

Relay for OLTC Control & Transformer Monitoring

Model REG-DA

- ▶ Wall mounting housing
- ▶ Panel mounting housing
- ▶ Din-rail mounting



1. Application

The REG-DA relay for OLTC control & Transformer Monitoring is used to perform both complex and simple measurement, control and regulation tasks on tap-changing transformers. To achieve these tasks, the REG-DA voltage regulator can be used with an array of add-on components, such as the BIN-D and ANA-D remote I/O modules, and an assortment of communication cards.

Each REG-DA has transducer and statistical modes, as well as optional multi-channel recorder, transformer monitoring module (TMM) and ParaGramer.

Transducer Mode displays all of the relevant measured variables of the voltage network, while Statistical Mode provides a clear overview of the various switching operations of the tap changer.

Voltage regulators operating in parallel are connected via a fibre optic or copper ELAN bus, which enables the automatic sharing of relevant data. ParaGramer then detects which transformers have been switched into a parallel control scheme and displays this information via a single-line diagram.

The powerful TMM functions enable the continuous monitoring of various conditions within the transformer and tap changer. Information such as hot-spot temperature (IEC 60354 or IEC 60076) and transformer loss-of-life are calculated, and if necessary up to six cooling levels can be activated.

As an alternative to direct measurement, the U, I, tap position and $\cos(\varphi)$ value can also be transmitted to the REG-DA via SCADA client function (IEC 61850, IEC 60870-5-104), IEC61850-9-2 Sampled Values, IEC61850 GOOSE or by mA inputs, thereby eliminating the need for CT and VT cabling to the regulator.

The REG-DA regulator can communicate with a SCADA system (see list of characteristics) through all of the common protocols.

Freely programmable inputs and outputs enable the implementation of application specific tasks.

A number of different communication cards are available for the REG-DA, with connections that range from copper RS232 to fibre optic Ethernet.

A variety of protocols are available to communicate with a SCADA system or RTU:

- IEC 61850 including GOOSE and Sampled Values
- IEC 60870 - 5 - 101 / 103 / 104
- DNP 3.0 via Ethernet
- DNP 3.0
- MODBUS TCP
- MODBUS RTU
- Profibus DP
- SPABUS
- LON (on request)

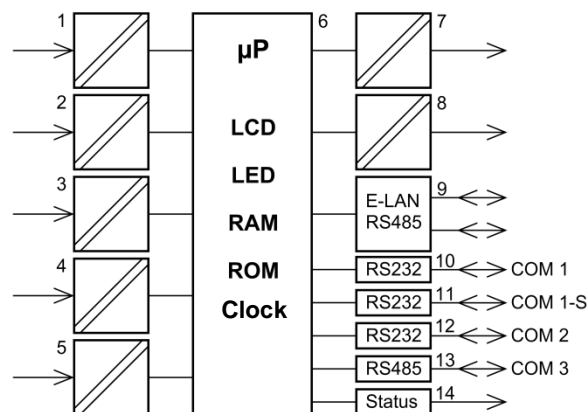
The integrated SCADA communication cards are capable of most of these protocols and may be switched between them and configured using the free WinConfig software. WinConfig is specifically designed to provide a similar configuration interface for all of the protocols, thereby reducing engineering time.

The communication interfaces of the REG-DA are equipped with cyber security features including role based access control (RBAC) with remote user authentication via e.g. the Radius protocol.

2. Characteristics of the REG-DA

- Cyber security with role based access control (RBAC) and remote authentication via e.g. Radius
- Large backlit LCD (128 x 128) with all important information (tap, voltage etc.)
- Measurement functions (U, I, P, Q, S, cos φ, φ, I sin φ, f)
- Recorder function (3-channel line recorder)
- Statistics function (total number of switching operations, switching operations per tap)
- Event recorder (logbook)
- Transformer monitoring functions to calculate the hot-spot temperature and lifetime consumption and to control the fans and oil pumps. In addition the moisture content in cellulose and the risk of bubble formation is evaluated
- 14 (26) freely programmable binary inputs
- 9 (21) freely programmable binary outputs
- Freely programmable analogue inputs or outputs (mA)
- PT100 direct input
- Input for tap-potentiometer (resistor input) (200 Ω...20 kΩ total resistance)
- Regulation of three winding transformers
- Regulation of phase-shifting transformers
- Regulation of transformer banks
- Control of capacitor banks
- Limit-value monitoring for all measured quantities
- 4 freely programmable setpoint values
- Dynamic adjustment of the setpoint values based on the load (Z-compensation, LDC)
- Programmable rated U and I values
- Open programmability enables implementation of PLC functions (background program)
- Peripheral bus (COM3) for additional interface modules (ANA-D, BIN-D, Modbus converter)
- Ability to enter externally measured quantities (gas-in-oil ratio, winding temperature, etc.) by communicating directly with the measuring devices through Modbus
- All of the measurements (including external measurements) and events can be transferred to SCADA
- ParaGramer function to view and automate the parallel connection of up to fifteen transformers
- Provisioning software to set parameters, program devices, and view and archive data
- REGSim™ simulation software to simulate parallel operations, network and load situations
- UL certification

3. Description

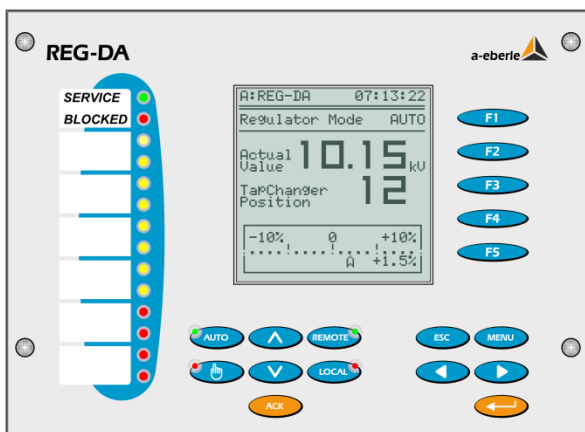


Functions of the REG-DA regulator (all options)

- | | |
|----|---|
| 1 | three current and two voltage measuring inputs |
| 2 | Analogue inputs, PT100 (optional) |
| 3 | Binary inputs |
| 4 | Input for resistance-coded tap-position indicator (optional) |
| 5 | Auxiliary voltage / Power Supply |
| 6 | Display and processing unit |
| 7 | Analogue outputs |
| 8 | Binary outputs |
| 9 | ELAN connection (2 x RS485 with repeater function) |
| 10 | COM1, RS232 |
| 11 | COM1-S, RS232 (can be used alternatively to COM1, on devices with characteristic S2 the COM1-S can be switched into COM4) |
| 12 | COM2, RS232 (on devices with characteristic S2 the COM2 can be split into COM2 and COM5) |
| 13 | COM3, RS485 |
| 14 | Status contact (life contact) |

3.1 Regulator mode

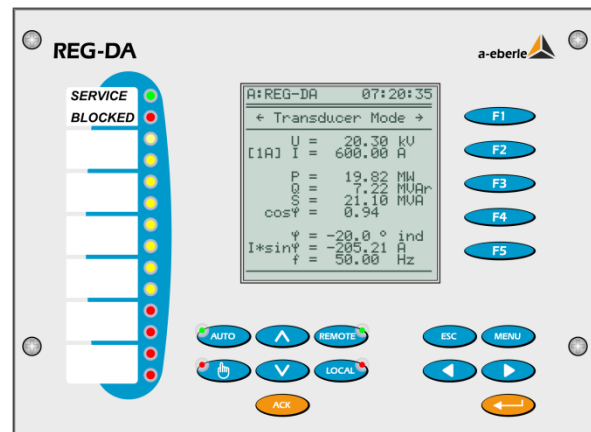
The actual value and a fixed or load-dependent setpoint value are continually compared in the regulator, which then determines the correct commands for the transformer's tap changer. The regulator's parameters can be fine-tuned to the dynamic time behaviour of the grid voltage to obtain high control performance for a low number of switching operations.



3.2 Transducer mode

The values of all relevant variables of a three-wire, three-phase system with balanced or unbalanced load are calculated from the measured CT & VT inputs.

All of the measured and calculated values can then be viewed on the LCD display, or transferred by analogue signal and SCADA connection.



Connecting transformers in parallel

Each regulator is capable of operating in parallel with up to 9 other regulators, without the need for additional components.

A number of different parallel control schemes are available, catering for transformers that operate in parallel on a single busbar, as well as those that are feeding the same grid from different substations.

Parallel control schemes are listed in Table 1 below:

Case	REG-DA – Programme	Conditions
Parallel operation on one or more busbars	$\Delta I \sin \varphi$	Identical transformers, identical or different tap size
	$\Delta I \sin \varphi (S)$	Transformers with different performances, different or equal tap size
	Master/slave	Identical transformers, same tap size
Free feed in	$\Delta \cos \varphi$	Any transformer, any tap size
Emergency program in the event of a ELAN failure	$\Delta \cos \varphi$	Any transformer, any tap size, for the programs $\Delta I \sin \varphi$ and $\Delta I \sin \varphi (S)$

Table 1 Parallel operated transformers

Measured quantities on the displays

- Voltage U_{eff}
- Current I_{eff}
- Active power P
- Reactive power Q
- Apparent power S
- $\cos \varphi$
- Phase angle φ
- Reactive current $I \cdot \sin \varphi$
- Frequency f
- Circulating reactive current (see page 2 of the transducer display)

All of the measured and calculated values can be transferred to an analogue output or to SCADA.

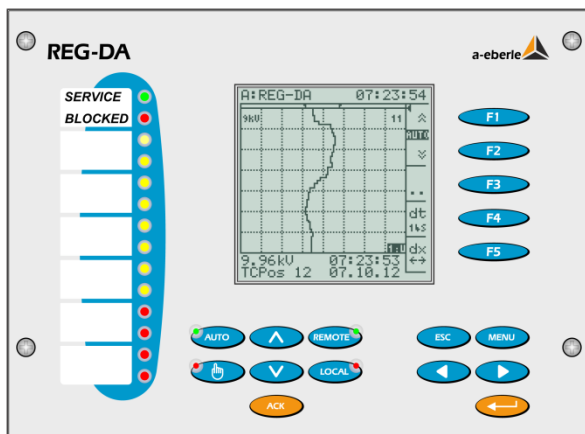
We take care of it.

3.3 Recorder mode

Up to two selectable analogue values can be continuously recorded and displayed as a line chart with an adjustable time grid. The tap position*, setpoint value*, tolerance band and Manual/Auto state, as well as the time and date are recorded in addition to these measured quantities. This enables the voltage and the time-correlated tap position to be viewed at any time, for example. The average storage time for voltage and tap position (1 channel) is approximately six weeks.

The stored values can also be retrieved and displayed by the WinREG Control software, using the REGView module.

(*requires the voltage to be recorded on channel 1)



Time grid dt 14 s, 1, 5, 10, 30, min / Division

Regardless of the selected time grid (feed rate) of the display, all of the measurements are stored at a standard rate of 1 data point per second. Each data point then represents the arithmetic mean of 10 measurements that were generated at 100 ms intervals.

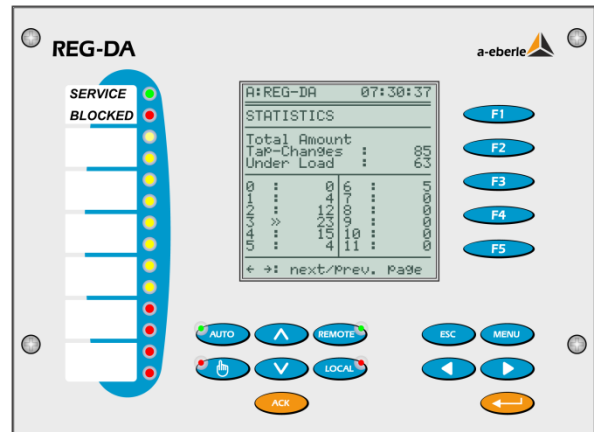
Storage behaviour in the case of an overflow	Overwrite with FIFO (First in First out)
Storage time (voltage plus tap)	< 18.7 days worst case on average > 1 month

3.4 Statistics mode

The Statistics mode records all of the tap changer's switching operations. Separate logs are stored for switching operations under load and without load.

This information can be used to analyse how many taps were made in a certain timeframe, as well as how often a particular tap was selected. This information is then used to fine-tune the regulator's settings.

The stored values can also be retrieved and displayed by the WinREG Control software, using the Service module.



