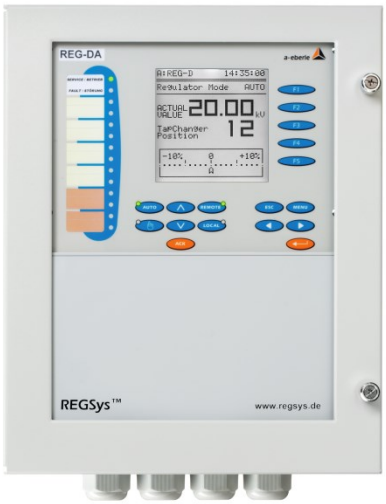
Relay for OLTC Control & Transformer Monitoring

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(φ) 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 (external module)
- SPABUS

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.

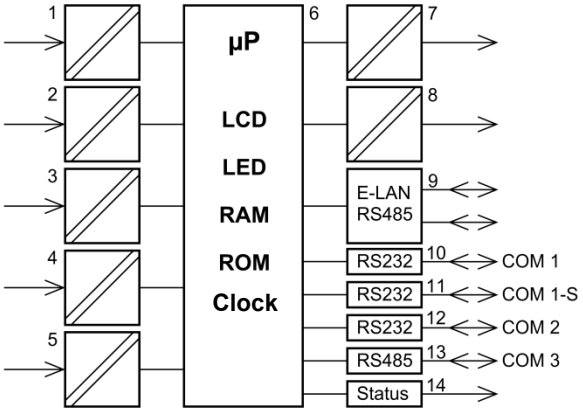
2. Characteristics of the REG-DA

- 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

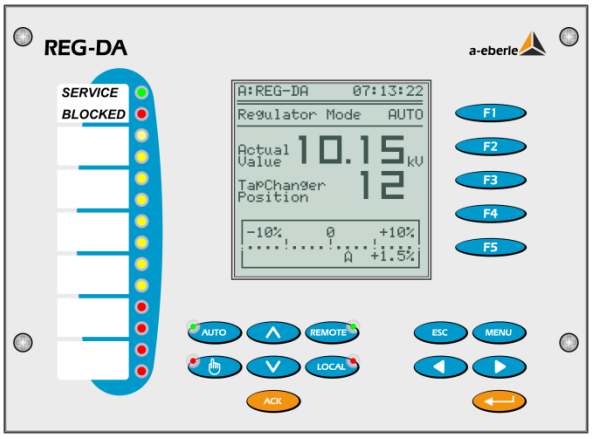


Functions of the REG-DA regulator (all options)

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.



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:

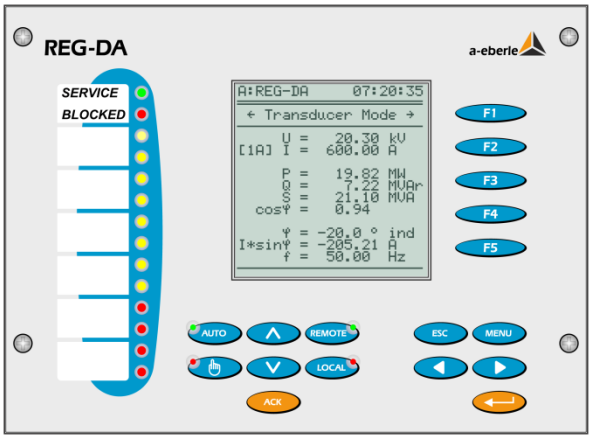
Case	REG-DA – Programme	Conditions
Parallel operation on one or more busbars	ΔI sin φ	Identical transformers, identical or different tap size
	ΔI sin φ (S)	Transformers with different performances, different or equal tap size
	Master/ slave	Identical transformers, same tap size
Free feed in	Δ cos φ	Any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

***Table 1** Parallel operated transformers*

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.



Measured quantities on the displays	Voltage U_{eff} Current I_{eff} Active power P Reactive power Q Apparent power S cos φ Phase angle φ Reactive current I*sinφ Frequency f Circulating reactive current (see page 2 of the transducer display)

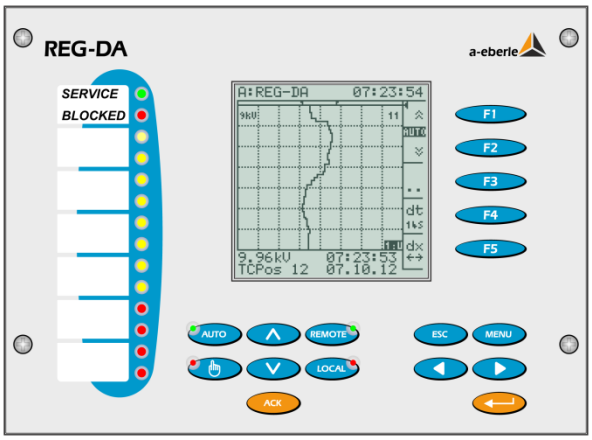
All of the measured and calculated values can be transferred to an analogue output or to SCADA.

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 Control software.

(*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.

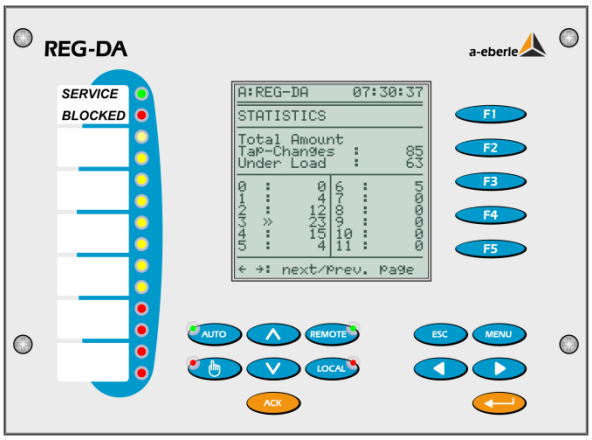
Storage behaviour in the case of an overflow	Overwrite with FIFO (**F**irst **i**n **F**irst **o**ut)
Storage time (voltage plus tap)	< 18.7 days worst case on average > 1 month

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 Control software, using the Online/Service module.



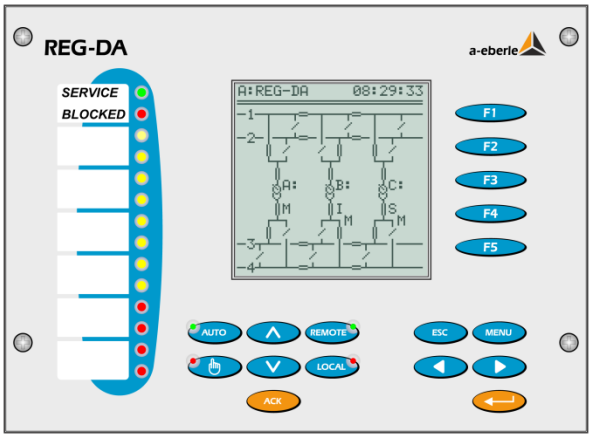
3.5 ParaGramer mode

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.

