5	80 – 50,000ms	isolator or earthing switch	OM3	10,000 ms
	tr ON	Follow up time ON for SG5	0 - 5000ms			1000 ms
	tr OFF	Follow up time OFF for SG5	0 - 5000ms			1000 ms

Interlocking				
Parameter	*Setting/Setting Range*	*Description of Parameter Setting*	*Pre-setting*	*Step range*
All SG	active	Any issued control command will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG1 off	active	Every OFF command for SG1 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG1 on	active	Every ON command for SG1 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG2 off	active	Every OFF command for SG2 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG2 on	active	Every ON command for SG2 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG3 off	active	Every OFF command for SG3 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG3 on	active	Every ON command for SG3 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG4 off	active	Every OFF command for SG4 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG4 on	active	Every ON command for SG4 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG5 off	active	Every OFF command for SG5 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	
SG5 on	active	Every ON command for SG5 will be blocked		-
	inactive	Only the field and system interlockings apply	inactive	

Digital Inputs (DI-Group1 - fixed allocation)				
DI-Gruppe	*DI-No*	*Parameters*	*Setting/ Setting Range*	*Description*
Group 1 (fixed)	DI 1	DI 1 (fixed function)	„SG1 Signal 0“	Position switch. device 1: OFF
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000ms	Debouncing time
	DI 2	DI 2 (fixed function)	„SG1 Signal I“	Position switch. Device 1: ON
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000 ms	Debouncing time
	DI 3	DI 3 (fixed function)	„SG2 Signal 0“	Position switch. Device 2: OFF
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000 ms	Debouncing time
	DI 4	DI 4 (fixed function)	„SG2 Signal I“	Position switch. device 2: ON
			„active 1“	Open circuit principle
			„aktiv 0“	Closed circuit principle
			„inaktiv“	Out of function
			0…60,000 ms	Debouncing time
	DI 5	DI 5 (fixed function)	„SG3 Signal 0“	Position switch. device 3: OFF
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000 ms	Debouncing time
	DI 6	DI 6 (fixed function)	„SG3 Signal I“	Position switch. device 3: ON
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000 ms	Debouncing time
	DI 7	DI 7 (fixed function)	„SG4 Signal 0“	Position switch. device 4: OFF
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60,000 ms	Debouncing time t
	DI 8	DI 8 (fixed function)	„SG4 Signal I“	Position switch. device 4: ON
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 9	DI 9 (fixed function)	„SG5 Signal 0“	Position switch. device 5: OFF
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 10	DI 10 (fixed function)	„SG5 Signal I“	Position switch. Device 5: ON
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time

Digital Inputs (Variable Allocation for DI Groups 2 to 4 — Here: Exemplarily for Group2)				
DI-Group	*DI-No.*	*Parameters*	*Setting/Setting Range*	*Description*
Group 2 (variabel)	DI 11	DI 11 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 12	DI 12 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 13	DI 13 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000ms	Debouncing time
	DI 14	DI 14 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 15	DI 15 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000ms	Debouncing time
	DI 16	DI 16 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time
	DI 17	DI 17 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000ms	Debouncing time
	DI 18	DI 18 (function can be assigned)	Displayed text of the assigned input function	To be chosen from catalogue (Annex)
			„active 1“	Open circuit principle
			„active 0“	Closed circuit principle
			„inactive“	Out of function
			0…60.000 ms	Debouncing time

Signal Relay (Variable Assignment – By Way of Example)			
Relay Name	*Parameters*	*Setting/Setting Range*	*Description*
K14	t min	0…1000 ms	Minimum relay holding time
		„active 1"	Open circuit principle
		„active 0"	Closed circuit principle
		„inactive"	Out of function
	Reset .	„active"	Relay reset
		„inactive"	
	(Messages can be assigned)	Text of the assigned output message	To be chosen from the List of output messages (see Annex)
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned d output message	
		Text of the assigned output message	
		Text of the assigned output message	
		Text of the assigned output message	

LEDs (variable assignment – by way of example)			
LED Names	*Parameters*	*Setting*	*Description*
LED 5	Quit LED	„None“	There is no reset of the LED indication necessary for messages
		„All“	LED indications have to be reset for all messages after change of status
		„Alarm“	Reset of LED indication for trip and alarm signals (e.g. „Trip: I>F“ or „Alarm: I>F“)
		„Trip“	Reset of LED indications for trip signals (e.g. “Trip: I>F“)
	(Functions/Messages can be assigned)	„Input“	These settings define whether an input or output function is to be assigned
		„Output“	
		„Text of assigned function/message“	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message “	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message “	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input	These settings define whether an input or output function is to be assigned
		„Output	
		„Text of assigned function/message “	To be chosen from the catalogue (Annex)
	(Functions/Messages can be assigned)	„Input“	These settings define whether an input or output function is to be assigned
		„Output“	
		„Text of assigned function/message “	To be chosen from the catalogue (Annex)

Disturbance Recorder				
Parameters	*Setting/ Setting Range*	*Description*	*Presetting.*	*Step Range*
Sample n	160...4400	Number of measuring points, starting from the trigger event	1800	1
Pre-trig	0...4400	Number of measuring points prior to the trigger event	240	1
T. Source	„pi.up on"	Start of fault value recording with incoming message for „Protective Alarm" (pick up value)		-
	„pi.up re"	Start of fault value recording with outgoing message for „Protective Alarm" (pick up value)		
	„trip on"	Start of fault value recording with incoming message for „Protective Trip"	„trip on"	
	„trip rel"	Start of fault value recording with outgoing message for „Protective Trip"		
	„Input fct."	External start of fault value recording (no internal trigger events) via active digital input (DI) „Fault Recorder ON"		
	„inactive"	Start of the fault value recording only possible via menu parameter „Man. Tigger" (CMP1 or SL SOFT)		
Storage	„Int. RAM"	Internal volatile storage of the CSP2 (Standard Version)	„Int. RAM"	-
	„RAM Card"	Internal non-volatile extended storage of the CSP2 (optional)		
	„FLASHRAM"	(for use in Woodward only)		
auto del	„active"	Storing of fault recording files until store is full, afterwards the FIFO principle applies!	„active"	-
	„inactive"	Storing of fault recording files until store is full, afterwards there is no recording possible!		

Disturbance Recorder				
Parameters	*Setting/ Setting Range*	*Description*	*Presetting.*	*Step Range*
Sample n	160...4400	Number of measuring points, starting from the trigger event	1800	1
Pre-trig	0...4400	Number of measuring points prior to the trigger event	240	1
T. Source	„pi.up on"	Start of fault value recording with incoming message for „Protective Alarm" (pick up value)		-
	„pi.up re"	Start of fault value recording with outgoing message for „Protective Alarm" (pick up value)		
	„trip on"	Start of fault value recording with incoming message for „Protective Trip"	„trip on"	
	„trip rel"	Start of fault value recording with outgoing message for „Protective Trip"		
	„Input fct."	External start of fault value recording (no internal trigger events) via active digital input (DI) „Fault Recorder ON"		
	„inactive"	Start of the fault value recording only possible via menu parameter „Man. Tigger" (CMP1 or SL SOFT)		
Storage	„Int. RAM"	Internal volatile storage of the CSP2 (Standard Version)	„Int. RAM"	-
	„RAM Card"	Internal non-volatile extended storage of the CSP2 (optional)		
	„FLASHRAM"	(for use in Woodward only)		
auto del	„active"	Storing of fault recording files until store is full, afterwards the FIFO principle applies!	„active"	-
	„inactive"	Storing of fault recording files until store is full, afterwards there is no recording possible!		