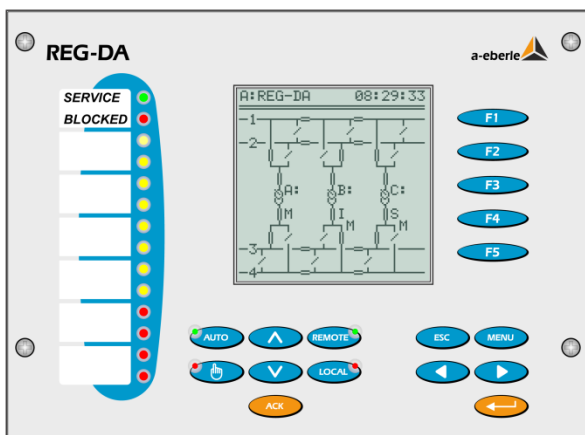
3.5 ParaGramer mode

ParaGramer is an efficient tool that automatically detects which transformers have been switched into a parallel control scheme and displays this information via a single-line diagram.

The artificial word ParaGramer is a combination of the terms parallel and single-line diagram.

Paragramer can monitor the positions of circuit breakers, isolators, bus ties and bus couplings. Based on the status of these inputs and of the regulators in the parallel scheme, the system automatically determines optimum tap positions for all of the transformers.

Multiple busbars are configurable on both the HV and LV sides of the transformers.



As shown in the graphic, both transformers A and C are working on busbar '3', while transformer B is feeding into busbar '4'.

3.5 Transformer monitoring module TMM

The Transformer Monitoring module collects and calculates information about the condition of the transformer and tap changer.

The hot-spot temperature is calculated in accordance with IEC 60354 and IEC 60076, and is used to determine the transformers loss of life.

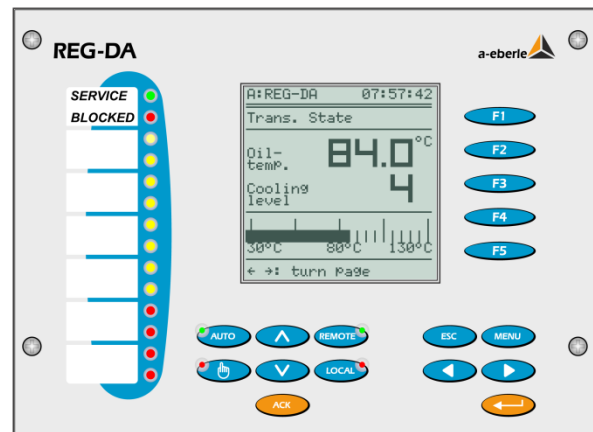
The optional TM+ function evaluates the moisture content of the cellulose and the risk of bubble formation.

Up to 6 groups of fans and 2 oil pumps can be controlled to regulate the temperature of the transformer. The operating times of the fans and pumps are stored for maintenance purposes.

Oil temperature is measured either directly as a PT100 input, or via a mA transducer, and also be recorded using the Recorder mode.

A total of three analogue input slots are available in the REG-D, allowing the monitoring of several temperatures, oil levels, gas levels and so on.

Please refer to characteristic group 'E' in the Order specifications for a list of the combination options.



4. Technical specifications

Regulations and standards

- IEC 61010-1 / EN 61010-1
- CAN/CSA C22.2 No. 1010.1-92
- CISPR 22 Ed.6 (2009-09)
- IEC 60255-11 / EN 60255-11
- IEC 60255-21 / EN 60255-21
- IEC 60255-22-1 / EN 60255-22-1
- IEC 60255-25 / EN 60255-25
- IEC 60255-26 / EN 60255-26
- IEC 60255-27 / EN 60255-27
- IEC 61326-1 / EN 61326-1
- IEC 60529 / EN 60529
- IEC 60068-1 / EN 60068-1
- IEC 60688 / EN 60688
- IEC 61000-6-2 / EN 61000-6-2
- IEC 61000-6-4 / EN 61000-6-4

UL Certificate Number 050505 - E242284



AC voltage inputs (U _E)	
Nominal input voltage U _n	100 VAC
Input voltage range	0 ... 160 VAC
Rated voltage	230 VAC
Frequency range	16... <u>50</u> ... <u>60</u> ...65 Hz
Crest factor @ U _r	≤ 2
Input resistance	100...102 kΩ
Internal consumption	≤ 0.01mW/V ²
Bandwidth	420 Hz
ADC	12 Bit, 24 samples/cycle
Over voltage category	300V CAT II / 150V CAT III
Isolation	reinforced*
Isolation test voltage	2.3kVAC, 5s

* The voltage measurement inputs can be interconnected with a 100kΩ resistor.

AC input (I _E)	
Nominal input current I _n	1 A / 5 A, software selectable
Measurement range	0 ... 2.1·I _n
Rated current	10 A
Over load capacity	100 A for 1s
Frequency range	16... <u>50</u> ... <u>60</u> ...65 Hz
Crest factor @ I _n	≤ 3
Internal consump. @ 5A	≤ 0,5 VA
Bandwidth	420Hz
ADC	12 Bit, 24 samples/cycle
Over voltage category	300V CAT II / 150V CAT III
Isolation	reinforced, per channel
Isolation test voltage	2.3kVAC, 5s

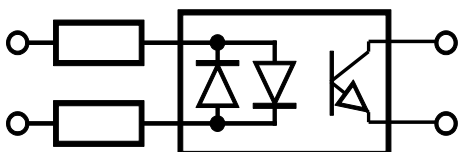
Measured values	
True RMS voltages	U ₁₂ , U ₂₃ , U ₃₁ (≤ 0.25%)
True RMS current	I ₁ , I ₂ , I ₃ (≤ 0.25%)
Active power	P (≤ 0.5%)
Reactive power	Q (≤ 0.5%)
Apparent power	S (≤ 0.5%)
Power factor	cos φ (≤ 0.5%)
Phase angle	φ (≤ 0.5%)
Reactive current	I · sin φ (≤ 1%)
Frequency	f (≤ 0.05%)

Reference conditions	
Reference temperature	23°C ± 1 K
Input quantities	U _E = 0 ... 160 V I _E = 0 ... 1A / 0 ... 5A
Frequency	45 Hz...65 Hz
Shape of the curve	Sinusoidal, form factor 1.1107
Load (only for characteristics E91...E99)	R _n = 5 V / Y ₂ ± 1%
Other	IEC 60688 - Part 1

Ambient conditions	
Temperature range	
Function	-15°C ... +60 °C -15°C ... +50 °C with characteristic PB1 to PB4
Transport and storage	-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	IEC 60068-2-31 100 mm drop height, unpacked
Vibration	IEC 60255-21-1, Class 1
Shock	IEC 60255-21-2, Class 1
Earthquake resistance	IEC 60255-21-3, Class 1

Binary inputs (BI)	
General	
Signal frequency	0 ... 70Hz
AC debouncing	40 ... 70Hz
Form factor	≤ 1.16
Binary input type HV (High voltage)	
Input voltage	≤ 250V (r.m.s.)
Input resistance	107...116kΩ
Over voltage category	300V CAT II
Isolation between input groups	basic isolation ^{a)}
Isolation against touchable parts	reinforced
Isolation test voltage	2.3kVAC, 5s
Binary input type LV (Low voltage)	
Input voltage	≤ 50V (r.m.s.)
Input resistance	6.5...8.1kΩ
Characteristic D0 – Binary input groups 1...4, 5...8, 9...12, 13...16	
Characteristic D1 – Binary input groups 9...12, 13...16	
Characteristic D2 – Binary input groups 1...4, 5...8	
Characteristic D6 – Binary input groups 1...4, 5...8	
Input type	HV
H – Level	≥ 48 V
L - Level	< 10 V
Characteristic D1 – Binary input groups 1...4, 5...8	
Characteristic D3 – Binary input groups 1...4, 5...8	
Characteristic D4 – Binary input groups 1...4, 5...8, 9...12, 13...16	
Characteristic D5 – Binary input groups 1...4, 5...8	
Input type	LV
H - Level	≥ 10 V
L - Level	< 5 V
Characteristic D8 – Binary input groups 1...4, 5...8	
Characteristic D9 – Binary input groups 1...4, 5...8, 9...12, 13...16	
Input type	HV
H – Level	≥ 80 V
L - Level	< 40 V
Characteristic D7 – Binary input groups 1...4, 5...8, 9...12, 13...16	
Input type	HV
H - Level	≥ 176 V
L - Level	< 88 V

^{a)} In the case of DC voltage, the sum of the operating voltages of adjacent binary input groups must not exceed 300V!



Simplified diagram of a binary input

Binary outputs (BO)	
max. switching frequency	≤ 1 Hz
Potential isolation	Isolated from all internal device potentials
Contact load	AC: 250 V, 5 A (cosφ = 1.0) AC: 250 V, 3 A (cosφ = 0.4) Switching capacity max. 1250 V A 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	≥ 5 · 10 ⁵ electrical
Over voltage category	300V CAT II
Isolation between outputs or output groups	Basic isolation ^{b) c)}
Isolation against touchable parts	reinforced
Isolation test voltage	2.3kVAC, 5s

^{b)} In case of DC voltage, the sum of the working voltages of adjacent outputs or output groups must not exceed 300V!

^{c)} If an output or an output group is connected to a dangerous active circuit, the neighboring outputs or output groups must not be connected with SELV circuits or other touchable parts!

Auxiliary Voltage		
Characteristic	H0	H2
AC		
Nominal voltage range	100 ... 240 V	–
Total voltage range	90 ... 264 V	–
DC		
Nominal voltage range	100 ... 300 V	20 ... 70 V
AC Power consumption	≤ 35 VA ≤ 45 VA (PB1...4)*	–
DC Power consumption	≤ 25 W ≤ 35 W (PB1...4)*	≤ 25 W
Frequency	50/60 Hz	DC
Microfuse	T1 250 V	T2 250 V
Over voltage category	300V CAT II	150V CAT II
Isolation	reinforced	reinforced
Isolation test voltage	2.3kVAC, 5s	1.4kVAC, 5s

The following applies to all characteristics:

Voltage dips of ≤ 25 ms do not cause a power on reset of the device. Fuses are time lag (slow blow) type.

*Devices with characteristic PB1 to PB4 have a power supply module with more output power.

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Electrical safety	
Safety class	I
Degree of pollution	2
Standards	IEC 61010-1

Electromagnetic compatibility	
EMC requirements	EN 61326-1 Equipment class A Continuous, unmonitored operation, industrial location and EN 61000-6-2 and EN 61000-6-4 and EN 60255-X
Interference emissions	
Conducted and radiated emission	EN 61326 Table 3 EN 61000-6-4 EN 60255-25/-26 CISPR 22 Ed. 6
Harmonic currents	EN 61000-3-2
Voltage fluctuations and flicker	EN 61000-3-3
Disturbance immunity	EN 61326 Table A1 EN 61000-6-2 EN 60255-11/-22/-26
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 magnetic fields	IEC 61000-4-8 100 A/m (50 Hz), continuous 1000 A/m (50 Hz), 1 s
Voltage dips	IEC 61000-4-11, EN 60255-11 30% / 500ms, 60% / 200ms
Voltage interruptions	IEC 61000-4-11 100% / 5s
Damped oscillations	IEC 61000-4-12, Class 3, 2.5 kV
Ripple on d.c. input power port immunity test	IEC 60255-11 AC ripple 15% of U_r , 100 Hz, 5 min

Analogue inputs (AI)	
Quantity	See order specifications
Input range Y1...Y2	-20 mA...0...20 mA points Y1 and Y2 are programmable
Control limit	$\pm 1.2 Y2$
Voltage drop	$\leq 1.5 V$
Isolation	functional, per channel
Common-mode rejection	> 80 dB

Series-mode rejection	> 60 dB / Decade from 10 Hz
Overload capacity	$\leq 50 mA$ continuous
Error limit	0.5%

The REG-DA is supplied with 1 x mA Analogue Input (e.g. for the tap position indicator) as standard.

