Transformer Terminal RET 54_

Technical Reference Manual, General

Contents

1. About this manual

1.1. Copyrights

1.2. Trademarks

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1.3. General

This document, Technical Reference Manual for RET 54_, provides a general technical description of the transformer terminals RET 541, RET 543 and RET 545. Version A of the Technical Reference Manual complies with RET 54_ transformer terminals of the Release 3.0.

For detailed information about the separate protection and other functions listed in Section 5.1.1., refer to the latest version of the CD-ROM “Technical Descriptions of Functions”.

1.4. Abbreviations

AI	Analog Input
CB	Circuit Breaker
CBFP	Circuit Breaker Failure Protection
CPU	Central Processing Unit
CT	Current Transformer
DI	Digital Input
DNP	Distributed Network Protocol
DO	Digital Output
EMC	Electro-Magnetic Compatibility
GND	Ground
HMI	Human Machine Interface
HSPO	High-Speed Power Output
IDMT	Inverse Definite Minimum Time
I/O	Input/Output
IEC_103	IEC 60870-5-103, communication protocol standardized by International Electrotechnical Commission
IRF	Internal Relay Fault
LCD	Liquid-Crystal Display
LED	Light-Emitting Diode
LON	Local Operating Network
LonMark	An independent world-wide industry association, which facilitates the development and implementation of open, interoperable LonWorks based control products and systems.
L/R	Local/Remote
LV	Low Voltage
MIMIC	A graphic configuration picture on the LCD of a relay
MV	Medium Voltage
NO/NC	Normally Open/ Normally Closed
PCB	Printed Circuit Board
PLC	Programmable Logic Controller
PMT	Protocol Mapping Tool
PO	Power Output
PS	Power Supply
RTD	Resistance Temperature Device
SNVT	Standard Network Variable Type
SO	Signal Output
SMS	Substation Monitoring System
SPA	Data communication protocol developed by ABB
SPACOM	An ABB product family
TCR	Thermal Coefficient of Resistance
TCS	Trip Circuit Supervision
TLT	Transformer Linearization Tool
VT	Voltage Transformer

1.5. Related documents

Name of the manual	**MRS number**
General Manuals	
Installation Manual	1MRS750526-MUM
Technical Descriptions of Functions (CD-ROM)	1MRS750889-MCD
RE_ 54_ Operator’s Manual	1MRS750500-MUM
Protection & Control Terminals REF 54_, RET 54_, REM 54_, REC 523 Configuration Guideline	1MRS750745-MUM
RER 103 Bus Connection Module, Technical Description	1MRS750532-MUM
RER 123 Bus Connection Module, Technical Description	1MRS751143-MUM
RER 133 Bus Connection Module, Technical Description	1MRS755163
REF 54_, RET54_, REX 521 DNP 3.0 Communication Protocol, Technical Description	1MRS755260
REF 54_, RET54_ Modbus Communication Protocol, Technical Description	1MRS755238
Manuals for RET 54_	
Technical Reference Manual, General	1MRS755225
Parameter and event lists for RET 54_	
Parameter List for RET 541 and RET 543	1MRS755228
Parameter List for RET 545	1MRS755229
Event List for RET 541 and RET 543	1MRS755226
Event List for RET 545	1MRS755227
Tool-specific manuals	
CAP 505 Installation and Commissioning Manual	1MRS751901-MEN
CAP 505 User’s Guide	1MRS752292-MUM
CAP 505 Protocol Mapping Tool, Operation Manual	1MRS755277
CAP 505 Relay Mimic Editor, Configuration Guide	1MRS751904-MEN
LIB, CAP, SMS, Tools for Relays and Terminals, User’s Guide	1MRS752008-MUM
LNT 505 Operator’s manual	1MRS751706-MUM
CAP 501 Installation and Commissioning Manual	1MRS751899-MEN
CAP 501 User’s Guide	1MRS751900-MUM

1.6. Document revisions

Version	**Date**	**History**
A	20.1.2005	Manual created
B	2.5.2005	Minor revision

2. Safety information

	Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.
	National and local electrical safety regulations must always be followed.
	The device contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.
	The frame of the device has to be carefully earthed.
	Only a competent electrician is allowed to carry out the electrical installation.
	Non-observance can result in death, personal injury or substantial property damage.
	Breaking the sealing tape on the upper handle of the device will result in loss of warranty and proper operation will no longer be guaranteed.
	When the plug-in unit has been detached from the case, do not touch the inside of the case. The relay case internals may contain high voltage potential and touching these may cause personal injury.

3. Introduction

3.1. General

The RET 54_ transformer terminal is part of the ABB Distribution Automation system and extends the functionality and flexibility of the concept further. This is possible due to the modern technology applied both in hardware and software solutions.

Increased performance is achieved by utilizing the multiprocessor architecture. Digital signal processing combined with a powerful CPU and distributed I/O handling facilitates parallel operations and improves response times and accuracy. The HMI including an LCD display with different views makes the local use of the RET 54_ transformer terminal safe and easy. The HMI[1] instructs the user how to proceed.

RET543right

Fig. 3.1.-1 RET 54_ transformer terminal

3.2. Hardware versions

The family of RET 54_ transformer terminals contains several hardware versions. Depending on the number of I/Os available, the product is called RET 541, RET 543 or RET 545, see the following tables.

1. HMI is referred to as MMI in the terminal and in the Relay Setting Tool

Table 3.2.-1 Hardware versions of RET 541, 6I/3U transformers

HW modules	Order number									
	RET541A_230AAAA	RET541A_230BAAA	RET541A_230CAAA	RET541A_230AAAB	RET541A_230BAAB	RET541A_233AAAA	RET541A_233BAAA	RET541A_233CAAA	RET541A_233AAAB	RET541A_233BAAB
Analog interface										
Current trafo 1/5 A	6	6	6	6	6	6	6	6	6	6
Voltage trafo 100 V	3	3	3	3	3	3	3	3	3	3
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC /AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC										
BIO2: threshold voltage 80 VDC										
BIO2: threshold voltage 18 VDC										
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	15					15				
Power outputs, single pole	0					0				
Power outputs, double pole	5					5				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-2 Hardware versions of RET 541, 7I/2U transformers

HW modules	Order number									
	RET541A_231AAAA	RET541A_231BAAA	RET541A_231CAAA	RET541A_231AAAB	RET541A_231BAAB	RET541A_234AAAA	RET541A_234BAAA	RET541A_234CAAA	RET541A_234AAAB	RET541A_234BAAB
Analog interface										
Current trafo 1/5 A	7	7	7	7	7	7	7	7	7	7
Voltage trafo 100 V	2	2	2	2	2	2	2	2	2	2
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC /AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC										
BIO2: threshold voltage 80 VDC										
BIO2: threshold voltage 18 VDC										
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	15					15				
Power outputs, single pole	0					0				
Power outputs, double pole	5					5				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-3 Hardware versions of RET 541, 8I/1U transformers

HW modules	Order number									
	RET541A_232AAAA	RET541A_232BAAA	RET541A_232CAAA	RET541A_232AAAB	RET541A_232BAAB	RET541A_235AAAA	RET541A_235BAAA	RET541A_235CAAA	RET541A_235AAAB	RET541A_235BAAB
Analog interface										
Current trafo 1/5 A	8	8	8	8	8	8	8	8	8	8
Voltage trafo 100 V	1	1	1	1	1	1	1	1	1	1
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC /AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC										
BIO2: threshold voltage 80 VDC										
BIO2: threshold voltage 18 VDC										
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	15					15				
Power outputs, single pole	0					0				
Power outputs, double pole	5					5				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-4 Hardware versions of RET 543, 6I/3U transformers

HW modules	Order number									
	RET543A_240AAAA	RET543A_240BAAA	RET543A_240CAAA	RET543A_240AAAB	RET543A_240BAAB	RET543A_243AAAA	RET543A_243BAAA	RET543A_243CAAA	RET543A_243AAAB	RET543A_243BAAB
Analog interface										
Current trafo 1/5 A	6	6	6	6	6	6	6	6	6	6
Voltage trafo 100 V	3	3	3	3	3	3	3	3	3	3
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC/AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC		1			1		1			1
BIO2: threshold voltage 80 VDC	1			1		1			1	
BIO2: threshold voltage 18 VDC			1					1		
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	25					25				
Power outputs, single pole	2					2				
Power outputs, double pole	9					9				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-5 Hardware versions of RET 543, 7I/2U transformers

HW modules	**Order number**									
	RET543A_241AAAA	**RET543A_241BAAA**	**RET543A_241CAAA**	**RET543A_241AAAB**	**RET543A_241BAAB**	**RET543A_244AAAA**	**RET543A_244BAAA**	**RET543A_244CAAA**	**RET543A_244AAAB**	**RET543A_244BAAB**
Analog interface										
Current trafo 1/5 A	7	7	7	7	7	7	7	7	7	7
Voltage trafo 100 V	2	2	2	2	2	2	2	2	2	2
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC/AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC		1			1		1			1
BIO2: threshold voltage 80 VDC	1			1		1			1	
BIO2: threshold voltage 18 VDC			1					1		
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	25					25				
Power outputs, single pole	2					2				
Power outputs, double pole	9					9				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-6 Hardware versions of RET 543, 8I/1U transformers

HW modules	Order number									
	RET543A_242AAAA	RET543A_242BAAA	RET543A_242CAAA	RET543A_242AAAB	RET543A_242BAAB	RET543A_245AAAA	RET543A_245BAAA	RET543A_245CAAA	RET543A_245AAAB	RET543A_245BAAB
Analog interface										
Current trafo 1/5 A	8	8	8	8	8	8	8	8	8	8
Voltage trafo 100 V	1	1	1	1	1	1	1	1	1	1
Main processor boards										
CPU module	1	1	1	1	1	1	1	1	1	1
Power supply boards										
PS1: 80...265 VDC/AC (High)		1			1		1			1
PS1: 80...265 VDC/AC (Medium)	1			1		1			1	
PS1: 18...80 VDC/AC (Low)			1					1		
PS2: 80...265 VDC										
PS2: 18...80 VDC										
Digital I/O boards										
BIO1: threshold voltage 155 VDC		1			1		1			1
BIO1: threshold voltage 80 VDC	1			1		1			1	
BIO1: threshold voltage 18 VDC			1					1		
BIO2: threshold voltage 155 VDC		1			1		1			1
BIO2: threshold voltage 80 VDC	1			1		1			1	
BIO2: threshold voltage 18 VDC			1					1		
Analog I/O board										
RTD/analog module						1	1	1	1	1
Display boards										
Graphic HMI display, fixed	1	1	1			1	1	1		
Graphic HMI display, external				1	1				1	1
Mechanic										
1/2 enclosure	1	1	1	1	1	1	1	1	1	1
Digital inputs	25					25				
Power outputs, single pole	2					2				
Power outputs, double pole	9					9				
Signal outputs (NO)	2					2				
Signal outputs (NO/NC)	5					5				
Supervised trip circuits	2					2				
IRF outputs	1					1				
RTD/analog inputs	0					8				
Analog outputs	0					4				

Table 3.2.-7 Hardware versions of RET 545, 6I/3U transformers

HW modules	Order number				
	RET545A_250AAAA	RET545A_250BAAA	RET545A_250CAAA	RET545A_250AAAB	RET545A_250BAAB
Analog interface					
Current trafo 1/5 A	6	6	6	6	6
Voltage trafo 100 V	3	3	3	3	3
Main processor boards					
CPU module	1	1	1	1	1
Power supply boards					
PS1: 80...265 VDC/AC (High)					
PS1: 80...265 VDC/AC (Medium)					
PS1: 18...80 VDC/AC (Low)					
PS2: 80...265 VDC	1	1		1	1
PS2: 18...80 VDC			1		
Digital I/O boards					
BIO1: threshold voltage 155 VDC		2			2
BIO1: threshold voltage 80 VDC	2			2	
BIO1: threshold voltage 18 VDC			2		
BIO2: threshold voltage 155 VDC		1			1
BIO2: threshold voltage 80 VDC	1			1	
BIO2: threshold voltage 18 VDC			1		
Analog I/O board					
RTD/analog module					
Display boards					
Graphic HMI display, fixed	1	1	1		
Graphic HMI display, external				1	1
Mechanic					
1/2 enclosure	1	1	1	1	1
Digital inputs	34				
Power outputs, single pole	3				
Power outputs, double pole	11				
Signal outputs (NO)	4				
Signal outputs (NO/NC)	8				
Supervised trip circuits	2				
IRF outputs	1				
RTD/analog inputs	0				
Analog outputs	0				

Table 3.2.-8 Hardware versions of RET 545, 7I/2U transformers

HW modules	**Order number**				
	RET545A_251AAAA	**RET545A_251BAAA**	**RET545A_251CAAA**	**RET545A_251AAAB**	**RET545A_251BAAB**
Analog interface					
Current trafo 1/5 A	7	7	7	7	7
Voltage trafo 100 V	2	2	2	2	2
Main processor boards					
CPU module	1	1	1	1	1
Power supply boards					
PS1: 80...265 VDC/AC (High)					
PS1: 80...265 VDC/AC (Medium)					
PS1: 18...80 VDC/AC (Low)					
PS2: 80...265 VDC	1	1		1	1
PS2: 18...80 VDC			1		
Digital I/O boards					
BIO1: threshold voltage 155 VDC		2			2
BIO1: threshold voltage 80 VDC	2			2	
BIO1: threshold voltage 18 VDC			2		
BIO2: threshold voltage 155 VDC		1			1
BIO2: threshold voltage 80 VDC	1			1	
BIO2: threshold voltage 18 VDC			1		
Analog I/O board					
RTD/analog module					
Display boards					
Graphic HMI display, fixed	1	1	1		
Graphic HMI display, external				1	1
Mechanic					
1/2 enclosure	1	1	1	1	1
Digital inputs	34				
Power outputs, single pole	3				
Power outputs, double pole	11				
Signal outputs (NO)	4				
Signal outputs (NO/NC)	8				
Supervised trip circuits	2				
IRF outputs	1				
RTD/analog inputs	0				
Analog outputs	0				

Table 3.2.-9 Hardware versions of RET 545, 8I/1U transformers

HW modules	Order number				
	RET545A_252AAAA	RET545A_252BAAA	RET545A_252CAAA	RET545A_252AAAB	RET545A_252BAAB
Analog interface					
Current trafo 1/5 A	8	8	8	8	8
Voltage trafo 100 V	1	1	1	1	1
Main processor boards					
CPU module	1	1	1	1	1
Power supply boards					
PS1: 80...265 VDC/AC (High)					
PS1: 80...265 VDC/AC (Medium)					
PS1: 18...80 VDC/AC (Low)					
PS2: 80...265 VDC	1	1		1	1
PS2: 18...80 VDC			1		
Digital I/O boards					
BIO1: threshold voltage 155 VDC		2			2
BIO1: threshold voltage 80 VDC	2			2	
BIO1: threshold voltage 18 VDC			2		
BIO2: threshold voltage 155 VDC		1			1
BIO2: threshold voltage 80 VDC	1			1	
BIO2: threshold voltage 18 VDC			1		
Analog I/O board					
RTD/analog module					
Display boards					
Graphic HMI display, fixed	1	1	1		
Graphic HMI display, external				1	1
Mechanic					
1/2 enclosure	1	1	1	1	1
Digital inputs	34				
Power outputs, single pole	3				
Power outputs, double pole	11				
Signal outputs (NO)	4				
Signal outputs (NO/NC)	8				
Supervised trip circuits	2				
IRF outputs	1				
RTD/analog inputs	0				
Analog outputs	0				

4. Instructions

4.1. Application

RET 541/543/545 transformer terminals are designed to be used for the protection, control, measurement and supervision of two-winding power transformers and generator-transformer blocks in distribution networks. RET 54_ terminals can also be used in harsh environments e.g. in heavy industry, marine and off-shore applications.

The main protection function is three-phase current differential protection with stabilized and instantaneous stages for fast and selective winding short-circuit and interturn protection. Besides 2nd and 5th harmonic restraints, the stabilized stage also includes a waveform recognition-based blocking-deblocking feature. Reliable operation even with partially saturated current transformers, that is, short operate times at faults occurring in the zone to be protected and high stability at external faults are achieved. Increased sensitivity can be obtained by automatic adaptation to the position changes of the on load tap changer. Interposing current transformers are not needed: Any vector group matching and CT ratio corrections in a wide range are numerically implemented as well as zero-sequence current elimination, which prevents unwanted trips at earth faults occurring outside the protected area.

In addition to the differential protection, the Basic version terminals incorporate the following protections: Restricted earth fault protection with stabilized numerical or high impedance principle, unbalance and thermal overload protections, three phase overcurrent and directional or non-directional earth fault back-up protection with definite and IDMT characteristics on both sides of the transformer.

The Multi-version terminals, including further overvoltage and undervoltage, residual overvoltage, underfrequency and overfrequency, overexcitation, directional overcurrent and underimpedance line back-up protections, fulfil the most demanding application requirements.

With the optional automatic voltage regulation function, RET 54_ transformer terminal can be applied as a comprehensive integrated transformer management terminal. The voltage regulator can be applied for a single transformer or for parallel transformers with Master-Follower, Negative Reactance or Minimizing Circulating Current principles.

A special Control version terminal with just voltage regulator and control functions can be applied, when integration of voltage regulation and protection is not allowed. For an example of an application with basic functions, see Figure 4.1.-1.

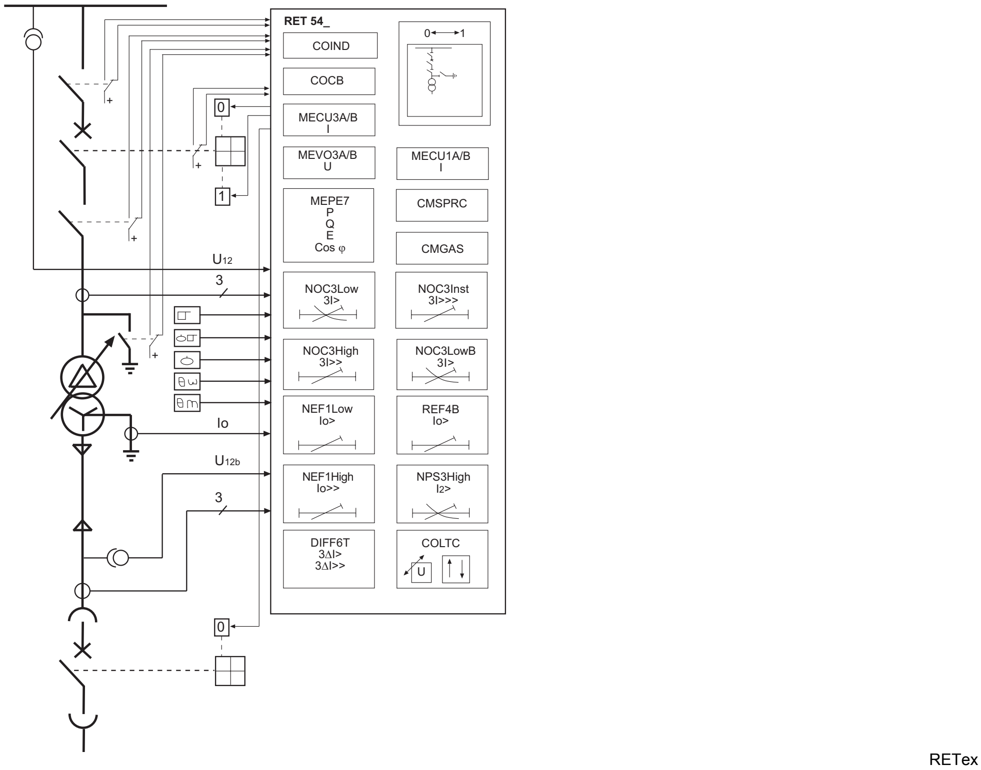


Fig. 4.1.-1 An application example of the integrated transformer terminal RET 543 with basic functions.

While offering full protection with local and remote control in a cost-effective way, the integrated terminal technology of the RET 541/543/545 units provides a wide variety of control logic, measurement and condition monitoring functions, thus minimizing the need for auxiliary relays and panel work.

The graphical configuration tool (based on the IEC 61131-3 standard) enables easy creation of application-specific configurations and MIMIC pictures corresponding to different switchgear systems. The process status is shown on a dynamic large graphical display. Detailed information, for instance, measured values, events and application-specific alarms, are presented in the display views.

RET 541/543/545 terminals can measure two sets of three phase currents, phase-to-phase or phase-to-earth voltages, neutral current, residual voltage, frequency and power factor. Active and reactive power is calculated from the measured currents and voltages. Energy can be calculated on the basis of the measured power. The measured values can be indicated locally and remotely as scaled primary values.

With the condition monitoring functions, RET 54_ transformer terminal monitors e.g. trip circuits, gas pressure of the breaker and breaker wear, and provides scheduled time intervals for maintenance.

The RTD1 card, available as an option to the RET 541 and RET 543 terminals, provides versatile analog inputs enabling e.g. tap position supervision of the on load tap changer, RTD inputs for top and bottom oil temperature monitoring, and ambient temperature biasing for accurate thermal overload protection. The mA outputs allow transfer of any measurement data to PLCs.

By means of the graphic HMI display, the control functions in the transformer terminal indicate the position of disconnectors, circuit breakers and tap changer locally. Local control of these objects is possible via the push buttons on the front panel of the transformer terminal. Furthermore, the transformer terminal allows position information of the objects to be transmitted to the remote control system. Controllable objects, such as CBs, can also be opened and closed over the remote control system.

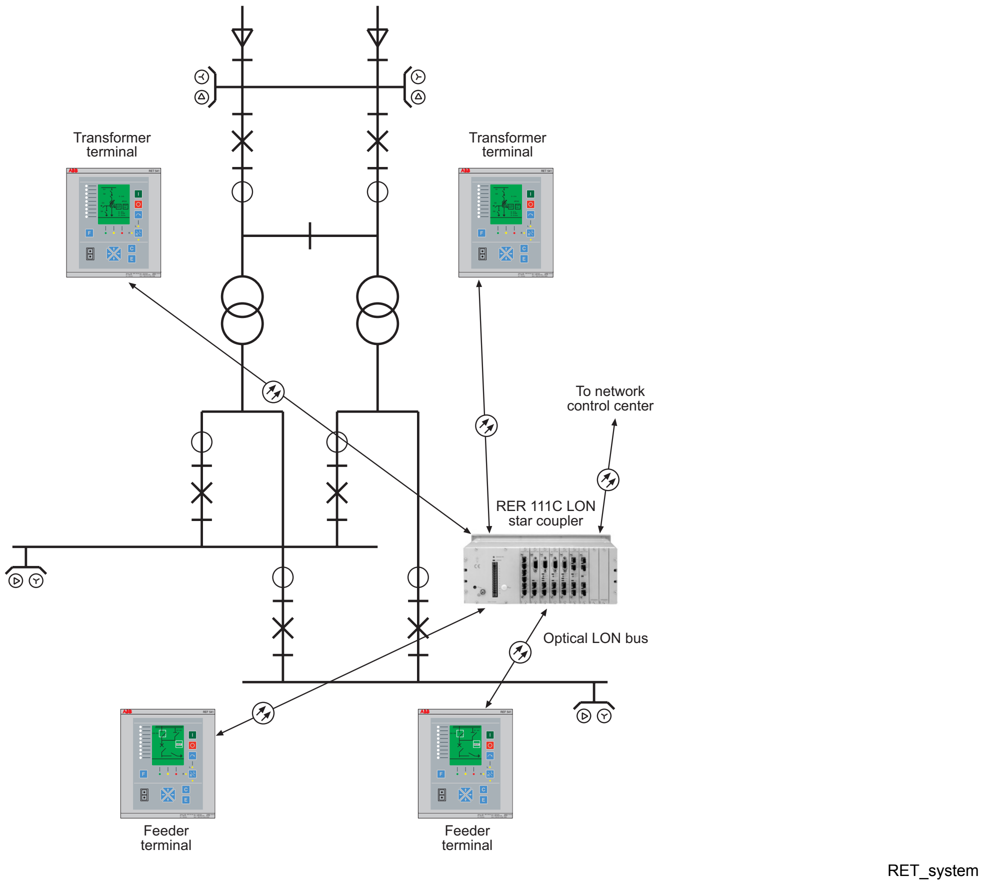


Fig. 4.1.-2 A distributed protection and control system based on REF 54_ feeder and RET 54_ transformer terminals.

Supporting a wide range of communication protocols, including SPA, LON, IEC 60870-5-103, DNP 3.0 and Modbus RTU/ASCII, commonly used by utilities and industries, the terminals are flexibly integrated into different control systems. Connection to Profibus DP or IEC 61850 based systems is possible via the interface adapters SPA-ZC 302 or SPA-ZC 400.

4.2. Requirements

If the environmental conditions differ from those specified in section “Technical data”, as to temperature and humidity, or if the atmosphere around the transformer terminal contains chemically active gases or dust, the terminal should be visually inspected in association with secondary testing. The visual inspection should focus on:

- Signs of mechanical damage to the transformer terminal case and terminals,
- dust on the transformer terminal cover or case, and
- signs of corrosion on terminals, on the case or inside the transformer terminal.

For information about the maintenance of transformer terminals, refer to Section “Service” on page 102.

Transformer terminals are measuring instruments and should be handled with care and protected against moisture and mechanical stress, especially during transport.

4.3. Configuration

The RET 54_ transformer terminals are adapted to specific applications by using the Relay Configuration Tool included in the CAP 505 tools. This tool is used for configuring the basic terminal, protection and logic function blocks, control and measurement functions, timers and other functional elements included in the logic functions category (refer to Section “Transformer terminal configuration” on page 31).

The MIMIC picture, alarm texts and LED indicators are configured with the Relay Mimic Editor (refer to Section “MIMIC configuration” on page 32).

The configuration of LON network is described in section “LON network configuration” on page 34. If the application includes no horizontal communication, network variables are not needed and the section about LON network configuration is thus not relevant.

The customer can configure the RET 54_ transformer terminal according to own functional requirements and preferences or utilize the pre-engineered configuration solutions.

For more detailed information about the configuration, refer to the Configuration Guideline and the tool-specific manuals (refer to “Related documents” on page 9).

5. Technical Description

5.1. Functional description

5.1.1. Functions of the transformer terminal

The functions of the RET 54_ transformer terminal are categorized as:

- Protection functions
- measurement functions
- control functions
- condition monitoring functions
- communication functions
- general functions
- standard functions

The functions are further divided to three subsets that correspond to different functionality levels (refer to Section “Ordering Information” on page 103).

5.1.1.1. Protection functions

Protection is one of the most important functions of the RET 54_ transformer terminal. The protection function blocks (e.g. NOC3Low) are independent of each other and have e.g. their own setting groups and data recording.

The protection function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

Table 5.1.1.1-1 Protection functions available for the RET 54_

Function	Description
DEF2Low	Directional earth-fault protection, low-set stage
DEF2High	Directional earth-fault protection, high-set stage
DEF2Inst	Directional earth-fault protection, instantaneous stage
Diff6T	Stabilized three-phase differential protection for transformers
DOC6Low	Three-phase directional overcurrent protection, low-set stage
DOC6High	Three-phase directional overcurrent protection, high-set stage
DOC6Inst	Three-phase directional overcurrent protection, instantaneous stage
Freq1St1	Underfrequency or overfrequency protection, stage 1
Freq1St2	Underfrequency or overfrequency protection, stage 2
Freq1St3	Underfrequency or overfrequency protection, stage 3
Freq1St4	Underfrequency or overfrequency protection, stage 4
Freq1St5	Underfrequency or overfrequency protection, stage 5
FuseFail	Fuse failure supervision
Inrush3	Three-phase transformer inrush and motor start-up current detector
NEF1Low	Non-directional earth-fault protection, low-set stage
NEF1High	Non-directional earth-fault protection, high-set stage
NEF1Inst	Non-directional earth-fault protection, instantaneous stage
NOC3Low	Three-phase non-directional overcurrent protection, low-set stage
NOC3LowB	Three-phase non-directional overcurrent protection, low-set stage B
NOC3High	Three-phase non-directional overcurrent protection, high-set stage
NOC3Inst	Three-phase non-directional overcurrent protection, instantaneous stage

*Table 5.1.1.1-1 Protection functions available for the RET 54_*

Function	Description
NPS3Low	Negative-phase-sequence (NPS) protection, low-set stage
NPS3High	Negative-phase sequence (NPS) protection, high-set stage
OE1Low	Overexcitation protection, low-set stage U/f>
OE1High	Overexcitation protection, high-set stage U/f>>
OV3Low	Three-phase overvoltage protection, low-set stage
OV3High	Three-phase overvoltage protection, high-set stage
PSV3St1	Phase-sequence voltage protection, stage 1
PSV3St2	Phase-sequence voltage protection, stage 2
REF1A	High-impedance based restricted earth-fault protection
REF4A	Stabilized restricted earth-fault protection (high voltage side)
REF4B	Stabilized restricted earth-fault protection (low voltage side)
ROV1Low	Residual overvoltage protection, low-set stage
ROV1High	Residual overvoltage protection, high-set stage
ROV1Inst	Residual overvoltage protection, instantaneous stage
TOL3Dev	Three-phase thermal overload protection for devices
UI6Low	Three-phase underimpedance protection, low-set stage
UI6High	Three-phase underimpedance protection, high-set stage
UV3Low	Three-phase undervoltage protection, low-set stage
UV3High	Three-phase undervoltage protection, high-set stage

5.1.1.2. Measurement functions

The measurement function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

*Table 5.1.1.2-1 Measurement functions available for the RET 54_*

Function	Description
MEAI1	General measurement 1 / analog input on RTD/analog module
MEAI2	General measurement 2 / analog input on RTD/analog module
MEAI3	General measurement 3 / analog input on RTD/analog module
MEAI4	General measurement 4 / analog input on RTD/analog module
MEAI5	General measurement 5 / analog input on RTD/analog module
MEAI6	General measurement 6 / analog input on RTD/analog module
MEAI7	General measurement 7 / analog input on RTD/analog module
MEAI8	General measurement 8 / analog input on RTD/analog module
MEAO1	Analog output 1 on RTD/analog module
MEAO2	Analog output 2 on RTD/analog module
MEAO3	Analog output 3 on RTD/analog module
MEAO4	Analog output 4 on RTD/analog module
MECU1A	Neutral current measurement, stage A
MECU1B	Neutral current measurement, stage B
MECU3A	Three-phase current measurement, stage A
MECU3B	Three-phase current measurement, stage B
MEDREC16	Transient disturbance recorder
MEFR1	System frequency measurement
MEPE7	Three-phase power and energy measurement
MEVO1A	Residual voltage measurement, stage A
MEVO1B	Residual voltage measurement, stage B

*Table 5.1.1.2-1 Measurement functions available for the RET 54_*

Function	Description
MEVO3A	Three-phase voltage measurement, stage A
MEVO3B	Three-phase voltage measurement, stage B

5.1.1.3. Control functions

The control functions are used to indicate the position of switching devices, i.e. circuit breakers and disconnectors, and to execute open and close commands for controllable switching devices in the switchgear. Furthermore, there are supplementary functions for control logic purposes, e.g. on/off switches, MIMIC alarm, LED control, numerical data for the MIMIC and logic controlled position selection.

The control functions configured using the Relay Configuration Tool can be associated with position indicators that are part of the MIMIC configuration picture displayed on the HMI. Position indicators are used to indicate the position of switching devices via the MIMIC picture and to control them locally. For more information about the MIMIC configuration, refer to Section “MIMIC configuration” on page 32.

