

REC316*4

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Numerical Control Unit

Operating Instructions

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6th Edition

Applies for software version V6.3

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**1. Introduction****B****2. Description of hardware****C****3. Setting the functions****F****4. Description of function and application****D****5. Operation (HMI)****E****6. Self-testing and diagnostics****C****7. Installation and maintenance****C****8. Technical data****A****9. Interbay bus (IBB) interface****E****10. Supplementary information****G****12. Appendices****C**

How to use the Operating Instructions for the REC316*4 V6.3

What do you wish to know about the device ...	What precisely?	Look in the following Indices (I) / Sections (S):
* General theoretical familiarisation	— Brief introduction — General overview — Technical data — Hardware — Software	— I 1 (Introduction) — I 1, S 2.1. to S 7.1. (all Section summaries) — I 8 (Data Sheet) — I 2 (Description of hardware) — I 3 (Setting the functions) — I 4 (Description of function and application) — I 6 (Self-testing and diagnostics) — I 10 (Software changes)
* How to install and connect it	— Checks upon receipt — Location — Process connections — Control system connections	— S 7.2.1. — S 7.2.2. — I 12 (Wiring diagram), S 7.2., S 7.3.2. to S 7.3.5. — I 9 (OBI) — S 9.6. (OBI address list)
* How to set and configure it	— Installing the HMI — Starting the HMI — Configuration — Setting functions — Quitting the HMI	— S 5.2. — S 7.3.1., S 5.2.3. — S 3.2. to S 3.4., S 5.4., S 5.5., S 5.11. — S 3.5. to S 3.7., S 5.4., S 5.5., S 5.11. — S 5.2.3.
* How to check, test and commission it	— Checking the connections — Functional test — Commissioning checks	— S 7.2.3. to S 7.2.7. — S 5.9. — S 7.3.6.
* How to maintain it	— Fault-finding — Updating software — Adding hardware	— S 7.4.1., S 5.8. — S 7.5. — S 7.6.
* How to view and transfer data	— Sequential recorder — Disturbance recorder — Measurements — Local Display Unit	— S 5.6. — S 5.6., S 3.7.4. — S 5.7. — S 5.13.

March 01

1. INTRODUCTION

1.1. General 1-2

1.2. Application 1-3

1.3. Main features 1-4

1. INTRODUCTION

1.1. *General*

The control unit REC 316*4 is one of the new generation of fully digital control and protection systems, i.e. the analogue-to-digital conversion of the measured input variables takes place immediately after the input transformers and the resulting digital signals are processed exclusively by programmed micro-processors.

Within the PYRAMID system for integrated control and protection, REC 316*4 serves as a compact bay control unit with integrated protection functions.

Because of its compact design, the use of only a few different hardware units, modular software and continuous self-diagnosis and monitoring functions, the REC 316*4 scheme optimally fulfils all the demands and expectations of a modern control scheme with respect to efficient plant management and technical functionality.

AVAILABILITY, i.e. the ratio between mean fault-free operating time and total operational life, is certainly the most important requirement a control device has to fulfil. As a result of continuous monitoring, this ratio in the case of REC 316*4 is almost unity.

The menu-controlled MMC (man/machine communication) program and the compact construction enable simple operation and connection of the control unit. Absolute FLEXIBILITY, i.e. adaptability to practical applications, already existing control concepts or a control concept to be replaced (retro-fitting), is assured by ancillary functions incorporated in the software and by the ability to freely configure inputs and outputs via the MMC.

Broad experience in the field of substation control and protection has gone into the development of the REC 316*4 to give it the highest possible degree of RELIABILITY and SAFETY. Digital processing of all the signals means that the ACCURACY of the scheme remains constant throughout its useful life.

The designation “RE. 316*4” is used in the following sections where data applies to the series of devices in general.

1.2. Application

The numerical control unit REC316*4 is designed to perform data acquisition, monitoring, and control functions in MV and HV substations. It is installed in the individual switchgear bays.

The switchgear bay control unit can be configured for SF₆ gas-insulated switchgear (GIS), for indoor and outdoor switchgear and for single, double or multiple busbar stations.

REC316*4 registers and processes the switchgear position signals, the measured variables and the alarms occurring in a switchgear bay. The corresponding data are then made available to the station control level at the communication interface (IBB).

REC316*4 receives control instructions from the station control level or from the local mimic, processes them in relation to the bay control logic and executes them.

The interlocks included in the REC316*4 control device prevent inadmissible switching operations, which could cause damage to plant or endanger personnel.

REC316*4 checks the synchronisation on both sides of the circuit-breaker before enabling the close command.

A frequency protection function is integrated in REC316*4, which enables "intelligent" load shedding.

REC316*4 also provides facility for adding feeder protection functions.

REC316*4 measures the currents and voltages at the main c.t.'s and v.t.'s, calculates the corresponding real power, reactive power and frequency and transfers the data to the station control level.

REC316*4 is equipped with a communication interface (IBB) for two-way communication via an optical fibre link with the station control level.

1.3. **Main features**

The library of function blocks for the REC316*4 control device includes the following control, protection, measurement and logic functions:

Control function: This depends on the particular application for which it is specifically created using CAP 316 (FUPLA function plan programming language).

- detection and plausibility check of switchgear position signals
- switchgear control
- interlocks
- generation and monitoring of switchgear commands
- run-time monitoring
- detection of alarms and alarm logic
- integration of the local mimic.

Protection functions:

- definite time overcurrent
- peak value overcurrent
- inverse time overcurrent
- directional definite time overcurrent
- directional inverse time overcurrent
- inverse time overcurrent ground fault protection
- definite time overvoltage
- peak value overvoltage
- power function
- overtemperature
- frequency function
- rate-of-change frequency function
- auto-reclosure
- synchrocheck function
- Breaker failure function

Logic functions:

- logic
- delay
- counter
- flatter detection
- Contact bounce filter.

Measurement and monitoring functions:

- single-phase measuring function for U, I, f, P and Q
- three-phase measuring function for U, I, f, P, Q and $\cos \varphi$
- three-phase current plausibility
- three-phase voltage plausibility.

The scheme includes a disturbance recorder memory and an event recorder memory.

The allocation of the opto-coupler inputs, the LED signals and the auxiliary relay signal outputs, the setting of the various parameters, the configuration of the scheme and the display of the events and system variables are all performed interactively by means of the menu-controlled MMC (man/machine communication).

REC 316*4 is equipped with serial interfaces for the connection of a local MMC (PC) and for remote communication with the station control system.

REC 316*4 is also equipped with continuous self-monitoring and self-diagnostic functions. Suitable testing devices (e.g. test set XS92b) are available for quantitative testing of measurement and protection functions.

REC 316*4 can be semi-flush or surface mounted or can be installed in an equipment rack.

March 01

2. DESCRIPTION OF HARDWARE

2.1.	Summary.....	2-2
2.2.	Mechanical design	2-4
2.2.1.	Hardware versions	2-4
2.2.2.	Construction.....	2-4
2.2.3.	Casing and methods of mounting	2-4
2.2.4.	Front of the protection unit	2-4
2.2.5.	PC connection.....	2-5
2.2.6.	Test facilities	2-5
2.3.	Auxiliary supply unit	2-6
2.4.	Input transformer unit.....	2-6
2.5.	Main processor unit.....	2-7
2.6.	Binary I/O unit	2-8
2.7.	Interconnection unit.....	2-8

2. DESCRIPTION OF HARDWARE

2.1. Summary

The hardware of the digital protection scheme RE. 316*4 comprises 4 to 8 plug-in units, a connection unit and the casing:

• Input transformer unit	Type 316GW61
• A/D converter unit	Type 316EA62
	or Type 316EA63
• Main processor unit	Type 316VC61a
	or Type 316VC61b
• 1 up to 4 binary I/O units	Type 316DB61
	or Type 316DB62
	or Type 316DB63
• Auxiliary supply unit	Type 316NG65
• Connection unit	Type 316ML61a
	or Type 316ML62a
• Casing and terminals for analogue signals and connectors for binary signals.	

The A/D converter Type 316EA62 or 316EA63 is only used in conjunction with the longitudinal differential protection and includes the optical modems for transferring the measurements to the remote station.

Binary process signals are detected by the binary I/O unit and transferred to the main processor which processes them in relation to the control and protection functions for the specific project and then activates the output relays and LED's accordingly.

The analogue input variables are electrically insulated from the electronic circuits by the screened windings of the transformers in the input transformer unit. The transformers also reduce the signals to a suitable level for processing by the electronic circuits. The input transformer unit provides accommodation for nine transformers.

Essentially the main processor unit 316VC61a or 316VC61b comprises the main processor (80486-based), the A/D converter unit, the communication interface control system and 2 PCMCIA slots.

Binary process signals, signals pre-processed by the control logic, events, analogue variables, disturbance recorder files and device control settings can be transferred via the communication interface to the station control room. In the reverse direction, signals to the control logic and for switching sets of parameter settings are transferred by the station control system to the protection.

RE. 316*4 can be equipped with one up to four binary I/O units.

There are two tripping relays on the units 316DB61 and 316DB62, each with two contacts and according to version either:

8 opto-coupler inputs and 6 signalling relays
or 4 opto-coupler inputs and 10 signalling relays.

The I/O unit 316DB63 is equipped with 14 opto-coupler inputs and 8 signalling relays.

The 16 LED's on the front are controlled by the 316DB6. units located in slots 1 and 2.

2.2. Mechanical design

2.2.1. Hardware versions

RE. 316*4 is available in a number of different versions which are listed in the [data sheet](#) under "Ordering information".

2.2.2. Construction

The RE. 316*4 is 6 U standard units high (U = 44.45 mm) and either 225 mm (Order code N1) or 271 mm wide (Order code N2). The various units are inserted into the casing from the rear ([see Fig. 12.3](#)) and then screwed to the cover plate.

2.2.3. Casing and methods of mounting

The casing is suitable for three methods of mounting.

Semi-flush mounting

The casing can be mounted semi-flush in a switch panel with the aid of four fixing brackets. The dimensions of the panel cut-out can be seen from the [data sheet](#). The terminals are located at the rear.

Installation in a 19" rack

A mounting plate with all the appropriate cut-outs is available for fitting the protection into a 19" rack ([see Data Sheet](#)). The terminals are located at the rear.

Surface mounting

A hinged frame ([see Data Sheet](#)) is available for surface mounting. The terminals are located at the rear.

2.2.4. Front of the protection unit

A front view of the protection and the functions of the frontplate elements can be seen from [Fig. 12.2](#).

A reset button is located behind the frontplate which serves three purposes:

- resetting the tripping relays and where they are configured to latch, also the signalling relays and LED's and deleting the distance protection display when running the control program

- resetting of error messages resulting from defects detected by the self-monitoring or diagnostic functions (short press)
- resetting the entire protection (warm start, press for at least ten seconds) following the detection of a serious defect by the self-monitoring or diagnostic functions.

These control operations can also be executed using the local control unit on the front of the device. Should the latter fail, the reset button can be pressed using a suitable implement through the hole in the frontplate.

2.2.5. *PC connection*

In order to set the various parameters, read events and measurements of system voltages and currents and also for diagnostic and maintenance purposes, a personal computer (PC) must be connected to the optical serial interface ([Fig. 12.2](#)).

2.2.6. *Test facilities*

A RE. 316*4 protection can be tested using a test set Type XS92b.

2.3. *Auxiliary supply unit*

The auxiliary supply unit 316NG65 derives all the supply voltages the protection requires from the station battery. Capacitors are provided which are capable of bridging short interruptions (max. 50 ms) of the input voltage. The auxiliary supply unit is protected against changes of polarity.

In the event of loss of auxiliary supply, the auxiliary supply unit also generates all the control signals such as re-initialisation and blocking signals needed by all the other units.

The technical data of the auxiliary supply unit are to be found in the [data sheet](#).

2.4. *Input transformer unit*

The input transformer unit 316GW61 serves as input interface between the analogue primary system variables such as currents and voltages and the protection. The mounting plate of the unit can accommodate up to nine c.t's and v.t's. The shunts across the secondaries of the c.t's are also mounted in the input transformer unit.

The input transformers provide DC isolation between the primary system and the electronic circuits and also reduce (in the case of the c.t's, with the aid of a shunt) the voltage and current signals to a suitable level for processing by the A/D converters. Thus the input transformer unit produces voltage signals at its outputs for both current and voltage channels.

The c.t's and v.t's actually fitted in the input transformer unit vary according to version. Further information can be obtained from the [data sheet](#).

2.5. *Main processor unit*

The main processor runs the control and protection algorithms as determined by the particular settings. It receives its data from the A/D converter unit and the I/O unit. The results computed by the algorithms are transferred either directly or after further logical processing to the binary I/O unit.

A 80486-based microprocessor is used in the main processor unit 316VC61a or 316VC61b. The samples taken by the A/D converter are pre-processed by a digital signal processor (DSP). The interfaces for connecting an MMI PC and for communication with the station control system (SPA, IEC60870-5-103) are included. A PCMCIA interface with two slots facilitates connection to other bus systems such as LON and MVB. The flash EPROM's used as program memory enable the software to be downloaded from the PC via the port on the front.

A self-monitoring routine runs in the background on the main processor. The main processor itself (respectively the correct operation of the program) is monitored by a watchdog.

2.6. *Binary I/O unit*

The binary I/O unit 316DB6. enables binary signals received via opto-couplers from station plant to be read and tripping and other signals to be issued externally.

All the input and output units provide electrical insulation between the external signalling circuits and the internal electronic circuits.

The I/O units in slots 1 and 2 also control the statuses of 8 LED's each on the frontplate via a corresponding buffer memory.

The numbers of inputs and outputs required for the particular version are achieved by fitting from one to four binary I/O units. The relationship between the versions and the number of I/O units is given in the [data sheet](#).

The opto-coupler inputs are adapted to suit the available input voltage range by choice of resistor soldered to soldering posts. This work is normally carried at the works as specified in the order.

The technical data of the opto-coupler inputs and the tripping and signalling outputs can be seen from the [data sheet](#).

2.7. *Interconnection unit*

The wiring between the various units is established by the inter-connecting unit 316ML62a (width 271 mm) or 316ML61a (width 225 mm). It is located inside the housing behind the frontplate and carries the connectors and wiring needed by the individual units.

In addition, the interconnection unit includes the connections to the local control unit, the reset button and 16 LED's for status signals.

March 01

3. SETTING THE FUNCTIONS

3.1.	General	3-4
3.1.1.	Library and settings.....	3-4
3.1.2.	Control and protection function sequence.....	3-5
3.1.2.1.	Repetition rate	3-5
3.1.2.2.	Computation requirement of protection functions	3-6
3.1.2.3.	Computing requirement of the control functions	3-9
3.2.	Control and protection function inputs and outputs	3-10
3.2.1.	C.t./v.t. inputs	3-10
3.2.2.	Binary inputs	3-11
3.2.3.	Signalling outputs	3-11
3.2.4.	Tripping outputs	3-12
3.2.5.	Measured variables.....	3-12
3.3.	Frequency range.....	3-12
3.4.	System parameter settings	3-13
3.4.1.	Hardware configuration.....	3-13
3.4.2.	Entering the c.t./v.t. channels.....	3-16
3.4.3.	Entering comments for binary inputs and outputs.....	3-17
3.4.4.	Masking binary inputs, entering latching parameters and definition of “double indications”	3-17
3.4.5.	Edit system parameters	3-17
3.4.5.1.	Edit system I/O	3-18
3.4.5.2.	Edit system name	3-21
3.4.5.3.	Edit system password	3-21
3.5.	Protection functions	3-23
3.5.1.	Definite time over and undercurrent..... (Current-DT)	3-23
3.5.2.	Peak value overcurrent..... (Current-Inst)	3-29
3.5.3.	Inverse time overcurrent	(Current-Inv) 3-35
3.5.4.	Directional definite time overcurrent protection	(DirCurrentDT) 3-41
3.5.5.	Directional inverse time overcurrent protection	(DirCurrentInv) 3-49
3.5.6.	Inverse definite minimum time earth fault overcurrent function	(I0-Invers) 3-61

3.5.7.	Definite time over and undervoltage protection	(Voltage-DT)	3-67
3.5.8.	Peak value overvoltage.....	(Voltage-Inst)	3-73
3.5.9.	Power.....	(Power)	3-79
3.5.10.	Overtemperature protection	(Overtemp.)	3-93
3.5.11.	Frequency protection	(Frequency)	3-101
3.5.12.	Rate-of-change of frequency protection.....	(df/dt)	3-107
3.5.13.	Auto-reclosure	(Autoreclosure)	3-111
3.5.13.1.	General		3-128
3.5.13.2.	Connections between auto-reclosure and distance functions		3-128
3.5.13.3.	Connections between auto-reclosure and overcurrent or differential functions.....		3-130
3.5.13.4.	Redundant schemes		3-132
3.5.13.5.	Master/follower logic		3-134
3.5.13.6.	Duplex logic		3-136
3.5.13.7.	Timers.....		3-138
3.5.13.8.	External binary inputs		3-142
3.5.13.9.	Close CB and signalling outputs		3-144
3.5.13.10.	Timing diagrams		3-146
3.5.13.11.	Checking the dead times		3-156
3.5.14.	Synchrocheck function.....	(SynchroChck)	3-159
3.5.14.1.	General		3-168
3.5.14.2.	Settings.....		3-170
3.5.14.3.	Binary inputs of the function.....		3-177
3.5.15.	Breaker failure protection.....	(BreakerFailure)	3-181
3.6.	Control functions		3-197
3.6.1.	Control function (FUPLA).....		3-197
3.6.1.1.	Control function settings - FUPLA.....		3-199
3.6.1.1.1.	General		3-200
3.6.1.1.2.	Timers.....		3-201
3.6.1.1.3.	Binary inputs		3-201
3.6.1.1.4.	Binary signals		3-201
3.6.1.1.5.	Measurement inputs		3-202
3.6.1.1.6.	Measurement outputs		3-202
3.6.1.1.7.	Flow chart for measurement inputs and outputs		3-202
3.6.1.2.	Loading FUPLA		3-203
3.6.2.	Logic	(Logic)	3-205
3.6.3.	Delay / integrator	(Delay)	3-209
3.6.4.	Contact bounce filter	(Debounce)	3-215
3.6.5.	LDU events	(LDUevents)	3-219
3.6.6.	Counter	(Counter)	3-223
3.6.7.	Signal flutter detector.....	(Defluttering)	3-227

3.7.	Measurement functions.....	3-233
3.7.1.	Measurement function .....(UlfPQ)	3-233
3.7.2.	Three-phase current plausibility (Check-I3ph)	3-239
3.7.3.	Three-phase voltage plausibility (Check-U3ph)	3-243
3.7.4.	Disturbance recorder (Disturbance Rec)	3-247
3.7.5.	Measurement module .....(MeasureModule)	3-261
3.7.5.1.	Impulse counter inputs.....	3-267
3.7.5.2.	Impulse counter operation	3-268
3.7.5.3.	Impulse counter operating principle	3-268
3.7.5.4.	Interval processing.....	3-269

3. SETTING THE FUNCTIONS

3.1. General

3.1.1. Library and settings

REC 316*4 provides a comprehensive library of control and protection functions for bay control and feeder protection.

The setting procedure is carried out with the aid of a personal computer and is extremely user-friendly. No programming is required for this purpose.

The number of control and protection functions active at any one time in a REC 316*4 system is limited by the available computing capacity of the main processor unit.

In each case, the operator program checks whether sufficient computing capacity is available and displays an error message if there is not.

The maximum of 48 protection functions are possible.

The settings and the software key determine which functions are active. This procedure enables the varying user requirements with respect to control and protection scheme configurations to be satisfied:

- Only functions which are actually needed should be activated. Every active function requires computing capacity, which can influence the operating time.
- Many of the functions can be used for multiple purposes, e.g.:
 - to achieve several stages of operation (with the same or different settings and time delays)
 - for use with different input channels.

The following functions, however, can only be configured once per set of parameter settings:

- Disturbance recorder
- Contact bounce filter
- VDEW6.
- Functions that are active in the same set of parameters can be logically interconnected, for example, for interlocking purposes.

3.1.2. **Control and protection function sequence**

3.1.2.1. **Repetition rate**

The control and protection system software controls the operating sequence of the functions completely independently. The functions are divided into routines, which are processed in sequence by the computer. The frequency at which the processing cycle takes place (repetition rate) is determined according to the technical requirements of the scheme.

For many functions, this will depend essentially on the permissible or desired tripping delay. From this follows that the faster tripping should take place, the higher will be the repetition rate. Typical relationships between tripping delay and repetition rate can be seen from Table 3.1.

Repetition rate	Explanation	Delay time
4	≥ 4 times every 20 ms ¹⁾	< 40 ms
2	≥ 2 times every 20 ms	40 ... 199 ms
1	≥ 1 times every 20 ms	≥ 200 ms

¹⁾ for 50 Hz or 60 Hz

Table 3.1 Typical function repetition rates

The operation of functions implemented as logics, e.g. control logic or auto-reclosure, does not depend on their settings.

The scanning of the binary inputs and the setting of the signalling and tripping outputs takes place at the sampling rate of the analogue inputs.

Whilst the operating speed of the various protection functions is more than adequate for their purpose, they do operate in sequence so that the effective operating times of such outputs as starting and tripping signals are subject to some variation. This variation is determined by the repetition rate controlling the operation of the function. Typical values are given in Table 3.2.

Repetition rate	Variation
4	-2...+5 ms
2	-2...+10 ms
1	-2...+20 ms

Table 3.2 Variation in the operating time of output signals of protection functions in relation to their repetition rates

3.1.2.2. **Computation requirement of protection functions**

The amount of computation a function entails is determined by the following factors:

- complexity of the algorithms used which is characteristic for each function.
- Repetition rate:
The faster the operating time of a protection function, the higher its repetition rate according to [Table 3.1](#). The computation requirement increases approximately in proportion to the repetition rate.
- Already active protection functions:
The protection system is able to use certain intermediate results (measured variables) determined by a protection function several times. As a consequence, additional stages of the same protection function with the same inputs generally only involve a little more computation for the comparison with the pick-up value, but not for conditioning the input signal.

The computation requirement of the REC 316*4 protection functions is given in [Table 3.3](#). The values are typical percentages in relation to the computing capacity of a fictitious main processing unit.

According to [Table 3.1](#), the computation requirement of some of the functions increases for low settings of the time delay t and therefore a factor of 2 or 4 has to be used in some instances. When entering the settings for a function with several stages, the one with the shortest time delay is assumed to be the first stage.

REC 316*4 units have a computing capacity of 250% if equipped with a 316VC61a or 316VC61b processor module. This is valid for all units having a local control and display unit at the front. Older units with a 316VC61 processor module only have a computing capacity of 200%.

The computing load can be viewed by selecting 'List Procedure List' from the 'List Edit Parameters' menu and is given for the four sets of parameters in per thousand. The greatest value in the four sets of parameters determines the computing load.

Function	1st stage		2nd and higher stages		Factor for (**)	
	Single-phase	Three-phase	Single-phase	Three-phase	t < 40 ms	t < 200 ms
Auto-reclosure		1		ditto		
SynchroCheck		16		ditto		2
Overtemp.	12		15	ditto		
Current	2		3	1	4	2
with inrush restraint		5		5	4	2
Current-Inst	3		4	2	4	2
Current-Inv	4		7	3		
DirCurrentDT		19		ditto	4	2
DirCurrentInv		21		ditto		
I0-Invers		4		3		
Voltage	2		3	1	4	2
Voltage-Inst	3		4	2	4	2
Power	5		14	3	8	2
Frequency	15		-	3		2
df/dt	50			5		
BreakerFailure	34		46	ditto		
Bus transfer		30		ditto		
UifPQ		5		ditto		
MeasureModule						
Voltage/CurrentInp		10		ditto		
Cnt		8		ditto		
Check-I3ph		5		ditto		
Check-U3ph		5		ditto		
Disturbance Rec						
excluding binary input		20		(*)		
including binary input		40		(*)		
FUPLA		1/ 2/ 4 (***)		ditto		
Logic		4		ditto		
Delay		8		ditto		
Counter		8		ditto		
Defluttering		4		ditto		
Contact bounce filter		0.1		(*)		
Analog RIO Trig		2			4	2
LDU events		4		ditto		
VDEW6		1		(*)		

(*) can only be set once

(**) always 1 for delays ≥ 200 ms

(***) depends on repetition rate (low / medium / high)

Table 3.3 Computation requirement of protection functions
(in percent)

Example:

Table 3.4 shows the computation requirement according to [Table 3.3](#) for a simple control and protection scheme with four active protection functions. Since the protection functions 1 and 2 use the same analogue inputs, the amount of computing capacity required for function 2 is reduced to that of a second stage.

Function No.	Type	Input channel	Settings			Percentage incl. factor
			Phases	Pick-up	Time	
1	current	1 (,2,3)	three	$10.0 I_N$	30 ms	$3 \% \times 4 = 12\%$
2	current	1 (,2,3)	three	$2.5 I_N$	100 ms	$1 \% \times 2 = 2\%$
3	current	4	single	$3.5 I_N$	300 ms	$2 \% \times 1 = 2\%$
4	voltage	7	single	$2.0 U_N$	50 ms	$2 \% \times 2 = 4\%$
Total						20%

Table 3.4 Example for calculating the computation requirement

3.1.2.3. *Computing requirement of the control functions*

The computing capacity required by the control function cannot be expressed directly as a percentage of the total computing capacity. Apart from the size of the code, the computing capacity is largely determined by the type of control logic.

The load of the protection and control functions on the main processor must be checked by selecting the menu item 'Measurement values' and then 'Display AD (CT/VT) channels' after loading the protection and control functions.

ABB Switzerland Ltd

REC316*4 - Control Unit

Mai

Measurement Values

Display AD(CT/VT) Channels

Ed	Di	Ch.Nr.	Amplitude	Phase	Frequency
Ev	Di				
Me	Di	1	0.000 [100V/√3]	-.-- deg	-.--- Hz
Te	Di	2	0.000 [100V/√3]	-.-- deg	
Di	Di	3	0.000 [100V/√3]	-.-- deg	
SM	Di	4	0.000 [1A]	-.-- deg	
Do	Di	5	0.000 [1A]	-.-- deg	
RE	Di	6	0.000 [100V]	-.-- deg	
	Di	7	0.000 [1A]	-.-- deg	
	Di	8	0.000 [1A]	-.-- deg	
	Di	9	0.000 [1A]	-.-- deg	
	Di				
	Di	Time: 2001-06-06 15:26;32			(267)
	Di				
	RE				

On - Line 9600 bps

SCS:VDEW

V6.2b | V6.2b

The number at the bottom right of the box (2400) is an indication of the load on the processor. This number must not exceed 20,000 when all the functions are active, i.e. none of the functions may be blocked. It applies for the normal operating condition, i.e. not while the unit is in the tripped state.

The cycling time for high-priority tasks must be set at 20 ms (default, [see Section 3.6.1.1](#). 'Control function settings – FUPLA').

The above procedure ensures the correct running of both protection and control functions.

3.2. Control and protection function inputs and outputs

3.2.1. C.t./v.t. inputs

(see Section 5.5.4.1.)

The protection scheme can include three types of input transformers, which can also have different ratings:

- protection c.t's
- metering c.t's (core-balance)
- v.t's.

The number and arrangement of the input transformers are defined either by sub-code K.. in the ordering code or by transformer type entered for K=0.

Before being processed by the protection functions, the currents and voltages coming from the input transformers are digitised in the analogue section of the main processor unit.

Every analogue input channel is designated either single or three-phase:

- C.t's:
 - three-phase protection
 - single-phase protection
 - single-phase metering (core-balance)
- V.t's:
 - three-phase Y connected
 - single-phase.

A protection function can only be used in a three-phase mode, if a corresponding three-phase group of c.t./v.t. input channels is available.

All protection function settings are based on the input values (secondary ratings) of the REC 316*4. The fine adjustment to suit the effective primary system quantities is accomplished by varying the reference settings of the analogue inputs.

3.2.2. **Binary inputs**

(see Section 5.5.4.4.)

REC 316*4 recognises one of the following values:

- logical “0” (fixed value) or FALSE
- logical “1” (fixed value) or TRUE
- binary input value (316DB6.)
- binary control and protection values as defined by the function number and the corresponding signalling output
- binary values from the station control level
- binary values from the distributed input units (500RIO11)
- binary values with interlocking data

All the above can also be set as binary inputs of control and protection functions.

All the binary addresses set may be used either directly or inverted.

3.2.3. **Signalling outputs**

(see Section 5.5.4.2.)

All the control and protection signalling outputs provide the following facilities:

- external signalling via LED's
- external signalling via relays
- event recording
- control of tripping relays
- external signalling via the communications interface
- external signalling via distributed output units (500RIO11)
- output of interlocking data

The following applies to external signals via a signalling relay or a LED:

- A signalling relay or LED can only be activated by a one signal.
- Every signalling relay and LED can be individually set to latch.

A signal can activate up to two output channels, e.g.:

- 2 signalling relays
- 1 signalling relay and 1 LED
- 1 signalling relay and 1 tripping relay.

An output each can also be configured for the communication interface, the distributed output units, interlocking data and event recording.

Important signals are duplicated, e.g. 'GenTrip' and 'General-TripAux'.

3.2.4. *Tripping outputs*

(see Section 5.5.4.3.)

All protection functions can directly excite the tripping relays. A tripping logic matrix is provided for this purpose which enables any function to be connected to any tripping channel. A tripping channel can be activated by any number of protection functions.

Only the binary I/O units 316DB61 and 316DB62 are equipped with tripping relays. Each unit has two relays each with two contacts making four in all.

3.2.5. *Measured variables*

(see Section 5.7.)

Apart from being processed internally, the analogue variables measured by the REC 316*4 protection functions can also be viewed externally as:

- a value:
The input variables measured by the protection functions are available to the station control system via the communication interface.
They can also be viewed locally on a PC (personal computer) running the operator program or on the local display unit (LDU) on the frontplate. Their values are referred to the secondary voltages and currents at the input of the REC 316*4.
- a recorded event:
The instant a protection function trips, the value of the corresponding measured variable is recorded as an event.

3.3. *Frequency range*

The protection functions can be set to operate at a power system frequency f_N of either 50 Hz or 60 Hz. The algorithms which execute the protection functions have been optimised to produce the best results at the rated frequency f_N . Discrepancies from the rated frequency cause an additional error.

3.4. **System parameter settings**

3.4.1. **Hardware configuration**

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
NomFreq	Hz	50	50	60	10
A/D		on VC61	(Select)		
AD Config K		00	00	99	1
Slot 1		not used	(Select)		
Slot 2		not used	(Select)		
Slot 3		not used	(Select)		
Slot 4		not used	(Select)		
SWVers SX...		X	(Select)		
SWVers S.XXX		100	1	999	1

Explanation of the parameters:

NomFreq

Determination of the rated frequency:

- 50 Hz or 60 Hz.

A/D

defines the type of A/D converter. Choose either “EA62...” or “EA63...” to correspond to the A/D converter unit inserted in the longitudinal line differential protection:

- on VC61: A/D converter on 316VC61a or 316VC61b
- EA6. MasterS: Short data transmission distance
- EA6. SlaveS: Short data transmission distance
- EA6. MasterL: Long data transmission distance
- EA6. SlaveL: Long data transmission distance
- EA6. MstFoxS: Short data transfer distance using FOX
- EA6. MstFoxL: Long data transfer distance using FOX
- EA6. SlvFoxS: Short data transfer distance using FOX
- EA6. SlvFoxL: Long data transfer distance using FOX.

The setting of the data transmission distance is normally determined by the attenuation of the optical fibre cable between the two units.

However, when using FOX optical fibre equipment, the setting is determined by the connection between the RE.316*4 and the FOX equipment.

The data transmission distance setting influences the output power of the transmission diode. It must therefore be selected such that the receiver diode at the remote end is not overloaded.

To make sure that the setting is correct, measure the optical signal strength while commissioning the system. The output power must be in the respective range given in the following table (MM = Multi-mode optical cable 50/125µm, SM = Single-mode optical cable 9/125 µm):

OFL Type	Setting	
	EA6.....S	EA6.....L
MM	-26 ... -20 dBm	-16 ... -13 dBm
SM	-32 ... -22 dBm	-20 ... -17 dBm

Select the setting such that taking the attenuation to be expected due to the optical cable into account, the power at the receiving end is between **-34dBm to -22dBm**. Measure the signal strength at the receiving end to make sure that it is within this range.

Note:

- Take care when measuring the output power to set the level for the correct type of optical cable in use.
- One device must be configured as master (or 'MstFox') and the other as slave (i.e. 'SlvFox').
- The same transmission distance, i.e. either 'EA62...S' or 'EA6.....L', has to be configured at both ends.
- If an A/D converter Type 316EA62 or 316EA63 is installed, the 'A/D' parameter must be set to 'EA6.....' even if the optical fibre link is not in operation yet.

AD Config K:

Version and type of input transformer unit:

- 0...47: K0: Free choice of input transformer types
K41...K47: Input transformer unit according to the Data Sheet.

This parameter must be set before configuring the protection functions and cannot be changed subsequently. The setting must agree with the type of the I/P transformer actually installed in the device. The hardware is not checked.

A list of input transformer unit codes is to be found in the Data Sheet ([Section 8](#)).

Slot 1:

Defines the type of I/O board in slot 1:

- not used, 316DB61, 316DB62 or 316DB63.

Slot 2:

Defines the type of I/O board in slot 2:

- not used, 316DB61, 316DB62 or 316DB63.

Slot 3:

Defines the type of I/O board in slot 3:

- not used, 316DB61, 316DB62 or 316DB63.

Slot 4:

Defines the type of I/O board in slot 4:

- not used, 316DB61, 316DB62 or 316DB63.

SWVers SX...:

First part (letter) of the software code.

SWVers S.XXX:

Second part (figures) of the software code.

A summary of the protection functions according to software codes is given in the Data Sheet ([Section 8](#)).

3.4.2. **Entering the c.t./v.t. channels**

(see Section 5.5.5.)

Edit A/D channel type

If K=00 is set for the hardware configuration, c.t. and v.t. channels can be entered in any order, providing a corresponding input transformer unit is fitted.

Edit A/D nominal value

Enter the rated values for the c.t.'s and v.t.'s in the input transformer unit (1 A, 2 A, 5 A, 100 V or 200 V). S and T phases of three-phase channels assume the same value as R phase.

Edit A/D prim/sec ratio

These values are only of relevance in connection with the IEC60870-5-103 protocol. S and T phases of three-phase c.t. and v.t. channels assume the same value as R phase.

Edit A/D channel ref. val.

The reference value settings enable differences between the ratings of protected unit, c.t. or v.t. and protection to be compensated. They are a factor which can be set in the range 0.5 to 2. The setting for R phase applies also to the other two phases of three-phase channels.

Example: Rated voltage = 110 V

Reference value of the voltage channel

$$= \frac{110 \text{ V}}{100 \text{ V}} = 1.100$$

Effects of changing the reference values:

With the exception of the impedance settings for the distance function, the protection function settings (parameters expressed in relation to 'IN' and 'UN') are automatically adjusted to the new reference values. In the case of the distance function, however, adjusting just the currents and not the voltages will change the impedance pick-up values. For this reason the reference values for the current inputs should not be changed.

Edit A/D channel comment

Facility is provided for the user to enter a comment for each analogue channel, which is displayed together with the channel type when the corresponding c.t. or v.t. input parameter of a protection function is selected.

3.4.3. *Entering comments for binary inputs and outputs*

(see Section 5.5.5.)

Facility is provided for the user to enter individual comments for each binary input and each signalling or tripping output. This operation is carried out via the sub-menuS EDIT BINARY INPUTS, EDIT TRIP OUTPUTS and EDIT SIGNAL OUTPUTS.

3.4.4. *Masking binary inputs, entering latching parameters and definition of “double indications”*

(see Section 5.5.5.)

The sub-menu ‘Edit binary inputs’ provides facility for excluding (masking) binary signals from being recorded as events.

Every LED, signal and tripping command can be set to a latch or not to latch via the sub-menu ‘Edit signal outputs’ or ‘Edit trip outputs’, providing the ‘LEDSigMode’ parameter was also set to latching beforehand.

Note that the green LED1 (standby signal) cannot be set to a latching mode.

In the ‘Edit binary inputs’ menu, up to 30 pairs of consecutive binary inputs can be combined to form double signals. A runtime supervision can also be configured for each of them.

3.4.5. *Edit system parameters*

(see Section 5.5.6.)

The settings made in the three sub-menus accessed via the ‘Edit system parameters’ menu apply for all control and protection functions. The three sub-menus are:

- Edit system I/O
- Edit system name
- Edit system password.

3.4.5.1. Edit system I/O

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
LEDSigMode		AccumSigAll	(Select)		
Confirm Pars		on	(Select)		
TimeSynchByPC		on	(Select)		
Relay Ready	SignalAddr				
GenTrip	SignalAddr	ER			
GenTripAux	SignalAddr				
GenStart	SignalAddr	ER			
GenStartAux	SignalAddr				
InjTstOutput	SignalAddr				
Test active	SignalAddr				
MMI is on	SignalAddr	ER			
InjTstEnable	BinaryAddr	F			
ExtReset	BinaryAddr	F			
Enable Test	BinaryAddr	T			
Rem. Setting	BinaryAddr	F			
ParSet2	BinaryAddr	F			
ParSet3	BinaryAddr	F			
ParSet4	BinaryAddr	F			
ParSet1	SignalAddr	ER			
ParSet2	SignalAddr	ER			
ParSet3	SignalAddr	ER			
ParSet4	SignalAddr	ER			
Modem Error	SignalAddr	ER			
QuitStatus	SignalAddr	ER			
MVB PB Warn	SignalAddr	ER			
MVB PB Crash	SignalAddr	ER			
PB BA1Ready	SignalAddr	ER			
PB BA2Ready	SignalAddr	ER			
PB BA3Ready	SignalAddr	ER			
PB BA4Ready	SignalAddr	ER			
PB LA faulty	SignalAddr	ER			
PB LB faulty	SignalAddr	ER			

Explanation of parameters:**LEDSigMode**

Display mode for LED signals:

- **AccumSigAll**
Signals are not reset, but accumulate. In this case, events which excite the same signals are superimposed on each other.
- **Reset for START (ResetSigAll)**
'GenStart' lights and all other LED's are reset.
All subsequent signals are displayed and those associated with the last event remain latched.
- **Reset for TRIP (ResetSigTrip)**
'GenStart' lights and all other LED's are reset.
The signals generated by the last event are reset and new ones are only displayed, if tripping takes place.
- **No latching (No Latch)**
LED signals reset as soon as the condition causing them disappears.

In all three latching modes, the LED's can be reset either by selecting the menu item 'Latch Reset' in the RESET menu on the local control unit or by briefly activating the 'Ext. reset' binary input.

Only those LED's latch in the on state that are configured to do so according to [Section 3.4.4](#).

Confirm Pars

switches the parameter confirm mode on and off.

Use the <→> to confirm and the <ESC> key to correct.

TimeSynchByPC

switches the synchronisation of the REC 316*4 clock to the PC clock on and off when starting up.

Relay Ready

Signal showing that the relay is ready to operate.

GenTrip, GenTripAux ([see Section 5.5.4.3.](#))

General tripping signal generated via an OR function of all tripping signals assigned to the tripping logic when any one of the protection functions trips.

GenStart, GenStartAux (see Section 5.5.4.2.)

General starting signal generated via an OR function of all starting signals designated as events.

InjTstOutput

This signal is of no significance for REC 316*4.

Test active (see Section 5.9.)

Signal indicating that the device is in the test mode.

This signal remains set for as long as the MMI menu 'Test functions' is open.

MMI is on

Signal indicating that the control PC is connected and serviceable.

InjTstEnable

Input for switching to and from the test mode. It is normally used in conjunction with the test adapter Type XX93 or 316 TSS 01 and assigned to the binary input OC 101. This input has to be inverted when using the test plug casing Type XX93.

F: - operating mode

T: - test mode

xx: - all binary inputs

Caution:

- An active input does not influence the stand-by signal (green LED1).
- When the input is active, the Baud rate of the MMC interface is switched to 9600 bps.

ExtReset

Input for remote resetting the signalling LED's and relays:

F: - no external reset

xx: - all binary inputs

Enable Test

Input for enabling the test functions controlled by the MMC:

F: - test functions blocked

T: - test functions enabled

xx: - all binary inputs

Rem. Setting (see Section 5.11.1.)

Input for switching between sets of parameters.

- F: - Sets of parameters can only be switched by applying signals to the inputs "ParSet 2...4".
- T: - Sets of parameters can only be switched by signals from the station control system.
- xx: - all binary inputs

Inputs for switching between different sets of parameters.

ParSet2...ParSet4 (see Section 5.11.1.)

Inputs for switching between different sets of parameters.

ParSet1...ParSet4 (see Section 5.11.1.)

Signal indicating the active set of parameters.

Modem Error

Signal indicating a data transmission error on the optical link between two longitudinal differential relays. This signal is generated instantly in the event of an error (see Section 3.8. Data transmission at REL 316*4).

The diagnostic function reports this error after a delay of 80 ms, i.e. only when it is certain that the communications channel is permanently disturbed.

QuitStatus

signals the operation of the reset button on the front of the protection.

MVB_PB_Warn, MVB_PB_Crash,

PB_BA1Ready...PB_BA4Ready, PB LA faulty, PB LB faulty

These messages are only generated when using an MVB process bus (see Operating Instructions for the remote I/O system RIO580, 1MRB520192-Uen).

3.4.5.2. Edit system name

A name can be entered which then appears in the HMI header.

3.4.5.3. Edit system password

This enables an existing password to be replaced by a new one.

3.5. *Protection functions*

3.5.1. *Definite time over and undercurrent (Current-DT)*

A. Application

General purpose current function (over and under) for

- phase fault protection
- back-up protection

or for monitoring a current minimum.

B. Features

- insensitive to DC component
- insensitive to harmonics
- single or three-phase measurement
- maximum respectively minimum value detection in the three-phase mode
- detection of inrush currents.

C. Inputs and outputs

I. C.t./v.t. inputs:

- Current

II. Binary inputs:

- Blocking

III. Binary outputs:

- pick-up
- tripping

IV. Measurements:

- current amplitude.

D. Definite time current function settings - Current-DT

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Delay	s	01.00	0.02	60.00	0.01
I-Setting	IN	02.00	0.02	20.00	0.01
MaxMin		MAX (1ph)	(Select)		
NrOfPhases		001	1	3	2
CurrentInp	CT/VT-Addr	0			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping O/P of the function (matrix tripping logic).

Delay

Time between the function picking up and tripping.

I-Setting

Pick-up current setting.

Forbidden settings:

- $> 1.6 I_N$ when supplied from metering cores
- $< 0.2 I_N$ when supplied from protection cores.

MaxMin

defines operation as overcurrent or undercurrent or with inrush blocking. Settings:

- MIN (3ph): Undercurrent.
Three-phase functions detect the highest phase current.
Not permitted for single-phase functions.
- MIN (1ph): Undercurrent.
Three-phase functions detect the lowest phase current.

- MAX (3ph): Overcurrent.
Three-phase functions detect the lowest phase current.
Not permitted for single-phase functions.
- MAX (1ph): Overcurrent.
Three-phase functions detect the highest phase current.
- MAX-Inrush: Blocks during inrush currents if one phase exceeds setting.

NrOfPhases

defines whether single or three-phase measurement.

CurrentInp

defines the c.t. input channel. All current I/P's may be selected. In the case of three-phase measurement, the first channel (R phase) of the group of three selected must be specified.

BlockInp

I/P for blocking the function.

F: - not blocked

T: - blocked

xx: - all binary I/P's (or O/P's of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

E. Setting instructions

Settings:

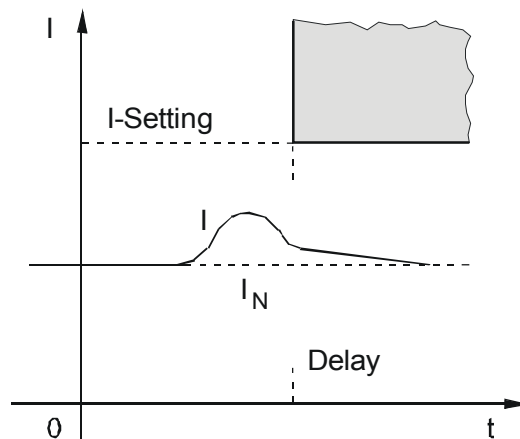
Setting	I-Setting
Delay	Delay
Over or undercurrent	MaxMin
Number of phases	NrOfPhases

Setting I-Setting

The current setting 'I-Setting' must be sufficiently high on the one hand to avoid any risk of false tripping or false signals under normal load conditions, but should be low enough on the other to detect the lowest fault current that can occur. The margin which has to be allowed between the maximum short-time load current and the setting must take account of:

- the tolerance on the current setting
- the reset ratio.

The maximum short-time load current has to be determined according to the power system conditions and must take switching operations and load surges into account.



HEST 905 010 C

Fig. 3.5.1.1 Operating characteristic of the definite time over-current function

Compensating any difference between the rated currents of c.t. I_{N1} and protected unit I_{GN} is recommended. This is achieved with the aid of the reference value of the A/D channel or by correcting the overcurrent setting.

For example, for $I_{GN} = 800 \text{ A}$ and $I_{N1} = 1000 \text{ A}$, the setting for a pick-up current of $1.5 I_{GN} = 1200 \text{ A}$ would have to be

$$1.5 \frac{I_{GN}}{I_{N1}} = 1.5 \frac{800 \text{ A}}{1000 \text{ A}} = 1.2$$

CurrentInp

An interposing c.t. in the input is essential for current settings lower than $< 0.2 I_N$.

Delay

The delay is used to achieve discrimination of the overcurrent function. It is set according to the grading table for all the overcurrent units on the power system. The zone of protection of our overcurrent function extends to the location of the next downstream overcurrent relay.

Should the downstream relay fail to clear a fault, the overcurrent function trips slightly later as a back-up protection.

Setting MaxMin

This parameter enables the following operating modes to be selected:

- MIN (3ph): Pick-up when the highest phase current also falls below the setting. This setting is not permitted for single-phase measurement.
- MIN (1ph): Pick-up when the lowest phase current falls below the setting.
- MAX (3ph): Pick-up when the lowest phase current also exceeds the setting. This setting is not permitted for single-phase measurement.
- MAX (1ph): Pick-up when the highest phase current exceeds the setting.
- MAX-Inrush: Blocking of inrush currents when a phase current exceeds the setting.

Operation of the inrush blocking feature (parameter MaxMin set to 'MAX-Inrush')

The inrush detector picks up and blocks operation of the function when the amplitude of the fundamental component of the current exceeds the setting of the current function.

The inrush detector is based on the evaluation of the second harmonic component of the current I_{2h} in relation to the fundamental frequency component I_{1h} (evaluation of the amplitudes).

The output of the function is disabled when the ratio I_{2h}/I_{1h} exceeds 10 % and enabled again when it falls below 8 %.

There is no setting for the peak value of I_{2h}/I_{1h} .

The function can operate with inrush blocking in both the single and three-phase mode (parameter 'NrOfPhase').

In the three-phase mode, the phase used for evaluation is the one with the highest amplitude at rated frequency (pick-up and inrush detection).

3.5.2. Peak value overcurrent (*Current-Inst*)

A. Application

- General current monitoring with instantaneous response (over and undercurrent)
- Current monitoring where insensitivity to frequency is required (over and undercurrent).

B. Features

- processes instantaneous values and is therefore fast and largely independent of frequency
- stores the peak value following pick-up
- no suppression of DC component
- no suppression of harmonics
- single or three-phase measurement
- maximum value detection in the three-phase mode
- adjustable lower frequency limit $f_{\min}$.

C. Inputs and outputs

I. C.t./v.t. inputs

- current

II. Binary inputs

- blocking

III. Binary outputs

- pick-up
- tripping

IV. Measurements

- current amplitude (only available if function trips).

D. Peak value current function settings - Current-Inst

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		0000000			
Delay	s	00.01	0.00	60.00	0.01
I-Setting	IN	04.00	0.1	20	0.1
f-min	Hz	40	2	50	1
MaxMin		MAX	(Select)		
NrOfPhases		001	1	3	2
CurrentInp	CT/VT-Addr	0			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping output of the function (matrix).

Delay

Time between the function picking up and tripping.

I-Setting

Pick-up current setting.

Setting restrictions:

- not > 1.6 I_N when supplied from metering cores
- not < 0.2 I_N when supplied from protection cores.

f-min

defines the minimum frequency for which measurement is required.

Setting restriction:

not < 40 Hz when supplied from metering cores.

MaxMin

defines operation as overcurrent or undercurrent. Settings:

- MAX: overcurrent
- MIN: undercurrent.

NrOfPhases

defines whether single or three-phase measurement.

CurrentInp

defines the c.t. input channel.

All current inputs may be selected.

In the case of three-phase measurement, the first channel (R phase) of the group of three selected must be specified.

BlockInp

Binary address used as blocking input.

- F: - not blocked
- T: - blocked
- xx: - all binary inputs (or outputs of protection functions).

Trip

Output for signalling tripping.

Start

Output for signalling pick-up.

E. Setting instructions

Settings:

Current pick-up	I-Setting
Delay	Delay
Minimum frequency	f-min
Over or undercurrent	MaxMin

The instantaneous overcurrent function is a high-speed protection which operates in a wide frequency range. It is intended primarily for two applications.

A protection measuring peak value is necessary for protecting units, for which the influence of DC component and harmonics may not be neglected. This is especially the case where rectifiers with semiconductors are involved.

The measuring principle of the function is relatively insensitive to frequency and operates in a range extending from 4 to 120 % of rated frequency. It is therefore able to protect units with synchronous starting equipment during the starting sequence before reaching system frequency (e.g. gas turbine sets with solid-state starters).

The function detects when the instantaneous value of the input current exceeds the peak value corresponding to the setting. For example, for a setting of $10 I_N$, it will pick up when the input current exceeds $10 \sqrt{2} I_N = 14.14 I_N$ (see Fig. 3.5.2.1). A fault current of $6 \times 1.8 \sqrt{2} I_N = 15.27 I_N$ could reach this level as a consequence of a DC component.

The minimum frequency must be entered for every application, because it determines the reset time. A low minimum frequency means a long reset delay and since a good protection is expected to have a quick response, the reset time should be as short as possible, i.e. the minimum frequency setting should not be lower than absolutely necessary.

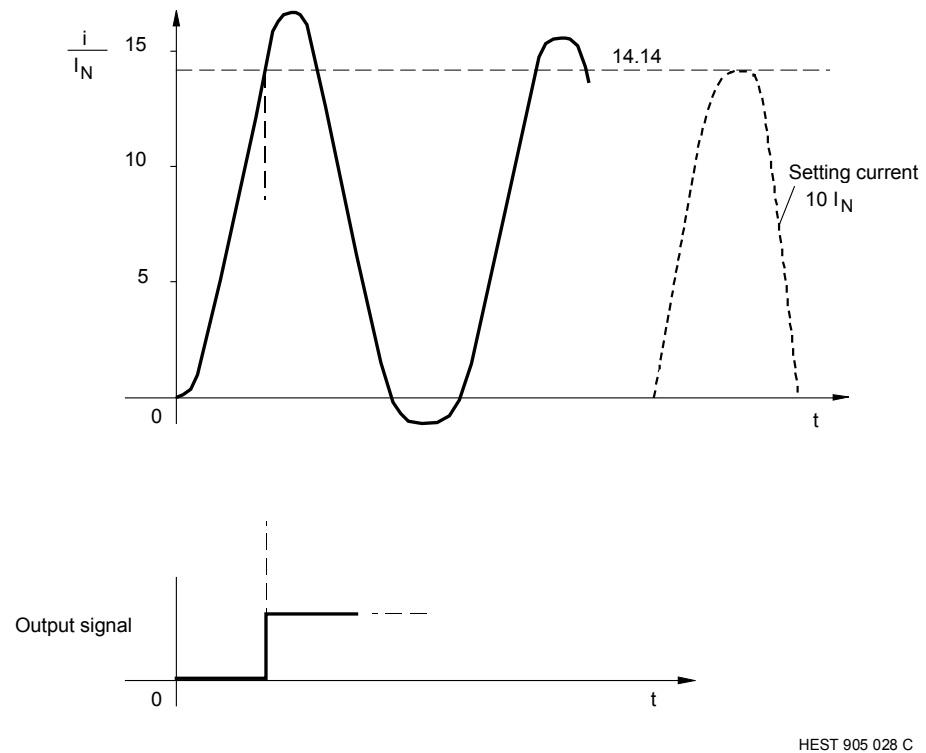


Fig. 3.5.2.1 Operation of the peak value overcurrent function

Typical settings:

a) Peak value phase fault protection

I-Setting	according to application
Delay	0.01 s
f-min	40 Hz

b) Phase fault protection of a machine with synchronous starter during start-up

I-Setting	$1.5 I_N$
Delay	5 s
f-min	2 Hz

3.5.3. *Inverse time overcurrent (Current-Inv)*

A. Application

Overcurrent function with time delay inversely proportional to the current and definite minimum tripping time (IDMT).

B. Features

- operating characteristics (see Fig. 3.5.3.1) according to British Standard 142:
 - c = 0.02 : normal inverse
 - c = 1 : very inverse and long time earth fault
 - c = 2 : extremely inverse.
- insensitive to DC component
- insensitive to harmonics
- single or three-phase measurement
- detection of the highest phase value in the three-phase mode
- wider setting range than specified in B.S. 142.

C. Inputs and outputs

I. C.t./v.t. inputs:

- current

II. Binary inputs:

- Blocking

III. Binary outputs:

- pick-up
- tripping

IV. Measurements:

- current amplitude.

D. Inverse time overcurrent settings - Current-Inv

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet4..1		P1	(Select)		
Trip		00000000			
c-Setting		1.00	(Select)		
k1-Setting	s	013.5	0.01	200.0	0.01
I-Start	IB	1.10	1.00	4.00	0.01
t-min	s	00.00	0.0	10.0	0.1
NrOfPhases		1	1	3	2
CurrentInp	CT/VT-Addr	0			
IB-Setting	IN	1.00	0.045	2.50	0.01
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping O/P of the function (matrix tripping logic).

c-Setting

Setting for the exponential factor determining the shape of the operating characteristic according to BS 142 or for selecting the RXIDG characteristic.

k1-Setting

Constant determining the parallel shift of the characteristic (time grading).

I-Start

Pick-up current at which the characteristic becomes effective.

t-min

Definite minimum tripping time.

NrOfPhases

defines the number of phases measured.

CurrentInp

defines the c.t. input channel. All current I/P's may be selected. In the case of three-phase measurement, the first channel (R phase) of the group of three selected must be specified.

IB-Setting

Base current for taking account of differences of rated current I_N .

BlockInp

defines the input for an external blocking signal.

- F: - not used
- T: - function always blocked
- xx: - all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

E. Setting instructions

Settings:

Base current	IB-Setting
Characteristic enabling current	I-Start
Type of characteristic	c-Setting
Multiplier	k1-Setting

The IDMT overcurrent function is used to protect transformers, feeders and loads of the auxiliaries supply system against phase and earth faults. The function responds largely only to the fundamental component of the fault current.

Base current “IB-Setting”

An IDMT relay does not have a fixed current setting above which it operates and below which it does not, as does a definite time-overcurrent relay. Instead, its operating characteristic is chosen such that it is always above the load current. To this end, the relay has a reference current I_{B1} that is set the same as the load current of the protected unit I_{B1} . The reference current I_B determines the relative position of the relay characteristic which is enabled when the current exceeds the reference current by a given amount (“I-Start”). By setting the reference current I_B to equal the load current of the protected unit I_{B1} instead of its rated current, for

$I_{B1} < I_N$ of the protected unit: the protection is more sensitive

$I_{B1} > I_N$ of the protected unit: the protection permits maximum utilisation of the thermal capability of the protected unit.

Example:

Load current of protected unit	$I_{B1} = 800 \text{ A}$
C.t. rated current	$I_{N1} = 1000 \text{ A}$
	$I_{N2} = 5 \text{ A}$
Relay rated current	$I_N = 5 \text{ A}$

Relay reference current “IB-Setting”:

$$I_B = I_{B1} \frac{I_{N2}}{I_{N1}} = 800 \text{ A} \frac{5 \text{ A}}{1000 \text{ A}} = 4 \text{ A}$$

Setting:

$$\frac{I_B}{I_N} = \frac{4 \text{ A}}{5 \text{ A}} = 0.8$$

An alternative is to adjust the position of the IDMT characteristic to match the rated load of the protected unit and set the reference current to its rated current instead of its load current.

Enabling the characteristic 'I-Start'

The IDMT characteristic is enabled when the current exceeds the setting 'I-Start'. A typical setting for 'I-Start' is $1.1 I_B$.

Choice of characteristic 'c-Setting'

The constant 'c-Setting' determines the shape of the IDMT characteristic.

The settings for the standard characteristics according to B.S. 142 are:

"normal inverse"	: $c = 0.02$
"very inverse" and "long time earth fault"	: $c = 1.00$
"extremely inverse"	: $c = 2.00$.

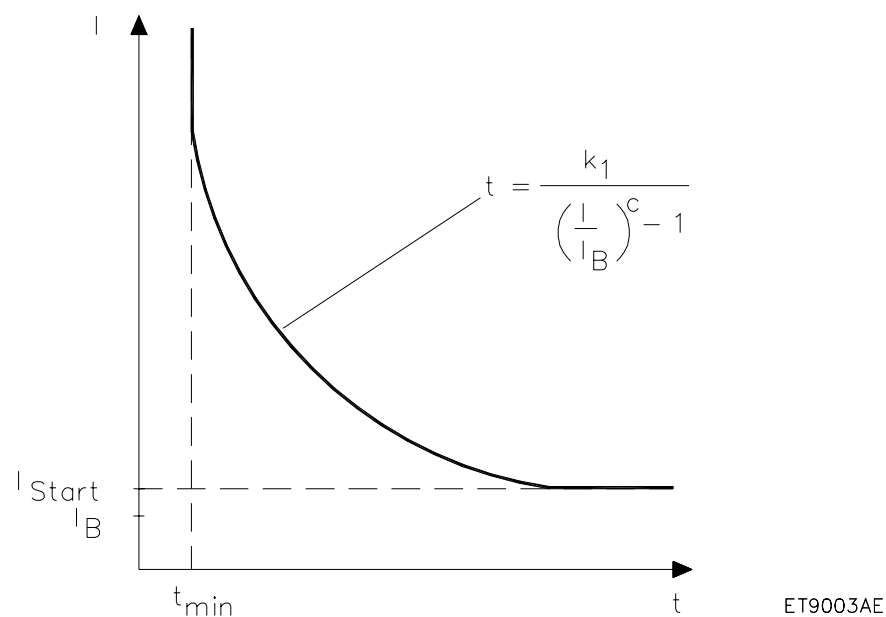


Fig. 3.5.3.1 Operating characteristic of the IDMT overcurrent function

"c-Setting" can also be set to "RXIDG", in which case the function's inverse characteristic corresponds to that of the relay Type RXIDG:

$$t [s] = 5.8 - 1.35 \ln (I/I_B)$$

The parameter "k1-Setting" has no influence in this case.

Multiplier 'k1-Setting'

The multiplier 'k1-Setting' enables the IDMT characteristic chosen by the setting of parameter c to be shifted without changing its shape. This is used for grading the operating times of a series of IDMT relays along a line to achieve discrimination.

For example, in the case of the "very inverse" characteristic, the constant $c = 1$ and the factor $k1 \leq 13.5$. The operating time t is given by the equation

$$t = \frac{k1}{\frac{I}{I_B} - 1}$$

Assuming a grading time of 0.5 s at 6 times the base current I_B is required, the factor $k1$ for each of the relays is given by

$$k1 = 5 t$$

This produces for operating times between 0.5 and 2.5 s the following settings for $k1$:

t [s]	k1 [s]
0.5	2.5
1	5
1.5	7.5
2	10
2.5	12.5

The characteristics according to BS 142 are set as follows:

"normal inverse"	: $k1 = 0.14$ s
"very inverse"	: $k1 = 13.5$ s
"extremely inverse"	: $k1 = 80$ s
"long time earth fault"	: $k1 = 120$ s.

Typical settings:

IB-Setting	corresponding to load current of the protected unit
I-Start	1.1 IB
c-Setting	according to desired characteristic for the protected unit
k1-Setting	according to the time grading calculation
t-min	0.00

3.5.4. ***Directional definite time overcurrent protection (DirCurrentDT)***

A. Application

Directional overcurrent function for

- detecting phase faults on ring lines
- detecting phase faults on double-circuit lines with an infeed at one end
- backup protection for a distance protection scheme.

B. Features

- directionally sensitive three-phase phase fault protection
- insensitive to DC component
- insensitive to harmonics
- voltage memory feature for close faults.

C. Inputs and outputs

I. C.t./v.t. inputs

- current
- voltage

II. Binary inputs

- Blocking
- PLC receive

III. Binary outputs

- start
- start R
- start S
- start T
- forwards measurement
- backwards measurement
- tripping

IV. Measurements

- current amplitude
of the three phase currents (I_R , I_S , I_T)
- active power
A positive measurement indicates the forwards direction
($I_R * U_{ST}$, $I_S * U_{TR}$, $I_T * U_{RS}$)
- voltage amplitude
Amplitudes of the phase-to-phase voltages
(U_{ST} , U_{TR} , U_{RS}).

D. Directional overcurrent settings - DirCurrentDT

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet4..1		P1	(Select)		
Trip		B00000000			
CurrentInp	CT/VT-Addr	0			
VoltageInp	CT/VT-Addr	0			
I-Setting	IN	2.0	0.1	20.0	0.01
Angle	Deg	45	-180	+180	15
Delay	s	1.00	0.02	60.00	0.01
tWait	s	0.20	0.02	20.00	0.01
MemDirMode		Trip	(Select)		
MemDuration	s	2.00	0.20	60.00	0.01
Receive	BinaryAddr	T			
Ext Block	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr				
Start R	SignalAddr	ER			
Start S	SignalAddr	ER			
Start T	SignalAddr	ER			
MeasFwd	SignalAddr				
MeasBwd	SignalAddr				

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the function's tripping output (matrix tripping logic).

CurrentInp

defines the c.t. input channel. Only three-phase c.t.'s can be set and the first channel (R phase) of the group of three selected must be specified.

VoltageInp

defines the v.t. input channel. Only three-phase v.t.'s can be set and the first channel (R phase) of the group of three selected must be specified.

I-Setting

Pick-up setting for tripping.

Angle

Characteristic angle.

Delay

Delay between pick-up and tripping.

tWait

Time allowed for the directional decision to be received from the opposite end in a blocking scheme.

MemDirMode

determines the response of the protection after the time set for memorising power direction:

- trip
- block.

MemDuration

Time during which the power direction last determined remains valid.

Receive

Input for the signal from the opposite end of the line:

T: not used

xx: all binary inputs (or outputs of protection functions).

Ext Block

F: not blocked

xx: all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

Start R

R phase pick-up signal.

Start S

S phase pick-up signal.

Start T

T phase pick-up signal.

MeasFwd

signals measurement in the forwards direction.

MeasBwd

signals measurement in the backwards direction.

E. Setting instructions

Settings:

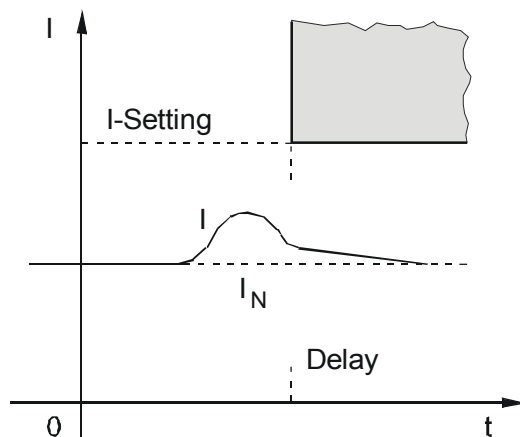
Pick-up current	I-Setting
Characteristic angle	Angle
Delay	Delay
Time allowed for receipt of signal	tWait
Response at the end of the memorised power direction time	MemDirMode
Time during which the memorised direction is valid	MemDuration

Pick-up value I-Setting

“I-Setting” must be chosen high enough to prevent false tripping or alarms from taking place and low enough to reliably detect the minimum fault current. The setting must be sufficiently above the maximum transient load current and allow for:

- c.t. and relay inaccuracies
- the reset ratio.

The maximum transient load current has to be determined according to the power system operating conditions and take account of switching operations and load surges.



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Fig. 3.5.4.1 Operating characteristic of the definite time over-current detector

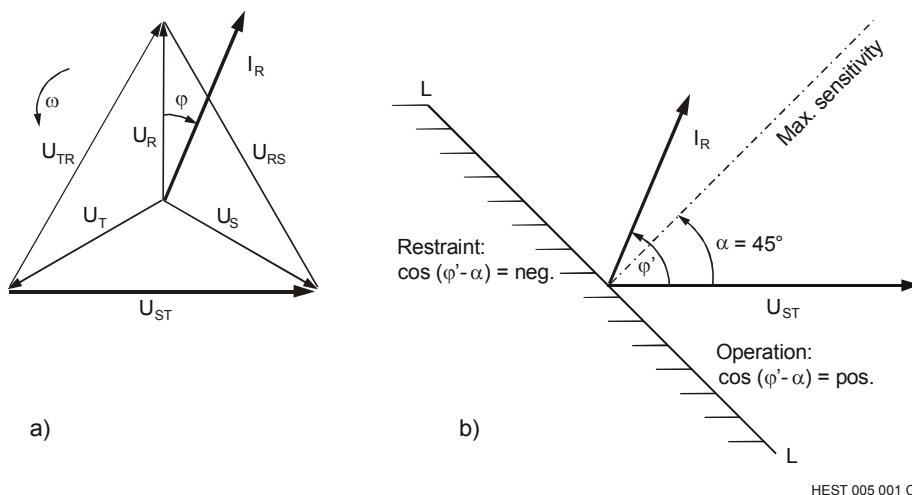
Where the rated c.t. current I_{N1} differs from the rated current I_{GN} of the protected unit, compensating the measurement to achieve a match is recommended. This is done by correcting either the reference value of the A/D input or the setting.

For example, assuming $I_{GN} = 800 \text{ A}$ and $I_{N1} = 1000 \text{ A}$, the setting to pick up at $1.5 I_{GN} = 1200 \text{ A}$ would be

$$1,5 \frac{I_{GN}}{I_{N1}} = 1,5 \frac{800 \text{ A}}{1000 \text{ A}} = 1,2$$

Characteristic angle

Determining the phase-angle of the current provides an additional criterion for preserving discrimination compared with non-directional overcurrent protection. The directional sensitivity is $\pm 180^\circ$ in relation to the reference voltage. This is illustrated in the following diagrams. The angles given apply for connection according to the connections in [Section 12](#).



HEST 005 001 C

ϕ' = phase-angle between current and voltage
(positive angle)

α = Characteristic angle

L = Border line between operating and restraint areas

a) Definition of current
and voltage

b) Operating characteristic

Fig. 3.5.4.2 Vector diagram for a fault in the forwards direction on R phase

The function determines the power direction by measuring the phase-angle of the current in relation to the opposite phase-to-phase voltage. Which current is compared with which voltage can be seen from the following table.

Current input	Phase-to-neutral voltage	Calculated voltage
I_R	U_S, U_T	$U_{ST} = U_S - U_T$
I_S	U_T, U_R	$U_{TR} = U_T - U_R$
I_T	U_R, U_S	$U_{RS} = U_R - U_S$

The voltage measurement automatically compensates the group of connection of the v.t.'s. For example, the phase-to-phase values are calculated for Y-connected v.t.'s (v.t. type UTS), while the input voltages are used directly for delta-connected v.t.'s (v.t. type UTD).

Delay

The delay enables the protection to be graded with other time-overcurrent relays to achieve discrimination. Its setting is thus chosen in relation to the timer settings of upstream and downstream protective devices. The zone of protection covered by this overcurrent protection extends to the next overcurrent protection device.

Should in the event of a fault in the next downstream zone, the protection for that zone fail, this protection function takes over after the time set for "Delay" and clears the fault as backup.

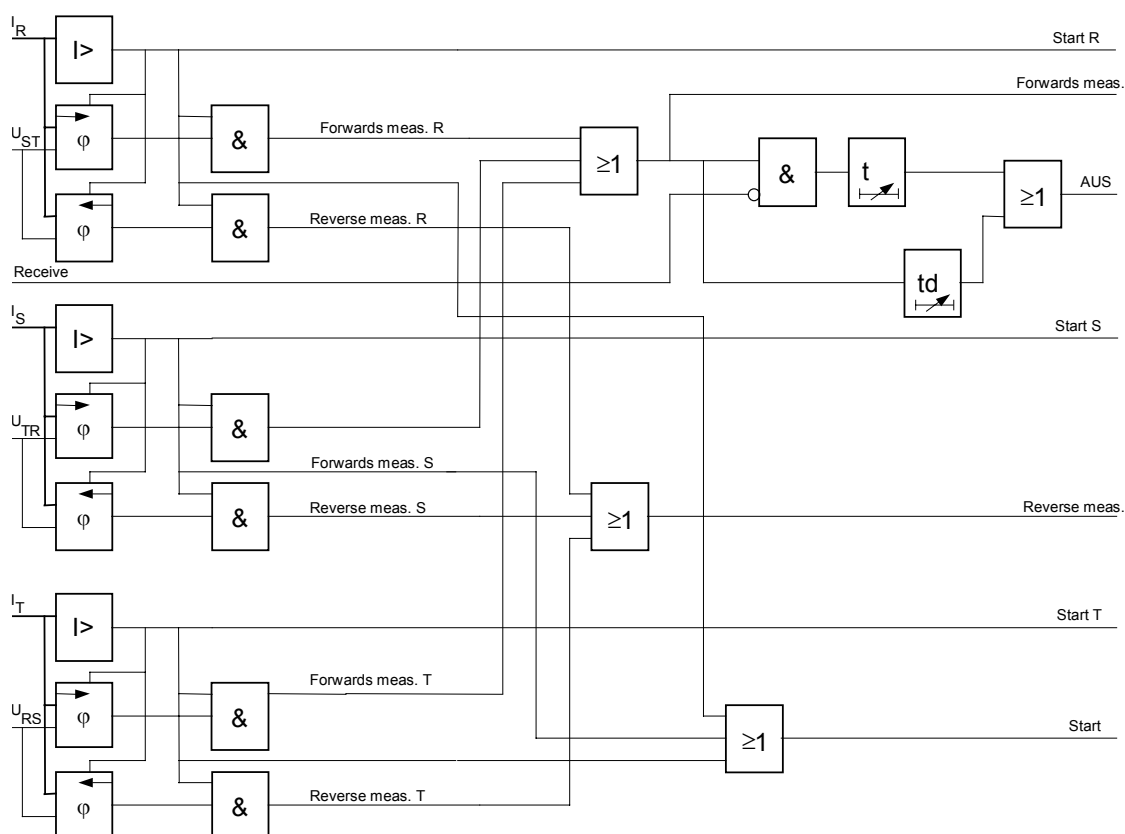


Fig. 3.5.4.3 Block diagram
 td = "Delay"
 t = "tWait"

Time allowed for a signal to be received

Where directional functions are configured in both line terminals, each can send a signal from its "MeasBwd" output to the "Receive" input of the function at the opposite end of the line (e.g. via a PLC channel) when it is measuring a fault in the reverse direction. This signal prevents the respective directional overcurrent function from tripping, because the fault cannot be in the zone between them. The functions therefore have to allow time, i.e. the "wait time", for the signal from the opposite line terminal to be received. If none is received within "tWait", the circuit-breakers are tripped at both ends.

The time set for "Delay" acts in this kind of scheme as a backup which does not rely on the communication channel. Thus when the "Receive" input is being used, the setting for "Delay" must be longer than the setting for "tWait":

$$\text{"Delay"} > \text{"tWait"}.$$

Response after decay of the memorised voltage

The voltage measured by the protection can quickly decay to almost zero for a close fault and make determining direction unreliable. For this reason, the function includes a voltage memory feature and for the first 200 milliseconds after the incidence of an overcurrent, the voltage measured immediately before the fault is used as reference to determine fault direction.

After this time, the last valid direction is used for an adjustable period (see next paragraph).

“MemDirMode” provides facility for setting how the protection must respond after this time or in the event that the circuit-breaker is closed onto a fault and no voltage could be memorised beforehand. The two possible settings are the protection can trip or it can block.

Time during which the memorised direction is valid

The “MemDuration” setting determines how long the last valid direction measurement shall be used. The setting should be as short as possible (200 ms) when the function is being used as backup for a distance function in an HV power system, because an actually measured voltage is only available during this time and therefore it is only possible to detect a reversal of direction during this time. For longer settings, the last valid power direction is used instead of the actually memorised voltage.

3.5.5. ***Directional inverse time overcurrent protection*** ***(DirCurrentInv)***

A. Application

Directional overcurrent function for

- detecting phase faults on ring lines
- detecting phase faults on double-circuit lines with an infeed at one end
- backup protection for a distance protection scheme.

B. Features

- directionally sensitive three-phase phase fault protection
- operating characteristics (see Fig. 3.5.5.1) according to British Standard B.S.142:
 - c = 0.02: normal inverse
 - c = 1: very inverse und long time earth fault
 - c = 2: extremely inverse.
- insensitive to DC component
- insensitive to harmonics
- voltage memory feature for close faults.

C. Inputs and outputs

I. C.t./v.t. inputs

- current
- voltage

II. Binary inputs

- Blocking
- PLC receive

III. Binary outputs

- start
- start R
- start S
- start T
- forwards measurement
- backwards measurement
- tripping

IV. Measurements

- current amplitude
of the three phase currents (I_R , I_S , I_T)
- active power
A positive measurement indicates the forwards direction
($I_R * U_{ST}$, $I_S * U_{TR}$, $I_T * U_{RS}$)
- voltage amplitude
Amplitudes of the phase-to-phase voltages
(U_{ST} , U_{TR} , U_{RS}).

D. Directional overcurrent settings - DirCurrentInv

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet4..1		P1	(Select)		
Trip		B00000000			
CurrentInp	CT/VT-Addr	0			
VoltageInp	CT/VT-Addr	0			
I-Start	IN	1.10	1.00	4.00	0.01
Angle	Deg	45	-180	+180	15
c-Setting		1.00	(Select)		
k1-Setting	s	13.5	0.01	200.00	0.01
t-min	s	0.00	0.00	10.00	0.01
IB-Setting	IN	1.00	0.04	2.50	0.01
tWait	s	0.20	0.02	20.00	0.01
MemDirMode		Trip	(Select)		
MemDuration	s	2.00	0.20	60.00	0.01
Receive	BinaryAddr	T			
Ext Block	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr				
Start R	SignalAddr	ER			
Start S	SignalAddr	ER			
Start T	SignalAddr	ER			
MeasFwd	SignalAddr				
MeasBwd	SignalAddr				

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the function's tripping output (matrix tripping logic).

CurrentInp

defines the c.t. input channel. Only three-phase c.t.'s can be set and the first channel (R phase) of the group of three selected must be specified.

VoltageInp

defines the v.t. voltage input channel. Only three-phase v.t.'s can be set and the first channel (R phase) of the group of three selected must be specified.

I-Start

Pick-up current at which the characteristic becomes effective.

Angle

Characteristic angle.

c-Setting

Setting for the exponential factor determining the operating characteristic according to BS 142.

k1-Setting

Constant determining the parallel shift of the characteristic.

t-min

Definite minimum operating time, operating characteristic constant.

IB-Setting

Base current for taking account of differences of rated current I_N .

tWait

Time allowed for the directional decision to be received.

MemDirMode

determines the response of the protection after the time set for memorising power direction:

- trip
- block.

MemDuration

Time during which the power direction last determined remains valid.

Receive

Input for the signal from the opposite end of the line:

- T: not used
xx: all binary inputs (or outputs of protection functions).

Ext Block

- F: not blocked
xx: all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

Start R

R phase pick-up signal.

Start S

S phase pick-up signal.

Start T

T phase pick-up signal.

MeasFwd

signals measurement in the forwards direction.

MeasBwd

signals measurement in the backwards direction.

E. Setting instructions

Settings:

Base current	IB-Setting
Characteristic enabling current	I-Start
Type of characteristic	c-Setting
Multiplier	k1-Setting
Characteristic angle	Angle
Delay	Delay
Time allowed for receipt of signal	tWait
Response at the end of the memorised power direction time	MemDirMode
Time during which the memorised direction is valid	MemDuration

Base current “IB-Setting”

A tripping current is not set on an IDMT overcurrent function as it is on a definite time overcurrent function. Instead the position of the characteristic is chosen such that it is above the load current. The function, however, has a “base current” setting which is set to the full load current I_{B1} of the protected unit. The base current setting determines the position of the basic characteristic. The characteristic is enabled when the base current is exceeded by a preset amount (I-Start). The adjustment of the base current IB to the load current I_{B1} of the protected unit instead of its rated current enables for

$I_{B1} < \text{rated current of prot. unit} : \text{more sensitive protection}$

$I_{B1} > \text{rated current of prot. unit} : \text{maximum utilisation of the thermal capability of the protected unit.}$

Example:

Load current of the protected unit	$I_{B1} = 800 \text{ A}$
C.t rated current	$I_{N1} = 1000 \text{ A}$
	$I_{N2} = 5 \text{ A}$
Protection rated current	$I_N = 5 \text{ A}$
Protection base current	

$$IB = I_{B1} \frac{I_{N2}}{I_{N1}} = 800 \text{ A} \frac{5 \text{ A}}{1000 \text{ A}} = 4 \text{ A}$$

Setting

$$\frac{IB}{I_N} = \frac{4 \text{ A}}{5 \text{ A}} = 0.8 \text{ A}$$

An alternative is to adjust the position of the IDMT characteristic to match the rated load of the protected unit and set the base current to its rated current instead of its load current.

Enabling the characteristic 'I-Start'

The IDMT characteristic is enabled when the current exceeds the setting 'I-Start'. A typical setting for 'I-Start' is $1.1 I_B$.

Choice of characteristic 'c-Setting'

The constant 'c-Setting' determines the shape of the IDMT characteristic. The settings for the standard characteristics according to B.S. 142 are:

"normal inverse"	: $c = 0.02$
"very inverse" and "long time earth fault"	: $c = 1.00$
"extremely inverse"	: $c = 2.00$.

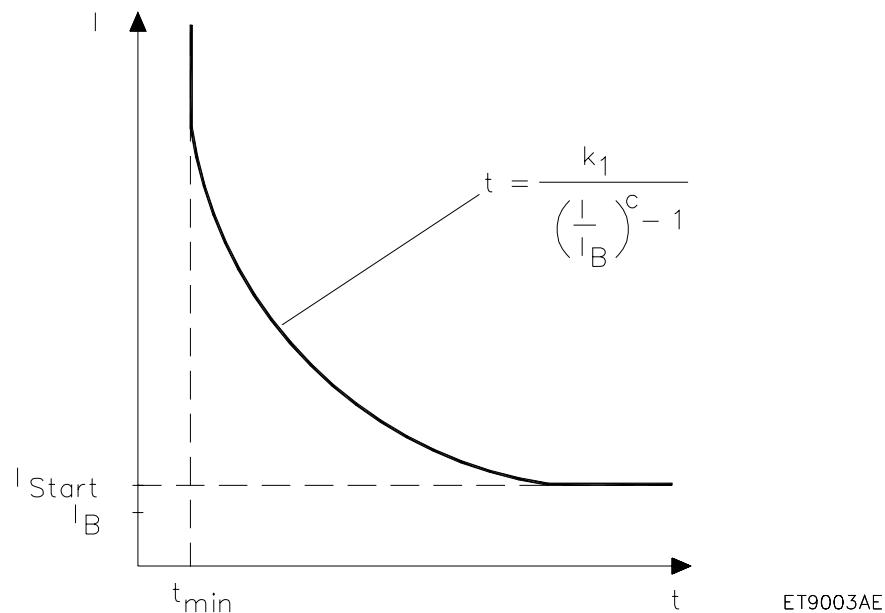


Fig. 3.5.5.1 Operating characteristic of the directional IDMT overcurrent function

Multiplier 'k1-Setting'

The multiplier 'k1-Setting' enables the IDMT characteristic chosen by the setting of parameter c to be shifted without changing its shape. This is used for grading the operating times of a series of IDMT relays along a line to achieve discrimination.

For example, in the case of the "very inverse" characteristic, the constant $c = 1$ and the factor $k1 \leq 13.5$. The operating time t is given by the equation

$$t = \frac{k1}{\left(\frac{I}{I_B} - 1\right)}$$

Assuming a grading time of 0.5 s at 6 times the base current I_B is required, the factor $k1$ for each of the relays is given by

$$k1 = 5 t.$$

This produces for operating times between 0.5 and 2.5 s the following settings for $k1$:

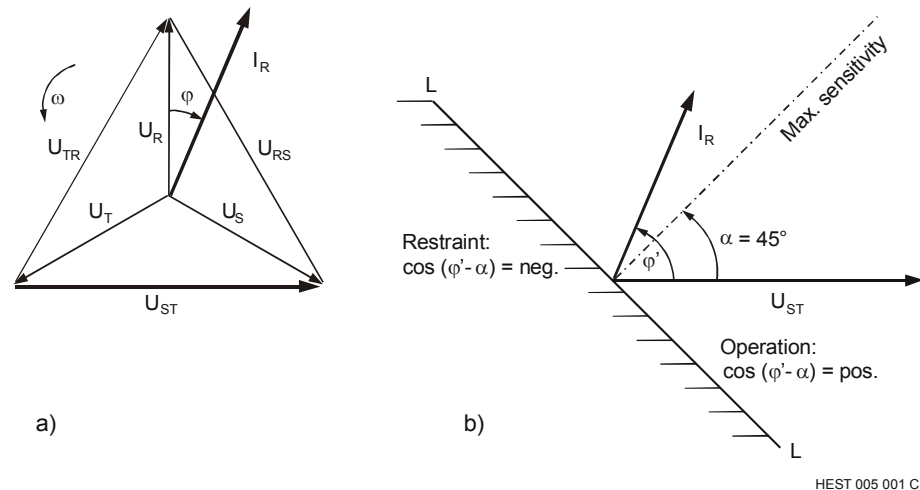
t [s]	k1 [s]
0.5	2.5
1	5
1.5	7.5
2	10
2.5	12.5

The characteristics according to BS 142 are set as follows:

"normal inverse"	: $k1 = 0.14$ s
"very inverse"	: $k1 = 13.5$ s
"extremely inverse"	: $k1 = 80$ s
"long time earth fault"	: $k1 = 120$ s.

Characteristic angle

Determining the phase-angle of the current provides an additional criterion for preserving discrimination compared with non-directional overcurrent protection. The directional sensitivity is $\pm 180^\circ$ in relation to the reference voltage. This is illustrated in the following diagrams. The angles given apply for connection according to the connections in [Section 12](#).



φ' = phase-angle between current and voltage
 (positive angle)
 α = Characteristic angle
 L = Border line between operating and restraint areas

a) Definition of current and voltage b) Operating characteristic

Fig. 3.5.5.2 Vector diagram for a fault in the forwards direction on R phase

The function determines the power direction by measuring the phase-angle of the current in relation to the opposite phase-to-phase voltage. Which current is compared with which voltage can be seen from the following table.

Current input	Phase-to-neutral voltage	Calculated voltage
I_R	U_S, U_T	$U_{ST} = U_S - U_T$
I_S	U_T, U_R	$U_{TR} = U_T - U_R$
I_T	U_R, U_S	$U_{RS} = U_R - U_S$

The voltage measurement automatically compensates the group of connection of the v.t.'s. For example, the phase-to-phase values are calculated for Y-connected v.t.'s (v.t. type UTS), while the input voltages are used directly for delta-connected v.t.'s (v.t. type UTD).

Time allowed for a signal to be received

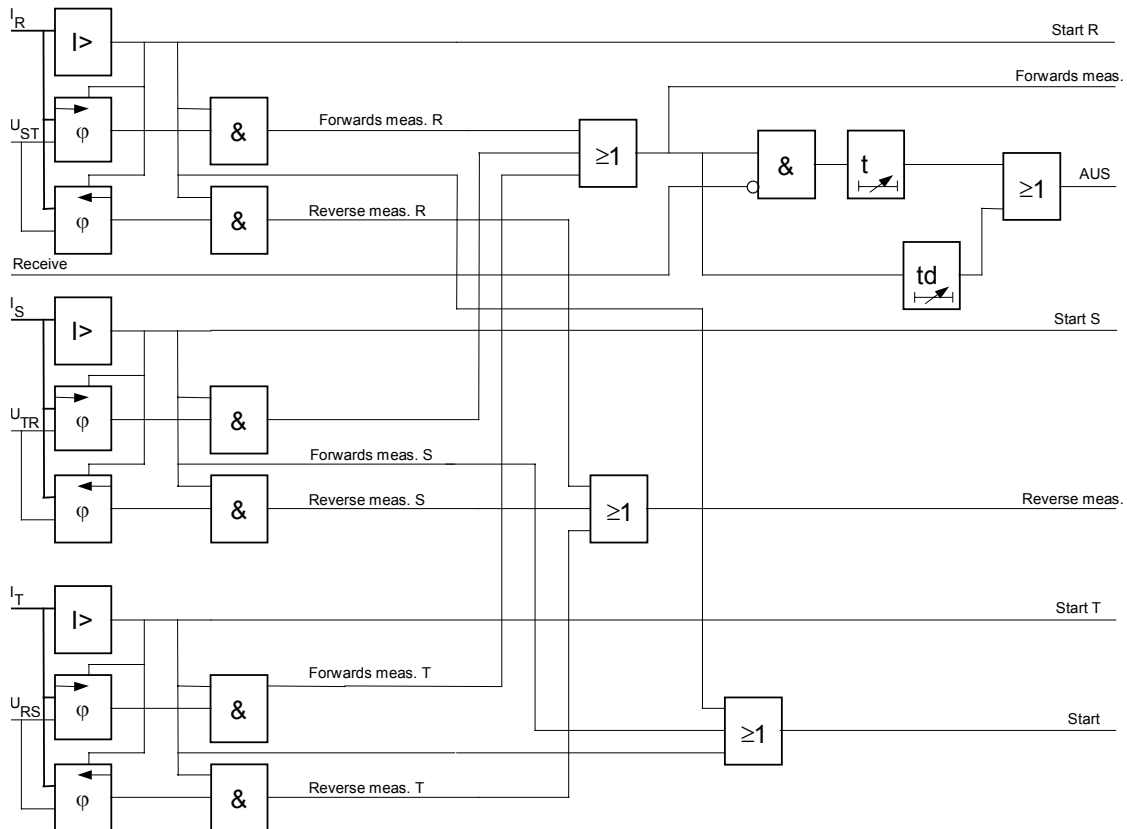


Fig. 3.5.5.3 Block diagram
td = "Delay"
t = "tWait"

Where directional functions are configured in both line terminals, each can send a signal from its "MeasBwd" output to the "Receive" input of the function at the opposite end of the line (e.g. via a PLC channel) when it is measuring a fault in the reverse direction. This signal prevents the respective directional overcurrent function from tripping, because the fault cannot be in the zone between them. The functions therefore have to allow time, i.e. the "wait time", for the signal from the opposite line terminal to be received. If none is received within "tWait", the circuit-breakers are tripped at both ends.

The time set for “Delay” acts in this kind of scheme as a backup which does not rely on the communication channel. Thus when the “Receive” input is being used, the setting for “Delay” must be longer than the setting for “tWait”:

“Delay” > “tWait”.

Response after decay of the memorised voltage

The voltage measured by the protection can quickly decay to almost zero for a close fault and make determining direction unreliable. For this reason, the function includes a voltage memory feature and for the first 200 milliseconds after the incidence of an overcurrent, the voltage measured immediately before the fault is used as reference to determine fault direction.

After this time, the last valid direction is used for an adjustable period (see next paragraph).

“MemDirMode” provides facility for setting how the protection must respond after this time or in the event that the circuit-breaker is closed onto a fault and no voltage could be memorised beforehand. The two possible settings are the protection can trip or it can block.

Time during which the memorised direction is valid

The “MemDuration” setting determines how long the last valid direction measurement shall be used. The setting should be as short as possible (200 ms) when the function is being used as backup for a distance function in an HV power system, because an actually measured voltage is only available during this time and therefore it is only possible to detect a reversal of direction during this time. For longer settings, the last valid power direction is used instead of the actually memorised voltage.

3.5.6. ***Inverse definite minimum time earth fault overcurrent function (I0-Invers)***

A. Application

Overcurrent function with IDMT characteristic. A typical application is as back-up for the E/F protection function, in which case it measures $3 I_0$ either supplied from an external source or internally derived.

B. Features

- Tripping characteristic according to British Standard 142 (see Fig. 3.5.6.1):
 - $c = 0.02$: normal inverse
 - $c = 1$: very inverse and long time earth fault
 - $c = 2$: extremely inverse.
- DC component filter
- harmonic filter
- external $3 I_0$ signal or $3 I_0$ internally derived from the three phase currents
- wider setting range than specified in BS 142.

C. Inputs and outputs

I. C.t./v.t. inputs

- Current

II. Binary inputs

- Blocking

III. Binary outputs

- Starting
- Tripping

IV. Measurements

- Neutral current.

D. IDMT function settings - I0-Invers

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
c-Setting		1.00	(Select)		
k1-Setting	s	013.5	0.01	200.0	0.01
I-Start	IB	1.10	1.00	4.00	0.01
t-min.	s	00.0	00.0	10.0	0.1
NrOfPhases		1	1	3	2
CurrentInp	CT/VT-Addr	0			
IB-Setting	IN	1.00	0.04	2.50	0.01
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Tripping logic (matrix).

c-Setting

Setting for the exponential factor determining the shape of the operating characteristic according to BS 142 or for selecting the RXIDG characteristic.

k1-Setting

Constant determining the tripping characteristic.

I-Start

Pick-up setting (initiates the tripping characteristic).

t-min.

Definite minimum time of the tripping characteristic.

NrOfPhases

Number of phases evaluated for measurement:

- 1 : neutral current direct from an c.t. input
- 3 : neutral current derived internally from the three phases.

CurrentInp

defines the c.t. input channel. All the current channels are available for selection. In the case of a three-phase measurement, the first channel (R phase) of the group of three must be selected.

IB-Setting

Reference current to take account of discrepancies with respect to I_N .

BlockingInp

I/P for the external blocking signal.

- F: - unused
- T: - function always blocked
- xx: - all binary I/P's (or O/P's of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

E. Setting instructions

Protection function enable 'I-Start'

The IDMT function starts to run when the current applied to the function exceeds the setting 'I-Start'. 'I-Start' is normally set to $1.1 I_B$.

Choice of tripping characteristic 'c'

The shape of the IDMT characteristic is determined by the constant 'c'.

The standard IDMT characteristics according to BS 142 are:

"normal inverse"	: c = 0.02
"very inverse" and "long time earth fault"	: c = 1.00
"extremely inverse"	: c = 2.00

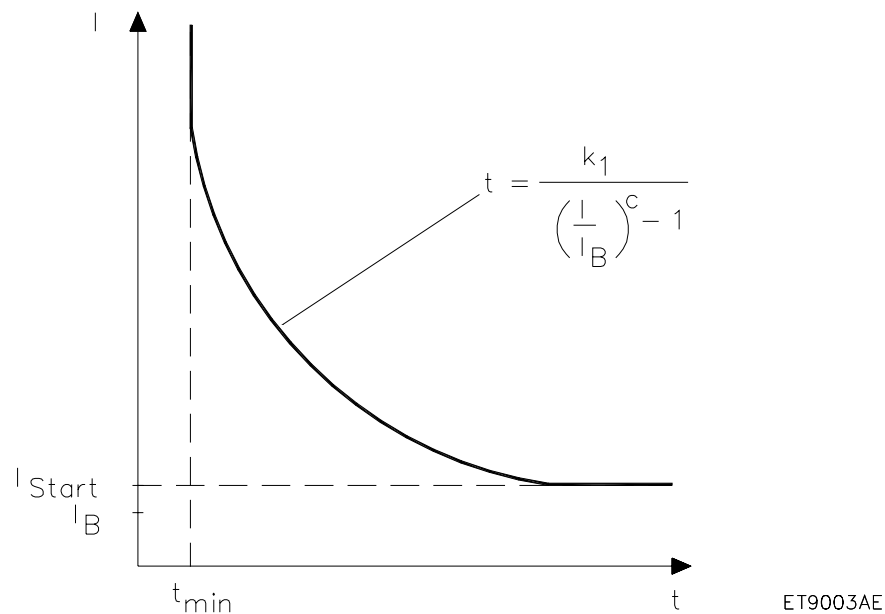


Fig. 3.5.6.1 IDMT tripping characteristic for 'I0-Invers' ($I = 3 I_0$)

"c-Setting" can also be set to "RXIDG", in which case the function's inverse characteristic corresponds to that of the relay Type RXIDG:

$$t [s] = 5.8 - 1.35 \ln (I/I_B)$$

The parameter "k1-Setting" has no influence in this case.

Time multiplier 'k1-Setting'

Discriminative operation of the relays along a line is achieved by time-grading. Assuming all the relays to be set to the same I_B , this involves setting the time multiplier in equal steps (grading time), increasing from the load towards the source.

For example, in the case of the "very inverse" characteristic, the constant $c = 1$ and the factor $k1 \leq 13.5$. The operating time t is then given by

$$t = \frac{k1}{\frac{3I_0}{I_B} - 1}$$

Assuming the grading time of the protection functions to be 0.5 s at $6 \times I_B$, the settings of $k1$ according to the formula

$$k1 = 5 t$$

for operating times between 0.5 and 2.5 s become:

t [s]	k1 [s]
0.5	2.5
1	5
1.5	7.5
2	10
2.5	12.5

The characteristics according to BS 142 are set as follows:

"normal inverse"	: $k1 = 0.14$ s
"very inverse"	: $k1 = 13.5$ s
"extremely inverse"	: $k1 = 80$ s
"long time earth fault"	: $k1 = 120$ s.

Definite minimum time 't-min.'

Where the IDMT function is being applied as back-up protection for a directional E/F protection, the definite minimum time 't-min.' must be set as follows

$$t_{\text{min.}} = t_{\text{basic}} + t_{\text{comp}}$$

t_{basic} = basic time of the E/F function

t_{comp} = comparison time of the E/F function (1 s).

Interconnections between IDMT and directional E/F functions

The IDMT protection is non-directional.

Directional operation can, however, be achieved by linking the directional signal ('MeasFwd', i.e. fault in forwards direction) from the E/F protection to the blocking I/P of the IDMT function. The I/P must be inverted so that blocking of the IDMT function is cancelled by an active forwards signal.

When using this arrangement, it must be noted that, when 'MeasFwd' does not pick up, the IDMT function cannot trip when the reference voltage of the E/F function is too low. If tripping is required for this case, the directional E/F signal 'MeasBwd' must be applied to the blocking input.

Applications with single-phase reclosure

In schemes involving single-phase reclosure, the 'IO-Invers' function has to be blocked for the time that one pole of a circuit-breakers is open if the minimum tripping time 'tmin' is set less than the single-phase dead time. This avoids false three-phase tripping due to the load currents in the healthy phases.

Typical settings:

IB	to be calculated
I-Start	1.1 IB
c	depends on the protected unit
k1	to be calculated
t-min.	0.00

3.5.7. *Definite time over and undervoltage protection (Voltage-DT)*

A. Application

Standard voltage applications (overvoltage and undervoltage function).

B. Features

- DC component filter
- harmonic filter
- single or three-phase voltage measurement
- maximum value, respectively minimum value, detection for three-phase measurement.

C. Inputs and outputs

I. Analogue inputs:

- Voltage

II. Binary inputs:

- Blocking

III. Binary outputs:

- Pick-up
- Tripping

IV. Measurements:

- Voltage amplitude.

D. Over/undervoltage protection settings - Voltage-DT

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Delay	s	02.00	0.02	60.00	0.01
V-Setting	UN	1.200	0.010	2.000	0.002
MaxMin		MAX (1ph)	(Select)		
NrOfPhases		001	1	3	2
VoltageInp	AnalogAddr	0			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Tripping circuit to which the O/P of the over/undervoltage function is connected (matrix tripping logic).

Delay

Time delay between the function picking up and tripping.

V-Setting

Voltage setting for tripping.

MaxMin

Over or undervoltage mode selection:

- MIN (3ph): Undervoltage.
Three-phase functions detect the highest phase voltage.
Not permitted for single-phase functions.
- MIN (1ph): Undervoltage.
Three-phase functions detect the lowest phase voltage.

- MAX (3ph): Overvoltage.
Three-phase functions detect the lowest phase voltage.
Not permitted for single-phase functions.
- MAX (1ph): Overvoltage.
Three-phase functions detect the highest phase voltage.

NrOfPhases

Number of phases included in the measurement.

VoltageInp

Analogue I/P channel. All the voltage channels are available for selection. In the case of a three-phase measurement, the first channel (R phase) of the group of three must be selected.

BlockInp

I/P for blocking the function.

F: - not blocked

T: - blocked

xx: - all binary I/P's (or O/P's of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

E. Setting instructions

Settings:

Setting	V-Setting
Delay	Delay
Over or undervoltage	MaxMin
Number of phases measured	NrOfPhases

Two of these functions are frequently applied in a two-stage scheme. The first stage detects lower prolonged overvoltages while the second guards against higher overvoltages which have to be cleared quickly.

Pick-up voltage (U-Setting)

Single-phase v.t.:

A setting of $1.3 U_N$ corresponds to a pick-up voltage of 130 V at the input of the v.t.

Note that although a setting of $2.0 U_N$ is possible, the range of the analogue inputs of the input transformer units K01...K17 (REL 316*4) and K41...K47 (REC 316*4) is only $1.3 U_N$ (i.e. max. 130 V or 260 V).

Y connected three-phase v.t.'s:

A setting of $1.3 U_N$ corresponds to a pick-up voltage of $130 \text{ V} / \sqrt{3}$ at the input of the v.t. (phase-to-neutral voltage).

Compensating any difference between the rated voltages of v.t.'s U_{N1} and protected unit U_{GN} is recommended. This is achieved with the aid of the reference value of the A/D channel or by correcting the voltage setting.

For example, for $U_{GN} = 12 \text{ kV}$ and $U_{N1} = 15 \text{ kV}$, the setting for a pick-up voltage of $1.4 U_{GN}$ would have to be

$$1.4 \frac{U_{GN}}{U_{N1}} = 1.4 \frac{12 \text{ kV}}{15 \text{ kV}} = 1.12$$

MaxMin setting

This parameter provides a choice of the following settings:

- MIN (3ph) : Protection picks up when all three phase voltages have fallen below setting.
- MIN (1ph) : Protection picks up when the lowest of the phase voltages falls below setting.
- MAX (3ph) : Protection picks up when all three phase voltages have exceeded setting.
- MAX (1ph) : Protection picks up when the highest of the phase voltages exceeds setting.

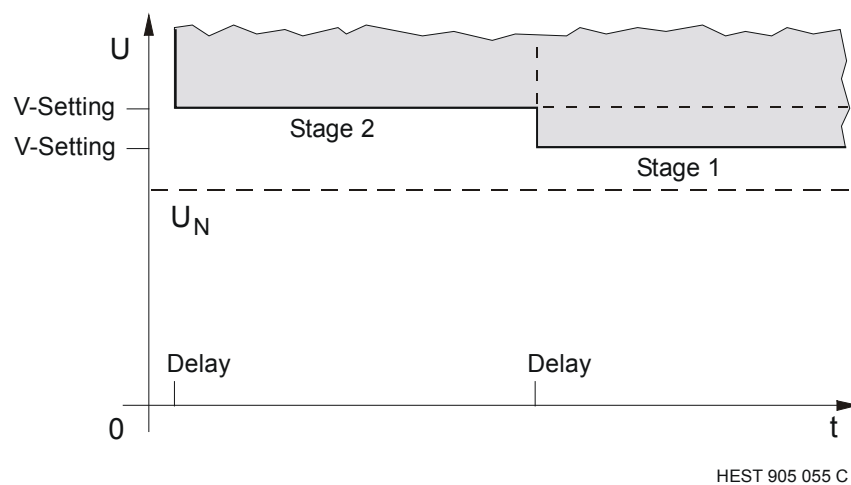


Fig. 3.5.7.1 Operating characteristic of a two-stage overvoltage protection
 U_N = rated relay voltage

Typical settings:

1st. stage	
V-setting	$1.15 U_N$
Delay	2 s
MaxMin	MAX (1ph)
2nd. stage	
V-setting	$1.4 U_N$
Delay	0.1 s
MaxMin	MAX (1ph)

3.5.8. Peak value overvoltage (Voltage-Inst)

A. Application

- General voltage monitoring with instantaneous response (over and undervoltage)
- Voltage monitoring where insensitive to frequency is required (over and undervoltage).

B. Features

- processes instantaneous values and is therefore fast and largely independent of frequency
- stores the peak value following pick-up
- no suppression of DC component
- no suppression of harmonics
- single and three-phase measurement
- maximum value detection in the three-phase mode
- adjustable lower frequency limit $f_{\min}$.

C. Inputs and outputs

I. C.t./v.t. inputs

- voltage

II. Binary inputs

- blocking

III. Binary outputs

- pick-up
- tripping

IV. Measurements

- voltage amplitude (only available if function trips).

D. Peak value voltage function settings - Voltage-Inst

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Delay	s	00.01	0.00	60.00	0.01
V-Setting	UN	1.40	0.01	2.00	0.01
f-min	Hz	40	25	50	1
MaxMin		MAX	(Select)		
NrOfPhases		001	1	3	2
VoltageInp	CT/VT-Addr	0			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping O/P of the function (matrix).

Delay

Time between the function picking up and tripping.

V-Setting

Pick-up voltage setting.

f-min

defines the minimum frequency for which measurement is required.

MaxMin

defines operation as overvoltage or undervoltage. Settings:

- MAX: overvoltage
- MIN: undervoltage.

NrOfPhases

defines whether single or three-phase measurement.

VoltageInp

defines the v.t. input channel.

All voltage inputs may be selected.

In the case of three-phase measurement, the first channel (R phase) of the group of three selected must be specified.

BlockInp

Binary address used as blocking input.

F: - not blocked

T: - blocked

xx: - all binary inputs (or outputs of protection functions).

Trip

Output for signalling tripping.

Start

Output for signalling pick-up.

E. Setting instructions

Settings:

Overvoltage	V-Setting
Delay	Delay
Minimum frequency	f-min
Over or undervoltage	MaxMin

The instantaneous overvoltage function is a high-speed protection, which operates in a wide frequency range. It is intended primarily for the following applications:

- where an overvoltage protection is required, which is largely insensitive to frequency especially for $f > f_N$.

The limited capacity of the v.t.'s to transform low frequencies must be taken into account for $f < f_N$:

Input transformer units K01...K17 (REL 316*4) and K41...K47 (REC 316*4):

$$1.3U_N \cdot \frac{f}{f_N}$$

Input transformer units K21...K24 (RET 316*4) and K61...K68 (REG 316*4):

$$2.25U_N \cdot \frac{f}{f_N}$$

- where high-speed protection is required. The high speed is achieved by measuring the instantaneous value of the voltage and since DC components and harmonics are not suppressed, by eliminating the inertia of the digital input filter.

Compared with the normal voltage function, the instantaneous function has a larger tolerance on the pick-up setting. It should therefore only be used in the above two cases.

The measuring principle is the same as that of the peak value current function and therefore reference should be made to that Section for a description of the principle and the significance of the minimum frequency setting f-min.

Pick-up voltage (U-Setting)

Single-phase v.t.:

A setting of $1.3 U_N$ corresponds to a pick-up voltage of 130 V at the input of the v.t.

Note that although a setting of $2.0 U_N$ is possible, the range of the analogue inputs of the input transformer units K01...K17 (REL 316*4) and K41...K47 (REC 316*4) is only $1.3 U_N$ (i.e. max. 130 V or 260 V).

Y connected three-phase v.t's:

A setting of $1.3 U_N$ corresponds to a pick-up voltage of $130 V/\sqrt{3}$ at the input of the v.t.(phase-to-neutral voltage).

Typical settings:

V-Setting	according to application
Delay	according to application
f-min	40 Hz

3.5.9. Power (Power)

A. Application

Power function for monitoring

- reverse power
- active power
- reactive power
- power direction.

B. Features

- definite time delay
- over or underpower
- adjustable characteristic angle
- provision for correction of phase errors caused by the input circuit
- one, two or three-phase measurement (two-phase only with delta connected v.t.'s)
- wide range of applications (see Fig. 3.5.9.2 and Fig. 3.5.9.3)
- correction of c.t. and v.t. phase errors
- insensitive to DC components in voltage and current
- insensitive to harmonics in voltage and current.

C. Inputs and outputs

I. C.t./v.t. inputs:

- current
- voltage

II. Binary inputs:

- Blocking

III. Binary outputs:

- pick-up
- tripping

IV. Measurements:

- power.

D. Power function settings - Power

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
P-Setting	PN	-0.050	-0.100	1.200	0.005
Angle	deg	000.0	-180.0	180.0	5.0
Drop-Ratio	%	60	30	170	1
Delay	s	00.50	0.05	60.00	0.01
MaxMin		MIN	(Select)		
Phi-Comp	deg	0.0	-5.0	5.0	0.1
NrOfPhases		001	1	3	1
CurrentInp	CT/VT-Addr	0			
VoltageInp	CT/VT-Addr	0			
PN	UN*IN	1.000	0.500	2.500	0.001
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr				

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

channel of the tripping logic (matrix) activated by the function's tripping O/P.

P-Setting

Power setting for tripping.

Forbidden settings:

- $< 0.005 P_N$ connected to metering cores
- $< 0.020 P_N$ connected to protection cores

In view of the required accuracy, the use of metering cores is recommended for settings $\leq 0.2 P_N$.

Angle

Characteristic angle between voltage and current for maximum sensitivity.

0° = active power measurement

90° = reactive power measurement (inductive),

Settings between these limits are possible, e.g. for directional measurements at locations on the power system.

The correction of phase errors caused by the input circuit is also possible.

Drop-Ratio

Reset value in relation to the pick-up value. Thus depending on the sign of the pick-up value, the setting of the reset ratio must be greater or less than 100 %.

Forbidden settings:

- Reset ratios >100 % for MAX and P-Setting >0
- Reset ratios <100 % for MAX and P-Setting <0
- Reset ratios <100 % for MIN and P-Setting >0
- Reset ratios >100 % for MIN and P-Setting <0.

A large hysteresis must be selected for low pick-up settings and a small one for high pick-up settings (see Fig. 3.5.9.1).

Forbidden settings for hysteresis ($= |100\% - \text{reset ratio}|$) settings:

- $\leq 0.5\% / (|P - \text{Setting}/P_N| + 0.01)$
- $\geq 10\% / |P - \text{Setting}/P_N|$
- These conditions are fulfilled by setting, for example,

$$\text{for } 0.2 \leq \frac{P - \text{Setting}}{P_N} \leq 1: \quad 95\%$$

and

$$\text{for } 0.005 \leq \frac{P - \text{Setting}}{P_N} \leq 0.2: \quad 60\%.$$

Delay

Time between the function picking up and tripping. The time the function takes to reset is also influenced by the delay set for operation, i.e.:

for $t > 100$ ms, the function resets after 50 ms, otherwise re-setting is instantaneous.

MaxMin

Defines the operating mode as:

- MAX: overpower
- MIN: underpower.

Caution:

The number and its sign are relevant and not just the value, i.e. "MIN" must be set for reverse power, because tripping takes place for a power less than zero (P-Setting < 0).

Phi-Comp

Input of an angle to compensate c.t. and v.t. errors in the case of highly accurate power measurements.

The setting is determined by the difference between c.t. and v.t. errors.

NrOfPhases

Number of phases measured:

- 1: single-phase
- 2: two-phase, i.e. for a three-phase measurement with V connected v.t.'s,
$$P = U_{RS} \times I_R \times \cos \varphi - U_{ST} \times I_T \times \cos \varphi$$

A two-phase power measurement is only possible when connected to delta connected v.t.'s.
- 3: three-phase
$$P = U_R \times I_R \times \cos \varphi + U_S \times I_S \times \cos \varphi + U_T \times I_T \times \cos \varphi$$

(The measurement is only correct with delta connected v.t.'s if the three phase voltages are symmetrical.)

CurrentInp

defines the c.t. input channel.

All current I/P's may be selected.

In the case of multi-phase measurement, the first channel of the group of three (R phase) must be selected.

VoltageInp

defines the v.t. input channel.

All voltage I/P's may be selected.

In the case of multi-phase measurement, the first channel of the group of three (R phase) must be selected.

PN

Rated power as given by $U_N \times I_N$. This enables the amplitude of the power being measured to be compensated, e.g. to the rated power factor of a generator.

BlockInp

I/P for blocking the function.

F: - not blocked

T: - blocked

xx: - all binary I/P's (or O/P's of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

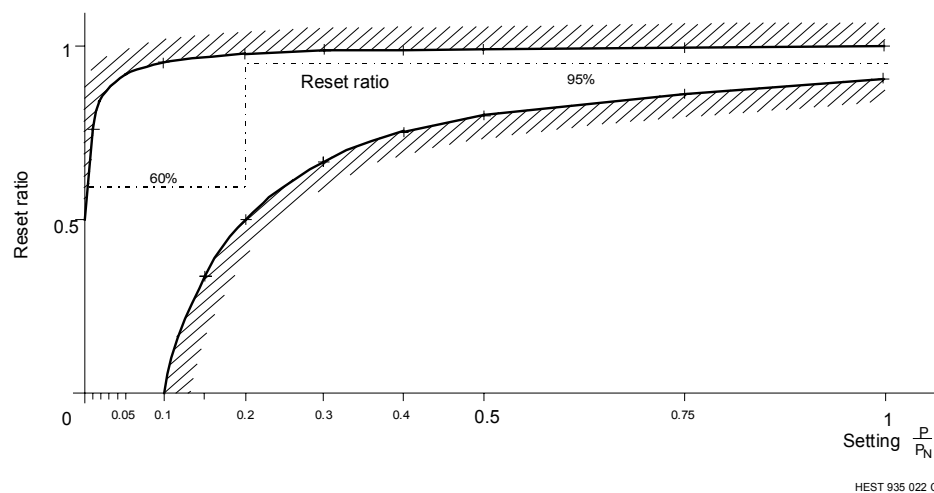


Fig. 3.5.9.1 Permissible reset ratio settings

E. Setting instructions

(function with two additional timers)

Settings:

Reference power	PN
Setting	P-Setting
Reset ratio	Drop-Ratio
Over/underpower	MaxMin
Characteristic angle	Angle
Phase error compensation	Phi-Comp
tripping delay	Delay

The power function can be used for many applications. Some examples are given in Fig. 3.5.9.2 and [Fig. 3.5.9.3](#). The angles given apply for connection according to the connections in [Index 12](#).

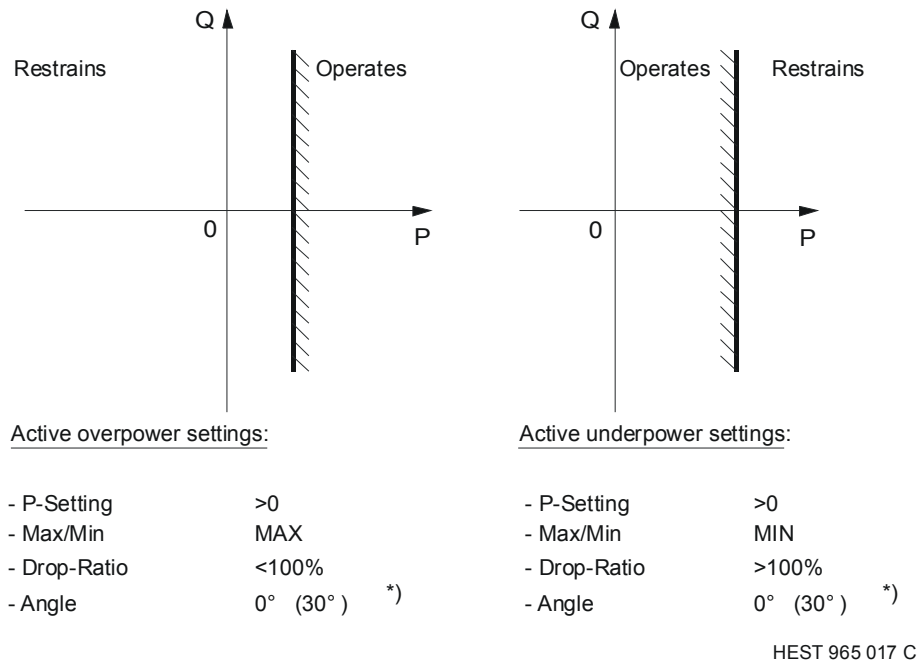
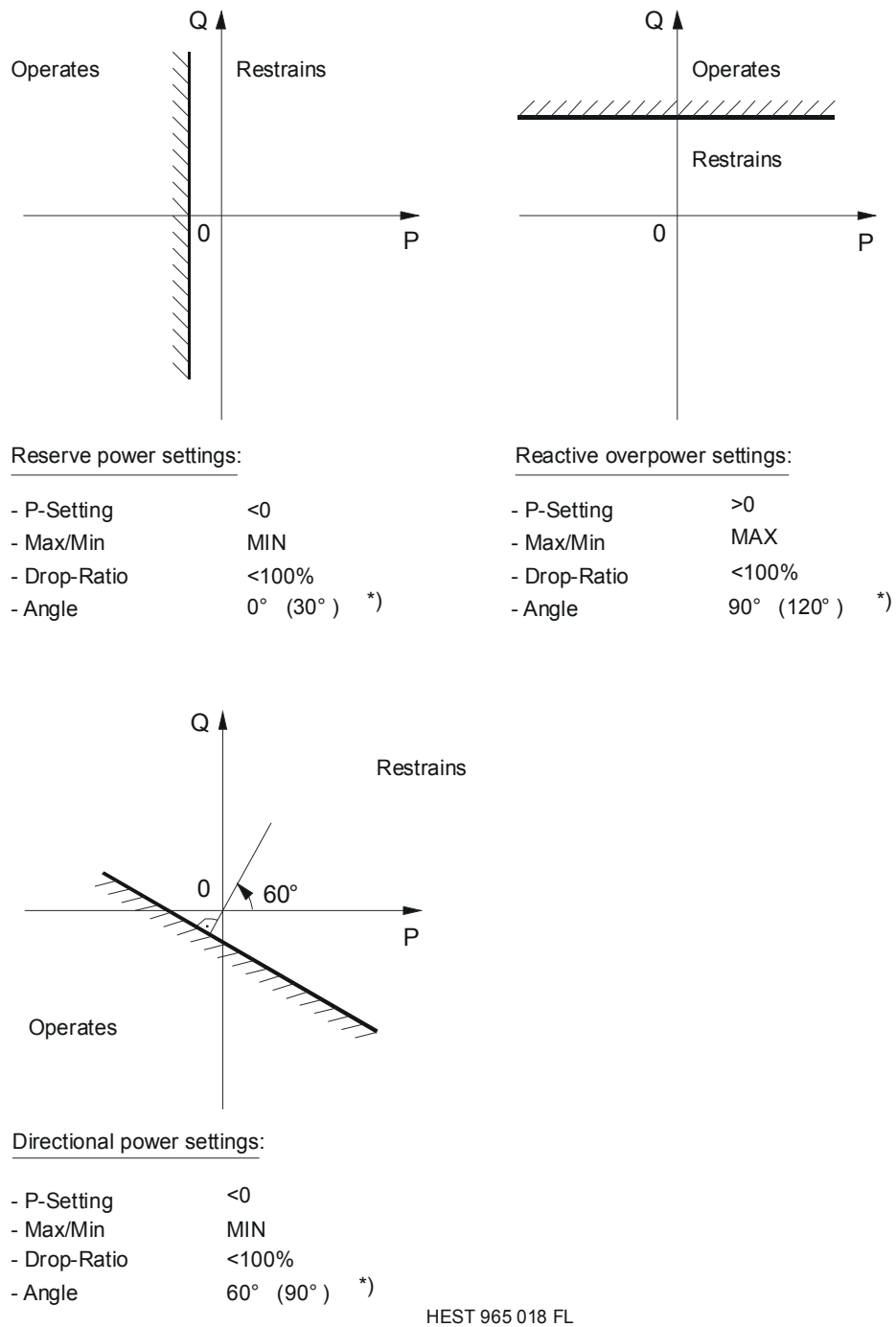


Fig. 3.5.9.2 Power function settings for different applications

*) The values in brackets apply for a single-phase measurement with the v.t. connected phase-to-phase (e.g. I_R current and U_{RS} voltage) or for a three-phase measurement with delta connected v.t.'s.



HEST 965 018 FL

Fig. 3.5.9.3 Power function settings for different applications

*) The values in brackets apply for a single-phase measurement with the v.t. connected phase-to-phase (e.g. I_R current and U_{RS} voltage) or for a three-phase measurement with delta connected v.t.'s.

Determining the settings

Where the rated currents and possibly also rated voltages of c.t.'s, v.t.'s and the protected unit differ, it is of advantage to refer the setting to the rated power of the protected unit. This necessitates modifying the sensitivity using the setting for P_N .

Setting the reference power P_N :

$$\frac{P_N}{U_N \times I_N} = \frac{S_{GN}}{\sqrt{3} \times U_{N1} \times I_{N1}} \quad \begin{aligned} S_{GN} &= \sqrt{3} \times U_{GN} \times I_{GN} \\ P_{GN} &= S_{GN} \times \cos \varphi_{GN} \end{aligned}$$

where:

S_{GN} , P_{GN} , U_{GN} , I_{GN} , $\cos \varphi_{GN}$: ratings of the protected unit

U_{N1} , I_{N1} : primary v.t. and c.t. ratings

P_N , U_N , I_N : protection ratings.

Example 1

Generator: 96 MVA, 13,8 kV, 4 kA, $\cos \varphi = 0,8$

V.t's/c.t's: $\frac{14.4}{\sqrt{3}} \text{ kV} / \frac{100}{\sqrt{3}} \text{ V}; \quad 5 \text{ kA} / 5 \text{ A}$

Protection: 100 V; 5 A

Reverse power: 0.5 % P_{GN}

Alternative 1: No modification of P_N

Settings:

Reference power $\frac{P_N}{U_N \times I_N} = 1.0$

Reverse power:

$$\frac{P}{P_N} = 0.005 \frac{U_{GN} \times I_{GN}}{U_{N1} \times I_{N1}} \cos \varphi_{GN} = 0.005 \frac{13.8 \times 4}{14.4 \times 5} 0.8 = 0.003$$

Alternative 2: Modification for $\cos\varphi_{GN}$

Settings:

$$\text{Reference power } \frac{P_N}{U_N \times I_N} = \frac{P_{GN}}{S_{GN}} = \cos \varphi_{GN} = 0.8$$

$$\text{Reverse power: } \frac{P}{P_N} = 0.005 \frac{U_{GN} \times I_{GN}}{U_{N1} \times I_{N1}} = 0.005 \frac{13.8 \times 4}{14.4 \times 5} = 0.004$$

Alternative 3: Modification for φ_{GN} and c.t./v.t.. data

Settings:

Rated power

$$\frac{P_N}{U_N I_N} = \frac{U_{GN} \times I_{GN}}{U_{N1} \times I_{N1}} \cos \varphi_{GN} = \frac{13.8 \times 4}{14.4 \times 5} \times 0.8 = 0.614$$

$$\text{Reverse power } \frac{P}{P_N} = 0.005$$

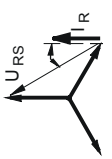
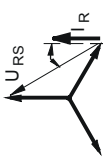
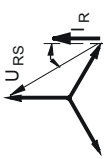
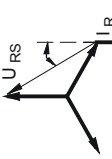
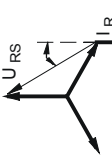
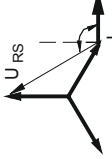
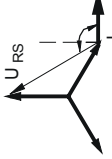
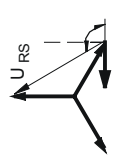
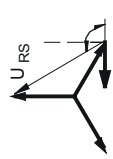
Characteristic angle

The power function is connected to the phase currents and a phase-to-neutral or phase-to-phase voltage. The purpose of the phase compensation is twofold:

- to compensate the phase difference between the phase voltage and the any measured phase-to-phase voltage
- to determine whether the function responds to active or re-active power.

The following table summarises the most important operating modes to simplify setting the corresponding parameters correctly. The angles given apply for connection according to the connections in [Index 12](#).

The phase compensation also provides facility for changing the direction of measurement or to compensate incorrect v.t. or c.t. polarity.

Function	"MaxMin"	"Drop-Ratio"			"P-Setting"	"Angle" *)
Active power	max	MAX	< 100%			+30°
	min	MIN	> 100%			+30°
Reverse power	max	MIN	< 100%			+30°
	min	MAX	> 100%			+30°
Inductive reactive power	max	MAX	< 100%			+120°
	min	MIN	> 100%			+120°
Capacitive reactive power	max	MIN	< 100%			+120°
	min	MAX	> 100%			+120°

*) Applicable for a single or three-phase measurement using phase-to-phase voltages (the setting is 30° less for a three-phase measurement with Y connected v.t's or a two-phase measurement with V connected v.t's).

HES 965 019 C

Fig. 3.5.9.4 Settings different applications when measuring phase R current in relation to the phase-to-phase voltage U_{RS}

Phase compensation

This setting is for correcting the phase error between the v.t.'s and c.t.'s, which have a considerable adverse influence on the measurement of active power at low power factors.

Example 2

The active power error at rated current and a power factor of $\cos\varphi = 0$ for a total phase error δ of 10' is

$$\Delta P = 0.03 \times \delta = 0.03 \times 10 = 0.3\% \quad [\%; 1; \text{min}]$$

This is an error which is not negligible at a setting of 0.5%.

The total error corresponds to the difference between the v.t. and c.t. errors. The case considered in this example of full reactive current (100%) would scarcely occur in practice, but currents from about 80% are possible.

Application as reverse power protection

The reverse power function is used primarily to protect the prime mover. It is necessary for the following kinds of prime mover:

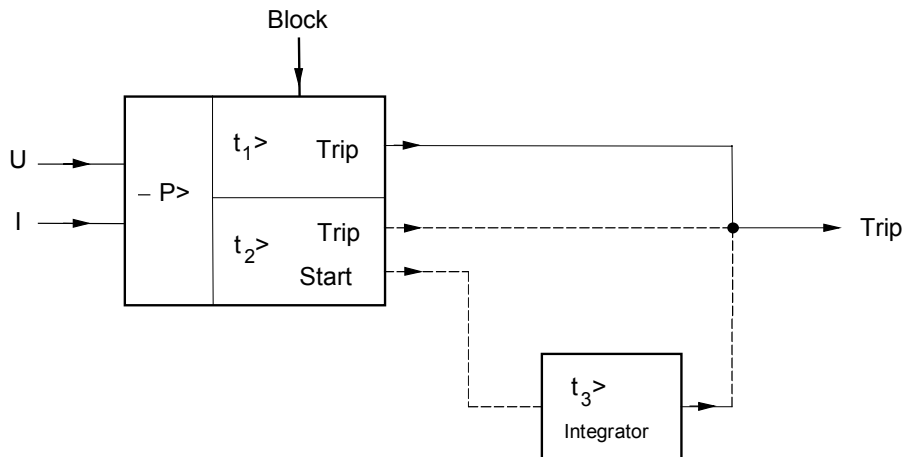
- steam turbines
- Francis and Kaplan hydro units
- gas turbines
- diesel motors.

Two reverse power functions are used for prime movers with ratings higher than 30 MW, because of their importance and value.

The reverse power function has two stages. The setting is half the slip power of the generator/prime mover unit and is the same for both stages.

The first stage has a short time delay and is intended to protect against overspeeding during the normal shutdown procedure. By tripping the main circuit-breaker via the reverse power function, the possibility of overspeeding due to a regulator failure or leaking steam valves is avoided. To prevent false tripping in the case of steam turbines, the reverse power function is enabled by auxiliary contacts on the main steam valves of the prime mover.

The purpose of the second stage is to guard against excessively high temperature and possible mechanical damage to the prime mover. The time delay can be longer in this case, because the temperature only increases slowly. Should power swings occur at low load due to the speed regulator or system instability, the second stage will not be able to trip, because the function repeatedly picks up and resets before the time delay can expire. It is for just such cases that the integrator (“Delay” function) is needed to ensure reliable tripping.



- t_1 fast stage interlocked with the main turbine steam valve
- t_2 slow stage
- t_3 slow stage with an integrator where power swings are to be expected

Fig. 3.5.9.5 Reverse power protection for steam turbines

Typical settings:

PN	determined by the generator $\cos\phi_{GN}$	
P-Setting	(steam turbines of medium power)	- 0.005
MaxMin		MIN
Drop-Ratio		60 %
Angle	connection to I_R and U_R	0°
	connection to I_R and U_{RS}	+30°
	connection to I_R and U_{ST}	-90°
	connection to I_R and U_{TR}	+150°
Phi-Comp		0.0
Stage 1:		
Delay		0.5 s
Stage 2:		
Delay		20 s
or		
Integrator ("Delay" function) for delay on operation and reset		
Trip time		20 s
Reset time		3 s
Integration		1

Note:

The following must be set for a "Minimum forward power" scheme according to Anglo-Saxon practice:

P-Setting	>0
MaxMin	MIN
Drop-Ratio	150%

3.5.10. *Overtemperature protection (Overtemp.)*

A. Application

Overtemperature protection with accurate thermal image of the protected unit.

B. Features

- 1st. order thermal model
- alarm and tripping stages
- adjustable initial temperature
- DC component filter
- harmonic filter
- single or three-phase current measurement
- maximum value detection for three-phase measurement
- temperature rise calculated 40 times for each thermal time constant setting.

C. Inputs and outputs

I. C.t./v.t. inputs

- Current

II. Binary inputs

- Blocking

III. Binary outputs

- Alarm
- Tripping

IV. Measurements

- Temperature rise
- Power dissipation
- Current.

D. Overtemperature protection settings - Overtemp.

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Theta-Begin	%	100	000	100	001
Theta-Warn	%	105	050	200	001
Theta-Trip	%	110	050	200	001
NrOfPhases		1	1	3	2
CurrentInp	CT/VT-Addr	0			
IB-Setting	IN	1.00	0.50	2.50	0.01
BlockInp	BinaryAddr	F			
Warning	SignalAddr	ER			
Trip	SignalAddr	ER			
TimeConstant	min	005.0	002.0	500.0	000.1

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Tripping logic (matrix) for this function.

Theta-Begin

Initial temperature rise. This temperature rise is set every time the function is initiated, e.g. when the protection is switched on or settings are changed.

Theta-Warn

Temperature rise at which alarm is given.

Theta-Trip

Temperature rise at which tripping takes place.

NrOfPhases

No. of phase currents measured.

CurrentInp

defines c.t. input channel.

All the current channels are available for selection. In the case of a three-phase measurement, the first channel (R phase) of the group of three must be selected.

IB-Setting

Reference current: Normal operating current of the protected unit referred to the rated current of the protection.

BlockInp

I/P for blocking the function

F: - not blocked

T: - blocked

xx: - all binary I/P's (or O/P's of protection functions).

Warning

Alarm signal.

Trip

Tripping signal.

TimeConstant

Thermal time constant for calculating the temperature rise.

Settings < 2 minutes are not permitted.

E. Setting instructions

Settings:

Initial temperature rise	Theta-Begin
Temperature rise for alarm	Theta-Warn
Temperature rise for tripping	Theta-Trip
No. of phase currents measured	NrOfPhases
Reference current	IB-Setting
Thermal time constant	TimeConstant

The overtemperature function guards against inadmissible temperature rise caused by overcurrents. The temperature rise is modelled on the basis of the influence of the current flowing through the protected unit on a thermal image of the protected unit. In contrast to the overload protection, this function can protect units of any power rating and thermal capacity. It monitors the temperature rise and not the absolute temperature. It takes account therefore neither of the ambient temperature nor the effectiveness of a cooling system.

The protection operates with a thermal image of the temperature rise. A current change causes the temperature of the protected unit to rise from an initial value to a final value according to one or several exponential functions. The various influences on the temperature rise are the thermal response of, for example in the case of a power transformer, the cooling water, the oil, the windings etc. One exponential function such as that of the transformer oil is always more dominant than the others. The thermal image used in the protection for modelling the transient temperature rise operates according to an exponential function.

The excursion of the temperature rise modelled by the protection is determined by the following:

- the final steady-state temperature corresponding to the current
- the increased temperature rise due to the transfer functions.

The protection assumes that at the rated current I_{GN} of the protected unit, the temperature rise represents 100 %. Neglecting any compensation of the A/D channel or the base current I_B , the protection measures a current I_R determined by the rated current of the c.t's:

$$I_R = I_{GN} \frac{I_{N2}}{I_{N1}}$$

where

I_{GN} : rated current of the protected unit
 I_{N1}, I_{N2} : rated primary and secondary c.t. currents.

The current referred to the rated current I_N of the protection is:

$$i_R = \frac{I_R}{I_N} = \frac{I_{GN}}{I_N} \times \frac{I_{N2}}{I_{N1}}$$

The steady-state temperature rise becomes:

$$\Delta \vartheta_W = \left(\frac{I_{GN}}{I_N} \times \frac{I_{N2}}{I_{N1}} \right)^2 \times 100\%$$

At a constant current, the tripping time is:

$$t = \tau \ln \left(\frac{\vartheta_0 [\%] - 100 \times \left(\frac{I}{I_B} \right)^2}{\vartheta [\%] - 100 \times \left(\frac{I}{I_B} \right)^2} \right)$$

where

ϑ_0 : initial temperature rise
 ϑ : pick-up temperature rise
 τ : thermal time constant.

The variables in the submenu 'DISPLAY OPERATING VALUES' are the calculated temperature rise, the power dissipation and the current. The first two are mean values over the period of calculation ($= \tau / 40$).

The values shown in the event list is the power dissipation at the instant of tripping.

Example:

Rated current of the protected unit	$I_{GN} = 8000 \text{ A}$
C.t. ratings	$I_{N1} = 10000 \text{ A}$
	$I_{N2} = 5 \text{ A}$
Rated relay current	$I_N = 5 \text{ A}$

The temperature rise measured by the protection at a rated current of I_{GN} is:

$$\Delta\vartheta_W = \left(\frac{8000}{5} \times \frac{5}{10000} \right)^2 \times 100\% = 64\%$$

The settings for overtemperatures of 5% and 10% respectively are:

$$\text{Theta-Warn} = 67\%$$

$$\text{Theta-Trip} = 70\%$$

Normally the protection is configured such that the initial temperature rise is 100 % ('Theta-Begin' = 100 %).