Analogue outputs (AO)	
Quantity	See order specifications
Output range Y1...Y2	-20 mA...0...20 mA Y1 and Y2 programmable
Control limit	$\pm 1.2 Y2$
Isolation	Functional, per channel
Load range	$0 \leq R \leq 8 V / Y2$
Alternating component	<0.5% of Y2

Temperature input PT100	
Quantity	one PT100 input at Level III possible two PT100 inputs at Level II possible
Type of connection	Three-wire circuit
Current through sensor	< 8 mA
Isolation	functional
Line compensation	no compensation required
Transmission behaviour	linear

Resistance input (tap change potentiometer)		
Characteristic	R1	R3
Quantity	See order specifications	
Connection	Three-wire / Four-wire with open wire detection	
Total resistance in the resistor chain	180Ω ... 2 kΩ	2kΩ ... 20kΩ
Tap resistance	5Ω ... 100Ω	50Ω ... 2kΩ
Number of taps	≤ 38	
Isolation	functional	
Current through resistor chain	$\leq 25 mA$	$\leq 2.5 mA$

Communication interfaces			
Name	Standard	Wires	Isolation
COM1	RS232	4, GND	-
COM1-S	RS232	4, GND	functional
COM2	RS232	4, GND	functional
COM3	RS422	4, GND	functional
E-LAN-L	RS485/422	2/4, GND	functional
E-LAN-R	RS485/422	2/4, GND	functional
DCF77	RS485	2, GND	functional

Device real time clock	
Accuracy	+/- 20 ppm 0 ... 10 ppm with charact. S2
Buffer battery	Lithium button cell 3V Type CR1632

Limit-value monitoring	
Limit values	programmable
Response times	programmable
Alarm indicators	LEDs are programmable or are programmable on an LCD

Indicator elements		
The regulator has 14 light-emitting diodes (LED)		
LED Service	Normal operation	Green
LED Blocked	Faulty operation	Red
LED 1 ... LED 8	Freely programmable	Yellow
LED 9 ... LED 12	Freely programmable	Red

5. Mechanical design

Housing	Sheet steel, RAL 7035 light-grey
<ul style="list-style-type: none"> — Height — Width — Total depth — Mounting depth — Weight 	325 mm incl. cable glands 250 mm 114 mm 87 mm ≤ 6.0 kg
Housing door	with silicate glass
Front panel	Plastic, RAL 7035 grey on aluminium brackets
Control panel cut-out	
<ul style="list-style-type: none"> — Height — Width 	282 mm 210 mm
Protection type with flange plate and cable gland	IP 54 IP 30 with characteristic PB1 to PB4
Protection type with brush sealing	IP 12 IP 10 with characteristic PB1 to PB4

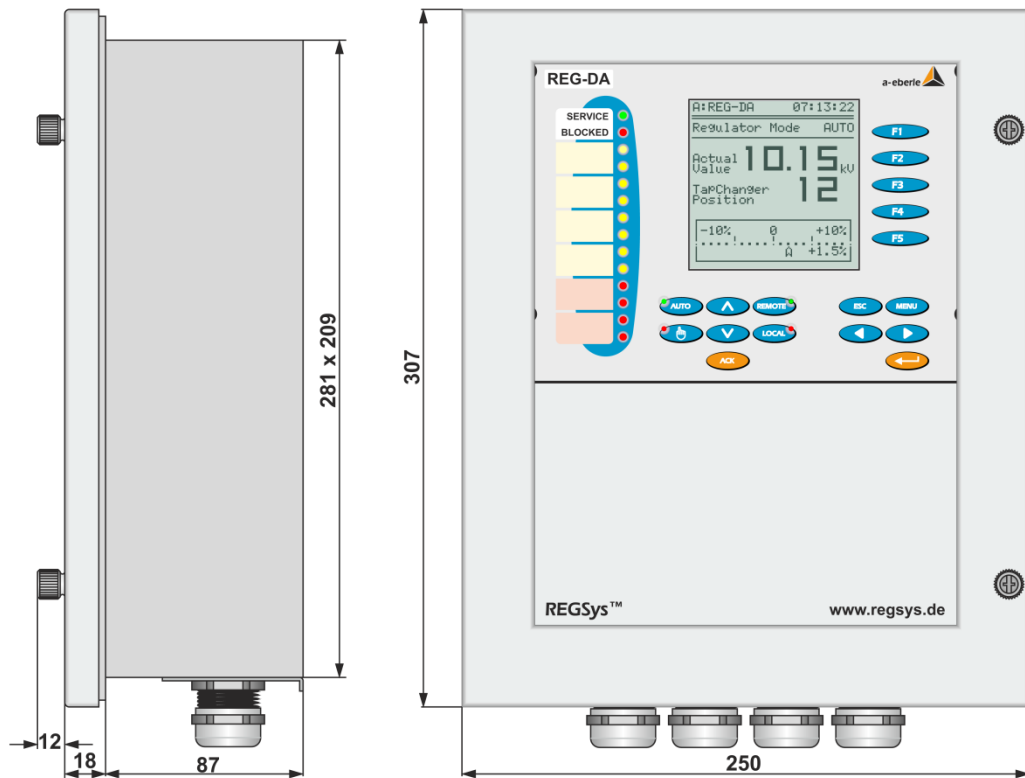
Display	
LC - Display	128 x 128 graphic display
Back-lighting	LED, automatic switch off after 15 minutes

Each LED can be labelled on site.
If the labelling wishes are known at the time of order placement, labelling can be done at the factory.

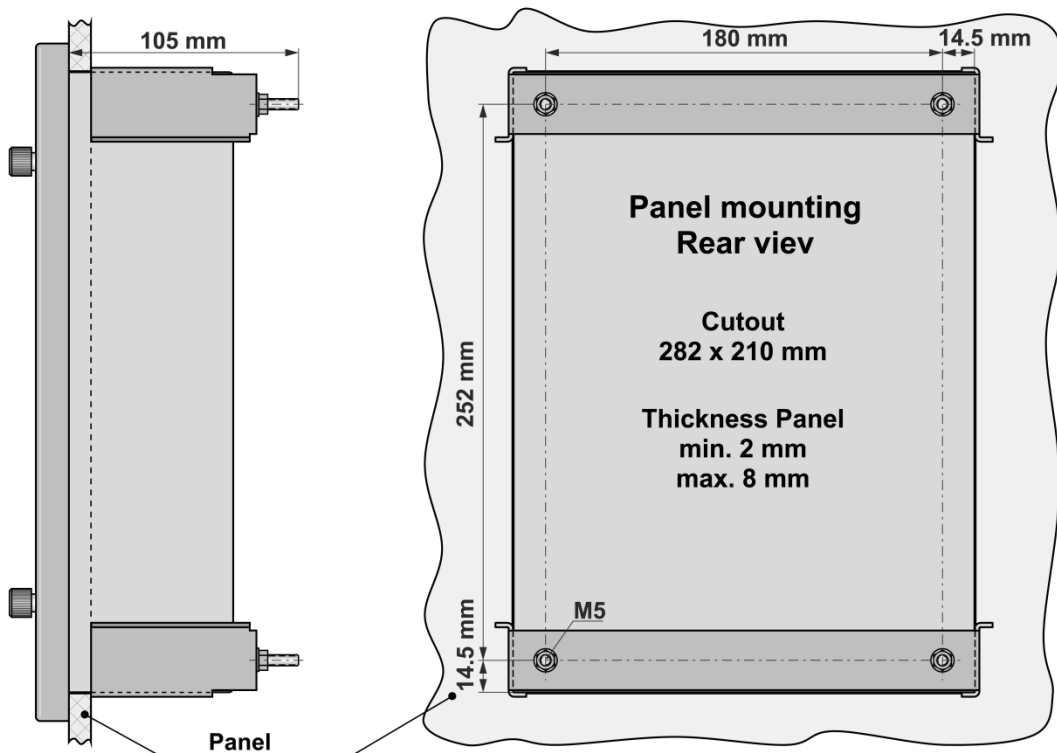
Storage	
Firmware and recorder data Characteristic S2	Flash memory
Device characteristics and calibration data	serial EEPROM with ≥ 1000 k write/read cycles
Other data and recorder data Characteristic S1	MRAM

Conductor Cross Section and tightening torque of Terminals				
Level	Function/ terminal no.	cross section / mm ²		torque Nm
		stranded	solid	
I	measurement input 1..10	4	6	0,6
I	BIs, relays, power supply 11...60	2,5	2,5	0,6
II	SCADA interface (without REG-PE TK860), 87...98, 130...151	0,5	0,5	---
II	SCADA interface (only REG-PE TK860) 87...94	2,5	2,5	0,6
II	Extensions C10, C90..99 100...113	2,5	2,5	0,6
III	COMs, analogue IO 61...86/200...211	1,5	1,5	0,25

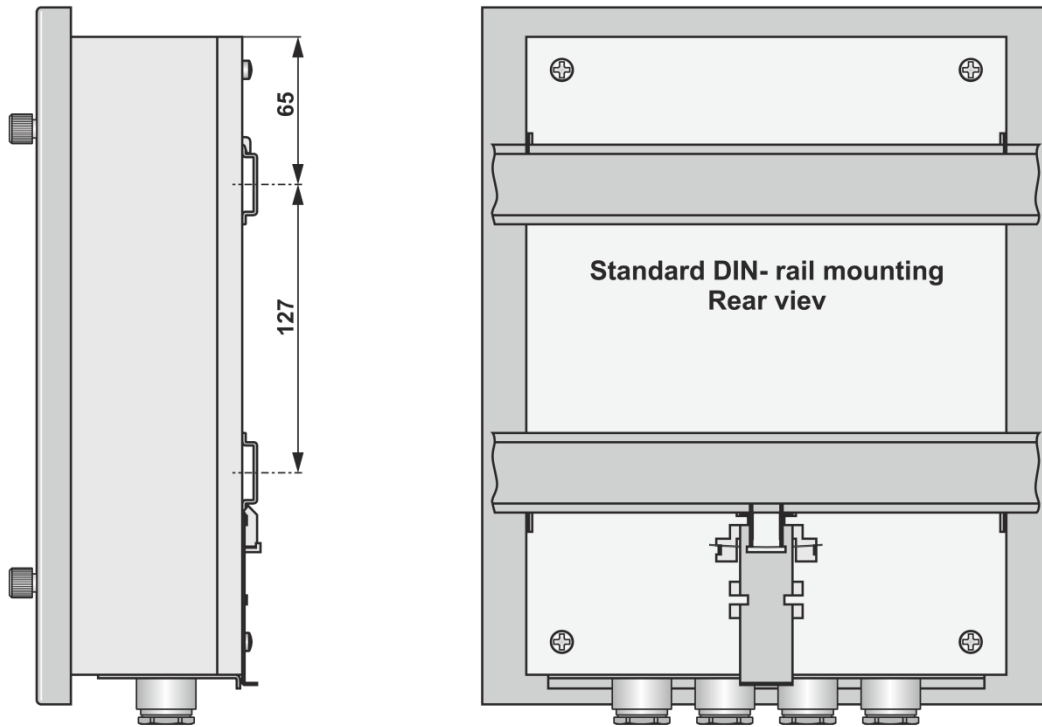
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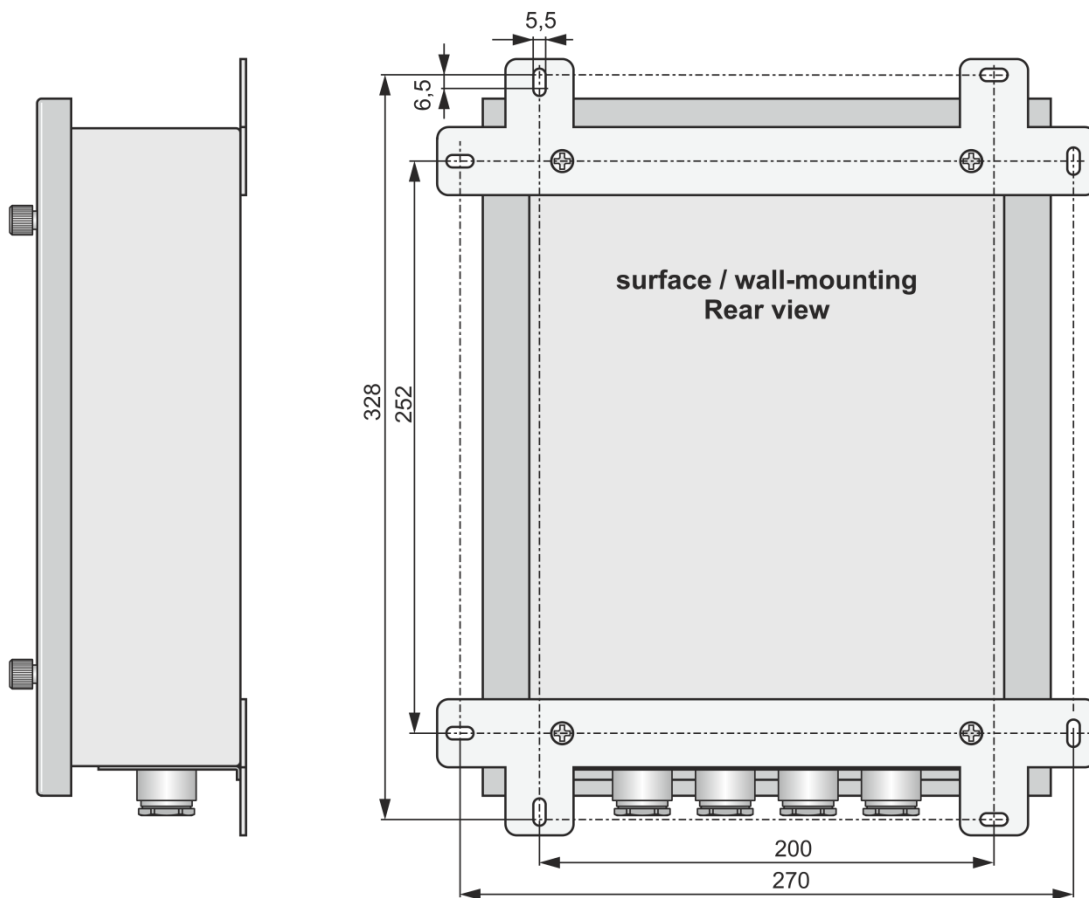
Mechanical dimensions, in mm



Mechanical dimensions, panel mounting



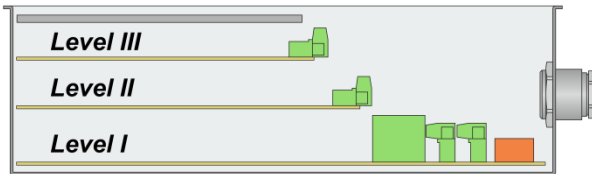
Mechanical dimensions, DIN rail mounting, in mm



Mechanical dimensions, wall mounting, in mm

General information about the connection technology

The regulator has three printed circuit boards or connection levels.



