Controller for Petersen Coils

REG-DPA

- **Wall mounting version**
- **Panel-mount housing**
- **Standard DIN-rail assembly**

1. Application

The freely programmable REG-DPA regulator is used in medium and high-voltage grids to control arc suppression coils (Petersen coils) that are adjustable under continuous load. It can also solve all other control, measurement and recording tasks related to the Petersen coil.

Control methods:

- **Classic**

The regulator controls Petersen-coils in several ways. Depending on the requirements, the regulator can be set to a percentage or absolute detuning. For overhead transmission grids with high natural unbalance, a certain zero sequence voltage and detuning value can be set to balance between high neutral voltage displacement und right compensation. When an earth fault occurs, the regulator can correct the Petersen coil by the detuning and tune the grid to the resonance. There are a number of ways in which the regulator can control several Petersen coils in a compensation district.

- **Optional current injection**

In some grid configurations, it is possible that the Petersen coil cannot be tuned in the traditional way. For example such situations are:

- Very balanced grids (cable grids)
- Measuring signal that is heavily distorted by crosstalk (non-linear consumer or generator in the grid area)
- Overhead transmission grids with asymmetrical conditions

The optional current injection can deal with all of these side-effects and accurately tune the Petersen coil to the real grid situation.

Resistor control (increase residual watt current)

It contains a freely configurable resistance control to increase the residual watt current supporting fault finding using the cos(φ) method. A thermal image of that resistor is computed to protect the same as an independent function unit.

Take over control tasks for pulse location

The free programmability of the regulator enables it to perform special tasks, such as controlling a pulse cabinet.

Pulse locating is a method to search for earth faults in the medium voltage grid by introducing a pulse pattern to the fault current. The regulator can be equipped with a background program that controls and monitors the pulse locating unit. This ensures that the conditions for successful pulse locating are met.

Control system / Communication

The REG-DPA regulator has a system bus (E-LAN) that enables it to communicate with other system devices.

A parallel (relay contacts) and serial remote control centre connection are available. The following protocols are available (additional protocols on request):

- IEC 60870 - 5 - 101 / 103 / 104
- IEC 61850
- DNP 3.0 over Ethernet
- DNP 3.0
- MODBUS RTU / MODBUS TCP
- SPABUS

2. Characteristics

Multimaster system architecture

The REG-DPA is part of a range of devices that is based on a standard hardware platform.

If multiple devices are connected through the system bus E-LAN, every bus participant can be configured or read from a single PC. In addition, several PCs can access individual system participants (multimaster).

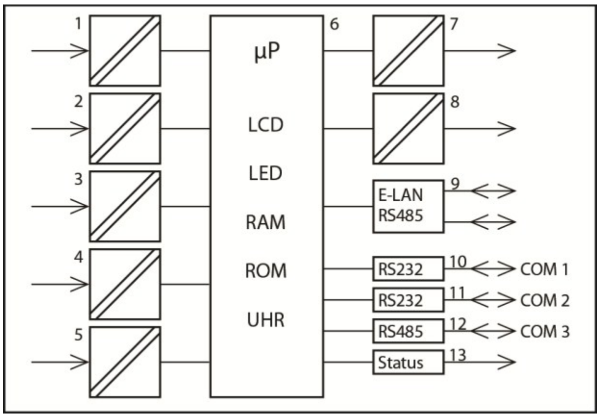


Figure 1: REG-DPA regulator functions

1	Voltage transducer (zero sequence voltage)
2	Position signal (resistance sensor) for the coil
3	Current transducer (e.g. current through the P-coil)
4	Binary inputs
5	Power supply
6	Display and processing unit
7	Binary outputs
8	Analogue outputs
9	E-LAN connection (2 x RS485 with repeater function)
10	COM1, RS232
11	COM2, RS232
12	COM3, RS485
13	Status - Signal (relay)

2.1 Regulator functions

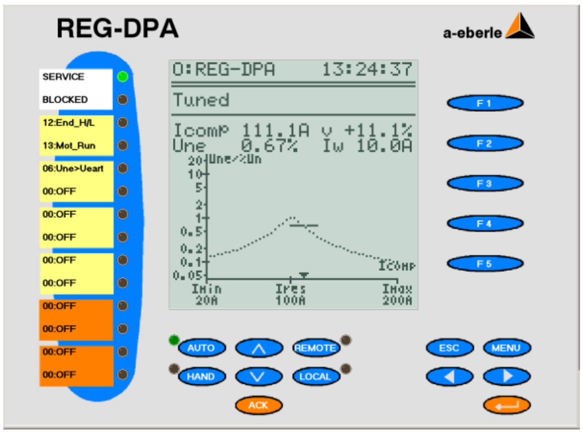


Figure 2: Regulation of the detuning

A change in the grid's switching status is recognized by a change in the zero sequence voltage. The regulator repositions the Petersen coil while taking into account the configurable conditions to the set detuning current.

The following data are displayed in addition to the regulator's status:

- Coil position
- Zero sequence voltage
- Detuning (v)
- Total active current in the grid over the fault location (Iw)
- The resonance curve and its parameters

The switching status is monitored through a complex evaluation of the zero sequence voltage (value and phase).

Regulation to percentage or absolute detuning current:

The regulator positions the Petersen coil according to the configured setpoint value and effective positioning tolerance.

Special requirements for the 110 kV grid

Additional parameters can be taken into account for high-voltage grids, such as a maximum continuous adjacent zero sequence voltage. The following conditions are also taken into account:

- Value of the allowable zero sequence voltage
- Compensation limit = Value of the detuning current that may not be exceeded

Adjusting the Petersen coil during the earth fault:

The regulator can be configured so that the Petersen-coil can be corrected by compensation value during an earth fault. Additional corrections can be made through binary inputs.

Parallel operation of Petersen coils:

A number of methods are available to control Petersen coils that are switched in parallel.

- Parallel control with communication over E-LAN (master-slave)
- Parallel control without communication
- Parallel control with recognition of external grid coupling (only with optional current injection)

2.2 Recorder and logbook function

An integrated **recorder** continuously records the progression of the zero sequence voltage and the coil position. The time line diagram can both be displayed and evaluated on the regulator or on a PC. This integrated 'grid spy' enables long-term changes in the zero sequence voltage to be recorded and monitored. The configuration software WinEDC is used to evaluate and archive recorded data on the PC.

The progression of the zero sequence voltage Uen is also displayed as a line diagram. The time grid (feed rate) for the recording is adjustable. The stored values and the allocated time can be displayed using a keyboard or PC.

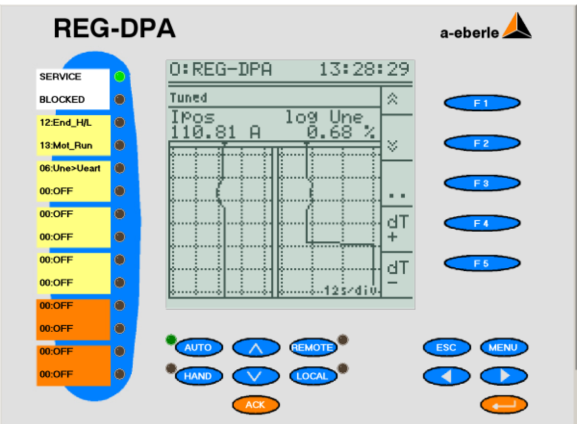


Figure 3: Recorderview

Important events are recorded in a **logbook** with date and time information and can be displayed on the screen or a PC statistic

2.3 Regulator statistics

Statistics mode displays the most important sum times and counters. This information can be used to determine how many tuning procedures were carried out in which time frame, and how many were successfully completed. It also enables you to recognize for how many tuning procedures the P-coil's adjustment range was insufficient.

Statistics mode also records the number of earth faults and increases in residual watt current that were carried out.

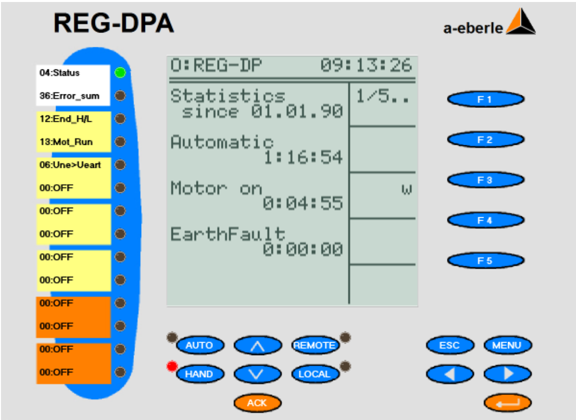


Figure 4: Statistics Page 1/5

2.4 Resistor control

The freely configurable and autonomous resistor control automatically connects a resistor to increase the residual watt current in the event of an earth fault. A resistor's load is monitored with a 'thermal image' whereby the current zero sequence voltage ¬is taken into account when it is connected. The connection is blocked in the event of over temperature. The remaining resistor connections are displayed in the screen until the limit temperature has been reached.

A recurring connection by transient earth faults can be suppressed.

A resistor can be connected manually through a binary input or the remote control system.

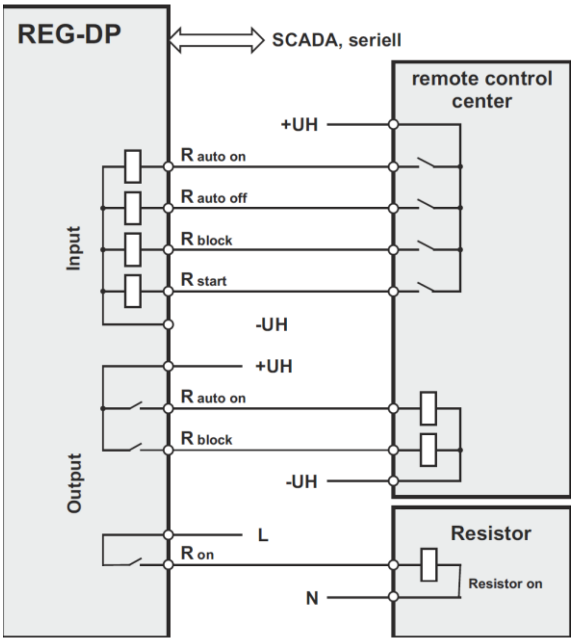


Figure 5: Example for the resistor control

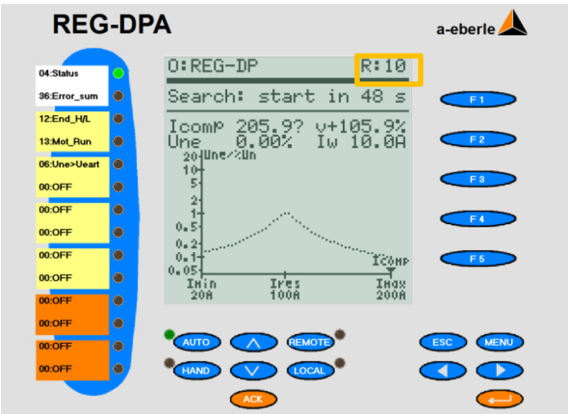


Figure 6: R:10 = Number of possible resistor cycles

2.5 Configuration

The configuration of the regulator is menu driven, and therefore very easy.

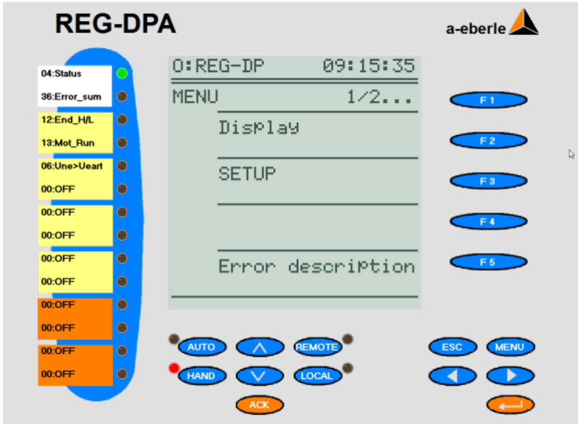


Figure 7: Regulator Menu

The putting into operation of the regulator and its configuration for the P-coil (e.g. linearization of the coil position) is largely automatic. The process' reactions are continuously monitored and checked for plausibility. Errors are analysed and displayed in the status bar. Additional information and troubleshooting tips can be viewed as an additional menu.