Protocol type PROFIBUS DP				
Parameters	Setting Range	Description	Presetting	Step Range
P_DP_No.	0…126	ID number of the Slave (CSP2) connected	„1“	1
t call	200…240000 ms	Max. hold time before the automation system sends an inquiry telegram to the CSP2	„24000 ms“	1 ms

Protocol type MODBUS RTU				
Parameters	Setting/Setting Range	Description	Presetting	Step Range
Parity	„Even“	In the data byte an even number of bits is transmitted with valence "1"	„Even“	-
	„odd“	In the data byte an odd number of bits is transmitted with valence "1".		
	„None“	There is no parity bit transmitted in the data byte		
Stop Bit	„1“	Number of Stop-Bits in the data byte is 1	„1“	-
	„2“	Number of Stop-Bits in the data byte is 2		
Baud Rate	„1200“	Used data transmission rate [bit/s]		-
	„2400“			
	„4800“			
	„9600“			
	„19200“		„9600“	
timeout	50… 1000 ms	Max. idle time before the CSP2 sends a response telegram to the host computer	„900 ms“	1 ms
t call	200…600000 ms	Max. idle time before the host computer sends an inquiry telegram to the CSP2	„240000 ms“	1 ms
slave ID	1…247	Device address (Slave) in the bus system	„1“	1

CAN-BUS				
Parameters	Setting/Setting Range	Description	Presetting	Step Range
CAN Device No.	1…16	ID number of the CSP2 or the CSP2/CMP1 system	1	1
single CMP	„yes“	Setting for version 2 of the multi-device communication		-
	„no“	Setting for version 1 of the multi-device communication	„no“	

Statistical Parameters					
Parameters	Setting Range	Description	Note	Presetting	Step Range
Δt [s]	1…86400 s	Computation interval for maximum values and average values	Recommend. 900	60 s	1 s
Hour [h]	0…24 h	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 h	1 h
Minute [min]	0…60 min	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 min	1 min
Second [s]	0 …60 s	Setting of the timer for synchronisation of the statistical measurement	Start of the measurement intervals	00 s	1 s

BCD-Coding of the Tap Changer Positions Via Input Functions							
Position	*Output Message for Tap Changer Position (Message Text)*	*Decimal Position “Unit”*		*Decimal Position “Unit”*			
		Valency					
		2^5	2^4	2^3	2^2	2^1	2^0
		Input Function					
		« Tc.BCD 5 »	« Tc.BCD 4 »	« Tc.BCD 3 »	« Tc.BCD 2 »	« Tc.BCD 1 »	« Tc.BCD 0 »
0	« Tc.Pos.0 »	0	0	0	0	0	0
1	« Tc.Pos.1 »	0	0	0	0	0	1
2	« Tc.Pos.2 »	0	0	0	0	1	0
3	« Tc.Pos.3 »	0	0	0	0	1	1
4	« Tc.Pos.4 »	0	0	0	1	0	0
5	« Tc.Pos.5 »	0	0	0	1	0	1
6	« Tc.Pos.6 »	0	0	0	1	1	0
7	« Tc.Pos.7 »	0	0	0	1	1	1
8	« Tc.Pos.8 »	0	0	1	0	0	0
9	« Tc.Pos.9 »	0	0	1	0	0	1
——	P*	0	0	1	0	1	0
——		0	0	1	0	1	1
——		0	0	1	1	0	0
——		0	0	1	1	0	1
——		0	0	1	1	1	0
——		0	0	1	1	1	1
10	« Tc.Pos.10 »	0	1	0	0	0	0
11	« Tc.Pos.11 »	0	1	0	0	0	1
12	« Tc.Pos.12 »	0	1	0	0	1	0
13	« Tc.Pos.13 »	0	1	0	0	1	1
14	« Tc.Pos.14 »	0	1	0	1	0	0
15	« Tc.Pos.15 »	0	1	0	1	0	1
16	« Tc.Pos.16 »	0	1	0	1	1	0
17	« Tc.Pos.17 »	0	1	0	1	1	1
18	« Tc.Pos.18 »	0	1	1	0	0	0
19	« Tc.Pos.19 »	0	1	1	0	0	1
——«	P*	0	1	1	0	1	0
——		0	1	1	0	1	1
——		0	1	1	1	0	0
——		0	1	1	1	0	1
——		0	1	1	1	1	0
——		0	1	1	1	1	1
20	« Tc.Pos.20 »	1	0	0	0	0	0
21	« Tc.Pos.21 »	1	0	0	0	0	1
22	« Tc.Pos.22 »	1	0	0	0	1	0
23	« Tc.Pos.23 »	1	0	0	0	1	1
24	« Tc.Pos.24 »	1	0	0	0	0	1
25	« Tc.Pos.25 »	1	0	0	0	1	0
26	« Tc.Pos.26 »	1	0	0	0	1	1
27	« Tc.Pos.27 »	1	0	0	0	1	1
28	« Tc.Pos.28 »	1	0	0	0	1	0
29	« Tc.Pos.29 »	1	0	0	0	1	1
——	P*	1	0	0	0	1	1
——		1	0	0	0	1	0
——		1	0	0	0	1	1
——		1	0	0	0	1	1
——		1	0	0	0	1	1
——		1	0	0	0	1	1
30	« Tc.Pos.30 »	1	1	0	0	0	0
31	« Tc.Pos.31 »	1	1	0	0	0	1
32	« Tc.Pos.32 »	1	1	0	0	1	0
33	« Tc.Pos.33 »	1	1	0	0	1	1
34	« Tc.Pos.34 »	1	1	0	1	0	0
35	« Tc.Pos.35 »	1	1	0	1	0	1
36	« Tc.Pos.36 »	1	1	0	1	1	0
37	« Tc.Pos.37 »	1	1	0	1	1	1
38	« Tc.Pos.38 »	1	1	1	0	0	0
39	“ Tc.Pos.39”	1	1	1	0	0	1

Tap Changer Supervision				
Parameter	*Setting / Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	“active”	The tap changer supervision is activated		-
	“inactive”	The tap changer supervision is de-activated	“inactive”	
regard	„Ur W1“	Adjustment of winding number at winding end W1	„Ur W1“	
	„Ur W2“	Adjustment of winding number at winding end W2		
Tc input	„Inp.fct.“	(Detection of tap changer position via digital input) (BCD).	„Inp.fct.“	-
	(not available)	(Detection of tap changer position via analogue input 1)	-	
	(not available)	(Detection of tap changer position via analogue input 2)	-	
Min.T.pos	„0“	BCD-coding: Decimal “0” is allocated to the lowest step of the tap changer.		-
	„1“	BCD-coding: Decimal “1” is allocated to the lowest step of the tap changer.	„1“	
Min.T.vo	80…100 %	Allocation of the voltage value for the lowest step position (in % refers to the rated voltage of the winding end to be changed).	„100 %“	0,1 %
V.inc.po	0…10 %	Voltage value change per tap changer position (in % refers to the rated voltage of the winding end to be changed).	„1“	0,1 %
Pos.no.	1…39	Number of tap changer positions to be detected	„39“	1
Neut.Pos	80…200 %	Defining the neutral position of the tap changer.	„100 %“	0,1 %
T stabl	0…50 s	BCD-coding: Delay time ranging from status change of the digital inputs to read-in of the new tap changer position.	„1 s“	1 s