With I_B adjusted, the settings become:

$$\text{Base current: } \frac{I_B}{I_N} = \frac{I_{GN}}{I_N} \times \frac{I_{N2}}{I_{N1}} = \frac{8000}{5} \times \frac{5}{10000} = 0.8$$

The settings for alarm and tripping are then:

$$\text{Theta-Warn} = 105\%$$

$$\text{Theta-Trip} = 110\%$$

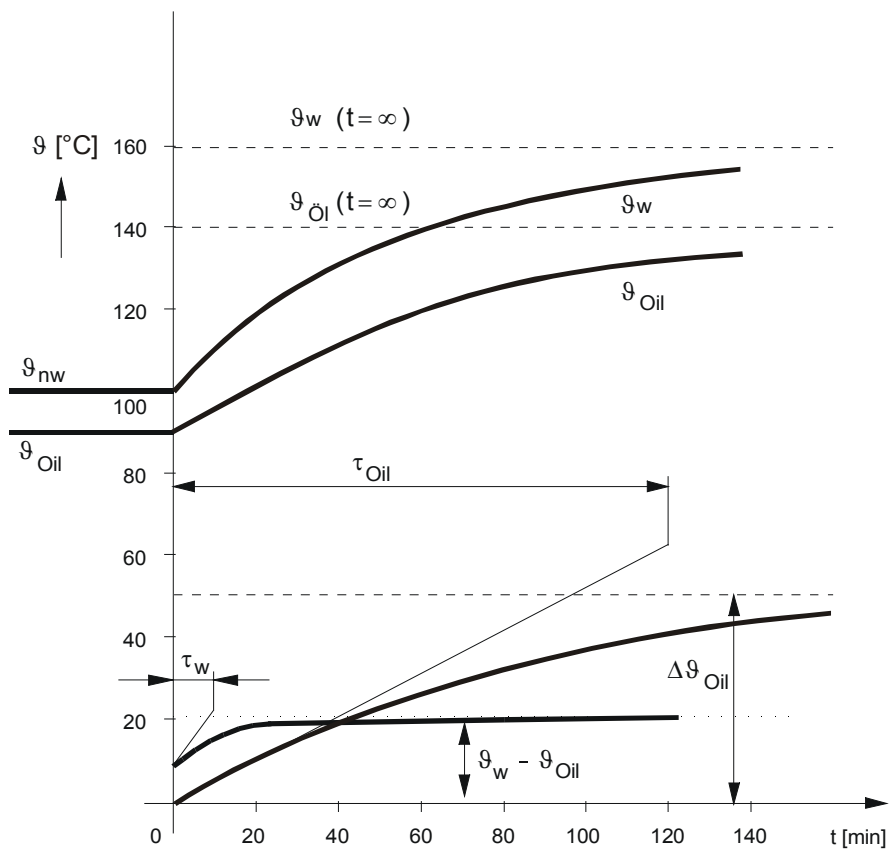
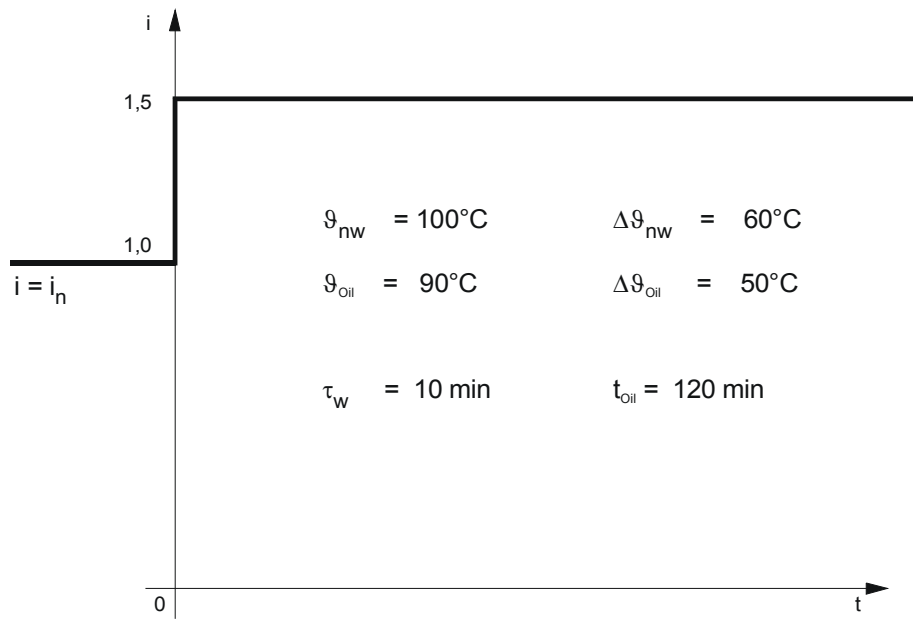
Transformers have two distinct exponential functions, one for the oil and one for the winding. The corresponding mean values are:

$$\text{Oil} \quad : \Delta\vartheta_{oil} = 50 \text{ K} \quad \tau_{oil} = 120 \text{ min}$$

$$\text{Winding} \quad : \Delta\vartheta_W - \Delta\vartheta_{oil} = 10 \text{ K} \quad \tau_W = 10 \text{ min}$$

The total temperature rise of the winding is thus $\Delta\vartheta_W = 60 \text{ K}$.

Since however the model operates with just a single exponential function, its temperature rise has to follow the best possible equivalent exponential function as shown in [Fig. 3.5.10.1](#). The steady-state temperature rise of this equivalent function is identical to the total temperature rise of the winding, i.e. $\Delta\vartheta_W = 60 \text{ K}$ in the example above. Its time constant, however, is typically 60 to 80% of the temperature rise of the oil (see [Fig. 3.5.10.2](#)).



HEST 905 035 C

Fig. 3.5.10.1 Temperature rise of a transformer winding

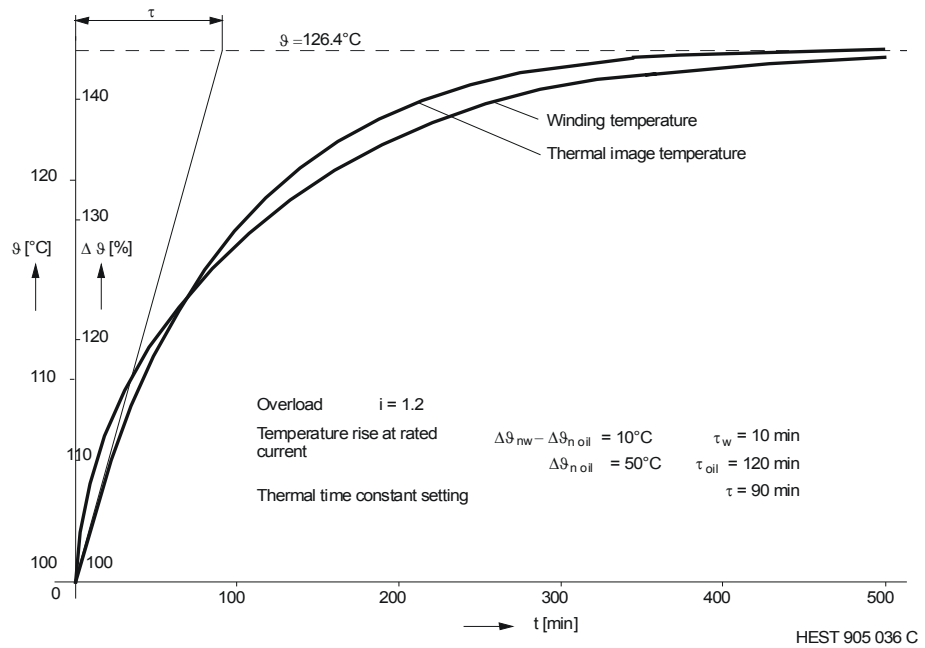


Fig. 3.5.10.2 Actual temperature rise of the winding compared to the temperature rise of the thermal image

Typical settings:

IB-Setting	to be calculated
Theta-Beginn	100%
Theta-Warn	105%
Theta-Trip	110%

3.5.11. Frequency protection (Frequency)**A. Application**

- Under and overfrequency
- Load-shedding.

B. Features

- measurement of one voltage
- frequency calculation based on the complex voltage vector
- insensitive to DC component
- insensitive to harmonics
- undervoltage blocking.

C. Inputs and outputs**I. C.t./v.t. inputs:**

- voltage

II. Binary inputs:

- blocking

III. Binary outputs:

- undervoltage blocking
- start
- trip

IV. Measurements:

- frequency
- voltage.

D. Frequency function settings - Frequency

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Frequency	Hz	48.00	40.00	65.00	0.01
BlockVoltage	UN	0.20	0.20	0.80	0.10
Delay	s	01.00	0.10	60.00	0.01
MaxMin		MIN	(Select)		
VoltageInp	CT/VT-Addr	0			
Blocked (U<)	SignalAddr				
BlockingInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr				

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping relay activated by the tripping output of the function (matrix).

Frequency

Operating value.

Setting restrictions:

- underfrequency not $\geq f_N$
- overfrequency not $\leq f_N$

BlockVoltage

Peak value of the voltage for blocking.

(reset ratio approx. 1.05)

Delay

Time between the function picking up and tripping.

MaxMin

defines operation as overfrequency or underfrequency.

Settings:

- MAX: Overfrequency.
- MIN: Underfrequency.

VoltageInp

defines the voltage input channel.
All voltage inputs may be selected.

Blocked (U<)

defines the output for signalling blocking by undervoltage.
(signal address)

BlockingInp

Binary address used as blocking input.

F: - not blocked

T: - blocked

xx: - all binary inputs (or outputs of protection functions).

Trip

Output for signalling tripping.

Start

Output for signalling pick-up.

E. Setting instructions

There are often several stages of frequency protection using several single-stage relays.

Settings:

Frequency	Frequency
Delay	Delay
Undervoltage blocking	BlockVoltage
Under or over frequency	MaxMin

Frequency protection is used either to protect synchronous machines and prime-movers against the effects of operating at under or overfrequency or for load-shedding in the event of an overload.

The adverse effects in the former case prevented by the frequency protection are:

- excessive temperature rise and additional iron losses in the generator
- damage to the generator and the prime-mover by vibration.

Some synchronous machines are subject to severe vibration if they are operated at speeds other than their rated speed.

Vibration occurs more usual at speeds below rated frequency, but can occur both above and below. A complete scheme often comprises therefore 4 stages, two for alarm and tripping for overfrequency and two for alarm and tripping for underfrequency. Tripping is delayed to avoid the risk of maloperation during transients.

Typical settings:

1. Protection of machines

	1st. stage	2nd. stage	3rd. stage	4th. stage
	Alarm	Tripping	Alarm	Tripping
Frequency (Hz)	51.0	52.0	49.0	48.0
Delay (s)	1.5	3	1.5	3
BlockVoltage	0.6	0.6	0.6	0.6
MaxMin	MAX	MAX	MIN	MIN

Table 3.5.11.1 Typical settings for alarm and tripping stages

2. Load-shedding

	1st. stage	2nd. stage	3rd. stage	4th. stage	5th. stage
	Alarm	Load-shed.	Alarm	Load-shed.	Load-shed.
Frequency (Hz)	49.8	49.0	48.7	48.8	47.5
Delay (s)	0.5	0.0	0.0	0.0	0.0
BlockVoltage	0.6	0.6	0.6	0.6	0.6
MaxMin	MIN	MIN	MIN	MIN	MIN

Table 3.5.11.2 Typical settings for alarm and tripping stages

3.5.12. *Rate-of-change of frequency protection (df/dt)*

A. Application

- Static, dynamic and adaptive load shedding in power utility and industrial distribution systems
- Generator protection.

B. Features

- one phase voltage as input variable
- supervises the rate-of-change df/dt of the frequency
- provision for enabling by absolute frequency
- insensitive to DC component
- insensitive to harmonics and other high-frequency signals
- undervoltage blocking.

C. Inputs and outputs

I. C.t./v.t. inputs

- voltage

II. Binary inputs

- blocking

III. Binary outputs

- blocked by undervoltage
- tripping

IV. Measurements

- rate-of-change of frequency
- absolute frequency
- voltage amplitude.

D. Rate-of-change frequency settings – df/dt

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet4..1		P1	Select		
Trip		00000000			
df/dt	Hz/s	-1.0	-10.0	+10.0	0.1
Frequency	Hz	48.00	00.00	65.00	0.01
BlockVoltage	UN	0.2	0.2	0.8	0.1
Delay	s	00.10	00.10	60.00	0.01
VoltageInp	CT/VT-Addr.	0			
Blocked (U<)	SignalAddr				
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping O/P of the function (matrix tripping logic).

df/dt

Rate-of-change of frequency pick-up setting.

Inadmissible settings:

- $df/dt = 0$
- $df/dt > 0$ for absolute frequency settings $< f_N$
- $df/dt < 0$ for absolute frequency settings $> f_N$.

Frequency

Setting of the absolute frequency enabling criterion.

Operation for overfrequency or underfrequency is determined by the absolute frequency setting:

- Underfrequency for frequency settings $< f_N$
- Overfrequency for frequency settings $> f_N$

The absolute frequency criterion is disabled for a setting of 'Frequency' = 0. In this case, tripping is dependent solely on the rate-of-change setting df/dt .

Inadmissible settings:

- Frequency = f_N
- Frequency $< f_N - 10$ Hz
- Frequency $> f_N + 5$ Hz.

BlockVoltage

Pick-up setting for undervoltage blocking (reset ratio approx. 1.05, reset time approx. 0.1 s).

Delay

Delay from the instant the function picks up to the generation of a tripping command.

VoltageInp

defines the voltage input channel. All voltage inputs may be selected with the exception of the special voltage inputs for the 100% ground stator fault protection.

Blocked (U<)

signals when the function is blocked by the undervoltage criterion.

BlockInp

defines the input for an external blocking signal.

F: - enabled

T: - disabled

xx: - all binary inputs (or outputs of protection functions).

Trip

Output for signalling tripping.

E. Setting instructions

Several rate-of-change of frequency stages are often needed and the additional stages are achieved by configuring the function as many times as is necessary.

Settings:

Rate-of-change of frequency	df/dt
Absolute frequency	Frequency
Undervoltage	BlockVoltage
Delay	Delay

The rate-of-change of frequency function only trips when the rate-of-change is higher than setting, the absolute frequency criterion picks up and the voltage is not lower than the under-voltage setting.

The additional absolute frequency criterion prevents unwanted operation of the rate-of-change function during power system transients. Where it is desired that the rate-of-change function should operate without regard to the absolute frequency, this is achieved by setting the absolute frequency criterion to '0'.

3.5.13. **Auto-reclosure (Autoreclosure)**

A. Application

The function can be configured for single or three-phase auto-reclosure.

The unit can operate in conjunction with any of the three protection functions (distance, longitudinal differential and overcurrent protection) and either an internal or external synchrocheck function.

However, an additional standard FUPLA logic T142 as detailed in the document 1KHF600220 is necessary for single-phase reclosing in 1½ breaker applications.

B. Features

- up to 4 fast or slow reclosure attempts
- first cycle with up to 4 individually configurable single and/or three-phase reclosure attempts
- independent operating indicators for each reclosure cycle
- wide dead time setting range
- provision to control bypassing of the synchrocheck unit and extending the dead time for the first zone by external signals
- clearly defined response to changing fault conditions during the dead time (evolving faults)
- Logic for 1st. and 2nd. main protection (redundant), duplex and master/follower schemes.

C. Inputs and outputs

I. C.t./v.t. inputs

- none

II. Binary inputs

• Start	(Start)	
• Redundant start	(Start 2)	*)
• Redundant start	(Start 3)	*)
• Three-phase trip	(Trip CB 3P)	
• Redundant three-phase trip	(Trip CB2 3P)	*)
• Redundant three-phase trip	(Trip CB3 3P)	*)
• General trip	(Trip CB)	
• Redundant general trip	(Trip CB2)	*)
• Redundant general trip	(Trip CB3)	*)

*) 2 and 3 denote the I/P's of protection functions 2 and 3 or relays 2 and 3 in a redundant protection scheme (see Fig. 3.5.13.4).

• CB ready for open/close/open cycle	(CB ready)	
• CB2 ready for open/close/open cycle	(CB2 ready)	**)
• CB ready for close/open cycle	(CO Ready)	
• CB2 ready for close/open cycle	(CO Ready 2)	**)
• CB open	(CB open)	
• CB2 open	(CB2 open)	**)
• CB2 preferred circuit-breaker	(CB2 Priority)	**)
• Synchrocheck	(SynchroChck)	
• Synchrocheck 2	(SynchroChck2)	**)
• Dead line	(Dead Line)	
• Dead line 2	(Dead Line2)	**)
• External blocking input	(ExtBlkAR)	
• Conditional blocking input	(CondBlkAR)	
• Manual close blocking input	(Manual Close)	
• External synchrocheck bypass	(Ext.SCBypas)	
• External extension of dead time (1st. attempt)	(Extend t1)	
• Delay from master CB	(MasterDel)	
• Block from master CB	(MasterUnsucc)	
• Block reclosure by follower (redundant scheme)	(Inhibit Inp)	
• External 1P-1P selector for 1st. AR	(MD1_EXT_1P_1P)	
• External 1P-3P selector for 1st. AR	(MD1_EXT_1P_3P)	
• External 1P3P-3P selector for 1st. AR	(MD1_EXT_1P3P_3P)	
• External 1P3P-1P3P selector for 1st. AR	(MD1_EX_1P3P_1P3P)	

III. Binary outputs

• CB close signal	(Close CB)	
• CB2 close signal	(Close CB2)	**)
• Overreach switching signal	(ZExtension)	
• Definitive trip	(Def. Trip)	
• Prepare trip of all three phases	(Trip 3-Pol)	
• Block Follower CB	(BlkFlwr)	
• Delay Follower CB	(DelFlwr)	
• Block for Follower. recloser	(Inhibit Outp)	
• Reclosure function ready	(AR Ready)	
• Reclosure function blocked	(AR Blocked)	
• Reclosure cycle running	(AR in prog.)	
• 1st. single-phase reclosure in progress	(First AR 1P)	
• 1st. three-phase reclosure in progress	(First AR 3P)	
• 2nd. Reclosure in progress	(Second AR)	
• 3rd. reclosure in progress	(Third AR)	
• 4th. reclosure in progress	(Fourth AR)	

**) 2 denotes the I/O's for CB2 in a duplex scheme (see Fig. 3.5.13.7).

IV. Measurements

- None.

D. Autoreclosure settings - Autoreclosure

Summary of parameters:

Text	Units	Default	Min.	Max.	Step

GENERAL

ParSet 4..1		P1	(Select)		
1. AR Mode		1P3P-1P3P	(Select)		
2..4. AR Mode		off	(Select)		

TIMERS

t Dead1 1P	s	001.20	0,05	300	0.01
t Dead1 3P	s	000.60	0,05	300	0.01
t Dead1 Ext.	s	001.00	0,05	300	0.01
t Dead2	s	001.20	0,05	300	0.01
t Dead3	s	005.00	0,05	300	0.01
t Dead4	s	060.00	0,05	300	0.01
t Oper	s	000.50	0,05	300	0.01
t Inhibit	s	005.00	0,05	300	0.01
t Close	s	000.25	0,05	300	0.01
t Discrim.1P	s	000.60	0.10	300	0.01
t Discrim.3P	s	000.30	0.10	300	0.01
t Timeout	s	001.00	0,05	300	0.01
t AR Block	s	005.00	0,05	300	0.01

GENERAL BINARY INPUTS

Start	BinaryAddr	off (F)			
Trip CB 3P	BinaryAddr	off (F)			
Trip CB	BinaryAddr	off (F)			
Start 2	BinaryAddr	off (F)			
Trip CB2 3P	BinaryAddr	off (F)			
Trip CB2	BinaryAddr	off (F)			
Start 3	BinaryAddr	off (F)			
Trip CB3 3P	BinaryAddr	off (F)			
Trip CB3	BinaryAddr	off (F)			
CB Ready	BinaryAddr	off (F)			
CO Ready	BinaryAddr	off (F)			
CB Open	BinaryAddr	off (F)			
Dead line	BinaryAddr	off (F)			
Ext. Blk AR	BinaryAddr	off (F)			
Cond.Blk AR	BinaryAddr	off (F)			
Manual Close	BinaryAddr	off (F)			
Inhibit Inp.	BinaryAddr	off (F)			
Extend t1	BinaryAddr	off (F)			
MD1 EXT 1P 1P	BinaryAddr	off (F)			

Text	Units	Default	Min.	Max.	Step
MD1 EXT 1P 3P	BinaryAddr	off (F)			
MD1 EXT 1P3P 3P	BinaryAddr	off (F)			
MD1 EXT 1P3P 1P3P	BinaryAddr	off (F)			

CLOSE COMMAND

Close CB	Trip Chan	00000000			

GENERAL SIGNALS

Close CB	SignalAddr				
Trip 3-Pol	SignalAddr				
Def. Trip	SignalAddr				
AR Ready	SignalAddr				
AR in Prog.	SignalAddr				
AR Blocked	SignalAddr				
First AR 3P	SignalAddr				
First AR 1P	SignalAddr				
Second AR	SignalAddr				
Third AR	SignalAddr				
Fourth AR	SignalAddr				
Inhibit Outp	SignalAddr				

SYNCHROCHECK

SCBypas 1P		off	(Select)		
SCBypas 1P3P		off	(Select)		
Ext.SCBypas	BinaryAddr	off (F)			
SynchroChck	BinaryAddr	off (F)			

ZONE EXTENSION

ZE Prefault		on	(Select)		
ZE 1. AR		off	(Select)		
ZE 2. AR		off	(Select)		
ZE 3. AR		off	(Select)		
ZE 4. AR		off	(Select)		
ZExtension	SignalAddr				

MASTER/FOLLOWER LOGIC

Master mode		off	(Select)		
MasterDelay	BinaryAddr	off (F)			
Mast.noSucc	BinaryAddr	off (F)			
DelayFlwr.	SignalAddr				
Blk.toFlwr.	SignalAddr				

Text	Units	Default	Min.	Max.	Step

DUPLEX LOGIC

CB2 Ready	BinaryAddr	off (F)			
CO Ready 2	BinaryAddr	off (F)			
CB2 open	BinaryAddr	on (T)			
SynchroChck2	BinaryAddr	off (F)			
Dead line 2	BinaryAddr	off (F)			
Close CB2	Trip Chan	00000000			
Close CB2	SignalAddr				
CB2 Priority	BinaryAddr	off (F)			

(ADDITIONAL LOGIC)

P INPUT1	BinaryAddr	off (F)			
:					
P INPUT16	BinaryAddr	off (F)			
TMSEC Timer1	ms	0	0	30000	1
:					
TMSEC Timer8	ms	0	0	30000	1
P OUTPUT1	SignalAddr				
:					
P OUTPUT8	SignalAddr				

Remarks on the signal designations:

The I/O signals specifically for redundant or duplex schemes include the figure '2', respectively '3' in their designations.

The signals belonging to the basic configuration (1 protection function and 1 auto-reclosure function) do not necessarily include the figure '1' in their designations.

Explanations of parameters:**GENERAL****ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

1. AR Mode**Type of first reclosure**

1. 1P-1P	single-phase trip and reclosure for earth faults (single-phase dead time), no reclosure for phase faults
1. 1P-3P	single-phase trip followed by three phase trip after approx. 20 ms, three-phase reclosure for earth faults (three-phase dead time initiated by single-phase trip), no reclosure for -phase faults
1. 1P3P-3P	three-phase trip and reclosure for earth and phase faults (three-phase dead time)
1. 1P3P-1P3P	single-phase trip and reclosure for earth faults (single-phase dead time), three-phase trip and reclosure for phase faults (three-phase dead time)
Ext. Wahl	External selection by the binary inputs MD1_EXT_1P_1P, MD1_EXT_1P_3P, MD1_EXT_1P3P_3P and MD1_EX_1P3P_1P3P.

2..4. AR Mode**Maximum number of reclosure attempts (all three-phase)**

off	no 2nd., 3rd. or 4th. reclosure
2 AR	2 reclosures
3 AR	3 reclosures
4 AR	4 reclosures.

TIMERS**t Dead1 1P**

Dead time for first single-phase reclosure.

t Dead1 3P

Dead time for first three-phase reclosure.

t Dead1 Ext.

Extension of 1st. dead time for single or three-phase reclosure (effective as long as a logical '1' (pulse or continuous) is applied to the 'Extend t1' I/P before the dead time finishes (falling edge.)

t Dead2

2nd. dead time.

t Dead3

3rd. dead time.

t Dead4

4th. dead time.

t Oper

Maximum duration of a fault for which a reclosure attempt is made.

t Inhibit

Period (CB recovery time) from the falling edge of the last reclosure attempt during which the autoreclosure function is blocked and after which the function is reset.

In the event of an evolving fault between discrimination and dead times, the period commences at the instant of another trip occurring between the two times.

The reclaim timer is also started if the protection trips after the fault duration time 't Oper' has elapsed.

t Close

Duration of CB close signal.

t Discrim.1P

Evolving fault discrimination time for single-phase reclosure.

t Discrim.3P

Evolving fault discrimination time for three-phase reclosure.

t Timeout

Period following the dead time during which the CB close signal has to occur. If it does not, the 'Def. Trip' signal is generated.

t AR Block

Time during which reclosure is blocked. 't AR Block' is started by every blocking signal ('Ext.Blk AR', 'Cond.Blk. AR', 'Manual Close', 'Inhibit Inp' and 'MasternoSucc').

GENERAL BINARY INPUTS**Start *)**

I/P for signalling the start of a reclosure cycle.

This I/P is connected to the 'General start' signal of a protection function.

Trip CB 3P *)

I/P for the three-phase trip signal.

The three-phase trip from a protection function is connected to this I/P.

*) For the auto-reclosure function to operate correctly, at least the 'Start' and 'Trip CB 3P' inputs must be connected to a protection function or via a binary system I/P to an external protection relay.

Trip CB

I/P for the general trip signal

The general trip from a protection function is connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Start 2

I/P for the AR start signal.

In redundant protection schemes, the general start signal from the 2nd. protection is connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Trip CB2 3P

I/P for the three-phase trip signal.

In redundant protection schemes, the three-phase tripping signal from the 2nd. protection is connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Trip CB2

I/P for the general trip signal.

In redundant protection schemes, the general start signal from the 2nd. protection is connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Start 3

I/P for the AR start signal.

The general start signal from the 3rd. protection can be connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Trip CB3 3P

I/P for the three-phase trip signal.

The three-phase tripping signal from the 3rd. protection can be connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

Trip CB3

I/P for the general trip signal.

The general start signal from the 3rd. protection can be connected to this I/P.

Set to 'off' ('F' or 'False'), if not needed.

CB Ready

I/P excited by a signal from the CB when it is ready (open/close/open).

Set to 'on' ('T' or 'True'), if not needed or not fitted.

I/P logic: 'CB ready' OR 'CB2 ready'

In a duplex scheme, either an active 'CB ready' or 'CB2 ready' I/P enables an auto-reclosure cycle.

Resetting of this input is delayed internally by 100 ms.

CO Ready

I/P excited by a signal from the CB when it is ready for a close/open cycle.

Set to 'on' ('T' or 'True') if not needed, not fitted and 'Dead line' or 'ExtSCBypas' not used.

I/P logic for enabling the closing command: [('synchrocheck' AND 'CO Ready') OR 'Dead line' OR 'ExtSCBypas'].

CB Open

I/P excited by a signal from the CB when it is open.

Set to 'off' ('F' or 'False'), if not needed.

To avoid the operation of fast circuit-breakers from being blocked unintentionally, the effect of this input is delayed internally by 100 ms.

Dead line

I/P indicating that the line is de-energised ('CB open' input if the v.t.'s are on the busbar side).

Set to 'off' ('F' or 'False'), if not needed.

An active I/P overrides the following logical relationship of the I/P's: 'synchrocheck' AND 'CO Ready'.

Ext. Blk AR

I/P for blocking the internal auto-reclosure function.

Even an autoreclosure cycle that is in progress is immediately blocked by a signal applied to this input.

The output signals 'Trip 3 Pol' and 'Def Trip' are generated and a three-phase definitive trip takes place.

Set to 'off' ('F' or 'False'), if not needed.

Cond. Blk. AR

I/P for a conditional blocking signal.

Blocking only takes place providing an AR cycle is not in progress.

Set to 'off' ('F' or 'False'), if not needed.

When tripping is by the distance protection SOTF logic or a directional E/F PLC signal, the corresponding signals can be connected to this I/P to prevent auto-reclosure.

Manual Close

Blocking I/P excited by the manual CB close signal.

Even an autoreclosure cycle that is in progress is immediately blocked by a signal applied to this input.

Set to 'off' ('F' or 'False'), if not needed.

Inhibit Inp.

I/P for blocking the follower reclosure function in a redundant scheme. The follower is blocked from the end of the master closing signal until the end of the reclaim time.

Set to 'off' ('F' or 'False'), if not needed.

Extend t1

Input for conditionally extending the dead time (single and three-phase) for the first (fast) reclosure.

Set to 'off' ('F' or 'False'), if not needed.

MD1_EXT_1P_1P, MD1_EXT_1P_3P, MD1_EXT_1P3P_3P
and MD1_EX_1P3P_1P3P

Inputs for externally selecting the mode for the first reclosure. They are only effective when the parameter '1. AR Mode' is set to 'Ext. select'.

Unused inputs must be set to 'off' ('F' or 'False'). If a signal is applied to more than one input, the next mode in the list is the one that is active. The auto-reclosure function is blocked if none of the inputs is used.

CLOSE COMMAND**Close CB**

Auxiliary relay O/P for the CB close command.

GENERAL SIGNALS

Close CB

CB close signal.

Trip 3-Pol

Signal to the distance function so that it can only carry out a three-phase trip.

This signal is inverted and connected to the distance protection I/P '1P AR'.

This signal is active in many situations, but particularly when the AR function is blocked, the CB is not ready for AR, the CB is open, the single-phase discrimination time 't 1P Discrim' finishes or the output signal 'First AR 3P' is active.

It resets at the end of reclaim time.

Def. Trip

Signal initiating lock-out tripping of the CB.

This signal is normally active when the protection trips again after the last programmed reclosing shot or trips while the AR function is blocked. The signal resets after a fixed time of 500 ms.

AR Ready

Signal indicating that the AR function is ready for a reclosure cycle. This signal is active when the AR function is ON and standing by and also during the closing command.

AR in Prog.

Signal indicating that a reclosure cycle is in progress.

This signal is active from the beginning of the dead time until the end of the last reclosure attempt.

AR Blocked

Signal indicating that the auto-reclosure relay is blocked.

First AR 3P

Signal indicating that the 1st. three-phase reclosure attempt is in progress.

First AR 1P

Signal indicating that the 1st. single-phase reclosure attempt is in progress.

Second AR

Signal indicating that the 2nd. reclosure attempt is in progress (always three-phase).

Third AR

Signal indicating that the 3rd. reclosure attempt is in progress (always three-phase).

Fourth AR

Signal indicating that the 4th. reclosure attempt is in progress (always three-phase).

Inhibit Outp

Signal for blocking the follower AR function in a redundant scheme.

This signal is active from the end of the close command from the master AR function to the end of the reclaim time.

SYNCHROCHECK BYPASS SETTINGS**SCBypas 1P**

Bypass of the synchrocheck and close/open ready signals for the first single-phase reclosure:

- 'on' First single-phase reclosure not enabled by synchrocheck and close/open ready signals (bypass always active).
- 'off' First single-phase reclosure enabled by the synchrocheck and close/open ready signals (bypass inactive).

SCBypas 1P3P

Bypass of the synchrocheck and close/open ready signals for the first single or three-phase reclosure:

- 'on' First reclosure not enabled by synchrocheck and close/open ready signals (bypass always active).
- 'off' First reclosure enabled by synchrocheck and close/open ready signals (bypass inactive).

Ext.SCBypas

Bypasses the 'synchroChck' and 'CO Ready' signals.

Set to 'off' ('F' or 'False'), if not needed.

I/P logic for enabling the close command: [('synchrocheck' AND 'CO Ready') OR 'Dead line' OR 'Ext.SCBypas'].

I/P logic for enabling the close command: [('synchroChk2' AND 'CO Ready 2') OR 'Dead line' OR 'Ext.SCBypas'].

SynchroChck

I/P for a signal from a synchrocheck relay.

Set to 'on' ('T' or 'True'), if not needed, not fitted and 'Dead line' or 'ExtSCBypas' not used.

I/P logic: [('synchrocheck' AND 'CO Ready') OR 'Dead line' OR 'Ext.SCBypas'].

ZONE EXTENSION

To achieve the functions described below, the 'ZExtension' signal must be connected to the distance protection function (see [Section 3.5.13.2.](#)).

This signal can be used to initiate fast tripping in schemes including overcurrent functions (see [Section 3.5.13.3.](#)).

ZE Prefault

Distance relay reach setting before the first fault:

'on'	overreaching ('ZExtension' signal active)
'off'	underreaching ('ZExtension' signal inactive).

ZE 1. AR

Distance relay reach after the 1st. reclosure attempt:

'on'	overreaching ('ZExtension' signal active)
'off'	underreaching ('ZExtension' signal inactive).

ZE 2. AR

Distance relay's reach after the 2nd. reclosure attempt:

'on'	overreaching ('ZExtension' signal active)
'off'	underreaching ('ZExtension' signal inactive).

ZE 3. AR

Distance relay's reach after the 3rd.. reclosure attempt:

'on'	overreaching ('ZExtension' signal active)
'off'	underreaching ('ZExtension' signal inactive).

ZE 4. AR

Distance relay's reach after the 4th. reclosure attempt:

'on'	overreaching ('ZExtension' signal active)
'off'	underreaching ('ZExtension' signal inactive).

ZExtension

Signal to the distance function to switch it to overreach or enable an overcurrent function with a short delay.

MASTER/FOLLOWER LOGIC

Master Mode

(for 1½ breaker and redundant schemes)

Selection of an auto-reclosure function to be "Master":

'on'	Master O/P signals transmitted.
'off'	Master O/P's blocked.

MasterDelay

I/P for a signal delaying the closing command from the follower reclosure function.

This signal picks up when the dead time of the master reclosure function starts and is reset either by a new trip after the last reclosure of the cycle or at the end of the wait time following successful reclosure by the master.

Set to 'off' ('F' or 'False'), if not needed.

Mast.noSucc

I/P for a blocking signal from the master CB.

This signal is triggered by the rising edge of the 'Def.Trip' output from the master reclosure function and resets after a fixed time of 500 ms.

Set to 'off' ('F' or 'False'), if not needed.

DelayFlwr.

Signal to delay the follower CB for as long as the master circuit-breaker has not completed its auto-reclosure cycle.

The signal picks up at the start of master AR dead time and is reset either by the rising edge of the 'Def.Trip' output or the falling edge of the 'Close CB' output after the time 'tClose'.

Blk.toFlwr

Signal to block the follower CB as long as reclosure of the master CB is unsuccessful.

The excursion of this signal is the same as for the 'Def.Trip' output.

DUPLEX LOGIC**CB2 Ready**

I/P excited by a signal from CB2 when it is ready (open/close/open).

Set to 'off' ('F' or 'False'), if not needed or not fitted.

I/P logic: 'CB ready' OR 'CB2 ready'

In a duplex scheme, the auto-reclosure cycle is enabled either by an active 'CB ready' or 'CB2 ready' I/P.

Resetting of this input is delayed internally by 100 ms.

CO Ready 2

I/P excited by a signal from CB2 when it is ready for a close/open operation.

Set to 'on' ('T' or 'True'), if not needed, not fitted and 'Dead line 2' is not used.

I/P logic for enabling the close command: [('synchrocheck2' AND 'CO Ready 2') OR 'Dead line 2' OR 'ExtSCBypas'].

CB2 open

I/P excited by a signal from CB2 when it is open.

Set to 'on' ('T' or 'True'), if not needed. Observe the information given for the duplex logic in a duplex scheme ([see Section 3.5.13.5.](#)).

SynchroChck2

I/P for a signal from a synchrocheck function belonging to CB2.

Set to 'on' ('T' or 'True'), if not needed, not fitted and 'Dead line 2' or 'ExtSCBypas' not used.

I/P logic for enabling the close command: [('synchrocheck2' AND 'CO Ready 2') OR 'Dead line 2' OR 'ExtSCBypas'].

Dead line 2

I/P indicating that line 2 is de-energised (CB2 open and v.t's 2 on the busbar side).

Set to 'off' ('F' or 'False'), if not needed.

An active I/P overrides the following logical relationship of the I/P's: 'synchrocheck 2' AND 'CO Ready 2'.

Close CB2

Tripping relay O/P for the CB2 close command.

Close CB2

Auxiliary relay O/P for the CB2 close signal.

CB2 Priority

Input for determining the preferred circuit-breaker:

'off' ('F' or 'False')	CB1 is preferred circuit-breaker
'on' ('T' or 'True')	CB2 is preferred circuit-breaker.

If both circuit-breakers are closed before a fault, only the preferred circuit-breaker performs the entire auto-reclosure cycle. The other circuit-breaker closes either after successful

auto-reclosure or when the close command to the preferred circuit-breaker is not enabled (missing 'CO Ready' or 'Synchro-check').

(ADDITIONAL LOGIC)

The following settings are only of consequence if a special auto-reclosure logic is installed. In this case, consult the associated description for the significance of the various settings.

P_INPUT1, P_INPUT2...P_INPUT16

Additional binary input for a special auto-reclosure logic.

TMSEC_Timer1, TMSEC_Timer2...TMSEC_Timer8

Additional timer settings for a special auto-reclosure logic.

P_OUTPUT1, P_OUTPUT2...P_OUTPUT8

Additional signals for a special auto-reclosure logic.

PROJECT DIRECTORY

The user can choose the subdirectory in which to store the auto-reclosure logic. The default name "AURESTD" applies when using the standard logic in the MMI directory.

It is necessary to change the name and path when using a special logic. In this case, consult the associated description for the procedure.

E. Setting instructions

3.5.13.1. *General*

The auto-reclosure function can perform from 1 to 4 auto-reclosure attempts. The first attempt can be either single or three-phase while the subsequent attempts are always three-phase. The type and number are determined by the parameters '1. AR Mode' (4 different modes for the 1st. reclosure cycle) and '2..4 AR Mode'.

The function can operate in conjunction with either an external distance protection relay or other internal protection functions.

It can also operate in a scheme comprising two or more protection functions (see Sections 3.5.13.2. to [3.5.13.5.](#)).

3.5.13.2. *Connections between auto-reclosure and distance functions*

The auto-reclosure function determines from the states of the input signals 'start', 'Trip CB' and 'Trip CB 3P', whether the distance protection has picked up and whether it has performed a single or a three-phase trip. Only the 'Trip CB' signal is generated for a single-phase trip, whereas both the 'Trip CB' and 'Trip CB 3P' signals are generated for a three-phase trip.

The external distance relay or internal distance function decides whether single or three-phase tripping should take place.

The auto-reclosure function can send two signals to the distance protection. The 'Trip 3-Pol' signal informs the distance protection whether it should perform a single or a three-phase trip. The 'ZExtension' signal switches the distance protection's overreaching zone on and off.

When setting the parameters, attention should be paid to the order of the functions. For runtime reasons, the distance function should be configured before the auto-reclosure function.

Where the SOTF logic is not required to operate during auto-reclosure, connect the 'AR in prog.' Signal to the 'ExtBlkSOTF' binary I/P of the distance function. The 'SOTF 10 s' timer in the distance function's SOTF logic is normally activated for dead times <10 s and in this case the above connection is not necessary.

If the SOTF logic initiates tripping, an auto-reclosure cycle can be inhibited by connecting the 'start SOTF' from the distance function to the 'CondBlkAR' I/P of the auto-reclosure function.

The exchange of signals in the various schemes (one distance and one auto-reclosure function, and several protection functions and one reclosure function) can be seen from Fig. 3.5.13.1, Fig. 3.5.13.2 and Fig. 3.5.13.5.

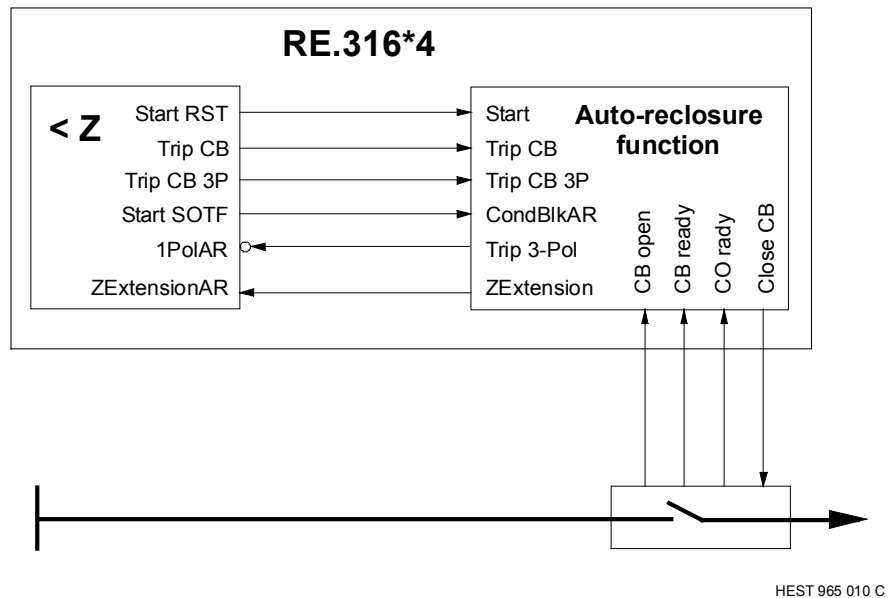


Fig. 3.5.13.1 Distance and auto-reclosure functions in the same unit

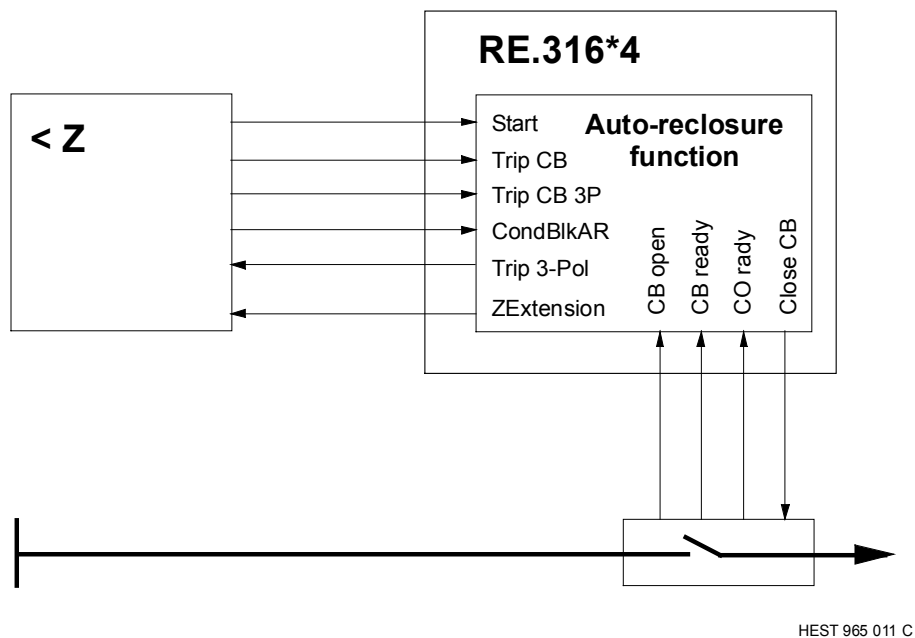


Fig. 3.5.13.2 Distance protection and auto-reclosure functions in different units

3.5.13.3. **Connections between auto-reclosure and overcurrent or differential functions**

- a) When setting the parameters, attention should be paid to the order of the functions. For run-time reasons, the overcurrent function should be configured before the auto-reclosure function.

To prevent the discrimination timer from operating, connect the overcurrent 'Trip' signal to the two inputs 'Start' and 'Trip CB 3P' of the auto-reclosure function.

The time 't Close' must be set longer than the maximum operating time of the activated (graded) overcurrent functions to prevent the reclaim time from blocking the AR function in the event of a permanent fault:

$$t_{\text{Close from AR function}} > t_{\text{max. overcurrent time delay}}$$

In cases where the zone extension signal is used in conjunction with overcurrent functions (see zone extension settings), the terms 'overreach' and 'underreach' have the following meanings:

- 'overreach': enabling of an overcurrent function having a short (non-graded) time delay.
- 'underreach' : enabling of an overcurrent function having a long (graded) time delay.

The exchange of signals in conjunction with O/C functions is shown in [Fig. 3.5.13.3](#).

- b) If only three-phase trip and reclosure operation is required in conjunction with a differential current function, connect the differential function trip output to the 'Start' and 'Trip CB 3P' inputs of the reclosure function.

The additional FUPLA logic T129 is required for single-phase trip and reclosure.

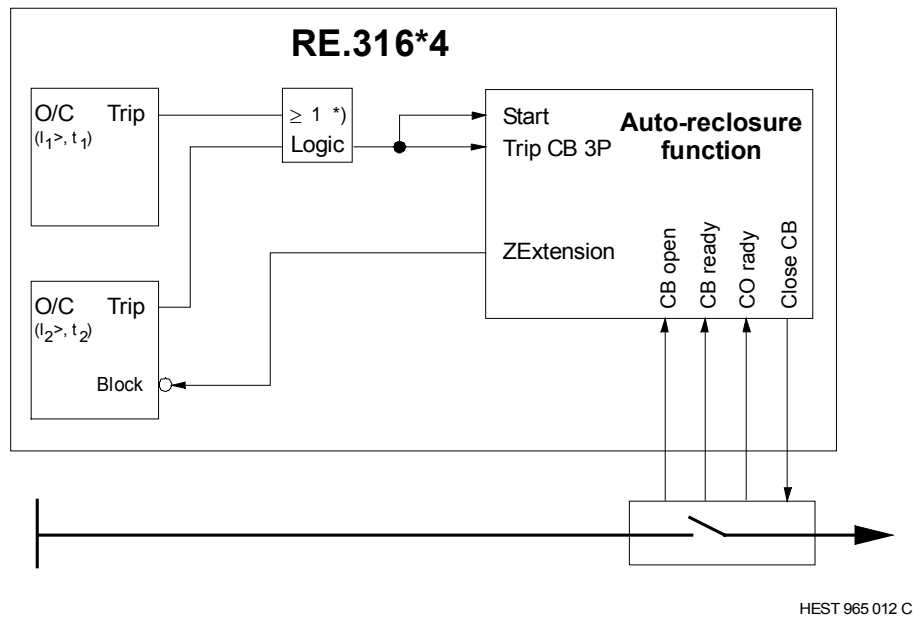


Fig. 3.5.13.3 Overcurrent and auto-reclosure functions in the same unit

where:

t_1 standard delay (0.5 ... 1.5 s)

t_2 short delay (0.02 ... 0.2 s)

$I_1 >$, $I_2 >$ pick-up value 'I set' for 'Trip'.

*) The 'Trip' signal from the second current function may be connected to the inputs 'Start 2' and 'Trip CB2 3P' instead of to the logic function.

3.5.13.4. Redundant schemes

Provision is made for coordinating the operation of two protection functions and one or two auto-reclosure functions per line terminal (see Fig. 3.5.13.4 and Fig. 3.5.13.5).

A master/follower logic has to be used to avoid any time-race problems due to differing timer tolerances.

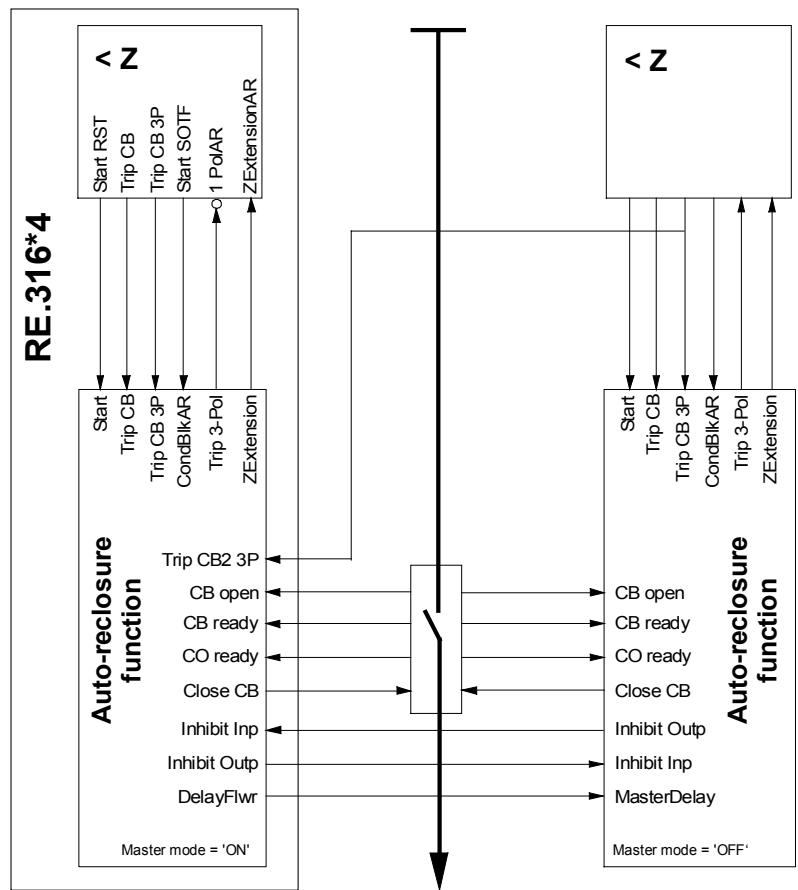
A redundant scheme assumes first and second main protection schemes each with its own reclosure function. The operation of the reclosure functions therefore has to be coordinated by configuring one as 'master' and the other as 'follower'. If the master AR starts first, it delays the operation of the follower AR until it has either achieved successful reclosure or otherwise.

If the follower AR is enabled first, its dead time starts to run, but should the master start during the follow's dead time, operation of the follower reclosure function is suspended and the master takes over and performs its reclosure cycle.

The follower is on "hot standby" and only takes over, if the master AR or its protection function fails to operate.

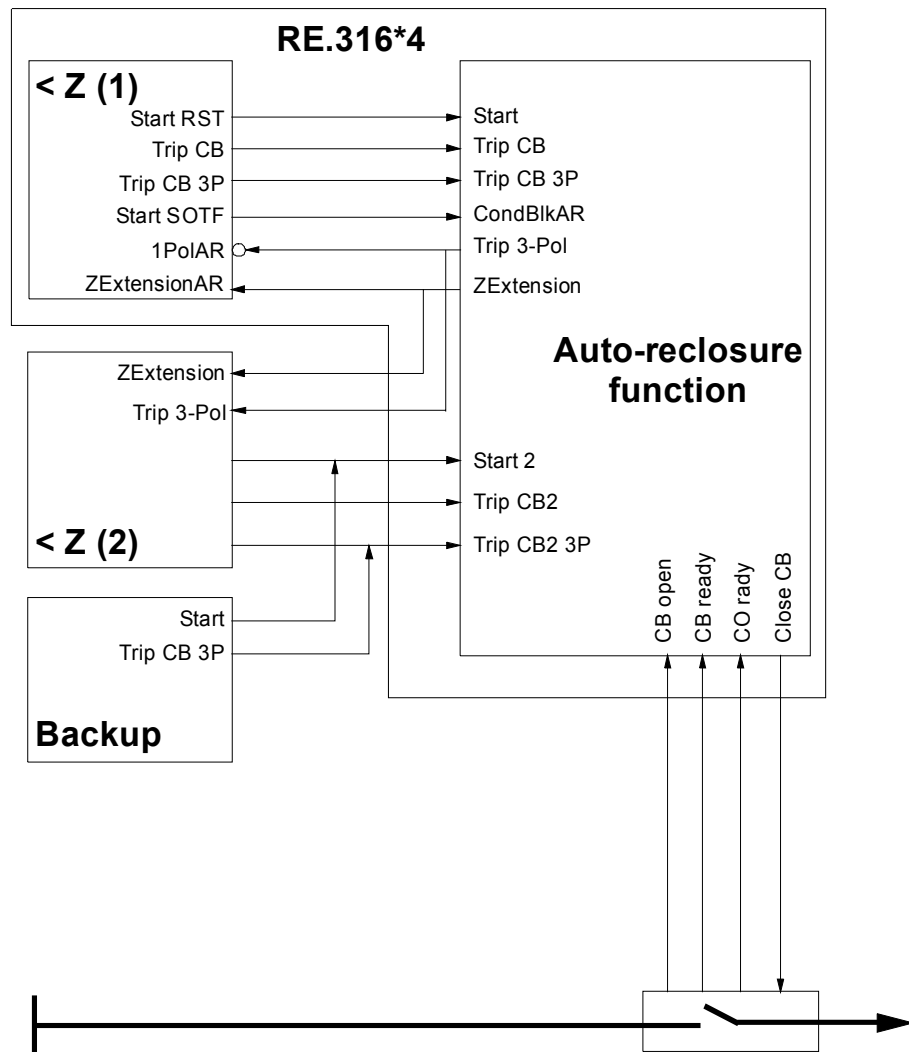
The signal from a faulty contact like 'CO Ready' to the master recloser, however, would result in a 'Def.Trip' output after the time 't Timeout' and this would also block the Follower AR.

In the circuit of Fig. 3.5.13.4, the master and follower functions can also be the other way round by appropriately configuring the system software.



HEST 965 013 C

Fig. 3.5.13.4 Redundant scheme (first and second main < Z and auto-reclosure functions) with master/follower logic



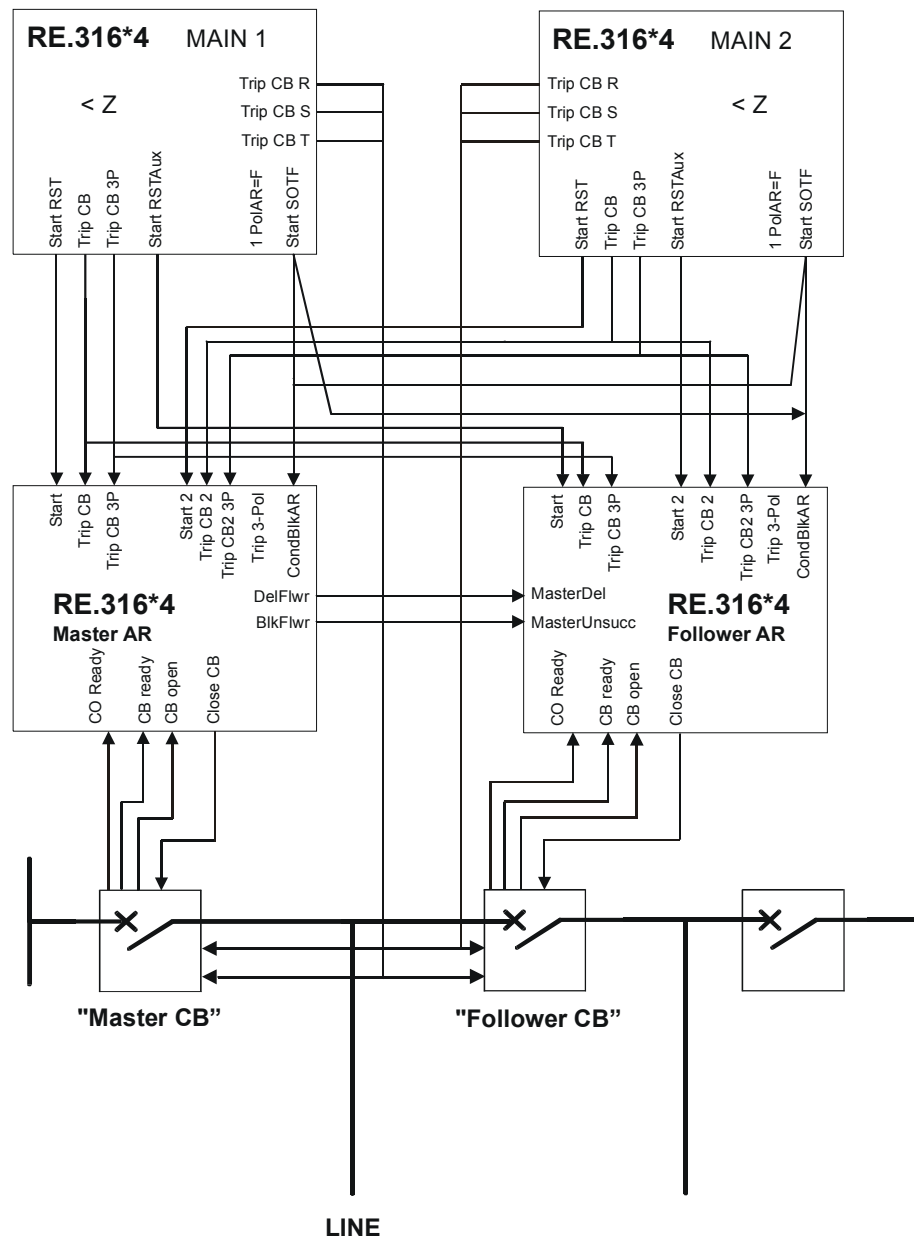
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Fig. 3.5.13.5 Several protection functions and a common auto-reclosure unit

3.5.13.5. Master/follower logic

Provision is made for a master/follower logic in 1½ breaker schemes with two line protections per line and an auto-reclosure function per circuit-breaker.

One of the reclosure functions is assigned the role of master by appropriately setting the parameter 'Master mode'. After a successful reclosure, the master AR then enables the follower AR, respectively its CB (the connections are as given in Fig. 3.5.13.6 for a three-phase trip and reclosure for all types of faults).



HEST 005 002 C

Fig. 3.5.13.6 Earth and phase fault master/follower scheme for AR mode 1P3P-3P

Note: A second line on the diameter (1½ breaker scheme) requires additional connections and logic.

Follower CB delay 'DelayFlwr'

The master reclosure function sends an active 'DelFlwr' signal to the 'MasterDelay' I/P of the follower to delay its 'Close CB' command to the follower CB until the master reclosure function issues the 'Close CB' command, which is followed by a wait time of 300 ms as a precaution to allow time for a successful reclosure. If the reclosure is unsuccessful, the output remains high until the signal 'Def.Trip' is activated (the 'DelayFlwr' signal resets and 'Blk to Flwr' signal is generated).

Should this signal reset before the end of the follower dead time, the close command to the follower CB is issued at the end of the dead time.

Blocking reclosure by the follower 'Blk.toFlwr'

The master reclosure function sends an active 'Blk.toFlwr' signal to the follower 'Mast.noSucc' I/P to block reclosure by the follower, if the reclosure attempt by the master was unsuccessful as indicated by the generation of its 'Def.Trip' output.

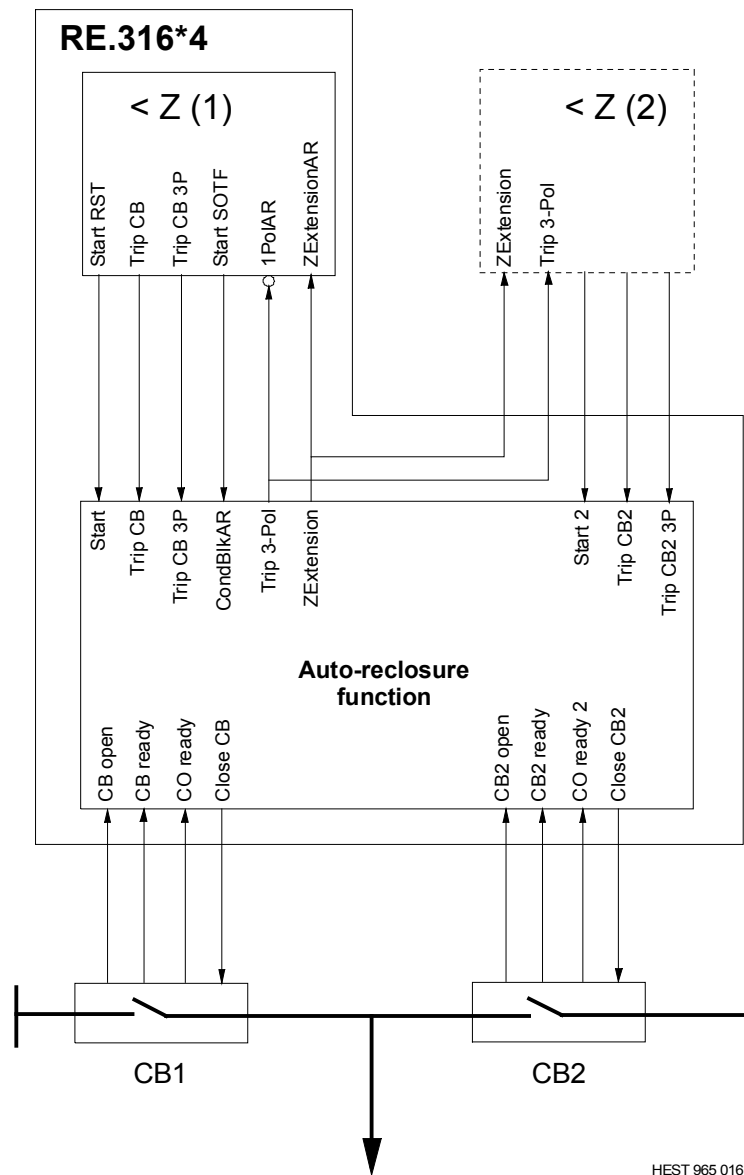
3.5.13.6. Duplex logic

A duplex logic for a line with two circuit-breakers is also included (see [Fig. 3.5.13.7](#)).

Observe the following in connection with a duplex scheme:

Note: One of the breakers has to be set to low priority.

- For the scheme to operate correctly, the corresponding CB signals must be connected to the 'CB open' and 'CB2 open' inputs for the duplex logic (setting to 'off' disables the duplex logic). Follow the procedure below, if separate 'CB ready' and 'CB open' signals are not available from the circuit-breakers:
 - Connect the two circuit-breaker signalling contacts 'CB ready' (air-pressure or spring charging) and 'CB closed' in series. For this, 't Close' must be set longer than the maximum spring charging time to suppress the definitive trip signal in the case of a successful reclosure.
 - Assign the combined signals to the corresponding 'CB ready' inputs.
 - Assign the same signals but inverted to the corresponding 'CB open' inputs.

Fig. 3.5.13.7 Duplex scheme ($< Z$ can be redundant)

3.5.13.7. Timers

The timers have setting ranges extending up to 300 s in steps of 10 ms.

The purpose of each of the timers is described below.

Dead times 't Dead1 1P' to 't Dead 4'

Provided the trip signal is issued before 't Oper' elapses, the dead time is the period between the tripping signal ('Trip CB') and the close signal ('Close CB').

The required dead time must be entered separately for each reclosure cycle. This necessitates setting the following parameters: 't Dead1 1P', 't Dead1 3P', 't Dead 2', 't Dead 3' and 't Dead 4'.

Provision is made for externally switching the dead times 't Dead1 1P' and 't Dead1 3P' for the first (fast) reclosure attempt to a second setting. The corresponding additional time period can be set with the aid of the parameter 't Dead 1 Ext' and activated via the binary I/P 'Extend t1'.

The 2nd., 3rd. and 4th. reclosure attempts are always three-phase.

Extended dead time 't Dead 1 Ext'

This time provides facility for extending the dead time (e.g. should the communications channel be defective or for a redundant scheme with 2 auto-reclosure functions). The extended dead time is enabled by the binary input 'Extend t1'.

Maximum fault duration for a reclosure attempt 't Oper'

If a fault has persisted for some time, the probability of a successful reclosure reduces. The likelihood of the power system becoming unstable is also greater for an unsuccessful auto-reclosure attempt following a fault which has persisted for a long period. It is for these reasons that the time after the inception of a fault during which reclosure can be initiated is limited. The fault duration is set using parameter 't Oper'.

The timer for the fault duration is started by the pick-up signal from the protection function (Start). Faults resulting in tripping after 't Oper' are locked out ('Def. Trip') and reclosure does not take place.

Should the fault duration time expire before the protection trips, auto-reclosure is blocked and the reclaim time is started.

Example:

Time 'T Oper' < 'Delay(2)' of the distance function means that auto-reclosure only takes place for faults in the first distance zone ('Delay(1)').

This function is not required for schemes that only use current functions. The binary inputs 'Start' and 'Trip CB 3P' are connected together (see Section 3.5.13.3.).

Reclaim time 't inhibit'

The purpose of the inhibit time is among other things to permit the circuit-breaker to recover its full voltage withstand. To this end, it disables the auto-reclosure function for the time set for parameter 't inhibit' after one of the following events:

- the last reclosing attempt
- a definitive trip resulting from a protection trip after the fault duration time 't Oper'
- a recurring trip between discrimination time and dead time (evolving fault, see O/P signal 'Def. Trip').

Close signal duration 't Close'

The maximum duration of the circuit-breaker close signal (command O/P 'Close CB') is determined by the parameter 't Close'. Any tripping signal which occurs during this time overrides the close signal. A second, third or fourth reclosure attempt can only take place, if the next trip occurs within the time 't Close'.

Discrimination times 't 1P discrim.' and 't 3P discrim.'

The discrimination time determines the procedure in the event of a different kind of fault occurring during the dead time (evolving fault), i.e. one of the other two phases also picks up or the tripping signal resets and picks up again. The discrimination time is started together with the dead time. Should a tripping signal recur due to an evolving fault between the expiry of the discrimination time and before the end of the dead time, the reclaim timer is started and a definitive trip ('Def. Trip') initiated. The dead time is also discontinued and the signal 'AR in prog.' reset.

If the first fault was initially an earth fault and evolves during the time 't Dead1 1P', but before the end of the discrimination time 't Discrim 1P', the dead time 't Dead1 3P' is started and three-phase reclosure takes place.

The discrimination time 't Discrim 3P' is also needed for 2 or 1½ breaker schemes, where each circuit-breaker has its own auto-reclosure function.

A typical setting for the parameters 't Discrim 1P' or 't Discrim 3P' for single and three-phase reclosure is 50 % of the shortest dead time.

The minimum permissible setting for the discrimination time is:

$$100 \text{ ms} + \text{CB time}$$

Note:

The time 't1EvolFaults' during which a subsequent fault has to be detected (evolving or unsuccessful reclosure) is a distance function setting.

The distance protection parameter 't1EvolFaults' enables the time to be set during which a subsequent fault (evolving or unsuccessful reclosure) results in a three-phase trip, i.e. every second trip by the distance protection function trips all three phases. The auto-reclosure function also signals the switchover to three-phase tripping by exciting the signal 'Trip 3-Pol' at the end of the fault discrimination time 't Discrim. 1P'.

It is advisable to set the time 't1EvolFaults' longer than the auto-reclosure dead time 't Dead1 1P'.

't Timeout'

The parameter 't Timeout' determines the period after the dead time within which the close signal must be issued, otherwise a 'Def.Trip' is generated and no further reclosure attempt is made. Before a close command is issued at the end of every dead time, the logic [('synchroChck' AND 'CO ready') OR 'Dead Line' OR 'ExtSCBypas')] is checked and the command only enabled providing all the criteria are correct within the setting of 't Timeout'.

Blocking time 't AR Block'

The auto-reclosure function can be enabled or disabled by the following binary I/P signals:

- ExtBlkAR - also blocks during the reclosure cycle
- Manual close - also blocks during the reclosure cycle
- Inhibit Inp - also blocks during the reclosure cycle

- CB Ready - blocks excepting during the reclosure cycle
- CB2 Ready - blocks excepting during the reclosure cycle *)
- CO Ready - blocks at the end of the reclosure cycle after expiry of the time 't time-out'
- CO Ready 2 - blocks at the end of the reclosure cycle after expiry of the time 't time-out' *)
- Mast.noSucc - blocks the follower CB after an unsuccessful reclosure attempt by the master
- CondBlkAR - blocks excepting during the reclosure cycle.

Should a 'CondBlkAR' signal occur during a reclosure cycle (i.e. the 'AR in prog.' signal is active), it only becomes effective from the end of the current reclosure cycle and providing it is still active.

A reclosure cycle remains blocked for the duration of the set blocking time 't AR Block' after the last binary I/P has been enabled. Blocking also takes place during initialisation of the protection relay when its auxiliary supply is switched on or the parameter settings are being loaded.

*) 2 denotes the I/O's for CB2 in a duplex scheme (see Fig. 3.5.13.7.).

3.5.13.8. *External binary inputs*

Starting and tripping signals from the protection function: 'Start' ('Start 2', 'Start 3'), 'Trip CB' and 'Trip CB 3P' ('Trip CB2', 'Trip CB3', 'Trip CB2 3P', 'Trip CB3 3P')

In order to control the auto-reclosure function, it is necessary to configure the three I/P signals 'Trip CB' (general trip), 'Trip CB 3P' (three-phase trip) and 'Start'. The normal procedure to achieve this is to select the protection signals via the sub-menu 'OUTPUT FROM FUNCTION'. Since the auto-reclosure function is completely independent, signals from other functions may also be selected.

In a 1st. and 2nd. main (redundant) protection scheme with one auto-reclosure relay (see [Section 3.5.13.4.](#)), the I/P signals 'Trip CB2', 'Trip CB2 3P' and 'Start 2' must also be connected to the second protection function.

Circuit-breaker ready signals: 'CB ready' and 'CO Ready' ('CB2 ready' and 'CO Ready 2')

The I/P's for the parameters 'CO Ready' and 'CB ready' (or 'CO Ready 2' and 'CB2 ready' in a duplex scheme) must be connected to the circuit-breakers in order to signal that they are ready to perform a complete reclosure cycle. In cases where one of the I/P's is not used, it must be set to 'TRUE'.

An active 'CB ready' signal informs the auto-reclosure function that reclosure is permissible (i.e. sufficient energy is available for a full open/close/open cycle).

Once a reclosure cycle has started, this signal is ignored (because the pressure varies during a reclosure cycle of an air-blast breaker).

Resetting of this signal is internally delayed by 100 ms.

The 'CO Ready' signal (close-open cycle can be carried out) is only effective during a reclosure cycle, i.e. during the dead time. Should there be insufficient energy to open the circuit-breaker again following closure, the close signal is disabled and a 'Def. Trip' (definitive trip) is generated.

This I/P is only used in conjunction with circuit-breakers, which provide the corresponding information (C-O query), e.g. spring-charged and air-blast circuit-breakers with two switching energy levels.

Circuit-breaker open 'CB open' ('CB2 open')

It is also necessary to include the initial status of the circuit-breakers to prevent one from receiving a close signal, which was already open before the fault occurred.

The binary I/P 'CB open' (and 'CB2 open' in a duplex scheme) is thus provided to determine the initial status of a circuit-breaker.

The pick-up of these signals is delayed by 100 ms to prevent any unwanted blocking of fast circuit-breakers.

A circuit-breaker which was already open before the 'Start' signal was received ('CB open' at logical '1') is not closed by the auto-reclosure function.

Where a circuit-breaker does not provide the necessary information ('CB open' signal), the I/P must be permanently set to 'off' ('F' or 'False'). Providing the scheme is also not a duplex scheme (i.e. only one CB), the binary I/P 'CB2 open' must also be permanently set to 'on' ('T' or 'True').

Accordingly, these are the default settings for 'CB open' and 'CB2 open'.

The auto-reclosure function can then operate with a single circuit-breaker without a 'CB open' signal and no superfluous close signal is generated for the non-existing CB2.

De-energised line 'Dead Line' ('Dead Line 2') with checking of synchronism 'synchroChck' ('synchroChck2')

Before the 'Close CB' (or 'Close CB2') instruction can be issued, either the 'Dead line' or the 'synchroChck' I/P (or 'Dead line 2' or 'synchroChck2' in a duplex scheme) must be at logical '1'.

Logic: [('synchroChck' AND 'CO ready') OR 'Dead Line' OR 'ExtSCBypas']

Logic: [('synchroChck2' AND 'CO ready 2') OR 'Dead Line 2' OR 'ExtSCBypas']

External blocking 'ExtBlkAR' and 'CondBlkAR'

The reclosure function is always blocked by an active 'ExtBlkAR' I/P.

An active 'CondBlkAR' I/P will only block the function, providing a reclosure cycle is not running (i.e. the 'AR in prog.' signal is at logical '0').

The 'Cond.Blk AR' signal is needed to prevent a reclosure cycle, when no reclosure is wanted for a first trip that occurs during 't Oper'. This is the case, for example, for trips by the switch-onto-fault (SOTF) protection or by a directional E/F protection via PLC.

To prevent the SOFT from initiating auto-reclosure, the distance protection 'SOFT start' signal must be connected to the 'Cond BlkAR' input.

'Manual close'

The reclosure function is immediately blocked (for the blocking time 't AR Block') by a 'Manual close' signal. This signal is also needed for the overreaching logic to switch the 'ZExtension' signal to 'on'.

External synchrocheck bypass signal 'ExtSCBypas'

This I/P provides facility for bypassing the 'synchroChck' and 'CO Ready' (or SynchroChck2' and 'CO Ready 2' for CB2) enabling I/P's.

It is only active for the first fast three-phase or single-phase reclosure attempt.

External extension of the dead time 'Extend t1'

A logical '1' at the 'Extend t1' I/P extends the dead times 't Dead1 1P' and 't Dead1 3P' by the setting 't Dead1 Ext' for the first (fast) reclosure attempt. This could be necessary, for example, in the event of a communication channel failure or in a redundant scheme.

3.5.13.9. Close CB and signalling outputs

The most important auto-reclosure output is the 'Close CB' command which must be assigned to a heavy-duty auxiliary O/P relay. This and 14 other heavy-duty and signalling O/P's are provided.

This signal picks up when the closing command is issued and resets at the end of the time 't Close' or earlier if there is a tripping occurs upon reclosing.

Status of the auto-reclosure function ('AR Ready' and 'AR Blocked')

The signal 'AR Ready' is generated when the auto-reclosure function is ready to perform a reclosure cycle and the signal 'AR Blocked' when it is blocked.

The 'AR Ready' signal is active providing a reclosure cycle is not blocked (no 'AR Blocked' signal) and a dead time is not running.

The 'AR Ready' signal is active during a reclose command for purposes of enabling the synchrocheck function (see Fig. 3 in the synchrocheck function section).

Auto-reclosure cycle in progress

There are six signals which show that a reclosure cycle is running and what stage has been reached:

'AR in prog.'	reclosure cycle in progress
'First AR 1P'	first single-phase reclosure attempt
'First AR 3P'	first three-phase reclosure attempt
'second AR'	second reclosure attempt
'Third AR'	third reclosure attempt
'Fourth AR'	fourth reclosure attempt.

The signal 'AR in prog' picks up at the start of the dead time and is reset by the falling edge of the last reclose command.

Circuit-breaker closing signals 'Close CB' and 'Close CB2'

The CB closing command is normally assigned to a heavy-duty auxiliary O/P relay by correspondingly configuring the parameter 'Close CB' (also 'Close CB2' in a duplex scheme). It is also possible to assign the same signal to a signalling O/P under the same parameter name.

A trip subsequent to a close command during the time 't Close' + 300 ms switches the dead time step (second, third and fourth AR) or initiates a lock-out trip (depending on the setting). A close command is reset immediately after a trip.

Definitive trip 'Def. Trip'

The 'Def. Trip' signal indicates that the circuit-breaker will remain tripped and no further reclosure attempts will be made. The following conditions can cause a definitive trip:

- All reclosure attempts were unsuccessful.
- A starting or tripping signal was generated after the discrimination time and before dead time.
- Tripping takes place while a reclosure cycle is blocked (either via the blocking I/P or by the reclaim time).
- The 'synchroChck' (or 'Dead line') and/or 'CO Ready' I/P's were not enabled during 't Timeout' due to lack of synchronism.
- The 'CB open' signal is still active 300 ms after the close signal has reset (i.e. the CB has not responded to the close signal).
- The trip signal that followed the start signal occurred after the fault duration time 't Oper'.
- Tripping occurred for a phase fault and the mode selected for the first reclosure cycle is 1P-1P or 1P-3P.

Perform three-phase trip 'Trip 3-Pol'

The 'Trip 3-Pol' O/P instructs the line protection to trip all three phases.

The signal can be externally or internally connected.

This signal is generated automatically, if reclosure is blocked, 'CB Ready' is inactive, the CB is open, the single-phase discrimination time 't1P Discrim' has elapsed or the signal 'First AR 3P' is active.

Zone extension 'ZExtension'

The setting of the auto-reclosure parameter 'ZE Prefault' determines the pre-fault reach of the distance protection when the auto-reclosure function is inactive (before the first fault), i.e. setting 'ZE Prefault' to 'on' activates the output signal 'ZExtension' which then switches the distance function to overreach.

The parameters 'ZE 1. AR reach' to 'ZE 4. AR reach' provide facility for individually switching the reach for each reclosure attempt. Setting one of these parameters to 'on' means that the 'ZExtension' O/P is at logical '1' and the distance relay is switched to overreach either before fault occurrence or for the following reclosure attempt, otherwise the distance relay is set to underreach.

With the exception of its first change of state when providing 'ZEPrefault' is set to 'ON' it resets together with the signal 'Trip CB' or 'Trip CB 3P', this signal picks up and resets together with the 'Close CB' signal.

The distance relay is switched to overreaching for a 'Manual close'.

It is switched to underreaching when the auto-reclosure function is blocked.

Note also that the 'ZExtension' signal is connected to the binary input 'ZEMode AR' of the zone extension logic in the distance protection function.

3.5.13.10. Timing diagrams

The time relationship between the various signals during operation of the auto-reclosure function can be seen from [Fig. 3.5.13.8](#) to [Fig. 3.5.13.16](#).

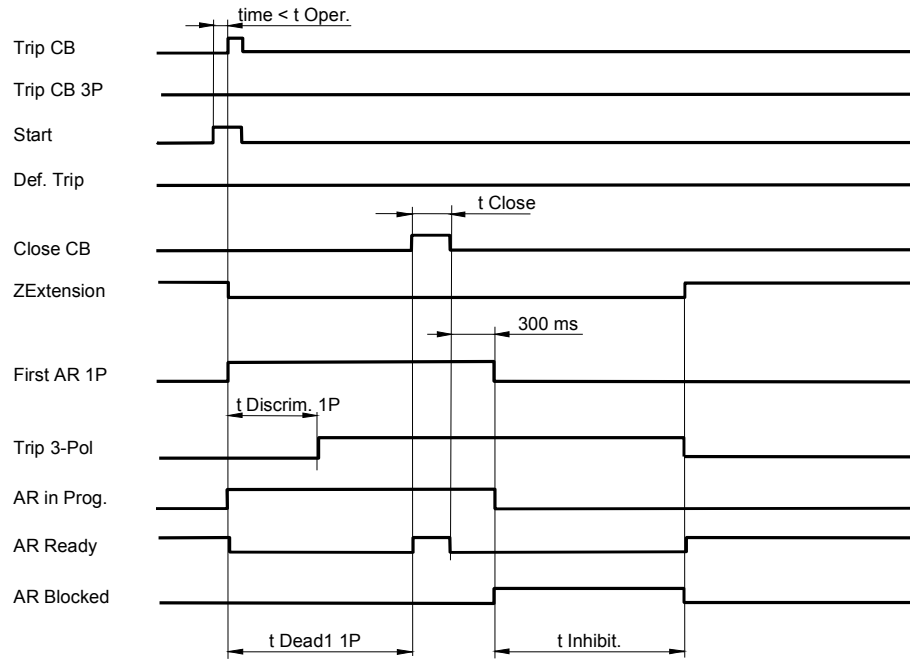
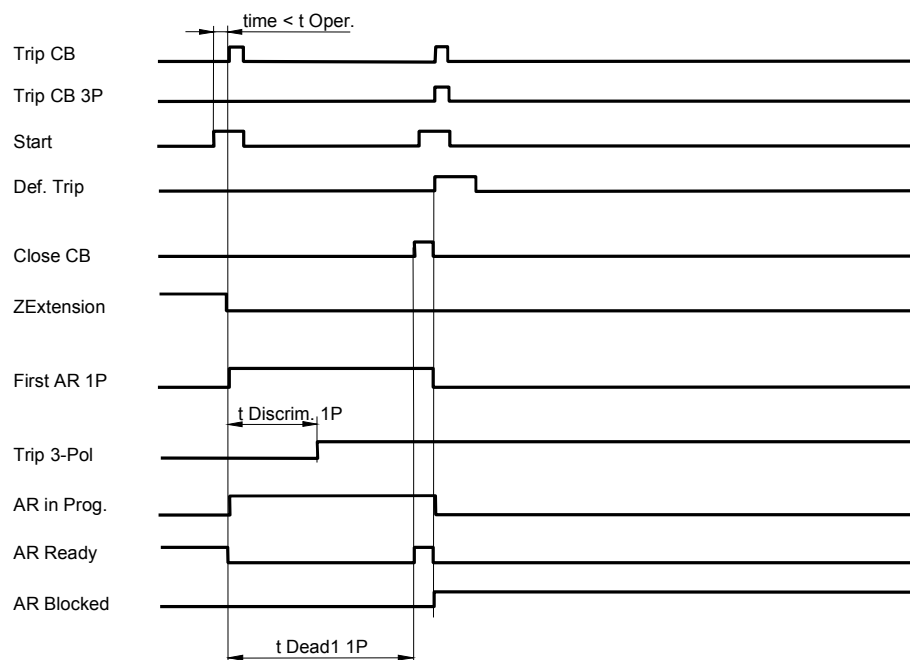
Successful AR**Unsuccessful AR**

Fig. 3.5.13.8 Timing diagram for a single or double busbar arrangement with 1 distance and 1 AR function. Response for an earth fault.

Settings:

'1. AR Mode' = '1P-1P' or '1P3P-1P3P',
 '2..4. AR Mode' = 'off', 'ZE Prefault' = 'on',
 'ZE 1. AR' = 'off'.

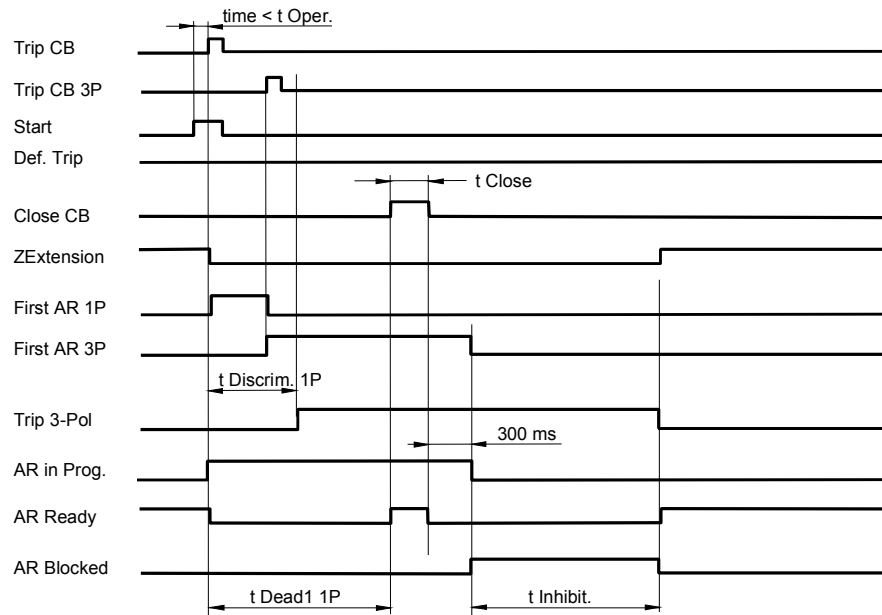
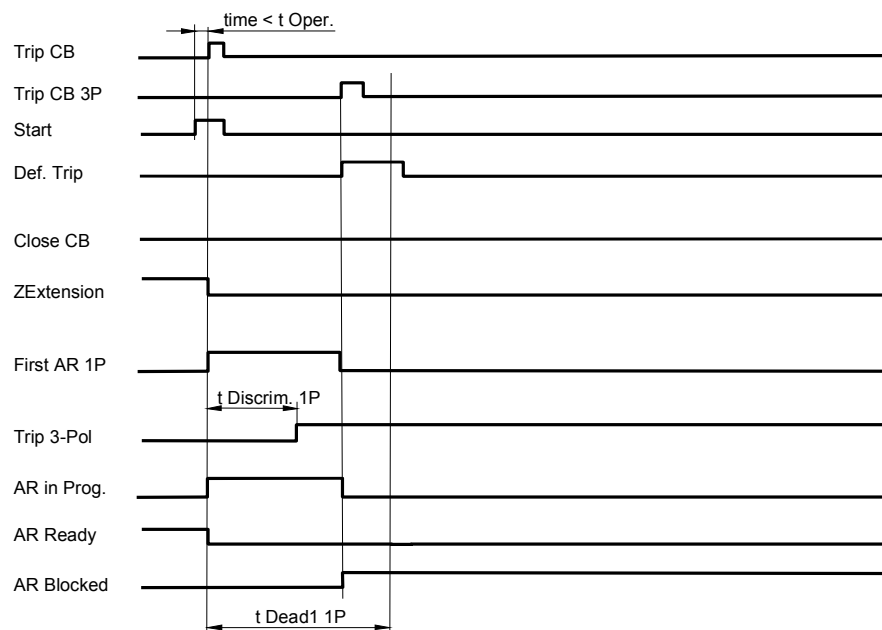
Successful AR (evolving fault during 't Discrim1P')**Unsuccessful AR (evolving fault within 't Dead1 1P', but after 't Discrim1P')**

Fig. 3.5.13.9 Timing diagram for a single or double busbar arrangement with 1 distance and 1 AR function. Response for an earth fault which evolves.

Settings:

'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 'off',
'ZE Prefault' = 'on', 'ZE 1. AR' = 'off'.

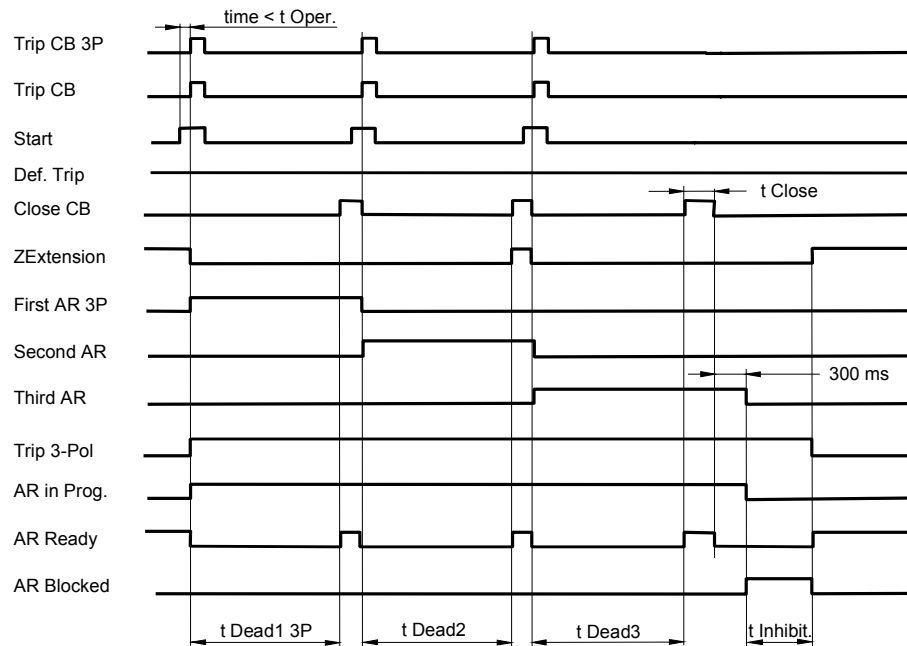
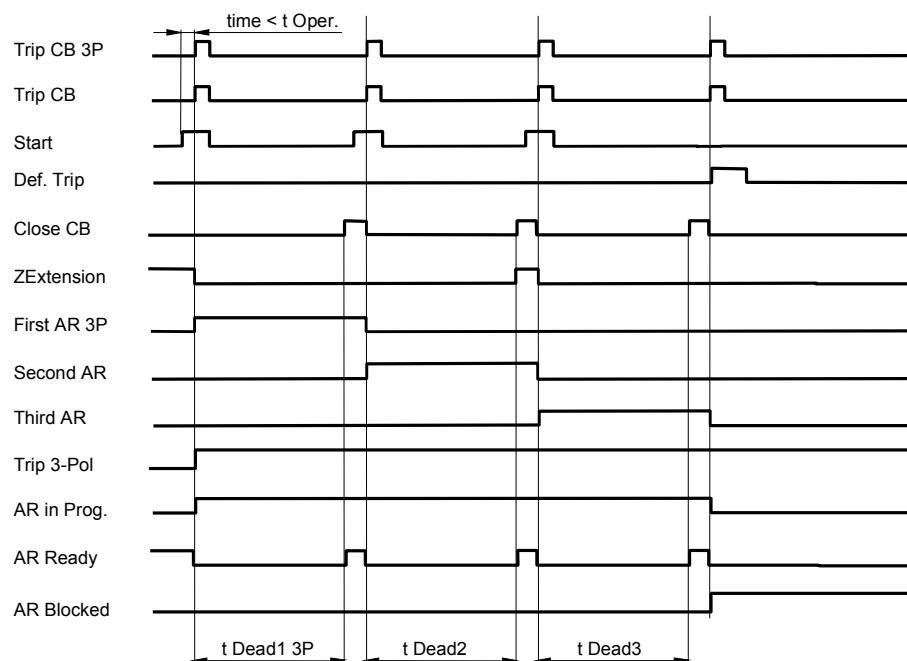
Successful AR**Unsuccessful AR**

Fig. 3.5.13.10 Timing diagram for a single or double busbar arrangement with 1 distance and 1 AR function. Response for multiple phase faults.

Settings:

'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 3,
 'ZE Prefault' = 'on', 'ZE 1. AR' = 'off',
 'ZE 2. AR' = 'on' and 'ZE 3. AR' = 'off'.

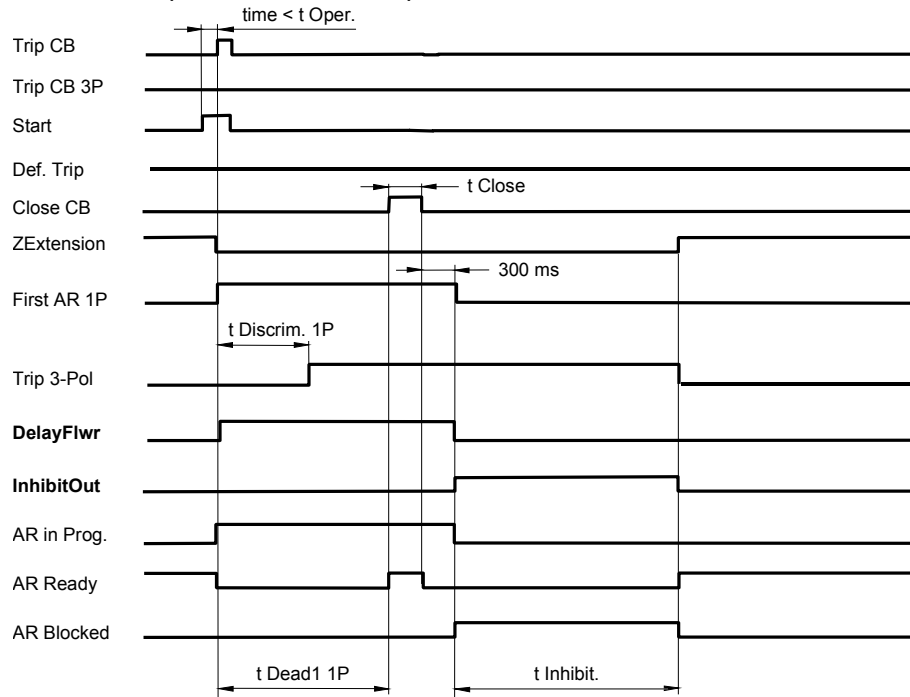
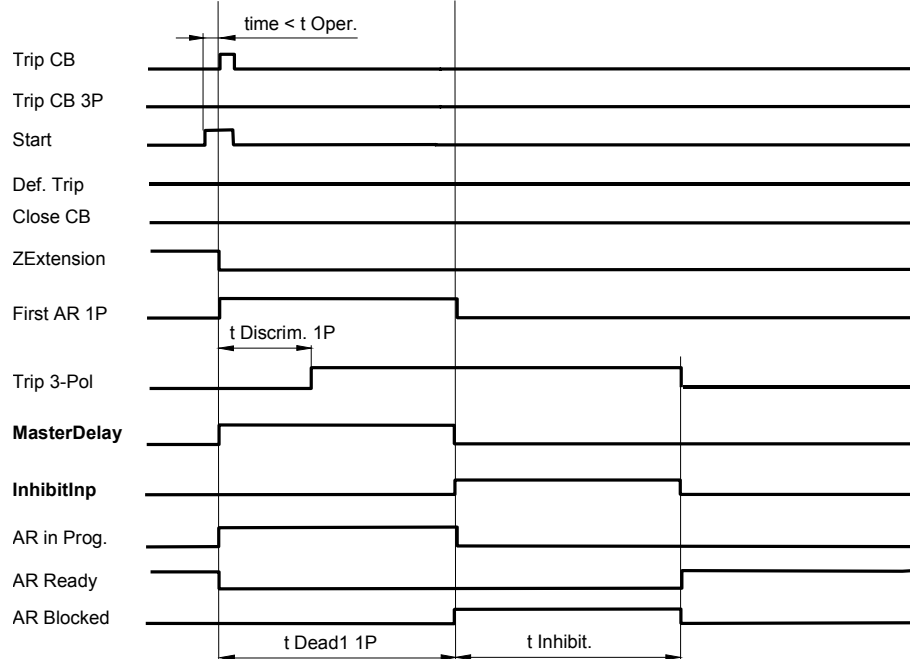
Master AR (Master Mode = "ON")**Follower AR (Master Mode = "OFF", AR on "hot standby")**

Fig. 3.5.13.11 Timing diagram for redundant scheme with 2 AR's. Response for 1 successful reclosure.

Settings:

'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 'off',
'ZE Prefault' = 'on' and 'ZE 1. AR' = 'off'.

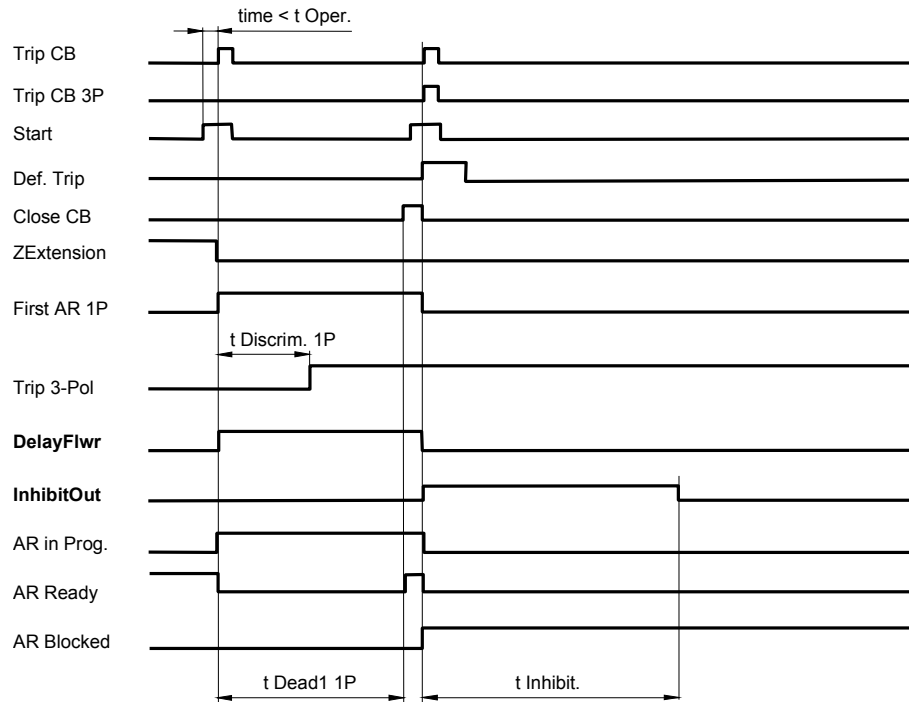
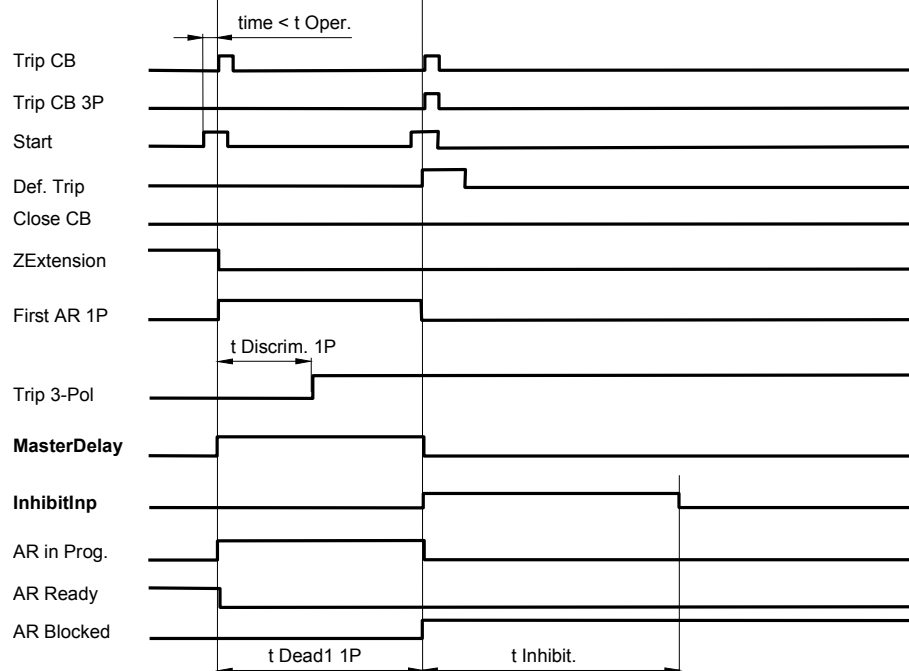
Master AR (Master Mode = "ON")**Follower AR (Master Mode = "OFF", AR on "hot standby")**

Fig. 3.5.13.12 Timing diagram for redundant scheme with 2 AR's. Response for 1 unsuccessful reclosure.

Settings:

'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 'off',
'ZE Prefault' = 'on' and 'ZE 1. AR' = 'off'.

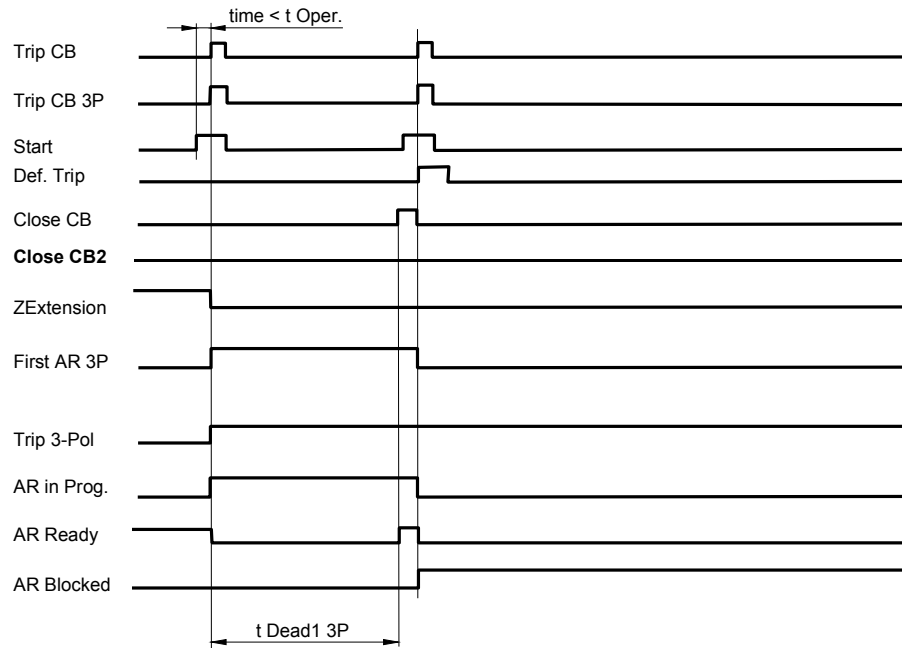
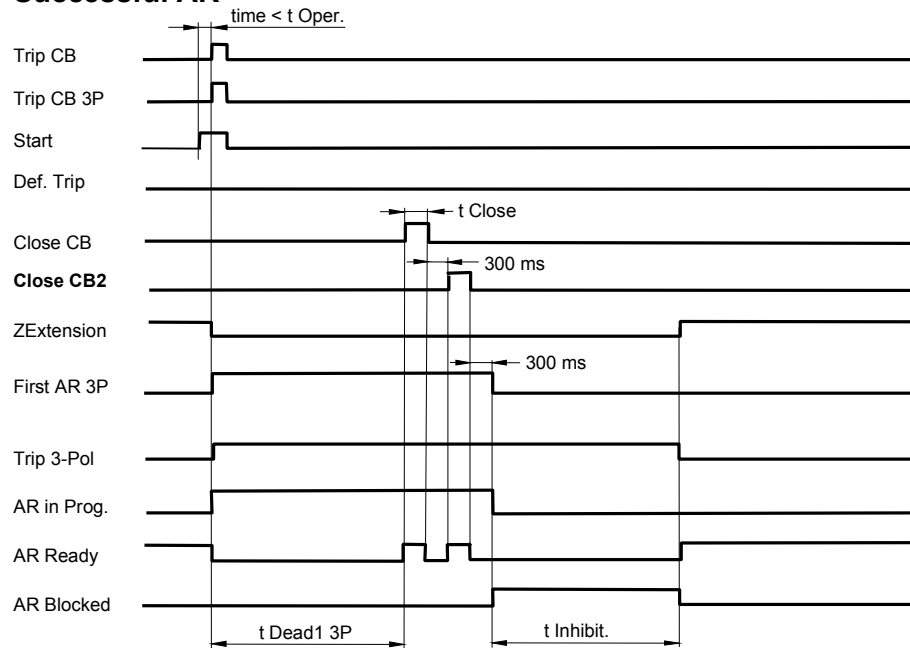
Unsuccessful AR**Successful AR**

Fig. 3.5.13.13 Timing diagram for duplex scheme.
Response for a multiple phase fault.

Settings:

'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 'off',
'ZE Prefault' = 'on', 'ZE 1. AR' = 'off'
and 'CB2 Priority' = 'off'.

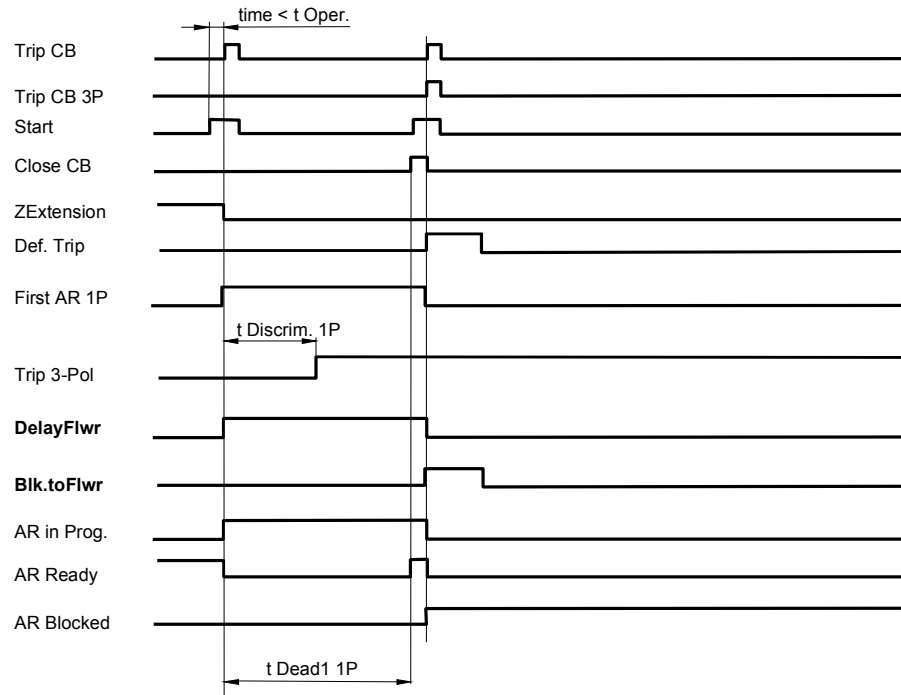
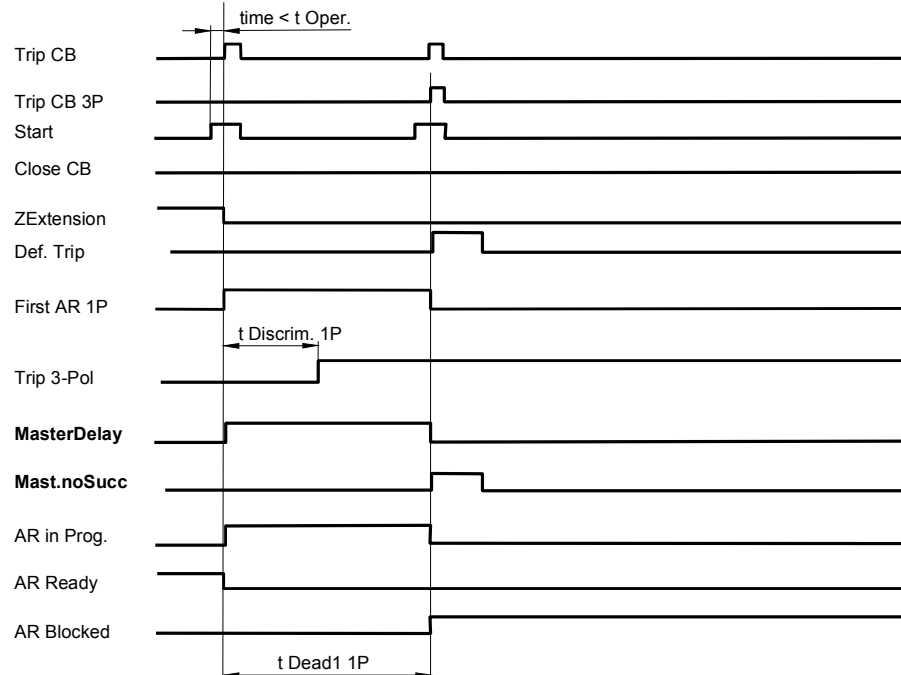
Master AR (Master Mode = "ON", CB on bus side)**Follower AR (Master Mode = "OFF", Centre CB)**

Fig. 3.5.13.14 Timing diagram for a 1½ breaker scheme.
Response for an unsuccessful reclosure.

Settings:

'1. AR Mode' = '1P3P-1P3P' or '1P-1P',
'2..4. AR Mode' = 'off', 'ZE Prefault' = 'on'
and 'ZE 1. AR' = 'off'.

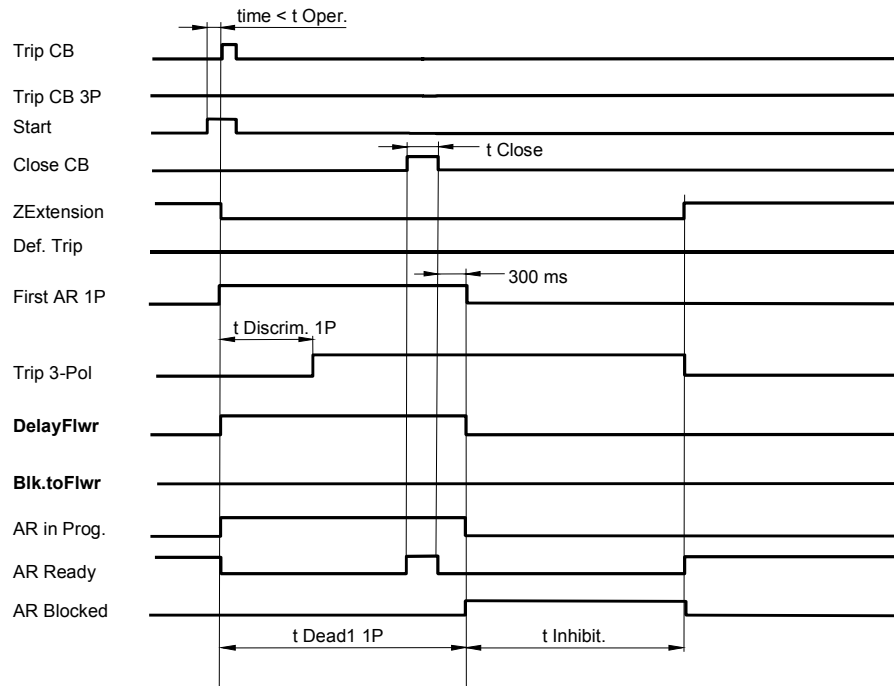
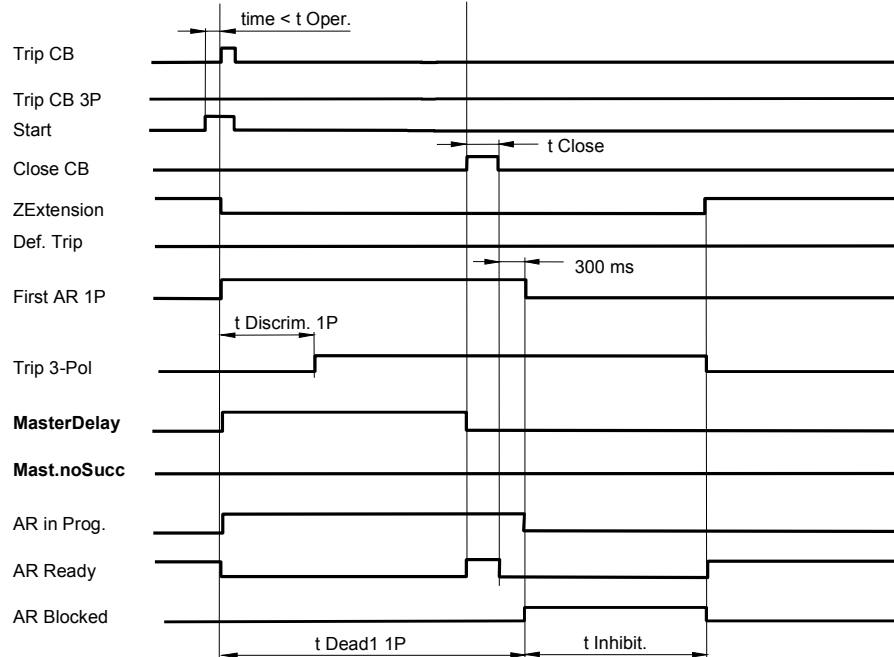
Master AR (Master Mode = "ON", CB on bus side)**Follower AR (Master Mode = "OFF", Centre CB)**

Fig. 3.5.13.15 Timing diagram for a 1½ breaker scheme.
Response for a successful reclosure.

Settings:

'1. AR Mode' = '1P3P-1P3P' or '1P-1P',
'2..4. AR Mode' = 'off', 'ZE Prefault' = 'on'
und 'ZE 1. AR' = 'off'.

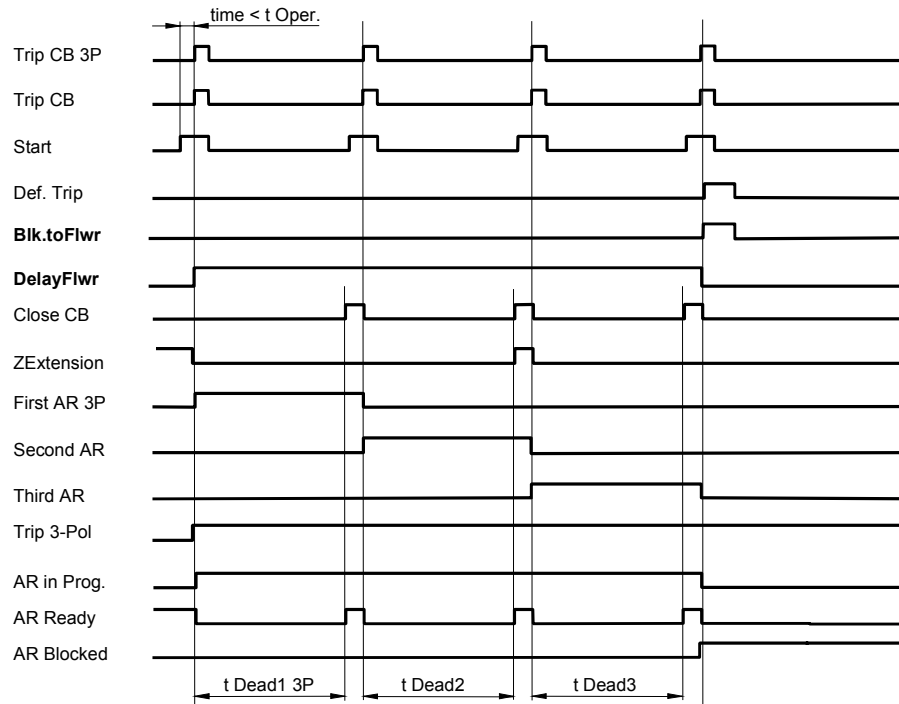
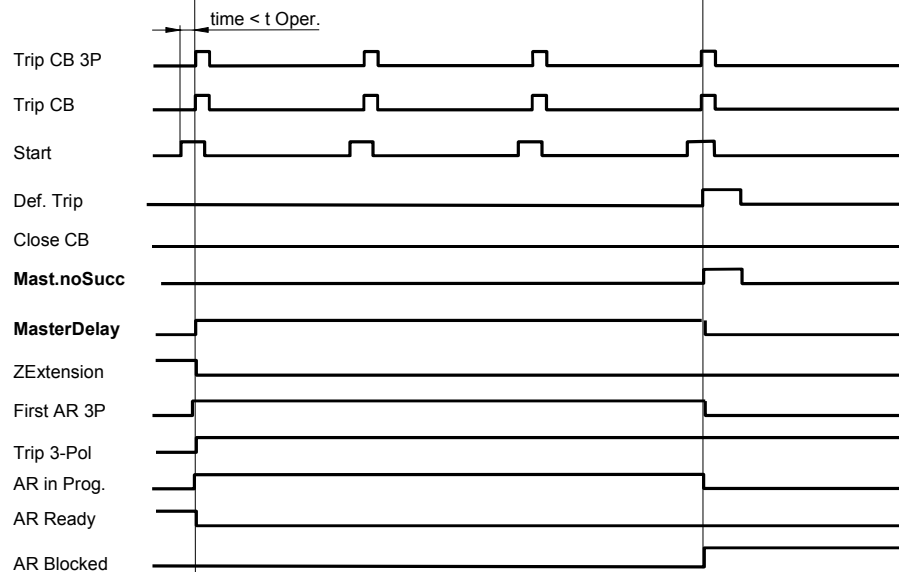
Master AR (Master Mode = "ON", CB on bus side)**Follower AR (Master Mode = "OFF", Centre CB)**

Fig. 3.5.13.16 Timing diagram for 1½ breaker scheme.
Response for an unsuccessful multiple reclosure.

Settings:

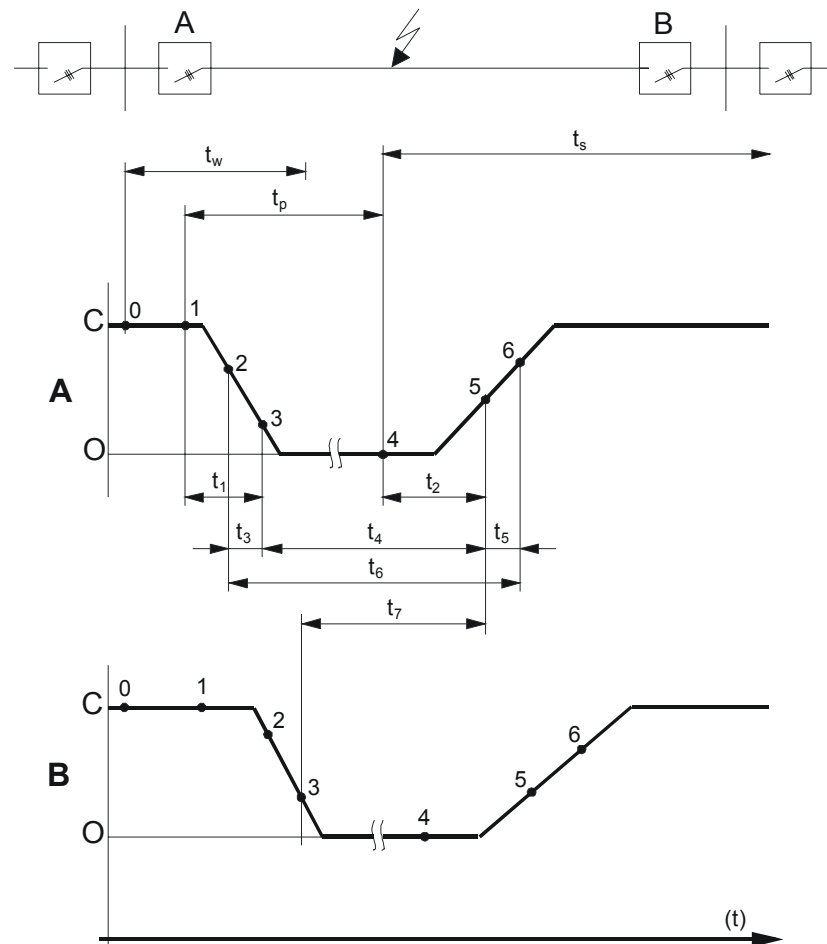
'1. AR Mode' = '1P3P-1P3P', '2..4. AR Mode' = 'off',
'ZE Prefault' = 'on', 'ZE 1. AR' = 'off',
'ZE 2. AR' = 'on' and 'ZE 3. AR' = 'off'.

3.5.13.11. Checking the dead times

When commissioning the auto-reclosure function, it is not sufficient to check the combined operation of protection function, auto-reclosure function and circuit-breaker, the resulting dead times must also be determined.

Since the dead time settings do not correspond to the effective total dead times, especially in a scheme with two circuit-breakers (see Fig. 3.5.13.17), the period during which the circuit-breaker is actually open must be measured. This entails adjusting the dead time until the measured breaker time minus arcing and pre-ignition times and the inevitable CB tolerances result in an adequate composite dead time.

Providing the circuit-breakers at both ends of the line are of the same type and thus permit the same tolerances to be assumed at both ends, the same dead time t_p can be set in the two terminal stations. Where this is not the case, the tripping and closing times of the two circuit-breakers must also be measured in addition to the dead times. The dead times set for the two auto-reclosure functions must then ensure that a sufficiently long “overlapping” dead time exists to enable the circuit-breakers to deionise.



HEST 925 035 C

A: circuit-breaker 1
C: "closed" position

B: circuit-breaker 2
O: "open" position

0: start

1: 'trip' signal

2: contacts part

3: current interrupted

4: 'close' signal

5: current flows again

6: contacts make

 t_1 : tripping time t_2 : reclosing time t_3 : arc extinction time t_4 : dead time t_5 : pre-ignition time t_6 : duration of interruption t_7 : resulting dead time t_p : dead time t_s : inhibit time t_w : fault duration

Fig. 3.5.13.17 Resulting composite dead time
(Source: "Guidelines for auto-reclosure in electrical power systems" published by the German Association of Power Utilities VDEW)

3.5.14. **Synchrocheck function (SynchroChck)**

A. Application

Checking the synchronisation criteria (amplitudes, phase-shift and frequency difference) of two electrical systems and, providing the corresponding limits are satisfied, enabling them to be connected in parallel.

B. Features

- Monitoring synchronism:
Single-phase voltage measurement.
Comparison of the voltages (dU), phase-shift (dPh) and frequencies (df) of two voltage vectors. Calculation of the corresponding differences between the voltage vectors in the complex plane.
Evaluation of the fundamental frequency components of the voltage signals (after filtering of harmonic and DC components).
- Monitoring voltage:
Single or three-phase voltage measurement.
Evaluation of instantaneous values (non-digitally filtered analogue signals) resulting in a large permissible frequency range. Detection of the largest and smallest of the three phase voltages in the case of three-phase measurement.
No filtering of harmonics or DC component.
- Choice of phase for the voltage I/P's on busbar and line sides (for amplitude and phase-angle adjustment).
- Additional voltage I/P (for use in double busbar stations) with provision for remote switchover.
- Provision for remote selecting the operating mode.

C. Inputs and outputs

I. Analogue inputs:

- Voltages (2 or 3 single or three-phase I/P's for 'uBusInput1', 'uBusInput2' and 'uLineInput')

II. Binary inputs:

- 2 I/P's for enabling the synchrocheck function ('ReleaseInp1' and 'ReleaseInp2')
- 3 I/P's for interlocking the synchrocheck O/P's ('BlckTrigBus1', 'BlckTrigBus2' and 'BlckTrigLine')

- 1 I/P for bypassing the synchrocheck function (OverridSync)
- 2 I/P's for remotely selecting operating mode ('OpModeInp1' and 'OpModeInp2')
- 2 I/Ps for remotely switching voltage channels in double busbar stations ('uBus1Activ' and 'uBus2Activ').

III. Binary outputs:

- Function pick-up (Start)
- Circuit-breaker closing enable signal (PermitToClos)
- Function disabled signal (SyncBlockd)
- Enable O/P blocked signal (TrigBlockd)
- Synchrocheck bypassed signal (OverridSync)
- Amplitude difference in permissible range (AmplDifOK)
- Phase-shift in permissible range (PhaseDifOK)
- Frequency difference in permissible range (FreqDifOK)
- Busbars energised (LiveBus)
- Busbars de-energised (DeadBus)
- Line energised (LiveLine)
- Line de-energised (DeadLine).

IV. Measurements:

Synchronism check (single-phase)

- Voltage amplitude difference
 $(dU) = U_{\text{bus}} - U_{\text{line}}$
- Phase-shift
 $(dPh) = Ph_{\text{Busbar}} - Ph_{\text{Line}}$
- Frequency difference
 $(|df|) = |f_{\text{bus}} - f_{\text{line}}|$

Voltage check (single or three-phase)

- max. busbar voltage (MaxuBus)
- min. busbar voltage (MinuBus)
- max. line voltage (MaxuLine)
- min. line voltage (MinuLine)

[Single-phase: max. voltage = min. voltage
 Three-phase: max. voltage = max. phase-to-phase voltage
 min. voltage = min. phase-to-phase voltage].

D. Synchrocheck function settings - SynchroCheck

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
PermitToClos	Trip Chan	00000000			
maxVoltDif	UN	0.20	0.05	0.40	0.05
maxPhaseDif	deg	10.0	05.0	80.0	05.0
maxFreqDif	Hz	0.20	0.05	0.40	0.05
minVoltage	UN	0.70	0.60	1.00	0.05
maxVoltage	UN	0.30	0.10	1.00	0.05
Operat.-Mode		SynChck	(Select)		
supervisTime	s	0.20	0.05	5.00	0.05
t-Reset	s	0.05	0.00	1.00	0.05
uBusInp-Ph		1ph R-S	(Select)		
uBusInput1	AnalogAddr	0			
uBusInput2	AnalogAddr	0			
uLineInp-Ph		3ph Y	(Select)		
uLineInput	AnalogAddr	0			
uBus1Activ	BinaryAddr	T			
uBus2Activ	BinaryAddr	F			
ReleaseInp1	BinaryAddr	T			
ReleaseInp2	BinaryAddr	F			
BckTrigBus1	BinaryAddr	F			
BckTrigBus2	BinaryAddr	F			
BckTrigLine	BinaryAddr	F			
OverridSync	BinaryAddr	F			
OpModeInp1	BinaryAddr	F			
OpModeInp2	BinaryAddr	F			
PermitToClos	SignalAddr	ER			
Start	SignalAddr				
SyncBlockd	SignalAddr				
TrigBlockd	SignalAddr				
SyncOverrid	SignalAddr				
AmplDifOK	SignalAddr				
PhaseDifOK	SignalAddr				
FreqDifOK	SignalAddr				
LiveBus	SignalAddr				
DeadBus	SignalAddr				
LiveLine	SignalAddr				
DeadLine	SignalAddr				

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

PermitToClos

Logic (matrix) O/P channel at which the CB close signal is available.

maxVoltDif

Max. permissible voltage difference $|dU|$ between the phases used for checking synchronism.

maxPhaseDif

Max. permissible phase-shift $|dPh|$ between the voltages of the phases used for checking synchronism.

maxFreqDif

Max. permissible difference of frequency $|df|$ between the phases used for checking synchronism.

minVoltage

Voltage level for discriminating between busbar and line being live (lowest phase voltage in the case of three-phase measurement).

maxVoltage

Voltage level for discriminating between busbar and line being dead (highest phase voltage in the case of three-phase measurement).

Operat.-Mode

Possible synchrocheck function operating modes:

- “SynChck only”: Synchrocheck
[Synchrocheck conditions fulfilled AND
(bus live AND line live)]
- “BusD & LineL”: Synchrocheck OR
(bus dead AND line live)
- “BusL & LineD”: Synchrocheck OR
(bus live AND line dead)
- “BusD | LineD”: Synchrocheck OR
(bus dead AND line live) OR
(bus live AND line dead)
- “BusD & LineD”: Synchrocheck OR
(bus live AND line dead).

supervisTime

Period between the function picking up and it issuing the CB close enable ('PermitToClos').

All the conditions for synchronism must remain fulfilled during this time, otherwise the function is reset.

t-Reset

Reset time following the non-fulfilment of one or more synchronism conditions.

uBusInp-Ph

Choice of phase I/P on the busbar side.

Possible settings:

1 ph RS, ST or TR; 1 ph RE, SE or TE; 3 ph Y; 3 ph Δ

The phase chosen must agree with the voltage I/P channel selected (i.e. 'uBusInput1' and, if selected, 'uBusInput2').

uBusInput1

1st. voltage I/P channel on the busbar side. This must agree with the phase chosen ('uBusInp-Ph'). In the case of a three-phase connection ('uBusInp-Ph' = '3 ph Y' or '3 ph Δ '), the first channel (R phase) of a three-phase group must be chosen.

uBusInput2

2nd. voltage I/P channel (if applicable) on the busbar side.

This must agree with the chosen phase ('uBusInp-Ph'). In the case of a three-phase connection ('uBusInp-Ph' = '3 ph Y' or '3 ph Δ '), the first channel (R phase) of a three-phase group must be chosen.

If a second I/P is not configured, the function only takes account of the 1st. voltage I/P channel ('uBusInput1').

uLineInp-Ph

Choice of phase I/P on the line side.

Possible settings:

1 ph RS, ST or TR; 1 ph RE, SE or TE; 3 ph Y; 3 ph Δ

The phase chosen must agree with the voltage I/P channel selected (i.e. 'uLineInput').

uLineInp

Voltage I/P channel on the line side. This must agree with the chosen phase ('uLineInp-Ph'). In the case of a three-phase connection ('uLineInp-Ph' = '3 ph Y' or '3 ph Δ'), the first channel (R phase) of a three-phase group must be chosen.

uBus1Activ, uBus2Activ

Binary I/P's for switching between voltage I/P channels by an remote signal in the case of double busbars (mimic busbar). This I/P's are only active providing the second busbar I/P channel has been configured ('uBusInput2').

F: - I/P disabled

T: - I/P enabled

xx: - all binary I/P's (or O/P's of protection functions).

'uBus1Activ'	'uBus2Activ'	Selected voltage I/P
(T) TRUE	(F) FALSE	'uBusInput1' active
(F) FALSE	(T) TRUE	'uBusInput2' active
Other conditions		The previous voltage I/P remains active

ReleaseInp1, ReleaseInp2

Binary I/P's for enabling the synchrocheck function. (The I/P's are connected internally to an OR gate so that at least one must be set to "TRUE" (T) or appropriately controlled by an remote signal.) If both I/P's are set to "FALSE" (F), the functions routine (synchronism algorithm) does not run.

These I/P's are used where the synchrocheck function is only needed at certain times (e.g. in auto-reclosure schemes).

F: - synchrocheck function disabled

T: - synchrocheck function enabled

xx: - all binary I/P's (or O/P's of protection functions)

BlkSynchBus1, BlkSynchBus2, BlkSynchLine

Binary I/P's for interlocking the enabling signals at the O/P of the synchrocheck function.

These would be typically controlled by fuse failure equipment (m.c.b's) monitoring the v.t. circuits.

F: - blocking I/P disabled

T: - blocking I/P continuously enabled

xx: - all binary I/P's (or O/P's of protection functions)

Parts of the function effected by the blocking I/P's:

- Assuming that both busbar I/P channels have been configured, the active blocking I/P depends on the statuses of the binary I/P's 'uBus1Activ' and 'uBus2Activ':

'uBus1Activ'	'uBus2Activ'	Selected voltage I/P
(T) TRUE	(F) FALSE	'BlkTrigBus1' and 'BlkTrigLine'
(F) FALSE	(T) TRUE	'BlkTrigBus2' and 'BlkTrigLine'
Other conditions		The previous blocking I/P's remain active

- Assuming that only the first busbar I/P channel has been configured, all the blocking I/P's are active regardless of the statuses of the binary I/P's 'uBus1Activ' and 'uBus2Activ'.

The active blocking I/P's are connected internally to an OR gate and the CB close enabling O/P's are blocked, if one of them is set to "TRUE" (T).

OverridSync

Binary I/P for bypassing the synchrocheck function. This causes an enabling signal to be issued regardless of whether the synchronism conditions are fulfilled or not. It overrides the function's blocking and other enabling I/P's.

F: - I/P disabled

T: - I/P enabled (The synchrocheck O/P 'PermitToClos' is continuously active.)

xx: - all binary I/P's (or O/P's of protection functions)

OpModelnp1, OpModelnp2

I/P's for remotely selecting the operating mode:

F: - I/P disabled

T: - I/P continuously enabled

xx: - all binary I/P's (or O/P's of protection functions)

'I/P1 mode'	'I/P2 mode'	Synchrocheck mode
(F) FALSE	(F) FALSE	Mode specified in the control program ('Operat.-Mode')
(F) FALSE	(T) TRUE	Synchrocheck OR (bus dead AND line live)
(T) TRUE	(F) FALSE	Synchrocheck OR (bus live AND line dead)
(T) TRUE	(T) TRUE	Synchrocheck OR (bus dead AND line live) OR (bus live AND line dead)

PermitToClos

Signal indicating that the synchrocheck function is enabling closure of the circuit-breaker. It is generated at the end of the measuring period ('supervisTime') and remains active for as long as the synchronism conditions are fulfilled, or until a blocking signal is received, or the synchrocheck function re-sets.

Start

Signal generated at the instant the conditions for synchronism are fulfilled for the first time.

SyncBlockd

Signal indicating that the synchrocheck function is disabled, i.e. both the I/P's 'synchEnable1' and 'synchEnable2' are set to "FALSE" (F), and that the synchrocheck algorithm has been discontinued.

TrigBlockd

The CB close enabling O/P's are blocked (one or more blocking I/P's are at logical '1'), but the synchrocheck algorithm continues to run.

SyncOverrid

Signal indicating that the synchrocheck function is bypassed and a CB close enabling signal is being generated ('PermitToClos) regardless of whether the synchronism conditions are fulfilled or not.

AmplDifOK

Signal indicating that the voltage difference $|dU|$ between the phases used for checking synchronism has fallen below the value of the parameter 'maxVoltDif'.

PhaseDifOK

Signal indicating that the phase-shift $|dPh|$ between the phases used for checking synchronism has fallen below the value of the setting of 'maxPhaseDif'.

FreqDifOK

Signal indicating that the difference of frequency $|df|$ between the phases used for checking synchronism has fallen below the value of the setting of 'maxFreqDif'.

LiveBus

Signal indicating that the busbar is energised.
($U > \text{'minVoltage'}$)

DeadBus

Signal indicating that the busbar is de-energised.
($U < \text{'maxVoltage'}$)

LiveLine

Signal indicating that the line is energised.
($U > \text{'minVoltage'}$)

DeadLine

Signal indicating that the line is de-energised.
($U < \text{'maxVoltage'}$)

E. Setting instructions

3.5.14.1. *General*

It is only permissible to connect two energised parts of a power system, if the difference between the amplitudes of their voltages and the phase-shift between them are within acceptable limits.

The purpose of the synchrocheck function is to determine these parameters and decide whether it is permissible to connect the systems in parallel.

The function thus issues an enable signal ('PermitToClos'), providing the voltages of the two systems are higher than the set minimum voltage ('minVoltage') and

- the difference between the voltage amplitudes $|dU|$
- the phase-shift $|dPh|$
- the difference between the frequencies $|df|$

do not exceed the limits set for the parameters 'maxVoltDif', 'maxPhaseDif' and 'maxFreqDif' for the adjustable time 'supervis Time'.

According to the operating mode ('Operat.-Mode') selected, the function also permits de-energised parts of a power system to be coupled.

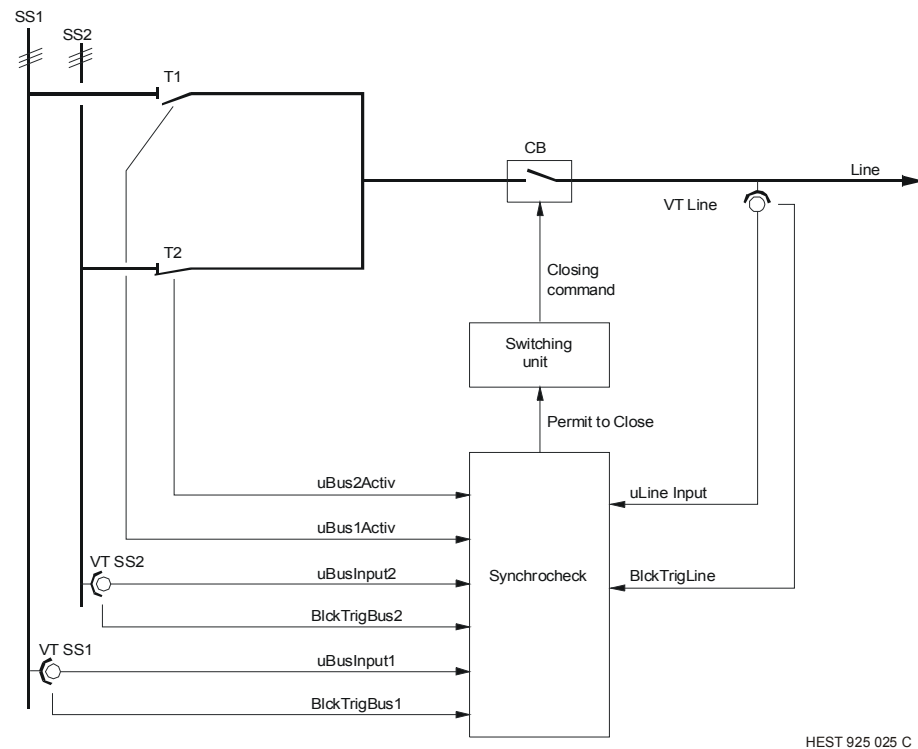
Provision is also made for switching between voltage I/P's belonging to the busbars of a double busbar station by appropriately controlling two binary I/P's ('uBus1Activ' and 'uBus2Activ'). Note that the function can only check the synchronism of two voltages at any one time, that of one of the busbars and that of the line.