The auxiliary voltage, the VT & CT inputs, as well as the relay outputs, binary inputs etc., are all connected on **Level I**.

The hardware for all SCADA connectivity is on **Level II**.

Additional binary inputs and outputs, and mA inputs and outputs can also be installed on Level II.

There are two slots available, each of which can be equipped with the following modules:

- Module 1 : 6 binary inputs AC/ 48 V...250 V
- Module 2 : 6 relay outputs
- Module 3 : 2 mA inputs
- Module 4 : 2 mA outputs
- Module 5 : PT100 – input
- Module 6 : Standalone monitoring unit PAN-A2 occupies both slots



If the REG-DA is equipped with four Ethernet ports (Characteristic PB 1..4), then there is only one slot on level II available for additional in- and outputs.

The connections for the REG-DA COM ports, the E-LANs, additional analogue inputs and outputs, as well as for the PT100 direct input (E91 + E94) or resistance input (E97 + E98) cards, are located on **Level III**.

Optical Protocol Interfaces

For fibre optic serial connections up to a baud rate of 19200 (e.g. DNP, IEC 60870-5-101 or 103), ST, FSMA or VL connectors are directly mounted on the flange plate for access without opening the REG-DA door.

Please refer to the list of characteristics for an overview of the available options.



Fibre optical connection (ST-connector, V17, V19)



Fibre optical connection (FSMA-connector, V13, V15)

When working with an Ethernet connection (such as for IEC 61850, IEC 60870-5-104 or DNP 3.0 over Ethernet), the corresponding plug connection is accessible on Level II (RJ45 and/or LC fibreglass).



*Fibre optical connection (2 x Ethernet-LC) at Level II;
REG-DA Com ports at Level III*

Optical transmitter

Serial communication up to 19200 baud
(characteristic V13 ... V19, V22)

Product	Wave length	Fibre	Pmin [dBm] ¹⁾	Pmax [dBm] ¹⁾
Fibreglass ST Fibreglass FSMA	$\lambda = 820 \text{ nm}$	50/125 μm NA=0.2	-19.8	-12.8
		62.5/125 μm NA=0.275	-16.0	-9.0
		100/140 μm NA=0.3	-10.5	-3.5
		200 μm HCS NA=0.37	-6.2	+1.8
All-plastic ST	$\lambda = 650 \text{ nm}$	1 mm POF	-7.5	-3.5
		200 μm HCS	-18.0	-8.5
All-plastic FSMA	$\lambda = 650 \text{ nm}$	1 mm POF	-6.2	0.0
		200 μm	-16.9	-8.5
All-plastic VL	$\lambda = 650 \text{ nm}$	1mm POF	-16,5 ²	-7,6 ²

1) TA = 0..70°C, IF = 60 mA, measured after 1 m fibre optic cable

2) TA = 0..70°C, IF = 60 mA, measured after 0.5 m fibre optic cable

Communication over Ethernet 100 Mbit (100Base Fx)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass ST Fibreglass LC	1310 nm	62.5/125 μm NA=0.275	-19	-14

Communication over Ethernet 1000 Mbit (1000Base LX)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass LC	1310 nm	9/125 μm	-9,5	-3

Communication over Ethernet 1000 Mbit (1000Base SX)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass LC	850 nm	62.5/125 μm NA=0.275	-9,5	-4

Optical receiver

Serial communication up to 19200 baud
(characteristic V13 ... V19, V22)

Product	Wave length	Fibre	Pmin [dBm] ¹⁾	Pmax [dBm] ¹⁾
Fibreglass ST Fibreglass FSMA	$\lambda = 820 \text{ nm}$	100/140 μm NA=0.3	-24.0	-10.8
All-plastic ST		1 mm POF	-20.0	0.0
All-plastic FSMA	$\lambda = 650 \text{ nm}$	200 μm HCS	-22.0	-2.0
		1 mm POF	-21.6	-2.0
All-plastic VL	$\lambda = 650 \text{ nm}$	200 μm	-23.0	-3.4
		1mm POF	-21,6	-9,5

1) TA = 0...70°C, VCC = 5 V \pm 5%, output level LOW (active)

Communication over Ethernet 100 Mbit (100Base Fx)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass ST Fibreglass LC	1310 nm	62.5/125 μm NA=0.275	-14	-32

Communication over Ethernet 1000 Mbit (1000Base LX)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass LC	1310 nm	9/125 μm	-21	-3

Communication over Ethernet 1000 Mbit (1000Base SX)

Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass LC	850 nm	62.5/125 μm NA=0.275	-17	-3

6. Terminal configuration

No.	Option	M1*	M2*	M9*	
Level I	2	Measuring voltage	U1a	U1a	
	5		U1b	U1b	
	8	Measuring voltage	-	U2a	
	10		-	U2b	
	1	S1	Current input I ₁		
	3	S2			
	4	S1	Current input I ₂		
	6	S2			
	7	S1	Current input I ₃		
	9	S2			
21	L/(+)	U _H = Auxiliary voltage			
22	L/(-)				
Level III	63	mA input	+	A1	
	64	mA input	-	A1	
	61	mA input or output	+	A2	
	62	mA input or output	-	A2	
	65	mA input or output	+	A3	
	66	mA input or output	-	A3	
	67	mA input or output	+	A4	
	68	mA input or output	-	A4	
Level I	11	Binary input 1	Freely programmable		
	12	Binary input 2	Freely programmable		
	13	Binary input 3	Freely programmable		
	14	Binary input 4	Freely programmable		
	15	Binary input 1...4	GND		
	16	Binary input 5	AUTO		
	17	Binary input 6	MAN		
	18	Binary input 7	Freely programmable		
	19	Binary input 8	Freely programmable		
	20	Binary input 5...8	GND		
	23	Binary input 9	BCD 1		
	24	Binary input 10	BCD 2		
	25	Binary input 11	BCD 4		
	26	Binary input 12	BCD 8		
	27	Binary input 9...12	GND		
	28	Binary input 13	BCD 10		
	29	Binary input 14	BCD 20		
	30	Binary input 15	BCD sgn.		
	31	Binary input 16	Freely programmable		
	32	Binary input 13...16	GND		
33		Freely programmable	R ₅		
34		Freely programmable	R ₄		
35		Freely programmable	R ₃		
37		Freely programmable	R ₃		
38		Freely programmable	R ₃		
39		lower	R ₂		
40					
41					
42		higher	R ₁		
43					
44					
45					
46					

Level I	47		>I	R ₁₁
	48		>U	R ₁₀
	49		<U	R ₉
	50		Local	R ₈
	51		Remote	R ₇
	52		TC error**	R ₆
	53		GND	R _{6...R11}
	54		closes in the event of Life contact (status)	
	55		opens in the event of	
	56			
Level III	57		MANUAL	
	58		MAN/AUTO	
	59		AUTO	
	69	E-	E-LAN (L)	
	70	E+		
	71	EA-		
	72	EA+		
	200	GND		
	73	E-	E-LAN (R)	
	74	E+		
	75	EA-		
76	EA+			
201	GND			
77	Tx+	COM3 (RS485)		
78	Tx-			
79	Rx+			
80	Rx-			
81	GND			
82	TxD	COM2 / COM5 (RS232) On devices with characteristic S2 and firmware version ≥ 3.29 and ESCC2 version ≥ 10 the COM2 can be split into COM2 and COM5 (84:TxD, 85:RxD, 86:GND)		
83	RxD			
84	RTS			
85	CTS			
86	GND			
202	DCF-	DCF 77 ***		
203	DCF+			
204	GND			
205	TxD	COM1 – S / COM 4 (COM 4 only on devices with characteristic S2)		
206	RxD			
207	RTS			
208	CTS			
209	GND			
210	GND	Aux. power supply output 5 V DC (max. 2W)		
211	VCC+			
Level II	Please refer to Terminal Configuration Level II (page 16) for additional fitting options on Level II. And to the terminal configuration of the SCADA interface on page 17 for the SCADA interface connections.			

*Option M1 Used for standard applications.

Three-wire networks are generally considered as symmetrical (I₁ = I₂ = I₃)

Option M2 Only used in asymmetrically loaded three-phase systems (I₁ ≠ I₂ ≠ I₃)

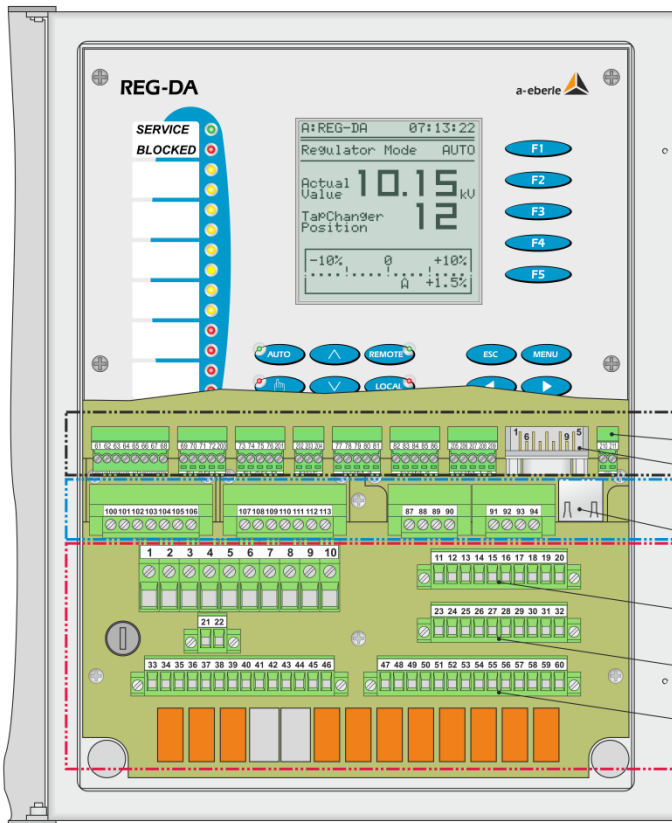
Option M9 For triple-wound applications, two galvanically isolated voltage inputs are available for U1 and U2.

** TC = tap changer

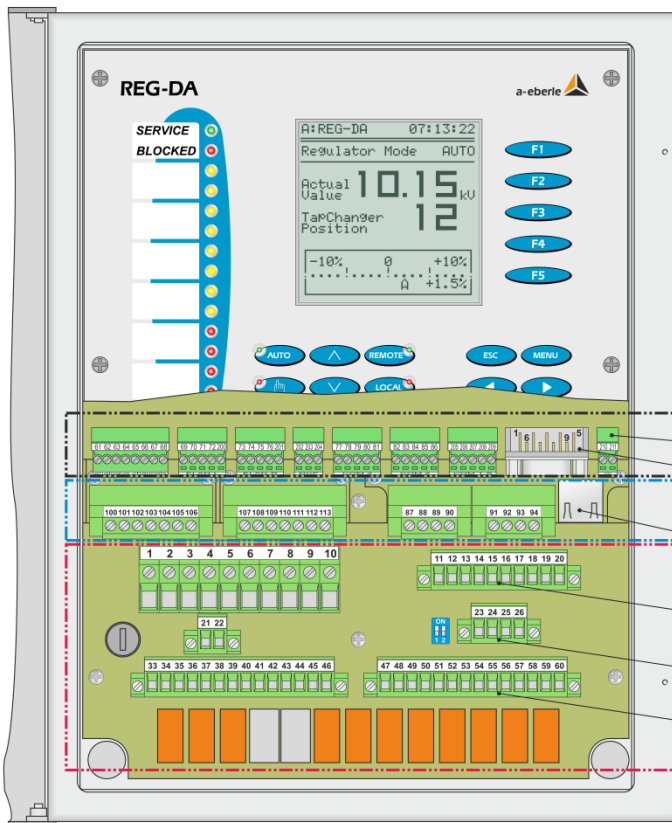
*** Please refer to terminal configuration of the SCADA interface on page 17 for the SCADA interface connections.