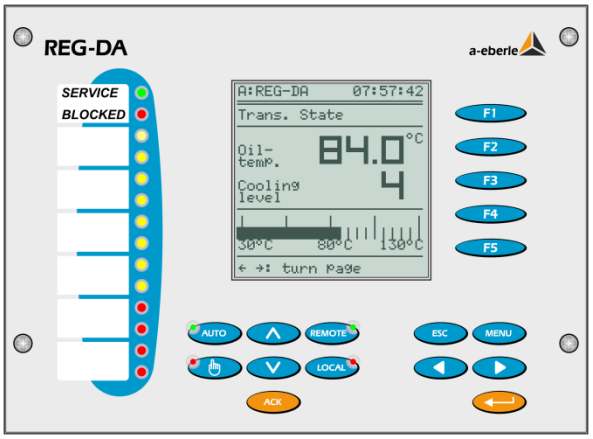
The optional TM+ function evaluates the moisture content of the cellulose and the risk of bubble formation.

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

Certificate of Compliance

Certificate Number 050505 - E242284
Report Reference E242284, April 7th, 2005
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Underwriters Laboratories Inc.®

Issued to: A EBERLE GMBH & CO KG
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This is to certify that representative samples of: Voltage Regulator
Model: REG-DA

Have been investigated by Underwriters Laboratories Inc.® in accordance with the Standard(s) indicated on this Certificate.

Standard(s) for Safety: UL 61010C-1 - Safety for Process Control Equipment
CSA C22.2 No. 1010.1-92 - Safety of Electrical Equipment for Measurement Control and Laboratory Use; Part 1, General Requirements

Additional Information: ELECTRICAL RATING:

110-240Vac, 50-60Hz, 20VA
110-220VDC, 20W

Only those products bearing the UL Recognized Component Marks for the U.S. and Canada should be considered as being covered by UL's Recognition and Follow-Up Service and meeting the appropriate U.S. and Canadian requirements.
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Look for the UL Recognized Component Mark on the product

Manfred Müller, Senior Project Engineer
Walter Hofmann, Senior Project Engineer

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....50....60....65 Hz
Crest factor @ U_r	≤ 2
Input resistance	100...102 kΩ
Internal consumption	≤ 0.01mW/V²
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....50....60....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

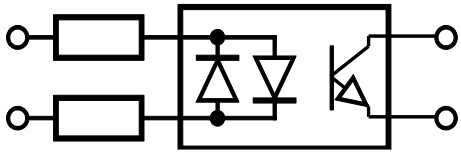
Measured values	
True RMS voltages	U_{12}, U_{23}, U_{31} (≤ 0.25%)
True RMS current	I_1, I_2 , I_3 (≤ 0.25%)
Active power	P (≤ 0.5%)
Reactive power	Q (≤ 0.5%)
Apparent power	S (≤ 0.5%)
Power factor	cos φ (≤ 0.5%)
Phase angle	φ (≤ 0.5%)
Reactive current	I · sin φ (≤ 1%)
Frequency	f (≤ 0.05%)

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)	Rn = 5 V / Y2 ± 1%
Other	IEC 60688 - Part 1

Ambient conditions	
Temperature range	
Function Transport and storage	-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	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

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 L - Level	≥ 48 V < 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 L - Level	≥ 10 V < 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 L - Level	≥ 80 V < 40 V
Characteristic D7 – Binary input groups 1...4, 5...8, 9...12, 13...16	
Input type	HV
H - Level L - Level	≥ 176 V < 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	≥ $5 \cdot 10^5$ 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**	**H0 with PB 1..4**	**H2**
AC Nominal voltage range Total voltage range	 100 … 240V 90 … 264V	 100 … 240V 90 … 264V	 – –
DC Nominal voltage range Total voltage range	100 … 300V	100 … 250V 100 … 370V	20 … 70 V
AC Power consumption	≤ 35 VA	≤ 65 VA	–
DC Power consumption	≤ 25 W	≤ 25 W	≤ 25 W
Frequency	50/60 Hz	50/60 Hz	DC
Microfuse	T1 250 V	T1 250 V	T2 250 V
Over voltage category	300V CAT II	300V CAT II	150V CAT II
Isolation	reinforced	reinforced	reinforced
Isolation test voltage	2.3kVAC, 5s	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.

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	± 1.2 Y2
Voltage drop	≤ 1.5 V
Isolation	functional, per channel
Common-mode rejection	> 80 dB
Series-mode rejection	> 60 dB / Decade from 10 Hz
Overload capacity	≤ 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	± 1.2 Y2
Isolation	Functional, per channel
Load range	0 ≤ R ≤ 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	≤ 25 mA	≤ 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

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

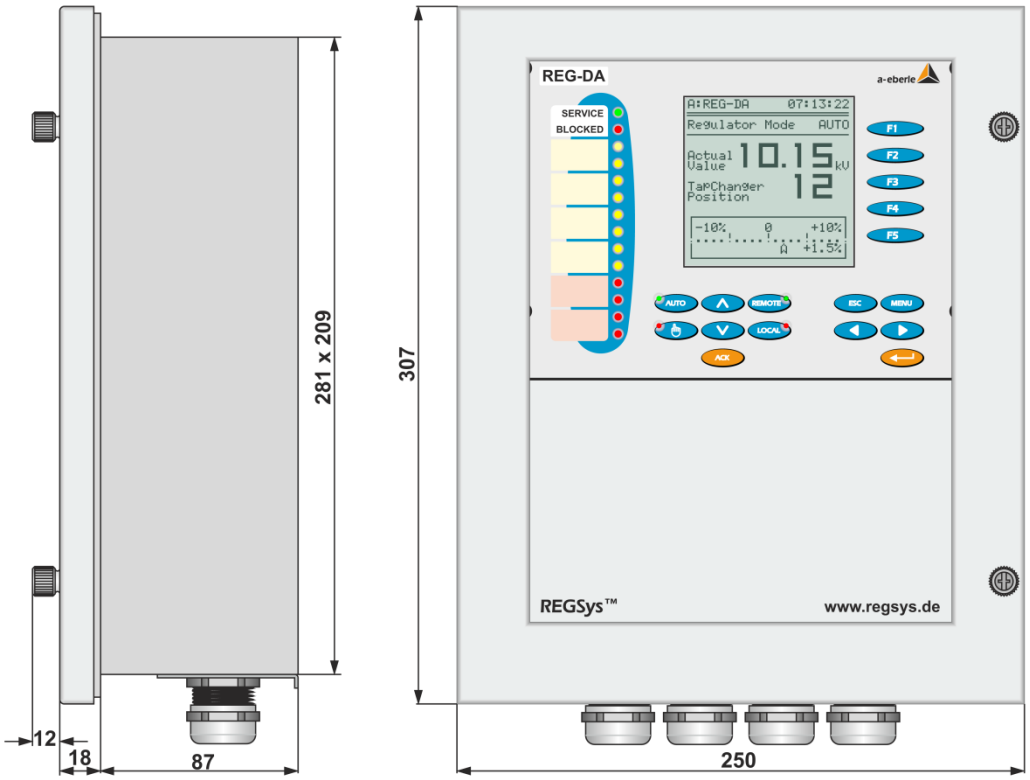
Each LED can be labelled on site.
If the labelling wishes are known at the time of order placement, labelling can be done at the factory.