The synchrocheck function is therefore used mainly

- to connect infeeds in parallel and to connect outgoing feeders to the system
- to interconnect two synchronous or asynchronous parts of a power system
- in auto-reclosure schemes
- as a safety check when carrying out manual switching operations.

Note:

The expressions in brackets are the names of the corresponding setting parameters. Refer also to [Section D](#).

Application example: Feeder connected to double busbars

HEST 925 025 C

Fig. 3.5.14.1 Principle of synchrocheck scheme for determining the instant when it is permissible to connect a feeder to the power system. (The voltages of busbar “SS2” and the line are monitored.)

where:

SS1, SS2	: busbar 1, busbar 2
VT SS1, VT SS2, VT Line	: v.t's on busbar 1, busbar 2 and line
T1, T2	: isolators on busbars 1 and 2
CB	: circuit-breaker
uBusInput1, uBusInput2	: voltage I/P channels on the busbar side
uLineInput	: voltage I/P channel on the line side

BlckTrigBus1, BlckTrigBus2, BlckTrigLine	:	I/P's for blocking the synchro-check function by the v.t. fuse failure equipment.
uBus1Activ, uBus2Activ	:	Binary I/P's for switching between the analogue busbar voltage I/P's in accordance with the configuration of the isolators (mimic busbar).

3.5.14.2. **Settings**

Max. voltage difference |dU|	maxVoltDif
Max. phase-shift |dPh|	maxPhaseDif
Max. frequency difference |df|	maxFreqDif
Minimum voltage level for monitoring (determination of whether plant is energised)	minVoltage
Maximum voltage level for monitoring (determination of whether plant is de-energised)	maxVoltage
Choice of operating mode	Operat.-Mode
Measuring period (delay before issuing enable)	supervisTime
Reset delay	t-Reset
Choice of phase for monitoring on the busbar side	uBusInp-Ph
Choice of phase for monitoring on the line side	uLineInp-Ph

Monitoring the conditions for synchronism ('maxVoltDif', 'maxPhaseDif' and 'maxFreqDif')

The determination of voltage difference, phase-shift and frequency difference is performed for just one of the phases of the three-phase system. For this purpose, the analogue values are first filtered by a digital Fourier bandpass filter (to obtain the fundamentals) and then the orthogonal components 'U bus' and 'U line' are derived.

The phase-shift dPh between the voltages and the difference between their amplitudes dU are calculated from the corresponding vector diagram in the complex plane.

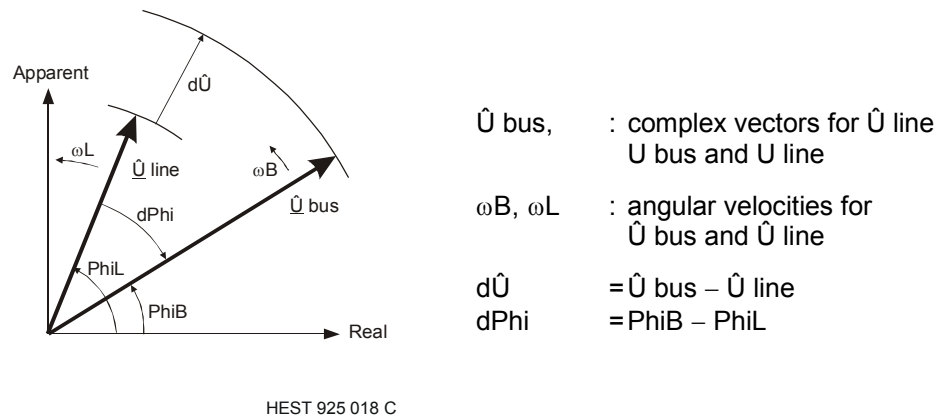


Fig. 3.5.14.2 Monitoring the conditions for synchronism

The frequency difference df is obtained by determining the rate at which the phase-shift between the voltage vectors varies:

$$df \approx \frac{d}{dt}(d\Phi) \approx (\omega_B - \omega_L)$$

The conditions for synchronism are fulfilled, providing the values of the resulting variables are within the limits set for 'maxVoltDif', 'maxPhaseDif' and 'maxFreqDif'.

Typical values:

maxVoltDif: 0.2 UN

maxPhaseDif: 10°

maxFreqDif:

50 mHz	- for connecting largely synchronous parts of a stable closely meshed system or where high demands with regard to synchronism have to be fulfilled.
100 mHz	- in auto-reclosure schemes with long dead times (e.g. three-phase slow reclosure) or for auto-reclosure of short transmission lines.
200 mHz	- in auto-reclosure schemes with short dead times, but where high slip frequencies are to be expected.

Note:

The setting of the synchronism measuring period ('supervisTime') must be chosen to correspond to the settings for the maximum phase-shift and maximum frequency difference.

**Monitoring the voltage in two power systems
(‘minVoltage’, ‘maxVoltage’)**

The determination of voltage amplitude can be either based on monitoring a single phase or all three phases depending on how the particular AnalogAddr is configured. If the three phases are included, then the highest voltage of the three is detected for the maximum limit, respectively the lowest of the three for the minimum limit.

In order to be able to monitor the voltages in a wide frequency range, instantaneous values are measured (instead of digitally filtered analogue voltages).

The voltage detectors may be used to determine whether a system is de-energised or whether it is energised:

- A system is considered to be “de-energised”, if its voltage (highest of the three phases in the case of three-phase measurement) falls below the setting of the parameter ‘maxVoltage’.
- A system is considered to be “energised”, if its voltage (lowest of the three phases in the case of three-phase measurement) exceeds the setting of the parameter ‘minVoltage’.

On no account will an enable signal permitting closure of the circuit-breaker be issued, should the voltage lie between the limits of ‘maxVoltage’ and ‘minVoltage’.

Typical values:

minVoltage	0.70 UN
maxVoltage	0.30 UN

**Choosing the operating mode of the synchrocheck function
(‘Operat.-Mode’)**

Basically, an enable signal will always be issued, if the conditions for synchronism ('dU', 'dPh' and 'df') are fulfilled for the prescribed period and both systems, i.e. busbar and line, are energised (voltage > 'minVoltage').

In cases where closure of the circuit-breaker should also be enabled when one system is de-energised, e.g. connection of a radial feeder, this can be achieved by appropriately setting the parameter 'Operat.-Mode':

'Operat.-Mode'	Closure enabled when:
"Only SyncChk"	Synchronism conditions fulfilled AND (busbar > 'minVoltage' AND line > 'minVoltage')
"BusD & LineL"	"Only SyncChk" OR (busbar < 'maxVoltage' AND line > 'minVoltage')
"BusL & LineD"	"Only SyncChk" OR (busbar > 'minVoltage' AND line < 'maxVoltage')
"BusD | LineD"	"Only SyncChk" OR (busbar < 'maxVoltage' AND line > 'minVoltage') OR (busbar > 'minVoltage' AND line < 'maxVoltage')
"BusD & LineD"	"Only SyncChk" OR (busbar < 'maxVoltage' AND line < 'maxVoltage')

- **Remote mode selection:**

Four of the five operating modes can be selected by external signals applied to two of the function's binary I/P's ('OpModelnp1' and 'OpModelnp2').

Binary I/P signals		Mode (see above)
'OpModelnp1'	'OpModelnp2'	
(F) FALSE	(F) FALSE	"Mode set in the control program" ('Operat.-Mode')
(F) FALSE	(T) TRUE	"BusD & LineL"
(T) TRUE	(F) FALSE	"BusL & LineD"
(T) TRUE	(T) TRUE	"BusD | LineD"

Choice of phase for the voltage I/P on the busbar and line sides ('uBusInp-Ph', 'uLineInp-Ph')

The phase voltage ('uBusInp-Ph', 'uLineInp-Ph') to be used for determining synchronism can be entered separately for busbar

and line I/P's (to facilitate individual adjustment of phase-angle and amplitude).

All single and three-phase voltages are available for setting (1ph RS, ST or TR; 1ph RE, SE or TE; 3ph Y; 3ph Δ), but the ones chosen must agree with the setting for the corresponding I/P channels (see [Section D](#). "Synchrocheck function settings").

Where both busbar I/P's are in use, the definition of the phase ('uBusInp-Ph') applies to both busbars.

Notes:

- A phase-to-phase measurement is to be preferred for a single-phase voltage measurement.
If a single-phase I/P has to be chosen on both sides, the same phase should be used wherever possible.
- If a three-phase 'Y' connection is selected, phase-to-phase voltages are formed internally. This reduces the harmonic content and enables the function to continue to be used in ungrounded systems, which are required to remain in service with a single earth fault.
- According to the setting for 'uBusInp-Ph' and 'uLineInp-Ph', either a just one phase or all three phases are monitored. Whether or not the conditions for synchronism ('dU', 'dPh' and 'df') are fulfilled is determined on the basis of a single phase, whereby the following apply:
 - Where three phases are monitored on busbar and line sides, the phase-to-phase potential U_{RS} is the one extracted for further processing.
 - Should a three-phase measurement be defined on one side and a single-phase on the other, Then the single-phase voltage set for the single-phase I/P is used on both sides.

The measuring period ('supervisTime'), reset time ('t-Reset') and the operating time of the function and also the dead time of any auto-reclosure function

- **Measuring period ('supervisTime'):**

This adjustable delay time, which is initiated at the end of the pick-up time, is the period during which all the conditions for synchronism must be continuously fulfilled to permit closure of the circuit-breaker. The timer is reset should one of the parameters move out of the permissible range.

Providing they all remain within their preset ranges, the enable signal ('PermitToClos') is issued at the end of the measuring period.

Especially in auto-reclosure applications, it is of advantage to set the measuring period ('supervisTime') in relation to the settings for 'Phase diff.' and 'maxFreqDif'. It also provides facility for allowing for the operating time of the circuit-breaker:

$$'supervisTime' [s] \leq \frac{2 \times ('maxPhaseDif') [^\circ]}{('maxFreqDif') [Hz] \times 360} - (tv + ts) [s]$$

where:

ts: circuit-breaker operating time

Typical range: 0 ... 100 ms.

tv: time required by the function to pick up
(response by the function to transient phenomena in the input voltage and timer tolerances):

- typically 60... 80 ms for values of 'supervisTime' < 200 ms
- typically 80... 100 ms for values of 'supervisTime' ≥ 200 ms.

The above setting for the measuring period ensures that for a constant frequency difference df within the setting of 'maxFreqDif', the phase-shift dPh will still be inside the set permissible angular range (- 'maxPhaseDif' to + 'maxPhaseDif') at the end of the time 'supervisTime'.

Typical values:

For a phase-shift setting ('maxPhaseDif') of 10°:

'maxFreqDif'	'supervisTime'
200 mHz	100... 200 ms
100 mHz	250... 450 ms
50 mHz	600...1000 ms

- **Minimum operating time of the function:**

The minimum operating time achieved by the function, i.e. the shortest possible time between the instant the synchronism conditions are fulfilled for the first time and the generation of the signal enabling the circuit-breaker to be closed 'PermitToClos', is given by the sum of the measuring time setting 'supervisTime' and the pick-up response time 'tv' of the function.

Min. operating time = ('supervisTime') + tv

- **Auto-reclosure dead time:**

In an auto-reclosure scheme, the dead time set for the auto-reclosure function must be at least as long as the minimum operating time of the synchrocheck function given above in order to permit the synchrocheck function to issue an enable signal ('PermitToClos') within the dead time:

dead time $\geq$ min. operating time = ('supervisTime') + tv

- **Reset time ('t-Reset'):**

From the instant that one or more of the synchronism conditions are no longer fulfilled, the enabling signal O/P ('PermitToClos') and the pick-up signal reset after the time set for 't-Reset'.

This ensures the a CB closing signal can be maintained for a certain minimum time.

Typical value:

t-Reset 50 ms.

Note:

- Where high slip frequencies df are to be expected, 't-Reset' must be short enough to prevent the phase-shift from exceeding the set permissible range of phase-angles (-'PhaseDif' to + 'PhaseDif') during the reset time.

3.5.14.3. Binary inputs of the function**Inputs for switching between analogue busbar inputs ('uBus1Activ', 'uBus2Activ')**

Where the two busbar I/P's ('Bus I/P1' and 'Bus I/P2') have been configured for a double busbar installation, the measurement can be switched from one busbar to the other by signals corresponding to the isolator positions applied to the I/P's 'uBus1Activ' and 'uBus2Activ':

'uBus1Activ' 'uBus2Activ'		Analogue I/P's for synchronisation
(T) TRUE	(F) FALSE	'uBusInput1' and 'uLineInput' 'uBusInput2' and 'uLineInput'
(F) FALSE	(T) TRUE	

Other combinations of the states of these two I/P's do not result in any switching of the AnalogAddr channels and the prevailing situation is maintained.

Notes:

- The function (timer, all measuring elements and the associated O/P's) is automatically reinitialised when busbar I/P's are switched. This procedure takes about **60 ms** (internal response times). The function then begins to evaluate the new busbar voltage and from this instant onwards the generation of an enable signal ('PermitToClos') relating to the new system configuration is possible.
- 'The two binary I/P's 'uBus1Activ' and 'uBus2Activ' are inactivated in configurations in which only one busbar I/P ('uBusInput1') is defined.

Blocking inputs for preventing the synchrocheck function from issuing an enable signal ('BlckTrigBus1', 'BlckTrigBus2', 'BlckTrigLine')

These are assigned to the corresponding voltage I/P's and used mainly when the v.t. circuit can be interrupted by fuse-failure equipment (miniature circuit-breakers). In such cases, the blocking I/P's are connected to auxiliary contacts on the fuse-failure equipment. This precaution eliminates any risk of the synchrocheck function permitting the closure of a circuit-breaker onto a line it considers to be de-energised, which in reality is under voltage.

Functionality of the blocking I/P's:

- Both busbar voltage I/P's have been configured:

Which of the blocking I/P's is enabled depends on which of the busbar I/P's 'uBus1Activ' and 'uBus2Activ' is active, i.e. on which voltage I/P is active:

'uBus1Activ'	'uBus2Activ'	Active blocking I/P's
(T) TRUE	(F) FALSE	'BlckTrigBus1' and 'BlckTrigLine'
(F) FALSE	(T) TRUE	'BlckTrigBus2' and 'BlckTrigLine'

Other combinations of the states of these two I/P's do not influence the blocking I/P's and the prevailing situation is maintained.

- If only one busbar voltage I/P is configured, all the blocking I/P's ('BlksyncBus1', 'BlksyncBus2' and 'BlckTrigLine') are enabled regardless of the states of the binary I/P's 'uBus1Activ' and 'uBus2Activ'.

The active blocking I/P's are connected to an OR function so that a logical '1' from any one of them causes all the measuring elements and the associated O/P's ('start', 'AmplDifOK', 'PhaseDifOK', 'FreqDifOK', 'LiveBus', 'LiveLine', 'DeadBus' and 'DeadLine') and also the enabling O/P ('PermitToClos') to reset. The algorithm of the synchrocheck function, however, continues to run.

Inputs for enabling the synchrocheck function ('ReleaseInp1', 'ReleaseInp2')

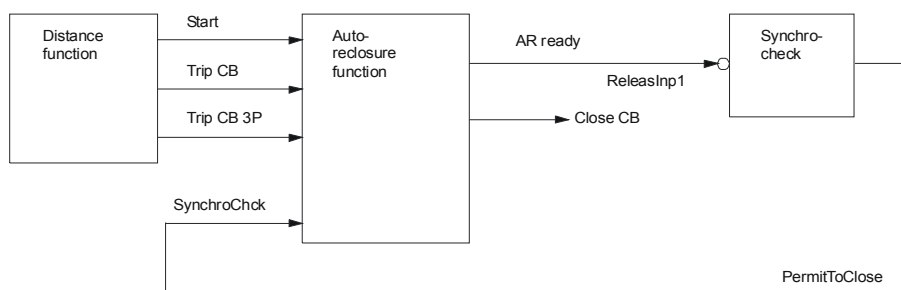
Since the synchrocheck function is only required during the relevant switching operations and auto-reclosure cycles, it may be blocked at all other times to save processor time. The binary I/P's 'ReleaseInp1' and 'ReleaseInp2' are used for this purpose. Internally they are the I/P's of an OR gate, so that at least one must be active before the synchrocheck program will run.

If neither of the two enabling signals is at logical '1', processing of the algorithm ceases. All the function's measuring element O/P's also reset immediately and any circuit-breaker close enabling signal ('PermitToClos') resets after the time set for 't-Reset'.

Conditional enabling of the synchrocheck function is especially recommended, where it has to operate in conjunction with other functions in the same unit such as distance protection, which are critical from the operating time point of view, so as not to adversely influence their tripping times.

Application example:

The scheme below shows a synchrocheck function in the same unit as the distance protection and autoreclosure functions. The synchrocheck function is only required during the dead times of the autoreclosure function. This is achieved by connecting the inverted O/P signal 'AR ready' generated by the autoreclosure function to the binary I/P 'ReleaseInp1' (or 'ReleaseInp2') of the synchrocheck unit.



HEST 965 020 C

Fig. 3.5.14.3 Block diagram showing the interconnections between the functions for a scheme with conditional enabling of the synchrocheck function

Input for bypassing the synchrocheck function ('OverridSync')

A signal applied to this binary I/P causes a 'PermitToClos' signal to be generated immediately regardless of whether the conditions for synchronism are fulfilled or not.

This I/P overrides all other blocking or enabling I/P's.

Inputs for remotely selecting the operating mode ('OpModeInp1', 'OpModeInp2')

Refer to "Choosing the operating mode of the synchrocheck function" in [Section 3.5.14.2](#). "Choosing the operating mode of the synchrocheck function".

3.5.15. Breaker failure protection (BreakerFailure)

A. Application

- Redundant tripping schemes (RED ¹⁾)
- Repeated tripping attempts (BFP ²⁾)
- Backup tripping (BFP)
- End fault protection (EFP ³⁾)
- Unconditional tripping (UT ⁴⁾)
- External trip initiation.

B. Features

- insensitive to DC component
- insensitive to harmonics
- single or three-phase operation
- blocking
- two independent timers (t1, t2)
- transfer tripping
- provision for disabling features (RED, BFP, EFP, UT)
- unique ID for each binary input and output.

C. Inputs and outputs

I. C.t./v.t. inputs

- current.

II. Binary inputs

- 13205 Block BFP
- 13710 Start L1
- 13720 Start L2
- 13730 Start L3
- 13740 Start L1L2L3
- 13705 External start
- 13770 CB Off
- 13775 CB On
- 13780 Ext. trip t2
- 13785 Ext. trip EFP

¹⁾ Redundant

²⁾ Breaker failure protection

³⁾ End fault protection

⁴⁾ Unconditional trip

III. Binary outputs

- 23305 Trip t1
- 23315 Trip t1 L1
- 23320 Trip t1 L2
- 23325 Trip t1 L3
- 23310 Trip t2
- 23340 Remote trip
- 23345 Red. Trip L1
- 23350 Red. Trip L2
- 23355 Red. Trip L3
- 23375 EFP Rem trip
- 23370 EFP Bus trip
- 23330 Repeat trip after t1
- 23360 Unconditional trip after t1
- 23380 External trip after t1
- 23335 Backup trip after t2
- 23365 Unconditional trip after t2

IV. Measurements

- Current amplitude L1
- Current amplitude L2
- Current amplitude L3.

D. Breaker failure protection settings – BreakerFailure

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
CB commands					
TRIP t1		B00000000			
TRIP t1 L1		B00000000			
TRIP t1 L2		B00000000			
TRIP t1 L3		B00000000			
TRIP t2		B00000000			
REMOTE TRIP		B00000000			
RED TRIP L1		B00000000			
RED TRIP L2		B00000000			
RED TRIP L3		B00000000			
EFP REM TRIP		B00000000			
EFP BUS TRIP		B00000000			

General parameters

ParSet4..1		P1	(Select)		
I Setting	IN	1.20	0.20	5.00	0.01
Delay t1	s	0.15	0.02	60.00	0.01
Delay t2	s	0.15	0.02	60.00	0.01
Delay tEFP	s	0.04	0.02	60.00	0.01
t Drop Retrip	s	0.05	0.02	60.00	0.01
t Drop BuTrip	s	0.05	0.02	60.00	0.01
t Puls RemTrip	s	0.05	0.02	60.00	0.01
t1 active		on	(Select)		
t2 active		on	(Select)		
RemTrip active		on	(Select)		
EFP active		on	(Select)		
Red active		on	(Select)		
Start Ext act.		on	(Select)		
RemTrip after		t1	(Select)		
NrOfPhases		3	1	3	2
CurrentInp	CT/VT-Addr	0			
Block BFP	BinaryAddr	F			

Text	Unit	Default	Min.	Max.	Step
Start L1	BinaryAddr	F			
Start L2	BinaryAddr	F			
Start L3	BinaryAddr	F			
Start L1L2L3	BinaryAddr	F			
External Start	BinaryAddr	F			
CB Off	BinaryAddr	F			
CB On	BinaryAddr	F			
Ext Trip t2	BinaryAddr	F			
Ext Trip EFP	BinaryAddr	F			
Trip t1	SignalAddr	ER			
Trip t1 L1	SignalAddr	ER			
Trip t1 L2	SignalAddr	ER			
Trip t1 L3	SignalAddr	ER			
Trip t2	SignalAddr	ER			
Remote Trip	SignalAddr	ER			
Red Trip L1	SignalAddr	ER			
Red Trip L2	SignalAddr	ER			
Red Trip L3	SignalAddr	ER			
EFP Rem Trip	SignalAddr	ER			
EFP Bus Trip	SignalAddr	ER			
Retrip t1	SignalAddr	ER			
Uncon Trip t1	SignalAddr	ER			
Ext Trip t1	SignalAddr	ER			
Backup Trip t2	SignalAddr	ER			
Uncon Trip t2	SignalAddr	ER			

Explanation of parameters:

TRIP t1

defines the tripping channel activated by the function's tripping output TRIP t1 (matrix tripping logic). This output is activated for a 'Retrip', 'External Trip Initiate' or 'Unconditional Trip'.

TRIP t1 L1, L2 or L3

defines the tripping channel activated by the function's tripping outputs TRIP t1 L1, L2 or L3 (matrix tripping logic). This output is activated for a phase segregated 'Retrip'.

TRIP t2

defines the tripping channel activated by the function's tripping output TRIP t2 (matrix tripping logic). This output is activated for a 'Backup Trip' or 'Unconditional Trip' the after second time step t2.

REMOTE TRIP

defines the tripping channel activated by the function's tripping output REMOTE TRIP (matrix tripping logic).

RED TRIP L1, L2 or L3

defines the tripping channel activated by the function's tripping outputs RED TRIP L1, L2 or L3 (matrix tripping logic).

EFP REM TRIP

defines the tripping channel activated by the function's tripping output EFP REM TRIP (matrix tripping logic).

EFP BUS TRIP

defines the tripping channel activated by the function's tripping output EFP BUS TRIP (matrix tripping logic).

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

I Setting

Pick-up of the current criterion for the breaker failure protection (BFP), end fault protection (EFP) and the redundant tripping logic (RED).

Delay t1

'Retrip' tripping delay

Delay t2

Backup tripping delay.

Delay tEFP

End fault protection delay.

t Drop Retrip

Reset delay for 'Retrip', 'Redundant Trip' and 'External Trip Initiate'.

t Drop BuTrip

Reset delay for backup tripping attempt.

t Puls RemTrip

Transfer tripping impulse width.

t1 active

defines whether timer t1 is enabled or disabled.

'on' Timer t1 enabled

'off' Timer t1 disabled.

t2 active

defines whether timer t2 is enabled or disabled.

'on' Timer t2 enabled

'off' Timer t2 disabled.

RemTrip active

defines whether transfer tripping is enabled or disabled.

'on' Transfer tripping enabled

'off' Transfer tripping disabled.

EFP active

defines whether the end fault protection is enabled or disabled.

'on' End fault protection enabled

'off' End fault protection disabled.

Red active

defines whether the redundant logic is enabled or disabled.

'on' Redundant tripping logic enabled

'off' Redundant tripping logic disabled.

Start Ext active

defines whether the unconditional tripping logic is enabled or disabled.

'on' Unconditional tripping logic enabled

'off' Unconditional tripping logic disabled.

RemTrip after

defines the delay for transfer tripping.

't1' after BFP time t1

't2' after BFP time t2.

NrOfPhases

defines the number of phases supervised.

'1' single-phase operation

'3' three-phase operation.

CurrentInp

defines the c.t. input channel. Single and three-phase c.t.'s can be set. The first channel (R phase) of the group of three selected must be specified for three-phase c.t.'s.

Block BFP

Input for blocking the function.

F: not blocked

T: blocked

xx: all binary inputs (or outputs of protection functions).

Start L1, L2 or L3

BFP or RED Start in phase L1, L2 or L3

F: disabled

T: enabled

xx: all binary inputs (or outputs of protection functions).

Start L1L2L3

BFP or RED Start in all three phases

F: disabled

T: enabled

xx: all binary inputs (or outputs of protection functions).

External Start

starts the unconditional trip.

F: disabled

T: enabled

xx: all binary inputs (or outputs of protection functions).

CB Off

signals that the circuit-breaker is fully open and also used to start the end zone fault protection.

F: CB not fully open

T: CB fully open

xx: all binary inputs (or outputs of protection functions).

CB On

signals that the circuit-breaker is fully closed.

F: CB not fully closed

T: CB fully closed

xx: all binary inputs (or outputs of protection functions).

Ext Trip t2

Input for signals from the other BFP units in the station.

- F: No external trip after t2
T: External trip after t2
xx: all binary inputs (or outputs of protection functions).

Ext Trip EFP

Input for signals from the end zone fault outputs of the other BFP units in the station.

- F: No trip for end zone fault
T: Trip for end zone fault
xx: all binary inputs (or outputs of protection functions).

Trip t1

signals a trip which is activated by one of the following logics:

- Repeat trip (see "Retrip t1")
- External trip (see "Ext Trip t1")
- Unconditional trip (see "UnconTrip t1").

Trip t1 L1, L2 or L3

signals a repeat trip of phase L1, L2 or L3.

Trip t2

signals a backup trip. This signal is activated by the following logics:

- Backup trip after t2 (see "Backup Trip t2")
- Unconditional trip after t2 (see "UnconTrip t2").

Remote Trip

signals a transfer trip.

Red Trip L1, L2 or L3

signals a redundant trip of phase L1, L2 or L3.

EFP Rem Trip

signals an end zone trip. This signal is an impulse of length 't Puls Rem Trip' generated when the EFP timer has timed out.

EFP Bus Trip

signals an end zone trip. This signal is generated when the EFP timer has timed out and resets 'tDrop Bu Trip' after the initiating signal has reset.

Retrip t1

signals a repeat trip after t1. This signal is generated when the BFP timer t1 in one of the phases has timed out.

Uncon Trip t1

signals an unconditional trip after t1. This signal is generated when the UT timer t1 has timed out.

Ext Trip t1

signals an external trip. This signal is generated when either the input "Ext Trip t2" or "Ext Trip EFP" is enabled.

Backup Trip t2

signals a backup trip after t2. This signal is generated when the BFP timer t2 has timed out.

Uncon Trip t2

signals an unconditional trip after t2. This signal is generated when the UT timer t2 has timed out.

E. Setting instructions

Settings:

Pick-up current setting:	I Setting
Tripping delay:	Delay t1 Delay t2 Delay tEFP
Rest delay:	t Drop Retrip t Drop BuTrip
Impulse:	t Puls RemTrip
Enabled signals:	t1 active t2 active RemTrip active EFP active Red active Start Ext active.

Pick-up current setting “I Setting”

If the BFP current detector pick-up setting is too low, there is a possibility that the detectors may reset too late after it has successfully tripped the circuit-breaker. This can be caused by damped oscillations on the secondary side of the c.t.

On the other hand, if the setting is too high, the BFP may fail to operate at all should, for example, the current fall below pick-up again due to severe c.t. saturation. A typical setting for the pick-up current is just below the minimum fault current that can occur on the respective line.

Tripping delays t1 and t2

The tripping delay settings enable the BFP to be adapted to its particular operating environment (e.g. circuit-breaker characteristics etc.). Fig. 3.5.15.1 shows a typical timing diagram for clearing a fault.

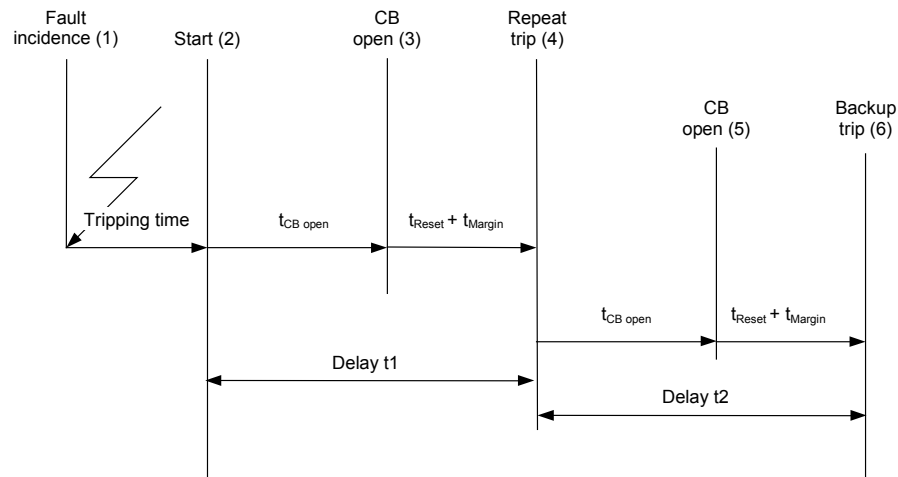


Fig. 3.5.15.1 Operation of the BFP/UT timers t1 and t2

Timing in the case of breaker failure:

- (1) A fault has occurred and been detected by a protective device.
- (2) A tripping command is transmitted to the circuit-breaker after the unit protection operating time which also starts the BFP. The tripping command can be either single (Start Lx) or three-phase (Start L1L2L3). The redundant signals are also activated at the same time.
- (3) The circuit-breaker ruptures the fault current.
- (4) After the reset delay t_{Reset} plus a safety margin t_{Margin} , the BFP either detects that the fault current has been interrupted and the protection function resets, or the fault current continues to flow and a second attempt is made by the BFP to trip the circuit-breaker.
- (5) The second attempt to trip the circuit-breaker is successful and the fault current is interrupted.

- (6) After a further reset delay t_{Reset} plus a safety margin t_{Margin} , the BFP either detects that the fault current has been interrupted and the protection function resets, or the fault current continues to flow and the BFP initiates backup tripping.

If the BFP is only required to carry out a single breaker failure step, timer t_1 can be disabled (see 't1 active'). The response of the BFP corresponds once again to [Fig. 3.5.15.1](#), but with timer t_1 set to zero.

Timing in the case of an unconditional trip:

- (1) A fault has occurred and been detected by a protective device.
- (2) A signal at input 'Ext Start' starts the UT function.
- (3) The circuit-breaker ruptures the fault current.
- (4) If after the reset delay t_{Reset} plus a safety margin t_{Margin} , the CB auxiliary contact "CB On" still signals to the UT that the CB is closed, a second attempt is made by the UT function to trip the circuit-breaker.
- (5) The second attempt to trip the circuit-breaker is successful and the fault current is interrupted.
- (6) If after a further reset delay t_{Reset} plus a safety margin t_{Margin} the CB auxiliary contact "CB On" still signals to the UT that the CB is closed, backup tripping is initiated by the UT function.

$$\text{Delay } t_1 \geq t_{\text{CB open}} + t_{\text{Reset}} + t_{\text{Margin}}$$

$$\text{Delay } t_2 \geq t_{\text{CB open}} + t_{\text{Reset}} + t_{\text{Margin}}$$

$t_{\text{CB open}}$ CB opening time including arc extinction time

t_{Reset} Reset time of the current criterion ¹⁾

t_{Margin} Allowance for variations in normal fault clearing times ²⁾

¹⁾ see reset time of the current detector t_{Reset}

²⁾ see safety margin t_{Margin}

Tripping delay t_{EFP}

The setting for t_{EFP} can be seen from Fig. 3.5.15.2 which shows a typical timing diagram for tripping a fault.

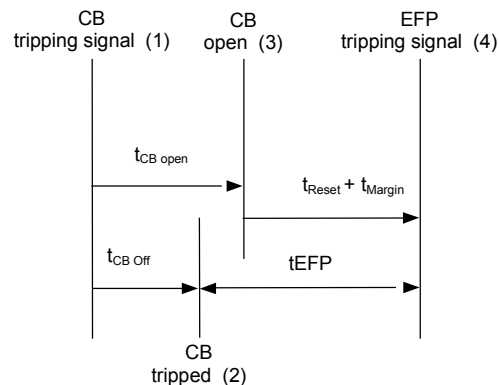


Fig. 3.5.15.2 Timing diagram for an end zone fault

- (1) Tripping command applied to the CB.
- (2) CB auxiliary contact sends a signal that the CB is open to the “CB Off” input of the function which is used to start the EFP.
- (3) The circuit-breaker ruptures the fault current.
- (4) After a reset delay plus a safety margin, the current unit either detects that the fault current has been interrupted and the EFP function resets, or the fault current continues to flow and an EFP signal is issued.

$$t_{\text{EFP}} \geq t_{\text{CB open}} - t_{\text{CB Off}} + t_{\text{Reset}} + t_{\text{Margin}}$$

t_{CB open} CB opening time including arc extinction time

t_{CB Off} CB opening time of the CB auxiliary contact (Signal „CB open“)

t_{Reset} Reset time of the current detector ³⁾

t_{Margin} Allowance for variations in normal fault clearing time ⁴⁾

³⁾ see reset time of the current detector t_{Reset}

⁴⁾ see Margin time t_{Margin}

Reset time of the current detector t_{Reset}

The current detector reset time is determined by the power system configuration as follows:

- Power system time constant up to 300 ms
- Fault current up to $40 I_N$

Primary c.t.'s TPX: $t_{\text{Reset}} = 28 \text{ ms } (I_{\text{Setting}} \geq 0.2 I_N)$

Primary c.t.'s TPY: $t_{\text{Reset}} = 28 \text{ ms } (I_{\text{Setting}} \geq 1.2 I_N)$
 $t_{\text{Reset}} = 38 \text{ ms } (I_{\text{Setting}} \geq 0.4 I_N)$

Safety margin t_{Margin}

A safety margin of 20 ms is recommended.

Reset times 't Drop Retrip' and 't Drop BuTrip'

The function includes two independently adjustable signal reset delays.

't Drop Retrip' determines the reset delay for the following signals:

23305 Trip t1
23315 Trip t1 L1
23320 Trip t1 L2
23325 Trip t1 L3
23345 Red Trip L1
23350 Red Trip L2
23355 Red Trip L3
23330 Retrip t1
23360 Uncon Trip t1
23380 Ext Trip t1.

't Drop BuTrip' determines the reset delay for the following signals:

23310 Trip t2
23370 EFP Bus Trip
23335 Backup Trip t2
23365 Uncon Trip t2.

Impulse ‘t Puls RemTrip’

‘t Puls RemTrip’ determines the width of the transfer tripping impulse for the following signals:

23340 Remote Trip

23375 EFP Rem Trip.

Enabling and disabling the various features

A number of the function’s features can be enabled and disabled.

t1 active

This setting provides facility for disabling the timer t1. When it is disabled, none of the “repeat trip” group of signals is generated.

t2 active

This setting provides facility for disabling the timer t2. When it is disabled, none of the “backup trip” group of signals is generated.

RemTrip active

This setting provides facility for disabling transfer tripping. When it is disabled, none of the “remote trip” group of signals is generated.

EFP active

This setting provides facility for disabling the end fault protection. When it is disabled, none of the “end fault” group of signals is generated.

Red active

This setting provides facility for disabling the redundant protection. When it is disabled, none of the “redundant” group of signals is generated.

Start Ext act.

This setting provides facility for disabling the unconditional trip feature. When it is disabled, none of the “unconditional trip” group of signals is generated.

3.6. Control functions

3.6.1. Control function (FUPLA)

A. Application

The control function is designed to perform data acquisition, monitoring, and control functions in MV and HV substations. The control logic of a switchgear bay can be configured for SF₆ gas-insulated switchgear (GIS), for indoor and outdoor switchgear and for single, double or multiple busbar stations.

The control function registers and processes the switchgear position signals, the measured variables and the alarms occurring in a switchgear bay. The corresponding data are then made available at the communication interface (IBB).

The control function receives instructions from the station control system (SCS) or from the local mimic, processes them in relation to the bay control logic configuration and then executes them.

The interlocks included in the control function device prevent inadmissible switching operations, which could cause damage to plant or endanger personnel.

B. Features

The control function depends on the particular application for which it is specifically created using CAP 316. It includes essentially:

- detection and plausibility check of switchgear position signals
- switchgear control
- interlocks
- monitoring of switchgear commands
- run-time supervision
- integration of the local mimic
- detection of alarms and alarm logic
- processing of measured variables.

Eight FUPLA functions can be configured. The total maximum size of FUPLA code for all the functions is 128 kB. The FUPLA function cannot be copied and not configured as 48th function. The function plan programming language CAP 316 is described in the publication 1MRB520059-Uen.

C. Inputs and outputs**I. C.t./v.t. inputs:**

- Constants, measured protection variables, IBB inputs and sampled values

II. Analogue outputs:

- Measured variable outputs

III. Binary inputs:

- Blocking input, binary input for blocking FUPLA
- Binary inputs from the IBB, the system and protection functions

IV. Binary outputs:

- Binary outputs to the IBB, the system, protection functions and for event processing

V. Measurements:

- Measured variable outputs.

3.6.1.1. Control function settings - FUPLA

When reconfiguring the FUPLA function, the directory where the files 'project1.bin' and 'project.cfg' are located must be entered before all other parameters. The project name in the file 'project1.bin' is used automatically as the name of the FUPLA function, but the name can be changed later.

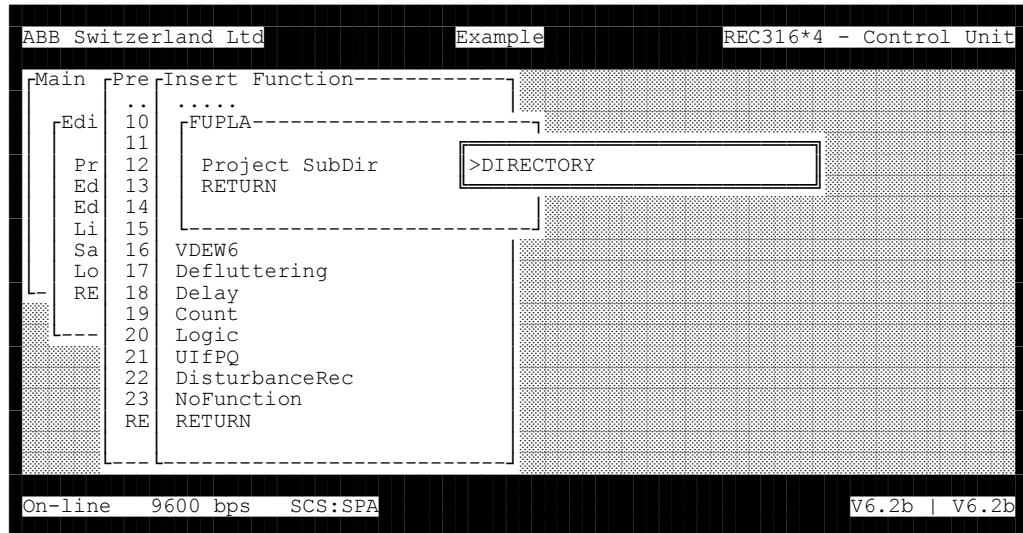


Fig. 3.6.1.1 Entering the FUPLA directory

The individual parameters can then be entered.

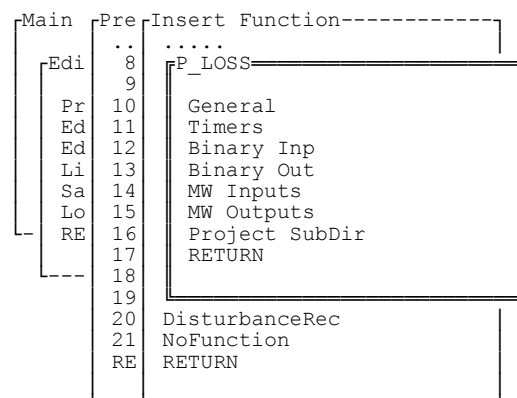


Fig. 3.6.1.2 Entering the individual parameters

3.6.1.1.1. General

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
RepetitRate		low	low	high	1
Cycl. time ho	ms	20	0	1000	1
Blocking	BinaryAddr	F			

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

RepetitRate

Determines the number of FUPLA runs per cycle.

high: four FUPLA runs per cycle

medium: two FUPLA runs per cycle

low: one FUPLA run per cycle.

Cycl. time

Determines the interval between FUPLA starts.

Blocking

(F → FALSE, T → TRUE, system binary input, protection function binary output or input via the IBB).

This blocks FUPLA.

3.6.1.1.2. **Timers**

EXTIN signals of the time factor type and signals belonging to the TMSEC group are displayed in this window.

The signals can be connected to the following sources:

- **Measured variable constant**

Setting range and resolution:

TMSEC signal group:	0...60.000 s,	for TON
	0...50.00 s,	for TONS
TIMEFACTOR signal group:	0...4000 s,	for TONL

- **Protection function binary output (measured variable)**

Observe the factors ms (TON), 10 ms (TONS), 1 s (TONL).

- **Input from the IBB**

Observe the factors ms (TON), 10 ms (TONS), 1 s (TONL).

3.6.1.1.3. **Binary inputs**

Binary inputs can be connected to the following sources:

- Always ON ("1")
- Always OFF ("0")
- Binary system inputs
- Protection function binary outputs
- Inputs from the IBB: 768 inputs in 24 groups of 32 signals each.

3.6.1.1.4. **Binary signals**

Binary signals can be connected to the following sinks:

- LED's
- Signalling relays
- Event processor (excluding 'BinExtOut' blocks)
- Protection function binary inputs
- Tripping channels
- Outputs to the IBB: 768 inputs in 24 groups of 32 signals each.

3.6.1.1.5. *Measurement inputs*

Measurement inputs can be connected to the following sources:

- Measured variable constant, integer or percent range.
- Protection function measured variable, the range for angles is $\pm 180.00^\circ$ and currents and voltages are transferred in the corresponding units.
- Input from the IBB, integer range.
- C.t./v.t. input channels.

3.6.1.1.6. *Measurement outputs*

Measurement outputs can be connected to the following sinks:

- Measurements Nos. 1...64.

3.6.1.1.7. *Flow chart for measurement inputs and outputs*

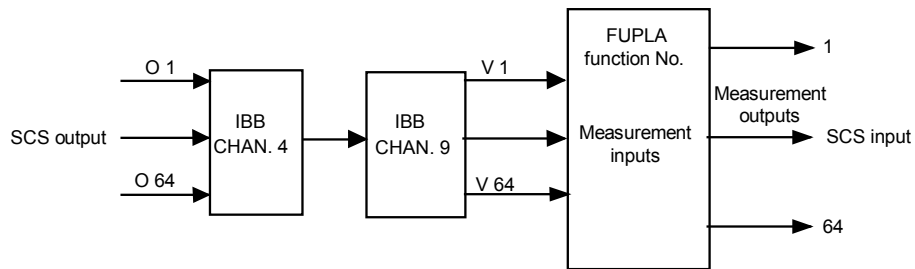


Fig. 3.6.1.3 Flowchart for measured variable inputs and outputs

IBB channel No. 4 is write-only and IBB channel No. 9 read-only. The range of values for IBB channel No. 4 is -32768...+32767 which corresponds to a 16 Bit integer.

3.6.1.2. Loading FUPLA

The FUPLA code has to be loaded again each time the FUPLA configuration is changed. After making internal FUPLA changes and copying the new versions of the files 'project1.bin' and 'project.cfg' to the FUPLA directory, select "Editor" from the main menu and then 'RETURN' to load the new FUPLA code.

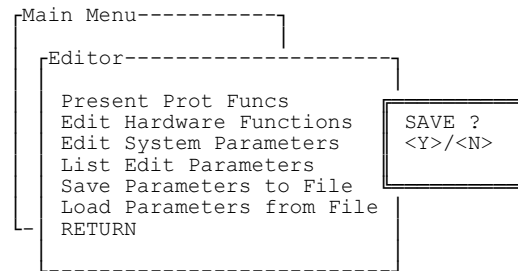


Fig. 3.6.1.4 Editor, Save ?

3.6.2. **Logic (Logic)**

A. Application

Logical combination of binary input signals or of output signals from the protection functions, e.g. for

- specific signals required by the application
- supplementary protection functions.

B. Features

- binary I/P channels assignable to
 - binary I/P signals
 - protection function O/P signals
- All I/P channels can be inverted
- Following logic functions available for selection:
 - OR gate with 4 I/P's
 - AND gate with 4 I/P's
 - R/S flip-flop with 2 I/P's for setting and 2 I/P's for resetting:
 - The O/P is "0", if at least one of the reset I/P's is "1".
 - The O/P is "1", if at least one of the set I/P's is "1" AND none of the reset I/P's is "1".
 - The O/P status is sustained when all the I/P's are at "0".
- Every logic has an additional blocking I/P, which when activated switches the O/P to "0".

C. Inputs and outputs

I. C.t./v.t. inputs:

- none

II. Binary inputs:

- 4 logic inputs
- blocking

III. Binary O/P's:

- tripping

IV. Measurements:

- none.

D. Logic function settings - Logic

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Logic Mode		OR	(Select)		
BinOutput	SignalAddr	ER			
BlockInp	BinaryAddr	F			
BinInp1 (R1)	BinaryAddr	F			
BinInp2 (R2)	BinaryAddr	F			
BinInp3 (S1)	BinaryAddr	F			
BinInp4 (S2)	BinaryAddr	F			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Definition of the tripping circuit excited by the function's O/P (tripping matrix).

Logic Mode

Definition of the logic function to be performed by the 4 binary I/P's. Possible settings:

- OR: OR gate with all 4 binary I/P's
- AND: AND gate with all 4 binary I/P's
- R/S flip-flop: Flip-flop with 2 set I/P's (S1 and S2) and 2 reset I/P's (R1 and R2). The O/P is set or reset when at least one of the corresponding I/P's is at logical "1" (OR gate). Reset I/P's take priority over the set I/P's.

BinOutput

Output for signalling a trip.

BlockInp

Input for blocking the function.

F: - not used

xx: - all binary inputs (or outputs of protection functions).

The O/P is always at logical "0" when the blocking I/P is at logical "1".

The blocking I/P acts as a reset I/P for the flip-flop function.

BinInp1 (R1), BinInp2 (R2), BinInp3 (S1), BinInp4 (S2)

Binary inputs 1 to 4 (AND or OR function)

Reset inputs 1 and 2 and set inputs 1 and 2 (RS flip-flop)

F: - not used (OR logic or RS flip-flop)

T: - not used (AND logic)

xx: - all binary inputs (or outputs of protection functions).

3.6.3. ***Delay / integrator (Delay)***

A. Application

General purpose timer for

- integration of pulsating binary signals to obtain a continuous signal, e.g. output of the loss-of-excitation function (out-of-step protection) or reverse power protection
- extension of short I/P signals (pulse prolongation)
- simple time delay.

B. Features

- I/P channel and blocking input assignable to
 - binary I/P signals
 - protection function output signals
- I/P channel and blocking input can be inverted.
- adjustable reset time
- 2 types of time delay
 - Integration: Only the time during which the I/P signal is at logical "1" counts at the end of the time delay.
 - No integration: The total time from the instant the timer starts until it is either reset or expires counts.

C. Inputs and outputs

I. C.t./v.t. inputs:

- none

II. Binary inputs:

- input signal
- blocking

III. Binary outputs:

- pick-up
- tripping

IV. Measurements:

- time from the instant the timer starts.

D. Delay/integrator function settings - Delay

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Trip-Delay	s	01.00	00.00	300.00	0.01
Reset-Delay	s	00.01	00.00	300.00	0.01
Integration	0/1	0	0	1	1
BinaryInp	BinaryAddr	F			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Definition of the tripping logic (matrix) excited by the function's output.

Trip-Delay

Time between start signal at the input and the tripping signal at the output.

Reset-Delay

Time required for the timer to reset after the input signal has disappeared.

Integration

Determination of the response of the function in the presence of a pulsating I/P signal:

- 0: The delay continues to run, providing the I/P signal does not disappear for longer than the reset time ([see Fig. 3.6.3.1](#)).
- 1: The time during which the I/P is at logical "1" is integrated, i.e. tripping does not take place until the sum of logical "1" time equals the set delay time ([see Fig. 3.6.3.2](#)).

BinaryInp

Timer input.

xx: - all binary inputs (or outputs of protection functions).

BlockInp

Input for blocking the function.

F: - enabled

T: - disabled

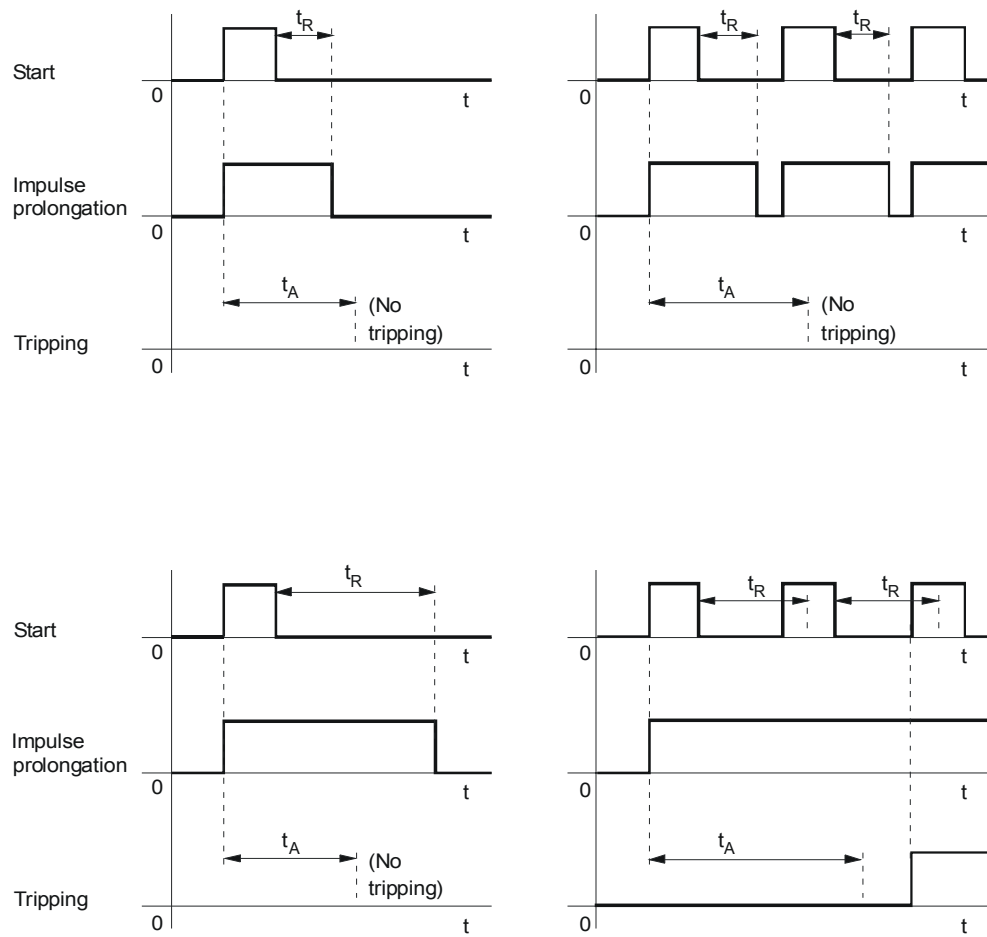
xx: - all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.



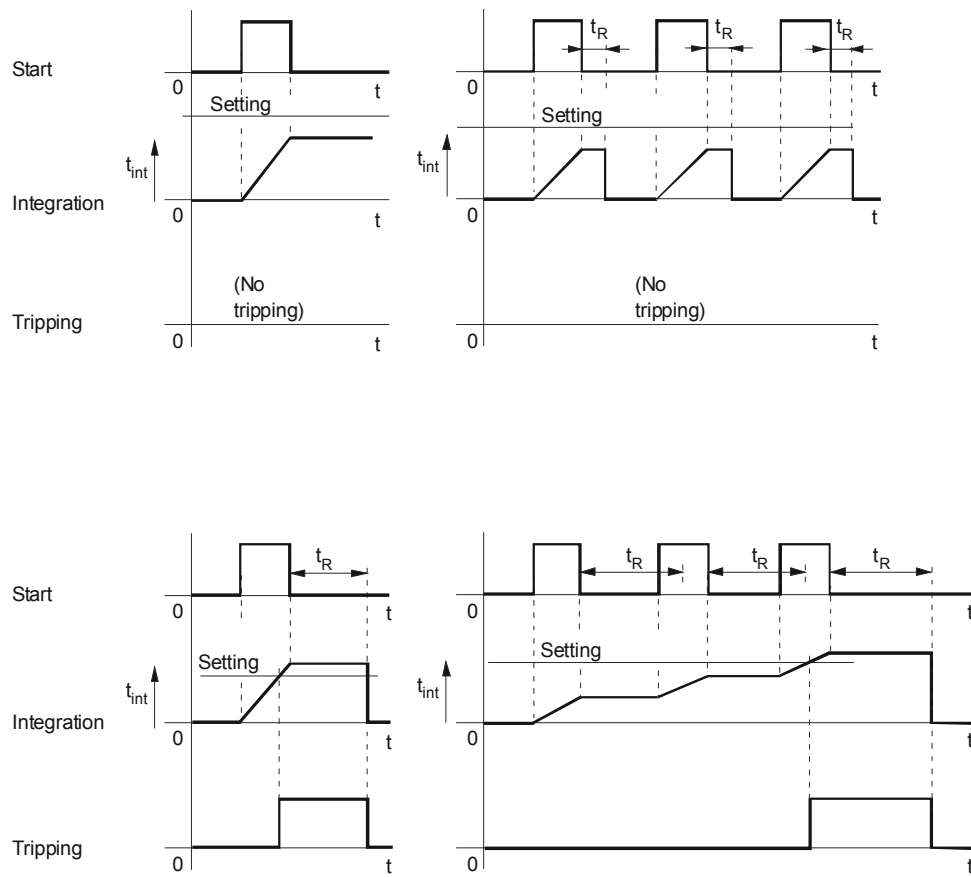
HEST 935 019 C

Note: Tripping only takes place, if a start also occurs within the time t_R .

t_A tripping time ("Trip-Delay")

t_R reset time ("Reset-Delay")

Fig. 3.6.3.1 Operation of the "Delay" function without integration



HEST 935 020 C

t_{int} integrated time for tripping
 t_R reset time ("Reset-Delay")
 Setting "Trip-Delay"

Fig. 3.6.3.2 Operation of the "Delay" function with integration

3.6.4. *Contact bounce filter (Debounce)*

A. Application

Suppresses the contact bounce phenomena of binary signals. This function is only used for the signals of binary input modules.

B. Features

- Adjustable maximum bounce time
- The first edge of the respective input signal is prolonged by the time 'SupervisTime'.

C. Inputs and outputs

I. C.t./v.t. inputs:

- none

II. Binary inputs:

- Binary signals (input signals)

III. Binary outputs:

- none

IV. Measurements:

- none.

D. Contact bounce filter settings - Debounce

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
BinInp 1	BinaryAddr	F			
SupervisTime	Setting	1 ms	1 ms	10000 ms	1 ms
BinInp 2	BinaryAddr	F			
SupervisTime	Setting	1 ms	1 ms	10000 ms	1 ms
BinInp 3	BinaryAddr	F			
SupervisTime	Setting	1 ms	1 ms	10000 ms	1 ms
.					
.					
BinInp 16	BinaryAddr	F			
SupervisTime	Setting	1 ms	1 ms	10000 ms	1 ms

Explanation of parameters:

BinInp 1...16

Binary inputs Nos. 1...16

F: - not used

xx: - all binary inputs.

SupervisTime

Maximum bounce time setting.

E. Setting instructions

The first edge of the input signal is prolonged by the time set for 'SupervisTime'.

Connect functions requiring filtered signals to the correct binary inputs to start with.

The contact bounce filter 'Debounce' may only be configured once per set of parameters.

3.6.5. LDU events (*LDUevents*)

A. Application

Generates events that can be viewed on the local display unit (LDU) and provides facility for setting a user name.

B. Features

- binary input that can be set by
 - a binary input signal
 - an output signal from a protection function
- provision for inverting signals applied to the inputs
- direct connection of input to output: input 1 controls output 1, input 2 control output 2 etc.
- additional blocking input for entire function: all outputs are reset to logical “0” when blocking input at logical “1”.

An event lists the name of the signal connected to the input and not the name of the output.

C. Inputs and outputs

I. C.t./v.t. inputs:

- None

II. Binary inputs:

- 4 independent inputs
- Blocking

III. Binary outputs:

- 4 independent outputs

IV. Measurements

- None.

D. LDU event function settings – LDUEvents

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		000000000			
BlockInp	BinaryAddr	F			
BinInput1	BinaryAddr	F			
BinInput2	BinaryAddr	F			
BinInput3	BinaryAddr	F			
BinInput 4	BinaryAddr	F			
BinOutput1	SignalAddr	ER			
BinOutput2	SignalAddr	ER			
BinOutput3	SignalAddr	ER			
BinOutput4	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Does not perform any function, always “0”.

BlockInp

Binary address used as blocking input.

F: - not used

xx: - all binary inputs (or outputs of a protection function).

All outputs at logical “0” when the blocking input is active.

BinInput1, BinInput2, BinInput3, BinInput4

Binary inputs 1 to 4: Every input acts directly on the corresponding output and can only be influenced by the inversion and blocking parameters.

BinOutput1, BinOutput2, BinOutput3, BinOutput4

Signalling outputs 1 to 4: Every input acts directly on the corresponding output. Whether an output is recorded as an event can be enabled or disabled. When it is enabled, it appears on the local display.

Note:

In contrast to all other functions, the name of the signal connected to the corresponding input appears in the event list instead of the name of the output. A function can therefore be given a descriptive, easily understood name that appear in the event list and on the local display.

3.6.6. Counter (Counter)**A. Application**

General counters, e.g. for

- counting the output impulses of the field failure or reverse power protection functions
- prolongation of short input signals.

B. Features

- Input channel and blocking input can be set by
 - Binary input signals
 - Output signal from a protection function
- Provision for inverting signals applied to the inputs.

C. Inputs and outputs**I. C.t./v.t. inputs**

- None

II. Binary inputs

- Input signal
- Blocking

III. Binary outputs

- Start
- Trip

IV. Measurements

- Count reached.

D. Counter settings - Count

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
Count-Thresh		1	1	100	1
Drop-Time	s	00.04	00.01	30.00	00.01
Reset delay	s	010.0	000.1	300.0	000.1
BinaryInp	BinaryAddr	F			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			
Start	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

defines the tripping channel activated by the tripping O/P of the function (matrix tripping logic).

Count-Thresh

Number of input impulses counted by the counter before it trips.

Drop time

Time the counter output signal is maintained after the input signal causing it has reset.

Reset-Delay

Time after the input signal has reset before the counter is reset to zero if it did not trip.

BinaryInp

Counter input

xx: - all binary inputs (or outputs of protection functions).

BlockInp

defines the input for an external blocking signal.

F: - function enabled

T: - function disabled

xx: - all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Start

Pick-up signal.

3.6.7. Signal flutter detector (Defluttering)

A. Application

Suppresses the recording of multiple events for binary signals subject to contact bounce.

B. Features

- Input channels can be set by
 - Binary input signals
 - Output signals (trips) from protection functions
 - Provision for inverting signals applied to the inputs
 - Adjustable supervision time and permissible signal change
- Two outputs assigned to each input:
 - Signal flutter detected (too many signal changes during the supervision time)
 - Image of the status of the input signal

C. Inputs and outputs

I. C.t./v.t. inputs

- None

II. Binary inputs

- Binary signals (input signals)

III. Binary outputs

- Signal flutter detected
- Image of the input signal status

IV. Measurements

- None.

D. Signal flutter detector settings - Defluttering

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
SupervisTime	s	1.0	0.1	60.0	0.1
NrOfChanges		2	2	100	1
BinInp 1	BinaryAddr	F			
BinInp 2	BinaryAddr	F			
BinInp 3	BinaryAddr	F			
BinInp 4	BinaryAddr	F			
StateOfInp	SignalAddr	ER			
StateOfInp	SignalAddr	ER			
StateOfInp	SignalAddr	ER			
StateOfInp	SignalAddr	ER			
FlutterMess1	SignalAddr	ER			
FlutterMess2	SignalAddr	ER			
FlutterMess3	SignalAddr	ER			
FlutterMess4	SignalAddr	ER			

Explanation of parameters:

ParSet4..1

Parameter for determining in which set of parameters a particular function is active.

SupervisTime

defines the time during which multiple signals count as signal flutter.

NoOfChanges

defines the number of signal changes during the supervision time to count as signal flutter. If a higher number of signal changes is detected during the supervision time, the signal is deemed to be fluttering.

BinInp 1

Binary input No. 1

F: - function disabled

xx: - all binary inputs (or outputs of protection functions).

BinInp 2

Binary input No. 2

F: - function disabled

xx: - all binary inputs (or outputs of protection functions).

BinInp 3

Binary input No. 3

F: - function disabled

xx: - all binary inputs (or outputs of protection functions).

BinInp 4

Binary input No. 4

F: - function disabled

xx: - all binary inputs (or outputs of protection functions).

StateOfInp

signals the status of input No. 1

StateOfInp

signals the status of input No. 2

StateOfInp

signals the status of input No. 3

StateOfInp

signals the status of input No. 4

FlutterMess1

signals that flutter detected on input No. 1

FlutterMess2

signals that flutter detected on input No. 2

FlutterMess3

signals that flutter detected on input No. 3

FlutterMess4

signals that flutter detected on input No. 4

E. Setting instructions

General:

If a signal at an input changes its state in a given period of time (SupervisTime) more frequently than a given number of times (NoOfChanges), the input is deemed to be fluttering due, for example, to contact bounce. As a result, no further signal changes at the input are recorded as events. Its basic protective function, however, remains intact. This condition is maintained until fewer signal changes are counted than the number defined for the given period.

Settings:

Supervision time	SupervisTime
Number of signal changes permissible	NoOfChanges

The function's counters continuously count the signal changes at the inputs selected. They are reset at the end of each supervision period. Should the number of signal changes counted during the period exceed the maximum permissible for the input, the input is tagged as fluttering and the corresponding output set. The 'fluttering' condition is maintained for as long as the number of signal changes is higher the set limit and is only cancelled and the output reset when a smaller number of changes is counted during the period.

To prevent the flutter function from fluttering itself (i.e. the number of changes of an input is just about equal to the number of changes setting), the number of changes for resetting to the non-fluttering state must be less than the number of changes required for pick-up minus ten percent, but at least one change less when the number of changes for pick-up is set to less than ten.

Note that the start and finish of a supervision period is not signalled externally. It can therefore occur that fluttering is not signalled although the number of changes briefly exceeded the maximum permissible, but the excess happened to straddle two supervision periods.

Typical settings:

SupervisTime 10 s

NoOfChanges 20

3.7. Measurement functions

3.7.1. Measurement function (UlfPQ)

A. Application

Measurement of voltage, current, real and apparent power and frequency, e.g. for display on the monitor of the control unit or for transferring to a high level station control system for further processing.

B. Features

- single-phase measurement (1 voltage and 1 current I/P)
- phase-to-ground or optionally phase-to-phase voltage measurement (providing three-phase Y connected v.t's are installed)
- evaluation of the fundamental frequency components
- high accuracy in the frequency range $(0.9 \dots 1.1) f_N$
- frequency of voltage measured unless voltage too low, in which case current is measured; if both are too low, the result is set to rated frequency
- at least 1 measurement per second
- filters for voltage and current DC components
- filters for voltage and current harmonics
- provision for compensation of connection and measurement phase errors.

C. Inputs and outputs

I. C.t./v.t. inputs

- voltage
- current

II. Binary inputs

- none

III. Binary outputs

- none

IV. Measurements:

• voltage	(unit UN)
• current	(unit IN)
• real power	(unit PN (P))
• apparent power	(unit PN (Q))
• frequency	(unit Hz).

D. Measurement function settings - UlfPQ

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet. 4..1		P1	(Select)		
CurrentInp	CT/VT-Addr	0			
Angle	degrees	0.000	-180.0	180.0	0.1
VoltageInp.	CT/VT-Addr	0			
PN-Setting	UN*IN	1.000	0.200	2.500	0.001
Voltage mode		direct	(Select)		

Explanation of parameters

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

CurrentInp

Defines the c.t. input channel.

All current inputs are available for selection.

Angle

Characteristic angle for measuring real power. The phase-angle is also taken into account when measuring apparent power.

The default setting of 0.0 degrees should not be changed, when voltage and current I/P's are in phase when measuring purely real power, e.g. when measuring the phase-to-ground voltage and current of the same conductor.

The setting may vary from 0.0 in the following cases:

- compensation of c.t. and v.t. phase errors
- compensation of the phase-shift between phase-to-ground and phase-to-phase voltages
- compensation of the phase-shift between voltage and current in general (e.g. when measuring S-T voltage and R current).

VoltageInp

Defines the v.t. input channel.

All voltage I/P's are available for selection.

PN

Rated power corresponding to $U_N \times I_N$.

This enables the amplitude of the measured power to be adjusted, for example, to equal the rated power factor of a generator.

Voltage mode

Definition of the method of voltage measurement and therefore also the calculation of power. Possible settings:

- direct The voltage of the selected voltage I/P is measured directly.
- delta The phase-to-phase voltage formed by the selected voltage I/P and the cyclically lagging voltage channel is measured.
This setting is not permitted when only a single-phase is connected or when phase-to-phase voltages are connected.

E. Setting instructions

The measurement function must be carefully set to obtain the best accuracy. The following must be observed:

- C.t./v.t. input channel reference values
The reference values for the voltage and current input channels must be set such that, when the rated values are applied to the inputs, 1.000 UN and 1.000 IN are measured by the function.

In most cases it will be possible to retain the default reference setting (1.000) for the c.t. and v.t. input channels. Note that any changes made to the reference value of a three-phase voltage or current I/P applies to all phases.
- “Angle” setting for phase error compensation
The parameter “Phase-angle” must be correctly set in order to measure real and apparent power correctly. In most cases it will be possible to retain the default reference setting of 0.0 degrees when measuring the phase-to-ground voltage and current of the same conductor.

Other settings may be necessary in the following cases:

- a) A phase-to-phase voltage is being measured, e.g. measurement of the R phase current in relation to the R - S voltage:
=> phase compensation: +30.0°
- b) Compensation of c.t. and v.t. phase errors.
=> phase compensation: according to calibration, e.g. (–5.0°...+5.0°)
- c) Change of measuring direction or correction of c.t. or v.t. polarity.
=> phase compensation: +180.0° or –180°

Where several of these factors have to be taken into consideration, the phase compensation in all the cases must be added and the resultant set.

The angles given apply for connection according to the connections in [Section 12](#).

- Power reference value “PN”
In most cases it will be possible to retain the default reference setting (1.000). Since the errors in the voltage and current reference values add geometrically, a fine setting is recommended to achieve the best possible accuracy.

Check the settings for “Angle” and “PN” using an accurate test set according to the following procedure:

- a) Inject purely active power at rated voltage and current.
- b) The active power measurement must be as close as possible to 1.000 or oscillate symmetrically to either side of it.
→ Adjust the value of “PN” as necessary.
- c) The reactive power measurement must be as close as possible to 0.000 or oscillate symmetrically to either side of it.
→ Adjust the value of “Angle” as necessary.

3.7.2. **Three-phase current plausibility (Check-I3ph)**

A. Application

Checking the plausibility of the three-phase current inputs for

- monitoring the symmetry of the three-phase system
- detection of a residual current
- supervision of the c.t. input channels.

B. Features

- evaluation of
 - the sum of the three phase currents
 - the sequence of the three phase currents
- provision for comparing the sum of the three phase currents with a residual current I/P
- adjustment of residual current amplitude
- blocking at high currents (higher than $2 \times I_N$)
- blocking of phase-sequence monitoring at low currents (below $0.05 \times I_N$)
- insensitive to DC components
- insensitive to harmonics.

C. Inputs and outputs

I. C.t./v.t. inputs:

- phase currents
- neutral current (optional)

II. Binary inputs:

- blocking

III. Binary outputs:

- tripping

IV. Measurements:

- difference between the vector sum of the three phase currents and the neutral current.

D. Current plausibility function settings - Check-I3ph

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip		00000000			
I-Setting	IN	0.20	0.05	1.00	0.05
Delay	s	10.0	0.1	60.0	0.1
CT-Compens		01.00	-2.00	+2.00	0.01
CurrentInp	CT/VT-Addr	0			
SumInp.	CT/VT-Addr	0			
BlockInp	BinaryAddr	F			
Trip	SignalAddr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Definition of the tripping logic (matrix) excited by the function's O/P.

I-Setting

Current setting for tripping.

Delay

Time between start signal at the I/P and the tripping signal at the O/P.

Forbidden settings:

≤ 1 s for current settings $\leq 0.2 I_N$.

CT-Compens

Amplitude compensation factor for the residual current I/P, enabling different transformation ratios of the main c.t.'s for phase and residual currents to be equalised.

The polarity of the residual current can be reversed by entering negative values.

CurrentInp

Defines the current input channel.

Any of the three-phase current I/P's may be selected.

The first channel (R phase) of a three-phase group is entered.

SumInp

Defines the neutral current input channel.

Any of the single-phase current I/P's may be selected.

BlockInp

Input for blocking the function.

F: - enabled

T: - disabled

xx: - all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Note:

If the phase sequence is incorrect, tripping takes place regardless of setting (I-Setting).

3.7.3. *Three-phase voltage plausibility (Check-U3ph)*

A. Application

Checking the plausibility of the three-phase voltage inputs for

- detection of residual voltage
- monitoring the asymmetry of the three-phase voltage system due to the zero-sequence component
- supervision of the v.t. input channels.

B. Features

Evaluation of

- the sum of the three phase voltages
- the sequence of the three phase voltages
- provision for comparing the sum of the three phase voltages with a residual voltage I/P
- adjustment of residual voltage amplitude
- blocking at high voltages (higher than $1.2 \times U_N$)
- blocking of phase-sequence monitoring at low voltages (below $0.4 \times U_N$ phase-to-phase)
- insensitive to DC components
- insensitive to harmonics.

Evaluation of the phase voltages is only possible in the case of Y connected input transformers, otherwise the residual component cannot be detected.

C. Inputs and outputs

I. C.t./v.t. inputs:

- phase voltages
- neutral voltage (optional)

II. Binary inputs:

- Blocking

III. Binary outputs:

- tripping

IV. Measurements:

- Difference between the vector sum of the three phase voltages and the neutral voltage.

D. Voltage plausibility function settings - Check-U3ph

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
Trip	00000000				
V-Setting	UN	0.20	0.05	1.20	0.1
Delay	s	10.0	0.1	60.0	0.1
VT-Compens		01.00	-2.00	+2.00	0.01
VoltageInp	CT/VT-Addr	0			
SumInp	CT/VT-Addr	0			
BlockInp	BinaryAddr	F			
Trip	Signaladdr	ER			

Explanation of parameters:

ParSet 4..1

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

Trip

Definition of the tripping logic (matrix) excited by the function's output.

V-Setting

Voltage setting for tripping.

Delay

Time between start signal at the I/P and the tripping signal at the O/P.

Forbidden setting:

$\leq 1 \text{ s}$ for voltage settings $\leq 0.2 U_N$.

VT-Compens

Amplitude compensation factor for the residual voltage I/P, enabling different transformation ratios of the main v.t's for phase and residual voltages to be equalised.

The polarity of the residual voltage can be reversed by entering negative values.

VoltageInp

Defines the voltage input channel.

Any of the three-phase voltage inputs may be selected.

The first channel (R phase) of a three-phase group is entered.

Not applicable with delta connected v.t's.

SumInp

Defines the neutral voltage input channel.

Any of the single-phase voltage inputs may be selected.

BlockInp

Input for blocking the function.

F: - enabled

T: - disabled

xx: - all binary inputs (or outputs of protection functions).

Trip

Tripping signal.

Note:

If the phase sequence is incorrect, tripping takes place regardless of setting (U-Setting).

3.7.4. Disturbance recorder (*Disturbance Rec*)

A. Application

Recording current and voltage wave forms and the values of function variables before, during and after operation of a protection function.

B. Features

- records up to 9 c.t. and v.t. inputs
- records up to 12 measured function variables
- records up to 16 binary inputs
- sampling rate of 12 samples per period (i.e. 600, respectively 720 Hz)
- 9 analogue and 8 binary signals recorded in approx. 5 seconds
- function initiated by the general pick-up or general trip signals, or by any binary signal (binary I/P or O/P of a protection function).
- data recorded in a ring shift register with provision for deleting the oldest record to make room for a new one.
- choice of procedure if memory full: either 'stop recording' or 'Overwrite oldest records'.

C. Inputs and outputs

I. C.t./v.t. inputs:

- all installed inputs available

II. Measured variable inputs:

- all installed measured function variables available

III. Binary inputs:

- all installed inputs available (also outputs of protection functions)

IV. Binary outputs:

- start of recording
- memory full

V. Measurements:

- none.

D. Disturbance recorder function settings - Disturbance Rec

Summary of parameters:

Text	Units	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
StationNr		1	0	99	1
preEvent	ms	40	40	400	20
Event	ms	100	100	3000	50
postEvent	ms	40	40	400	20
recMode		A	(Select)		
TrigMode		TrigOnStart	(Select)		
StorageMode		StopOnFull	(Select)		
BinOutput	SignalAddr	ER			
MemFullSign	SignalAddr	ER			
AnalogInp 1	CT/VT-Addr				
AnalogInp 2	CT/VT-Addr				
.					
.					
AnalogInp 12	CT/VT-Addr				
BinInp 1	BinaryAddr	F			
BinInp 2	BinaryAddr	F			
.					
.					
BinInp 16	BinaryAddr	F			
BinInp 1		no trig	(Select)		
BinInp 2		no trig	(Select)		
.					
.					
BinInp 16		no trig	(Select)		
MWAImp 1	MeasVar				
.					
.					
MWAImp 12	MeasVar				
MWAScale1	Factor	1	1	1000	1
.					
.					
MWAScale12	Factor				

Explanation of parameters:**ParSet 4..1**

Parameter for determining in which set of parameters a particular function is active (see [Section 5.11.](#)).

Only the original function in each set may be active. The following must be observed, however, if a disturbance recorder is active in every set of parameters or the original function was copied:

The old record is deleted when switching to a different set of parameters to avoid misinterpretation. A record must therefore be read out before switching sets of parameters.

StationNr

Number of the disturbance recorder for identifying records for subsequent evaluation.

preEvent

Definition of how long the recorder runs before a possible event.

Event

Definition of the maximum limit for the duration of an event (recording mode A). In recording mode B, the same parameter sets the duration of recording.

postEvent

Definition of how long the recorder runs after an event (after EventDur).

recMode (Recording mode)

Definition of how events should be recorded. Possible settings:

- A: Recording only while the trigger signal is active. (minimum time = 100 ms, maximum time = event duration setting).
- B: Recording from the instant of the trigger signal for the event duration setting.

TrigMode

Definition of the instant of triggering and how binary signals are recorded. The configured c.t. and v.t. channels are always recorded. Possible settings:

- TrigByStart: The disturbance recorder is triggered when a protection function picks up (general pick-up). Binary signals are not recorded.

- TrigByTrip: The disturbance recorder is triggered when a protection function trips (general trip). Binary signals are not recorded.
- TrigByBin1: The disturbance recorder is triggered by the binary I/P 1. Binary signals are not recorded.
- TrigAnyBin: Defined binary signals are recorded and recording is triggered by any of them via an OR gate.
- TrStrt&Bin: Defined binary signals are recorded and recording is triggered by any of them via an OR gate and also when a protection function picks up (general pick-up).
- TrTrip&Bin: Defined binary signals are recorded and recording is triggered by any of them via an OR gate and also when a protection function trips (general pick-up).

Note:

If the trigger conditions are connected to an OR gate and one of them is fulfilled, the other trigger conditions bear no influence and no further records are made. In this situation, a record is initiated when the disturbance recorder is reset.

StorageMode

determines the procedure when the memory is full:

- StopOnFull: No further data are recorded when the memory is full.
- Overwrite: The oldest records are overwritten and therefore lost.

BinOutput

O/P signalling that recording is taking place.

MemFullSign

Warning that the memory is $\frac{3}{4}$ full. Normally, there remains sufficient room for at least one more record after this signal is generated.

AnalogInp 1...AnalogInp 12

Defines the c.t. and v.t. inputs to be recorded. The setting is the number of the I/P.

The numbers of the c.t. and v.t. inputs do not necessarily have to agree with the numbers of the c.t. and v.t. channels, however, no gaps are permitted (setting zero).

BinInp 1...BinInp 16

Binary inputs to be recorded (for triggering modes "TrStrt&Bin, TrigAnyBin and TrTrip&Bin"). Binary address (binary input or output of a protection function). No recording takes place for F→FALSE or T→TRUE.

A particular order is not necessary. There may also be gaps.

BinInp 1...BinInp 16

Definition of a corresponding binary signal as one of the trigger signals for initiating recording. All the trigger signals thus defined, are connected to an OR gate so that any one of them can start recording. Possible settings are:

- No trigger: The corresponding signal has no influence on the start of recording.
- Trigger: A positive-going edge of the corresponding signal from logical '0' to logical '1' initiates recording.
- Inv. trigger: A negative-going edge of the corresponding signal from logical '1' to logical '0' initiates recording.

MWAImp 1...MWAImp 12

Measured variables to be recorded.

Possible settings are:

- Disconnect, no input
- Constant measured variable, analogue value as a constant
- Binary output of a protection function, measured variable of the selected function
- Input from IBB, input variable of IBB channel 4, inputs 1...64.

MWAScale1...MWAScale12

Scaling factors for reading the disturbance records.

E. Setting instructions

General:

The disturbance recorder function may only be configured once for each set of parameters.

The special “disturbance recorder” function serves to record current and voltage waveforms and measured function variables when a protection function picks up. A battery buffered 64 kByte memory is provided for this purpose, which enables 9 analogue and 8 binary signals to be recorded within a maximum of approx. 5 seconds.

To ensure that the memory is not filled by useless data, recording only takes place after a starting signal (trigger signal). Each time a start signal is generated, the data are recorded for a pre-defined time and saved as an “event”. Thus depending on the definitions of the relevant times, the memory has capacity for between 1 and approx. 56 events.

To enable the circumstances leading up to an event and also the responses after an event to be studied, an event comprises three parts, the pre-event data (recorded before the start signal), the data of the event itself and the post-event data. The durations of these three periods can be independently defined.

How the data prior to an event is obtained requires a little more explanation. Data are continuously recorded from the instant the programming of the perturbograph function has been completed. They are fed into a ring shift register, the older data at the beginning being overwritten as soon as the register is full. This cyclic overwriting of the ring register continues until a start signal initiates the recording of an event (trigger signal). Thus the circumstances immediately prior to the actual event are available in the ring register.

The duration of the record of the actual event is determined by the tripping signal (trigger signal), i.e. recording continues for as long as it is active (recording mode A). If the tripping signal is very short, recording lasts for at least 100 milliseconds and if it is very long, recording is discontinued upon reaching the maximum duration (set event time). A second mode of operation is also provided (recording mode B), for which the duration of recording always equals the set event time regardless of the duration of the trigger signal.

The post-event circumstances are of less importance, especially in recording mode B, in which case simply the duration of recording is extended. The essential thing is that during post-event recording, a new trigger signal can initiate the recording of new events. This, however, means that two events overlap and it may not always be possible to fully reconstruct the circumstances of both events (part of the pre-event data is in the preceding event).

The entire event memory operates as a ring register. This means that a single event can be deleted to make room for a new one without having to delete the others.

The procedure followed when the memory is full can be selected. Either recording is discontinued and no new events are recorded, or the oldest records are overwritten so that the memory always contains the latest events. It must be noted that in this mode, a record can be deleted before it has been transferred to an operator station. Even if transfer of a record is in progress, it will be interrupted to make room for a new record.

Application programs

Disturbance recorder data (currents, voltages and measured variables) can be transferred back to the RE. 316*4 device using the conversion program INTERFAC (in conjunction with the test set XS92b) (see INTERFAC Operating Instructions CH-ES 86-11.53 E).

Refer to [Section 9.3.](#) for the procedure for transferring disturbance data via the IBB.

Disturbance recorder data files are stored in a binary format and can only be evaluated using the WinEVE program (see WinEVE Operating Instructions *BHT 450 045 D0000) or the REVAL program (see REVAL Operating Instructions 1MDU10024-EN).

Measured function variables may have values which cannot be entirely reproduced by the evaluation software. Such variables can be reduced using the scaling factors 'MeasScale'. The highest number the evaluation software can reproduce faithfully is ± 16535 . The evaluation software automatically takes account of the scaling factors.

The following table shows scaling examples for the most important measured function variables.

Function	Meas. variable	Nominal value	'MeasScale'
UIfPQ	f (50Hz)	20000	2
UIfPQ	P	820698	52
UIfPQ	Q	820698	52
SynchroCheck	degrees (180°)	31415	2
Power	PN	1641397	105

'MeasScale' is given by: $\frac{\text{Nominal value}}{16535} + \text{Margin}$

Processor capacity:

The disturbance recorder function runs on the same central processing unit (CPU) as the protection functions. The processor capacity required by the disturbance recorder function as a percentage of the total capacity and in relation to the number of signals is:

- 20% for 9 analogue and 0 binary signals
- 40% for 9 analogue and 16 binary signals.

The disturbance recorder function will thus be generally confined to recording the analogue variables and be triggered by the general start or general trip signals. Changes in the states of binary signals are nevertheless registered by the event recorder.

Recording duration:

The time during which data are recorded can be determined from the following relationship:

$$t_{\text{rec}} = \frac{65535 - ((n + 1) \times 22)}{(2a + b) \times 12} \times p$$

where t_{rec} : max. recording time

n: Number of events recorded

a: Number of c.t. and v.t. channels recorded

b: Number of Bytes required for binary channels (one Byte per eight binary signals)

p: duration of one cycle at power system frequency (e.g. 20 ms for 50 Hz).

Example:

$$n = 10$$

$$a = 9$$

$$b = 2 \text{ (i.e. 9 to 16 signals)}$$

$$p = 20 \text{ ms}$$

$$t_{\text{rec}} = \frac{65535 - ((10 + 1) \times 22)}{(2 \times 9 + 2) \times 12} \times 20 \text{ ms} = 5.44 \text{ s}$$

It follows that for the given number of channels and power system frequency, the capacity is sufficient for 10 events of 540 ms duration each.

File PLOT.TXT

PLOT.TXT for WinEVE, REVAL (programs for evaluating disturbance recorder data) and INTERFAC (data conversion program for running disturbance data on the test set XS92b).

General remarks

The programs (WinEVE, REVAL and INTERFAC) need the file PLOT.TXT to be able to process the disturbance recorder data. For INTERFAC, all disturbance recorder data RExxxx.xxx must start with the letters RE.

Example PLOT.TXT

Hardware configuration: A/D config: K9
 Overcurrent: A1 (IN = 1A)
 Overvoltage: U1 (UN = 100V)

N: 001

S: ABB_Relays_Ltd

D 0	:	D 0	/CO:	1
D 1	:	D 1	/CO:	2
D 2	:	D 2	/CO:	3
D 3	:	D 3	/CO:	4
D 4	:	D 4	/CO:	5
D 5	:	D 5	/CO:	6
D 6	:	D 6	/CO:	7
D 7	:	D 7	/CO:	8
D 8	:	D 8	/CO:	9
D 9	:	D 9	/CO:	10
D10	:	D10	/CO:	11
D11	:	D11	/CO:	12
D12	:	D12	/CO:	13
D13	:	D13	/CO:	14
D14	:	D14	/CO:	15
D15	:	D15	/CO:	1

U 0	:	UR	/CO:	2	/TR:	0.1981	/UN:	UN
U 1	:	US	/CO:	4	/TR:	0.1981	/UN:	UN
U 2	:	UT	/CO:	11	/TR:	0.1981	/UN:	UN
I 3	:	I0	/CO:	10	/TR:	10.83	/UN:	IN
U 4	:	U	/CO:	7	/TR:	0.1981	/UN:	UN
U 5	:	U	/CO:	13	/TR:	0.1981	/UN:	UN
I 6	:	IR	/CO:	8	/TR:	10.83	/UN:	IN
I 7	:	IS	/CO:	12	/TR:	10.83	/UN:	IN
I 8	:	IT	/CO:	9	/TR:	10.83	/UN:	IN

where:

N: station number: text
 S: station name: text
 Dnn binary channels: text (max. 8 char.)
 Unn:, Inn: voltage channel, current channel: text (max. 8 char.)
 /CO 1 to 15: number of the plot colour for WinEVE
 (In the case of REVAL the plotting colour is determined by the particular layout.)

/TR: conversion ratio for WinEVE, REVAL

/UN: unit for WinEVE, REVAL: text.

Note:

'Unn:' and 'Inn:' are needed by INTERFAC to indicate whether a channel is being used for voltage or current.

All c.t. and v.t. channels 'Ann:' may be chosen for WinEVE.

Ratio TR

Voltage channels for REL 316*4 and REC 316*4

100 V:	TR = 19.81	in V	
200 V:	TR = 39.62	in V	
	TR = 0.1981	times UN	(PLOT.TXT)

Voltage channels for REG 316*4 and RET 316*4

15 V:	TR = 5.144	in V	
100 V:	TR = 34.312	in V	
200 V:	TR = 68.624	in V	
	TR = 0.34312	times UN	(PLOT.TXT)

Current channels RE. 316*4

Protection:	1 A:	TR = 10.83	
	2 A:	TR = 21.66	
	5 A:	TR = 54.11	
		TR = 10.83	times IN (PLOT.TXT)

Metering:	1 A:	TR = 0.2506	
	2 A:	TR = 0.5011	
	5 A:	TR = 1.253	
		TR = 0.2506	times IN (PLOT.TXT)

These ratios enable WinEVE to determine the secondary values. These ratios must be multiplied by the ratio of the main c.t's and v.t's to obtain the primary system values.

INTERFAC does not evaluate CO, TR and UN.

Automatic creation of the file plotxxx.txt:

The file plotxxx.txt is automatically saved in the current directory from which the operator program (MMI) was started when saving the RE. 316*4 settings or in any directory given in the configuration file 'rexx.cfg', e.g.:

EVEDATA = .\RE2

Several files plotxxx.txt with different station numbers (xxx) can be combined to a single plot.txt. The file plot.txt must be at the same location as the disturbance recorder data for the REVAL evaluation program.

Example:

PLOT.TXT (existing file), plot020.txt (data for station No. 20) and plot021.txt (data for station No. 21) can be combined using the DOS command:

```
C:\REL316
```

```
C>copy PLOT.TXT+plot020.txt+plot021.txt PLOT.TXT
```

The file **PLOT.TXT** can be modified using an editor.

The evaluation is based on data expressed as multiples of UN or IN.

Instructions for installing the data evaluation program

The data evaluation program must be installed in strict accordance with the relative operating instructions.

WINEVE

Copy the file "PLOT.TXT" to the directory:

```
C:\I650\EVENTS
```

A disturbance should be recorded during the commissioning of every relay and the record stored in the directory given above.

The procedure for installing the station parameter files is as follows:

- Start the WINEVE program.
- Open a fault record
The following error message appears:

```
C:\I650\STATION\ST0xx.PAR  
Could not find file.
```
- Click on OK.
- Select the menu item "Import station file" in the "Parameter" menu.
- Select the file PLOT.TXT belonging to this disturbance recording.

- Select the menu item “Save station” in the “Parameter” menu.

This procedure must be repeated for all the relays. The configuration file PLOT.TXT is no longer necessary and the error message concerning the missing station file does not appear. WINEVE provides facility for editing and resaving all the station parameters (texts, colours etc.).

Exception: The ratios TR have to be changed in the file PLOT.TXT and the file re-imported and saved again as described above.

REVAL

Copy the file “PLOT.TXT” to the following directory:

C:\SMS\REVAL\EVENTS

REVAL rereads the file PLOT.TXT every time a disturbance record is loaded, however, any colours specified in PLOT.TXT are ignored. Instead, the colours are assigned by REVAL and can be edited after a disturbance record has been loaded.

3.7.5. Measurement module (*MeasureModule*)

A. Application

Measurement of 3 phase voltages, 3 phase currents, active and reactive power, power factor $\cos \varphi$ ($\cos \phi$) and frequency, e.g. for display on an operating device or transmission to a station monitoring system.

B. Features

- Measurement of 3 phase voltages (Y and delta), currents, active and reactive power, power factor $\cos \varphi$ and frequency.
- Provision for using the 3 phase current inputs in combination with either 3 phase-to-phase voltages or 3 phase-to-earth voltages.
- 2 independent impulse counter inputs for calculation of interval and accumulated energy
- The three-phase measurement and impulse counters can be used independently and may also be disabled.
- Up to 4 measurement module functions can be configured on one RE..16 device.
- All inputs and outputs can be configured by the user.

C. Inputs and Outputs

I. C.t./v.t. inputs

- Voltage
- Current

II. Binary inputs

- 2 impulse inputs
- 2 reset inputs

III. Binary outputs

- 2 outputs for the new counter value

IV. Measurement values

- Voltage URS (Unit UN)
- Voltage UST (Unit UN)
- Voltage UTR (Unit UN)
- Voltage UR (Unit UN)
- Voltage US (Unit UN)
- Voltage UT (Unit UN)
- Current R (Unit IN)
- Current S (Unit IN)
- Current T (Unit IN)
- Active power P (Unit PN)
- Reactive power Q (Unit QN)
- Power factor $\cos \varphi$ (Unit $\cos \phi$)
- Frequency f (Unit Hz)
- Interval energy value 1 (E1Int)
- Interval pulse number 1 (P1Int)
- Accumulated energy value 1 (E1Acc)
- Accumulated pulse number (P1Acc)
- Interval energy value 2 (E2Int)
- Interval pulse number 2 (P2Int)
- Accumulated energy value 2 (E2Acc)
- Accumulated pulse number 2 (P2Acc).

D. Measurement module function settings (MeasureModule)

Summary of parameters:

Text	Unit	Default	Min.	Max.	Step
ParSet 4..1		P1	(Select)		
VoltageInp		0			
CurrentInp	CT/VT-Addr	0			
PN	$UN \cdot IN \cdot \sqrt{3}$	1.000	0.200	2.500	0.001
AngleComp	Deg	0.000	-180	180	0.1
t1-Interval	Select	15 min			
PulseInp1	BinaryAddr	F			
Reset1	BinaryAddr	F			
ScaleFact1		1.0000	0.0001	1.0000	0.0001
Cnt1New	SignalAddr				
t2-Interval	Select	15 min			
PulseInp2	BinaryAddr	F			
Reset2	BinaryAddr	F			
ScaleFact2		1.0000	0.0001	1.0000	0.0001
Cnt2New	SignalAddr				

Explanation of parameters:**ParSet4..1**

Parameter for determining in which set of parameters a particular function is active ([see Section 5.11.](#)).

VoltageInp

defines the voltage input channel. Only three-phase v.t's can be set and the first channel (R phase) of the group of three selected must be specified.

Voltage and current inputs must be assigned before the three-phase measurement part of the function can be activated. If only the pulse counter part of the function is to be used, both c.t. and v.t. inputs must be disabled.

CurrentInp

defines the current input channel. Only three-phase c.t.'s can be set and the first channel (R phase) of the group of three selected must be specified.

Current and voltage input signals must come from the same c.t./v.t. input module.

PN

Reference value for measuring power. It enables the amplitude of the power values to be adjusted to take account, for example, of the rated power factor $\cos \varphi$ or to compensate the amplitude errors of the input transformers.

AngleComp

Angular setting for compensating the phase error. It is set to obtain the best possible power measuring accuracy. In many cases, the default setting of 0.0 degrees will be acceptable, but a different setting may be necessary to compensate the following:

- a) c.t. and v.t phase errors
→ typical setting: $-5^\circ \dots +5^\circ$
- b) correction of c.t. or v.t. polarity
→ typical setting: -180° or $+180^\circ$.

t1-Interval

Interval set for accumulating pulses assigned to $E1_{acc\_interval}$ and $Pulse1_{acc\_interval}$.

The following settings are possible: 1 min, 2 min, 5 min, 10 min, 15 min, 20 min, 30 min, 60 min and 120 min.

PulseInp1

Input for energy counter impulse.

- F: not used
- T: always active. This setting should not be used.
- xx: all binary inputs (or outputs of protection functions).

Note: Minimum pulse-width is 10 ms.

Reset1

Input to reset $E1_{accumulate}$ and $Pulse1_{accumulate}$ outputs.

- F: no reset
- T: always reset
- xx: all binary inputs (or outputs of protection functions).

ScaleFact1

Factor for scaling E1 outputs in relation to pulse counter output:

$$E1_{\text{acc\_interval}} = \text{Pulse1}_{\text{acc\_interval}} \times \text{ScaleFact1}$$

$$E1_{\text{accumulate}} = \text{Pulse1}_{\text{accumulate}} \times \text{ScaleFact1}.$$

Cnt1New

Output to indicate that new values are available at impulse counter 1 outputs and have been frozen. The binary output is cleared 30 s after the interval starts.

t2-Interval

See t1-Interval.

PulseInp2

See PulseInp1.

Reset2

See Reset1.

ScaleFact2

See ScaleFact1.

Cnt2New

See Cnt1New.

E. Setting Instructions

To get the best performance from the measurement module, be sure to set it properly. The following notes should help to decide the correct settings:

- Reference values for the analogue input channels
The settings in this case should be chosen such that the functions measures 1.000 UN and 1.000 IN when rated voltage and current are being applied. In many cases the default setting (1.000) will be satisfactory.
- Phase compensation "Angle comp"
This setting is important for correct measurement of active and reactive power and the power factor $\cos \varphi$. For most cases, it is possible to accept the default value 0.0°.

A different setting may be necessary to compensate the following:

- a) c.t. and v.t. phase errors
→ typical setting: between -5.0° and +5.0°
- b) correction of direction of the measurement or c.t. or v.t. polarity
→ typical setting: -180.0° or +180.0°

Add multiple errors to obtain the correct compensation setting.

The angles given apply for connection according to the connections in [Section 12](#).

- Voltage measurement
The zero-sequence component in case of delta-connected v.t.'s is assumed to be zero, but with Y-connected v.t.'s the zero-sequence voltage does have an influence on the phase-to-ground measurements. In an ungrounded power system, the phase-to-ground voltages will float in relation to ground.
- Power and frequency measurements
A power measurement is obtained by summing the powers of the three-phase system: $3 \times \underline{S} = \underline{U}_R \times \underline{I}_R^* + \underline{U}_S \times \underline{I}_S^* + \underline{U}_T \times \underline{I}_T^*$. The measurement is largely insensitive to frequency in the range (0.8...1.2) f_N . The frequency measured is that of the positive sequence voltage. Should the voltage be too low, the frequency is not measured and a value of 0.0 Hz results.
- Where only the impulse counter is in use, both analogue inputs (current and voltage) must be disabled.

- Where only the measurement part of the function is in use, the binary impulse and reset inputs of both impulse counters must be disabled, i.e. “always FALSE”.

3.7.5.1. *Impulse counter inputs*

The impulses counted are normally generated by a measuring or metering device (see Fig. 3.7.5.1).

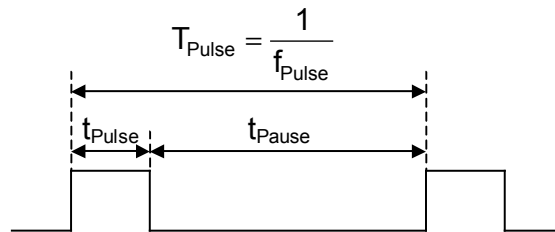


Fig. 3.7.5.1 Impulse counter input signal

The maximum impulse repetition rate is 25 Hz (see Fig. 3.7.5.1). Thus the minimum time between the positive-going edges of two input impulses is $T_{\text{Puls, min}} = \frac{1}{25} \text{ Hz} = 40 \text{ ms}$.

The pulse-width is determined by the function generating the impulses and the ratio between the pulse-width and the interval between lagging and leading edges should be in the range 1:3 to 1:1, i.e.:

$$t_{\text{Pulse, min}} = \frac{1}{1+3} \times T_{\text{Pulse, min}} = \frac{1}{4} \times T_{\text{Pulse, min}} = 10 \text{ ms}.$$

Since the impulse counter is polled approximately every 5 ms, impulses are reliably detected with a safety factor of about 2.

The impulse counter evaluates the positive-going edges (0→1) of the input signal.

To filter any contact bounce (debouncing) phenomena, only the first positive-going edge is evaluated within a given period (typically 10 ms).

3.7.5.2. *Impulse counter operation*

Fig. 3.7.5.2 shows the principles of impulse counter operation.

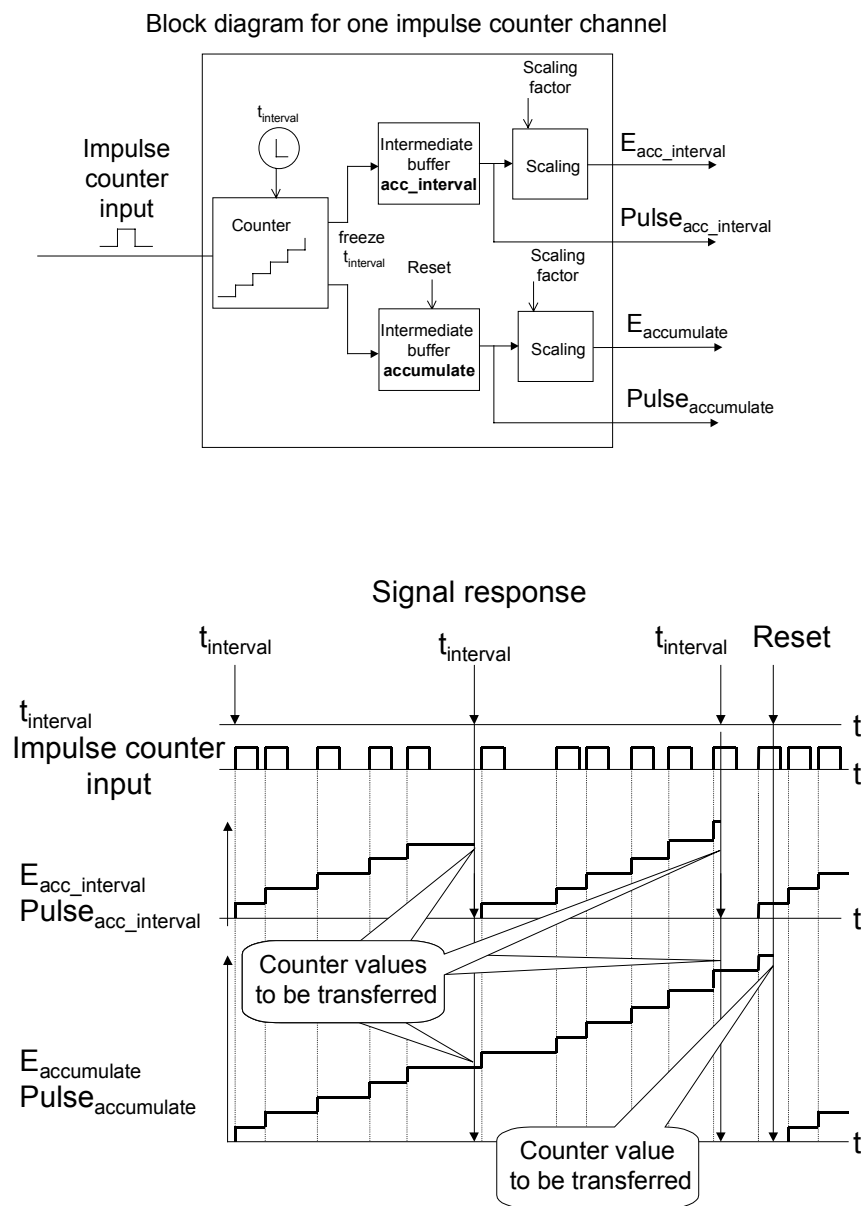


Fig. 3.7.5.2 Block diagram for one impulse counter channel and signal response

3.7.5.3. *Impulse counter operating principle*

The binary inputs “Reset1” and “Reset2” reset the counter values $E_{accumulate}$ and $Pulse_{accumulate}$ to zero. The interval values $E_{acc\_interval}$ and $Pulse_{acc\_interval}$ are not reset.

When a reset command is applied to binary input “Reset1” or “Reset2”, measurement events with the values of $E_{\text{accumulate}}$ and $\text{Pulse}_{\text{accumulate}}$ are created for the respective channel before its counters are reset.

Impulse counter values are stored in a RAM with a battery supply and are not lost should the auxiliary supply fail. Impulses arriving at the inputs while the software is being initialised, e.g. after settings have been made, are lost.

- Capacity for $\text{Pulse}_{\text{accumulate}}$:
At the maximum impulse repetition rate, the total number of impulses counted during a year is $25 \text{ pps} \times 3,600 \text{ s/h} \times 8,760 \text{ h/year} = 788,400,000$ impulses per year. The output is reset to zero when a counter reaches 2,000,000,000, i.e. 2×10^9 . Unless special measures taken or a counter is reset, it can overflow at the worst after approx. 2,5 years.
- Should an impulse counter overflow, the value of $\text{Pulse}_{\text{accumulate}}$ is recorded in the event list. No further measures have been included, because
 - 1) an overflow is hardly likely to occur.
 - 2) should an overflow occur, it is obvious providing the counters are checked regularly, for example, by an SCS. If necessary, the total number of impulses counted since the last reset can be determined even after an overflow.

3.7.5.4. Interval processing

The interval starts at a full hour plus a even multiple of t_{Interval} and is synchronised to a full minute by the internal RE..16 clock.

Assuming t_{Interval} is set to 120 min, the interval is started at even hours throughout the day.

Impulse counter and energy outputs are set at the start of the first regular interval, even if the previous interval was incomplete. This ensures that no impulses are lost after starting the function.

When t_{Interval} expires, the following takes place:

- The counter values $E_{\text{accumulate}}$, $\text{Pulse}_{\text{accumulate}}$, $E_{\text{acc\_interval}}$ and $\text{Pulse}_{\text{acc\_interval}}$ are stored in the intermediate buffers and remain unchanged until the end of the next interval.
- When the new impulse counter results are frozen at the end of the interval, the binary output “Cnt1New”, respectively “Cnt2New” is set to TRUE. It is reset after 30 s regardless of interval duration and can be used to initiate reading of a new set of frozen interval values.
- If selected for transmission, transmission of the counter values via the LON interface is initiated by the positive-going edge of this output.
- The values $E_{\text{acc\_interval}}$ and $\text{Pulse}_{\text{acc\_interval}}$ of the respective channel are only recorded as measurement events providing the output “Cnt1New”, respectively “Cnt2New” is being used, for example, to control an event recorder, LED or signalling relay.

The freezing of results, resetting and event recording of the interval counters is illustrated in Fig. 3.7.5.3.

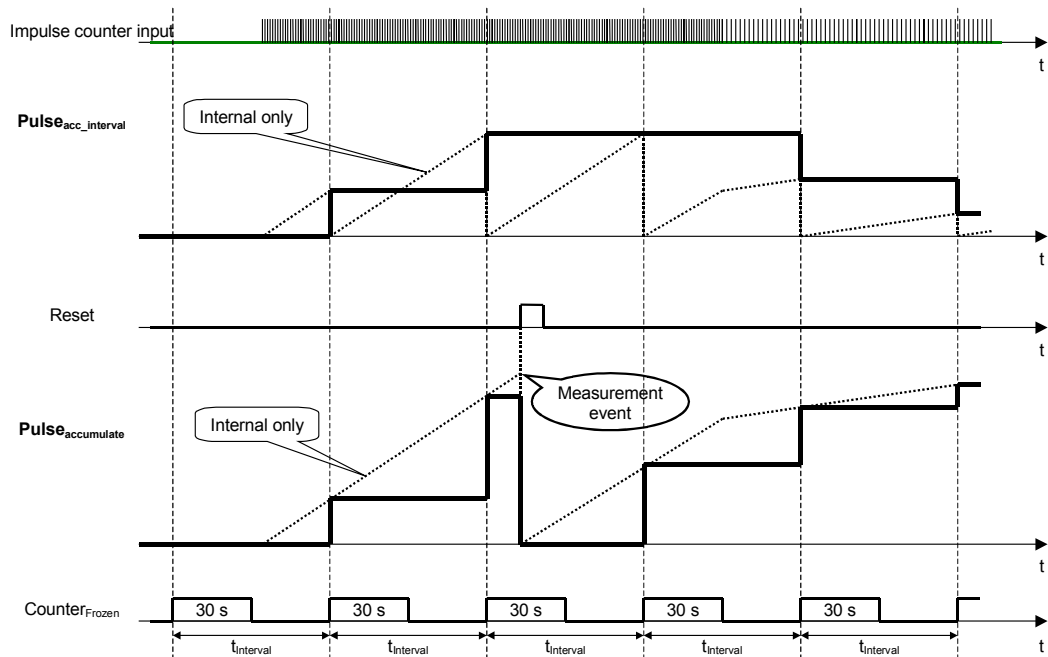


Fig. 3.7.5.3 Interval processing

August 00

4. PRINCIPLE OF OPERATION AND APPLICATION

4.1.	Summary.....	4-2
4.1.1.	Function plan programming (FUPLA)	4-2
4.1.2.	Control unit.....	4-3
4.1.3.	Feeder protection.....	4-3
4.2.	Protection functions	4-4
4.2.1.	Auto-reclosure.....	4-4
4.2.1.1.	Logic segment.....	4-4
4.2.1.2.	Explanation of the signal names	4-12
4.2.2.	Breaker failure protection.....	4-15
4.2.2.1.	Introduction	4-15
4.2.2.2.	Three-phase/ single-phase mode	4-16
4.2.2.3.	'Redundant Trip'	4-16
4.2.2.4.	'Retrip'	4-17
4.2.2.5.	'Backup Trip'	4-17
4.2.2.6.	'Remote Trip'	4-17
4.2.2.7.	'Unconditional Trip'	4-17
4.2.2.8.	'End Fault Trip'	4-18
4.2.2.9.	'External Trip'	4-18

4. PRINCIPLE OF OPERATION AND APPLICATION

4.1. *Summary*

The control device REC 316*4 is designed to perform data acquisition, monitoring, and control functions in the individual switchgear bays of MV and HV substations.

The control function for a switchgear bay can be configured for SF₆ gas-insulated switchgear (GIS), for indoor and outdoor switchgear and for single, double or multiple busbar stations.

The control function processes the switchgear position signals, the measured variables and the alarms occurring in a switchgear bay, makes the corresponding data available at the communication interface (OBI) and receives in the reverse direction the control instructions from the station control level or from the local mimic, which it then processes and executes as determined by the bay control logic.

The extensive library of software functions provides a comprehensive selection of supplementary protection, measurement and logic functions.

4.1.1. *Function plan programming (FUPLA)*

Function charts are created and documented using a graphical chart editor (CAP 316). Function plans of any complexity can be devised by appropriately combining the simple logical elements contained in the function library. The function library includes elements such as AND, OR, FLIP-FLOP, timers etc. Groups of these elements can be combined to form macros and these then to form larger macros.

Apart from the function block library, there is also a library of macros for complex operations such as coupling to the object bus, handling alarms, interlocks and the control of isolators and circuit-breakers.

The signal connections between the function plan and the protection functions are established interactively using the HMI and the FUPLA engineering tool.

4.1.2. Control unit

The following example of a 50 kV GIS bay with 7 objects to be controlled illustrates the facilities provided by the control unit.

Installed in the bay are two busbar isolators, a circuit-breaker, a feeder isolator and a grounding isolator. The bay is controlled from the station control level via the communication interface (OBI) or from the local mimic. The control logic can be configured to provide all the necessary interlocks. The circuit-breaker close command is also interlocked by a check synchronism function.

The control function has sufficient capacity for 56 process inputs and 32 process outputs. The control logic is linked to the station control level via 30 inputs and 30 outputs via the communication interface (OBI).

4.1.3. Feeder protection

The protection function library includes overcurrent, overvoltage, power, frequency, overtemperature and auto-reclosure modules for the protection of the feeder.

4.2. Protection functions

4.2.1. Auto-reclosure

4.2.1.1. Logic segment

The auto-reclosure logic comprises several FUPLA segments which are illustrated in the following diagrams.

The allocation of input and output signals to the parameter designations used in the HMI is given in [Section 4.2.1.2.](#)

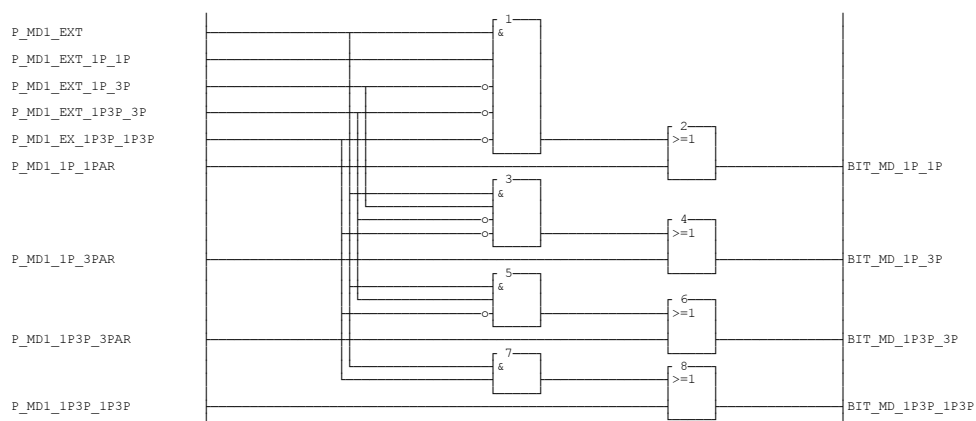


Fig. 4.1 Segment MODE_1AR:
Selection of the mode for the first auto-reclosure attempt

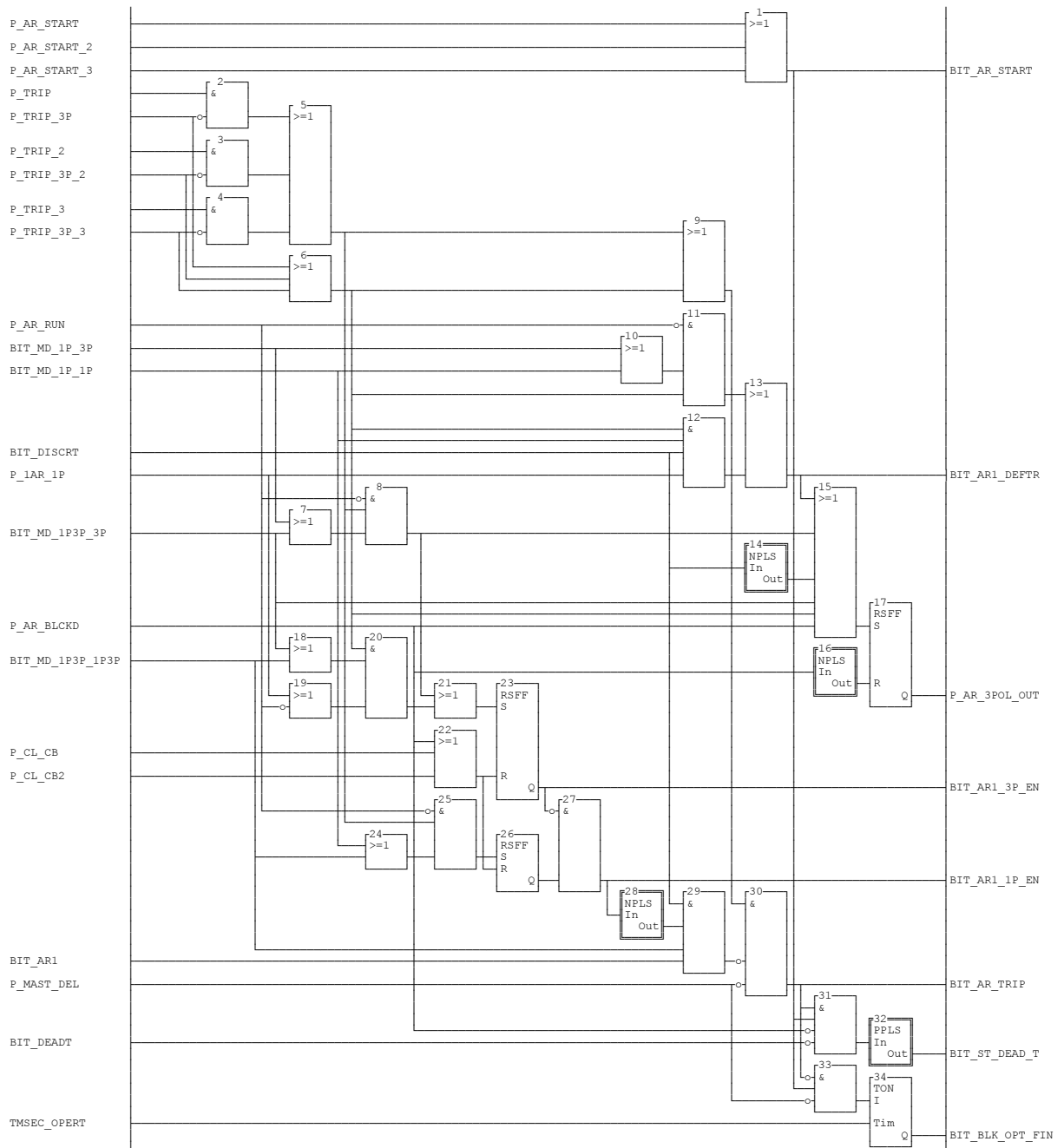


Fig. 4.2 Segment ARTRIP:
Starting and tripping inputs, determination of auto-reclosure mode, initiation of auto-reclosure and determination of fault duration

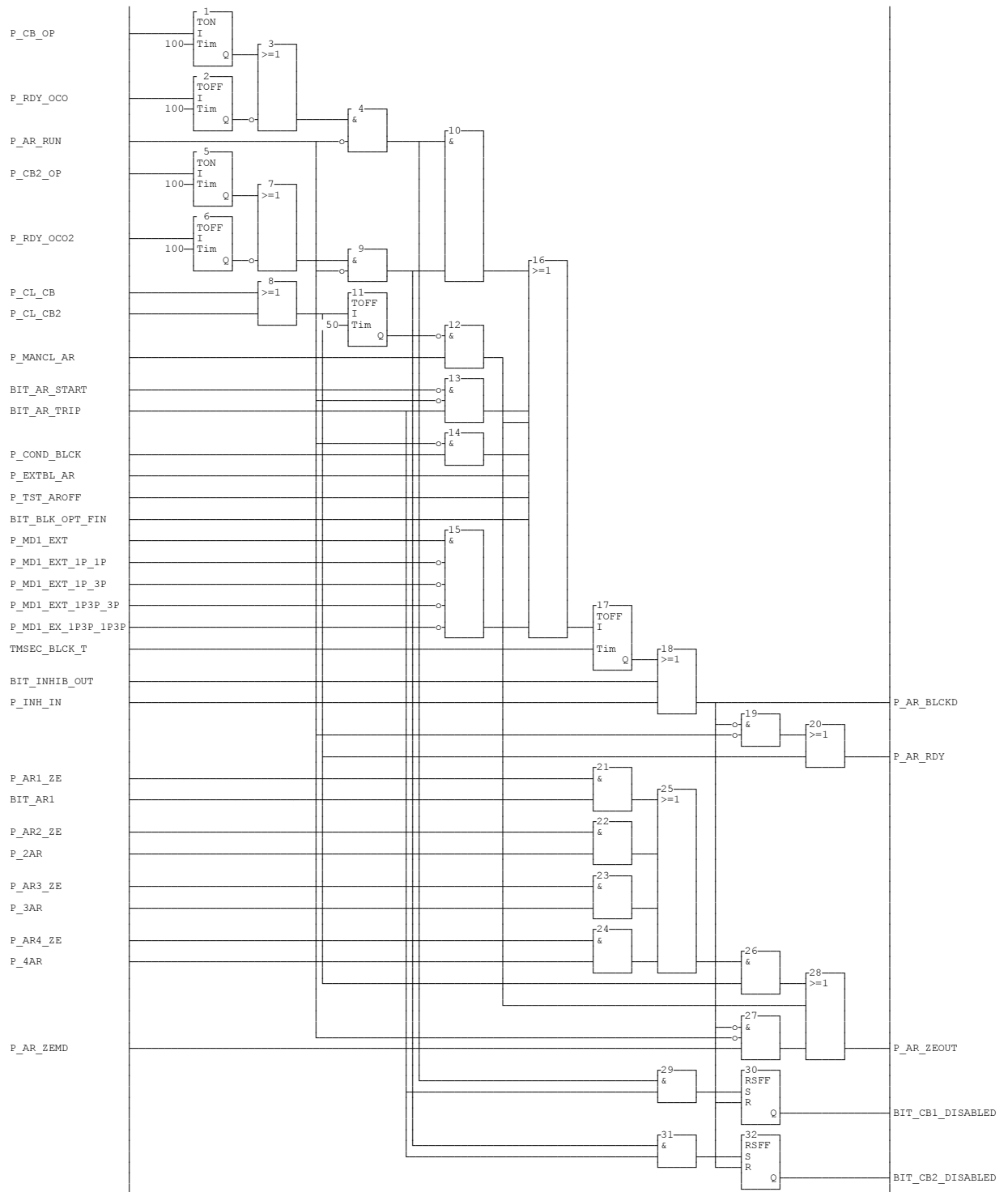


Fig. 4.3 Segment BLOCK:
Blocking and zone extension logic

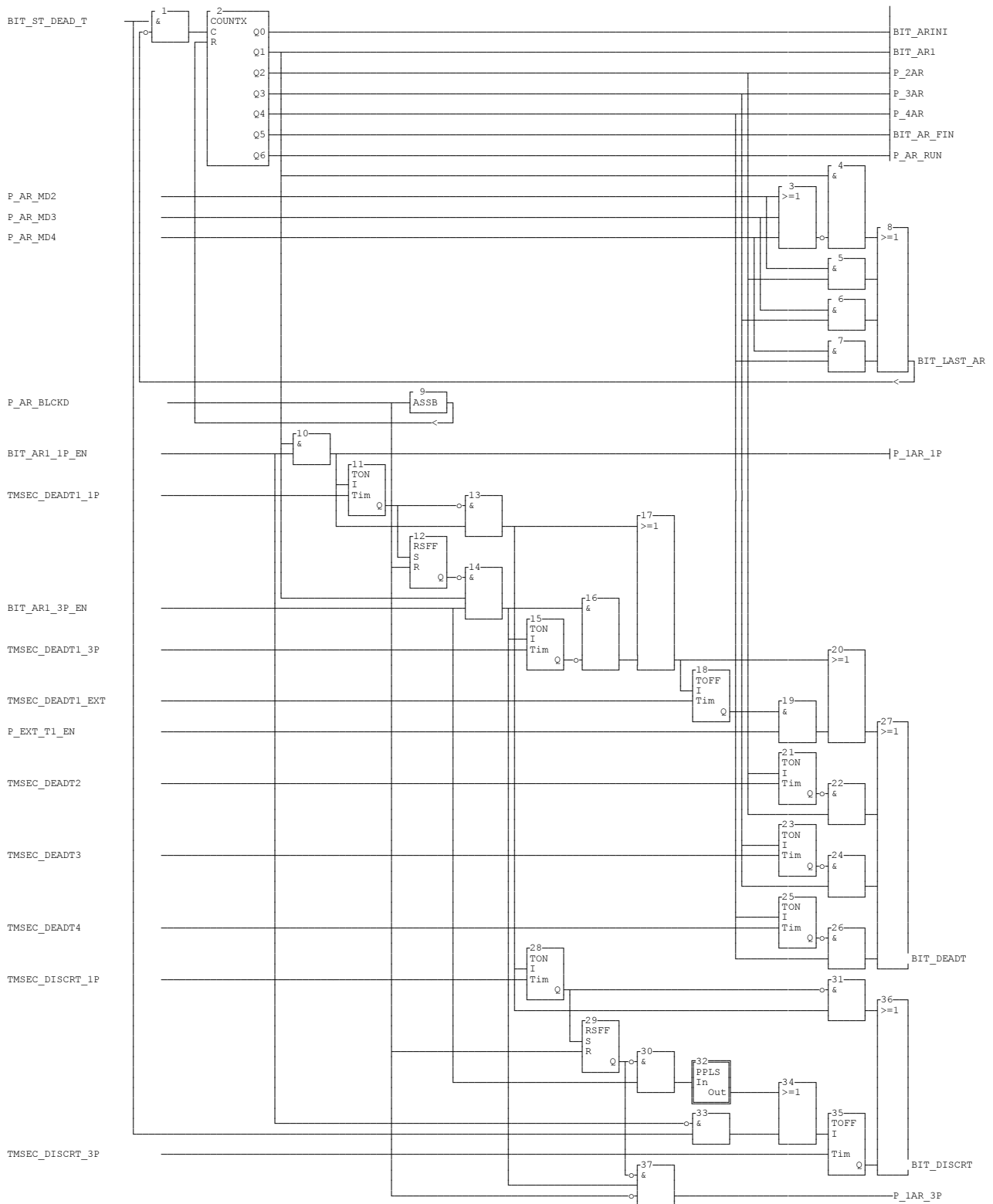


Fig. 4.4 Segment ARCOUNT:
Auto-reclosure attempt counter

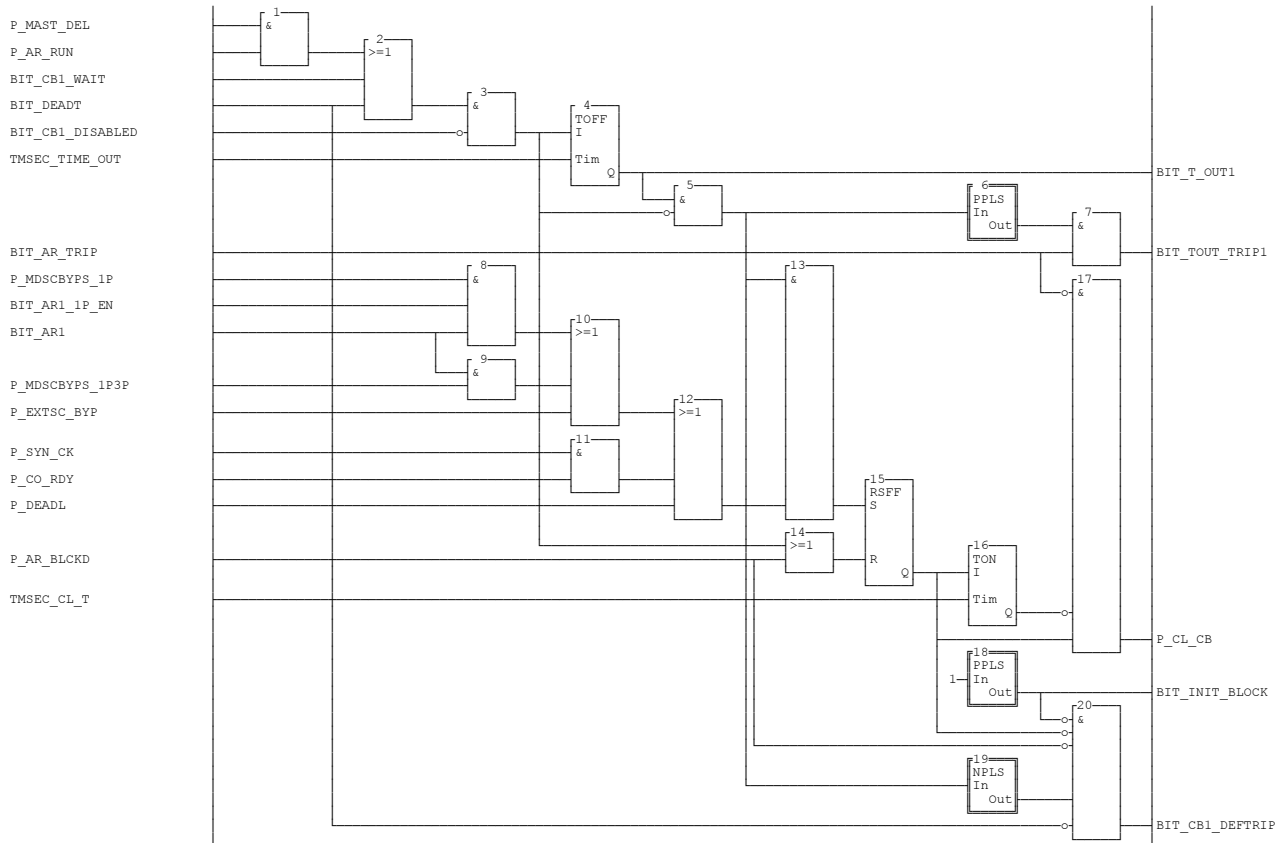


Fig. 4.5 Segment CLOSE1:
Close command for the first circuit-breaker

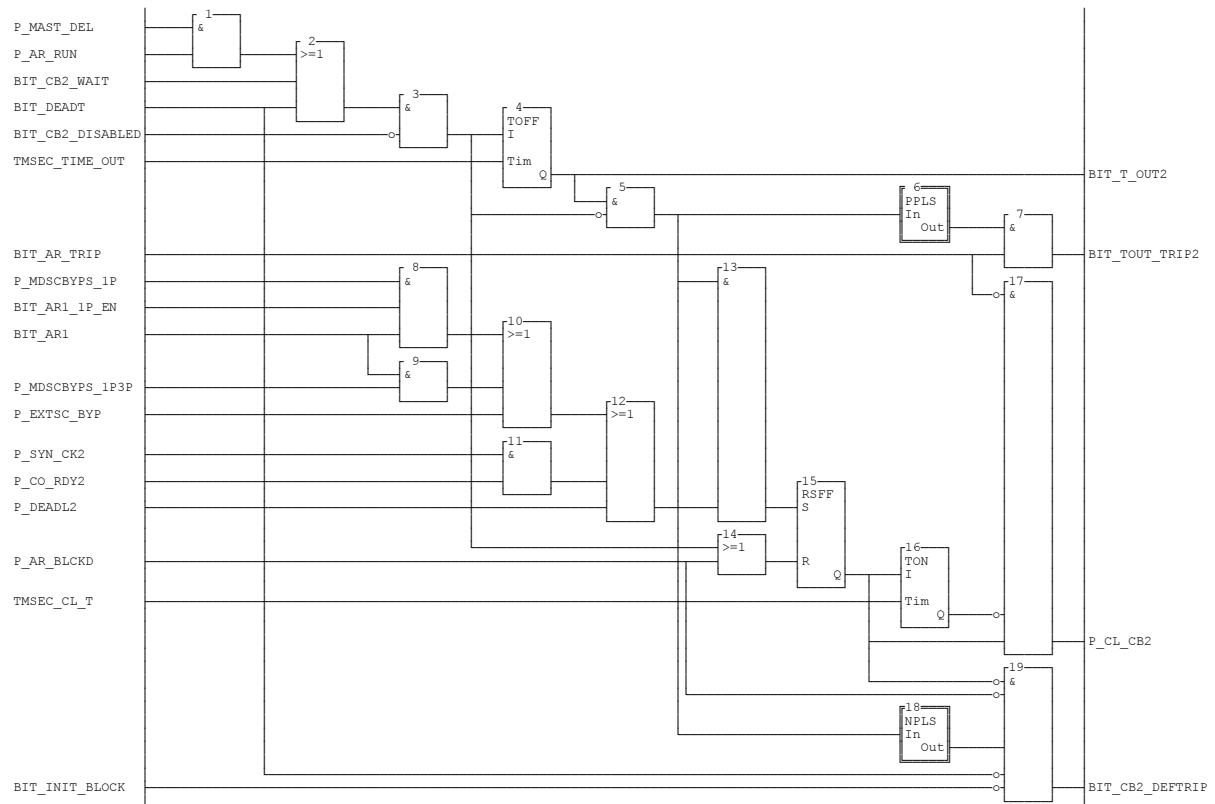


Fig. 4.6 Segment CLOSE2:
Close command for the second circuit-breaker

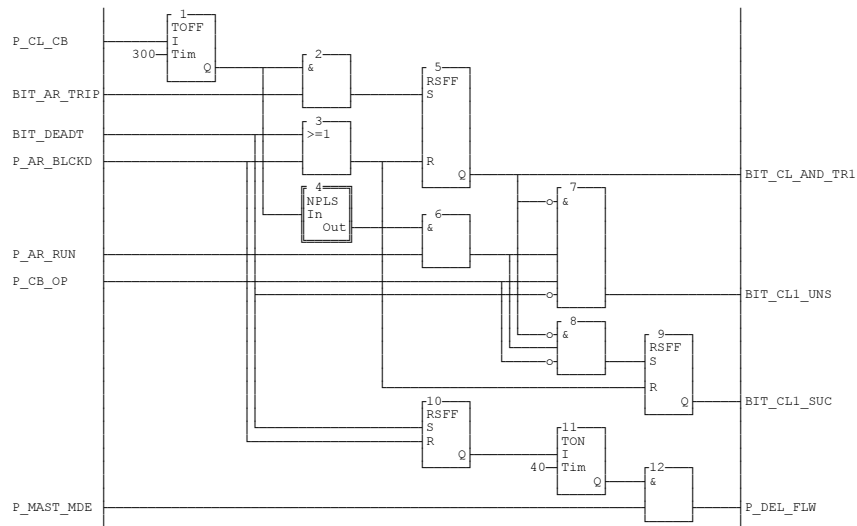


Fig. 4.7 Segment SUCCES1:
Closure supervision for the first circuit-breaker

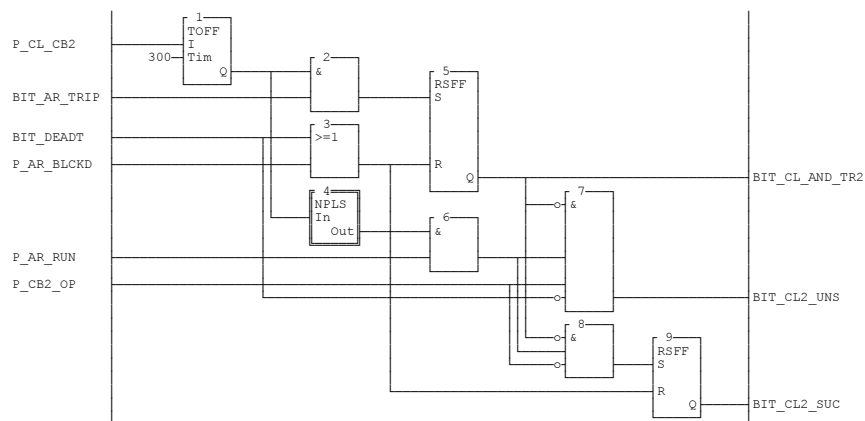


Fig. 4.8 Segment SUCCES2:
Closure supervision for the second circuit-breaker

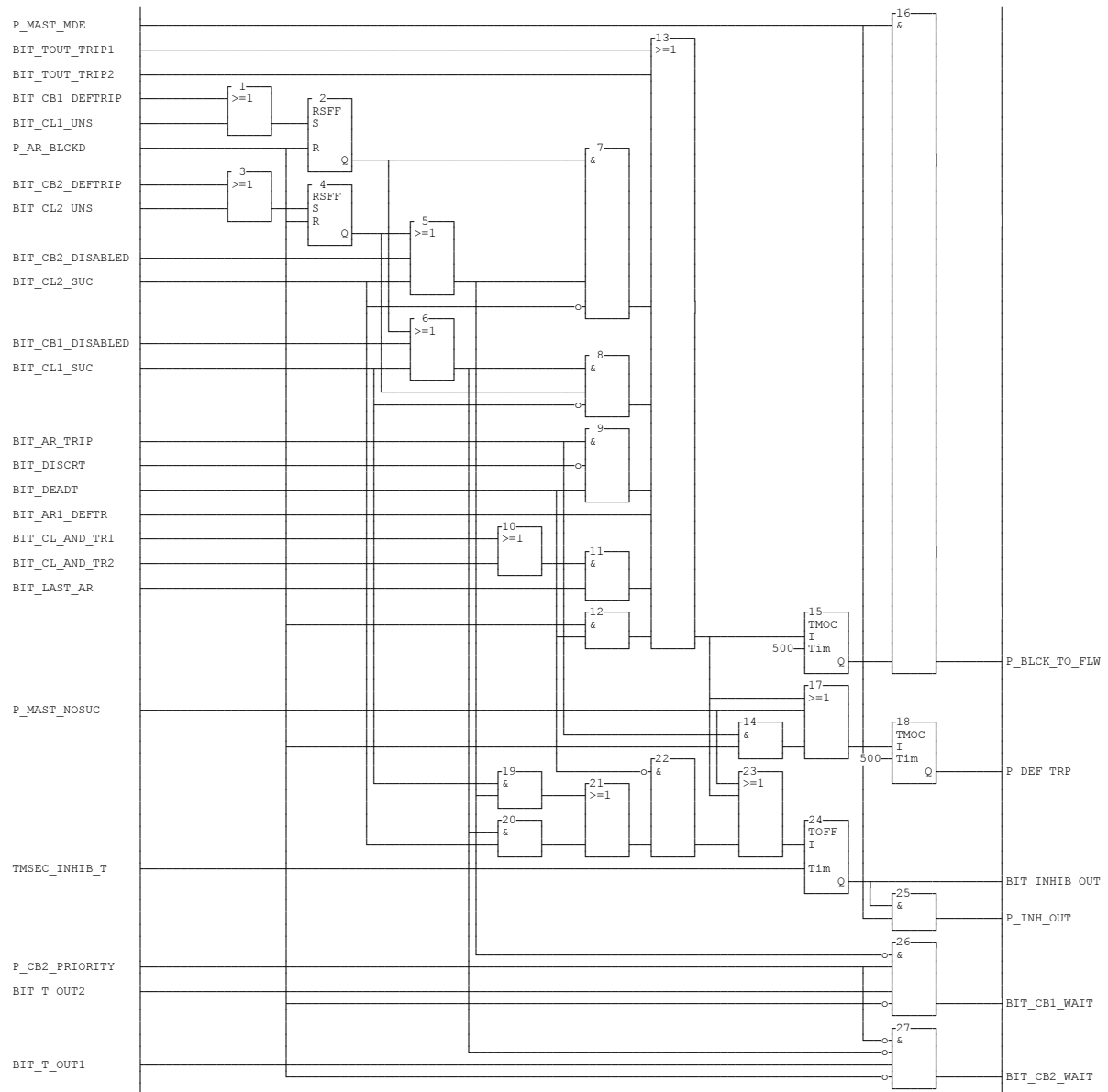


Fig. 4.9 Segment DEFTRIP:
Master/follower and duplex logic,
final TRIP signal

4.2.1.2. *Explanation of the signal names*

The relationship between the names of the FUPLA input and output signals and the designations of the corresponding parameters used for the HMI can be seen from the following tables. The interconnections between the various segments are not shown.