3. Technical specifications

3.1 Regulations and standards

- IEC 61010-1
- CAN/CSA C22.2 No. 1010.1-92
- IEC 60255-22-1
- IEC 61326-1
- IEC 60529
- IEC 60068-1
- IEC 60688
- IEC 61000-6-2
- IEC 61000-6-4
- IEC 61000-6-5

3.2 AC voltage inputs

AC voltage input (U_{en})	
Zero sequence voltage U_o	0,1V ... 120V
Shape of the curve	Sinus
Frequency range	45....50....60....65 Hz
Internal consumption	≤ U^2 / 100 kΩ
Overload capacity	1,2 * 120V

AC voltage input (U_{12})	
Synchronization voltage U_{12}	0,1V ... 230V
Shape of the curve	Sinus
Frequency range	45....50....60....65 Hz
Internal consumption	≤ U^2 / 100 kΩ
Overload capacity	1,2 * 230V

3.3 AC current inputs

AC current inputs (I_p und I_2)	
Current range	1 A / 5 A (hardware- und softwaremäßig wählbar)
Shape of the curve	Sinus
Frequency range	45....50....60....65 Hz
Internal consumption	≤0,5 VA
Overload capacity	10 A continuous 30 A for 10 s 60 A for 1 s 500 A for 5 ms

3.4 Potentiometer input

Position signal (I_{Pos})	
Transmitter	Potentiometer
Nominal value Rn	0,2 kΩ, 0,5 kΩ, 1 kΩ, 3 kΩ
Measuring voltage	ca. 5 VDC
Current selectable through jumper (pure)	1 mA (3 kOhm) 5 mA (600 Ohm) 10 mA (300 Ohm) 20 mA (150 Ohm)

Error message when sensor breaks or is short circuited or when the voltage of the loop is outside of the measurement range.

3.5 Binary Inputs (BI)

Binary inputs (BI)	
Inputs E1 ... E16	
Control signals U_{st}	im Bereich AC/DC 48 V ... 250 V,
Shape of the curve, permissible	Rechteck, Sinus
48 V...250 V – H - Level – L - Level	 ≥ 48 V < 10 V
Signal frequency	DC, 40 ... 70 Hz
Input resistance	108 kΩ
Potential isolation	Optocoupler; each galvanically isolated from each other.
Debouncing	Software filter with integrated 50Hz filter

3.6 Binary outputs (BO)

Binary outputs (BO)	
R 1 ... R13 max. switching frequency	≤ 1 Hz
Potential isolation	Isolated from all device-internal potentials
Contact load	AC: 250 V, 5 A (cosφ = 1.0) AC: 250 V, 3 A (cosφ = 0.4) Switching capacity max. 1250 VA DC: 30 V, 5 A resistive DC: 30 V, 3.5 A L/R=7 ms DC: 110 V, 0.5 A resistive DC: 220 V, 0.3 A resistive Switching capacity max. 150 W
Inrush current	250 V AC, 30 V DC 10 A for max. 4 s
Switching operations	$\geq 5 \cdot 10^5$ electrical

3.7 Analogue outputs

20 mA - Analogue outputs	
Quantity	See order specifications
Output range Y1...Y2	-20 mA...0...20 mA, Y1 and Y2 freely programmable
Control limit	± 1.2 Y2
Potential isolation	Optocoupler
Burden range	0 ≤ R ≤ 8 V / Y2
Alternating component	< 0.5% of Y2

The output can be continuously short-circuited or operated open. The output connections are galvanically isolated from all of the other circuits.

3.8 Display

Display	
LC – Display	128 x 128 displays graphics
Lighting	LED, switches off after 15 min

Reference conditions	
Reference temperature	23°C ± 1 K
Input quantities	U_E = 0 ... 120V U_{12} = 0,1 ... 230V I_E = 0 ... 1A / 0 ... 5A
Auxiliary voltage	$H = H_n \pm 1$ %
Frequency	45 Hz...65 Hz
Shape of the curve	Sinusoidal, form factor 1.1107
Burden (only for Characteristics E91...E99)	R_n = 5 V / Y2 ± 1 %
Other	IEC 60688 - Part 1

3.9 Electrical safety

Electrical safety	
Safety class	I
Degree of pollution	2

Over-voltage category	II and III
Category III	**Category II**
Input circuits for current and voltage transducer	Control circuits, analogue inputs, analogue outputs, power supply, ELAN, COMs

Operating voltages		
50 V	**120 V**	**230 V**
E-LAN, COM1 ... COM3 Analogue inputs, analogue outputs Inputs 10...50 V	Voltage inputs, current inputs	Auxiliary voltage, sync voltage for binary inputs (E1...E16, Relay outputs R1...R13), status

3.10 Power supply

Stromversorgung		
Characteristic	**H1**	**H2**
AC	85...264V	-
DC	88...280V	18 ...72V
Power consump-tion	≤ 33 VA	≤ 15 W
Frequency	50 Hz / 60 Hz	-
Microfuse	T1 250V	T2 250V

The following applies to all characteristics:

Voltage dips of ≤ 40 ms result neither in data loss nor malfunctions.

3.11 Electromagnetic compatibility

Electromagnetic compatibility	
EMC requirements	EN 61326-1 Equipment class A Continuous, un-monitored operation, industrial area and EN 61000-6-2 and 61000-6-4
Interference emissions	
Conducted and radiated emission	EN 61326 Table 3 EN 61000-6-4
Harmonic currents	EN 61000-3-2
Voltage fluctuations and flicker	EN 61000-3-3
Conducted and radiated emission	EN 61326 Table 3 EN 61000-6-4
Disturbance immunity	EN 61326 Table A1 and EN 61000-6-2
ESD	IEC 61000-6-5 6 kV/8 kV contact/air
Electromagnetic fields	IEC 61000-4-3 80 – 2000 MHz: 10 V/m
Fast transient	IEC 61000-4-4 4 kV/2 kV
Surge voltages	IEC 61000-4-5 4 kV/2 kV
Conducted HF signals	IEC 61000-4-6 150 kHz – 80 MHz: 10 V
Power-frequency mag-netic fields	IEC 61000-4-8 100 A/m (50 Hz), contin-uous 1000 A/m (50 Hz), 1 s
Voltage dips	IEC 61000-4-11 30% / 20 ms, 60% / 1 s
Voltage interruptions	IEC 61000-4-11 100% / 5s
Damped oscillations	IEC 61000-4-12, Class 3, 2.5 kV

3.12 Climatic conditions

Ambient conditions	
Temperature range Transport and storage function	 -15 °C ... +60 °C -25 °C ... +65 °C
Dry cold	IEC 60068-2-1, - 15 °C / 16 h
Dry heat	IEC 60068-2-2, + 65 °C / 16 h
Humid heat constant	IEC 60068-2-78 + 40 °C / 93% / 2 days
Humid heat cyclical	IEC 60068-2-30 12+12 h, 6 cycles +55 °C / 93%
Drop and topple over	IEC 60068-2-31 100 mm drop height, unpackaged
Vibration	IEC 60255-21-1, Class 1
Shock	IEC 60255-21-2, Class 1
Earthquake resistance	IEC 60255-21-3, Class 1

3.13 Storage

Storage	
Firmware and recorder data Characteristic S2	Flash storage
Device characteris-tics and calibration data	serial EEPROM with ≥ 1000 k write/read cycles
Other data and recorder data Characteristic S1	SDRAM, battery-backed (plug-in lithium battery), backup to flash storage possible

3.14 Mechanical design

Mechanical design	
Housing	Sheet steel, RAL 7035 gray
Height Width Overall depth Mounting depth Mass	288 mm 216 mm 114 mm 87 mm ≤ 3 kg
Housing doors	with silica glass
Front panel	plastic, RAL 7035 gray, on aluminium supports
Control panel cutout – Height – Width	 282 mm 210 mm
Protection type	IP 54
Rain Test	3R UL50
In-panel mounting	in conformity with DIN 41494 Part 5

3.15 Optical Interface

The REG-DPA regulator can also be directly connect-ed via a fibre optic cable interface. Sending and receiving devices are available for glass and plastic fibre optic cables.

In addition, it can be choose between various me-chanical connection possibilities (ST or FSMA connection). Features V13 to V19 give an overview of the various possibilities

3.16 Electrical logical interface

Logic level of receiving output : CMOS
(Uh_{min} : > 0,9VCC, Ul_{max} < 0,1VCC @ Io = 1mA)

Logic level of receiving intput: CMOS
(Uh_{min} : > 0,7VCC, Ul_{max} < 0,3VCC), Schmitt-Trigger

3.17 Optical transmitter

Product	Type	Fibre	Pmin [dBm][1)]	Pmax [dBm][1)]
Glass-ST Glass-SMA	HFBR-1414-T HFBR-1404 λ = 820nm	50/125µm NA=0,2	-19,8	-12,8
		62,5/125µm NA=0,275	-16,0	-9,0
		100/140µm NA=0,3	-10,5	-3,5
		200µm HCS NA=0,37	-6,2	+1,8
POF_ST	HFBR-1515B λ = 650nm	1mm POF	-7,5	-3,5
		200µm HCS	-18,0	-8,5
POF_SMA	HFBR-1505C λ = 650nm	1mm POF	-6,2	0,0
		200µm HCS	-16,9	-8,5

3.18 Optical receiver

Product	Type	Fibre	Pmin [dBm][2)]	Pmax [dBm][2)]
Glass-ST Glass-SMA	HFBR-2412-T HFBR-2402 0 ... 5MBd λ = 820nm	100/140µm NA=0,3	-24,0	-10,0
POF_ST	HFBR-2515B 0 ... 10MBd λ = 650nm	1mm POF	-20,0	0,0
		200µm HCS	-22,0	-2,0
POF_SMA	HFBR-2505C 0 ... 10MBd λ = 650nm	1mm POF	-21,6	-2,0
		200µm HCS	-23,0	-3,4

4. General information about the connections

The regulator has three circuit boards / connection levels.

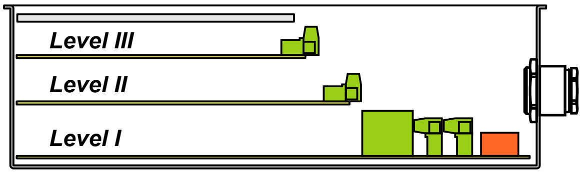


Figure 8: Internal structure of REG-DPA

On level 1 the auxiliary voltage, input voltage and currents, as well as the relay outputs, binary inputs, etc. are connected.

Level II contains the hardware for all control system connections is contained. The appropriate connection elements on Level II must be used for RS232 or RS485 connections. If an Ethernet connection is used, the corresponding connection on Level II is also available (must be connected for IEC 61850 or IEC 60870-5-104!).

The connection elements for fibre-optic cables (send and receive diodes as ST or FSMA connection) are mounted directly on the flange plate and can be connected there without having to open the device.