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

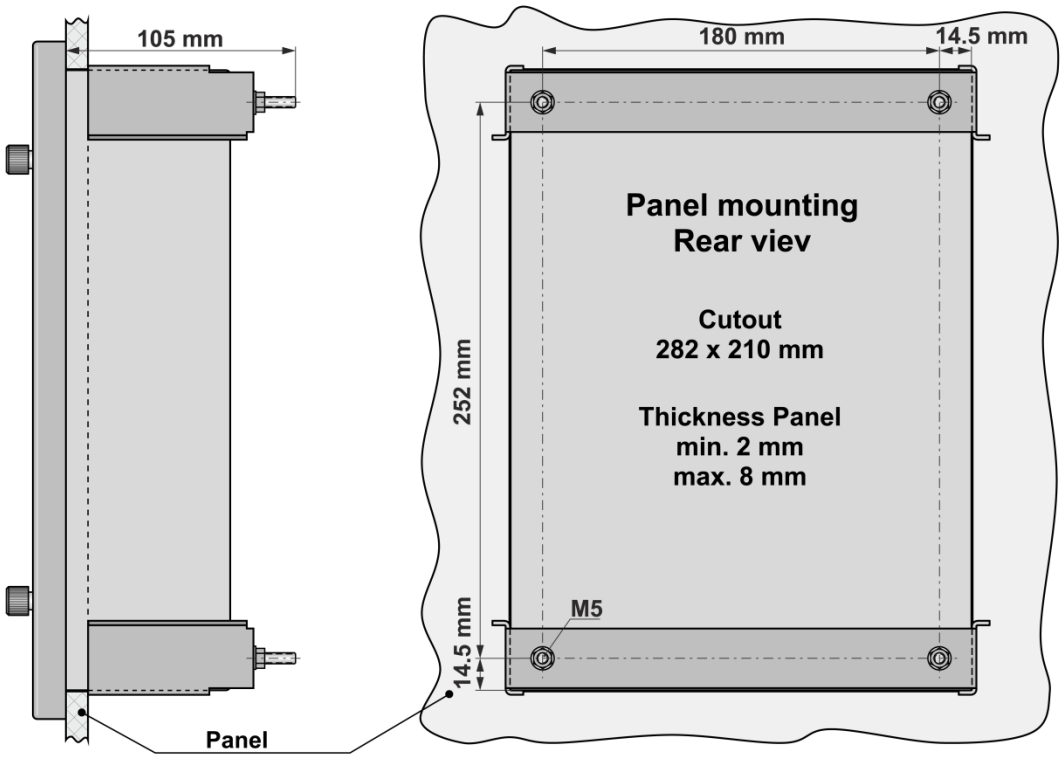
5. Mechanical design

Housing – Height – Width – Total depth – Mounting depth – Weight	Sheet steel, RAL 7035 light-grey 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 – 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

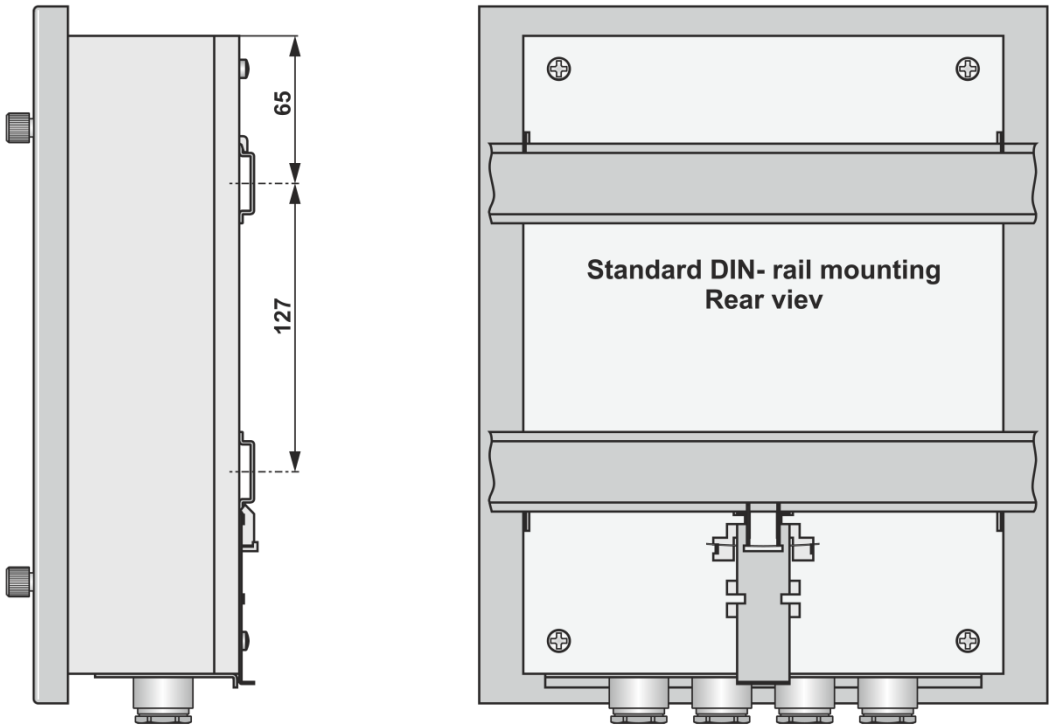
Conductor Cross Section and tightening torque of Terminals				
Level	**Function/ terminal no.**	**cross section / mm²**		**torque**
		stranded	**solid**	**Nm**
I	measurement input 1..10	4	6	0,6
I	BIs, relays, power supply 11…60	2,5	2,5	0,6
II	SCADA interface (without REG-PE TK860), 87…98, 130…151	0,5	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