Timer settings

FUPLA signal name	HMI parameter designation	HMI parameter setting
TMSEC_BLK_T	t AR Block.	0.05 ... 300
TMSEC_CL_T	t Close	0.05 ... 300
TMSEC_DEADT1_1P	t Dead 1P	0.05 ... 300
TMSEC_DEADT1_3P	t Dead 3P	0.05 ... 300
TMSEC_DEADT1_EXT	t Dead Ext	0.05 ... 300
TMSEC_DEADT2	t Dead2	0.05 ... 300
TMSEC_DEADT3	t Dead3	0.05 ... 300
TMSEC_DEADT4	t Dead4	0.05 ... 300
TMSEC_DISCRT_1P	t Discrim. 1P	0.10 ... 300
TMSEC_DISCRT_3P	t Discrim. 3P	0.10 ... 300
TMSEC_INHIB_T	t Inhibit	0.05 ... 300
TMSEC_OPERT	t Oper	0.05 ... 300
TMSEC_TIME_OUT	t Timeout	0.05 ... 300

Binary inputs

FUPLA signal name	HMI parameter designation	HMI parameter setting
P_AR_MD2	2..4AR mode	2 WE
P_AR_MD3	2..4AR mode	3 WE
P_AR_MD4	2..4AR mode	4 WE
P_AR_START	Start	-
P_AR_START_2	Start 2	-
P_AR_START_3	Start 3	-
P_AR_ZEMD	ZE Prefault	on
P_AR1_ZE	ZE 1. AR	on
P_AR2_ZE	ZE 2. AR	on

FUPLA signal name	HMI parameter designation	HMI parameter setting
P_AR3_ZE	ZE 3. AR	on
P_AR4_ZE	ZE 4. AR	on
P_CB_OP	CB Open	-
P_CB2_OP	CB2 Open	-
P_CB2_PRIORITY	CB2 Priority	-
P_CO_RDY	CO Ready	-
P_CO_RDY2	CO Ready 2	-
P_COND_BLACK	Cond.Blk AR	-
P_DEADL	Dead line	-
P_DEADL2	Dead line 2	-
P_EXT_T1_EN	Extend t1	-
P_EXTBL_AR	Ext. Blk AR	-
P_EXTSC_BYB	Ext.SCBypas	-
P_INH_IN	Inhibit Inp.	-
P_MANCL_AR	Manual Close	-
P_MAST_DEL	MasterDelay	-
P_MAST_MDE	Master mode	on
P_MAST_NOSUC	Mast.noSucc	-
P_MD1_1P_1PAR	1. AR Mode	1. 1P-1P
P_MD1_1P_3PAR	1. AR Mode	1. 1P-3P
P_MD1_1P3P_3PAR	1. AR Mode	1. 1P3P-3P
P_MD1_1P3P_1P3P	1. AR Mode	1. 1P3P-1P3P
P_MD1_EXT	1. AR Mode	Ext. select
P_MD1_EXT_1P_1P	MD1_EXT_1P_1P	-
P_MD1_EXT_1P_3P	MD1_EXT_1P_3P	-
P_MD1_EXT_1P3P_3P	MD1_EXT_1P3P_3P	-
P_MD1_EX_1P3P_1P3P	MD1_EX_1P3P_1P3P	-
P_MDSCBYPS_1P	SCBypas 1P	-
P_MDSCBYPS_1P3P	SCBypas 1P3P	-
P_RDY_OCO	CB Ready	-
P_RDY_OCO2	CB2 Ready	-

FUPLA signal name	HMI parameter designation	HMI parameter setting
P_SYN_CK	SynchroChck	-
P_SYN_CK2	SynchroChck2	-
P_TRIP	Trip CB	-
P_TRIP_2	Trip CB2	-
P_TRIP_3	Trip CB3	-
P_TRIP_3P	Trip CB 3P	-
P_TRIP_3P_2	Trip CB2 3P	-
P_TRIP_3P_3	Trip CB3 3P	-

Output signals

FUPLA signal name	HMI parameter designation
P_1AR_1P	First AR 1P
P_1AR_3P	First AR 3P
P_2AR	Second AR
P_3AR	Third AR
P_4AR	Fourth AR
P_AR_3POL_OUT	Trip 3-Pol
P_AR_BLKCD	AR Blocked
P_AR_RDY	AR Ready
P_AR_RUN	AR in Prog.
P_AR_ZEOUT	ZExtension
P_BLK_TO_FLW	Blk.toFlwr.
P_CL_CB	CB Close
P_CL_CB2	CB2 Close
P_DEF_TRP	Def. Trip
P_DEL_FLW	DelayFlwr.
P_INH_OUT	Inhibit Outp

4.2.2. Breaker failure protection

4.2.2.1. Introduction

This function provides backup protection to clear a fault after being enabled by the unit protection for the case that the circuit-breaker (CB) should fail. It has to operate as quickly and reliably as possible especially on EHV systems where stability is crucial.

To this end, current detectors continuously monitor the line currents and if they do not reset after a preset time, which allows for the operating times of the unit protection and the circuit-breaker, a tripping command is issued to either attempt to trip the same circuit-breaker again or trip the surrounding circuit-breakers.

Resetting of current detectors is influenced by the following factors:

- Even after the main CB contacts open, the current does not immediately drop to zero, but to a level determined by the fault resistance and the resistance of the arc across the open CB contacts. The current only becomes zero after the de-ionisation time of the CB arc.
- The pick-up setting of the detector.
- The fault level prior to operation of the CB.
- Whether the main c.t.'s saturate. If a c.t. saturates, its secondary current may not pass through zero at the same time as its primary current and if the primary current is interrupted at zero, the c.t. flux may be at some positive or negative value. The secondary current therefore decays through the burdens of the relays thus increasing the reset time.

The resetting time varies typically between 20 and 30 ms.

Since for the above application, the current detectors should reset as quickly as possible, Fourier filter algorithms are included to minimise the affect of c.t. saturation and eliminate completely or substantially any DC offset.

The block diagram below shows the basic functions, which are explained in the following Sections.

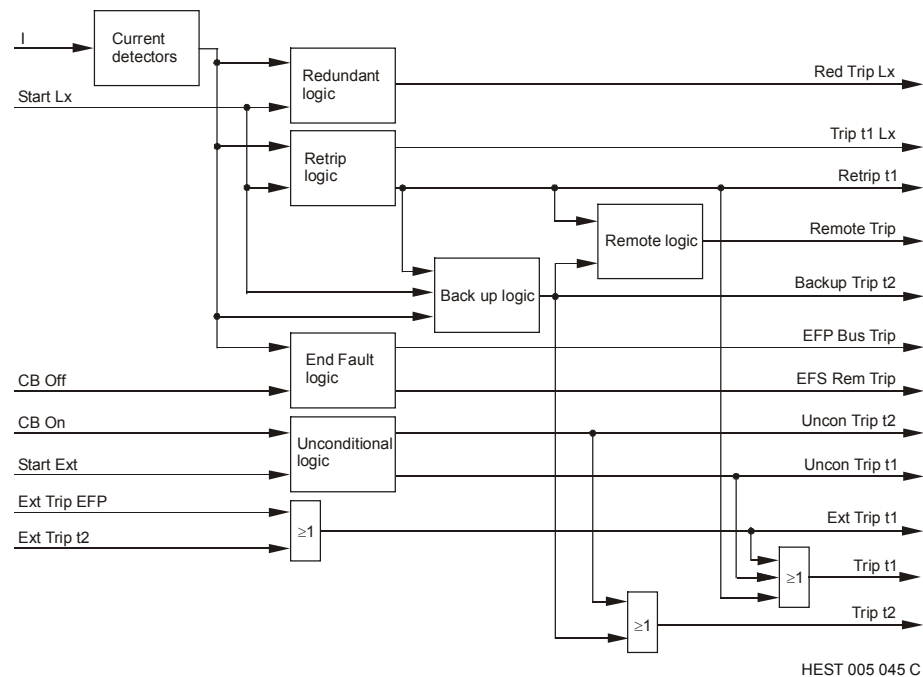


Fig. 4.10 Block diagram

4.2.2.2. *Three-phase/ single-phase mode*

The function has three current detectors. When it is used in the three-phase mode, each current detector measures the current in each of the three phases.

In order to accommodate a fourth current detector measuring the neutral current, this function has to be duplicated and the second function set to the single-phase mode and the appropriate current pick-up. The two functions then operate in parallel.

This arrangement also covers the two special cases of phase-to-phase and phase-to-ground faults.

4.2.2.3. *'Redundant Trip'*

The 'Redundant Trip' logic performs phase-segregated direct tripping of the same circuit-breaker without any intentional time delay, if the Start inputs are active and the corresponding current detectors have picked up. This ensures that the breaker receives a tripping command in the event of a unit protection trip circuit failure, which would otherwise cause a second attempt to trip the same breaker or backup tripping of the surrounding breakers.

4.2.2.4. 'Retrip'

The unit protection issues a trip command and simultaneously starts individual phases or all three phases of the breaker fail function.

A second attempt is made to trip the corresponding phase or phases after the first time step (t1), providing the current detectors have not reset.

The 'Retrip' logic can be disabled if not required.

Separate timers for each phase ensure correct operation during evolving faults.

4.2.2.5. 'Backup Trip'

A second time step (t2) follows the first time step (t1) and initiates backup tripping which is always of all three phases. If the first time step is disabled, the second time step is started immediately, providing the current detectors have activated by the starting signal from the protection.

The backup trip logic trips all surrounding breakers feeding the fault.

4.2.2.6. 'Remote Trip'

The 'Remote Trip' logic trips the breaker at the remote end of the line.

Remote tripping can take place concurrently with the 'Retrip' or 'Backup' functions or not at all as desired.

In contrast to the other tripping commands which remain activate for a given period after the initiating signal has reset, the remote tripping signal is an impulse with a width which is adjustable irrespective of when the starting signal from the protection resets.

4.2.2.7. 'Unconditional Trip'

This feature was introduced to respond to low-level faults with currents too low for the current detectors to pick up or do not initially cause any fault current at all such as mechanical protection devices like Buchholz, etc.

The start input bypasses the current detectors and activates the time steps if the breaker is in the closed position. In all other respects, this logic is similar to the 'Retrip' and 'Backup' logics.

4.2.2.8. 'End Fault Trip'

While in the case of a fault between a circuit-breaker and a single set of c.t.'s, the circuit-breaker may not fail, the affect on the power system and the action that has to be taken are the same as if the circuit-breaker had failed.

Where there is only a single set of c.t.'s on the busbar side of a circuit-breaker, the zones of protection do not overlap and a fault between the circuit-breaker and the c.t.'s is seen as a line fault, although it belongs to the busbar zone and persists after the circuit-breaker has been tripped. The breaker failure protection's 'End Fault Trip' logic ultimately clears such faults at the end of the second time step.

This logic is enabled if the breaker is open and the current detectors are still picked up, indicating a fault between the breaker and the c.t.'s. The speed of tripping is determined by the time delay setting.

Depending on whether the single set of c.t.'s is on the line side or bus side of the circuit-breaker, either the section of busbar or the circuit-breaker at the remote end of the line is tripped.

4.2.2.9. 'External Trip'

This function has been included to make the breaker fail protection more user-friendly and reduce the amount of systems engineering required. It generates an instantaneous trip when either of the following inputs is activated:

- The input connected to the second time steps of other breaker fail protection devices in the station.
- The input connected to the end fault outputs of other breaker fail protection devices in the station.

March 01

5. OPERATION (HMI)

5.1.	Summary.....	5-5
5.2.	Installation and starting the operator program.....	5-6
5.2.1.	PC requirements	5-6
5.2.2.	Installing the operator program	5-6
5.2.3.	Starting and shutting down the operator program	5-9
5.3.	Operation	5-11
5.3.1.	General	5-11
5.3.2.	Standard key functions applicable to all menus	5-11
5.3.3.	Using the mouse	5-12
5.3.4.	Information displayed on the screen	5-12
5.4.	Main menu and sub-menus.....	5-13
5.5.	Editor	5-20
5.5.1.	Present prot. funcs.....	5-21
5.5.1.1.	Changing the settings of a function.....	5-23
5.5.1.2.	Changing a function comment	5-23
5.5.1.3.	Copying a function	5-25
5.5.1.4.	Deleting a function	5-26
5.5.2.	Adding a new function.....	5-28
5.5.3.	General information on editing parameters	5-28
5.5.3.1.	Entering numerical settings.....	5-29
5.5.3.2.	Selecting from a list of alternatives	5-30
5.5.4.	Explanation of the types of channels	5-32
5.5.4.1.	C.t./v.t. input channels	5-32
5.5.4.2.	Signalling channels	5-33
5.5.4.3.	Tripping channels.....	5-39
5.5.4.4.	Binary channels	5-40
5.5.5.	Editing hardware functions.....	5-47
5.5.5.1.	Inserting a channel comment.....	5-52
5.5.5.2.	Analog (CT/VT) Channels	5-53
5.5.5.3.	Excluding (masking) binary channels as events	5-54
5.5.5.4.	Tripping and signalling channel latching	5-55
5.5.5.5.	Definition of double signals	5-55
5.5.6.	Editing system functions	5-58
5.5.7.	Listing settings	5-61
5.5.8.	Saving the contents of the editor.....	5-62
5.5.8.1.	Downloading to the device	5-63

5.5.8.2.	Saving in and loading from a file	5-63
5.6.	Event handling and operation of the disturbance recorder	5-64
5.7.	Displaying variables	5-69
5.7.1.	Displaying AD(CT/VT) channels	5-69
5.7.2.	Displaying load values	5-70
5.7.3.	Displaying binary inputs, signalling relays, LED's or tripping relays.....	5-71
5.7.4.	Displaying analogue inputs and outputs	5-71
5.7.5.	Displaying ITL inputs and outputs	5-72
5.7.6.	Displaying SCS outputs	5-73
5.7.7.	Displaying FUPLA signals.....	5-74
5.8.	Diagnostics	5-75
5.9.	Test functions.....	5-76
5.10.	Documentation.....	5-83
5.11.	Operation with several sets of parameters.....	5-84
5.11.1.	Switching sets of parameters	5-84
5.11.2.	Creating sets of parameters.....	5-85
5.11.2.1.	Assigning a protection function to a set of parameters	5-85
5.11.2.2.	Copying a protection function with its settings	5-86
5.11.2.3.	Displaying a function with its settings.....	5-87
5.11.3.	Logics.....	5-87
5.12.	Remote HMI	5-88
5.12.1.	Summary.....	5-88
5.12.2.	Modem requirements	5-88
5.12.3.	Remote HMI shell	5-89
5.12.3.1.	Installation.....	5-89
5.12.3.2.	Configuring a new station.....	5-89
5.12.3.3.	Establishing the connection to the station	5-94
5.12.4.	Configuring a remote HMI for operation via the SPA-BUS interface	5-95
5.12.4.1.	Remote HMI connected directly to the electro-optical converter	5-95
5.12.4.2.	Remote HMI connected via a modem to the electro-optical converter	5-96
5.12.5.	Configuring a remote HMI connected to an SRIO	5-97
5.12.5.1.	Remote HMI connected directly to the SRIO	5-97
5.12.5.2.	Remote HMI connected via a modem to the SRIO	5-98
5.12.6.	Local control of a device via the interface at the front	5-99
5.12.6.1.	Remote HMI right of access to device functions	5-99
5.12.7.	Control via an SPA-BUS or an SRIO	5-99
5.12.7.1.	HMI start-up	5-100

5.12.7.2.	SPAComm window	5-101
5.12.8.	SRIO settings.....	5-102
5.13.	Local display unit	5-103
5.13.1.	Summary.....	5-103
5.13.2.	Limitations.....	5-103
5.13.3.	General description.....	5-103
5.13.3.1.	Mechanical assembly and front view.....	5-103
5.13.3.2.	Electrical connections	5-104
5.13.3.3.	Password	5-104
5.13.3.4.	Passive operation	5-104
5.13.3.5.	LDU keypad	5-105
5.13.4.	The three status LED's	5-106
5.13.4.1.	General	5-106
5.13.4.2.	Starting RE.316*4	5-106
5.13.4.3.	No active protection functions	5-107
5.13.4.4.	Normal operation	5-107
5.13.4.5.	Pick-up of a protection function (General start).....	5-107
5.13.4.6.	Protection function trip (General Trip)	5-107
5.13.4.7.	Fatal device error	5-108
5.13.5.	Text display (LCD)	5-108
5.13.5.1.	General	5-108
5.13.5.2.	Language.....	5-108
5.13.5.3.	Interdependencies	5-108
5.13.5.4.	Configuration.....	5-109
5.13.6.	Menu structure.....	5-109
5.13.7.	Entry menu.....	5-111
5.13.8.	Main menu	5-111
5.13.8.1.	Measurands	5-112
5.13.8.1.1.	AD-Channels.....	5-113
5.13.8.1.2.	Load values.....	5-114
5.13.8.1.3.	Binary signals.....	5-115
5.13.8.2.	Event list	5-118
5.13.8.3.	User's guide	5-118
5.13.8.4.	Disturbance recorder list	5-119
5.13.8.5.	Diagnostics menu	5-119
5.13.8.5.1.	Diagnosis information	5-119
5.13.8.5.2.	IBB status information	5-120
5.13.8.5.3.	Process bus information	5-120
5.13.8.5.4.	LED descriptions.....	5-121
5.13.8.6.	RESET menu	5-122
5.13.9.	Automatic display.....	5-123
5.13.9.1.	General description.....	5-123
5.13.9.2.	Automatic display sequence	5-123
5.13.9.3.	Stopping the automatic display routine	5-123
5.13.9.4.	Automatic display cycle.....	5-123

5.14.	SMS010	5-124
5.14.1.	Installing SMS010 and 'Reporting' and 'SM/RE.316*4' for SMS010	5-124
5.14.2.	SMS010 Editor	5-125
5.14.2.1.	Main menu	5-125
5.14.3.	Sub-menu 'SMS010 editor'	5-126
5.14.4.	Descriptions of the various menu items	5-127
5.14.4.1.	Menu item 'Edit Event. Dsc' for processing Event.DSC	5-127
5.14.4.2.	Menu item 'Edit Logging. Dsc' for processing Logging.DSC	5-129
5.14.4.3.	Menu item 'Create New DSC Files'	5-130
5.14.5.	Creating a station after installing SMS010	5-131
5.14.5.1.	Creating the application structure	5-131
5.14.5.2.	Updating the Spin.CNF file.....	5-135
5.14.5.3.	Creating a report station	5-137
5.14.5.4.	Entering the SRIO address for 'Reporting'	5-138

5. OPERATION (HMI)

5.1. Summary

The user shell for the RE. 316*4 has been designed to be largely self-sufficient and requires a minimum of reference to the manual. This approach achieves a number of advantages:

- functions selected from extremely user-friendly menus with full screen displays and a combination of overlapping windows.
- 'pop-up' prompts wherever practical to guide the user and avoid errors.
- provision for creating, editing and checking sets of parameters off-line, i.e. without being connected to the protection equipment.
- provision for transferring sets of parameters to and from files.
- self-explanatory texts using a minimum of codes.
- provision for the user to enter his own descriptions of functions, inputs and outputs.

5.2. *Installation and starting the operator program*

5.2.1. *PC requirements*

The HMI for the RE. 316*4 runs in the protected mode. The minimum requirements for the PC are 16 MB of RAM, 12 MB free hard disc space and an operating system MS Windows 3.x, Windows 95 or Windows NT4.0 or higher. A 486 series processor or higher is recommended.

The HMI communicates with the RE. 316*4 at a baud rate of 9600 Baud. A problem can be encountered with some PC's if the memory manager EMM386 is active.

Temporarily disable the EMM386 memory manager by entering 'REM' at the beginning of the corresponding line in the 'config.sys' file:

REM DEVICE=.....\EMM386.....

Disabling the EMM386 memory manager is recommended. The consequence is less PC main memory below 640 kB, because the device drivers are loaded there instead of in the upper memory range. This, however, has no influence on the operation of the HMI.

5.2.2. *Installing the operator program*

We recommend the strict observation of the following points before installing the software on a your hard disc:

1. Ensure that your original floppy discs are write-protected.
2. Make backup copies of the original discs. Store the original program discs in a safe place and use the copies to install the program.

The program is located on the floppy discs labelled "RE.316*4 Software" in compressed form. There is also an installation program on the disc to simplify the installation program.

Installation on a hard disc under Windows 3.1 / 3.11:

1. Insert the first disc "Disk 1/4" into drive A.
2. Select 'Run' in the 'File' menu and enter 'a:\setup' in the window that opens.

Installation on a hard disc under Windows 95 / NT 4.0:

1. Insert the first disc "Disk 1/4" into drive A.
2. Click on 'Start' on the task bar at the bottom of the screen.
Select 'Run' in the menu that then opens and enter 'a:\setup'.

Simply follow the instructions on the screen for the remainder of the procedure. The installation of the remote HMI shell is optional. Respond appropriately to the requests for language, drive, directory and program group.

HMI files and configuration

After installation, the following files amongst others are in the HMI directory:

- pcgc91.exe: operator program.
- re*.cfg: configuration file.
- readme.e: text file with explanations of the installation procedure and the latest information about new SW versions.
- diststd.bin: distance protection function logic.
- aurestd.bin: auto-reclosure function logic.
- Sub-directory VDEW6: VDEW6 function logic.

Before the operator program can be executed, the device driver "ansi.sys" has to be loaded. The installation program automatically modifies the configuration files for the operating system.

DOS, Windows 3.x:

In the file C:\CONFIG.SYS:
device=c:\dos\ansi.sys.

Windows 95:

In the file C:\CONFIG.W40:
device=c:\win95\command\ansi.sys

Windows NT 4.0:

In the file C:\WINNT\SYSTEM32\CONFIG.NT:
device=%SystemRoot%\system32\ansi.sys

When the operator program is started, it searches for the configuration file 're*.cfg' which contains the settings it needs.

Example for a configuration file 're2.cfg':

```
;program parameters: (* 13-Mar-1998 16:36 *)
;RETP={REG216, REC216, RET316, REC316, REL316}
;LANG={ENG, DEU, FRA}
;COLOR={BW80,RGB}
;COMT={RDM,SRIO,TC57,SPA,MDM}
;BAUD={1200,2400,4800,9600,19200}
;SLVE={10...890} (Default slave No.)
;TNR={T..., P....}
;MPAR=AT&FE0
;
RETP=REC316
LANG=DEU
COLOR=RGB
EVEDATA=
ONHOOK=~~~~~+++~~~~~ATH0
CPUTYPE=PENTIUM
SLVE=2
SRIO_ADDR=950
COMT=TC57
TNR=T581625
MPAR=AT&D0E0M0S0=0
PORT=1
BAUD=9600
BAUD_XX=BAUD96
```

The following parameters are of consequence in order to communicate with the RE. 316*4 via the interface on the front of the unit:

```
RETP=
LANG=
COMT=TC57
PORT=
BAUD_XX=
```

5.2.3. Starting and shutting down the operator program

To start the operator program click on the icon created during the installation procedure.

The corresponding sequence can be seen from the flow chart below (Fig. 5.1). The program starts in the off-line mode or with a new ("empty") relay as REC 316*4. The choice of relay type and the main configuration parameters can be entered or edited by selecting the menu item 'Edit hardware functions'.

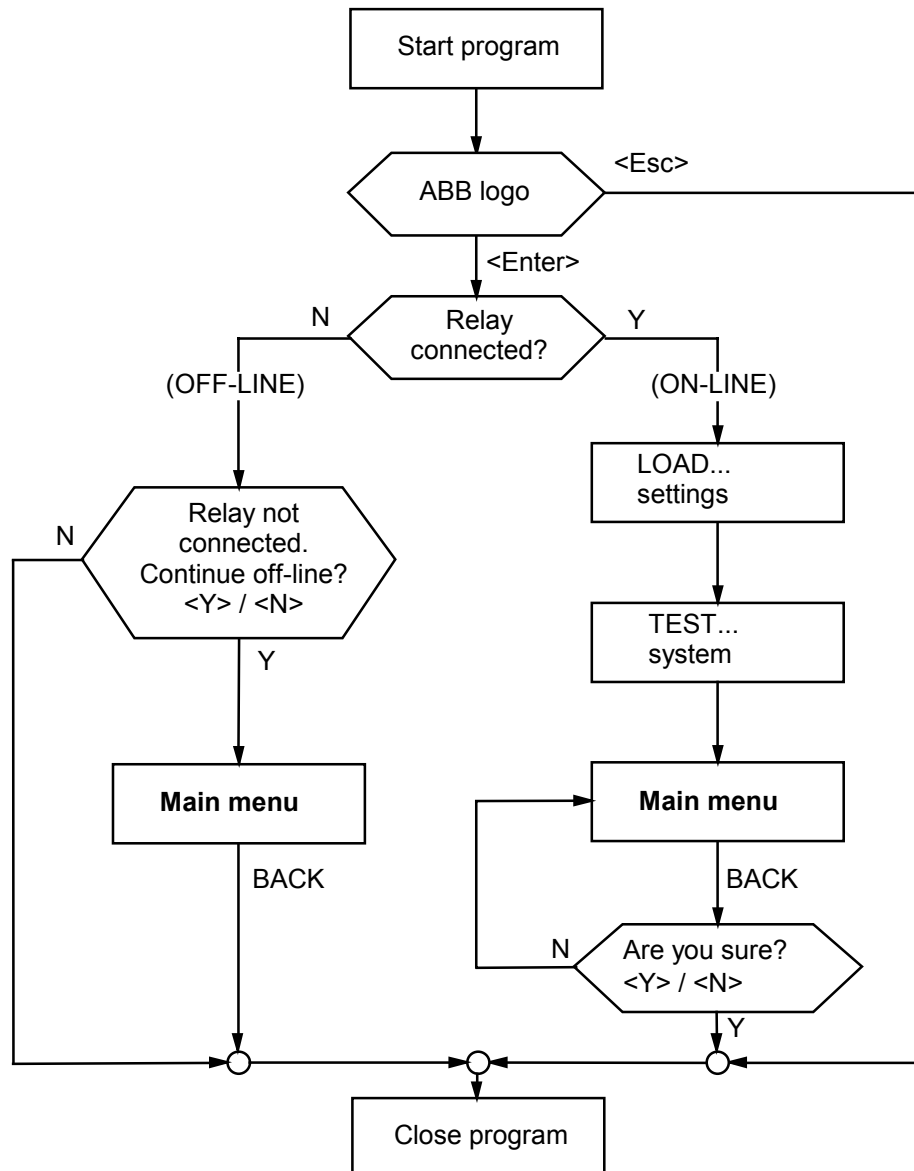


Fig. 5.1 Flow chart of the operator program start-up and shut-down sequence

Note:

If the system is required to operate on-line to exchange data between the PC and the RE. 316*4, the two must be connected by a serial data cable. The cable connects the serial port COM 1 or COM 2 on the PC to the optical connector on the front of the RE. 316*4. The protection must be in operation, i.e. the green stand-by LED must be lit or flashing.

Units that are not synchronised by the station control system via the interbay bus adopt the PC time when the HMI is started.

5.3. Operation

5.3.1. General

The HMI can be in one of four modes:

- Menu: waiting for the user to select a menu item.
- Operation: waiting for the user to enter data, e.g. parameter settings, confirmation of prompts, password etc.
- Output: display of measured variables, event lists etc. These windows are closed by pressing <Enter>.
- Wait: while the program executes a command (keyboard disabled). This can occur in any of the above modes.

A menu presents the user with a list of functions to choose from. A menu item is selected by moving the selection bar up or down using the up and down arrow keys and then pressing <Enter>.

As the user moves down the menu structure, the menus overlap each other on the screen. The whole screen is used to display data. Auxiliary menus and messages are displayed in pop-up windows and editing functions uses a combination of windows and full screen.

5.3.2. Standard key functions applicable to all menus

Except while setting parameters, responding to prompts and executing special functions, the user is always confronted by a menu, from which a menu item or line normally has to be selected. The following keys perform the same functions for all menus:

<↑>	Previous line
<↓>	Next line
<PgUp>	Scroll up
<PgDn>	Scroll down
<Home>	Go to the beginning of the menu
<End>	Go to the end of the menu
<Enter>	Execute the operation described by the line
<Esc>	Back to the previous window.

5.3.3. *Using the mouse*

Menus can be opened and closed and menu items selected using the mouse instead of the keyboard. The mouse and the mouse buttons are equivalent to the following keys:

Arrow keys Movement of the mouse.

<Enter> Left mouse button

<Insert> Right mouse button.

5.3.4. *Information displayed on the screen*

The following information is displayed at the bottom of the screen:

- Status of the connection to the RE. 316*4:
“On-line” or “Off-line”.
- Interface baud rate:
“4800 bps”, “9600 bps” or “19200 bps”.
- Active protocol for communication with the station control system (SCS):
“SCS:SPA” or “SCS:VDEW” or “SCS:LON” or “SCS:MVB”.
- Software version:
The version of the operator program is on the left and that of the device software on the right.
- An activity indicator is located between the two version numbers. A rotating dash indicates that the operator program is communicating with the device.

5.4. **Main menu and sub-menus**

The main menu gives the user the choice of performing one of the following operations:

1. Editor	loads the editor and enables all the protection and system functions to be listed, changed and saved.
2. Event handling	lists all the events in the event memory and enables the events to be deleted.
3. Measurements	displays protection variables including the A/D converter inputs.
4. Test functions	checks the protection functions in the various sets of parameters and the operation of the LED signals, tripping relays and signalling relays.
5. Diagnostics	provides fault-finding information for the protection system.
6. SMS010 editor	enables events and measured variables to be configured for processing by SMS010.
7. Documentation	the device configuration can be can be exported as a text file for use when engineering the SCS.
8. RETURN	closes the operator program.

All the above options are available when the PC is connected on-line, but only 1, 6, 7 and 8 when it is off-line.

Note:

With the exception of the editor, all the menu items are only relevant when the PC is connected on-line to the protection equipment, e.g. for transferring data. All printed and displayed data are identical to those loaded in the protection and not related to those being processed using the editor.

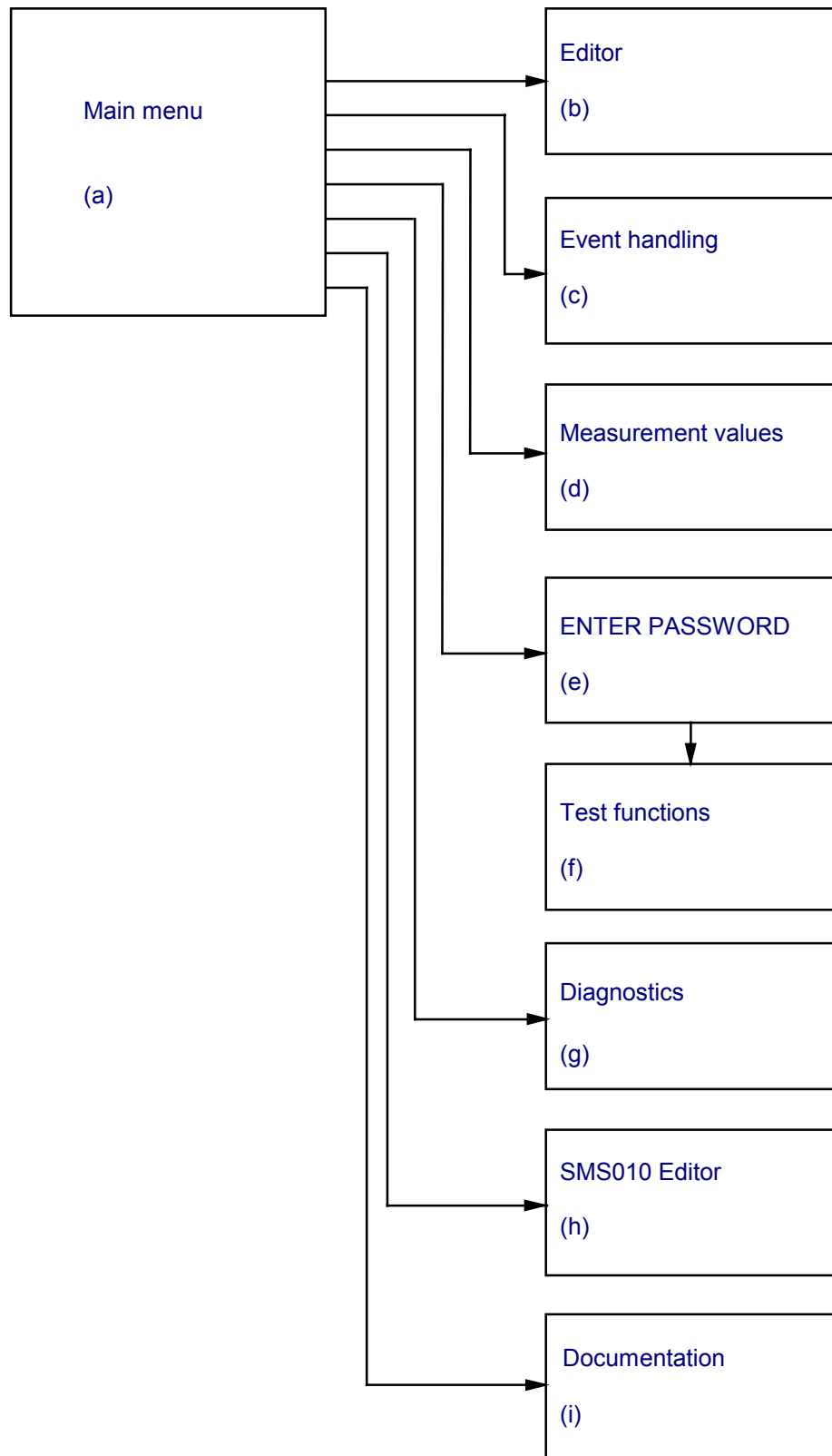


Fig. 5.2 Main and sub-menu structure
(see displays a to i on the following pages)

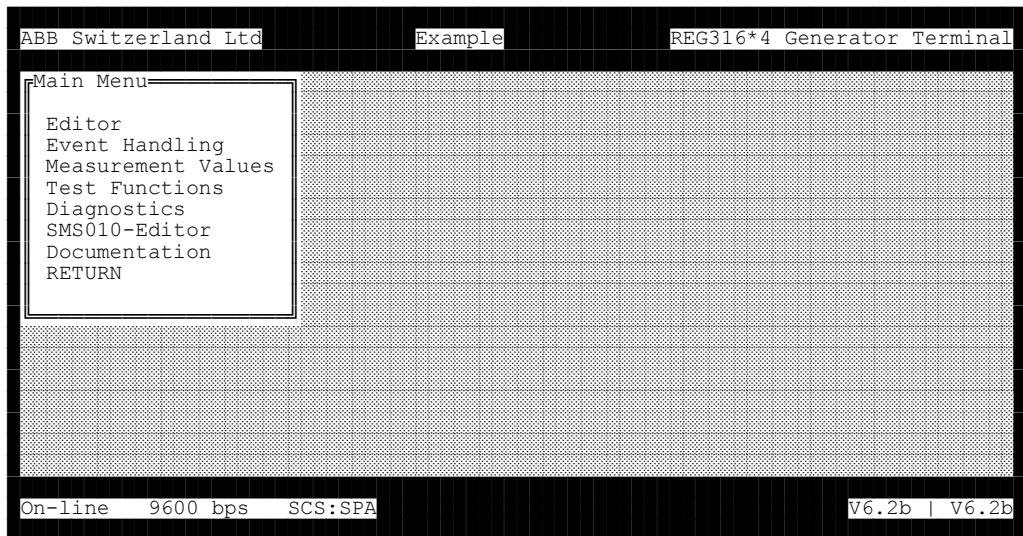
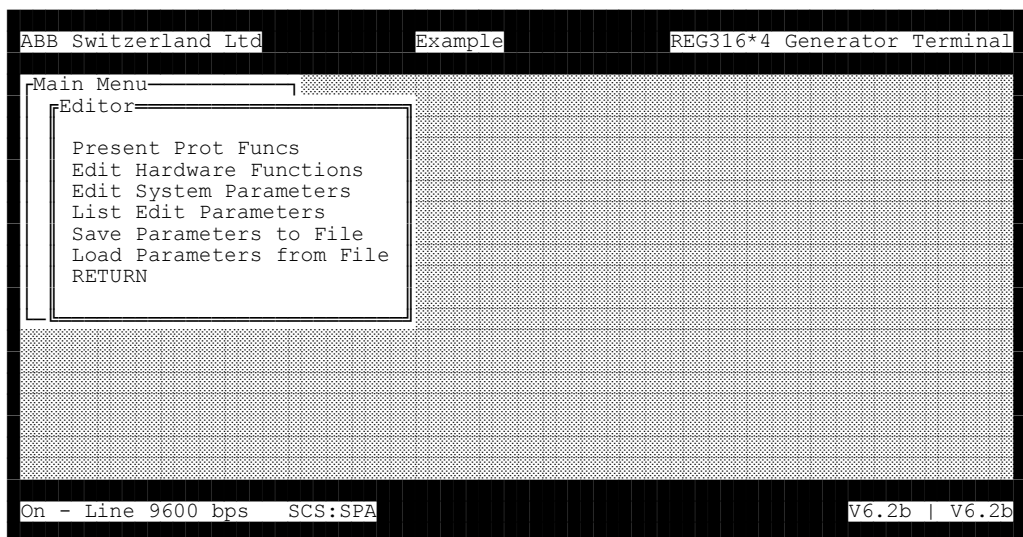


Fig. 5.2 a Main menu

Fig. 5.2 b Editor
(see Section 5.5.)

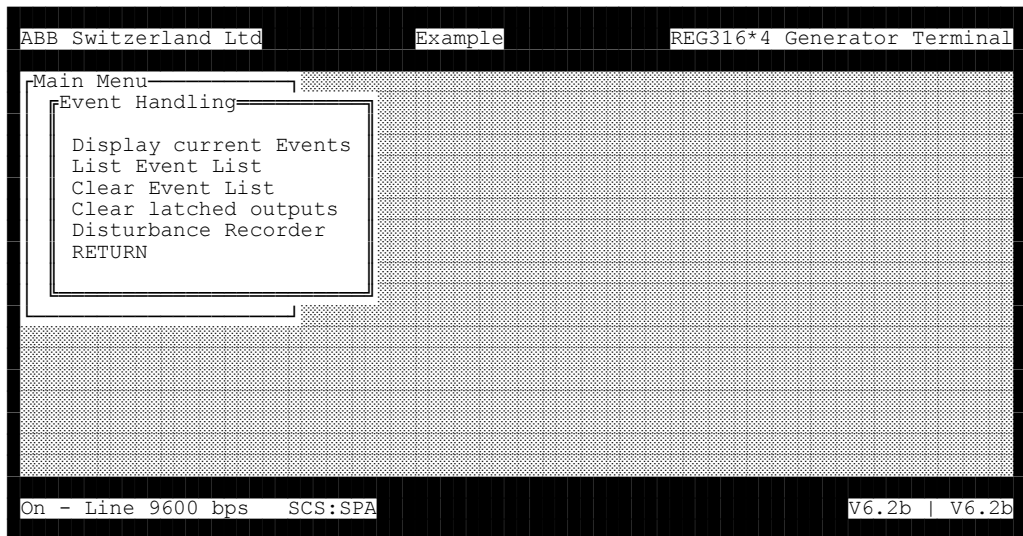


Fig. 5.2 c Event handling
(see Section 5.6.)

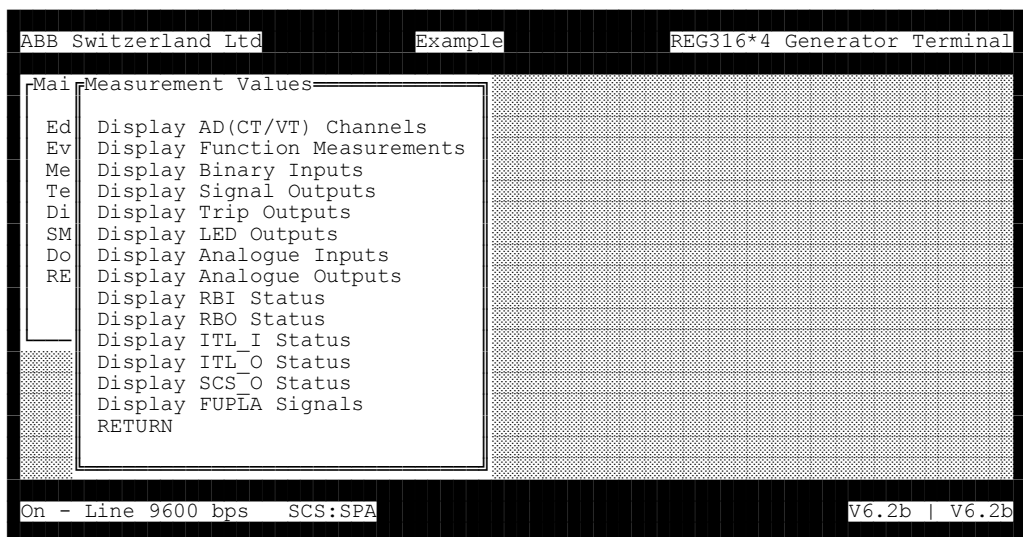


Fig. 5.2 d Measurement values
(see Section 5.7.)

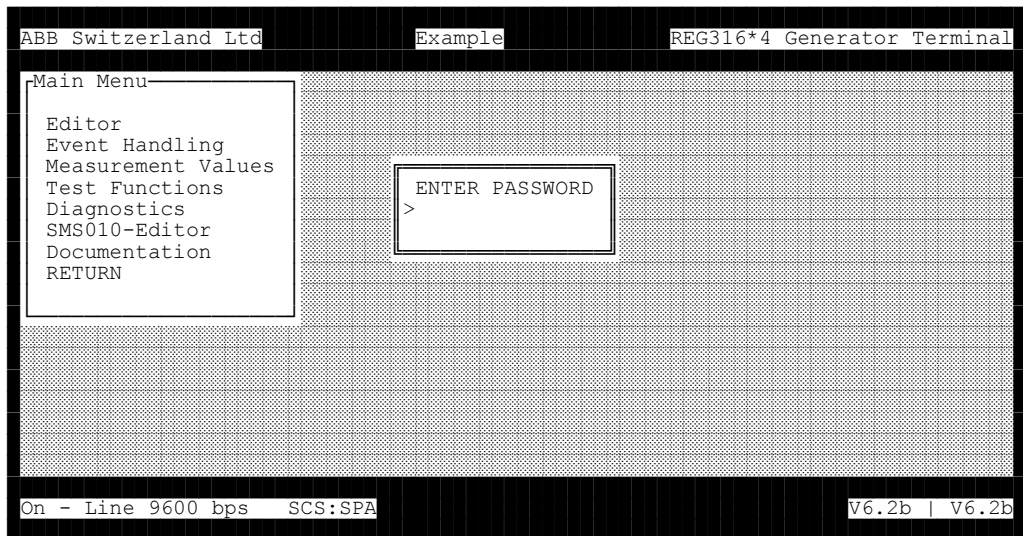
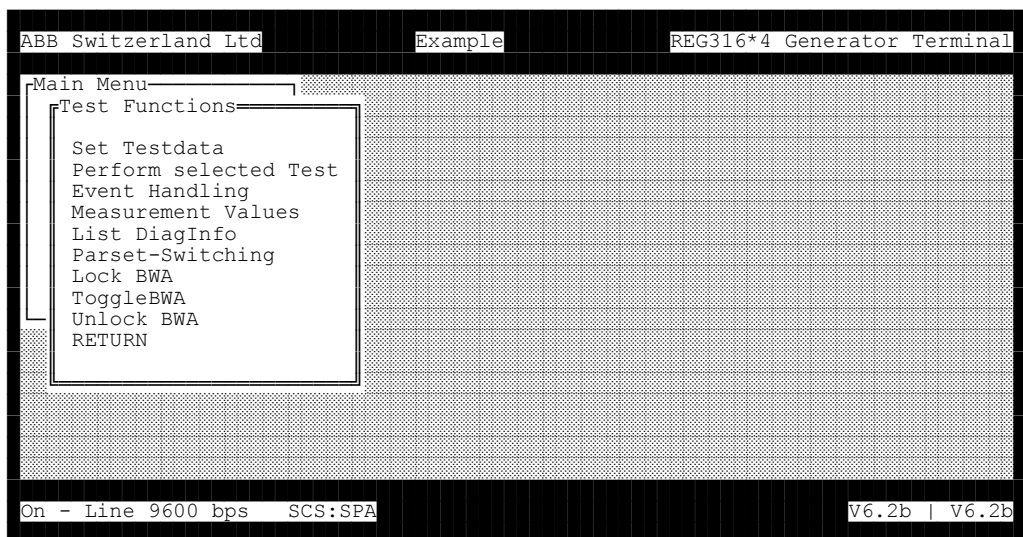


Fig. 5.2 e ENTER PASSWORD

Fig. 5.2 f Test functions
(see Section 5.9.)

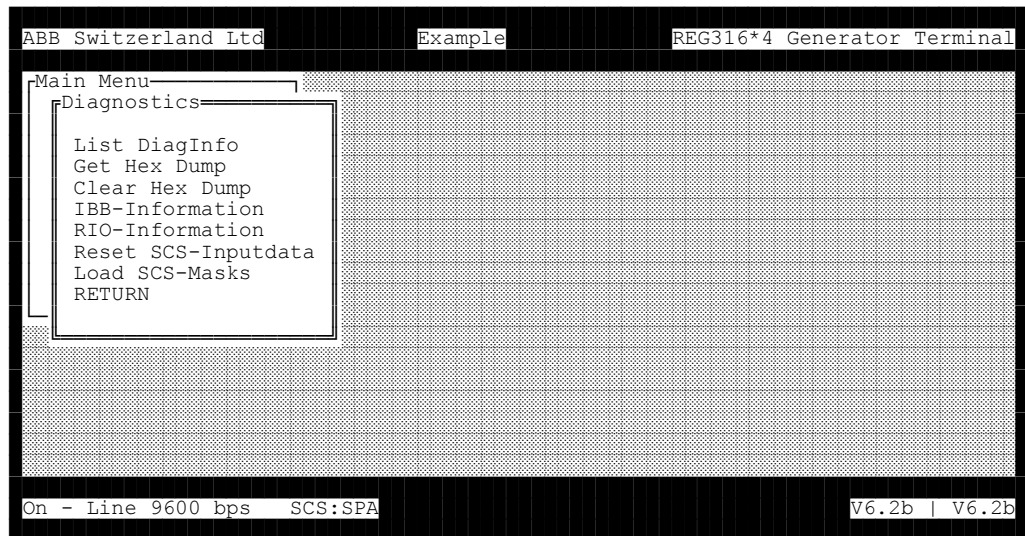


Fig. 5.2 g Diagnostics
(see Section 5.8.)

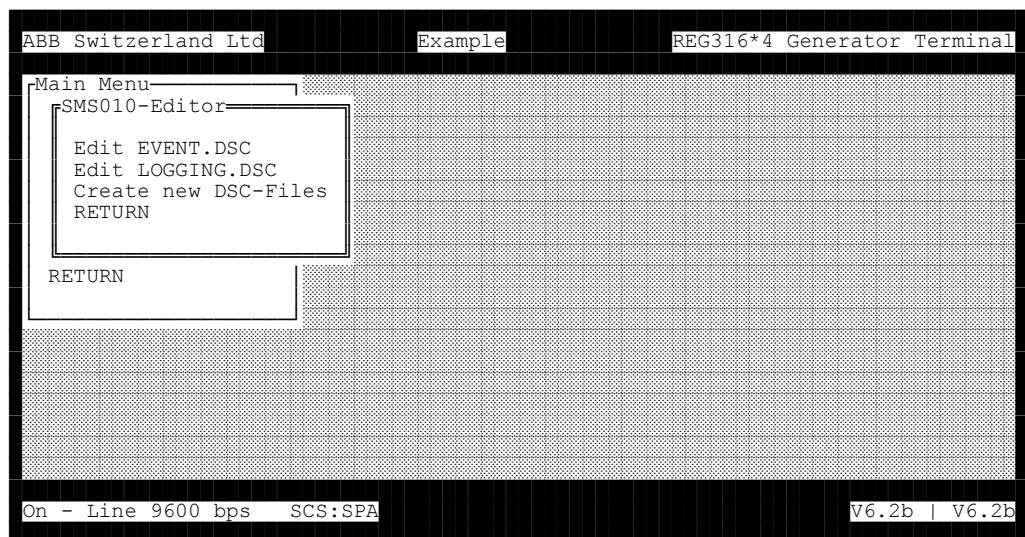


Fig. 5.2 h SMS010 editor
(see Section 5.14.)

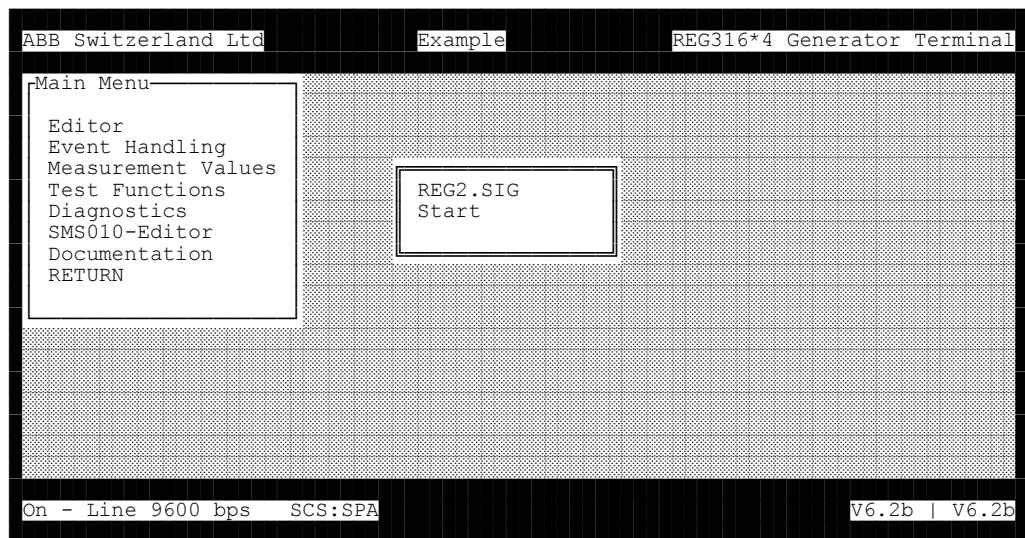


Fig. 5.2 i Documentation
(see Section 5.10.)

5.5. *Editor*

Edited data are stored in a separate buffer memory and nothing is changed in the protection until the save routine is executed. Thus a complete set of parameters can be created off-line without the PC being connected to the device. The only difference between off-line and on-line editing is that in the on-line mode, the user starts with copy of the current parameters and settings downloaded from the device. The "Editor" menu provides the following options:

1. "Present prot. funcs":
Edit, copy or delete a currently active function in the system or insert a new function.
2. "Edit hardware functions":
Edit parameters which effect the device hardware, e.g. configuration, analogue, binary, tripping and signalling channels and the OBI configuration.
3. "Edit system parameters":
Edit parameters not connected with functions.
4. "List edit parameters":
A list of the settings can be displayed on the screen, saved in a file or printed on a printer connected to the parallel port of the PC.
5. "Save parameters to file":
Saves the complete set of parameters (entire contents of the editor buffer) in a file.
6. "Load parameters from file":
Reverse operation of 5. A previously saved set of data is loaded from a file to the editor.
7. "RETURN":
Saves the edited set of parameters and returns the user to the main menu.

5.5.1. **Present prot. funcs.**

The settings and name of every active function can be changed or the function can be copied or deleted. The procedure is given in Fig. 5.3.

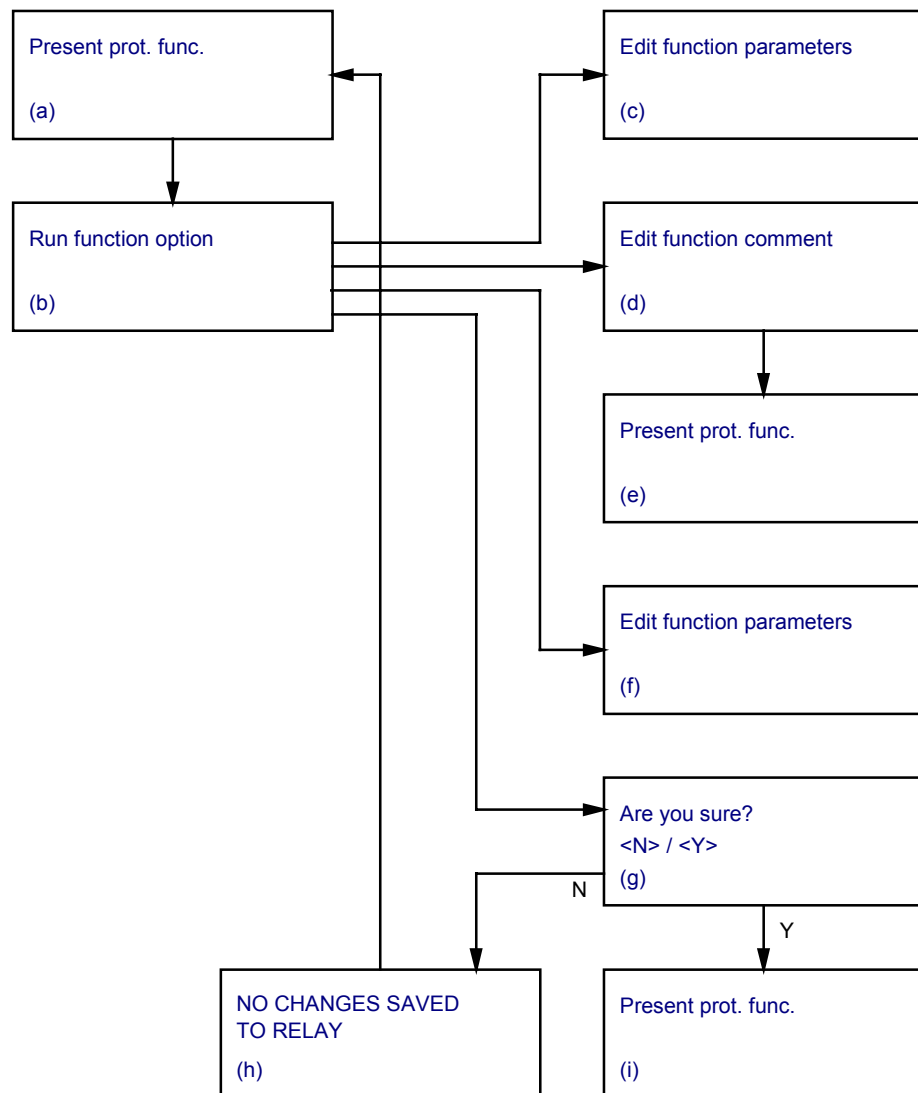


Fig. 5.3 Editing an active protection function
(see displays a to i on the following pages)

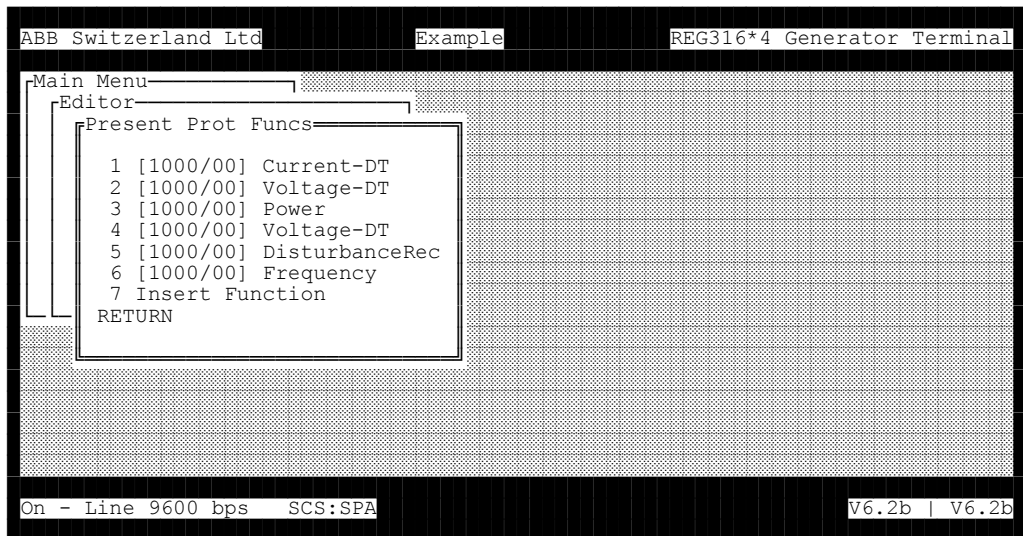


Fig. 5.3 a Present prot. funcs.

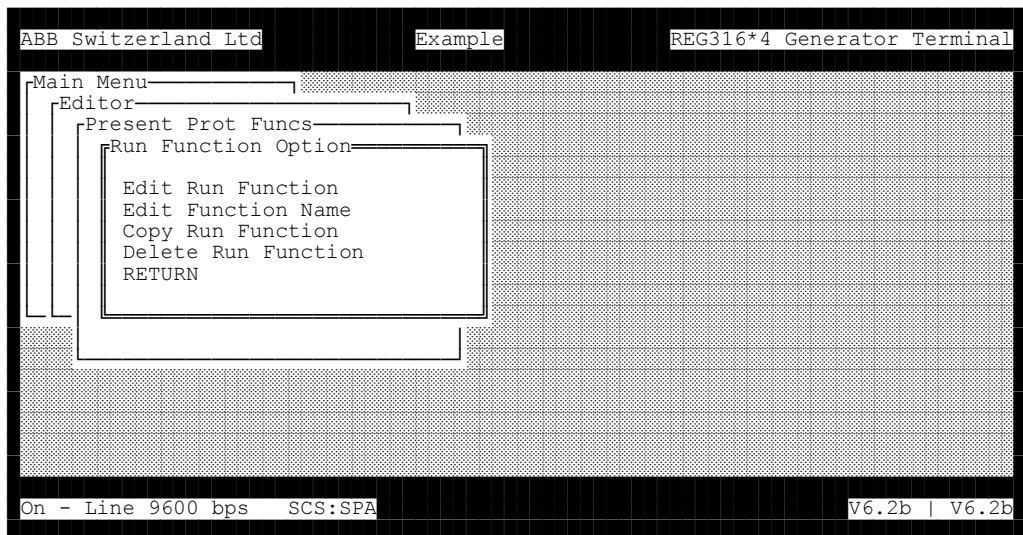


Fig. 5.3 b Run function option

5.5.1.1. *Changing the settings of a function*

Function settings are changed using the “Edit function parameters” window. How this is done for the different kinds of parameters is explained in [Sections 5.5.3.](#) and [5.5.4.](#)

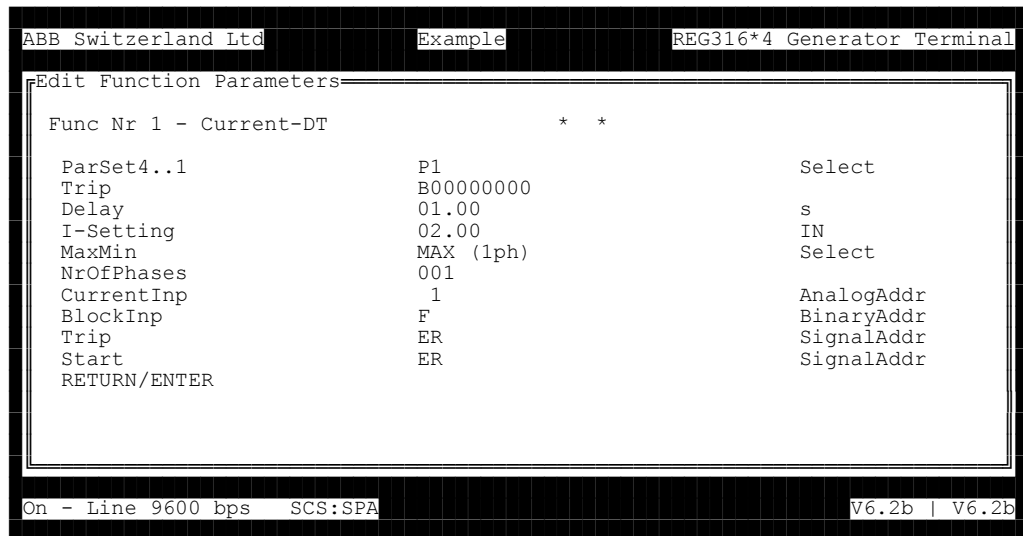


Fig. 5.3 c Edit function parameters

5.5.1.2. *Changing a function comment*

The “Edit function comment” window provides facility for entering a comment of up to 25 characters. Press <ENTER> to terminate the input. A comment either complements or replaces the function name in all windows. A comment that is no longer needed is deleted in the same window using the space bar. Comments are downloaded to the device together with the settings.

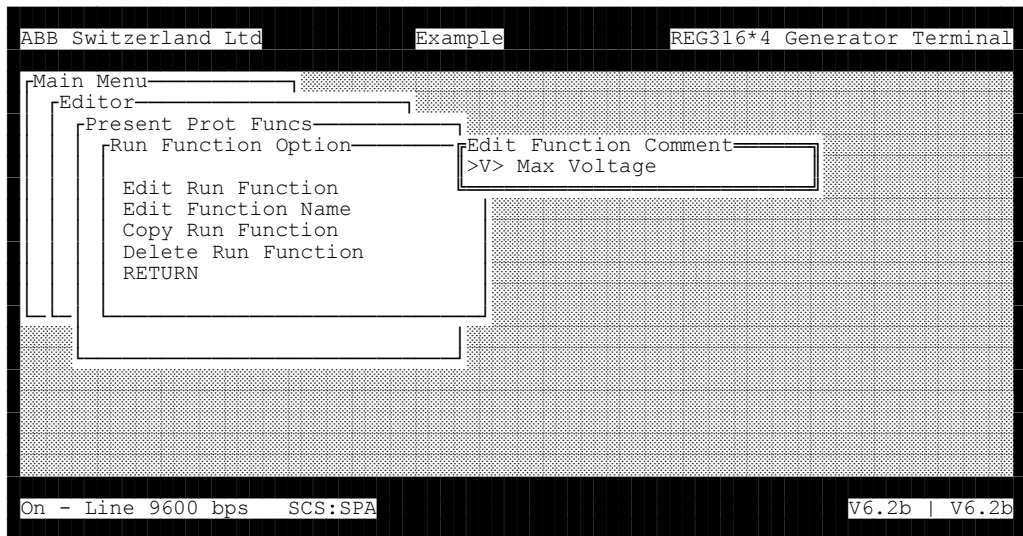


Fig. 5.3 d Edit function comment

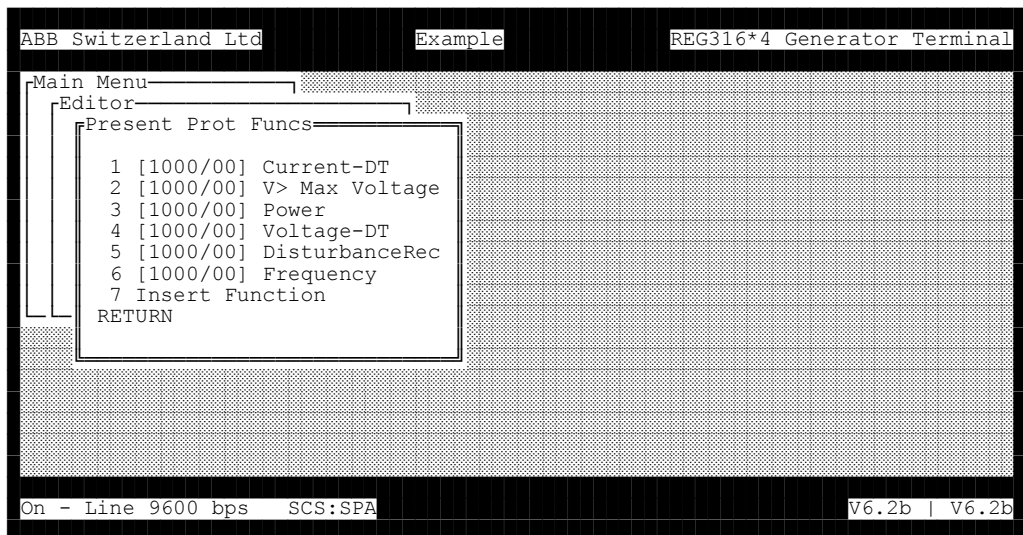


Fig. 5.3 e Present prot. funcs.

5.5.1.3. Copying a function

If a function's settings in a second set of parameters are largely the same as in a first, the function can be copied.

The settings of the copied function are the same as the original, but the following parameters can not be changed subsequently:

- all analogue inputs
- all signalling channels
- all tripping channels.

These parameters are not listed for this reason in the copied function's list of parameters (see Figures 5.3 c and e). However, if they are changed in the original, they are also automatically changed in the copy.

The settings for the binary inputs and parameters "ParSet4..1" have to be re-entered for the copy. The binary input sources must be active in the same set of parameters as the copy. The copied function must not be active in the same set of parameters as the original and the parameter set number of the original must be lower:

$$P1 \leq pO \leq P4 \quad \text{and} \quad pO < pK \leq P4$$

where

pO = parameter set number of the original function

pK = parameter set number of the copied function.

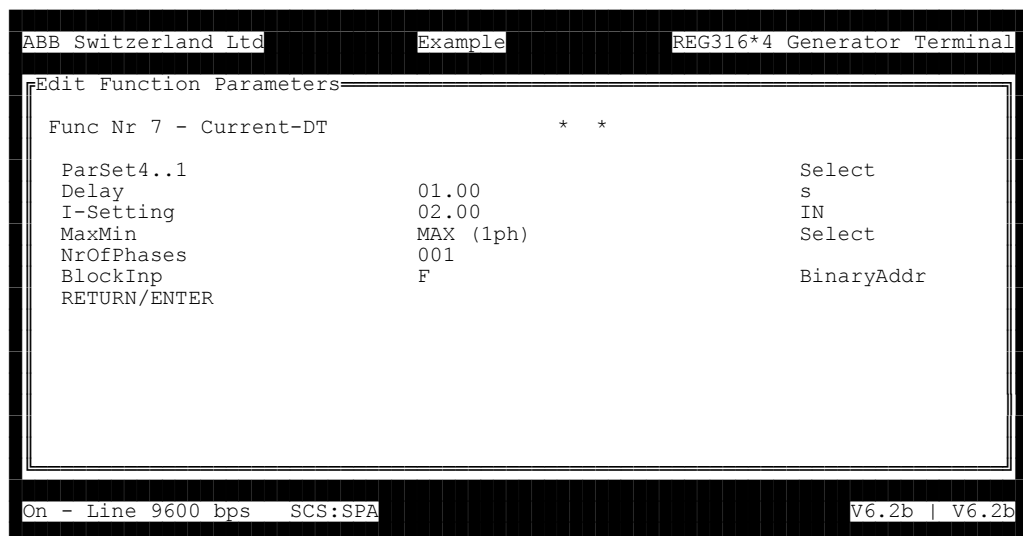


Fig. 5.3 f Edit function parameters

5.5.1.4. *Deleting a function*

A function can only be deleted, if there are no copies of it and it is not needed by another function (e.g. a binary output used to block another function). As a safety precaution, the user is requested to confirm the deletion in response to the question “Are you sure?”. If the particular function is at the bottom of the list, it disappears altogether, otherwise its description is replaced by “Not used” to avoid having to renumber the functions.

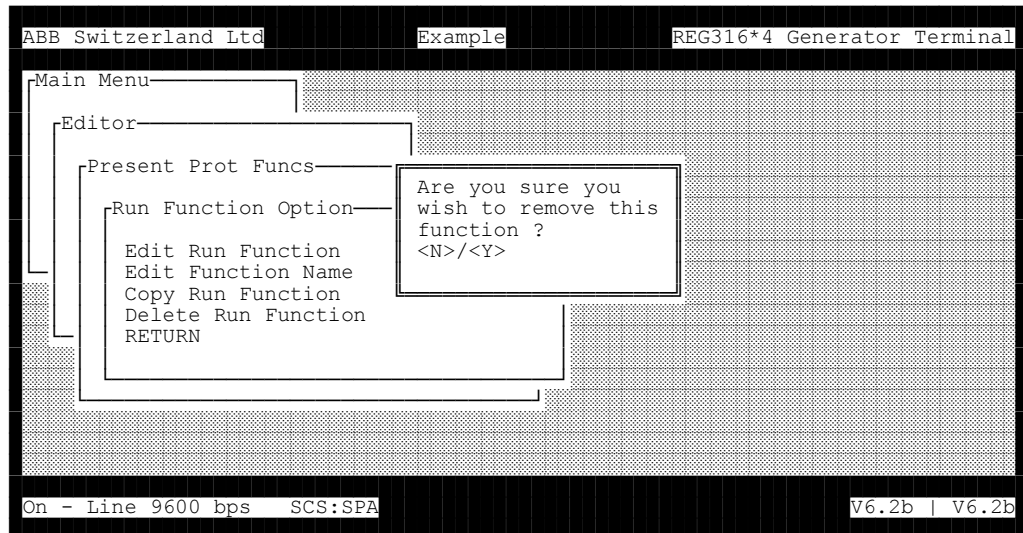


Fig. 5.3 g Are you sure?

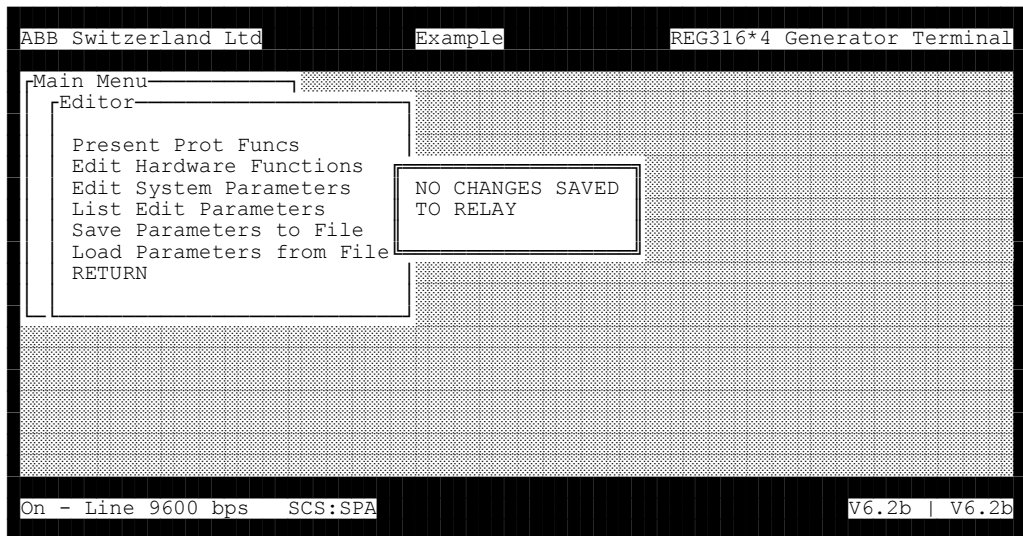


Fig. 5.3 h NO CHANGES SAVED TO RELAY

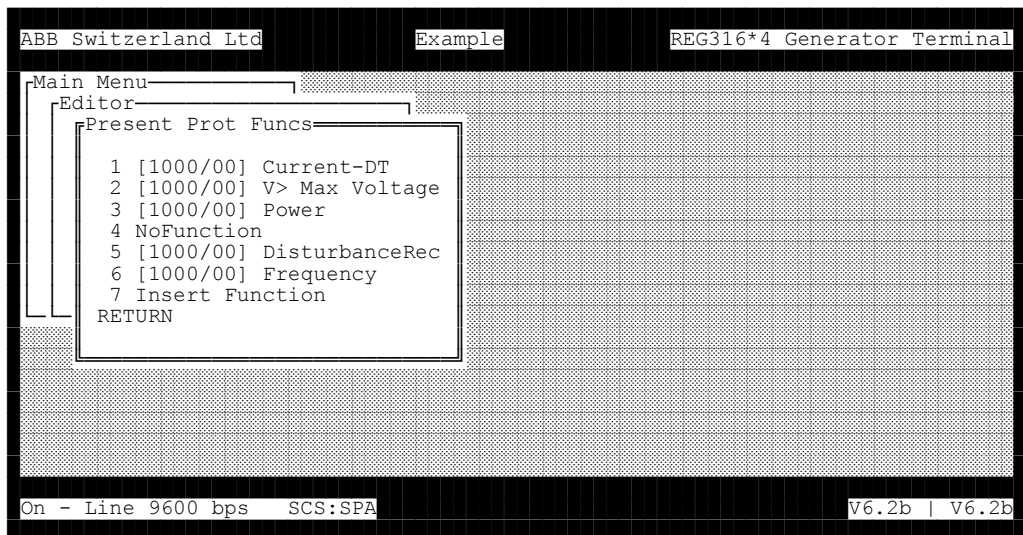


Fig. 5.3 i Present prot. funcs.

5.5.2. *Adding a new function*

An additional function is added either by selecting the second last menu item “Insert function” from the “Present prot. funcs.” menu (see Fig. 5.3 i) or a “No function” line if there is one. Upon pressing <Enter>, a list of the available functions appears. Select the desired function from the list and press <Enter> again. This opens the “Edit function parameters” window (see Fig. 5.3 c) and the parameters can be set. The procedure for the different kinds of parameters is explained in Sections 5.5.3. and 5.5.4.

The last entry in the list of available functions is “No function”. Selecting this line and pressing <Enter> adds a “No function” line to the list of active functions. This method can be used, for example, to adjust the list so that a given function has the same number in all the relays although.

5.5.3. *General information on editing parameters*

There are two types of parameters, which have to be entered:

1. those requiring the entry of a numerical value, e.g. current or voltage settings
2. those requesting selection from a list of alternatives, e.g. options or channels

Window used for both types of parameters:

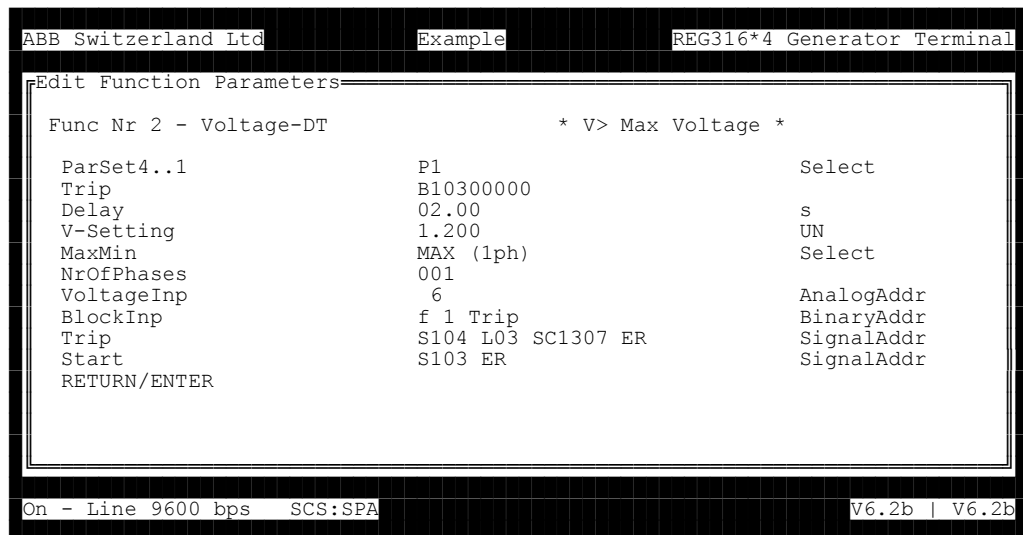


Fig. 5.4 List of parameters

Keys used for both types of parameters:

List of parameters:

- <↑> - Up a line
- <↓> - Down a line
- <PgUp> - One page up
- <PgDn> - One page down
- <Home> - Go to the beginning
- <End> - Go to the end
- <Enter> - Display the data entry/option select window
- <Esc> - Return to previous window without saving changes
- <Enter> - "Return/Input" - check and save parameters and return to previous menu.

Input/Selection window:

- <Enter> - Return to the list of parameters and insert the setting from the "Input/Selection" window.
- <Esc> - Return to the list of parameters without inserting the setting from the "Input/Selection" window.

5.5.3.1. Entering numerical settings

The data input window appears on the right of the list of parameters:

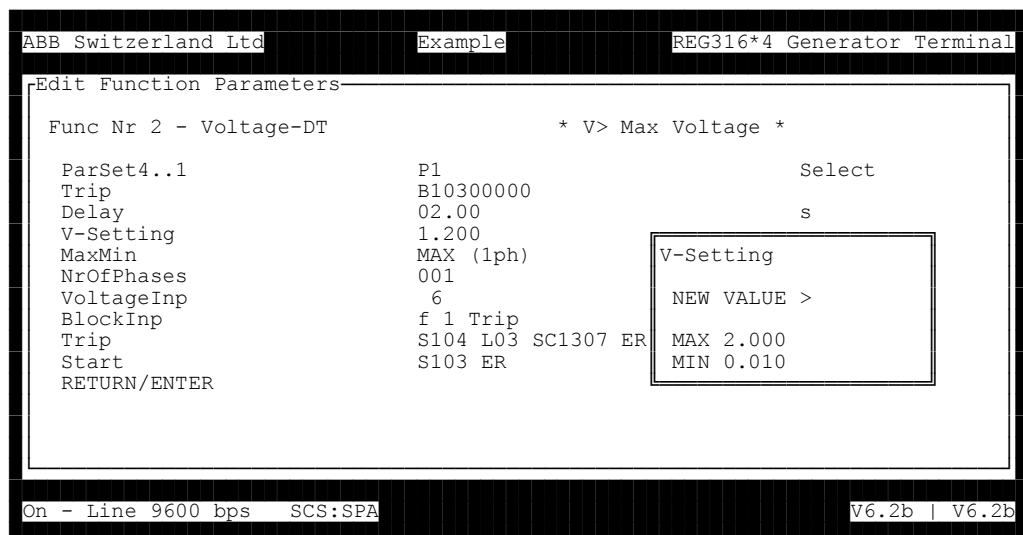


Fig. 5.5 Window for entering numerical settings

Keys:

<0...9>, <.>, <+>, <->, - entry of new numerical setting

Each parameter only has a given number of decimal places and the number entered is rounded accordingly.

A warning is displayed, if a setting outside the permissible range is entered. The user is requested to accept the next permissible value or to try again.

Closest allowed value 20.00
Should it be entered?
 <Y>/<N>

HEST 905 076 FL

5.5.3.2. **Selecting from a list of alternatives**

There are two alternative selection procedures:

- **Option:** Selection of a **single** option from a list.
- **Channel:** Selection of one or several of the available channels.

Option selection:

The “Option selection” window is used when a **single** choice has to be made from a list of alternatives. The selected option is indicated by a single chevron “>”.

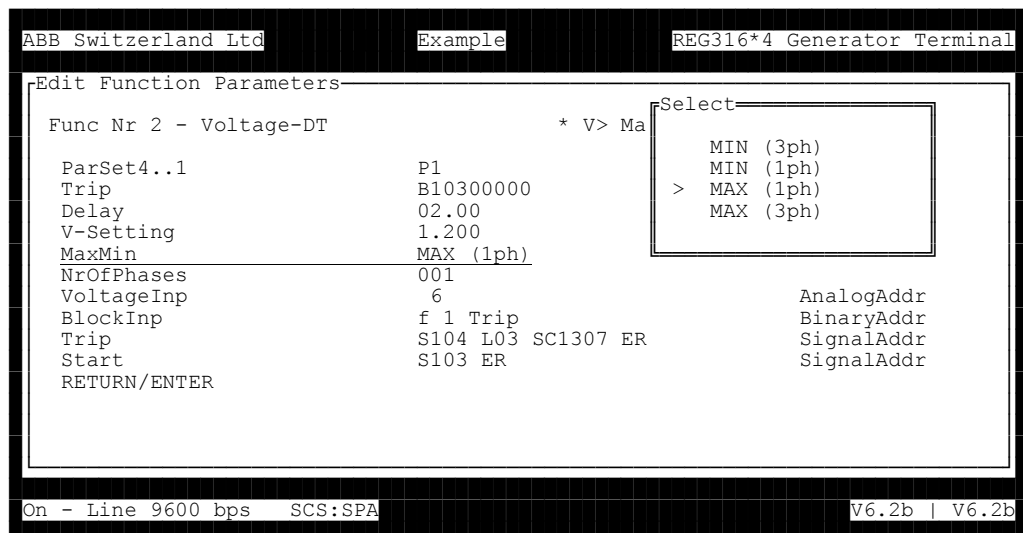


Fig. 5.6 Option selection window

Keys:

- <↑>, <↓>, <PgUp>, <PgDn> - Move the cursor in the selection window
- <Ins> - Selects a channel.

Channel selection:

The available alternatives in the “Channel selection” window are shown as rows of boxes, which apart from the channel number, also contain a field for up to 2 characters (see Fig. 5.7). The channel description consists of a explanatory text and/or a comment entered by the user when configuring the hardware functions (see Section 5.5.5). The corresponding information is displayed as the selection bar is moved from one option to the next.

There are two methods of selection:

1. Multiple selection - All the channels, which have just been selected with the aid of the cursor and the <Ins> key, are indicated by “X”. The cursor jumps to the first available channel upon opening the window.
2. Single selection - The channel selected is indicated by “X” and the “X” moves automatically, if a new selection is made. The cursor jumps to the first available channel upon opening the window.

Keys:

- <←→>, <→> - Move the cursor in the selection window
- <Ins> - Selects a channel
- <Del> - De-selects an option (multiple selection only)
- <-> - Inverts a channel
(binary inputs only).

The system only permits channels to be selected it considers to be plausible, otherwise a warning bleep sounds (but there is no error message). Examples of implausible selections are setting a channel defined as a current input as a voltage input, or attempting to assign a signal to an output (relay or LED) which is already occupied.

5.5.4. Explanation of the types of channels

There are four types of channels which conform generally to the rules given in the preceding sections. Each one, however, has in addition characteristics and abbreviations peculiar to itself.

5.5.4.1. C.t./v.t. input channels

The c.t. and v.t. input channels are assigned in the “A-D Input Channels” selection window:

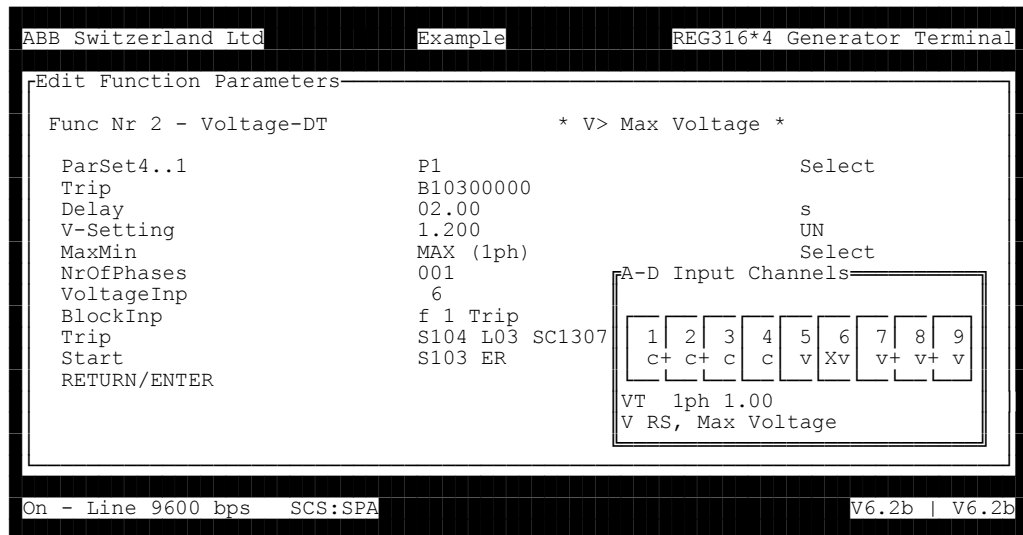


Fig. 5.7 “A-D Input Channels” selection window

The nine boxes in the selection window representing the c.t. and v.t. input channels available are designated as follows:

Top: 1...9 : Channel No.

Bottom: c : c.t.

v : v.t.

o : no input transformer connected

+

: two “+” signs link a three-phase input transformer group

X : selected channel.

The input transformer type and any user comment are displayed in the lower part of the window for the field currently selected.

The arrangement of the c.t. and v.t. input channels is established by the ordering code (K...). Prior to assigning the c.t. and v.t. input channels, the K code in the menu “Edit Relay Configuration” must be set (see Section 3.4.1.).

Only the first phase of a three-phase group may be selected; the other two phases are automatically included without any special indication. Any channel may be selected, on the other hand, for a single-phase function.

The channel number is indicated in the parameter value column of the “Edit function parameters” window.

5.5.4.2. Signalling channels

Signals can be assigned individually to the event recorder, up to two physical outputs (LED's, signalling and tripping relays and distributed outputs) and an output to a station control system (SCS) and for interlocking purposes (ITL). The bleep sounds if an attempt is made to use more than two physical outputs.

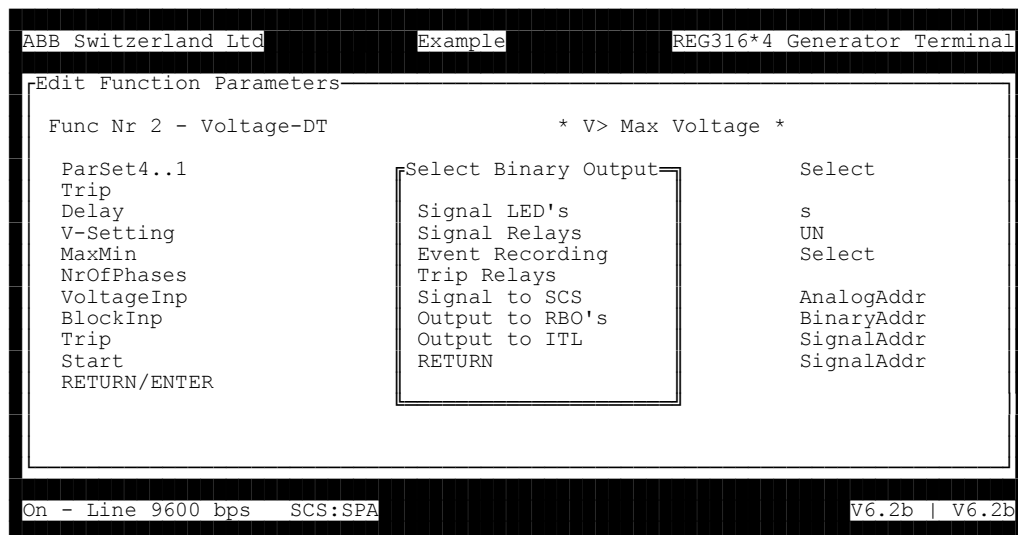


Fig. 5.8 Setting signalling channels

LED signals

Before LED's can be assigned, the respective I/O unit (1 for LED's 1 to 8 or 2 for LED'S 9 to 16) must be selected in the “Select I/O slot” window. The “LED's” selection window then appears.

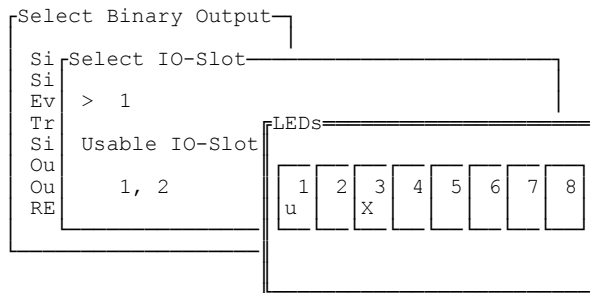


Fig. 5.9 “LED’s” selection window

The eight boxes representing the LED’s in the selection window are designated as follows:

Top: 1...16 : Channel No.

Bottom: u (used) : channel in use

X : selected channel.

Note that channel 1 is not available for assignment, because LED 1 is always assigned to the standby alarm signal.

The number of the selected LED (e.g. L03) is indicated in the parameter value column of the “Edit function parameters” window.

Signalling relays

Before signalling relays can be assigned, the respective I/O unit (1 to 4) must be selected in the “Select I/O slot” window. The “Signal relays” selection window then appears.

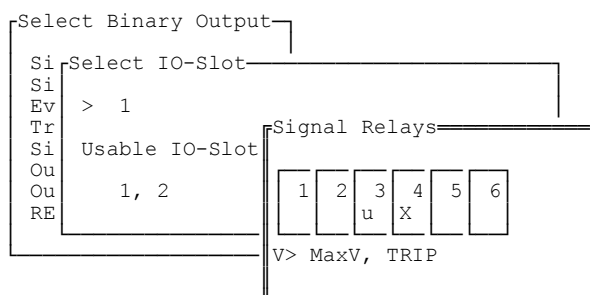


Fig. 5.10 “Signal relays” selection window

The boxes representing the signalling relays in the selection window are designated as follows:

Top: 1...10 : Channel No.

Bottom: u (used) : channel in use

X : selected channel.

Any user comment is displayed in the lower part of the window for the field currently selected.

The plug-in unit and channel numbers for the selected signalling relay (e.g. S104) are indicated in the parameter value column of the "Edit function parameters" window.

Sxxy: x = plug-in unit number (1...4)

yy = channel number (1...10).

Event recording

The flag which determines whether a signal is recorded as an event is set in the "Event recording" window:

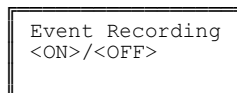


Fig. 5.11 Setting and resetting the event recording flag

"ER" is displayed in the parameter value column of the "Edit function parameters" window to indicate that the corresponding signal is recorded as an event.

Caution:

A function 'Pick-up' signal will normally only generate a general start alarm, if it is set to be recorded as an event (ER). Exceptions are the distance function, because its general start signal 'Start R+S+T' always counts as an event and therefore always initiates a general start alarm, and the differential functions, the tripping signals of which set the general start alarm when they are configured to be recorded as events.

Caution:

A function's tripping command will normally only generate a general tripping alarm, if it is assigned to the tripping logic (matrix) and configured to be recorded as an event (ER). The distance function is an exception, because it always sets the general tripping alarm.

Tripping relays

Tripping relays can be used for signalling purposes. From Version V4.2 signals can be assigned to tripping relays to which a signal ('u' indication in the signalling channel selection window) or a tripping logic (signals and trips OR logic) has already been assigned. The procedure for assigning tripping relays is the same as for [signalling relays](#) above.

The plug-in unit and channel numbers for the selected tripping relay (e.g. C201) are indicated in the parameter value column of the "Edit function parameters" window.

Cxyy: x = plug-in unit number (1...4)
 yy = channel number (1...2).

SCS signals

Before a signal can be assigned to the SCS, the respective group (1 to 24) must be selected in the "Select SCS group" window. The SCS signal groups 1c...24c are intended for transmitting short signals via the interbay bus(signal capturing). The "Signals to SCS" selection window then appears.

Select Binary Output
↗

Select SCS-Group
↗

Si
Si
Ev > 13
Tr
Si Usable SCS-Group
Ou
Ou 1..24,1c..24c
RE

Signals To SCS
Select Binary Output

1	2	3	4	5	6	7 X	8	9	10	11 u	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32								

Fig. 5.12 “Select SCS group” and “Signals to SCS” selection windows

The fields in the selection window are designated as follows:

Top: 1...32 : Channel No.

Bottom: u (used) : channel in use

X : selected channel.

The SCS assignment (e.g. SC1307) is indicated in the parameter value column of the “Edit function parameters” window.

SCxxyy: xx = SCS group number (1...24)

yy = data node within a group (1...32).

Signal to RBO (remote binary output)

When assigning signals to the RBO (distributed output system), first select the group (1 to 80) in the “Select RBO No.” window.

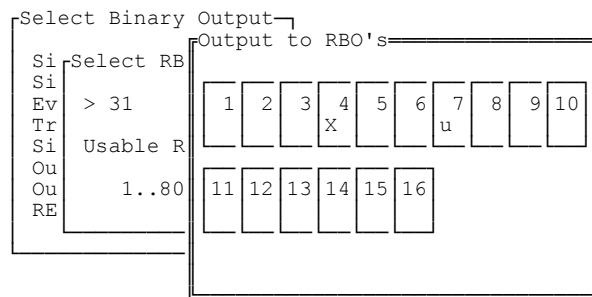


Fig. 5.13 “Select RBO group” and “Signals to RBO” selection windows

The fields in the selection window are designated as follows:

Top: 1...16 : Channel No.

Bottom: u (used) : channel in use

X : selected channel.

The RBO assignment (e.g. R101) is indicated in the parameter value column of the “Edit function parameters” window.

Ryyxx: y = RBO group number (1...80)

xx = output relay within a group (1...16).

Signal to ITL (interlocking)

When assigning signals to the ITL (interlocking data), first select the group (1 to 3) in the “Select ITL group” window.

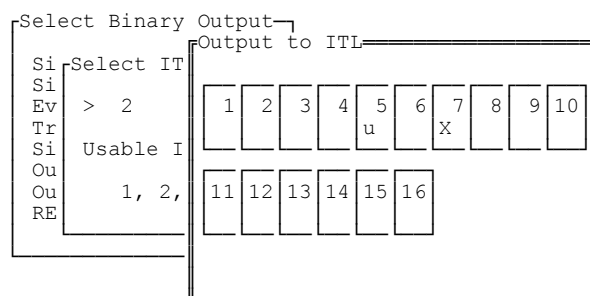


Fig. 5.14 “Select ITL group” and “Signals to ITL” selection windows

The fields in the selection window are designated as follows:

Top: 1...16 : Channel No.

Bottom: u (used) : channel in use

X : selected channel.

The ITL assignment (e.g. I101) is indicated in the parameter value column of the “Edit function parameters” window.

lyxx: y = ITL group number (1...3)

xx = data node within a group (1...16).

5.5.4.3. Tripping channels

The tripping signals of the various functions can be assigned to one or several tripping channels in order to achieve the required tripping logic:

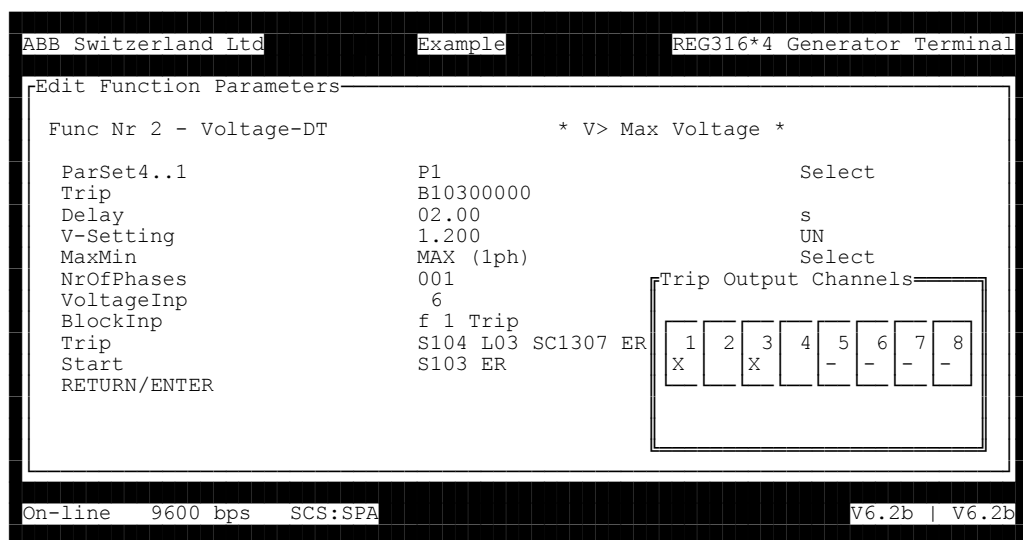


Fig. 5.15 “Trip output channel” selection window

The fields representing the tripping channels in the selection window are designated as follows:

Top: 1...8 : Channel No.

Bottom: - : Non-existent tripping channel

X : selected channel.

Any user comment is displayed in the lower part of the window for the channel currently selected.

Only I/O units types 316DB61 and 316DB62 are equipped with two tripping relays.

The selected channels appear in the parameter value column of the “Edit function parameters” window as a bit string with ‘1’ to ‘8’ indicating the currently selected channel and ‘0’ the inactive channels (e.g. 10300000).

Caution:

A function’s tripping command will normally only generate a general tripping alarm, if it is assigned to the tripping logic (matrix) and configured to be recorded as an event (ER). The distance function is an exception, because it always sets the general tripping alarm.

5.5.4.4. Binary channels

Binary inputs of functions can either be switched permanently on or off or be connected to the system binary input, a binary output of another function, an SCS input, an RBI input (distributed input system) or an ITL input. The corresponding setting is made in the “Select binary input” window:

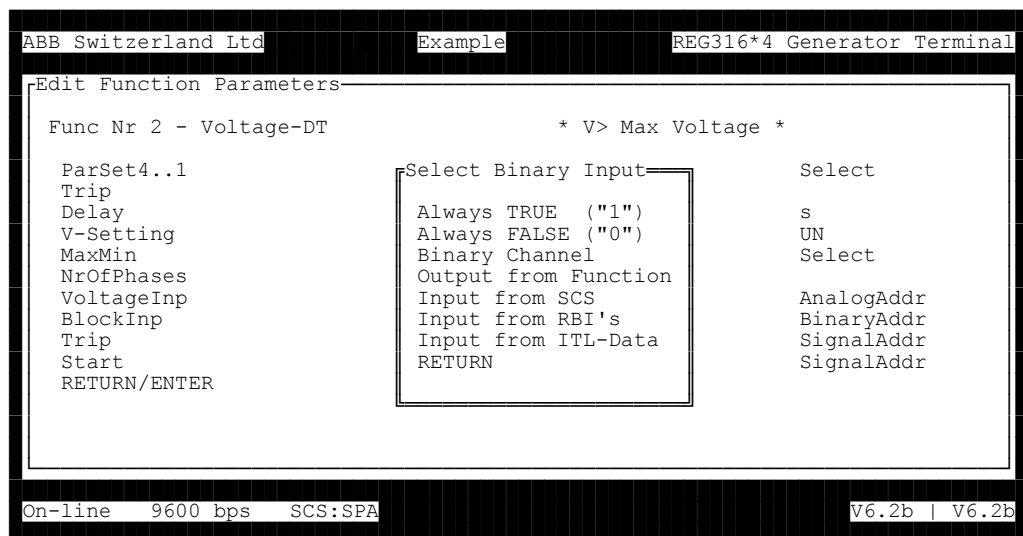


Fig. 5.16 “Select binary input” window

Always TRUE or Always FALSE

The binary inputs of functions can be set permanently on (logical 1) or off (logical 0) by moving the selection bar to the corresponding line and pressing <Enter>.

“T” (true) in the parameter value column of the “Edit function parameters” window indicates a permanently switched on input and “F” (false) a permanently switched off input.

System binary input

Every function input can be assigned either inverted or non-inverted to a system binary input (opto-coupler input). The respective I/O unit (1 to 4) is selected first and then the “Binary input channels” selection window opens:

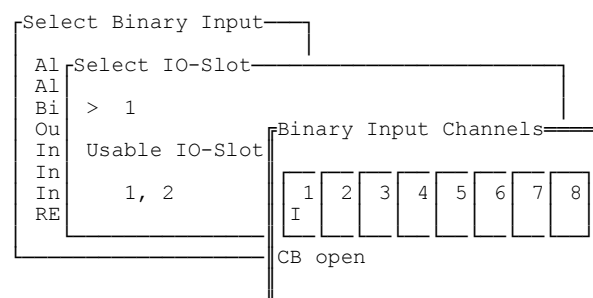


Fig. 5.17 “Binary input channels” selection window

The fields representing the binary input channels in the selection window are designated as follows:

Top: 1...14 : Channel No.

Bottom: X : selected channel (<Ins> key)

I : selected channel inverted (<-> key).

Any user comment is displayed in the lower part of the window for the field currently selected.

The plug-in unit and channel number of the selected binary input and a minus sign if it is inverted (e.g. -101) are indicated in the parameter value column of the “Edit function parameters” window.

xyzz: x = non-inverted () or inverted (-) input
 y = plug-in unit number (1...4)
 zz = channel number (1...14).

Note:

To cancel the selection of a channel, select “Always FALSE” or “Always TRUE” in the “Select Binary Input” window.

Since channels can have several inputs assigned to them, channel with inputs already assigned to them are not especially indicated in the channel selection window.

Output of another function

Every function input can be assigned either inverted or non-inverted to output of another function. The respective function is first selected in the “Output from function” window and then the selection window with all the outputs of the corresponding function opens:

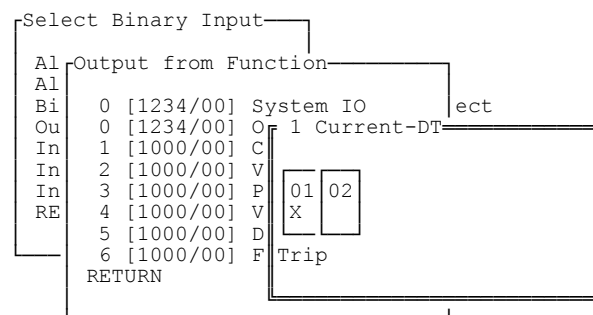


Fig. 5.18 “Output from function” selection window

The fields in the selection window are designated as follows:

Top: 1...47 : Channel No.

Bottom: X : selected channel (<Ins> key)

 I : selected channel inverted (<-> key).

The signal name is displayed in the lower part of the window for the field currently selected.

The function number and signal name of the selected output and a minus sign if it is inverted (e.g. -f 1 TRIP) are indicated in the parameter value column of the “Edit function parameters” window.

xf y z: x = non-inverted () or inverted (-) input
 y = function number
 z = signal name.

Caution:

Care must be taken when connecting binary signals as mistakes can cause mal-operation of the protection.

SCS input

Every function input can be assigned to an SCS input in either an inverted or non-inverted sense. The respective group (1 to 24) is first selected in the “Select SCS group” window:

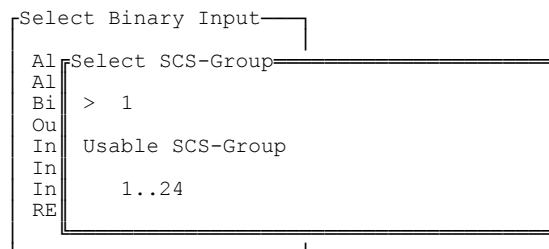


Fig. 5.19 “Select SCS group” selection window

The “Inputs from SCS” window appears after the group has been selected:

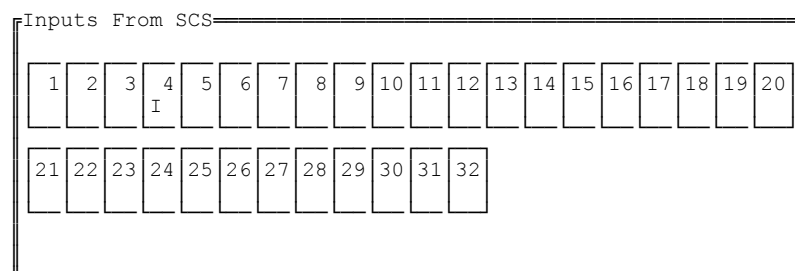


Fig. 5.20 “Inputs from SCS” selection window

The fields in the SCS input selection window are designated as follows:

Top: 1...32 : Channel No.

Bottom: X : selected channel (<Ins> key)

I : selected channel inverted (<-> key).

The SCS assignment (e.g. -SCSI2104) is indicated in the parameter value column of the “Edit function parameters” window.

xSCSIyyzz: x = non-inverted () or inverted (-) input

yy = SCS group number (1...24)

zz = data node within the group (1...32).

RBI input (distributed input system)

Every function input can be assigned to an RBI input in either an inverted or non-inverted sense. The respective group (1 to 80) is first selected in the “Select RBI No.” window, after which the “Inputs from RBI” appears:

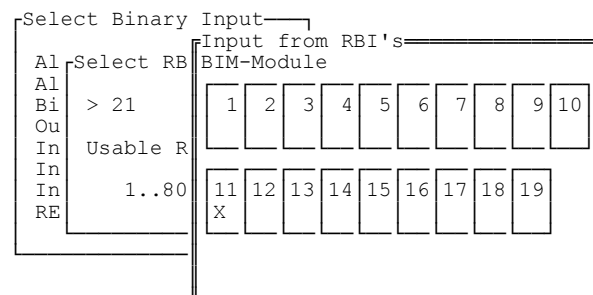


Fig. 5.21 “Select RBI group” and “Inputs from RBI” selection windows

The fields in the RBI input selection window are designated as follows:

Top: 1...19 : Channel No.

Bottom: X : selected channel (<Ins> key)

I : selected channel inverted (<-> key).

The RBI assignment (e.g. -R12111) is indicated in the parameter value column of the “Edit function parameters” window.

xRlyyzz: x = non-inverted () or inverted (-) input

yy = RBI device No. (1...80)

zz = input in the device (1...19).

Note:

Special information is available at inputs 17, 18 and 19:

- Input 17: A “1” at this input indicates that the device is transferring data (“Device connected”).
- Input 18: A “1” at this input indicates that the device is signalling a defect on line A (“Line A fault”).
- Input 19: A “1” at this input indicates that the device is signalling a defect on line B (“Line B fault”).

ITL data input (interlocking data)

Every function input can be assigned to an ITL input in either an inverted or non-inverted sense. The respective group (1 to 64) is first selected in the “Select ITL No.” window:

Fig. 5.22 “Select ITL group” selection window

The “Inputs from ITL” selection window then appears:

Fig. 5.23 “Input from ITL-Data” selection window

The fields in the ITL input selection window are designated as follows:

Top: 1...49 : Channel No.

Bottom: X : selected channel (<Ins> key)

I : selected channel inverted (<-> key).

The ITL assignment (e.g. -ITL2225) is indicated in the parameter value column of the "Edit function parameters" window.

xITLyyzz: x = non-inverted () or inverted (-) input
yy = ITL group No. (1...64)
zz = data node within the group (1...49).

Note:

A signal is available at input No. 49 that indicates that the respective device is active or not ("1" respectively "0").

5.5.5. *Editing hardware functions*

The hardware functions include all the hardware device settings. The menu structure can be seen from Fig. 5.24:

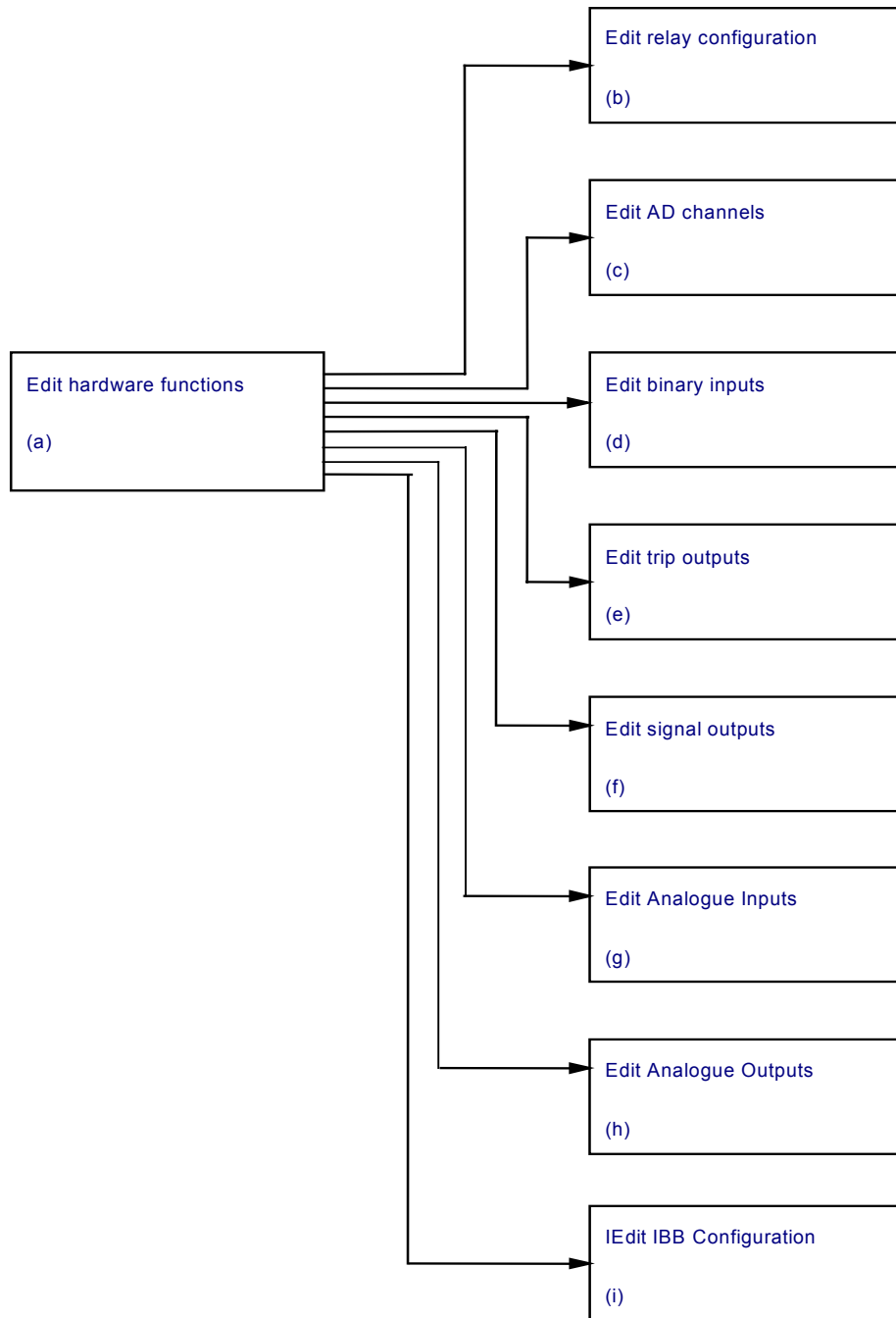


Fig. 5.24 Editing hardware functions
(see displays a to i on the following pages)

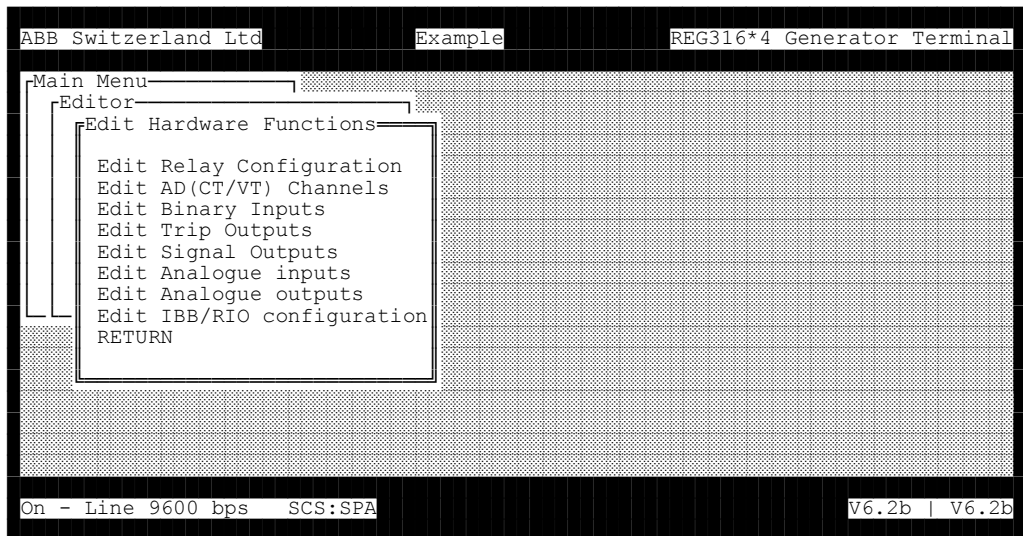


Fig. 5.24 a Edit hardware functions

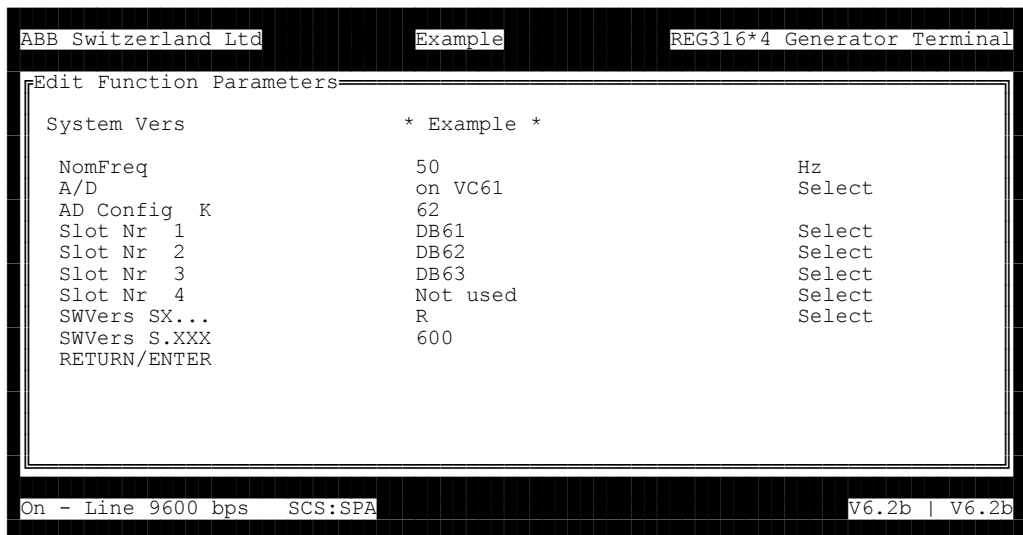


Fig. 5.24 b Edit relay configuration

The parameters are explained in [Section 3.4.1](#).

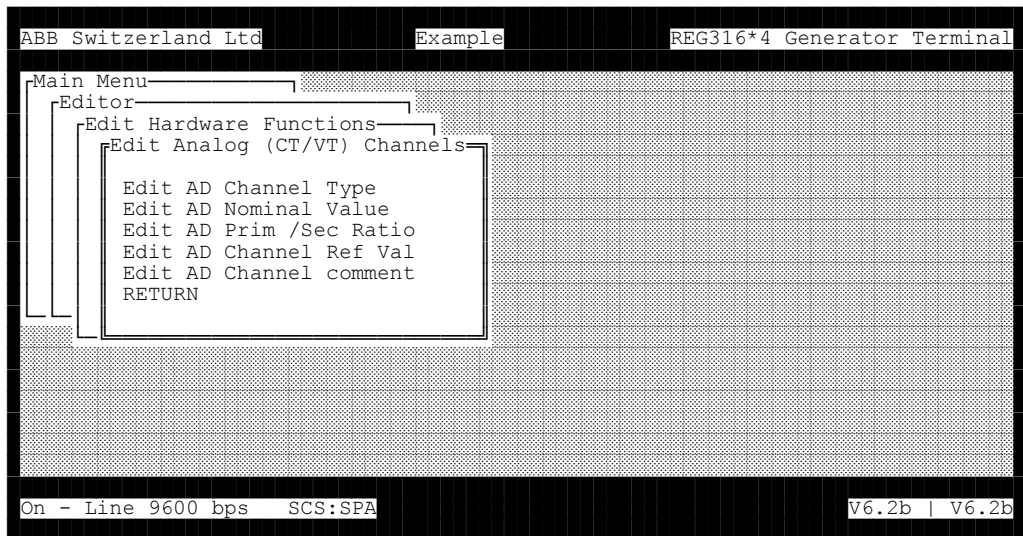


Fig. 5.24 c Edit AD(CT/VT) channels

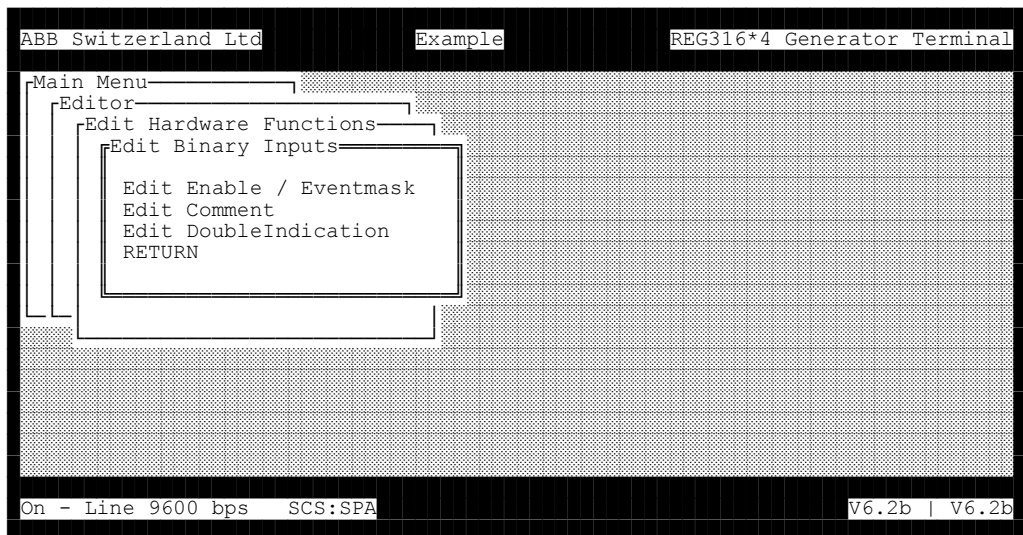


Fig. 5.24 d Edit binary inputs

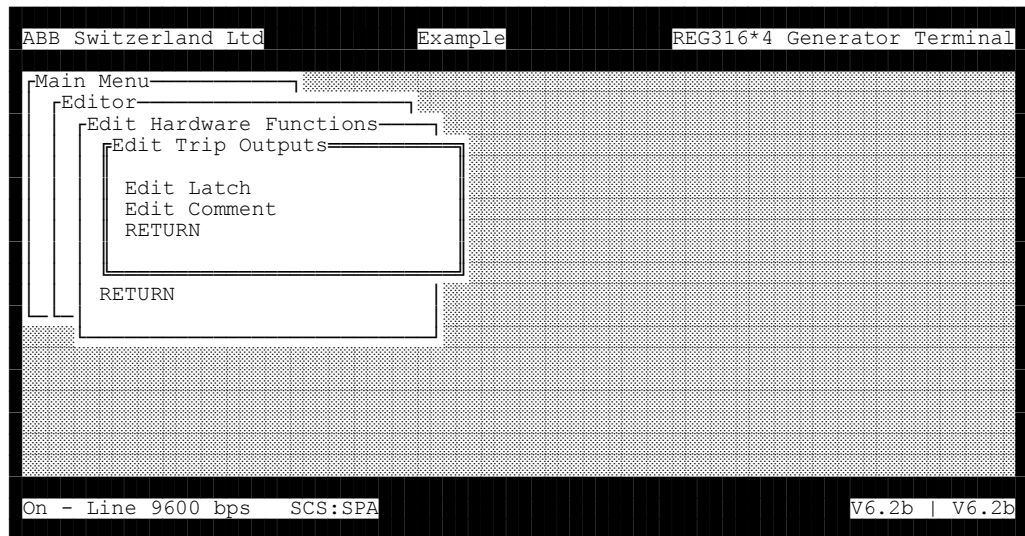


Fig. 5.24 e Edit trip outputs

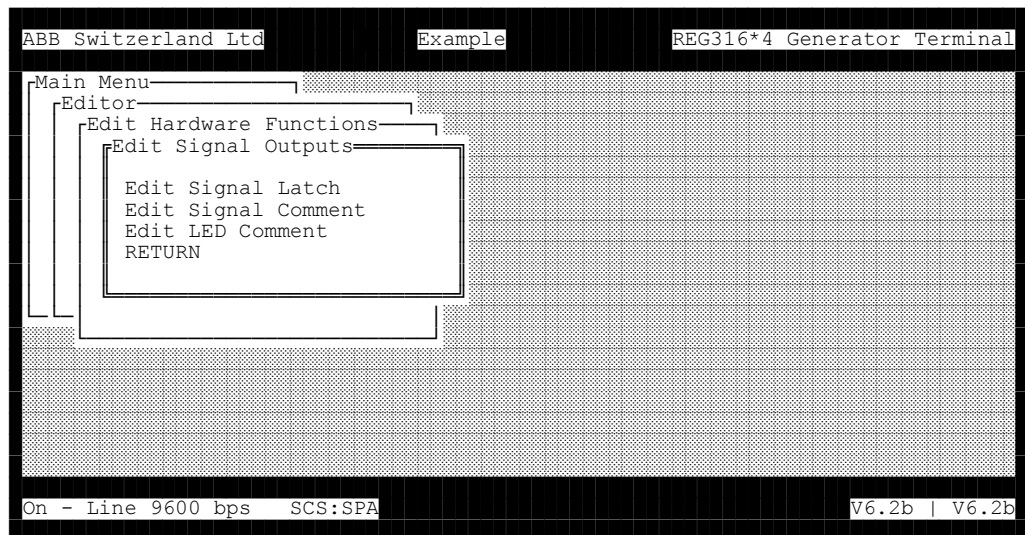


Fig. 5.24 f Edit signal outputs

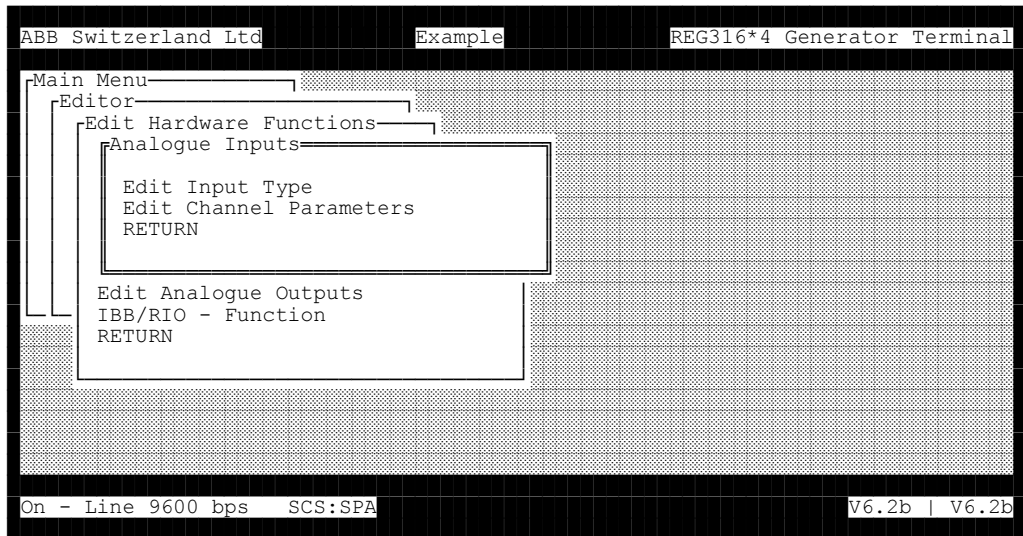


Fig. 5.24 g Edit Analogue Inputs

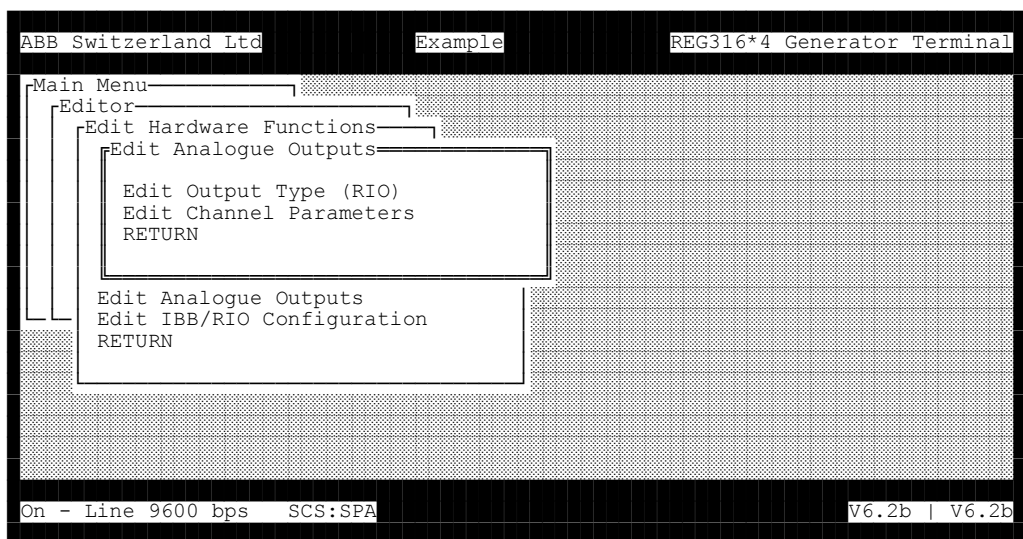


Fig. 5.24 h Edit Analogue Outputs

Refer to the Operating Instructions 1MRB520192-Uen for the distributed input/output system RIO580 for the various sub-menus and the parameters for configuring the analogue inputs and outputs.

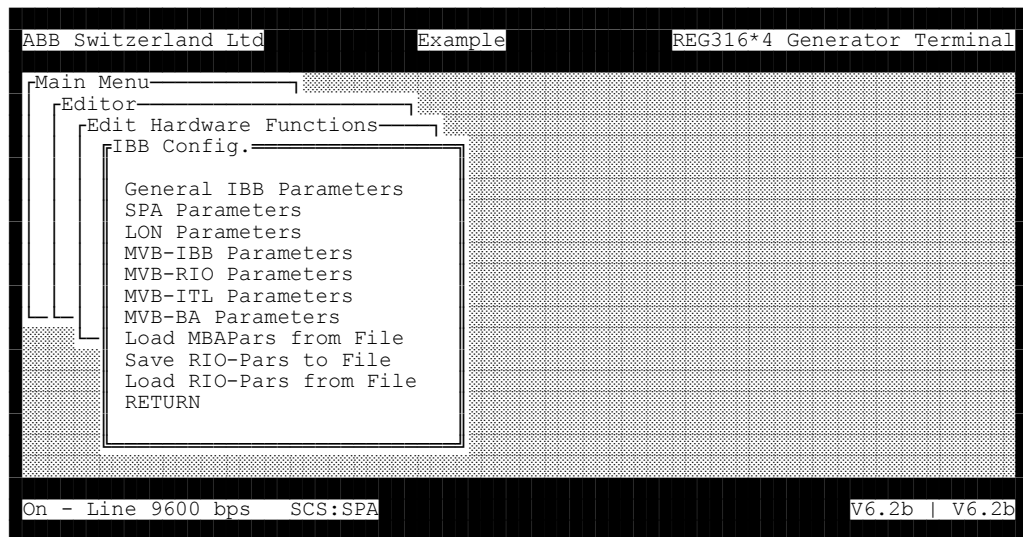


Fig. 5.24 i Edit IBB Configuration

The various submenus and the parameters in them are explained in [Section 9.2](#). Refer to publication 1MRB520225-Uen for the LON interbay bus settings, to publication 1MRB520270-Uen for the MVB interbay bus settings and to publication 1MRB520192-Uen for the MVB process bus settings.

5.5.5.1. *Inserting a channel comment*

A comment of up to 25 characters can be entered for every channel by selecting the menu item "Edit comments". The procedure is different to that for the binary, tripping and signalling channels.

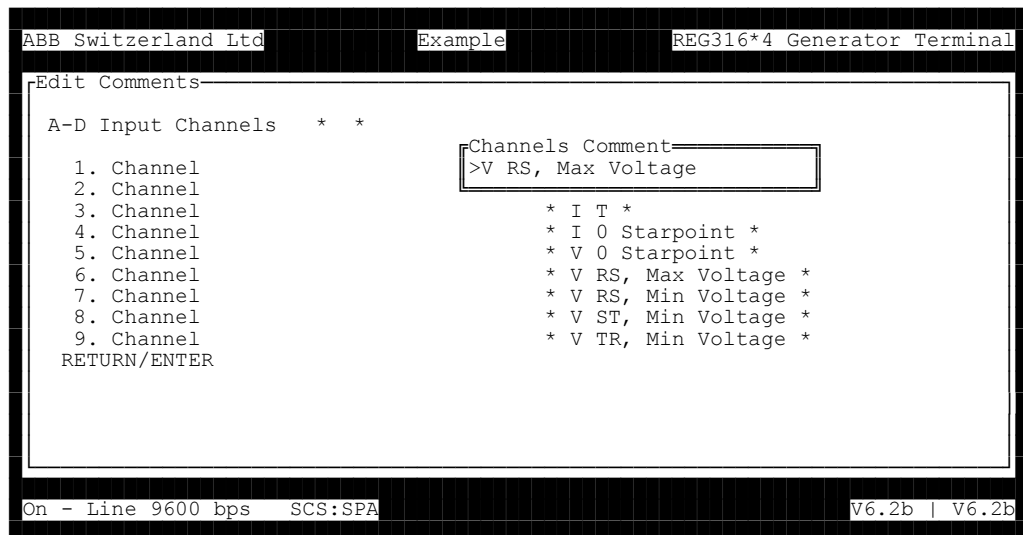


Fig. 5.25 Editing the comments of analogue channels

Press <Enter> to open the data input window for editing channel comments.

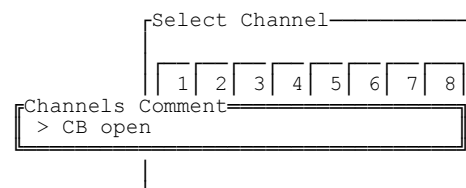
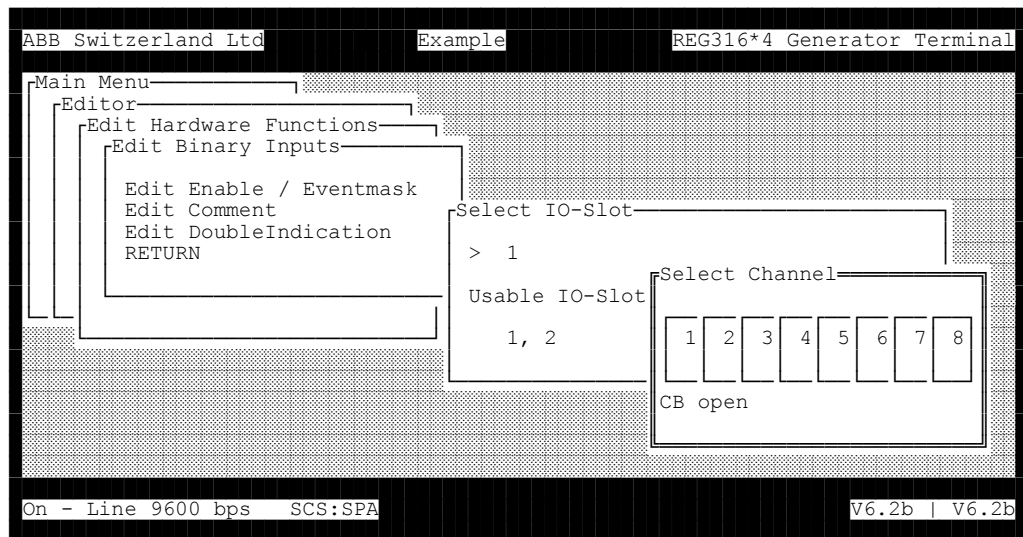


Fig. 5.26 Editing comments for binary, tripping and signalling channels

After selecting the corresponding plug-in unit, the available channels are displayed in the “Select channel” window. The comment for the selected channel appears in the lower part of the window and the data input window for editing it can be opened by pressing <Return>.