Figure 9: Fiber optic (ST-connection)

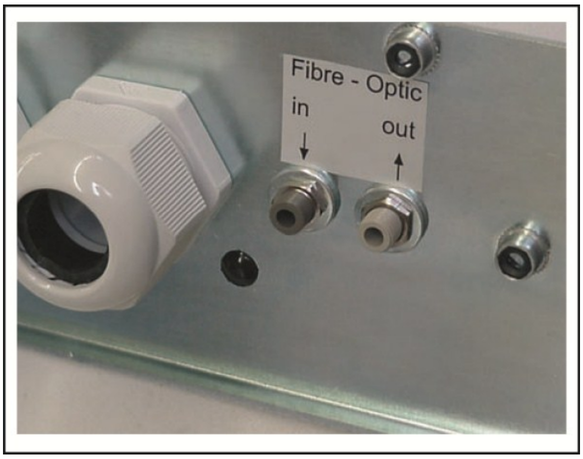


Figure 10: Fibre optic (FSMA-connection)

Furthermore, additional binary inputs and outputs as well as mA inputs and outputs can also be accommodated on Level II.

In total, two connection points are available and they can be **equipped with the following modules:**

Modul 1:	6 binary inputs AC/DC 48V...250V
Modul 1:	6 relay outputs
Modul 1:	2 x 20 mA- inputs
Modul 1:	2 x 20 mA- outputs

Level III contains the connections for the individual COM, E-LAN, the analogue inputs and outputs and the PT100 input

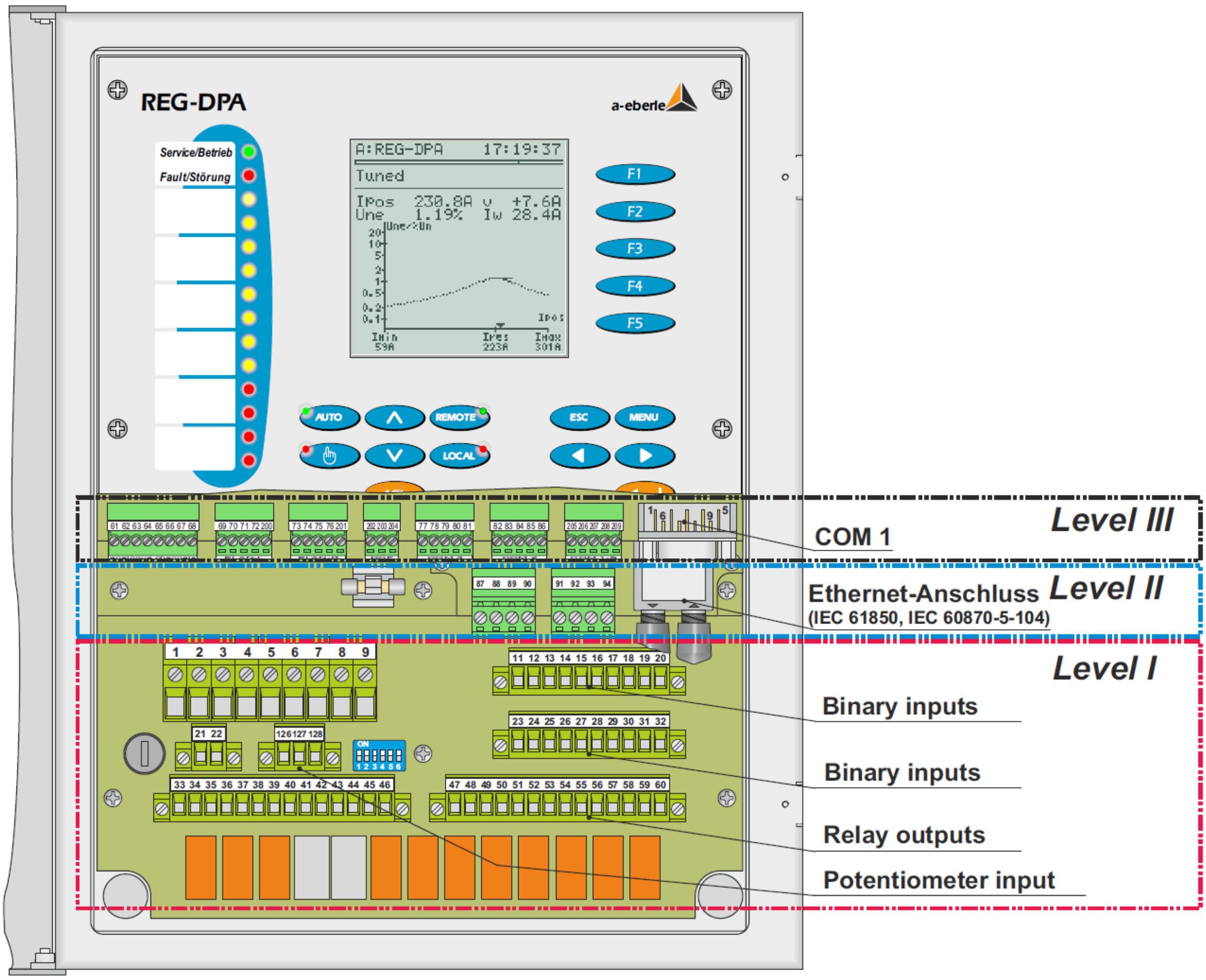


Figure 11: Location of the connector terminals

5. Terminal blocks

5.1 Level I

5.1.1 Binary outputs

	Nr.	Description	Function	Configuration
Level I	33	R3	NOC	freely programmable
	34		Terminal	
	35	R4	NOC	freely programmable
	36		Terminal	
	37	R5	NOC	freely programmable
	38		Terminal	
	39	R2	NCC	Higher
	40		Terminal	
	41		Terminal	
	42		NOC	
	43	R1	NCC	Lower
	44		Terminal	
	45		Terminal	
	46		NOC	
	47	R6	NOC	freely programmable
	48	R7	NOC	freely programmable
	49	R8	NOC	freely programmable
	50	R9	NOC	freely programmable
	51	R10	NOC	freely programmable
	52	R11	NOC	freely programmable
	53	R6..R11	Terminal	
	54	R13	NOC	closes at fault
	55		Terminal	Life-contact (Status)
	56		NCC r	opens at fault
	57	R12	NOC	HAND
	58		Terminal	
	59		NCC	AUTO

All of the REG-DPA's are freely programmable, but have default settings.

5.1.2 Binary inputs

	Nr.	Description			Configuration
Level I	11	Binary inputs	E1	+	Endswitch high
	12		E2	+	Endswitch low
	13		Terminal E1..E2	-	
	14		E3	+	freely programmable
	15		E4	+	freely programmable
	16		E5	+	freely programmable
	17		E6	+	freely programmable
	18		E7	+	freely programmable
	19		E8	+	freely programmable
	20		Terminal E3..E8	-	
	23		E9	+	freely programmable
	24		E10	+	freely programmable
	25		E11	+	freely programmable
	26		E12	+	freely programmable
	27		Terminal E9..E11	-	
	28		E13	+	freely programmable
	29		E14	+	freely programmable
	30		E15	+	freely programmable
	31		E16	+	freely programmable
	32		Terminal E13..E16	-	

5.1.3 U_{ne}, U_{Sync}, I_p and auxiliary voltage

	Nr.	Description				Configuration
Level I	1	Synchronisation voltage	(U_{sync})	L1		U_{12}
	2			L2		
	4	Zero sequence voltage	U_{ne}	n		U_{NE}
	5			e		
	7	Stromeingang	I_p	k		I_p
	8			l		
	21	Auxiliary voltage	U_H	L/(+)		U_H
	22			N/(-)		
	126	Coil position	I_{pos}	Pot +		
	127			Us		
	128			Pot-		

5.2 Level II (additional inputs and outputs)

5.2.1 Scada module

	Nr.	Descripiton	Function		Configuration
Level II		Scada module			IEC LON DNP 3.0 SPA Bus Modbus

5.2.2 Feature C01

6 additional binary inputs AC/DC 48…250V

	Nr.	Description	Function		Configuration
Module 1	100	Binary inputs	E17	+	freely programmable
	101		E18	+	freely programmable
	102		E19	+	freely programmable
	103		E20	+	freely programmable
	104		E21	+	freely programmable
	105		E22	+	freely programmable
	106		Terminal E17..E22	-	

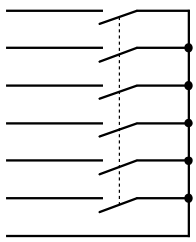
5.2.3 Feature C02

12 additional binary inputs AC/DC 48…250V

	Nr.	Description	Function		Configuration
Module 1	100	Binary inputs	E17	+	freely programmable
	101		E18	+	freely programmable
	102		E19	+	freely programmable
	103		E20	+	freely programmable
	104		E21	+	freely programmable
	105		E22	+	freely programmable
	106		Terminal E17..E22	-	
Module 1	107	Binary inputs	E23	+	freely programmable
	108		E24	+	freely programmable
	109		E25	+	freely programmable
	110		E26	+	freely programmable
	111		E27	+	freely programmable
	112		E28	+	freely programmable
	113		Terminal E23..E28	-	

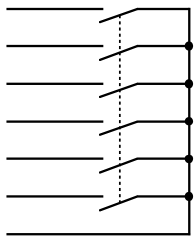
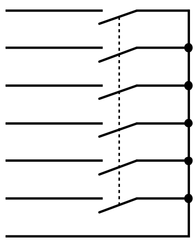
5.2.4 Feature C03

6 additional relays (NO contacts)

	Nr.	Description	Function		Configuration
Module 2	100		R14	NOC	freely programmable
	101		R15	NOC	freely programmable
	102		R16	NOC	freely programmable
	103		R17	NOC	freely programmable
	104		R18	NOC	freely programmable
	105		R19	NOC	freely programmable
	106		R14..R19	Terminal	

5.2.5 Feature C04

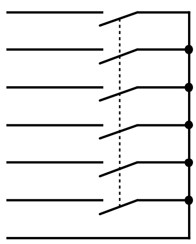
12 additional relays (NO contacts)

	Nr.	Description	Function		Configuration
Module 2	100		R14	NOC	freely programmable
	101		R15	NOC	freely programmable
	102		R16	NOC	freely programmable
	103		R17	NOC	freely programmable
	104		R18	NOC	freely programmable
	105		R19	NOC	freely programmable
	106		R14..R19	Terminal	
Module 2	107		R20	NOC	freely programmable
	108		R21	NOC	freely programmable
	109		R22	NOC	freely programmable
	110		R23	NOC	freely programmable
	111		R24	NOC	freely programmable
	112		R25	NOC	freely programmable
	113		R20..R25	Terminal	

5.2.6 Feature C05

6 additional binary inputs AC/DC 48…250V

6 additional relays (NO contacts)

	Nr.	Description	Function		Configuration
Module 1	100	Binary inputs	E17	+	freely programmable
	101		E18	+	freely programmable
	102		E19	+	freely programmable
	103		E20	+	freely programmable
	104		E21	+	freely programmable
	105		E22	+	freely programmable
	106		E17..E22	Terminal (-)	
Module 2	107		R14	NOC	freely programmable
	108		R15	NOC	freely programmable
	109		R16	NOC	freely programmable
	110		R17	NOC	freely programmable
	111		R18	NOC	freely programmable
	112		R19	NOC	freely programmable
	113		R14..R19	Terminal	

5.2.7 Feature C06

2 additional analogue 20mA inputs

	Nr.	Description	Function		Configuration
Module 3	100	Analogue input	E10	+	
	101			-	
	102	Analogue input	E11	+	
	103			+	

5.2.8 Feature C07

4 additional analogue 20mA inputs

	Nr.	Description	Function		Configuration
Module 3	100	Analogue input	E10	+	
	101			-	
	102	Analogue input	E11	+	
	103			+	
Module 3	104	Analogue input	E12	+	
	105			-	
	106	Analogue input	E13	+	
	107			+	

5.2.9 Feature C08

2 additional analogue 20mA outputs

	Nr.	Description	Function		Configuration
Module 3	100	Analogue output	A10	+	
	101			-	
	102	Analogue output	A11	+	
	103			+	