Parameter sets				
Parameters	*Settings*	*Description*	*Presetting*	*Step Range*
Active Set	„1“	ID number display of active parameter set and input field for switching over via CMP1	„1“	1
	„2“			
	„3“			
	„4“			
Paraswitch	„Not Permitted“	No switch-over action possible	„Not Permitted“	-
	„ Not Permitted “	Switching over: Possible viaCMP1 or control system		
	„Input fct“	Switching over: Possible via digital input only (DI-function „Switch. Over P-Set“)		
Input fct. active	„1“	„Protect. Parameter Set 1“ is active, if DI is inactive	„1“	1
	„2“	„Protect. Parameter Set 2“ is active, if DI is inactive		
	„3“	„Protect. Parameter Set 3“ is active, if DI is inactive		
	„4“	„Protect. Parameter Set 4“ is active, if DI is inactive		
nput fct. inactive	„1“	„Protect. Parameter Set 1“ is active, if DI is active		1
	„2“	„Protect. Parameter Set 2“ is active, if DI is active	„2“	
	„3“	„Protect. Parameter Set 3“ is active, if DI is active		
	„4“	„Protect. Parameter Set 4“ is active, if DI is active		
Trip ack.	„active“	A protection trip has to be reset either via button „C“ at the CMP, the DI „Reset“ or via SCADA before the CB can be reconnected	„inactive“	-
	„inactive“	After a protection trip the CB can be re connected without reset		

Tripping Processing and Measuring Location

Parameters	*Assignment*	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Internal protect.funct.*	*Input function*
I>	Measuring location	W1	Measuring at winding end W1	W1		
		W2	Measuring at winding end W2			
	Trip loc	W1	Trip command to CB1 of the winding end W1 only		•	
		W2	Trip command to CB2of the winding end W2 only			
		W1 & W2	Trip command to both CBs	W1 & W2		
I>>	Measuring location	W1	See above (s.a.)	W1		
		W2	s.a.			
	Tripping	W1	s.a.		•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
I H2	Measuring location	W1	s.a.	W1		
		W2	s.a.			
Ie>	Measuring location	W1	s.a.	W1		
		W2	s.a.			
	Trip loc	W1	s.a.		•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ie>>	Measuring location	W1	s.a.	W1		
		W2	s.a.			
	Trip loc	W1	s.a.		•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ie H2	Measuring location	W1	s.a.	W1	•	
		W2	s.a.			
Id>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
Id>>	Trip loc	W1	s.a.	W1		
		W2	s.a		•	
			s.a.			
Ide>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
Ide>>	Trip loc	W1	s.a.	W1		
		W2	s.a.		•	
			s.a.			
Thermal replica ϑ>	Measuring location	W1	s.a.	W1		
		W2	s.a.			
	Trip loc	W1	s.a.		•	
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
U/f>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
			s.a.			
U/f>>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
			s.a.			
Temperature supervision ϑ1>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
		W1 & W2	s.a.	W1 & W2		
Temperature supervision ϑ2>	Trip loc	W1	s.o.	W1		
		W2	s.o.		•	
		W1 & W2	s.a.	W1 & W2		

Tripping Processing and Measuring Location

		W1	s.a.	W1		
U>	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
U>>	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
U<	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
U<<	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Ue>	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Ue>>	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
FF supervision	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
f1	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
f2	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
f3	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
f4	Trip loc	W2	s.a.		•	
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Protect.trip.1	Trip loc	W2	s.a.			•
			s.a.			
		W1	s.a.	W1		
Protect.trip.2	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Protect.trip.3	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Protect.trip.4	Trip loc	W2	s.a.			•
			s.a.			
		W1	s.a.	W1		
Protect.trip.5	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Protect.trip.6	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Tripp.temp.	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Tripp.Buchh.	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Tripp.Diff	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
		W1	s.a.	W1		
Tripp.Imped	Trip loc	W2	s.a.			•
		W1 & W2	s.a.	W1 & W2		
Tripp.Motor	Trip loc	W1	s.a.	W1		•

Tripping Processing and Measuring Location

		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		
Ext CT off	Trip loc	W1	s.a.	W1		•
		W2	s.a.			
		W1 & W2	s.a.	W1 & W2		

Phase Current Differential Protection Id>				
Parameter	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	„active“	Differential protection function is activated	„inactive“	-
	„inactive“	Differential protection function is de-activated		
ex block	„active“	Differential protection function is ineffective when the input function “Protect.Block” is active		-
	„inactive“	Differential protection function is effectife irrespectively of the input function “Protect.Block“ state	„inactive“	
trip bloc	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
Applic.	Trafo	Application for ”Transformer“ as object to be protected	Trafo	-
	Cable	Application for short “Lines/Cabel/Bus Bar“ as object to be protected		
Id min	0.1…1 x In	Constant minimum pick-up current(differential current) for a stabilising current up to Is = 2 x In	0.1 x In	0.001 x In
Id(Is0)	0.1…1 x In	Starting point of the static tripping characteristic when Is = 0	0.3 x In	0.001 x In
Id(Is1)	0.2…2 x In	Breaking point of the static tripping characteristic when Is = 2 x In	1.0 x In	0.001 x In
Id(Is2)	2.0…8 x In	Value of the static tripping characteristic when Is = 10 x In	4.0 x In	0.001 x In
d(H, m)	0…8 x In	Stabilising factor for rising the static tripping characteristic in case of stationary or transient harmonic components, which are ascertained by Fourier analysis (H) or transients monitor (m).	0.0 x In	0.001 x In
Stab.H2	Active	Stabilising of differential protection function Id> against stationary or transient components of the 2nd harmonic at the phase current (e.g. rush-effect)	inactive	-
	Inactive			
H2.sta	10…50 %	Threshold (2nd harmonic - basic wave ratio) for stabilising the protection function Id> against stationary 2nd harmonic.	30	0.1
H2.tra	10…25 %	Threshold (2nd harmonic – basic wave ratio) for temporary stabilisation of the protection function Id> against transient 2nd harmonic.	15	0.1
Stab.H4	Active	Stabilisation of the differential protection function Id> against stationary or transient components of the 4th harmonic at the phase current (e.g. CT saturation).	inactive	-
	Inactive			
H4.sta	10…50 %	Threshold (4th harmonic – basic wave ratio) for stabilising the protection function Id> against stationary 4th harmonic.	30	0.1
Stab.H5	Active	Stabilisation of differential protection function Id> against stationary or transient components of the 5th harmonic at the phase current (e.g. transformer overexcitation).	inactive	-
	Inactive		C	
H5.sta	10…50 %	Threshold (5th harmonic – basic wave ratio) for stabilising the protection function Id> against stationary 5th harmonic.	30	0.1
H5.tra	10…25 %	Threshold (5th harmonic – basic wave ratio) for temporary stabilisation of the protection function Id> against transient 5th harmonic.	15	0.1
t trans	50…120000 ms	Time of temporary stabilisation of the differential protection function Id> when thresholds for „H2.tra“ and „H5.tra“ (transient harmonic) are exceeded.	1000 ms	1 ms
Crossbl.	Active	Phase overlapping stabilisation of the differential protection function Id>	active	
	Inactive	Phase selective stabilisation of the differential protection function Id>		

High Phase Current Differential Protection Id>>				
Function	„active“	Differential protection function is activated		-
	„inactive“	Differential protection function is de-activated	„inactive“	
ex block	„active“	Differential protection function is ineffective when the input function „Protect. Block.“ is active		-
	„inactive“	Differential protection function is effective irrespectively of the input function „Protect. Block.“ state.	„inactive“	
Tripbloc.	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
Id>>	2.0…30 x In	Unstabilised high phase differential step: Pick-up value of the differential current based on the rated current	10 x In	0.001 x In
Sl.mon.	„active“	Transients monitor is activated	„active“	-
	„inactive“	Transients monitor is de-activated		
Sl.limit	100 … 500%	Gradient limit when the transients monitor (gradient monitor) initiates stabilisation against CT saturation (temporary rise of the static characteristic by the value adjusted at d[H,m]).	500%	1%