The control function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

*Table 5.1.1.3-1 Control functions available for the RET 54_*

Function	Description
CO3DC1	Three-state disconnector 1 with indication
CO3DC2	Three-state disconnector 2 with indication
COCB1	Circuit breaker 1 control with indication
COCB2	Circuit breaker 2 control with indication
COCBDIR	Direct open for CBs via HMI
CODC1	Disconnector 1 control with indication
CODC2	Disconnector 2 control with indication
CODC3	Disconnector 3 control with indication
CODC4	Disconnector 4 control with indication
CODC5	Disconnector 5 control with indication
COIND1	Switching device 1 indication
COIND2	Switching device 2 indication
COIND3	Switching device 3 indication
COIND4	Switching device 4 indication
COIND5	Switching device 5 indication
COIND6	Switching device 6 indication
COIND7	Switching device 7 indication
COIND8	Switching device 8 indication
COLOCAT	Logic-controlled control position selector
COLTC	On-load tap changer controller (voltage regulator)
COSW1	On/off switch 1
COSW2	On/off switch 2
COSW3	On/off switch 3
COSW4	On/off switch 4
MMIALAR1	Alarm channel 1, LED indicator

*Table 5.1.1.3-1 Control functions available for the RET 54_*

Function	Description
MMIALAR2	Alarm channel 2, LED indicator
MMIALAR3	Alarm channel 3, LED indicator
MMIALAR4	Alarm channel 4, LED indicator
MMIALAR5	Alarm channel 5, LED indicator
MMIALAR6	Alarm channel 6, LED indicator
MMIALAR7	Alarm channel 7, LED indicator
MMIALAR8	Alarm channel 8, LED indicator
MMIDATA1	MIMIC data monitoring point 1
MMIDATA2	MIMIC data monitoring point 2
MMIDATA3	MIMIC data monitoring point 3
MMIDATA4	MIMIC data monitoring point 4
MMIDATA5	MIMIC data monitoring point 5

5.1.1.4. Condition monitoring functions

The condition monitoring function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

*Table 5.1.1.4-1 Conditioning monitoring functions available for the RET 54_*

Function	Description
CMBWEAR1	Circuit-breaker electric wear 1
CMBWEAR2	Circuit-breaker electric wear 2
CMCU3	Supervision function of the energizing current input circuit
CMGAS1	Gas pressure monitoring
CMGAS3	Three-pole gas pressure monitoring
CMSCHED	Scheduled maintenance
CMSPRC1	Spring charging control 1
CMTCS1	Trip circuit supervision 1
CMTCS2	Trip circuit supervision 2
CMTIME1	Operate time counter 1 for the operate time used (e.g. motors)
CMTIME2	Operate time counter 2 for the operate time used (e.g. motors)
CMTRAV1	Breaker travel time 1
CMVO3	Supervision function of the energizing voltage input circuit

5.1.1.5. Communication functions

The RET 54_ transformer terminal provides the IEC_103, Modbus[1], DNP 3.0[1], SPA and LON serial communication protocols.

In a customer-specific transformer terminal configuration, special events can be generated via an EVENT230 event function. EVENT230 is documented on the CD-ROM “Technical descriptions of Functions” (refer to “Related documents” on page 9).

For more information about communication in the RET 54_ transformer terminal, refer to Section “Serial communication” on page 69.

1. Requires the use of Bus Communication Module RER 133.

5.1.1.6. General functions

The general function blocks are documented on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

Table 5.1.1.6-1 General functions available for the RET 54_

Function	Description
INDRESET	Resetting of operation indicators, latched output signals, registers and waveforms i.e. the disturbance recorder
MMIWAKE	Activation of HMI backlight
SWGRP1	Switchgroup SWGRP1
SWGRP2	Switchgroup SWGRP2
SWGRP3	Switchgroup SWGRP3
......	
SWGRP20	Switchgroup SWGRP20

5.1.1.7. Standard functions

Standard functions are used for logics, such as interlocking, alarming and control sequencing. The use of logic functions is not limited and the functions can be interconnected with each other as well as with protection, measurement, power quality, control, condition monitoring and general functions. In addition, the digital inputs and outputs as well as LON inputs and outputs can be connected to standard functions by using the Relay Configuration Tool.

The standard function blocks are documented on the CD-ROM “Technical descriptions of Functions” (refer to “Related documents” on page 9).

Table 5.1.1.7-1 Standard functions available for the RET 54_

Function	Description
ABS	Absolute value
ACOS	Principal arc cosine
ADD	Extensible adder
AND	Extensible AND connection
ASIN	Principal arc sine
ATAN	Principal arc tangent
BCD2INT	Type conversion from BCD coded input to SINT (Tap changer)
BITGET	Get one bit
BITSET	Set one bit
BOOL_TO_*	Type conversion from BOOL to WORD / USINT / UINT / UDINT / SINT / REAL / INT / DWORD / DINT / BYTE
BOOL2INT	Type conversion from BOOL inputs to INT output
BYTE_TO_*	Type conversion from BYTE to WORD / DWORD
COMH	Hysteresis comparator
COS	Cosine in radians
CTD	Down-counter
CTUD	Up-down counter
CTU	Up-counter
DATE_TO_UDINT	Type conversion from DATE to UDINT
DINT_TO_*	Type conversion from DINT to SINT / REAL / INT
DIV	Divider
DWORD_TO_*	Type conversion from DWORD to WORD / BYTE
EQ	Extensible comparison to equal

*Table 5.1.1.7-1 Standard functions available for the RET 54_*

Function	Description
EXP	Natural exponential
EXPT	Exponentiation
F_TRIG	Falling edge detector
GE	Extensible comparison to greater or equal
GRAY2INT	Type conversion from GRAY coded input to SINT (Tap changer)
GT	Extensible comparison to greater
INT_TO_*	Type conversion from INT to REAL / DINT
INT2BOOL	Type conversion from INT input to BOOL outputs
LE	Extensible comparison to less or equal
LIMIT	Limitation
LN	Natural logarithm
LOG	Logarithm base 10
LT	Extensible comparison to less
MAX	Extensible maximum
MIN	Extensible minimum
MOD	Modulo
MOVE	Move
MUL	Extensible multiplier
MUX	Extensible multiplexer
NAT2INT	Type conversion from natural binary coded input to SINT (Tap changer)
NE	Comparison to greater or less
NOT	Complement
OR	Extensible OR connection
R_TRIG	Rising edge detector
REAL_TO_*	Type conversion from REAL to USINT / UINT / UDINT / SINT / INT / DINT
ROL	Rotate to left
ROR	Rotate to right
RS	Reset dominant bistable function block
RS_D	Reset dominant bistable function block with data input
SEL	Binary selection
SHL	Bit-shift to left
SHR	Bit-shift to right
SIN	Sine in radians
SINT_TO_*	Type conversion from SINT to REAL / INT / DINT
SUB	Subtractor
SQRT	Square root
SR	Set dominant bistable function block
XOR	Extensible exclusive OR connection
TAN	Tangent in radians
TIME_TO_*	Type conversion from TIME to UDINT / TOD / REAL
TOD_TO_*	Type conversion from TOD to UDINT / TIME / REAL
TOF	Off-delay timer
TON	On-delay timer
TP	Pulse
TRUNC_REAL_TO*	Truncation toward zero from REAL to DINT / INT / SINT / UDINT / UINT / USINT

Table 5.1.1.7-1 Standard functions available for the RET 54_

Function	Description
UDINT_TO_*	Type conversion from UDINT to USINT / UINT / REAL
UINT_TO_*	Type conversion from UINT to USINT / UDINT / REAL / BOOL
USINT_TO_*	Type conversion from USINT to UINT / UDINT / REAL
WORD_TO_*	Type conversion from WORD to DWORD / BYTE

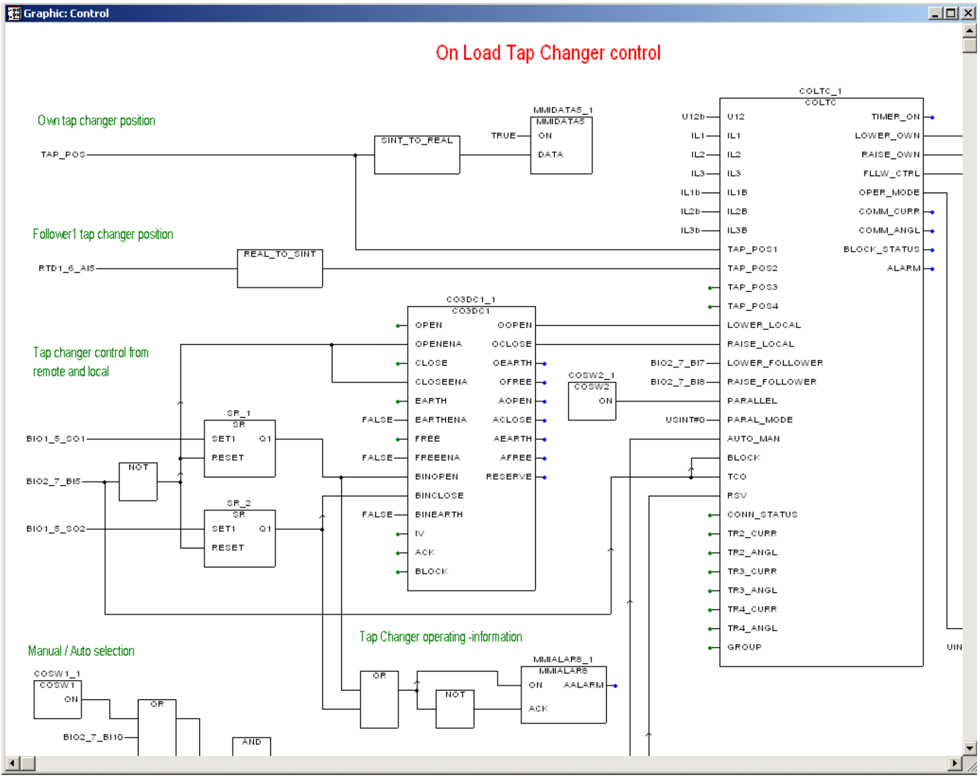
5.1.2. Configuration

5.1.2.1. Transformer terminal configuration

The Relay Configuration Tool is based on the IEC 61131-3 standard. The standard defines the programming language used for the configuration. The programmable system of RET 54_ transformer terminals allows the output contacts to be operated in accordance with the state of the logic inputs and the outputs of the protection, control, measurement and condition monitoring functions. The PLC functions (e.g. interlocking and alarm logic) are programmed with Boolean functions, timers, counters, comparators and flip-flops. The program is written in a function block diagram language by using the configuration software.

After the configuration has been built and successfully compiled, and the MIMIC configuration has been designed, the Relay Configuration Tool project (RCT project in CAP 505) including the relay configuration and MIMIC configuration can be downloaded to the relay with the Relay Download Tool. The project can also be uploaded from the transformer terminal with the same tool. However, the relay configuration, the RCT project and the MIMIC configuration are saved in a non-volatile memory only after they have been stored via the parameter “Store”. To activate new configurations, the transformer terminal should be reset via the parameter “Software reset”. These parameters can be found in the menu `Configuration/General`. Likewise, the storing and the resetting can be done by using the relay command buttons “Store” and “Reset” in the Relay Download Tool.

For more information about the configuration and the Relay Configuration Tool, refer to the Configuration Guideline and the tool manuals (refer to “Related documents” on page 9).



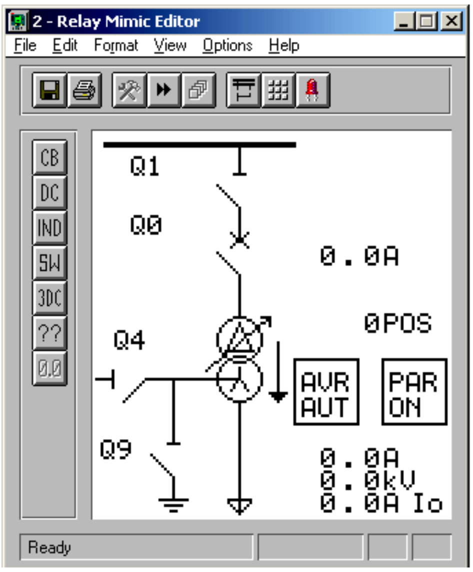
iec_conf_RET

Fig. 5.1.2.1.-1 Example of a transformer terminal configuration with the Relay Configuration Tool

5.1.2.2. MIMIC configuration

The control functions configured using the Relay Configuration Tool can be associated with position indicators that are part of the MIMIC configuration picture displayed on the graphic LCD of the HMI. The MIMIC configuration picture is designed with the Relay Mimic Editor. In addition, the editor is used to define the eight programmable LED indicators and the corresponding alarm texts on the front panel, the alarm modes, and the interlocking LED texts.

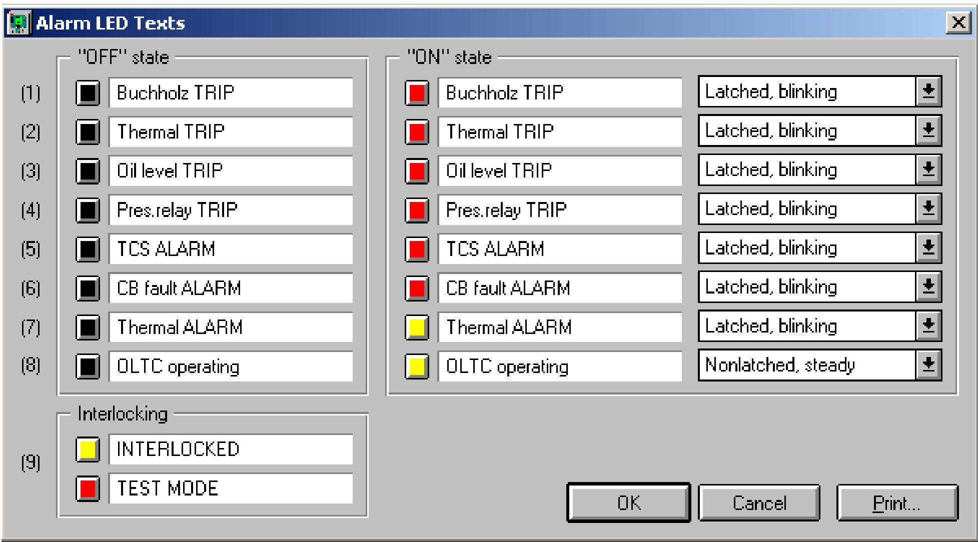
The MIMIC picture may include a single-line diagram, measured values with units, free texts, etc. The position indicators (open, closed, undefined) are drawn according to the customer's requirements. Note that the operation of the objects themselves is determined by means of the Relay Configuration Tool.



RET_Mimic

Fig. 5.1.2.2.-1 MIMIC configuration with the Relay Mimic Editor

The content of the alarm view is configured with the Relay Mimic Editor by defining the ON and OFF state texts (max. 16 characters), see Figure 5.1.2.2.-2 below. For defining the corresponding LED colors, refer to Section “Alarm LED indicators” on page 86.



RET_LEDs2

Fig. 5.1.2.2.-2 Alarm channel configuration

Interlocking LED texts can also be defined in the view illustrated above, but the interlocking LED colors cannot be changed. For the operation of the interlocking LED, refer to Section “Interlocking” on page 88.

For more information about the use of the editor, refer to the Relay Mimic Editor manual (see “Related documents” on page 9).

5.1.2.3. LON network configuration

The LON Network Tool is used for binding network variables between RED 500 terminals. Typically, LON is used for transferring status data between the terminals for interlocking sequences running in the units, see Figure 5.1.2.3.-1 below and Figure 5.1.13.9.-1 on page 81.

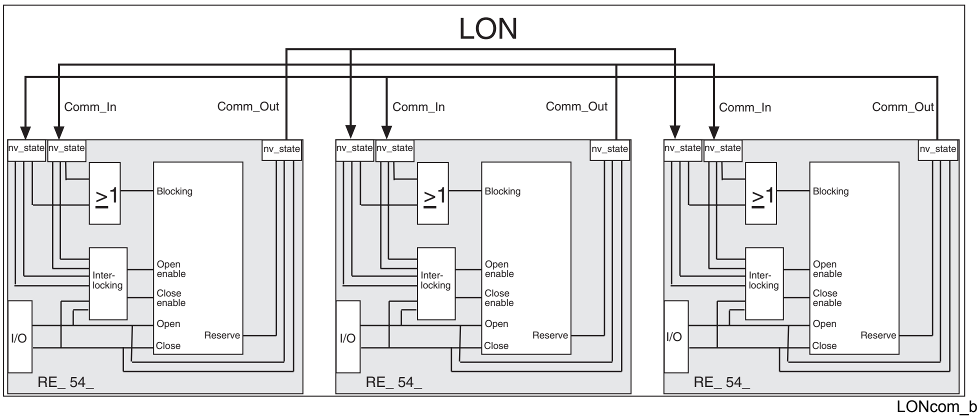


Fig. 5.1.2.3.-1 Communication between RED 500 terminals in station interlocking

For more information about the use of the tool, refer to the LNT 505 Operator’s Manual (see “Related documents” on page 9).

5.1.2.4. DNP 3.0 and Modbus configuration

Protocol Mapping Tool (PMT) is used for DNP 3.0 and Modbus configuration. PMT is integrated in CAP 505. For more information about PMT, refer to CAP 505 Protocol Mapping Tool, Operation Manual (see “Related documents” on page 9).

5.1.2.5. Rated frequency

The rated frequency of the transformer terminal is set in association with configuration via a dialog box in the Relay Configuration Tool. The set rated frequency cannot be changed afterwards via the HMI or serial communication, but it can be read via the global control parameter “Rated frequency” of the transformer terminal.

5.1.3. Parameters and events

The function blocks and I/O cards include a large number of parameters and events. In addition, general parameters and events are provided, e.g. parameters for control and communication as well as events for testing and self-supervision.

The function block specific parameters are listed in each function block description. Moreover, all parameters and events for RET 54_ are listed in the parameter and event lists. The function block descriptions as well as the parameter and event lists are included on the CD-ROM “Technical Descriptions of Functions” (see “Related documents” on page 9).

5.1.4. Parameterization

To ensure that a protection function block protects the transformer in the desired manner, the default values of parameters are to be checked and properly set before taking the function block into use.

The parameters can be set either locally over the HMI or externally via the serial communication.

5.1.4.1. Local parameterization

When the parameters are set locally via the HMI, the setting parameters can be chosen from the hierarchical menu structure. The desired language for parameter description can also be selected. Detailed information about setting and navigation is found in the RE_ 54_ Operator's Manual.

5.1.4.2. External parameterization

The Relay Setting Tool is used for parameterization and setting the RET 54_ transformer terminals externally. The parameters can be set off-line on a PC and downloaded to the transformer terminal over a communication port. The menu structure of the setting tool, including views relating to parameterization and settings, is the same as the menu structure of the transformer terminal. The use of the tool is instructed in the LIB, CAP, SMS, Tools for Relays and Terminals, User's Guide (see "Related documents" on page 9).

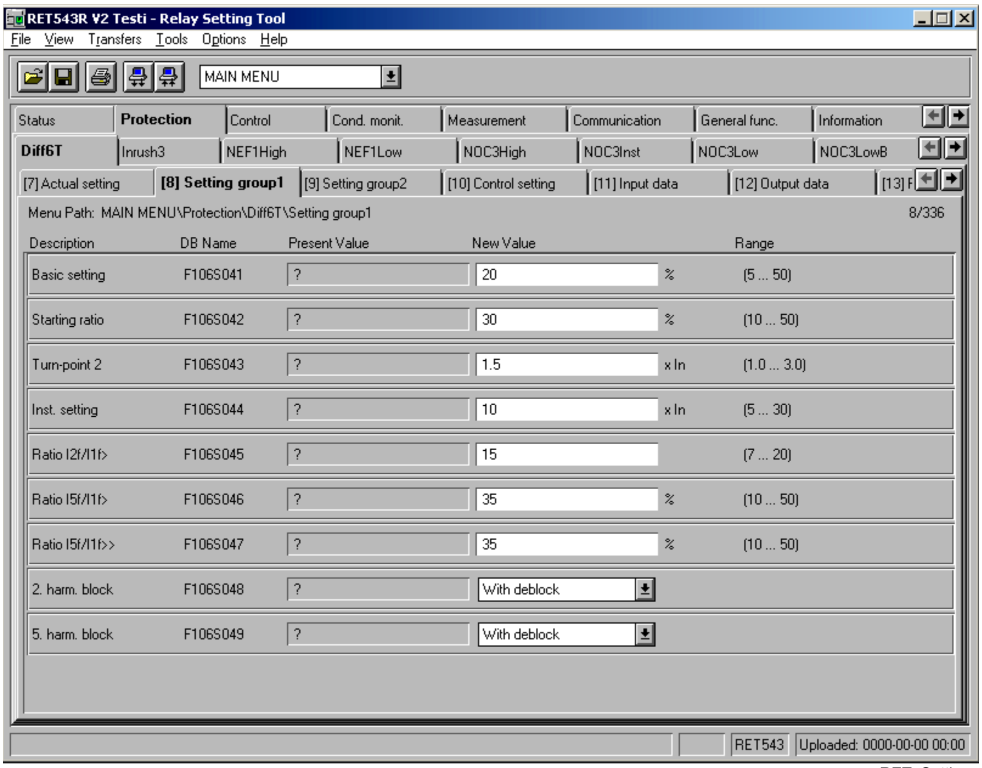


Fig. 5.1.4.2.-1 Main dalog box of the Relay Setting Tool

5.1.4.3. Storing of parameters and recorded data

When parameter values are changed, the new values take effect immediately. However, the new parameter values as well as the recorded data are saved in a non-volatile memory only after they have been stored via the parameter “Store” in the menu `Configuration/General` (also refer to the Operator’s Manual) or via the relay tools.

Provided the storing was completed successfully, the information stored in the non-volatile memory is preserved in the memory also in case of a power interruption. During the storing procedure, it is not possible to reset the transformer terminal via the parameter “Software reset” or to load a new project.

When the values for the measuring devices (refer to sections “Scaling the rated values of the protected unit for analog channels” and “Technical data of the measuring devices” on page 40) are changed via the HMI or the Relay Setting Tool, the new values take effect only after they have been stored via the parameter “Store” and the transformer terminal has been reset via the parameter “Software reset” in the menu `Configuration/General` or by using the relay command buttons “Store” and “Reset” in the Relay Download Tool.

The same applies for some communication parameters, i.e. the SPA baud rate, most Modbus and DNP 3.0 parameters, the RTD data frame parameter of the IEC_103 protocol, the protocol selection parameters (Protocol 2 and Protocol 3 in the menu `Communication/General`) and the command timeout parameter in the menu `Communication/General`.

5.1.5. Auxiliary voltage

For its operation the RET 54_ terminal, including the external display module, requires a secured auxiliary voltage supply. The transformer terminal’s internal power supply module forms the voltages required by the transformer terminal electronics. The power supply module is a galvanically isolated (flyback-type) DC/DC converter. A green protection LED indicator on the front panel is lit when the power supply module is in operation.

The main unit and the external display module must each be provided with separate power supply from a common source.

The transformer terminal is equipped with a capacitor back-up system that enables the internal clock to keep time for up to 48 hours in case of an auxiliary power failure.

5.1.5.1. Power supply versions

There are two basic types of power supply modules available for the RET 54_ transformer terminals: type PS1/_ and type PS2/_. The module PS1/_ is used in RET 541 and RET 543 terminals. The module PS2/_ is intended for the RET 545 terminal. Both modules are available in two versions: PS1/48 V, PS1/240 V, PS2/48 V, PS2/240 V.

There are also differences in the threshold voltages of the power supply modules’ digital inputs. PS1/_ has three different alternatives for threshold voltage of the binary inputs: low, medium and high version. The threshold voltage of the low version is 18 V DC, medium version 80 V DC and high version 155 V DC. The module PS1/48 V is a low version power supply and PS1/240 V is a medium or high version. The type PS2/_ does not have binary inputs.

The auxiliary voltages of power supply modules and the corresponding rated input voltages of digital inputs are:

Power supply module	Rated input voltage of power supply	Rated input voltage of digital inputs
PS1/240 V (High)	110/120/220/240 V AC or 110/125/220 V DC	220 V DC
PS1/240 V (Medium)	110/120/220/240 V AC or 110/125/220 V DC	110/125/220 V DC
PS1/48 V (Low)	24/48/60 V DC	24/48/60/110/125/220 V DC
PS2/240 V	110/120/220/240 V AC or 110/125/220 V DC	-
PS2/48	24/48/60 V DC	-
External display module	110/120/220/240 V AC or 110/125/220 V DC	-

When RET 54_ is delivered with a fixed display module, the input voltage range of the power supply module is marked on the front panel of the transformer terminal. When the transformer terminal is provided with an external display module, the input voltage of the display module is marked on the front panel of the module and the input voltage of the main unit is marked on the side of the unit.

The external display module is only available together with a main unit equipped with the PS_/240 power supply module.

The power supply version is specified by the first letter in the order number of RET 54_ (refer to Section “Ordering Information” on page 103). The voltage range of the digital inputs is tied to the selected power supply. If a power supply version with the higher rated input voltage is selected, the transformer terminals will be delivered with digital inputs that also have the higher rated input voltage.

For further technical data of the power supply, refer to Table 5.2.1-2 on page 90.

5.1.5.2. Low auxiliary voltage indication

The RET 54_ transformer terminal is provided with a low auxiliary voltage indication feature. The power supply module issues an internal alarm signal when a drop in the power supply voltage is detected (ACFail, active low). The alarm signal is activated if the power supply voltage falls about 10% below the lowest rated DC input voltage of the power supply module, see the table below:

Rated input voltage	Low indication level
PS_/240	
• Rated input voltage 110/125/ 220 V DC	99 V DC
• Rated input voltage 110/120/220/ 240 V AC	88 V AC
PS_/48	
• Rated input voltage 24/48/60 V DC	21.6 V DC

The indication of a low auxiliary voltage (ACFail) is available in the transformer terminal configuration environment and can be connected to any signal output of the RET 54_. The auxiliary voltage indication in the transformer terminal configuration is as follows:

RET 541: PS1_4_ACFail

RET 543: PS1_4_ACFail

RET 545: PS2_4_ACFail

5.1.5.3. Overtemperature indication

The RET 54_ transformer terminal includes an internal temperature supervision function. The power supply module issues an internal alarm signal when overtemperature has been detected inside the terminal enclosure. The alarm signal will be activated once the temperature inside the terminal enclosure increases to +78^{o}C (+75...+83^{o} C). Overtemperature indication is available in the transformer terminal configuration and can be connected to any signal output of the terminal. The overtemperature indication input in the transformer terminal configuration is as follows:

RET 541: PS1_4_TempAlarm

RET 543: PS1_4_TempAlarm

RET 545: PS2_4_TempAlarm

5.1.6. Analog channels

The transformer terminal measures the analog signals needed for protection, measuring, etc. via galvanically separated matching transformers. The RET 54_ transformer terminals are provided with the following matching transformers:

- 6 current and 3 voltage transformers:
  CT1, CT2, CT3, CT4, CT5, CT6, VT1, VT2, VT3
- 7 current and 2 voltage transformers:
  CT1, CT2, CT3, CT4, CT5, CT6, CT7, VT1, VT2
- 8 current and 1 voltage transformers:
  CT1, CT2, CT3, CT4, CT5, CT6, CT7, CT8, VT1

Furthermore, the transformer terminal includes virtual analog channels (refer to Section “Calculated analog channels” on page 42) for calculating the neutral current, phase-to-phase voltage and residual voltage from phase currents and voltages.

Each analog channel is separately configured with the Relay Configuration Tool. Both the measuring unit for each analog channel and the type of signal to be measured are to be configured.

Table 5.1.6-1 Physical analog channels of the transformer terminals

	Measuring units		
Ch No.	Current Transformer (CT)	Voltage Transformer (VT)	Signal type (selectable alternatives)
2	Current Transformer CT1 (I_n= 1 A/5 A)		Not in use, I_{L1}, I_{L2}, I_{L3}, I_{L1b}, I_{L2b}, I_{L3b}, I_0, I_{0b}
3	Current Transformer CT2 (I_n= 1 A/5 A)		
4	Current Transformer CT3 (I_n= 1 A/5 A)		
5	Current Transformer CT4 (I_n= 1 A/5 A)	Voltage Transformer VT1 (U_n=100V/110V/115V/120V)	Not in use, I_{L1}, I_{L2}, I_{L3}, I_{L1b}, I_{L2b}, I_{L3b}, I_0, I_{0b}, U_{12}, U_{23}, U_{31}, U_{12b}, U_{23b}, U_{31b}, U_{12c}, U_1, U_2, U_3, U_{1b}, U_{2b}, U_{3b}, U_{1c}, U_0, U_0b
6	Current Transformer CT5 (I_n= 1 A/5 A)	Voltage Transformer VT1 or VT2 (U_n=100V/110V/115V/120V)	
7	Current Transformer CT4, CT5 or CT6 (I_n= 1 A/5 A)		Not in use, I_{L1}, I_{L2}, I_{L3}, I_{L1b}, I_{L2b}, I_{L3b}, I_0, I_{0b}
8	Current Transformer CT5, CT6 or CT7 (I_n= 1 A/5 A)		
9	Current Transformer CT6, CT7 or CT8 (I_n= 1 A/5 A)		
10		Voltage Transformer VT1, VT2 or VT3 (U_n=100V/110V/115V/120V)	U_{12}, U_{23}, U_{31}, U_{12b}, U_{23b}, U_{31b}, U_{12c}, U_1, U_2, U_3, U_{1b}, U_{2b}, U_{3b}, U_{1c}, U_0, U_0b

The letters b and c after the signal type are used to distinguish between signals of the same type.

5.1.6.1. Scaling the rated values of the protected unit for analog channels

A separate scaling factor can be set for each analog channel. The factors enable differences between the ratings of the protected unit and those of the measuring device (CTs, VTs etc.) The setting value 1.000 means that the rated value of the protected unit is exactly the same as that of the measuring device.

When scaling factors are used, it should be noted that they affect the operation accuracy and the dynamic measuring range of the terminal. The accuracies stated in the description of each function block (CD-ROM "Technical Descriptions of Functions") only apply with the default values of the scaling factors. For example, a high factor affects the operation of sensitive protection functions, such as the directional earth-fault protection.

The scaling factor is calculated channel by channel as follows:

Scaling factor = I_{nmd} / $I_{np,}$ where

I_{nmd}	Rated primary current of the measuring device (A)
I_{np}	Rated primary current of the protected unit connected to the channel

Example:

Rated primary current of current trafo = 500 A:	I_{nmd} = 500 A
Rated current of the protected unit = 250 A:	I_{np} = 250 A
Scaling factor for current channels:	500 A / 250 A = 2.000[1]

The scaling factors for the analog channels can be set via the HMI of the transformer terminal or with the Relay Setting Tool. The HMI path for the scaling factors is: `Main Menu/ Configuration/ Protected unit/ Ch 2: scaling, Ch 3: scaling...`

For storing the values listed above, refer to Section "Storing of parameters and recorded data" on page 36.

5.1.6.2. Technical data of the measuring devices

When the transformer terminal is configured, the technical data of the measuring devices is set in separate dalog boxes in the Relay Configuration Tool. The set values will affect the measurements carried out by the transformer terminal.

For storing the values listed below, refer to Section "Storing of parameters and recorded data" on page 36.

Values to be set for a current transformer:

- rated primary current (1...6000 A) of the primary current transformer
- rated secondary current (5 A, 2 A, 1 A, 0.2 A) of the primary current transformer
- rated current (5 A, 1 A, 0.2 A) of the current measuring input (= rated current of the matching transformer of the transformer terminal)
- amplitude correction factor (0.9000...1.1000) of the primary current transformer at rated current
- correction parameter for the phase displacement error of the primary current transformer at rated current (-5.00°...0.00°)
- amplitude correction factor of the primary current transformer at a signal level of 1% of the rated current (0.9000...1.1000)
- correction parameter for the phase displacement error of the primary current transformer at a signal level of 1% of the rated current (-10.00°...0.00°)

Values to be set for a voltage transformer:

- rated voltage of voltage input (same as the secondary rated voltage of the primary voltage transformer connected to the voltage input, 100 V, 110 V, 115 V, 120 V)
- rated voltage of primary voltage transformer (0.100...440.000 kV)
- amplitude correction factor of the primary voltage transformer voltage at rated voltage (0.9000...1.1000)
- correction parameter for the primary transformer phase displacement error at rated voltage (-2.00°... 2.00°)

The measurement values stated by the manufacturer of the measuring device are used for calculating the correction parameters and factors according to the following formulas:

Current transformers

Amplitude error at current I_n (e = error in per cent)	Amplitude correction factor 1 = 1 / (1+ e/100)
Amplitude error at current 0.01 x I_n (e = error in per cent)	Amplitude correction factor 2 = 1 / (1+ e/100)
Phase displacement error at current I_n (e = error in degrees)	Phase displacement error 1 = - e
Phase displacement error at current 0.01 x I_n (e = error in degrees)	Phase displacement error 2 = - e

Voltage transformers

Amplitude error at voltage U_n (e = error in per cent)	Amplitude correction factor = 1 / (1+ e/100)
Phase displacement error at voltage U_n (e = error in degrees)	Phase displacement error = - e

5.1.6.3. Calculated analog channels

The RET 54_ transformer terminal includes virtual channels to obtain phase-to-phase voltages, residual voltage and neutral current. Both the amplitude and the phase angle arecalculated for the virtual channels.