5.2.10 Feature C09

4 additional analogue 20mA outputs

	Nr.	Description	Function		Configuration
Module 3	100	Analogue output	A10	+	
	101			-	
	102	Analogue output	A11	+	
	103			+	
Module 3	104	Analogue output	A12	+	
	105			-	
	106	Analogue output	A13	+	
	107			+	

6. Block diagrams

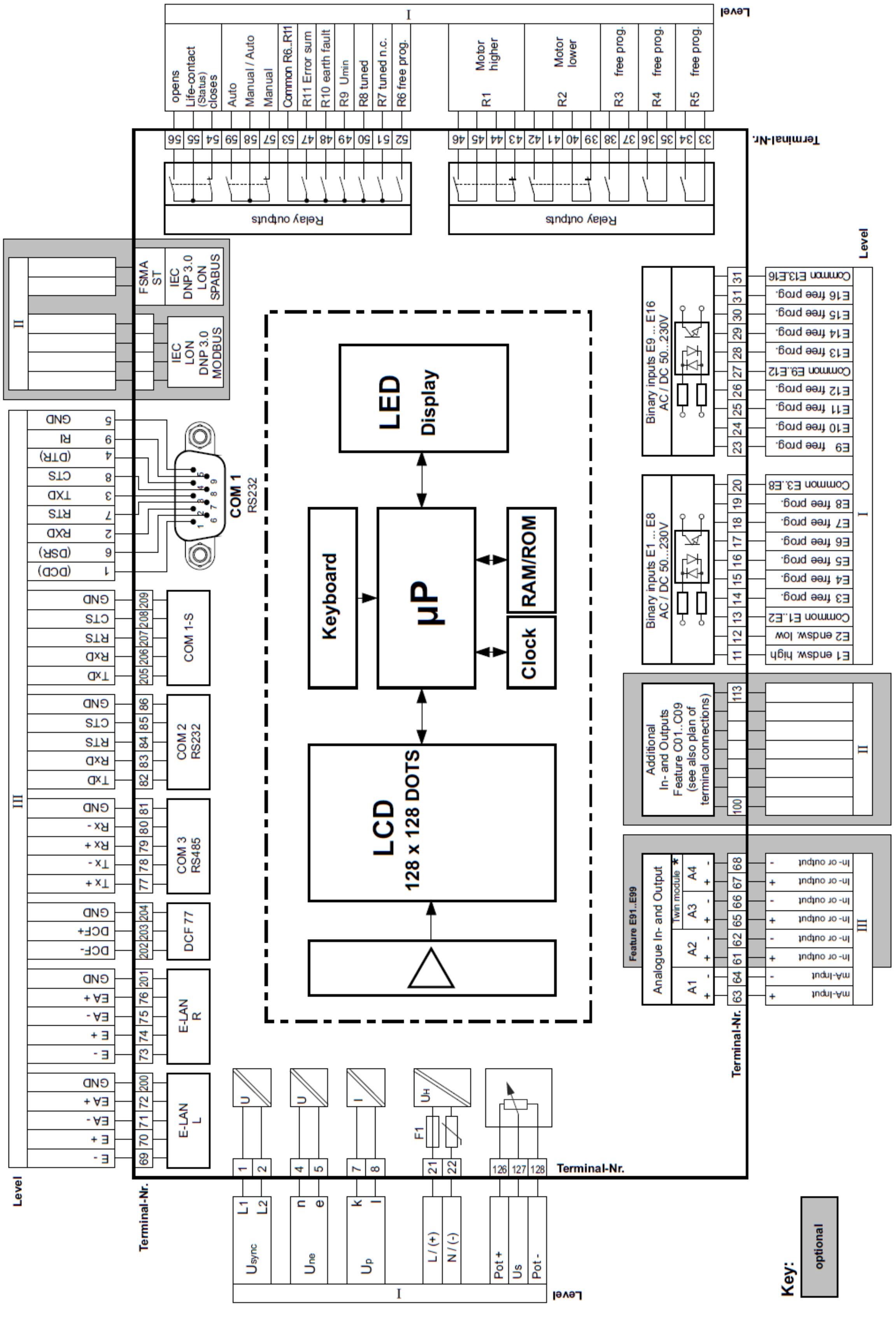


Figure 12: Overview of default configuration REG-DPA

7. Housing technology

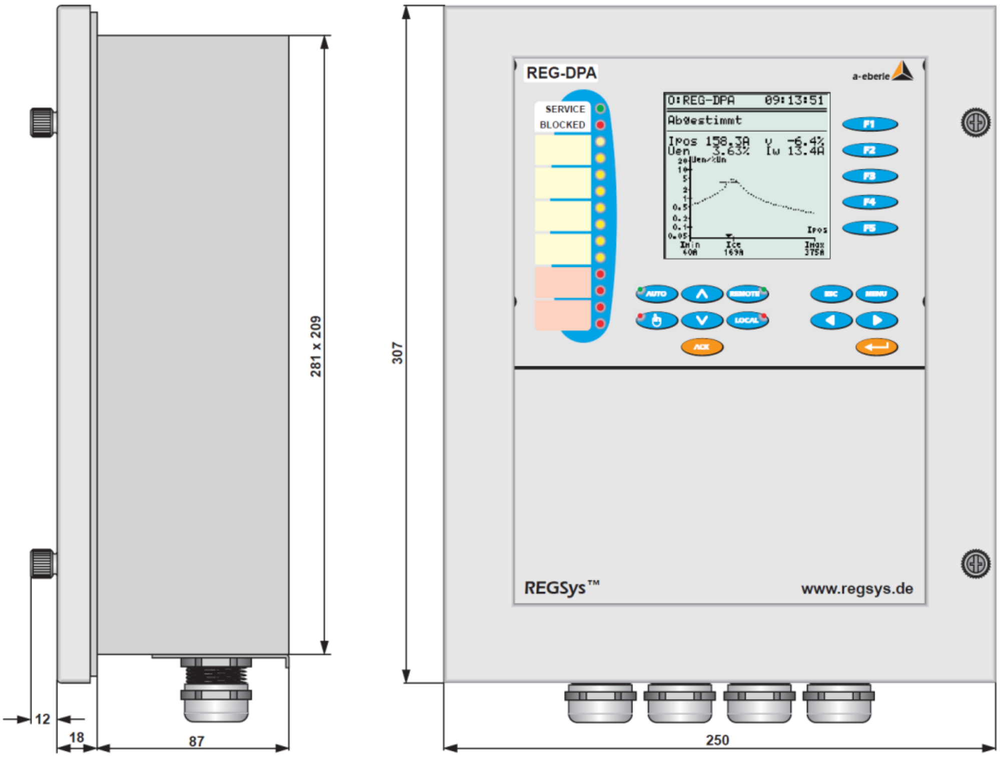


Figure 13: Mechanical dimensions REG-DPA

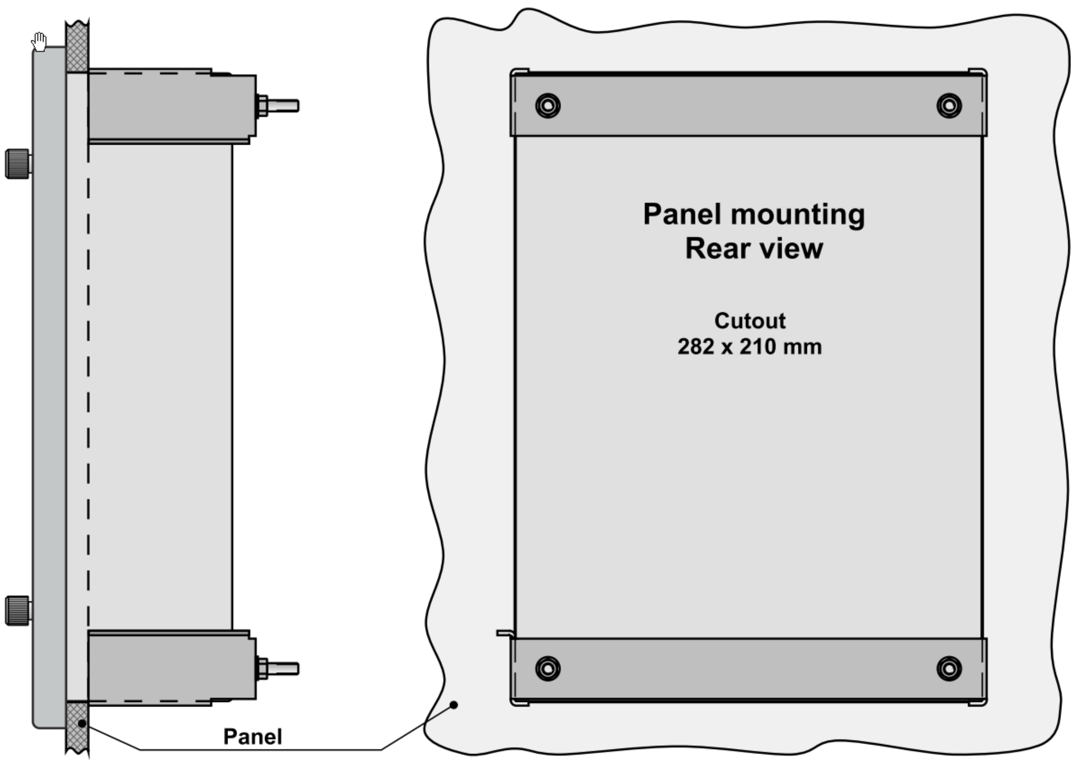


Figure 14: Mechanical dimensions, Panel mount housing

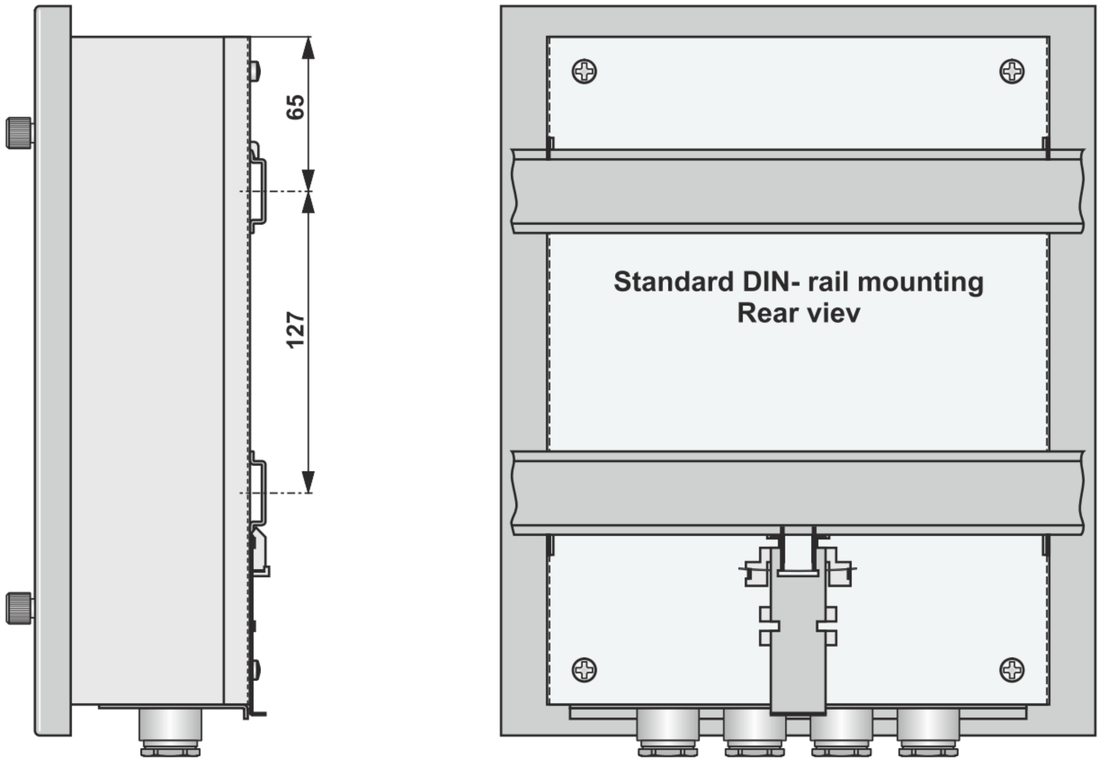


Figure 15: Mechanical dimensions, standard DIN-rail assembling

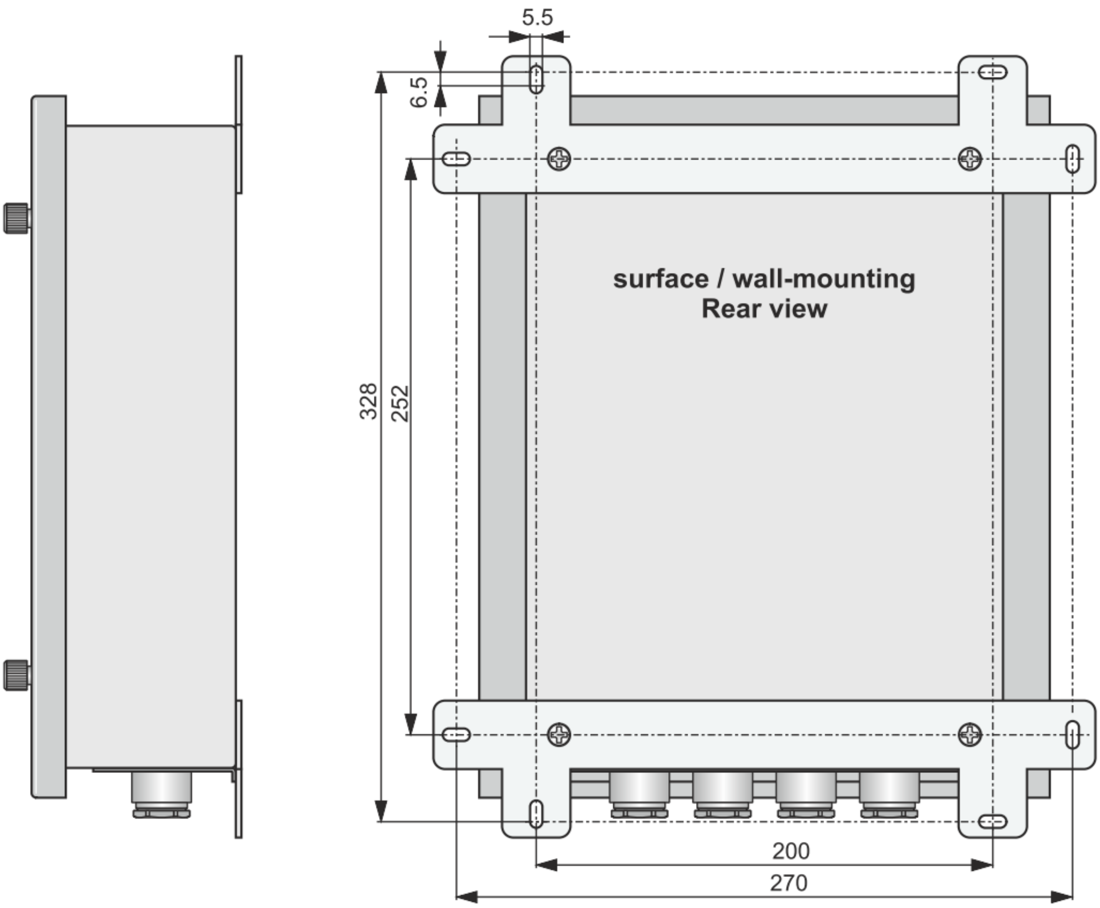


Figure 16: Mechanical dimensions, wall-mounting version

8. Interfaces

RS232 Interfaces

The REG-DPA regulator has two RS 232 serial interfaces (COM1, COM2); COM 1 is accessible on the front panel and COM 2 on the terminal strip. COM 2 is used to connect the regulator system to higher level control systems. Customer-specific protocols can be implemented through COM 2.

Connection elements

Connection element	
COM 1	Pin strip, sub min D on the front of the device, pin allocation as PC multipoint terminal connector
COM1S	plug connector (Level III)
COM 2	plug connector (Level III)
	plug connector (Level III)
Connection options	PC, terminal, modem, PLC
Number of data bits/protocol	Parity 8, even, off, odd
Transmission rate bit/s	1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115000
Handshake	RTS / CTS or X_{ON} / X_{OFF}

RS485 interfaces

- Connection to E-LAN
- Dual interface RS 485 with repeater function

E-LAN (Energy Local Area Network)

Characteristics

- 255 addressable participants
- Multi-master structure
- Integrated repeater function
- Open ring, bus or a mixture of bus and ring
- Protocol is based on SDLC/HDLC frames
- Transmission rate 62.5 kbit/s or 125 kbit/s
- Frame length 10 ... 30 Bytes
- medium-throughput approx. 100 frames/s

COM3

Use to connect ≤ 15 random interface modules (ANA-D, BIN-D) to the regulator REG-DPA.

9. Basic REG-DPA connection to Petersen coil

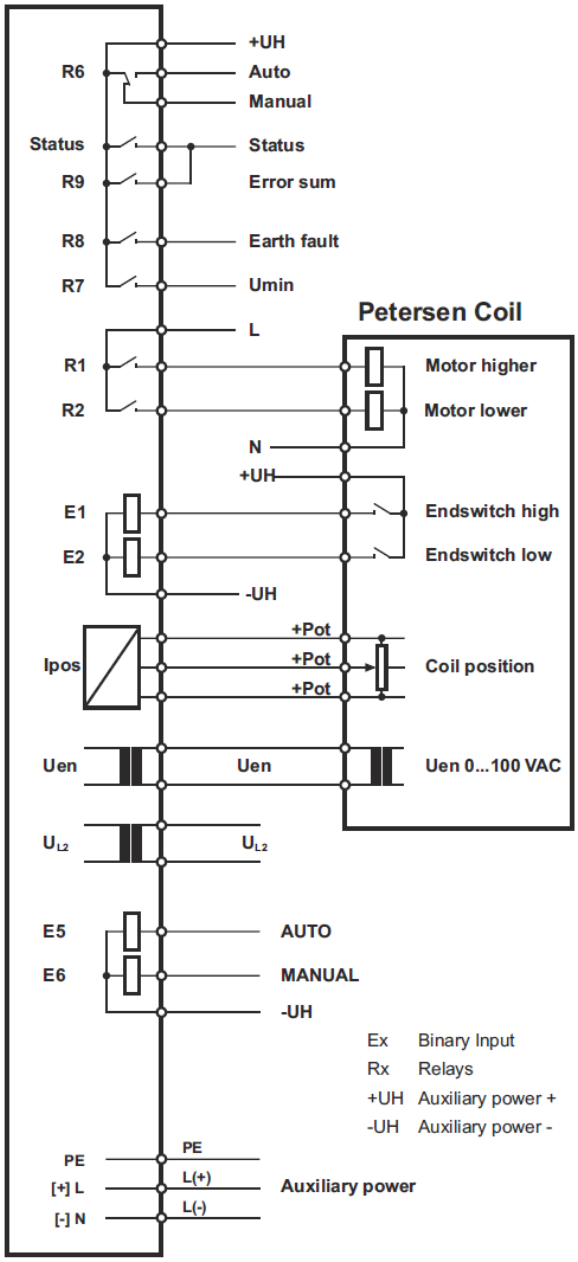


Figure 17: Connecting REG-DPA to a Petersen coil

10. Optional current injection

There are situations in the grid in which classic regulation cannot be used to successfully tune the Petersen coil.

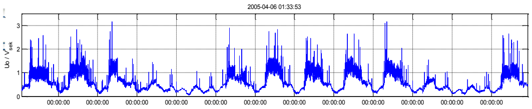


Figure 18: Flickering zero sequence voltage

- Flickering zero sequence voltage
- Very symmetrical grids (balanced)

We developed the optional current injection specifically for these cases.

The current injection creates a signal that is fed into the grid through the power auxiliary winding in the Petersen coil. The REG-DPA calculates a resonance curve based on the grid's response (zero sequence voltage).

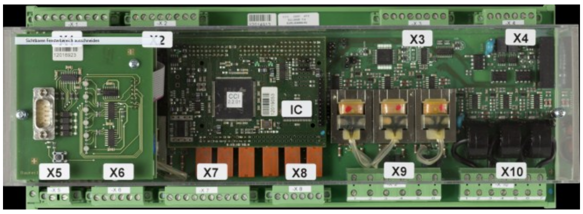


Figure 19: Current feed-in controller (CCI Controller)