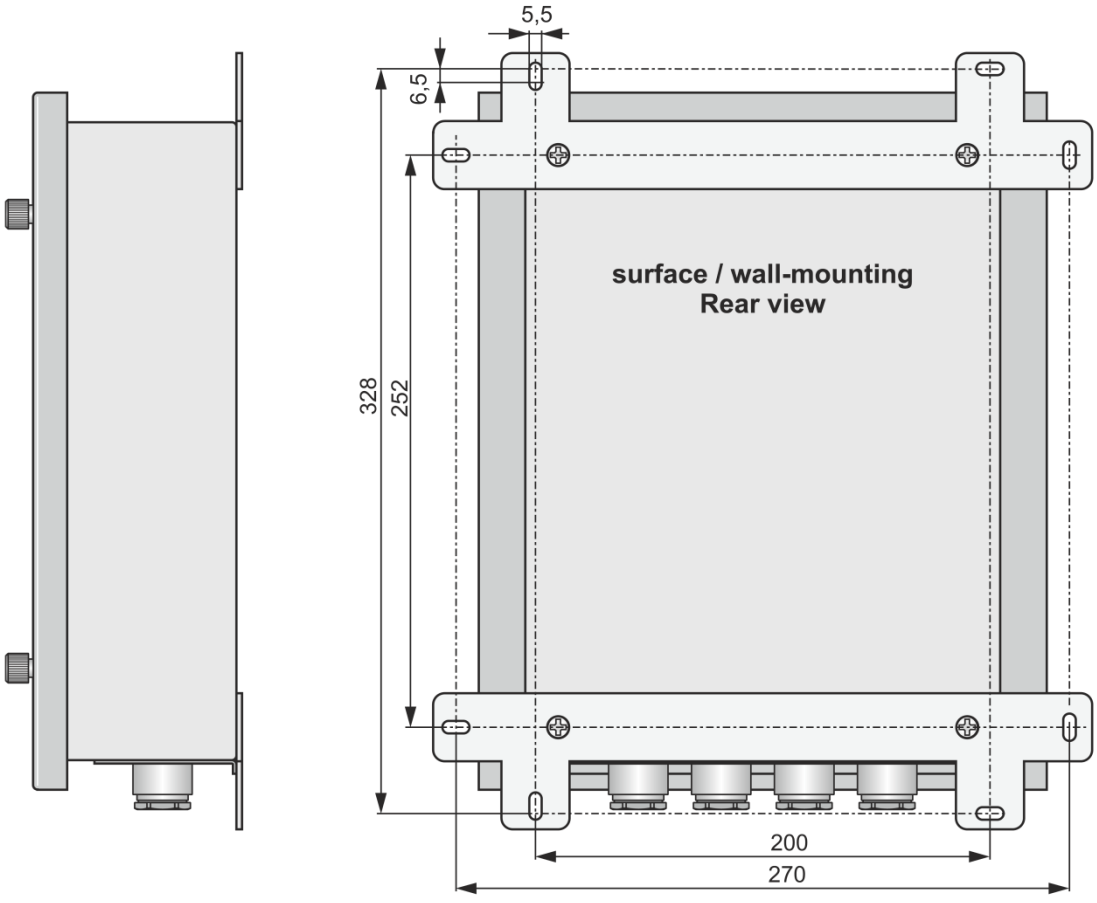
Mechanical dimensions, in mm



Mechanical dimensions, panel mounting



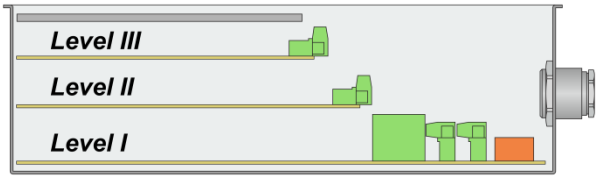
Mechanical dimensions, DIN rail mounting, in mm



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

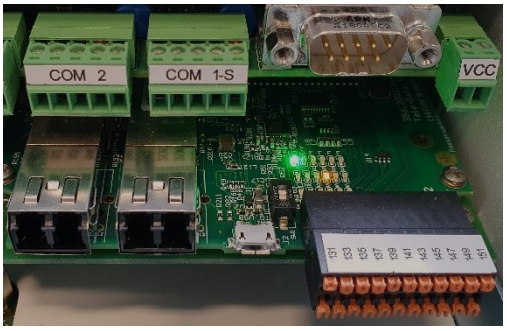
For fibre optic serial connections up to a baud rate of 19200 (e.g. DNP, IEC 60870-5-101 or 103), ST, FSMA or VL connectors are directly mounted on the flange plate for access without opening the REG-DA door.

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	λ = 820 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	λ = 650 nm	1 mm POF	-7.5	-3.5
		200 µm HCS	-18.0	-8.5
All-plastic FSMA	λ = 650 nm	1 mm POF	-6.2	0.0
		200 µm	-16.9	-8.5
All-plastic VL	λ = 650 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	9/125µm	-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	λ = 820 nm	100/140 µm NA=0.3	-24.0	-10.8
All-platic ST	λ = 650 nm	1 mm POF	-20.0	0.0
		200 µm HCS	-22.0	-2.0
All-plastic FSMA	λ = 650 nm	1 mm POF	-21.6	-2.0
		200 µm	-23.0	-3.4
All-plastic VL	λ = 650 nm	1mm POF	-21,6	-9,5

1) TA = 0...70°C, VCC = 5 V±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

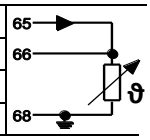
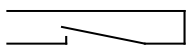
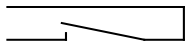
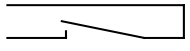
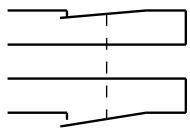
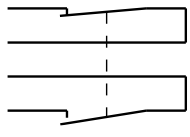
Communication over Ethernet 1000 Mbit (1000Base LX)

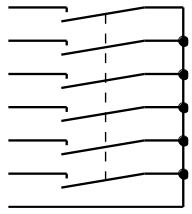
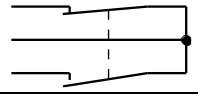
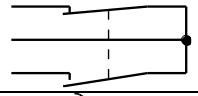
Product	Wave length	Fibre	Pmin [dBm]	Pmax [dBm]
Fibreglass LC	1310 nm	9/125µm	-21	-3

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.					
Level I		Option	M1*	M2*	M9*
	2 5	Measuring voltage	U1a U1b	U_{L1} U_{L2}	U1a U1b
	8 10	Measuring voltage	-	U_{L3} -	U2a U2b
	1 3	S1 S2	Current input I_1		
	4 6	S1 S2	Current input I_2		
	7 9	S1 S2	Current input I_3		
	21 22	L/(+) L/(-)	U_H = Auxiliary voltage		
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 34		Freely programmable		R_5
	35 36		Freely programmable		R_4
	37 38		Freely programmable		R_3
	39 40 41 42		lower		R_2
	43 44 45 46		higher		R_1

Level I	47 48 49 50 51 52 53		>I R_{11} >U R_{10} <U R_9 Local R_8 Remote R_7 TC error** R_6 GND R_6...R_{11}
	54 55 56		closes in the event of Life contact (status) opens in the event of
	57 58 59		MANUAL MAN/AUTO AUTO
Level III	69 70 71 72 200	E- E+ EA- EA+ GND	E-LAN (L)
	73 74 75 76 201	E- E+ EA- EA+ GND	E-LAN (R)
	77 78 79 80 81	Tx+ Tx- Rx+ Rx- GND	COM3 (RS485)
	82 83 84 85 86	TxD RxD RTS CTS GND	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)
	202 203 204	DCF- DCF+ GND	DCF 77 ***
	205 206 207 208 209	TxD RxD RTS CTS GND	COM1 – S / COM 4 (COM 4 only on devices with characteristic S2)
	210 211	GND VCC+	Aux. power supply output 5 V DC (max. 2W)
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)