Phase Current Inrush Supervision I H2				
Parameter	*Setting/ Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	„active"	The phase current inrush supervision I H2 is activated		-
	„inactive"	The phase current inrush supervision I H2 is de-activated	„inactive"	
ex block	„active"	The phase current inrush supervision I H2 is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The phase current inrush supervision I H2 is effective, irrespectively of the input function „Protect.Block." state	„inactive"	
I H2. tra	5…40 %	Threshold value for trip blocking by the protection functions I> and I>> with reference to the relation of I H2/I H1.	10 %	0.1 %
I H1 max.	0.2…20 x In	Maximum value of the basic wave of the phase current, based on the rated transformer current up to which trip blocking for the protection functions I> and I>> is effective.	5 x In	0.001 x In
Crossbl.	„active"	Phase-overlapping blocking of I> and I>> is activated.		-
	„inactive"	Phase-overlapping blocking of I> and I>> is de-activated.		
tmax CRBL	0…30000 ms	Time for phase-overlapping blocking of I> and I>> by function „3-P Block".	0 ms	1 ms

Earth Current Inrush Supervision IeH2				
Parameter	*Setting/Setting Range*	*Description*	*Pre-Setting*	*Step Range*
Function	"active"	The earth current inrush supervision IeH2 is activated		-
	"inactive"	The earth current inrush supervision IeH2 is de-activated	"inactive"	
ex block	"active"	The earth current inrush supervision IeH2 is ineffective when the input function "Protec.Block." is active		-
	"inactive"	The earth current inrush supervision IeH2 is effective, irrespectively of the status of the input function "Protec.Block"	„inaktive"	
Ie H2 tra	5…100 %	Threshold value Ie H2/Ie H1 for trip blocking by the protective functions Ie> und Ie>>	10 %	0,1 %
IeH1 max	0,2…10 x In	Maximum value of the phase current basic wave, based on the rated transformer current up to which trip blocking for the protective functions Ie> and Ie>> is effective.	5 x In	0,001 x In

Overcurrent protection stage: I>F (Forward direction or non-direction)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
MTA	0°…355°	Typical angle between phase current and reference voltage	45°	1°	±3°
Function	„active“	I>F stage is put into function	„active“	-	
	„inactive“	I>F stage is put out of function			
ex block	„active“	I>F stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	I>F stage is effective irrespectively of the input function „Protect. Block.“ state.	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev lock	„active“	I>F stage is ineffective when the DI „ Backw. Interl.“ Is active		-	
	„inactive“	I>F stage is effective irrespectively of the DI “Backw. Interl.” state “	„inactive“		
direct.	„active“	I>F stage trips in forward direction only (directional)		-	
	„inactive“	I>F stage trips in both directions (non-directional)	„inactive“		
char F	„DEFT“	DMT characteristic	„DEFT“	-	
	„NINV“	INV characteristic (normal inverse)			
	„VINV“	INV characteristic (very inverse)			
	„EINV“	INV characteristic (extremely inverse)			
	„LINV“	INV characteristic (long time inverse)			
I>F	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1 xIn	0.001 x In	±3% of the adjustment value or 1% I_N
t I>F	30…300000 ms	Trip time delay; for DEFT characteristics only	1000 ms	1 ms	DEFT ±1% or ±20 ms
t char F	0.05 2	Characteristic factor; for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV, LINV ±10% EINV
t rst F	0…60000 ms	Reset time for intermittent phase faults; for INV characteristcs only	1000ms	1 ms	only INV ±1% of the adjustment value
IH2	„active“	Activation of phase current inrush protection I H2 for the I>F- element			
	„inactive“	De-activation of phase current inrush protection I H2 for the I>F- element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the I>F stage the AR is started		-	
	„inactive“	By trip of the I>F stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t I>FFT	0…10000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0“	AR instantaneous trip at the first protect. trip via step I>F	„0“	1	
	„1“	AR instantaneous trip at the first auto. reconnection attempt after a failure has occurred			

Overcurrent protection stage: I>F (Forward direction or non-direction)					
	„2"	AR instantaneous trip at the second auto. reconnection attempt after a failure has occurred			
	„3"	AR instantaneous trip at the third auto. reconnection attempt after a failure has occurred			
	„4"	AR instantaneous trip at the fourth auto. reconnection attempt after a failure has occurred			
	„5"	AR instantaneous trip at the fifth auto. reconnection attempt after a failure has occurred			
	„6"	AR instantaneous trip at the sixth auto. reconnection attempt after a failure has occurred			
SOTF	„active"	SOTF function is put into active state		-	
	„inactive"	SOTF function is put into inactive state	„inactive"		
t I>FSO	30…300,000 ms	Trip time delay for the SOTF function	100 ms	1 ms	±1% or ±20 ms

Overcurrent protection stage: I>B (Backward direction or non-direction)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Function	„active"	I>B stage is put into function		-	
	„inactive"	I>B stage is put out of function	„inactive"		
ex block	„active"	I>B stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	I>B stage is effective irrespectively of the input function „Protect. Block." state.	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
rev lock	„active"	I>B stage is ineffective when the DI „Backw. Interl." Is active		-	
	„inactive"	I>B stage is effective irrespectively of the DI "Backw. Interl." state "	„inactive"		
direct.	„active"	I>B stage trips in backward direction only (directional)		-	
	„inactive"	I>B stage trips in both directions (non-directional)	„inactive"		
char B	„DEFT"	DMT characteristic	„DEFT"	-	
	„NINV"	INV characteristic (normal inverse)			
	„VINV"	INV characteristic (very inverse)			
	„EINV"	INV characteristic (extremely inverse)			
	„LINV"	INV characteristic (long time inverse)			
I>B	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1 x IN	0.001 x In	±3% of the adjustment value or 1% I_N
t I>B	30...300,000 ms	Trip time delay; for DEFT characteristics only	2000 ms	1 ms	DEFT ±1% or ±20 ms
t char B	0.05 2	Characteristic factor; for IMT characteristics only	0.2	0.01	INV ±5% NINV ±7.5% VINV, LINV ±10% EINV
t rst B	0…60,000 ms	Reset time for intermittent phase faults; for IMT characteristcs only	1000 ms	1 ms	only INV ±3% of the adjustment value
IH2	„active"	Activation of inrush phase current protection I H2 for the I>B- element			
	„inactive"	De-activation of inrush phase current protection I H2 for the I>B- element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		

Overcurrent protection stage: I>B (Backward direction or non-direction)					
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the I>B stage the AR is started		-	
	„inactive"	By trip of the I>B stage the AR cannot be started	„inactive"		
AR-FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t I>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0"	AR instantaneous trip at the first protect. trip via stage I>B	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state		-	
	„inactive"	SOTF function is put into inactive state	„inactive"		
t I>BSO	30...300,000 ms	Trip time delay for the SOTF function	100 ms	1 ms	±1% or ±20 ms

Short-circuit protection stage: I>>F (Forward direction or non-direction)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
MTA	0°…355°	Typical angle between phase current and reference voltage	45°	1°	±3° of the adjustment value
Function	„active"	I>>F stage is put into function		-	
	„inactive"	I>>F stage is put out of function	„inactive"		
ex block	„active"	I>>F stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	I>>F stage is effective irrespectively of input function "Protect. Block."state	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
rev. lock	„active"	I>>F stage is ineffective when the DI „Backw. Interl." is active		-	
	„inactive"	I>>F stage is effective irrespectively of the DI "Backw. Interl." state	„inactive"		
direct.	„active"	I>>F stage trips in forward direction only (directional)		-	
	„inactive"	I>>F stage trips in both directions (non-directional)	„inactive"		
I>>F	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	2 x In	0.001 x In	±3% of the adjustment value or 1% I_N
t I>>F	30…300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IH2	„active"	Activation of the inrush phase current protection I H2 for the I>>F element			
	„inactive"	De-activation of the inrush phase current protection I H2 for the I>>F element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the I>>F stage the AR is started		-	
	„inactive"	By trip of the I>>F stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t I>>FFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0"	AR instantaneous trip at the first protect. trip via stage I>>F	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state		-	
	„inactive"	SOTF function is put into inactive state	„inactive"		
t I>>FSO	30…300000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Short-circuit protective stage: I>>B (Backward direction or non-directional)

Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Function	„active“	I>>B stage is put into function		-	
	„inactive“	I>>B stage is put out of function	„inactive“		
ex block	„active“	I>>B stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	I>>B stage is effective irrespectively of the input function “Protect. Block.” state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local is being issued	„inactive“		
rev lock	„active“	I>>B stage is ineffective when the DI „rev lock“ is active		-	
	„inactive“	I>>B stage is effective irrespectively of the DI “rev lock” state	„inactive“		
direct.	„active“	I>>B stage trips in backward direction only (directional)		-	
	„inactive“	I>>B stage trips in both directions (non-directional)	„inactive“		
I>>B	0.1…40 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	2 x In	0.001 x In	±3% of the adjustment value or 1% I_N
t I>>B	30…300000 ms	Trip time delay for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IH2	„active“	Activation of the phase current inrush protection I H2 for the I>>B element			
	„inactive“	De-activation of the phase current inrush protection I H2 for the I>>B element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0…120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the I>>B stage the AR is started		-	
	„inactive“	By trip of the I>>B stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t I>>BFT	0…10000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh.	„0“	AR instantaneous trip at the first protect. trip via stage I>>B	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t I>>BSO	30…300000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Earth-overcurrent protection stage: Ie>F (Forward direction or non-directional)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Earthing	„SOLI“	System with solidly earthed star point (MTA = variable)	„SOLI“	1°	±5° of the adjustment value at I_E >1.0*I_N and U_E> 5% U_N
	„RESI“	System with resistance-earthed star point (MTA = variable)		1°	±5° of the adjustment value at I_E >1.0*I_N and U_E> 5% U_N
	„COS“	System with earth fault compensation (MTA = 180°, fixed)			±5° at I_E * cosφ >20% I_N and U_E> 10 V
	„SIN“	System with isolated star point MTA = -90° = 270°, fixed)			±5° at I_E * sinφ >20% I_N and U_E> 10 V
MTA	0°…355°	Typical angle between earth current component and residual voltage (can only be adjusted when earthing = SOLI or RESI“)	110°	1°	
Function	„active“	Ie>F stage put into function		-	
	„inactive“	Ie>F stage put out of function	„inactive“		
ex block	„active“	Ie>F stage is ineffective when input function „Protect.Block.“ is active		-	
	„inactive“	Ie>F stage is effective irrespectively of the input function “Protect. Block.” state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev. lock	„active“	Ie>F stage is ineffective when DI „rev. lock“ Is active		-	
	„inactive“	Ie>F stage is effective irrespectively of the DI “rev. lock” state	„inactive“		
direct.	„active“	Ie>F stage trips in forward direction only (directional)		-	
	„inactive“	Ie>F stage trips in both directions (non-directional)	„inactive“		
Ue lock	„active“	Ie>F stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive“	Ie>F stage is effective no matter whether the residual voltage protection Ue> or Ue>> is activated or not	„inactive“		
char F	„DEFT“	DEFT Definite time characteristic	„DEFT“	-	
	„NINV“	INV characteristic (normal inverse)			
	„VINV“	INV characteristic (very inverse)			
	„EINV“	INV characteristic (extremely inverse)			
	„LINV“	INV characteristic (long time inverse)			
Ie>F	0.01…20 x In	Pickup value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	0.5 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>F	50...300,000 ms	Trip time delay, for DEFT characteristics only	5000 ms	1 ms	DEFT ±1% or ±20 ms
t char F	0.05 2	Characteristic factor, for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV,LINV ±10% EINV
t rst F	0…60,000 ms	Reset time for intermittent phase faults, for INV characteristics only	0 ms	1 ms	only INV ±3% of the adjustment value

Earth-overcurrent protection stage: Ie>F (Forward direction or non-directional)					
IeH2	„active"	Activation of the inrush earth current protection Ie H2 for the Ie>F -element			
	„inactive"	De-activation of the inrush earth current protection Ie H2 for the Ie>F- element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the Ie>F step the AR is started		-	
	„inactive"	By trip of the Ie>F step the AR cannot be started	„inactive"		
AR-FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t Ie>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0"	AR instantaneous trip at the first protect. trip via stage Ie>F	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state		-	
	„inactive"	SOTF function is put into inactive state	„inactive"		
t Ie>FSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Earth-overcurrent protection stage: Ie>B (Backward direction or non-directional)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Function	„active“	Ie>B stage is put into function		-	
	„inactive“	Ie>B stage is put out of function	„inactive“		
ex block	„active“	Ie>B stage ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Ie>B stage is effective irrespectively of the input function “Protect. Block.“ state	„inactive“		
tripbloc.	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev. lock	„active“	Ie>B stage is ineffective when the DI „rev. lock“ is active		-	
	„inactive“	Ie>B stage is effective irrespectively of the DI “rev. lock“ state	„inactive“		
direct.	„active“	Ie>B stage trips in backward direction only (directional)		-	
	„inactive“	Ie>B stage trips in both direction (non-directional)	„inactive“		
Ue lock	„active“	Ie>B stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive“	Ie>B stage is effective no matter whether the residual voltage protection Ue> or Ue>> is activated or not	„inactive“		
char B	„DEFT“	DEFT Definite time characteristic	„DEFT“	-	
	„NINV“	INV characteristic (normal inverse)			
	„VINV“	INV characteristic (very inverse)			
	„EINV“	INV characteristic (extremely inverse)			
	„LINV“	INV characteristic (long time inverse)			
Ie>B	0.01…20 x In	Pickup value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	0.5 x In	0.001 x In	±3% of the adj. value or 0.3% I_N
t Ie>B	50…300,000 ms	Trip time delay, for DEFT characteristics only	5000 ms	1 ms	±1% or ±20 ms
t char B	0.05 2	Characteristic factor, for INV characteristics only	1.0	0.01	INV ±5% NINV ±7.5% VINV,LINV ±10% EINV
t rst B	0…60,000 ms	Reset time for intermittent phase faults, for INV characteristics only	0 ms	1 ms	only INV ±3% of the adjustment value
IeH2	„active“	Activation of the inrush earth current protection Ie H2 for the Ie>B element			
	„inactive“	De-activation of the inrush earth current protection Ie H2 for the Ie>B-element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the Ie>B stage the AR is started		-	
	„inactive“	By trip of the Ie>B stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t Ie>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0“	AR instantaneous trip at the first protect. trip via stage Ie>B	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		