10.1 Four connections to retrofit the current injection

The following connections have to be established if the current feed-in is to be retrofitted:

- **Power supply 230 V AC** (internally fused with 16 A)
- **Communication connection** between REG-DPA **(COM3)** and CCI controller; 4-wire RS 485 shielded telephone cable; distance CCI to REG-DPA up to 200 m
- Connection **to the power auxiliary winding** designed for 16 A; voltage-proof up to 500 V AC
- **U_{en} measurement** parallel to REG-DPA; Ex. see next pages

10.2 Technical specifications

10.2.1 CCI Controller power supply

Power supply AC Version	
Nominal voltage (U_n)	100...240 V AC 100...350 V DC
Overload capacity	1.3 * U_n
Overload for 1s	2 * U_n
Power consumption	≤ 15 VA
Frequency	DC or 50/60 Hz
Voltage dip (100%)	< 50 ms

Power supply DC Version	
Nominal voltage (U_n)	110 V DC ±20%
Overload capacity	1.3 * U_n
Overload for 1s	2 * U_n
Power consumption	≤ 15 VA
Voltage dip (100%)	< 50 ms

10.2.2 CCI Controller measurement inputs

AC voltage inputs U1...U3	
Voltage range U_{nom} with jumper without jumper	 0...120 V 0...500 V
Shape of the curve	Sine
Frequency range	45....50....55 Hz
Input resistance with jumper without jumper	 60 kΩ 280 kΩ
Permanent overload	U_{nom} *1.2

AC voltage inputs L1...L3	
Voltage range U_{nom}	0...250 V
Shape of the curve	Sine
Frequency range	45....50....55 Hz
Input resistance	140 kΩ
Permanent overload	U_{nom} *1.2

AC power inputs I1...I3	
Current range I_{nom} with jumper without jumper	 0...5 A 0...25 A
Shape of the curve	Sine
Frequency range	45....50....55 Hz
Power consumption	≤ 0.1 VA
Permanent overload Permanent ≤ 10s ≤ 1s ≤ 5ms	I_{nom} *1.2 10 A 30 A 100 A 500 A

10.2.3 CCI Controller binary inputs

Binary inputs E1...E6	
Input voltage	AC and DC
H - Level E1...E2 E3...E4 E5...E6	 < 80 V AC/DC < 10 V AC/DC < 65 V AC/DC
L - Level E1...E2 E3...E4 E5...E6	 < 40 V AC/DC < 5 V AC/DC < 45 V AC/DC
Signal frequency	DC...65 Hz
Potential isolation	Optocoupler
Input resistance E1, E2 E3, E4 E5, E6	 ca. 100 kΩ ca. 5 kΩ ca. 100 kΩ
Potential isolation	Optocoupler; all inputs galvanically isolated from each other

10.2.4 CCI Controller binary inputs

Relay outputs	
max. switching frequen-cy	≤ 1 kHz
Contact load	AC:250 V, 5 A (cos φ = 1.0) AC:250 V, 3 A (cos φ = 0.4) DC switching capacity: 250 V_{DC}: <= 75 W 30 V_{DC}: <= 150 W
Switching operations	> 10^5 electrical
Potential isolation	galvanically isolated from all device-internal potentials

10.3 Inductance (derating)

Inductance	
Quantity	2
Inductance	104 mH
Nominal frequency:	50 Hz
Voltage range	up to 550 V AC

10.4 Connection options for current injection to REG-DPA and Petersen coil

A magnetic coupling between the power auxiliary winding and the measuring transducer for Uo directly on the P-coil can affect the calculation results. We recommend the following interconnection options when measuring Uo in conjunction with the current injection.