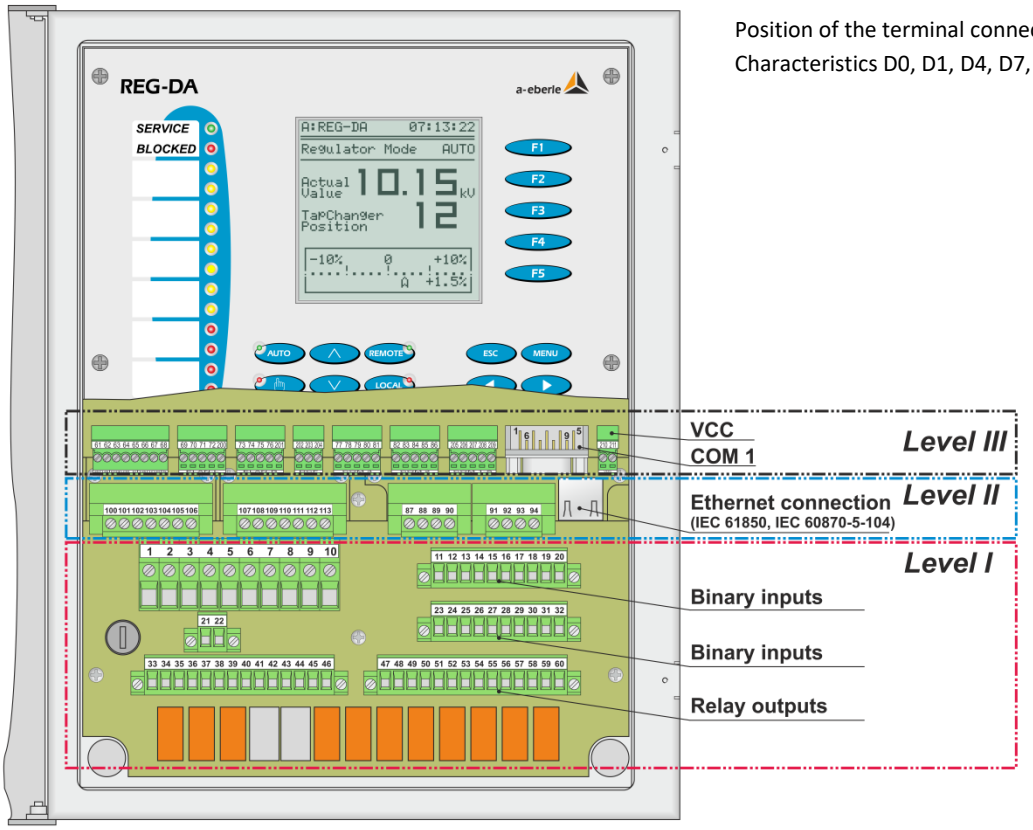
Option M9 For triple-wound applications, two galvanically isolated voltage inputs are available for U1 and U2.

** TC = tap changer

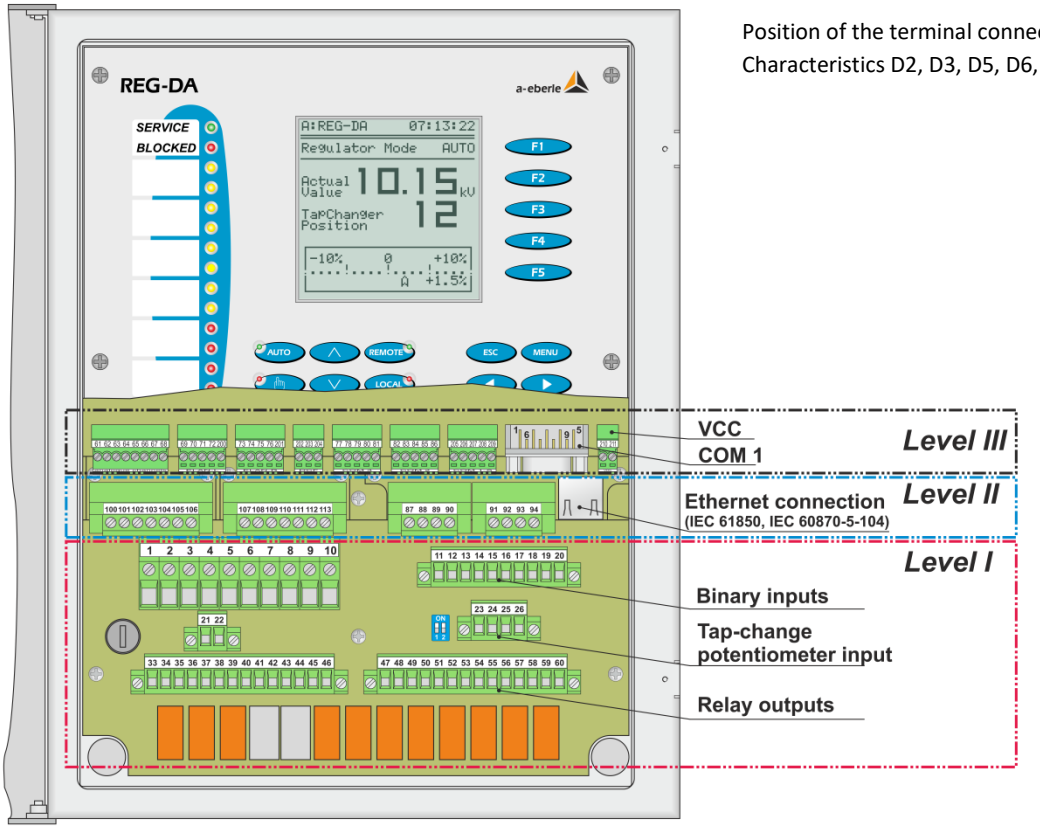
*** Please refer to terminal configuration of the SCADA interface on page 17 for the SCADA interface connections.

*** 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



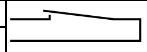
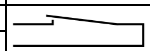
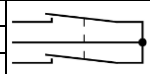
Position of the terminal connections
Characteristics D2, D3, D5, D6, D8

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			
	102		raise command interlock	
	103			
	104		Overvoltage >U Root Undervoltage <U	
	105			
	106			
	107		measuring voltage	U1a
	108			U1b
	109		COM 1 COM 2 RS 232	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+	A10
	101		Ue+	
	102		Ue-	
	103		Ik-	
Module 5	104	PT100	Ik+	A12
	105		Ue+	
	106		Ue-	
	107		Ik-	

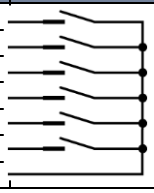
Characteristic C91 – 6 additional binary inputs AC/DC 48 V ... 250 V

	No.		
Module 1	100	Binary input	E17
	101	Binary input	E18
	102	Binary input	E19
	103	Binary input	E20
	104	Binary input	E21
	105	Binary input	E22
	106	GND	E17 ... E22

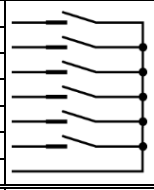
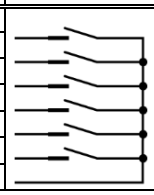
Characteristic C92 – 12 additional binary inputs AC/DC 48 V ... 250 V

	No.		
Module 1	100	Binary input	E17
	101	Binary input	E18
	102	Binary input	E19
	103	Binary input	E20
	104	Binary input	E21
	105	Binary input	E22
	106	GND	E17 ... E22
Module 1	107	Binary input	E23
	108	Binary input	E24
	109	Binary input	E25
	110	Binary input	E26
	111	Binary input	E27
	112	Binary input	E28
	113	GND	E23 ... E28

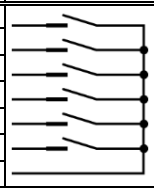
Characteristic C93 – 6 additional relay outputs (NOC)

	No.			
Module 2	100			R12
	101			R13
	102			R14
	103			R15
	104			R16
	105			R17
	106			GND R12 ... R17

Characteristic C94 – 12 additional outputs (NOC)

	No.			
Module 2	100			R12
	101			R13
	102			R14
	103			R15
	104			R16
	105			R17
	106			GND R12 ... R17
Module 2	107			R18
	108			R19
	109			R20
	110			R21
	111			R22
	112			R23
	113			GND R18 ... R23

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

	No.		
Module 1	100	Binary input	E17
	101	Binary input	E18
	102	Binary input	E19
	103	Binary input	E20
	104	Binary input	E21
	105	Binary input	E22
	106	GND	E17 ... E22
Module 2	107		R12
	108		R13
	109		R14
	110		R15
	111		R16
	112		R17
	113		GND R12 ... R17