5.5.5.2. **Analog (CT/VT) Channels**

The “Edit Analog (CT/VT) Channels” menu provides facility for making the following settings which are described in detail in [Section 3.4.2.](#):

- **Channel type:**
If the parameter “AD config” was set to K = 00 when configuring the relay, a type of input transformer can be selected for every analogue channel. Three-phase groups of input transformers can only be assigned to channels 1...3, 4...6 or 7...9.
- **Rated value:**
The rating of the input c.t. or v.t. must be entered. The values of all three channels of a three-phase group change when one is changed.

- Primary/secondary ratio:
These values are only of consequence in connection with the VDEW6 protocol. The ratio of all three channels of a three-phase group change when one is changed.
- Change reference value:
Reference values enable the protection ratings to be adjusted to those of the primary plant. The reference values of all three channels of a three-phase group change when one is changed.

5.5.5.3. *Excluding (masking) binary channels as events*

Binary channels can be excluded from counting as events and appearing in the event list.

Upon selecting the menu item “Edit enable / event mask”, the window opens for changing the corresponding settings. The channels are displayed in groups of eight and each one can be selected and the mask set by pressing <Ins> or removed by pressing <Del>.

The channels appear in the parameter value column of the “Edit function parameters” window as a bit string with ‘1’ to ‘8’ indicating the masked channels and ‘0’ the non-masked channels (e.g. 12300670). The parameters that start with “R” concern the distributed input system.

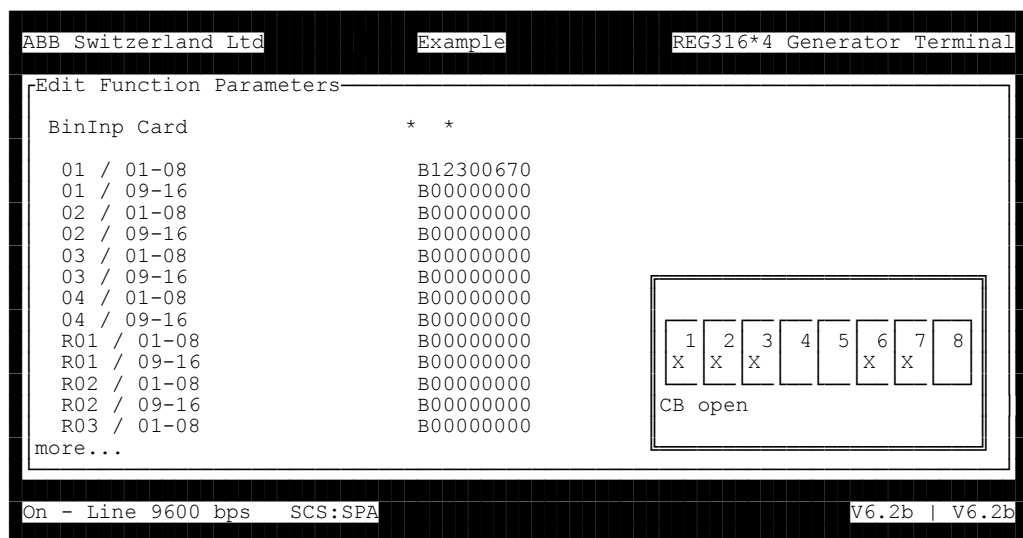


Fig. 5.27 Changing the event masking settings

5.5.5.4. *Tripping and signalling channel latching*

Every LED and tripping and signalling relay can be individually set to latch by selecting the menu item “Change latching mode”.

The procedure is the same as the one described above for excluding binary channels from counting as events.

5.5.5.5. *Definition of double signals*

Up to 30 double signals can be defined for binary channels.

Upon selecting the menu item “Edit double signals”, a menu appears with a choice of either local inputs or distributed input system inputs (process bus inputs).

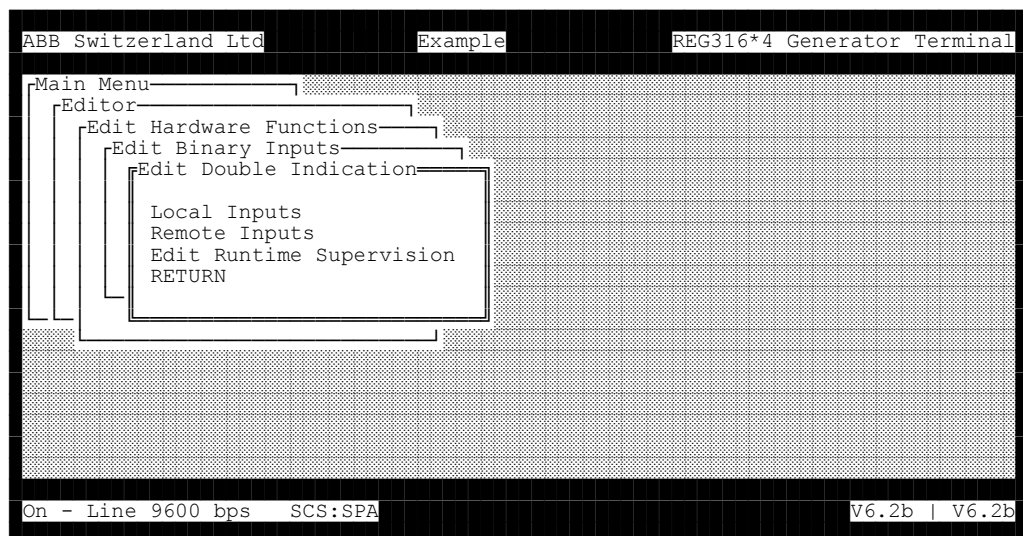


Fig. 5.28 Menu for selecting the kind of double signal

You then have to select the device you wish to edit to open the settings window. Now mark the respective channel using the <Ins> key. This defines it and the channel immediately following it as a double channel. Press the <Del> key to cancel the marking. When on of the channels marked as a double channel changes, a double record appears in the event list. It should be noted that double signals are automatically excluded from being recorded as normal events.

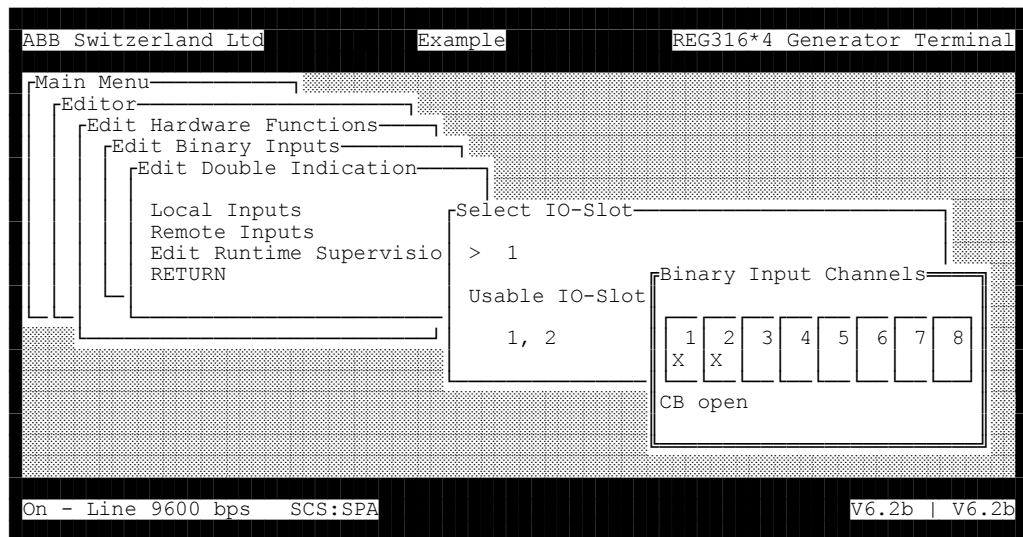


Fig. 5.29 Defining double signals

Edit runtime supervision:

The “Edit runtime supervision” dialogue provides facility for enabling or disabling the runtime supervision for each double indication.

What does the runtime supervision function do?:

Double signals are needed to unequivocally determine the status (position) of switchgear. For this purpose, the two signals detecting the end positions of the switch are connected to two consecutive inputs and form a “double indication”. Double indications are presented in a somewhat different form in the event list. Instead of “on” or “off”, the signals are listed as “0-0”, “0-1”, “1-0” or “1-1”, whereby “0-1” means that the switch is closed and “1-0” that it is open. The switch is moving when the signals produce “0-0”, while the combination “1-1” should not occur at all in normal operation.

The event “0-0” only signifies a transitory status while the switch (CB or isolator) is actually moving. Providing everything is functioning normally this signal is less interesting and therefore can be suppressed. Should on the other hand, the switch stick in an intermediate position, this signal suddenly becomes more important. The runtime supervision enables these two conditions to be distinguished. It can be set independently for each double indication and is active for a setting other than zero. The event “0-0” is thus initially suppressed and remains so as long as the switch reaches either its open or closed limit position before the end of the runtime supervision setting. This prevents the event

list from becoming overburdened with unnecessary data. The “0-0” event is subsequently added to the event list, should a switch not reach its end position within the specified time. The time stamp corresponds to the start of the switch movement. The status “1-1” is never suppressed even during the period of the runtime and appears in the event list immediately.

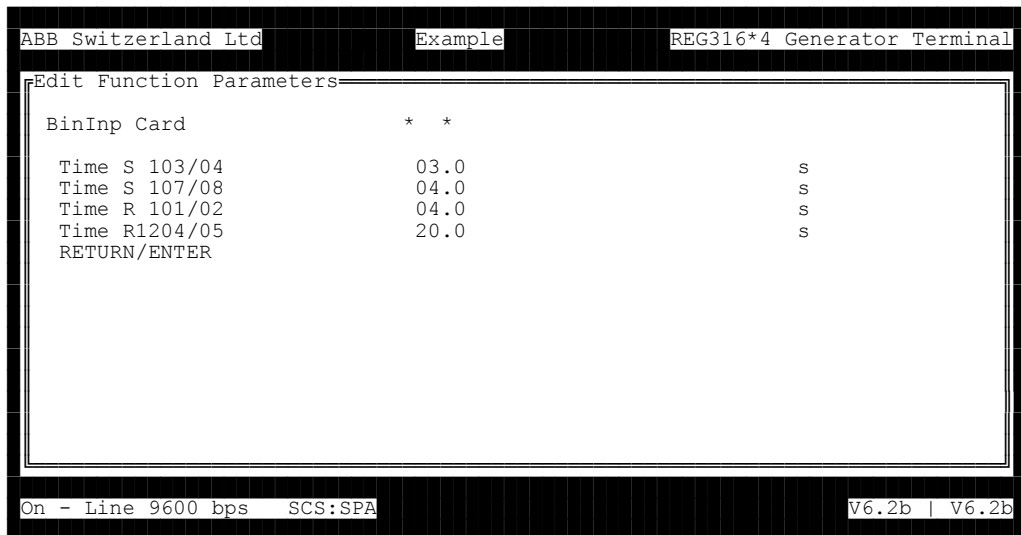


Fig. 5.30 Editing the runtime supervision

The runtime setting is entered in the dialogue “Edit runtime supervision” for each of the double indications that has been defined.

“S” signifies a double indication configured for a local input and an “R” one for a series RIO580 input unit.

The device number and the two inputs used for a double indication are given in the following form:

xxy1/y2

where xx = device number
 y1 = number of the first input
 y2 = number of the second input.

Timer data:

Min. setting: 0.0 s
Max. setting: 60.0 s
Increments: 0.1 s
Default setting: 0.0 s (i.e. runtime disabled).

5.5.6. *Editing system functions*

System functions include all the settings common to all functions. The menu structure can be seen from Fig. 5.31.

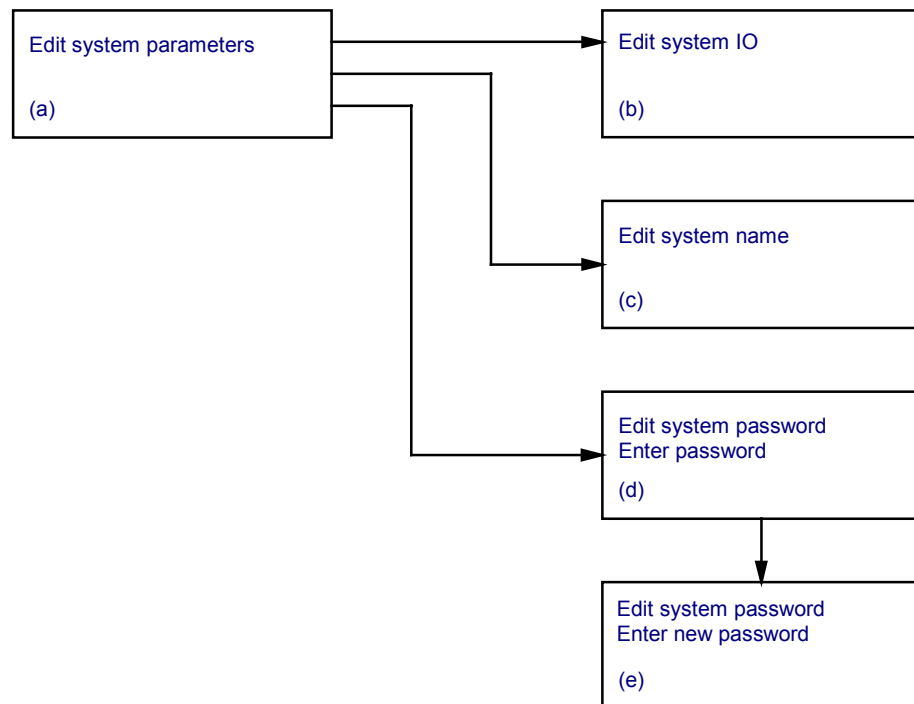


Fig. 5.31 Editing system functions
(see displays a to e on the following pages)

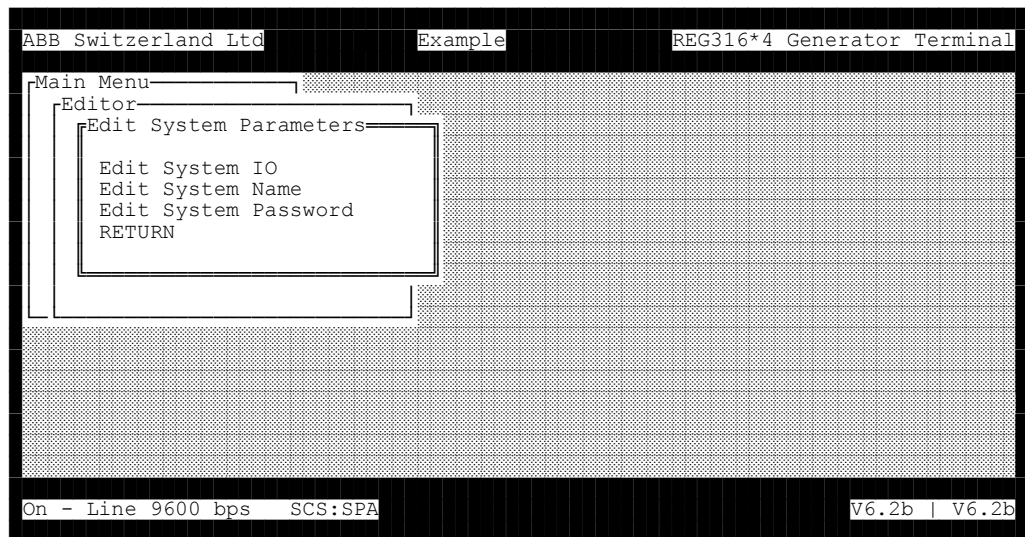


Fig. 5.31 a Edit system parameters

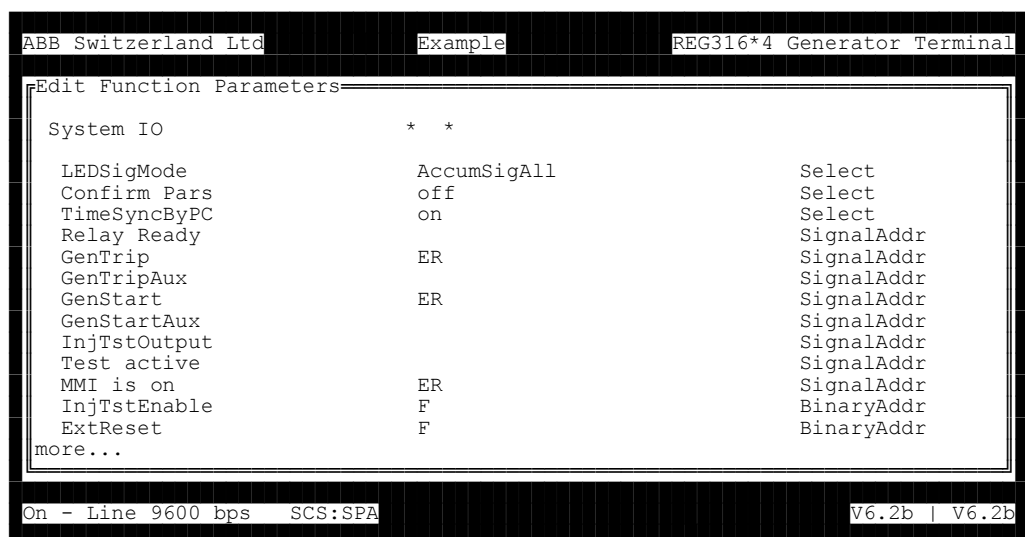


Fig. 5.31 b Edit function parameters

System settings concern those independent of functions, binary inputs and signals. Refer to [Section 3.4.5.1](#) for the significance of the various parameters.

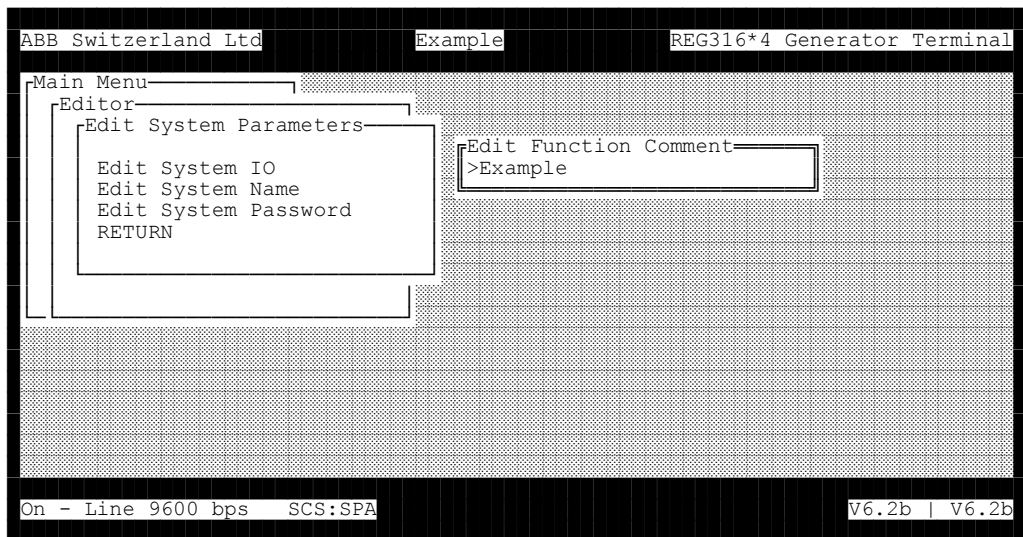


Fig. 5.31 c Edit system name

A name of up to 25 characters can be entered for every device which then appears in the header of the HMI window.

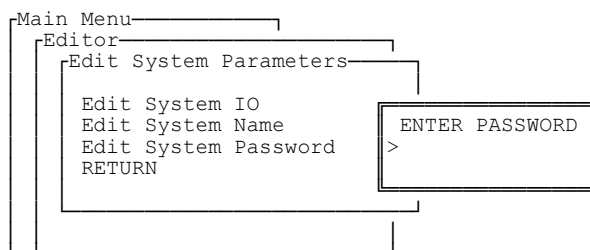


Fig. 5.31 d Edit system password, entering the old password

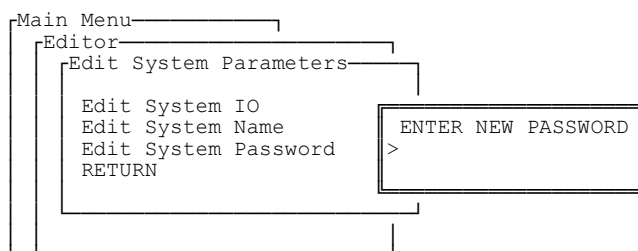


Fig. 5.31 e Edit system password, entering the new password

After entering the old password, the user can enter a new one of up to 6 characters.

The default password is blank, i.e. it is only necessary to press <Enter>.

If a password has been forgotten, a new one can be entered by entering SYSMAN for the old password.

5.5.7. Listing settings

All the settings or groups of settings can be viewed on the screen, printed or saved in a file. The various possibilities can be seen from Fig. 5.32.

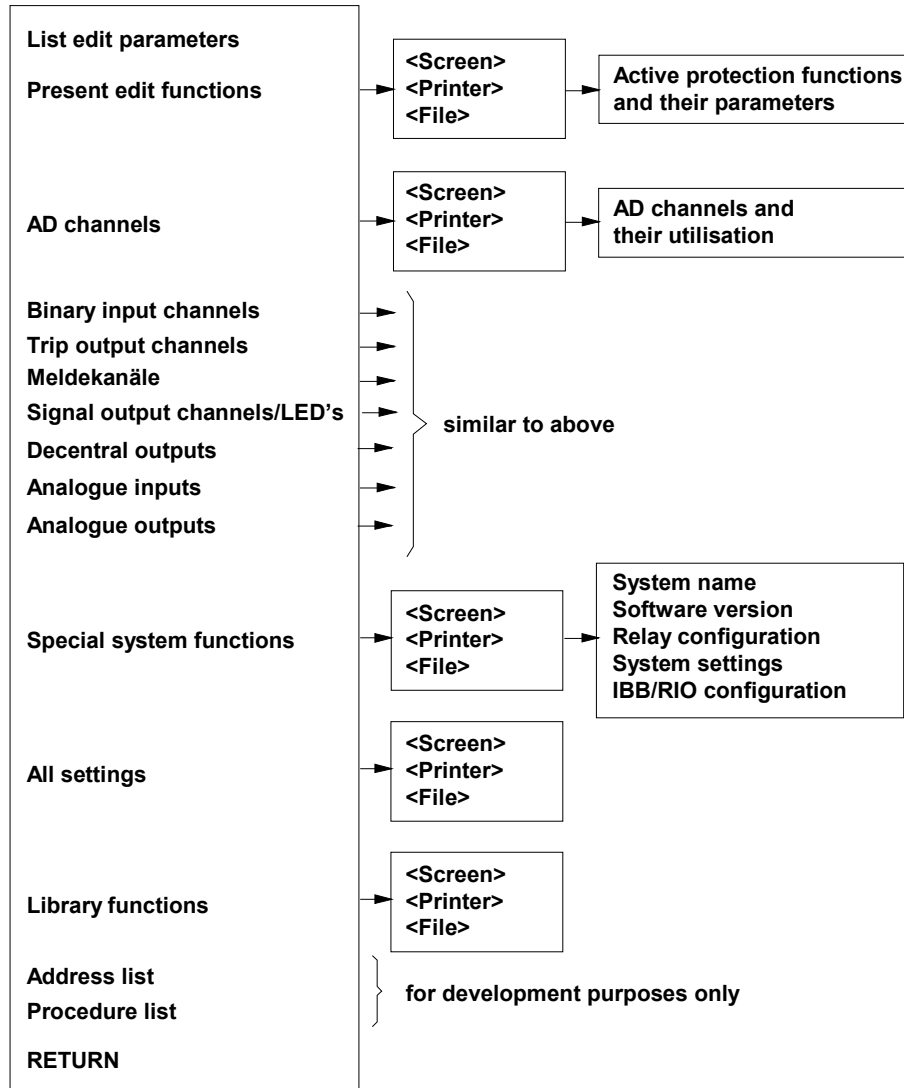


Fig. 5.32 Listing relay settings

5.5.8. Saving the contents of the editor

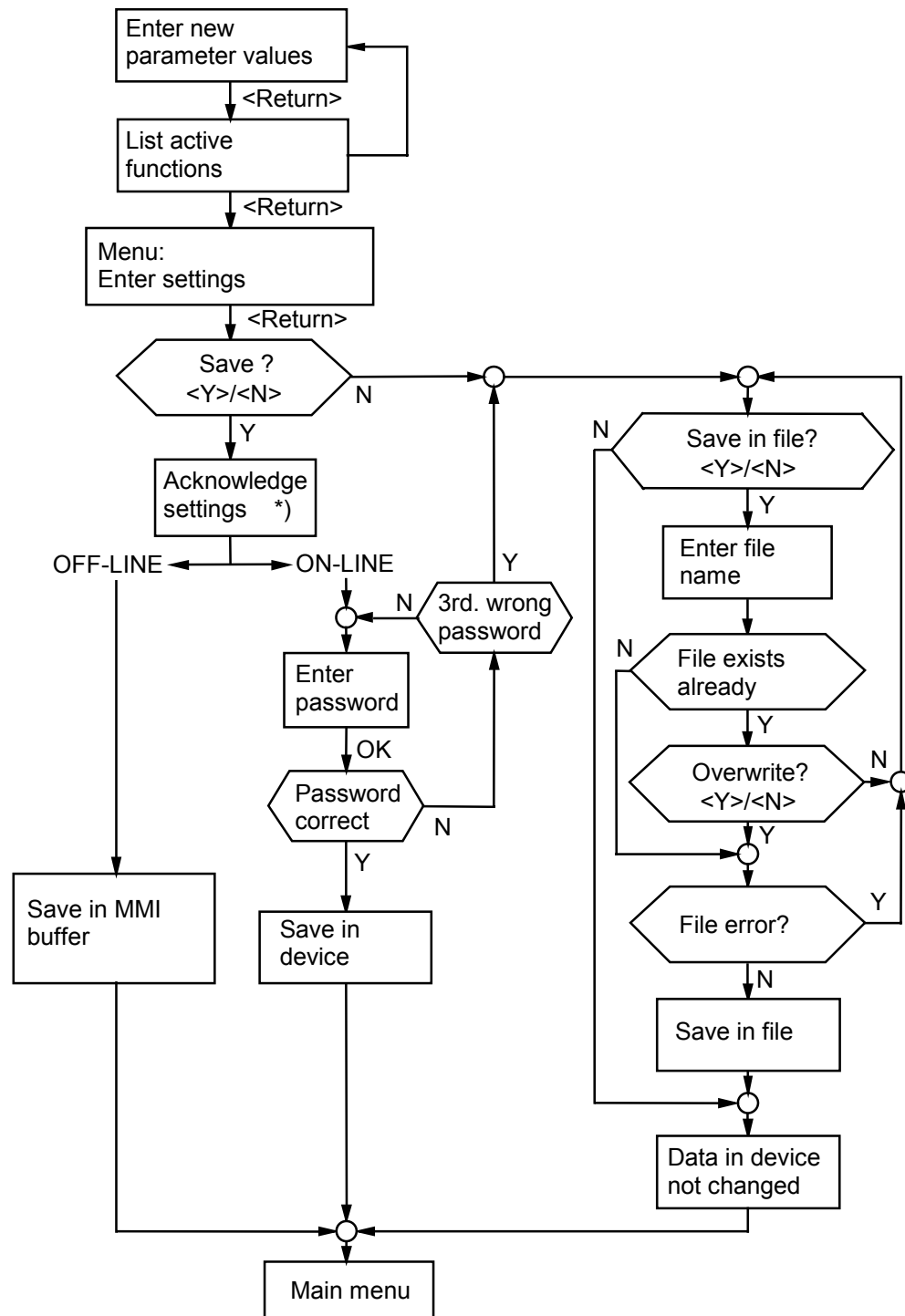


Fig. 5.33 Flow chart for saving the contents of the editor

*) Only if the "ParamConf" parameter is set.

5.5.8.1. *Downloading to the device*

The contents of the editor is downloaded to the device by repeatedly selecting the "RETURN" line in the editor window. The procedure can be seen from [Fig. 5.33](#).

As this operation is an extremely important one, a number of internal checks are carried out (e.g. comparison of the software code which is set with the existing software key). The downloading procedure is aborted if errors are discovered (a corresponding message is displayed) and the existing device settings are not changed.

Confirming parameters

If the "ParamConf" parameter is set, every new or changed parameter has to be individually confirmed by pressing the <→> key before it is saved. The corresponding menu for correcting a parameter can be opened by pressing <Esc>.

5.5.8.2. *Saving in and loading from a file*

The complete set of parameters including the hardware and system configuration data can be saved in a file either on a floppy or on the hard disc by one of the following:

- selecting the menu item "Save Parameters to File"
- repeatedly selecting "RETURN" as illustrated in [Fig. 5.33](#).

The user is requested to enter a file name which must conform to the DOS format (max. 8 characters of file name and 3 characters extension). The file is created in the current directory, if a path is not entered (max. 35 characters). Corresponding error messages are displayed should problems be encountered during the saving operation.

Loading a file from a drive is the reverse process of saving one. The user is requested to enter the name of the file. If a file of that name is found, it is first checked for compatibility and then loaded into the editor with the new set of parameters.

Note:

Loading a set of parameters from a file overwrites any data in the editor beforehand. Therefore if you do not wish to lose the existing data in the editor, they must be saved in a file before any other file is loaded.

5.6. *Event handling and operation of the disturbance recorder*

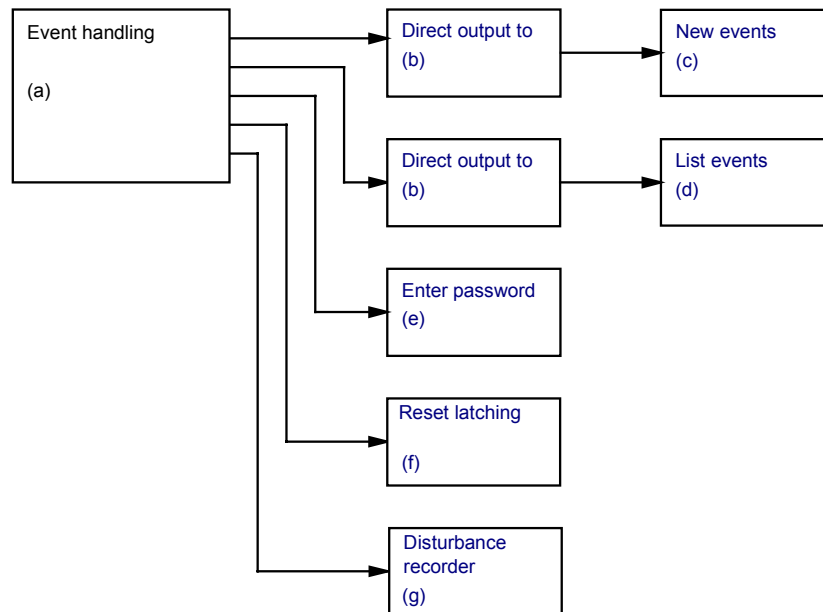


Fig. 5.34 Event handling
(see displays a to g on the following pages)

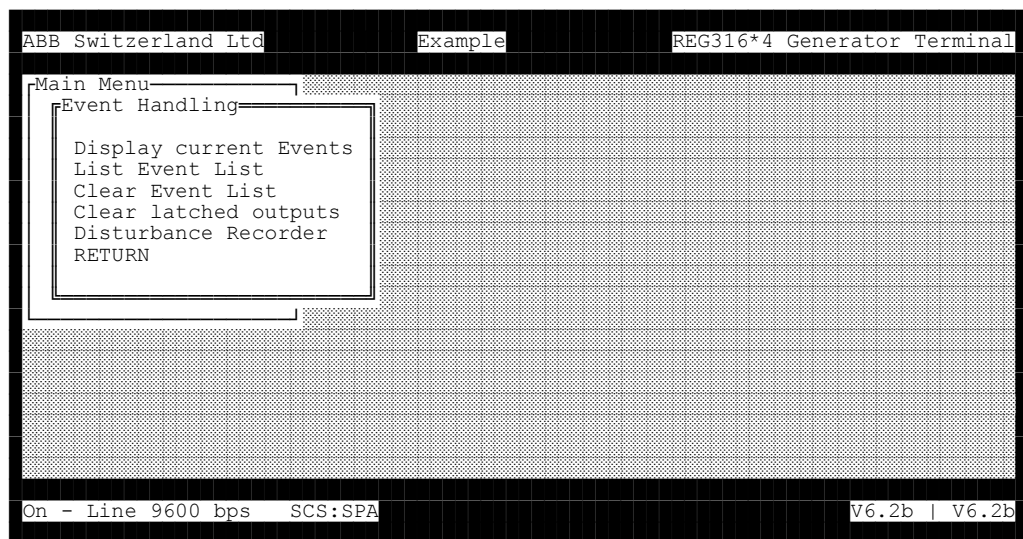


Fig. 5.34 a Event handling

Events can be viewed in two different ways as determined by the two sub-menus “Display new events” and “List events”.

In both cases, an invalid time stamp is indicated by a red 'T' between the date and the time. An invalid time stamp results from the failure of the synchronisation signal on the interbay bus. The events of units that are not connected to the station automation system are all marked as invalid following an interruption of the auxiliary supply until the respective unit is resynchronised to the PC time by running the HMI.

Display new events

In this mode, both the current relay events and the latest relay events are displayed.

All the events are recorded in chronological order together with the actual times they occurred (i.e. the time of the PC clock). The events are only displayed once, i.e. if the sub-menu is closed and then reopened, the display is empty until new events are recorded.

If the transfer of the events to <Printer> or <File> was chosen, all the events detected by the protection can be recorded over any period of time. However, the HMI is busy and therefore blocked while this is going on. A "Load" or "Print" window indicates that the continuous display or printing mode is active. It remains so until <Esc> is pressed. Do not switch the printer off, before leaving the continuous printing mode.

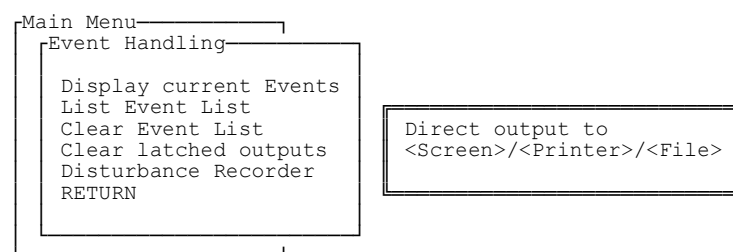


Fig. 5.34 b Direct output to

ABB Switzerland Ltd			Example		REG316*4 Generator Terminal	
33	1998-03-27	13:28;48.991	1	Current-DT	Trip	OFF
34	1998-03-27	13:28;48.991	1	Current-DT	Start	OFF
35	1998-03-27	13:28;48.991			GenStart	OFF
36	1998-03-27	13:28;49.261			GenStart	ON
37	1998-03-27	13:28;49.261	1	Current-DT	Start	ON
38	1998-03-27	13:28;49.265	5	DisturbanceR	BinOutput	ON
39	1998-03-27	13:28;49.365	5	DisturbanceR	BinOutput	OFF
40	1998-03-27	13:28;50.261	1	Current-DT	Trip	ON
41	1998-03-27	13:28;50.261	1	Current-DT		4.036 IN

On-line 9600 bps SCS:SPA V6.2b | V6.2b

Fig. 5.34 c New events

List events

The entire contents of the even memory (255 records) listed displayed in the display mode.

Should the signal 'General start' pick up, the events are listed with times in relation to the occurrence of the general start signal, otherwise their actual times are given. The list can be viewed any number of times until it is deleted.

The display can be moved up or down line-by-line or scrolled page-by-page using the keys <↑>, <↓> or <PgUp>, <PgDn>. The keys <Home> and <End> jump to the beginning, respectively end of the list.

ABB Switzerland Ltd			Example		REG316*4 Generator Terminal	
28	D:	00000 00:00;00.000	1	Current-DT	Start	ON
29	D:	00000 00:00;00.000	5	DisturbanceR	BinOutput	ON
30	D:	00000 00:00;00.100	5	DisturbanceR	BinOutput	OFF
31	D:	00000 00:00;01.000	1	Current-DT	Trip	ON
32	D:	00000 00:00;01.000	1	Current-DT		4.036 IN
33	D:	00000 00:00;24.770	1	Current-DT	Trip	OFF
34	D:	00000 00:00;24.770	1	Current-DT	Start	OFF
35	1998-03-27	13:28;48.991			GenStart	OFF
36	1998-03-27	13:28;49.261			GenStart	ON
37	D:	00000 00:00;00.000	1	Current-DT	Start	ON
38	D:	00000 00:00;00.003	5	DisturbanceR	BinOutput	ON
39	D:	00000 00:00;00.103	5	DisturbanceR	BinOutput	OFF
40	D:	00000 00:00;01.000	1	Current-DT	Trip	ON
41	D:	00000 00:00;01.000	1	Current-DT		4.036 IN
42	D:	00000 00:00;09.680	1	Current-DT	Trip	OFF
43	D:	00000 00:00;09.680	1	Current-DT	Start	OFF
44	1998-03-27	13:28;58.941			GenStart	OFF

On-line 9600 bps SCS:SPA V6.2b | V6.2b

Fig. 5.34 d Event list

Deleting events

Providing a valid password is entered, the event list can be deleted as follows.

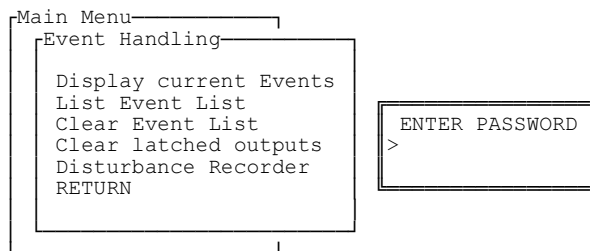


Fig. 5.34 e Enter password

Resetting latched outputs

After entering your password, you can reset the outputs that latch.

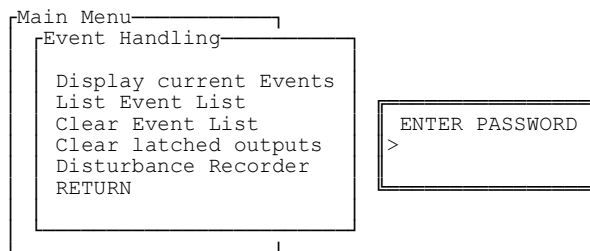


Fig. 5.34 f Enter password

Disturbance recorder

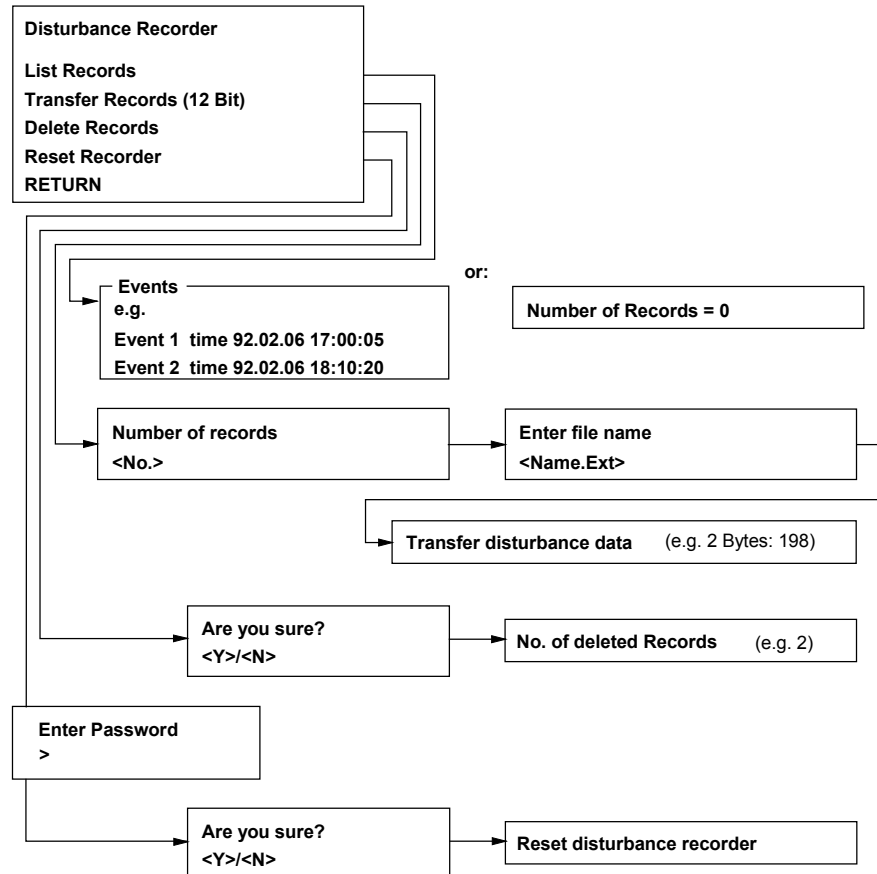


Fig. 5.34 g Operation of the disturbance recorder

According to the above diagram, the disturbance recorder can operate in one of the following modes:

List records:

All the records in the memory are displayed.

Transfer records (12 Bit):

One of the records is transferred. The number of the record and the name of the file in which it should be stored must be given.

Delete records:

The oldest record is deleted.

Reset disturbance recorder:

The disturbance recorder is reinitialised and all the old records are deleted.

5.7. Displaying variables

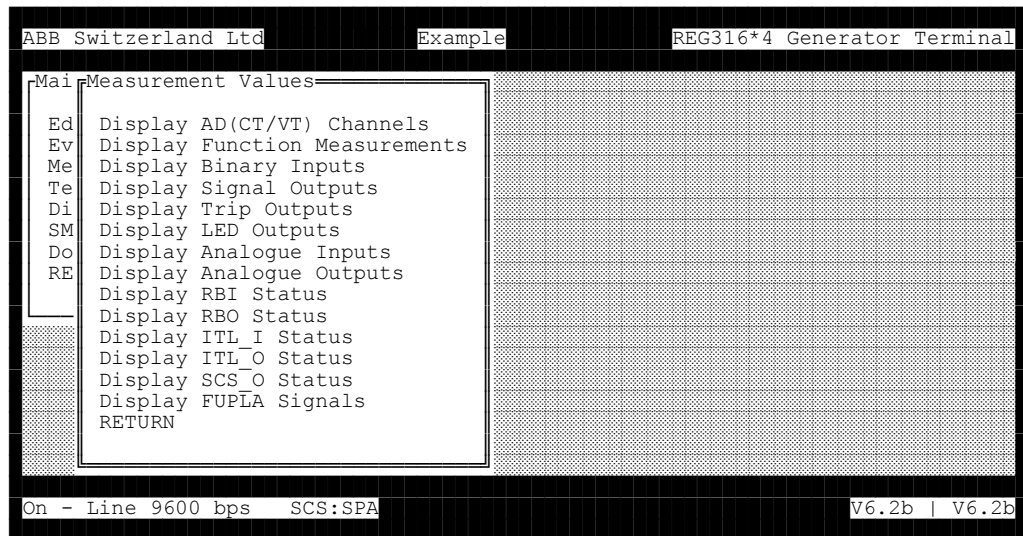


Fig. 5.35 Processing measurements

The load values measured by the protection functions and all the device inputs and outputs can be displayed.

The logic signals of all the FUPLA segments can be checked by selecting the menu item "Display FUPLA signals". This is used primarily for testing at the works.

5.7.1. Displaying AD(CT/VT) channels

All 9 c.t. and p.t. inputs can be viewed at the same time:

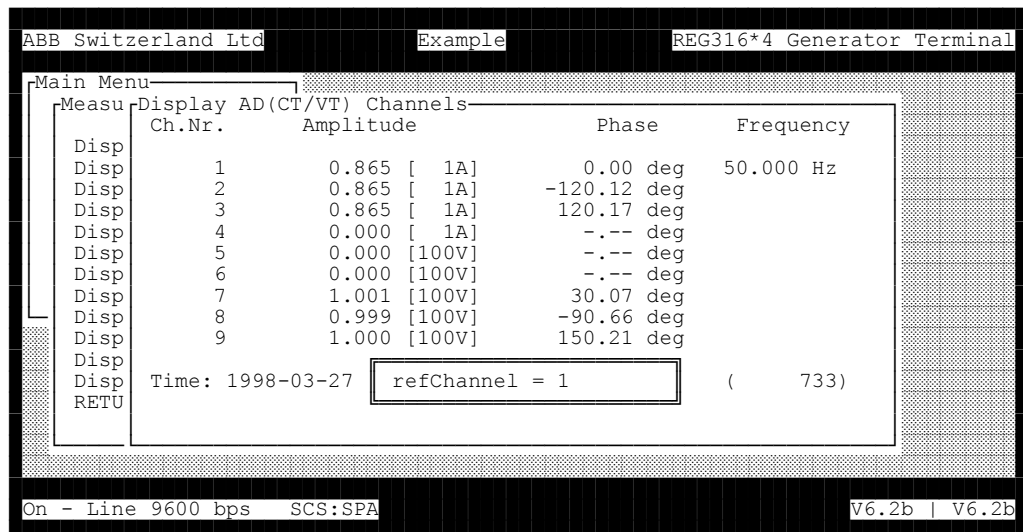


Fig. 5.36 Display AD(CT/VT) channels

Press an arrow key to open the reference channel window and select the reference channel by entering its number. The reference channel measures the frequency and provides the reference for angular measurements.

5.7.2. *Displaying load values*

Load values are measured by every protection function with a measurement algorithm. The desired function can be selected via the sub-menu “Display load values”.

Note that the list includes all the active functions for all the sets of parameters, i.e. also those which do not measure load values such as:

- auto-reclosure
- remote binary
- FUPLA
- VDEW6
- defluttering
- logic
- disturbance recorder.

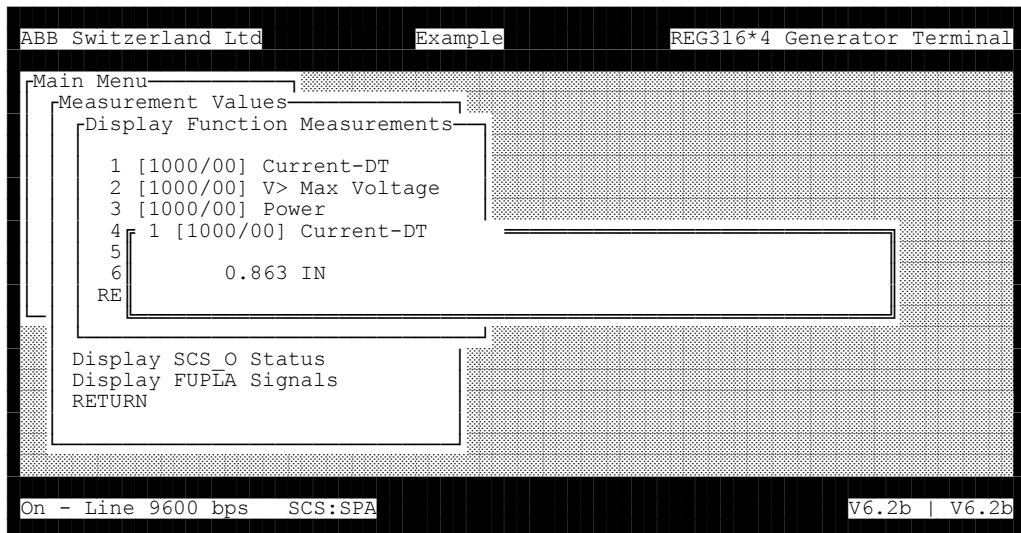


Fig. 5.37 Display function measurements (load values)

5.7.3. *Displaying binary inputs, signalling relays, LED's or tripping relays*

The inputs or outputs are displayed upon entering the number of the corresponding local or distributed input/output plug-in unit. Active inputs and outputs are indicated by an "X".

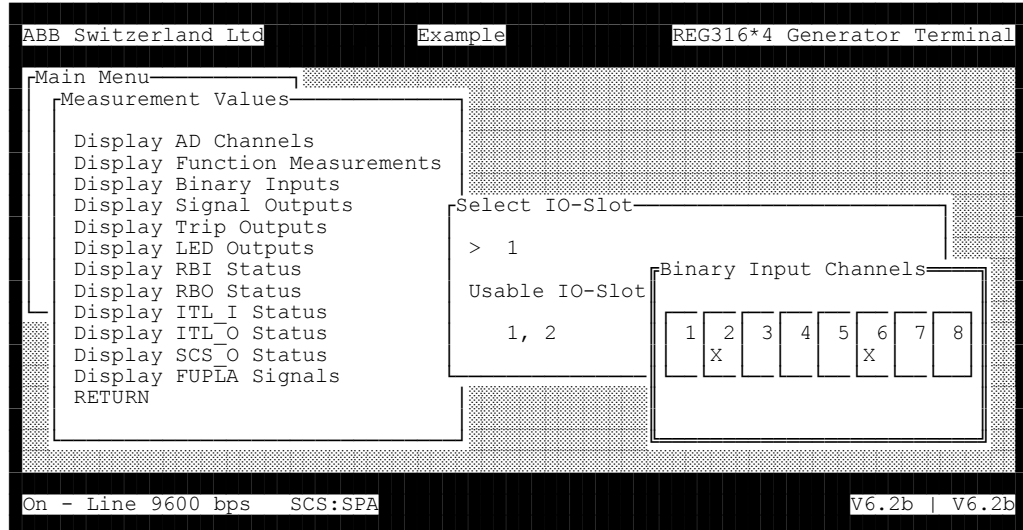


Fig. 5.38 Display binary inputs

5.7.4. *Displaying analogue inputs and outputs*

Enter the device number to view the associated inputs or outputs.

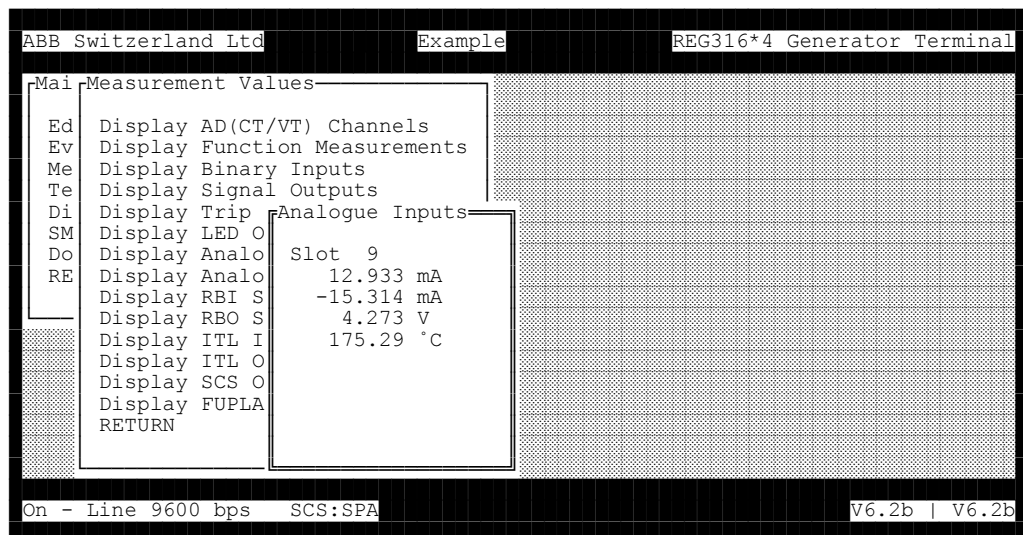


Fig. 5.39 Display analogue inputs

5.7.5. *Displaying ITL inputs and outputs*

ITL data can also be displayed. There are 48 outputs altogether (3 groups of 16 outputs each) and 3072 inputs (64 groups of 48 inputs each). The data belonging to a group are displayed when the group is selected, active signals being marked by “X”. The counter transferred with the data to check the transmission is also displayed. In the case of outputs, it is the one belonging to the output itself, while for inputs the input’s own and the transmitter counter are both displayed.

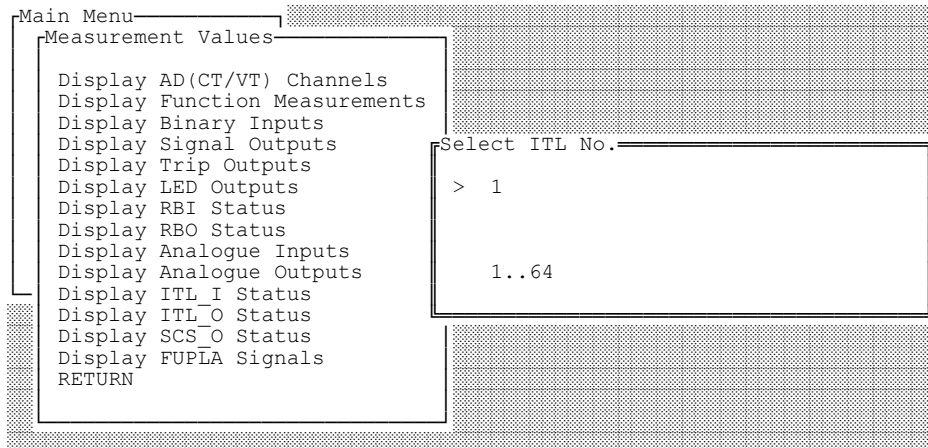


Fig. 5.40 Selecting the ITL data group

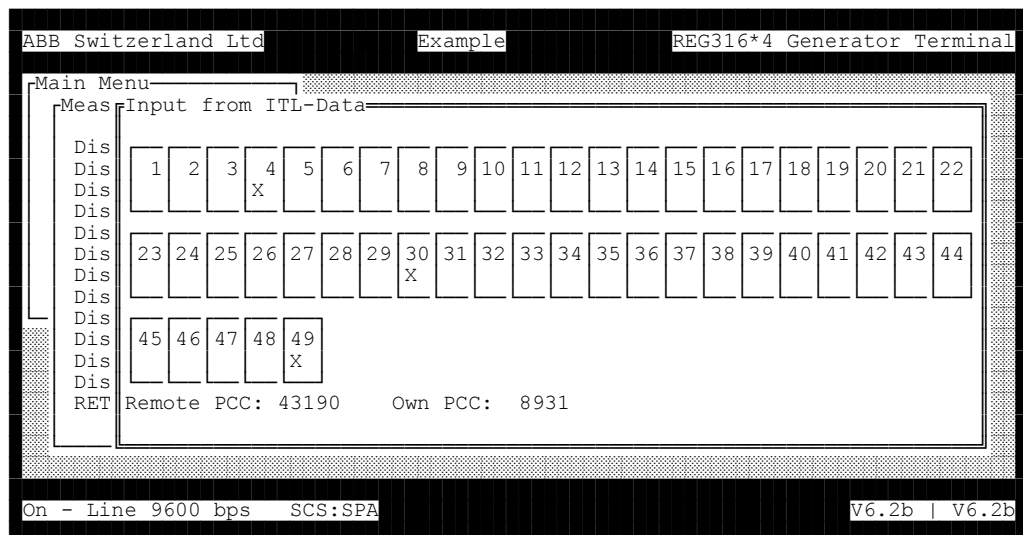


Fig. 5.41 Displaying ITL data inputs

The two counters indicate whether the corresponding data are refreshed.

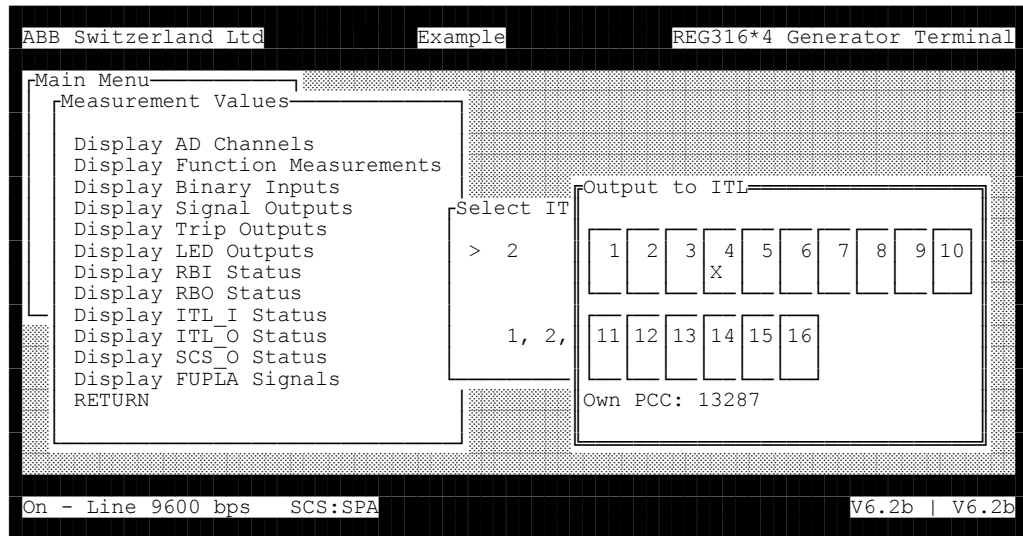


Fig. 5.42 Displaying ITL data outputs

5.7.6. *Displaying SCS outputs*

SCS outputs are displayed in 3 groups of 8 times 32 signals each. Use the <↑> and <↓> keys to switch between the groups. The SCS group (1...3) is displayed at the upper edge of the window.



Fig. 5.43 Displaying SCS outputs

Active outputs are marked by “I”.

5.7.7. *Displaying FUPLA signals*

FUPLA signals can also be displayed. For this purpose, the FUPLA file with the extension “xx.BIN” must be available in a format that the HMI program can read.

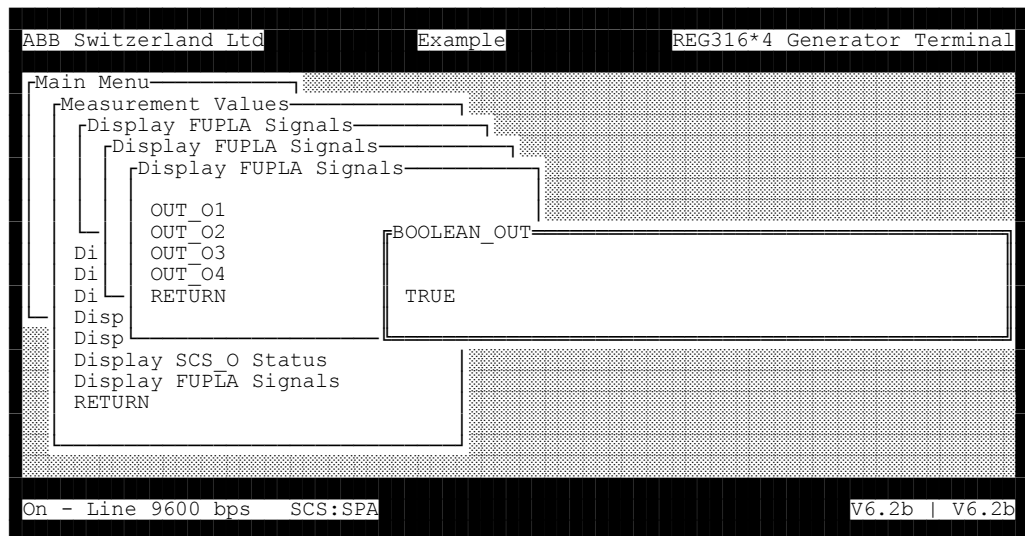


Fig. 5.44 Displaying FUPLA data

5.8. **Diagnostics**

The diagnostics menu includes the following:

- “Display diagnostic data”
The results of the self-monitoring function for the entire device, the main processor, the analogue input unit 316EA62 (where fitted) and the analogue inputs on the main processor unit are displayed. The time when the settings were last changed is also given.
The names and statuses of all the FUPLA logics loaded in the device are also displayed.
- “Load HEX dump”, “Delete HEX dump”
This information is only intended for development purposes.
- “IBB information”
Information concerning the status of the IBB link. The data displayed depend on the type of bus protocol in use (LON, VDEW, SPA or MVB).
- “RIO information”
Information concerning the status of the process bus and the distributed input/output system (from V5.0).
- “Reset SCS data”
The SCS input data are deleted after entering a password (from V4.04).
- “Load SCS forms”
Enables forms in a file created by the HMI documentation function to be saved so that the signalling of events can be controlled via the SCS (from V5.0).

Refer to [Section 6](#) for further details.

5.9. Test functions

Since some of them can disrupt the normal operation of the device, test functions can only be accessed after entering the valid password. They are used mainly during commissioning and may only be activated when the plant is out of service, or with the tripping and signalling circuits externally disconnected if in service.

The protection is re-initiated upon closing the “Test functions” menu and the set of parameters previously used in operation re-activated.

The procedure for using the test functions can be seen from the following figures.

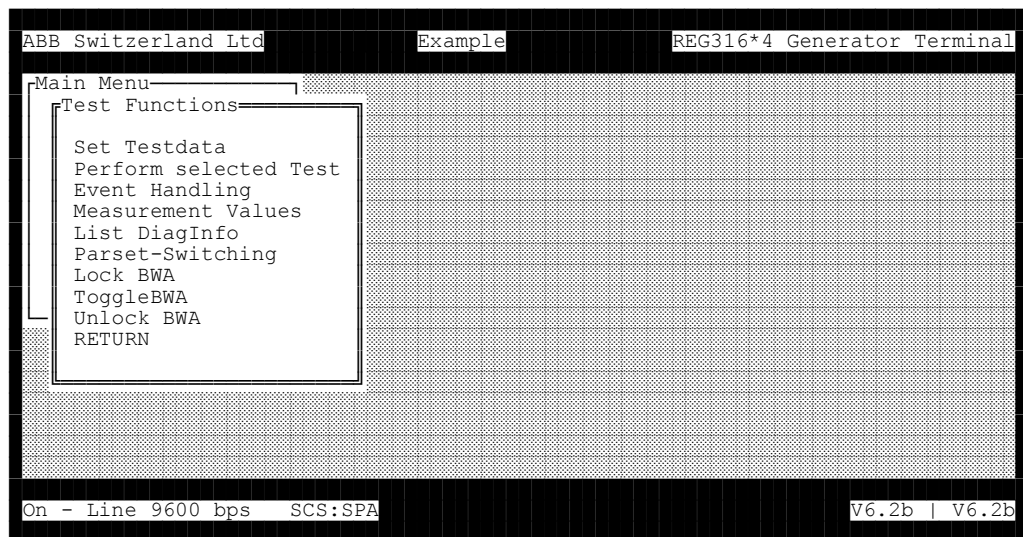


Fig. 5.45 Test functions

Set test data

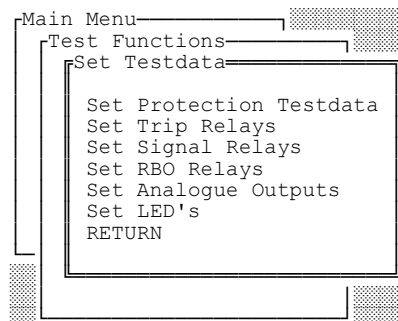


Fig. 5.46 Set test data

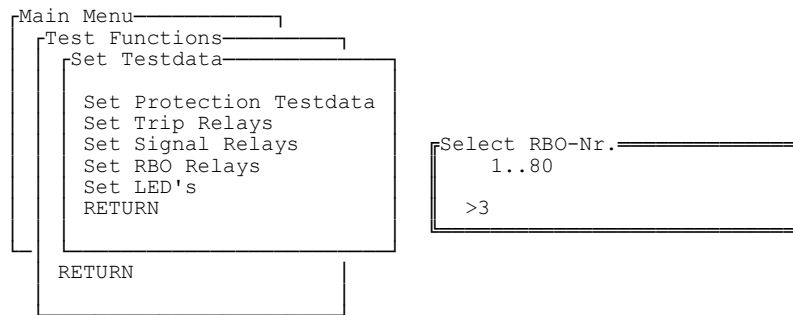


Fig. 5.51 Selecting an RBO No.

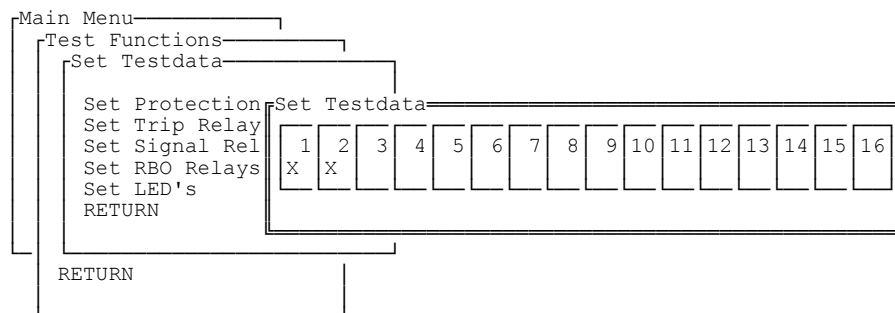


Fig. 5.52 Entering test data

4. Testing the analogue outputs (distributed output):

The desired output channel can be selected (using <Ins>) after entering the device number. The output is the value entered when the test is performed.

Only one output per device can be controlled.

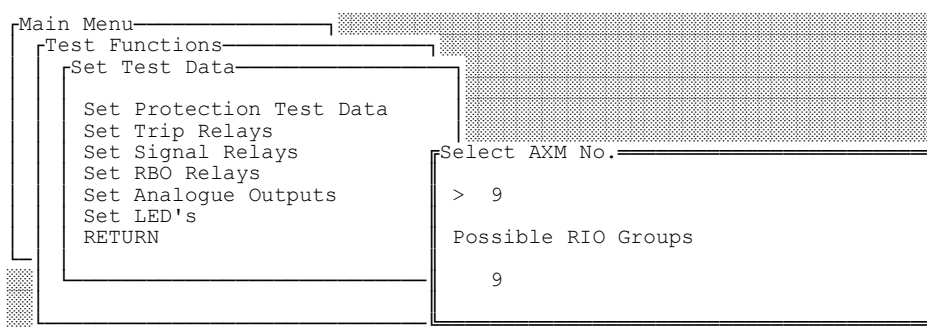


Fig. 5.53 Selecting the AXM No.

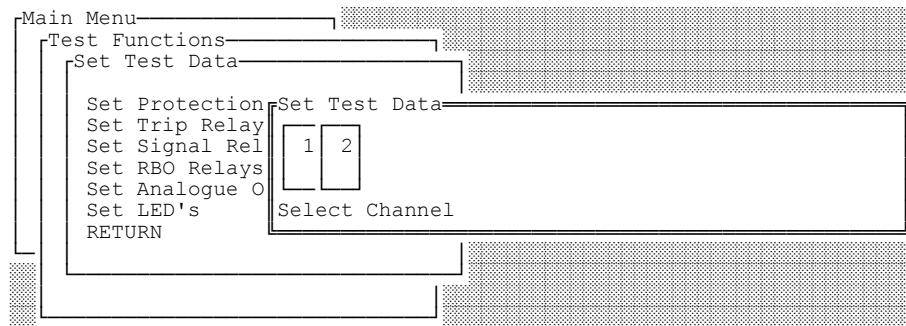


Fig. 5.54 Selecting the channel

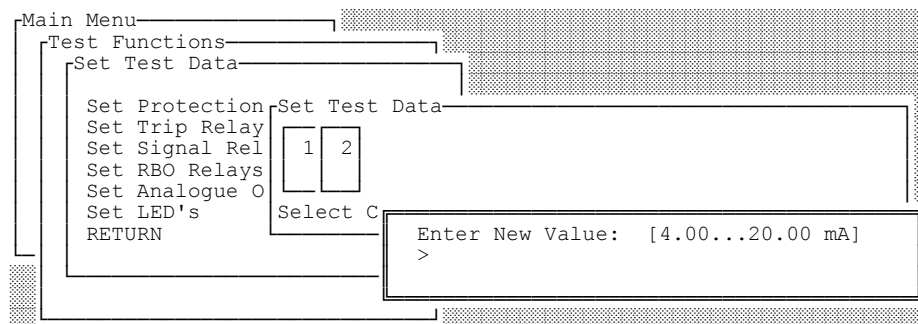


Fig. 5.55 Setting the output value

Perform selected test

After entering the test data, repeatedly press the <End> and <Enter> keys to return to the “Test functions” menu.

Select the menu item “Perform selected test” to start the test and apply the test data which has been set.

“Event handling”, “Measurement values” and “List diag. info.”

These menu items enable the corresponding functions to be used in the test mode and provide the facilities described in [Sections 5.6. to 5.8.](#)

Parset switching

To test a protection function belonging to another set of parameters, the respective set of parameters has to be activated first. Menu item “Parset switching” enables the parameter set to be selected and activated after entering the valid password.

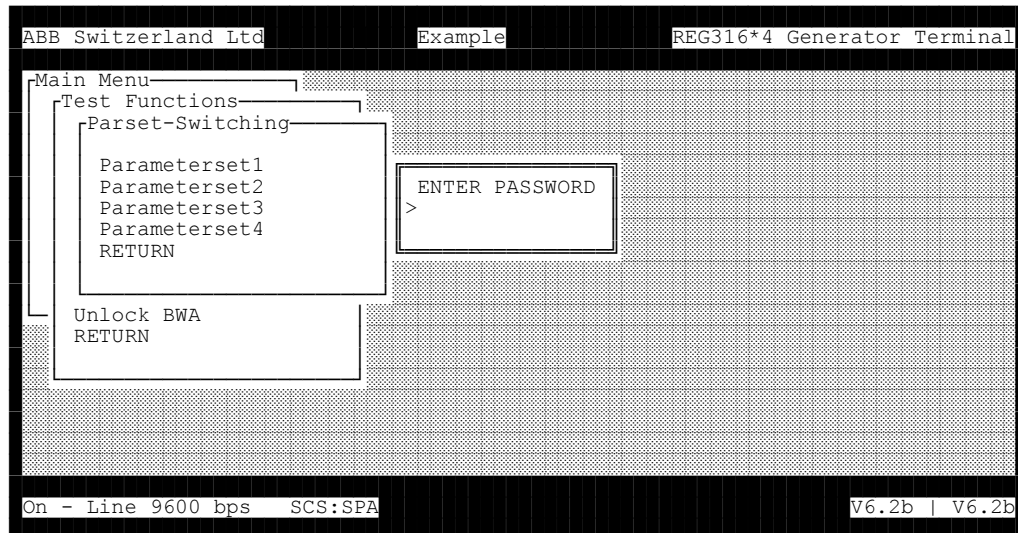


Fig. 5.56 Switching sets of parameters

Lock, Toggle, Unlock BWA

BWA is a memory range in the device in which the statuses of the binary outputs (signalling and tripping relays etc.) and the functions are stored. “Toggle BWA” inverts, i.e. toggles, the status of the selected binary output. The latter is determined by the index in the BWA as defined in the file Siglist.txt, which is created by the HMI ‘Documentation’ function (see [Section 5.10.](#)).

“Lock BWA” prevents functions from changing the statuses of the binary outputs during the test procedure. The “Lock BWA” condition is indicated by the fact that the test window is shifted to the right. “Unlock BWA” cancels the locked conditions. Closing the test function also unlocks the BWA.

The changed status is displayed by entering the BWA index and pressing <ENTER>.

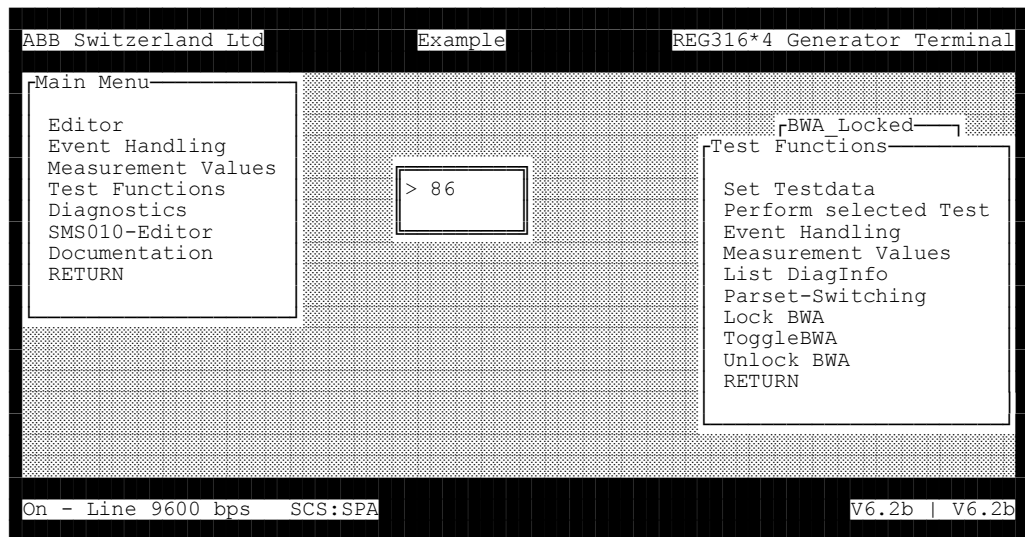


Fig. 5.57 Toggle BWA: selecting the signal to toggle

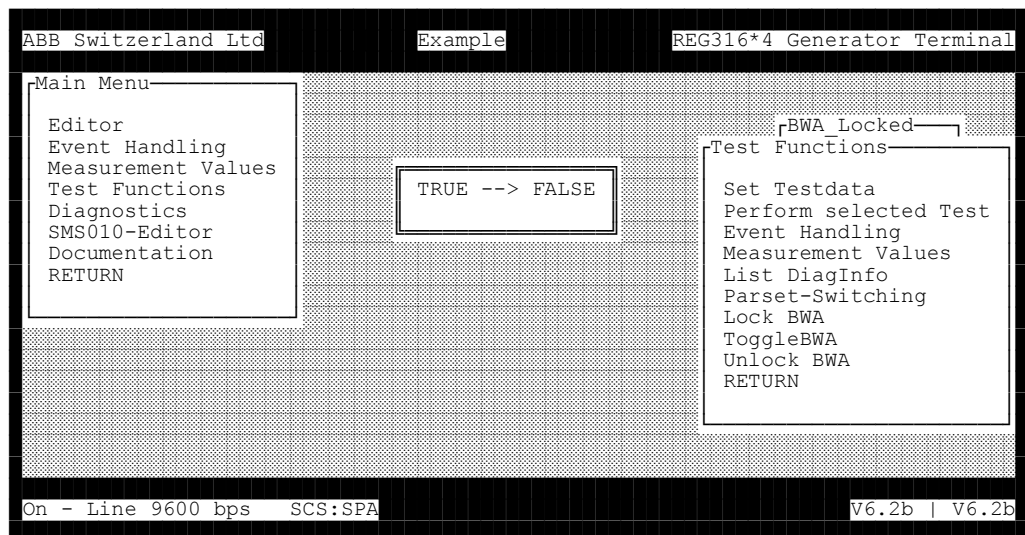


Fig. 5.58 Toggle BWA: displaying the signal status change

Extract from the file Siglist.txt :

For BWA index 27, for example, "Toggle BWA" switches the current function "TRIP" signal on and off.

FunctionName	FuncType	SignalStdName	BWAIndex	SigType
System IO	34	GenTrip	3	SI
System IO	34	GenStart	5	SI
Logic	31	BinOutput	26	SI
Current	3	TRIP	27	SI
Current	3	Start	28	SI

5.10. **Documentation**

This menu item provides facility for generating various files required when engineering an SCS system.

The files generated are as follows:

recxx.evt	List of all the possible events with provision for defining whether an event should be recorded as such (masking).
recxx.inp	List of all the binary inputs used.
recxx.out	List of all the binary outputs used.
recxx.pbi	List of distributed input/output modules with details of type and configuration.
recxx.sig	List of all signals and their main data (name, address, event No., BWA index etc.)

xx = device address on the SCS bus.

5.11. **Operation with several sets of parameters**

The units of the RE. 316*4 series permit up to four independent sets of relay settings or protection configurations to be defined. Only one of these sets of parameters can be active at any one time when the protection is in operation. Provision is made for switching between sets of parameters.

5.11.1. **Switching sets of parameters**

One of the four sets of parameters is selected by

- a) applying a signal to a binary input (opto-couplers)
- b) a signal from the station automation system (SCS).

Setting binary inputs

A maximum of four binary inputs are used for switching sets of parameters. They are configured by selecting the menu item "Edit inputs/outputs" in the "Edit system functions" menu.

If when configuring the inputs using the HMI they are left at their default setting of "F" (FALSE = always OFF), the protection can only operate with parameter set 1.

"Remote sel." : If this I/P is activated, a signal from the station control system (SCS) is necessary to switch between sets of parameters, otherwise the I/P's "ParSet2", "ParSet3" and "ParSet4" determine which set of parameters is active.

"ParSet2", "ParSet3" and "ParSet4":

These three I/P's enable one of the four sets of parameters to be selected.

ParSet2	ParSet3	ParSet4	Active set of para.
F	F	F	1
T	F	F	2
F	T	F	3
T	T	F	no change
F	F	T	4
T	F	T	no change
F	T	T	no change
T	T	T	no change

As can be seen from the table, the current set of parameters remains effective, if a signal is applied to more than one of the I/P's at the same time.

Setting signalling outputs

Four outputs ("ParSet1" ... "ParSet4") are needed to indicate externally via a signalling relay or a LED and/or record in the event list which of the four sets of parameters is currently active. These outputs are configured via the HMI in the same way as all other signalling outputs.

5.11.2. Creating sets of parameters

5.11.2.1. Assigning a protection function to a set of parameters

All protection functions have a parameter "ParSet4..1". The corresponding setting determines in which set of parameters the function is effective.

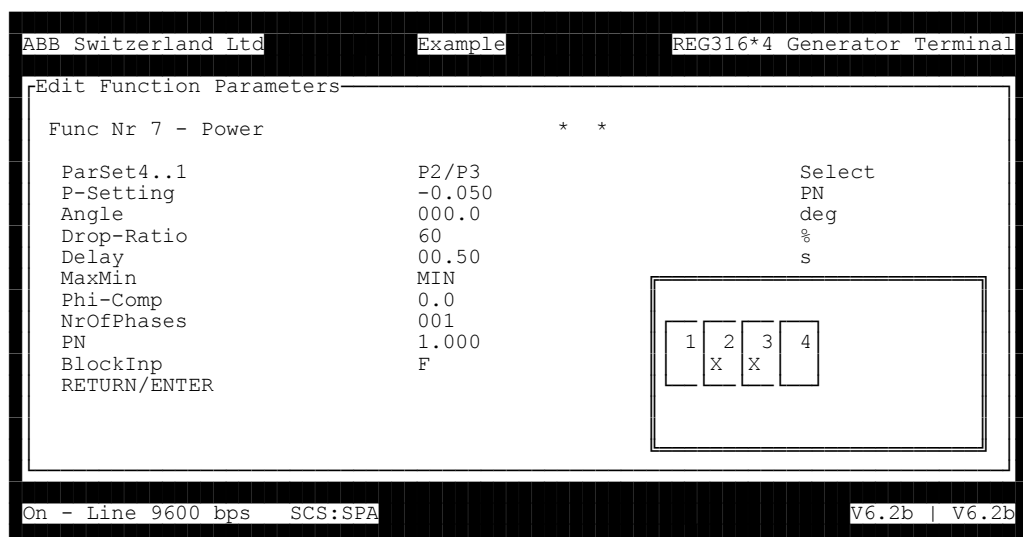


Fig. 5.59 Assigning sets of parameters

5.11.2.2. ***Copying a protection function with its settings***

A protection function can be copied together with its settings from one set of parameters to another, if its settings in the second set of parameters remain mostly the same. The procedure is described in [Section 5.5.1.3](#).

The copied Version of the protection function assumes precisely the same settings as the original function. The following parameters of a copied function cannot be changed subsequently

- all analogue inputs
- all signalling outputs
- all tripping channels.

The copied function must not be active in the same set of parameters as the original and the parameter set number of the original function must be lower:

RULE: $P1 \leq pO \leq P4 \quad <---> \quad pO < pK \leq P4$

pO = parameter set number of the original function

pK = parameter set number of the copied function.

The originals of existing copied functions cannot be deleted.

5.11.2.3. *Displaying a function with its settings*

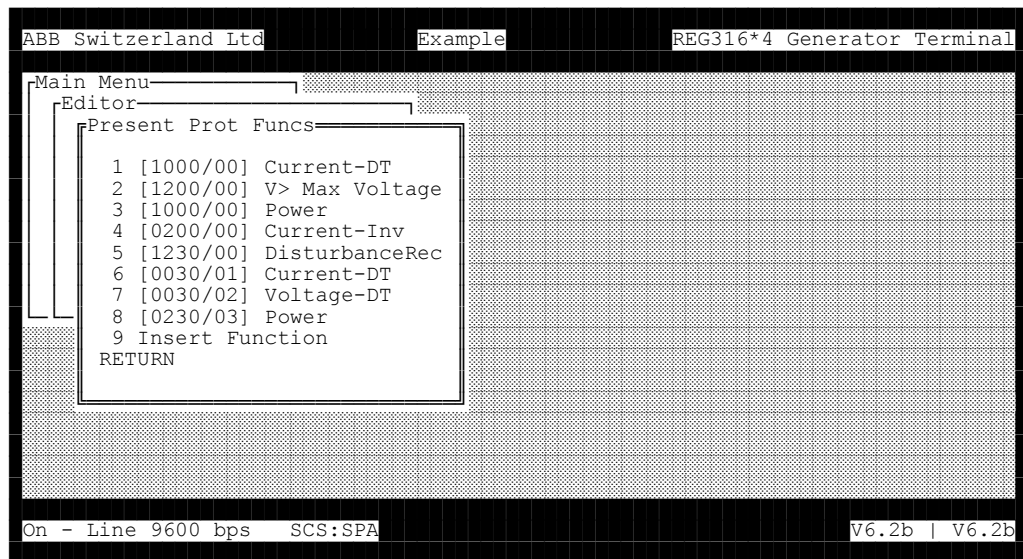


Fig. 5.60 Presentation by the HMI of the protection functions

The list of functions and their settings are presented as follows:

A [B / C] D (e.g. 1 [1000/00] Current-DT)

- A: Function No.
- B: active in parameter set No., e.g.
0030: parameter set 1
1230: parameter sets 1, 2 and 3
- C: 0 = original function
n = copy of function n
- D: function name.

5.11.3. *Logics*

Where several protection functions are related by a common logic, they must all be active in the same set of parameters.

Note:

Outputs of copied distance protection functions can only be connected to inputs of functions listed after the distance function in the function list.

5.12. Remote HMI

5.12.1. Summary

The firmware provides facility for controlling RE.316*4 devices grouped according to stations. All the HMI functions are available. User access via the remote HMI to such functions as 'Load setfile', 'Test function', 'Time synchronisation' and 'SPA communication' can be restricted.

We do not recommend loading and downloading 'Setfiles' via a modem link as all the device settings will be lost should the line be interrupted during file transfer.

Remote HMI facilities:

- local control of a device via the interface on the front
- control of several devices in an SPA_BUS loop via a modem and the SPA-BUS interface
- control of several devices in an SPA_BUS loop via the SPA-BUS interface
- control of several devices in an SPA_BUS loop via an SRIO. In this operating mode, the HMI sets the SRIO clock and synchronises the device clocks.
- control of several devices in an SPA_BUS loop via a modem link and an SRIO. In this operating mode, the HMI sets the SRIO clock and synchronises the device clocks.
- safe operation since the simultaneous access by local and remote HMI's is excluded
- system of access rights to restrict the operations possible on the HMI
- event recording transferred to a pre-defined individual directory for each device
- convenient HMI user shell for easy control.

5.12.2. Modem requirements

A modem used in conjunction with the remote HMI must be suitable for asynchronous operation and the interface baud rate must be independent of the line baud rate. It must be possible to set the interface baud rate to correspond to the SPA/SRIO baud rate.

The modem must be set to answer automatically when it receives a call.

Initialisation string for the remote modem:

Fixed DTE rate:	&B1
DTE async speed:	9600 Baud
DTR ignored:	&D0
RTS ignored	&R1
DSR always on	&S0
Auto answer:	S0=2
Handshake off:	&H0

Save modem settings: AT&W0.

5.12.3. *Remote HMI shell*

The HMI shell requires an operating system Windows 3.xx, Windows 95 or Windows NT 4.x. Menus guide the user through the procedures for configuring stations and devices. The device HMI is started in a DOS window.

5.12.3.1. *Installation*

Place installation disc No. 1 in drive A and select 'Run' in the 'File' menu to start the installation.

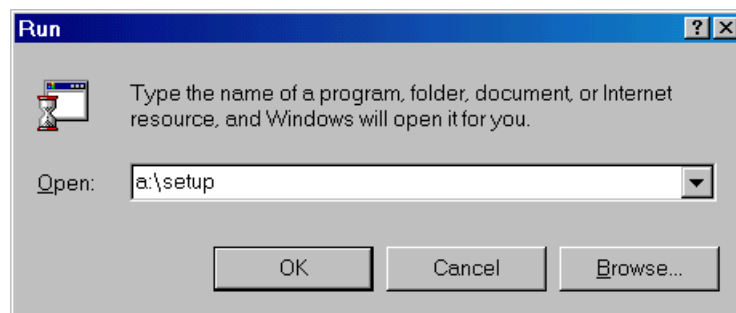


Fig. 5.61 Starting the installation of the HMI

5.12.3.2. *Configuring a new station*

After starting the remote HMI, select 'New station' in the 'File' menu to open the dialogue for entering the station name.

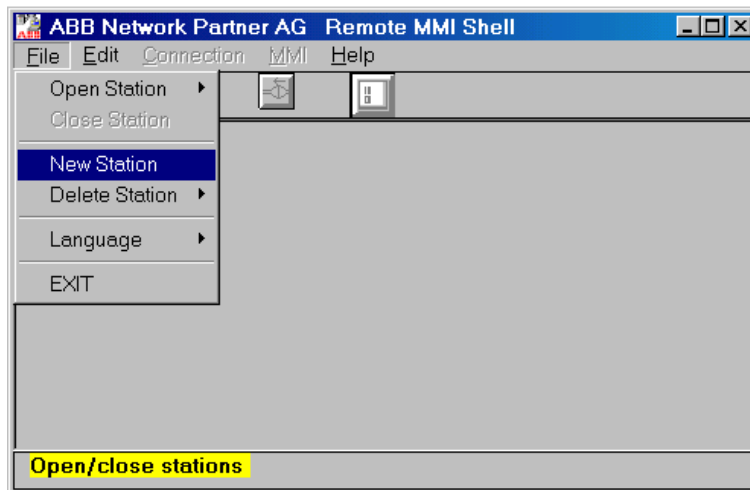


Fig. 5.62 Configuring a new station

Enter the station new in the dialogue (max. 8 characters) and click on OK.

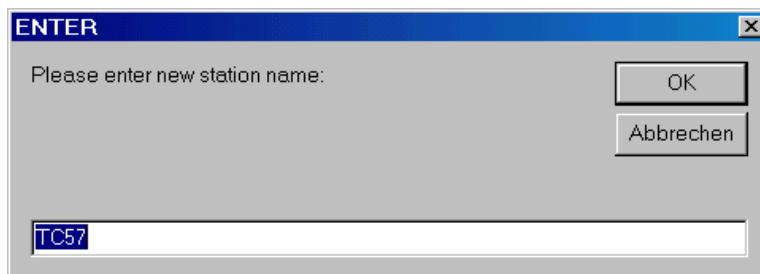


Fig. 5.63 Entering the name of the new station

Then select the new station from the list that appears when the 'Edit' menu is opened and the station configuration dialogue appears.

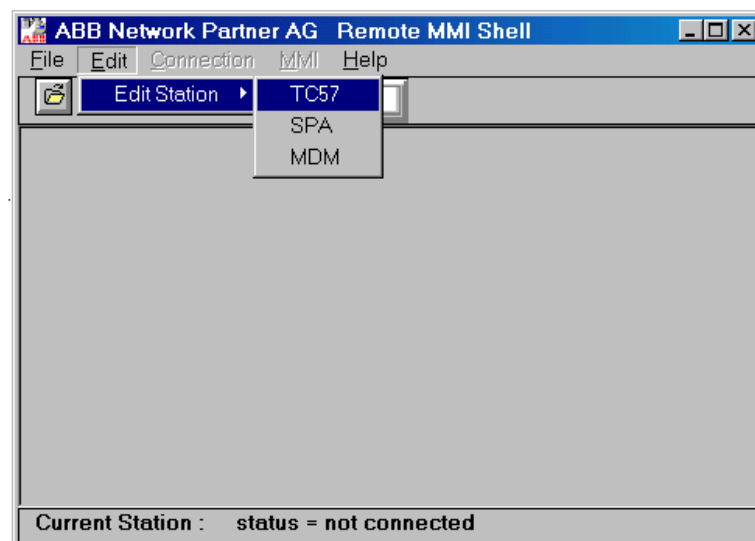


Fig. 5.64 List for selecting the station to be configured

The next task is to edit the files 'Station.cfg' and 'MMKShell.mnu' in the configuration dialogue.

The following parameters are set in 'Station.cfg':

COMT : Communication parameters
 TC57 = communication via interface at the front
 SPA = communication via the SPA-BUS interface
 MDM = communication via modem and SPA-BUS interface
 SRIO = direct communication via SRIO
 RDM = communication via modem and SRIO.

BAUD : Baud rate.

TNR : Station telephone number (T...tone dialling,
 P...impulse dialling)

MPAR : Modem initialisation parameters; in most cases the default settings are satisfactory.

Select SAVE to confirm the parameter settings and update the file.

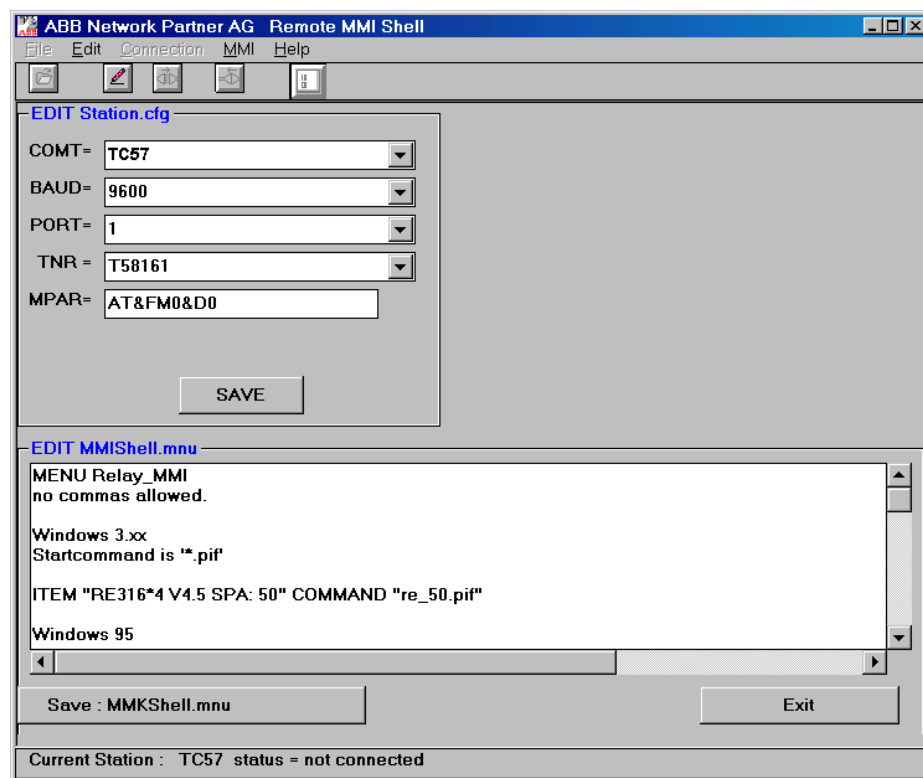


Fig. 5.65 Window for editing the station configuration

An entry for each device in the station has to be made in the file 'MMKShell.mnu'. The actual entry varies according to Windows version.

Windows 3.xx :

ITEM "Text" COMMAND "Filename.pif".

The text entered in the first pair of inverted commas appears in the 'HMI' menu. Windows 3.xx uses *.pif files in which the characteristics of the DOS program are entered. Start the PIF editor after saving 'MMKShell.mnu'.

The following entries have to be made:

Program file name: Path to the HMI file pcgc91.exe, e.g.
C:\MMK\PCGC91

Program title: Name of the window in which the HMI is running

Program parameters: Write the 'Default' is replaced by the desired name for the *.cfg file.

Save the *.pif file.

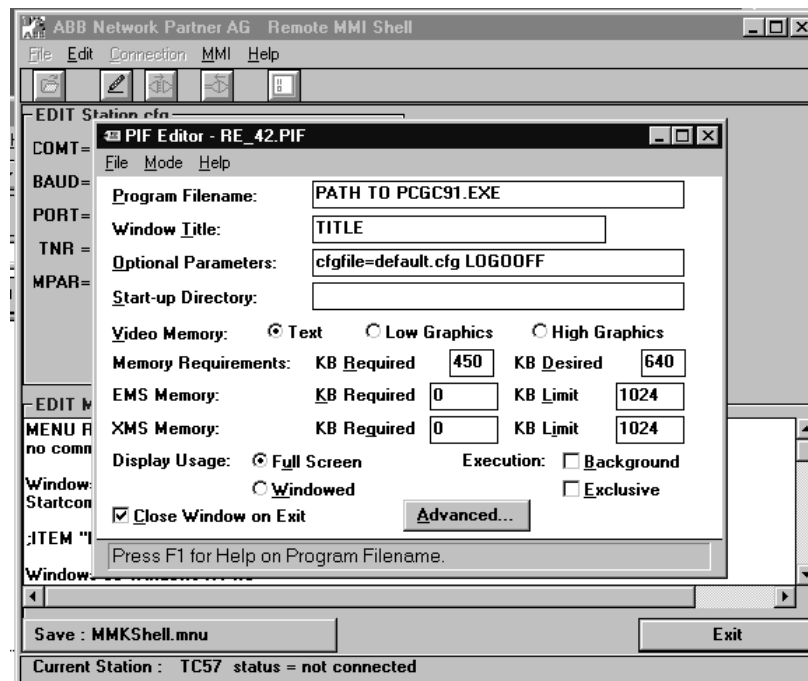


Fig. 5.66 Pif editor

Entry in 'MMKShell.mnu' for Windows 95 and Windows NT:

ITEM "Text" COMMAND "Path to MMK\PCGC91
CFGFILE=NAME.CFG LOGOOFF"

The 'NAME.CFG' file is created after saving the 'MMKShell.mnu' file and can be edited in the dialogue 'Edit NAME.CFG' by selecting it from the 'HMI' menu:

RETYP	Device type, e.g. REG316
LANG	HMI language
COLOR	RGB = colour screen
EVEDATA	Directory where the HMI saves disturbance recorder data. The directory will be created if it does not already exist.
SLVE	SPA slave address.
BAUD	Only in conjunction with communication parameter TC57, 9600 Baud or 19200 Baud.

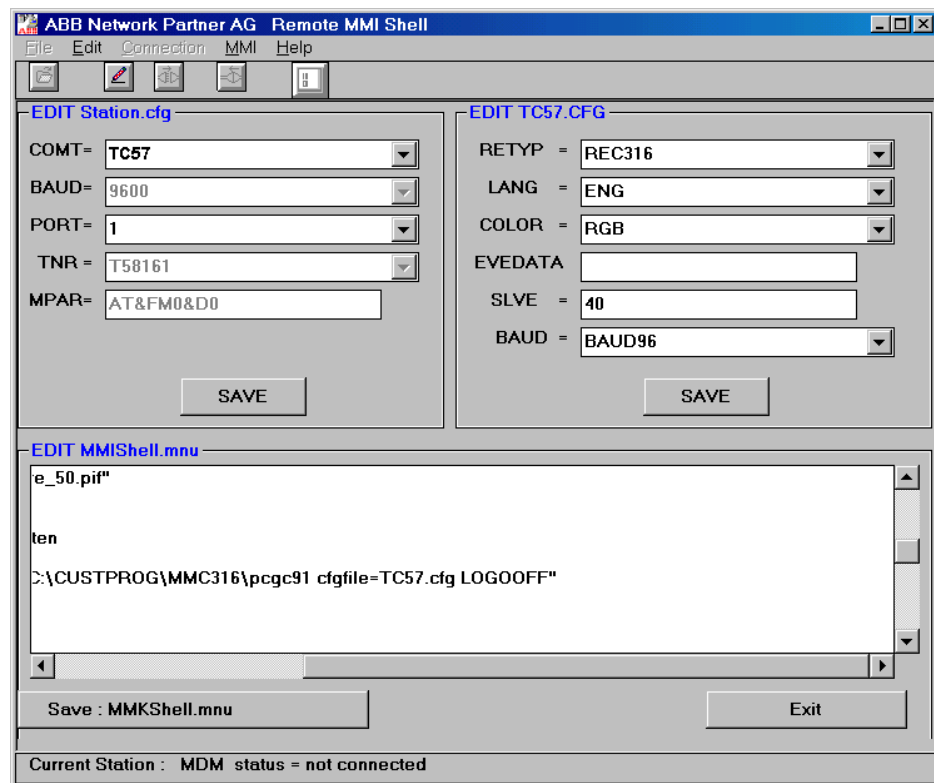


Fig. 5.67 Editing *.cfg

Click on 'Exit' to terminate the edit mode.

5.12.3.3. *Establishing the connection to the station*

Select the desired station via 'File' and 'Open station'.

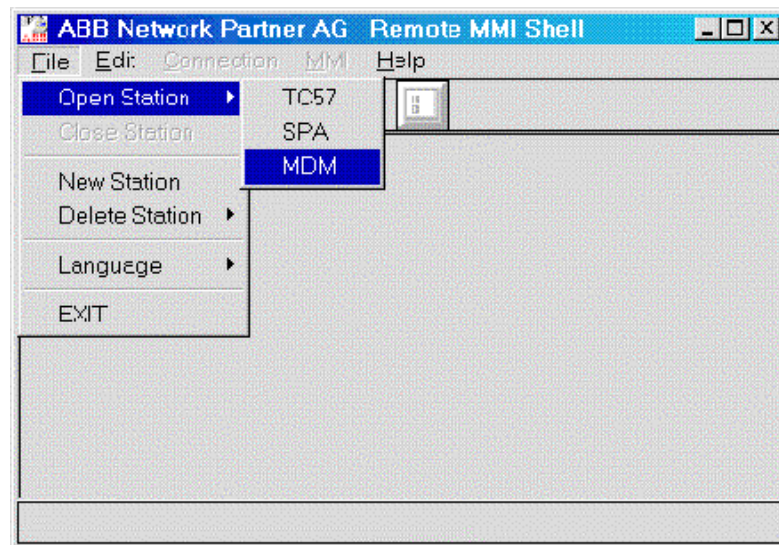


Fig. 5.68 Establishing the connection to the station

Depending on the communication parameter that has been set, the HMI can be started either directly or, once the link has been established, via the modem.

If the communication parameter is set to RDM or MDM, connection has to be established via the modem. The HMI menu is not available (grey) until the link is in operation. After clicking on 'Connect' in the 'Connection' menu, a script window opens in which the exchange of data between the modem and the remote HMI is logged.

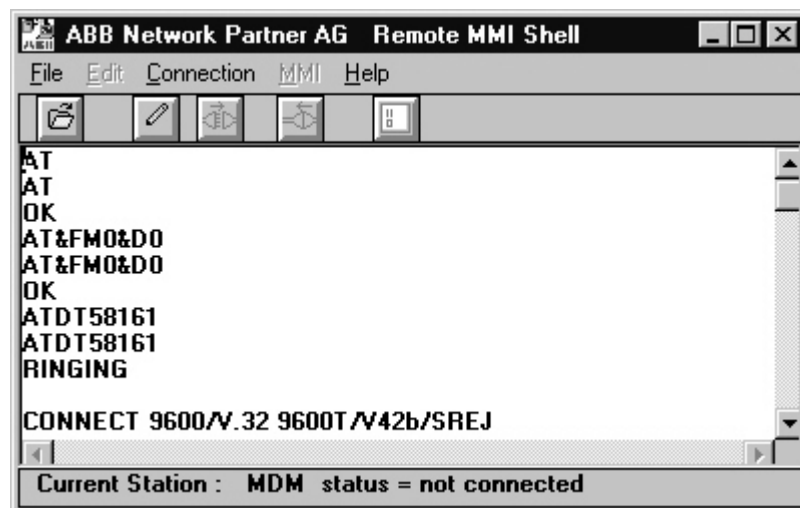


Fig. 5.69 Script window

The following confirmation dialogue is displayed providing the connection is established within the timeout period set on the modem:



Fig. 5.70 Confirming the connection

After clicking on 'OK', the script window closes and the 'HMI' menu becomes available.

You can now start the desired HMI.

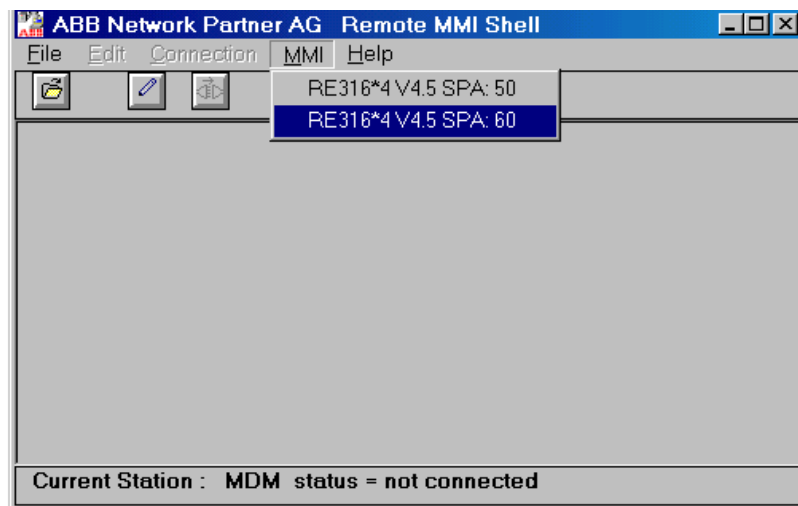


Fig. 5.71 Starting the HMI

Select 'Disconnect' in the 'Connection' menu to close the link.

5.12.4. *Configuring a remote HMI for operation via the SPA-BUS interface*

5.12.4.1. *Remote HMI connected directly to the electro-optical converter*

COMT=SPA enables several devices to be controlled in an SPA-BUS loop. A suitable electro-optical converter (SPA-ZC22) must be inserted between the SPA-BUS loop and the PC.

Providing synchronisation is enabled, the clocks in the devices are synchronised to the PC clock by a broadcast telegram when the remote HMI is started.

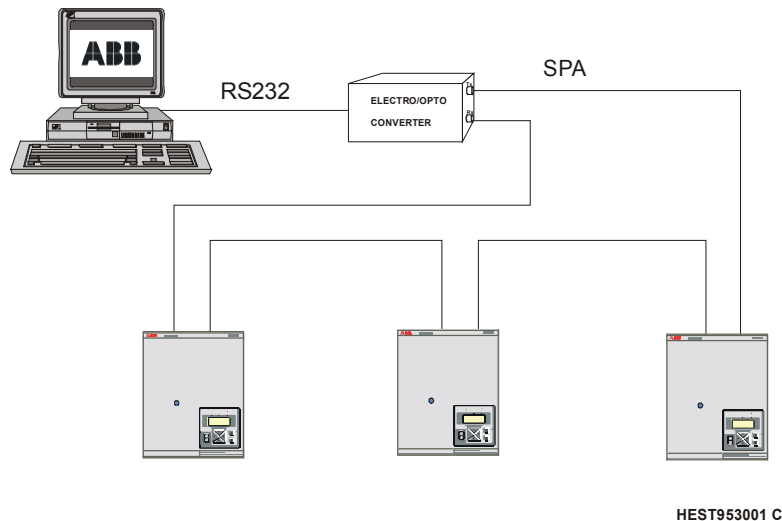


Fig. 5.72 Remote HMI connected directly to an electro-optical converter

5.12.4.2. **Remote HMI connected via a modem to the electro-optical converter**

COMT=MDM enables several devices to be controlled in an SPA-BUS loop via a modem. A suitable electro-optical converter (SPA-ZC22) must be inserted between the SPA-BUS loop and the modem.

Providing synchronisation is enabled, the clocks in the devices are synchronised to the PC clock by a broadcast telegram when the remote HMI is started.

A genuine hardware handshake with the remote modem is not possible in this mode and the DTR signal is therefore not set.

The modem handshake must be switched off and the DTR line ignored. The line baud rate must not be higher than that of the SPA-BUS.

Modem settings:

DTR = ignored

Handshake=off

Consult the manual supplied with your modem for the modem parameters.

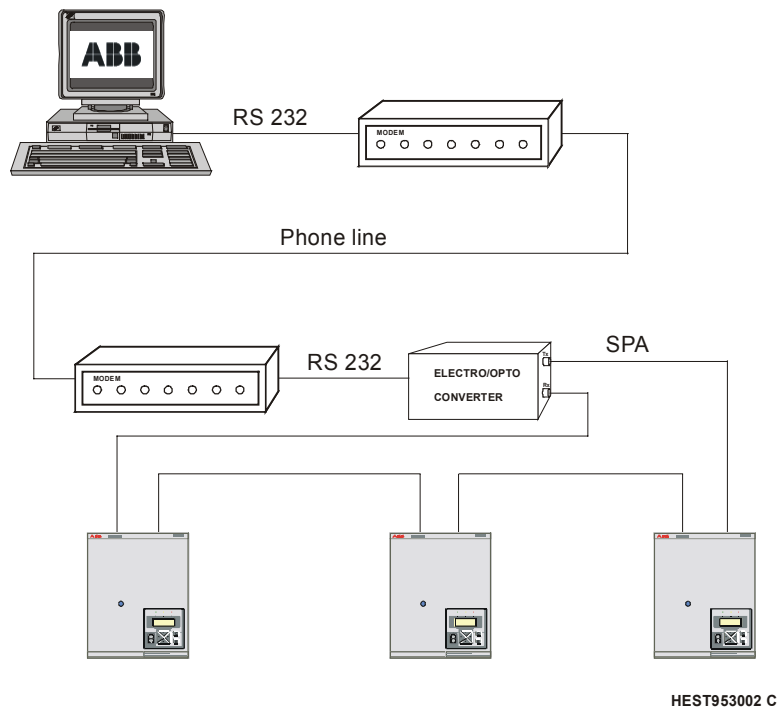


Fig. 5.73 Remote HMI connected via a modem to the electro-optical converter

5.12.5. **Configuring a remote HMI connected to an SRIO**

5.12.5.1. **Remote HMI connected directly to the SRIO**

COMT = SRIO.

A bus master Type SRIO 500/1000M is used to synchronise the device clocks once a second. Providing the remote HMI is on-line and time synchronisation is enabled, the SRIO clock is synchronised to the PC clock.

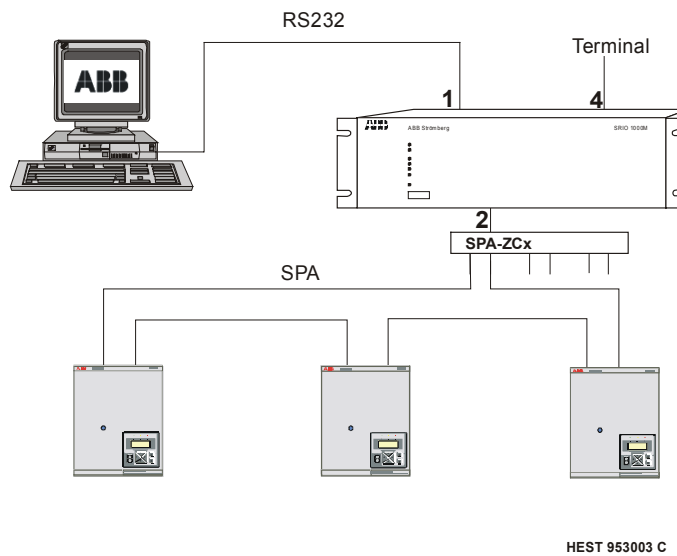


Fig. 5.74 Remote HMI connected directly to the SRIO

5.12.5.2. *Remote HMI connected via a modem to the SRIO*

COMT = RDM.

The control of several devices via an SRIO can be expanded using a modem connection.

SRIO only provides a full hardware handshake for BUS 1.

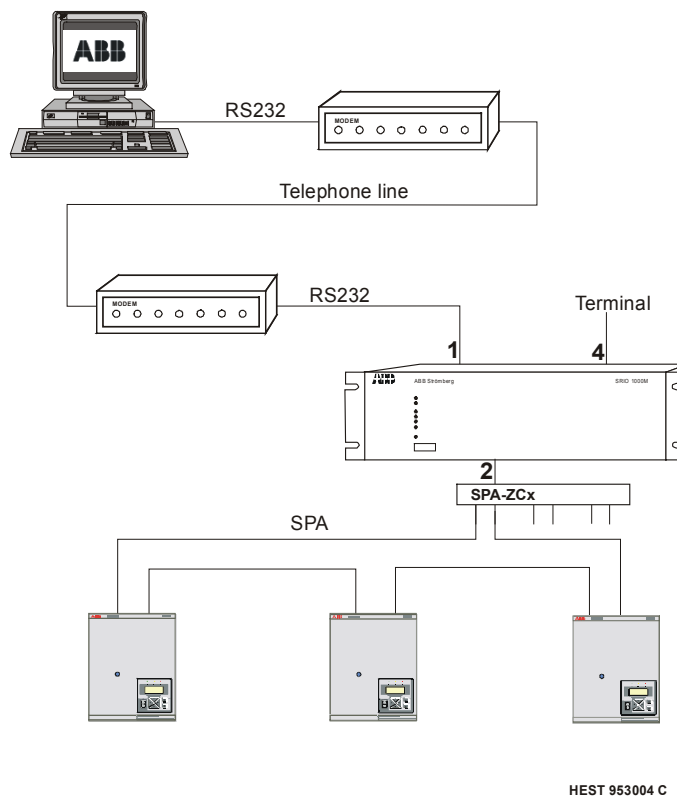


Fig. 5.75 Remote HMI connected via a modem to the SRIO

5.12.6. **Local control of a device via the interface at the front**

All the HMI menu items are available in this operating mode. It is also possible to read and change passwords and assign access rights.

5.12.6.1. **Remote HMI right of access to device functions**

Provision is made for restricting access by the remote HMI. After successively selecting the menu items 'Edit hardware functions', 'Edit special functions' and 'OBI function', the following menu items are accessible for COMT=TC57:

RemoteMMI	enabled / disabled Determines access in general by the remote HMI via the SPA-BUS.
TimeSync	enabled / disabled Determines time synchronisation by the remote HMI.
SPAComm	enabled / disabled Determines access to the SPA communication window in the remote HMI.
Testfunction	enabled / disabled Determines access to the test functions in the remote HMI.
Downloading	enabled / disabled Determines access by the remote HMI to the download function for parameter settings. When downloading is disabled, changes to parameter settings can still be made, but only saved in a file.

5.12.7. **Control via an SPA-BUS or an SRIO**

The slave control window appears after the program starts and a check is made to determine whether the corresponding device is ready.

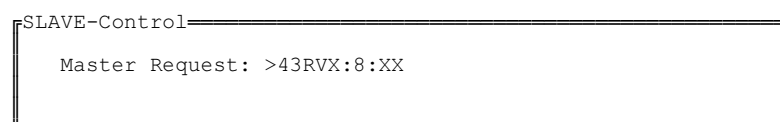


Fig. 5.76 Master request

Providing the selected device is ready, it replies by sending its device address and type.

```
Slave-Control
Master Request: >43RVX:8:XX
Slave Response: <43D:REG316:1C
```

Fig. 5.77 Slave response

The device's response is checked and the HMI start window opens if it is correct.

```
SLAVE-Control
Master Request: >43RVX:8:XX
Slave Response : ERROR
```

Fig. 5.78 ERROR

If a valid response is not received within 15 seconds, the message 'ERROR' is displayed and the program proposes the off-line mode after a further 5 seconds.

5.12.7.1. **HMI start-up**

The exchange of data via the modem, SRIO etc., is much slower than when directly connected to the front of the device. To avoid having to read all the device data every time the HMI is started, a file called ReXX.dat is created and a reference written in the device every time device data are changed and saved. XX is the device's SPA address. After the HMI is started, it reads the reference in the device and searches for the ReXX.dat file in the working directory with the same reference. Providing the file is found, the HMI uses the data in the file and does not have to read the data in the device. The connection is thus established much more quickly.

As the device data are not normally saved via the remote HMI, the ReXX.dat files have to be expressly copied to the station directory after everything has been finally configured.

As soon as the device data have been loaded, the HMI displays the main menu, to which the menu item 'SPAComm' has been added.

5.12.7.2. SPAComm window

The SPAComm window provides facility for sending SPA-BUS commands to the device specifically selected and also to all the other devices in the same SPA-BUS loop.

Details of the SPA syntax are to be found in 'SPA-BUS COMMUNICATION PROTOCOL V2.4', 34 SPACOM 2EN1C.

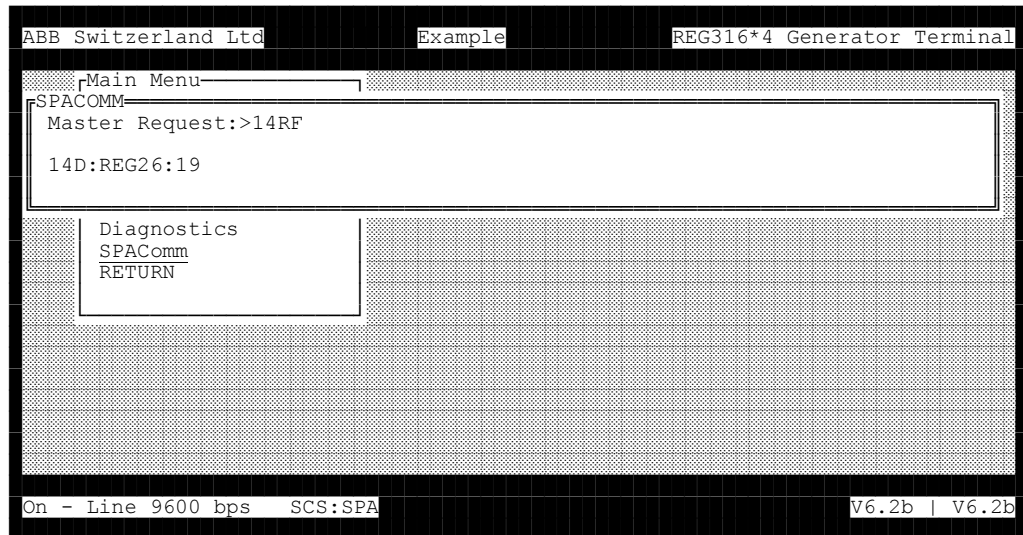


Fig. 5.79 SPAComm window

To enter a command, press <ENTER> and enter it on the REQUEST line. Press <ENTER> again to terminate the input. Press <ESC> to quit the input mode without making an entry.

Entering EXIT and pressing <ENTER> closes the window.

It is not necessary to enter the default address.

By entering the character 'F' before a command, all the commands entered before it are transferred in a continuous string until a command not preceded by an 'F' is encountered.

5.12.8. SRIO settings

Refer to 'Programming manual SRIO 1000M and 500M' having the No. '34 SRIO 1000M 2 EN1 B' for how to program the SRIO 500/1000M.

SRIO 500/1000M must be configured as follows:

BUS_MODE:

BUS	Code	MODE
1	9	Saco 100M Slave mode
2	6	Fast SPA Master mode
3	0	Null mode
4	10	Terminal mode

BUS-Setup:

setup	BUS 1	BUS 2	BUS 4
baud	9600	9600	9600
parity	2	2	0
stopbit	1	1	1
cts	1	0	0
dcd	1	0	0
aut.lf	1	0	1
timeout	60000	3000	0
resend	0	3	0

ANSI_SETUP must be set to 'half-duplex'; the other parameters in ANSI_SETUP are of no consequence.

After the new BUS modes have been saved (STORE F), the system has to be restarted.

The SRIO slave address must agree with the address in the file re-01.cfg (950). The SRIO address is set in SYSPAR P4.

A (dummy) data point must be entered in the SRIO data base for every device in the SPA-BUS loop.

5.13. Local display unit

5.13.1. Summary

The local display unit (LDU), i.e. local human/machine interface (HMI), is a simpler alternative to the HMI running on a PC and forms an integral part of an RE.316*4. It provides service personnel with facility for viewing statuses and events and reading measurements. The hierarchically structured menus give limited access to process and system data. The unit is operated with the aid of just a few pushbuttons. Three light-emitting diodes (LED's) indicate the status of the system independently of the menu being displayed.

5.13.2. Limitations

The local display unit forms an integral part of an RE.316*4 device and provides a number of facilities for service personnel.

Information about the process and the state of the device can be viewed on the LDU, but it is not possible to either change or copy device settings. The device can be restarted, however, by selecting the corresponding menu item.

5.13.3. General description

The LDU is primarily intended for service personnel so that they can obtain brief information on the status of the RE.316*4 device and the protected unit.

A general indication is provided by the three LED's and details can be read via the various menus on the LCD. It is neither possible to configure the functions of the LED's or the menu structure nor edit the texts of the different displays, however, the latter correspond to the texts on the HMI on the PC and vary to suit the configuration of the particular RE.316*4.

5.13.3.1. Mechanical assembly and front view

The LDU is fitted at the bottom right of the frontplate. The LED's that are familiar from older units are at the top left and the reset button is accessible through a small hole in the frontplate.

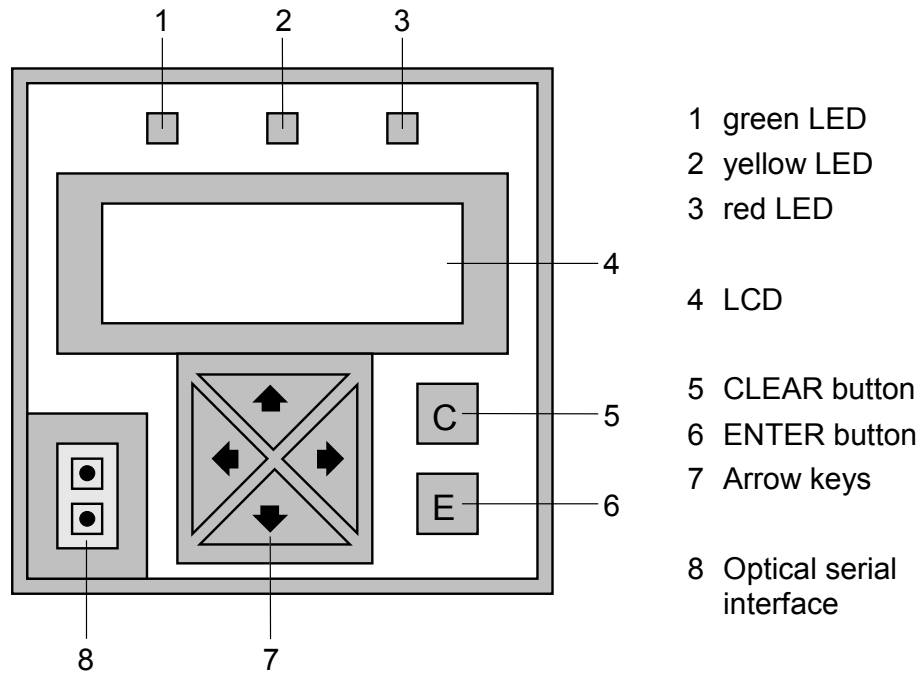


Fig. 5.80 Front view of the local display unit (LDU)

5.13.3.2. **Electrical connections**

The HMI running on the PC is connected to the device via the optical interface on the LDU. PC and device are thus electrically insulated.

A special cable has to be used to connect the PC that converts electrical into optical signals and vice versa.

5.13.3.3. **Password**

Password protection is unnecessary for the LDU.

5.13.3.4. **Passive operation**

The user communicates with the RE.316*4 via the LDU in a passive role, i.e. device and process data can be viewed, but none of the data or parameters displayed can be changed in any way. Changes can only be made using the HMI on the PC.

The only exception to this rule is the reset function which is accessed via the corresponding menu item.

5.13.3.5. *LDU keypad*

The LDU keypad comprises six pushbuttons which are only ever pressed one at a time to perform the various control functions. Pressing a second button has no effect as long as the first button remains pressed. The function of the second button is only executed after the first one has been released.

There are two ways of navigating within the menu structure:

- Step-by-step: A button is pressed to perform a first operation and then a second button to perform the next operation and so on.
- Holding a button depressed: An operation can be repeated by holding the corresponding button depressed longer than the normal response time (fixed setting of 0.5 seconds).

The pushbuttons perform the following functions:

“E”

executes an operation (ENTER function), i.e. a menu item is executed which in the case of the LDU means moving down a level in the menu structure. The button has no function on the lowest level in the menu structure.

“C”

corresponds to the ESCAPE button on a PC. It is used to close an active menu. It returns the user from every menu item to the entry menu.

“↑”, “↓”

The upwards and downwards arrow keys are used either for selecting a desired menu item at the same level in the menu structure or for selecting a value to be viewed in the active menu (e.g. different events in the event list). These keys are represented in the text by the symbols “^” and “v”.

“→”

The right arrow key performs the same function as the “E” button. It is represented in the text by the symbol “>”.

“←”

The left arrow key closes the active menu and returns the user to the next level up in the menu structure. It is represented in the text by the symbol “<”.

5.13.4. The three status LED's

5.13.4.1. General

A RE.316*4 unit can be in different statuses, the most important of which are indicated by the three LED's on the LDU. They have the colours green, yellow and red and each can be either off, flashing or continuously lit.

In the diagrams below, the LED's are represented by squares. An empty square indicates that the respective LED is off, a black square that it is lit and a diagonally half black, half empty square that it is flashing.

■ = lit ▤ = flashing □ = off

The three LED's are described on the first line of the entry menu.

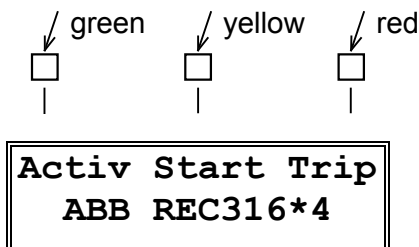


Fig. 5.81 LED markings

5.13.4.2. Starting RE.316*4

The yellow and green LED's flash throughout the initialisation procedure to indicate that the device is not operational. The green LED in the row of LED's at the top left of the device flashes as well.

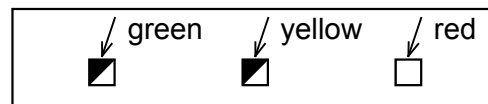


Fig. 5.82 LED statuses when starting the RE.316*4

5.13.4.3. No active protection functions

If none of the protection functions is active (none programmed or all blocked), the initialisation procedure is completed and no errors were found, the device is not standing by. In this status, the green LED on the LDU flashes and the green LED in the row of LED's at the top left of the device lights continuously.

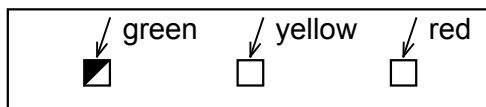


Fig. 5.83 LED statuses when none of the protection functions is active

5.13.4.4. Normal operation

When the device is active and there are no errors or faults, the green, yellow and red LED's are all off.

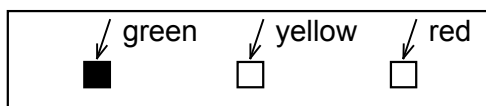


Fig. 5.84 LED statuses in normal operation

5.13.4.5. Pick-up of a protection function (General start)

The pick-up of at least one protection function (General start signal active) is indicated by the fact that the green and yellow LED's light. The yellow LED remains lit after the general start has reset and only extinguishes after it has been actively reset (see Section 5.13.8.6.).

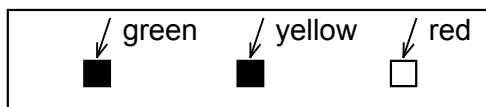


Fig. 5.85 LED statuses for a general start

5.13.4.6. Protection function trip (General Trip)

The trip of at least one protection function (General Trip signal active) is indicated by the fact that the green, yellow and red LED's light. The yellow and red LED's remain lit after the general

trip has reset and only extinguish after they have been actively reset (see Section 5.13.8.6).

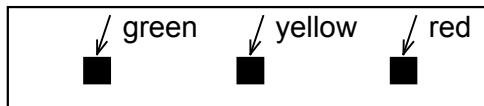


Fig. 5.86 LED statuses for a general trip

5.13.4.7. **Fatal device error**

All three LED's flash when a serious error is detected that disables the device.

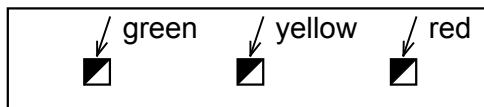


Fig. 5.87 LED statuses for a fatal error

5.13.5. **Text display (LCD)**

5.13.5.1. **General**

Upper and lower case characters are displayed and all the characters needed for German, English and French are installed.

The display of variables (measurements, binary signals etc.) is refreshed at intervals of approximately a second.

5.13.5.2. **Language**

The LDU supports a number of languages, however, the language used by the HMI on the PC during commissioning is the language set on the LDU and cannot be changed during normal operation. The LDU language is programmed automatically to that of the HMI on the PC. Care must therefore be taken when changing parameter settings that the HMI on the PC is operating in the desired language.

5.13.5.3. **Interdependencies**

The menus are not dependent on changes in the process or the status of the device, i.e. a menu text remains on the display until the user selects a different menu item. The only exceptions are the start-up procedure and downloading parameter settings from

the PC to the device during which time the entry menu is displayed. No menus can be selected while text is being downloaded from the PC to the RE.316*4.

For measuring values the display is refreshed approximately every second.

5.13.5.4. Configuration

The menu structure described below is largely fixed and nothing needs to be configured. It is neither possible to add a menu item nor change a menu text. Certain menu items and texts vary with system configuration and are therefore indirectly variable. For example, if an additional protection function is configured, the menu items needed to view its measurements are automatically inserted. The signal texts are copied from the HMI on the PC.

5.13.6. Menu structure

The information displayed on the LDU is accessed via a menu structure with five levels. An overview of the menu structure is given in the diagram below. The user can only move from one menu item to another in a vertical direction, i.e. it is impossible to go directly from one menu item to another on the same level, but in a different branch.

Every menu item consists of two parts:

- Header (first line on the LCD): The header shows the name of the active menu. A menu name starts and finishes with a hyphen to distinguish it from the menu items available for selection. The header with the menu name is always displayed even if there are more than three items in the menu and it is necessary to scroll through them.
- Menu lines: The menu items available for selection are displayed on lines two, three and four. Note: An arrow pointing downwards at the end of line 4 means that the menu contains more menu items below the one displayed. These can be viewed by pressing the arrow key "v". An arrow pointing upwards at the end of line 2 means that the menu contains more menu items above the one displayed. These can be viewed by pressing the arrow key "^".

ENTRY MENU

MAIN MENU

MEASURANDS

AD-Channels

Nominal values

Prim.Values

Sec.Values

Function Measurands

1st. Function

:

n. Function

Binary Signals

Input Signals

RBI Inputs

ITL Inputs

Signal Relays

Trip Relays

RBO Outputs

ITL Outputs

Analog Signals

Input signals

Output signals

EVENT LIST

USER'S GUIDE

DISTURBANCE RECORDER

DIAGNOSIS MENU

Diagnosis Info

IBB Status Info

Process Bus Info

LED Description

RESET MENU

LED Reset

Latch Reset

Clear Eventlist

System Restart

Fig. 5.88 Menu structure

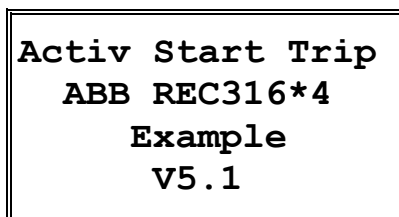
5.13.7. **Entry menu**

The entry menu is at the top of the menu structure. It is displayed every time the system is started or after pressing the “C” button to exit a menu item and does not have a header, but simply four lines of text. The user accesses the main menu from the entry menu by pressing either button “E” or “>”.

The entry menu comprises two parts:

- The first line states the significance of the three LED's:
green LED: “Active”
yellow LED: “Start”
red LED: “Trip”.
- Lines two to four show the name of the device, the system name assigned to it and the software version. The main menu is accessed by pressing either the “E” or “>” button.

The entry menu always comprises four lines and the buttons “C”, “^” and “v” have no effect. There is nothing to select in this display. If the RE.316*4 has not been configured, “Local Display” appears on line 3, otherwise the name assigned to the device using the HMI on the PC. Fig. 5.89 shows a typical entry menu:



```
Activ Start Trip
  ABB REC316*4
    Example
      V5.1
```

Fig. 5.89 Entry menu

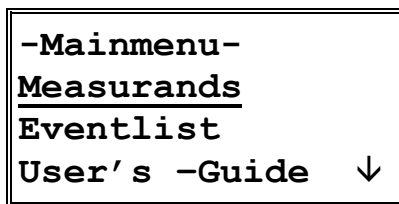
5.13.8. **Main menu**

The main menu lists the groups of submenus that can be selected to obtain more information on the device and the primary process. The name “Main Menu” is in the header and three of the submenus on the three lines below. Unless the submenus shown are at the top or the bottom of the list there is an arrow at the end of line four pointing downwards and/or at the end of line two pointing upwards to show in which direction the user can scroll to see the other menu items. The first of the menu items (line 2 of the display) is always underlined which means that it is selected. The list can be scrolled using the arrow keys “^” and

“v” so that a different menu item is moved to line 2 and is under-scored. One of the menu items is always underscored, i.e. is al-ways selected. The function of a selected menu item is executed by pressing either button “E” or “>”.

The main menu includes the following menu items:

- Measurands
- Event list
- User’s guide
- Disturbance recorder
- Diagnostic menu
- Reset menu.

A rectangular display box with a double border. Inside, the text is as follows: Line 1: -Mainmenu-; Line 2: Measurands; Line 3: Eventlist; Line 4: User's -Guide followed by a downward arrow symbol (↓) on the same line.

```
-Mainmenu-  
Measurands  
Eventlist  
User's -Guide ↓
```

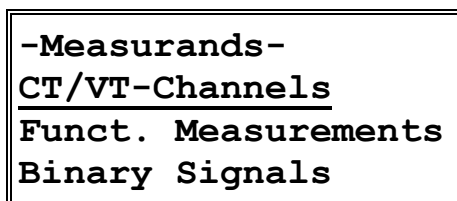
Fig. 5.90 Main menu

5.13.8.1. *Measurands*

The measurands menu lists all the menu items associated with measurements. The name “Measurands” is in the header and the available submenus on the three lines below.

The measurements menu includes the following menu items:

- AD-Channels
- Funct. measurands
- Binary signals
- Analogue signals.

A rectangular display box with a double border. Inside, the text is as follows: Line 1: -Measurands-; Line 2: CT/VT-Channels; Line 3: Funct. Measurements; Line 4: Binary Signals.

```
-Measurands-  
CT/VT-Channels  
Funct. Measurements  
Binary Signals
```

Fig. 5.91 Measurements menu

5.13.8.1.1. AD-Channels

This menu provides facility for choosing between displaying rated, primary or secondary values.

```

-CT/VT-Channels-
Nominal values
Prim.Values
Sec.Values
  
```

Fig. 5.92 AD-Channels

The three submenus all list the c.t. and v.t. input signals available for display. Their headers are “Rated values”, Primary values” and “Secondary values” respectively and the measurements are shown on the three lines below. You can scroll through the list using the “^” and “v” keys. The “E” and “>” have no effect, because this is the lowest level of this branch of the menu structure. An arrow at the end of line four pointing downwards and/or at the end of line two pointing upwards indicate in which direction the user can scroll to see the other values.

The values and text shown (units etc.) vary according to the configuration of the RE.316*4. Nine current or voltage input values can be listed and the phase-angle of the measured value in relation to the reference channel is given on each line.

```

-Nominal values-
3  0.865IN 120°↑
4  1.102UN  0°
5  1.021UN-120°↓
  
```

Fig. 5.93 Rated values

Frequency display and setting the reference channel

The tenth measurement is the frequency of the reference channel.