The virtual channel voltages and currents are numerically derived from the phase voltages and phase currents according to the Table 5.1.6.3-1. Though primarily meant to be used with sensors, the calculated analog channels can also be usedwith conventional current and voltage transformers.

The virtual channels will be numbered according to the priority numbers in the Table 5.1.6.3-1. The virtual channels used first will be numbered as 11 and the following as 12, 13 etc. For example, U0s is numbered as 11 and U12s as 12, if these virtual channels are selected for use.

When sensitive earth-fault protection is needed, core balance transformers are not recommended to be replaced with the numerically derived sum of phase currents. Normally, an earth-fault setting below 10% of the rated value requires the use of a core balance transformer.

Table 5.1.6.3-1 Virtual analog channels

Virtual channel	Numeric derivation	Priority number
I_{0s}	$= -(I_{L1} + I_{L2} + I_{L3})$ 1)	1
I_{0bs}	$= -(I_{L1b} + I_{L2b} + I_{L3b})$ 1)	2
U_{0s}	$= (U_1 + U_2 + U_3)/3$	3
U_{0bs}	$= (U_{1b} + U_{2b} + U_{3b})/3$	4
U_{12s}	$= (U_1 - U_2)$	5
U_{23s}	$= (U_2 - U_3)$	6
U_{31s}	$= (U_3 - U_1)$	7
U_{12bs}	$= (U_{1b} - U_{2b})$	8
U_{23bs}	$= (U_{2b} - U_{3b})$	9
U_{31bs}	$= (U_{3b} - U_{1b})$	10

1) A minus in front of the parenthesis means, that the default direction of the neutral current is assumed to be from the line to the busbar, while the normal power flow is from the busbar to the line.

5.1.7. Digital inputs

The RET 541, RET 543 and RET 545 transformer terminals differ from each other regarding the number of digital inputs available.

The digital inputs of the RET 54_ transformer terminals are voltage-controlled and optically isolated. For technical data of the digital inputs, refer to Table 5.2.1-3 on page 90.

The parameters for input filtering, input inversion and pulse counters (see sections below) can be set in the Configuration menu under each I/O card (e.g. `Configuration/BIO1/Input filtering`).

The events and parameters of I/O cards are included in the event and parameter lists on the CD-ROM “Technical Descriptions of Functions” (see “Related documents” on page 9).

Table 5.1.7-1 Digital inputs available for the RET 54_

	RET 541	**RET 543**	**RET 545**
Inputs	PS1_4_BI1 [1)]	PS1_4_BI1 [1)]	BIO1_5_BI1
	PS1_4_BI2 [1)]	PS1_4_BI2 [1)]	BIO1_5_BI2
	PS1_4_BI3 [1)]	PS1_4_BI3 [1)]	BIO1_5_BI3
	BIO1_5_BI1	BIO1_5_BI1	BIO1_5_BI4
	BIO1_5_BI2	BIO1_5_BI2	BIO1_5_BI5
	BIO1_5_BI3	BIO1_5_BI3	BIO1_5_BI6
	BIO1_5_BI4	BIO1_5_BI4	BIO1_5_BI7
	BIO1_5_BI5	BIO1_5_BI5	BIO1_5_BI8
	BIO1_5_BI6	BIO1_5_BI6	BIO1_5_BI9 [1)]
	BIO1_5_BI7	BIO1_5_BI7	BIO1_5_BI10 [1)]
	BIO1_5_BI8	BIO1_5_BI8	BIO1_5_BI11 [1)]
	BIO1_5_BI9 [1)]	BIO1_5_BI9 [1)]	BIO1_5_BI12 [1)]
	BIO1_5_BI10 [1)]	BIO1_5_BI10 [1)]	BIO1_6_BI1
	BIO1_5_BI11 [1)]	BIO1_5_BI11 [1)]	BIO1_6_BI2
	BIO1_5_BI12 [1)]	BIO1_5_BI12 [1)]	BIO1_6_BI3
		BIO2_7_BI1	BIO1_6_BI4
		BIO2_7_BI2	BIO1_6_BI5
		BIO2_7_BI3	BIO1_6_BI6
		BIO2_7_BI4	BIO1_6_BI7
		BIO2_7_BI5	BIO1_6_BI8
		BIO2_7_BI6	BIO1_6_BI9 [1)]
		BIO2_7_BI7	BIO1_6_BI10 [1)]
		BIO2_7_BI8	BIO1_6_BI11 [1)]
		BIO2_7_BI9 [1)]	BIO1_6_BI12 [1)]
		BIO2_7_BI10 [1)]	BIO2_7_BI1
			BIO2_7_BI2
			BIO2_7_BI3
			BIO2_7_BI4
			BIO2_7_BI5
			BIO2_7_BI6
			BIO2_7_BI7
			BIO2_7_BI8
			BIO2_7_BI9 [1)]
			BIO2_7_BI10 [1)]
Digital inputs / total	15	25	34

[1)] These digital inputs can be programmed as either digital inputs or pulse counters, refer to Section “Pulse counters” on page 45.

5.1.7.1. Filter time of a digital input

The filter time eliminates debounces and short disturbances on a digital input. The filter time is set for each digital input of the RET 54_ transformer terminal. The operation of input filtering is illustrated below.

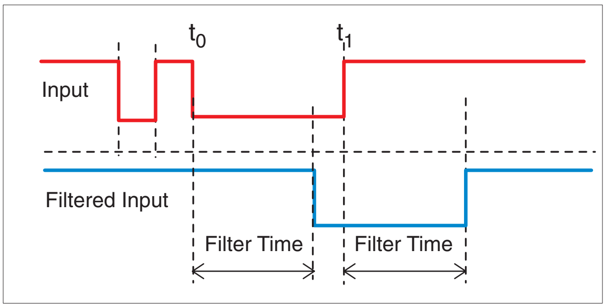


Fig. 5.1.7.1.-1 Filtering of a digital input

In the figure above, the input signal is named ‘Input’, the filter timer ‘Filter Time’ and the filtered input signal ‘Filtered Input’. At the beginning, the input signal is at high state, the short low state is filtered and no input state change is detected. The low state starting from the time t_0 exceeds the filter time, which means that the change in the input state is detected and the time tag attached to the input change is t_0. The high state starting from t_1 is detected and the time tag t_1 is attached.

Each digital input has a filter time parameter “Input # filter”, where # is the number of the digital input of the module in question (e.g. Input 1 filter).

Parameter	Values	Default
Input # filter	1....15000 ms	5 ms

5.1.7.2. Inversion of a digital input

The parameter “Input # invert” can be used to invert a digital input:

Control voltage	Input # invert	State of digital input
No	0	FALSE (0)
Yes	0	TRUE (1)
No	1	TRUE (1)
Yes	1	FALSE (0)

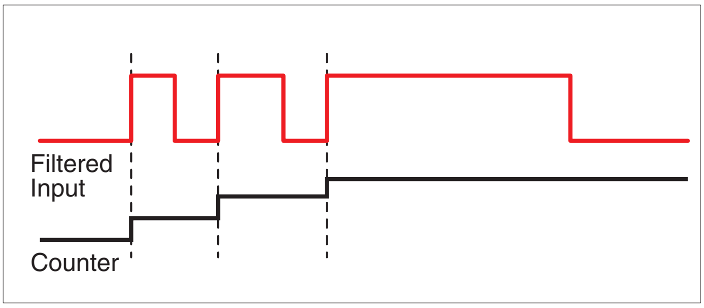
When the digital input is inverted, the state of the input is TRUE (1) when no control voltage is applied to its terminals. Accordingly, the input state is FALSE (0) when a control voltage is applied to the terminals of the digital input.

Parameter	Values	Default
Input # invert	0 (not inverted)	0
	1 (inverted)	

5.1.7.3. Pulse counters

Some specific digital inputs (refer to Section “Digital inputs” on page 42) of the RET 54_ transformer terminal can be programmed either as digital inputs or as pulse counters. This programming is done via the parameter “Input # mode” (in this parameter as well as in others mentioned below, # denotes the input number).

When an input operates as a pulse counter, the positive input transitions (0 -> 1) of a filtered input are counted and the counter value of “Input # counter” increases in the range 0... 2147483647. The pulse counters are updated with a period of 500 ms. The frequency range of a digital input parameterized to operate as a pulse counter is 0...100 Hz.



dipo2_b

Fig. 5.1.7.3.-1 Principle of the pulse counter function

The parameter “Input # preset” can be used to give a counter the start value.The start value is loaded into the counter by:

- Writing the desired start value to the parameter “Input # preset”,
- writing the value 1 to the parameter “Counter trigger”. Then all the updated values of the “Input # preset” parameters are copied to the corresponding “Input # counter” parameters.

Writing the value 2 to the “Counter trigger” parameter copies all the “Input # preset” values to the corresponding “Input # counter” parameters. Writing the value 0 clears all the counters.

Parameter	Values	Default
Input # preset	0..... 2147483647	0
Input # mode	1 = digital input 2 = counter	1

Counter trigger	0 = clear all counters
	1 = load updated Input # preset values
	2 = load all Input # preset values	

5.1.7.4. Oscillation suppression

Oscillation suppression is used to reduce the load from the system when, for some unrecognized reason, a digital input starts oscillating. A digital input is regarded as oscillating if the number of valid state changes (= number of events after filtering) during 1 second is equal to or greater than the set value “Input osc. level”

(Oscillation level). During oscillation, the digital input is blocked (the status is invalid) and an event is generated. The state of the input will not change when it is blocked, i.e. its state depends on the condition before blocking.

The digital input is regarded as non-oscillating if the number of valid state changes during 1 second is less than the set value of "Input osc. level" minus the set value of "Input osc. hyst." (Oscillation hysteresis). Note that the oscillation hysteresis must be set lower than the oscillation level to enable the input to be restored from oscillation. When the input returns to a non-oscillating state, the digital input is deblocked (the status is valid) and an event is generated.

Parameter	Values	Default
Input osc. level	2...50 events/s	50 events/s
Input osc. hyst.	2...50 events/s	10 events/s

Unlike most parameters for digital I/O cards, the parameters "Input osc. level" and "Input osc. hyst." can be found in the menu `Configuration/General`.

5.1.7.5. Attributes of a digital input for transformer terminal configuration

The validity of the digital input (invalidity), the state of the input (value), the time tag for the state change (time) and the counter value of the input can be issued for each digital input by the attributes BI#IV, BI#, BI#Time and BI#Count, where # denotes the number of the input. These attributes are available in the transformer terminal configuration and can be used for different purposes.

The example below shows how the attributes of the digital input 1 (PS1_4_BI1 on PS1 module) of the transformer terminal RET 541 are named for the configuration:

PS1_4_BI1IV; digital input invalidity

PS1_4_BI1; digital input value

PS1_4_BI1Time; time tag

PS1_4_BT1Count; counter value

Invalidity (BI#IV)

When a digital input oscillates, the invalidity attribute IV changes to TRUE (1) and the input is blocked. The digital input is regarded as being blocked and oscillating if the number of state changes per second exceeds the set "Input osc. level" value (events/s).

When a digital input does not oscillate, the invalidity attribute IV changes to FALSE (0) and the input becomes operative. The digital input is regarded as being operative and non-oscillating if the number of state changes per second is less than the set "Input osc. level" value minus the set "Input osc. hyst." value (events/s).

If the digital input is used in counter mode, IV is always TRUE (1).

Value (BI#)

Depending on the state of the digital input, the digital input value is TRUE (1) or FALSE (0). The BI# value changes on the rising or falling edge of the input. To prevent undesired state changes of the digital input due to e.g. switch debouncing, the change of the attribute value is delayed by the filter time.

The value attribute of the digital input is not updated when the input is programmed as counter digital input.

Time (BI#Time)

Each change (rising or falling edge) detected in the state of a digital input is time-tagged at an accuracy of ±1 ms. The time tag represents the moment (time) of the latest input change of the value attribute. The time is not recorded until the filtering time of the state change has elapsed, which means that the filtering time does not affect the time tag value.

Count (BI#Count)

The count attribute indicates the number of positive input transitions of a filtered input. Refer to section “Pulse counters” on page 45.

The counter attribute of a digital input is not updated when the input is programmed as a normal digital input.

5.1.8. Digital outputs

The outputs of the RET 54_ transformer terminal are categorized as follows:

HSPO	High-speed power output, double-pole contact, preferred for tripping purposes and for circuit breaker and disconnector control
PO	Power output, either single-pole or double-pole contact, preferred for circuit breaker and disconnector control
SO	Signal output, either NO (Normally Open) or NO/NC (Normally Open/ Normally Closed) contact

The events and parameters of I/O cards are included in the event and parameter lists on the CD-ROM “Technical Descriptions of Functions” (see “Related documents” on page 9).

For information about terminal connections for the outputs, refer to terminal diagrams (beginning on page 95), where all the outputs are included with relay connector terminals.

For technical data of the outputs, see Table 5.2.1-6 on page 91.

Table 5.1.8-1 Digital outputs

	RET 541	**RET 543**	**RET 545**
Outputs	PS1_4_HSPO1 [1)]	PS1_4_HSPO1 [1)]	PS2_4_HSPO1 [1)]
	PS1_4_HSPO2 [1)]	PS1_4_HSPO2 [1)]	PS2_4_HSPO2 [1)]
	PS1_4_HSPO3	PS1_4_HSPO3	PS2_4_HSPO3
	PS1_4_HSPO4	PS1_4_HSPO4	PS2_4_HSPO4
	PS1_4_HSPO5	PS1_4_HSPO5	PS2_4_HSPO5
	PS1_4_SO1	PS1_4_SO1	PS2_4_HSPO6
	BIO1_5_SO1	BIO1_5_SO1	PS2_4_HSPO7
	BIO1_5_SO2	BIO1_5_SO2	PS2_1_HSPO8
	BIO1_5_SO3	BIO1_5_SO3	BIO1_5_SO1
	BIO1_5_SO4	BIO1_5_SO4	BIO1_5_SO2
	BIO1_5_SO5	BIO1_5_SO5	BIO1_5_SO3
	BIO1_5_SO6	BIO1_5_SO6	BIO1_5_SO4
		BIO2_7_PO1	BIO1_5_SO5
		BIO2_7_PO2	BIO1_5_SO6
		BIO2_7_PO3	BIO1_6_SO1
		BIO2_7_PO4	BIO1_6_SO2
		BIO2_7_PO5	BIO1_6_SO3
		BIO2_7_PO6	BIO1_6_SO4
			BIO1_6_SO5
			BIO1_6_SO6
			BIO2_7_PO1
			BIO2_7_PO2
			BIO2_7_PO3
			BIO2_7_PO4
			BIO2_7_PO5
			BIO2_7_PO6
Outputs / total	12	18	26

[1)] Trip Circuit Supervision function included

5.1.8.1. High-speed double-pole power outputs (HSPO)

The high-speed power outputs PS1_4_HSPO1... PS1_4_HSPO5 and PS2_4_HSPO1...PS2_4_HSPO7 can be connected as double-pole outputs where the object to be controlled (e.g. a circuit breaker) is electrically connected between the two relay contacts, see the figure below. The high-speed double-pole power output is recommended to be used for tripping purposes.

When TCS is used (see Table 5.1.8-1 on page 48), the outputs are connected as shown in Figure 5.1.11.-1 on page 66.

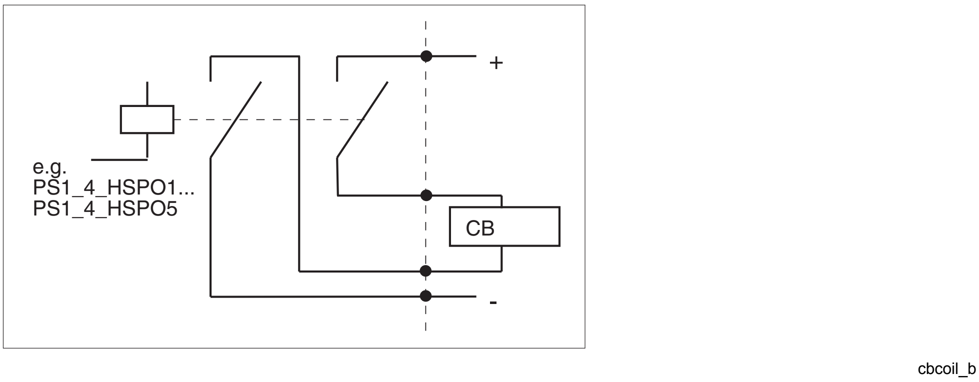


Fig. 5.1.8.1.-1 High-speed double-pole power outputs (HSPO)

The high-speed power outputs PS1_4_HSPO1... PS1_4_HSPO5 and PS2_4_HSPO1...PS2_4_HSPO7 can also be connected as single-pole power outputs where the object to be controlled (e.g. a circuit breaker) is electrically connected in series with the two relay contacts, see the figure below.

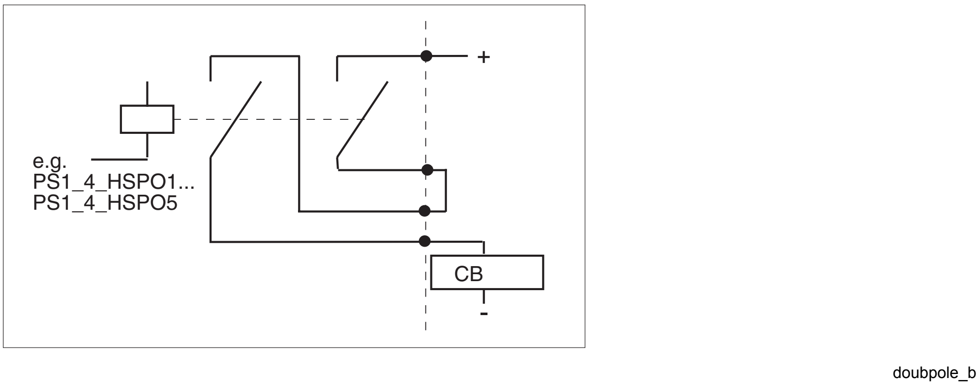
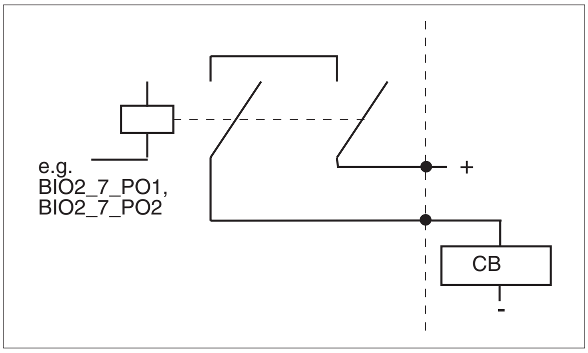


Fig. 5.1.8.1.-2 High-speed single-pole power outputs (HSPO)

5.1.8.2. Single-pole power outputs (PO) and a high-speed single-pole power output (HSPO)

The single-pole power outputs BIO2_7_PO1 and BIO2_7_PO2 as well as the high-speed single-pole power output PS2_4_HSPO8 are outputs where the object to be controlled is connected in series with two heavy-duty output relay contacts, see the figure below. These outputs can be used for tripping purposes and for circuit breaker and disconnector control.

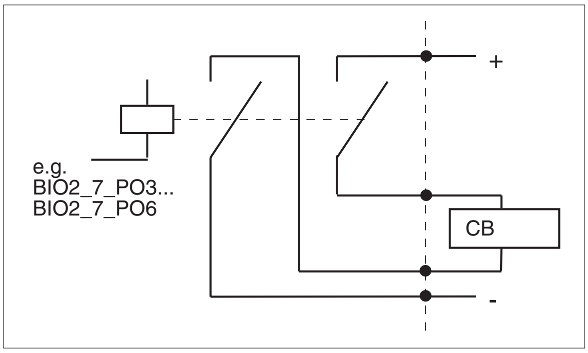


PO1conn_b

Fig. 5.1.8.2.-1 Single-pole power outputs BIO2_7_PO1 and BIO2_7_PO2, and the high-speed single-pole power output PS2_4_HSPO8

5.1.8.3. Double-pole power outputs (PO)

The double-pole power outputs BIO2_7_PO3... BIO2_7_PO6 are outputs where the object to be controlled (e.g. a circuit breaker) is electrically connected between the two relay contacts, see the figure below. These outputs can be used for tripping purposes and for circuit breaker and disconnector control.



PO3conn_b

Fig. 5.1.8.3.-1 Double-pole power outputs (PO)

If the power outputs BIO2_7_PO3... BIO2_7_PO6 are used as single-pole outputs, the object to be controlled (e.g. a circuit breaker) is electrically connected in series with the two relay contacts to provide sufficient current breaking capacity, see the figure below.

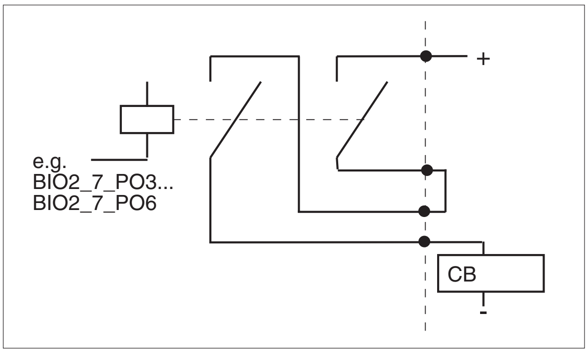


Fig. 5.1.8.3.-2 Single-pole power outputs (PO)

5.1.8.4. Signal outputs (SO)

The signalling relay outputs (BIO1_5_SO_) are not heavy-duty outputs and thus they cannot be used for controlling e.g. a circuit breaker. Available relay contacts are either Normally Open or Normally Open/Normally Closed type (NO or NO/NC), see the figure below. These outputs can be used for alarming and other signalling purposes.

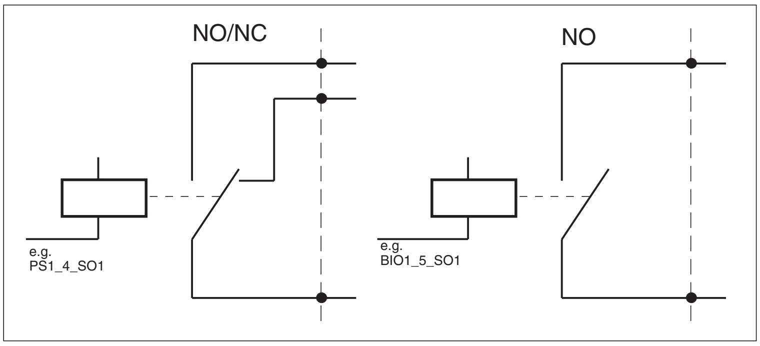


Fig. 5.1.8.4.-1 Signal outputs (SO)

5.1.9. RTD/analog inputs

The RET 541 and RET 543 transformer terminals equipped with an RTD/analog module (RTD1) have eight general purpose analog inputs for DC measurement. The RTD/analog inputs are galvanically isolated from the transformer terminal power supply and enclosure. However, the inputs share a common ground.

For technical data of the RTD/analog inputs, refer to Table 5.2.1-4 on page 91.

	RET 541/RET 543 + RTD1
RTD/analog inputs	RTD1_6_AI1
	RTD1_6_AI2
	RTD1_6_AI3
	RTD1_6_AI4
	RTD1_6_AI5
	RTD1_6_AI6
	RTD1_6_AI7
	RTD1_6_AI8

The parameters for the RTD/analog inputs are included in the parameter lists on the CD-ROM “Technical Descriptions of Functions” (see “Related documents” on page 9).

5.1.9.1. Selection of input signal type

The general purpose RTD/analog inputs accept voltage-, current- or resistance-type signals. The inputs are configured for a particular type of input signal by means of the channel-specific “Input mode” parameters that can be found in the menu `Configuration/RTD1/Input #`. The default value is “Off” which means that the channel is not sampled at all, and the IN+, IN- and SHUNT terminals are at high impedance state.

Parameter	**Values**	**Default**
Input mode	0 = Off	Off
	1 = Voltage	
	2 = Current	
	3 = Resistance 2W [1)]	
	4 = Resistance 3W [2)]	
	5 = Temperature 2W [1)]	
	6 = Temperature 3W [2)]	

1) Two-wire measurement
2) Three-wire measurement

5.1.9.2. Selection of input signal range

For each measuring mode, a separate parameter is provided for choosing between the available measurement ranges. These channel-specific parameters, which can be found in the menu `Configuration/RTD1/Input #`, are named “Voltage range”, “Current range”, “Resistance range” and “Temperature range”. All range parameters can be set but only one is used. The value of the “Input mode” parameter determines which range parameter is used. The “Temperature range” parameter also defines the sensor type to be used, e.g. PT100.

Table 5.1.9.2-1 Measurement ranges

Parameter	Values	Default
Voltage range	0 = 0...1V	0...1 V
	1 = 0...5 V	
	2 = 1...5 V	
	3 = 0...10 V	
	4 = 2...10 V	
	5 = -5...5 V	
	6 = -10...10 V	
Current range	0 = 0...1 mA	0...1 mA
	1 = 0...5 mA	
	2 = 1...5 mA	
	3 = 0...10 mA	
	4 = 0...20 mA	
	5 = 4...20 mA	
	6 = -1...1 mA	
	7 = -2.5...2.5 mA	
	8 = -5...5 mA	
	9 = -10...10 mA	
	10 = -20...20 mA	
Resistance range	0 = 0...100 Ω	0...100 Ω
	1 = 0...200 Ω	
	2 = 0...500 Ω	
	3 = 0...1000 Ω	
	4 = 0...2000 Ω	
	5 = 0...5000 Ω	
	6 = 0...10000 Ω	
Temperature range	0 = Pt100 -45...150 °C	Pt100 -45...150 °C
	1 = Pt100 -45...600 °C	
	2 = Pt250 -45...150 °C	
	3 = Pt250 -45...600 °C	
	4 = Pt1000 -45...150 °C	
	5 = Pt1000 -45...600 °C	
	6 = Ni100 -45...150 °C	
	7 = Ni100 -45...250 °C	
	8 = Ni120 -45...150 °C	
	9 = Ni120 -45...250 °C	
	10 = Ni250 -45...150 °C	
	11 = Ni250 -45...250 °C	
	12 = Ni1000 -45...150 °C	
	13 = Ni1000 -45...250 °C	
	14 = Cu10 -45...150 °C	
	15 = Ni120US -45...150 °C	
	16 = Ni120US -45...250 °C	

5.1.9.3. Transducer supervision

The measuring signal level of each transducer is constantly supervised. If the measured signal falls more than 4% below or rises more than 4% over the specified input signal range of a particular channel, the transducer or the transducer wiring is considered to be faulty and the channel-specific invalid signal is immediately activated. The invalid signal is deactivated as soon as the transducer signal is within the valid range.

When necessary, the valid measuring range may be narrower than the default -4...104% of the selected measuring range. A narrower range can be defined by means of the parameters "Input high limit" and "Input low limit" that can be found in the menu `Configuration/RTD1/Input #`.

Parameter	Values	Default
Input low limit	-4...104%	-4%
Input high limit	-4...104%	104%

When an input is configured for resistance or temperature measurement, the internal excitation current generator forces a current pulse through the measuring circuit when the input is sampled. If the actual current level does not match the programmed level due to too high impedance in the circuit, the invalid signal is immediately activated. The invalid signal is deactivated as soon as the circuit resistance is low enough.

5.1.9.4. Signal filtering

Short disturbances on an input are eliminated by signal filtering. The filter time, which defines the step response time, is set for each transducer input of the transformer terminal by the "Filter time" parameters in the menu `Configuration/RTD1/Input #`. The filtering algorithm is a so-called median filter which shows no reaction to interference spikes but levels out directly on permanent changes.

Parameter	Values	Default
Filter time	0 = 0.4 s 1 = 1 s 2 = 2 s 3 = 3 s 4 = 4 s 5 = 5 s	5 s

5.1.9.5. Input scaling/linearization

The user can scale each RTD/analog input linearly or non-linearly by constructing a separate linearization curve for each input. The name implies the typical use, i.e. the linearization of not directly supported non-linear sensors. The curve consists of at least two ponts (for linear scaling) and up to ten points, where the x-axis of the curve is 0 to 1000 per mille of the range selected for the input, and the y-axis is the scaled absolute value of the input. The linearization curves can be enabled and disabled with the `Linear. curve` parameters in the menu `Configuration/RTD1/Input #`.

Parameter	Values	Default
Linear.curve	0=Disabled 1=Enabled	Disabled

The curve is constructed for the transformer terminal by using the Transducer Linearization Tool (TLT) in the relay tool package CAP 505 .Figure 5.1.9.5.-1 shows an example construction.

When the linearization curve is enabled, the `Input high limit` and `Input low limit` parameters define the scaled range instead of the range selected by the original range parameters. The range of the scaled input is defined as the range between the smallest y-axis value and the largest y-axis value.

Application example for tap changer position linearization

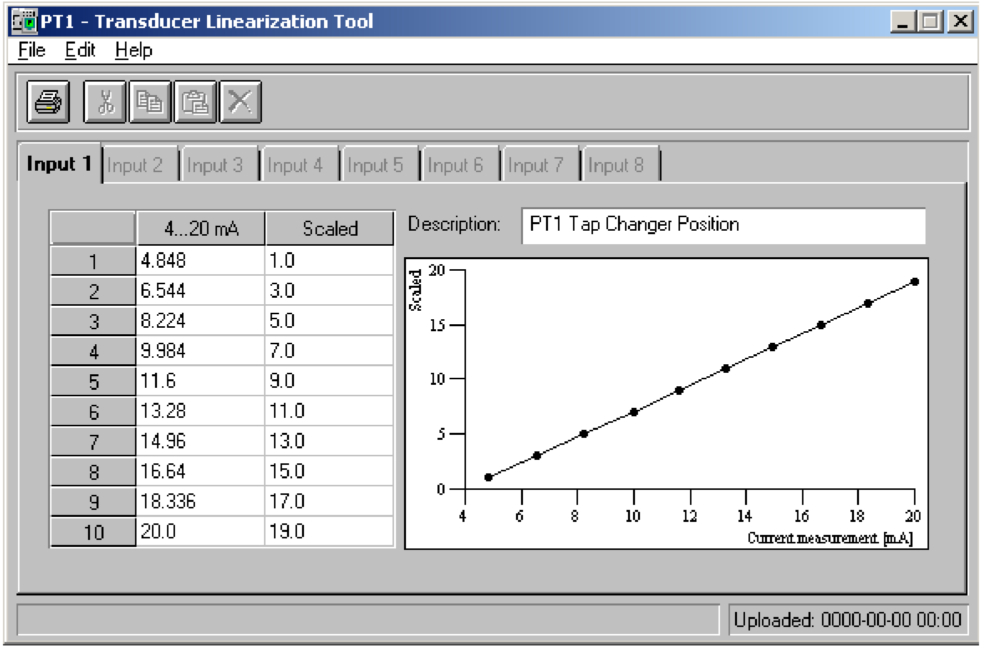
In this example, the transformer tap changer position indication is wired as a mA signal from the corresponding measuring transducer and connected to input 1 of the RTD1 card. The tap changer has been controlled through the whole operating area, from minimum to maximum turns of tap, and a corresponding mA signal for the tap position has been measured.

Table 5.1.9.5-1 Example of tap changer mA measurements

Measurement	TAP_POS	POS (mA)
1	1	4,85
2	3	6,54
3	5	8,23
4	7	9,98
5	9	11,60
6	11	13,28
7	13	14,96
8	15	16,64
9	17	18,33
10	19	20,01

The range to be linearized should be selected from the relay settings before linearizing. In this way, the TLT knows the original range to be linearized.