Earth-overcurrent protection stage: Ie>B (Backward direction or non-directional)					
t Ie>BSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Earth short-circuit protection stage: Ie>>F (Forward direction or non-directional)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
MTA	0°…355°	Typical angle between earth current component and residual voltage (can only be adjusted when earthing = SOLI or RESI")	110°	1°	
Function	„active"	Ie>>F stage is put into function		-	
	„inactive"	Ie>>F stage is put out of function	„inactive"		
ex block	„active"	Ie>>F stage ineffective when input function „Protect. Block." is active		-	
	„inactive"	Ie>>F stage effective irrespectively of the input function "Protect. Block." state	„inactive"		
tripbloc.	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
rev. lock	„active"	Ie>>F stage ineffective when DI „rev. lock" is active		-	
	„inactive"	Ie>>F stage effective irrespectively of the DI "rev. lock" state	„inactive"		
direct.	„active"	Ie>>F stage trips in forward direction only (directional)		-	
	„inactive"	Ie>>F stage trips in both directions (non-directional)	„inactive"		
Ue lock	„active"	Ie>>F stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive"	Ie>>F stage is effective no matter whether the residual voltage supervision Ue> or Ue>> is activated or not	„inactive"		
Ie>>F	0.01…20 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1.0 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>>F	50 …300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IeH2	„active"	Activation of the inrush earth current protection Ie H2 for the Ie>>F element			
	„inactive"	De-activation of the inrush earth current protection Ie H2 for the Ie>>F element	„inactive"		
PiUp inc	„active"	Activation of the dynamic elevation of the tripping characteristic			
	„inactive"	De-activation of the dynamic elevation of the tripping characteristic	„inactive"		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active"	By trip of the Ie>>F stage the AR is started		-	
	„inactive"	By trip of the Ie>>F stage the AR cannot be started	„inactive"		
AR FT	„active"	AR instantaneous trip is put into function		-	
	„inactive"	AR instantaneous trip is put out of function	„inactive"		
t Ie>>FFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0"	AR instantaneous trip at the first protect. trip via stage Ie>>F	„0"	1	
	„1"	AR instantaneous trip at the first auto. reclosing attempt			
	„2"	AR instantaneous trip at the second auto. reclosing attempt			
	„3"	AR instantaneous trip at the third auto. reclosing attempt			
	„4"	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5"	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6"	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active"	SOTF function is put into active state			
	„inactive"	SOTF function is put into inactive state	„inactive"		
t Ie>>FSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Earth short-crcuit protection stage: Ie>>B (Backward direction or non-directional)					
Parameters	**Setting/Setting Range**	**Description**	**Presetting**	**Step Range**	**Tolerance**
Function	„active“	Ie>>B stage is put into function		-	
	„inactive“	Ie>>B stage is put out of function	„inactive“		
ex block	„active“	Ie>>B stage ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Ie>>F stage effective irrespectively of the input function “Protect. Block.“ state	„inactive“		
trip bloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
rev. lock	„active“	Ie>>B stage ineffective when DI „rev. lock“ is active		-	
	„inactive“	Ie>>B stage effective irrespectively of the DI “rev. lock“ state	„inactive“		
direct.	„active“	Ie>>B stage trips in backward direction only (directional)		-	
	„inactive“	Ie>>B stage trips in both directions (non-directional)	„inactive“		
Ue lock	„active“	Ie>>B stage is only effective if the residual voltage protection Ue> or Ue>> is activated		-	
	„inactive“	Ie>>B stage is effective no matter whether the residual voltage supervision Ue> or Ue>> is activated or not	„inactive“		
Ie>>B	0.01…20 x In	Pick-up value of the overcurrent related to the rated current Disengaging ratio 97% or 0.5% x In	1.0 x In	0.001 x In	±3% of the adjustment value or 0.3% I_N
t Ie>>B	50 …300,000 ms	Trip time delay, for DEFT characteristics only	1000 ms	1 ms	±1% or ±20 ms
IeH2	„active“	Activation of the inrush earth current protection Ie H2 for the Ie>>B element			
	„inactive“	De-activation of the inrush earth current protection Ie H2 for the Ie>>B element	„inactive“		
PiUp inc	„active“	Activation of the dynamic elevation of the tripping characteristic			
	„inactive“	De-activation of the dynamic elevation of the tripping characteristic	„inactive“		
PiUp fac	1.00…8.00	Dynamic elevation factor of the tripping characteristic	2.00	0.01	
t PiUp	0… 120000	Dynamic elevation time of the tripping characteristic	3000 ms	1 ms	
AR	„active“	By trip of the Ie>>B stage the AR is started		-	
	„inactive“	By trip of the Ie>>B stage the AR cannot be started	„inactive“		
AR FT	„active“	AR instantaneous trip is put into function		-	
	„inactive“	AR instantaneous trip is put out of function	„inactive“		
t Ie>>BFT	0…10,000 ms	Trip time delay for AR instantaneous trip	0 ms	1 ms	±1% or ±20 ms
FT at sh	„0“	AR instantaneous trip at the first protect. trip via stage Ie>>B	„0“	1	
	„1“	AR instantaneous trip at the first auto. reclosing attempt			
	„2“	AR instantaneous trip at the second auto. reclosing attempt			
	„3“	AR instantaneous trip at the third auto. reclosing attempt			
	„4“	AR instantaneous trip at the fourth auto. reclosing attempt			
	„5“	AR instantaneous trip at the fifth auto. reclosing attempt			
	„6“	AR instantaneous trip at the sixth auto. reclosing attempt			
SOTF	„active“	SOTF function is put into active state		-	
	„inactive“	SOTF function is put into inactive state	„inactive“		
t Ie>>BSO	50…300,000 ms	Trip time delay for SOTF function	100 ms	1 ms	±1% or ±20 ms

Overload protection with thermal image ϑ>					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
tau w	5…60,000 s	Warming-up time constant of the component (see data sheet of the component)	10 sec	1 s	
tau c	5…60,000 s	Cooling-down time constant of the component (see data sheet of the component)	10 sec	1 s	
Function	„active"	ϑ> stage is put into function		-	
	„inactive"	ϑ>-stage is put out of function	„inactive		
ex block	„active"	ϑ> stage is ineffective when input function "Protect. Block." is active		-	
	„inactive"	ϑ> stage is effective irrespectively of the input function "Protect. Block." State	„inactive"		
trip bloc	„active"	OFF command to the local CB is being blocked in case of overload		-	
	„inactive"	OFF command to the local CB is being issued in case of overload	„inactive"		
ϑ Alarm	50..100%	Activation value for overload alarm (in per cent)	80%	1%	±1%
Ib>	0.5…2.4 x In	Pick-up value for the max. permissible thermal continuous current (basic current) related to the rated current Disengaging ratio 97% or 1% x In	1 x In	0.001 x In	±3% of the adjustment value or 1% I_N
K	0.8…1.2	Overload factor	1	0.01	

Temperature Supervision ϑ1>				
Parameter	Setting/ Setting Range	Description	Pre-Setting.	Step Range
Function	„active"	The temperature supervision ϑ1> is activated		-
	„inactive"	The temperature supervision ϑ1> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ1> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervisionϑ1> is effective irrespectively of the input function „Protect.Block." state	„inactive"	
Alarm ϑ1>	0…200 °C	Temperature threshold value for alarm signal for sensors Pt100 and Ni100	95°C	1 °C
Alarm PTC	0…30.0 kΩ	Temperature threshold value for alarm signal for PTC sensor 1	5.0 kΩ	0.1 kΩ
Function	„active"	The temperature supervision ϑ1> is activated		-
	„inactive"	The temperature supervision ϑ1> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ1> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervision ϑ1> is effective irrespectively of the input function „Protect.Block." state.	„inactive"	
Trip ϑ1>	0…200 °C	Temperatur-e threshold value for tripping (sensors Pt100 and Ni100)	95°C	1 °C
Trip PTC	0…30.0 kΩ	Temperature threshold for tripping (PTC sensor 1)	5.0 kΩ	0.1 kΩ