Figure 20: Example of in-panel mounting: Current injection mounted directly into the motor drive box of the Petersen coil

10.4.1 Connections to measure U_o at open delta winding

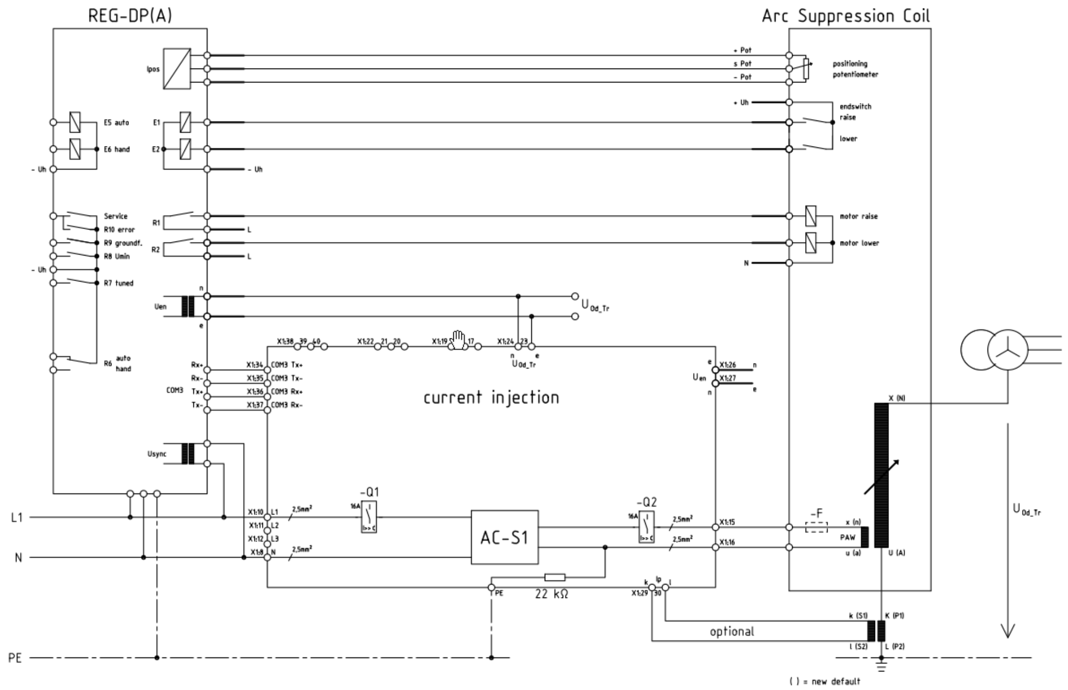


Figure 21: REG-DPA connection, current injection and Petersen coil;

10.4.2 Connections to measure U_0 through separate/external measuring transducer

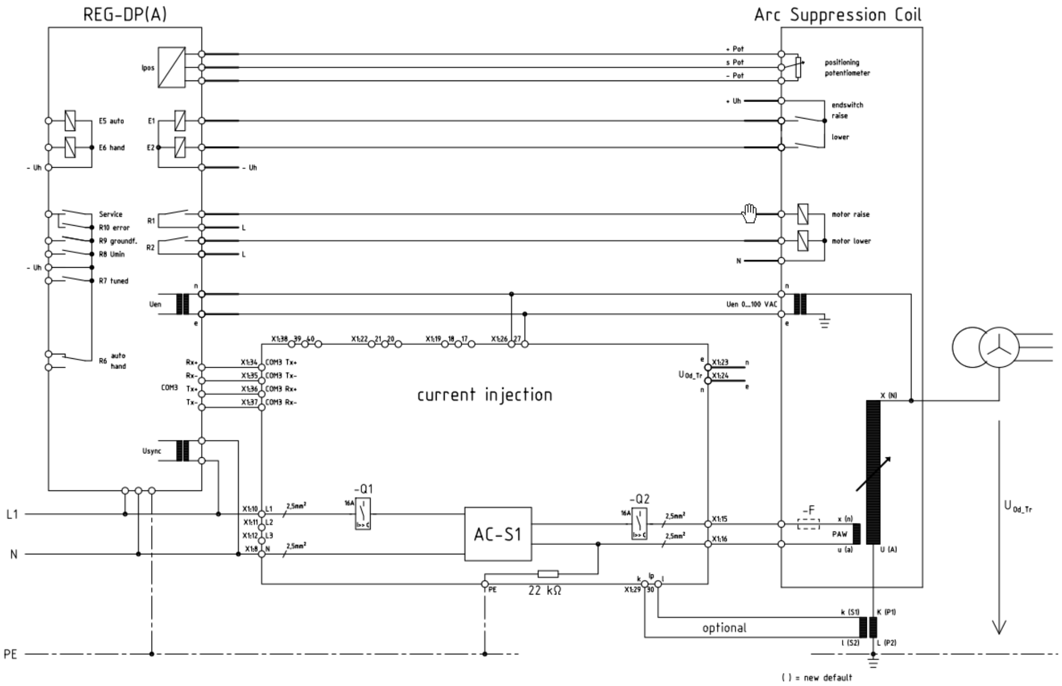


Figure 22: Uo measurement over external or remote voltage transducer

10.4.3 Connections for current injection when the power auxiliary winding is missing

In this case, the power section of the current feed-in is connected to a separate feed-in transducer.

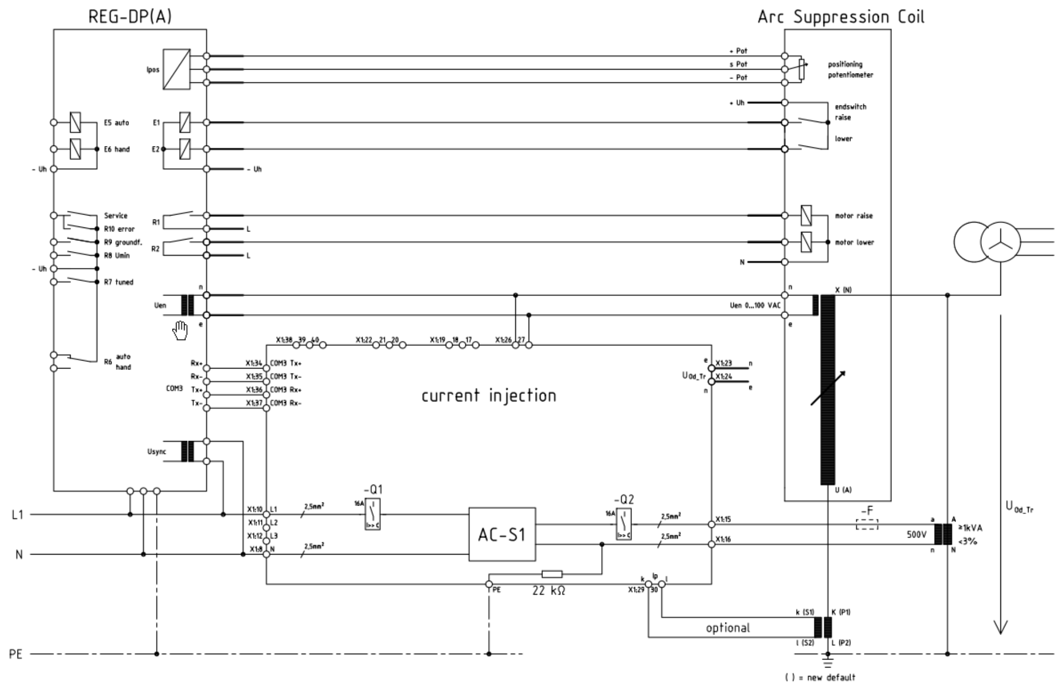


Figure 23: External power auxiliary winding and use of internal voltage transducer for the Petersen coil

10.4.4 Example of external feed-in transducer as spare power auxiliary winding (PAW)

NOTE! This transducer can only be used with the current injection. It is **not** a full replacement for a standard power auxiliary winding.

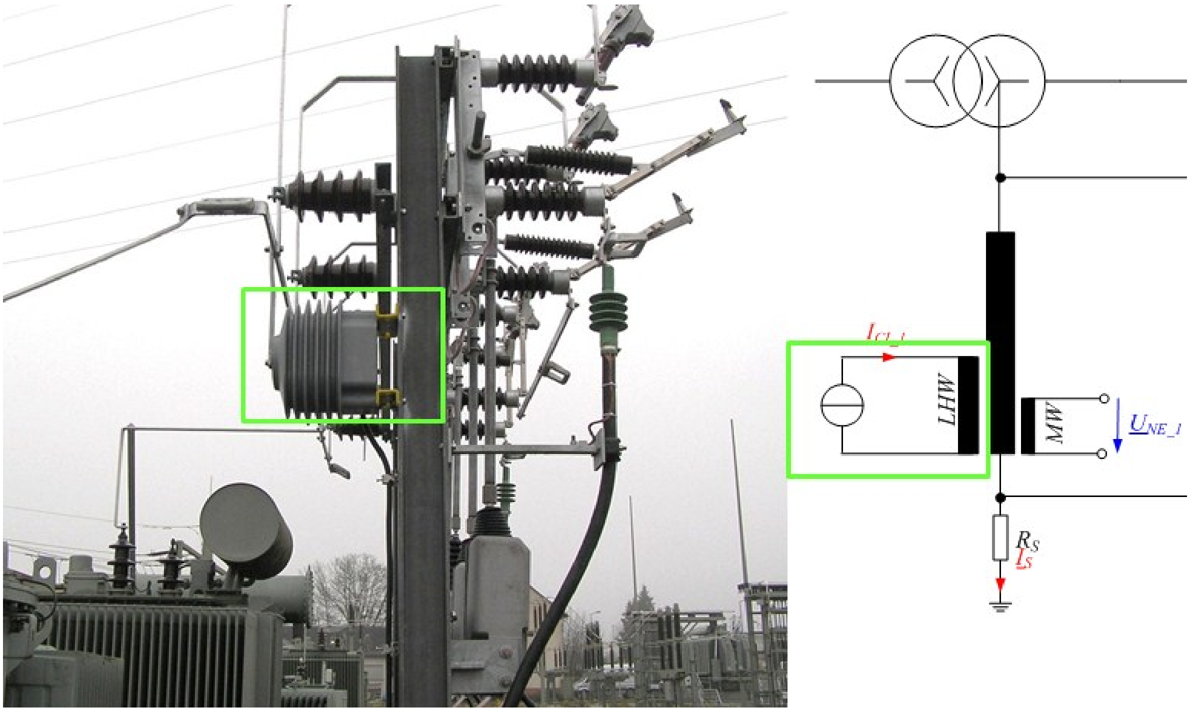


Figure 24: Spare power auxiliary winding (PAW) for current injection

The technical data for the transducer for a 20 **kV grid** are as follows:

Technical data for transducer for spare PAW	
Type	single-phase
Primary nominal voltage	$20\ kV/\sqrt{3}$
Secondary nominal voltage	500 V
Class	3
Nominal output/Nominal burden	1000 VA