The TLT allows for a maximum of ten points to be linearized. If the range is already linear, but in a different scale, then only the low and the high points are needed for linearizing. The following picture shows how values are added into TLT.

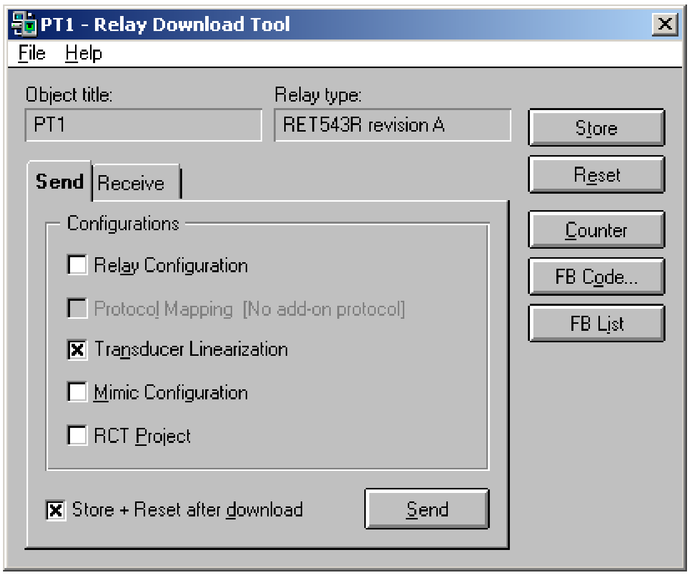


TLT_example

Fig. 5.1.9.5.-1 Linearization curve example

When the linearization for all the necessary RTD1 channels is ready, the tool can be exited. After exiting, the tool starts to prepare a downloadable linearizing file. This file can be downloaded to the terminal by using the Relay Download Tool, also included in the CAP 505 software. In the download tool, the transducer linearization check box should be checked before the downloading is started.

If the "Store + Reset after download" check box is checked when clicking the Send button, then the Store and Reset commands are sent automatically after a successful download of the selected files (see Figure 5.1.9.5.-2).



TLT_send

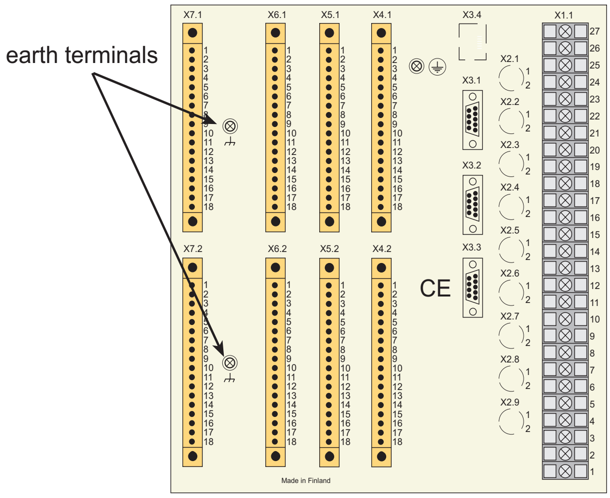
Fig. 5.1.9.5.-2 Downloading the linearization curve to the transformer terminal

5.1.9.6. Transducer connections

The RTD/analog inputs may be connected to a large variety of different measuring transducer types, both standardized and customer-specified types.

Three connection screws have been reserved for each channel. Further, one connection screw (analog ground) has been reserved per every two channels.

Two earth terminals (see figure below), located to the left of the connectors, are reserved for connecting the protective sheaths of the transducer input cables. The cable sheath is generally earthed in one end of the cable only.



earthter_b

Fig. 5.1.9.6.-1 Earth terminals

Current transducers

When a current transducer is connected to the RTD/analog input, the SHUNT and IN+ terminals are linked together as are the GND and IN- terminals. The incoming current signal is connected to the IN+ terminal and the outgoing current signal to the IN- terminal.

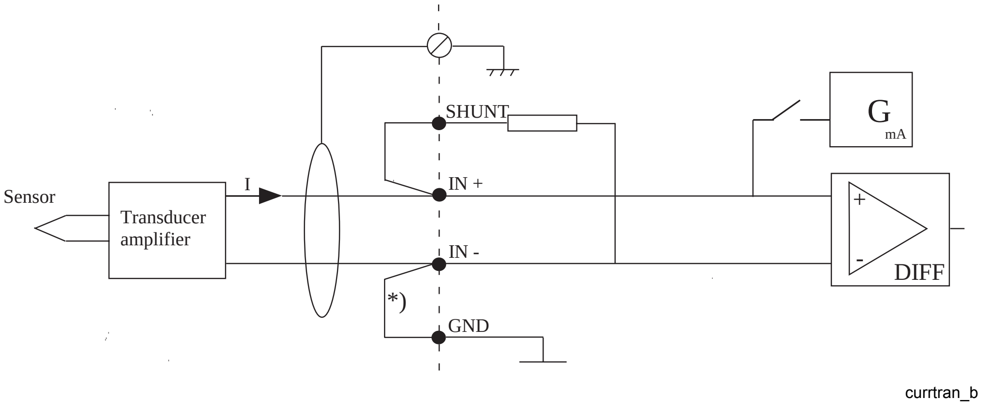


Fig. 5.1.9.6.-2 Principle diagram for the connection of current transducers

Voltage transducers

When a voltage transducer is connected to the RTD/analog input, the GND and IN- terminals are linked together. The incoming voltage signal is connected to the IN+ terminal and the return voltage signal lead to the IN- terminal.

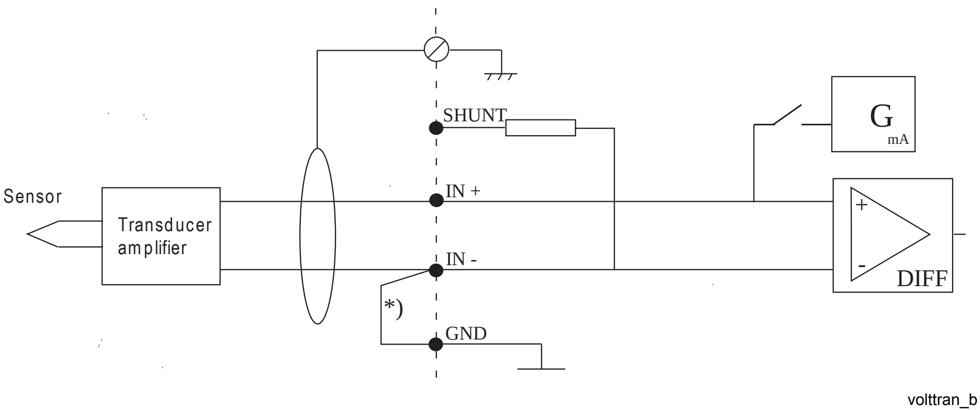


Fig. 5.1.9.6.-3 Principle diagram for the connection of voltage transducers

*) The GND terminals are galvanically isolated from the supply and enclosure of the transformer terminal, but they are all connected to each other, i.e. they share the same potential. When several inputs are connected to single-ended signal sources that share a common ground, ground loops result if the connection GND <-> IN- is done on every input. In this situation, the connection GND <-> IN- is done on only one of the concerned RTD/analog inputs.

Resistance sensors

The resistance sensors may be connected to the RTD/analog input according to either the three-wire or the two-wire connection principle. With the three-wire measuring principle, the wire resistance is automatically compensated. The resistor, or RTD sensor, is connected across the IN+ and IN- inputs, and the - side of the resistor/RTD sensor is connected to the GND input. The leads connected to the IN+ and GND inputs must be of the same type.

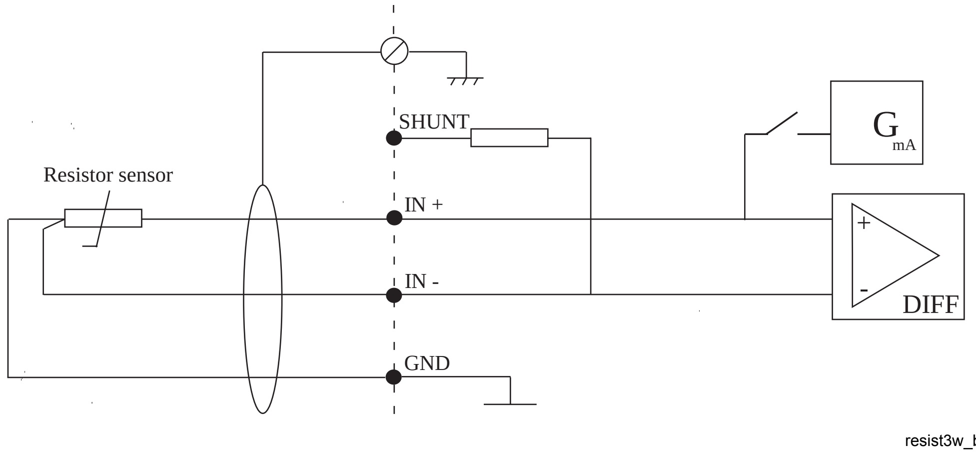


Fig. 5.1.9.6.-4 Principle diagram of the three-wire connection

With the two-wire connection principle, the IN- and GND terminals are linked together. The resistor is connected across the IN+ and IN- inputs.

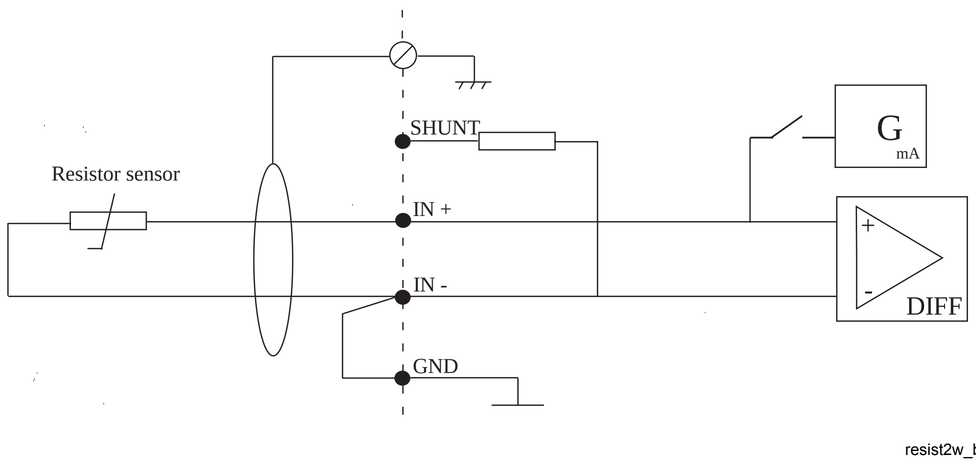


Fig. 5.1.9.6.-5 Principle diagram of the two-wire connection

5.1.9.7. Attributes of an RTD/analog input for transformer terminal configuration

The value and the validity of the input can be issued for each RTD/analog input by the attributes AI# (REAL type) and AI#IV (BOOL type), where # denotes the number of the input. These attributes are available in the transformer terminal configuration and can be used for different purposes.

Value (AI#)

The AI# value represents the filtered absolute value of the physical input with the unit according to the selected measuring mode, i.e. V, mA, Ω or °C.

Invalidity (AI#IV)

The AI#IV attribute represents the invalidity status of the input. The attribute is set to FALSE when the value (AI#) is valid, and to TRUE when the value is invalid. The input is invalid when one or more of the following conditions are true: the measured value is outside the defined limits (see the parameters “Input high limit” and “Input low limit”), an open-loop condition is detected (only possible on resistance and temperature measuring modes) or the continuous recalibration of the module has failed. The value (AI#) is not locked when the invalid attribute is set to TRUE, i.e. the invalid value is available for inspection.

5.1.9.8. RTD/analog input configuration example

The RTD/analog inputs are supported in the Relay Configuration Tool by the general measurement function blocks MEAI1...MEAI8. As an example, to monitor temperature using a PT100 sensor, the measured value of the RTD/analog input is connected to the function block by connecting the value attribute RTD1_6_AI1 to the RawAI input of the function block. The output HighAlarm is used to activate a relay contact when the temperature exceeds a preset limit. The measured temperature is displayed on the MIMIC view of the HMI by the connected MMIDATA1 function block. To avoid unnecessary activation of the relay contact in case of a fault, the corresponding invalid attribute of the RTD/analog input RTD1_6_AI1IV is connected to the IV input of the function block.

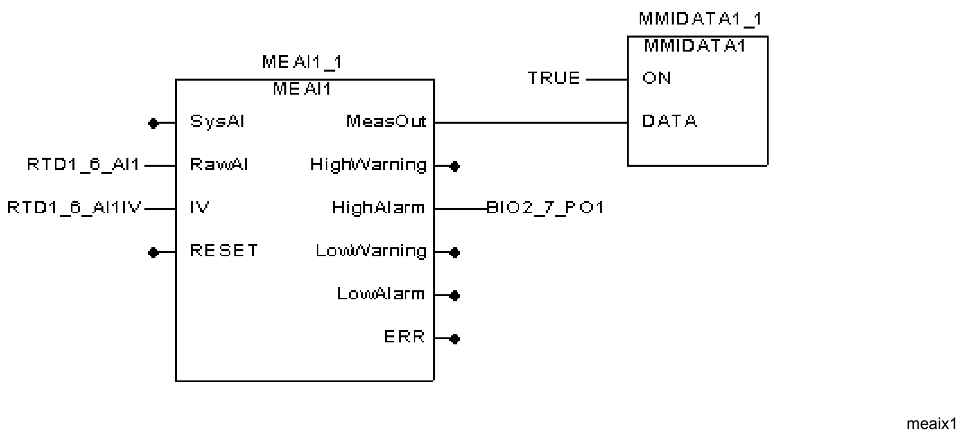


Fig. 5.1.9.8.-1 RTD/analog input configuration example

5.1.9.9. Self-supervision

Each input sample is validated before it is fed into the filter algorithm. The samples are validated by measuring an internally set reference voltage immediately after the inputs are sampled. If the measured offset voltage deviates from the set value more than 1.5% of the measuring range, the sample is discarded. If the fault continues longer than for the set filter time, the invalid attributes of all inputs are set to TRUE to indicate a hardware fault. Should the measurement succeed later, the invalid attributes are reset to FALSE. This prevents most sudden hardware faults from affecting the measured value before the invalid attribute is set. To ensure that the specified measurement accuracy is met, a more thorough test of the hardware is performed by the continuous recalibration procedure which will catch errors that degrade the measurement accuracy.

5.1.9.10. Calibration

The RTD/analog module is calibrated at the factory. To be able to maintain the specified accuracy in spite of aging and varying temperature, the card also includes special hardware to allow self-recalibration on the field. This recalibration procedure runs continuously, even when no measurements are activated, to ensure that the card is always optimally calibrated. If the recalibration procedure fails, the reason is a hardware failure. In this case the card's measurement accuracy is no longer obtained, and the invalidity attributes of all inputs are set to TRUE. However, the card continues updating the measured input values, and if the invalidity attributes are not used in the transformer terminal configuration, the situation could go unnoticed. Should the recalibration succeed later, the invalidity attributes return to normal operation.

5.1.9.11. RTD temperature vs. resistance

For the resistance values of temperature sensors at specified temperatures, see the table below.

TEMP C°	Platinum TCR 0.00385			Nickel TCR 0.00618				Nickel TCR 0.00672	Copper TCR 0.00427
	Pt 100	**Pt 250**	**Pt 1000**	**Ni 100**	**Ni 120**	**Ni 250**	**Ni 1000**	**Ni 120 US**	**Cu 10**
-40.0	84.27	210.675	842.7	79.1	94.92	197.75	791	92.76	7.490
-30.0	88.22	220.55	882.2	84.1	100.92	210.25	841	-	-
-20.0	92.16	230.4	921.6	89.3	107.16	223.25	893	106.15	8.263
-10.0	96.09	240.225	960.9	94.6	113.52	236.5	946	-	-
0.0	100.00	250	1000	100.0	120	250	1000	120.00	9.035
10.0	103.90	259.75	1039	105.6	126.72	264	1056	-	-
20.0	107.79	269.475	1077.9	111.2	133.44	278	1112	134.52	9.807
30.0	111.67	279.175	1116.7	117.1	140.52	292.75	1171	-9	-
40.0	115.54	288.85	1155.4	123.0	147.6	307.5	1230	149.79	10.580
50.0	119.40	298.5	1194	129.1	154.92	322.75	1291	-	-
60.0	123.24	308.1	1232.4	135.3	162.36	338.25	1353	165.90	11.352
70.0	127.07	317.675	1270.7	141.7	170.04	354.25	1417	-	-
80.0	130.89	327.225	1308.9	148.3	177.96	370.75	1483	182.84	12.124
90.0	134.70	336.75	1347	154.9	185.88	387.25	1549	-	-
100.0	138.50	346.25	1385	161.8	194.16	404.5	1618	200.64	12.897
120.0	146.06	365.15	1460.6	176.0	211.2	440	1760	219.29	13.669
140.0	153.58	383.95	1535.8	190.9	229.08	477.25	1909	238.85	14.442
150.0	-	-	-	198.6	238.32	496.5	1986	-	-
160.0	161.04	402.6	1610.4	206.6	247.92	516.5	2066	259.30	15.217
180.0	168.46	421.15	1684.6	223.2	267.84	558	2232	280.77	-
200.0	175.84	439.6	1758.4	240.7	288.84	601.75	2407	303.46	-
220.0	-	-	-	259.2	311.04	648	2592	327.53	-
240.0	-	-	-	278.9	334.68	697.25	2789	353.14	-
250.0	194.07	485.175	1940.7	289.2	347.04	723	2892	-	-
260.0	-	-	-	-	-	-	-	380.31	-
300.0	212.02	530.05	2120.2	-	-	-	-	-	-
350.0	229.67	574.175	2296.7	-	-	-	-	-	-
400.0	247.04	617.6	2470.4	-	-	-	-	-	-
450.0	264.11	660.275	2641.1	-	-	-	-	-	-
500.0	280.90	702.25	2809	-	-	-	-	-	-
550.0	297.39	743.475	2973.9	-	-	-	-	-	-
600.0	313.59	783.975	3135.9	-	-	-	-	-	-

5.1.10. Analog outputs

The RET541 and RET543 transformer terminals equipped with an RTD/analog module have four general purpose 0...20 mA analog current outputs. All outputs are galvanically isolated from the supply and enclosure of the transformer terminal and from each other.

For technical data of the analog outputs, refer to Table 5.2.1-7 on page 91.

	RET541/RET543 + RTD1
Analog outputs	RTD1_6_AO1
	RTD1_6_AO2
	RTD1_6_AO3
	RTD1_6_AO4

The parameters and events for the analog outputs are included in the event and parameter lists on the CD-ROM “Technical Descriptions of Functions” (refer to “Related documents” on page 9).

5.1.10.1. Selection of analog output range

The outputs can be set to two different current ranges with the “Output range” parameters in the menu `Configuration/RTD1/Output #`.

Parameter	**Values**	**Default**
Output range	0 = 0...20 mA 1 = 4...20 mA	0...20 mA

5.1.10.2. Attributes of an analog output for transformer terminal configuration

The value and the validity of the output can be issued for each analog output by the attributes AO# (REAL type) and AO#IV (BOOL type), where # denotes the number of the output. These attributes are available in the transformer terminal configuration and can be used for different purposes.

Value (AO#)

The value written to AO# is transferred to a current signal at the output. The output response time is ≤85 ms, consisting of the software delay and the rise time of the analog output, counted from the moment when the value attribute is updated in the configuration program.

Invalidity (AO#IV)

The AO#IV attribute represents the invalidity status of the output. The attribute is set to FALSE when the value (AO#) is valid, i.e. an equal amount of current is flowing through the output, and to TRUE when the value is invalid, i.e. the current at the output is different from the value of AO#. When the AO#IV attribute is TRUE, this indicates one of two situations: either the current loop connected to the output is broken or the value attribute is written with a value outside the range defined by the “Output range” parameter. The transition of the AO#IV state may also generate an event. Event generation is controlled by the “Event mask” parameter found in the menu `Configuration/RTD1`.

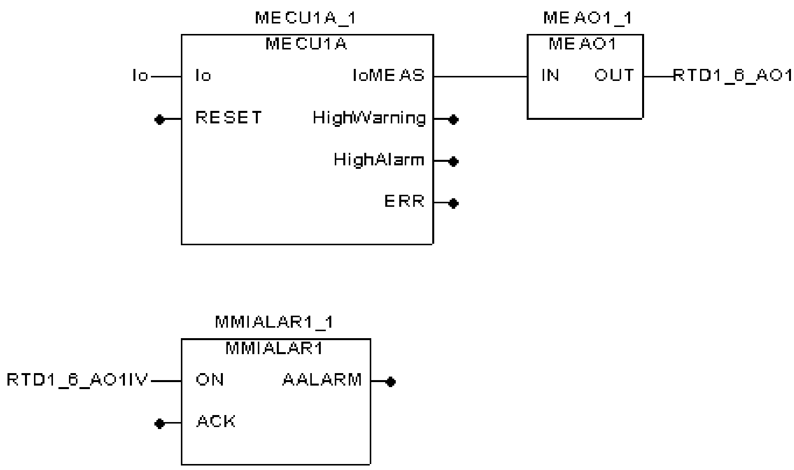
The output behaviour when the value attribute is outside the defined limits is as follows:

Output range	Value of AO#	Output current	Invalidity attribute AO#IV
0...20 mA	>20	20 mA	TRUE
	0...20	0...20 mA	FALSE
	<0	0 mA	TRUE
4...20 mA	>20	20 mA	TRUE
	4...20	4...20 mA	FALSE
	<4	0 mA	TRUE

Note that the output is also forced to 0 mA on the 4...20 mA range when the value is below the low limit. This behavior can be used to indicate a fault to the receiver.

5.1.10.3. Analog output configuration example

The analog outputs are supported in the Relay Configuration Tool by the MEAO1...MEAO4 analog output function blocks. As an example, to display the measured value of neutral current on an analog gauge, the neutral current measurement block MECU1A is connected to MEAO1, which in turn is connected to the RTD1_6_AO1 global variable. The output invalid signal RTD1_6_AO1IV is connected to the MMIALAR1 function block to achieve a visual indication of a fault. The MEAO# function blocks contain the parameters necessary for scaling the measured value to fit the selected output range. The MEAO# function blocks also limit the output change frequency to achieve a tolerable system load.



meaox1

Fig. 5.1.10.3.-1 Analog output configuration example

5.1.11. Trip circuit supervision

The trip circuit supervision inputs TCS1 and TCS2 in the RET 54_ transformer terminal consist of two functional units:

- a constant-current generator including the necessary hardware elements
- a software-based functional unit for signalling

The functional units are based on the CMTCS1 and CMTCS2 function blocks included in the condition monitoring category.

The supervision of the trip circuit is based on the constant-current injection principle. If the resistance of the trip circuit exceeds a certain limit, for instance due to bad contact or oxidation, or if the contact has welded, the voltage over the supervised contact falls below 20 V AC/DC (15...20V) and the supervision function of the trip circuit is activated. If the fault persists, the trip circuit supervision alarm signal ALARM is obtained once the preset delay time of the function block CMTCS_ elapses.

The input/output circuits are galvanically isolated from each other. The constant-current generator forces a 1.5 mA measuring current through the circuit-breaker trip circuit. The constant current generator is connected over the trip contact of the transformer terminal circuit. The current generator for the TCS1 is connected to the terminals X4.1/12-13 and the current generator for the TCS2 to the terminals X4.1/17-18 of the RET 54_ transformer terminal.

Under no-fault conditions, the voltage over the contact of the constant current generator must be above 20 V AC/DC.

The following instructions must be read very carefully.

Mathematically, operating condition can be expressed as:

$$U_c - (R_{ext} + R_{int} + R_s) \cdot I_c \geq 20\,VAC/\mathrm{DC}$$

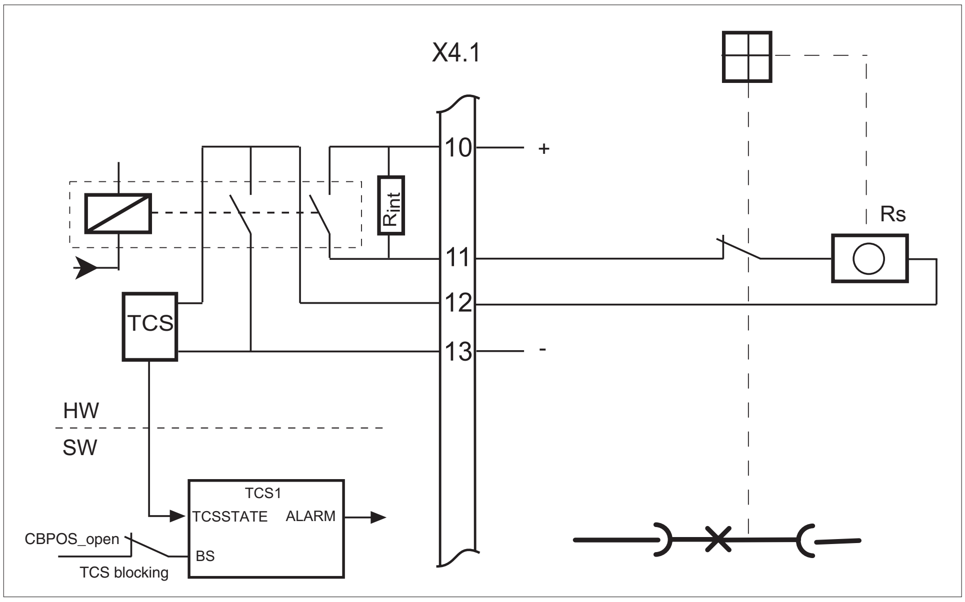
where

- U_c = operating voltage over the supervised trip circuit
- I_c = measuring current through the trip circuit, approximately 1.5 mA (0.99... 1.72 mA)
- R_{ext} = external shunt resistor value
- R_{int} = internal shunt resistor value, 1 kΩ
- R_s = trip coil resistance value

The resistor R_{ext} must be so calculated that the trip circuit supervision current through the resistor is low enough not to influence the trip coil of the circuit breaker. On the other hand, the voltage drop over the resistor R_{ext} must be low enough not to jeopardize the operating condition presented in the formula above.

The following values are recommended for the resistor R_{ext} in Figure 5.1.11.-1 below:

Operating voltage Uc	Shunt resistor R_{ext}
48 V DC	1.2 kΩ, 5 W
60 V DC	5.6 kΩ, 5 W
110 V DC	22 kΩ, 5 W
220 V DC	33 kΩ, 5 W



TCSclose_b

Fig. 5.1.11.-1 Operating principle of the trip-circuit supervision (TCS), without an external resistor. The TCS blocking switch is set, blocking the TCS1 when the circuit breaker is open. The terminal numbers are related to HSPO1.

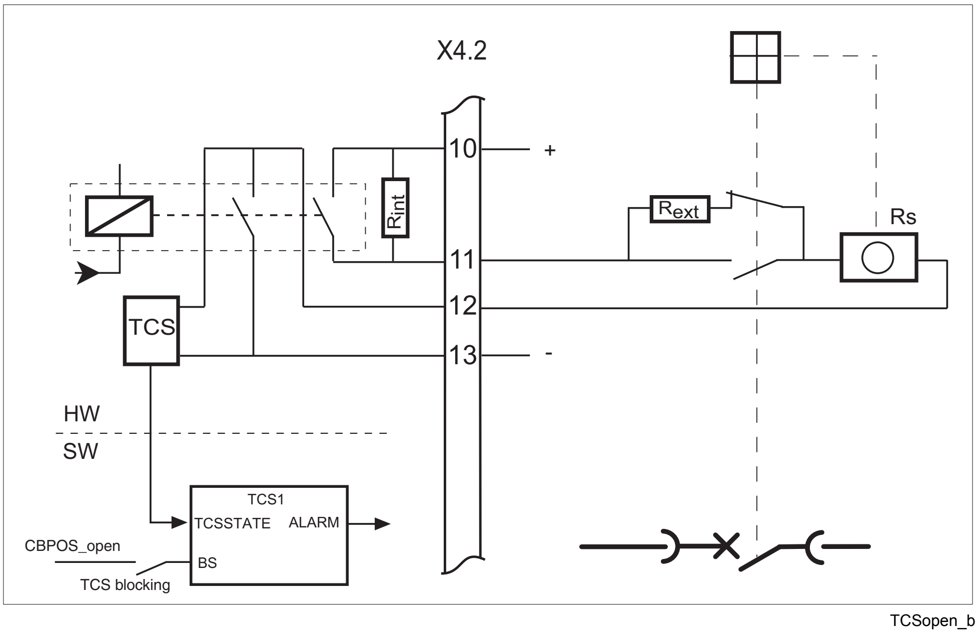


Fig. 5.1.11.-2 Operating principle of the trip-circuit supervision (TCS), with an external resistor. The TCS blocking switch is open, enabling trip-circuit supervision independent of circuit breaker position. The terminal numbers are related to HSPO1.

5.1.11.1. Configuring the trip circuit supervision CMTCS_

The Relay Configuration Tool can be used to connect the trip circuit supervision input status signals to the function blocks CMTCS1 and CMTCS2. The configuration of the blocking signal is user-specific and can only be defined in the transformer terminal configuration. The trip circuit supervision inputs in the transformer terminal configuration are as follows:

TCS1 and TCS2 inputs in RET 541 and RET 543:

Trip Circuit Supervision 1 input	PS1_4_TCS1
Trip Circuit Supervision 2 input	PS1_4_TCS2

TCS1 and TCS2 inputs in RET 545:

Trip Circuit Supervision 1 input	PS2_4_TCS1
Trip Circuit Supervision 2 input	PS2_4_TCS2

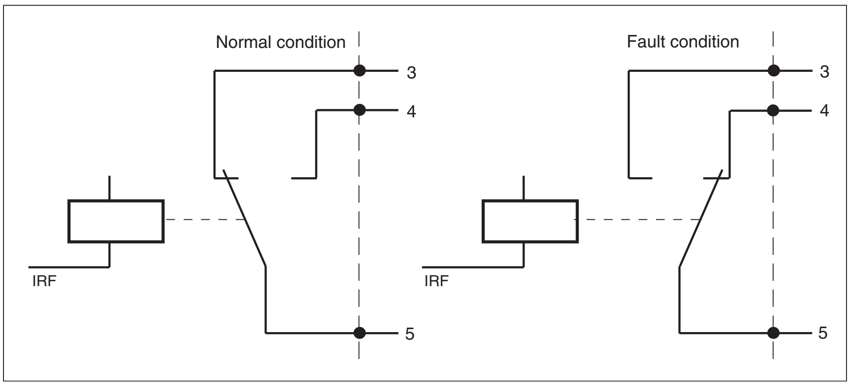
For more information about the trip circuit supervision function, refer to the Technical Descriptions of Functions for CMTCS1 and CMTCS2 (see “Related documents” on page 9).

5.1.12. Self-supervision (IRF)

The RET 54_ transformer terminal is provided with an extensive self-supervision system. The self-supervision system handles run-time fault situations and informs the user of faults via the HMI and LON/SPA communication. See also Table 5.2.1-12 on page 93.

5.1.12.1. Fault indication

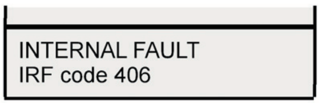
The self-supervision signal output operates on the closed circuit principle. Under normal conditions the output relay is energized and the contact gap 3-5 is closed. Should the auxiliary power supply fail or an internal fault be detected, the contact gap 3-5 is opened.



IRFoutput_b

Fig. 5.1.12.1.-1 Self-supervision output (IRF)

When a fault has been detected, the green Ready indicator starts blinking, a fault indication text is displayed on the HMI and an event 0/E57 is generated. The fault indication text on the HMI consists of two rows: a general message 'internal fault', followed by the generated IRF code of the fault as shown below:



irf

Fault indication has the highest priority on the HMI and can not be overrun by any other HMI indication. The fault indication text is displayed until cleared by pressing the C button for 2 seconds. Then the green READY indicator still remains blinking.

5.1.12.2. Fault operation

When entering IRF state the relay will take the following actions to ensure that a false trip can not be caused by the fault:

- All relay outputs will be forced to zero (released), and subsequent changes blocked.
- All virtual outputs (COMM_OUT1...32) will be written to zero, and subsequent changes blocked.
- The analog outputs will freeze at the current value.
- Event transmission will be blocked, except for IRF events E56/E57 and startup event E50.