*** The DCF77 input is implemented from FW 2.22 onwards.

The allocation of terminals 23 to 32 changes depending on characteristics D0 / D1/ D4 / D7 / D9 and D2 / D3 / D5/ D6 / D8



Position of the terminal connections
Characteristics D0, D1, D4, D7, D9



Position of the terminal connections
Characteristics D2, D3, D5, D6, D8

6.1 Terminal Configuration Level II

Examples for Characteristics: C9.x, C10, C91...C99



It's not possible to combine all of the features Cxx with four Ethernet ports (characteristic PB1...4). Please refer to the order specifications for more details. The specific terminal configuration of a REG-DA can be found in the wiring diagram!

Characteristic C10 – Standalone monitoring function

No.			
Module 6	100		lower command interlock
	101		raise command interlock
	102		raise command interlock
	103		Overvoltage >U
	104		Root
	105		Undervoltage <U
	106		measuring voltage
	107		U1a
	108		U1b
	109		COM1 / RxD
	110		COM1 / TxD
	111		COM1/2/GND
	112		COM2 / RxD
113		COM2 / TxD	

Characteristic C9.1 – (2 x PT100)

No.			
Module 5	100	PT100	Ik+
	101		Ue+
	102		Ue-
Module 5	103		Ik-
	104	PT100	Ik+
	105		Ue+
	106		Ue-
	107		Ik-

Characteristic C91 – 6 additional binary inputs AC/DC 48 V ... 250 V

No.		
Module 1	100	Binary input
	101	Binary input
	102	Binary input
	103	Binary input
	104	Binary input
	105	Binary input
106	GND	E17 ... E22

Characteristic C92 – 12 additional binary inputs AC/DC 48 V ... 250 V

No.		
Module 1	100	Binary input
	101	Binary input
	102	Binary input
	103	Binary input
	104	Binary input
	105	Binary input
106	GND	E17 ... E22
Module 1	107	Binary input
	108	Binary input
	109	Binary input
	110	Binary input
	111	Binary input
	112	Binary input
	113	GND

Characteristic C93 – 6 additional relay outputs (NOC)

No.		
Module 2	100	
	101	
	102	
	103	
	104	
	105	
106		GND R12 ... R17

Characteristic C94 – 12 additional outputs (NOC)

No.		
Module 2	100	
	101	
	102	
	103	
	104	
	105	
106		GND R12 ... R17
Module 2	107	
	108	
	109	
	110	
	111	
	112	
	113	

Characteristic C95 – 6 additional binary inputs AC/DC 48 V ... 250 V and 6 additional relay outputs (NOC)

No.		
Module 1	100	Binary input
	101	Binary input
	102	Binary input
	103	Binary input
	104	Binary input
	105	Binary input
106	GND	E17 ... E22
Module 2	107	
	108	
	109	
	110	
	111	
	112	
	113	

Characteristic C96 – 2 additional analogue inputs

No.			
Module 3	100	analogue input	+
	101		-
Module 3	102	analogue input	+
	103		-

Characteristic C97 – 4 additional analogue inputs

No.			
Module 3	100	analogue input	+
	101		-
	102		+
Module 3	103	analogue input	-
	104		+
Module 3	105	analogue input	-
	106		+
	107		-

Characteristic C98 – 2 additional analogue outputs

No.			
Module 4	100	analogue output	+
	101		-
Module 4	102	analogue output	+
	103		-

Characteristic C99 – 4 additional analogue outputs

No.			
Module 4	100	analogue output	+
	101		-
Module 4	102	analogue output	+
	103		-
Module 4	104	analogue output	+
	105		-
Module 4	106	analogue output	+
	107		-

6.2 Terminal Configuration for SCADA interface on Level II

Characteristics: Z01, 03, 10..15, 17..23, 90, 91, 99, XW90...98, CS, PB, CZ

Characteristics Z10..15, 17..20, 90, 91

REG-P TK400 communication interface (discontinued item, for replacement see REG-P[■] TK28-4 in the right column)

	No.			
COM1 RS485	87	RS485-N (B)		
	88	RS485-P (A)		
COM1 RS232	89	RS232-TxD		
	90	RS232-RxD		
	91	RS232-RTS		
	92	RS232-CTS		
	93	RS232-GND		
PE	94	PE		
COM1 fibre optic	95	Fibre optic In	Fibre optic module (optional)	Fibre optic cable
	96	Fibre optic Out		
	97	Fibre optic GND		
	98	Fibre optic VCC		
Ethernet 1	RJ45 connector			

Characteristic Z99—Profibus-DP communication interface

	No.	
PARAM (R111)	1	RS232-GND
	2	RS232-GND
	3	RS232-RxD
	4	RS232-TxD
Profibus-DP (SUB-D)	3	B-Line (Rx/Tx +)
	4	RTS
	5	GND BUS
	6	+5 V BUS
	8	A-Line (Rx/Tx -)

Characteristics XW90..93+97+98

REG-PE TK 860 communication interface (discontinued item, for replacement see REG-P(E)[■] TK28-4/6 in the right column)

	No.			
PARAM 1	87	RS232-RxD		
	88	RS232-TxD		
	89	RS232-GND		
	90	RS232-GND-SCR		
PARAM 2	91	RS232-RxD		
	92	RS232-TxD		
	93	RS232-GND		
	94	RS232-GND-SCR		
Ethernet	RJ45 connector	or	Fibre optic cable (ST or LC)	

Characteristics CS90..91+97+98 combined with PB0, Charact. Z01+03+10..15+17..20+22..23+90..91, CZ01+03+10..23+ 90.. 91

REG-P[■] TK 28-4A communication interface

	Nr.			
	130	AUART2 Rx (internal use only)		
	131	AUART2 Tx (internal use only)		
FO	132	Fibre optic Rx	Fibre optic module (optional)	Fibre optic cable
	133	Fibre optic Tx		
5V ext.	134	GND		
	135	5V DC output		
PE	136	PE		
	137	PE		
COM1	138	GND COM1		
	139	RS485-P (B) COM1		
	140	RS485-N (A) COM1		
	141	RS232-TxD COM1		
	142	RS232-RxD COM1		
	143	RS232-RTS COM1		
	144	RS232-CTS COM1		
COM3	145	RS485-P (B) COM3		
	146	RS485-N (A) COM3		
	147	RS232-TxD COM3		
	148	RS232-RxD COM3		
	149	RS232-RTS COM3		
	150	RS232-CTS COM3		
	151	GND COM3		
PARAM		Micro USB		
Ethernet 1	RJ45 connector			

Characteristics XW94..96,

Characteristics CS92..96+98 combined with PB0





REG-PE[■] TK 28-6A communication interface

	Nr.			
	130	AUART2 Rx (internal use only)		
	131	AUART2 Tx (internal use only)		
FO	132	Fibre optic Rx	Not available on REG-PE TK28-6A	
	133	Fibre optic Tx		
5V ext.	134	GND		
	135	5V DC output		
PE	136	PE		
	137	PE		
COM1	138	GND COM1		
	139	RS485-P (B) COM1		
	140	RS485-N (A) COM1		
	141	RS232-TxD COM1		
	142	RS232-RxD COM1		
	143	RS232-RTS COM1		
	144	RS232-CTS COM1		
COM4	145	RS485-P (B) COM4		
	146	RS485-N (A) COM4		
	147	RS232-TxD COM4		
	148	RS232-RxD COM4		
	149	RS232-RTS COM4		
	150	RS232-CTS COM4		
	151	GND COM4		
PARAM		Micro USB		
Ethernet 1	RJ45 connector	or	Fibre optic (LC)	
Ethernet 2	RJ45 connector	or	Fibre optic (LC)	

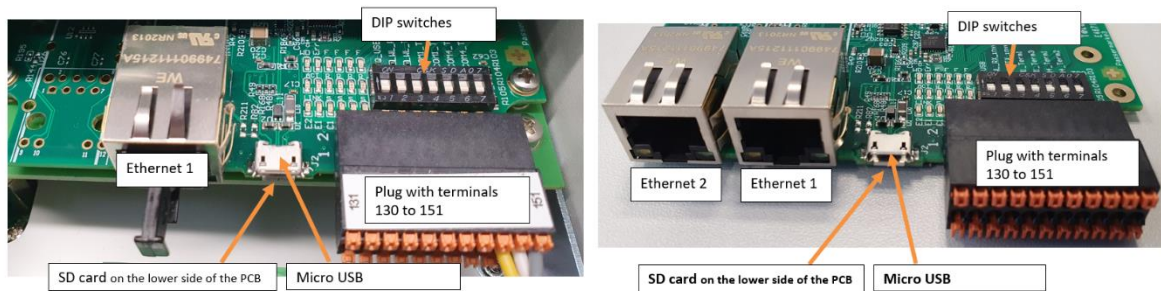
We take care of it.

Characteristics PB1..4

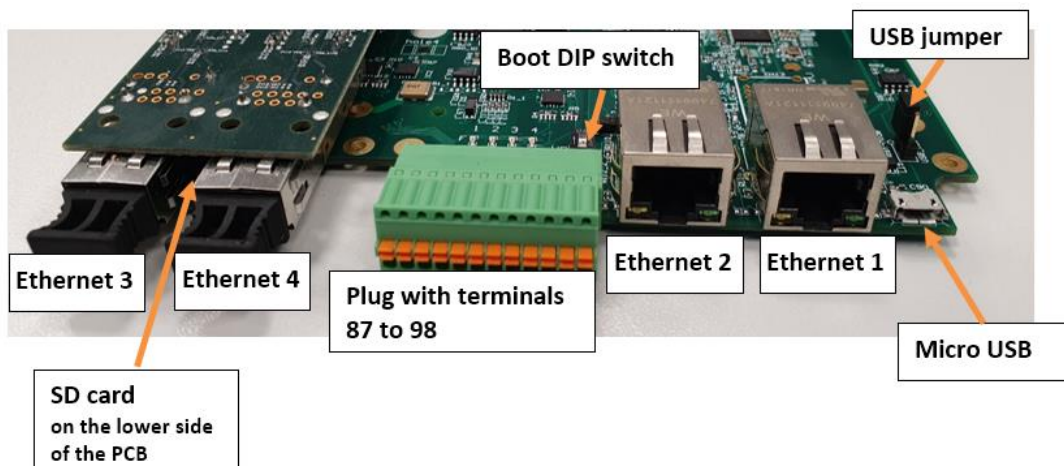
REG-PED^{SV} TK 102A communication interface

		Nr.	
COM1		87	RS485-P (B) COM1
		88	RS485-N (A) COM1
		89	RS232-TxD COM1
		90	RS232-RxD COM1
		91	RS232-RTS COM1
		92	RS232-CTS COM1
		93	GND COM1
PE		94	PE
PARAM		95	PARAM-RxD
		96	PARAM-TxD
5V ext.		97	GND
		98	5V DC output (only for A. Eberle use)
Ethernet 1	RJ45 connector	or	 Fibre optic (LC)
Ethernet 2	RJ45 connector	or	 Fibre optic (LC)
Ethernet 3	RJ45 connector	or	 Fibre optic (LC)
Ethernet 4	RJ45 connector	or	 Fibre optic (LC)