10.5 Design of current injection controller (CCI)

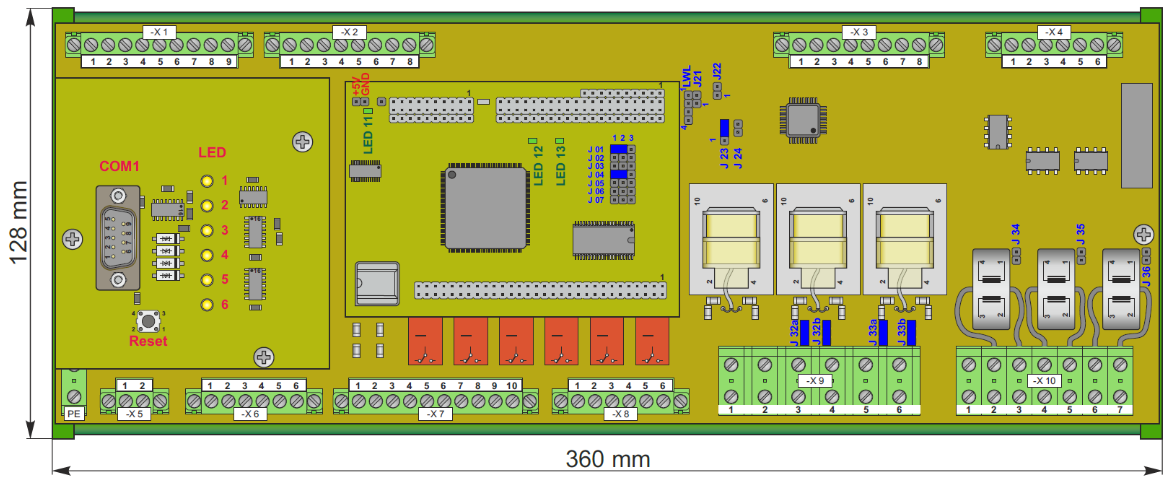


Figure 25: Dimensions of current feed-in controller (CCI)

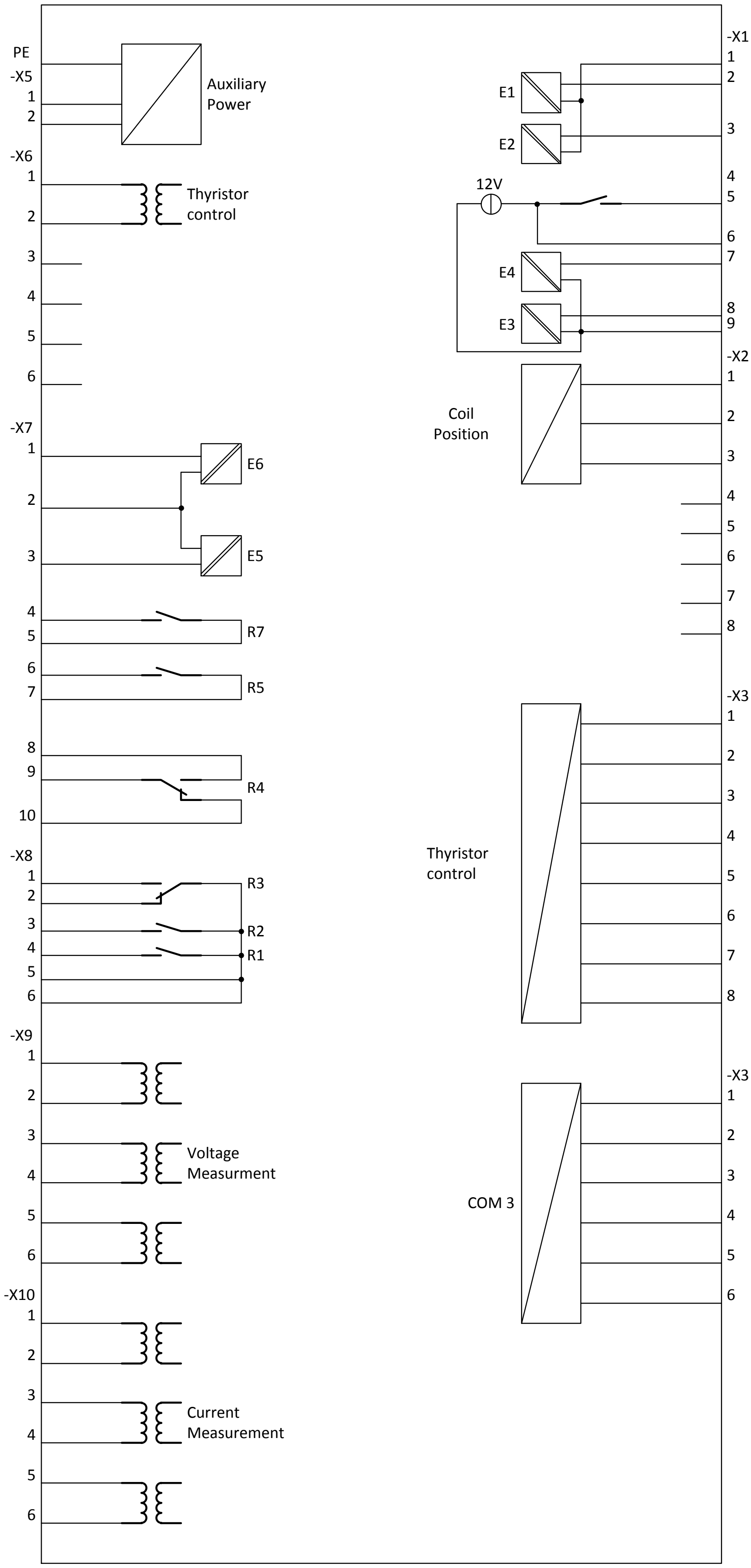


Figure 26: Terminal connections CCI

10.6 Terminal configuration CCI

10.6.1 Terminal strip – X1 binary inputs

Relay 6

Pin	Type	Function	Comments
X1:1	Input	Root E1..E2	Default: OFF
X1:2	Input	E2: SE-FUSE Fuse monitoring	max. 110 V DC
X1:3	Input	E5: End switch low	Default: OFF
X1:4			NC
X1:5	Relay	R6: Binary output	Pot. 12 V DC
X1:6	Relay	+12 V Output	Pot. 12 V DC
X1:7	Input	E4: Binary input	max. 12 V DC
X1:8	Input	E3: Binary input	max. 12 V DC
X1:9	Input	Root E3...E4	

10.6.2 Terminal strip – X2 potentiometer

Pin	Type	Function	Comments
X2:1	AO	Potentiometer +	ca. +3 V
X2:2	AI	Potentiometer loop	
X2:3	AO	Potentiometer -	
X2:4			NC
X2:5	AI	reserved	
X2:6		reserved	
X2:7	AO	reserved	+/- 5 V
X2:8		reserved	

10.6.3 Terminal strip – X3 AC switch (Thyristor)

Pin	Type	Function	Comments
X3:1		L1+	ca. +3 V
X3:2		(L2+)	
X3:3		L1-	
X3:4		(L2-)	NC
X3:5		Phase	
X3:6			
X3:7		+5 V	
X3:8		GND	

10.6.4 Terminal strip –X4 COM3 (RS 485) connection

Pin	Type	Function	Comments
X4:1		GND_1a	Isolated
X4:2	DO	Tx +	
X4:3	DO	Tx -	
X4:4	DI	Rx +	NC
X4:5	DI	Rx -	
X4:6		GND_1	Isolated

10.6.5 LEDs on current feed-in controller

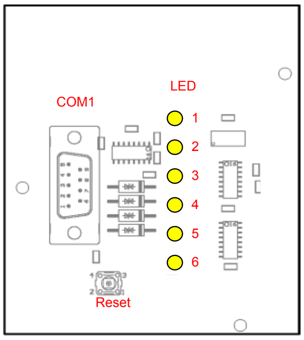


Figure 27: LED definitions current injection controller CCI

LED	Function	Status OK	Status error
1	U_{sync} measurement << 15 V	0	RED
2	U_{sync} Thyristors << 30V	0	RED
3		0	
4	Current injection active	GREEN	
5	PLL synchronized	GREEN	
6	Status current injec-tion controller (CCI)	GREEN flashing	I

10.6.6 PE

Pin	Typ e	Function	Comments
1		PE	Protective earth

10.6.7 Terminal strip – X5: Power supply

Pin	Type	Function	Comments
X5:1		L1 / +110 V DC	Supply voltage
X5:2		N / -110 V DC	

10.6.8 Terminal strip – X6: Synchronisation voltage Thyristor block

Pin	Type	Function	Comments
X6:1		Connection L1	U_{L1}: 230 V AC
X6:2		Connection N	
X6:3		Not used	
X6:4		Not used	
X6:5		Not used	
X6:6		Not used	

Note:
Cabinets that we prefabricate come equipped with the connections.

10.6.9 Terminal strip – X7 relay range 1

Pin	Type	Function	Comments
X7:1	Input	E6: End switch high	Default: OFF
X7:2	Input	Root end switch signal (E5..E6)	
X7:3	Input	E5: End switch low	Default: OFF
X7:4	Relay	R7: freely pro-grammable	Default: OFF
X7:5		R7: Root	
X7:6	Relay	R5: Motor lower	Default: OFF
X7:7		R5: Root	
X7:8	Relay	R4: Motor higher	Default: OFF
X7:9		R4: Root	
X7:10		R4: Not used	Default: OFF

Note:
The connections to X7 and X8 are redundant to the connections on the REG-DPA.

The wiring for the end switch and the motor contacts are directly done on the REG-DPA. This is why the connections for the current injection controller so not have to be configured.

10.6.10 Terminal strip – X8 relay range 2

Pin	Type	Function	Comments
X8:1	Relay	R3: opens upon failure	Default: OFF
X8:2	Relay	R3: closes upon failure	
X8:3	Input	E5: End switch low	Default: OFF
X8:4	Relay	R7: freely pro-grammable	Default: OFF
X8:5		R7: Root	
X8:6	Relay	R5: Motor lower	Default: OFF

10.6.11 Terminal strip – X9 inputs for voltage measurement

Pin	Type	Function	Comments
X9:1		Usync_1	0…100…500 V AC
X9:2		Usync_2	Default: 500 V
X9:3		Une_GND	0…100…500 V AC
X9:4		Une	Default: 100 V
X9:5		Uod_Tr_GND	0…100…500 V AC
X9:6		Uod_Tr	Default: 100 V (Only for extended algorithm)

10.6.12 Terminal strip – X10 current inputs

Pin	Type	Function	Comments
X10:1		PE	
X10:2		I1_a s1_ I_{CI}	0…1…5…10…25 A AC
X10:3		I1_b s2_ I_{CI}	Default: Current measured directly at CCI output
X10:4		I2_a s1_ I_S	0…1…5…10…25 A AC
X10:5		I2_b s2_ I_S	(Only for extended algorithm)
X10:6		I3_a s1_ I_F	0…1…5…10…25 A AC
X10:7		I3_b s2_ I_F	(Only for extended algorithm)

11. WinEDC configuration and configuration software

The WinEDC software is used to configure and program the system. It can be used in three different modes.

In **Panel mode**, the regulator can be displayed and controlled using the mouse. All of the settings, which can be made directly on the regulator using its membrane keyboard, can be carried out centrally in WinEDC.

Parameter mode enables each of the components to be quickly and easily configured. The parameters are set in a straightforward tree structure, saved for later use or transferred to a bus participant. This guarantees an easy and clear operation and is particularly useful when E-coil controllers and EOR-D earth fault detection relays in the REGSys™product line are used together in a plant component.

Terminal mode enables direct communication with the system.

The WinEDC Terminal is much easier to use than conventional terminal programs and makes programming the system a lot easier.