5.1.12.3. Fault recovery

The relay will try to recover from a fault either by restarting the module (I/O module or HMI) that reported the fault, or by restarting the whole relay. During restarting the IRF state will remain active until the internal self supervision program has determined that the relay is operating normally. If the fault is still persistent after restarting three times, the relay will be in permanent IRF state.

When returning to normal operation, the indication text will be replaced by this text: ‘internal fault *CLEARED*’, and the green READY indicator will return to steady state. In addition, an event 0/E56 is generated over the serial communication.

5.1.12.4. Fault codes

When an internal fault appears in RET 54_, the self-supervision system generates an IRF code that indicates the type of the fault. The fault code can be read from the transformer terminal main menu `Status/General/IRF code`. The fault code is also delivered as event data with the IRF event if LON communication is in use. The code indicates the first internal fault detected by the self-supervision system. The fault code can be read from the menu even though the relay has returned to normal operation.

Do not reset the transformer terminal before reading the IRF code. The code should be noted when overhaul is ordered. In case of a repeating IRF, send the relay to the manufacturer.

The following table gives an overview of the fault origin.

Codes	Explanation
0 ->	Faults related to a module of the transformer terminal, e.g. the MIMIC card, BIO/PS cards and RTD/analog module
3000 ->	Faults related to the parameter database
6000 ->	Faults related to the analog measurement inputs
7000 ->	Software faults
15000 ->	Faults related to testing

5.1.13. Serial communication

The transformer terminal has three serial communication ports, one on the front panel and two on the rear panel.

5.1.13.1. Serial communication port assignment

The bus communication protocol for the rear interface RS-232 (connector X3.2) is selected via the “Protocol 2” setting parameter and the bus communication protocol for the rear interface RS-485 (connector X3.3) is selected via the “Protocol 3” setting parameter. These parameters can be modified by using the local menu (`Communication/General`) or by using the Relay Setting Tool.

The following table shows supported parallel communication protocols on the front and the rear connectors of the RET 54_ transformer terminals.

Connectors/Communication parameters		
X3.2/Protocol 2	**X3.3/Protocol 3**	**Front connector**
SPA (SMS)	LON	SPA
SPA (SMS)	SPA	-
IEC_103	LON (SMS)	SPA
IEC_103	SPA (SMS)	-
IEC_103	-	SPA
DNP 3.0	LON (SMS)	SPA
DNP 3.0	SPA (SMS)	-
DNP 3.0	-	SPA
Modbus	LON (SMS)	SPA
Modbus	SPA (SMS)	-
Modbus	-	SPA
-	SPA	SPA

5.1.13.2. SPA/IEC_103 communication on the rear connector X3.2

The 9-pin D-type subminiature male connector (RS-232 connection) on the rear panel connects the transformer terminal to the distribution automation system via the SPA bus or the IEC_103. The fibre-optic interface module type RER 123 is used for connecting the transformer terminal to the fibre-optic communication bus for SPA and IEC_103 protocol.

5.1.13.3. DNP 3.0/Modbus communication on the rear connector X3.2

The 9-pin D-type subminiature male connector (RS-232 connection) on the rear panel connects the transformer terminal to the distribution automation system via the DNP 3.0 or the Modbus protocol. The RS-485 interface module type RER 133 is used for connecting the transformer terminal to the RS-485 communication bus of these protocols.

5.1.13.4. LON/SPA bus communication on the rear connector X3.3

The 9-pin D-type subminiature connector (RS-485 connection) on the rear panel connects the transformer terminal to the distribution automation system via the SPA bus or the LON bus. The fibre-optic interface module type RER 103 is used to connect the transformer terminal to the fibre-optic communication bus. The module RER 103 supports both SPA bus and LON bus communication.

The other communication parameters for the rear interface RS-485 are set also via the Communication menu.

5.1.13.5. Front panel optical RS-232 connection for a PC

The optical connector on the front panel isolates the PC galvanically from the transformer terminal. The front connector for the PC is standardized for ABB relay products and requires a specific opto-cable (ABB art. No 1MKC950001-1). The cable is connected to the serial RS-232 port of the PC. The other communication parameters for the rear RS-485 interface are also set in the Communication menu of the RET 54_ transformer terminal.

The front panel is intended for the connection of a PC for configuring the transformer terminal with the CAP 50_ tools. The front interface uses the SPA bus protocol.

5.1.13.6. Communication parameters

SPA

The SPA bus protocol uses an asynchronous serial communication protocol (1 start bit, 7 data bits + even parity, 1 stop bit) with adjustable data transfer rate; Baud rate (default 9.6 kbps) and SPA address (slave number).

The SPA communication parameters are the same for communication via the front optical RS-232 and the rear RS-485 connectors. The SPA address is the same also for transparent SPA communication on the LON.

Parameter	Value	Default	Explanation
SPA address	0...999	1	Slave number for communication
Baud rate	4800; 9600; 19200 bps	9600	Data transfer rate for communication
Rear connection	Connect		Activate rear SPA connection[1)]

1) This functionality is valid only in the transformer terminal revisions of releases prior to the Release 2.0. The parameter is accessible only via serial communication. SPA communication on the front connector inhibits the rear X3.3 SPA communication and the transparent SPA communication on the LON protocol and remains inhibited for one minute after the SPA communication has stopped. It is possible to release this blocking situation by writing the value 1 to the V202 variable.

LON

Adjustable LON serial communication parameters are Subnet number, Node number and Bit rate.

Parameter	Value	Default	Explanation
Subnet number	1...255	1	LON subnet number
Node number	1...127	1	LON node number
Bit rate	78.1; 1250 kbps	1250	LON communication speed

The bit rate 1250 kbps on the LON protocol is used for the optical serial communication network using the RER 103 module connected to the X3.3 connector.

IEC_103

Adjustable IEC_103 serial communication parameters are shown in the table below.

Parameter	Value	Default	Explanation
Unit address	1...254	1	IEC_103 station address
Baud rate	9600, 19200	9600	Communication speed
Function type	0...255	160 or 176 [1)]	Unit function type
Scale factor	1.2 or 2.4	1.2	Analog value scale factor
Frame type	0...17 [2)]	0	Measurement frame type
RTD data frame	0 or 1 [2)]	0	If RTD data frame is on, it is sent to class 2 data poll every second.

1) In REF 54_ and REM 54_: 160 = Overcurrent protection, in RET 54: 176 = Transformer differential protection
2) Refer to Table 9.7.-1

The IEC_103 protocol is used for the optical serial communication network using the RER 123 module connected to the X3.2 connector.

The unit address is used for identifying the device from the protocol point of view.

For more information, see Table 5.2.1-11 on page 93.

DNP 3.0

Adjustable DNP 3.0 serial communication parameters are shown in the table below.

Parameter name	Values	Default	Explanation
Unit address	0...65532	1	Address of the RET 54_ in the DNP 3.0 network. Must be the same as configured in the master station.
Master address	0...65532	2	Address of the master station (destination address for unsolicited responses). Must be the same as configured in the master station.
Primary data link timeout	100...10000 [ms] [1)]	300	This timeout is used when RET 54_ sends data using service 3 (user data with confirmation). The timeout must be set according to communication speed.
Primary data link layer retransmission count	0...100	0	Number of retransmissions on data link layer when RET 54_ sends spontaneous data.
Application layer timeout	1000...10000 [ms] [1)]	1000	This timeout is used when RET 54_ sends messages with confirmation request. The timeout must be set according to communication speed.
Application layer retransmission count	0...100	0	Number of retransmissions on the application layer when RET 54_ sends messages with confirmation request.
Confirmation on data link layer	0...1 [0=disabled; 1=enabled]	0	Enable/disable confirmations on data link layer.
Confirmation on application layer	0...1 [0=disabled; 1=enabled]	0	Enable/disable confirmations on application layer.
Default variation of binary input object	1...2	2	

Default variation of binary input change event object	1...3	2	
Default variation of binary output object	1...2	2	
Default variation of counter object	1...2	1	
Default variation of counter event object	1...2	1	
Default variation of analog input object	1...2	1	
Default variation of analog input event object	1...2	1	
Default variation of analog output status object	1...2	1	
Class 1 event delay	0...1000 [s]	1	Delay for spontaneous event reporting for class 1
Class 1 event. count	1...32	1	Event count for spontaneous event reporting for class 1
Class 2 event delay	0...1000 [s]	1	Delay for spontaneous event reporting for class 2
Class 2 event count	1...32	1	Event count for spontaneous event reporting for class 2
Class 3 event delay	0...1000 [s]	1	Delay for spontaneous event reporting for class 3
Class 3 event count	1...32	1	Event count for spontaneous event reporting for class 3
Unsolicited reporting mode 2)	0...3 [0=unsolicited responses are disabled; 1=send messages immediately; 2 =first send empty UR and wait for confirmation, then send data filled URs; 3=first send empty UR and wait for confirmation, wait for enable UR from master and then send data filled URs]	0	Unsolicited messages reporting behavior
Time synchronization mode	0...2 [0=Never; 1=Periodic; 2=Startup]	2	See DNP 3.0 Remote Communication Protocol for RET 54_ manual (1MRS755260).
Baud rate	0...6 [0=300; 1=600; 2=1200; 3=2400; 4=4800; 5=9600; 6=19200]	5	Communication speed of DNP protocol
Number of stop bits	1...2	1	
Next character timeout	0...65535 [ms] 1)	0	
End of frame timeout	2....65535 [ms] 1)	10	

Parity	0...2 [0=None; 1=Odd; 2=Even]	0	
Silent interval	10...65535 [ms]	20	Collision detection 3)
Time slot width	10...65535 [ms]	10	Collision detection 3)
Number of time slots	1...255	8	Collision detection 3))
Collision detection enabled	0...1 [0=Disabled; 1=Enabled]	0	Collision detection 3)
Protocol mapping diagnostic parameter			DNP protocol mapping file
Protocol mapping diagnostic parameter			Total entries counter
Protocol mapping diagnostic parameter			Number of entries not in use
Protocol mapping diagnostic parameter			Number of entries with invalid, uncorrectable contents (INV)
Protocol mapping diagnostic parameter			Number of entries with corrected contents (COR)
Protocol mapping diagnostic parameter			Number of entries referring to nonexistent block (NBL)
Protocol mapping diagnostic parameter			Number of entries referring to invalid objects from existing block (NOB)
Protocol mapping diagnostic parameter			Number of entries translated into protocol mapping
Protocol mapping diagnostic parameter			Protocol mapping name
Collision counter	0...65535	0	Collision detection3)
Frame error counter	0...65535	0	
Parity error counter	0...65535	0	
Overrun error counter	0...65535	0	

1) When using communication speeds below 1200 bits/s, be sure to set the values for parameters to values above the time it takes for one character to be sent. Note that if the values are not correctly set, the sent messages will be lost.
2) If parameter F503V024, Unsolicited reporting mode, is set to “0”, RET 54_ responds to an Enable Unsolicited Reporting request with the Internal indication IIN2.0 (Function Code Not Supported) bit set.
3) For more information, refer to DNP 3.0 Communication Protocol Technical Description (see “Related documents” on page 9)

Modbus

The Modbus protocol has two serial transmission modes: ASCII and RTU. These modes define the bit contents of the message fields transmitted in the network. Adjustable Modbus serial communication parameters are shown in the table below.

Parameter name	Values	Default	Explanation
Unit address	1...247	1	Address of the RET 54_ in the Modbus network. Must be same as configured in the master station.
CRC order	0/1 [0=LO/HI, 1=HI/LO]	0	The order of CRC bytes in protocol frame. Not used in ASCII mode
Protocol mode	0/1 [0=ASCII, 1=RTU]	1	Chooses whether the RET 54_ uses ASCII or RTU mode.
Password	ASCII codes	4 space characters	Password for control operations
Protocol mapping diagnostic parameter		0	Total entries counter

Protocol mapping diagnostic parameter		0	Number of entries not in use
Protocol mapping diagnostic parameter		0	Number of entries with invalid, uncorrectable contents (INV)
Protocol mapping diagnostic parameter		0	Number of entries with corrected contents (COR)
Protocol mapping diagnostic parameter		0	Number of entries referring to nonexistent block (NBL)
Protocol mapping diagnostic parameter of NOB entries		0	Number of entries referring to invalid objects from existing block (NOB)
Protocol mapping diagnostic parameter		0	Number of entries translated to operational protocol mapping
Baud rate	0...6 1) 2) [0=300 1=600 2=1200 3=2400 4=4800 5=9600 6=19200]	6	
Number of stop bits	0...2 3)	1	
Next character timeout	0=Not in use, 2...65535 [ms] 1)	1000 (ASCII) 0 (RTU)	
End Of Frame timeout	2....65535 [ms] 2)	1000 (ASCII) 2 (RTU)	
Parity	0...2 3) [0=None 1=Odd 2=Even]	2	
Number of data bits	5...8	7 (ASCII) 8 (RTU)	
Frame error counter	0...65535	0	Frame error counter 4)
Parity error counter	0...65535	0	Parity error counter 4)
Overrun error counter	0...65535	0	Overrun error counter 4)
Protocol mapping diagnostic parameter			Protocol mapping name
Protocol mapping diagnostic parameter			Modbus protocol mapping file

1) The change of Baud rate parameter value forces an automatic update of the Next character timeout parameter value to 1,5 character times. If the timeout value is lower then 2ms then it is disabled (set to 0 - not in use).
2) The change of Baud rate parameter value forces an automatic update of End Of Frame timeout parameter value to 3,5 character times.
3) The change of Parity parameter value forces an automatic update of the number of stop bits to 1, with parity used, and to 2 for parity none.
4) The counters are 16 bit cyclical counters, after reaching 0xFFFF (65535) next increment changes the value back to 0x0000. The default setting is reset to 0 at system start.

5.1.13.7. Parallel communication support

When SPA is used, the rear side communication is not stopped when the front connector is “active”. This enables e.g. uploading the disturbance records without affecting the communication to upper level.

Moreover, if LON is selected as a communication protocol and the front connector is “active”, transparent SPA write commands are not inhibited via the LON bus.

5.1.13.8. System structure

The system very often resembles the system in the figure below. The protection, control or alarm functions are implemented by using RET 54_ transformer terminals, SPACOM units or other SPA bus devices (devices connected to the system via the SPA bus). Generator or motor transformers are protected and controlled with RET 54_ transformer terminals. LON devices made by other manufacturers or other ABB companies may be used for various DI, AI and DO functions. MicroSCADA is used for remote control.

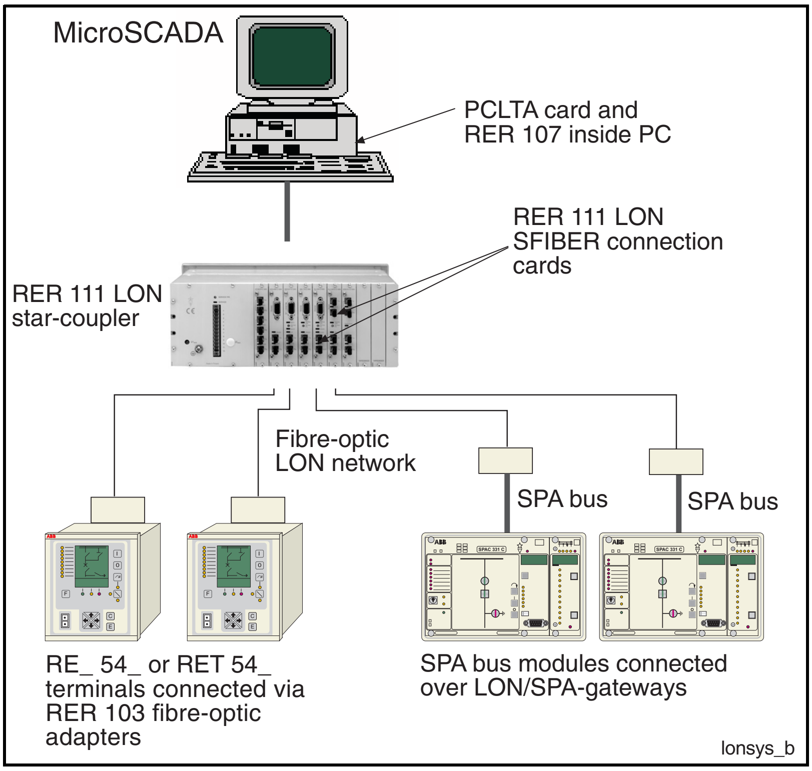


Fig. 5.1.13.8.-1 Example of a LON-based substation automation system

In the system described in the figure above, communication is usually arranged as shown in the table below.

Table 5.1.13.8-1 Communication arrangement example

Data type	RET <-> MicroSCADA	RET and LSG devices to each other
Control commands	transparent SPA bus messages	-
Events and alarms	sliding window protocol	-
State of breakers and isolators	sliding window protocol	network variables
Analog measurement values	sliding window protocol	-
Other DI, AI data	sliding window protocol	network variables
Other DO, AO data	transparent SPA bus messages	network variables
Parameter data	transparent SPA bus messages	-
SPA file transfer data	transparent SPA bus messages	-

Other supported system configurations are represented in the following figures. A LON bus and a parallel “SMS” bus connected as a SPA loop using the interface module RER 123 on connector X3.2, allows to implement the redundant SMS workstation.

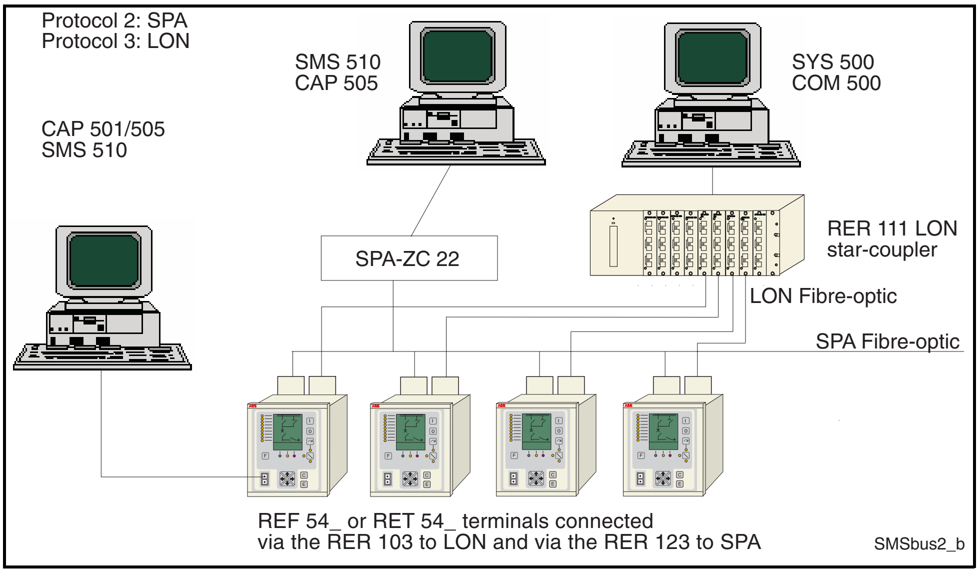


Fig. 5.1.13.8.-2 LON- and SPA-based substation automation system

The RET 54_ transformer terminals connected with the IEC_103 to the IEC_103 master device using RER 123 on connector X3.2.

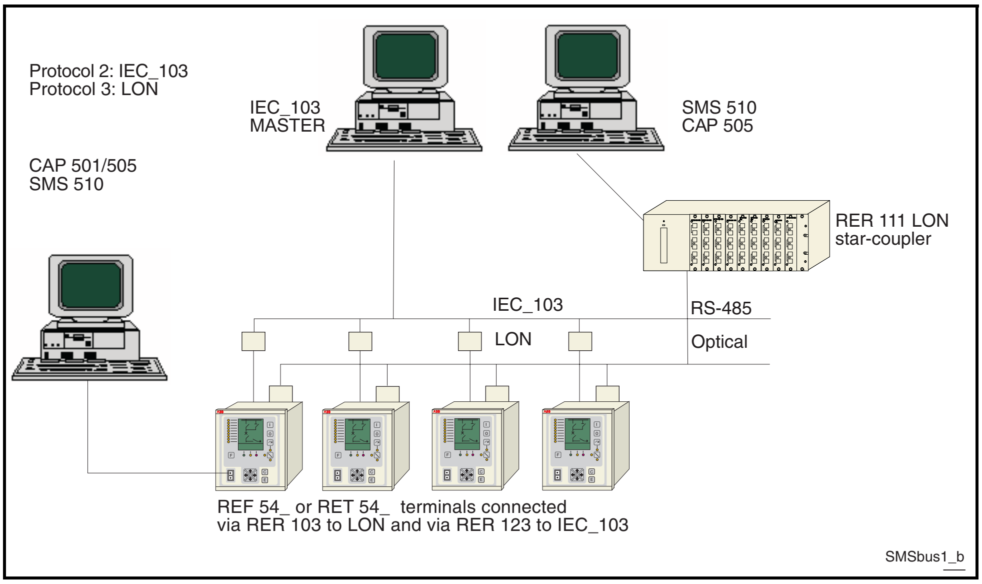


Fig. 5.1.13.8.-3 IEC_103- and LON-based substation automation system

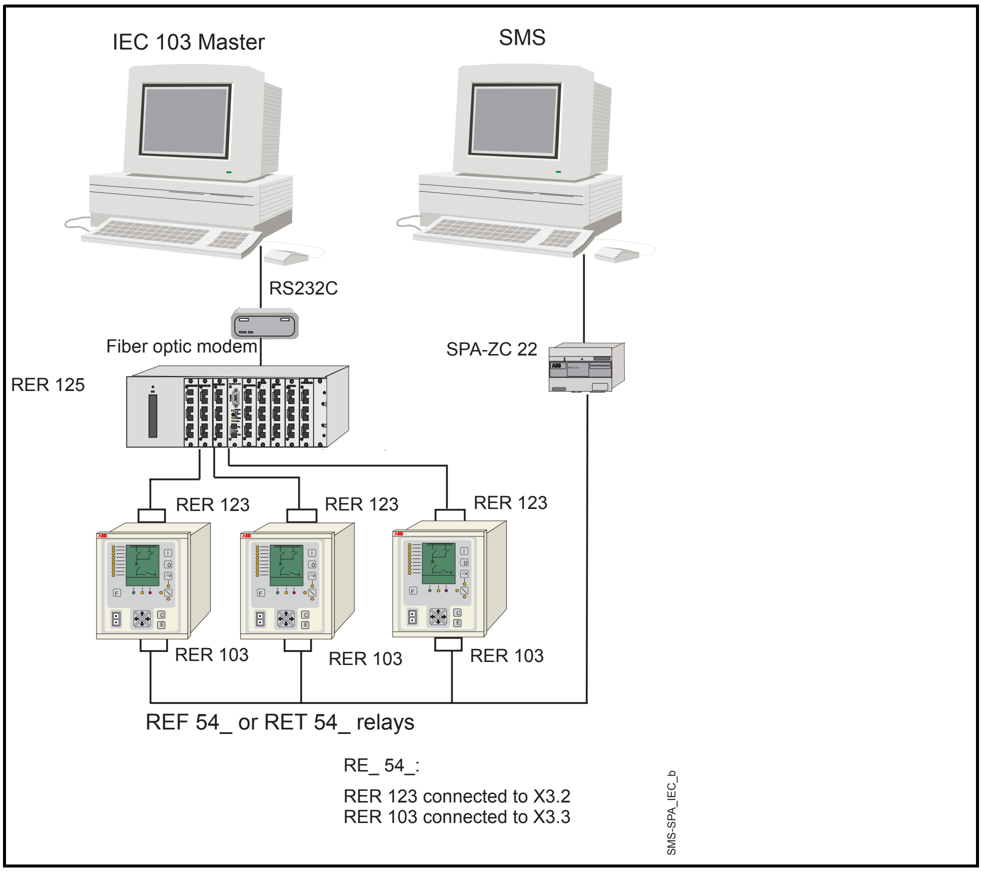


Fig. 5.1.13.8.-4 IEC_103- and SPA-based substation automation system

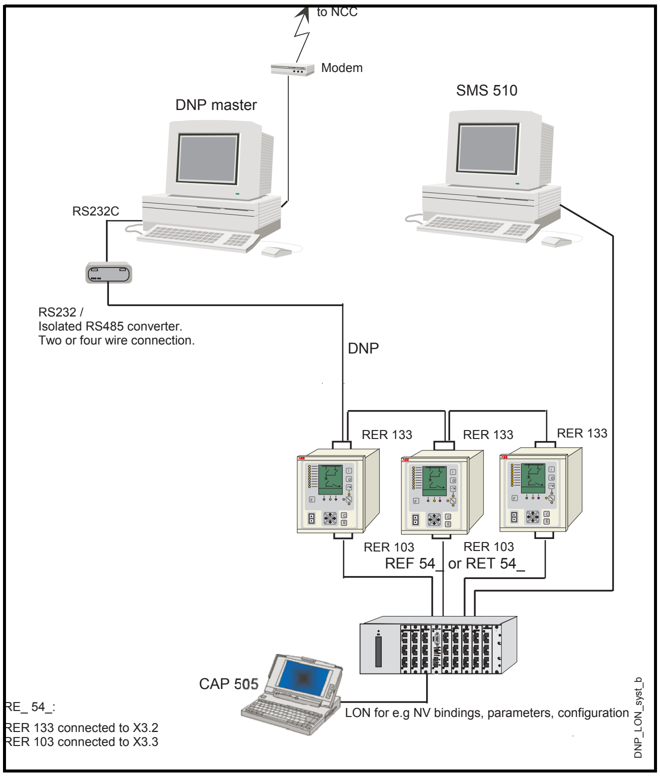


Fig. 5.1.13.8.-5 DNP 3.0- and LON-based substation automation system

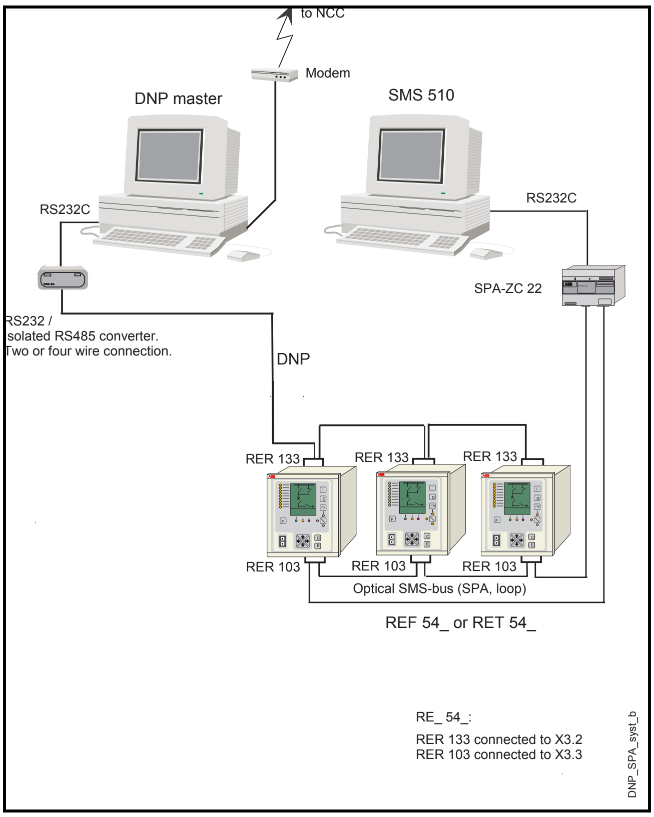


Fig. 5.1.13.8.-6 DNP 3.0- and SPA-based substation automation system

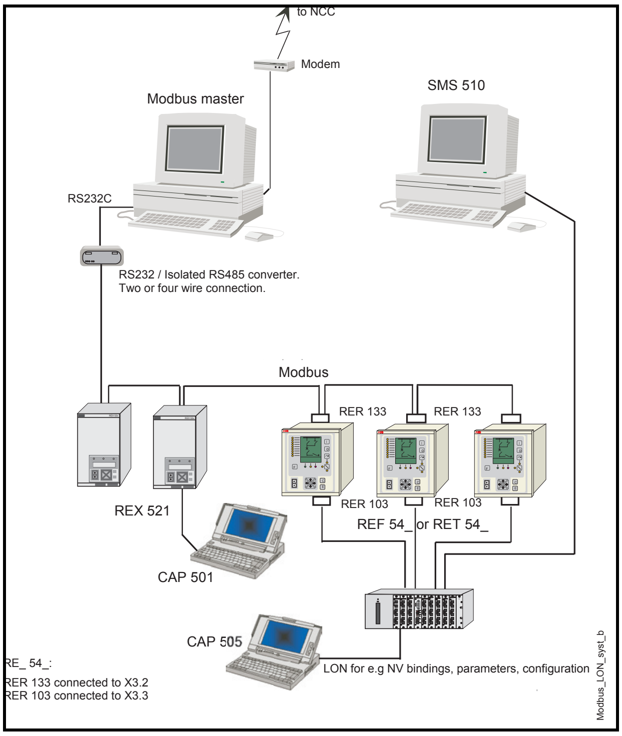


Fig. 5.1.13.8.-7 Modbus- and LON-based substation automation system

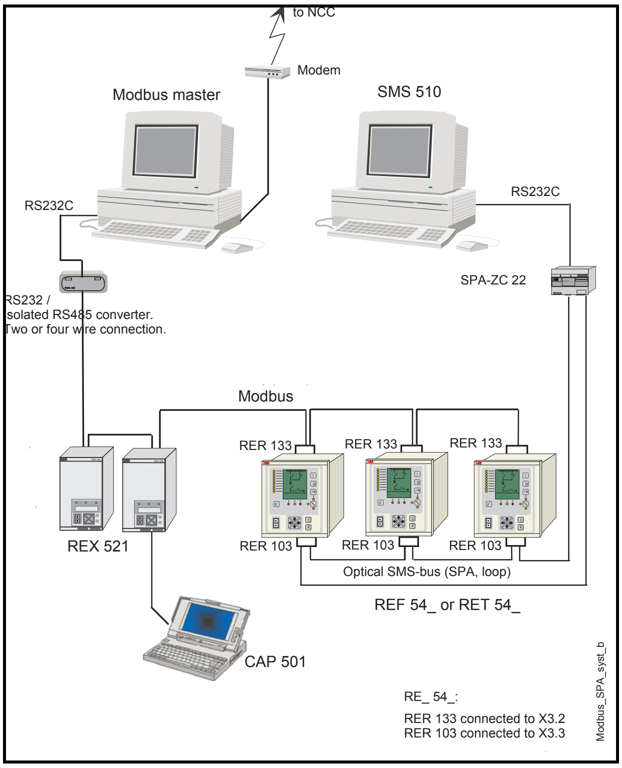


Fig. 5.1.13.8.-8 Modbus- and SPA-based substation automation system

5.1.13.9. LON inputs and outputs via a LON bus

The RET 54_ transformer terminal offers up to 32 freely programmable LON inputs and outputs on the LON bus. The inputs and outputs use the LonMark Standard network variable (NV type 83 = SNVT_state) for sending and receiving process data. The LON inputs and outputs are accessible in the transformer terminal configuration and can be freely used for different types of data transfer between RET 54_ transformer terminals and other devices that are able to communicate using the network variable of type SNVT_state.