To change the reference channel, scroll to line 11 using the arrow key “v”. The reference channel is set on this line. Each time the arrow key “v” is pressed after reaching line 11 selects the next higher input as reference channel. After the ninth input, the selection cycles back to the first. Press the arrow key “^” to complete the selection of the last pre-selected input as reference channel and exit. Input 1 is the default reference channel when initially selecting this menu item.

```

-AD-Channels-
9  0.77IN-120°↑
10 51.11Hz
11 Ref.Channel 1

```

Fig. 5.94 C.t. and p.t. inputs and selection of reference channel

5.13.8.1.2. Load values

This menu lists all the configured functions. The name “Funct. measurands” is in the header and the configured functions on the three lines below.

There are fewer or more lines of load values depending on the protection functions that are configured. ‘No function’ is on the second line where no function has been configured.

```

-Funct.Measurand
1.Current-DT
2.U>High Voltage
3.Power ↓

```

Fig. 5.95 Menu for selecting load values

Load values display

The menu lists all the measurements by the selected function that can be viewed. The name of the function is in the header and its measurements on the three lines below. If there are more than three measurements, the entire list can be viewed using the arrow keys “^” and “v”. The buttons “E” and “>” have no effect, because this is the lowest level of this branch of the menu structure. Lines 2 to 4 are empty for functions that do not have measurements.

The values and text shown (units etc.) vary according to the function selected.

```

-10.UifPQ-
1  0.997 UN
2  4.014 IN
3 10.999 P(PN) ↓

```

Fig. 5.96 Measurements by the UifPQ function

5.13.8.1.3. **Binary signals**

The binary signals menu lists all the different types of binary signals that can be viewed. The name “Binary Signals” is in the header and the different types of binary signals on the three lines below.

The menu includes the following menu items:

- Input signals
- RBI inputs
- ITL inputs
- Signal relays
- Trip relays
- RBO outputs
- ITL outputs.

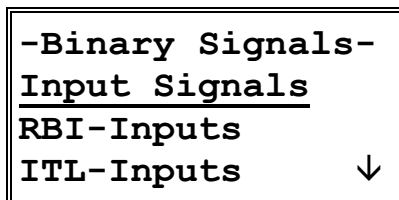


Fig. 5.97 Binary signals menu

Input signals, signalling relays and tripping relays

The selection and display of the binary inputs, signalling relays and tripping relays is very similar and therefore only the procedure for the binary inputs is explained as an example.

Selecting the menu item “Input signals” opens a submenu with the numbers of all input/output modules, the input signals of which can be viewed. The name “Input signals” is in the header and any binary input/output modules that are fitted are on the three lines below.

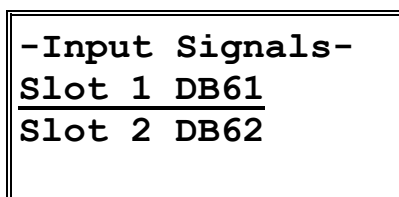


Fig. 5.98 Binary inputs

The module's binary values

The effective values, i.e. the statuses, of the inputs are displayed. The designation "Slot 1 DB6." is in the header and the values of the inputs are displayed on line 3. The buttons "E" and ">" have no effect, because this is the lowest level of this branch of the menu structure. As only a single line is needed, the arrow keys "v" and "^" are also ineffective. To make the statuses of the inputs easier to assimilate, a logical '0' is represented by a hyphen '-' and a logical '1' by an 'X'. The LSB is on the extreme left and the order is the same as on the HMI on the PC.

```
-Slot 1 DB61
-X-X---X
↑LSB
```

Fig. 5.99 Binary input statuses

RBI and ITL inputs and outputs

Since the selection and display of the RBI and ITL inputs and outputs is very similar, the procedure for the RBI inputs will be explained and applies for all the others.

When opened, the "RBI inputs" display shows the current statuses of the RBI inputs of the first module. If no input module is assigned to this number, all the inputs indicate a zero. The display can be switched from one module to the next using the arrow keys "v" and "^".

To make the statuses of the inputs easier to assimilate, a logical '0' is represented by a hyphen '-' and a logical '1' by an 'X'. The LSB is on the extreme left and the order is the same as on the HMI on the PC.

```
-RBI-Inputs-
1
-X-X---X-----
↑LSB
```

Fig. 5.100 RBI inputs

Analogue inputs and outputs

Since the selection and display of the analogue inputs and analogue outputs are very similar, the following example only illustrates the selection and presentation for analogue inputs.

The “Analogue Signals” menu provides a choice between inputs and outputs. The “Input Signals” menu shows the numbers of all the devices that have been configured to enable the one to be selected for which the input signals should be displayed.

```

-Analogue Signals
Input signals
Output signals
  
```

Fig. 5.101 Analogue signals

```

-Input signals
Device No.  9
Device No. 10
  
```

Fig. 5.102 Input signals

Displaying analogue variables

This menu lists all the measurements of the device selected which can be displayed. The device number is in the menu header and the measurements are listed below. The measurements in the list can be viewed using the “^” and “v” buttons. Since this is the lowest menu level in this branch, the buttons “E” and “>” have no effect.

```

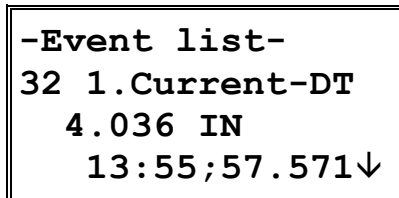
-Device No.  9-
1  14.01 mA
2   2.52 V
3 143.42 °      ↓
  
```

Fig. 5.103 Viewing the input variables of device No. 9

5.13.8.2. *Event list*

This menu item opens a list with the last 20 events together with the tripping values of the corresponding protection functions and also the special “LDU events” function. The name “Event List” is in the header and the latest event is displayed below it. The older events can be viewed using the arrow keys. The numbers of the events are the same on the LDU and the HMI on the PC. Note that an event cannot be wholly displayed because it needs 4 lines and only 3 are available. It is thus always necessary to use the arrow keys “v” and “^” to view all the information related to one event.

The text (function name and unit) is the same as that in the event list on the HMI on the PC.

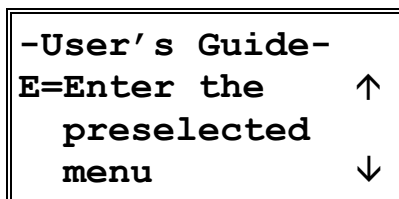


```
-Event list-  
32 1.Current-DT  
4.036 IN  
13:55;57.571↓
```

Fig. 5.104 Event list

5.13.8.3. *User's guide*

This menu item gives access to brief instructions on how to use the LDU, e.g. the functions of the buttons.

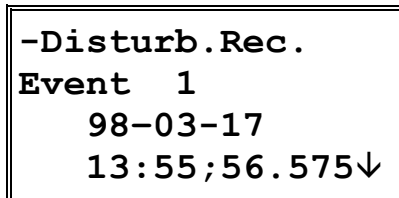


```
-User's Guide-  
E=Enter the      ↑  
preselected  
menu             ↓
```

Fig. 5.105 User's guide

5.13.8.4. **Disturbance recorder list**

The menu item 'Disturbance recorder' opens a list with the data stored in the disturbance recorder. Where there are several entries, they can all be viewed using the arrow keys "v" and "Λ". The oldest record is displayed first when the list is opened. '0 events' is displayed if no disturbance recorder data is stored.



```
-Disturb.Rec.  
Event 1  
    98-03-17  
    13:55;56.575↓
```

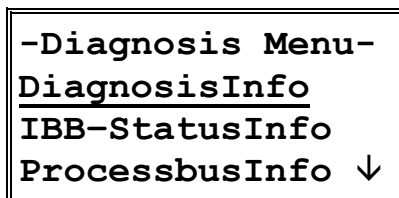
Fig. 5.106 List of disturbance records

5.13.8.5. **Diagnostics menu**

This menu item gives access to the different kinds of diagnostic information that can be viewed. The name "Diagnosis Menu" is in the header and the list of menu items below.

The following kinds of information are available for selection:

- DiagnosisInfo
- IBB StatusInfo
- ProcessbusInfo
- LED descriptions.



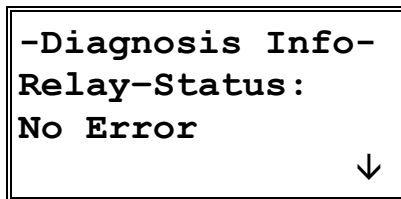
```
-Diagnosis Menu-  
DiagnosisInfo  
IBB-StatusInfo  
ProcessbusInfo ↓
```

Fig. 5.107 Diagnostics

5.13.8.5.1. **Diagnosis information**

Selecting this menu item displays the diagnostic information in a similar form to the HMI on the PC. The name "DiagnosisInfo" is in the header and the diagnostic information is displayed on the three lines below. The entire list can be viewed using the arrow keys "Λ" and "v".

The status of the device is at the top of the list followed by the time when the software was downloaded, the time when settings were last changed and finally the statuses of an FUP programs that are loaded.



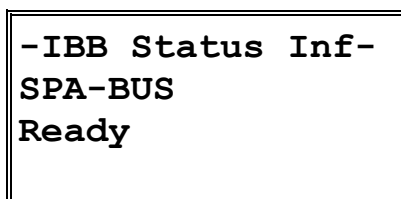
```
-Diagnosis Info-  
Relay-Status:  
No Error  
↓
```

Fig. 5.108 General status information

5.13.8.5.2. **IBB status information**

Select this menu item to view information on the interbay bus (LON, MVB etc.). The name “IBB StatusInfo” is in the header followed by three lines with the IBB diagnostic information. You can scroll through the list using the “^” and “v” keys:

- The interbay bus connected (SPA, VDEW, LON or MVB) is shown on the second line together with the information ‘Ready’ (operational), ‘No response’ (if no telegrams are transferred, but the device is ready) or ‘Inactive’ (this appears, for example, when the corresponding interface is not fitted). The HMI on the PC must be used to obtain more detailed information.
- Station number and the time
- Neuron chip ID (LON only)



```
-IBB Status Inf-  
SPA-BUS  
Ready
```

Fig. 5.109 Interbay bus information

5.13.8.5.3. **Process bus information**

Here information about the process bus can be viewed in a similar manner to information about the station bus. The name “ProcessbusInfo” is in the header and the operating mode, the status of the PC card, the PC card type, the software version and the PC card counter appear below.

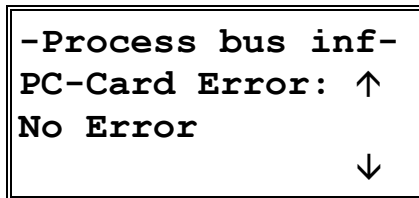


Fig. 5.110 Information about the process bus (PC card error)

5.13.8.5.4. LED descriptions

The significance of the LED's at the top left of the frontplate can be viewed on the LDU by selecting this menu item.

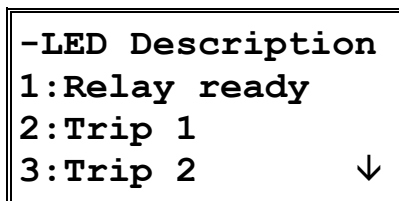


Fig. 5.111 Significance of the LED's

Entering the LED function texts

The texts describing the significance of the LED's displayed on the LDU is entered via the HMI. The corresponding dialogue is accessed in the HMI on the PC by selecting 'Editor' / 'Edit hardware functions' / 'Edit signal outputs' and then the menu item 'Edit LED description. The procedure is the same as for the existing menu item 'Edit signal comment'.

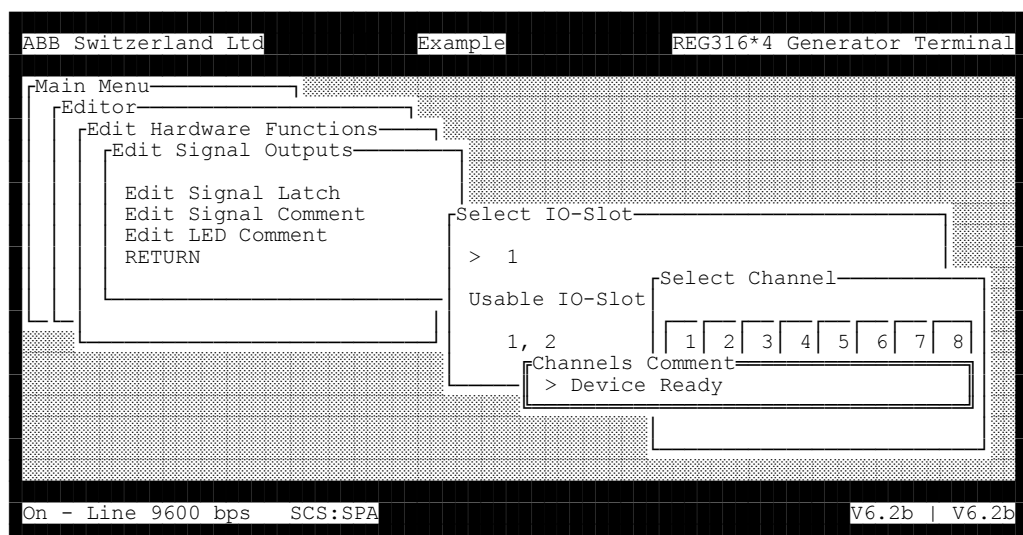


Fig. 5.112 Entering a comment to describe a LED

The text entered is then downloaded to the RE.316*4 together with all the other data and can be viewed on the LDU.

5.13.8.6. **RESET menu**

This menu item opens a submenu that enables the user to delete different kinds of obsolete information or execute a warm start.

The menu includes the following four items:

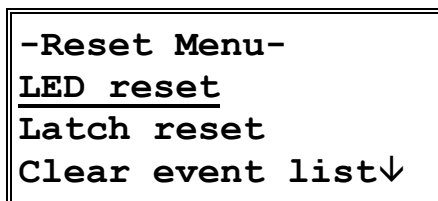
- LED reset
- Latch reset
- Clear event list
- System restart.

The first menu item (LED reset) resets the two LED's 'Start' and 'Trip' on the front of the LDU.

The second menu item (Latch reset) resets all the latched LED's on the frontplate and all latched outputs.

The third menu item deletes the event list (only the one in the LDU and not the one in the PC).

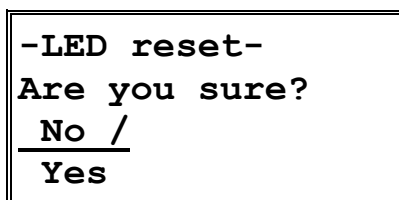
The fourth menu item restarts the RE.316*4.



```
-Reset Menu-  
LED reset  
Latch reset  
Clear event list↓
```

Fig. 5.113 Reset menu

Upon selecting any of the above menu items, a dialogue appears requesting confirmation that you wish to execute the action 'Are you sure? Yes/No?'. The default response is 'No'. Select the appropriate response using the arrow keys "v" and "^" (in the same way as selecting a menu item) and execute by pressing "E" or ">".



```
-LED reset-  
Are you sure?  
No /  
Yes
```

Fig. 5.114 Are you sure?

5.13.9. Automatic display

5.13.9.1. General description

In addition to the manual procedure for selecting information for display, there is an automatic display routine that cyclically presents the available information. It runs whenever the PC is not connected and no buttons on the LDU are being pressed.

5.13.9.2. Automatic display sequence

After the system has been started, the entry menu appears. The automatic display cycle starts providing no buttons are pressed for a minute. A particular menu item (e.g. measurements) that has been selected manually remains on the display even if no buttons are pressed. The automatic display routine only starts from the entry menu providing no buttons are pressed and the PC with the HMI is not connected.

5.13.9.3. Stopping the automatic display routine

Stop the automatic display routine by pressing the button "C" (clear button). The entry menu appears and you can navigate through the menu structure in the normal way.

5.13.9.4. Automatic display cycle

The sequence of the automatic display cycle is as follows:

- Entry menu
- Measurement(s) of 1st. function
- Measurement(s) of 2nd. function
-
- Measurement(s) of last function
- Event list.

In each case, the information remains visible for about 15 seconds before switching to the next block of information. Where a function generates more than three measurements, all of them are shown in sequence before the display proceeds to the next function. The same applies when there are more than three events in the event list.

5.14. SMS010

5.14.1. *Installing SMS010 and 'Reporting' and 'SM/RE.316*4' for SMS010*

Installation sequence

1. Install SMS010.
2. Install 'Reporting' for SMS010.
3. Install 'RE.316*4' for SMS010.

SMS010 must be installed before attempting to install 'Reporting' and 'RE.316*4', otherwise they cannot be installed.

The SMS010 installation program is on SMS Base, Disc 1. The installation program creates all the directories needed and copies all the files to the hard disc. Program examples are to be found on Disc 2.

The 'Reporting' installation program is on Reporting Program, Disc 1. The installation program creates all the directories needed and copies all the files to the hard disc. Program examples are to be found on Disc 2.

The 'HMI RE-316*4 for SMS010' installation program is on SM/RE.316, Disc 1. The installation program creates all the directories needed and copies all the files to the hard disc. If SMS010 is not in the default directory, a request appears to enter the directory where SMS010 is located. The program must be installed from a floppy drive.

The following files are copied to the hard disc:

- RE_316#4.EXE is copied to the directory \SMS010\Base\Support\, providing \SMS010\Base was the directory created when installing SMS010.
- The directory REC316 is created in \SMS010\Base\Modules.
- Files Rec316.CNF, Rec316.DEF and Rec316.SUP are copied to the directory \SMS010\Base\Modules\REC316.
- The file devices in directory \SMS010\Base\Modules are updated.

5.14.2. SMS010 Editor

5.14.2.1. Main menu

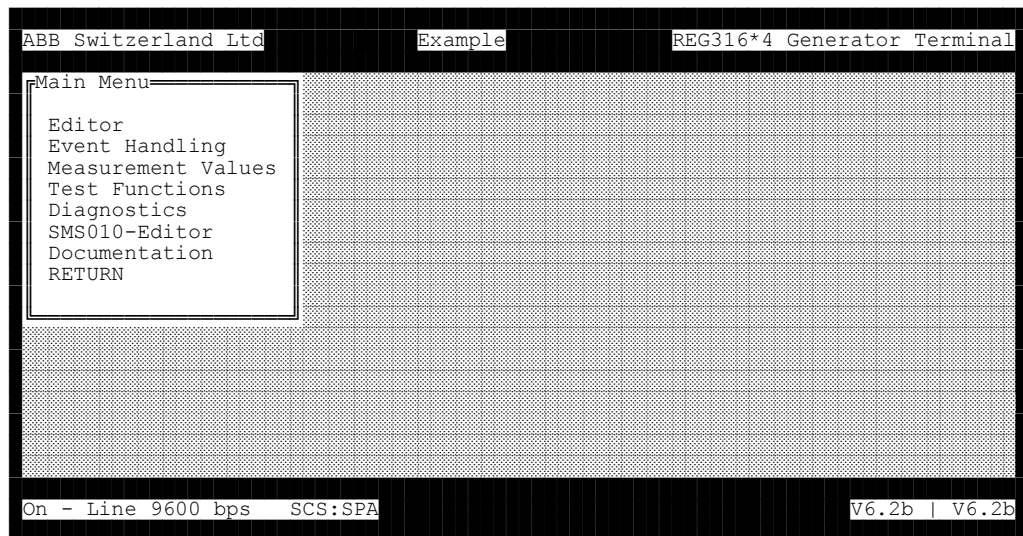


Fig. 5.115 Main menu

The menu item 'SMS010 editor' is added to the main menu when installing SMS010.

5.14.3. Sub-menu 'SMS010 editor'

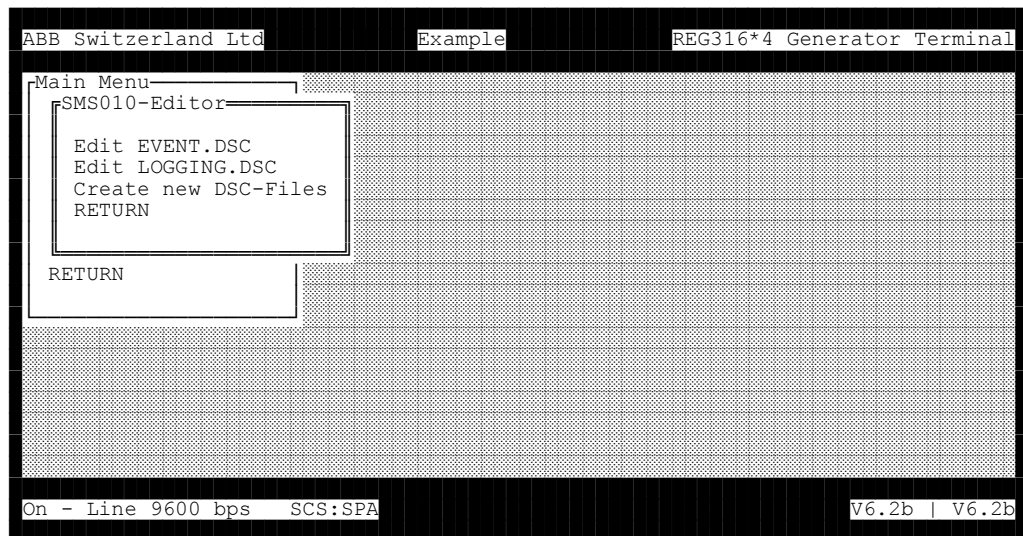


Fig. 5.116 SMS010 editor

The menu items in the 'SMS010 editor' sub-menu are used for creating and processing the files needed for integrating SMS010. Concerned are the 'Reporting' files EVENT.DSC, LOGGING.DSC and CHANNEL.DSC.

The menu items perform the following:

- Edit Event.dsc ⇒ for processing the file Event.DSC.
- Edit Logging.dsc ⇒ for processing the file Logging.DSC.
- Create New Dsc Files ⇒ for creating and configuring the files needed for 'Reporting' in the set of device parameter settings.

(In the off-line mode, a parameter file must be downloaded first using the editor's 'Load from file' function, since the 'Create new DSC files' function requires the currently active set of parameter settings.)

5.14.4. Descriptions of the various menu items

5.14.4.1. Menu item 'Edit Event. Dsc' for processing Event.DSC

ABB Switzerland Ltd

Example

REG316*4 Generator Terminal

SMS Edit

Relay address = 45

CHANNEL = 21

Page 19 of 28

45.021 Frequency

Code	Description		Report	Alarm	Audible	Reset
1	Blocked (U<)	ON	No	No	Yes	Yes
2	Blocked (U<)	OFF	Report	Yes	No	No
3	Trip	ON	Report	Yes	No	No
4	Trip	OFF	Report	Yes	No	No
5	Start	ON	Report	Yes	No	No
6	Start	OFF	Report	Yes	No	No

On - Line 9600 bps

SCS:SPA

V6.2b | V6.2b

Fig. 5.117 A typical page of the Event.DSC file.

Default settings:

- Report = Report
- Alarm = Yes
- Audible = No
- Reset = NO.

The number displayed for 'Relay address' is the slave address set for the relay and the one for 'Channel' the function number in the parameter list. The function type is also shown in the header.

- Code = Event number
- Description = Event designation
- Report = An occurrence of an event is only listed in the SMS010 report, if 'Report' is specified in this column.
- Alarm = Determines whether an alarm appears in the list or not.
- Audible = 'Yes' in this column causes the acoustic alarm to be given as well.
- Reset = Reset function (Yes/No).

The above settings can be changed using the space bar once they have been selected (Report/No. or Yes/No). None of the other settings can be changed.

Refer to the Section 'Reporting' in the SMS010 manual for a detailed explanation of the settings.

Keys:

- Page Up ⇒ previous page
- Page Down ⇒ next page
- Arrow key ↑ ⇒ one line up
- Arrow key ↓ ⇒ one line down
- Arrow key → ⇒ moves the cursor to the right
- Arrow key ← ⇒ moves the cursor to the left
- Space bar ⇒ for editing settings
- F1 ⇒ help
- ESC ⇒ for terminating the program. If changes were made, you are requested to confirm that they should be saved.

5.14.4.2. Menu item 'Edit Logging. Dsc' for processing Logging.DSC

ABB Switzerland Ltd

Example

REG316*4 Generator Terminal

Logging Edit

Page 1 of 2

Code	Addr	Parameter description		Show logging
14V1	45	Value of Addr. 45 Current-DT	IN	Yes
15V1	45	Value of Addr. 45 Current-DT	IN	No
17V1	45	Value of Addr. 45 UIfPQ	UN	No
17V2	45	Value of Addr. 45 UIfPQ	IN	No
17V3	45	Value of Addr. 45 UIfPQ	P (PN)	No
17V4	45	Value of Addr. 45 UIfPQ	Q (PN)	No
17V5	45	Value of Addr. 45 UIfPQ	Hz	No
18V1	45	Value of Addr. 45 Frequency	Hz	No
18V2	45	Value of Addr. 45 Frequency	UN	No
20V1	45	Value of Addr. 45 Delay	s	No
21V1	45	Value of Addr. 45 Frequency	Hz	No
21V2	45	Value of Addr. 45 Frequency	UN	No
22V1	45	Value of Addr. 45 Distance	[refLength]	No
22V2	45	Value of Addr. 45 Distance	Z (RE)	No
22V3	45	Value of Addr. 45 Distance	Z (RE)	No

On - Line 9600 bps

SCS:SPA

V6.2b | V6.2b

Fig. 5.118 A typical page in a logging file

After creating the Logging.dsc file, all the parameters are at the default setting 'No' in the 'Show Logging' column.

Meanings of the columns:

- Code = Number of the measured variable.
- Addr = Relay slave address.
- Parameter description = Description of the measured variable. This description also appears in the logging window of the SMS010 report.
- Show logging = Only measured variables with 'Yes' in this column appear in the SMS010 report.

The 'Show logging' parameter can be changed using the space bar once they have been selected (Yes/No). None of the other settings can be changed. The 'Reporting' function' can list a maximum of 16 measured variables.

Refer to the Section 'Reporting' in the SMS010 manual for a detailed explanation of the settings.

Keys:

- Page Up ⇒ previous page.
- Page Down ⇒ next page.
- Arrow key ↑ ⇒ one line up.
- Arrow key ↓ ⇒ one line down.
- Space bar ⇒ for editing settings.
- F1 ⇒ help.
- ESC ⇒ for terminating the program. If changes were made, you are requested to confirm that they should be saved.

5.14.4.3. Menu item 'Create New DSC Files'

This menu item is for creating the files needed from the parameter list of the particular device the first time the HMI is started. It is also needed every time the device parameter settings are changed.

In the off-line mode, a parameter file must be downloaded first using the editor's 'Load from file' function, since the 'Create new DSC files' function requires the currently active set of parameter settings.

The following files are created:

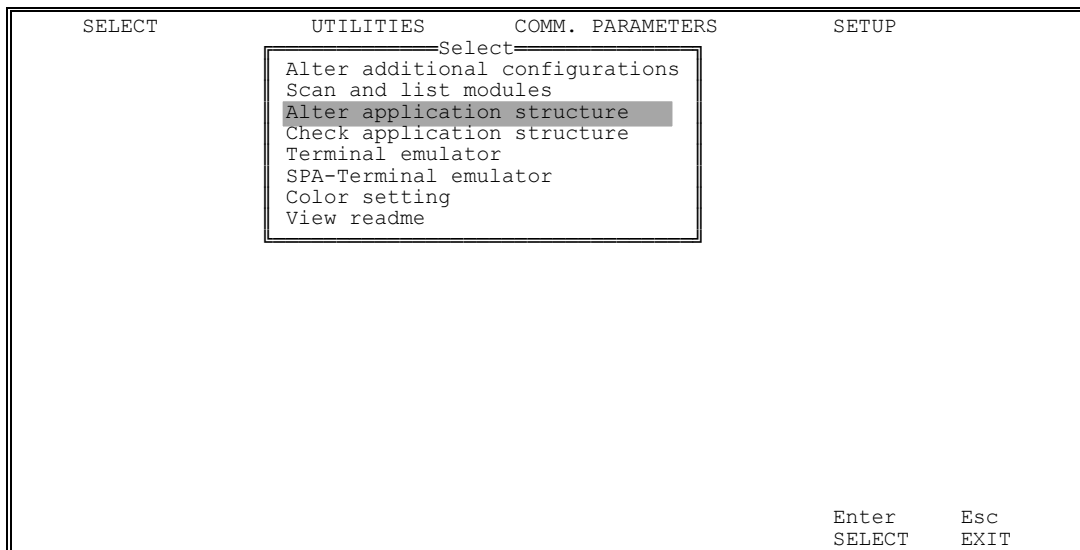
- Event.DSC ⇒ event handling file for 'Reporting'
- Logging.DSC ⇒ logging window file for 'Reporting'
- Channel.DSC ⇒ file with the function designations
- Functyp.DSC ⇒ required for updating files.

5.14.5. **Creating a station after installing SMS010**

When SMS is started for the first time, a message is displayed to the effect that the file 'Spacom.CNF' does not exist and the application structure is invalid.

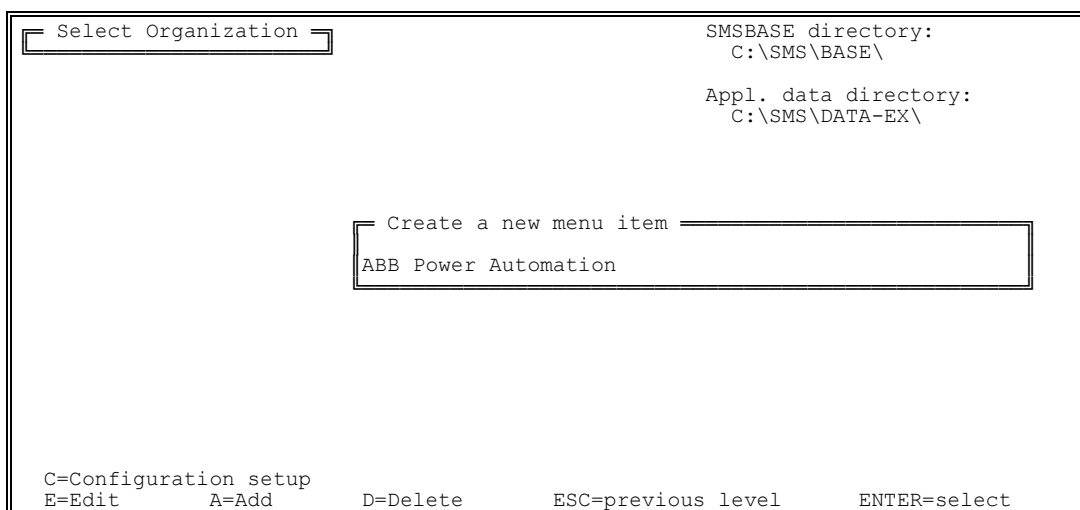
5.14.5.1. **Creating the application structure**

- Select *Alter application structure* from the *Utilities* menu to create a new application structure. There are five levels.



- **Level 1:**

A name for an organisation can be entered after entering 'a' (= add) in *Select organisation*.



- **Level 2:**

The next level and the *Select station* window are reached by pressing <Enter>. Press 'a' to enter a station name.

Select Organization ABB Po		Select Station	SMSBASE directory: C:\SMS\BASE\ Appl. data directory: C:\SMS\DATA-EX\ Create a new menu item ABB Baden
Organiz: ABB Power Automation Ltd			
E=Edit A=Add D=Delete ESC=previous level ENTER=select			

- **Level 3:**

The next level and the *Select object/bay* window are reached by pressing <Enter>. Press 'a' to enter a bay name. The Spin.CNF file is also created at this level by entering 'c' (*Create communications parameters*). Provision is also made at this level for changing the SPA protocol to SRIO.

Select Organization ABB Po		Select Station ABB Ba	Select Object/Bay	SMSBASE directory: C:\SMS\BASE\ Appl. data directory: C:\SMS\DATA-EX\ Create a new menu item NTP-2 REC316 45
Organiz: ABB Power Automation Ltd Station: ABB Baden				
C=Create communication parameters E=Edit A=Add D=Delete ESC=previous level ENTER=select				

- Creating the Spin.CNF file after entering 'c'.

Select Organization ABB Po Select Station ABB Ba Select Object/Bay NTP-2 REC316 45	SMSBASE directory: C:\SMS\BASE\ Appl. data directory: C:\SMS\DATA-EX\
Edit communication parameters	
Phone no: 161707 Connection: Direct Serial port: COM1 Protocol: SPA Baud rate: 9600 Parity: EVEN Data bits: 7	161707 Direct COM1 SRIO 9600 EVEN 7
C=Create communication parameters SPACE=next value ESC=quit ENTER=save	

- **Level 4:**

The next level and the *Select unit* window are reached by pressing <Enter>. Press 'a' to open the selection window. Select for example *REC 316* from this menu. Then select *Report station* to if you wish to create one.

Select Organization ABB Po Select Station ABB Ba Select Object/Bay NTP-2 REC316 45	SMSBASE directory: C:\SMS\BASE\ Appl. data directory: C:\SMS\DATA-EX\
A Manual Entry MODEM OTHER REC316 REPORT STATION	
Organiz: ABB Power Automation Ltd Station: ABB Baden Obj/Bay: NTP-2 REC316 45	
C=Create communication parameters ESC=quit ENTER=select	

- **Level 5:**

The next level, the *Select module/part of unit* window and the data input window *Setting Spacom slave address* are reached by pressing <Enter>. Now enter the SPA address for the device.

Select Organization	SMSBASE directory:
ABB Po	C:\SMS\BASE\
Select Station	
ABB Ba	
Select Object/Bay	
NTP-2	
Select Unit	a directory:
REC31	
Select Module/Part of Unit	
REC316 REC316	Control & Protection Terminal

Organiz: ABB Power Automation Ltd
 Station: ABB Baden
 Obj/Bay: NTP-2 REC316 45
 Unit: REC316 C Control & Protection Terminal

C=Create communication parameters S=Show transducer file
 E=Edit A=Add D=Delete ESC=previous level ENTER=select

- **Entering the address.**

Select Organization	SMSBASE directory:
ABB Po	C:\SMS\BASE\
Select Station	
ABB Ba	
Select Object/Bay	
NTP-2	
Select Unit	a directory:
REC31	
Select Module/Part of Unit	
REC316 REC316	Control & Protection Terminal

Setting SPACOM slave address
 The module address is: 001
 New address: 045

Organiz: ABB Power Automation Ltd
 Station: ABB Baden
 Obj/Bay: NTP-2 REC316 45
 Unit: REC316 C Control & Protection Terminal
 Mod/Part: REC316 REC316 Control & Protection Terminal

C=Create communication parameters S=Show transducer file
 E=Edit A=Add D=Delete ESC=previous level ENTER=select

If your wish to add further stations, return to the corresponding level. For example, to insert another device, repeat all steps from level 3.

5.14.5.2. Updating the Spin.CNF file

- Select *Edit communication parameter file* from the *Comm parameters* menu.

```

SELECT          UTILITIES          COMM. PARAMETERS          SETUP
                                     -----Select-----
                                     Edit communication parameter file
                                     Print communication parameter file

```

Enter Esc
 SELECT EXIT

- Select the desired station and respond with ‘Yes’ to the question ‘Continue with this file?’.

```

SELECT          UTILITIES      COMM. PARAMETERS      SETUP
                                Select
                                Edit communication parameter file
                                Print communication parameter file
Organiz         Station         Obj/Bay         Unit
ABB Power Automation ABB Baden

```

- Select '*SRIO*' from the *Protocol* sub-menu.

The screenshot shows the 'COMM. PARAMETERS' menu with the following structure:

- SELECT UTILITIES COMM. PARAMETERS SETUP
- Under COMM. PARAMETERS:
 - Select
 - Edit communication parameter file
 - Print communication parameter file
 - Comment
 - Interface type
 - Communication port
 - Protocol (highlighted)
 - Secondary protocol
 - RAW
 - SPA
 - SRIO (highlighted)

At the bottom right, there are controls: Enter / SELECT and Esc / EXIT.

- Select **NOT USED** from the *Secondary protocol* sub-menu

The screenshot shows the 'COMM. PARAMETERS' menu with the following structure:

- SELECT UTILITIES COMM. PARAMETERS SETUP
- Under COMM. PARAMETERS:
 - Select
 - Edit communication parameter file
 - Print communication parameter file
 - Comment
 - Interface type
 - Communication port
 - Protocol
 - Secondary protocol (highlighted)
 - Baud rate
 - RAW
 - SPA
 - SRIO
 - Not used (highlighted)

At the bottom right, there are controls: Enter / SELECT and Esc / EXIT.

- All other settings can be left at their default values.

Note that all the above settings must agree with the SRIO settings (Syspar 4).

5.14.5.3. Creating a report station

- Select *Alter application structure* from the *Utilities* menu.
- Omit levels 1 and 2 by pressing <Enter>.
- **Level 3:** To enter a bay name for the report station, select *Select object/bay* and enter 'a'.

The screenshot shows a multi-level menu structure. At the top left, a box contains 'Select Organization' with 'ABB Po' below it, and 'Select Station' with 'ABB Ba' below it. To the right of this is a box for 'Select Object/Bay' containing 'NTP-2 REC316 45' and 'NTP-2 REC316 94'. On the right side of the screen, two directories are listed: 'SMSBASE directory: C:\SMS\BASE\' and 'Appl. data directory: C:\SMS\DATA-EX\'.

In the center, there is a box titled 'Create a new menu item' with the text 'Report NTP' inside.

At the bottom left, the following information is displayed: 'Organiz: ABB Power Automation Ltd' and 'Station: ABB Baden'.

At the bottom, a legend explains the navigation keys: 'C/ALT+D=Change/Delete comm. parameter', 'E=Edit', 'A=Add', 'D=Delete', 'ESC=previous level', and 'ENTER=select'.

- **Level 4:** Press <Enter> to proceed to the *Select unit* window and enter 'a'. Now select *Report station* from the list which appears.

This screenshot shows the next step in the menu structure. The top-level boxes for 'Select Organization' and 'Select Station' remain. The 'Select Object/Bay' box now includes a 'Select' option. To its right, a new box titled 'A Manual Entry' lists four options: 'MODEM', 'OTHER', 'REC316', and 'REPORT STATION'. The 'REPORT STATION' option is highlighted with a grey background.

The directory information on the right remains the same: 'SMSBASE directory: C:\SMS\BASE\' and 'Appl. data directory: C:\SMS\DATA-EX\'.

At the bottom left, the information is updated to include 'Obj/Bay: Report NTP' along with 'Organiz: ABB Power Automation Ltd' and 'Station: ABB Baden'.

At the bottom, the legend is updated: 'C=Create communication parameters', 'ESC=quit', and 'ENTER=select'.

- **Level 5:**

Press <Enter> to proceed to the *Select module/part of unit* window and then the data input window *Set Spacom slave address*. The default values in this window can be accepted.

```

Select Organization  [ABB Po]
Select Station      [ABB Ba]
Select Object/Bay   [NTP-2]
Select Unit         [NTP 2]
Select Module/Part of Unit [REPORT]
Appl. data directory: SMS\DATA-EX\
[Report] [REPORT STATION Configuration]

Setting SPACOM slave address
The module address is: 001
New address: 001

Organiz:  ABB Power Automation Ltd
Station:  ABB Baden
Obj/Bay:  Report NTP
Unit:     REPORT STATION Configuration
Mod/Part: REPORT STATION Configuration
C=Create communication parameters  S=Show transducer file
E=Edit      A=Add      D=Delete      ESC=previous level      ENTER=select
  
```

Take care not to enter a device address in this window.

5.14.5.4. *Entering the SRIO address for 'Reporting'*

- Select the menu item *Select* from the main menu and then the *Select object/bay* window (Level 3). Now select the report station.

```

Select Organization  [ABB]
Select Station      [ABB]
Select Object/Bay   [NTP-2 REC316 45]
[Report NTP]

Organiz:  ABB Power Automation Ltd
Station:  ABB Baden

F3          F5          Enter      Esc
MODEM      PASSWORD    SELECT      EXIT
  
```

- Select Report station configuration in the Select unit window (Level 4).

```
Select Organization
ABB Select Station
ABB Select Object/Bay
NTP Select Unit
NTP REPORT STATION Configuration
Rep
```

Organiz: ABB Power Automation Ltd
Station: ABB Baden
Obj/Bay: Report NTP

Enter Esc
SELECT EXIT

- Select Report station configuration in the Select module/part of unit window (Level 5).

```
SELECT UTILITIES COMM. PARAMETERS SETUP
Select Organization
ABB Select Station
ABB Select Object/Bay
NTP Select Unit
NTP REP Select Module/Part of Unit
Rep REPORT STATION Configuration [1]
```

Organiz: ABB Power Automation Ltd
Station: ABB Baden
Obj/Bay: Report NTP
Unit: REPORT STATION Configuration

Enter Esc
SELECT EXIT

- Select the menu item *Select function* and then *Report station settings* (Level 6).

SELECT	UTILITIES	COMM. PARAMETERS	SETUP
Select Organization			
ABB Select Station			
ABB Select Object/Bay			
NTP Select Unit			
NTP REP Select Module/Part of Unit			
Rep REP Select function [1]			
			REPORT station settings

Organiz: ABB Power Automation Ltd
 Station: ABB Baden
 Obj/Bay: Report NTP
 Unit: REPORT STATION Configuration
 Mod/Part: REPORT STATION Configuration [1]

F7 F8 Enter Esc
 REPORT DOS SELECT EXIT

- The SRIO address can now be entered and all the 'Reporting' settings made in the window which opens.

REPORT STATION v 1.0		Screen 1 of 1
REPORT station settings		22.09.1993
Present values ----- Station unit address SACO/SRIO address = 950 Report station printouts Alarm print/save = No Event print/save = No Logging print/save = No Print day report = 7 Print week report = Monday Print month report = 1 Logging save to file = No Station polling settings Poll retry = 3 times Poll start = 12.00 hh:mm Poll interval = 0.01 hh:mm	PC-file time 05.03.1996 06:37 New values ----- Station unit address SACO/SRIO address = 950 Report station printouts Alarm print/save = No Event print/save = No Logging print/save = No Print day report = 7 Print week report = Monday Print month report = 1 Logging save to file = No Station polling settings Poll retry = 3 times Poll start = 12.00 hh:mm Poll interval = 0.01 hh:mm	
Set the address of the SACO/SRIO at the station. Range: 900..999		
PgDn PgUp NEXT PREV	F7 REPORT	Enter Esc CHANGE EXIT

Refer to the Section 'Reporting' in the SMS010 manual for a further information.

March 01

6. SELF-TESTING AND MONITORING

6.1.	Summary	6-2
6.2.	Monitoring the auxiliary supply.....	6-2
6.3.	Monitoring the firmware	6-2
6.4.	Monitoring the hardware	6-3
6.5.	Diagnostic events	6-3
6.6.	Device diagnosis.....	6-6
6.7.	HEX dump	6-8
6.8.	IBB information	6-8
6.8.1.	SPA bus.....	6-8
6.8.2.	LON bus.....	6-9
6.8.3.	MVB.....	6-11
6.8.4.	VDEW bus	6-13
6.9.	RIO information.....	6-13
6.10.	Resetting SCS data	6-13
6.11.	Load SCS mask.....	6-14

6. SELF-TESTING AND MONITORING

6.1. *Summary*

The continuous self-monitoring and diagnostic features incorporated in RE. 316*4 assure high availability both of the protection functions and the power system it is protecting. Hardware failures are signalled instantly via an alarm contact.

Special importance has been given to monitoring the external and internal auxiliary supply circuits. The correct operation and maintenance of tolerances of the A/D converter (both on external c.t./v.t. input boards Type 316EA62 or 316EA63 or in the CPU itself) are checked by making it continuously convert two precisely known reference voltages.

The execution of the program itself is monitored by a watchdog.

Security when transferring data by serial communication between the protection and a local control and setting unit (PC) or with a remote system (station control system) is provided by a communication protocol with a "Hamming" distance of 4.

Special functions are provided for monitoring the integrity of the v.t. connections and for checking the symmetry of the three phase voltages and currents.

6.2. *Monitoring the auxiliary supply*

Both the external auxiliary supply applied to the protection and the internal electronic supplies are continuously monitored. The supply unit is capable of bridging supply interruptions up to 50 ms. After this time, the O/P's are blocked and the unit is reset and reinitialised.

6.3. *Monitoring the firmware*

A hardware timer (watchdog) monitors the execution of the program. Providing the program runs correctly, the timer is reset at regular intervals. Should for some reason the execution of the program be interrupted and the timer not be reset, the O/P's are blocked and the unit reinitialised.

6.4. *Monitoring the hardware*

For the most part, the hardware is either monitored or self-testing both while the system is being initialised after switching on and afterwards during normal operation. Upon switching on the auxiliary supply, a test routine completely checks the hardware including the RAM and the flash EPROM checksums. The function and accuracy of the A/D converter is tested by converting a 10 V reference voltage to a digital value and checking that the result lies within $\pm 1\%$.

The switch-on test takes about 10 seconds while the green (stand-by) LED does not light and the protection functions are blocked. Upon successful completion of the test, the stand-by LED flashes and the start-up routine commences. As soon as the standby LED lights continuously, the device is operational.

The above routine continues to run as a background function during normal operation, checking the memories (excepting the RAM) at frequent intervals. The reference voltage is also repeatedly converted together with the current and voltage channels to monitor the A/D converters.

6.5. *Diagnostic events*

A corresponding entry is made in the event list whenever the diagnostic function detects a failure.

The following entries in the list are possible:

- System start
The device was switched on.
- Protection restart
The protection and control functions were activated.
- System warm start
The device was restarted after the reset button was pressed or a watchdog time-out.
- Protection stop
The protection and control functions were stopped by the parameters being re-entered.
- Supply failure
The device was switched off or there was a supply failure.

- Diagnosis: main processor 316VC61a/316VC61b ready (0001H).
- Diagnosis: A/D processor EA6. not ready.
The external A/D processor 316EA62 or 316EA63 is not ready. This occurs during normal operation, because the A/D processor on the 316VC61a/316VC61b is active.
- Diagnosis: internal A/D ready (0001H)
The A/D processor on the 316VC61a/316VC61b is ready.
- Diagnosis: system status: OK.

The above list of diagnostic messages reflects the operating state when the device is standing by. The following messages and hexadecimal weightings can be generated by a fault.

Designation	Function	Weighting
RDY	Device standing by	0001H
WDTO	Watchdog time-out	0002H
WDDIS	Watchdog disabled	0004H
HLT	Stop procedure initiated	0008H
SWINT	Software interrupt	0010H
RAM	RAM error	0100H
ROM	ROM error	0200H
VREF	Reference voltage out-of-tolerance	0400H
ASE	A/D converter error	0800H
EEPROM	Parameter memory error	2000H

The hexadecimal weighting of an error message may also be the addition of simpler errors. For example, VREF and ASE are recorded as $0400H + 0800H = 0C00H$.

Failures with a weighting less than 080H are listed as 'minor errors', e.g. a warm start after pressing the reset button.

Failures with a weighting higher than 0100H are 'fatal errors' and result in blocking of the protection and control functions.

Note: Normally, a fatal error always concerns the entire device. An exception to this rule occurs when an EEPROM error is detected on a 316EA62 or 316EA63.

The A/D converter 316EA62 or 316EA63 generates a number of diagnostic messages:

Designation	Function	Weighting
RDY	Device ready	0001H
Gr2Err	Local value error	0020H
Gr3Err	Error in the values received from the transmitting device	0040H
Param	Parameter error	0080H

Example

Event list after switching the device off and on:

```

MODURES - Events          EXAMPLE
-----
0 1998-03-30 11:37:08.338 Supply failure      CPU 1
1 1998-03-30 11:37:08.338 System start
2 1998-03-30 11:37:08.338 Diagnosis: Main processor VC61 ready (0001H)
3 1998-03-30 11:37:08.338 Diagnosis: A/D processor EA6. not ready
4 1998-03-30 11:37:08.338 Diagnosis: Internal A/D ready (0001H)
5 1998-03-30 11:37:08.338 Diagnosis: System status: OK
6 1998-03-30 11:37:09.050                               ParSatz2    ACTIVE
7 1998-03-30 11:37:09.056 Protection restart
8 1998-03-30 11:37:09.058                               Relay ready  ACTIVE
9 1998-03-30 11:37:09.058 Bin.I/P. No. 1/ 2 (Q0_OPEN                ) ACTIVE
                               Bin.I/P. No. 1/ 4 (Q1_OPEN                ) ACTIVE
                               Bin.I/P. No. 1/ 6 (Q2_OPEN                ) ACTIVE
                               Bin.I/P. No. 1/ 8 (Q9_OPEN                ) ACTIVE
                               Bin.I/P. No. 1/10 (Q8_OPEN                ) ACTIVE
                               Bin.I/P. No. 1/12 (Q51_OPEN               ) ACTIVE
                               Bin.I/P. No. 1/14 (Q52_OPEN               ) ACTIVE
10 1998-03-30 11:37:09.058 Bin.I/P. No. 2/10 (BUS-TIE_OPEN            ) ACTIVE
                               Bin.I/P. No. 2/12 (Q51_OPEN               ) ACTIVE
                               Bin.I/P. No. 2/14 (Q52_OPEN               ) ACTIVE
11 1998-03-30 11:37:40.051                               MMC active  ACTIVE.

```

6.6. *Device diagnosis*

Device diagnostic data can be viewed by selecting 'Diagnostics' from the MMI main menu.

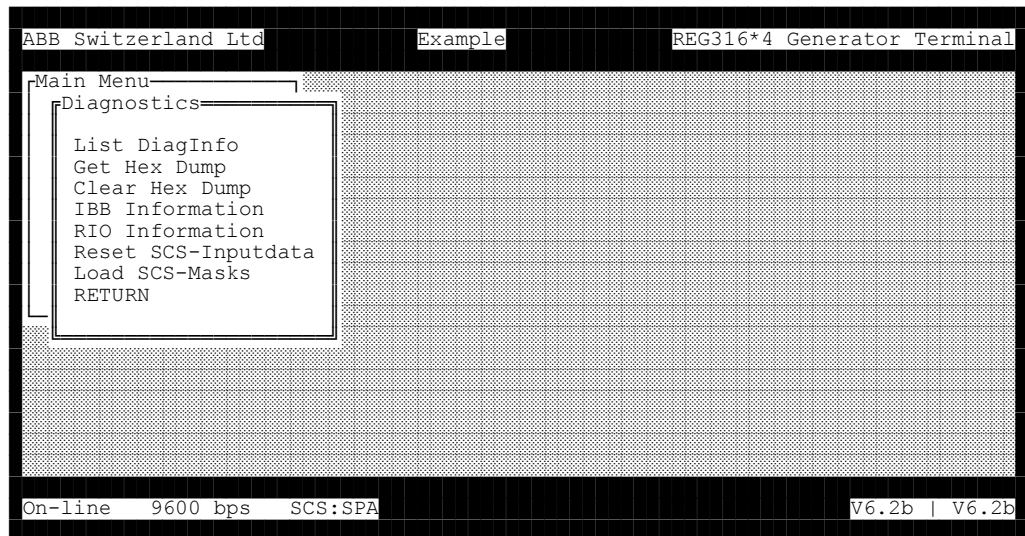


Fig. 6.1 Diagnostics menu

Status messages can be deleted using the reset button or the reset menu on the local display unit.

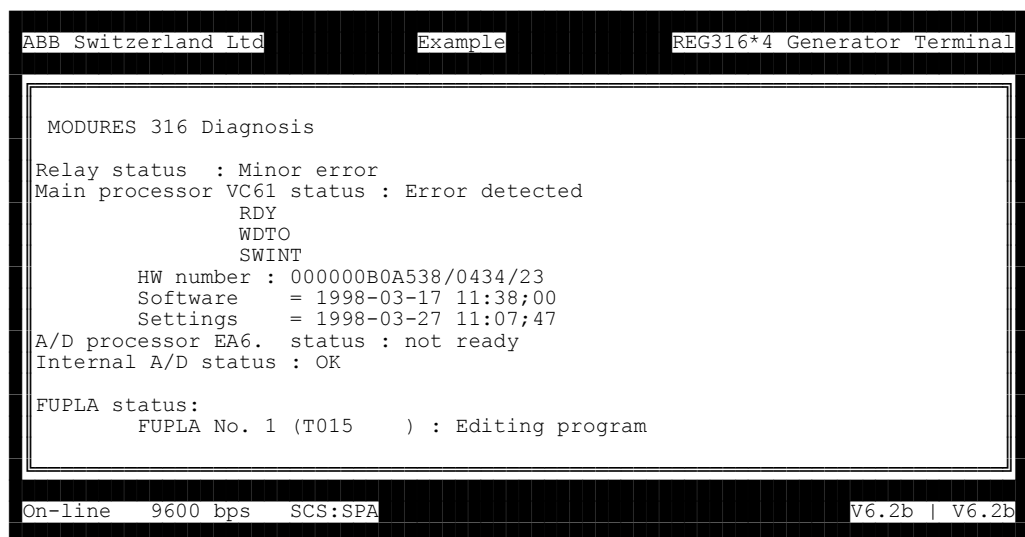


Fig. 6.2 Device diagnosis after a warm start

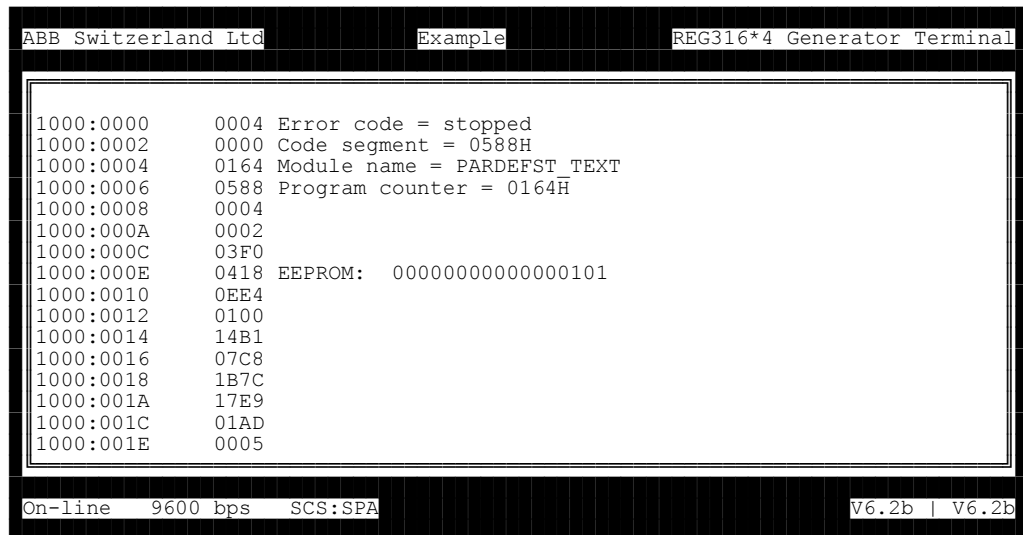
Fig. 6.2 shows the diagnostic data of a device after a warm start. The significance of the various parameters is as follows:

- HW number: 000000B0A538/0434/23
Every 316VC61a or 316VC61b processor board has a unique number. To this are added the codes for the microprocessor and the PCMCIA controller (PC card).
- Software = 1998-03-17 11:38;00
Date and time when the device firmware was created.
- Settings = 1998-03-27 11:07;47
Date and time when the parameter settings were last downloaded.
- A/D processor EA6. Status: not ready
The external 316EA62 or 316EA63 A/D processor is not fitted.
- Internal A/D Status: OK
The A/D processor on the 316VC61a or 316VC61b is standing by.
- FUPLA status: FUPLA No. 1 (T015): Editing program
Name of the FUPLA in the device. This uniquely identifies the FUPLA code loaded in the device. The FUPLA code can be processed either in the program ('Prog') or the parameter ('Para') memory. After the FUPLA code has been loaded, processing commences in the parameter memory. It is then copied to the program memory and runs in the background. The processing speed of the program memory is higher. Up to eight different FUPLA logics can be loaded at the same time and the status of each one is displayed. The following statuses are possible:

Blocked	The blocking input is preventing the execution of the FUPLA logic.
Halted	The execution of the FUPLA logic has been halted because, for example, the FUPLA code cannot be accessed temporarily.
Processing	The FUPLA logic is being processed.
Initialised	The FUPLA logic is already initialised, but inactive.
Inactive	The FUPLA logic is loaded, but is not running.

6.7. *HEX dump*

Additional information to the diagnostic information is available by selecting 'Diagnostics' from the main menu and then 'Load HEX dump'. Most of this data cannot be evaluated by the user, but they are frequently useful to ABB personnel for fault-finding. Once the data has been read, it should be deleted again by selecting 'Delete HEX dump' to make room for saving new data.



```
ABB Switzerland Ltd      Example      REG316*4 Generator Terminal
1000:0000      0004 Error code = stopped
1000:0002      0000 Code segment = 0588H
1000:0004      0164 Module name = PARDEFST_TEXT
1000:0006      0588 Program counter = 0164H
1000:0008      0004
1000:000A      0002
1000:000C      03F0
1000:000E      0418 EEPROM: 00000000000000101
1000:0010      0EE4
1000:0012      0100
1000:0014      14B1
1000:0016      07C8
1000:0018      1B7C
1000:001A      17E9
1000:001C      01AD
1000:001E      0005
On-line 9600 bps SCS:SPA V6.2b | V6.2b
```

Fig. 6.3 HEX dump

6.8. *IBB information*

Depending on the firmware installed and therefore the choice of the interbay bus, various data on the status of the bus in relation to the station control system and the PC card can be obtained via this menu item.

6.8.1. *SPA bus*

No special information is available about the SPA bus.

6.8.2. LON bus

In the case of LON bus, information about the PC card and the number of messages transmitted and received is provided.

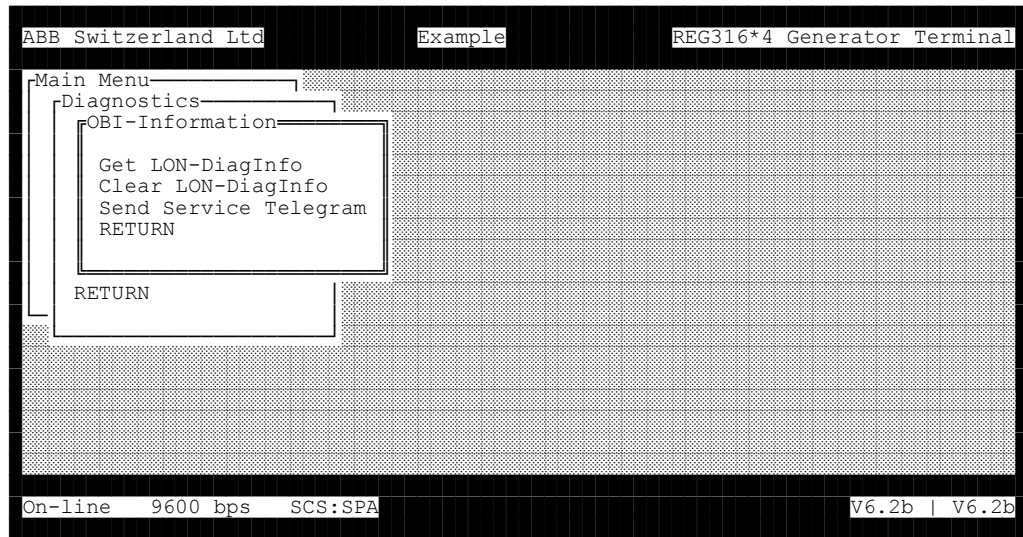


Fig. 6.4 Diagnostic menu for the LON bus

LON bus information

Note: The data displayed is static and not refreshed after it is called.

```

LONDiagInfo:

Neuron Chip ID-Nr.: 000058340300
LON-Interface ID:  DP_MIP
Domain 0: SubnetNr:  1
           NodeNr:   1

LON-Interface Status:
Transmission Errors:          0
Transaction Timeouts:        4
Receiver Transaction Timeouts: 0
Lost Messages:                0
Missed Messages:             0
Reset Cause:                  Software Reset
Interface State:              Configured and Online
Version Number:               4
Error Number:                 0
Model Number:                 0

LON-Driver Status:
Driver State:                  ok!
Cross Table for NetVariables: Valid
No. of Semaphore Hits:        6421
No. of Semaphore Misses:      1227
No. of Semaphore Fails:       3
No. of InBuffer Overflow:     0
No. of transmitted Messages:  4
No. of received Messages:     0
No. of Transmission Fails:    4
No. of OutBuffer Overflow:    0
No. of EventBuffer Overflow:  0
No. of lost incoming Messages: 0
  
```

Fig. 6.5 LON bus information

The table below explains the significance of the various items of information.

Neuron Chip ID-No.	Hardware number of the neuron chip on the PC card
LON interface ID	Must always be set to "DP_MIP".
Domain	Number of the domain to which the device belongs (can be set via the LON bus).
Subnet No.	Number of the sub-network to which the device belongs (can be set via the LON bus).
Node No.	Device node number (can be set via the LON bus).
Transmission errors	Number of errors detected during reception.
Transaction timeouts	Number of transaction confirmations not received.
Receiver transaction timeouts	Number of messages received that were lost, because of incorrect settings at the receiving end.
Lost messages	Number of messages lost, because the receive memory in the RE.316*4 was full.
Missed messages	Number of messages lost, because the receive memory on the PC card was full.
Reset cause	Reason for the last restart executed by the PC card.
Interface Status	Normal: "Configured and on-line".
Version number	PC card firmware version
Error number	0 = no error or error on the PC card.
Model number	Always 0
Driver state	OK or error message
Cross table for network variables	Valid or invalid (table loaded via the LON bus).
No. of semaphore hits	Information for ABB purposes
No. of semaphore misses	Information for ABB purposes
No. of semaphore fails	Information for ABB purposes
No. of IN buffer overflows	Number of messages lost, because the driver buffer was full.
No. of transmitted messages	Total number of messages transmitted since the information was deleted.
No. of received messages	Total number of messages received since the information was deleted.

No. of OUT buffer overflows	Number of messages that could not be transmitted, because the buffer on the PC card was full.
No. of event buffer overflows	Number of events that could not be transmitted, because the buffer on the PC card was full.
No. of lost incoming messages	Number of messages lost, because the driver receive buffer was full.

Delete LON diag. info

Selecting this menu item resets the various diagnostic information counters to zero.

Send service telegram

The menu item causes the PC card to send a service telegram which corresponds to pressing the service button on the PC card. It is needed when configuring the network.

6.8.3. MVB

This menu item provides information about the PC card and the number of messages transmitted and received.

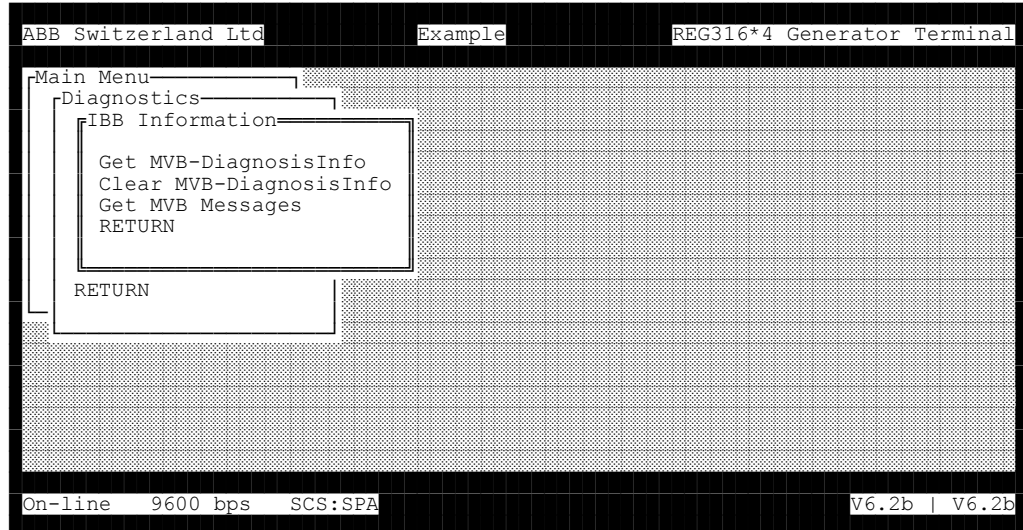


Fig. 6.6 MVB diagnostics menu

MVB information

Note that the information is continuously refreshed.

MVB-IBB-DiagInfo:

```

Working Mode:          InterbayBus
PC-Card Status:       Ready
PC-Card Error:        No Error
PC-Card Type:         InterbayBus
PC-Card SW-Vers:      1.11 1997-12-15
PC-Card HeartBeat:    55384
Driver State:         Ready
Driver Heartbeat:     4877
Nr. of received Messages: 12
Nr. of transmitted Messages: 12
Nr. of Transmission Fails: 0
Nr. of lost incoming Messages: 0
  
```

Fig. 6.7 MVB information

The table below explains the significance of the various items of information.

Working mode	Indicates the function of the PC card as connection to the inter-bay bus. If a PC card is not inserted, "Not connected" is displayed on this line.
PC-Card Status	Initialising, Ready, Minor error, Fatal error
PC-Card Error	No error, Unknown error, No response, Init. Error, Subsystem error etc.
PC-Card Type	Inter-bay bus. If a PC card is not inserted, "Software unknown" is displayed.
PC-Card SW-Vers.	PC card firmware date and version
PC-Card Heartbeat	Signals whether the PC card firmware is active or not.
Driver State	Initialising, Ready, Minor error, Fatal error
Driver Heartbeat	Signals whether the driver software in the RE.316*4 is active or not.
No. of received messages	Total number of messages received since the information was deleted.
No. of transmitted messages	Total number of messages received since the information was deleted.

No. of transmission fails	Number of errors while transmitting a message, for example, because the buffer on the PC card was not available.
No. of lost incoming messages	Number of messages lost, because the driver receive buffer was full.

Delete MVB diag. info

Selecting this menu item resets the various diagnostic information counters to zero.

Load MVB messages

Selecting this menu item displays the last message sent or received and also the last event transmitted. These data are only needed for development purposes and are not described in more detail for that reason.

6.8.4. *VDEW bus*

No special information is available for the VDEW bus.

6.9. *RIO information*

Information is displayed on the status of the process bus and the distributed input/output system. A detailed description of the data is given in publication 1MRB520192-Uen.

6.10. *Resetting SCS data*

After entering his password, an authorised user can delete the SCS input data.

6.11. Load SCS mask

This menu item provides facility to import a form (mask) from a file that was created using the MMI documentation function to configure the transfer of events via the SCS.

Part of a file of this kind is given below. In this case, the file only contains text and it can therefore be edited if necessary using a normal editor. Every possible event is listed with channel and event number (see [Index 9](#)). “OFF” means that an event is “masked”, i.e. it cannot be transferred to be recorded as an event. Conversely “ON” that it is transferred and recorded. The file is created automatically by the MMI and enables all the events that have been configured.

Extract from the file “recxx.evt”:

```
0E1  OFF
0E2  OFF
0E3  OFF
0E4  OFF
0E5  OFF
0E6  OFF
0E7  OFF
0E8  OFF
```

.....

February 00

7. INSTALLATION AND MAINTENANCE

7.1.	Summary.....	7-2
7.2.	Installation.....	7-3
7.2.1.	Checking the shipment	7-3
7.2.2.	Place of installation and ambient conditions	7-3
7.2.2.1.	Guidelines for RF grounding	7-4
7.2.2.2.	Guidelines for wiring rack assemblies	7-6
7.2.3.	Checking the c.t. connections	7-9
7.2.4.	Checking the v.t. connections	7-10
7.2.5.	Checking the auxiliary supply connections.....	7-10
7.2.6.	Checking the duty of the tripping and signalling contacts	7-11
7.2.7.	Checking the opto-coupler inputs.....	7-11
7.3.	Commissioning	7-12
7.3.1.	Connecting the setting and control PC.....	7-12
7.3.1.1.	Minimum PC requirements.....	7-12
7.3.1.2.	Serial interface parameters	7-12
7.3.1.3.	PC connecting cable	7-12
7.3.2.	Connecting the equipment to the auxiliary d.c. supply	7-13
7.3.3.	Connecting the binary inputs and outputs	7-13
7.3.4.	Connecting v.t. and c.t. circuits	7-14
7.3.5.	Connecting optical fibre cables for the longitudinal differential protection.....	7-15
7.3.6.	Commissioning tests	7-15
7.4.	Maintenance	7-17
7.4.1.	Fault-finding	7-17
7.4.1.1.	Stand-by LED on the frontplate	7-17
7.4.1.2.	Human/machine interface	7-18
7.4.1.3.	Restarting.....	7-19
7.5.	Software updates	7-21
7.5.1.	Settings	7-21
7.5.2.	Deleting the settings and the program and downloading a new program	7-21
7.5.3.	Problems transferring the new software.....	7-23
7.6.	Replacing hardware units.....	7-25

7. INSTALLATION AND MAINTENANCE

7.1. *Summary*

The place of installation and the ambient conditions must conform to the data given in the data sheet ([see Index 8](#)). Sufficient room must be left in front and behind the equipment to allow access for maintenance or adding to the system. Air must be allowed to circulate freely around the unit.

During the course of commissioning, all the wiring to the unit must be checked and the auxiliary supply voltage and the voltage for the opto-coupler inputs must be measured.

Functional testing can be carried out with the aid of the test set Type XS92b.

All the essential functions of the protection are subject to continuous self-testing and monitoring and therefore periodic maintenance and testing are not normally necessary.

It is recommended, however, to check the values of the voltages and currents of the external circuits from time to time using the on the input channel display on the HMI. The tripping circuits should be tested at the same time.

7.2. Installation

7.2.1. Checking the shipment

Check that the consignment is complete upon receipt. The nearest ABB agent must be notified immediately should there be any discrepancies in relation to the delivery note, shipping papers or the order.

Visually check the state of all items when unpacking them. Should any damage be found, the last carrier must be informed immediately followed by a claim in writing pointing out his responsibility for the damage. Also inform your nearest ABB office or agent and ABB Switzerland Ltd, Department UTAAA-P, CH-5401 Baden, Switzerland.

If the equipment is not going to be installed immediately, it must be stored in a suitable room in its original packing.

7.2.2. Place of installation and ambient conditions

When choosing the place of installation, ensure that there is sufficient space in front of the equipment, i.e. that the serial interface connector and the local control and display unit are easily accessible.

In the case of semi-flush mounting or installation in 19" equipment racks, space behind the equipment must be provided for adding ancillary units (e.g. 316DB61 and 316DB62), replacing units and changing electronic components (firmware).

Since every piece of technical equipment can be damaged or destroyed by inadmissible ambient conditions,

- the relay location should not be exposed to excessive air pollution (dust, aggressive substances)
- severe vibration, extreme changes of temperature, high levels of humidity, surge voltages of high amplitude and short rise time and strong induced magnetic fields should be avoided as far as possible
- air should be allowed to circulate freely around the equipment.

The equipment may be mounted in any attitude, but is normally mounted vertically (for reading the display and frontplate markings).

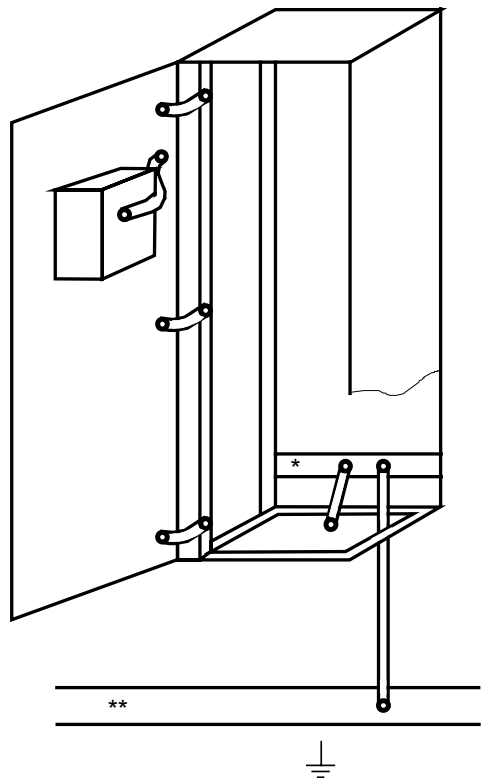
7.2.2.1. Guidelines for RF grounding

Grounding the casing in a cubicle

Connect the rear of the casing (individual unit or rack) to the hinged frame in the cubicle by a braided copper strip (at least 2 cm wide) which should be as short as possible. To prevent corrosion, a **Cupal disc** (copper-plated aluminium) must be inserted between aluminium and copper parts.

Connect the ground rail in the cubicle to the plant ground.

The interconnecting cable must have at least the same gauge as the ground rail in the cubicle.



HEST 965 021 FL

- non-insulated connection
- * ground rail
- ** plant ground

Fig. 7.1 RF grounding in a cubicle

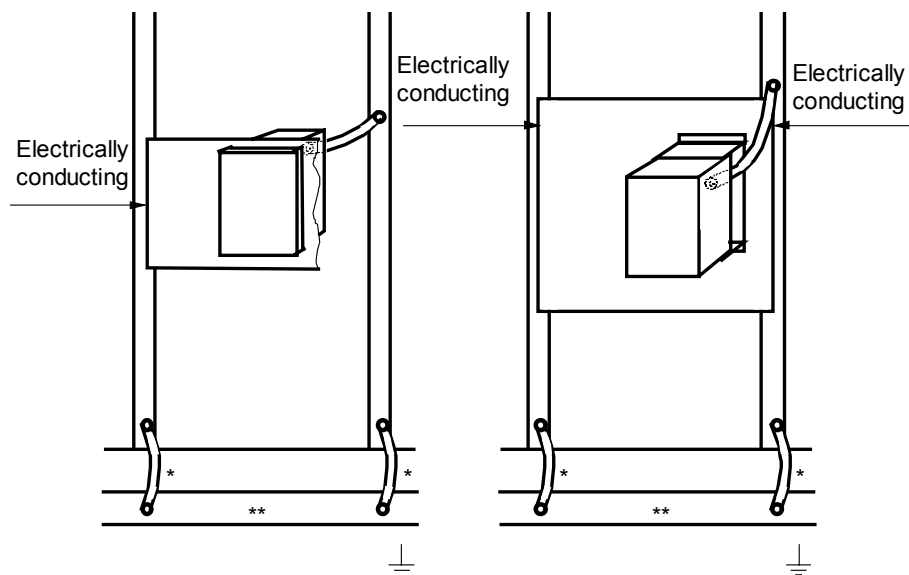
Grounding a casing in a rack

The equipment is fitted with a grounding screw ($\perp$) to which a flexible copper braiding (at least 2 cm wide) must be connected.

A suitable tinned copper braided connection of the correct length and fitted with lugs is available from ABB Switzerland Ltd (Order No. 1MRB 400047).

Choose the shortest possible route to the nearest grounding point on the cubicle frame or mounting plate, which must have a direct connection to the station ground.

All metal surfaces used for the ground connections must be protected against corrosion and be good electrical conductors, i.e. no paint or non-conducting agents.



HEST 965 022 FL

- non-insulated connection
- * braided copper (at least 3 cm wide)
- ** plant ground

Fig. 7.2 RF grounding for semi-flush mounting

Fig. 7.3 RF grounding for surface mounting

7.2.2.2. Guidelines for wiring rack assemblies

Where **digital protection devices** (individual units) or **protection systems** are supplied in a rack, it is essential that the binary inputs and outputs (BIO's) and the auxiliary supply which have to be wired from the rack to the cubicle terminals be run separately from the c.t. and v.t. cables (**not** in the same duct or loom).

This precaution reduces the parallel coupling of conducted interference.

Should this not be possible along the whole route, parallel coupling can be reduced by crossing at right angles. **Complete separation, however, is to be preferred.**

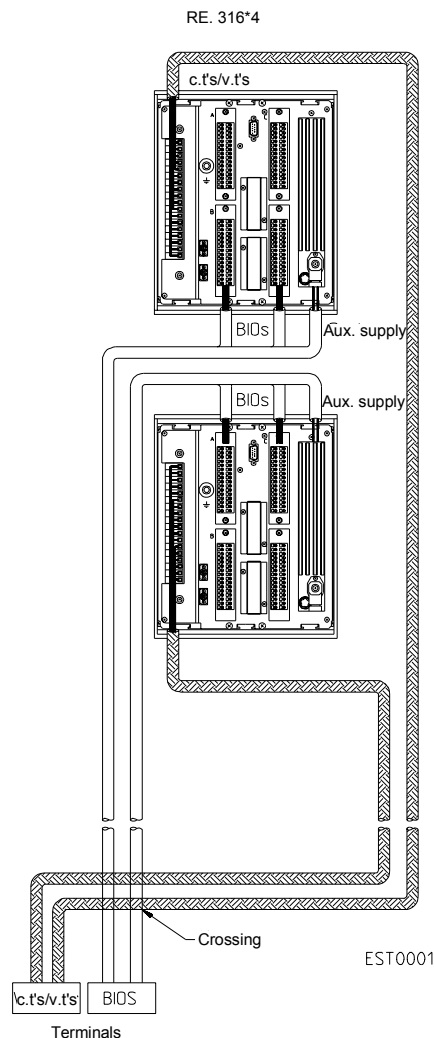


Fig. 7.4 Separation of rack wiring in a cubicle

Screened leads must be used for the c.t. and v.t. wiring from the terminals to the equipment.

Recommendation

It is also recommended to use screened leads for the binary inputs and outputs (BIO's) and the auxiliary supply.

The following applies if the equipment is not installed in a cubicle:

The terminals should be as close as possible to the equipment terminals so that the unscreened lengths of cables are very short!

Screened c.t., v.t., binary input and output and auxiliary supply cables can be secured in one of the following ways:

Assemblies fitted into panels:

C.t. and v.t. leads to the terminals can be secured, for example, to a surface (steel rail) using cable clamps. The surface must be in direct contact with the plant ground and the cable screens must make good contact with the cable clamps all the way round.

This, however, is not always the case and the screen is frequently not in contact at the sides which impairs the screening effect. To overcome this drawback, a **special ** copper braid tape** can be wound on top of the cable screen in the region of the clamps. This then ensures maximum screening efficiency.

****** Suitable tinned copper braid tape is available from **3M** under the designation:

"Scotch No. 24"

(Fitting instructions should also be requested.)

Assemblies fitted into cubicles: (2 alternatives)

- a) The c.t. and v.t. cables going to the terminals can pass through cable glands. Again the cable screens must be in good contact with the gland all the way round and the gland with the plant ground (e.g. via the panel or strip material in which the gland is fitted).

C.t. and v.t. leads to the terminals can be secured, for example, to a surface (steel or copper) using conduit clamps. The surface (e.g. floor plate) must be in direct contact with the plant ground and the cable screens must make good contact with the conduit clamps all the way round.

- b) This, however, is not always the case and the screen is frequently not in contact at the sides which impairs the screening effect. To overcome this drawback, a **special ** copper braid tape** can be wound on top of the cable screen in the region of the clamps. This then ensures maximum screening efficiency.

To prevent corrosion, a **Cupal disc** (copper-plated aluminium) must be inserted between aluminium and copper parts.

7.2.3. ***Checking the c.t. connections***

The c.t.'s must be connected in strict accordance with diagram supplied with the equipment.

The following checks must be carried out to check the c.t.'s and c.t. circuits:

- polarity check
- primary injection test
- plot the excitation curve
- c.t. circuit grounding.

The polarity check (as close as possible to the protection equipment) not only checks the current input circuit as a whole, it also checks the phase-angle of the c.t.

Primary injection checks for a ratio error and the wiring to the protection equipment. Each phase-to-neutral and phase-to-phase circuit should be injected. In each case, the phase currents **and** the neutral current should be measured.

The relative polarities of the c.t.'s and their ratios can also be checked using load current.

Plotting the excitation curve verifies that the protection is connected to a protection core and not a metering core.

Each electrically independent current circuit may only be earthed in one place, in order to avoid balancing currents created by potential differences.

Core-balance c.t.'s

If the residual current is obtained from a core-balance c.t., the ground for the cable screen must first be taken back through the core-balance c.t. before connecting it to ground. The purpose of this is to ensure that any spurious E/F current flowing along the screen of the cable cancels itself and is not measured falsely as an E/F on the relay's own feeder.

7.2.4. **Checking the v.t. connections**

The v.t.'s must be connected in strict accordance with diagram supplied with the equipment.

The following checks must be carried out to check the v.t. circuits:

- polarity check
- wiring check
- v.t. circuit grounding.

The rated voltage of an E/F protection scheme is defined as the voltage which occurs between the terminals “e” and “n” for a solid phase-to-ground fault. An E/F of this kind, e.g. on T phase (see Fig. 7.5), causes the voltages of R and S phases to increase from phase-to-neutral to phase-to-phase potential and these add vectorially to produce a voltage between terminals “e” and “n”, which is three times the phase-to-neutral voltage.

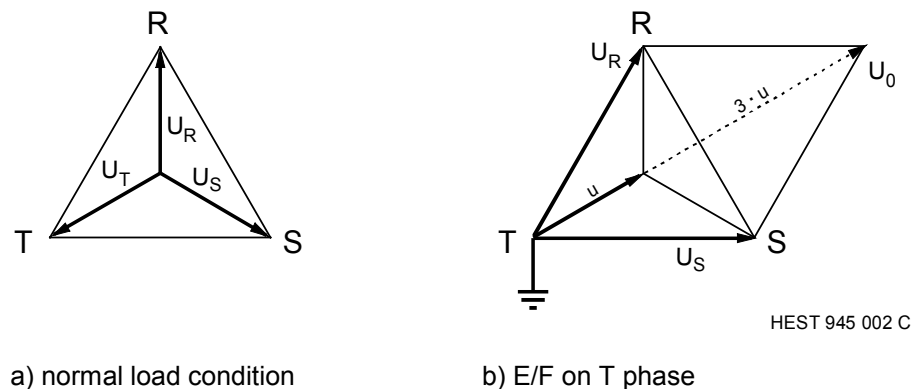


Fig. 7.5 Voltages in an ungrounded three-phase power system

7.2.5. **Checking the auxiliary supply connections**

Check that the supply is connected with the correct polarity. The d.c. supply voltage must lie within the permissible operating range of the power supply unit installed under all operating conditions (see Technical Data for the respective power supply unit).

The power supply unit, type 316NG65 is protected by a fuse, type T 3.15 A.

7.2.6. *Checking the duty of the tripping and signalling contacts*

Check that the loads connected to all the contacts are within the specified ratings given in the “Contact ratings” section of the data sheet.

7.2.7. *Checking the opto-coupler inputs*

Check the polarity and supply voltage of all opto-coupler inputs in relation to the ordering code (also given on the rating plate at the rear of the equipment).

7.3. Commissioning

Before commencing commissioning, i.e. before the station is energised, carry out the checks given in [Section 7.2](#).

7.3.1. Connecting the setting and control PC

Connect the serial interface of the PC to the interface connector on the front of the equipment. Details of the communication parameters and the connector pins are given in the following Sections.

7.3.1.1. Minimum PC requirements

The minimum requirements to be fulfilled by the HMI PC are:

- MS Windows 3.1x, Windows 95 or Windows NT4.0 operating system or higher
- 16 MByte RAM
- 1 floppy drive (3½"; 1.44 MByte) and a hard disc with at least 12 MByte of free space
- 1 serial interface (RS-232C)
- 1 parallel interface (Centronics).

7.3.1.2. Serial interface parameters

The HMI initialises the serial interface and automatically sets the corresponding parameters.

7.3.1.3. PC connecting cable

The connecting cable between the serial interface connectors on the frontplate of the protection equipment (optical connector on the front of the local control and display unit) and on the PC (9-pin SUB-D plug) is an optical fibre cable with the order No. 1MRB380084-R1 ([see Data Sheet](#)).

7.3.2. **Connecting the equipment to the auxiliary d.c. supply**

The plug for the auxiliary supply is inserted upon delivery in the connector at the rear of the power supply unit. This plug must be fitted to the power supply cable as shown in Fig. 7.6.

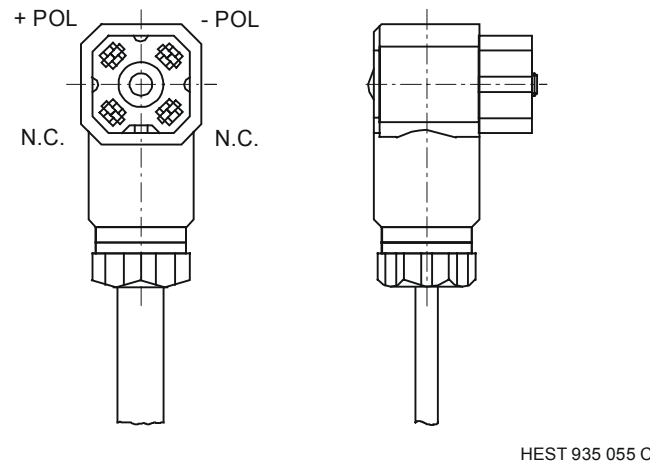


Fig. 7.6 Auxiliary supply plug

7.3.3. **Connecting the binary inputs and outputs**

In the case of the narrow casing (N1), the binary inputs and outputs have to be wired to connectors C and D at the rear for the first unit and to connectors A and B for the second unit.

In the case of the wide casing (N2), the binary inputs and outputs have to be wired to connectors G and H at the rear for the first unit, to connectors E and F for the second, to connectors C and D for the third unit and to connectors A and B for the fourth unit.

All external auxiliary relays or other inductances controlled by signals from the protection must be fitted with free-wheel diodes across their coils.

Instructions for wiring the terminals

- **Type and gauge of wire:**
The signal connections to the terminals are made with 1.5 mm² stranded wire. Do **not** use crimped sleeves or other terminations; the flexible cores are protected by the design of the terminals.
- **Terminating the wires:**
Do not strip more than 10 mm of insulation from the ends of

the wires. Insert the stripped ends of the cores perpendicularly to the rear of the device into the terminals and secure them by tightening the screw next to each one. As the channel for the wire in the terminals is slightly curved, twisting the wires slightly when inserting them is a help. Only insert one stranded wire into each terminal.

Take care that no strands protrude that may cause arcing or short-circuits.

- Bridging terminals:
Where it is necessary to bridge terminals, do so at external terminals on the cubicle.

7.3.4. *Connecting v.t. and c.t. circuits*

Instructions for wiring the terminals

- Type and gauge of wire:
The v.t. and c.t. connections to the terminals are made with 2.5 mm² stranded wire (e.g. H07V-K). The ends of the wires in this case must be fitted with crimped sleeves.
V.t. and c.t. connections may be made alternatively by 4 mm² solid wire.
- Terminating the wires:
Insert the ends of the wires perpendicularly to the rear of the device into the terminals and secure them by tightening the screw next to each one.
Take care that no strands protrude that may cause arcing or short-circuits.
- Bridging terminals:
Where it is necessary to bridge neighbouring terminals, do so directly at the protective device using standard links (e.g. as manufactured by PHOENIX). The terminals are designed to accommodate these in addition to a 2.5 mm² gauge lead. Alternatively, circuits have to be bridged at external terminals on the cubicle.

7.3.5. ***Connecting optical fibre cables for the longitudinal differential protection***

Optical fibre cables are connected using Type FC connectors.

Take care when inserting the connectors that only to tighten the screw fitting after checking that the nose on the plug is properly seated in the groove of the base.

To exclude any risk of false tripping when connecting or disconnecting a cable in operation, only do so after the auxiliary supply to at least one of the terminal units has been switched off.

In cases where the terminal units are connected via communications devices such as FOX-U, ensure that the communication in both directions is via the same route (equal lengths).

7.3.6. ***Commissioning tests***

For the protection scheme as a whole to operate correctly, it is not enough for just the protection equipment itself to be in order, the reliable operation of the other items of plant in the protection chain such as circuit-breakers, c.t's and v.t's (e.g. protection and metering core leads exchanged), station battery (earth fault), alarm and signalling circuits etc. and all the cabling is equally important.

The correct operation of the equipment itself is determined by the following tests:

- secondary injection of every current and voltage input
- activating and deactivating every binary input (opto-coupler)
- energising and de-energising every auxiliary tripping and signalling relay
- checking the settings (printed by the HMI).

These tests confirm that none of the protection hardware is defective. The actual protection functions are contained in the software and are continuously monitored. They do not therefore need to be especially tested during commissioning.

The following is a list of some of the tests and the faults they are intended to disclose.

Test	Faults disclosed
Injection of rated value at all c.t. and v.t. inputs (e.g. using test set Type XS 92b)	Hardware defective Wrong rated current Wrong rated voltage Wrong reference value
Activation/deactivation of all binary inputs (opto-couplers)	Hardware defective Incorrect setting (not inverted) Incorrect assignment
Energisation of all auxiliary tripping relays (using the test function)	Hardware defect Incorrect assignment
Energisation/de-energisation of all auxiliary signalling relays (using the test function)	Hardware defect Incorrect assignment

A further useful facility is provided by the “Display analogue values” menu which enables the currents and voltages applied to the protection to be viewed. It can thus be seen whether the amplitude and phase of the currents and voltages are correct. The Appendix in [Index 12](#) includes a test report.

7.4. Maintenance

Because of the self-testing and monitoring features included, the equipment requires neither special maintenance nor periodic testing.

Where testing is considered necessary, the following procedure is recommended:

- Measure the currents and voltages in the secondaries of the main c.t's and v.t's and compare the results with the values displayed by the HMI.
- Test the external circuits using the test functions provided by the HMI ([see Section 5.9.](#)).

The life of the wet electrolytic condensers is about 20 years. This assumes a mean ambient temperature outside the casing of 40 °C. An increase of 10 °C shortens the life by half and a decrease of 10 °C extends it by half.

7.4.1. Fault-finding

7.4.1.1. Stand-by LED on the frontplate

The following may be possible causes, should the green stand-by LED not light continuously, but be extinguished or flash although the auxiliary supply is switched on:

Stand-by LED extinguished

- The auxiliary supply unit Type 316N65 is not properly inserted or is defective. Insert properly or replace the unit.
- The input/output unit Type 316DB6. is not properly inserted or defective. Insert properly or replace the unit.
- The logic processor Type 316VC61a or 316VC61b is defective. Replace either the main processor unit or the complete equipment.

Green stand-by LED flashes

- The equipment does not have a valid set of parameter settings.
- The active set of parameters and the 'software key' do not agree.

- A hardware fault has been discovered by the diagnostic function on either the Type 316VC61a/316VC61b or 316EA62 unit.

To determine whether a set of settings has been downloaded to the equipment, connect it to a PC and start the HMI. Check via the menus 'Editor' and 'Edit function parameters' and 'Edit hardware functions' whether functions have settings and whether the hardware has been configured.

If the settings appear in order, check whether parameters or functions have been entered which are not permitted by the 'software key'.

Should it appear that there is a disagreement with the 'software key', proceed as follows:

- Connect the equipment to a PC and start the HMI.
- Download a slightly changed set of settings to the equipment. The HMI then compares the 'software key' with the programmed functions before it actually downloads the settings and reports an error if they do not agree (EPLD error).

7.4.1.2. *Human/machine interface*

If communication between the protection equipment and the PC this is not possible in spite of the fact that the stand-by LED is lit, first check the serial interface connectors and connecting cable. Where the connection appears to be in order, reboot the PC by switching it off and on and then restart the HMI.

Should this also prove unsuccessful, restart the device either by selecting the menu item 'Warm start' in the RESET menu on the local control and display unit (see [Section 5.13.8.6.](#)) or by holding the reset button depressed until the stand-by LED (green) starts to flash (about 10 seconds). This is a software restart, which is equivalent to switching the auxiliary supply off and on.

In the event of a defect, send the diagnostic information obtained via 'List DiagInfo' and 'Get Hex Dump' together with the device settings to your local support centre.

The following example is of a ROM defect in the main processor unit:

List DiagInfo:

```

MODURES 316 Diagnosis

Relay status : fatal error
Main processor VC61 status : Fault detected
  ROM
    HW number : 000000B0A538
    Software   = 1995-08-11 11:38;00
    Setting    = 1992-01-03 09:44;05
    Protection stop
A/D processor EA6. status : not ready
internal A/D status : no error

FUPLA status: FUPLA not loaded

Press any button to continue; press <ESC> to close.

```

Get Hex Dump:

```

1000:0000      0004 Error code = stopped
1000:0002      0000 Code segment = 00D8H
1000:0004      06D9 Module name = RUNPROT TEXT
1000:0006      00D8 Program counter = 06D9H
1000:0008      0004
1000:000A      0052
1000:000C      01F1
1000:000E      0178 EEPROM: 00000000000000101
1000:0010      0199
1000:0012      00A0
1000:0014      00E1
1000:0016      0730
1000:0018      0000
1000:001A      0000
1000:001C      0000
1000:001E      0005.

```

7.4.1.3. **Restarting**

The detection of an error or defect by the self-testing and monitoring functions during normal operation initiates the following:

- Processing by the protection functions is stopped and their operation blocked.
- The binary outputs are reset and further operation blocked. This includes resetting the 'Relay ready' signal, if it was activated.
- The stand-by signal (green LED on the frontplate) flashes.

Communication between the PC and the protection equipment remains intact, however, and provides facility for localising the cause of the problem.

Blocking of the protection is maintained until an attempt is made to restart it by pressing the reset button on the frontplate. Should restarting be successful, but the original defect still exists, the same sequence is repeated and the protection is blocked once again.

Either the 316VC61a or 316VC61b unit or the complete equipment has to be replaced in the case of error messages concerning the main or logic processors.

Should the diagnostic function report an error in the A/D processor (type 316EA62) although none is fitted, the message can be ignored. If one is fitted, however, it must be replaced.

An entry is made in the event list every time the protection is restarted.

7.5. Software updates

Updating the software with the latest version and where necessary also the hardware can add new functions or new features to the device.

The software version can be is given in the bottom right-hand corner of the HMI screen when it is operating on-line (the first number is the version of the HMI and the second number the version of the software in the equipment).

The HMI is compatible with the equipment software when the first digit after the point is the same in both numbers.

The equipment software can be updated without opening the equipment, because it is stored in a read/write memory (flash EPROM's).

Generally the software must be updated by ABB personnel. Nevertheless, the procedure is described below so that it can be performed by correspondingly qualified personnel (PC experience essential) if necessary.

7.5.1. Settings

Make a backup copy of the settings using the HMI (menu items 'Enter function parameters' and 'Save in file'). Then close the HMI.

7.5.2. Deleting the settings and the program and downloading a new program

The following additional files which are necessary to update the firmware are in the HMI directory after installation:

- spa316a.h26, lon316a.h26, vdew316a.h26: Software for the processor unit 316VC61a, depends on communications protocol.
- spa316b.h26, lon316b.h26, vdew316b.h26: Software for the processor unit 316VC61b, depends on communications protocol.

- spa316a.bat, lon316a.bat, vdew316a.bat: Batch file for loading the software into the processor unit 316VC61a, depends on communications protocol.
- spa316b.bat, lon316b.bat, vdew316b.bat: Batch file for loading the software into the processor unit 316VC61b, depends on communications protocol.

The type of processor board can be determined using the HMI diagnostic function. Upon selecting 'Show diagnostic data', one of the lines displayed is 'HW No.', which in the case of 316VC61**a** includes the code '0434':

HW-No.: xxxx/**0434**/xx

or for 316VC61**b** the code '04Ax':

HW-No.: xxxx/**04Ax**/xx

The new software is loaded into devices with the existing software version V5.0 is accomplished by running the corresponding batch file. For this purpose, make the active directory the HMI directory via the File Manager (Windows 3.1 or 3.11) or Explorer (Windows 95, 98 or NT 4.0) and execute the appropriate batch file. The version, type of processor board (316VC61a or 316VC61b) and the desired communication protocols are then displayed again. Click on N (no) to abort or on Y (yes) to continue.

The HMI proper does not then start, but simply a window appears with the question 'Are you sure? <Y>/<N>' as a safety precaution. If you enter 'N' the normal HMI starts; if you enter 'Y' the settings and the program are instantly deleted. The deleting procedure takes about twenty seconds. During this time 'Saving restart relay' flashes on the screen.

At the end of this operation, the file '*.h26' is transferred to the equipment. This takes about 5 minutes. During this time the progress is indicated by numbered lines and dots:

33.....

After transfer has been completed, the new program starts automatically and the time stamp of the *.h26 file is saved in the equipment.

During the whole of this operation do not make any entries at the keyboard of the PC, as this interrupts the automatic procedure.

7.5.3. *Problems transferring the new software*

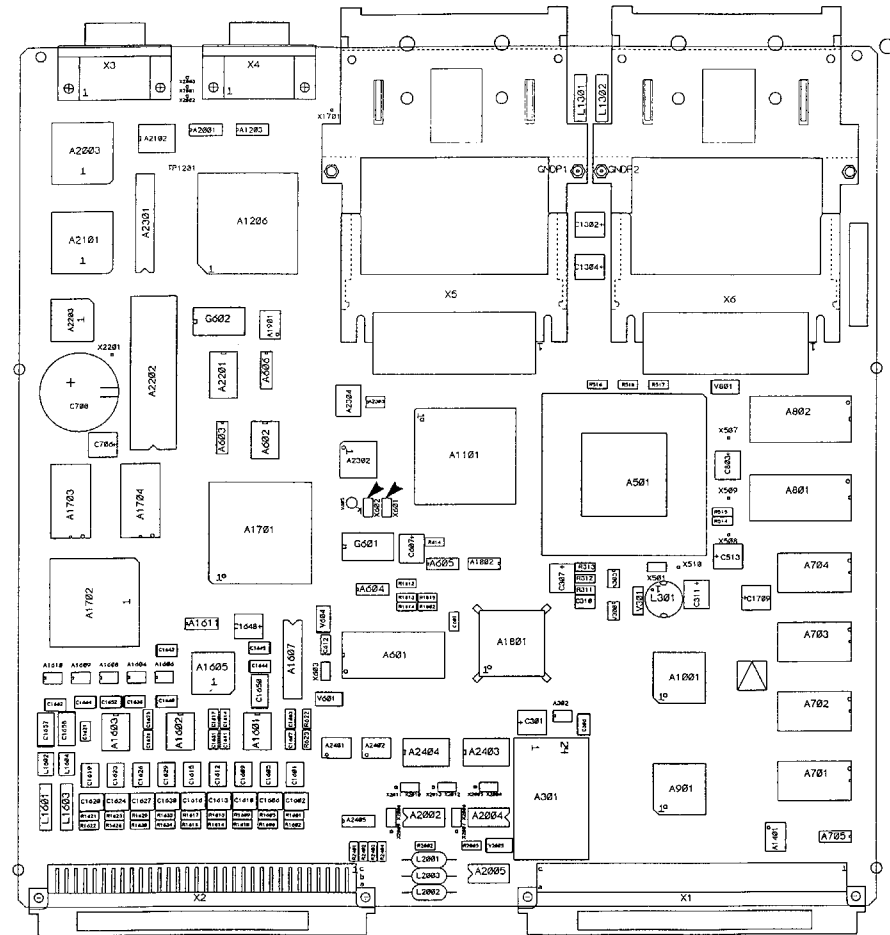
Problems and errors can never be excluded when transferring and saving new software (e.g. supply failure during transfer). Should something of this kind occur, an attempt can be made to repeat the transfer by executing the batch file again. If the equipment responds neither to the call by the batch file nor the HMI, try to reinitialise the equipment by switching the auxiliary supply off and back again and then repeat the transfer of the program file.

Should this also prove unsuccessful, the following procedure must be executed to delete the contents of the program memory in the main processor unit:

Devices with the main processor unit 316VC61a have to be opened and the main processor unit removed from them. Fit the two jumpers X601 and X602 and reinsert the main processor unit. Switch on the auxiliary supply and wait for thirty seconds. Switch off the auxiliary supply and withdraw the main processor again. The program is now deleted. Remove the two jumpers, plug the main processor in again, reassemble the equipment and repeat the program transfer procedure.

Switch of the auxiliary supply to devices equipped with main processor 316VC61b and then insert the pin supplied into the socket below the SPA or VDEW6 communication interface. Switch on the auxiliary supply for about thirty seconds, switch it off again and withdraw the pin. This procedure deletes the program and the new program can be loaded after switching on the auxiliary supply again.

Should the pin not be available, the same procedure can be used as described in the previous paragraph for the 316VC61a with the exception that the jumper marked 'TEST' has to be inserted instead of X601 and X602.



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Fig. 7.7 Main processor unit 316VC61a showing the jumpers X601 and X602 (derived from HESG 324 502)

7.6. ***Replacing hardware units***

Qualifications

Hardware units may only be replaced by suitably qualified personnel. Above all it is essential for the basic precautions concerning protection against electrostatic discharge be observed.

It may be necessary to transfer existing settings from the relay or download new ones to the relay, procedures which assume familiarity with the HMI.

Note that incorrect handling of the devices and their component parts can cause damage (to the devices or the plant) such as:

- false tripping of items of plant in operation
- destruction of main c.t's and v.t's etc.

The following are basic precautions which have to be taken to guard against electrostatic discharge:

- Before handling units, discharge the body by touching the station ground (cubicle).
- Hold units only at the edges, do not touch contacts or components.
- Only store and transport units in or on the original packing.

Tools required

Relays can be opened at the rear. The backplates are secured either Philips screws or Torx screws. Accordingly one of the following is required:

- Philips screwdrivers No. 1 and No. 2

or

- Torx screwdrivers No. 10 and No. 20.

Terminal screws are always of the normal slotted type. No other tools are required.

Procedure

Follow the check list in the Appendix of [Index 12](#) when replacing hardware units.

The check list is primarily intended for replacing defective units by ones of the same type (same code). If a different relay configuration is desired or necessary, units may have to be re-

placed. A change of software may also be involved. At least the codes in the relay and on the rating plate will have to be corrected. Where problems arise, consult ABB Switzerland Ltd.

In order to keep records of the PCB's installed up-to-date, the corresponding data should be forwarded to ABB Switzerland Ltd, when PCB's are changed ([see Appendix](#)).

Caution:

When replacing a processor board Type 316VC61a, the positions of the jumpers must be checked in relation to Fig. 7.8.

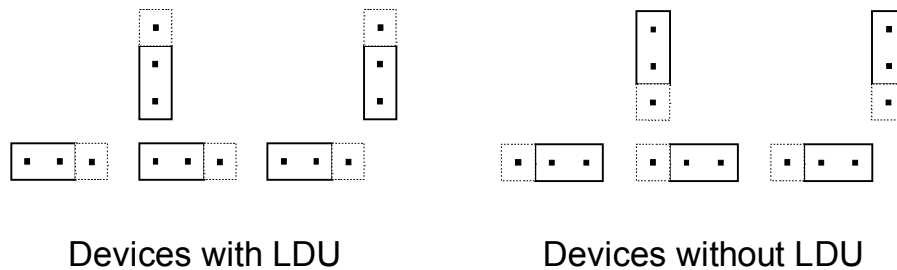
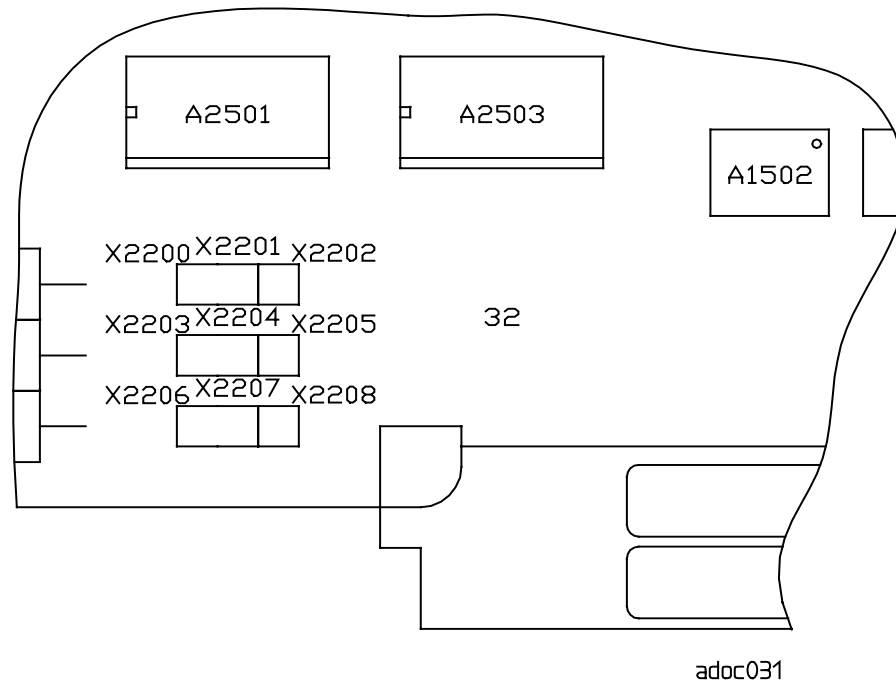


Fig. 7.8 Jumper positions on the processor board 316CV61a for devices with and without the local control and display unit (LDU)

Caution:

If a processor board, type 316VC61b is replaced in a unit, check the jumpers according to Fig. 7.9. These jumpers are located between the two connectors.



Including LDU: X2200 – X2201
 X2203 – X2204
 X2206 – X2207

Excluding LDU: X2201 – X2202
 X2204 – X2205
 X2207 – X2208

Fig. 7.9 Jumper positions on the 316VC61b processor board for devices including and excluding a local control and display unit (LDU) on the front (derived from HESG 324 526)

June 98

8. TECHNICAL DATA

Data Sheet REC 316*4 1MRK511016-Ben



Features

Application

- MV and HV systems for power transmission and distribution and for the power requirements of industrial plants and power stations
- Air or gas insulated switchgear
- Decentral installation in switch bay or kiosk
- New installations, refurbishment of existing plants
- A large number of standard functions for control, metering, monitoring, automation and protection
- Customer-specific solutions.

Control functions

- Control of circuit breakers, isolators and grounding devices
- State acquisition with plausibility check
- Command output with double command
- Run-time supervision
- Bay-oriented interlocking
- Stationwide interlocking
- Simple adaption through graphical engineering tool CAP316.

Protection functions

- Definite time over-/undervoltage protection
- High-set over-/undervoltage protection
- Definite time overcurrent protection with inrush detection
- High-set overcurrent protection
- Inverse time overcurrent protection with four characteristics according to B.S. 142
- Directional inverse and definite time overcurrent protection
- Thermal overload protection
- Frequency protection
- Rate-of-change of frequency
- The product range's entire function library of the RE.316 is available for customer-specific solutions
- Four independent, user-selectable setting groups
- Multi-activation facility of the available functions
- Breaker-failure protection.

Automation

- Single and/or three-phase multi-shot auto-reclosure

Features (cont'd)

- Synchrocheck function
- High-speed busbar transfer
- Load shedding.

Metering

- Metering function for the measurement of voltage, current, frequency and active and reactive power.

Process supervision

- Sequential recorder having a resolution of 1 ms
- Defluttering of binary inputs
- Disturbance recording of freely selectable analog inputs, such as vt's, ct's and internal results of protection functions as well as binary information.

Functions for programming by the user

- Logic (AND, OR and S/R flip-flop)
- Timer/integrator.

Application-specific functions

- Customizing of control functions with the graphical engineering tool CAP316.

Self-supervision

- Continuous self-supervision and diagnosis
- Test equipment for quantitative testing available
- Plausibility check of the three-phase current and voltage inputs.

Operational control

- Multi-lingual menu-based operator program CAP2/316 based on Windows
- Provision for storing four independent sets of settings in REC316*4.

Serial interfaces

- Frontplate interface for local connection of a personal computer
- Back plane interface for remote communication with a station control system: LON, IEC 60870-5-103, MVB (part of IEC 61375), SPA
- Back plane interface for process bus: MVB (part of IEC 61375).

Installation

- REC316*4 is suitable for semi-flush or surface mounting or installation in a rack.

Application

The numerical control unit REC316*4 is a compact multi-functional unit. It is designed for the control, metering, monitoring, automation and protection functions of MV and HV transmission systems. Simply programmable standard functions from a comprehensive software library of the RE.216/316 product range and a powerful and fast function block language make the unit a user-friendly and extremely flexible terminal.

The control of switching objects is performed with the highest possible supervision and safety. A large selection of protection functions reduces the number of necessary devices in HV bays through the combination of control and backup protection functions in one unit. The integrated autoreclosure function can be utilized by both main protection devices.

The closure of the circuit breaker can be supervised by a synchrocheck function. Motor busbars can be switched on with phase synchronization by a fast switch-over function.

Apart from the operating asset protection in cooperation with function block engineered modules using the CAP316 tool, the multi-configurable frequency function allows the generation of intelligent load shedding automatics. Automatic network restoration is enabled by integrating the REC316*4 into a station control system.

For metering, the quantities current, voltage, real power, apparent power and frequency are available. In addition the transmission of energy counting impulses to the control system is possible. The recording of disturbances, switching operations and analog results of protection functions is performed by the integrated disturbance recorder.

Device design

The REC316*4 belongs to the generation of fully numerical control and protection terminals, i.e. analogue to digital conversion of the input variables takes place immediately after the input transformers and all further processing of the resulting numerical signals is performed by microprocessors and controlled by programs. Resulting numerical processing ensures consistent ACCURACY and SENSITIVITY throughout its operational life.

REC316*4 is noted for its process interface, satisfying the highest EMC requirements, as well as for the standardized serial interfaces for integration into a control system. This enables an information exchange both in a vertical direction with systems of higher order and in a horizontal direction between various bay control units.

Because of its compact design, the very few hardware units it needs, its modular software and the integrated continuous self-diagnostic and supervision functions, REC316*4 ideally

fulfils the user's expectations of a modern control and protection terminal at a cost-effective price. The AVAILABILITY of a device, i.e. the ratio between its mean time in service without failure and the total life, is most certainly its most important characteristic. As a consequence of the continuous supervision of its functions, this quotient in the case of REC316*4 is typically always close to 1.

The menu-based HMI (Human Machine Interface) and the terminal's small size makes the tasks of connection, configuration and setting simple. A maximum of FLEXIBILITY, i.e. the ability to adapt the protection for application in a particular power system or to coordinate with, or replace units in an existing control and protection scheme, is provided in REC316*4 by the extensive library of standard functions and the powerful function block engineering. The free assignment of input and output signals is enabled via the HMI.

Hardware

The hardware concept for the REC316*4 numerical control unit comprises four different plug-in units, a connecting mother PCB and housing (Fig. 1):

- analog input unit
- central processing unit
- 1 to 4 binary input/output units
- power supply unit
- connecting mother PCB
- housing with connection terminals

In the analog input unit an input transformer provides the electrical and static isolation between the analogue input variables and the internal electronic circuits and adjusts the signals to a suitable level for processing. The input transformer unit can accommodate a maximum of nine input transformers (voltage-, protection current- or measuring transformer).

Every analog variable is passed through a first order R/C low-pass filter on the main CPU unit to eliminate what is referred to as the aliasing effect and to suppress HF interferences (Fig. 2). They are then sampled 12

times per period and converted to digital signals. The analog/digital conversion is performed by a 16 Bit converter.

A DSP carries out part of the digital filtering and makes sure that the data for the protection algorithms are available in the memory to the main processor.

The processor core essentially comprises the main microprocessor for the protection algorithms and dual-ported memories (DPMs) for communication between the A/D converters and the main processor. The main processor performs the protection algorithms and controls the local HMI and the interfaces to the station control system. Binary signals from the main processor are relayed to the corresponding inputs of the I/O unit and thus control the auxiliary output relays and the light emitting diode (LED) signals. The main processor unit is equipped with an RS232C serial interface via which among other things the protection settings are made, events are read and the data from the disturbance recorder memory are transferred to a local or remote PC.

On this main processor unit there are two PCC slots and one RS232C interface. These serial interfaces provide remote communica-

Hardware (cont'd)

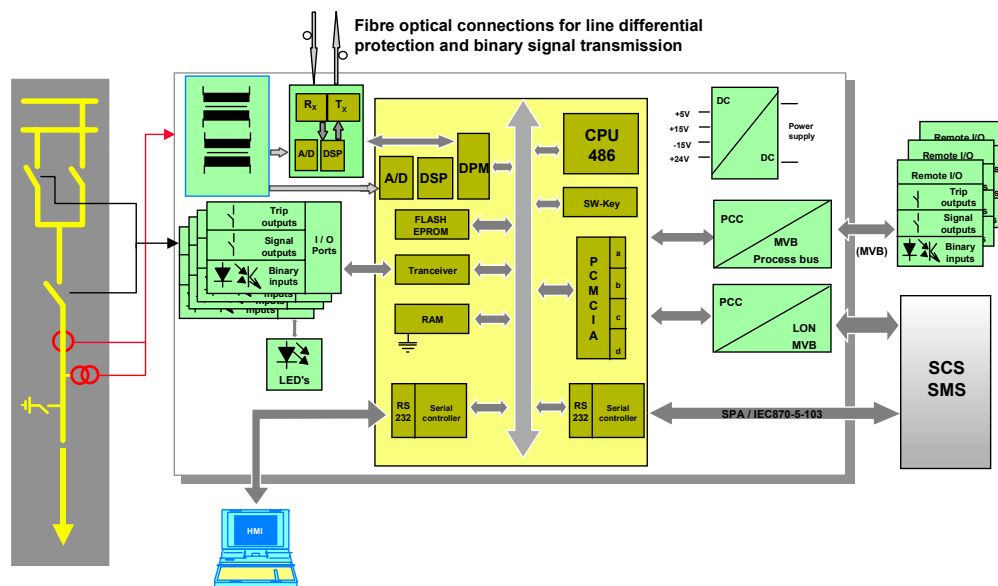


Fig. 1 Hardware platform overview

tion to the station monitoring system (SMS) and station control system (SCS) as well as to the remote I/O's.

REC316*4 can have one to four binary I/O units each. These units are available in three versions:

- two tripping relays with two heavy-duty contacts each, 8 optocoupler inputs and 6 signalling relays Type 316DB61
- two tripping relays with two heavy-duty contacts each, 4 optocoupler inputs and 10 signalling relays Type 316DB62

- 14 optocoupler inputs and 8 signalling relays Type 316DB63.

When ordering REC316*4 with more than 2 I/O units N2 casing must be selected.

According to whether one or two I/O units are fitted, there are either 8 LED's or 16 LED's visible on the front of the terminal.

Software

Both analogue and binary input signals are conditioned before being processed by the main processor: As described under hardware above, the analogue signals pass through the sequence input transformers, shunt, low-pass filter (anti-aliasing filter), multiplexer and A/D converter stages and DSP. In their digital form, they are then separated by numerical filters into real and apparent components

before being applied to the main processor. Binary signals from the optocoupler inputs go straight to the main processor. The actual processing of the signals in relation to the protection algorithms and logic then takes place.

Signal data flow

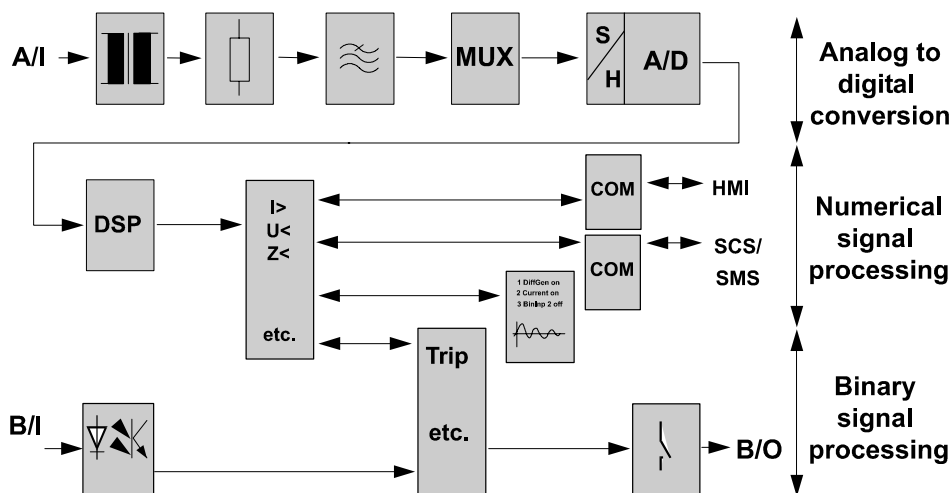


Fig. 2 Data Flow

Graphical engineering tool

The graphical programming language used in the tool CAP316 makes CAP316 a powerful and user-friendly engineering tool for the engineering of the control and protection units RE.216/316. It is similar to IEC 1131. CAP316 permits the function blocks representing the application to be directly translated into an application program (FUPLA) capable of running on the processors of the control and protection units RE.316*4. The program packet contains an extensive library of function blocks. Up to 8 projects (FUPLA's created with CAP316) are able to run simultaneously on a RE.316*4.

List of functions

Binary functions:

AND	AND gate
ASSB	Assign binary
B23	2-out-of-3 selector
B24	2-out-of-4 selector
BINEXTIN	External binary input

BINEXOUT
COUNTX
CNT
CNTD
OR
RSFF
SKIP
TFF
TMOC
TMOCS, TMOCL
TMOI
TMOIS, TMOIL
TOFF
TOFFS, TOFFL
TON
TONS, TONL
XOR

Analogue functions:

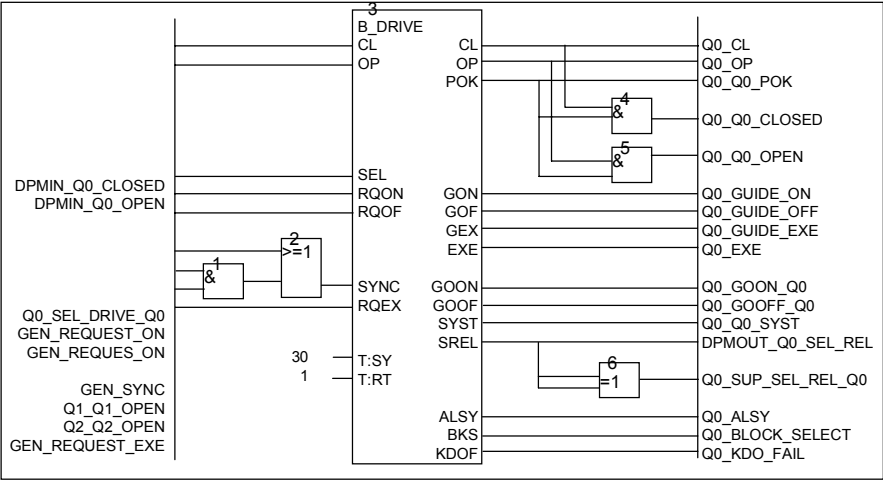
ABS	Absolute value
ADD	Adder/subtractor

External binary output
Shift register
Counter
Downwards counter
OR gate
RS flip-flop
Skip segment
T flip-flop with reset
Monostable constant
Monostable constant short, long
Monostable constant with interrupt
Monostable constant with interrupt short, long
Off delay
Off delay short, long
On delay
On delay short, long
Exclusive OR gate

Graphical engineering
tool (cont'd)

ADDL	Long integer adder/sub- tractor	LOADS	Load shedding function
ADMUL	Adder/multiplier	MAX	Maximum value detector
CNVIL	Integer to long integer converter	MIN	Minimum value detector
CNVLBCD	Long integer to BC con- verter	MUL	Multiplier
CNVLI	Long integer to integer converter	MULL	Long integer multiplier
CNVLP	Long integer to percent converter	NEGP	Percent negator
CNVPL	Percentage to long inte- ger converter	PACW	Pack BINARY signals into INTEGER
DIV	Divider	PDTS, PDTL	Differentiator
DIVL	Long integer divider	PTIS, PTIL	Delayed approximation
FCTL	Linear function	SQRT	Square root
FCTP	Polynomial function	SWIP	Percent switch
FILT	Filter	THRLL	Lower limit threshold
INTS, INTL	Integrator	THRUL	Upper limit threshold
KMUL	Factor multiplier	TMUL	Time multiplier
LIM	Limiter	UPACW	Unpack BINARY sig- nals from an INTEGER

Example:

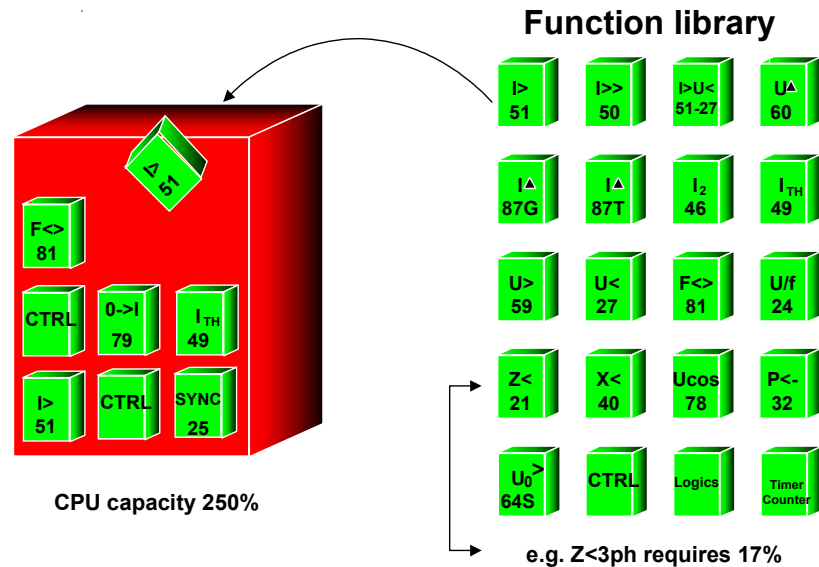


Part of a FUPLA application (Q0: Control and interlocking logic for three objects
Q0, Q1, Q2. B_DRIVE is a macro composed of binary function blocks)

Functions

The entire function library of the RE.316*4 product range is available in the REC316*4. A selection from this library for the standard versions of the REC316*4 is released via a key. Customer-specific keys and also input transformer configurations may be made on request. The available standard functions are

described below. Within the constraints of the available processing capacity, the same function may be included several times. Further user functions, such as the control of switching objects, are realized by the combination of FUPLA modules and standard functions.



Control of switching objects

The REC316*4 receives the control commands from the station control system or from a local operator control panel via fibre optic links. In both cases a three-step command input is adhered to for safety reasons. The user is informed about the actual switching state at any time, because the state of the switching object is registered via double signalling with plausibility check.

Command output is made with a double command, interlocked against all other switching objects in order to avoid undesired or simultaneous switching operations due to short-circuits or operator errors. Subsequent to the command output the individually adjustable run time supervision is started.

The bay-oriented interlocking makes sure that only permissible switching operations within a particular bay can be executed. For station-wide interlocking, interlocking signals are exchanged between the individual bay control units.

The control functions are created by the graphical function block engineering tool CAP316 and can easily be matched to the individual process requirements.

Auto-reclosure

The autoreclosure function included in REC316*4 permits up to four three-phase reclosure cycles to be carried out, each with an independently adjustable dead time for fast and slow autoreclosure. Where single-phase reclosure is being applied, the first reclosure is the single-phase one and the others are three-phase. The function may be actuated by internal protection functions or external protection relays via optocoupler inputs.

Synchrocheck

The synchrocheck function determines the difference between the amplitudes, phase-angles and frequencies of two voltage vectors. Checks are also included to detect a dead line or busbar.

High-speed busbar transfer

This function allows the fast synchronized transfer of motor busbars between the main and standby supply. Automatic transfer at phase coincidence of the voltages as well as slow transfer (low voltage, max. time) and manual transfer are included.

Functions (cont'd)

Thermal overload

The thermal overload function can be used for either cables or transformers. It is equipped with alarm and tripping stages and has a wide setting range for adjusting the time constant to match that of the protected unit.

Instantaneous overvoltage function (instantaneous tripping)

The frequency-dependent voltage function can be applied either as maximum or minimum function for instantaneous tripping or with settable delay. Single or three-phase measurement with maximum value detection for multi-phase functions.

The voltage function is supplementary to the voltage indicator used for interlocking of the feeder earthing switch. Adjustable lower limiting frequency.

Definite time voltage function

The voltage function can be set to operate on overvoltage or undervoltage with a definite time delay. Either single or three-phase measurements can be performed.

Instantaneous overcurrent function (instantaneous tripping)

The frequency-dependent current function can be applied either as maximum or minimum function for instantaneous tripping or with settable delay. Single or three-phase measurement with maximum value detection for multi-phase functions. Adjustable lower limiting frequency.

Definite time current function

The current function can be set to operate on overcurrent or undercurrent with a definite time delay. Either single or three-phase measurements can be performed.

Inverse time-overcurrent function

The operating time of the inverse time-overcurrent function reduces as the fault current increases and it can therefore achieve shorter operating times for fault locations closer to the source. Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse with an extended setting range are provided. The function can be configured for single-phase measurement or a combined three-phase measurement with detection of the highest phase current.

Inverse time ground fault overcurrent function

The inverse time ground fault overcurrent function monitors the neutral current of the system which is either measured via a neutral current input transformer or derived internally in the terminal from the three phase currents. Four different characteristics according to British Standard 142 designated normal inverse, very inverse, extremely inverse and long time inverse but with an extended setting range are provided.

Directional overcurrent protection

The directional overcurrent protection function is available either with inverse time or definite time overcurrent characteristic. This function comprises a voltage memory for faults close to the relay location. The function response after the memory time has elapsed can be selected (trip or block).

Frequency function

The frequency function is based on the measurement of one voltage. This function is able to be configured as maximum or minimum function and is applied as protection function and for load shedding. By multiple configuration of this function almost any number of stages can be realized.

Rate-of-change of frequency

This function offers alternatively an enabling by absolute frequency. It contains an undervoltage blocking facility. Repeated configuration of this function ensures a multi-step setup.

Measuring

Both measuring functions measure the single- or three-phase rms values of voltage, current, frequency, real power and apparent power for display on the local HMI or transfer to the station control system. A choice can be made between phase-to-neutral and phase-to-phase voltages.

Ancillary functions

Ancillary functions such as a logic and a delay/integrator enable the user to create logical combinations of signals and pick-up and reset delays.

A run-time supervision feature enables checking the opening and closing of all kinds of breakers (circuit-breakers, isolators, ground switches...). Failure of a breaker to open or close within an adjustable time results in the creation of a corresponding signal for further processing.

Plausibility check

The current and voltage plausibility functions facilitate the detection of system asymmetries, e.g. in the secondary circuits of c.t.'s and v.t.'s. The internal sum of phasors can be compared with an external summation when quantities are applied to an input.

Sequence of events recorder

The event recorder function provides capacity for up to 256 binary signals including time marker with a resolution in the order of milliseconds. It is also possible to activate flutter recognition in order to avoid filling up the memory by continuously recurring signal response (flutter).

Disturbance recorder

The disturbance recorder monitors up to 9 analogue inputs, 16 binary inputs and internal results of protection functions. The capacity for recording disturbances depends on the duration of a disturbance as determined by its pre-disturbance history and the duration of the disturbance itself. The total recording time is approximately 5 s.

Other protection functions

See data sheets of REL316*4, RET316*4 and REG316*4.

Human machine interface (HMI) - CAP2/316

For local communication with REC316*4, there is the setting software CAP2/316 available which is based on Windows. This software runs under the following operating systems:

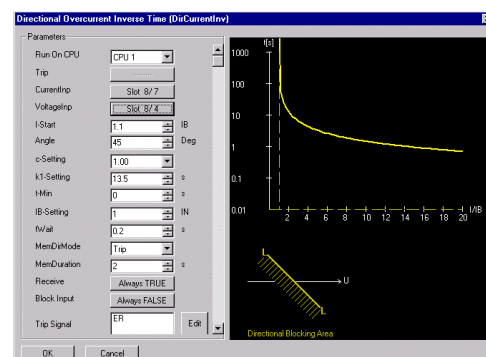
- Windows NT 4.0
- Windows 2000

This optimal programming tool is available for engineering, testing, commissioning and operation.

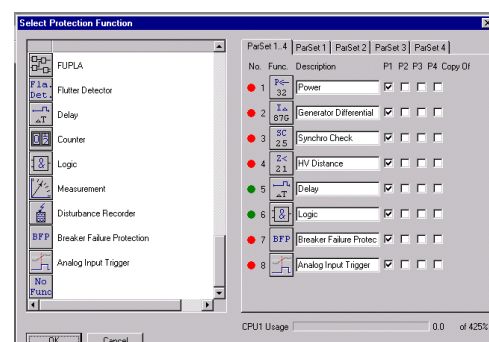
The software can be used either ON-LINE or OFF-LINE and furthermore contains a DEMO mode.



For each protection function a tripping characteristic is displayed. Apart from the basic understanding of the protection functions, the graphical display of these functions also makes the setting of the parameters clearer.



Any desired protection function can be selected from the software library of all released protection functions by means of the drag-and-drop feature.



Functions (cont'd)

Built-in HMI

The front HMI unit serves primarily for the signalling of actual events, measurands and diagnostic data. Settings are not displayed.

Features:

- Measurand display
 - Amplitude, angle, frequency of analogue channels
 - Functional measurands
 - Binary signals
- Event list
- Operating instructions
- Disturbance recorder information
- Diagnostic information
- Acknowledgment functions
 - Resetting LED's
 - Resetting latched outputs
 - Event erasing
 - Warmstart

Remote communication

REC316*4 is able to communicate with a station monitoring system (SMS) or a station control system (SCS) via an optical fibre link. The corresponding serial interface permits events, measurements, disturbance recorder data and protection settings to be read as well as control commands and demand value parameters to be received and sets of parameter settings to be switched.

Using the LON bus permits in addition the exchange of binary information between the individual bay controllers, e.g. signals for station interlocking.

Remote in- and outputs (RIO580)

Using the process bus type MVB remote in- and output units 500RIO11 can be connected to the RE.316*4 terminals. The in- and output channels can be extended to a large number by using RIO580 remote input/output system. Installing 500RIO11 I/O units close to the process reduces the wiring dramatically, since they are accessible via fibre optic link from the RE.316*4 terminals.

Analog signals can also be connected to the system via the 500AXM11 from the RIO580 family:

- DC current 4...20 mA
 0...20 mA
 -20...20 mA
- DC voltage 0...10 V
 -10...10 V
- Temp. sensor Pt100, Pt250, Pt1000,
 Ni100, Ni250, Ni1000.

Self-diagnosis and supervision

RE.316*4's self-diagnosis and supervision functions ensure maximum availability not only of the protection device itself, but also of the power system it is protecting. Hardware failures are immediately signalled by an alarm contact and the communication supervision of the control system. In particular, the external and internal auxiliary supplies are continuously supervised. The correct function and tolerance of the A/D converter are tested by cyclically converting two reference voltages. Special algorithms regularly check the processor's memories (background functions). A watchdog supervises the execution of the programs. The program execution in the processor itself is monitored by a watchdog function.

An important advantage of the extensive self-diagnosis and supervision functions is that periodic routine maintenance and testing are reduced.

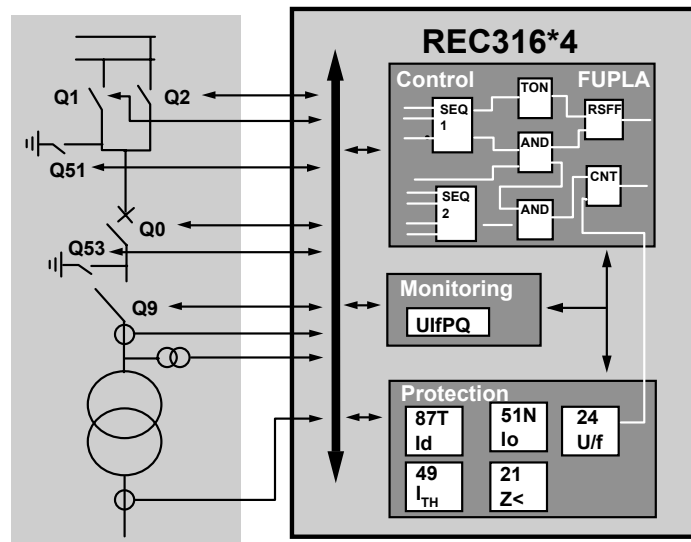
Supporting software

The operator program facilitates configuration and setting of the protection, listing parameters, reading events and listing the various internal diagnostic data.

The evaluation programs REVAL and WIN-EVE (MS Windows/Windows NT) are available for viewing and evaluating the disturbances stored by the disturbance recorder.

The program XSCON (MS Windows) is available for conversion of the RE.316*4's disturbance recorder data to ABB's test set XS92b format. This enables reproduction of electrical quantities recorded during the disturbance.

Example of an application



Example for control and protection of a transformer bay

Control

- Control of circuit breakers, isolators and grounding devices
- Bay-oriented interlocking
- Station interlocking
- Run time supervision
- Process supervision
- Measuring

Protection

- Transformer differential
- Thermal protection
- Overexcitation
- Distance protection
- etc.