Characteristic C96 – 2 additional analogue inputs

	No.			
Module 3	100	analogue input	+	A10
	101		-	
	102	analogue input	+	A11
	103		-	

Characteristic C97 – 4 additional analogue inputs

	No.			
Module 3	100	analogue input	+	A10
	101		-	
	102	analogue input	+	A11
	103		-	
Module 3	104	analogue input	+	A12
	105		-	
	106	analogue input	+	A13
	107		-	

Characteristic C98 – 2 additional analogue outputs

	No.			
Module 4	100	analogue output	+	A10
	101		-	
	102	analogue output	+	A11
	103		-	

Characteristic C99 – 4 additional analogue outputs

	No.			
Module 4	100	analogue output	+	A10
	101		-	
	102	analogue output	+	A11
	103		-	
Module 4	104	analogue output	+	A12
	105		-	
	106	analogue output	+	A13
	107		-	

6.2 Terminal Configuration for SCADA interface on Level II

Characteristics: Z, XW, CS, PB, CZ

Characteristics XW90..93+97+98,
CS90..93+97+98 combined with PB0,
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 CS94..96 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	

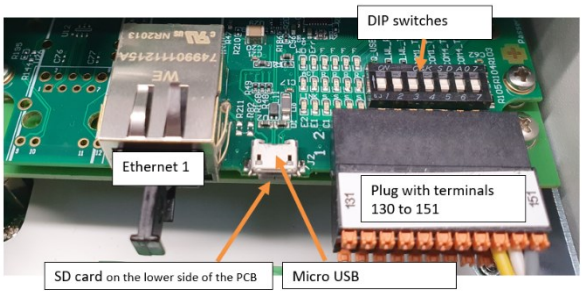
Ethernet 1	RJ45 connector	or	Fibre optic (LC)
Ethernet 2	RJ45 connector	or	Fibre optic (LC)

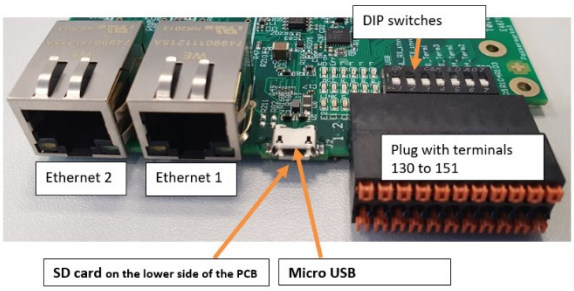
Characteristics PB1..4

REG-PED^{5V} TK 102A communication interface

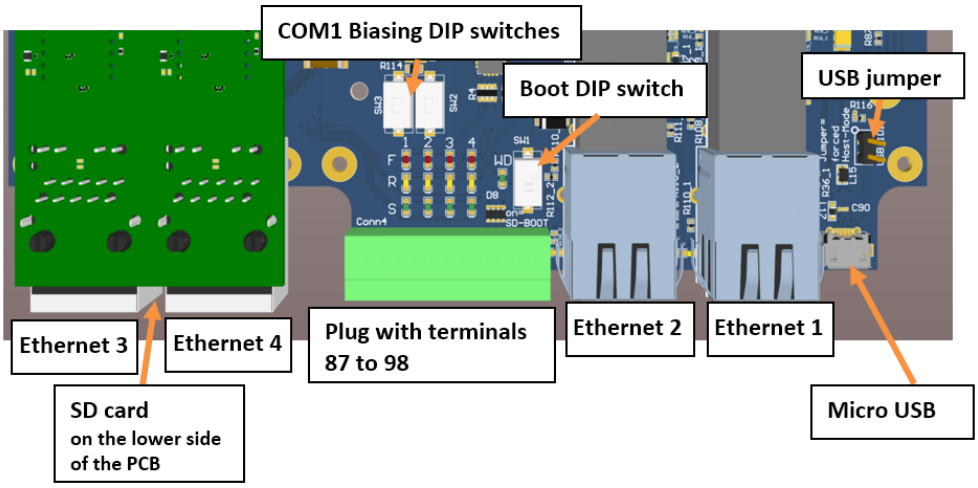
		Nr.			
COM1		87	RS485-P (B) COM1		
		88	RS485-N (A) COM1		
		89	RS232-TxD COM1		
		90	RS232-RxD COM1		
		91	RS232-RTS COM1		
		92	RS232-CTS COM1		
		93	GND COM1		
PE		94	PE		
PARAM		95	PARAM-RxD		
		96	PARAM-TxD		
	5V ext.	97	GND		
		98	5V DC output (only for A. Eberle use)		
Ethernet 1			RJ45 connector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