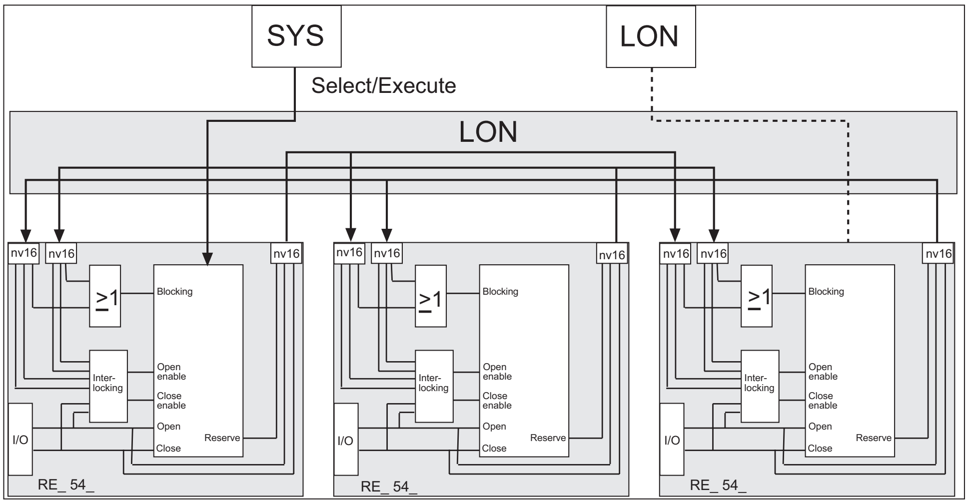


Fig. 5.1.13.9.-1 Principle of connecting LON inputs and outputs to logic functions of the transformer terminal

Each SNVT_state network variable can be used to communicate either an integer value in the range of 0-65535 or up to 16 Boolean values as a binary coded number. The type conversion function BOOL2INT is useful for packing and INT2BOOL for unpacking the binary coded variables. Each bit indicates the state of the Boolean value with, for example, the following interpretations:

0	1
off	on
inactive	active
disabled	enabled
low	high
false	true
normal	alarm

The communication inputs and outputs are seen in the relay configuration tool as global variables:

category	name	datatype	purpose
communication inputs (sinks)	COMM_INx COMM_INxIV	UINT BOOL	input value input invalidity flag, FALSE indicates a valid state
communication outputs (sources)	COMM_OUTx	UINT	output value

where x is a number from 1 to 32. Similar names are used in the LON Network Tool.

The basic operation principle is that every time the output value is changed by the configuration, the new value is propagated automatically over the LON network to all communication inputs that are bound to the output. The network variable connection can be from a single source to one or many sinks. An output can also be unbound, i.e. it is not transmitted to LON network at all. Also an input can be unbound, i.e. no updates will be accepted to this input.

Communication inputs acts as holding registers, they preserve the last received value until next update is received. When a relay has been started, initially all inputs will be zero and all invalidity flags will be TRUE. If an input is bound, the first network variable update received will update the input and the corresponding invalidity flag will be set to FALSE.

If the network variable connection is created using NV poll support, then the receiving device can query the value from the sending device. This occurs at relay startup and when open/close control of an object (for example COCB1) is selected or executed. An input invalidity flag indicates the status of the poll. When the poll is initiated, all input invalidity flags (with NV poll support) are set to TRUE. After each successful NV poll the corresponding invalidity flag is set to FALSE. After all polls are complete, the control command is allowed to be completed.

Communication outputs are prioritized by the number of the output. If multiple output values need to be transmitted at the same time, the output with the lowest number will be sent first. The relay configurations should be designed so that the most time critical and least often changed signals are assigned to outputs with the lowest numbers.

Communication outputs shall not change too frequently, otherwise outputs with a low priority may not be sent to the network at all, or the updates may be delayed. The maximum transmission rate is 50 updates per second for all communication outputs together. If the limit is exceeded, loss of data will occur. The system is however designed to always send the latest value when there is communication bandwidth available. It may be necessary to use a data latch with timer mechanism in the relay configuration to limit the update rate of an output.

Network variable connections are not supervised by the relay system software. For example, a broken fibre will not be detected by the relay.

For further information about horizontal communication, refer to the Protection & Control Terminals REF 54_, RET 54_, REM 54_, REC 523 Configuration Guideline .

5.1.13.10. Secured object control

Secured object control refers to the two-step select-execute process in order to execute open and close commands for controllable switching devices of the switchgear. Which communication protocol, SPA or LON, is used to transfer the remote select-execute commands affects the flow of actions in secured object control. It is the command time-out parameter (F001V019) that determines which scheme is used for secured object control.

In case of SPA communication, the command time-out parameter has to be shorter than 1.5 sec. The default is 0.5 seconds. Also when parallel communication is used, where LON is used for horizontal communication and SPA for control commands, the command time-out parameter has to be shorter than 1.5 sec.

In case of LON communication, the command time-out parameter has to be longer than or equal to 1.5 sec. A longer time-out is needed because the time for horizontal communication to take place needs to be taken into account.

Normally the time-out parameter of the client must always be adjusted in accordance with the IED command time-out parameter (longer time-out on the client side). At all times there shall be only one communication port from which secured object control is possible.

The command time-out parameter is located in `MAIN MENU/Communication/General`.

For more information about secured object control refer to the control function block manuals.

Setting the command time-out parameter for LON communication

The correct command time-out parameter value depends on how many LON communication inputs are in use (COMM_INx variables). If no horizontal communication is used, 1.5 seconds shall be used as time-out.

In order to take full advantage of the secured command handling procedure, the complete scenario must be known.

There are two scenarios:

1. Confirmed command handling with NV poll support: NV poll selected by the LNT tool.
2. Command handling with asynchronous blockings.

Confirmed command handling with NV poll support

If LON NV polling is used for communication inputs, the time-out must be based on the minimum time-out, and is calculated from:

amount_of_polled_inputs*poll_timeout*(retries+1)

which gives a typical minimum value of:

amount_of_polled_inputs*128ms...256ms*5

(see the LN settings and refer to the instructions given for default time-outs).

An over dimensioned longer time-out will not cause any harm, because the operation will always be faster in real life than the maximum time-out.

On application side, the comm_in and comm_outs need to be used systematically to ensure that exceptions to the normal operation are handled correctly (e.g. handling of the live bits).

Command handling with asynchronous blockings

Figure 4.1.13.8-1 shows the asynchronous blocking principle of sending the reserve-output state to the block-inputs of other bays. As horizontal communication is trusted directly, 1.5 seconds shall be used as command time-out.

For more information about asynchronous blockings refer to the horizontal communication engineering tip in the Protection & Control Terminals REF 54_, RET 54_, REM 54_, REC 523 Configuration Guideline .

5.1.14. Time synchronization

The internal clock of the RET54_ relay unit can be set from different sources:

1. The time can always be given manually from the front panel (`Configuration\General\Date`, `Configuration\General\Time`).

2. The time synchronization can also be set externally, either by a communication protocol or by a binary input. The parameter (`Configuration\General\Timesync source`) is used for selecting the source for external synchronization. The parameter has two states `Comm. channel` (default) and `Input X5.2/1,2`.

When `Comm. channel` is selected, the system clock is adjusted according to time synchronization messages from any of the supported communication protocols. When parallel communication is used, the user has to make sure that synchronization messages are received from only one communication channel.

When `Input X5.2/1,2` is selected, the relay expects a pulse train on the X5.2/1,2 binary input with a period of either one minute or one second. The system clock will be round to the nearest whole second or minute, depending on the period of the pulse train, on the rising edge of the input. If synchronization on falling edge is desired, the input can be inverted by setting the parameter `Configuration\BIO1 [5]\Input inversion\Input 12 invert` to `Enabled`. If time synchronization messages are also received from a communication protocol, they are accepted, but only the year-month-day-hour-minute-second part is written to the internal clock. Therefore a communication protocol such as SPA can be used to set the internal clock with a coarse time and simultaneously the binary input is used to fine-tune the accuracy.

Note that the clock of the protocol master and the pulse train on the binary input must be synchronized, with a deviation always less than 500 ms, otherwise the internal clock of the relay will make sudden one second jumps in either direction.

5.1.15. Display panel (HMI)

The transformer terminal is provided with either a fixed display or an external display module. The external display module requires a separate voltage supply from a common source with the main unit (refer to Section “Auxiliary voltage” on page 36). For more information about the rated input voltages, refer to Table 5.2.1-2 on page 90. A special cable (1MRS120511.001) delivered with the transformer terminal is needed for communication between the terminal and the external display panel. This standard cable is 1 meter in length. The cable is also available in an optional 3 meter version. (Ordering number 1MRS120511.003)

- Graphical LCD display, with the resolution 128 x 160 pixels, consisting of 19 rows divided into two windows
- main window (17 rows) providing detailed information on MIMIC, objects, events, measurements, control alarms and parameters of the terminal
- assisting window (2 rows) for terminal-dependent protection indications and alarms, and for general help messages
- three push-buttons for object control
- eight freely programmable alarm LEDs with different colors and modes according to the configuration (off, green, yellow, red, steady, blinking)

- LED indicator for control test and interlocking
- three protection LED indicators
- HMI push-button section with four arrow buttons and buttons for clear [C] and enter [E]
- optically isolated serial communication port
- backlight and contrast control
- freely programmable button [F]
- button for remote/local control (Control and position button [R\L])

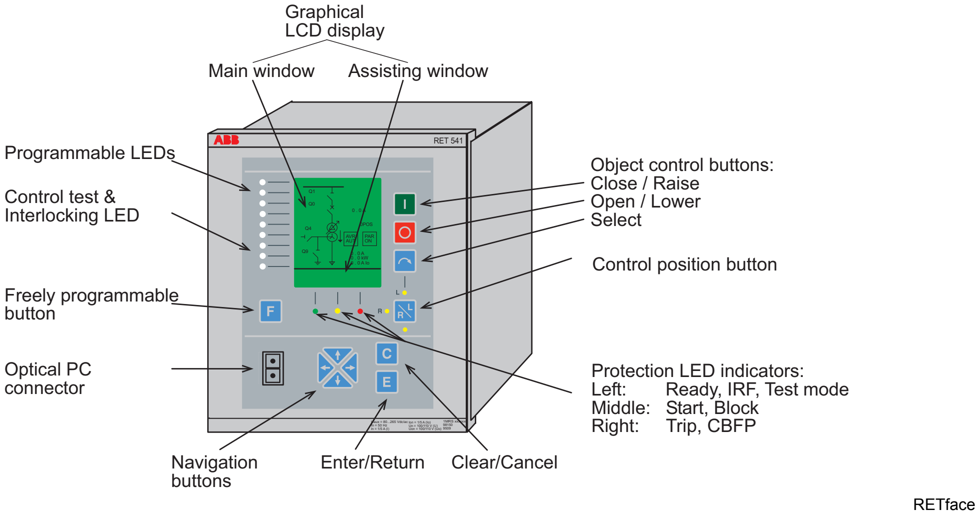


Fig. 5.1.15.-1 Front view of the RET 54_ transformer terminal

The HMI has two main levels, the user level and the technical level. The user level is for “everyday” measurements and monitoring whereas the technical level is intended for advanced transformer terminal programming.

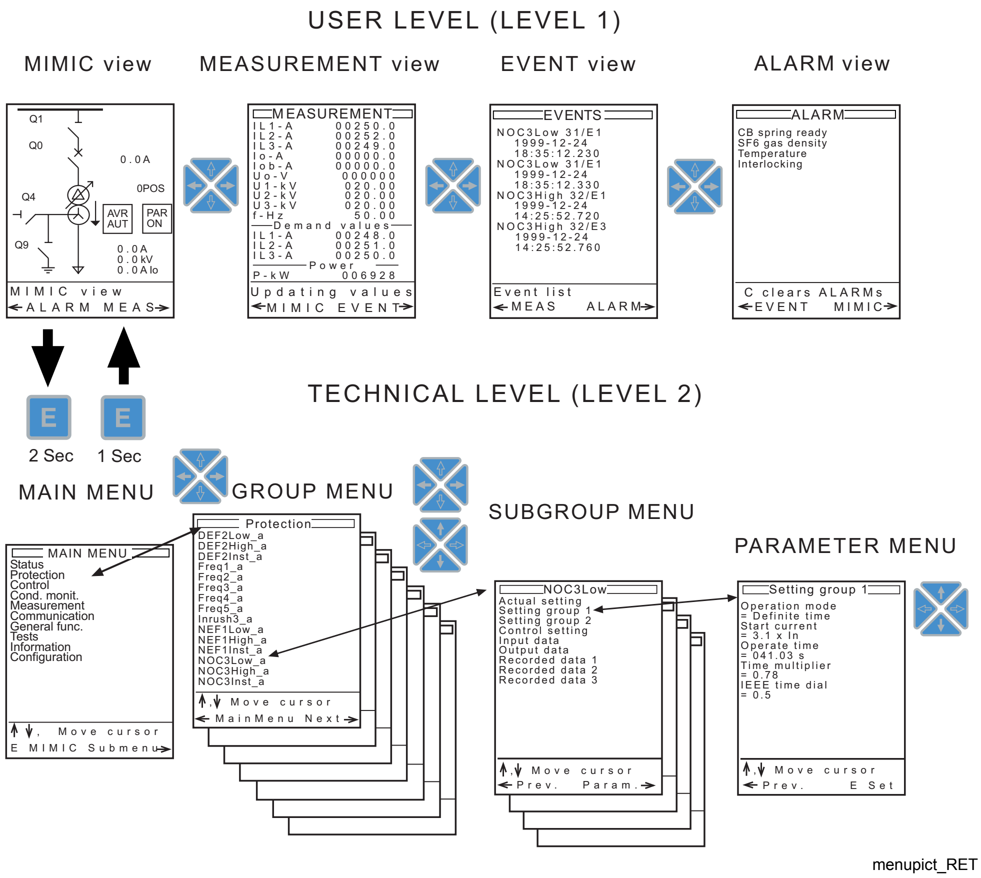


Fig. 5.1.15.-2 Menu level structure

For more detailed information about the HMI, refer to the RE_ 54_ Operator's Manual (see"Related documents" on page 9).

5.1.16. Alarm LED indicators

The RET 54_ transformer terminal offers eight alarm LED indicators to be configured with the Relay Mimic Editor. The LED colors are green, yellow or red, and their use can be freely defined (for defining the ON and OFF state texts, refer to Section "MIMIC configuration" on page 32). Three basic operation modes are supported:

- Non-latched light
- latched-steady light
- latched blinking light

Alarms can be acknowledged remotely, locally or by using logic.

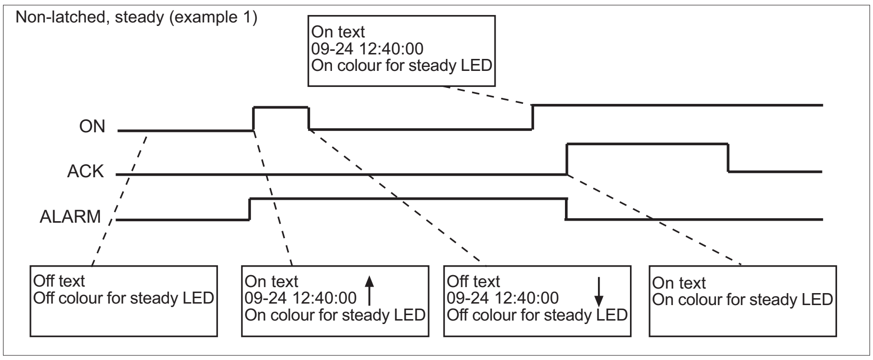
The alarm channels include time tagging for detected alarms. The time tagging principle used depends on the operation mode.

The alarm channels are seen as function blocks in the transformer terminal configuration:

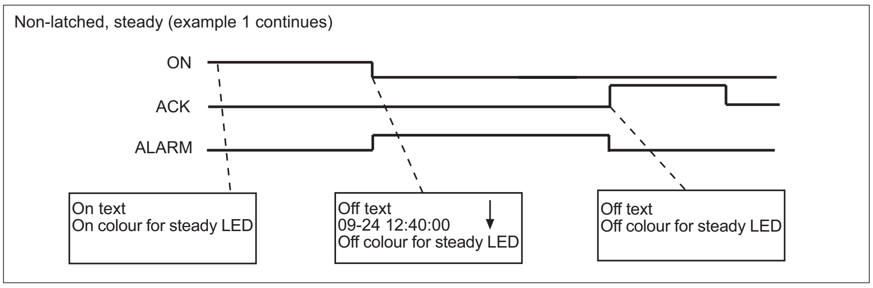
Alarm channel	Function block
Alarm channel 1	MMIALARM1
Alarm channel 2	MMIALARM2
Alarm channel 3	MMIALARM3
Alarm channel 4	MMIALARM4
Alarm channel 5	MMIALARM5
Alarm channel 6	MMIALARM6
Alarm channel 7	MMIALARM7
Alarm channel 8	MMIALARM8

5.1.16.1. Non-latched alarm

In a non-latched mode, the ON signal switches between ON and OFF state texts and the corresponding LED colors. Alarm acknowledgement (ACK) clears the last time stamp line of the alarm view, but leaves the corresponding alarm LED state unchanged. An event is generated on the rising and falling edge of the ON signal and by acknowledgement.



Alarind4_b



Alarind5_b

Fig. 5.1.16.1.-1 Example of a non-latched alarm

5.1.16.2. Latched alarm, steady LED

Latched, steady alarms can be acknowledged only when the ON signal is inactive. The time stamp of the first alarm is recorded. Successful acknowledgement clears the time stamp line of the alarm view and the corresponding alarm LED. An event is generated on the rising and falling edge of the ON signal and by acknowledgement.

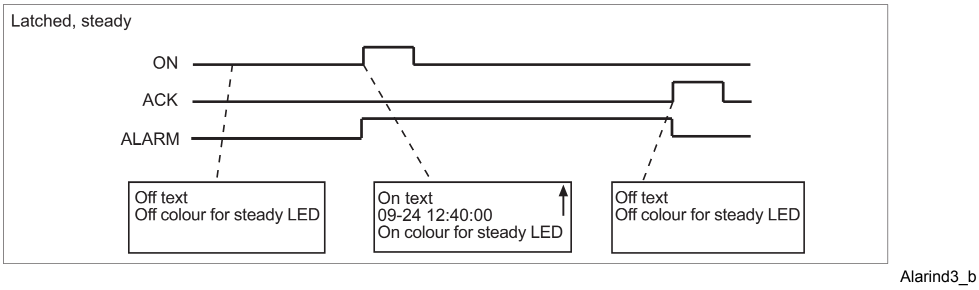


Fig. 5.1.16.2.-1 Example of a latched alarm with steady LED

5.1.16.3. Latched alarm, blinking LEDs

Latched, blinking alarms can be acknowledged after the rising edge of the ON signal. The time stamp of the first alarm is recorded. If the ON signal is inactive, acknowledgement clears the time stamp line of the alarm view and the corresponding alarm LED. However, if the ON signal is active during acknowledgement, the alarm LED mode turns stable and the time stamp is cleared. Later, when the ON signal is deactivated, the alarm LED color will automatically change to OFF color. An event is generated on the rising and falling edge of the ON signal and by acknowledgement. The visual indication, including resetting, of this alarm mode complies with the ISA-A standard.

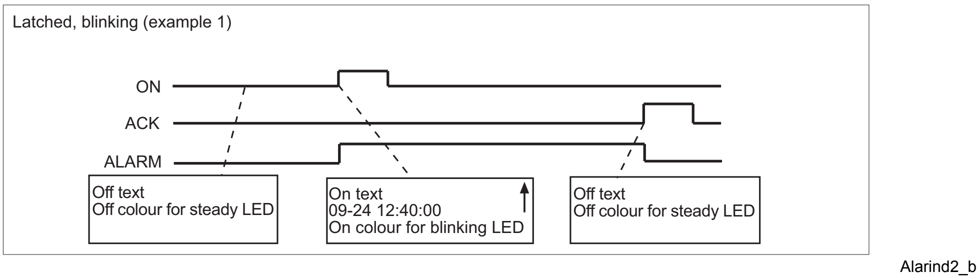


Fig. 5.1.16.3.-1 Example 1 of a latched alarm with blinking LEDs

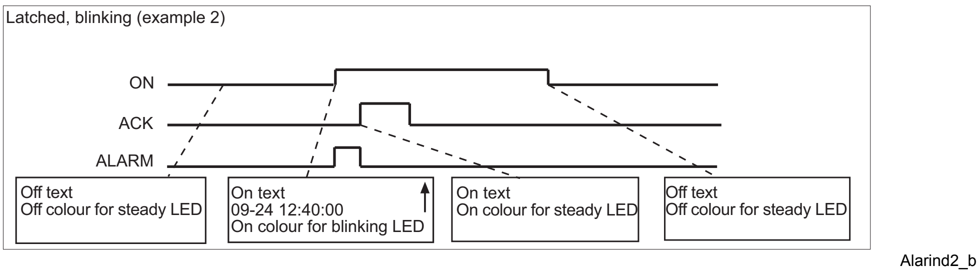


Fig. 5.1.16.3.-2 Example 2 of a latched alarm with blinking LEDs

5.1.16.4. Interlocking

The interlocking LED text can be defined in the same manner as for the other alarm channels. The color of the interlocking LED is yellow and cannot be changed. The normal LED state is inactive (no light). Furthermore, the interlocking LED has two special modes. The first mode, recognized by a steady yellow light, indicates that control operation has been interlocked. The second mode, recognized by a blinking red light, indicates that the interlocking is in bypass mode (control test mode).

General control test mode

The system provides a general interlocking bypass mode (`Main menu/Control/Interl bypass`) that overrides all interlocking signals. Activation of the interlocking bypass mode activates the interlocking enable signals of all control objects. Thus, all local control actions are possible and the enable signals (OPENENA, CLOSEENA) of controllable objects are not checked while the objects are commanded. As long as the mode is active, the interlocking LED on the HMI is blinking red. Additionally, the assisting window of the display will indicate the special condition.

5.2. Design description

5.2.1. Technical data

Table 5.2.1-1 Energizing inputs

Rated frequency		50.0/60.0 Hz	
Current inputs	rated current		0.2 A/1 A/5 A
	thermal withstand capability	continuously	1.5 A/4 A/20 A
		for 1 s	20 A/100 A/500 A
	dynamic current withstand, half-wave value		50 A/250 A/1250 A
	input impedance		<750 mΩ/<100mΩ/ <20 mΩ
Voltage inputs	rated voltage		100 V/110 V/115 V/120 V (parameterization)
	voltage withstand, continuous		2 x U_n (240 V)
	burden at rated voltage		<0.5 VA

Table 5.2.1-2 Auxiliary power supplies

Type	PS1/240V (RET 541, RET 543)	PS2/240V (RET 545 only)	External display module	PS1/48V (RET 541, RET 543)	PS2/48V (RET 545 only)
Input voltage, AC	110/120/220/240 V			-	
Input voltage, DC	110/125/220 V			24/48/60 V	
Voltage variation	AC 85…110%, DC 80…120% of rated value			DC 80…120% of rated value	
Burden	<50 W				
Ripple in DC auxiliary voltage	max. 12% of rated DC value (IEC 60255-11)				
Interruption time in auxiliary DC voltage without resetting	<40 ms, 110 V and <100 ms, 200 V			<60 ms, 48 V and <100 ms, 60 V	
Internal overtemperature indication	+78°C (+75…+83°C)				

Table 5.2.1-3 Digital inputs

Power supply version	PS1/240 V (High)	PS1/240 V (Medium), PS2/240 V	PS1/48 V (Low), PS2/48 V
Input voltage, DC	220 V	110/125/220 V	24/48/60/110/125/220 V
Activating range, DC	155...265 V	80...265 V	18…265 V
Current drain	~2…25 mA		
Power consumption/input	<0.8 W		
Pulse counting (specific digital inputs), frequency range	0...100 Hz		

Table 5.2.1-4 RTD/analog inputs

Supported RTD sensors	100 Ω Platinum	TCR 0.00385 (DIN 43760)
	250 Ω Platinum	TCR 0.00385
	1000 Ω Platinum	TCR 0.00385
	100 Ω Nickel	TCR 0.00618 (DIN 43760)
	120 Ω Nickel	TCR 0.00618
	250 Ω Nickel	TCR 0.00618
	1000 Ω Nickel	TCR 0.00618
	10 Ω Copper	TCR 0.00427
	120 Ω Nickel	TCR 0.00672 (MIL-T-24388C)
Max lead resistance (three-wire measurement)	200 Ω per lead	
Accuracy	± 0.5% of full scale ± 1.0% of full scale for 10 Ω Copper RTD	
Isolation	2 kV (inputs to outputs and inputs to protective earth)	
Sampling frequency	5 Hz	
Response time	≤ Filter time + 30 ms (430 ms...5.03 s)	
RTD / Resistance sensing current	max 4.2 mA RMS 6.2 mA RMS for 10 Ω Copper	
Current input impedance	274 Ω ± 0.1%	

Table 5.2.1-5 Signal outputs

Max system voltage	250 V AC/DC
Continuous carry	5 A
Make and carry for 0.5 s	10 A
Make and carry for 3 s	8 A
Breaking capacity when control circuit time-constant L/R <40 ms, at 48/110/220 V DC	1 A/0.25 A/0.15 A

Table 5.2.1-6 Power outputs

Max system voltage		250 V AC/DC
Continuous carry		5 A
Make and carry for 0.5 s		30 A
Make and carry for 3 s		15 A
Breaking capacity when control circuit time constant L/R <40 ms, at	48 V DC[1)]	5A
	110 V DC[1)]	3A
	220 V DC[1)]	1A
Minimum contact load		100 mA, 24 V AC/DC (2.4 VA)
TCS (Trip Circuit Supervision)	Control voltage range	20…265 V AC/DC
	Current drain through the supervision circuit	approx. 1.5 mA (0.99…1.72 mA)
	Minimum voltage (threshold) over a contact	20 V AC/DC (15…20 V)

1) two contacts in series

Table 5.2.1-7 Analog outputs

Output range	0...20 mA
Accuracy	± 0.5% of full scale
Max load	600 Ω
Isolation	2 kV (output to output, output to inputs and output to protective earth)
Response time	≤ 85 ms

Table 5.2.1-8 Environmental conditions

Specified service temperature range		-10…+55°C
Transport and storage temperature range		-40…+70°C
Enclosure class	front side, flush-mounted	IP 54
	rear side, connection terminals	IP 20
Dry heat test		according to IEC 60068-2-2
Dry cold test		according to IEC 60068-2-1
Damp heat test, cyclic		according to IEC 60068-2-30, r.h. = 95%, T = 25°…55°C
Storage temperature tests		according to IEC 60068-2-48

Table 5.2.1-9 Standard tests

Insulation tests	Dielectric test IEC 60255-5	Test voltage	2 kV, 50 Hz, 1 min.
	Impulse voltage test IEC 60255-5	Test voltage	5 kV, unipolar impulses, waveform 1,2/50 µs, source energy 0.5 J
	Insulation resistance measurements IEC 60255-5	Insulation resistance	> 100 MΩ, 500 V DC
Mechanical tests	Vibration tests (sinusoidal)		IEC 60255-21-1, class I
	Shock and bump test		IEC 60255-21-2, class I
	Seismic test		IEC 60225-21-3, class 2

Table 5.2.1-10 Electromagnetic compatibility tests

The EMC immunity test level fulfils the requirements listed below		
1 MHz burst disturbance test, class III, IEC 60255-22-1	common mode	2.5 kV
	differential mode	1.0 kV
Electrostatic discharge test, class III IEC 61000-4-2, IEC 60255-22-2	for contact discharge	6 kV
	for air discharge	8 kV
Radio frequency interference test	conducted, common mode IEC 61000-4-6, IEC 60255-22-6	10 V (rms), f = 150 kHz…80 MHz
	radiated, amplitude-modulated IEC 61000-4-3	10 V/m (rms), f = 80…1000 MHz
	radiated, pulse-modulated ENV 50204	10 V/m, f = 900 MHz
	radiated, test with a portable transmitter IEC 60255-22-3, method C	f = 77.2 MHz, P = 6 W; f = 172.25 MHz, P = 5 W
Fast transient disturbance test IEC 60255-22-4, IEC 61000-4-4	power supply	4 kV
	I/O ports	2 kV
Surge immunity test IEC 61000-4-5, IEC 60255-22-5	power supply	4 kV, common mode 2 kV, differential mode
	I/O ports	2 kV, common mode 1 kV, differential mode
Power frequency (50 Hz) magnetic field, IEC 61000-4-8	300 A/m	
Voltage dips and short interruptions IEC 61000-4-11	30%, 10 ms 60%, 100 ms 60%, 1000 ms >90%, 5000 ms	
Electromagnetic emission tests EN 55011 and EN 60255-25	conducted RF emission (mains terminal)	EN 55011, class A
	radiated RF emission	EN 55011, class A
CE approval	Complies with the EMC directive 89/336/EEC and the LV directive 73/23/EEC	EN 50263 EN 50081-2 EN 61000-6-2 EN 60255-6

Table 5.2.1-11 Data communication

Rear interface, connector X3.1	not used, reserved for future purposes	
Rear interface, connector X3.2	RS-232 connection	
	the fibre-optic interface module RER 123 for SPA and IEC_103	
	protocol	SPA, IEC_103
	the RS-485 interface module RER 133 for DNP 3.0 and Modbus	
	protocol	DNP 3.0 and Modbus
	data transfer rates	DNP 3.0 and Modbus: 300 bps...19.2 kbps, selectable
Rear interface, connector X3.3	RS-485 connection	
	protocol	SPA, LON
	the fibre-optic interface module RER 103 is needed for galvanic isolation	
	data transfer rates	SPA: 4.8/9.6/19.2 kbps, selectable LON: 78.0 kbps/1.2 Mbps, selectable
Rear interface, connector X3.4	RJ45 connection	
	galvanically isolated RJ45 connection for an external display panel	
	protocol	CAN
	communication cable	1MRS 120511.001 (1 m) 1MRS 120511.003 (3 m)
Front panel	optical connection	
	protocol	SPA
	communication cable	1MKC 9500011
SPA protocol	bit rates	4.8/9.6/19.2 kbps
	start bits	1
	data bits	7
	parity	even
	stop bits	1
LON protocol	bit rates	78.0 kbps/1.2 Mbps
IEC_103 protocol	bit rates	9.6/19.2 kbps
	data bits	8
	parity	even
	stop bits	1
DNP 3.0	bit rates	0.3/0.6/1.2/2.4/4.8/9.6/19.2 kbps
	data bits	8
	stop bits	1, 2
	parity	none, odd, even
Modbus	bit rates	0.3/0.6/1.2/2.4/4.8/9.6/19.2 kbps
	data bits	5, 6, 7, 8
	stop bits	1, 2
	parity	none, odd, even

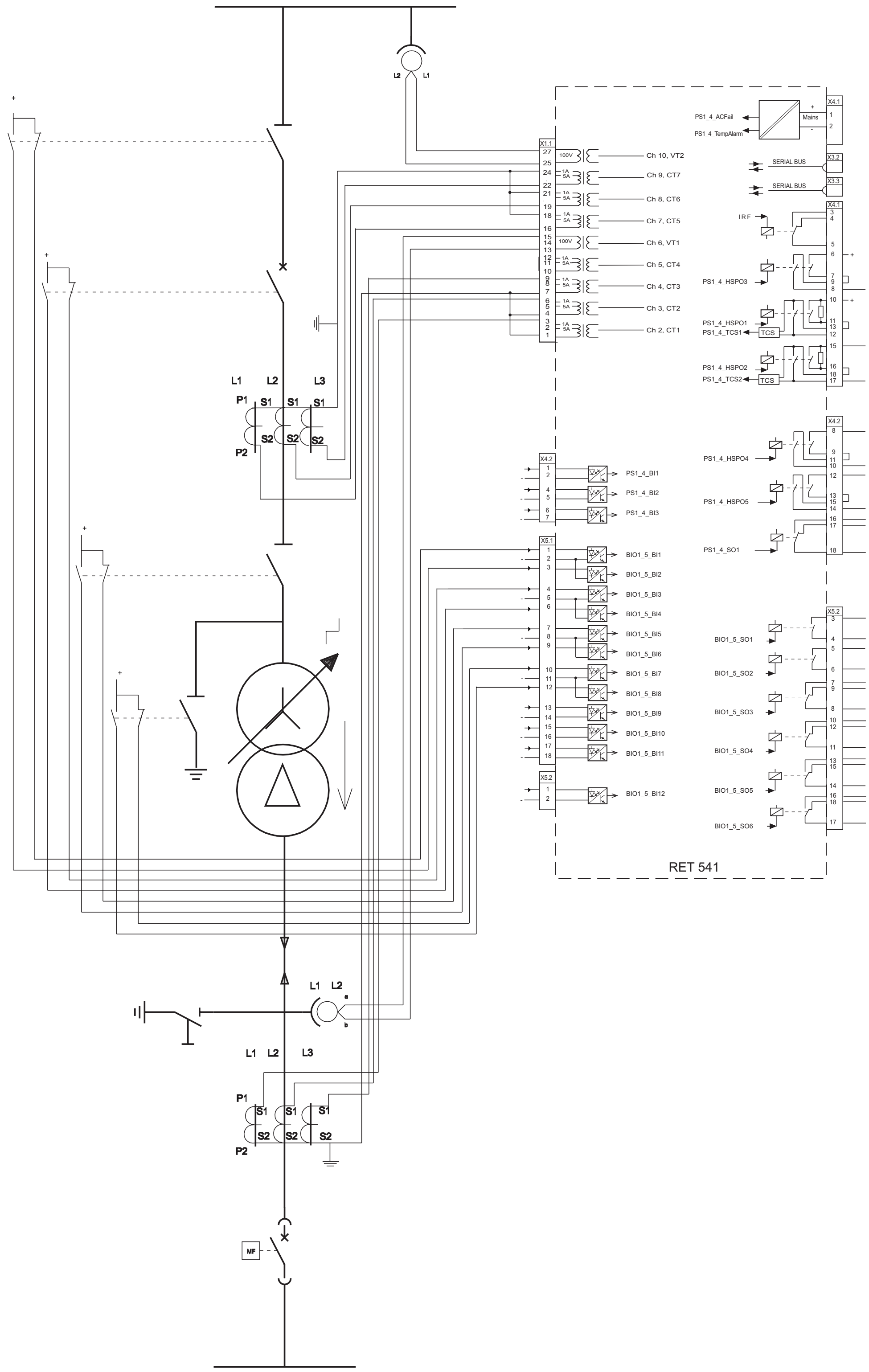
Table 5.2.1-12 General

Toolboxes	CAP 501 CAP 505 LNT 505
Event recording	all events are recorded in higher level syntax: reason, time, date the last 100 events are recorded
Data recording	records operate values
Protection functions Control functions Condition monitoring functions Measurement functions Power quality functions	see Technical Descriptions of Functions, CD-ROM (1MRS 750889-MCD)