Temperature Supervision ϑ2>				
Function	„active"	The temperature supervision ϑ2> is activated		-
	„inactive"	The temperature supervision ϑ2> is de-activated	„inactive	
ex Block	„active"	The temperature supervision ϑ2> is ineffective when the input function „Protect.Block" is active		-
	„inacktive"	The temperature supervision ϑ2> is effective irrespectively of the input function „Protect.Block." state	„inactive	
Alarm ϑ2>	0…200 °C	Temperature threshold value for alarm signal for sensors Pt100 and Ni100	95°C	1 °C
Alarm PTC	0…30.0 kΩ	Temperature threshold value for alarm signal for PTC sensor 2	5.0 kΩ	0.1 kΩ
Function	„active"	The temperature supervision ϑ2> is activated		-
	„inactive"	The temperature supervision ϑ2> is de-activated	„inactive"	
ex Block	„active"	The temperature supervision ϑ2> is ineffective when the input function „Protect.Block." is active		-
	„inactive"	The temperature supervision ϑ2> is effective irrespectively of the input function „Protect.Block" state	„inactive"	
Trip ϑ2>	0…200 °C	Temperatur-e threshold value for tripping (sensors Pt100 and Ni100)	95°C	1 °C
Trip PTC	0…30.0 kΩ	Temperatur-e threshold value for tripping (PTC-Sensor 2)	5.0 kΩ	0.1 kΩ

Automatic reclosing (AR)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Function	„active"	AR is put into function		-	
	„inactive"	AR is put out of function	„inactive"		
ex block	„active"	AR is ineffective when input function „Protect. Block." is active		-	
	„inactive"	AR is effective irrespectively of the input function „AR Protect. Block" state	„inactive"		
ex AR	„active"	AR start if the DI „AR Start" is active and at the same time a protective trip occurs via an active digital input, e.g. "Protect. Trip 1").		-	
	„inactive"	AR start via digital input „AR Start" is out of function	„inactive"		
syncheck	„active"	AR start only if DI „AR Sy. Check" (synchronizing check signal) is within time frame „t syncheck"		-	
	„inactive"	AR start without synchronisation check signal	„inactive"		
NC start	„active"	AR start when CB is in non-correspondence position		-	
	„inactive"	No AR start when CB is in non-correspondence position	„inactive"		
t syncro	10…100,000 ms	Synchronizing time (-frame) for a synchronized AR start	100,000 ms	1 ms	±1% of the adjustment value or ±20 ms
shots	1…6	Maximum number of reclosing attempts which could be carried out	1	1	
t F	10…10,000 ms	Fault time (fault definition time) for start of the AR function (for AR start via internal current protective functions only)	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP1	100...200,000 ms	Dead time between 1st protect. trip and the first reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP2	100...200,000 ms	Dead time between 2nd protect. trip and the second reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP3	100...200,000 ms	Dead time between 3rd protect. trip and the third reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP4	100...200,000 ms	Dead time between 4th protect. trip and the fourth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP5	100...200,000 ms	Dead time between 5th protect. trip and the fifth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DP6	100...200,000 ms	Dead time between 6th protect. trip and the sixth reclosing attempt in case of phase faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE1	100...200,000 ms	Dead time between 1st protect. trip and the first reclosing attempt in case of earth faults	100 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE2	100...200,000 ms	Dead time between 2nd protect. trip and the second reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE3	100...200,000 ms	Dead time between 3rd protect. trip and the third reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms

t DE4	100...200,000 ms	Dead time between 4th protect. trip and the fourth reclosing attempt in case of eartzh faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE5	100...200,000 ms	Dead time between 5th protect. trip and the fifth reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t DE6	100...200,000 ms	Dead time between 6th protect. trip and the sixth reclosing attempt in case of earth faults	1000 ms	1 ms	±1% of the adjustment value or ±20 ms
t block	100...300,000 ms	Blocking time for AR start	10,000 ms	1 ms	±1% of the adjustment value or ±20 ms
Alarm no.	1...65,535	AR counter as first alarm stage when inspection work at the CB is done	1000	1	1
Block. no.	1...65,535	AR counter as second alarm stage when inspection work at the CB is done	65,535	1	1

Control Circuit Supervision (CCS)					
Parameters	Setting/Setting Range	Description	Presetting	Step Range	Tolerance
Function	„active“	CCS is put into function		-	
	„inactive“	CCS is put out of function	„inactive“		
Ex Block	„active“	CCS function is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	CCS function is effective irrespectively of the input function “Protect. Block.” state	„inactive“		
CCS main	3...200 h	Setting of the time interval for a cyclic CCS test of all control outputs	„6 h“	1 h	± 2min per h
SG1	„active“	CCS function checks the SG1 control output	„active“	-	
	„inactive“	CCS function does not check the SG1 control output			
SG2	„active“	CCS function checks the SG2 control output		-	
	„inactive“	CCS function does not check the SG2 control output	„inactive“		
SG3	„active“	CCS function checks the SG3 control output		-	
	„inactive“	CCS function does not check the SG3 control output	„inactive“		
SG4	„active“	CCS function checks the SG4 control output		-	
	„inactive“	CCS function does not check the SG4 control output	„inactive“		
SG5	„active“	CCS function checks the SG5 control output		-	
	„inactive“	CCS function does not check the SD5 control output	„inactive“		

Overexcitation Protection U/f> (1st step)				
Parameters	Setting/ Setting Range	Description	Pre-Setting	StepRange
Function	„active“	U/f>-step is activated		-
	„inactive“	U/f>-step is de-activated	„inactive“	
ex block	„active“	U/f>-step is ineffective when the input function „Protect.Block“ is active		-
	„inactive“	U/f>-step is effective irrespectively of the state of the input function „Protect.Block.“	„inactive“	
Tripbloc	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
U/f>	100…150 %	Threshold value of the 1st overflux step, based on the Un/fn [%] ratio	105 %	0.1 %
t U/f>	30…300000 ms	Tripping delay time	„100 ms“	1 ms
Overexcitation Protection U/f>> (2nd step)				
Function	„active“	U/f>>-step is activated		-
	„inactive“	U/f>>-step is de-activated	„inactive“	
ex block	„active“	U/f>>-step is ineffective when the input function „Protect.Block.“ is active		-
	„inactive“	U/f>>-step is effective irrespectively of the state of the input function “Protect.Block.”	„inactive“	
Tripbloc	„active“	OFF command to the local CB is blocked		-
	„inactive“	OFF command to the local CB is issued	„inactive“	
U/f>>	100…150 %	Threshold value of the 2nd overflux step, based on Un/fn [%] ratio	110 %	0.1 %
t U/f>>	30…300000 ms	Tripping delay time	„100 ms“	1 ms

Frequency protection (Common parameters for all stages)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
U BF	0.1…1 x Un	Lower threshold value of the measuring voltage for blocking the frequency protection	0.1 x Un	0.001 x Un	±1% of the adjustment value or 0.5% U_N
t BF	50 ms	Delay time for blocking the frequency protection	Fixed	-	
t block	100… 20,000 ms	Persistance duration for blocking the frequency protection	2000 ms		±1% of the adjustment value or ±20 ms
Frequency Protection – 1st stage					
Function	„active“	1st frequency stage is put into function		-	
	„inactive“	1st frequency stage is put out of function	„inactive“		
ex block	„active“	Function of 1st frequency stage is ineffective when input function „Protect. Block.“ is active		-	
	„inactive“	Function of 1st frequency stage is effective irrespectively of the input function „Protect. Block.“ state	„inactive“		
tripbloc	„active“	OFF command to the local CB is being blocked		-	
	„inactive“	OFF command to the local CB is being issued	„inactive“		
f1	40…70 Hz	Pick-up value of the 1st frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	51 Hz	0.01 Hz	< 0.05 of rated f_N
t f1	100… 300,000 ms	Trip time delay of the 1st frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 ms
Frequency Protection – 2nd stage					
Function	„active“	2nd frequency stage is put into function		-	
	„inactive“	2nd frequency stage is put out of function	„inactive“		
ex block	„active“	Function of 2nd frequency stage is ineffective when input function „Protect. Block.“ is active		-	