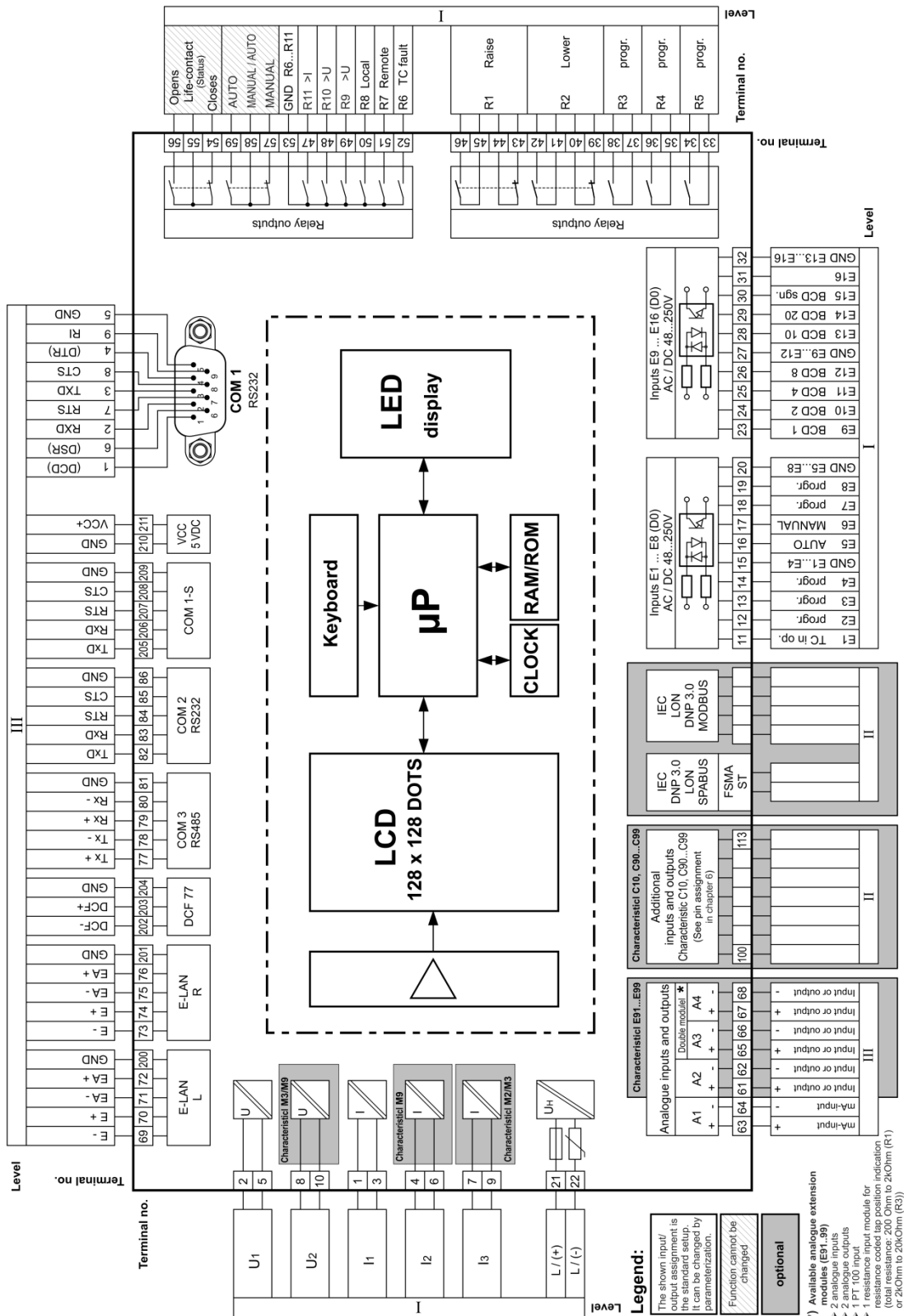
6.3 Interface assignment REG-P[□] TK28-4A and REG-PE[□] TK28-6A



6.4 Interface assignment REG-PED^{SV} TK102

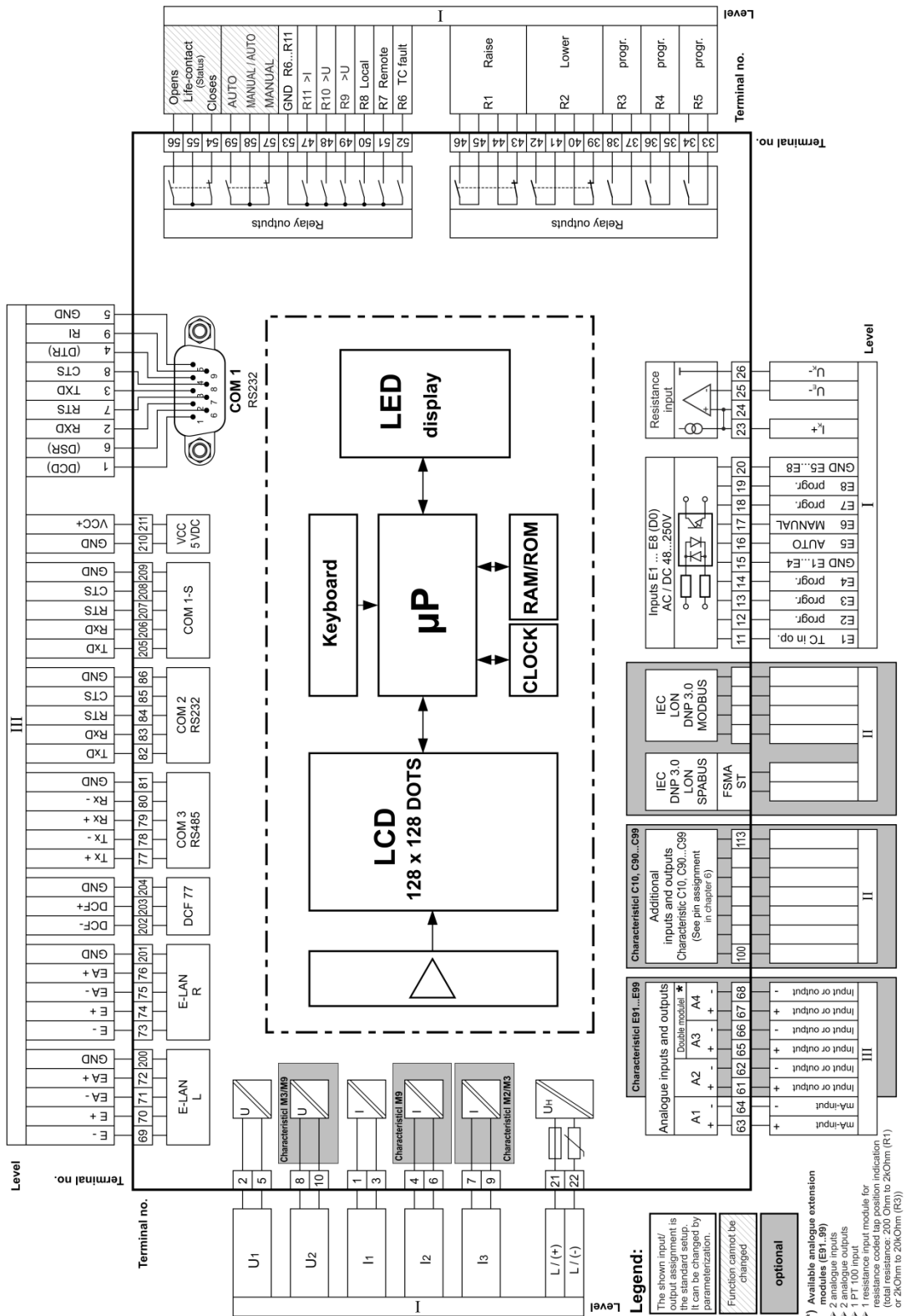


6.5 Block diagram - Characteristics D0, D1, D4, D7, D9



*) The dual module comes as a dual mA input module or a dual mA output module. The position is occupied by a PT100 module if the temperature is to be recorded directly.

6.6 Block diagram - Characteristics D2, D3, D5, D6, D8



*) The dual module comes as a dual mA input module or a dual mA output module. The position is occupied by a PT100 module if the temperature is to be recorded directly.

COM3 (peripheral interface)

Com3 is an RS485 or optional fibre optic interface used to connect up to 16 interface modules (BIN D, ANA D) in any combination to a REG-D or PAN-D. A COM3/Modbus converter can also be selected, in order to establish direct serial communication with other Modbus devices. This enables the REG-DA to acquire values such as the winding temperature or the gas-in-oil ratio from other devices and transmit them to the SCADA or record them in Recorder mode.

Time Synchronisation Input (DCF input)

A time synchronisation input enables the time on the REG-DA to be synchronised using a DCF77 signal. This input is designed for an RS485 (5 V) signal and can be wired as a time synchronisation bus to several devices. The termination (terminating resistor) can be switched on and off by using jumpers or switches on the CPU board.

If a DCF signal cannot be received, a GPS clock or controller card that emulates a DCF signal can be used. Time can also be synchronised through SCADA.

The dedicated time synchronisation input via DCF is not supported until firmware version 2.22.

WinREG runs on the following operating systems:

- Windows 7 / 8 / 10
- Windows Server from 2003 onwards

Most of the settings can be made either directly on the regulator using the regulator's membrane keyboard, or centrally through WinREG. If the device is to be accessed through a central point, all of the regulators must be connected to each other through the E-LAN.

7.2 WinREG Parameterisation and Configuration Software

WinREG is used to parameterise and program the system.

WinREG is modular and consists of the following programs:

PanelView enables you to display an accurate replica of each device and its operating options on your PC screen. All buttons and functions are active from this replica, and multiple devices on the ELAN can be displayed at once.

REGPara enables each of the components to be quickly and easily parameterised. The parameters are set in a straightforward tab structure, and can be saved for later use or transferred to another regulator on the ELAN bus.

The Terminal enables direct communication with the system.

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

Service enables the logbook and the tap statistics to be read out of the devices and archived.

This is also where the parameters for daylight savings, the allocation of add-on modules, and the remote control of simulation mode are found.

The Collector reads the recorded data from the REG-DA and archives it on the PC.

REGView is used to view and analyse recorded data directly on the REG-DA or in a data file (collector).

The WinTM module (parameters for the transformer monitoring module) and the WinDM module (parameters for the transformer monitoring device without voltage regulator) complete the software suite.

REG-DA Parameters (selection)

Parameter	Setting range
Permissible (voltage) deviation	$\pm 0.1 \dots 10 \%$ or $\pm 0.1 \dots 100 \%$ for P/Q regulation
Time factor	0.1 ... 30
Setpoint value 1..2	60.0 ... 140.0 V
Setpoint value 3..4	60.0 ... 140.0 V or -500 ... 500% for P/Q regulation
Time behaviour	$\Delta U \cdot t = \text{const}$ REG 5A/E LINEAR CONST
Trend memory	0 ... 60 s
Current influence (load-dependent setpoint)	Apparent current Active current Reactive current LDC
Apparent, active, reactive current	
Increase (I) (pos.)	0 ... 400 V/In
Increase (I) (neg.)	0 ... 400 V/In
Limit (I) (max.)	-40 ... 40 V
Limit (I) (min.)	-40 ... 40 V
LDC (Line drop compensation)	R : 0 ... $\pm 100 \Omega$ X : 0 ... $\pm 100 \Omega$
Undervoltage <U	-25% ... +10 %
Overvoltage >U	0 ... 25 %
Overcurrent >I	0 ... 210% (1A / 5A)
Undercurrent >I	0 ... 100 % (1A / 5A)
Inhibit High	65 V ... 150 V
Fast switching forward	0 ... -35 %
Fast switching backward	0 ... 35 %
Inhibit low	-75 % ... 0 %
Switching delay for <U, >U, <I, inhibit high, Fast switching, Inhibit low can be set separately	1 ... 999 s (Fast step-up 2...999 s)
Parallel programs	dl*sin(phi) dl*sin(phi)[S] dcos(phi) Master-Slave MSI MSI2
TC in operation - maximum time	3 ... 40 s

7.3 REGSim™ Simulation Software

REGSim™ was designed to simulate the parallel connection of several transformers in any network and load- configuration, and to show the results on a PC.

To ensure that the REG-DA produces the same results during the simulation as in a live environment, the transformers, the network and the load are accurately recreated mathematically.

The authenticity of the simulation is guaranteed because REGSim™ uses the REG-DA regulator's original algorithm.

All of the settings match those of the real regulator and the simulation is run in real time.

REGSim™ enables parameters to be tested and set before using them in a live environment.

8. Order specifications

- Only one code of the same capital letter is possible
- When the capital letter is followed by number 9, further details could be necessary
- The code can be omitted when the capital letter is followed by zero or one option is marked as standard
- Some characteristics cannot be combined with all of the other characteristics. Please read the notes and explanations.