Table 5.2.1-12 General

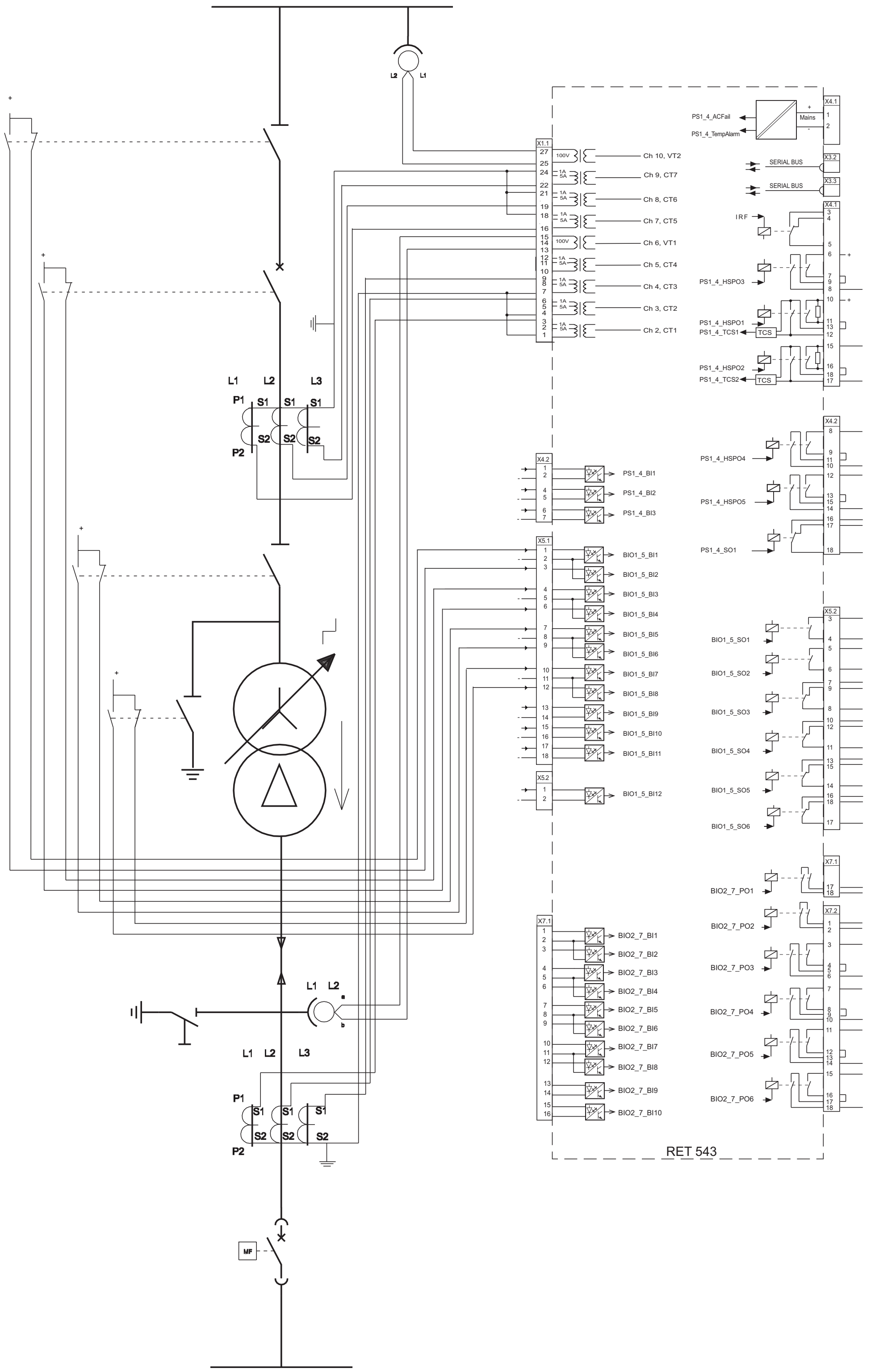
Self-supervision	RAM circuits ROM circuits Parameter memory circuits CPU watchdog Power supply Digital I/O modules HMI module RTD/analog input module Internal communication bus A/D converters and analog multiplexers	
Mechanical dimensions	Width: 223.7 mm (1/2 of a 19” rack) Height, frame: 265.9 mm (6U) Height, box: 249.8 mm Depth: 235 mm For dimension drawings, refer to the Installation Manual (1MRS 750526-MUM)	
	External display module:	Width: 223.7 mm Height: 265.9 mm Depth: 74 mm
Weight of the unit	~8 kg	

5.2.2. Terminal diagram of RET 541



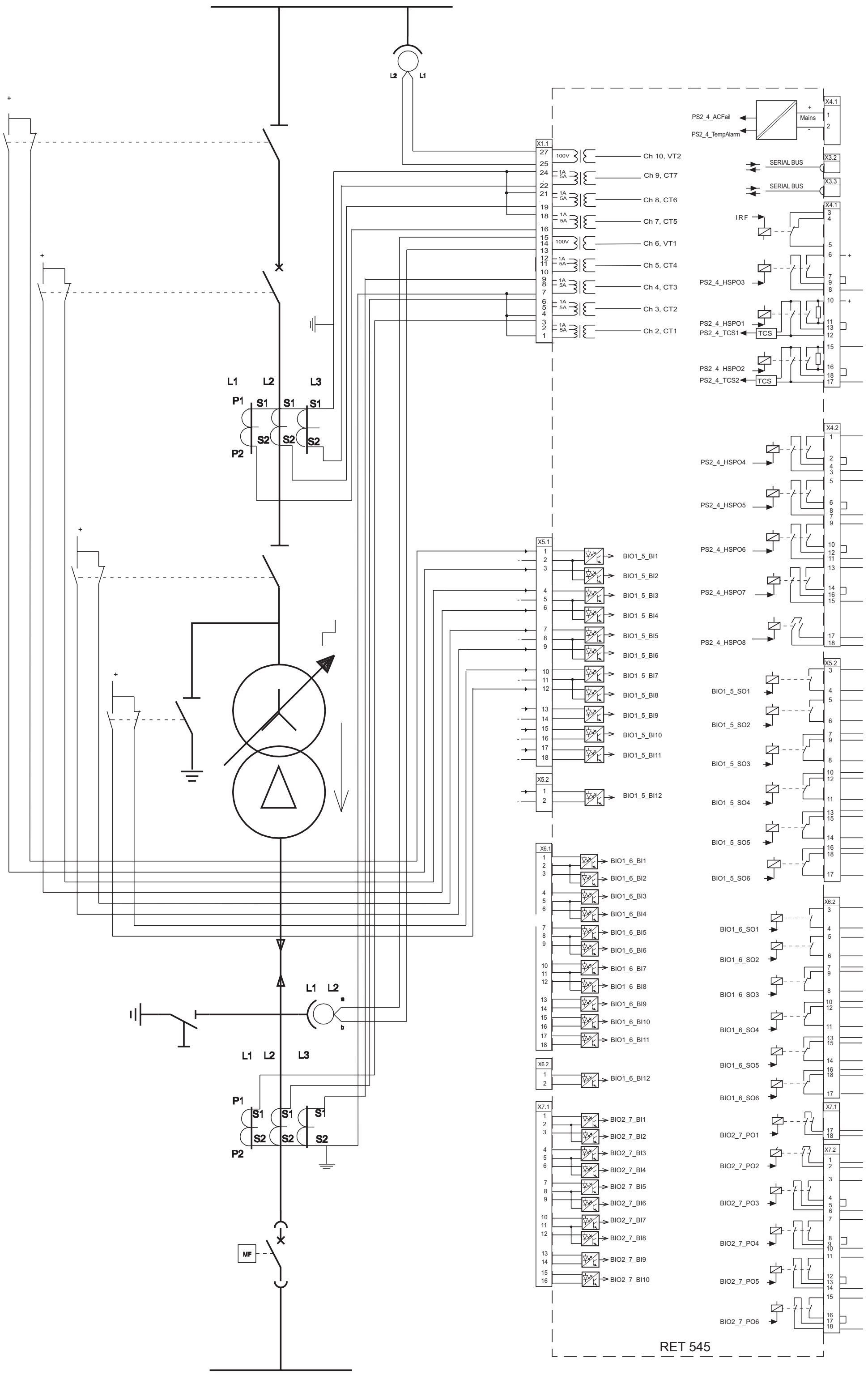
CD_541

5.2.3. Terminal diagram of RET 543



CD_543

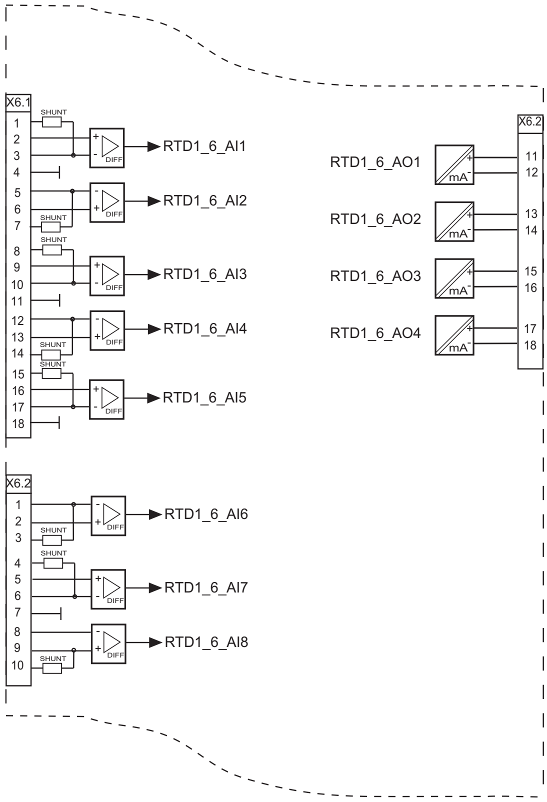
5.2.4. Terminal diagram of RET 545



CD_545_b

5.2.5. Terminal diagram of the RTD/analog module

Terminal diagrams for the RET 541 and RET 543 transformer terminals provided with an RTD/analog module are similar to the diagrams presented in sections “Terminal diagram of RET 541” on page 95 and “Terminal diagram of RET 543” on page 96, except for the part illustrating the RTD/analog module (see below), which is added to the diagrams considering the slot numbers.



RTD1diag_b

5.2.6. Terminal connections

All external circuits are connected to the terminal blocks on the rear panel. Terminal block X1.1 for the measuring transformers consists of fixed screw terminals fastened to the energizing input module. Each terminal is dimensioned for one max. 6 mm^2 or two max. 2.5 mm^2 wires.

The serial interface RS-232 on the rear panel (connector X3.2) is used for connecting the RET 54_ to the SPA bus, the IEC_103, Modbus or the DNP 3.0 bus. The Modbus/DNP 3.0 bus is connected to the X3.2 via a RER 133 connection module and a cable with a 9-pin D-type subminiature female connector at both ends. One end of the cable is screwed to the rear panel (X3.2) and the other end to RER 133 (ordering number: RER133). The cable is included in the delivery. The SPA/IEC_103 bus is connected to the X3.2 via a connection module RER 123 and a cable with a 9-pin D-type subminiature female connector at both ends. The other end of the cable is screwed to the rear panel (X3.2) and the other end to the RER 123, which is screwed to the rear side of the relay by using a mounting plate. The cable and the plate are included in the delivery of the RER 123 (ordering number: RER123-xx).

The serial interface RS-485 on the rear panel (connector X3.3) is used for connecting the transformer terminal to the SPA bus or the LON bus. The SPA/LON bus is connected via the connection module type RER 103 (ordering number: RER103-xx) fitted to the 9-pin D-type subminiature connector and screwed to the rear panel.

The connectors X4.1...X7.2 are 18-pin detachable multi-pole connector strips with screw terminals. The male part of the multi-pole connector strips is fastened to the printed circuit boards. The female parts, including accessories, are delivered together with the transformer terminal. The female connector part can be secured with fixing accessories and screws. One max. 1.5 mm^2 wire or two max. 0.75 mm^2 wires can be connected to one screw terminal.

The digital inputs and outputs (contacts) of the transformer terminal are connected to the multi-pole connectors X4.1...X7.2. The auxiliary power supply is connected to the terminals X4.1:1 (plus polarity) and X4.1:2 (minus polarity). When the RTD/analog module is used, the inputs and outputs are connected to the terminals X6.1:1 and X6.1:2. The transformer terminal self-supervision output IRF is linked to the terminals X4.1:3, X4.1:4 and X4.1:5.

Protective earth is connected to the screw marked with the earth symbol.

The connectors are designated according to the module slot in the RET 54_ transformer terminal.

Connector	Description
X1.1	connector for transformer inputs (current and voltage trafos) (module slot 1)
X3.1	not used, reserved for future purposes (slot 3)
X3.2	connector for RS-232 interface (slot 3)
X3.3	connector for RS-485 interface (slot 3)
X3.4	connector for the external display module (slot 2)
X4.1	upper connector for combined I/O and power supply module PS1/PS2 (slot 4)
X4.2	lower connector for combined I/O and power supply module PS1/PS2 (slot 4)
X5.1	upper connector for I/O module BIO1 (slot 5)
X5.2	lower connector for I/O module BIO1 (slot 5)
X6.1	upper connector for I/O module BIO1 (slot 6), RET 545 upper connector for RTD/analog module (slot 6), RET 541 or RET 543 with RTD/analog module
X6.2	lower connector for I/O module BIO1 (slot 6), RET 545 lower connector for RTD/analog module (slot 6), RET 541 or RET 543 with RTD/analog module
X7.1	upper connector for I/O module BIO2 (slot 7)
X7.2	lower connector for I/O module BIO2 (slot 7)

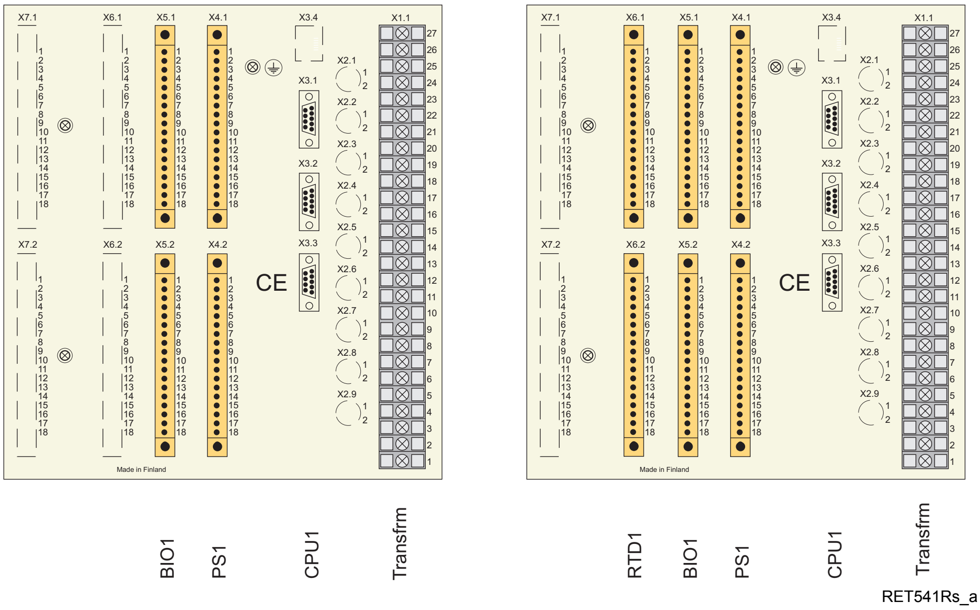


Fig. 5.2.6.-1 Rear views of RET 541 (right: with RTD/analog module)

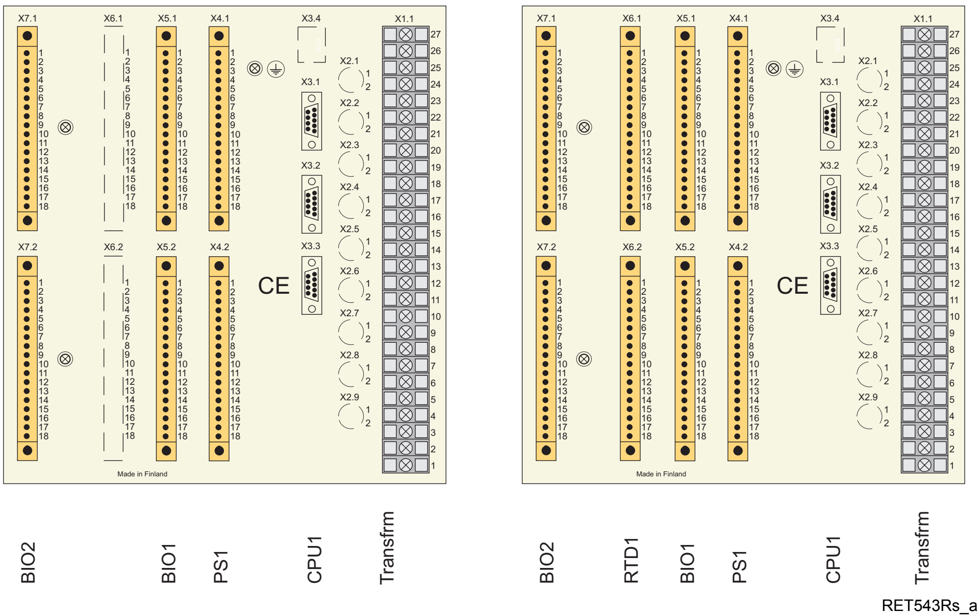
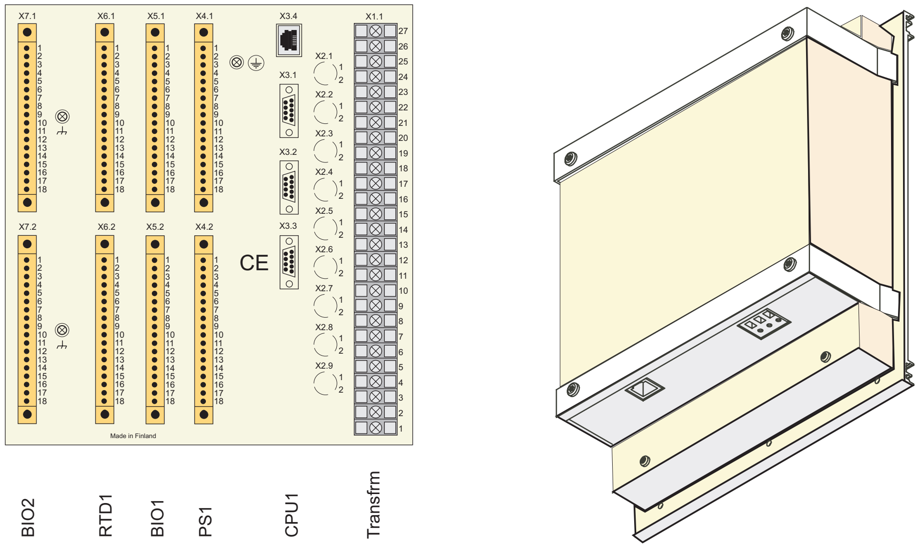
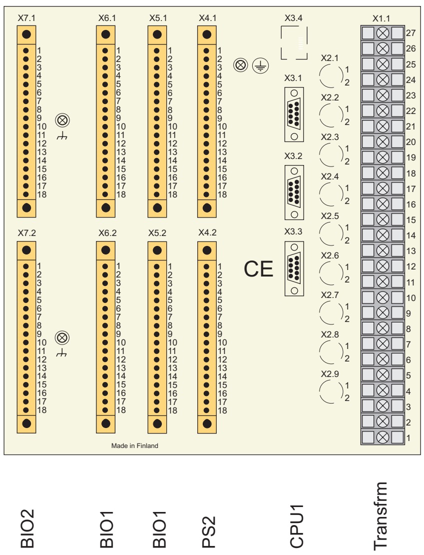


Fig. 5.2.6.-2 Rear views of RET 543 (right: with RTD/analog module)



RET543Re_a
ExtMMI_b

Fig. 5.2.6.-3 Rear view of RET 543 with an external display module and the external display module



RET545Rs_a

Fig. 5.2.6.-4 Rear view of RET 545

6. Service

When the transformer terminal is used under the conditions specified in section "Technical data", it is practically maintenance-free. The transformer terminal electronics include no parts or components subject to abnormal physical or electrical wear under normal operating conditions.

If the terminal fails in operation or if the operating values considerably differ from those mentioned in the transformer terminal specifications, the terminal should be overhauled. All repairs are to be taken by the manufacturer. Please contact the manufacturer or its nearest representative for further information about checking, overhaul and recalibration of the terminal.

To achieve the best possible operation accuracy, all parts of a RET 54_ product have been calibrated together. In the event of malfunction, please consult your relay supplier.

If the transformer terminal is required to be sent back to the manufacturer due to maloperation, it is essential that the Customer Feedback form, including especially the Service Report part, is carefully filled in and enclosed with the terminal.

If the transformer terminal is sent to the manufacturer, it has to be carefully packed to prevent further damage to the device.

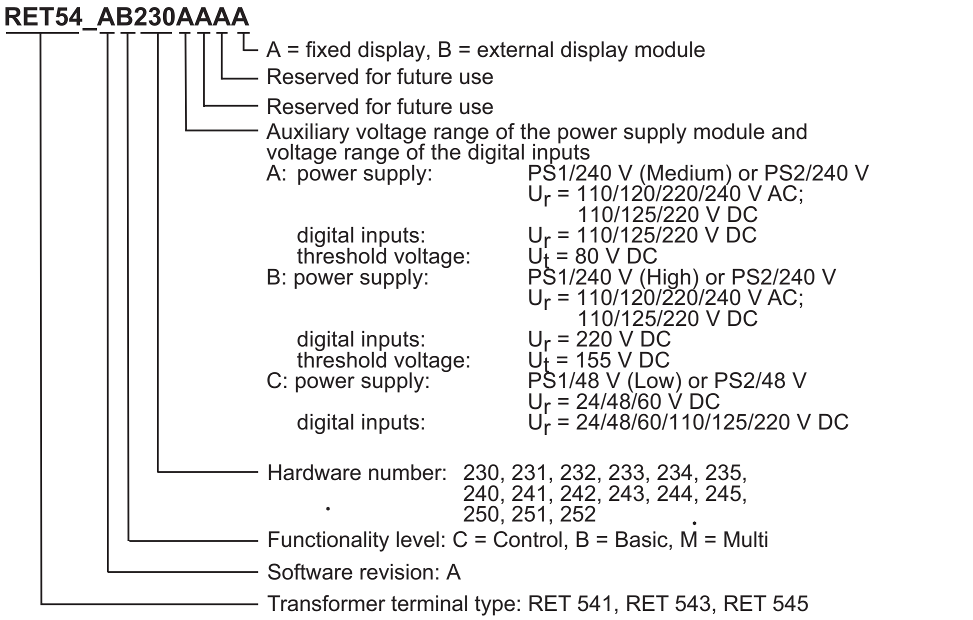
7. Ordering Information

7.1. Order number

The following is to be specified when ordering RET 54_ transformer terminals:

- Order number (see Figure 7.1.-1 below)
- Display language combination (e.g. English-German)
- Quantity of transformer terminals

Each RET 54_ transformer terminal has a specific order number that identifies the transformer terminal type as well as the hardware and the software as described in Figure 7.1.-1 below. The order number is printed on the marking strip on the front panel of the transformer terminal delivered, e.g. Order No: RET541AB230AAAA.



RET54_ordernumber_a

*Fig. 7.1.-1 Order number of RET 54_*

The functionality level determines the extent of the selection of function blocks available for the transformer terminal. For more detailed information on the separate function blocks included in each selection, please consult your relay supplier.

Functionality level	**Selection of function blocks**
C (Control) 1)	All control 2), condition monitoring and measurement functions
B (Basic)	All control 2), condition monitoring and measurement functions, basic protection functions
M (Multi)	All control 2), condition monitoring, measurement and protection functions

1) The Control functionailty level is only available in the 6I/3U hardware version.
2) The COLTC Tap Changer control function block comes as standard in the Control version. In the Basic and the Multi versions, COLTC is available as an option. The order number for COLTC is 1MRS100144.

The display language combination (see table below) is identified by a three-digit suffix in the software number printed on the front panel of the transformer terminal, e.g. Software No: 1MRS110031-0__.

Suffix	Language combination
001	English - German
002	English - Swedish
003	English - Finnish
007	English - Portuguese
008	English - Polish
009	English - Russian
010	English - Spanish

The RET 541, RET 543 and RET 545 transformer terminals differ from each other as to the number of digital inputs and outputs as follows.

Number of inputs/outputs	RET 541	RET 543	RET 545
Digital inputs	15	25	34
Trip circuit supervision inputs	2	2	2
Power outputs (NO single-pole)	0	2	3
Power outputs (NO double-pole)	5	9	11
Signal outputs (NO)	2	2	4
Signal outputs (NO/NC)	5	5	8
Self-supervision outputs	1	1	1

7.2. Hardware versions of RET 541, RET 543 and RET 545

For the number of digital inputs and outputs of RET 54_ transformer terminals, refer to section “Order number” above. The number of matching transformers and analog inputs and outputs, and the auxiliary voltage range vary between the different hardware versions of RET 54_. Moreover, RET 541 and RET 543 can be supplied with an RTD/analog module. For more detailed information about the hardware of RET 54_, refer to Section “Hardware versions” on page 11.

7.3. Software configuration

Each RET 54_ transformer terminal allows different software configurations based on separate functions (refer to Section “Functions of the transformer terminal” on page 25). Functions included in the selected functionality level (refer to Section “Ordering Information” on page 103) can be activated within the scope of the I/O connections and considering the total CPU load of the functions.

8. Revision History of RET 54_

8.1. Revision identification

The main releases of the RET 54_ products are differentiated with the software revision letter in the order number of the transformer terminal and the corresponding software number, both of which are printed on the marking strip on the front panel of the transformer terminal, for example as follows:

Order No: RET543**A**C240AAAA

Software No: 1MRS110033-001

Product	Revision	Software No	Release
RET 541	A	1MRS110031-0__	Release 3.0 (Q1 2005)
RET 541 (RTD1)	A	1MRS110032-0__	Release 3.0 (Q1 2005)
RET 543	A	1MRS110033-0__	Release 3.0 (Q1 2005)
RET 543 (RTD1)	A	1MRS110034-0__	Release 3.0 (Q1 2005)
RET 545	A	1MRS110035-0__	Release 3.0 (Q1 2005)

The revision letter determines the main release which may involve functional additions and changes to the product.

The extension -0__ after the software number defines the selected language combination.

9. Appendix A: The IEC 60870-5-103 bus

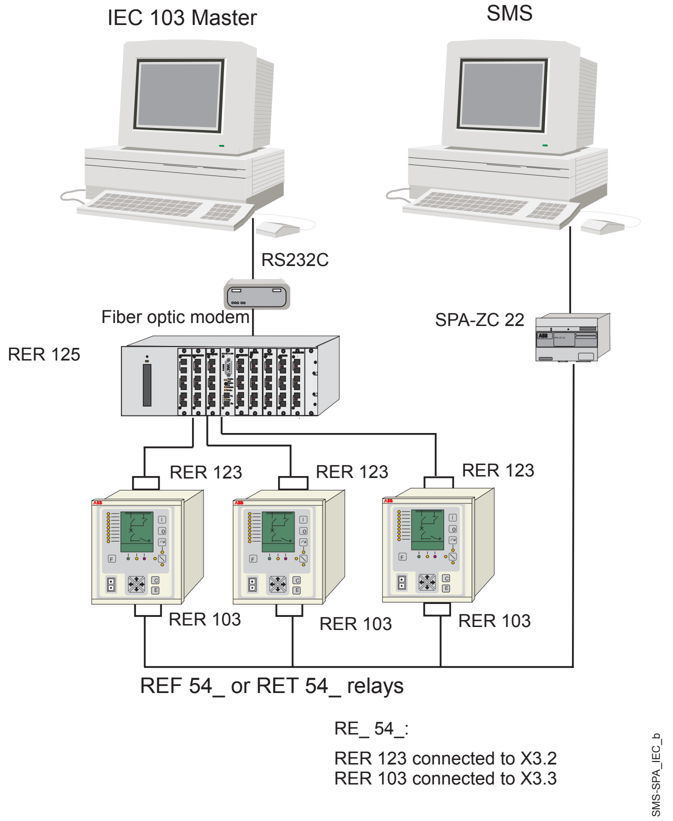


Fig. 9.-1 Example of the physical connection of the IEC 60870-5-103 control system

9.1. Functions supported by the RET 54_

Function	Function code	Comment
Reset CU	0	Replies with the identification string
User data	3	• GI command • time synchronization (unicast) • application control commands
Broadcast	4	Time synchronization only
Reset FCB	7	Replies with identification string
Request Access Demand	8	
Request Status of Link	9	
Request Class 1 Data	10	
Request Class 2 Data	11	

9.2. IEC_103 parameters

Adjustable IEC_103 serial communication parameters are shown in the table below.

Parameter	Value	Default value	Explanation
Unit address	1...254	1	IEC_103 station address
Baud rate	9600, 19200	9600	Communication speed
Function type	0...255	176	Unit function type
Scale factor	1.2 or 2.4	1.2	Analog value scale factor
Frame type	0...17 [1)]	1	Measurement frame type
RTD data frame	0 or 1 [2)]	0	If RTD data frame is on, then it is send to every second class 2 data poll. Store and reset is needed.

1) Refer to Table 9.7.-1
2) 0 = Off; 1 = On

9.3. The general principle of application data mapping

The interface between the RET 54_ physical applications and the IEC 60870-5-103 application layer is done accordingly:

Alternative A

If a corresponding RET 54_ application signal is defined by the IEC 60870-5-103 standard, the alternative A is used.

Alternative B

Refer to Digitale Stationsleittechnik - Ergänzende Empfelungen zur Anwendung in Verteilnetzstationen by Vereinigung Deutscher Elektrizitätswerke.

Alternative P

Private definitions are basically used because of two reasons:

1. The standard does not define the signal.
2. The signal is defined by the standard but the RET 54_ application signal interface differs from this model.

9.4. Class 1 data buffering and priorities

The internal IEC 60870-5-103/Class 1 buffer inside the RET 54_ can store up to 50 spontaneous events. The interrogation events and the possible response messages, that also are part of the class 1 data, do not occupy space in the buffer. The priority of the different categories of the pending class 1 data is always so that the response messages have the highest priority, thereafter the spontaneous events and finally the interrogation events. The IEC_103 data cannot be filtered by using event masks.