Technical data Hardware

Table 1: Analogue input variables

Number of inputs according to version, max. 9 analogue inputs (voltages and currents, 4 mm ² terminals)	
Rated frequency f_N	50 Hz or 60 Hz
Rated current I_N	1 A, 2 A or 5 A
Thermal rating of current circuit continuous for 10 s for 1 s dynamic (half period)	$4 \times I_N$ $30 \times I_N$ $100 \times I_N$ $250 \times I_N$ (peak)
Rated voltage U_N	100 V or 200 V
Thermal rating of voltage circuit continuous during 10 s	$1.3 \times U_N$ $2 \times U_N$
Burden per phase current inputs at $I_N = 1$ A at $I_N = 5$ A voltage inputs at U_N	<0.1 VA <0.3 VA <0.25 VA
V.t. fuse characteristic	Z acc. to DIN/VDE 0660 or equivalent

Table 2: Contact data

Tripping relays	
No. of contacts	2 relays per I/O unit 316DB61 or 316DB62 with 2 N/O contacts each. 1.5 mm ² terminals
Max. operating voltage	300 V AC or V DC
Continuous rating	5 A
Make and carry for 0.5 s	30 A
Surge for 30 ms	250 A
Making power at 110 V DC	3300 W
Breaking capacity for L/R = 40 ms Breaking current with 1 contact at U <50 V DC at U <120 V DC at U <250 V DC	1.5 A 0.3 A 0.1 A
Breaking current with 2 contacts in series at U <50 V DC at U <120 V DC at U <250 V DC	5 A 1 A 0.3 A
Signalling contacts	
No. of contacts	6, 10 or 8 acc. to I/O unit (316DB61, 316DB62 or 316DB63), 1 contact per sig. relay with 1.5 mm ² terminals Each interface unit equipped with 1 C/O contact and the all other N/O contacts
Max. operating voltage	250 V AC or V DC
Continuous rating	5 A
Make and carry for 0.5 s	15 A
Surge for 30 ms	100 A
Making power at 110 V DC	550 W
Breaking current for L/R = 40 ms at U <50 V DC at U <120 V DC at U <250 V DC	0.5 A 0.1 A 0.04 A
The user can assign tripping and signalling contacts to protection functions	

Table 3: Opto-coupler inputs

No. of opto-couplers	8, 4 or 14 acc. to I/O unit (316DB61, 316DB62 or 316DB63)
Input voltage	18 to 36 V DC / 36 to 75 V DC / 82 to 312 V DC / 175 to 312 V DC
Threshold voltage	10 to 17 V DC / 20 to 34 V DC / 40 to 65 V DC / 140 to 175 V DC
Max. input current	<12 mA
Operating time	1 ms
The user can assign the inputs to protection functions.	

Table 4: Light-emitting diodes

Choice of display modes:	
• Accumulates each new disturbance • Latching with reset at next pick-up • Latching only if protection trips with reset at next pick-up • Signalling without latching	
	1 green (standby) 1 red (trip) 6 or 14 yellow (all other signals)
The user can assign the red and yellow LED's to functions.	

Table 5: Configuration and settings

Local via the communication interface on the front port connector using an IBM-compatible PC with Windows NT 4.0 or Windows 2000. The operator program can also be operated by remote control via a modem.	
Operator program	in English or German

Table 6: Remote communication

RS232C interface Data transfer rate Protocol Electrical/optical converter (optional)	9 pin Sub-D female 9600 Bit/s SPA or IEC 60870-5-103 316BM61b
PCC interface Number	2 plug-in sockets for type III cards
PCC (optional) Interbay bus protocol Process bus protocol (interbay and process bus can be used concurrently)	LON or MVB (part of IEC 61375) MVB (part of IEC 61375)
LON bus Data transfer rate	PCC with fibre-optical port, ST connectors 1.25 MBit/s
MVB bus Data transfer rate	PCC with redundant fibre-optical port, ST connectors 1.5 Mbit/s
Event memory Capacity Time marker resolution	256 events 1 ms
Time deviation without remote synchronizing	<10 s per day
Engineering interface	integrated software interface for signal engineering with SigTOOL

Technical data Hardware (cont'd)
Table 7: Auxiliary supply

Supply voltage	
Voltage ranges	36 to 312 V DC
Voltage interruption bridging time	>50 ms
Fuse rating	≥4 A
Load on station battery at normal operation (1 relay energized)	<20 W
during a fault (all relays energized)	
with 1 I/O unit	<22 W
with 2 I/O units	<27 W
with 3 I/O units	<32 W
with 4 I/O units	<37 W
Additional load of the options line differential protection SPA, IEC 60870-5-103 or LON interface MVB interface	7.5 W 1.5 W 2.5 W
Buffer time of the event list and fault recorder data at loss of auxiliary supply	>2 days (typ. 1 month)

Table 8: General data

Temperature range operation storage	-10° C to +55° C -40° C to +85° C	EN 60255-6 (1994), IEC 60255-6 (1988)
Humidity	93%, 40° C, 4 days	IEC 60068-2-3 (1969)
Seismic test	5 g, 30 s, 1 to 33 Hz (1 octave/min)	IEC 60255-21-3 (1995), IEEE 344 (1987)
Leakage resistance	>100 MΩ, 500 V DC	EN 60255-5 (2001), IEC 60255-5 (2000)
Insulation test	2 kV, 50 Hz, 1 min 1 kV across open contacts	EN 60255-5 (2001), IEC 60255-5 (2000), EN 60950 (1995)
Surge voltage test	5 kV, 1.2/50 μs	EN 60255-5 (2001), IEC 60255-5 (2000) *
1 MHz burst disturbance test	1.0/2.5 kV, Cl. 3; 1MHz, 400 Hz rep.freq.	IEC 60255-22-1 (1988), ANSI/IEEE C37.90.1 (1989)
Fast transient test	2/4 kV, Cl. 4	EN 61000-4-4 (1995), IEC 61000-4-4 (1995)
Electrostatic discharge test (ESD)	6/8 kV (10 shots), Cl. 3	EN 61000-4-2 (1996), IEC 61000-4-2 (2001)
Immunity to magnetic interference at power system frequencies	300 A/m; 1000 A/m; 50/60 Hz	EN 61000-4-8 (1993), IEC 61000-4-8 (1993)
Radio frequency interference test (RFI)	• 0.15-80 MHz, 80% amplitude modulated 10 V, Cl. 3 • 80-1000 MHz, 80% amplitude modulated 10 V/m, Cl. 3 • 900 MHz, puls modulated 10 V/m, Cl. 3	EN 61000-4-6 (1996) EN 61000-4-6 (1996), EN 61000-4-3 (1996), IEC 61000-4-3 (1996), ENV 50204 (1995)
Emission	Cl. A	EN 61000-6-2 (2001), EN 55011 (1998), CISPR 11 (1990)
* Reduced values apply for repeat tests according to IEC publication 255-5, Clauses 6.6 and 8.6.		

Table 9: Mechanical design

Weight Size N1 casing Size N2 casing	approx. 10 kg approx. 12 kg
Methods of mounting	semi-flush with terminals at rear surface with terminals at rear 19" rack mounting, height 6U, width N1: 225.2 mm (1/2 19" rack). Width N2: 271 mm.
Enclosure Protection Class	IP 50 (IP 20 if MVB PCC interfaces are used) IPXXB for terminals.

Technical data Functions

Table 10: Autoreclosure (79)

• Single and three-phase autoreclosure. • Operation in conjunction with distance, longitudinal differential, overcurrent and synchrocheck functions and also with external protection and synchrocheck relays. • Logic for 1st. and 2nd. main protections, duplex and master/follower schemes. • Up to four fast or slow reclosure shots. • Detection of evolving faults.	
Settings:	
1st. reclosure	none 1P fault - 1P reclosure 1P fault - 3P reclosure 1P/3P fault - 3P reclosure 1P/3P fault - 1P/3P reclosure
2nd. to 4th. reclosure	none two reclosure cycles three reclosure cycles four reclosure cycles
Single-phase dead time	0.05 to 300 s
Three-phase dead time	0.05 to 300 s
Dead time extension by ext. signal	0.05 to 300 s
Dead times for 2nd., 3rd. and 4th. reclosures	0.05 to 300 s
Fault duration time	0.05 to 300 s
Reclaim time	0.05 to 300 s
Blocking time	0.05 to 300 s
Single and three-phase discrimination times	0.1 to 300 s
	All settings in steps of 0.01 s

Table 11: Synchrocheck function (25)

Determination of synchronism • Single-phase measurement. The differences between the amplitudes, phase-angles and frequencies of two voltage vectors are determined.	
Voltage supervision • Single or three-phase measurement • Evaluation of instantaneous values and therefore wider frequency range • Determination of maximum and minimum values in the case of three-phase inputs	
• Phase selection for voltage inputs • Provision for switching to a different voltage input (double busbar systems) • Remote selection of operating mode	
Settings:	
Max. voltage difference	0.05 to 0.4 U_N in steps of 0.05 U_N
Max. phase difference	5 to 80° in steps of 5°
Max. frequency difference	0.05 to 0.4 Hz in steps of 0.05 Hz
Min. voltage	0.6 to 1 U_N in steps of 0.05 U_N
Max. voltage	0.1 to 1 U_N in steps of 0.05 U_N
Supervision time	0.05 to 5 s in steps of 0.05 s
Resetting time	0 to 1 s in steps of 0.05 s
Accuracy	for 0.9 to 1.1 f_N
Voltage difference	±5% U_N
Phase difference	±5°
Frequency difference	±0.05 Hz

Table 12: High-speed busbar transfer (HBT)

Frequency range	0.8 to 1.04 f_N
Operating modes	- Manual transfer (with-break or no-break), with synchronism check - High-speed automatic transfer (max. phase angle and/or closing at phase coincidence) - Slow automatic transfer (low voltage and/or max. time)
Parameters: Closing time CB1 and CB2	0 to 150 ms in steps of 1 ms

For more details see separate data sheet 1MRB520156-Ben

Table 13: Thermal overload function (49)

• Thermal image for the 1st. order model. • Single or three-phase measurement with detection of maximum phase value.	
Settings:	
Base current I_B	0.5 to 2.5 I_N in steps of 0.01 I_N
Alarm stage	50 to 200% I_N in steps of 1% I_N
Tripping stage	50 to 200% I_N in steps of 1% I_N
Thermal time constant	2 to 500 min in steps of 0.1 min
Accuracy of the thermal image	$\pm 5\%$ I_N (at f_N) with protection c.t.'s $\pm 2\%$ I_N (at f_N) with metering c.t.'s

Table 14: Definite time current function (51DT)

• Over and undercurrent detection. • Single or three-phase measurement with detection of the highest, respectively lowest phase current. • 2nd. harmonic restraint for high inrush currents.	
Settings:	
Pick-up current	0.02 to 20 I_N in steps of 0.01 I_N
Delay	0.02 to 60 s in steps of 0.01 s
Accuracy of the pick-up setting (at f_N)	$\pm 5\%$ or $\pm 0.02 I_N$
Reset ratio overcurrent undercurrent	$>94\%$ (for max. function) $<106\%$ (for min. function)
Max. operating time without intentional delay	60 ms
Inrush restraint pick-up setting reset ratio	optional 0.1 I_{2h}/I_{1h} 0.8

Technical data Functions (cont'd)

Table 15: Definite time voltage function (27/59)

- Over and undervoltage detection - Single or three-phase measurement with detection of the highest, respectively lowest phase voltage	
Settings:	
Pick-up voltage	0.01 to 2.0 U_N in steps of 0.002 U_N
Delay	0.02 to 60 s in steps of 0.01 s
Accuracy of the pick-up setting (at f_N)	$\pm 2\%$ or $\pm 0.005 U_N$
Reset ratio ($U \geq 0.1 U_N$) overvoltage undervoltage	$> 96\%$ (for max. function) $< 104\%$ (for min. function)
Max. operating time without intentional delay	60 ms

Table 16: Inverse time-overcurrent function (51)

- Single or three-phase measurement with detection of the highest phase current - Stable response to transients	
Inverse time characteristic (acc. to B.S. 142 with extended setting range) normal inverse very inverse extremely inverse long time inverse	$t = k_1 / ((I/I_B)^C - 1)$ $c = 0.02$ $c = 1$ $c = 2$ $c = 1$
or RXIDG characteristic	$t = 5.8 - 1.35 \cdot \ln(I/I_B)$
Settings:	
Number of phases	1 or 3
Base current I_B	0.04 to 2.5 I_N in steps of 0.01 I_N
Pick-up current I_{start}	1 to 4 I_B in steps of 0.01 I_B
Min. time setting t_{min}	0 to 10 s in steps of 0.1 s
k_1 setting	0.01 to 200 s in steps of 0.01 s
Accuracy classes for the operating time according to British Standard 142 RXIDG characteristic	E 5.0 $\pm 4\%$ ($1 - I/80 I_B$)
Reset ratio	$> 94\%$

Table 17: Directional definite time overcurrent protection (67)

- Directional overcurrent protection with detection of the power direction - Backup protection for distance protection scheme	
- Three-phase measurement - Suppression of DC- and high-frequency components - Definite time characteristic - Voltage memory feature for close faults	
Settings:	
Current	0.02 to 20 I_N in steps of 0.01 I_N
Angle	-180° to $+180^\circ$ in steps of 15°
Delay	0.02 s to 60 s in steps of 0.01 s
tWait	0.02 s to 20 s in steps of 0.01 s

Memory duration	0.2 s to 60 s in steps of 0.01 s
Accuracy of pick-up setting (at f_N)	$\pm 5\%$ or $\pm 0.02 I_N$
Reset ratio	$> 94\%$
Accuracy of angle measurement (at 0.94 to 1.06 f_N)	$\pm 5^\circ$
Voltage input range	0.005 to 2 U_N
Voltage memory range	$< 0.005 U_N$
Accuracy of angle measurement at voltage memory	$\pm 20^\circ$
Frequency dependence of angle measurement at voltage memory	$\pm 0.5^\circ/\text{Hz}$
Max. Response time without delay	60 ms

Table 18: Directional inverse time overcurrent function (67)

• Directional overcurrent protection with detection of the power direction • Backup protection for distance protection scheme	
• Three-phase measurement • Suppression of DC- and high-frequency components • Inverse time characteristic • Voltage memory feature for close faults	
Settings:	
Current I_{Start}	1...4 I_B in steps of 0.01 I_B
Angle	$-180^\circ \dots +180^\circ$ in steps of 15°
Inverse time characteristic (acc. to B.S. 142 with extended setting range)	$t = k_1 / ((I/I_B)^C - 1)$
normal inverse	$c = 0.02$
very inverse	$c = 1$
extremely inverse	$c = 2$
long-time earth fault	$c = 1$
k_1 -setting	0.01 to 200 s in steps of 0.01 s
t-min	0 to 10 s in steps of 0.1 s
I_B -value	0.04 to 2.5 I_N in steps of 0.01 I_N
tWait	0.02 s to 20 s in steps of 0.01 s
Memory duration	0.2 s to 60 s in steps of 0.01 s
Accuracy of pick-up setting (at f_N)	$\pm 5\%$
Reset ratio	$> 94\%$
Accuracy of angle measurement (at 0.94 to 1.06 f_N)	$\pm 5^\circ$
Accuracy class of the operating time acc. to British Standard 142	E 10
Voltage input range	0.005 to 2 U_N
Voltage memory range	$< 0.005 U_N$
Accuracy of angle measurement at voltage memory	$\pm 20^\circ$
Frequency dependence of angle measurement at voltage memory	$\pm 0.5^\circ/\text{Hz}$
Max. Response time without delay	60 ms

Technical data Functions (cont'd)

Table 19: Inverse time ground fault overcurrent function (51N)

• Neutral current measurement (derived externally or internally) • Stable response to transients	
Inverse time characteristic (acc. to B.S. 142 with extended setting range)	$t = k_1 / ((I/I_B)^C - 1)$ normal inverse $c = 0.02$ very inverse $c = 1$ extremely inverse $c = 2$ long time inverse $c = 1$
or RXIDG characteristic	$t = 5.8 - 1.35 \cdot \ln(I/I_B)$
Settings:	
Number of phases	1 or 3
Base current I_B	0.04 to 2.5 I_N in steps of 0.01 I_N
Pick-up current I_{start}	1 to 4 I_B in steps of 0.01 I_B
Min. time setting t_{min}	0 to 10 s in steps of 0.1 s
k_1 setting	0.01 to 200 s in steps of 0.01 s
Accuracy classes for the operating time according to British Standard 142 RXIDG characteristic	E 5.0 $\pm 4\%$ ($1 - 1/80 I_B$)
Reset ratio	>94%

Table 20: Metering function UIfPQ

• Single-phase measurement of voltage, current, frequency, real power and apparent power • Choice of measuring phase-to-ground or phase-to phase voltages • Suppression of DC components and harmonics in current and voltage • Compensation of phase errors in main and input c.t's and v.t's	
Settings:	
Phase-angle	-180° to +180° in steps of 0.1°
Reference value of the power S_N	0.2 to 2.5 S_N in steps of 0.001 S_N

Refer to [Table 33](#) for accuracy.

Table 21: Three-phase measuring module

• Three-phase measurement of voltage (star or delta), current, frequency, real and apparent power and power factor. • Two independent impulse counter inputs for calculation of interval and accumulated energy. The three-phase measurement and the impulse counters can be used independently and may also be disabled. • This function may be configured four times.	
Settings:	
Angle	-180° to +180° in steps of 0.1°
Reference value for power	0.2 to 2.5 S_N in steps of 0.001 S_N
t1-Interval	1 min., 2 min., 5 min., 10 min., 15 min., 20 min., 30 min., 60 min. or 120 min.
Scale factor of power	0.0001 to 1
Max. impulse frequency	25 Hz
Min. impulse duration	10 ms
Accuracy of time interval	± 100 ms

See [Table 33](#) for accuracy

Table 22: Instantaneous overcurrent (50)

Features:	
• Maximum or minimum function (over- and undercurrent) • Single- or three-phase measurements • Wide frequency range (0.04 to 1.2 f_N) • Peak value evaluation	
Settings:	
Current	0.1 to 20 I_N in steps of 0.1 I_N
Delay	0 to 60 s in steps of 0.01 s
Accuracy of pick-up value (at 0.08 to 1.1 f_N)	$\pm 5\%$ or $\pm 0.02 I_N$
Reset ratio	>90% (for max. function) <110% (for min. function)
Max. trip time with no delay (at f_N)	≤ 30 ms (for max. function) ≤ 60 ms (for min. function)

Table 23: Instantaneous overvoltage protection function (59, 27) with peak value evaluation

Features:	
• Evaluation of instantaneous values, therefore extremely fast and frequency-independent on a wide scale • Storing of the highest instantaneous value after start • No suppression of d. c. components • No suppression of harmonics • 1- or 3phase • Maximum value detection for multi-phase functions • Variable lower limiting frequency f_{min}	
Settings:	
Voltage	0.01 to 2.0 U_N in steps of 0.01 U_N
Delay	0.00 to 60 s in steps of 0.01 s
Limiting f_{min}	25 to 50 Hz in steps of 1 Hz
Accuracy of pick-up value (at 0.08 to 1.1 f_N)	$\pm 3\%$ or $\pm 0.005 U_N$
Reset ratio	>90% (for max. function) <110% (for min. function)
Max. trip time at no delay (at f_N)	<30 ms (for max. function) <50 ms (for min. function)

Table 24: Frequency (81)

Features:	
• Maximum or minimum function (over-, underfrequency) • Minimum voltage blocking	
Settings:	
Frequency	40 to 65 Hz in steps of 0.01 Hz
Delay	0.1 to 60 s in steps of 0.01 s
Minimum voltage	0.2 to 0.8 U_N in steps of 0.1 U_N
Accuracy of pick-up value	± 30 mHz (at U_N and f_N)
Reset ratio	100%
Starting time	<130 ms

Technical data Functions (cont'd)

Table 25: Rate-of-change of frequency df/dt (81)

Features:	
• Combined pick-up with frequency criterion possible • Blocking by undervoltage	
Settings:	
df/dt	-10 to +10 Hz/s in steps of 0.1 Hz/s
Frequency	40 to 55 Hz in steps of 0.01 Hz at $f_N = 50$ Hz 50 to 65 Hz in steps of 0.01 Hz at $f_N = 60$ Hz
Delay	0.1 to 60 s in steps of 0.01 s
Minimum voltage	0.2 to 0.8 U_N in steps of 0.1 U_N
Accuracy of df/dt (at 0.9 to 1.05 f_N)	± 0.1 Hz/s
Accuracy of frequency (at 0.9 to 1.05 f_N)	± 30 mHz
Reset ratio df/dt	95% for max. function 105% for min. function

Table 26: Power function (32)

• Measurement of real or apparent power • Protection function based on either real or apparent power measurement • Reverse power protection • Over and underpower • Single, two or three-phase measurement • Suppression of DC components and harmonics in current and voltage • Compensation of phase errors in main and input c.t.'s and v.t.'s	
Settings:	
Power pick-up	-0.1 to 1.2 S_N in steps of 0.005 S_N
Characteristic angle	-180° to +180° in steps of 5°
Delay	0.05 to 60 s in steps of 0.01 s
Phase error compensation	-5° to +5° in steps of 0.1°
Rated power S_N	0.5 to 2.5 $U_N \cdot I_N$ in steps of 0.001 $U_N \cdot I_N$
Reset ratio	30% to 170% in steps of 1% of power pick-up
Accuracy of the pick-up setting	$\pm 10\%$ of setting or 2% $U_N \cdot I_N$ (for protection c.t.'s) $\pm 3\%$ of setting or 0.5% $U_N \cdot I_N$ (for core-balance c.t.'s)
Max. operating time without intentional delay	70 ms

Table 27: Breaker-failure protection (50BF)

Features	
• Individual phase current recognition • Single or three-phase operation • External blocking input • Two independent time steps • Remote tripping adjustable simultaneously with retripping or backup tripping • Possibility of segregated activating/deactivating each trip (Redundant trip, retrip, backup trip and remote trip).	
Settings	
Current	0.2 to 5 I_N in steps of 0.01 I_N
Delay t1 (repeated trip)	0.02 to 60 s in steps of 0.01 s
Delay t2 (backup trip)	0.02 to 60 s in steps of 0.01 s
Delay tEFS (End fault protection)	0.02 to 60 s in steps of 0.01 s
Reset time for retrip	0.02 to 60 s in steps of 0.01 s

Reset time for backup trip	0.02 to 60 s in steps of 0.01 s
Pulse time for remote trip	0.02 to 60 s in steps of 0.01 s
Number of phases	1 or 3
Accuracy of pick-up current (at f_N)	$\pm 15\%$
Reset ratio of current measurement	$> 85\%$
Reset time (for power system time constants up to 300 ms and short-circuit currents up to $40 \cdot I_N$)	≤ 28 ms (with main c.t.s TPX) ≤ 28 ms (with main c.t.s TPY and current setting $\geq 1,2 I_N$) ≤ 38 ms (with main c.t.s TPY and current setting $\geq 0,4 I_N$)

Table 28: Disturbance recorder

• Max. 16 c.t./v.t. channels • Max. 16 binary channels • Max. 12 analogue channels of internal measurement values • 12 samples per period (sampling frequency 600 or 720 Hz at a rated frequency of 50/60 Hz) • Available recording time for 9 c.t./v.t. and 8 binary signals approximately 5 s • Recording initiated by any binary signal, e.g. the general trip signal.	
Data format	EVE
Dynamic range	$70 \times I_N$, $1.3 \times U_N$
Resolution	12 bits
Settings:	
Recording periods	
Pre-event	40 to 400 ms in steps of 20 ms
Event	100 to 3000 ms in steps of 50 ms
Post-event	40 to 400 ms in steps of 20 ms

Ancillary functions

Table 29: Logic

Logic for 4 binary inputs with the following 3 configurations: 1. OR gate 2. AND gate 3. Bistable flip-flop with 2 set and 2 reset inputs (both OR gates), resetting takes priority
All configurations have an additional blocking input. Provision for inverting all inputs.

Table 30: Delay/integrator

• For delaying pick-up or reset or for integrating 1 binary signal • Provision for inverting the input	
Settings:	
Pick-up or reset time	0 to 300 s in steps of 0.01 s
Integration	yes/no

Technical data Functions (cont'd)

Table 31: Plausibility check

A plausibility check function is provided for each three-phase current and three-phase voltage input which performs the following: • Determination of the sum and phase sequence of the 3 phase currents or voltages • Provision for comparison of the sum of the phase values with a corresponding current or voltage sum applied to an input • Function blocks for currents exceeding $2 \times I_N$, respectively voltages exceeding $1.2 U_N$	
Accuracy of the pick-up setting at rated frequency	$\pm 2\% I_N$ in the range 0.2 to $1.2 I_N$ $\pm 2\% U_N$ in the range 0.2 to $1.2 U_N$
Reset ratio	>90% whole range >95% (at $U > 0.1 U_N$ or $I > 0.1 I_N$)
Current plausibility settings: Pick-up differential for sum of internal summation current or between internal and external summation currents	0.05 to $1.00 I_N$ in steps of $0.05 I_N$
Amplitude compensation for summation c.t.	-2.00 to +2.00 in steps of 0.01
Delay	0.1 to 60 s in steps of 0.1 s
Voltage plausibility settings: Pick-up differential for sum of internal summation voltage or between internal and external summation voltages	0.05 to $1.2 U_N$ in steps of $0.05 U_N$
Amplitude compensation for summation v.t.	- 2.00 to +2.00 in steps of 0.01
Delay	0.1 to 60 s in steps of 0.1 s

Table 32: Run-time supervision

The run-time supervision feature enables checking the opening and closing of all kinds of breakers (circuit-breakers, isolators, ground switches...). Failure of a breaker to open or close within an adjustable time results in the creation of a corresponding signal for further processing.	
Settings	
Setting time	0 to 60 s in steps of 0.01 s
Accuracy of run time supervision	± 2 ms

Table 33: Accuracy of the metering function UIfPQ and three-phase measuring module (including input voltage and input current c.t.)

Input variable	Accuracy		Conditions
	Core balance c.t.s with error compensation	Protection c.t.s without error compensation	
Voltage	$\pm 0.5\% U_N$	$\pm 1\% U_N$	0.2 to $1.2 U_N$ $f = f_N$
Current	$\pm 0.5\% I_N$	$\pm 2\% I_N$	0.2 to $1.2 I_N$ $f = f_N$
Real power	$\pm 0.5\% S_N$	$\pm 3\% S_N$	0.2 to $1.2 S_N$ 0.2 to $1.2 U_N$ 0.2 to $1.2 I_N$ $f = f_N$
Apparent power	$\pm 0.5\% S_N$	$\pm 3\% S_N$	
Power factor	± 0.01	± 0.03	$S = S_N, f = f_N$
Frequency	$\pm 0.1\% f_N$	$\pm 0.1\% f_N$	0.9 to $1.1 f_N$ 0.8 to $1.2 U_N$

$$S_N = \sqrt{3} \cdot U_N \cdot I_N \text{ (three-phase)}$$

$$S_N = 1/3 \cdot \sqrt{3} \cdot U_N \cdot I_N \text{ (single-phase)}$$

Fig. 3 Typical wiring diagram of REC316*4 in size N1 casing with two input/output units 316DB62

Ordering

Please specify:

- Quantity
- Ordering number
- ADE code + key

The following basic versions can be ordered:

Stand alone units REC316*4 with built-in HMI (see table below) HESG448750M0003

Table 34: REC316*4 basic versions

Order No. HESG448750M0003	Relay ID code		CTRL	AR	OCInst	OCDT	OCINV	OCInv Dir	OCDir Dir	TH	Freq	df/dt	HBT	HBT BAS 533	HBT BAS 535	Basic-SW
	A*B*C*D*U*K**E*I*F*J*Q*V*R*W*Y*N*M*	SX100 T***	X													X
	A*B*C*D*U*K**E*I*F*J*Q*V*R*W*Y*N*M*	SX200 T***	X	X	X	X	X	X	X	X						X
	A*B*C*D*U*K**E*I*F*J*Q*V*R*W*Y*N*M*	SX300 T***	X	X	X	X	X	X	X	X	X	X				X
	A*B*C*D*U*K**E*I*F*J*Q*V*R*W*Y*N*M*	SX900 T***	X	X	X	X	X	X	X	X	X	X	X			X
	A*B*C*D*U*K64E*I*F*J*Q*V*R*W*Y*N2M*	SX900 T903	X	X	X	X	X	X	X	X	X	X	X	X		X
	A*B*C*D*U*K64E*I*F*J*Q*V*R*W*Y*N2M*	SX900 T904	X	X	X	X	X	X	X	X	X	X	X		X	X
	A*B*C*D*U*K**E*I*F*J*Q*V*R*W*Y*N*M*	SX992 T***	Entire function library of RE.316*4													

Legend

CTRL: project-specific control logic (FUPLA)

Basic-SW: basic software including the following functions:

- synchrocheck function
- definite time overvoltage function
- instantaneous overvoltage protection function with peak value evaluation
- metering function UIFPQ
- three-phase measuring module
- power function
- logic
- delay
- counter
- disturbance recorder function
- flutter recognition
- inverse time ground fault overcurrent
- breaker-failure protection
- run-time supervision

Options

AR: - single or three-phase auto-reclosure

OCDir: - definite time overcurrent protection

OCInst: - instantaneous overcurrent protection

OCInv: - inverse time overcurrent protection

OCInv Dir: - directional inverse time overcurrent protection

OCDir Dir: - directional definite time overcurrent protection

TH: - thermal overload

Freq: - frequency protection

df/dt: - rate-of-change of frequency

HBT: - high-speed busbar transfer

HBT BAS 533: - high-speed busbar transfer, 2 breakers standard solution

HBT BAS 535: - high-speed busbar transfer, 3 breakers standard solution

All the functions of the basic version can be applied in any combination providing the maximum capacity of the processor and the number of analogue channels is not exceeded.

Other functions (function library of RE.316*4)

< Z:	- Distance including power swing
Long.diff:	- Line differential
BST:	- Binary signal transmission
E/Fungnd:	- Directional ground fault function for ungrounded systems or systems with Petersen coils
F/Fgnd:	- Directional ground fault function for grounded systems
Diff T:	- Transformer differential
Diff G:	- Generator differential
OCDT(REF):	- Restricted earth fault
EFStat100:	- Stator earth fault 95%, 100%
EFRot100:	- Rotor earth fault
NPSDT:	- Negative-sequence current
NPS Inv:	- Inverse time negative phase-sequence
U/F(inv):	- Overexcitation
UZ:	- Underimpedance
LossEx:	- Loss of excitation
Polsl:	- Pole slipping
VTDT (EF Stat):	- Definite time voltage function for stator earth fault protection
VTDT (EF Rot):	- Definite time voltage function for rotor earth fault protection
>I/<U:	- Combined overcurrent/undervoltage protection
V bal:	- Balanced voltage measurement protection
V check:	- Voltage plausibility
I check	- Current plausibility
OL Stat:	- Stator overload
OL Rot:	- Rotor overload
<Z HV Dist:	- High-voltage distance protection

Ordering (cont'd)

Table 35: Definitions of the relay ID codes in Table 34

Sub code	Significance	Description	Remarks
A- A0 A1 A2 A5	none 1A 2A 5A	rated current	state
B- B0 B1 B2 B5	none 1A 2A 5A	rated current	state
C- C0 C1 C2 C5	none 1A 2A 5A	rated current	state
D- D0 D1 D2 D5	none 1A 2A 5A	rated current	state
U- U0 U1 U2	none 100 V AC 200 V AC	rated voltage	state
K- K41 K42 K43 K44 K45 K46 K47 K64	3 CTs (3ph Code A-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 3 VTs (3ph star Code U-) 3 CTs (3ph Code A-) 3 VTs (3ph star Code U-) 3 VTs (3ph star Code U-) 3 CTs (3ph Code A-) 3 CTs (3ph Code C-) 3 CTs (3ph Code D-) 1 CT (1ph Code A-) 1 CT (1ph Code A-) 1 MT (1ph Code B-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 3 VTs (3ph star Code U-) 1 CT (1ph Code A-) 1 CT (1ph Code A-) 1 MT (1ph Code B-) 3 VTs (3ph star Code U-) 3 VTs (3ph star Code U-) 3 CTs (3ph Code A-) 1 MT (1ph Code B-) 1 VT (1ph Code U-) 1 VT (1ph Code U-) 3 VTs (3ph star Code U-) 3 CTs (3ph Code A-) 1 CT (1ph Code A-) 1 MT (1ph Code B-) 1 VT (1ph Code U-) 3 VTs (3ph delta Code U-) 3 CTs (3ph Code A-) 3 VTs (3ph delta Code U-) 3 VTs (3ph delta Code U-)	CT = current transformer VT = voltage transformer MT = metering transformer	

K00	Free arrangement of voltage and current analog inputs. There is a maximum of 9 analog inputs per unit.		On request
E- E1	8 optocoupler 6 signal. relays 2 command relays 8 LED's	1. binary input/output unit Type 316DB61	see previous table
E2	4 optocoupler 10 signal. relays 2 command relays 8 LED's	1. binary input/output unit Type 316DB62	
E3	14 optocoupler 8 signal. relays 8 LED's	1. binary input/output unit Type 316DB63	
I- I3 I4 I5 I9	82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	1. binary input/output unit optocoupler input voltage	state
F- F0 F1 F2 F3	none 8 optocoupler 6 signal. relays 2 command relays 8 LED's 4 optocoupler 10 signal. relays 2 command relays 8 LED's 14 optocoupler 8 signal. relays 8 LED's	2. binary input/output unit Type 316DB61 2. binary input/output unit Type 316DB62 2. binary input/output unit Type 316DB63	see previous table
J- J0 J3 J4 J5 J9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	2. binary input/output unit optocoupler input voltage	
Q- Q0 Q1 Q2 Q3	none 8 optocoupler 6 signal. relays 2 command relays 4 optocoupler 10 signal. relays 2 command relays 14 optocoupler 8 signal. relays	3. binary input/output unit Type 316DB61 3. binary input/output unit Type 316DB62 3. binary input/output unit Type 316DB63	
V- V0 V3 V4 V5 V9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	3. binary input/output unit optocoupler input voltage	
R- R0 R1 R2	none 8 optocoupler 6 signal. relays 2 command relays 4 optocoupler 10 signal. relays 2 command relays	4. binary input/output unit Type 316DB61 4. binary input/output unit Type 316DB62	see previous table

Ordering (cont'd)

R3		14 optocoupler 8 signal. relays	4. binary input/output unit Type 316DB63	
W-	W0 W3 W4 W5 W9	none 82 to 312 V DC 36 to 75 V DC 18 to 36 V DC 175 to 312 V DC	4. binary input/output unit optocoupler input voltage	state
Y-	Y0 Y1 Y2 Y3 Y4 ¹⁾	no comm. protocol SPA IEC 60870-5-103 LON MVB (part of IEC 61375)	Interbay bus protocol	
N-	N1 N2	casing width 225.2 mm casing width 271 mm		see previous table
M-	M1 M5 ¹⁾	Semi-flush mounting Surface mounting, standard terminals		Order M1 and separate assembly kit for 19" rack mounting
S-	SX000 to SY990 SZ990	basic versions REC316*4 order not acc. to Data Sheet		see previous table
T-	T0000 T0001x to T9999x T0990x T0903x T0904x	none FUPLA logic FUPLA logic written by others FUPLA logic for HBT standard solution for 2 breakers FUPLA logic for HBT standard solution for 3 breakers	Customer-specific logic x = version of the FUPLA logic	Defined by ABB Switzerland Ltd

¹⁾MVB interface (for interbay or process bus) not applicable for surface-mounted version

The order number has been defined for the basic version as above and the required accessories can be ordered according to the following Table.

Table 36: Accessories

Assembly kits					
Description					Order No.
19"-mounting plate for hinged frames, light-beige for use with:					
1 REC316*4 (size 1 casing)					HESG324310P1
2 REC316*4 (size 1 casing)					HESG324310P2
1 REC316*4 (size 2 casing)					HESG324351P1
REC316*4 size 1 surface mounting kit					HESG448532R0001
REC316*4 size 2 surface mounting kit					HESG448532R0002
PCC card interface					
Type	Protocol	Connector	Optical fibre*	Gauge **	Order No.
For interbay bus:					
PCCLON1 SET	LON	ST (bajonet)	G/G	62.5/125	HESG448614R0001
500PCC02	MVB	ST (bajonet)	G/G	62.5/125	HESG448735R0231
For process bus:					
500PCC02	MVB	ST (bajonet)	G/G	62.5/125	HESG 448735R0232
RS232C interbay bus interface					
Type	Protocol	Connector	Optical fibre*	Gauge **	Order No.
316BM61b	SPA	ST (bajonet)	G/G	62.5/125	HESG448267R401
316BM61b	IEC 60870-5-103	SMA (screw)	G/G	62.5/125	HESG448267R402
316BM61b	SPA	Plug/plug	P/P		HESG448267R431
* receiver Rx / transmitter Tx, G = glass, P = plastic **optical fibre conductor gauge in μm					
Human machine interface					
Type	Description			Order No.	
CAP2/316	Installation	German/English	CD	1MRB260030M0001	
** Unless expressly specified the latest version is supplied.					
Optical fibre PC connecting cable					
Type					Order No.
500OCC02 communication cable for device with LDU					1MRB380084-R1
Disturbance recorder evaluation program					
Type, description					Order No.
REVAL English	3½"-Disk				1MRK000078-A
REVAL German	3½"-Disk				1MRK000078-D
WINEVE	English/German				Basic version
WINEVE	English/German				Full version
SMS-BASE Module for RE.316*4					
					Order No.
SM/RE.316*4					HESG448645R1

Dimensioned drawings

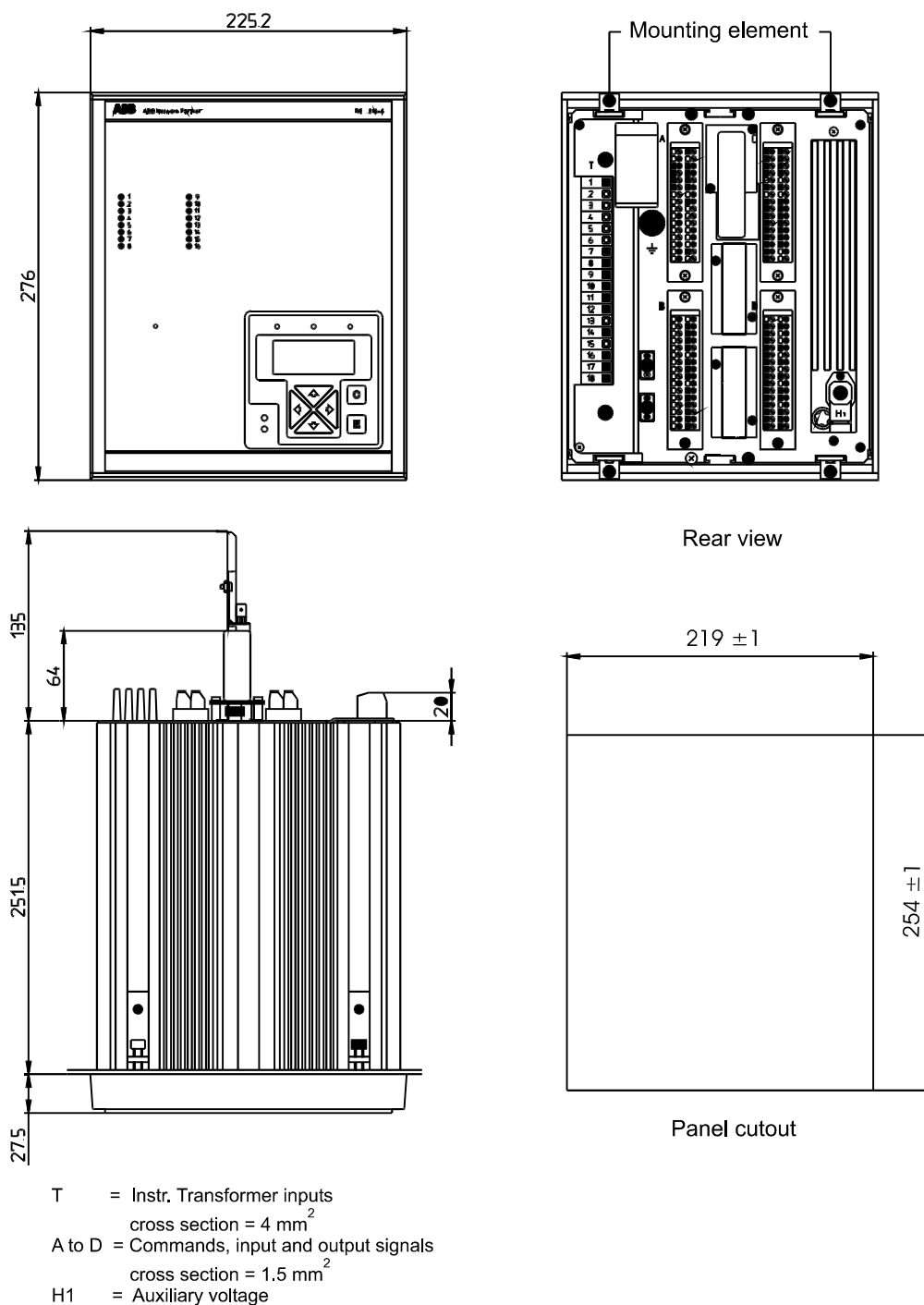


Fig. 4 Semi-flush mounting, rear connections. Size N1 casing.

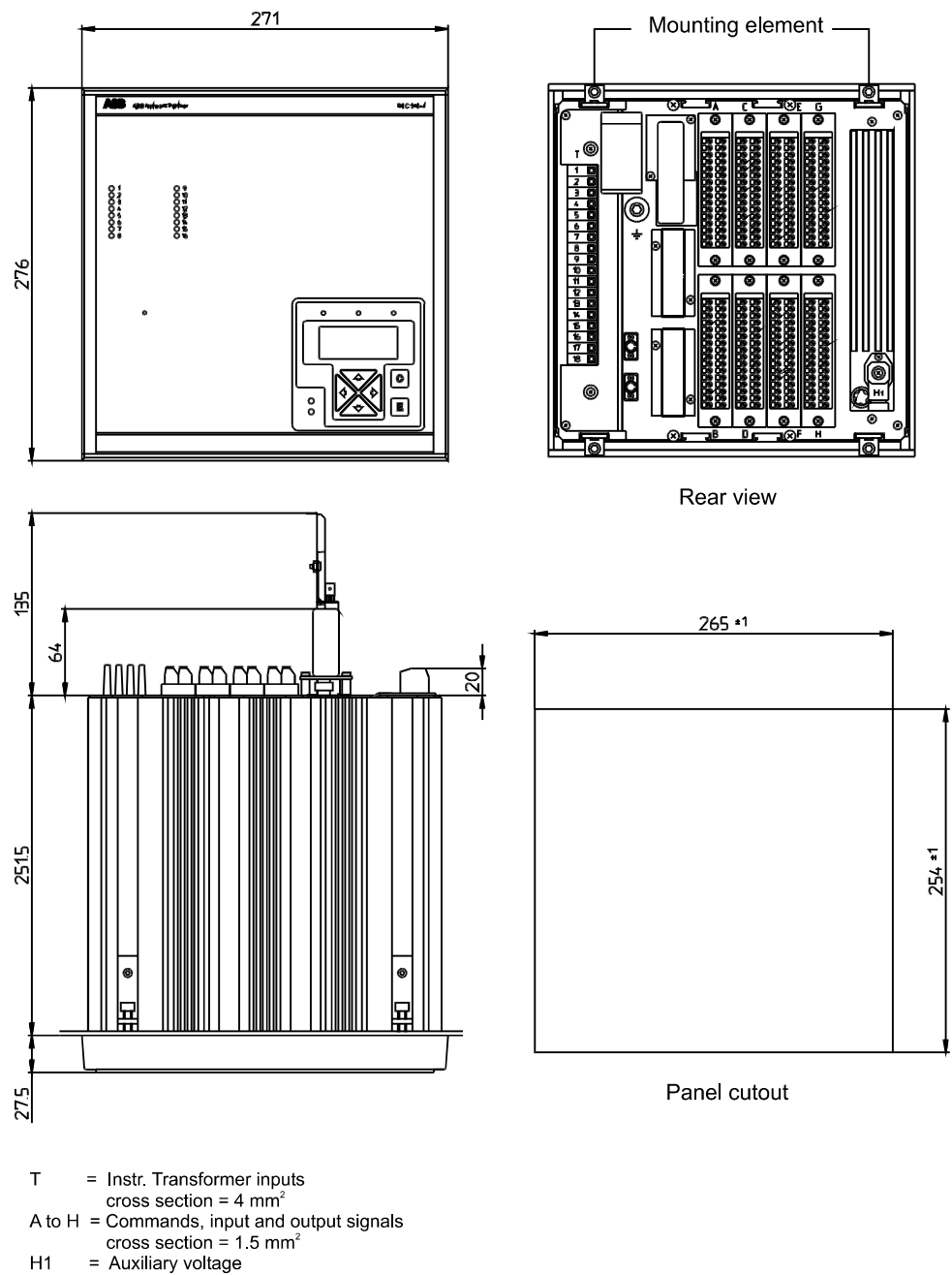


Fig. 5 Semi-flush mounting, rear connections. Size N2 casing.

Dimensioned drawings (cont'd)

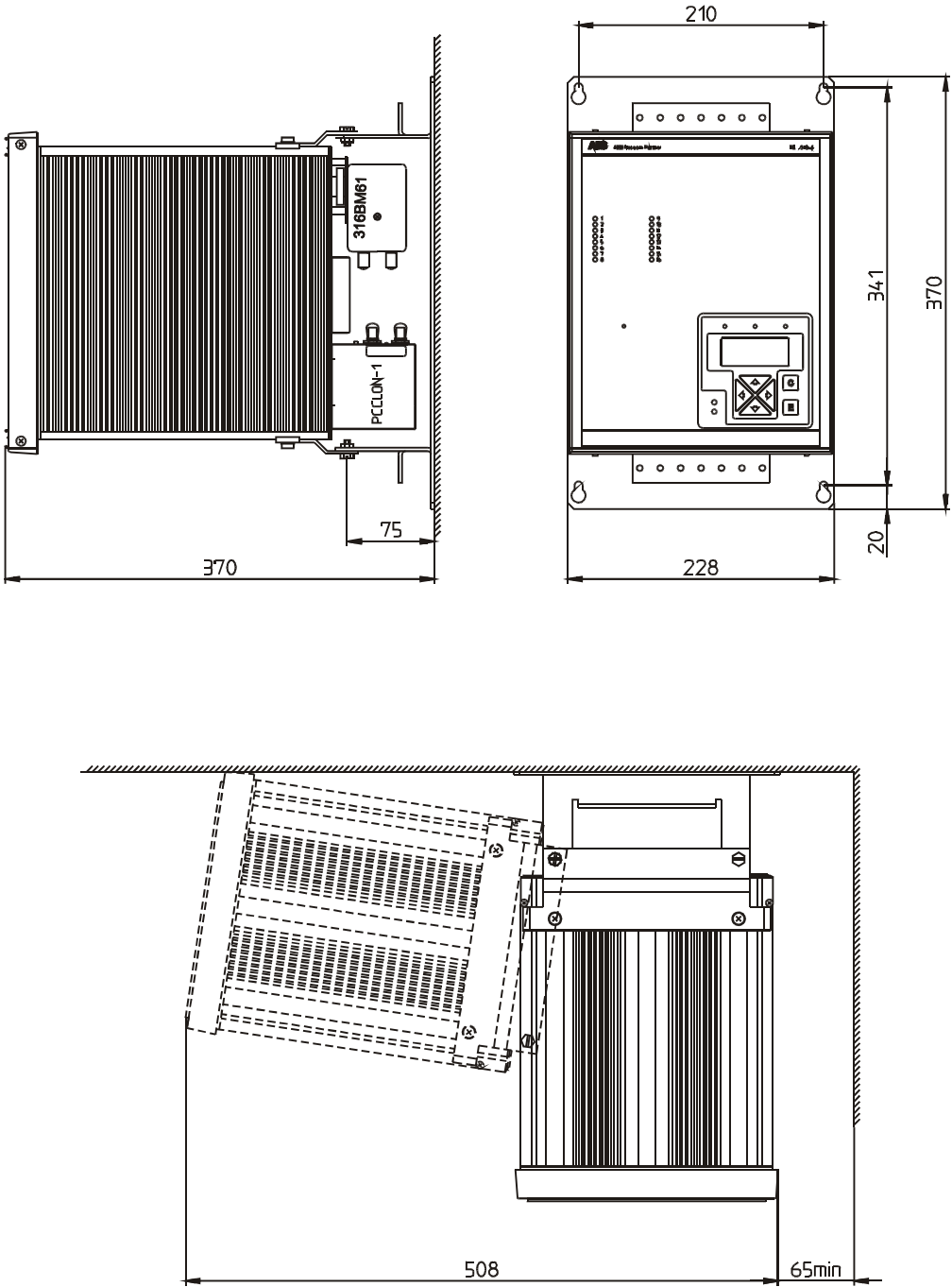


Fig. 6 Surface mounting, casing able to swing to the left, rear connections. Size N1 casing

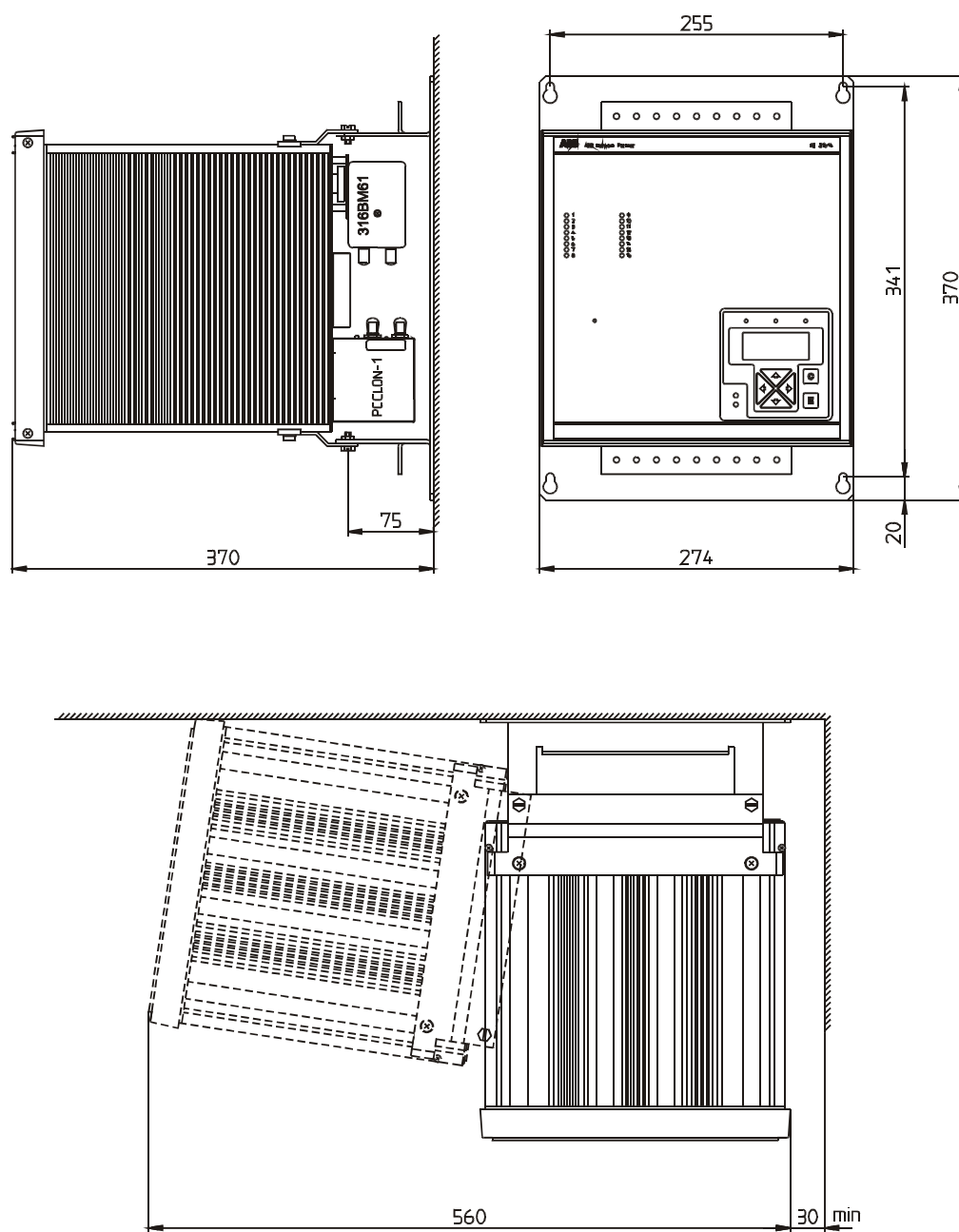


Fig. 7 Surface mounting, casing able to swing to the left, rear connections. Size N2 casing.

Example of an order

- Rated current 1 A, rated voltage 100 V AC
- 6 phase voltages, 3 phase currents
- 110 V DC aux. supply
- 8 command relays
- 24 signalling relays
- 32 opto-coupler inputs (110 V DC)
- 1 relay for 19" rack mounting
- Frequency function
- Autoreclosure
- Communication with the station control system (e.g. LON)
- Operator program in English on CD
- 1 mounting kit HESG324351P1
- 1 PC-Card LON
- 1 CD RE.216 / RE316*4
1MRB260030M0001
- 1 PC connecting cable (if not already available) 1MRB380084-R1

Alternatively, the relay ID code may be given instead. In this case the order would be:

- The corresponding order is as follows:
- 1 REC316*4, HESG448750M0003
 - 110 V DC aux. supply
 - Opto-coupler input voltage 110 V DC
 - Rated current 1 A
 - Rated voltage 100 V AC
 - 1 REC316*4, A1B0U1K42E1I3F1J3Q
1V3R1W3Y3M1N2SX300T0
 - 1 mounting kit HESG324351P1
 - 1 CD RE.216 / RE316*4
1MRB260030M0001
 - 1 PC-Card HESG448614R1
 - 1 PC connecting cable (if not already available) 1MRB380084-R1

Relay ID codes are marked on all relays. The significance of the sub codes can be seen from [Table 35](#).

Example of a specification

- Numerical control unit with extensive self-monitoring and analogue/digital conversion of all input quantities.
- It shall be suitable for bay-oriented data recording and supervision and control of MV and HV switchgear plants.
- A compact design and modular software shall enable a high flexibility of the control system in order to adapt itself easily to the requirements of the different switch bays.
- Apart from semi-flush mounting in a 19" electronic equipment rack, the control unit shall be able to be mounted directly in the control panel of the primary plant.
- The bay control logic shall be able to be designed for SF6 gas-insulated (GIS) plants as well as for indoor and outdoor switchgear plants in single, double and multiple busbar arrangements. This logic shall cover supervision and control of switching devices, interlocking devices, command outputs and alarm registration. It shall be able to be easily complemented by means of a graphical function plan language.
- The checking of feeder and busbar voltages for synchronization shall be guaranteed by a synchrocheck function integrated in the control unit.
- The control unit shall be configurable with an integrated voltage indication, entering the interlocking conditions of the feeder grounding device.
- The integrated metering function shall be able to calculate complementary the real power, apparent power and frequency, starting from the primary c.t.
- The integrated disturbance recorder should have a capacity of recording at least 9 analogue and 16 binary signals. It should be possible to assign CT and VT inputs as well as internal results of any included protection function, e.g. OCDT trip, to the disturbance recorder.
- The control unit shall be supported by a software library which supplies protection functions. A menu-assisted HMI (human machine interface) shall allow the user to activate protection functions available in the library.
- The data exchange between the control system and the station control system shall be ensured via a communication interface. The data connection itself shall be able to be designed with fibre optic conductors.

References

Operating instructions (printed)	1MRB520044-Uen
Operating instructions (CD)	1MRB260030M0001
REC316/REC316*4 Reference list	1MRB520209-Ren
CAP316 Data sheet	1MRB520167-Ben
Test Set XS92b Data sheet	1MRB520006-Ben
SigTOOL Data sheet	1MRB520158-Ben
High-speed Bus Transfer (HBT) Data sheet	1MRB520156-Ben
REL316*4 Data sheet	1MRK506013-Ben
RET316*4 Data sheet	1MRK504007-Ben
REG316*4 Data sheet	1MRK502004-Ben
RIO580 Data sheet	1MRB520176-Ben

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9. INTERBAY BUS (IBB) INTERFACE

9.1.	Connection to a station control system	9-3
9.2.	Setting the IBB/RIO function	9-4
9.3.	Transferring disturbance recorder data via the IBB	9-9
9.4.	Synchronisation	9-11
9.5.	SPA bus address format	9-11
9.5.1.	Masking events	9-12
9.6.	SPA address list	9-13
9.6.1.	Channel 0	9-13
9.6.2.	Channel 0 event list	9-14
9.6.3.	Channel 1 event list	9-14
9.6.4.	Channel 3 event list	9-14
9.6.5.	Channel 4 event list	9-15
9.6.6.	Channel 4 analogue input	9-15
9.6.7.	Binary input signals	9-15
9.6.8.	IBB input signals	9-16
9.6.9.	Binary output signals	9-17
9.6.10.	Tripping signals	9-17
9.6.11.	LED signals	9-17
9.6.12.	IBB output signals	9-18
9.6.13.	IBB output signal event masks	9-19
9.6.14.	Binary input event masks	9-21
9.6.15.	Hardware	35 9-22
9.6.16.	Channel 8 system I/O's	34 9-23
9.6.17.	IBB I/O	43 9-25
9.6.18.	Current-DT	2 9-26
9.6.19.	Current	3 9-27
9.6.20.	Diff-Transf	4 9-28
9.6.21.	Underimped	5 9-31
9.6.22.	MinReactance	6 9-32
9.6.23.	NPS-DT	7 9-33
9.6.24.	NPS-Inv	11 9-34
9.6.25.	Voltage	12 9-35
9.6.26.	Current-Inv	13 9-36
9.6.27.	OLoad-Stator	14 9-37
9.6.28.	OLoad-Rotor	15 9-38

9.6.29.	Power.....	18.....	9-39
9.6.30.	Imax-Umin	20.....	9-40
9.6.31.	Delay.....	22.....	9-41
9.6.32.	Diff-Gen	23.....	9-42
9.6.33.	Distance.....	24.....	9-43
9.6.34.	Frequency.....	25.....	9-53
9.6.35.	Overexcitat.....	26.....	9-54
9.6.36.	Count	27.....	9-55
9.6.37.	Overtmp. (RE. 316*4)	28.....	9-56
9.6.38.	Check-I3ph	29.....	9-57
9.6.39.	Check-U3ph.....	30.....	9-58
9.6.40.	Logic	31.....	9-59
9.6.41.	Disturbance Rec	32.....	9-60
9.6.42.	Voltage-Inst.....	36.....	9-63
9.6.43.	Autoreclosure.....	38.....	9-64
9.6.44.	EarthFaultIsol.....	40.....	9-68
9.6.45.	Voltage-Bal	41.....	9-69
9.6.46.	U/f-Inv	47.....	9-70
9.6.47.	UIfPQ	48.....	9-72
9.6.48.	SynchroCheck	49.....	9-73
9.6.49.	Rotor-EFP.....	51.....	9-76
9.6.50.	Stator-EFP	52.....	9-78
9.6.51.	I0-Invers.....	53.....	9-80
9.6.52.	Pole-Slip	55.....	9-81
9.6.53.	Diff-Line	56.....	9-83
9.6.54.	RemoteBin	57.....	9-86
9.6.55.	EarthFltGnd2	58.....	9-87
9.6.56.	FUPLA	59.....	9-89
9.6.57.	FlatterRecog	60.....	9-90
9.6.58.	HV distance	63.....	9-91
9.6.59.	LDU events	67.....	9-101
9.6.60.	Debounce	68.....	9-102
9.6.61.	df/dt.....	69.....	9-103
9.6.62.	DirCurrentDT	70.....	9-104
9.6.63.	DirCurrentInv	71.....	9-106
9.6.64.	BreakerFailure	72.....	9-108
9.6.65.	MeasureModule	74.....	9-111

9. INTERBAY BUS (IBB) INTERFACE

9.1. Connection to a station control system

An electrical-to-optical converter Type 316BM61b is plugged onto the rear of the protection to convert the electrical RS232 signals from the 316VC61a or 316VC61b into optical signals.

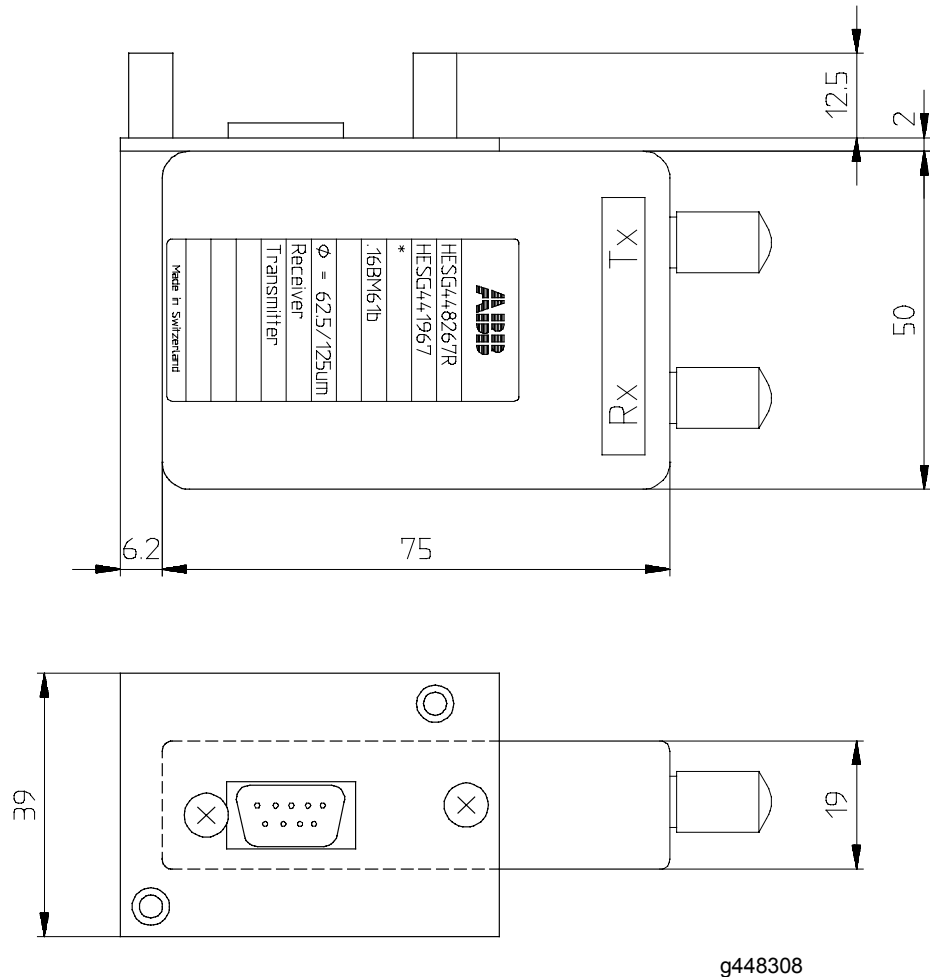


Fig. 9.1 Electrical-to-optical converter Type 316BM61b RS232 interface:

Pin 2:	Rx
Pin 3:	Tx
Pin 4:	+12 V
Pin 5:	0 V
Pin 9:	-12 V

Optical cable connections:

Optical fibre cables with bayonet connectors (ST) are used for the SPA bus (62.5 μ m fibres for 316BM61b).

Screw connectors (SMA plugs) are used instead of the bayonet connectors for the IEC60870-5-103 bus.

9.2. **Setting the IBB/RIO function**

The settings for the IBB/RIO are made via the following HMI menus:

- Main menu
- Editor
- Edit hardware functions
- IBB/RIO configuration.

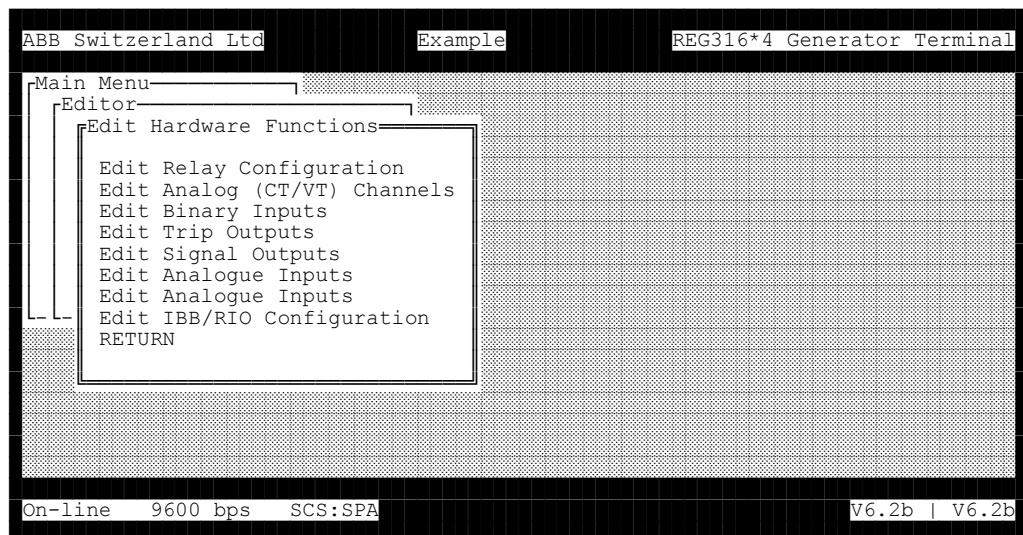


Fig. 9.2 Opening the “IBB/RIO configuration” window

The IBB/RIO function menu lists the following items (see Fig. 9.3):

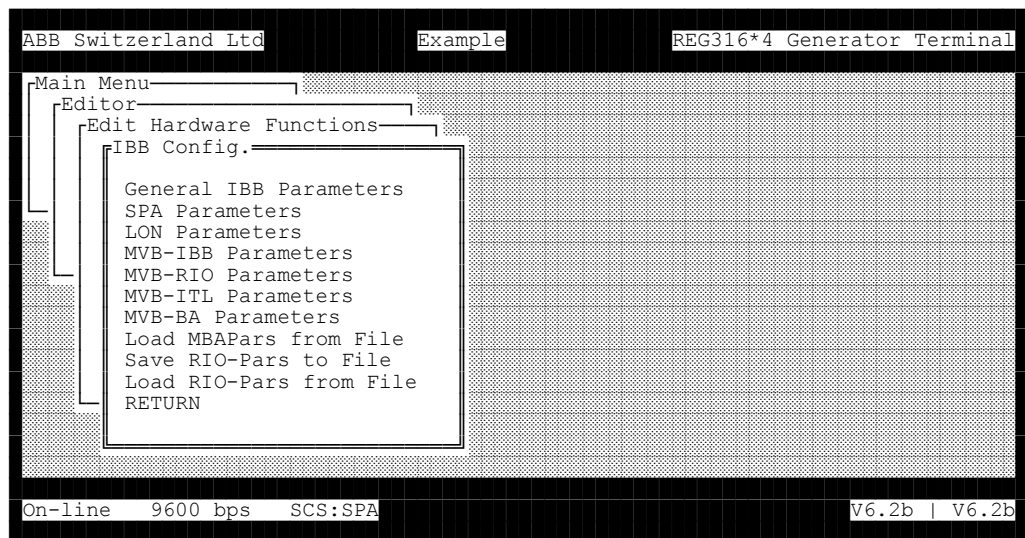


Fig. 9.3 IBB configuration

Caution:

The settings for the LON interbay bus are to be found in publication 1MRB520225-Uen, for the MVB interbay bus in 1MRB520270-Uen and for the MVB process bus in 1MRB520192-Uen.



Fig. 9.4 General IBB parameters

Slave/NodeAddr

Range 2- 255. Must be set to the correct SPA bus address.

TouchScreen/SMS

Setting determines whether the touch screen or an SMS has to be controlled:

- inactive Connection not in operation (default)
- active Connection in operation.

Note that this parameter has no influence in the versions for the SPA and IEC60870-5-103 buses.

The versions for the LON and MVB buses have a fully functional SPA interface in parallel with the interbay bus for connecting either a touch screen or an SMS. The parameter 'Touch-Screen/SMS' should only be set to 'active', when the second interface is in use, because the response time of the LON or MVB bus is somewhat longer.

Read Distr. Data

This parameter defines what has access to the disturbance recorder data:

- by IBB The disturbance recorder data can be read via the interbay bus (SCS).
- by SMS The disturbance recorder data can be read by the SMS.

Disturbance recorder data can always be read by the HMI regardless of the setting.

Note that this parameter has no influence in the versions for the SPA and IEC60870-5-103 buses.

TimeSynchr.

Defines the time for synchronisation via the IBB when the summer time bit is set:

- Standard time Only the summer time bit is set and standard time is used for synchronisation (preferred setting).
- Summer time Summer time is used for synchronisation in spite of the fact that the summer time bit is also set.

'Standard time' has to be selected when the summer time bit is not set (e.g. as in the case of the SPA bus).

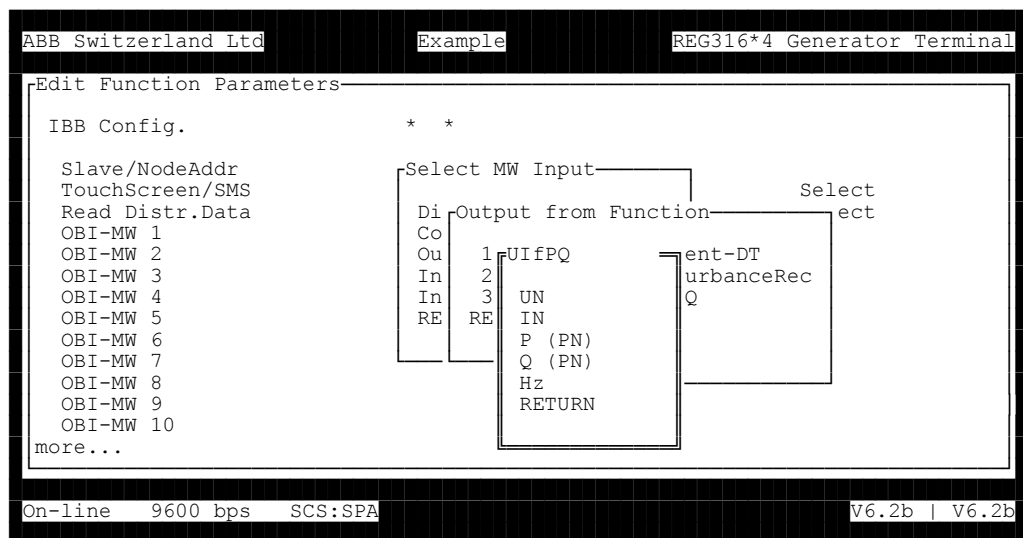


Fig. 9.5 Connecting an IBB measurement

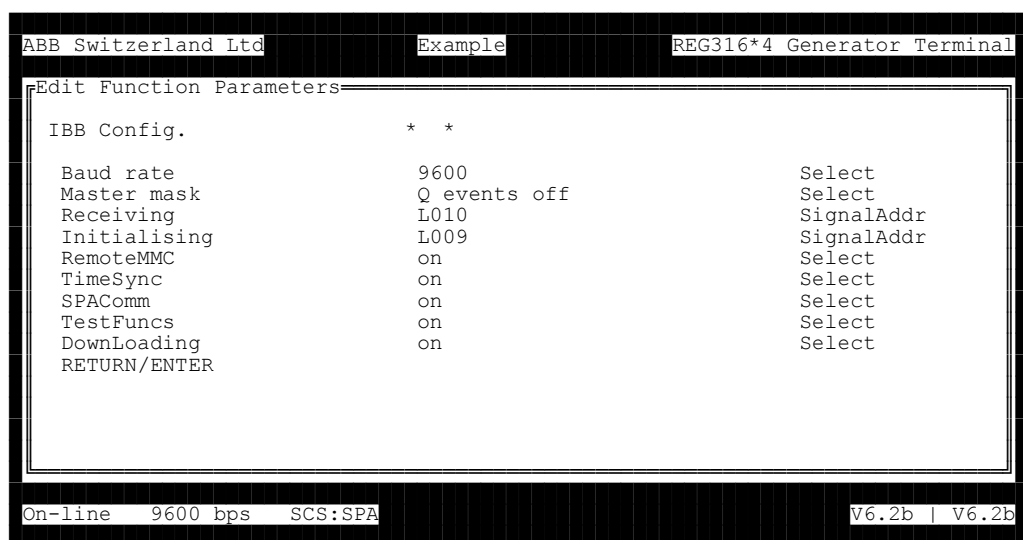


Fig. 9.6 SPA parameters

The parameters must be set as follows:

Baud rate

Default 9600 for SPA bus. Do not change.

Master mask

- Bit masks.
The bit masks set for every function via the SPA bus apply for all binary events. No masks are used for analogue events.
- Q events off
As above, but all analogue events are blocked. This is the default setting and must always be used when the device is connected to an **SCS100**.
- Event off
All events are masked (not recorded).
This setting is intended for testing and during commissioning when it is not wanted that events be transmitted to the control room.

Receiving

Indicates that valid SPA telegrams have been received.

Initialising

Indicates that the device is being initialised.

The following parameters determine the access rights of the remote HMI and can only be configured on the local HMI ([see Section 5.12.](#)):

- RemoteMMC on / off
Enables or disables the remote HMI.
- TimeSync on / off
Enables or disables synchronisation by the remote HMI.
- SPAComm on / off
Enables or disables the SPA communication window on the remote HMI.
- TestFunct. on / off
Enables or disables the test function on the remote HMI.
- Load code on / off
Enables or disables the downloading of a 'setfile' from the remote HMI.

9.3. ***Transferring disturbance recorder data via the IBB***

Disturbance recorder data (records) can be read and transferred via the SPA bus with the aid of the EVECOM program. Further details are contained in the Operating Instructions for EVECOM.

The data are made available in the EVE format when transfer is requested. Data transfer is controlled using the SPA BUS variables V20, M28, M30, M31, V16 and V17.

V20:

Write: WV20:1 starts the transmission of a telegram.

Read: RV20 returns the number of disturbance recorder records available.

V17:

Write: WV17:1...5 determines the compression factor, i.e. 1%...5%.

Read: RV17 returns the compression factor.

Compression reduces the number of periods that have to be transferred per channel. Assuming the 12 points of a period deviate by less than the specified compression factor from the corresponding points of the preceding period, the points themselves are not transferred, but simply the number of repeats in relation to the preceding period. For example, if a record consists of 100 periods all the same, then only the 12 points of one period and the number of repeats are transferred. Compression is applied independently for each individual channel.

M28:

Write: WM28:n selects a disturbance recorder record for transfer. n has a value between 1 and the number of records that that can be read using RV20. The conversion of the record to the EVE format starts and the first response is NAK. WM28:n has to be repeated until the response is ACK. (From firmware V4.0.)

Read: RM28 returns the directory information, time stamp and record number.
1995-05-10 12.34;23.423 RE001.001

M29:

Write: NAK.

Read: returns the number of lines in a record (0...1023). A line contains 26 Byte of data. 0 is returned if a record has not been selected (M28).

M30:

Write: WM30:n moves the pointer to the line to be transferred. The pointer is automatically incremented by one every time a line is transferred until there are no lines left. The pointer is set to 1 at the commencement of data transfer (WM28:n).

Read: RM30 returns the number of the line that was transferred last.

M31:

Write: NAK.

Read: RM31 transfers the line indicated by the pointer.

V16:

Write: WV16:1, WV16:0, deletes the oldest record.

Read: RV16 returns the status of the disturbance recorder.
0: Disturbance recorder not full.
1: Disturbance recorder full.

V20:

Write: WV20:0 terminates data transfer.

9.4. **Synchronisation**

The internal clock is synchronised either by the station control system (SCS 100) or a radio clock (DCF77). Synchronisation via the IBB takes priority over synchronisation by the HMI.

After the device is switched off and on again, the clock continues at the time before it was switched off until the next time telegram is received.

9.5. **SPA bus address format**

The structure of the SPA bus telegram is as follows:

<slave address><operation><channel No.><data type><data/event No.>

The slave address identifies the device.

The default address is 2. The slave address can be changed using the operator program (HMI). The HMI has to be used to assign an address to the device as defined in the station control system. The device also responds to data with the address 900 which is used to synchronise all the devices in an SPA bus loop simultaneously.

Possible **operations** are:

Read data from the device (R) and write data in the device (W).

The channel number identifies the active functions.

All channel numbers from 0 to 13 are reserved for system functions. Channel numbers from 14 to 60 are used for numbering the protection and control functions configured for the device.

Data type enables the different kinds of data in a device to be addressed specifically. The following types of data are used:

- S settings
- I binary or analogue inputs
- O binary or analogue outputs
- E single events
- V measurements, system variables and event masking
- Q measurements stored at the instant of tripping
- T time
- D date
- L event memory
- B back-up event memory.

Data and event numbers are needed to designate individual items of data and events in data channels.

The table below shows the channel number mapping for a typical configuration:

Function	Funct. No.	Chan. No.	Comment
Current	14	14	First protection function
Voltage	15	15	Second protection function
Delay	16	16	Third protection function

The function numbers in the above table correspond to the HMI numbers.

The measured variable of the first function (current) in a device with the slave address 2 is read as follows:

2R14V1.

The SPA bus syntax is defined in SPA BUS COMMUNICATION PROTOCOL V2.x, 34 SPACOM EN1C.

9.5.1. Masking events

Once all those binary inputs, IBB output signals and system and protection function events which are not to be recorded as events (masked) have been loaded into the device (e.g. using W14V155), they have to be copied to the non-volatile memory using the save command W255V255:1 so that they are not lost should the auxiliary supply fail.

9.6. SPA address list**9.6.1. Channel 0****Summary of parameters:**

Address	Access	Text	Default	Step
V102	R	VC type identification	316VC61	
V104	R	VC software version		
V110	R, W	Master event mask	1 Q events masked	0 Bit mask active 2 All events masked
V115	R	Time telegram counter		
V116	R	Date telegram counter		
V120	R	Restart counter	0	
V200	R, W	SPA address	2	2...255
V201	R, W	Baud rate	9600	4800, 9600, 19200
F	R	Module Type	REC316	REG316, REL316, RET316
S0	R	Number of functions	0	1...60
S1	R	Function type number		S1...S60
S100	R, W	Parameter set switch	1	1...4
T	R, W	Time		
D	R, W	Date and time		
L	R	Read event		
B	R	Read event again		

Date format: YY-MM-DD hh.mm;ss.sss

9.6.2. Channel 0 event list

Event No.	Cause	Event mask	Enable code
0E1	No error	V155	1
0E2	Minor error	V155	2
0E4	Major error	V155	4
0E8	Fatal error	V155	8
0E47	Protection stopped	V155	16
0E48	Protection restarted	V155	32
0E49	Warm protection start	V155	64
0E50	Cold protection start	V155	128
0E51	Event buffer overflow	V155	256

9.6.3. Channel 1 event list

Event No.	Cause	Event mask	Enable code
1E11	AD error	V155	1
1E31	Bus failure	V155	256
1E41	Supply failure	V155	4096

9.6.4. Channel 3 event list

Event No.	Cause	Event mask	Enable code
3E1	CPU OK	V155	1
3E2	CPU failure	V155	2
3E3	CPU RAM failure	V155	4
3E4	CPU ROM failure	V155	8
3E11	EA62 OK	V155	16
3E12	EA62 failure	V155	32
3E13	EA62 RAM failure	V155	64
3E14	EA62 ROM failure	V155	128
3E21	Internal AD OK	V155	256
3E22	Internal AD failure	V155	512
3E23	Internal AD RAM failure	V155	1024
3E24	Internal AD ROM failure	V155	2048

9.6.5. Channel 4 event list

Event No	Cause	Event mask	Enable code
4E21	PC-Card No failure	V156	16
4E22	PC-Card Fatal error	V156	32
4E23	PC-Card Non-urgent error	V156	64
4E24	PC-Card Not ready	V156	128

9.6.6. Channel 4 analogue input

Channel 4 provides 64 data points which are available either for analogue FUPLA inputs or analogue outputs via the distributed input/output unit 500AXM11. The numerical range is -32768...+32767 (16 Bit integers).

The data can be entered in decimal or 4-digit hexadecimal format.

The data remains intact in the event of a supply failure.

Real values are converted to integers,
 $\text{integer} = \text{real} \times 100$.

Input format: nnn.mm.
 FFFFH

Data point number: O1...O64

9.6.7. Binary input signals

The significance of the events, for standard as well as for double signals, is explained in [Section 9.6.14](#).

Channel	Inputs	Events	Slot
101	I1 - I16	E1 - E32	1
102	I1 - I16	E1 - E32	2
103	I1 - I16	E1 - E32	3
104	I1 - I16	E1 - E32	4

9.6.8. IBB input signals

Channel	Inputs	Group	No.
121	I1 - I32	1	1-32
122	I1 - I32	2	33-64
123	I1 - I32	3	65-96
124	I1 - I32	4	97-128
125	I1 - I32	5	129-160
126	I1 - I32	6	161-192
71	I1 - I32	7	193-224
72	I1 - I32	8	225-256
73	I1 - I32	9	257-288
74	I1 - I32	10	289-320
75	I1 - I32	11	321-352
76	I1 - I32	12	353-384
77	I1 - I32	13	385-416
78	I1 - I32	14	417-448
79	I1 - I32	15	449-480
80	I1 - I32	16	481-512
81	I1 - I32	17	513-544
82	I1 - I32	18	545-576
83	I1 - I32	19	577-608
84	I1 - I32	20	609-640
85	I1 - I32	21	641-672
86	I1 - I32	22	673-704
87	I1 - I32	23	705-736
88	I1 - I32	24	737-768

9.6.9. Binary output signals

Channel	Outputs	Events	Slot
101	O1 - O16	None	1
102	O1 - O16	None	2
103	O1 - O16	None	3
104	O1 - O16	None	4

9.6.10. Tripping signals

Channel	Outputs	Events	Slot
101	M1 - M16	None	1
102	M1 - M16	None	2
103	M1 - M16	None	3
104	M1 - M16	None	4

9.6.11. LED signals

Channel	Outputs	Events
120	O1 - O16	None

9.6.12. IBB output signals

Channel	Outputs	Group	Event No.
121	O1 - O32	1	121E1...E64
122	O1 - O32	2	122E1...E64
123	O1 - O32	3	123E1...E64
124	O1 - O32	4	124E1...E64
125	O1 - O32	5	125E1...E64
126	O1 - O32	6	126E1...E64
71	O1 - O32	7	71E1...E64
72	O1 - O32	8	72E1...E64
73	O1 - O32	9	73E1...E64
74	O1 - O32	10	74E1...E64
75	O1 - O32	11	75E1...E64
76	O1 - O32	12	76E1...E64
77	O1 - O32	13	77E1...E64
78	O1 - O32	14	78E1...E64
79	O1 - O32	15	79E1...E64
80	O1 - O32	16	80E1...E64
81	O1 - O32	17	81E1...E64
82	O1 - O32	18	82E1...E64
83	O1 - O32	19	83E1...E64
84	O1 - O32	20	84E1...E64
85	O1 - O32	21	85E1...E64
86	O1 - O32	22	86E1...E64
87	O1 - O32	23	87E1...E64
88	O1 - O32	24	88E1...E64

9.6.13. IBB output signal event masks

Output	Event	Event No.	Mask	Enable code
O1	On	1	V155	1
	Off	2	V155	2
O2	On	3	V155	4
	Off	4	V155	8
O3	On	5	V155	16
	Off	6	V155	32
O4	On	7	V155	64
	Off	8	V155	128
O5	On	9	V155	256
	Off	10	V155	512
O6	On	11	V155	1024
	Off	12	V155	2048
O7	On	13	V155	4096
	Off	14	V155	8192
O8	On	15	V155	16384
	Off	16	V155	32768
O9	On	17	V156	1
	Off	18	V156	2
O10	On	19	V156	4
	Off	20	V156	8
O11	On	21	V156	16
	Off	22	V156	32
O12	On	23	V156	64
	Off	24	V156	128
O13	On	25	V156	256
	Off	26	V156	512
O14	On	27	V156	1024
	Off	28	V156	2048
O15	On	29	V156	4096
	Off	30	V156	8192

Output	Event	Event No.	Mask	Enable code
O16	On	31	V156	16384
	Off	32	V156	32768
O17	On	33	V157	1
	Off	34	V157	2
O18	On	35	V157	4
	Off	36	V157	8
O19	On	37	V157	16
	Off	38	V157	32
O20	On	39	V157	64
	Off	40	V157	128
O21	On	41	V157	256
	Off	42	V157	512
O22	On	43	V157	1024
	Off	44	V157	2048
O23	On	45	V157	4096
	Off	46	V157	8192
O24	On	47	V157	16384
	Off	48	V157	32768
O25	On	49	V158	1
	Off	50	V158	2
O26	On	51	V158	4
	Off	52	V158	8
O27	On	53	V158	16
	Off	54	V158	32
O28	On	55	V158	64
	Off	56	V158	128
O29	On	57	V158	256
	Off	58	V158	512
O30	On	59	V158	1024
	Off	60	V158	2048

Output	Event	Event No.	Mask	Enable code
O31	On	61	V158	4096
	Off	62	V158	8192
O32	On	63	V158	16348
	Off	64	V158	327680

9.6.14. *Binary input event masks*

Channel	Event	Event No.	Mask	Enable code
I1	On	E1	V155	1
	Off	E2	V155	2
I2	On	E3	V155	4
	Off	E4	V155	8
I3	On	E5	V155	16
	Off	E6	V155	32
I4	On	E7	V155	64
	Off	E8	V155	128
I5	On	E9	V155	256
	Off	E10	V155	512
I6	On	E11	V155	1024
	Off	E12	V155	2048
I7	On	E13	V155	4096
	Off	E14	V155	8192
I8	On	E15	V155	16384
	Off	E16	V155	32768
I9	On	E17	V156	1
	Off	E18	V156	2
I10	On	E19	V156	4
	Off	E20	V156	8
I11	On	E21	V156	16
	Off	E22	V156	32

Channel	Event	Event No.	Mask	Enable code
I12	On	E23	V156	64
	Off	E24	V156	128
I13	On	E25	V156	256
	Off	E26	V156	512
I14	On	E27	V156	1024
	Off	E28	V156	2048
I15	On	E29	V156	4096
	Off	E30	V156	8192
I16	On	E31	V156	16384
	Off	E32	V156	32768

In the case of a double signal the significance of the events changes as shown in the following example where the inputs 2 and 3 are configured as double signal.

Input	Event No.	Significance	Significance at double signal
I2	E3	on	1-0
	E4	off	0-1
I3	E5	on	0-0
	E6	off	1-1

9.6.15. Hardware 35

Summary of parameters:

Address	Access	Text	Unit	Default	Min.	Max.	Step
1S1	R	SWVers SX...	<Select>	X	1	25	1
		A	1				
		B	2				
		C	3				
		...	...				
		Y	25				

9.6.16. Channel 8 system I/O's 34**Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
8S1	R	LEDSigMode	<Select>	AccumSigAll	1	4	1
		AccumSigAll	1				
		ResetOnStart	2				
		ResetOnTrip	3				
		NoLatching	4				
8S2	R	Confirm Pars	<Select>	on	0	1	1
		off	0				
		on	1				
8S3	R	TimeFromPC	<Select>	on	0	1	1
		off	0				
		on	1				

Event list

Event No.	Cause	Event mask	Enable code
8E1	GenTrip Set	V155	1
8E2	Ditto Reset	V155	2
8E3	GenStart Set	V155	4
8E4	Ditto Reset	V155	8
8E5	Test active Set	V155	16
8E6	Ditto Reset	V155	32
8E7	InjTstOP Set	V155	64
8E8	Ditto Reset	V155	128
8E9	Relay Ready Set	V155	256
8E10	Ditto Reset	V155	512
8E11	ParSet1 Set	V155	1024
8E12	Ditto Reset	V155	2048
8E13	ParSet2 Set	V155	4096
8E14	Ditto Reset	V155	8192

Event No.	Cause		Event mask	Enable code
8E15	ParSet3	Set	V155	16384
8E16	Ditto	Reset	V155	32768
8E17	ParSet4	Set	V156	1
8E18	Ditto	Reset	V156	2
8E19	HMI is on	Set	V156	4
8E20	Ditto	Reset	V156	8
8E21	Modem error	Set	V156	16
8E22	Ditto	Reset	V156	32
8E23	QuitStatus	Set	V156	64
8E24	Ditto	Reset	V156	128
8E25	MVB_PB_Warn	Set	V156	256
8E26	Ditto	Reset	V156	512
8E27	MVB_PB_Crash	Set	V156	1024
8E28	Ditto	Reset	V156	2048
8E29	PB_BA1Ready	Set	V156	4096
8E30	Ditto	Reset	V156	8192
8E31	PB_BA2Ready	Set	V156	16384
8E32	Ditto	Reset	V156	32768
8E33	PB_BA3Ready	Set	V157	1
8E34	Ditto	Reset	V157	2
8E35	PB_BA4Ready	Set	V157	4
8E36	Ditto	Reset	V157	8
8E37	PB LA faulty	Set	V157	16
8E38	Ditto	Reset	V157	32
8E39	PB LB faulty	Set	V157	64
8E40	Ditto	Reset	V157	128

9.6.17. IBB I/O 43**Event list**

Event No.	Cause	Event mask	Enable code
9E1	Receive Set	V155	1
9E2	Ditto Reset	V155	2
9E3	Initialisation Set	V155	4
9E4	Ditto Reset	V155	8
9E5	PrDatBlckSig Set	V155	16
9E6	Ditto Reset	V155	32

Measured variables

Function 9 (IBB I/O) makes measured variables available the number and significance of which depend on the FUPLA configuration. The number of measured variables is limited to 64.

Address	Access	Text	Format
9V1	R	IBBMW 1	Longinteger
9Vn	R	IBBMW n	Longinteger
9V64	R	IBBMW 64	Longinteger

9.6.18. Current-DT 2**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	00.01	0.00	60.00	0.01
14S10	R	I-Setting	IN	04.00	0.1	20	0.1
14S11	R	f-min	Hz	040.0	2	50	1
14S12	R	MaxMin	<Select>	MAX	-1	1	2
		MIN	-1				
		MAX	1				
14S13	R	NrOfPhases		001	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	2

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.19. Current 3**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	01.00	0.02	60.00	0.01
14S10	R	I-Setting	IN	02.00	0.02	20.00	0.01
14S11	R	MaxMin	<Select>	MAX (1ph)	-3	5	2
		MIN (3ph)	-3				
		MIN (1ph)	-1				
		MAX (1ph)	1				
		MAX (3ph)	3				
		Max-Inrush	5				
14S12	R	NrOfPhases		001	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.20. Diff-Transf 4**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	g	IN	0.20	0.10	0.50	0.10
14S10	R	v		0.50	0.25	0.50	0.25
14S11	R	b	1	1.50	1.25	5.00	0.25
14S12	R	g-High	IN	2.00	0.50	2.50	0.25
14S13	R	I-Inst	IN	10	3	15	1
14S14	R	a1		1.00	0.05	2.20	0.01
14S15	R	s1	<Select>	Y	0	1	1
		Y	0				
		D	1				
14S16	R	a2		1.00	0.05	2.20	0.01
14S17	R	s2	<Select>	y0	00	21	1
		y0	0				
		y1	1				
		y5	2				
		y6	3				
		y7	4				
		y11	5				
		d0	6				
		d1	7				
		d5	8				
		d6	9				
		d7	10				
		d11	11				
		z0	12				
		z1	13				
		z2	14				

Address	Access	Text	Unit	Default	Min.	Max.	Step
		z4	15				
		z5	16				
		z6	17				
		z7	18				
		z8	19				
		z10	20				
		z11	21				
14S18	R	a3		1.00	0.05	2.20	0.01
14S19	R	s3	<Select>	y0	00	21	1
		y0	0				
		y1	1				
		y5	2				
		y6	3				
		y7	4				
		y11	5				
		d0	6				
		d1	7				
		d5	8				
		d6	9				
		d7	10				
		d11	11				
		z0	12				
		z1	13				
		z2	14				
		z4	15				
		z5	16				
		z6	17				
		z7	18				
		z8	19				
		z10	20				
		z11	21				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S20	R	InrushRatio	%	10	6	20	1
14S21	R	InrushTime	s	5	0	90	1

Measured variables

Address	Access	Text	Dec.	Address	Access	Text	Dec.
14V1	R	IN (Id-R)	2	14V4	R	IN (IhR)	2
14V2	R	IN (Id-S)	2	14V5	R	IN (IhR)	2
14V3	R	IN (Id-T)	2	14V6	R	IN (IhR)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN (Id-R)	2
14Q2	R	IN (Id-S)	2
14Q3	R	IN (Id-T)	2

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Trip-R	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	
14E5	Trip-S	Set	V155	16	14I3
14E6	Ditto	Reset	V155	32	
14E7	Trip-T	Set	V155	64	14I4
14E8	Ditto	Reset	V155	128	
14E9	Inrush	Set	V155	256	14I5
14E10	Ditto	Reset	V155	512	
14E11	Stabil	Set	V155	1024	14I6
14E12	Ditto	Reset	V155	2048	

9.6.21. Underimped 5**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	00.50	0.20	60.00	0.01
14S10	R	Z-Setting	UN/IN	0.250	0.025	2.500	0.001
14S11	R	NrOfPhases		001	1	3	1

Measured variables

Address	Access	Text	Dec.
14V1	R	UN/IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN/IN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.22. MinReactance 6**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	00.50	0.20	60.00	0.01
14S10	R	XA-Setting	UN/IN	-2.00	-5.00	00.00	0.01
14S11	R	XB-Setting	UN/IN	-0.50	-2.50	+2.50	0.01
14S12	R	NrOfPhases		001	1	3	1
14S13	R	Angle	deg	000	-180	180	005
14S14	R	MaxMin	<Select>	MIN	-1	1	2
		MIN	-1				
		MAX	1				

Measured variables

Address	Access	Text	Dec.
14V1	R	UN/IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN/IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.23. NPS-DT 7**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	01.00	0.50	60.0	0.01
14S10	R	I2-Setting	IN	00.20	0.02	0.50	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.24. NPS-Inv 11**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	k1-Setting	s	10.00	5.00	60.00	0.10
14S10	R	k2-Setting	I2/IB	0.05	0.02	0.20	0.01
14S11	R	t-min	s	010.0	1.0	120.	0 0.1
14S12	R	t-max	s	1000	500	2000	1
14S13	R	t-Reset	s	0030	5	2000	1
14S14	R	IB-Setting	IN	1.00	0.50	2.50	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I20
14E4	Ditto	Reset	V155	8	

9.6.25. Voltage 12**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	02.00	0.02	60.00	0.01
14S10	R	U-Setting	UN	1.200	0.010	2.000	0.002
14S11	R	MaxMin	<Select>	MAX (1ph)	-3	3	2
		MIN (3ph)	-3				
		MIN (1ph)	-1				
		MAX (1ph)	1				
		MAX (3ph)	3				
14S12	R	NrOfPhases		001	1	3	1

Measured variables

Address	Access	Text	Dec.
14V1	R	UN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.26. Current-Inv 13**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	c-Setting	<Select>	1.00	0	2	1
		0.02	0				
		1.00	1				
		2.00	2				
		RXIDG	3				
14S10	R	k1-Setting	s	013.50	0.01	200.00	0.01
14S11	R	I-Start	IB	1.10	1.00	2.00	0.01
14S12	R	NrOfPhases		1	1	3	2
14S13	R	IB-Setting	IN	1.00	0.20	2.50	0.01
14S14	R	t-min	s	00.00	00.00	10.00	00.10

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.27. OLoad-Stator 14**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	k1-Setting	s	041.4	1.0	120.0	0.1
14S10	R	I-Start	IB	1.10	1.00	1.60	0.01
14S11	R	t-min	s	0010.0	1.0	120.0	0.1
14S12	R	tg	s	0120.0	10.0	2000.0	10.0
14S13	R	t-max	s	0300.0	100.0	2000.0	10.0
14S14	R	t-Reset	s	0120.0	10.0	2000.0	10.0
14S15	R	IB-Setting	IN	1.00	0.50	2.50	0.01
14S16	R	NrOfPhases		3	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.28. OLoad-Rotor 15**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	k1-Setting	s	033.8	1.0	50.0	0.1
14S10	R	I-Start	IB	1.10	1.00	1.60	0.01
14S11	R	t-min	s	0010.0	1.0	120.0	0.1
14S12	R	tg	s	0120.0	10.0	2000.0	10.0
14S13	R	t-max	s	0300.0	100.0	2000.0	10.0
14S14	R	t-Reset	s	0120.0	10.0	2000.0	10.0
14S15	R	IB-Setting	IN	1.00	0.50	2.50	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.29. Power 18**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	P-Setting	PN	-0.050	-0.100	1.200	0.005
14S10	R	Angle	deg	000.0	-180.0	180.0	5.0
14S11	R	Drop-Ratio	%	60	30	170	1
14S12	R	Delay	s	00.50	0.05	60.00	0.01
14S13	R	MaxMin	<Select>	MIN	-1	+1	2
		MIN	-1				
		MAX	1				
14S14	R	Phi-Comp.	deg	0.0	-5.0	5.0	0.1
14S15	R	NrOfPhases		001	1	3	1
14S16	R	PN	UN*IN	1.000	0.500	2.500	0.001

Measured variables

Address	Access	Text	Dec.
14V1	R	PN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	PN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.30. *I_{max}-U_{min}* 20**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	01.00	0.5	60.00	0.01
14S10	R	Strom	IN	02.00	0.5	20	0.1
14S11	R	Hold-Voltage	UN	00.70	0.4	1.1	0.01
14S12	R	Hold-Time	s	01.00	0.1	10	0.02
14S13	R	NrOfPhases		001	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3
14V2	R	UN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.31. Delay 22**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Trip-Delay	s	01.00	0.00	300.00	0.01
14S10	R	Reset-Delay	s	00.01	0.00	300.00	0.01
14S11	R	Integration	0/1	0	0	1	1

Measured variables

Address	Access	Text	Dec.
14V1	R	s	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	s	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.32. Diff-Gen 23**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	g-Setting	IN	0.10	0.10	0.50	0.05
14S10	R	v-Setting		0.25	0.25	0.50	0.25

Measured variables

Address	Access	Text	Dec.
14V1	R	IN (Id-R)	2
14V2	R	IN (Id-S)	2
14V3	R	IN (Id-T)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN (Id-R)	2
14Q2	R	IN (Id-S)	2
14Q3	R	IN (Id-T)	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip-R Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Trip-S Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Trip-T Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Trip Set	V155	64	14I4
14E8	Ditto Reset	V155	128	

9.6.33. Distance 24**Basic channel No.: 14****Summary of parameters:**

The starter and measurement settings (in columns Min., Max. and Step) with the unit 'ohms/phase' have to be divided by 10 for relays with a rated current of 5 A.

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP CB R		00000000B			
14S6	R	TRIP CB S		00000000B			
14S7	R	TRIP CB T		00000000B			
14S9	R	X (1)	Ω/ph	000.00	-300	300	0.01
14S10	R	R (1)	Ω/ph	000.00	-300	300	0.01
14S11	R	RR (1)	Ω/ph	000.00	-300	300	0.01
14S12	R	RRE (1)	Ω/ph	000.00	-300	300	0.01
14S13	R	k0 (1)	1	001.00	0	8	0.01
14S14	R	k0Ang(1)	deg	000.00	-180	90	0.01
14S15	R	Delay(1)	s	000.000	0	10	0.001
14S16	R	X (2)	Ω/ph	000.00	-300	300	0.01
14S17	R	R (2)	Ω/ph	000.00	-300	300	0.01
14S18	R	RR (2)	Ω/ph	000.00	-300	300	0.01
14S19	R	RRE (2)	Ω/ph	000.00	-300	300	0.01
14S20	R	k0 (2)	1	001.00	0	8	0.01
14S21	R	k0Ang(2)	deg	000.00	-180	90	0.01
14S22	R	Delay(2)	s	000.00	0	10	0.01
14S23	R	X (3)	Ω/ph	000.00	-300	300	0.01
14S24	R	R (3)	Ω/ph	000.00	-300	300	0.01
14S25	R	RR (3)	Ω/ph	000.00	-300	300	0.01
14S26	R	RRE (3)	Ω/ph	000.00	-300	300	0.01
14S27	R	k0 (3)	1	001.00	0	8	0.01
14S28	R	k0Ang(3)	deg	000.00	-180	90	0.01
14S29	R	Delay(3)	s	000.00	0	10	0.01

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S30	R	X (4/OR)	Ω /ph	000.00	-300	300	0.01
14S31	R	R (4/OR)	Ω /ph	000.00	-300	300	0.01
14S32	R	RR (4/OR)	Ω /ph	000.00	-300	300	0.01
14S33	R	RRE (4/OR)	Ω /ph	000.00	-300	300	0.01
14S34	R	k0 (4/OR)	1	001.00	0	8	0.01
14S35	R	k0Ang(4/OR)	deg	000.00	-180	90	0.01
14S36	R	Delay(4/OR)	s	000.00	0	10	0.01
14S37	R	X (BACK)	Ω /ph	000.00	-300	0	0.01
14S38	R	R (BACK)	Ω /ph	000.00	-300	0	0.01
14S39	R	RR (BACK)	Ω /ph	000.00	-300	0	0.01
14S40	R	RRE (BACK)	Ω /ph	000.00	-300	0	0.01
14S41	R	StartMode	<Select>	I>	2	6	2
		UZ	4				
		OC	6				
14S42	R	PhasSelMode	<Select>	solid ground	0	8	1
		Solid ground	0				
		RTS(R) cycl	1				
		TRS(T) cycl	2				
		RTS acycl	3				
		RST acycl	4				
		TSR acycl	5				
		TRS acycl	6				
		SRT acycl	7				
		STR acycl	8				
14S43	R	ComMode	<Select>	off	0	5	1
		off	0				
		PUTT Nondir	1				
		PUTT Fward	2				
		PUTT OR2	3				
		POTT	4				
		BLOCK OR	5				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S44	R	VTSupMode	<Select>	off	0	4	1
		off	0				
		I0	1				
		I2	2				
		I0*I2	3				
		Special	4				
14S45	R	Ref Length	Ω/ph	01.000	0.01	30.000	0.001
14S46	R	CT Neutral	<Select>	Busside	-1	1	2
		Busside	-1				
		Lineside	1				
14S47	R	k0m	1	000.00	0	8	0.01
14S48	R	k0mAng	deg	000.00	-90	90	0.01
14S49	R	Imin	IN	000.20	0.1	2	0.01
14S50	R	3I0min	IN	000.20	0.1	2	0.01
14S51	R	U0 VTSup	UN	000.20	0.01	0.5	0.01
14S52	R	I0 VTSup	IN	000.07	0.01	0.5	0.01
14S53	R	U2 VTSup	UN	000.20	0.01	0.5	0.01
14S54	R	I2 VTSup	IN	000.07	0.01	0.5	0.01
14S55	R	Istart	IN	004.00	0.5	10	0.01
14S56	R	XA	Ω/ph	000.0	0	999	0.1
14S57	R	XB	Ω/ph	000.0	-999	0	0.1
14S58	R	RA	Ω/ph	000.0	0	999	0.1
14S59	R	RB	Ω/ph	000.0	-999	0	0.1
14S60	R	RLoad	Ω/ph	000.0	0	999	0.1
14S61	R	AngleLoad	deg	045.0	0	90	0.1
14S62	R	Delay(Def)	s	002.00	0	10	0.01
14S63	R	UminFault	UN	000.05	0.01	2	0.01
14S64	R	MemDirMode	<Select>	Trip	0	2	1
		Block	0				
		Trip	1				
		Cond Trip	2				

Address	Access	Text	Unit	Default	Min.	Max.	Step
15S1	R	SOFT	<Select>	off	0	2	1
		off	0				
		Non-dir	1				
		Fwards OR2	2				
15S2	R	EventRecFull	<Select>	off	0	1	1
		off	0				
		on	1				
15S3	R	3U0min	UN	000.00	0	2	0.01
15S4	R	U Weak	UN	000.00	0	2	0.01
15S5	R	I OC BU	IN	000.00	0	10	0.01
15S6	R	Del OC BU	s	005.00	0	10	0.01
15S7	R	GndFaultMode	<Select>	I0	0	3	1
		I0	0				
		I0 OR U0	1				
		I0 AND U0	2				
		Blocked	3				
15S9	R	Dir Def	<Select>	Non-dir	1	2	1
		Non-dir	1				
		Fwards	2				
15S10	R	TripMode	<Select>	1PhTrip	1	3	1
		1PhTrip	1				
		3PhTrip	2				
		3PhTripDel3	3				
15S11	R	SOFT10sec	<Select>	off	0	1	1
		off	0				
		on	1				
15S12	R	t1EvolFaults	s	003.00	0	10	0.01
15S13	R	ZExtension	<Select>	off	0	1	1
		off	0				
		on	1				
15S14	R	Weak	<Select>	off	0	1	1
		off	0				
		on	1				

Address	Access	Text	Unit	Default	Min.	Max.	Step
15S15	R	Unblock	<Select>	off	0	1	1
		off	0				
		on	1				
15S16	R	Block Z1	<Select>	off	0	1	1
		off	0				
		on	1				
15S17	R	Echo	<Select>	off	0	1	1
		off	0				
		on	1				
15S18	R	TransBl	<Select>	off	0	1	1
		off	0				
		on	1				
15S19	R	t1TransBl	s	000.05	0	0.25	0.01
15S20	R	t2TransBl	s	003.00	0	10	0.01
15S21	R	t1Block	s	000.04	0	0.25	0.01
15S22	R	tPSblock	s	000.00	0	10	0.01
15S23	R	VTSupBlkDel	<Select>	off	0	1	1
		off	0				
		on	1				
15S24	R	VTSupDebDel	<Select>	off	0	1	1
		off	0				
		on	1				
15S25	R	TIMER_1	ms	0	0	30000	1
15S26	R	TIMER_2	ms	0	0	30000	1
15S27	R	TIMER_3	ms	0	0	30000	1
15S28	R	TIMER_4	ms	0	0	30000	1
15S29	R	TIMER_5	ms	0	0	30000	1
15S30	R	TIMER_6	ms	0	0	30000	1
15S31	R	TIMER_7	ms	0	0	30000	1
15S32	R	TIMER_8	ms	0	0	30000	1

Measured variables

Address	Access	Text	Dec.
14V1	R	[Ref Length]	2
14V2-14V3	R	Z (RE)	2
14V4-14V5	R	Z (SE)	2
14V6-14V7	R	Z (TE)	2
14V8-14V9	R	Z (RS)	2
14V10-14V11	R	Z (ST)	2
14V12-14V13	R	Z (TR)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	[Ref Length]	2
14Q2-14Q3	R	Z (RE)	2
14Q4-14Q5	R	Z (SE)	2
14Q6-14Q7	R	Z (TE)	2
14Q8-14Q9	R	Z (RS)	2
14Q10-14Q11	R	Z (ST)	2
14Q12-14Q13	R	Z (TR)	2

Note:

A tripping value will only be overwritten (e.g.: Z(RS)) if the same loop (RS) trips again.

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Start I0 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start U0 Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Meas Oreach Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Trip O/C Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Power Swing Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	Trip CB R Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	Trip CB S Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	
14E15	Trip CB T Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	Trip SOFT Set	V156	1	14I9
14E18	Ditto Reset	V156	2	
14E19	Start O/C Set	V156	4	14I10
14E20	Ditto Reset	V156	8	
14E21	Meas Main Set	V156	16	14I11
14E22	Ditto Reset	V156	32	
14E23	Trip CB Set	V156	64	14I12
14E24	Ditto Reset	V156	128	
14E25	Start R+S+T Set	V156	256	14I13
14E26	Ditto Reset	V156	512	
14E27	Com Send Set	V156	1024	14I14
14E28	Ditto Reset	V156	2048	
14E29	Dist Blocked Set	V156	4096	14I15
14E30	Ditto Reset	V156	8192	

Event No.	Cause	Event mask	Enable code	Status
14E31	FreqDev Set	V156	16384	14I16
14E32	Ditto Reset	V156	32768	
14E33	Start R Set	V157	1	14I17
14E34	Ditto Reset	V157	2	
14E35	Start S Set	V157	4	14I18
14E36	Ditto Reset	V157	8	
14E37	Start T Set	V157	16	14I19
14E38	Ditto Reset	V157	32	
14E39	Start E Set	V157	64	14I20
14E40	Ditto Reset	V157	128	
14E41	Start I> Set	V157	256	14I21
14E42	Ditto Reset	V157	512	
14E43	Start Z< Set	V157	1024	14I22
14E44	Ditto Reset	V157	2048	
14E45	Delay 2 Set	V157	4096	14I23
14E46	Ditto Reset	V157	8192	
14E47	Delay 3 Set	V157	16384	14I24
14E48	Ditto Reset	V157	32768	
14E49	Delay 4 Set	V158	1	14I25
14E50	Ditto Reset	V158	2	
14E51	Delay Def Set	V158	4	14I26
14E52	Ditto Reset	V158	8	
14E53	Start RST Set	V158	16	14I27
14E54	Ditto Reset	V158	32	
14E55	Weak infeed Set	V158	64	14I28
14E56	Ditto Reset	V158	128	
14E57	Meas Bward Set	V158	256	14I29
14E58	Ditto Reset	V158	512	
14E59	Trip CB 3P Set	V158	1024	14I30
14E60	Ditto Reset	V158	2048	
14E61	Trip CB 1P Set	V158	4096	14I31
14E62	Ditto Reset	V158	8192	

Event No.	Cause	Event mask	Enable code	Status
15E1	Trip RST Set	V155	1	15I1
15E2	Ditto Reset	V155	2	
15E3	Trip Com Set	V155	4	15I2
15E4	Ditto Reset	V155	8	
15E5	Delay 1 Set	V155	16	15I3
15E6	Ditto Reset	V155	32	
15E7	Com Boost Set	V155	64	15I4
15E8	Ditto Reset	V155	128	
15E9	Trip Stub Set	V155	256	15I5
15E10	Ditto Reset	V155	512	
15E11	VTSup Set	V155	1024	15I6
15E12	Ditto Reset	V155	2048	
15E13	VTSup Delay Set	V155	4096	15I7
15E14	Ditto Reset	V155	8192	
15E15	Start R Aux Set	V155	16384	15I8
15E16	Ditto Reset	V155	32768	
15E17	Start S Aux Set	V156	1	15I9
15E18	Ditto Reset	V156	2	
15E19	Start T Aux Set	V156	4	15I10
15E20	Ditto Reset	V156	8	
15E21	Start E Aux Set	V156	16	15I11
15E22	Ditto Reset	V156	32	
15E23	Start RST Aux Set	V156	64	15I12
15E24	Ditto Reset	V156	128	
15E25	Trip RST Aux Set	V156	256	15I13
15E26	Ditto Reset	V156	512	
15E27	Start SOFT Set	V156	1024	15I14
15E28	Ditto Reset	V156	2048	
15E29	Delay >= 2 Set	V156	4096	15I15
15E30	Ditto Reset	V156	8192	

Event No.	Cause	Event mask	Enable code	Status
15E31	Meas Fward Set	V156	16384	15I16
15E32	Ditto Reset	V156	32768	
15E33	BOOL_OUT1 Set	V157	1	15I17
15E34	Ditto Reset	V157	2	
15E35	BOOL_OUT2 Set	V157	4	15I18
15E36	Ditto Reset	V157	8	
15E37	BOOL_OUT3 Set	V157	16	15I19
15E38	Ditto Reset	V157	32	
15E39	BOOL_OUT4 Set	V157	64	15I20
15E40	Ditto Reset	V157	128	
15E41	BOOL_OUT5 Set	V157	256	15I21
15E42	Ditto Reset	V157	512	
15E43	BOOL_OUT6 Set	V157	1024	15I22
15E44	Ditto Reset	V157	2048	
15E45	BOOL_OUT7 Set	V157	4095	15I23
15E46	Ditto Reset	V157	8192	
15E47	BOOL_OUT8 Set	V157	16384	15I24
15E48	Ditto Reset	V157	32768	
15E49	Start 1ph Set	V158	1	15I25
15E50	Ditto Reset	V158	2	
15E51	DelDistBlock Set	V158	4	15I26
15E52	Ditto Reset	V158	8	

9.6.34. Frequency 25**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Frequency	Hz	48.00	40.00	65.00	0.01
14S10	R	U-Block	UN	0.20	0.20	0.80	0.10
14S11	R	Delay	s	01.00	0.10	60.00	0.01
14S12	R	MaxMin	<Select>	MIN	-1	1	2
		MIN	-1				
		MAX	1				

Measured variables

Address	Access	Text	Dec.
14V1	R	Hz	3
14V2	R	UN	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	Hz	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Block.(U<) Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Trip Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Start Set	V155	16	1I3
14E6	Ditto Reset	V155	32	

9.6.35. Overexcitat 26**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	01.00	0.10	60.00	0.01
14S10	R	U/f-Setting	UN/fN	01.20	0.20	2.00	0.01
14S11	R	MaxMin	<Select>	MAX	-1	1	2
		MIN	-1				
		MAX	1				

Measured variables

Address	Access	Text	Dec.
14V1	R	UN/fN	2
14V2	R	Hz	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN/fN	2

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.36. Count 27**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	CountThresh		1	1	100	1
14S10	R	Drop time	s	00.04	00.01	30.00	00.01
14S11	R	Reset-Delay	s	010.0	000.1	300.0	000.1

Measured variables

Address	Access	Text	Dec.
14V1	R		0

Tripping levels

Address	Access	Text	Dec.
14Q1	R		0

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	

9.6.37. Overtemp. (RE. 316*4) 28**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Theta-Beginn	%	100	000	100	001
14S10	R	Theta-Warn	%	105	050	200	001
14S11	R	Theta-Trip	%	110	050	200	001
14S12	R	NrOfPhases		1	1	3	2
14S13	R	TimeConstant	min	005.0	002.0	500.0	000.1
14S14	R	IB-Setting	IN	1.00	0.50	2.50	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	Theta-Nom	3
14V2	R	Pv-Nom	3
14V3	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	Theta-Nom	3
14Q2	R	Pv-Nom	3
14Q3	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Alarm Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Trip Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.38. Check-I3ph 29**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	I-Setting	IN	0.20	0.05	1.00	0.05
14S10	R	Delay	s	10.0	0.1	60.0	0.1
14S11	R	CT-Compens		+1.00	-2.00	+2.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	

9.6.39. Check-U3ph 30**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	U-Setting	UN	0.20	0.05	1.20	0.05
14S10	R	Delay	s	10.0	0.1	60.0	0.1
14S11	R	VT-Compens		+1.00	-2.00	+2.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	UN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	

9.6.40. Logic 31**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Logic Mode	<Select>	OR	0	2	1
		OR	0				
		AND	1				
		RS-Flipflop	2				

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	BinOutput Set	V155	1	1411
14E2	Ditto Reset	V155	2	

9.6.41. Disturbance Rec 32**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S9	R	StationNr	No.	01	00	99	01
14S10	R	preEvent	ms	40	40	400	20
14S11	R	Event	ms	100	100	3000	50
14S12	R	postEvent	ms	40	40	400	20
14S13	R	recMode	<Select>	A	0	1	1
		A	0				
		B	1				
14S14	R	TrigMode	<Select>	TrigOnStart	0	5	1
		TrigOnStart	0				
		TrigOnTrip	1				
		TrigOnBin	2				
		TrigAnyBi	3				
		TrigStart&Bi	4				
		TrigTrip&Bin	5				
14S15	R	BinInp 1	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S16	R	BinInp 2	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S17	R	BinInp 3	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S18	R	BinInp 4	<Select>	No trig	0	2	1

Address	Access	Text	Unit	Default	Min.	Max.	Step
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S19	R	BinInp 5	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S20	R	BinInp 6	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S21	R	BinInp 7	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S22	R	BinInp 8	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S23	R	BinInp 9	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S24	R	BinInp 10	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S25	R	BinInp 11	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S26	R	BinInp 12	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S27	R	BinInp 13	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S28	R	BinInp 14	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S29	R	BinInp 15	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S30	R	BinInp 16	<Select>	No trig	0	2	1
		No trig	0				
		Trigger	1				
		Inv. Trigger	2				
14S31	R	StorageMode	<Select>	StopOnFull	0	1	1
		StopOnFull	0				
		Overwrite	1				

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Bin output Set	V155	1	1411
14E2	Ditto Reset	V155	2	
14E3	Mem full Set	V155	4	1412
14E4	Ditto Reset	V155	8	

9.6.42. Voltage-Inst 36**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Delay	s	00.01	0.00	60.00	0.01
14S10	R	U-Setting	UN	1.40	0.01	2.00	0.01
14S11	R	f-min	Hz	040.0	25	50	1
14S12	R	MaxMin	<Select>	MAX	-1	1	2
		MIN	-1				
		MAX	1				
14S13	R	NrOfPhases		001	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	UN	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	1411
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	1412
14E4	Ditto Reset	V155	8	

9.6.43. Autoreclosure 38**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
1S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S6	R	CB2 close		00000000B			
14S9	R	1. AR Mode	<Select>	1. 1P3P-1P3P	1	5	1
		1. 1P-1P	1				
		1. 1P-3P	2				
		1. 1P3P-3P	3				
		1. 1P3P-1P3P	4				
		ExtSelection	5				
14S10	R	2..4AR Mode	<Select>	off	0	3	1
		off	0				
		2 AR	1				
		3 AR	2				
		4 AR	3				
14S11	R	Master Mode	<Select>	off	0	1	1
		off	0				
		on	1				
14S12	R	ZE Prefault	<Select>	on	0	1	1
		off	0				
		on	1				
14S13	R	ZE 1. AR	<Select>	off	0	1	1
		off	0				
		on	1				
14S14	R	ZE 2. AR	<Select>	off	0	1	1
		off	0				
		on	1				
14S15	R	ZE 3. AR	<Select>	off	0	1	1
		off	0				
		on	1				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S16	R	ZE 4. AR	<Select>	off	0	1	1
		off	0				
		on	1				
14S17	R	SCBypass 1P	<Select>	off	0	1	1
		off	0				
		on	1				
14S18	R	SCBypass1P3P	<Select>	off	0	1	1
		off	0				
		on	1				
14S19	R	t Dead1 1P	s	001.20	0.05	300	0.01
14S20	R	t Dead1 3P	s	000.60	0.05	300	0.01
14S21	R	t Dead1 Ext	s	001.00	0.05	300	0.01
14S22	R	t Dead2	s	001.20	0.05	300	0.01
14S23	R	t Dead3	s	005.00	0.05	300	0.01
14S24	R	t Dead4	s	060.00	0.05	300	0.01
14S25	R	t Oper.	s	000.50	0.05	300	0.01
14S26	R	t Inhibit	s	005.00	0.05	300	0.01
14S27	R	t Close	s	000.25	0.05	300	0.01
14S28	R	t Discrim.1P	s	000.60	0.10	300	0.01
14S29	R	t Discrim.3P	s	000.30	0.10	300	0.01
14S30	R	t Timeout	s	001.00	0.05	300	0.01
14S31	R	t AR Block.	s	005.00	0.05	300	0.01
14S32	R	TMSEC_Timer1	ms	0	0	30000	1
14S33	R	TMSEC_Timer2	ms	0	0	30000	1
14S34	R	TMSEC_Timer3	ms	0	0	30000	1
14S35	R	TMSEC_Timer4	ms	0	0	30000	1
14S36	R	TMSEC_Timer5	ms	0	0	30000	1
14S37	R	TMSEC_Timer6	ms	0	0	30000	1
14S38	R	TMSEC_Timer7	ms	0	0	30000	1
14S39	R	TMSEC_Timer8	ms	0	0	30000	1

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	CB Close Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	CB2 Close Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Trip 3-Pol Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	ZExtension Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Def. Trip Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	Delay Flwr. Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	Blk. to Flwr Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	
14E15	Inhibit Outp Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	AR Ready Set	V156	1	14I9
14E18	Ditto Reset	V156	2	
14E19	AR Blocked Set	V156	4	14I10
14E20	Ditto Reset	V156	8	
14E21	AR in Prog Set	V156	16	14I11
14E22	Ditto Reset	V156	32	
14E23	First AR 1P Set	V156	64	14I12
14E24	Ditto Reset	V156	128	
14E25	First AR 3P Set	V156	256	14I13
14E26	Ditto Reset	V156	512	
14E27	Second AR Set	V156	1024	14I14
14E28	Ditto Reset	V156	2048	
14E29	Third AR Set	V156	4096	14I15
14E30	Ditto Reset	V156	8192	

Event No.	Cause	Event mask	Enable code	Status
14E31	Fourth AR Set	V156	16384	14I16
14E32	Ditto Reset	V156	32768	
14E33	P_OUTPUT1 Set	V157	1	14I17
14E34	Ditto Reset	V157	2	
14E35	P_OUTPUT2 Set	V157	4	14I18
14E36	Ditto Reset	V157	8	
14E37	P_OUTPUT3 Set	V157	16	14I19
14E38	Ditto Reset	V157	32	
14E39	P_OUTPUT4 Set	V157	64	14I20
14E40	Ditto Reset	V157	128	
14E41	P_OUTPUT5 Set	V157	256	1421
14E42	Ditto Reset	V157	512	
14E43	P_OUTPUT6 Set	V157	1024	1422
14E44	Ditto Reset	V157	2048	
14E45	P_OUTPUT7 Set	V157	4096	1423
14E46	Ditto Reset	V157	8192	
14E47	P_OUTPUT8 Set	V157	16384	14I24
14E48	Ditto Reset	V157	32768	

9.6.44. EarthFaultIsol 40**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
149	R	P-Setting	PN	0.050	0.005	0.100	0.001
14S10	R	Angle	deg	000.00	-180.00	180.00	0.01
14S11	R	Drop-Ratio	%	60	30	95	1
14S12	R	Delay	s	00.50	0.05	60.00	0.01
14S13	R	Phi-Comp.	deg	0.00	-5.00	5.00	0.01
14S14	R	PN	UN*IN	1.000	0.500	2.500	0.001

Measured variables

Address	Access	Text	Dec.
14V1	R	PN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	PN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.45. Voltage-Bal 41**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	V-Unbalance	UN	0.20	0.10	0.50	0.05
14S10	R	Delay	s	0.04	0.00	1.00	0.01
14S11	R	t-Reset	s	1.50	0.10	2.00	0.01
14S12	R	NrOfPhases		003	1	3	2

Measured variables

Address	Access	Text	Dec.
14V1	R	UN (Ud-1)	2
14V2	R	UN (Ud-2)	2
14V3	R	UN (Ud-3)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN (Ud-1)	2
14Q2	R	UN (Ud-2)	2
14Q3	R	UN (Ud-3)	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Trip-Line1 Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Trip-Line2 Set	V155	64	14I4
14E8	Ditto Reset	V155	28	

9.6.46. U/f-Inv 47**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	V/f-Setting	UN/fN	01.10	1.05	1.20	0.01
14S10	R	t-min	min	0.20	0.01	2.00	0.01
14S11	R	t-max	min	60.0	5.0	100.0	0.1
14S12	R	t-Reset	min	60.0	0.2	100.0	0.1
14S13	R	t[V/f=1.05]	min	70.00	00.01	100.00	0.01
14S14	R	t[V/f=1.10]	min	70.00	00.01	100.00	0.01
14S15	R	t[V/f=1.15]	min	06.00	00.01	100.00	0.01
14S16	R	t[V/f=1.20]	min	01.000	00.001	30.000	0.001
14S17	R	t[V/f=1.25]	min	00.480	00.001	30.000	0.001
14S18	R	t[V/f=1.30]	min	00.300	00.001	30.000	0.001
14S19	R	t[V/f=1.35]	min	00.220	00.001	30.000	0.001
14S20	R	t[V/f=1.40]	min	00.170	00.001	30.000	0.001
14S21	R	t[V/f=1.45]	min	00.140	00.001	30.000	0.001
14S22	R	t[V/f=1.50]	min	00.140	00.001	30.000	0.001
14S23	R	UB-Setting	UN	01.00	0.80	1.20	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	UN/fN	2
14V2	R	Hz	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN/fN	2

Event list

Event No.	Cause	Event mask	Enable code	Status
4E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.47. UlfPQ 48**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S9	R	Angle	deg	000.0	-180.0	180.0	0.1
14S10	R	PN	UN*IN	1.000	0.200	2.500	0.001
14S11	R	Voltage mode	<Select>	direct	1	2	1
		direct	1				
		ph-to-ph	2				

Measured variables

Address	Access	Text	Dec.
14V1	R	UN	3
14V2	R	IN	3
14V3	R	P (PN)	3
14V4	R	Q (PN)	3
14V5	R	Hz	3

9.6.48. SynchroCheck 49**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	maxVoltDif	UN	0.20	0.05	0.40	0.05
14S10	R	maxPhaseDif	deg	10.0	05.0	80.0	05.0
14S11	R	maxFreqDif	Hz	0.20	0.05	0.40	0.05
14S12	R	minVoltage	UN	0.70	0.60	1.00	0.05
14S13	R	maxVoltage	UN	0.30	0.10	1.00	0.05
14S14	R	Operat.-Mode	<Select>	SynChck only	0	4	1
		SynChck only	0				
		DBus + LLine	1				
		LBus + DLine	2				
		DBus | DLine	3				
		DBus + DLine	4				
14S15	R	SupervisTime	s	0.20	0.05	5.00	0.05
14S16	R	t-Reset	s	0.05	0.00	1.00	0.05
14S17	R	LiveBus	<Select>	1ph R-S	0	7	1
		1ph R-S	0				
		1ph S-T	1				
		1ph T-R	2				
		1ph R-E	3				
		1ph S-E	4				
		1ph T-E	5				
		3ph-delta	6				
		3ph-Y	7				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S18	R	LiveLine	<Select>	3ph-Y	0	7	1
		1ph R-S	0				
		1ph S-T	1				
		1ph T-R	2				
		1ph R-E	3				
		1ph S-E	4				
		1ph T-E	5				
		3ph-delta	6				
		3ph-Y	7				

Measured variables

Address	Access	Text	Dec.
14V1	R	UN (dU)	2
14V2	R	deg (dPhi)	2
14V3	R	Hz (Idf)	2
14V4	R	UN (max. bus V)	2
14V5	R	UN (min. bus V)	2
14V6	R	UN (max. line V)	2
14V7	R	UN (min. line V)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN (dU)	2
14Q2	R	deg (dPhi)	2
14Q3	R	Hz (Idf)	2

Event list

Event No.	Cause	Event mask	Enable code	Status
4E1	PermitToClos Set	V155	1	1411
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	1412
14E4	Ditto Reset	V155	8	
14E5	SyncBlockd Set	V155	16	1413
14E6	Ditto Reset	V155	32	
14E7	TrigBlockd Set	V155	64	1414
14E8	Ditto Reset	V155	128	
14E9	SyncOverrid Set	V155	256	1415
14E10	Ditto Reset	V155	512	
14E11	AmplDifOK Set	V155	1024	1416
14E12	Ditto Reset	V155	2048	
14E13	PhaseDifOK Set	V155	4096	1417
14E14	Ditto Reset	V155	8192	
14E15	FreqDifOK Set	V155	16384	1418
14E16	Ditto Reset	V155	32768	
14E17	LiveBus Set	V156	1	1419
14E18	Ditto Reset	V156	2	
14E19	DeadBus Set	V156	4	14110
14E20	Ditto Reset	V156	8	
14E21	LiveLine Set	V156	16	14111
14E22	Ditto Reset	V156	32	
14E23	DeadLine Set	V156	64	14112
14E24	Ditto Reset	V156	128	

9.6.49. Rotor-EFP 51**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Alarm-Delay	s	0.50	0.20	60.00	0.05
14S10	R	Trip-Delay	s	0.50	0.20	60.00	0.05
14S11	R	RFr-AlarmVal	kOhm	10.0	0.1	25.0	0.1
14S12	R	RFr-TripVal	kOhm	01.0	0.1	25.0	0.1
14S13	R	REr	kOhm	1.00	0.90	5.00	0.01
14S14	R	Uir	<Select>	50 Volt	1	3	1
		20 Volt	1				
		30 Volt	2				
		50 Volt	3				
14S15	R	RFr-Adjust	kOhm	10.00	8.00	12.00	0.01
14S16	R	CoupC-Adjust	uF	4.00	2.00	10.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	Rfr (kOhm)	1
14V2	R	Ck" (uF)	2
14V3	R	REr" (kOhm)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	Rfr (kOhm)	1
14Q2	R	Ck" (uF)	2
14Q3	R	REr" (kOhm)	2

Event list for Rotor-EFP

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Trip Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Alarm Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Start Alarm Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	InterruptInt Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	InterruptExt Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	Rer-Adjust Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	
14E15	CoupC-Adjust Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	Extern-Block Set	V156	1	14I9
14E18	Ditto Reset	V156	2	

9.6.50. Stator-EFP 52**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	Alarm-Delay	s	0.50	0.20	60.00	0.05
14S10	R	Trip-Delay	s	0.50	0.20	60.00	0.05
14S11	R	RFs-AlarmVal	kOhm	10.0	0.1	20.0	0.1
14S12	R	RFs-TripVal	kOhm	01.0	0.1	20.0	0.1
14S13	R	REs	kOhm	1.00	0.70	5.00	0.01
14S14	R	REs-2.Starpt	kOhm	1.00	0.90	30.00	0.01
14S15	R	RFs-Adjust	kOhm	10.00	8.00	12.00	0.01
14S16	R	MTransRatio	100.0	10.0	200.0	0.1	
14S17	R	NrOfStarpt		1	1	2	1

Measured variables

Address	Access	Text	Dec.
14V1	R	Rfs (kOhm)	1
14V2	R	Inst. trans. ratio	1
14V3	R	REs" (kOhm)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	Rfs (kOhm)	1
14Q2	R	Inst. trans. ratio	1
14Q3	R	REs" (kOhm)	2

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start Trip	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	
14E5	Alarm	Set	V155	16	14I3
14E6	Ditto	Reset	V155	32	
14E7	Start Alarm	Set	V155	64	14I4
14E8	Ditto	Reset	V155	128	
14E9	InterruptInt	Set	V155	256	14I5
14E10	Ditto	Reset	V155	512	
14E11	InterruptExt	Set	V155	1024	14I6
14E12	Ditto	Reset	V155	2048	
14E13	2.Starpt	Set	V155	4096	14I7
14E14	Ditto	Reset	V155	8192	
14E15	MTR-Adjust	Set	V155	16384	14I8
14E16	Ditto	Reset	V155	32768	
14E17	Res-Adjust	Set	V156	1	14I9
14E18	Ditto	Reset	V156	2	
14E19	Extern-Block	Set	V156	4	14I10
14E20	Ditto	Reset	V156	8	

9.6.51. 10-Invers 53**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	c-Setting	<Select>	1	0	2	1
		0.02	0				
		1.00	1				
		2.00	2				
		RXIDG	3				
14S10	R	k1-Setting	s	013.50	0.01	200.00	0.01
14S11	R	I-Start	IB	1.10	1.00	2.00	0.01
14S12	R	NrOfPhases		1	1	3	2
14S13	R	IB-Setting	IN	1.00	0.20	2.50	0.01
14S14	R	t-min	s	00.00	00.00	10.00	00.10

Measured variables

Address	Access	Text	Dec.
14V1	R	IN	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.52. Pole-Slip 55**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP1		00000000B			
14S9	R	ZA	UN/IN	0.00	0.000	5.000	0.001
14S10	R	ZB	UN/IN	0.00	-5.000	0.000	0.001
14S11	R	ZC	UN/IN	0.00	0.000	5.000	0.001
14S12	R	Phi	deg	090	60	270	1
14S13	R	WarnAngle	deg	000	0	180	1
14S14	R	TripAngle	deg	090	0	180	1
14S15	R	n1		01	0	20	1
14S16	R	n2		01	0	20	1
14S17	R	t-Reset	s	5.000	0.500	25.000	0.010

Measured variables

Address	Access	Text	Dec.
14V1	R	UN/IN	3
14V2	R	Hz	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	UN/IN	3
14Q2	R	Hz	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Warning Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Generator Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Motor Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Zone1 Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Zone2 Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	Trip1 Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	Trip2 Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	

9.6.53. Diff-Line 56**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	g	IN	0.20	0.10	0.50	0.10
14S10	R	v		0.50	0.25	0.50	0.25
14S11	R	b	1	1.50	1.25	5.00	0.25
14S12	R	g-High	IN	2.00	0.50	2.50	0.25
14S13	R	I-Inst	IN	10	3	15	1
14S14	R	a1		1.00	0.05	2.20	0.01
14S15	R	s1	<Select>	D	0	1	1
		Y	0				
		D	1				
14S16	R	a2		1.00	0.05	2.20	0.01
14S17	R	s2	<Select>	d0	00	21	1
		y0	0				
		y1	1				
		y5	2				
		y6	3				
		y7	4				
		y11	5				
		d0	6				
		d1	7				
		d5	8				
		d6	9				
		d7	10				
		d11	11				

Address	Access	Text	Unit	Default	Min.	Max.	Step
		z0	12				
		z1	13				
		z2	14				
		z4	15				
		z5	16				
		z6	17				
		z7	18				
		z8	19				
		z10	20				
		z11	21				
14S18	R	InrushRatio	%	10	6	20	1
14S19	R	InrushTime	s	0	0	90	1

Measured variables

Address	Access	Text	Dec.	Address	Access	Text	Dec.
14V1	R	IN (Id-R)	2	14V4	R	IN (IhR)	2
14V2	R	IN (Id-S)	2	14V5	R	IN (IhS)	2
14V3	R	IN (Id-T)	2	14V6	R	IN (IhT)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN (Id-R)	2
14Q2	R	IN (Id-S)	2
14Q3	R	IN (Id-T)	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Trip-R Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Trip-S Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Trip-T Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Inrush Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	Stabil Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	

9.6.54. RemoteBin 57**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	RemTRIP 1		00000000B			
14S6	R	RemTRIP 2		00000000B			
14S7	R	RemTRIP 3		00000000B			
14S8	R	RemTRIP 4		00000000B			

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	RemChan 1 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	RemChan 2 Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	RemChan 3 Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	RemChan 4 Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	RemChan 5 Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	RemChan 6 Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	RemChan 7 Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	
14E15	RemChan 8 Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	RemBinError Set	V156	1	14I9
14E18	Ditto Reset	V156	2	

9.6.55. EarthFltGnd2 58**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	V-Setting	UN	0.200	0.003	0.100	0.001
14S10	R	I-Setting	IN	0.10	0.10	1.00	0.01
14S11	R	Angle	deg	60.0	0.0	90.0	5.0
14S12	R	tBasic	s	0.050	0.000	1.000	0.001
14S13	R	tWait	s	0.050	0.000	0.500	0.001
14S14	R	tTransBl	s	0.100	0.000	0.500	0.001
14S15	R	CT Neutral	<Select>	Lineside	0	1	1
		Lineside	0				
		Busside	1				
14S16	R	ComMode	<Select>	Permissive	0	1	1
		Permissive	0				
		Blocking	1				
14S17	R	SendMode	<Select>	MeasBwd	0	1	1
		Non-dir	0				
		MeasBwd	1				
14S18	R	1 Channel	<Select>	off	0	1	1
		off	0				
		on	1				
14S19	R	Echo	<Select>	off	0	3	1
		off	0				
		Weak	1				
		Bkr	2				
		Weak & Bkr	3				

Measured variables

Address	Access	Text	Dec.
14V1	R	UN	2
14V2	R	IN	2
14V3	R	Forwards	0

Note: This function does not provide tripping levels (Q).