CHARACTERISTIC	CODE
REG-DA Relay for OLTC control & Transformer Monitoring (Automatic Voltage Regulator) with E-LAN double interface, COM 2, COM 3, one mA-input to be used e.g. for measurement of oil temp. or as tap-changer position input via resistance transducer; Standard 16 binary inputs, 12 relay outputs, and status output, inclusive software for setting of parameters, programming and visualisation of all REG-DA data, incl. connecting cable. Note: COM2 is only freely accessible when operated without SCADA interface.	REG-DA
Model <ul style="list-style-type: none"> ● Sheet steel housing (H x W x D) 307 x 250 x 102 mm including flange plate with cable glands, brush sealing (alternatively mountable) and mounting material for panel or wall mounting ● Sheet steel housing (H x W x D) 307 x 250 x 102 mm including flange plate with cable glands, brush sealing (alternatively mountable) and mounting material for panel or wall mounting and standard DIN rail adapter 	B0 B1
Serial interface COM1 <ul style="list-style-type: none"> ● Serial interface COM1: RS232 with SUB-D connector (9-pin male), standard if charact. is not specified ● Serial interface COM1: USB (Mini-USB connector) 	I0 I1
Power supply <ul style="list-style-type: none"> ● Power supply: AC 100V ... 110V ... 240V / DC 100V ... 220V ... 300V ● Power supply: DC 20V ... 60V ... 70V 	H0 H2
Input current (rated value) <ul style="list-style-type: none"> ● Rated input current: I_r 1A (subsequently modifiable) ● Rated input current: I_r 5A (subsequently modifiable) 	F1 F2
Voltage and current measurement <ul style="list-style-type: none"> ● Three-wire three-phase system balanced load (1x U, 1x I) ● Three-wire three-phase system unbalanced load (2x U, 2x I, Aron connection) ● Measured quantities: primary voltage U, secondary voltage U and current I (2x U, 1x I) ● Other application with 2 x CT's and 2 x VT's; but 3 windings transformer always active (deactivation possible) 	M1 M2 M3 M9
Recorder function for quantities like U, I, P, Q, S, PF, tap position incl. PC software <ul style="list-style-type: none"> ● Recorder function incl. PC software: without ● Recorder function incl. PC software: for max. three channels ● Recorder function incl. PC software: for max. 256 channels (4 x 64), 108 MB internal memory and upgraded CPU, including S1 Note: If Sampled Values (IEC 61850-9-2LE) are used the feature S2 is mandatory!	S0 S1 S2
Transformer monitoring according to IEC 60354 or IEC 60076 <ul style="list-style-type: none"> ● Without Transformer Monitoring ● With Transformer Monitoring in accordance to IEC 60354 and IEC 60076 ● With extended Transformer Monitoring: moisture in paper/oil, bubbling temperature (T1 incl.) Note: The feature T2 is only available in combination with the features S2	T0 T1 T2
Parallel operation <ul style="list-style-type: none"> ● Parallel operation: without ● Parallel operation: with (incl. ParaGramer) ● Feature K1 and additional HVLVControl ● Feature K1 and additional Crosslink ● Feature K1 and additional Crosslink & HVLVControl ● Feature K1 and additional Ringlink ● Feature K1 and additional Ringlink & HVLVControl 	K0 K1 K2 K3 K4 K5 K6

CHARACTERISTIC	CODE
PQCtrl – Active or reactive power control <ul style="list-style-type: none"> ● PQCtrl: Without ● PQCtrl: With 	P0 P1
Additional analogue inputs and outputs <ul style="list-style-type: none"> ● without ● 1 x PT 100 input ● 2 x mA-inputs ● 2 x mA-outputs ● 1 x PT 100 input and 1 x mA-output ● 2 x mA inputs and 1 x mA-output ● 3 x mA-outputs ● 1 x resistor module R1 (180Ω...2kΩ, min 5Ω / step) ● 1 x resistor module R3 (2kΩ...20kΩ, min 50Ω / step) ● 1 x PT 100 input and 1 mA-Input ● 1 x mA-output ● 1 x mA-input ● 3 x mA-inputs ● 1 x mA-output and 1 resistor module R1 (180Ω...2kΩ, min 5Ω / step) ● 1 x mA-output and resistor module R3 (2kΩ...20kΩ, min 50Ω / step), identical with E9.4 ● 1 x mA-input and resistor module R3 (2kΩ...20kΩ, min 50Ω / step) ● 1 x mA-input and resistor module R1 (180Ω...2kΩ, min 5Ω / step) ● 1 x mA-input and 2 x mA-outputs ● other combinations of inputs and outputs 	E00 E91 E92 E93 E94 E95 E96 E97 E98 E9.1 E9.2 E9.3 E9.5 E9.6 E9.7 E9.8 E9.9 E9.10 E99
Binary inputs and tap change potentiometer input <ul style="list-style-type: none"> ● 16 binary inputs AC/DC 48...250 V (E1...E16) ● 8 binary inputs AC/DC 10..50 V (E1...E8) and 8 units AC/DC 48...250 V (E9...E16) ● 16 binary inputs AC/DC 10...50 V (E1...E16) ● 16 binary inputs AC/DC 190...250 V (E1...E16) ● 16 binary inputs AC/DC 80...250 V (E1...E16) ● Resistor input R1 (total resistance 180...2 kΩ, min 5Ω/step) and 8 binary inputs AC/DC 48V...250V ● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 10V...50V ● Resistor input R1 (total resistance 180...2 kΩ, min 5Ω/step) and 8 binary inputs AC/DC 10V...50V ● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 48V...250V ● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 80V...250V 	D0 D1 D4 D7 D9 D2 D3 D5 D6 D8

CHARACTERISTIC	CODE
<p>Level II: additional inputs and outputs as well as the monitoring function PAN-A2</p> <ul style="list-style-type: none"> ● without additional inputs and outputs on level II C00 ● 6 x AC/DC 48...250V (BI17...BI22) C91 ● 12 x AC/DC 48...250V (BI17...BI28) (not in combination with PB1...4) C92 ● 6 x relays (BO12...BO17) C93 ● 12 x relays (BO12...BO23) (not in combination with PB1...4) C94 ● 6 x AC/DC 48...250V (BI17...BI22) and 6 x relays (BO12...BO17) (not in combination with PB1...4) C95 ● 2 x mA-inputs C96 ● 4 x mA-inputs (not in combination with PB1...4) C97 ● 2 x mA-outputs C98 ● 4 x mA-outputs (not in combination with PB1...4) C99 ● Monitoring function (PAN-A2) (not in combination with PB1...4) C10 ● 2 x PT 100 inputs (not in combination with PB1...4) C9.1 ● 6 x AC/DC 80...250V (BI17...BI22) and 1 x PT 100 input (not in combination with PB1...4) C9.2 ● 1 x PT 100 input C9.4 ● 6 x relays (BO12...BO17) and 2 x mA-outputs (not in combination with PB1...4) C9.5 ● 12 x AC/DC 48...250V (BI17...BI28) and 6 x AC/DC 10...50V (BI29...BI34) (not in combination with Scada) C9.6 ● 6 x AC/DC 10...50V (BI17...BI22) C9.7 ● 12 x AC/DC 80...250V (BI17...BI28) (not in combination with PB1...4) C9.9 ● 6 x AC/DC 48...250V (BI17...BI22) and 1 x PT 100 input (not in combination with PB1...4) C9.10 ● 1 x PT 100 input and 2 x mA-inputs (not in combination with PB1...4) C9.11 ● 6 x AC/DC 80V...250V (BI17...BI22) C9.12 ● 6 x AC/DC 80V...250V (BI17...BI22) and 2 x mA-inputs (not in combination with PB1...4) C9.13 ● 2 x mA-outputs and 1 x PT 100 input (not in combination with PB1...4) C9.14 ● 2 x mA-outputs and 2 x mA-inputs (not in combination with PB1...4) C9.16 ● 6 x AC/DC 48...250V (BI17...BI22) and 2 x mA-inputs (not in combination with PB1...4) C9.17 ● Other combinations 6 inputs, 6 outputs, 2 analogue inputs, 2 analogue outputs or PT100 input (check number of slots in combination with PB1...4) C90 <p>Note for C90: Two slots are usually available on Level II. Each slot can be equipped with 6 binary inputs, 6 binary outputs or with an analogue module. In case that none SCADA-communication (XW90... 9x, CS90...9x, L1...L9) is selected, up to four additional modules can be equipped!</p> <p>In case of four Ethernet ports (characteristic PB1...4) the feature C90 can only use one slot.</p>	
<p>COM3 interface</p> <ul style="list-style-type: none"> ● with RS485 (standard, feature may be omitted) R1 ● with RS485 and for remote components fibre optic interface (fibre glass) with ST connector R2 <p>Note: COM3 is needed for ANA-D, BIN-D and COM3/Modbus converter.</p>	

CHARACTERISTIC	CODE	
Integrated SCADA connection for Ethernet based protocols (e.g. IEC 61850) without cyber security option		
<ul style="list-style-type: none"> ● without ethernet based protocols without cyber security option (continue with charact. group 'CS') 	XW00	
<ul style="list-style-type: none"> ● IEC 60870-5-104 with 1x RJ 45 (continue with characteristic group 'G') 	XW90	
<ul style="list-style-type: none"> ● IEC 60870-5-104 with 1x FO-ST connection (continue with characteristic group 'G') 	XW92	
<p>Note: Please specify the target SCADA system for connections in conformity with IEC 60850-5-104.</p>		
<ul style="list-style-type: none"> ● IEC 61850 with 1x RJ 45 connection (continue with characteristic group 'G') 	XW91	
<ul style="list-style-type: none"> ● IEC 61850 with 1x FO-ST connection (continue with characteristic group 'G') 	XW93	
<ul style="list-style-type: none"> ● IEC 61850 with 1x FO-LC connection (continue with characteristic group 'G') 	XW93.1	
<ul style="list-style-type: none"> ● IEC 61850 with 2x RJ45 connection (continue with characteristic group 'G') 	XW94	
<ul style="list-style-type: none"> ● IEC 61850 with 2x FO-ST connection (continue with characteristic group 'G') 	XW95	
<ul style="list-style-type: none"> ● IEC 61850 with 2x FO-LC connection (continue with characteristic group 'G') 	XW95.1	
<ul style="list-style-type: none"> ● IEC 61850 with 1x RJ45 and 1x FO-ST connection (continue with characteristic group 'G') 	XW96	
<ul style="list-style-type: none"> ● IEC 61850 with 1x RJ45 and 1x FO-LC connection (continue with characteristic group 'G') 	XW96.1	
<p>Note: Please specify the target SCADA system for connections in conformity with IEC 61850.</p>		
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1x RJ45 connection (continue with characteristic group 'G') 	XW97	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 2x RJ45 connection (continue with characteristic group 'G') 	XW94.1	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1x FO-ST connection (continue with characteristic group 'G') 	XW98	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1x FO-LC connection (continue with characteristic group 'G') 	XW98.1	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 2x FO-ST connection (continue with characteristic group 'G') 	XW95.2	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 2x FO-LC connection (continue with characteristic group 'G') 	XW95.5	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1x RJ45 and 1x FO-ST connection (continue with characteristic group 'G') 	XW96.4	
<ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1 x RJ45 and 1 x FO-LC connection (continue with characteristic group 'G') 	XW96.5	
<p>Note: Please specify the target SCADA system for connections in conformity with DNP 3.0.</p>		
<ul style="list-style-type: none"> ● MODBUS TCP/IP with 2x RJ45 connection (continue with code "G") 	XW94.2	
<ul style="list-style-type: none"> ● MODBUS RTU with RS485 and with 1x RJ45 and 1x FO-ST) connection (continue with code "G") 	XW96.2	
<ul style="list-style-type: none"> ● SPABUS with 1x RJ 45 (continue with code "Gx") 	XW91.2	
<ul style="list-style-type: none"> ● SPABUS with 1x FO-ST-connection (continue with code "Gx") 	XW93.2	
<ul style="list-style-type: none"> ● SPABUS with 1x FO-LC-connection (continue with code "Gx") 	XW93.3	
<ul style="list-style-type: none"> ● SPABUS with 2x RJ 45 (continue with code "Gx") 	XW94.4	
<ul style="list-style-type: none"> ● SPABUS with 1x RS485 and with 2x RJ45 (continue with code "Gx") 	XW94.5	
<ul style="list-style-type: none"> ● SPABUS with 2x FO-ST-connection (continue with code "Gx") 	XW95.3	
<ul style="list-style-type: none"> ● SPABUS with 2x FO-LC-connection (continue with code "Gx") 	XW95.4	
<ul style="list-style-type: none"> ● other SCADA protocols on demand 	XW99	