WinEDC runs on all versions of Windows from Windows95 to Windows 8 in 32-bit and 64-bit.

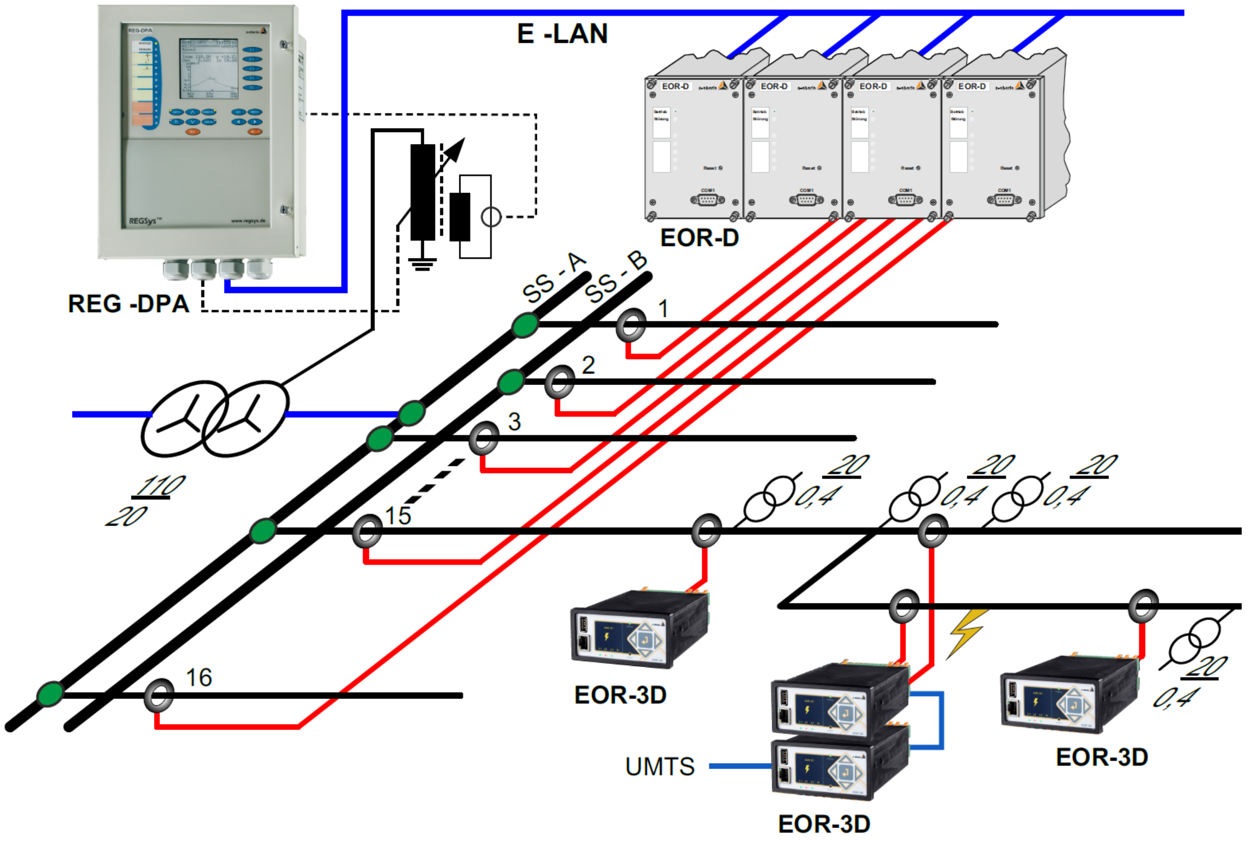


Figure 28: EORSys product range deployment

12. Order specifications

Please observe the following when placing an order:

- Only one unit can be ordered for codes with the same capital letter.
- When a code's capital letter is followed by the number 9, additional information in plain text is required.
- When a code's capital letter is followed only by zeroes the code may be omitted.
- X characteristics such as XL1 cannot be combined with all of the other characteristics. Please read the notes and explanations.

Characteristic	Code
Resonance regulator for Petersen coil resistance control, parallel control, Long-term recording and log book 16 binary inputs (freely programmable) 12 relay outputs (freely programmable), status relay, Current input (1 A or 5 A), COM 1, COM 2, COM 3 to connect a current injection WinEDC configuration software and connection cable (null modem)	**REG-DPA**
Note: COM2 is used for protocol communication. Hence available for external use without interface cards only	
Model	
• In-panel mounting housing/ Wall-mounting housing (H x B x T) 307 x 250 x 102 mm	B01
• DIN-Rail adapter	B02
Serial interface COM1	
• RS232	I0
• USB	I1
Power supply	
• external AC 85 V...110 V...264 V / DC 88 V...220 V...280 V	H1
• external DC 18 V...60 V...72 V	H2
Parallel control	
• communication over E-LAN	K0
• Distributed controller and communication without E-LAN	K1
Measurement input	
• additional current channel I2 (1 A or 5 A)	X18
Analogue outputs	
• without	E00
• (please specify measurement range or scaling when placing the order)	E90
– Output 1: Zero sequence voltage U_o	
– Output 2: Position of Petersen coil I_{pos}	
– Output 3: Current through the P-coil Ip	
– with two analogue inputs, freely configurable.	
• two analogue inputs, freely configurable (via background program).	E91
• random combination of modules	E900

Characteristic		Code
Control system connection		
• without	(continue with characteristic "L")	XW00
• IEC 60870-5-104/RJ45	(continue with characteristic "G")	XW90
• IEC 60870-5-104 with Fiber Optic-connection	(continue with characteristic "G")	XW92
• IEC 61850/RJ45	(continue with characteristic "G")	XW91
• IEC 61850 with Fibre Optic-ST connection	(continue with characteristic "G")	XW93
• IEC 61850 with Fibre Optic-LC connection	(continue with characteristic "G")	XW93.1
• IEC 61850 with 2xRJ45 connection	(continue with characteristic "G")	XW94
• IEC 61850 with 2xFibre Optic ST connection	(continue with characteristic "G")	XW95
• IEC 61850 with 2xFibre Optic-LC connection	(continue with characteristic "G")	XW95.1
• IEC 61850 with 1xRJ45 und 1xFibre Optic-ST connection	(continue with characteristic "G")	XW96
• IEC 61850 with 1xRJ45 und 1xFibre Optic-LC connection	(continue with characteristic "G")	XW96.1
• DNP 3.0 via Ethernet with 1xRJ45 connection	(continue with characteristic "G")	XW97
• DNP 3.0 via Ethernet with 2xRJ45 connection	(continue with characteristic "G")	XW94.1
• DNP 3.0 via Ethernet with 1xFibre Optic connection	(continue with characteristic "G")	XW98
• DNP 3.0 via Ethernet with 1xFO-LC connection	(continue with characteristic "G")	XW98.1
• DNP 3.0 via Ethernet with 2xFO-ST connection	(continue with characteristic "G")	XW95.2
• DNP 3.0 via Ethernet with 2xFO-LC connection	(continue with characteristic "G")	XW95.3
• DNP 3.0 via Ethernet with 1xRJ45;1xFO-ST connection	(continue with characteristic "G")	XW96.4
• DNP 3.0 via Ethernet with 1xRJ45;1xFO-LC connection	(continue with characteristic "G")	XW96.5

Note:
If you want a differing protocol for delivery, please choose an additional hardware variant "XWxx" (then continue with feature "Vxx").

Characteristic	Code
Inegrated protcol interface (IEC 60870-5-101/103, DNP…)	
• without (continue with characteristic "G")	L0
• to connect the REG-DPA to a control center	L2
• to connect several devices to a control center (REG-DPA/D/DA/DP etc.)	L9

Note:
Characteristic L9 can only be combined with Z15..Z19

Characteristic	Code
Connection type:	
• Copper	
– RS 232	V10
– RS 485 2-wire operation only	V11
• Fibre optic cable with FSMA connection technology, incl. fibreglass module	
– Fibreglass (Wave length 800...900 nm, range 2000 m)	V13
– Plastic (wave length 620...680 nm, range 50 m)	V15
• Fibre optic cable with ST connection technology, incl. fibreglass module	
– Fibreglass (Wave length 800...900 nm, range 2000 m)	V17
– Plastic (wave length 620...680 nm, range 50 m)	V19

Characteristic	Code
Protocol	
– IEC 60870-5-103 for ABB	Z10
– IEC 60870-5-103 for Areva	Z11
– IEC 60870-5-103 for others	Z90
– IEC 60870-5-101 for ABB	Z15
– IEC 60870-5-101 for IDS	Z17
– IEC 60870-5-101 for SAT	Z18
– IEC 60870-5-101 for Siemens (LSA/SAS)	Z19
– IEC 60870-5-101 für others	Z91
– DNP3	Z20
– SPABUS	Z22
– Modbus RTU	Z23
– DCF Simulation via NTP and / or E-LAN extansion via Ethernet (CSE)	DCF / E-LAN
Note: only for IEC-61850 – other protocols on request	
User Manual	
• German	G1
• English	G2
• Russian	G6
• Czech	G8
• other	G9
Display language	
• same as the operating manual	A0
• German	A1
• English	A2
• Russian	A6
• Czech	A8
• other	A9

ACCESSORIES	CODE	
Current injection with two fixed frequencies (Supply voltage AC 230 V)	CIF	
Peak current injection with two fixed frequencies with additional use of pulse locating (Supply voltage AC 230 V)		HPCI
consists of Thyristor actuator, controller and inductance on mounting panel for 19” cabinet mounting	C1	C1
consists of Thyristor actuator, controller and inductance in standard mounting for indoor installation ca. 800 x 800 x 300 mm	C2	C2
consists of Thyristor actuator, controller and inductance in standard mounting for outdoor installation ca. 800 x 800 x 300 mm	C3	C3
consists of Thyristor actuator, controller and inductance in standard mounting for outdoor installation (wall mounting) ca. 800 x 800 x 300 mm	C4	C4
Housing version is negotiable!	C9	C9

NOTE!

The current injection can only be used without restrictions if the measurement for the zero sequence voltage and the current are derived from the coil’s primary winding. This means that the zero sequence voltage should not be measured on the E-coil itself.

ACCESSORIES	CODE
Female multipoint connector 1 (electrical connector model F)	
Female multipoint connector (for power input with advanced contacts)	
Female multipoint connector 3 (mixed connector model F24 + H7)	
Dummy panel 28 TE	
Dummy panel 14 TE	
Dummy panel 7 TE	
Dummy panel 8 TE	
PC connection cable (null-modem cable)	
Modem connection cable	
1 pack microfuses T2 L 250 V	
Time synchronisation:	
Radio clock DFC 77	111.9024.01
GPS radio clock NIS time, RS 485, Uh: AC 85…110 V…264 V / DC 88 V…220 V…280 V	111.9024.45
GPS radio clock NIS time, RS 485, Uh: DC 18…60 V…72 V	111.9024.46
GPS radio clock NIS time, RS 232, Uh: AC 85…110 V…264 V / DC 88 V…220 V…280 V	111.9024.47
GPS radio clock NIS time, RS 232, Uh: DC 18…60 V…72 V	111.9024.48
Communication:	
Develo MicroLink 56Ki analogue modem, DIN rail device incl. 230 V AC power supply	111.9030.03
TCP/IP adapter 10 Mbit REG-COM; DIN rail device including power supply 230 V AC	A01
TCP/IP adapter 10 Mbit REG-COM; plug-in module 8TE, 3HE; Power supply AC 85…110 V…264 V / DC 88 V…220 V…280 V	A02
TCP/IP adapter 10 Mbit REG-COM; plug-in module 8TE, 3HE; Power supply DC 18…60 V…72 V	A03

Notes

Notes

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