	„inactive"	Function of 2nd frequency stage is effective irrespectively of the input function „Protect. Block." state	„inactive"		
tripbloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
f2	40…70 Hz	Pick-up value of the 2nd frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	52 Hz	0.001 Hz	< 0.05 of rated f_N
t f2	100… 300,000 ms	Trip time delay of the 2nd frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m
		Frequency Protection – 3rd stage			
Function	„active"	3rd frequency stage is put into function		-	
	„inactive"	3rd frequency stage is put out of function	„inactive"		
ex block	„active"	Function of 3rd frequency stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	Function of 3rd frequency stage is effective irrespectively of the DI „Protect. Block." state	„inactive"		
tripbloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
f3	40…70 Hz	Pick-up value of the 3rd frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	49 Hz	0.001 Hz	< 0.05 of rated f_N
t f3	100… 300,000 ms	Trip time delay of the 3rd frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m
		Frequency Protection – 4th stage			
Function	„active"	4th frequency stage is put into function		-	
	„inactive"	4th frequency stage is put out of function	„inactive"		
ex block	„active"	Function of 4th frequency stage is ineffective when input function „Protect. Block." is active		-	
	„inactive"	Function of 4th frequency stage is effective irrespectively of the input function „Protect. Block." state	„inactive"		
tripbloc	„active"	OFF command to the local CB is being blocked		-	
	„inactive"	OFF command to the local CB is being issued	„inactive"		
f4	40…70 Hz	Pick-up value of the 4th frequency stage as absolute value Disengaging ratio for under frequency 99.8% of the adjustment value Disengaging ratio for over frequency 100.2% of the adjustment value	48 Hz	0.001 Hz	< 0.05 of rated f_N
t f4	100… 300,000 ms	Trip time delay of the 4th frequency stage	100 ms	1 ms	±1% of the adjustment value or ±40 m

Residual voltage supervision: Ue> (1st stage)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active"	Ue> stage is put into function		-	
	„inactive"	Ue> stage is put out of function	„inactive"		
ex block	„active"	Ue> stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	Ue> stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
Ue>	0.01…2 x Un	Pick-up value of the residual voltage related to its rated value which is defined by the rated field data Disengaging ratio 97% of the adjustment value or 0.5%xUn	0.1 x Un	0.001	±2% of the adjustment value or 0.5% U_N
t Ue>	30 …300,000 ms	Trip time delay	200 ms	1 ms	±1% of the adjustment value or ±20 ms
Residual voltage supervision: Ue>> (2nd stage)					
Function	„active"	Ue>> stage is put into function		-	
	„inactive"	Ue>> stage is put out of function	„inactive"		
ex block	„active"	Ue>> stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	Ue>> stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
Ue>>	0.01…2 x Un	Pick-up value of the residual voltage related to its rated value which is defined by the rated field data Disengaging ratio 97% of the adjustment value or 0.5%xUn	0.2 x Un	0.001	±2% of the adjustment value or 0.5% U_N
t Ue>>	30 …300,000 ms	Trip time delay	100 ms	1 ms	±1% of the adjustment value or ±20 ms

Voltage Transformer Supervision (VTS)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active"	VTS is put into function		-	
	„inactive"	VTS is put out of function	„inactive"		
ex block	„active"	VTS stage is ineffective when the input function „Protect. Block." is active		-	
	„inactive"	VTS stage is effective irrespectively of the input function "Protect. Block" state	„inactive"		
tripbloc	„active"	Off command to the local CB is being blocked		-	
	„inactive"	Off command to the local CB is being issued	„inactive"		
t VTS	10…20,000 ms	Trip time delay	„200 ms"	1 ms	±1% of the adjustment value or ±20 ms

Circuit breaker failure protection (CBF W1)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	CBF W1 is put into function		-	
	„inactive“	CBF W1 is put out of function	„inactive“		
ex block	„active“	CBF W1 is ineffective when the DI „Protect. Block.“ is active		-	
	„inactive“	CBF W1 is effective irrespectively of the DI “Protect. Block” state	„inactive“		
tripbloc	„active“	Second OFF command to the local CB1 is being blocked		-	
	„inactive“	Second Off command to the local CB1 is being issued	„inactive“		
t CBF W1	100…10000 ms	Time delay until alarm message „Alarm: CBF W1“ is issued	„200 ms“	1 ms	±1% of the adjustment value or ±20 ms
I CBF W1	0 … 0.1xIn	Threshold value for detection of the zero current when a CBF W1 occurs	0.0 x In	0.001 x In	±3% of the adjustment value bzw 1% I_N

Circuit breaker failure protection (CBF W2)					
Parameters	*Setting/Setting Range*	*Description*	*Presetting*	*Step Range*	*Tolerance*
Function	„active“	CBF W2 is put into function		-	
	„inactive“	CBF W2 is put out of function	„inactive“		
ex block	„active“	CBF W2 is ineffective when the DI „Protect. Block.“ is active		-	
	„inactive“	CBF W2 is effective irrespectively of the DI “Protect. Block” state	„inactive“		
tripbloc	„active“	Second OFF command to the local CB2 is being blocked		-	
	„inactive“	Second Off command to the local CB2 is being issued	„inactive“		
t CBF W2	100…10000 ms	Time delay until alarm message „Alarm: CBF W2“ is issued	„200 ms“	1 ms	±1% of the adjustment value or ±20 ms
I CBF W2	0 … 0.1xIn	Threshold value for detection of the zero current when a CBF W2 occurs	0.0 x In	0.001 x In	±3% of the adjustment value bzw 1% I_N

Base unit (single device) of transformer differential protection and control system [1]	**CSP2-**		**S**	**CC**			
Application: 2-winding transformers; Current and voltage protection functions, measuring functions, monitoring functions, automatic reclosing, disturbance recording, programmable logic functions, control functions, up to 5 recognizable devices (display), wide range power supply: AC and DC Control (direct/indirect) of max. 5 switching elements – DC driven (2 CB/isolator/earthing switch)		**T25**					
Applicable to SL-DRAW capability			**S**				
Measuring Conventional transformer technology: Phase currents and earth current 1 A/5 A, voltage 100 V/110 V Analogue temperature measuring				**CC**			
Communication without					**00**		
Type of protocol: IEC 60870-5-103 — Interface: SCADA: fibre optic (FO) [2]					**3F**		
electrical: RS485					**3W**		
PROFIBUS DP — fibre optic (FO) [2]					**PF**		
electrical: RS485					**PW**		
MODBUS RTU — fibre optic (FO) [2]					**MF**		
electrical: RS485					**MW**		
Menu German						**G**	
English						**E**	
Disturbance recording Standard							*****
extended non-volatile memory							**K**

* Please leave box empty if option is not desired (no extra charge).

[1] the complete feeder protection and control system consists of **one** base unit (CSP) and **one** indication and operation unit (CMP)

[2] Wave length: 850 nm; phase diameter (core/sleeve): 62.5/125 µm multimode; plug type: type FH-ST, range: up to 2 km

Indication and operating unit for protection and control systems	**CMP1-**	**1**	**2**	
Front plate IP 54; key switches, LCD - Display, control buttons, wide range power supply: AC and DC		**1**		
Interfaces 2 x RS232 (front plate and rear) CAN-Bus (rear)			**2**	
Front plate design (Logo) Standard (Woodward)				**0**
OEM				**1**

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