Circuit breaker failure protection (CBFP) is represented with the information type number 85 in the device function type.

The user cannot effect the event flow from the IEC 60870-5-103 protocol by adjusting the event masks of the RET 54_ applications.

9.5. Class 2 data

The measurement (analog) values are transported to the control system as a response to a class 2 request command. The class 2 data is always cyclically updated (COT=2). Refer to Table 9.7.-1 on page 116 for measurement data.

9.5.1. Class 2 measurand sets (ASDU frames)

The IEC 60870-5-103 standard defines the measurands to be transmitted as either Meas I (typeId 3) or Meas II (typeId 9) ASDU frames. According to the standard, the Meas I ASDU can have four different profiles and Meas II has one profile. These five profiles are supported in the RET 54_. In addition, there are twelve more private class 2 ASDU frames defined. The user can choose which one of these twelve measurand sets to use. The measurand set number (1...17) can be adjusted via the "Frame type" parameter.

RTD card's measurand can be transmitted on its own frame. If RTD data frame parameter is set to one, every other class 2 data is a RTD data frame. The alternate frame is RTD data frame and the another one is normal user selectable data frame.

9.5.2. Class 2 value scaling

The IEC 60870-5-103 standard defines the scale (max range) of the measurements to be either 1.2 or 2.4 times the rated value for the measurement. The selection between the 1.2 scaling or the 2.4 scaling can be done via the "Scale factor" parameter. In the RET menu values are 0 = 1.2 and 1 = 2.4.

9.6. Default mappings

Explanations to Table 9.6.-1:

St	Status
A	According to the IEC 60870-5-103 standard
B	According to "Digitale Stationsleittechnik - Ergänzende Empfehlungen zur Anwendung in Verteilnetzstationen"
P	Private definition
Ftyp	Function type Note: If stated as *), the signal type Ftyp corresponds with the unit function type. Unit function type may be adjusted via the "Function type" parameter.
InfNum	Information element number
GI	General interrogation 0 = Not in interrogation 1 = Interrogable
Typ	TypeId
COT	Cause of transmission values
1	Spontaneous
9	Interrogated

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
Protection functions							
DEF2HIGH	START signal from Io>> ->	P	163	95	1	1	1,9
DEF2HIGH	TRIP signal from Io>> ->	P	163	93	0	1	1
DEF2HIGH	CBFP signal from Io>> ->	A	*)	85	0	2	1
DEF2INST	START signal from Io>>> ->	P	163	97	1	1	1,9
DEF2INST	TRIP signal from Io>>> ->	P	163	99	0	1	1
DEF2INST	CBFP signal from Io>>> ->	A	*)	85	0	2	1
DEF2LOW	START signal from Io> ->	P	163	67	1	1	1,9
DEF2LOW	TRIP signal from Io> ->	P	163	92	0	1	1
DEF2LOW	CBFP signal from Io> ->	A	*)	85	0	2	1
DIFF6T	TRIP signal of 3DI> stage	P	253	107	0	1	1
DIFF6T	TRIP signal of 3DI>> stage	P	253	117	0	1	1
DIFF6T	CBFB signal 3DI> or 3DI>>	A	*)	85	0	2	1
DOC6HIGH	START signal from 3I>> -> stage	P	164	94	1	1	1,9
DOC6HIGH	TRIP signal from 3I>> -> stage	P	164	91	0	1	1
DOC6HIGH	CBFP signal from 3I>> -> stage	A	*)	85	0	2	1
DOC6INST	START signal from 3I>>> -> stage	P	164	96	1	1	1,9
DOC6INST	TRIP signal from 3I>>> -> stage	P	164	98	0	1	1
DOC6INST	CBFP signal from 3I>>> -> stage	A	*)	85	0	2	1
DOC6LOW	START signal from 3I> -> stage	P	164	84	1	1	1,9
DOC6LOW	TRIP signal from 3I> -> stage	P	164	90	0	1	1
DOC6LOW	CBFP signal from 3I> -> stage	A	*)	85	0	2	1
FREQ1ST1	START1 signal from f>,f< St1	P	171	84	1	1	1,9
FREQ1ST1	TRIP1 signal from f>,f< St1	P	171	90	0	1	1
FREQ1ST1	START2 signal from f>,f< St1	P	171	94	1	1	1,9
FREQ1ST1	TRIP2 signal from f>,f< St1	P	171	91	0	1	1
FREQ1ST2	START1 signal from f>,f< St2	P	172	84	1	1	1,9
FREQ1ST2	TRIP1 signal from f>,f< St2	P	172	90	0	1	1
FREQ1ST2	START2 signal from f>,f< St2	P	172	94	1	1	1,9
FREQ1ST2	TRIP2 signal from f>,f< St2	P	172	91	0	1	1
FREQ1ST3	START1 signal from f>,f< St3	P	183	84	1	1	1,9
FREQ1ST3	TRIP1 signal from f>,f< St3	P	183	90	0	1	1
FREQ1ST3	START2 signal from f>,f< St3	P	183	94	1	1	1,9
FREQ1ST3	TRIP2 signal from f>,f< St3	P	183	91	0	1	1
FREQ1ST4	START1 signal from f>,f< St4	P	174	84	1	1	1,9
FREQ1ST4	TRIP1 signal from f>,f< St4	P	174	90	0	1	1
FREQ1ST4	START2 signal from f>,f< St4	P	174	94	1	1	1,9
FREQ1ST4	TRIP2 signal from f>,f< St4	P	174	91	0	1	1
FREQ1ST5	START1 signal from f>,f< St5	P	175	84	1	1	1,9
FREQ1ST5	TRIP1 signal from f>,f< St5	P	175	90	0	1	1
FREQ1ST5	START2 signal from f>,f< St5	P	175	94	1	1	1,9
FREQ1ST5	TRIP2 signal from f>,f< St5	P	175	91	0	1	1
FUSEFAIL	Fuse failure	P	253	83	1	1	1,9
INRUSH3	START signal from 3I2f>	P	167	84	1	1	1,9
NEF1HIGH	START signal from Io>> stage	P	162	95	1	1	1,9
NEF1HIGH	TRIP signal from Io>> stage	A	160	93	0	2	1
NEF1HIGH	CBFP signal from Io>> stage	A	*)	85	0	2	1
NEF1INST	START signal from Io>>> stage	P	162	97	1	1	1,9
NEF1INST	TRIP signal from Io>>> stage	P	162	99	0	1	1

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
NEF1INST	CBFP signal from Io>>> stage	A	*)	85	0	2	1
NEF1LOW	START signal from Io> stage	A	160	67	1	2	1,9
NEF1LOW	TRIP signal from Io> stage	A	160	92	0	2	1
NEF1LOW	CBFP signal from Io> stage	A	*)	85	0	2	1
NOC3HIGH	START signal from 3I>> stage	P	162	94	1	1	1,9
NOC3HIGH	TRIP signal from 3I>> stage	A	160	91	0	2	1
NOC3HIGH	CBFP signal from 3I>> stage	A	*)	85	0	2	1
NOC3INST	START signal from 3I>>> stage	P	162	96	1	1	1,9
NOC3INST	TRIP signal from 3I>>> stage	P	162	98	0	1	1
NOC3INST	CBFP signal from 3I>>> stage	A	*)	85	0	2	1
NOC3LOW	START signal from 3I> stage	A	160	84	1	2	1,9
NOC3LOW	TRIP signal from 3I> stage	A	160	90	0	2	1
NOC3LOW	CBFP signal from 3I> stage	A	*)	85	0	2	1
NOC3LowB	START signal from 3I> stage	P	253	101	1	1	1,9
NOC3LowB	TRIP signal from 3I> stage	P	253	111	0	1	1
NOC3LowB	CBFP signal from 3I> stage	A	*)	85	0	2	1
NPS3High	START signal from I2>> stage	P	21	91	1	1	1,9
NPS3High	TRIP signal from I2>> stage	P	21	94	0	1	1
NPS3High	CBFP signal from I2>> stage	A	*)	85	0	2	1
NPS3Low	START signal from I2> stage	P	21	84	1	1	1,9
NPS3Low	TRIP signal from I2> stage	P	21	90	0	1	1
NPS3Low	CBFP signal from I2> stage	A	*)	85	0	2	1
OE1High	START signal from U/f >>	P	253	103	1	1	1,9
OE1High	TRIP signal from U/f >>	P	253	113	0	1	1
OE1High	CBFP signal from U/f >>	A	*)	85	0	2	1
OE1Low	START signal from U/f >	P	253	102	1	1	1,9
OE1Low	TRIP signal from U/f >	P	253	112	0	1	1
OE1Low	CBFP signal from U/f >	A	*)	85	0	2	1
OV3HIGH	START signal from 3U>> stage	P	165	94	1	1	1,9
OV3HIGH	TRIP signal from 3U>> stage	P	165	91	0	1	1
OV3LOW	START signal from 3U> stage	P	165	84	1	1	1,9
OV3LOW	TRIP signal from 3U> stage	P	165	90	0	1	1
PSV3St1	START signal from U2>, stage 1	P	179	1	1	1	1,9
PSV3St1	START signal from U1<, stage 1	P	179	2	1	1	1,9
PSV3St1	START signal from U1>, stage 1	P	179	3	1	1	1,9
PSV3St1	TRIP signal from U2>, stage 1	P	179	4	0	1	1
PSV3St1	TRIP signal from U1<, stage 1	P	179	5	0	1	1
PSV3St1	TRIP signal from U1>, stage 1	P	179	6	0	1	1
PSV3St2	START signal from U2>, stage 2	P	180	1	1	1	1,9
PSV3St2	START signal from U1<, stage 2	P	180	2	1	1	1,9
PSV3St2	START signal from U1>, stage 2	P	180	3	1	1	1,9
PSV3St2	TRIP signal from U2>, stage 2	P	180	4	0	1	1
PSV3St2	TRIP signal from U1<, stage 2	P	180	5	0	1	1
PSV3St2	TRIP signal from U1>, stage 2	P	180	6	0	1	1
REF1A	TRIP signal of dIo>, REF1A	P	253	125	0	1	1
REF1A	CBFP signal of REF1A	A	*)	85	0	2	1
REF4A	START signal of REF4A	P	253	106	1	1	1,9
REF4A	TRIP signal of REF4A	P	253	116	0	1	1
REF4A	CBFP signal of REF4A	A	*)	85	0	2	1
REF4B	START signal of REF4B	P	253	110	1	1	1,9
REF4B	TRIP signal of REF4B	P	253	120	0	1	1

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
REF4B	CBFP signal of REF4B	A	*)	85	0	2	1
ROV1HIGH	START signal from Uo>> stage	P	170	94	1	1	1,9
ROV1HIGH	TRIP signal from Uo>> stage	P	170	91	0	1	1
ROV1INST	START signal from Uo>>> stage	P	170	96	1	1	1,9
ROV1INST	TRIP signal from Uo>>> stage	P	170	98	0	1	1
ROV1LOW	START signal from Uo> stage	P	170	84	1	1	1,9
ROV1LOW	TRIP signal from Uo> stage	P	170	90	0	1	1
TOL3Dev	START signal from 3Ith>	P	184	84	1	1	1,9
TOL3Dev	TRIP signal from 3Ith>	P	184	90	0	1	1
TOL3Dev	CBFP signal from 3Ith>	A	*)	85	0	1	1
UI6High	START signal from Z<< stage	P	253	109	1	1	1,9
UI6High	TRIP signal from Z<< stage	P	253	119	0	1	1
UI6High	CBFP signal from Z<< stage	A	*)	85	0	2	1
UI6Low	START signal from Z< stage	P	253	108	1	1	1,9
UI6Low	TRIP signal from Z< stage	P	253	118	0	1	1
UI6Low	CBFP signal from Z< stage	A	*)	85	0	2	1
UV3HIGH	START signal from 3U<< stage	P	166	94	1	1	1,9
UV3HIGH	TRIP signal from 3U<< stage	P	166	91	0	1	1
UV3LOW	START signal from 3U< stage	P	166	84	1	1	1,9
UV3LOW	TRIP signal from 3U< stage	P	166	90	0	1	1
Control functions							
CO3DC1	3-state sw. 1 position OC	P	253	17	1	1	1,9
CO3DC1	3-state sw. 1 command seqence	P	253	9	0	1	1
CO3DC1	3-state sw. 1 open output	P	253	10	0	1	1
CO3DC1	3-state sw. 1 close output	P	253	11	0	1	1
CO3DC1	3-state sw. 1 opening time	P	253	12	0	1	1
CO3DC1	3-state sw. 1 closing time	P	253	13	0	1	1
CO3DC1	3-state sw. 1 command status	P	253	14	0	1	1
CO3DC1	3-state sw. 1 earthing time	P	253	15	0	1	1
CO3DC1	3-state sw. 1 freeing time	P	253	16	0	1	1
CO3DC1	3-state sw. 1 position FE	P	253	18	1	1	1,9
CO3DC2	3-state sw. 2 position OC	P	253	19	1	1	1,9
CO3DC2	3-state sw. 2 command seqence	P	253	20	0	1	1
CO3DC2	3-state sw. 2 open output	P	253	21	0	1	1
CO3DC2	3-state sw. 2 close output	P	253	22	0	1	1
CO3DC2	3-state sw. 2 opening time	P	253	23	0	1	1
CO3DC2	3-state sw. 2 closing time	P	253	24	0	1	1
CO3DC2	3-state sw. 2 command status	P	253	25	0	1	1
CO3DC2	3-state sw. 2 earthing time	P	253	26	0	1	1
CO3DC2	3-state sw. 2 freeing time	P	253	27	0	1	1
CO3DC2	3-state sw. 2 position FE	P	253	28	1	1	1,9
COCB1	Breaker 1 position	B	240	160	1	1	1,9
COCB1	Breaker 1 command sequence	P	242	201	0	1	1
COCB1	Breaker 1 open output	P	242	202	0	1	1
COCB1	Breaker 1 close output	P	242	203	0	1	1
COCB1	Breaker 1 opening time	P	242	204	0	1	1
COCB1	Breaker 1 closing time	P	242	205	0	1	1
COCB1	Breaker 1 command status	P	242	206	0	1	1
COCB2	Breaker 2 position	P	242	207	1	1	1,9
COCB2	Breaker 2 command sequence	P	253	29	0	1	1
COCB2	Breaker 2 open output	P	243	201	0	1	1

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
COCB2	Breaker 2 close output	P	243	202	0	1	1
COCB2	Breaker 2 opening time	P	243	203	0	1	1
COCB2	Breaker 2 closing time	P	243	204	0	1	1
COCB2	Breaker 2 command status	P	243	205	0	1	1
COCBDIR	Breaker open command	P	253	30	0	1	1
CODC1	Disconnector 1 position	P	243	206	1	1	1,9
CODC1	Disconnector 1 command seq.	P	253	31	0	1	1
CODC1	Disconnector 1 open output	P	253	32	0	1	1
CODC1	Disconnector 1 close output	P	253	33	0	1	1
CODC1	Disconnector 1 opening time	P	253	34	0	1	1
CODC1	Disconnector 1 closing time	P	253	35	0	1	1
CODC1	Disconnector 1 command status	P	253	36	0	1	1
CODC2	Disconnector 2 position	P	253	37	1	1	1,9
CODC2	Disconnector 2 command seq.	P	253	38	0	1	1
CODC2	Disconnector 2 open output	P	253	39	0	1	1
CODC2	Disconnector 2 close output	P	253	40	0	1	1
CODC2	Disconnector 2 opening time	P	253	41	0	1	1
CODC2	Disconnector 2 closing time	P	253	42	0	1	1
CODC2	Disconnector 2 command status	P	253	43	0	1	1
CODC3	Disconnector 3 position	P	253	44	1	1	1,9
CODC3	Disconnector 3 command seq.	P	253	45	0	1	1
CODC3	Disconnector 3 open output	P	253	46	0	1	1
CODC3	Disconnector 3 close output	P	253	47	0	1	1
CODC3	Disconnector 3 opening time	P	253	48	0	1	1
CODC3	Disconnector 3 closing time	P	253	49	0	1	1
CODC3	Disconnector 3 command status	P	253	50	0	1	1
CODC4	Disconnector 4 position	P	253	51	1	1	1,9
CODC4	Disconnector 4 command seq.	P	253	52	0	1	1
CODC4	Disconnector 4 open output	P	253	53	0	1	1
CODC4	Disconnector 4 close output	P	253	54	0	1	1
CODC4	Disconnector 4 opening time	P	253	55	0	1	1
CODC4	Disconnector 4 closing time	P	253	56	0	1	1
CODC4	Disconnector 4 command status	P	253	57	0	1	1
CODC5	Disconnector 5 position	P	253	58	1	1	1,9
CODC5	Disconnector 5 command seq.	P	253	59	0	1	1
CODC5	Disconnector 5 open output	P	253	60	0	1	1
CODC5	Disconnector 5 close output	P	253	61	0	1	1
CODC5	Disconnector 5 opening time	P	253	62	0	1	1
CODC5	Disconnector 5 closing time	P	253	63	0	1	1
CODC5	Disconnector 5 command status	P	253	64	0	1	1
COIND1	Indication 1 position	B	240	161	1	1	1,9
COIND2	Indication 2 position	B	240	164	1	1	1,9
COIND3	Indication 3 position	P	240	165	1	1	1,9
COIND4	Indication 4 position	P	253	65	1	1	1,9
COIND5	Indication 5 position	P	253	66	1	1	1,9
COIND6	Indication 6 position	P	253	67	1	1	1,9
COIND7	Indication 7 position	P	253	68	1	1	1,9
COIND8	Indication 8 position	P	253	69	1	1	1,9
COLOCAT	Logic position setting	P	253	100	0	1	1
COLTC	Raise output signal	P	253	121	1	1	1,9
COLTC	Lower output signal	P	253	122	1	1	1,9

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
COLTC	Paralleling failure	P	253	123	1	1	1,9
COLTC	Tap changer alarm	P	253	124	1	1	1,9
COLTC	Tap changer position value (float)	P	253	126	1	4	1,9
COSW1	On/off object 1 position	P	253	79	1	1	1,9
COSW2	On/off object 2 position	P	253	80	1	1	1,9
COSW3	On/off object 3 position	P	253	81	1	1	1,9
COSW4	On/off object 4 position	P	253	82	1	1	1,9
MMIALAR1	Alarm 1 status	P	253	88	1	1	1,9
MMIALAR2	Alarm 2 status	P	253	89	1	1	1,9
MMIALAR3	Alarm 3 status	P	253	90	1	1	1,9
MMIALAR4	Alarm 4 status	P	253	91	1	1	1,9
MMIALAR5	Alarm 5 status	P	253	92	1	1	1,9
MMIALAR6	Alarm 6 status	P	253	93	1	1	1,9
MMIALAR7	Alarm 7 status	P	253	94	1	1	1,9
MMIALAR8	Alarm 8 status	P	253	95	1	1	1,9
Condition monitoring functions							
CMBWEAR1	Breaker 1 electric wear alarm	P	194	10	0	1	1
CMBWEAR2	Breaker 2 electric wear alarm	P	194	11	0	1	1
CMCU3	Current input circuit alarm	A	*)	32	1	1	1,9
CMGAS1	Low gas density alarm	P	238	1	1	1	1,9
CMGAS1	Low gas density warning	P	238	2	1	1	1,9
CMGAS3	Low gas density alarm	P	238	3	1	1	1,9
CMSCHED	Scheduled maintenance alarm	P	238	4	0	1	1
CMSPRC1	Spring 1 charging motor	P	238	7	0	1	1
CMSPRC1	Spring 1 max charging alarm	P	238	5	1	1	1,9
CMSPRC1	Spring 1 min charging alarm	P	238	6	1	1	1,9
CMTCS1	Trip circuit supervision 1 alarm	A	*)	36	1	1	1,9
CMTCS2	Trip circuit superv. 2 alarm	P	238	10	1	1	1,9
CMTIME1	Accumulated time 1 alarm	P	238	12	1	1	1,9
CMTIME1	Accumulated time 1 measurement	P	238	11	1	1	1,9
CMTIME2	Accumulated time 1 alarm	P	238	13	1	1	1,9
CMTIME2	Accumulated time 1 measurement	P	238	14	1	1	1,9
CMTRAV1	Breaker 1 open travel alarm	P	238	16	1	1	1,9
CMTRAV1	Breaker 1 close travel alarm	P	238	15	1	1	1,9
CMVO3	Input voltage circuit alarm	A	*)	33	1	1	1,9
Communication functions							
EVENT230	Customer event 0-1	P	252	1	0	1	1
EVENT230	Customer event 2-3	P	252	2	0	1	1
EVENT230	Customer event 4-5	P	252	3	0	1	1
EVENT230	Customer event 6-7	P	252	4	0	1	1
EVENT230	Customer event 8-9	P	252	5	0	1	1
EVENT230	Customer event 10 -11	P	252	6	0	1	1
EVENT230	Customer event 12-13	P	252	7	0	1	1
EVENT230	Customer event 14-15	P	252	8	0	1	1
EVENT230	Customer event 16-17	P	252	9	0	1	1
EVENT230	Customer event 18-19	P	252	10	0	1	1
EVENT230	Customer event 20-21	P	252	11	0	1	1
EVENT230	customer event 22-23	P	252	12	0	1	1
EVENT230	Customer event 24-25	P	252	13	0	1	1
EVENT230	Customer event 26-27	P	252	14	0	1	1
EVENT230	Customer event 28-29	P	252	15	0	1	1

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
EVENT230	Customer event 30-31	P	252	16	0	1	1
EVENT230	Customer event 32-33	P	252	17	0	1	1
EVENT230	Customer event 34-35	P	252	18	0	1	1
EVENT230	Customer event 36-37	P	252	19	0	1	1
EVENT230	Customer event 38-39	P	252	20	0	1	1
EVENT230	Customer event 40-41	P	252	21	0	1	1
EVENT230	Customer event 42-43	P	252	22	0	1	1
EVENT230	Customer event 44-45	P	252	23	0	1	1
EVENT230	Customer event 46-47	P	252	24	0	1	1
EVENT230	Customer event 48-49	P	252	25	0	1	1
EVENT230	Customer event 50-51	P	252	26	0	1	1
EVENT230	Customer event 52-53	P	252	27	0	1	1
EVENT230	Customer event 54-55	P	252	28	0	1	1
EVENT230	Customer event 56-57	P	252	29	0	1	1
EVENT230	Customer event 58-59	P	252	30	0	1	1
EVENT230	Customer event 60-61	P	252	31	0	1	1
EVENT230	Customer event 62-63	P	252	32	0	1	1
LocalMMI	Password changed	P	252	34	0	1	1
LocalMMI	Setting done	P	252	33	0	1	1
Measurement functions							
MEAI1	High warning	P	210	11	0	1	1
MEAI1	High alarm	P	210	21	0	1	1
MEAI1	Low warning	P	210	111	0	1	1
MEAI1	Low alarm	P	210	121	0	1	1
MEAI2	High warning	P	211	11	0	1	1
MEAI2	High alarm	P	211	21	0	1	1
MEAI2	Low warning	P	211	111	0	1	1
MEAI2	Low alarm	P	211	121	0	1	1
MEAI3	High warning	P	212	11	0	1	1
MEAI3	High alarm	P	212	21	0	1	1
MEAI3	Low warning	P	212	111	0	1	1
MEAI3	Low alarm	P	212	121	0	1	1
MEAI4	High warning	P	213	11	0	1	1
MEAI4	High alarm	P	213	21	0	1	1
MEAI4	Low warning	P	213	111	0	1	1
MEAI4	Low alarm	P	213	121	0	1	1
MEAI5	High warning	P	214	11	0	1	1
MEAI5	High alarm	P	214	21	0	1	1
MEAI5	Low warning	P	214	111	0	1	1
MEAI5	Low alarm	P	214	121	0	1	1
MEAI6	High warning	P	215	11	0	1	1
MEAI6	High alarm	P	215	21	0	1	1
MEAI6	Low warning	P	215	111	0	1	1
MEAI6	Low alarm	P	215	121	0	1	1
MEAI7	High warning	P	216	11	0	1	1
MEAI7	High alarm	P	216	21	0	1	1
MEAI7	Low warning	P	216	111	0	1	1
MEAI7	Low alarm	P	216	121	0	1	1
MEAI8	High warning	P	217	11	0	1	1
MEAI8	High alarm	P	217	21	0	1	1
MEAI8	Low warning	P	217	111	0	1	1

Table 9.6.-1 Class 1 data signals

Function block name	Event	St	Ftyp	Inf Num	GI	Typ	COT
MEAI8	Low alarm	P	217	121	0	1	1
MEDREC16	Recorder memory is full	P	195	50	0	1	1
MEDREC16	Recorder triggered	P	195	51	0	1	1
General functions							
CH000	IRF error	P	253	1	0	1	1
CH001	Test mode	P	253	5	0	1	1
CH002[1)]	Recent control position	P	253	6	1	1	1,9
INDRESET	Indications	P	253	85	0	1	1
INDRESET	Indications, latched	P	253	86	0	1	1
INDRESET	Indicat., latched, registered	P	253	87	0	1	1

[1)] 0 = disable, 1 = local, 2 = remote

Explanations to Table 9.6.-2:

St	Status
A	According to the IEC 60870-5-103 standard
B	According to “Digitale Stationsleittechnik - Ergänzende Empfehlungen zur Anwendung in Verteilnetzstationen”
P	Private definition
Ftyp	Function type Note: If stated as *), the signal type Ftyp corresponds with the unit function type. Unit function type may be adjusted via the “Function type” parameter.
InfNum	Information element number
COT cmd	Cause of transmission values in command direction
20	General command
COT resp	Cause of transmission values in response direction
20	Positive acknowledgement
21	Negative acknowledgement

Table 9.6.-2 Commands

Commands		St	Ftyp	Inf Num	Typ	COT cmd	COT resp
COCB1	Circuit breaker	B	240	160	20	20	20,21
COCB2	Circuit breaker	P	242	207	20	20	20,21
CODC1	Disconnector	P	243	206	20	20	20,21
CODC2	Disconnector	P	253	37	20	20	20,21
CODC3	Disconnector	P	253	44	20	20	20,21
CODC4	Disconnector	P	253	51	20	20	20,21
CODC5	Disconnector	P	253	58	20	20	20,21
CO3DC1	Disconnector	P	253	17	20	20	20,21
CO3DC1	Disconnector Earth	P	253	18	20	20	20,21
CO3DC2	Disconnector	P	253	19	20	20	20,21
CO3DC2	Disconnector Earth	P	253	28	20	20	20,21
COSW1	On / Off switch 1	P	253	79	20	20	20,21
COSW2	On / Off switch 2	P	253	80	20	20	20,21
COSW3	On / Off switch 3	P	253	81	20	20	20,21
COSW4	On / Off switch 4	P	253	82	20	20	20,21

9.7. Class 2 measurand sets

Explanations to the Table 9.7.-1:

SetNo	Class 2 measurand set No (1...11). Measurand set can be selected by setting the parameter “Measurement frame type”.
St	
A	According to the IEC 60870-5-103 standard
P	Private definition
FuncType/ InfoNum	Class 2 Frame identification Note: If stated as *), the signal type Ftyp corresponds with the unit function type. Unit function type may be adjusted via the “Function type” parameter.
Num data	The number of the data values in the class 2 message data part
Typ	Meas type 3 or 9 (when the definition is private, meas type 9 is used)
Data	Measurement data in class 2 message data part: Not available: -

Table 9.7.-1 Recommended Class 2 measurand sets

Set No		St	Functyp	Info Num	Num data	Typ	Data
1	Meas I: 144	A	*)	144	1	3	IL2
2	Meas I: 145	A	*)	145	2	3	IL2, U12
3	Meas I: 146	A	*)	146	4	3	IL1, U12, P, Q
4	Meas I: 147	A	*)	147	2	3	Io, Uo
5	Meas II: 148	A	*)	148	9	9	IL1, IL2, IL3, U1, U2, U3, P, Q, f
6	Meas II: ABB1	P	134	137	16	9	IL1, IL2, IL3, Io, -, -, -, U12, U23, U31, P, Q, f, -, -, PF
7	Meas II: ABB2	P	134	137	16	9	IL1, IL2, IL3, Io, U1, U2, U3, -, -, -, P, Q, f, -, -, PF
8	Meas II: ABB3	P	135	137	12	9	IL1, IL2, IL3, U1, U2, U3, Io, Uo, P, Q, PF, f
9	Meas II: ABB4	P	135	138	12	9	IL1, IL2, IL3, U12, U23, U31, Io, Uo, P, Q, PF, f
10	Meas II: ABB5	P	135	139	4	9	IL1, IL2, IL3, Io
11	Meas II: ABB6	P	135	140	5	9	IL1, IL2, IL3, Io, Uo
12	Meas II: ABB7	P	136	141	14	9	IL1, IL2, IL3, IL1B, IL2B, IL3B, U1, I0, U0, I0B, P, Q, PF, f
13	Meas II: ABB8	P	136	142	14	9	IL1, IL2, IL3, IL1B, IL2B, IL3B, U12, I0, I0B, U0, P, Q, PF, f
14	Meas II: ABB9	P	136	143	15	9	IL1, IL2, IL3, U12, U23, U31, U1b, I0, I0B, U0, U0B, P, Q, PF, f
15	Meas II: ABB10	P	136	144	15	9	IL1, IL2, IL3, U1, U2, U3, U12B, I0, IOB, U0, U0B, P, Q, PF, f
16	Meas II: ABB11	P	136	145	20	9	IL1, IL2, IL3, IL1B, IL2B, IL3B, U1, U2, U3, U1B, U2B, U3B, I0, I0B, U0, U0B, P, Q, PF, f
17	Meas II: ABB12	P	136	146	20	9	IL1, IL2, IL3, IL1B, IL2B, IL3B, U12, U23, U31, U12B, U23B, U31B, Io, IoB, Uo, UoB, P, Q, PF, f

RTD frame if card installed and frame selected

RTD**)		P	136	147	8	9	RTD1, RTD2, RTD3, RTD4, RTD5, RTD6, RTD7, RTD8

*) According to the device function type.
**) Selected by RTD data frame parameter.

RTD data nominal values

Nominal values are according to the RTD input signal type and the range parameters mentioned in the Technical Reference Manual rounded to the nearest integer (e.g. 2.5 = 3).

If linearization curve is used for RTD input, the nominal value of this channel is the absolute maximum value for this curve. A store and reset is needed after adjusting the RTD input signal type and range parameters, if new nominal values are wanted in IEC_103

Function blocks and available measurements

Table 9.7.-2 shows which function blocks produce measurement data mapped to the IEC_103 class 2 measurement frames. This is how the relay configuration is expected to be implemented. However, if signal types connected to a function block do not match the following table, corresponding locations in the class 2 frame will also be replaced by the actual signal types connected to the function block.

Table 9.7.-2 Function blocks and available measurements

FB name	Measurements
MECU1A	Io
MECU1B	Iob
MECU3A	IL1, IL2, IL3
MECU3B	IL1b, IL2b, IL3b
MEFR1	f
MEPE7	P, Q, PF
MEVO1A	Uo
MEVO1B	Uob
MEVO3A	U1, U2, U3, U12, U23, U31
MEVO3B	U1b, U2b, U3b, U12b, U23b, U31b

COLTC Tap changer position is transmitted as Class 1 data. Message type identification 4, float format.

Available measurements depend on the configuration (e.g. phase voltage or phase-to-phase voltage).

Example

If set No 11 is used, the ASDU octets will look like in the following figure:

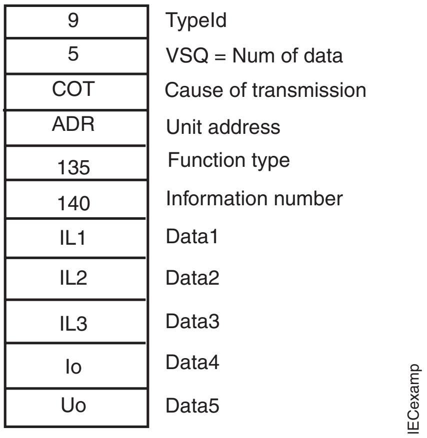


Fig. 9.7.-1 Example on ASDU octets

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