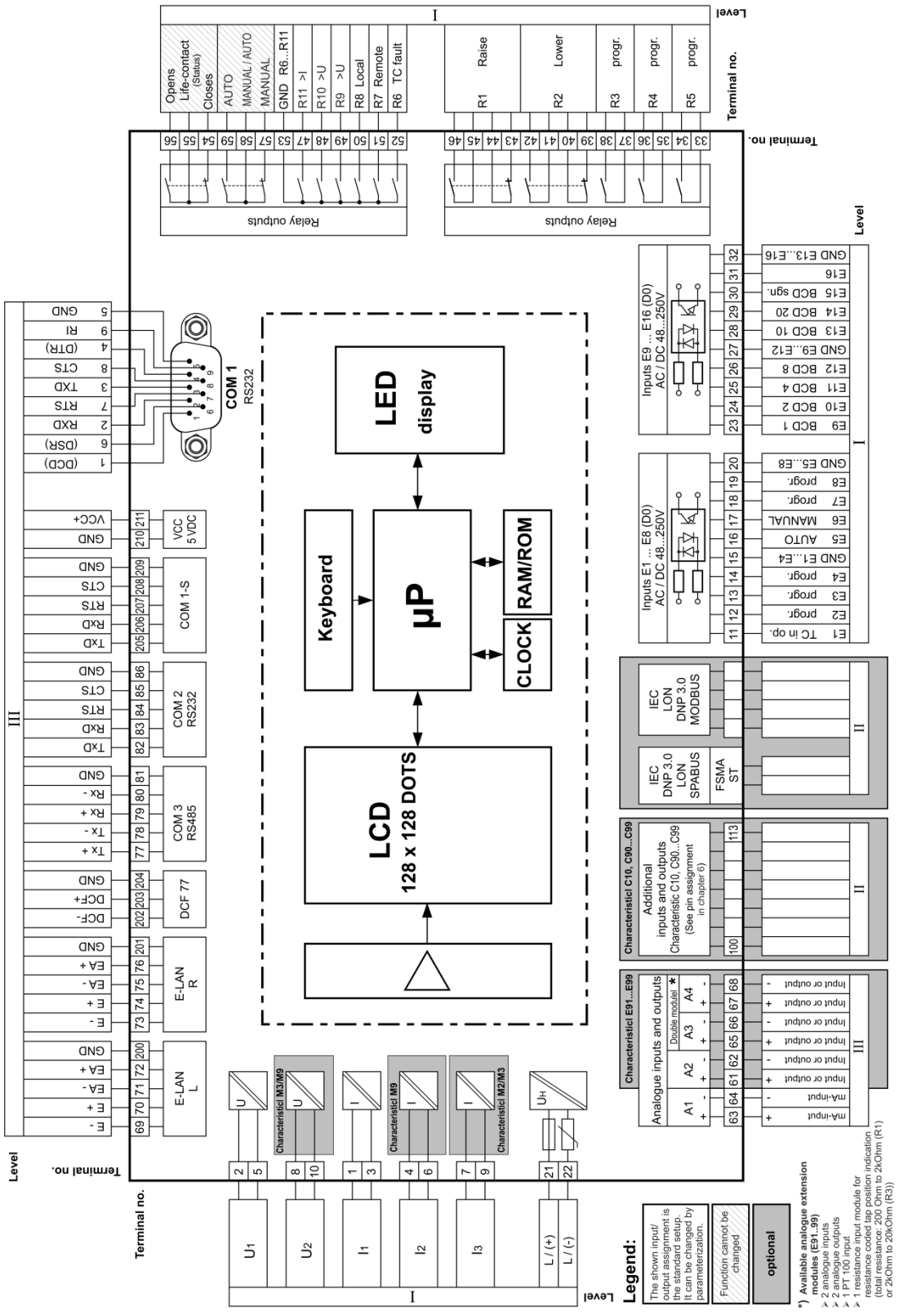




6.4 Interface assignment REG-PED^{SV} TK102

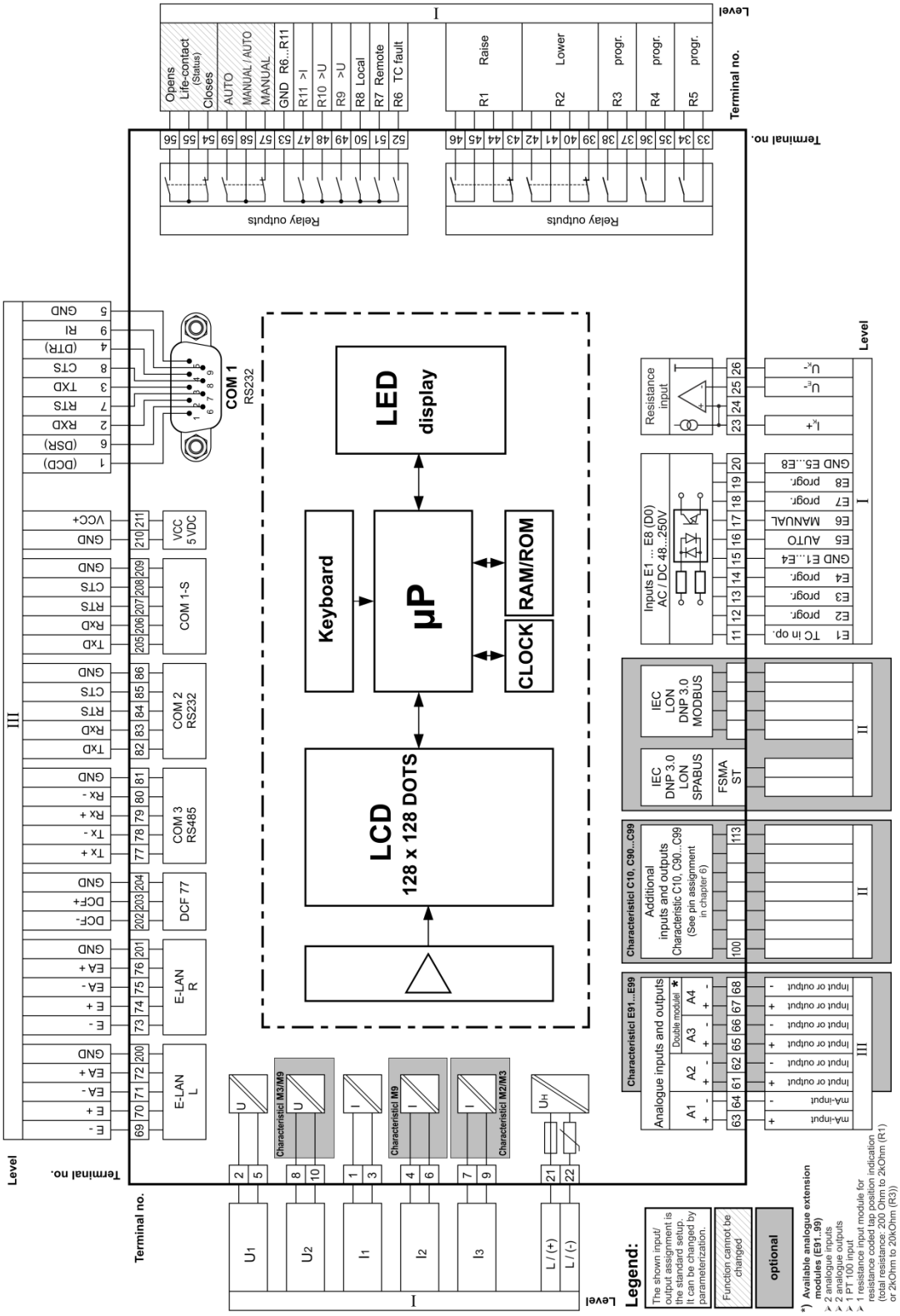


6.5 Block diagram - Characteristics D0, D1, D4, D7, D9

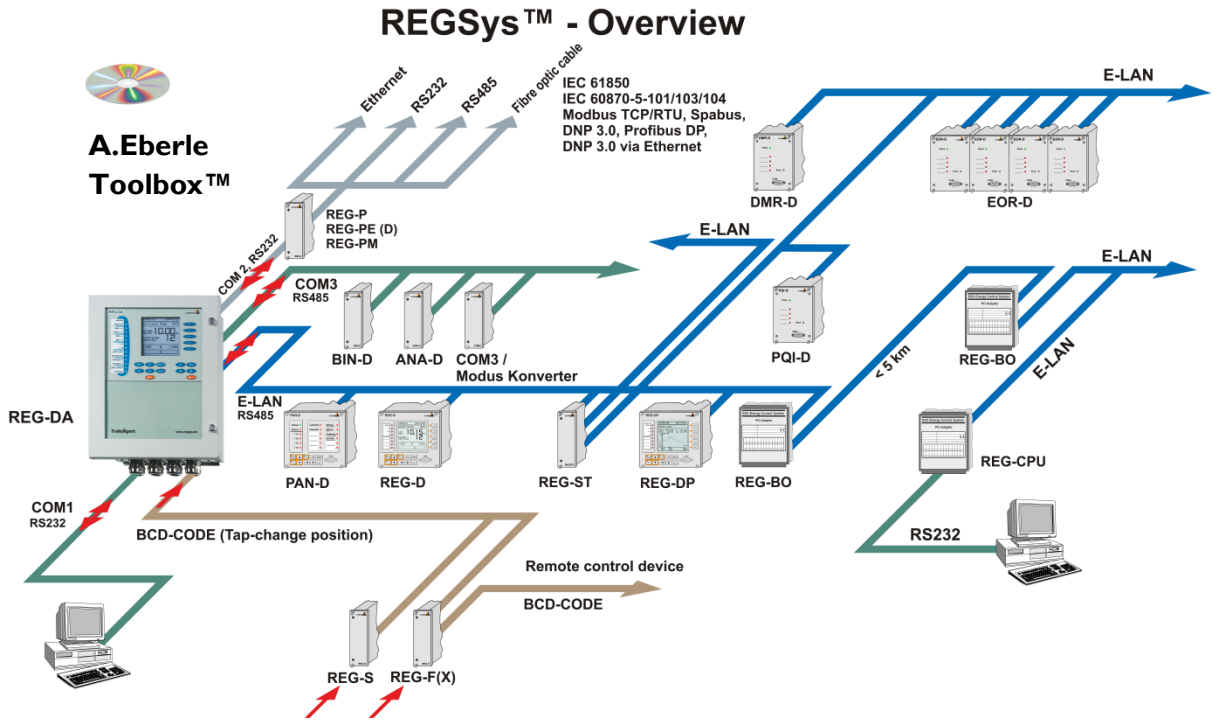


*) The dual module comes as a dual mA input module or a dual mA output module. The position is occupied by a PT100 module if the temperature is to be recorded directly.