Event list

Event No.	Cause		Event mask	Enable code	Status
14E1	Trip	Set	V155	1	14I1
14E2	Ditto	Reset	V155	2	
14E3	Start	Set	V155	4	14I2
14E4	Ditto	Reset	V155	8	
14E5	MeasFwd	Set	V155	16	14I3
14E6	Ditto	Reset	V155	32	
14E7	MeasBwd	Set	V155	64	14I4
14E8	Ditto	Reset	V155	128	
14E9	Senden	Set	V155	256	14I5
14E10	Ditto	Reset	V155	512	
14E11	Recve Inh	Set	V155	1024	14I6
14E12	Ditto	Reset	V155	2048	

9.6.56. FUPLA 59**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S8	R	NoFUPMV	x	0	0		1
14S9	R	RepRate	x	low (2)	low (2)	high (0)	1
14S10	R	CycleTime	x	20	0	1000	1

Measured variables

The number of FUPLA measured variables depends on the configuration. Within this total configured, the order of the FUPLA measured variables measured variable numbers can be determined by assigning numbers to them.

Address	Access	Text	Dec.
14V1	R	FUPMV 1	2
14V2	R	FUPMV 2	2
14Vn	R	FUPMV n	2

Events

FUPLA events can only be configured as IBB events. Events are not recorded under the FUPLA function number. Because of the variable number of signals/events, FUPLA would require a variable number of channels.

IBB events

FUPLA 'Extout' to IBB channel and ER:

Events are recorded under their SPA address, IBB group and event number,

Addr 121 E1 .

Binary signals are assigned to IBB channels using the HMI. It is not possible to mask IBB events.

9.6.57. FlatterRecog 60**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S9	R	SupervisTime	s	1.0	0.1	60.0	0.1
14S10	R	NoOfChanges		2	2	100	1

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	InputStatus1 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	InputStatus2 Set	V155	4	14I3
14E4	Ditto Reset	V155	8	
14E5	InputStatus3 Set	V155	16	14I5
14E6	Ditto Reset	V155	32	
14E7	InputStatus4 Set	V155	64	14I7
14E8	Ditto Reset	V155	128	
14E9	FlatterSig1 Set	V155	256	14I2
14E10	Ditto Reset	V155	1024	
14E11	FlatterSig2 Set	V155	512	14I4
14E12	Ditto Reset	V155	2048	
14E13	FlatterSig3 Set	V155	4096	14I6
14E14	Ditto Reset	V155	8192	
14E15	FlatterSig4 Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	

9.6.58. HV distance 63**Basic channel No.: 14****Summary of parameters:**

The starter and measurement settings (in columns Min., Max. and Step) with the unit 'ohms/phase' have to be divided by 10 for relays with a rated current of 5 A.

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP CB R		00000000B			
14S6	R	TRIP CB S		00000000B			
14S7	R	TRIP CB T		00000000B			
14S9	R	X (1)	Ω/ph	000.00	-300	300	0.01
14S10	R	R (1)	Ω/ph	000.00	-300	300	0.01
14S11	R	RR (1)	Ω/ph	000.00	-300	300	
14S12	R	RRE (1)	Ω/ph	000.00	-300	300	
14S13	R	k0 (1)	1	001.00	0	8	0.01
14S14	R	k0Ang(1)	deg	000.00	-180	90	0.01
14S15	R	Delay(1)	s	000.000	0	10	0.001
14S16	R	X (2)	Ω/ph	000.00	-300	300	0.01
14S17	R	R (2)	Ω/ph	000.00	-300	300	0.01
14S18	R	RR (2)	Ω/ph	000.00	-300	300	0.01
14S19	R	RRE (2)	Ω/ph	000.00	-300	300	0.01
14S20	R	k0 (2)	1	001.00	0	8	0.01
14S21	R	k0Ang(2)	deg	000.00	-180	90	0.01
14S22	R	Delay(2)	s	000.00	0	10	0.01
14S23	R	X (3)	Ω/ph	000.00	-300	300	0.01
14S24	R	R (3)	Ω/ph	000.00	-300	300	0.01
14S25	R	RR (3)	Ω/ph	000.00	-300	300	0.01
14S26	R	RRE (3)	Ω/ph	000.00	-300	300	0.01
14S27	R	k0 (3)	1	001.00	0	8	0.01
14S28	R	k0Ang(3)	deg	000.00	-180	90	0.01
14S29	R	Delay(3)	s	000.00	0	10	0.01

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S30	R	X (4/OR)	Ω /ph	000.00	-300	300	0.01
14S31	R	R (4/OR)	Ω /ph	000.00	-300	300	0.01
14S32	R	RR (4/OR)	Ω /ph	000.00	-300	300	0.01
14S33	R	RRE (4/OR)	Ω /ph	000.00	-300	300	0.01
14S34	R	k0 (4/OR)	1	001.00	0	8	0.01
14S35	R	k0Ang(4/OR)	deg	000.00	-180	90	0.01
14S36	R	Delay(4/OR)	s	000.00	0	10	0.01
14S37	R	X (BACK)	Ω /ph	000.00	-300	0	0.01
14S38	R	R (BACK)	Ω /ph	000.00	-300	0	0.01
14S39	R	RR (BACK)	Ω /ph	000.00	-300	0	0.01
14S40	R	RRE (BACK)	Ω /ph	000.00	-300	0	0.01
14S41	R	PhasSelMode	<Select>	Non-dir	9	10	1
		Non-dir	9				
		Fward OR	10				
14S42	R	ComMode	<Select>	off	0	5	1
		off	0				
		PUTT Nondir	1				
		PUTT Fward	2				
		PUTT OR2	3				
		POTT	4				
		BLOCK OR	5				
14S43	R	VTSupMode	<Select>	off	0	4	1
		off	0				
		I0	1				
		I2	2				
		I0*I2	3				
		Special	4				
14S44	R	Ref Length	Ω /ph	01.000	0.01	30.000	0.001
14S45	R	CT Neutral	<Select>	Busside	-1	1	2
		Busside	-1				
		Lineside	1				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S46	R	k0m	1	000.00	0	8	0.01
14S47	R	k0mAng	deg	000.00	-90	90	0.01
14S48	R	lmin	IN	000.20	0.1	2	0.01
14S49	R	3l0min	IN	000.20	0.1	2	0.01
14S50	R	U0 VTSup	UN	000.20	0.01	0.5	0.01
14S51	R	I0 VTSup	IN	000.07	0.01	0.5	0.01
14S52	R	U2 VTSup	UN	000.20	0.01	0.5	0.01
14S53	R	I2 VTSup	IN	000.07	0.01	0.5	0.01
14S54	R	XA	Ω/ph	000.0	0	999	0.1
14S55	R	XB	Ω/ph	000.0	-999	0	0.1
14S56	R	RA	Ω/ph	000.0	0	999	0.1
14S57	R	RB	Ω/ph	000.0	-999	0	0.1
14S58	R	RLoad	Ω/ph	000.0	0	999	0.1
14S59	R	AngleLoad	deg	045.0	0	90	0.1
14S60	R	SR error	deg	0.00	-2.00	2.00	0.01
14S61	R	TR error	deg	0.00	-2.00	2.00	0.01
14S62	R	Delay(Def)	s	002.00	0	10	0.01
14S63	R	UminFault	UN	000.05	0.01	2	0.01
14S64	R	MemDirMode	<Select>	Trip	0	2	1
		Block	0				
		Trip	1				
		Cond Trip	2				
15S1	R	SOFT	<Select>	off	0	2	1
		off	0				
		Non-dir	1				
		Fwards OR2	2				
15S2	R	EventRecFull	<Select>	off	0	1	1
		off	0				
		on	1				
15S3	R	3U0min	UN	000.00	0	2	0.01
15S4	R	U Weak	UN	000.00	0	2	0.01

Address	Access	Text	Unit	Default	Min.	Max.	Step
15S5	R	I OC BU	IN	000.00	0	10	0.01
15S6	R	Del OC BU	s	005.00	0	10	0.01
15S7	R	GndFaultMode	<Select>	I0	4	7	1
		I0	4				
		I0 OR U0	5				
		I0(I2)	6				
		I0(I2) OR U0	7				
15S9	R	Dir Def	<Select>	Non-dir	1	2	1
		Non-dir	1				
		Fwards	2				
15S10	R	TripMode	<Select>	1PhTrip	1	3	1
		1PhTrip	1				
		3PhTrip	2				
		3PhTripDel3	3				
15S11	R	SOFT 10sec	<Select>	off	0	1	1
		off	0				
		on	1				
15S12	R	t1EvolFaults	s	003.00	0	10	0.01
15S14	R	Weak	<Select>	off	0	1	1
		off	0				
		on	1				
15S15	R	Unblock	<Select>	off	0	1	1
		off	0				
		on	1				
15S16	R	Echo	<Select>	off	0	1	1
		off	0				
		on	1				
15S17	R	TransBl	<Select>	off	0	1	1
		off	0				
		on	1				
15S18	R	t1TransBl	s	000.05	0	0.25	0.01

Address	Access	Text	Unit	Default	Min.	Max.	Step
15S19	R	t2TransBl	s	003.00	0	10	0.01
15S20	R	t1Block	s	000.04	0	0.25	0.01
15S21	R	tPSblock	s	000.00	0	10	0.01
15S22	R	VTSupBlkDel	<Select>	off	0	1	1
		off	0				
		on	1				
15S23	R	VTSupDebDel	<Select>	off	0	1	1
		off	0				
		on	1				
15S24	R	TIMER_1	ms	0	0	30000	1
15S25	R	TIMER_2	ms	0	0	30000	1
15S26	R	TIMER_3	ms	0	0	30000	1
15S27	R	TIMER_4	ms	0	0	30000	1
15S28	R	TIMER_5	ms	0	0	30000	1
15S29	R	TIMER_6	ms	0	0	30000	1
15S30	R	TIMER_7	ms	0	0	30000	1
15S31	R	TIMER_8	ms	0	0	30000	1
15S32	R	I Load	IN	0.5	0	2	0.1

Measured variables

Address	Access	Text	Dec.
14V1	R	[Ref Length]	2
14V2-14V3	R	Z (RE)	2
14V4-14V5	R	Z (SE)	2
14V6-14V7	R	Z (TE)	2
14V8-14V9	R	Z (RS)	2
14V10-14V11	R	Z (ST)	2
14V12-14V13	R	Z (TR)	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	[Ref Length]	2
14Q2-14Q3	R	Z (RE)	2
14Q4-14Q5	R	Z (SE)	2
14Q6-14Q7	R	Z (TE)	2
14Q8-14Q9	R	Z (RS)	2
14Q10-14Q11	R	Z (ST)	2
14Q12-14Q13	R	Z (TR)	2

Note:

A tripping value will only be overwritten (e.g.: Z(RS)) if the same loop (RS) trips again.

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Start I0 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start U0 Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Meas Oreach Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Trip O/C Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Power Swing Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	Trip CB R Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	Trip CB S Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	
14E15	Trip CB T Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	Trip SOFT Set	V156	1	14I9
14E18	Ditto Reset	V156	2	
14E19	Start O/C Set	V156	4	14I10
14E20	Ditto Reset	V156	8	
14E21	Meas Main Set	V156	16	14I11
14E22	Ditto Reset	V156	32	
14E23	Trip CB Set	V156	64	14I12
14E24	Ditto Reset	V156	128	
14E25	Start R+S+T Set	V156	256	14I13
14E26	Ditto Reset	V156	512	
14E27	Com Send Set	V156	1024	14I14
14E28	Ditto Reset	V156	2048	
14E29	Dist Blocked Set	V156	4096	14I15
14E30	Ditto Reset	V156	8192	

Event No.	Cause		Event mask	Enable code	Status
14E31	FreqDev	Set	V156	16384	14I16
14E32	Ditto	Reset	V156	32768	
14E33	Start R	Set	V157	1	14I17
14E34	Ditto	Reset	V157	2	
14E35	Start S	Set	V157	4	14I18
14E36	Ditto	Reset	V157	8	
14E37	Start T	Set	V157	16	14I19
14E38	Ditto	Reset	V157	32	
14E39	Start E	Set	V157	64	14I20
14E40	Ditto	Reset	V157	128	
14E41	Delay 2	Set	V157	256	14I21
14E42	Ditto	Reset	V157	512	
14E43	Delay 3	Set	V157	1024	14I22
14E44	Ditto	Reset	V157	2048	
14E45	Delay 4	Set	V157	4096	14I23
14E46	Ditto	Reset	V157	8192	
14E47	Delay Def	Set	V157	16384	14I24
14E48	Ditto	Reset	V157	32768	
14E49	Start RST	Set	V158	1	14I25
14E50	Ditto	Reset	V158	2	
14E51	Weak	Set	V158	4	14I26
14E52	Ditto	Reset	V158	8	
14E53	Meas Bward	Set	V158	16	14I27
14E54	Ditto	Reset	V158	32	
14E55	Trip CB 3P	Set	V158	64	14I28
14E56	Ditto	Reset	V158	128	
14E57	Trip CB 1P	Set	V158	256	14I29
14E58	Ditto	Reset	V158	512	
14E59	Trip RST	Set	V158	1024	14I30
14E60	Ditto	Reset	V158	2048	

Event No.	Cause		Event mask	Enable code	Status
14E61	Trip Com	Set	V158	4096	14I31
14E62	Ditto	Reset	V158	8192	
15E1	Delay 1	Set	V155	1	15I1
15E2	Ditto	Reset	V155	2	
15E3	Com Boost	Set	V155	4	15I2
15E4	Ditto	Reset	V155	8	
15E5	Trip Stub	Set	V155	16	15I3
15E6	Ditto	Reset	V155	32	
15E7	VTSup	Set	V155	64	15I4
15E8	Ditto	Reset	V155	128	
15E9	VTSup Delay	Set	V155	256	15I5
15E10	Ditto	Reset	V155	512	
15E11	Start R Aux	Set	V155	1024	15I6
15E12	Ditto	Reset	V155	2048	
15E13	Start S Aux	Set	V155	4096	15I7
15E14	Ditto	Reset	V155	8192	
15E15	Start T Aux	Set	V155	16384	15I8
15E16	Ditto	Reset	V155	32768	
15E17	Start E Aux	Set	V156	1	15I9
15E18	Ditto	Reset	V156	2	
15E19	Start RST Aux	Set	V156	4	15I10
15E20	Ditto	Reset	V156	8	
15E21	Trip RST Aux	Set	V156	16	15I11
15E22	Ditto	Reset	V156	32	
15E23	Start SOFT	Set	V156	64	15I12
15E24	Ditto	Reset	V156	128	
15E25	Delay >= 2	Set	V156	256	15I13
15E26	Ditto	Reset	V156	512	
15E27	Meas Fward	Set	V156	1024	15I14
15E28	Ditto	Reset	V156	2048	

Event No.	Cause		Event mask	Enable code	Status
15E29	BOOL_OUT1	Set	V156	4096	15I15
15E30	Ditto	Reset	V156	8192	
15E31	BOOL_OUT2	Set	V156	16384	15I16
15E32	Ditto	Reset	V156	32768	
15E33	BOOL_OUT3	Set	V157	1	15I17
15E34	Ditto	Reset	V157	2	
15E35	BOOL_OUT4	Set	V157	4	15I18
15E36	Ditto	Reset	V157	8	
15E37	BOOL_OUT5	Set	V157	16	15I19
15E38	Ditto	Reset	V157	32	
15E39	BOOL_OUT6	Set	V157	64	15I20
15E40	Ditto	Reset	V157	128	
15E41	BOOL_OUT7	Set	V157	256	15I21
15E42	Ditto	Reset	V157	512	
15E43	BOOL_OUT8	Set	V157	1024	15I22
15E44	Ditto	Reset	V157	2048	
15E45	Start 1ph	Set	V157	4096	15I23
15E46	Ditto	Reset	V157	8192	
15E47	DelDistBlock	Set	V157	16384	15I24
15E48	Ditto	Reset	V157	32768	

9.6.59. LDU events 67**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	BinOutput1 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	BinOutput2 Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	BinOutput3 Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	BinOutput4 Set	V155	64	14I4
14E8	Ditto Reset	V155	128	

9.6.60. Debounce 68**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S9	R	SupervisTime1	ms	1	1	10000	1
14S10	R	SupervisTime2	ms	1	1	10000	1
14S11	R	SupervisTime3	ms	1	1	10000	1
14S12	R	SupervisTime4	ms	1	1	10000	1
14S13	R	SupervisTime5	ms	1	1	10000	1
14S14	R	SupervisTime6	ms	1	1	10000	1
14S15	R	SupervisTime7	ms	1	1	10000	1
14S16	R	SupervisTime8	ms	1	1	10000	1
14S17	R	SupervisTime9	ms	1	1	10000	1
14S18	R	SupervisTime10	ms	1	1	10000	1
14S19	R	SupervisTime11	ms	1	1	10000	1
14S20	R	SupervisTime12	ms	1	1	10000	1
14S21	R	SupervisTime13	ms	1	1	10000	1
14S22	R	SupervisTime14	ms	1	1	10000	1
14S23	R	SupervisTime15	ms	1	1	10000	1
14S24	R	SupervisTime16	ms	1	1	10000	1

9.6.61. df/dt 69**Basic channel No.: 14****Summary of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	TRIP		00000000B			
14S9	R	df/dt	Hz/s	-1.0	-10.0	10.0	0.1
14S10	R	Frequency	Hz	48.00	00.00	65.00	0.01
14S11	R	BlockVoltage	UN	0.2	0.2	0.8	0.1
14S12	R	Delay	s	00.10	0.10	60.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	Hz/s	2
14V2	R	Hz	3
14V3	R	UN	2

Tripping levels

Address	Access	Text	Dec.
14Q1	R	Hz/s	2
4Q2	R	Hz	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Blocked(U<) Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	TRIP Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

9.6.62. DirCurrentDT 70**Basisc channel No.: 14****Summery of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	Trip		00000000B			
14S9	R	I-Setting	IN	2.00	0.20	20.00	0.01
14S10	R	Angle	deg	45	-180	+180	15
14S11	R	Delay	s	01.00	0.02	60.00	0.01
14S12	R	tWait	s	0.20	0.02	20.00	0.01
14S13	R	MemDirMode	<Select>	Trip	0	1	1
		Trip	0				
		Block	1				
14S14	R	MemDuration	s	2.00	0.20	60.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN (R)	3
14V2	R	IN (S)	3
14V3	R	IN (T)	3
14V4	R	PN (I_R , U_{ST})	3
14V5	R	PN (I_S , U_{TR})	3
14V6	R	PN (I_T , U_{RS})	3
14V7	R	UN (ST)	3
14V8	R	UN (TR)	3
14V9	R	UN (RS)	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN (R)	3
14Q2	R	IN (S)	3
14Q3	R	IN (T)	3
14Q4	R	PN (I _R , U _{ST})	3
14Q5	R	PN (I _S , U _{TR})	3
14Q6	R	PN (I _T , U _{RS})	3
14Q7	R	UN (ST)	3
14Q8	R	UN (TR)	3
14Q9	R	UN (RS)	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Start R Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Start S Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Start T Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	MeasFwd Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	MeasBwd Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	

9.6.63. DirCurrentInv 71**Basisc channel No.: 14****Summery of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	Trip		00000000B			
14S9	R	I-Start	IB	1.10	1.00	4.00	0.01
14S10	R	Angle	deg	45	-180	+180	15
14S11	R	c-Setting	<Select>	1.00	0	2	1
		0.02	0				
		1.00	1				
		2.00	2				
14S12	R	k1-Setting	s	13.50	0.01	200.00	0.01
14S13	R	t-min	s	0.00	0.00	10.00	0.01
14S14	R	IB-Setting	IN	1.00	0.04	2.50	0.01
14S15	R	tWait	s	0.20	0.02	20.00	0.01
14S16	R	MemDirMode	<Select>	Trip	0	1	1
		Trip	0				
		Block	1				
14S17	R	MemDuration	s	2.00	0.20	60.00	0.01

Measured variables

Address	Access	Text	Dec.
14V1	R	IN (R)	3
14V2	R	IN (S)	3
14V3	R	IN (T)	3
14V4	R	PN (I_R , U_{ST})	3
14V5	R	PN (I_S , U_{TR})	3
14V6	R	PN (I_T , U_{RS})	3
14V7	R	UN (ST)	3
14V8	R	UN (TR)	3
14V9	R	UN (RS)	3

Tripping levels

Address	Access	Text	Dec.
14Q1	R	IN (R)	3
14Q2	R	IN (S)	3
14Q3	R	IN (T)	3
14Q4	R	PN (I_R , U_{ST})	3
14Q5	R	PN (I_S , U_{TR})	3
14Q6	R	PN (I_T , U_{RS})	3
14Q7	R	UN (ST)	3
14Q8	R	UN (TR)	3
14Q9	R	UN (RS)	3

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Trip Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Start Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	Start R Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	Start S Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	Start T Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	MeasFwd Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	MeasBwd Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	

9.6.64. BreakerFailure 72**Basisc channel No.: 14****Summery of parameters:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	<Select>	P1	00000010B	00011110B	
14S5	R	23105 TRIP t1		00000000B			
14S9	R	23110 TRIP t1 L1		00000000B			
14S13	R	23115 TRIP t1 L2		00000000B			
14S17	R	23120 TRIP t1 L3		00000000B			
14S21	R	23125 TRIP t2		00000000B			
14S25	R	23130 REMOTE TRIP		00000000B			
14S29	R	23135 RED TRIP L1		00000000B			
14S33	R	23140 RED TRIP L2		00000000B			
14S37	R	23145 RED TRIP L3		00000000B			
14S41	R	23150 EFS REM TRIP		00000000B			
14S45	R	23155 EFS BUS TRIP		00000000B			
14S49	R	I Setting	IN	1.20	0.2	5	0.01
14S50	R	Delay t1	s	0.15	0.02	60	0.01
14S51	R	Delay t2	s	0.15	0.02	60	0.01
14S52	R	Delay tEFP	s	0.04	0.02	60	0.01
14S53	R	t Drop Retrip	s	0.05	0.02	60	0.01
14S54	R	t Drop BuTrip	s	0.05	0.02	60	0.01
14S55	R	t Pulse RemTrip	s	0.05	0.02	60	0.01
14S56	R	t1 active	<Select>	on	0	1	1
		off	0				
		on	1				
14S57	R	t2 active	<Select>	on	0	1	1
		off	0				
		on	1				
14S58	R	RemTrip active	<Select>	on	0	1	1
		off	0				
		on	1				

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S59	R	EFP active	<Select>	on	0	1	1
		off	0				
		on	1				
14S60	R	Red active	<Select>	on	0	1	1
		off	0				
		on	1				
14S61	R	Start Ext act.	<Select>	on	0	1	1
		off	0				
		on	1				
14S62	R	RemTrip after	<Select>	t1	0	1	1
		t2		0			
		t1		1			
14S63	R	NrOfPhases		001	1	3	2

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	23305 Trip t1 Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	23315 Trip t1 L1 Set	V155	4	14I2
14E4	Ditto Reset	V155	8	
14E5	23320 Trip t1 L2 Set	V155	16	14I3
14E6	Ditto Reset	V155	32	
14E7	23325 Trip t1 L3 Set	V155	64	14I4
14E8	Ditto Reset	V155	128	
14E9	23310 Trip t2 Set	V155	256	14I5
14E10	Ditto Reset	V155	512	
14E11	23340 Remote trip Set	V155	1024	14I6
14E12	Ditto Reset	V155	2048	
14E13	23345 Red Trip L1 Set	V155	4096	14I7
14E14	Ditto Reset	V155	8192	

Event No.	Cause	Event mask	Enable code	Status
14E15	23350 Red Trip L2 Set	V155	16384	14I8
14E16	Ditto Reset	V155	32768	
14E17	23355 Red Trip L3 Set	V156	1	14I9
14E18	Ditto Reset	V156	2	
14E19	23375 EFP Rem Trip Set	V156	4	14I10
14E20	Ditto Reset	V156	8	
14E21	23370 EFP Bus Trip Set	V156	16	14I11
14E22	Ditto Reset	V156	32	
14E23	23330 Retrip t1 Set	V156	64	14I12
14E24	Ditto Reset	V156	128	
14E25	23360 Uncon Trip t1 Set	V156	256	14I13
14E26	Ditto Reset	V156	512	
14E27	23380 Ext Trip t1 Set	V156	1024	14I14
14E28	Ditto Reset	V156	2048	
14E29	23335 Backup Trip t2 Set	V156	4096	14I15
14E30	Ditto Reset	V156	8192	
14E31	23365 Uncon Trip t2 Set	V156	16384	14I16
14E32	Ditto Reset	V156	32768	

9.6.65. MeasureModule 74**Basic channel number: 14****Parameter summary:**

Address	Access	Text	Unit	Default	Min.	Max.	Step
14S4	R	ParSet4..1	Select	P1	00000010B	000111110B	
14S9	R	PN	UN*IN*√3	1.000	0.200	2.500	0.001
14S10	R	AngleComp	Deg	0.000	-180.0	180.0	0.1
14S11	R	t1-Interval	Select		0	8	
		1 min	0				
		2 min	1				
		5 min	2				
		10 min	3				
		15 min	4				
		20 min	5				
		30 min	6				
		60 min	7				
		120 min	8				
14S12	R	ScaleFact1	1	1.0000	0.0001	1.0000	0.0001
14S13	R	t2-Interval	Select	4	0	8	
		1 min	0				
		2 min	1				
		5 min	2				
		10 min	3				
		15 min	4				
		20 min	5				
		30 min	6				
		60 min	7				
		120 min	8				
14S14	R	ScaleFact2	1	1.0000	0.0001	1.0000	0.0001

Measured variables

Address	Access	Text	Dec.
14V1	R	URS(UN)	3
14V2	R	UST(UN)	3
14V3	R	UTR(UN)	3
14V4	R	UR(UN)	3
14V5	R	US(UN)	3
14V6	R	UT(UN)	3
14V7	R	IR(IN)	3
14V8	R	IS(IN)	3
14V9	R	IT(IN)	3
14V10	R	P (PN)	3
14V11	R	Q (PN)	3
14V12	R	cos phi	3
14V13	R	Hz	3
14V14	R	E1Int	3
14V15	R	P1Int	0
14V16	R	E1Acc	3
14V17	R	P1Acc	0
14V18	R	E2Int	3
14V19	R	P2Int	0
14V20	R	E2Acc	3
14V21	R	P2Acc	0

Tripping levels

Address	Access	Text	Dec.
14Q16	R	E1Acc	3
14Q17	R	P1Acc	0
14Q20	R	E2Acc	3
14Q21	R	P2Acc	0

Event list

Event No.	Cause	Event mask	Enable code	Status
14E1	Cnt1New Set	V155	1	14I1
14E2	Ditto Reset	V155	2	
14E3	Cnt2New Set	V155	4	14I2
14E4	Ditto Reset	V155	8	

July 02

10. SUPPLEMENTARY INFORMATION

10.1.	Changes in Version 5.0 in relation to Version 4.5	10-3
10.1.1.	Local display unit (LDU).....	10-3
10.1.2.	New 'LDU events' function.....	10-3
10.1.3.	New processor unit 316VC61a	10-3
10.2.	Known software weaknesses in V5.0	10-3
10.2.1.	Year 2000 conformity.....	10-3
10.2.2.	'LDU events' function.....	10-3
10.3.	Changes in Version 5.1 in relation to Version 5.0	10-4
10.3.1.	Distributed input/output system RIO580	10-4
10.3.2.	Year 2000 conformity.....	10-4
10.3.3.	'LDU events' function.....	10-4
10.4.	Changes in Version 5.1a in relation to Version 5.1	10-4
10.4.1.	'IO-Invers' function.....	10-4
10.5.	Changes in Version 5.1b in relation to Version 5.1a	10-4
10.5.1.	'Min-Reactance' function.....	10-4
10.6.	Changes in Version 5.1c in relation to Version 5.1b	10-4
10.6.1.	Year 2000 conformity.....	10-4
10.7.	Changes in Version 5.2 in relation to Version 5.1c	10-5
10.7.1.	Frequency rate of change protection	10-5
10.7.2.	Touch screen or SMS in parallel with the SCS connection	10-5
10.8.	Changes in Version 5.2a in relation to Version 5.2	10-5
10.8.1.	Frequency rate of change protection 'df/dt'	10-5
10.9.	Changes in Version 6.0 in relation to Version 5.2(a).....	10-5
10.9.1.	Directional overcurrent functions 'DirCurrentDT' and 'DirCurrentInv'	10-5
10.9.2.	Breaker failure protection 'BreakerFailure'	10-5
10.9.3.	Runtime supervision	10-5
10.9.4.	New processor unit 316VC61b	10-6
10.10.	Changes in Version Version 6.2 in relation to Version 6.0	10-6
10.10.1.	Analogue input/output unit 500AXM11.....	10-6
10.10.2.	'Analogue RIO Trigger' function	10-6

10.10.3.	Measurement module	10-6
10.10.4.	Commands via a Stage 2 LON bus	10-6
10.11.	Changes in Version 6.3 in relation to Version 6.2	10-6
10.11.1.	A/D converter unit 316EA63	10-6
10.11.2.	Updating the 316EA63 firmware	10-7

10. SUPPLEMENTARY INFORMATION

10.1. *Changes in Version 5.0 in relation to Version 4.5*

10.1.1. *Local display unit (LDU)*

From Version V5.0, the software supports the local display unit (see [Section 5.13.](#)).

10.1.2. *New 'LDU events' function*

The LDU events list only includes tripping levels. The new function 'LDU events' enables additional events to be selected for listing (see [Section 3.6.5.](#)).

10.1.3. *New processor unit 316VC61a*

All devices equipped with the local display unit (LDU) also have the new processor unit 316VC61a; devices not equipped with the LDU can have either the 316VC61 or 316VC61a.

Whether there is a 316VC61a in a device not equipped with a local control and display unit can be determined using the HMI diagnostic function. Upon selecting 'Show diagnostic data', one of the lines displayed is 'HW No.', which in the case of 316VC61a includes the code '0434':

HW-Nr.: xxxx/**0434**/xx

The computing capacity of the 316VC61a is 250% (compared with 200% in the case of 316VC61).

10.2. *Known software weaknesses in V5.0*

10.2.1. *Year 2000 conformity*

Version V5.0 is influenced to a minor extent by the year 2000 problem, but the correct operation of the devices during and after the change of the century is assured. The only shortcoming concerns the time stamp, which retains '19' in the year instead of changing to '20'. All other data is correct and the events are listed in the correct chronological order.

10.2.2. *'LDU events' function*

The 'LDU events' function is not available when the HMI is operating off-line.

10.3. Changes in Version 5.1 in relation to Version 5.0**10.3.1. Distributed input/output system RIO580**

From Version V5.1, the software supports the distributed input/output system RIO580. The latter comprises a number of distributed input/output units that are connected to an RE.316*4 device via an MVB (multipurpose vehicle bus) and an MVB PC board. Refer to Data Sheet 1MRB520176-Ben and Operating Instructions 1MRB520192-Ben for further details.

10.3.2. Year 2000 conformity

With the exception of the VDEW version, for which the synchronisation of the time will not function via the VDEW bus in the year 2000, all Version V5.1 devices are fully immune to the year 2000 problem.

10.3.3. 'LDU events' function

The 'LDU events' function is also now available when the HMI is operating off-line.

10.4. Changes in Version 5.1a in relation to Version 5.1**10.4.1. 'I0-Invers' function**

The 'I0-Invers' is always enabled regardless of the software key in use.

10.5. Changes in Version 5.1b in relation to Version 5.1a**10.5.1. 'Min-Reactance' function**

The underreactance function can now also be connected to Y-connected v.t's.

10.6. Changes in Version 5.1c in relation to Version 5.1b**10.6.1. Year 2000 conformity**

All devices are immune to the year 2000 problem from Version V5.1c onwards.

10.7. Changes in Version 5.2 in relation to Version 5.1c**10.7.1. Frequency rate of change protection**

A df/dt function has been added to the function block library. Because of an error, however, it is not displayed for all the software keys there are (see Section 10.8.1.).

10.7.2. Touch screen or SMS in parallel with the SCS connection

Where a station control system (SCS) is connected via a LON or MVB bus, there is a second fully functional SPA interface available in parallel which can be used for connecting a touch screen an SMS.

10.8. Changes in Version 5.2a in relation to Version 5.2**10.8.1. Frequency rate of change protection 'df/dt'**

V5.2a of the HMI shows the 'df/dt' function for all software keys, for which the 'Frequency' function has been enabled.

10.9. Changes in Version 6.0 in relation to Version 5.2(a)**10.9.1. Directional overcurrent functions 'DirCurrentDT' and 'DirCurrentInv'**

Two directional overcurrent functions 'DirCurrentDT' with definite time and 'DirCurrentInv' with inverse time characteristic have been added to the function block library. They are accessible for all software keys for which the current and voltage functions are enabled.

10.9.2. Breaker failure protection 'BreakerFailure'

A 'BreakerFailure' function has been added to the function block library which is accessible to all software keys.

10.9.3. Runtime supervision

A runtime supervision function can be specified for pairs of inputs that have been configured as "double indications" (see Section 5.5.5.5.).

10.9.4. New processor unit 316VC61b

Version 6.0 supports the new 316VC61b processor unit. To determine whether a device contains a 316VC61b processor unit or not, open 'List diagnostic information' in the HMI diagnostic function and check the code '04Ax' on line 'HW No.':

HW No.: xxxx/**04Ax**/xx

10.10. Changes in Version Version 6.2 in relation to Version 6.0**10.10.1. Analogue input/output unit 500AXM11**

Versions from V6.2 onwards support the analogue input/output unit 500AXM11 of the distributed input/output system RIO580.

10.10.2. 'Analogue RIO Trigger' function

An 'Analogue RIO Trigger' function has been added to the function block library which is available for all software keys and facilitates the supervision of the input signals of the analogue input/output unit 500AXM11. Refer to the Operating Instructions for the distributed input/output system RIO580, Publication 1MRB520192-Uen, for further details.

10.10.3. Measurement module

The 'MeasureModule' function has been added to the function block library. It is available for all software keys and facilitates the three-phase measurement of voltage, current, active and reactive power, power factor and frequency. Two counter impulse inputs are also provided for metering energy.

10.10.4. Commands via a Stage 2 LON bus

In automation systems equipped with a Stage 2 LON interbay bus, commands can be transferred from the automation system to the bay units.

10.11. Changes in Version 6.3 in relation to Version 6.2**10.11.1. A/D converter unit 316EA63**

From Version V6.3, the software supports the new A/D converter unit 316EA63 which supersedes the previous plug-in unit 316EA62.

10.11.2. *Updating the 316EA63 firmware*

The new A/D converter unit 316EA63 allows the firmware to be downloaded without opening the unit. If updating is necessary, this is done in a similar fashion as updating the main processor firmware ([see Section 7.5.](#)). After each update of the main processor firmware, the 316EA63 firmware must also be updated.

When applying the DOS HMI, updating is made by calling up the batch file 'loadEA63.bat', which is listed in the HMI directory.

When applying the Windows HMC CAP2/316, the item 'EA63 download' in the menu 'Options' must be selected.

March 01

12. APPENDICES

12.1	List of abbreviations and symbols	12-2
Fig. 12.2	Numerical control unit REC 316*4 (front view).....	12-3
Fig. 12.3	Numerical control unit REC 316*4 showing a rear view with the location of modules in the narrow casing N1 (top) and wide casing N2 (bottom)	12-4
Fig. 12.4	C.t. and v.t. connections for directional functions (‘DirCurrentDT’, ‘DirCurrentInv’, ‘Power’, ‘UlfPQ’ and ‘MeasureModule’)	12-5

Check list for replacing hardware units
Report for replacing hardware units

TEST REPORT

Typical wiring diagram for the numerical control unit REC 316*4

Notification

12.1 ***List of abbreviations and symbols***

I_A	: balancing current
I_B	: load current
I_N	: rated current
I_K	: fault current
K_I	: main c.t. ratio
K_U	: main v.t. ratio
U_N	: rated voltage

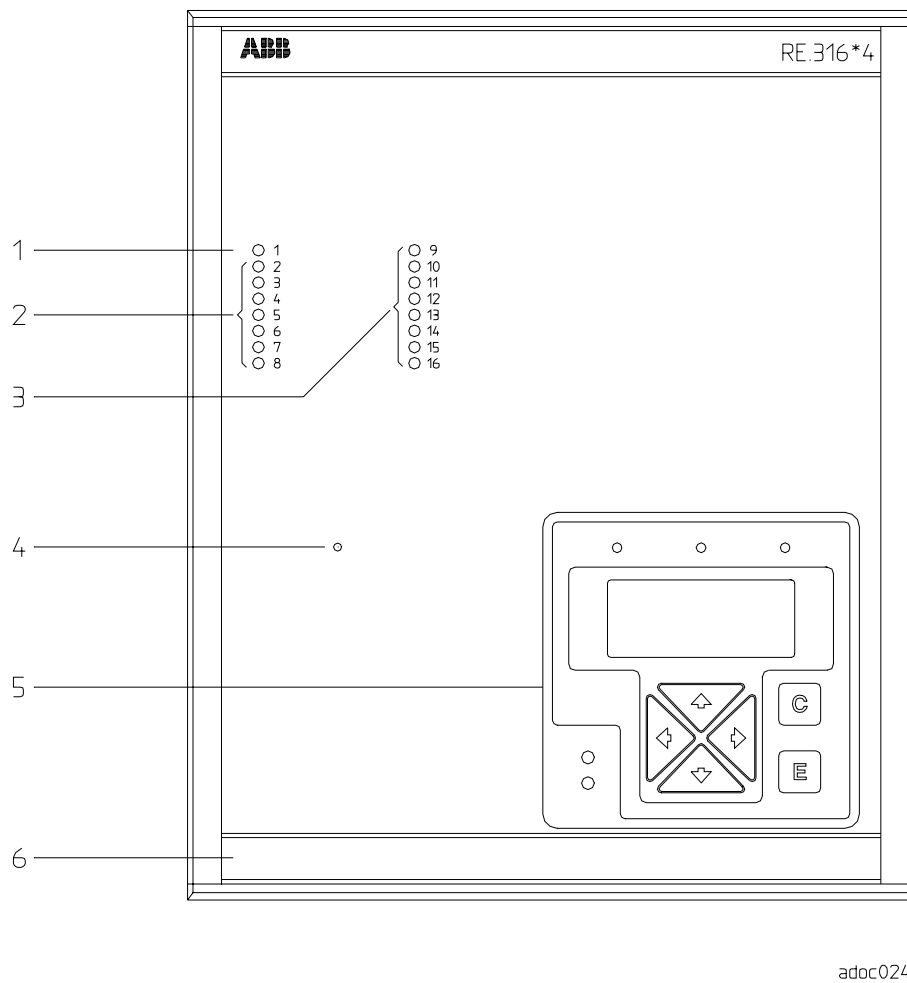


Fig. 12.2 Numerical control unit REC 316*4 (front view)

- 1 green LED (stand-by)
- 2 LED's belonging to 1st. input unit
- 3 LED's belonging to 2nd. input unit
- 4 Reset button behind the frontplate
- 5 Local display and control unit (LDU) with optical serial interface
- 6 Space for marking

316GW61
316EA62/316EA63
316DB61/316DB62/316DB63
316VC61a/316VC61b
316DB61/316DB62/316DB63
316NG65

HEST 965023 C

316GW61
316EA62/316EA63
316VC61a/316VC61b
316DB61/316DB62/316DB63
316DB61/316DB62/316DB63
316DB61/316DB62/316DB63
316DB61/316DB62/316DB63
316NG65

HEST 965024 C

Fig. 12.3 Numerical control unit REC 316*4 showing a rear view with the location of modules in the narrow casing N1 (top) and wide casing N2 (bottom)

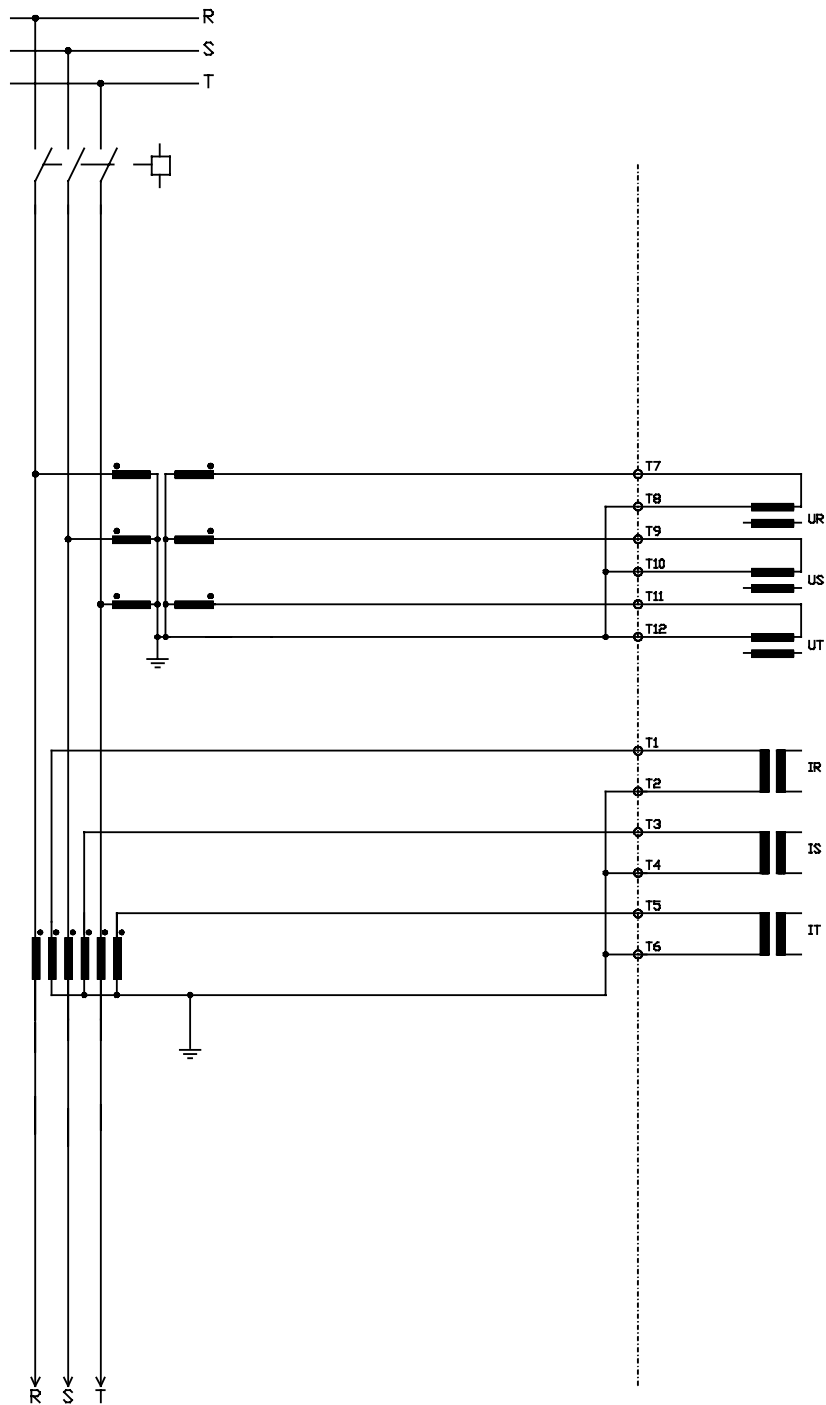


Fig. 12.4 C.t. and v.t. connections for directional functions ('DirCurrentDT', 'DirCurrentInv', 'Power', 'UlfPQ' and 'MeasureModule')

Providing the c.t.'s and v.t.'s are connected as shown in Fig. 12.4, the power direction data given in Section 3 apply, i.e. real power is positive when it flows from the busbar into the line.



Checklist for replacing hardware modules in RE . 316*4 units

99-06

	Not applicable Not fitted	Completed
Read out and save the existing unit settings (always necessary when replacing the 316VC61).	☐	☐
Read out or print the diagnostic and event lists (for defects)	☐	☐
Switch off the auxiliary supply.		☐
Short-circuit the external c.t. leads and then disconnect them.	☐	☐ 1)
Disconnect the external v.t. leads.	☐	☐ 1)
Disconnect the current and voltage circuits from the unit.	☐	☐ 1)
Unscrew the electrical-to-optical converter Type 316BM61 (OBI) or withdraw the PC card.	☐	☐
If necessary, fit a coupling device to loop the optical fibre cable so that the rest of the system can continue to operate.		
Remove the covers from the unit.		☐ 2)
Mark the slot of the module to be replaced and withdraw it.		☐ 3)
Make a note of the module's technical data.		☐
Compare the ordering code and software of old and new modules.		☐
Make a note of the technical data of the new module.		☐
Insert the new module in the slot previously marked.		☐
Refit the covers on the unit.		☐
Refit the electrical-to-optical converter Type 316BM61 (OBI) or reinsert the PC card.	☐	☐
Reconnect the ground to the unit if it was removed.	☐	☐
Reconnect c.t. and v.t. circuits.	☐	☐
Switch on the auxiliary supply.		☐
Download to the unit the settings previously saved (always necessary when replacing the 316VC61) and also any FUPLA logic on the disc.	☐	☐
Check the operation of the unit (e.g. check the voltages and currents in the "Display analogue channels" menu. Depending on the type of module that has been replaced, other checks may be necessary such as for a 316DB61/62/63 the alarms, tripping signals and binary inputs).		☐

1) Only necessary when replacing the input transformer module 316GW61.

2) **Flush-mounted version:** Remove the auxiliary supply plug, unscrew the backplate (4 large and 4 small screws around the edge, 2 screws holding the power supply unit and 2 screws holding the RS232 interface; the connectors do not have to be removed).

Surface-mounted version: Swing the relay out on its hinges and remove the backplate as for the flush-mounted version.

3) Refer to the respective Operating Instructions for the locations of the modules (slots).



Report to be filled in after replacing hardware modules in RE . 316*4 units

02-05

To enable a record of the modules to be kept (traceability), please forward the following information to ABB Power Automation Ltd (by fax or mail) whenever modules are replaced:

Address

ABB Switzerland Ltd
Utility Automation
Department UTAAA-P
Bruggerstrasse 71a
CH-5401 Baden
Switzerland

Fax ++ 41 58 585 31 30

General data

Client Station Feeder

RE. 316*4 data (sticker on unit)

Type of unit
Unit ID
Serial No. Item
Drawing No. / Revision index
Ordering code
Software version FW: MMC:
(sticker below reset button)

Module data

	Old module	New module
Type of module / Revision		
Module ID		
Serial No.		
Drawing No. / Revision index		
Barcode No.		
Software version of IC's (if any)		A Vers. A Vers. A Vers. A Vers.

Date when hardware replaced

Remarks:
.....
.....

Name:

Signature:

Date:

Control and Protection Unit Type REC316*4

Checklist

Kind of check

Remarks

Relay number

Visual check for transport damage

Visual check of external wiring

Check of relay grounding

Check of supply voltage (DC/AC)

Check of settings

Check of C.T. circuits

Check of P.T. circuits

Secondary injection with test set type

Check of input signals

Check of control and interlocking

Check of signalisation/alarms

Check of starting breaker failure protection

Check of tripping

Final check

Date:

Signature:

Client

Date:

Signature:

Control and Protection Unit Type REC316*4

Settings

According to separate print out

Software version of the relay

Secondary injection

Channel number	Main C.T./P.T. ratio [A/A], [kV/V]	AD channel rated value * [A], [V]	AD channel ref. value [-]	Injected value [A], [V]	Display AD calculated [UN], [IN]	Channels displayed [UN], [IN]
1						
2						
3						
4						
5						
6						
7						
8						
9						

* 100/200 V or 1/2/5 A respectively

Remark: If the AD channel reference value is not 1.0 it is advisable to inject rated value * ref. value to get on the display 1.00 * UN/IN.

Example: Rated current generator = 540 A, C.T. ratio = 600/5 ---> Ref. value = 0.9

Injected current = 5 * 0.9 A = 4.5 A ---> Display = 1.00 * [4.50 A]

Special checks/ functions

Result

.....

.....

.....

Date:

Signature:

Client

Date:

Signature:

Control and Protection Unit Type REC316*4

Activation/Deactivation of Binary Inputs

☐ DB61 ☐ DB62 ☐ DB63

	Function/Remarks	Result
OC 101		
OC 102		
OC 103		
OC 104		
OC 105		
OC 106		
OC 107		
OC 108		
OC 109		
OC 110		
OC 111		
OC 112		
OC 113		
OC 114		

☐ DB61 ☐ DB62 ☐ DB63

	Function/Remarks	Result
OC 201		
OC 202		
OC 203		
OC 204		
OC 205		
OC 206		
OC 207		
OC 208		
OC 209		
OC 210		
OC 211		
OC 212		
OC 213		
OC 214		

☐ DB61 ☐ DB62 ☐ DB63

	Function/Remarks	Result
OC 301		
OC 302		
OC 303		
OC 304		
OC 305		
OC 306		
OC 307		
OC 308		
OC 309		
OC 310		
OC 311		
OC 312		
OC 313		
OC 314		

☐ DB61 ☐ DB62 ☐ DB63

	Function/Remarks	Result
OC 401		
OC 402		
OC 403		
OC 404		
OC 405		
OC 406		
OC 407		
OC 408		
OC 409		
OC 410		
OC 411		
OC 412		
OC 413		
OC 414		

Date:

Signature:

Client

Date:

Signature:

Control and Protection Unit Type REC316*4

Activation/Deactivation of Alarm Relays

		Function/Remarks	Result
☐ DB61	S 101	.....	.....
☐ DB62	S 102	.....	.....
☐ DB63	S 103	.....	.....
	S 104	.....	.....
	S 105	.....	.....
	S 106	.....	.....
	S 107	.....	.....
	S 108	.....	.....
	S 109	.....	.....
	S 110	.....	.....
☐ DB61	S 201	.....	.....
☐ DB62	S 202	.....	.....
☐ DB63	S 203	.....	.....
	S 204	.....	.....
	S 205	.....	.....
	S 206	.....	.....
	S 207	.....	.....
	S 208	.....	.....
	S 209	.....	.....
	S 210	.....	.....
☐ DB61	S 301	.....	.....
☐ DB62	S 302	.....	.....
☐ DB63	S 303	.....	.....
	S 304	.....	.....
	S 305	.....	.....
	S 306	.....	.....
	S 307	.....	.....
	S 308	.....	.....
	S 309	.....	.....
	S 310	.....	.....
☐ DB61	S 401	.....	.....
☐ DB62	S 402	.....	.....
☐ DB63	S 403	.....	.....
	S 404	.....	.....
	S 405	.....	.....
	S 406	.....	.....
	S 407	.....	.....
	S 408	.....	.....
	S 409	.....	.....
	S 410	.....	.....

Date:

Signature:

Client

Date:

Signature:

Control and Protection Unit Type REC316*4

Activation of Tripping Relays

		Function/Remarks	Result
☐ DB61	C 101 Contact 1	.....	.....
☐ DB62	C 101 Contact 2	.....	.....
	C 102 Contact 1	.....	.....
	C 102 Contact 2	.....	.....
☐ DB61	C 201 Contact 1	.....	.....
☐ DB62	C 201 Contact 2	.....	.....
	C 202 Contact 1	.....	.....
	C 202 Contact 2	.....	.....
☐ DB61	C 301 Contact 1	.....	.....
☐ DB62	C 301 Contact 2	.....	.....
	C 302 Contact 1	.....	.....
	C 302 Contact 2	.....	.....
☐ DB61	C 401 Contact 1	.....	.....
☐ DB62	C 401 Contact 2	.....	.....
	C 402 Contact 1	.....	.....
	C 402 Contact 2	.....	.....

Date:

Signature:

Client

Date:

Signature:



ABB Schweiz AG

Utility Automation

NUMERISCHES STEUERGERAET
NUMERICAL CONTROL UNIT
UNITE DE CONTROLE-COMMANDE NUMERIQUE
UNIDAD DE CONTROL NUMERICO

REC316*4

TYPISCHES ANSCHLUSS-SCHEMA
TYPICAL CONNECTION DRAWING
SCHEMA DE RACCORDEMENT TYPIQUE
ESQUEMA DE CONEXION TIPICO

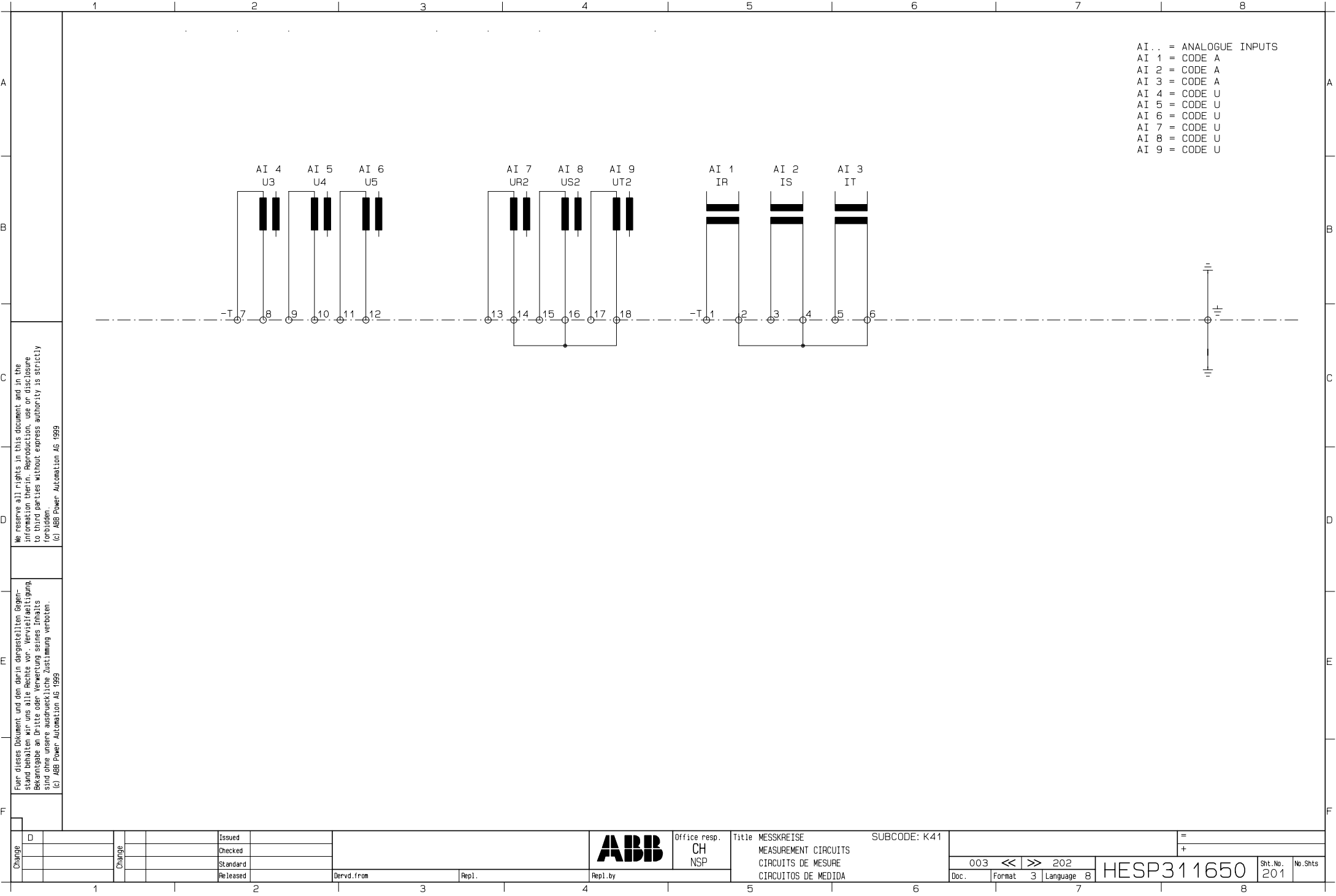
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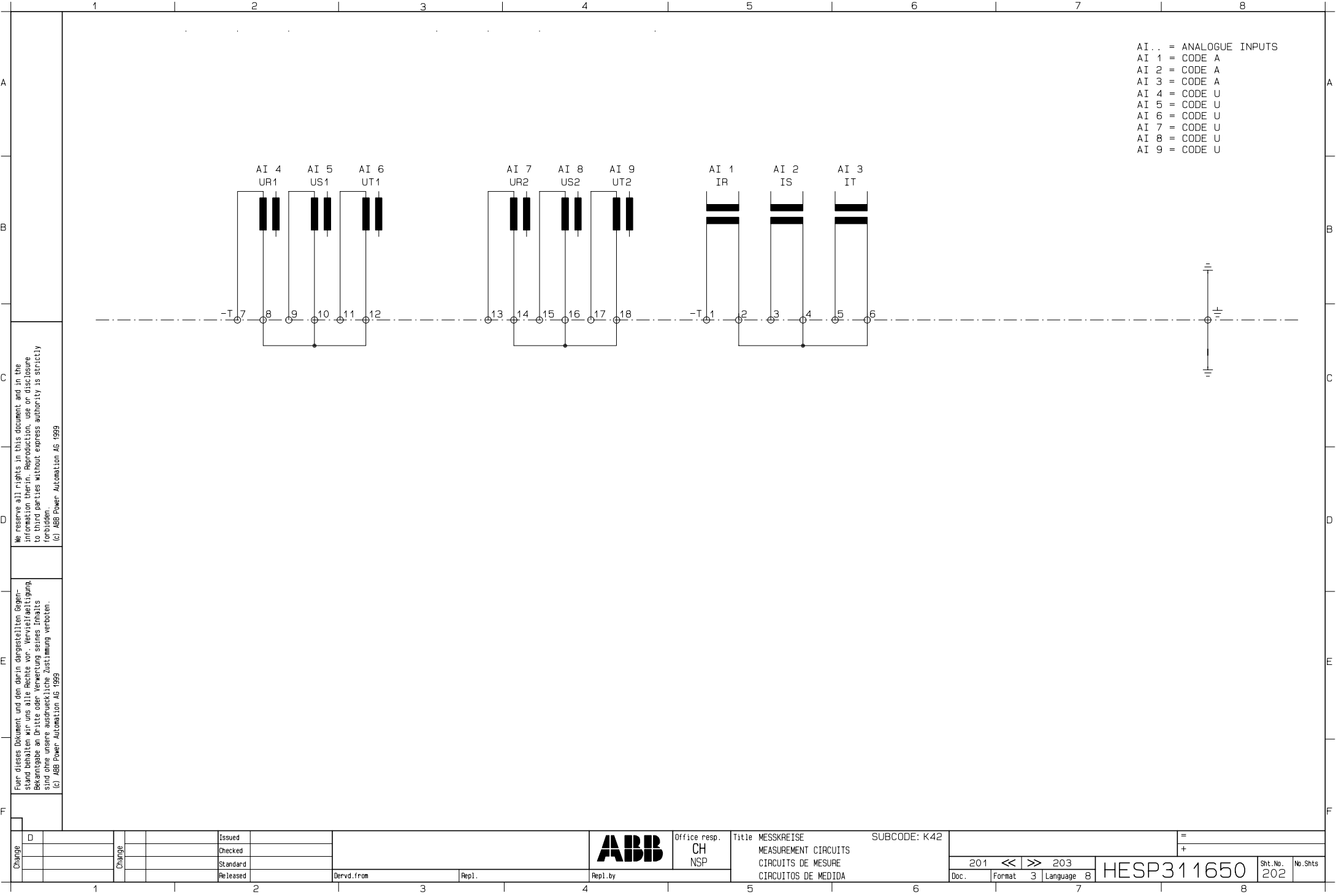
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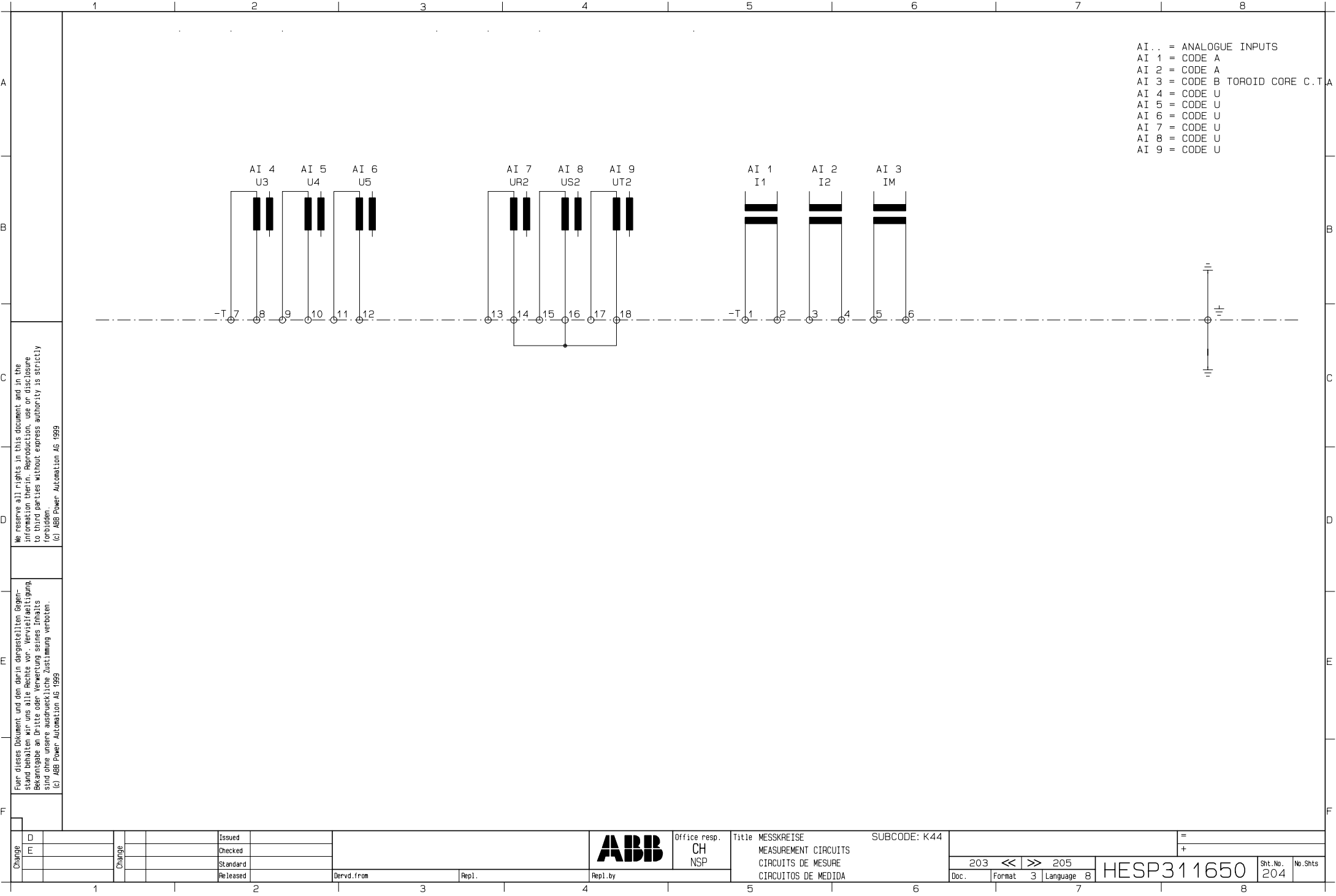


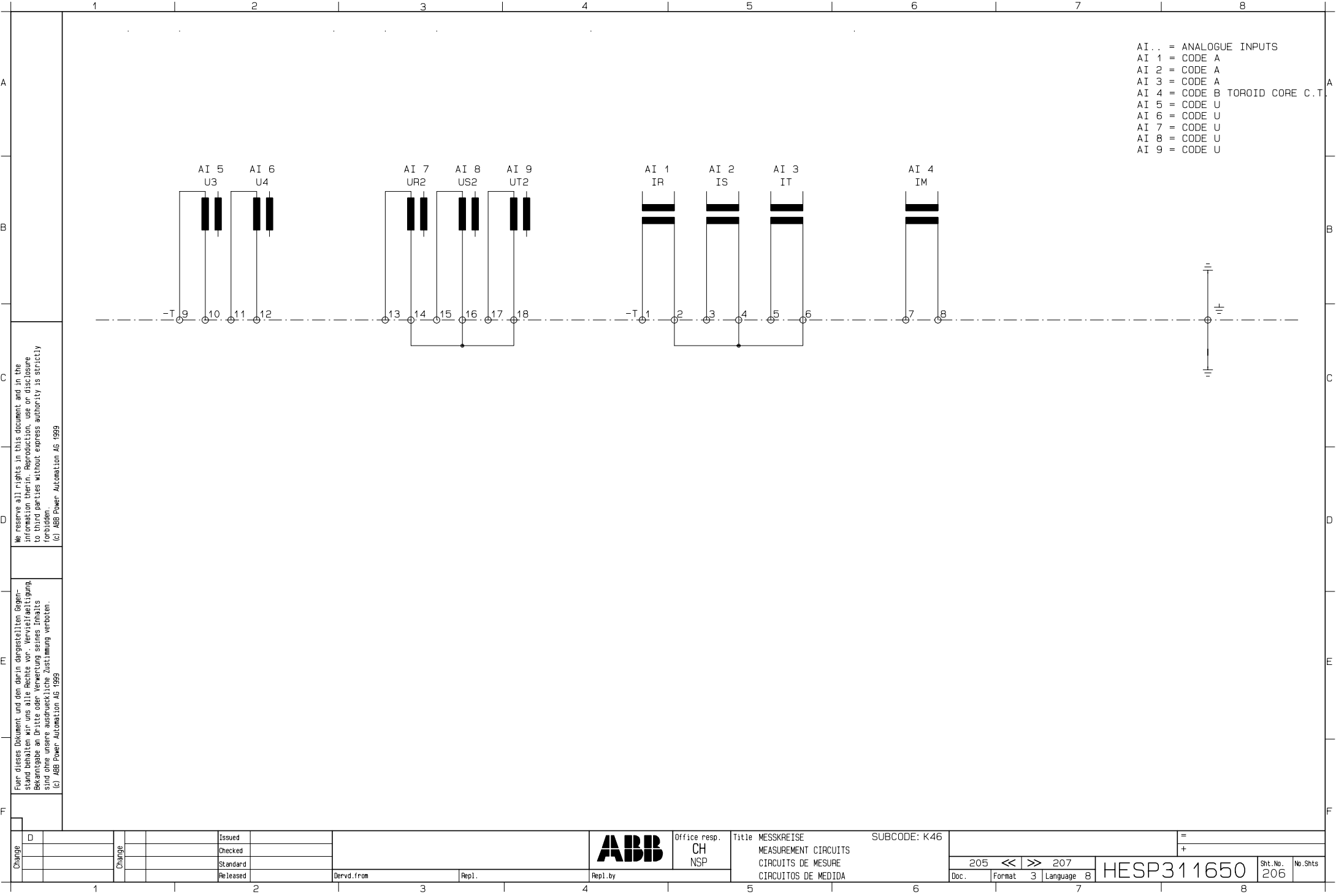
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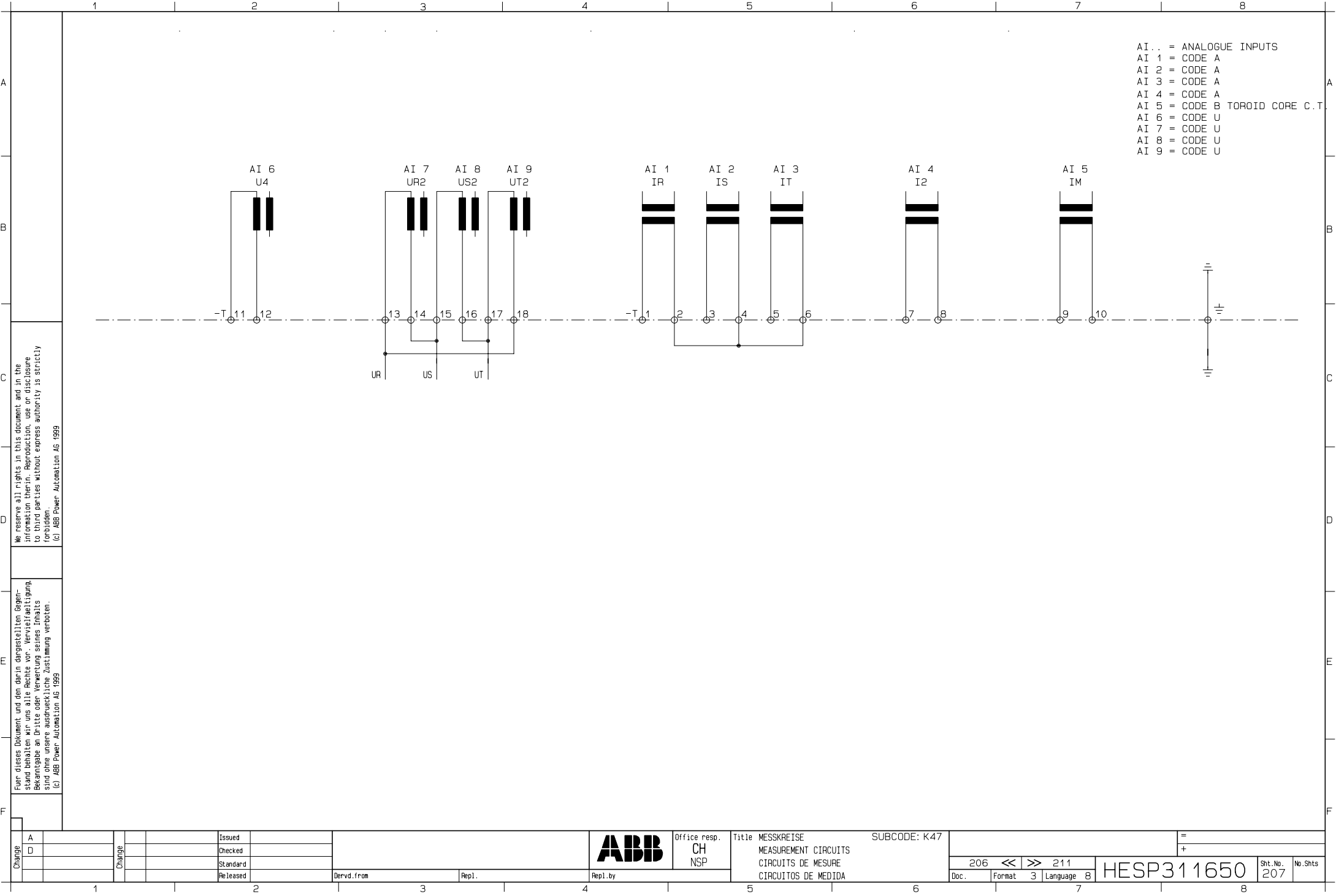


AI.. = ANALOGUE INPUTS
AI 1 = CODE A
AI 2 = CODE A
AI 3 = CODE A
AI 4 = CODE B TOROID CORE C.T.
AI 5 = CODE U
AI 6 = CODE U
AI 7 = CODE U
AI 8 = CODE U
AI 9 = CODE U

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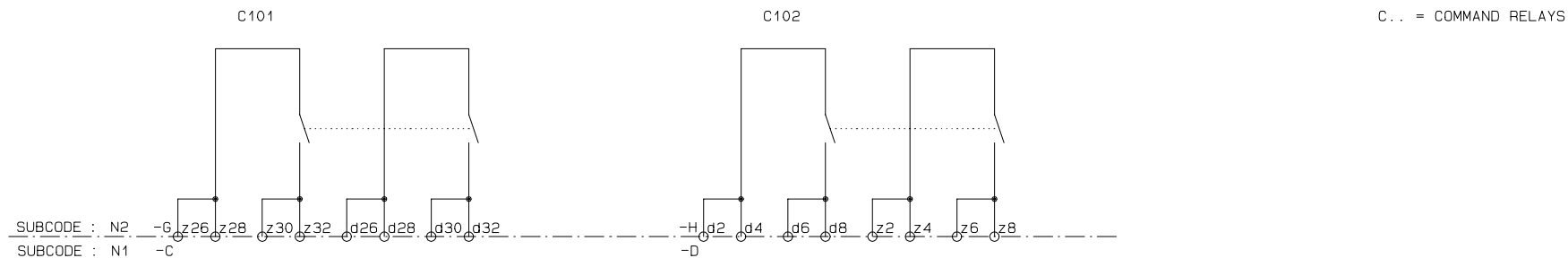
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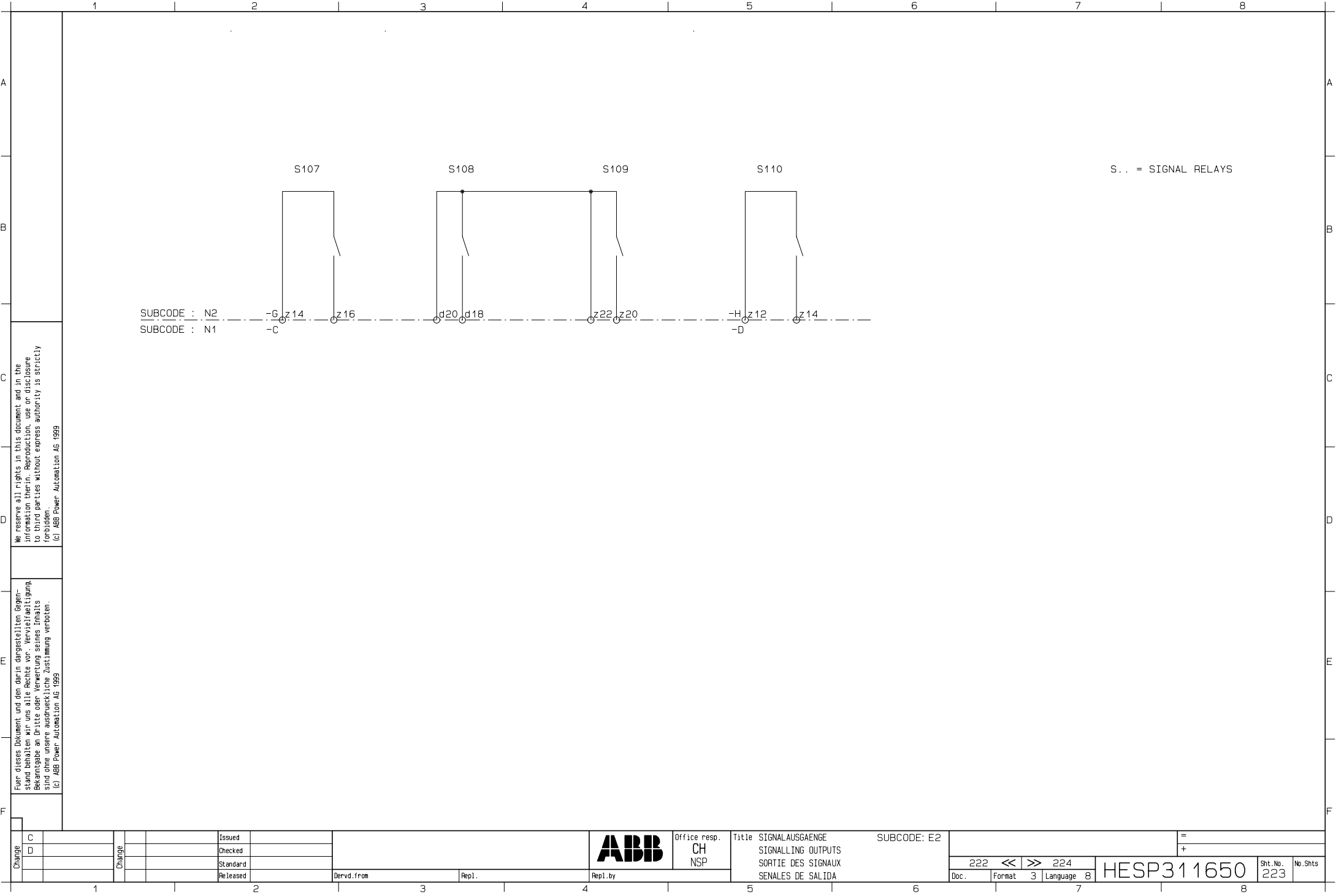
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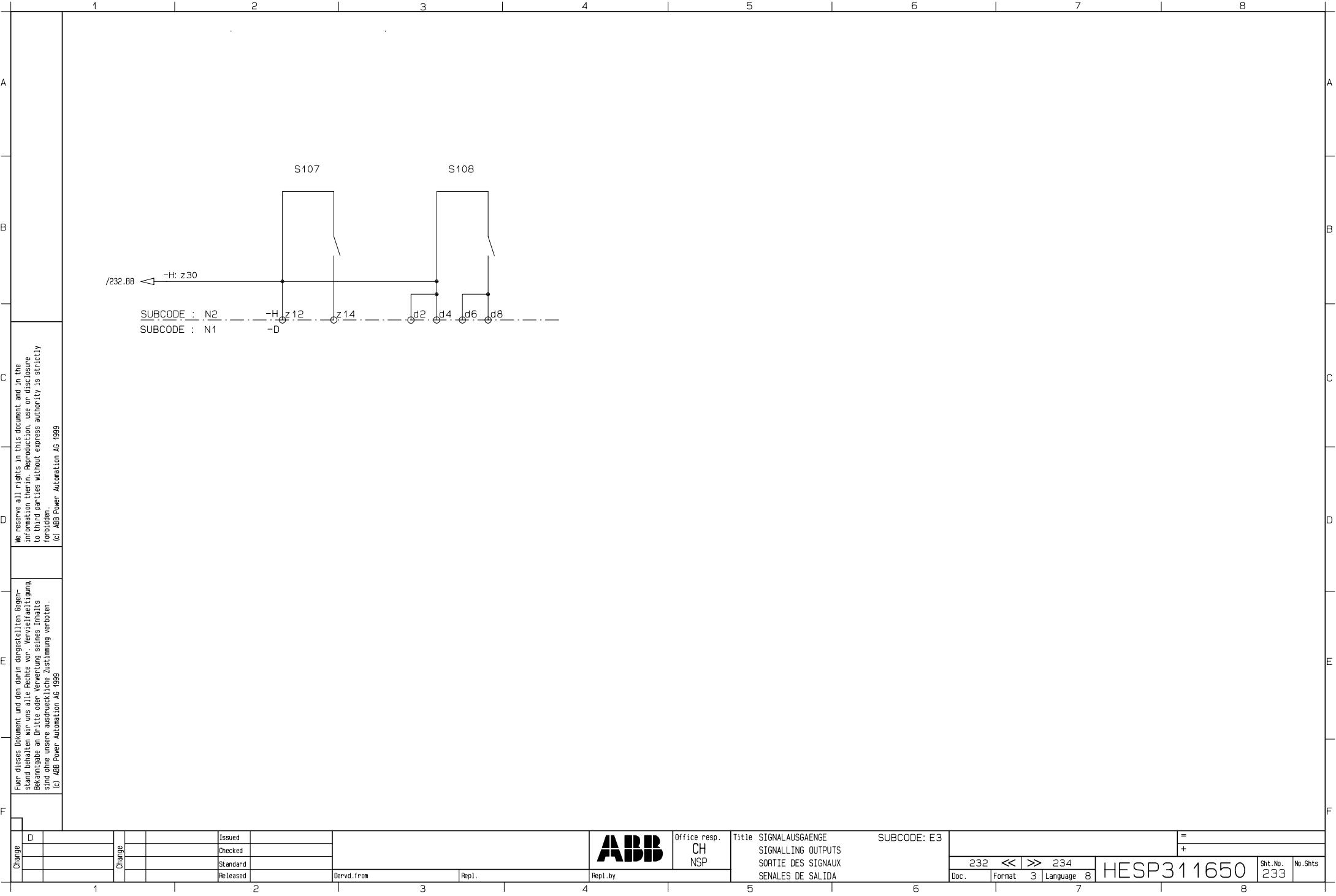
S109

S110

S... = SIGNAL RELAYS

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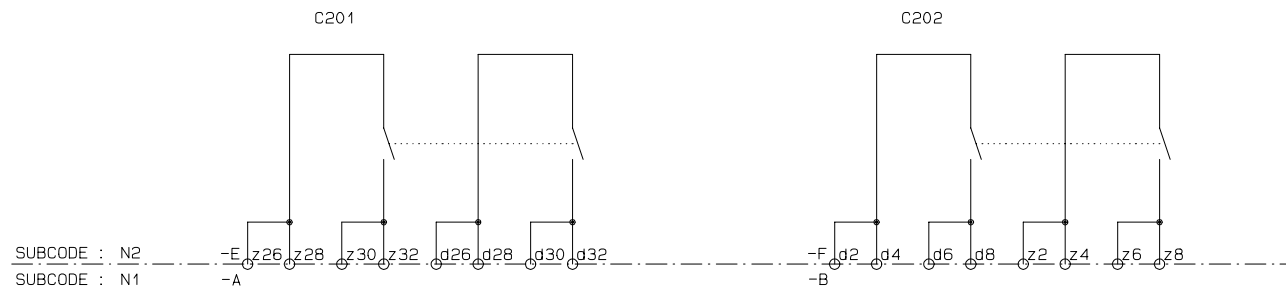


Office resp.
CH
NSP

Title SIGNALAUSGAENGE
SIGNALLING OUTPUTS
SORTIE DES SIGNAUX
SENALES DE SALIDA

SUBCODE: E3

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C.. = COMMAND RELAYS

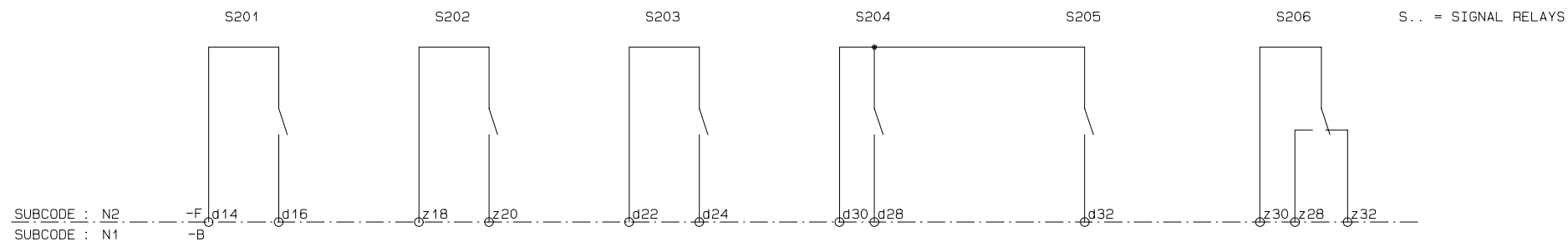
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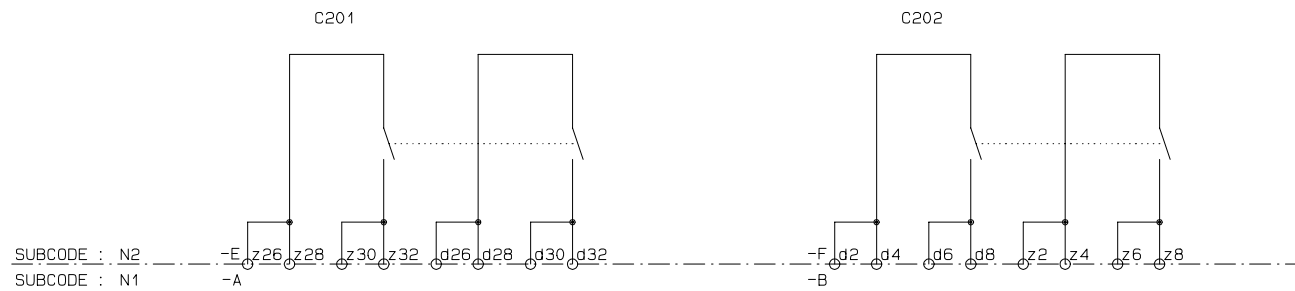
S.. = SIGNAL RELAYS

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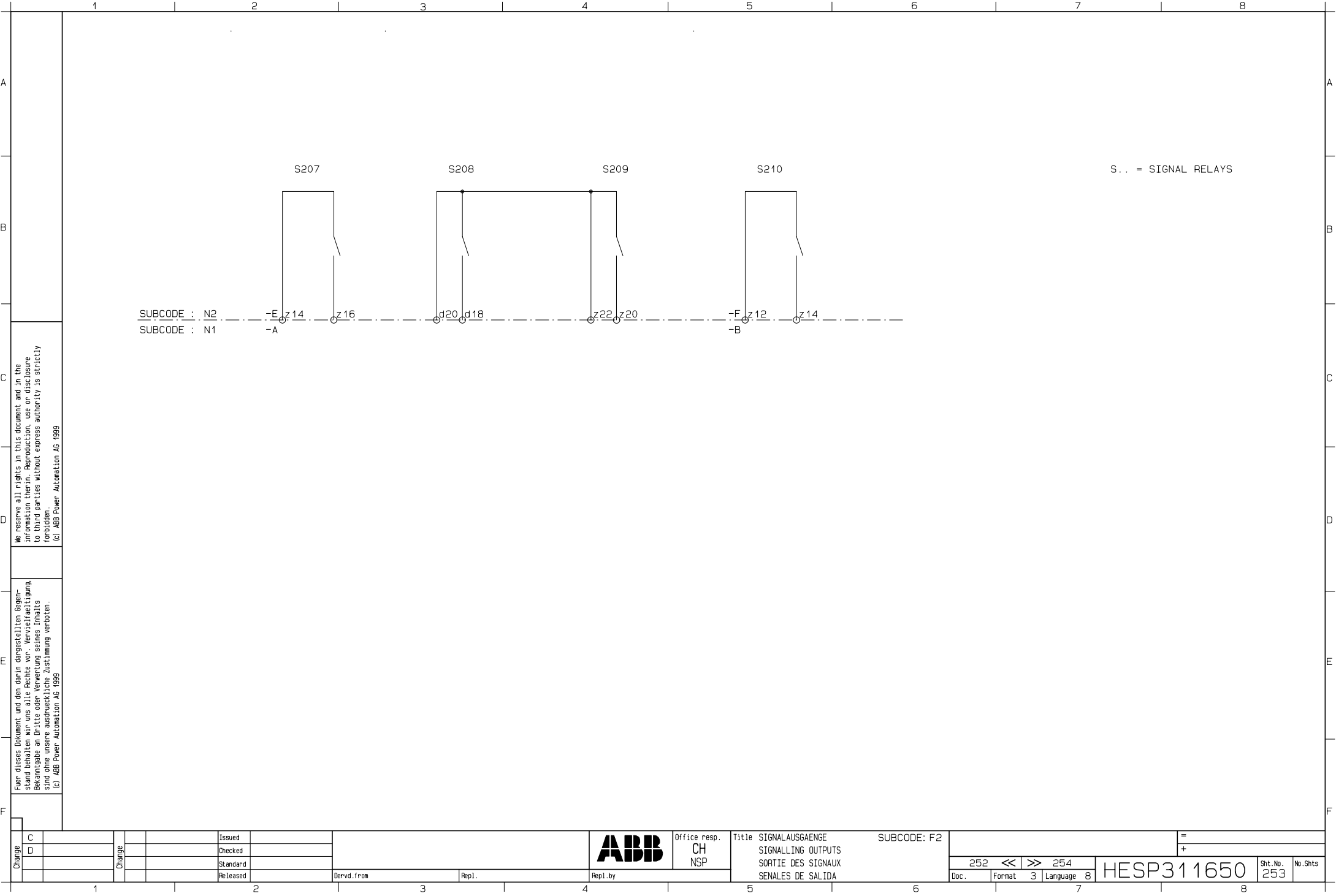
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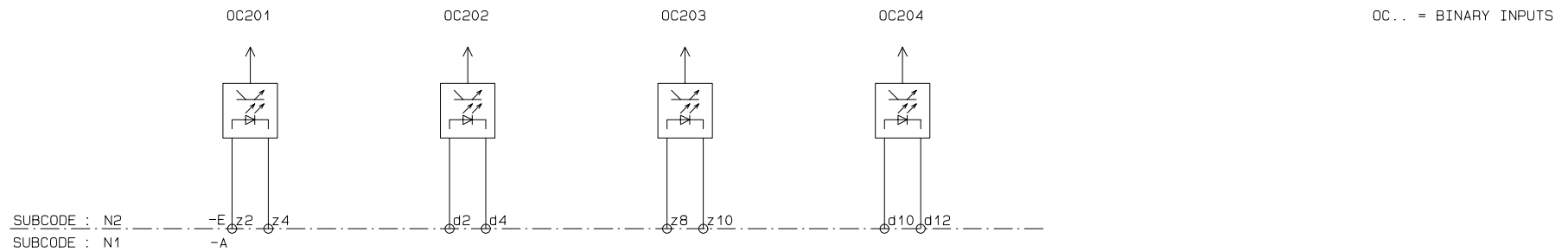
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Change	D	Change		Issued				Office resp. CH NSP	Title KOMMANDOKREISE COMMAND CIRCUITS CIRCUITS DE COMMANDE CIRCUITO DE COMANDO	SUBCODE: F2																					
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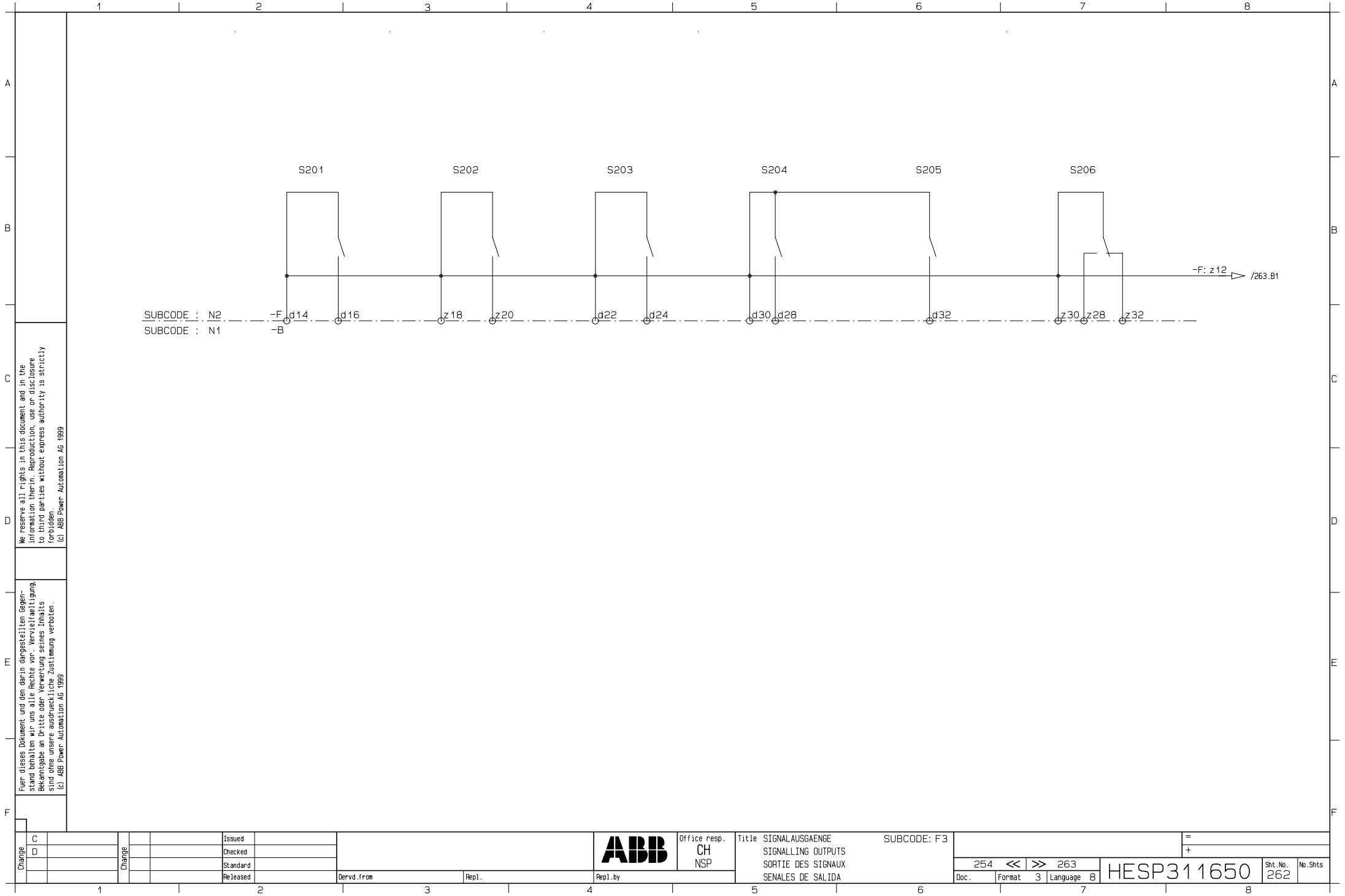
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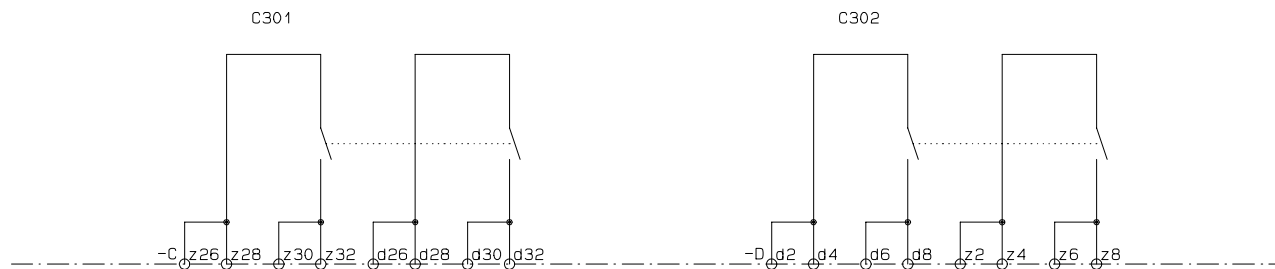
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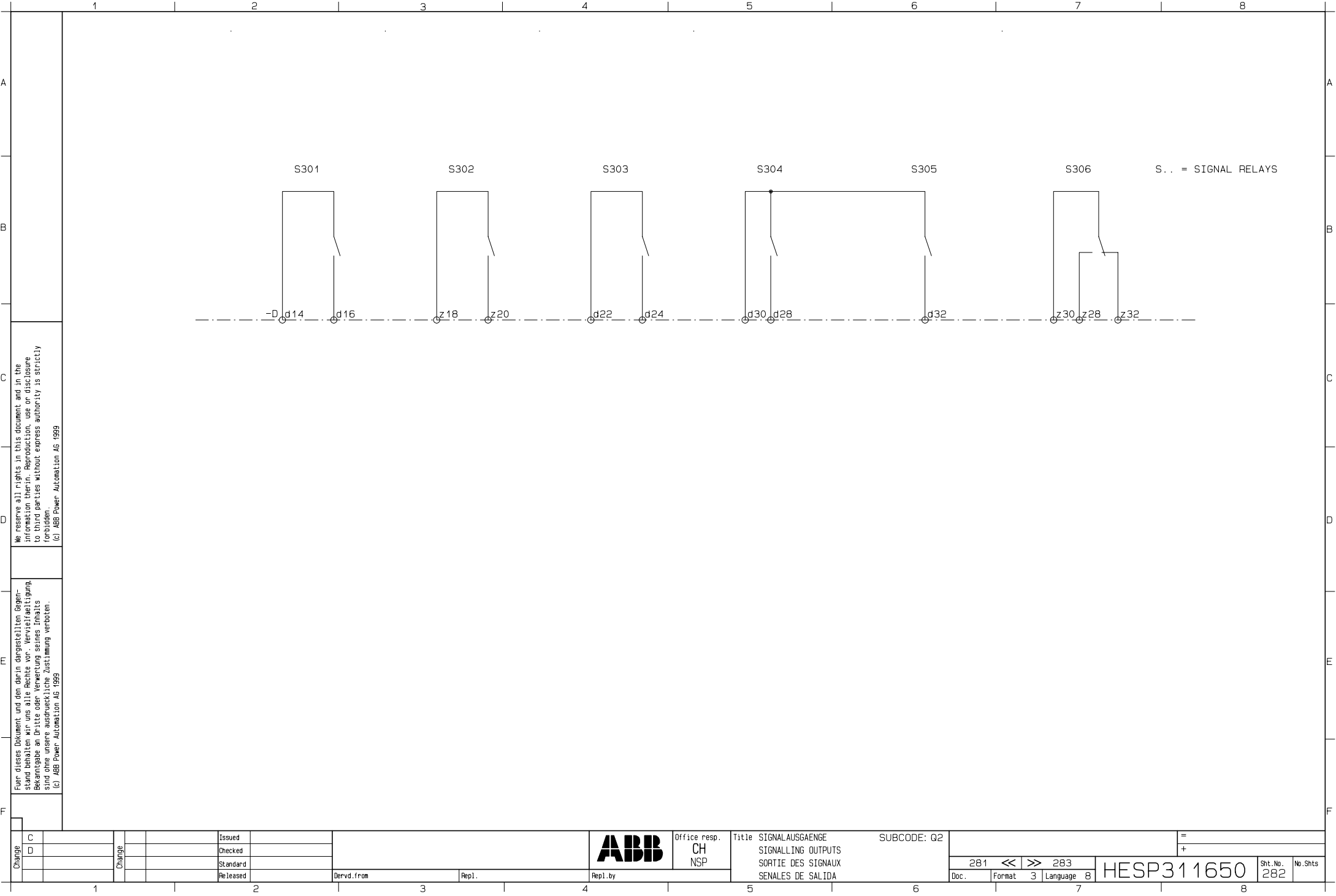
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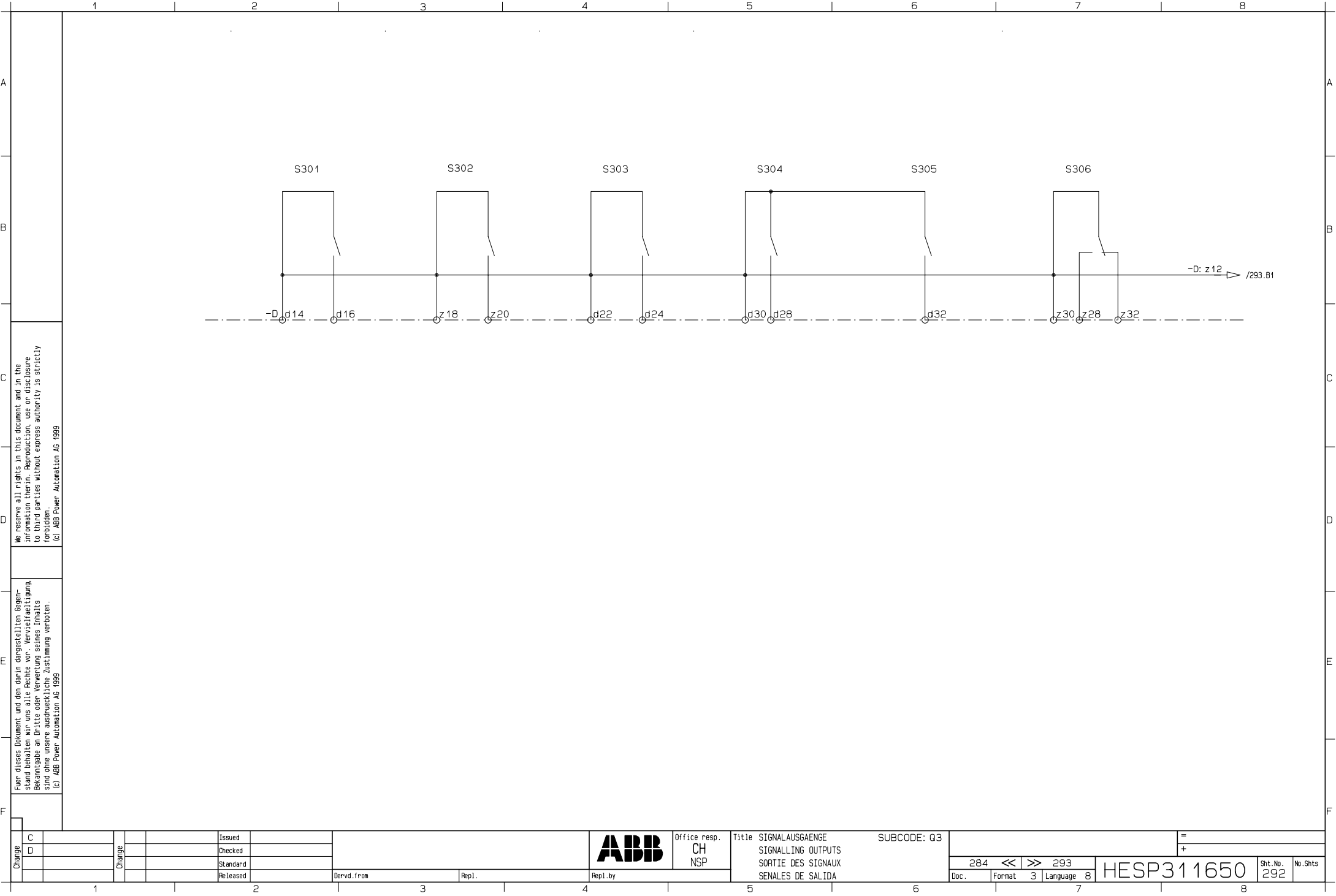
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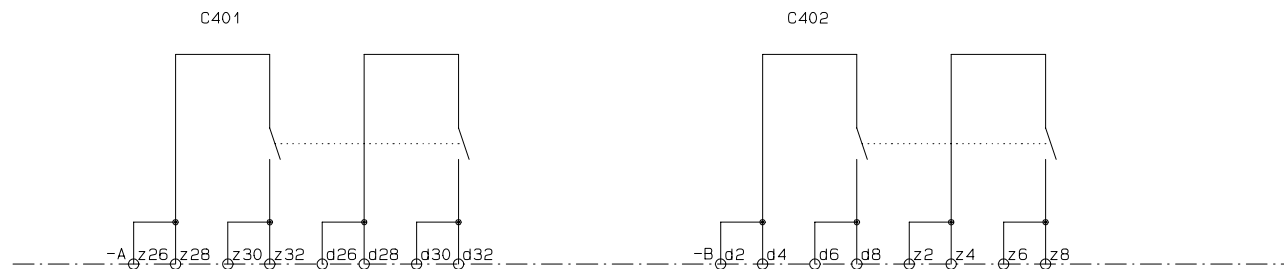
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Change	C	Change		Issued		Office resp. CH NSP	Title SIGNALAUSGAENGE SIGNALLING OUTPUTS SORTIE DES SIGNAUX SENALES DE SALIDA	SUBCODE: Q3				=					
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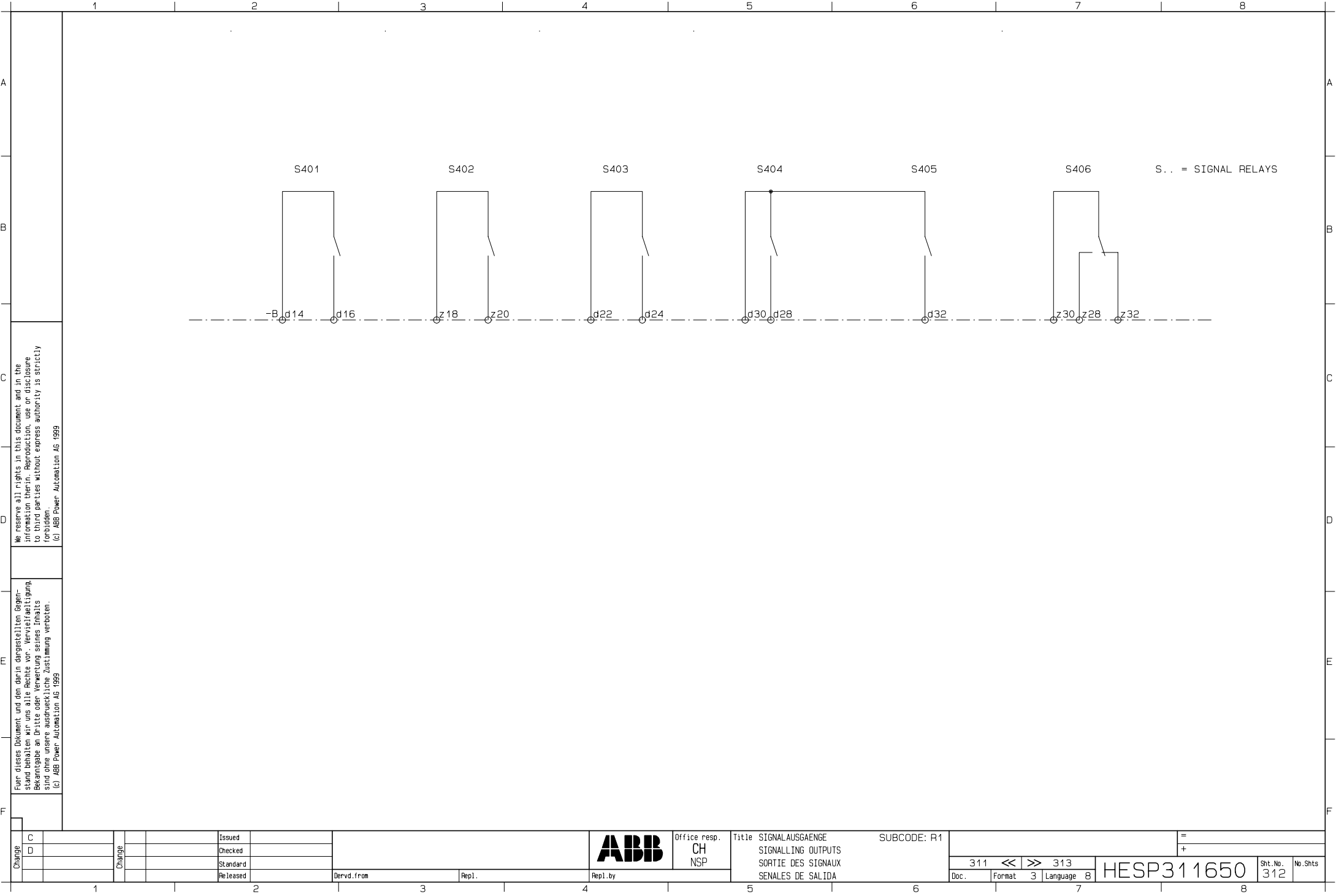
C.. = COMMAND RELAYS

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Change	D		Change			Issued			Office resp. CH NSP	Title KOMMANDOKREISE COMMAND CIRCUITS CIRCUITS DE COMMANDE CIRCUITO DE COMANDO	SUBCODE: R1					=			
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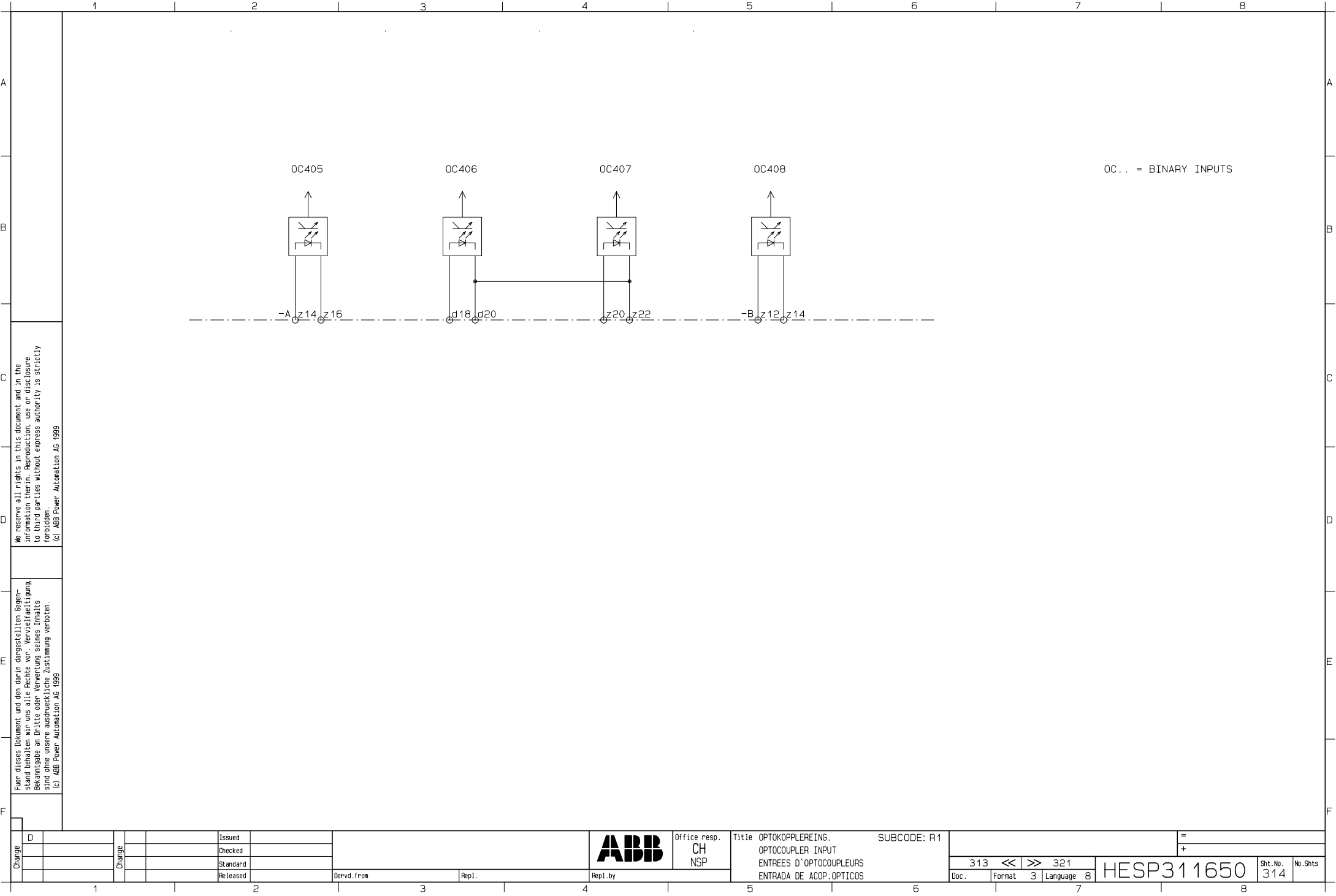
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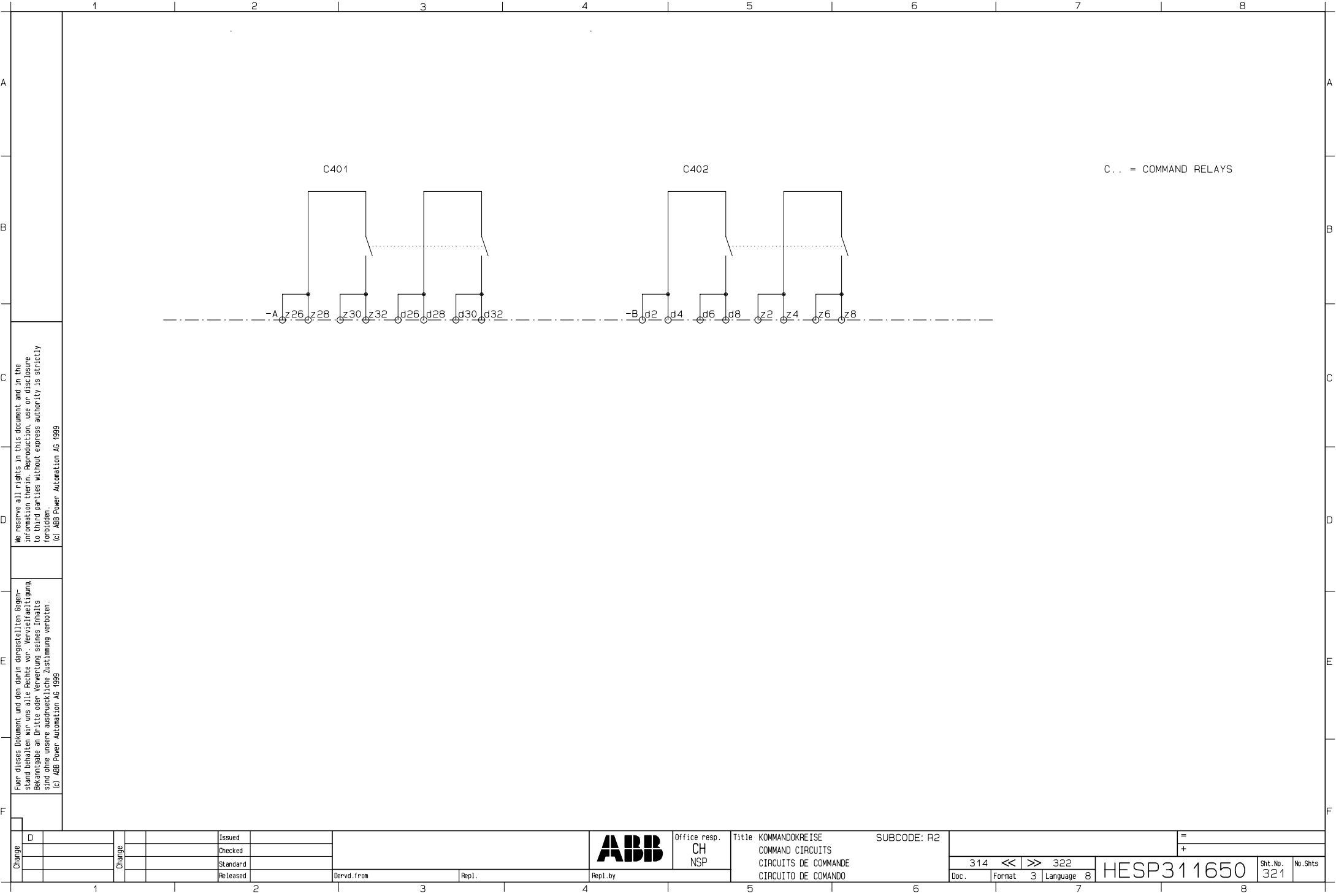


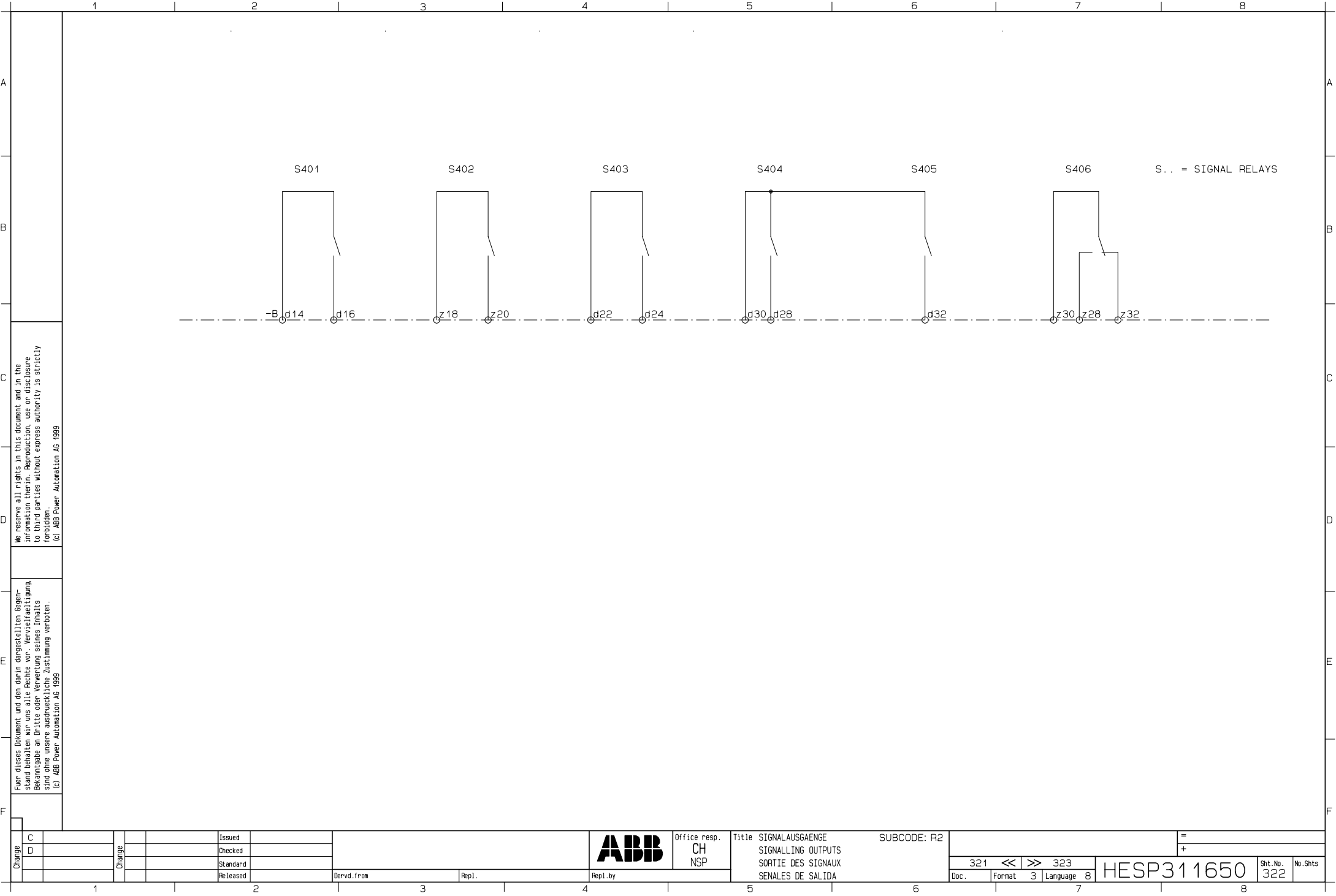
OC... = BINARY INPUTS

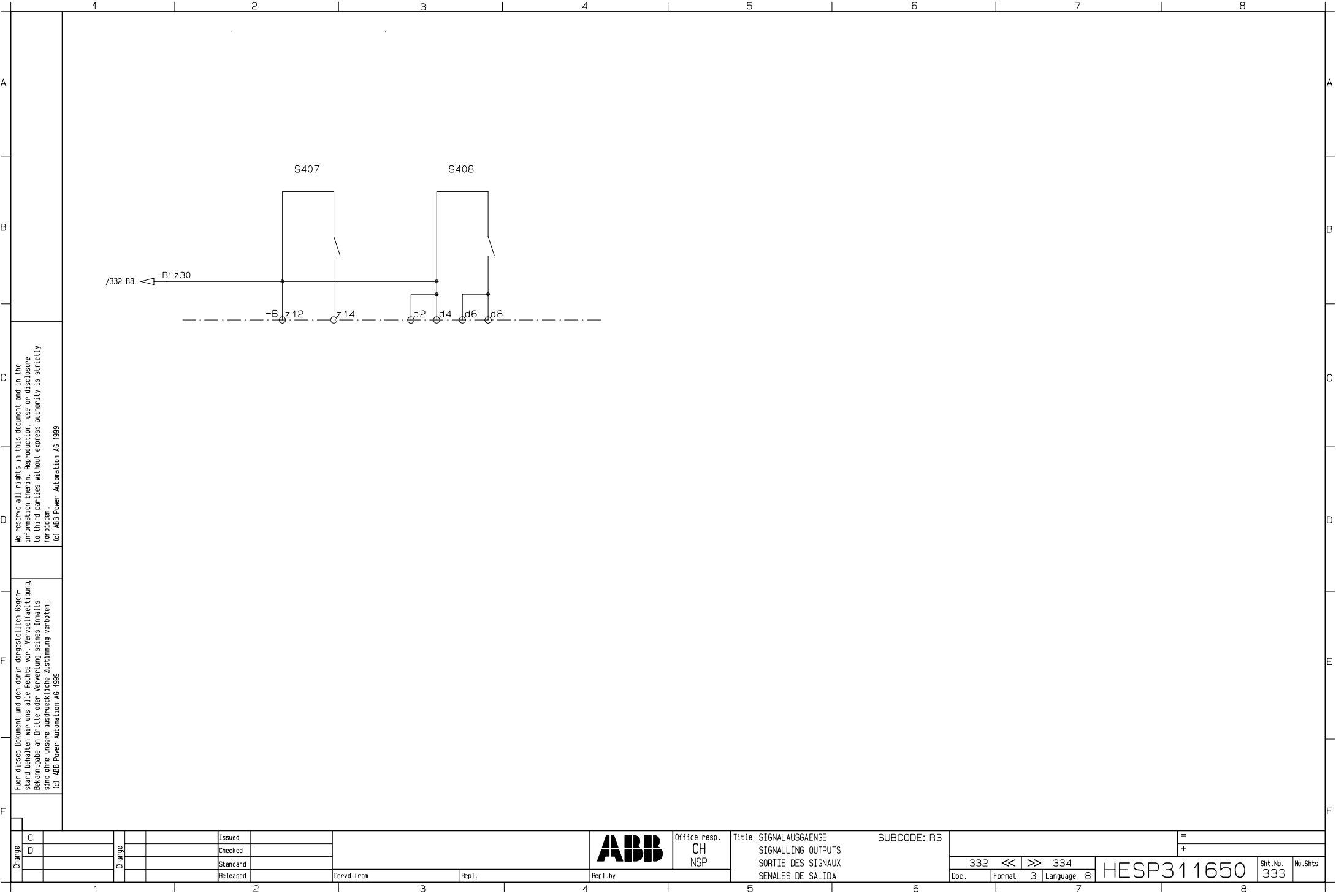
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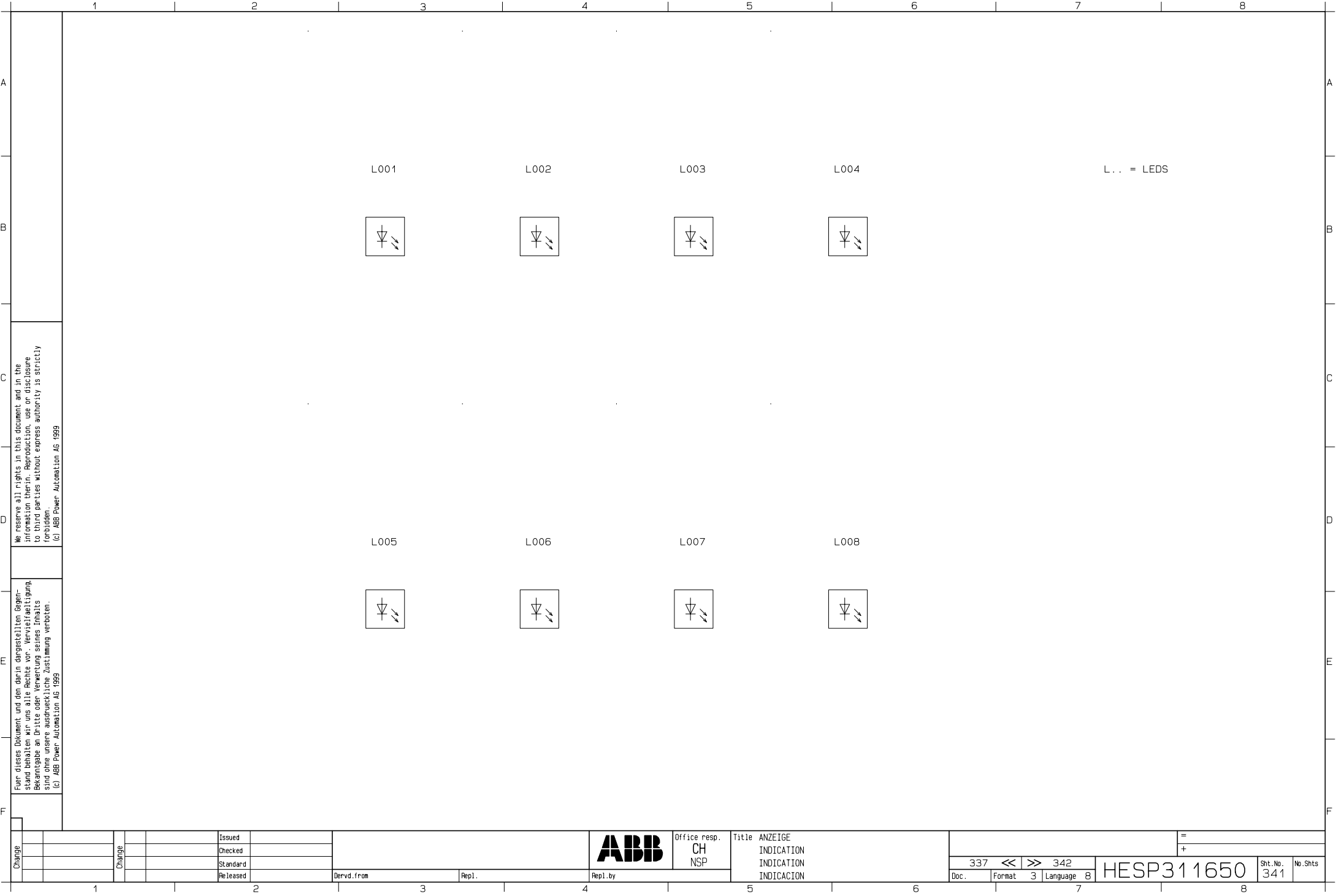


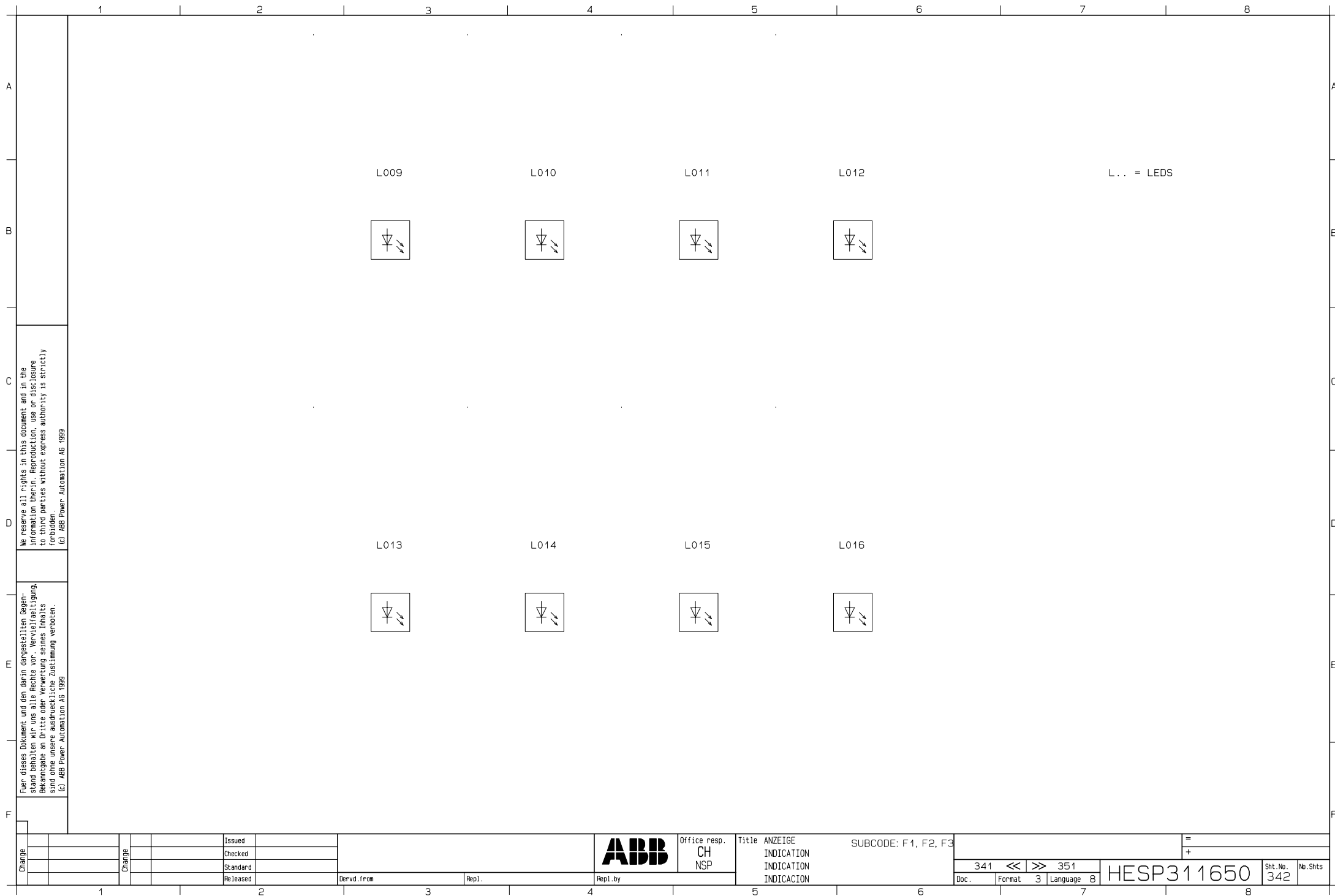


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Telefax +41 58 585 28 00

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Please attach a completed form to every unit and forward them to the address below.

Place of delivery Baden/Switzerland:

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Utility Automation
Repair Center, UTAAA-P
Warenannahme Terminal CA
CH-5401 Baden

Equipment data:

Unit type:

Serial No.:

In operation since:

Reason for return: (tick where applicable)

- ☐ Overfunction
- ☐ No function
- ☐ Outside tolerance
- ☐ Abnormal operating temperature
- ☐ Sporadic error
- ☐ Unit for checking

Remarks/Description of fault:

Customer: Date:

Address:

Please contact: Phone: Fax:

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ABB Switzerland Ltd
Utility Automation
Betreuung Software, Abt. UTASS
Bruggerstrasse 71a
CH-5401 Baden
Telefax +41 58 585 86 57
e-mail: SA-LEC-Support@ch.abb.com

Unit/	☐ REC 316*4	SW Version:	☐ REC 216	SW Version:
System:	☐ REG 316*4	SW Version:	☐ REG 216	SW Version:
	☐ REL 316*4	SW Version:	☐ HMI	SW Version:
	☐ RET 316*4	SW Version:	☐ other:	SW Version:
	☐ XS92a / XS92b	SW Version:		

Problem: ☐ Program error (unit/system) ☐ Program error (HMI /PC)
☐ Error in manual ☐ Suggestion for improvement
☐ other:

Can the error be reproduced at will? ☐ yes ☐ no

Particulars of hardware and software (unit/system configuration including jumper positions, type of PC etc.):

Problem located? ☐ yes ☐ no
Suggested changes enclosed? ☐ yes ☐ no

The following are enclosed (floppy with settings etc.):

☐ Floppy ☐ Unit/system settings, file name:
☐ other:

Description of problem:

Customer: Date:

Address:

Please contact: Phone: Fax:

DESCRIPTION OF PROBLEM: (continuation)

ACTION (internal use of ABB Switzerland Ltd, Dept. UTASS only)

Received by: Date:
Answered by: Date:

Problem solved? ☐ yes ☐ no

Week: Name: Position: Consequence:

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Experience has shown that reliable operation of our products is assured, providing the information and recommendations contained in these Operating Instructions are adhered to.

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In addition to these instructions, any applicable local regulations and safety procedures must always be strictly observed both when connecting up and commissioning this equipment.

Any work such as insertion or removal of soldered jumpers or setting resistors, which may be necessary, may only be performed by appropriately qualified personnel.

We expressly accept no responsibility for any direct damage, which may result from incorrect operation of this equipment, even if no reference is made to the particular situation in the Operating Instructions.



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