WITHOUT Cyber Security

CHARACTERISTIC	CODE	
<p>Integrated SCADA connection for Ethernet based protocols (e.g. IEC 61850) with cyber security option</p> <ul style="list-style-type: none"> ● without (continue with code 'L') ● IEC 60870-5-104 with 1x RJ 45 (continue with code "SN") ● IEC 60870-5-104 with 1x FO-ST connection (continue with code "SN") <p>Note: Please specify the target SCADA system for connections in conformity with IEC 60850-5-104.</p> <ul style="list-style-type: none"> ● IEC 61850 with 1x RJ 45 (continue with code "SN") ● IEC 61850 with 1x FO-ST connection (continue with code "SN") ● IEC 61850 with 1x FO-LC connection (continue with code "SN") ● IEC 61850 with 2x RJ45 connection (continue with code "PB") ● IEC 61850 with 2x FO-ST connection (continue with code "PB") ● IEC 61850 with 2x FO-LC connection (continue with code "PB") ● IEC 61850 with 1x RJ45 and 1x FO-ST connection (continue with code "PB") ● IEC 61850 with 1x RJ45 and 1x FO-LC connection (continue with code "PB") <p>Note: Please specify the target SCADA system for connections in conformity with IEC 61850.</p> <ul style="list-style-type: none"> ● DNP 3.0 over Ethernet with 1x RJ45 connection (continue with code "SN") ● DNP 3.0 over Ethernet with 2x RJ45 connection (continue with code "PB") ● DNP 3.0 over Ethernet with 1x FO-ST connection (continue with code "SN") ● DNP 3.0 over Ethernet with 1x FO-LC connection (continue with code "SN") ● DNP 3.0 over Ethernet with 2x FO-ST connection (continue with code "PB") ● DNP 3.0 over Ethernet with 2x FO-LC connection (continue with code "PB") ● DNP 3.0 over Ethernet with 1x RJ45 and 1 x FO-ST connection (continue with code "PB") ● DNP 3.0 over Ethernet with 1x RJ45 and 1 x FO-LC connection (continue with code "PB") <p>Note: Please specify the target SCADA system for connections in conformity with DNP 3.0.</p> <ul style="list-style-type: none"> ● MODBUS TCP/IP with 2x RJ45 connection (continue with code "PB") ● MODBUS RTU with RS485 and with 1x RJ45 and 1x FO-ST connection (continue with code "PB") ● SPABUS with 1x RJ 45 (continue with code "SN") ● SPABUS with 1x FO-ST connection (continue with code "SN") ● SPABUS with 1x FO-LC connection (continue with code "SN") ● SPABUS with 2x RJ 45 (continue with code "PB") ● SPABUS with 1x RS485 and with 2x RJ45 (continue with code "PB") ● SPABUS with 2x FO-ST connection (continue with code "PB") ● SPABUS with 2x FO-LC connection (continue with code "PB") ● other SCADA protocols on demand 	<p>CS00</p> <p>CS90</p> <p>CS92</p> <p>CS91</p> <p>CS93</p> <p>CS93.1</p> <p>CS94</p> <p>CS95</p> <p>CS95.1</p> <p>CS96</p> <p>CS96.1</p> <p>CS97</p> <p>CS94.1</p> <p>CS98</p> <p>CS98.1</p> <p>CS95.2</p> <p>CS95.5</p> <p>CS96.4</p> <p>CS96.5</p> <p>CS94.2</p> <p>CS96.2</p> <p>CS91.2</p> <p>CS93.2</p> <p>CS93.3</p> <p>CS94.4</p> <p>CS94.5</p> <p>CS95.3</p> <p>CS95.4</p> <p>CS99</p>	WITH Cyber Security
<p>Add. Ethernet ports (4 in total) e.g. Process bus according to IEC 61850-9-2LE:</p> <ul style="list-style-type: none"> ● without (continue with code "SN") ● 2 x RJ45 (100/1000 Mbit) (continue with code "SN") ● 1 x RJ45 and 1 x FO- LC (1 GBit, Multimode, SX) (continue with code "SN") ● 1 x RJ45 and 1 x FO- LC (1 GBit, Multimode, LX) (continue with code "SN") ● 1 x RJ45 and 1 x FO- LC (100 MBit, Multimode) (continue with code "SN") ● 2 x FO- LC (1000 MBit, Multimode, SX) (continue with code "SN") ● 2 x FO- LC (1000 MBit, Multimode, LX) (continue with code "SN") ● 2 x FO- LC (100 MBit, Multimode) (continue with code "SN") <p>Note: If the feature PB is used for sampled values (IEC 61850-9-2LE) the feature S2 is mandatory! For PB 1...4, the fibre optic Ethernet standard can also be selected for the underlying code "CS"; if no entry is made, 100MBit applies. If LX or SX is specified, the according 1000MBit standard is selected.</p>	<p>PB0</p> <p>PB1</p> <p>PB4SX</p> <p>PB4LX</p> <p>PB4</p> <p>PB3SX</p> <p>PB3LX</p> <p>PB3</p>	
<p>SNMPv3 (Simple Network Management Protocol Version 3)</p> <ul style="list-style-type: none"> ● without SNMPv3 (continue with code "G") ● with SNMPv3 (continue with code "G") 	<p>SN0</p> <p>SN1</p>	

CHARACTERISTIC	CODE
Integrated SCADA connection for serial protocols like IEC 60870- 5-101/...-103, DNP3.0, ... <ul style="list-style-type: none"> ● without integrated protocol interface for serial protocol (continue with code "G") ● with integrated SCADA interface for serial prot. for connection of one REG-DA (cont. with code "V") ● with integrated SCADA interface for serial protocol for connection of more than one system (REG-D/DA/DP etc.) (continue with code "V") Note: L9 can only be combined with characteristics Z01, Z15 to Z19 and Z91.	L0 L1 L9
Connection type <ul style="list-style-type: none"> ● Copper <ul style="list-style-type: none"> — RS232 — RS485 2-wire operation only ● Fibre optic cable with FSMA connection technology <ul style="list-style-type: none"> — Fibreglass (Wave length 800...900 nm, range 2000 m) — All-plastic (Wave length 620...680 nm, range 50 m) ● Fibre optic cable with ST connection technology <ul style="list-style-type: none"> — Fibreglass (Wave length 800...900 nm, range 2000 m) — All-plastic (Wave length 620...680 nm, range 50 m) ● Fibre optic cable with VL connection technology <ul style="list-style-type: none"> — All-plastic (Wave length 620...680 nm for SPABUS) (continue with code "Z or CZ")	V10 V11 V13 V15 V17 V19 V22
Protocol (without cyber security) <ul style="list-style-type: none"> ● IEC60870-5-103 Standard ● IEC60870-5-103 for ABB ● IEC60870-5-103 for Alstom/Schneider-Electric/GE ● IEC60870-5-103 for SAT ● IEC60870-5-103 for Siemens (LSA/SAS) ● IEC60870-5-103 for Sprecher Automation ● IEC60870-5-103 for others ● IEC60870-5-101 Standard ● IEC60870-5-101 for ABB ● IEC60870-5-101 for IDS ● IEC60870-5-101 for SAT ● IEC60870-5-101 for Siemens (LSA/SAS) ● IEC60870-5-101 for others ● DNP 3.00 (serial only) ● SPABUS ● MODBUS RTU ● Profibus-DP (always with V11!) (continue with code "G")	Attention! Select only Z or CZ Z03 Z10 Z11 Z12 Z13 Z14 Z90 Z01 Z15 Z17 Z18 Z19 Z91 Z20 Z22 Z23 Z99

WITHOUT Cyber Security

CHARACTERISTIC	CODE	
<p>Protocol (with cyber security)</p> <ul style="list-style-type: none"> ● IEC60870-5-103 Standard ● IEC60870-5-103 for ABB ● IEC60870-5-103 for Alstom/Schneider-Electric/GE ● IEC60870-5-103 for SAT ● IEC60870-5-103 for Siemens (LSA/SAS) ● IEC60870-5-103 for Sprecher Automation ● IEC60870-5-103 for others ● IEC60870-5-101 Standard ● IEC60870-5-101 for ABB ● IEC60870-5-101 for IDS ● IEC60870-5-101 for Siemens (SAT) ● IEC60870-5-101 for Siemens (LSA/SAS) ● IEC60870-5-101 for others ● DNP 3.00 ● SPABUS ● MODBUS RTU <p>(continue with code "G")</p> <p>Note: Cyber security is not yet available for all serial protocols, please contact A. Eberle.</p>	<p>Attention! Select only Z or CZ</p> <p>CZ03 CZ10 CZ11 CZ12 CZ13 CZ14 CZ90 CZ01 CZ15 CZ17 CZ18 CZ19 CZ91 CZ20 CZ22 CZ23</p>	<p>WITH Cyber Security</p>
<p>Operating instructions</p> <ul style="list-style-type: none"> ● German ● English ● French ● Spanish ● Italian ● Russian ● Portuguese ● Czech ● other 	<p>G1 G2 G3 G4 G5 G6 G7 G8 G9</p>	
<p>Display language</p> <ul style="list-style-type: none"> ● German ● English ● French ● Spanish ● Italian ● Russian ● Portuguese ● Czech ● Dutch ● Polish 	<p>A1 A2 A3 A4 A5 A6 A7 A8 A9 A10</p>	

REG-DA accessories	ID-No.
Fuses, batteries:	
1 pack microfuses T1 L 250 V, 1 A, for auxiliary voltage range H0	582.1002
1 pack microfuses T2 L 250 V, 2 A, for auxiliary voltage range H2	582.1019
1 lithium battery (pluggable)	570.0003.00
1 lithium battery (solderable)	on request
1 button cell CR1632	570.0005
Connection technique:	
Connection adapter set from fibre optic connector LC to ST including 1m fibre	111.9048.99
PC connection cable (zero-modem cable)	582.020B.00
PC connection cable (USB A to Mini USB for devices with order code I1)	582.020U
Modem connection cable	582.2040
RS232 10 m extension cable	582.2040.10
USB/RS232 adapter with integrated null-modem cable (FTDI), 1,5m	111.9046.01
Interface E-LAN-FO: RS485/FO, Fiber optics: multi-mode, max. transmission distance: 2.5 km, FO-connector: ST, (E-LAN → FO or FO → E-LAN) Note: 2 units required per line	111.9030.10
Interface E-LAN-FO: RS485/FO, Fiber optics: single-mode, max. transmission distance: 15 km, FO-connector: SC, (E-LAN → FO or FO → E-LAN) Note: 2 units required per line	111.9030.11
Time synchronisation:	
Radio clock (DCF 77)	111.9024.01
GPS radio clock NIS time, RS485, Uh: AC 85 V ... 110V ... 264 V / DC 88 V ... 220V ... 280V	111.9024.45
GPS radio clock NIS time, RS485, Uh: DC 18 V ... 60V ... 72V	111.9024.46
GPS radio clock NIS time, RS232, Uh: AC 85 V ... 110V ... 264 V / DC 88 V ... 220V ... 280V	111.9024.47
GPS radio clock NIS time, RS232, Uh: DC 18 V ... 60V ... 72V	111.9024.48
Modems:	
Modem: INSYS EBW-L100, Router 4G / LTE	111.9049.04
Modem: Antenna for router	111.9049.01
INSYS External antenna (magnetic base antenna)	111.9030.68
INSYS extension cable f. ext. antenna	111.9030.68.01
SHDSL Ethernet modem, (Westermo DDW-120) for establishing a TCP / IP connection via 2 - wire 10..60V DC, DIN rail	111.9030.16
Power supply:	
Phoenix power supply adaptor for DIN rail mounting: In: AC 120 V...230 V, DC 90 ... 250 V, Out: DC 24 V 1.3A	111.9030.36
Additional input and output module:	
Analogue module with 2 mA-inputs for REG-D(P)/-D(P)A (level III)	320.0004.00
Analogue module with 2 mA-outputs for REG-D(P)/-D(P)A (level III)	320.0003
Resistor module R1 (180Ω...2kΩ, min 5Ω / step) for REG-D/-DA (level III)	320.0002.01
Resistor module R3 (2kΩ...20kΩ, min 50Ω / step) for REG-D/-DA (level III)	320.0002.03
PT 100 input according DIN 43760; 3-wire connection (-40...+160°C) for REG-D(P)/-D(P)A (level III)	320.0005.01
Analogue module with 2 mA-inputs for REG-D(P)A (level II)	356.2020.00

We take care of it.

REG-DA accessories	ID-No.
Analogue module with 2 mA-outputs for REG-D(P)A (level II)	356.2021.00
Analogue module with 1 mA-input for REG-D(P)A (level II)	356.2009.00
Analogue module with 1 mA-output for REG-D(P)A (level II)	320.0007
PT 100 input according DIN 43760; 3-wire connection (level II) for REG-D(P)A	356.2022.01
Operating instructions:	
Additional operating instructions for REG-DA (please specify the language)	GX

Add-ons for REG-DA	CODE
Transformer monitoring module - TMM Consists of: <ul style="list-style-type: none"> ● Firmware update ● User guide and PC software for setup ● Analogue module with two inputs for the temperature transducer ● Input for PT100 in a three-wire circuit Additional analogue input, output or PT100 module. See Accessories	TMM A1 A2

Software for REG-DA	CODE
REGView as CD-ROM WinREG add-on functions Collector and RegView to archive and view data recorded with REG-D(A) and PAN-D.	REGView
REGSim as CD-ROM Simulates the parallel operation of transformers	REGSim

General Add-ons	CODE
Profibus DP module incl. RS485 interface and connection cable for external power supply DC 24V <ul style="list-style-type: none"> ● For DIN-rail 35 mm, size 120 x 75 x 27 mm Note: external 24 V DC power supply necessary	Profibus-DP B0
TCP/IP adapter (COMServer) <ul style="list-style-type: none"> ● Com-Server DIN-rail power supply 24V/15W ● Com-Server 100BT, LC, 24 Volt AC/DC ● Com-Server 100BT, 3-way, 12-24 Volt AC/DC 	REG-COM 111.9037.12 111.9037.20 111.9037.08
COM3 converter COM3 to Modbus converter to connect external devices with Modbus interface to the transformer monitoring module. For example, to analyse the gas-in-oil ratio online, directly measure the winding temperature, etc., Auxiliary voltage DC 18 ... 72 V	COM3-MOD
IRIG-DCF77 converter <ul style="list-style-type: none"> ● as wall-mounting housing 20 HP ● AC 100 V ... 110 V ... 240 V / DC 100 V ... 220 V ... 300 V ● DC 20 V ... 60 V ... 70 V 	IRIG-DCF B02 H1 H2

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