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.



7. Interfaces and software

Several regulators need to be interconnected in a network when transformers are connected in parallel. The ΔI*sinφ, ΔI*sinφ (S) and Master-Follower parallel programs can only be implemented through the system bus (ELAN). This bus enables each of the members in a group of parallel regulators to communicate with each other easily, without using any additional components.

The regulators do not have to be connected in order to run a parallel program that functions in accordance to the Δcosφ method. It may not be possible to connect the participants due to the long distances between them, for example.

If an interconnection needs to be established over long distances, the ELAN can be redirected through a fibre optic cable or an Ethernet connection.

7.1 Serial interfaces

The REG-DA has two (three) RS232 serial interfaces with three connections (COM1, COM1-S (COM4), COM2).

COM1 is the parameterisation interface, while COM1-S is an alternative connection option for COM1. COM1 has priority, meaning that when COM1 is connected, COM1-S is disabled. Devices connected to COM1-S do not have to be physically disconnected. This enables COM1-S to function as an alternative remote parameterisation interface that is only active when parameters are not being set locally. On devices with characteristic S2 it's possible to switch the COM1-S interface into a permanently working COM interface (COM4). The COM4 uses the same physical connection then the COM1-S. The COM1 can also be configured as a USB port (optional).

COM2 is mainly used to connect the regulator to the SCADA system. If a SACDA interface is not installed, COM2 in the terminal compartment can be used to connect a modem, a COM server, a PC or a DCF77 receiver.

Connection Elements

COM1	Sub-D 9-pole male (optionally as mini-USB) at Level III
COM1-S / COM4	Terminal connection at Level III
COM2 / COM5	Terminal connection at Level III
Connection options	PC, modem, PLC, SCADA interface, DCF77 signal
Number of data bits/protocol	Data bits: 8 Parity: even, none
Transmission rate bit/s	1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400*, 460800*, 921600*
HANDSHAKE	RTS / CTS, XON / XOFF, delay, none

* Only available on REG-DA with feature S2 on COM1 and COM2

ELAN (**E**nergy - **L**ocal **A**rea **N**etwork)

Each REG-DA regulator comes with two E-LAN interfaces that are used to connect individual regulators and monitoring units to a voltage regulation system.

E-LAN Characteristics

- 255 addressable participants
- Multi-master structure
- Integrated repeater function
- Open ring, bus or point-to-point connection possible
- Transmission rate 15.6 ... 375 kbit/s

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(A) 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.

7.2 A.Eberle Toolbox™ Parameterisation and Configuration Software

The software A.Eberle Toolbox™ (AET) is used to parameterise and program the system.
The following functions are available:

- Device management (project)
- Parameterisation incl. transformer monitoring, background programs and features
- Readout and visualisation of recorder and statistics data.
- HMI for visualising the REG-DA front panel
- Terminal programme for direct communication with the REG-DA
- Firmware update

Communication with the device can be established via a serial interface or network-based (COMserver).

The AET runs on the following operating systems:

- Windows 10
- Windows Server from 2012 onwards

Most of the settings can be made either directly on the regulator using the regulator's membrane keyboard, or centrally through AET. 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.

The SCADA interface card is set up with the software WinConfig.

REG-DA Parameters (selection)

Parameter	Setting range
Permissible (voltage) deviation	± 0.1 ... 10 % or ± 0.1 ... 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	ΔU · t = 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.) Increase (I) (neg.) Limit (I) (max.) Limit (I) (min.)	 0 ... 400 V/In 0 ... 400 V/In -40 ... 40 V -40 ... 40 V
LDC (Line drop compensation)	R : 0 ... ± 100 Ω X : 0 ... ± 100 Ω
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	dI*sin(phi) dI*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 ● 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 ● 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 ● Power supply: AC 100V ... 110V ... 240V / DC 100V ... 220V ... 300V ● Power supply: DC 20V ... 60V ... 70V	H0 H2
Input current (rated value) ● Rated input current: Ir 1A (subsequently modifiable) ● Rated input current: Ir 5A (subsequently modifiable)	F1 F2
Voltage and current measurement ● 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 ● 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 ● 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

CHARACTERISTIC	CODE
Parallel operation	
● Parallel operation: without	K0
● Parallel operation: with (incl. ParaGramer)	K1
● Feature K1 and additional HVLVControl	K2
● Feature K1 and additional Crosslink	K3
● Feature K1 and additional Crosslink & HVLVControl	K4
● Feature K1 and additional Ringlink	K5
● Feature K1 and additional Ringlink & HVLVControl	K6
PQCtrl – Active or reactive power control	
● PQCtrl: Without	P0
● PQCtrl: With	P1
Additional analogue inputs and outputs	
● without	E00
● 1 x PT 100 input	E91
● 2 x mA-inputs	E92
● 2 x mA-outputs	E93
● 1 x PT 100 input and 1 x mA-output	E94
● 2 x mA inputs and 1 x mA-output	E95
● 3 x mA-outputs	E96
● 1 x resistor module R1 (180Ω...2kΩ, min 5Ω / step)	E97
● 1 x resistor module R3 (2kΩ...20kΩ, min 50Ω / step)	E98
● 1 x PT 100 input and 1 mA-Input	E9.1
● 1 x mA-output	E9.2
● 1 x mA-input	E9.3
● 3 x mA-inputs	E9.5
● 1 x mA-output and 1 resistor module R1 (180Ω...2kΩ, min 5Ω / step)	E9.6
● 1 x mA-output and resistor module R3 (2kΩ...20kΩ, min 50Ω / step), identical with E9.4	E9.7
● 1 x mA-input and resistor module R3 (2kΩ...20kΩ, min 50Ω / step)	E9.8
● 1 x mA-input and resistor module R1 (180Ω...2kΩ, min 5Ω / step)	E9.9
● 1 x mA-input and 2 x mA-outputs	E9.10
● other combinations of inputs and outputs	E99
Binary inputs and tap change potentiometer input	
● 16 binary inputs AC/DC 48...250 V (E1...E16)	D0
● 8 binary inputs AC/DC 10..50 V (E1…E8) and 8 units AC/DC 48...250 V (E9…E16)	D1
● 16 binary inputs AC/DC 10...50 V (E1…E16)	D4
● 16 binary inputs AC/DC 190...250 V (E1...E16)	D7
● 16 binary inputs AC/DC 80...250 V (E1...E16)	D9
● Resistor input R1 (total resistance 180...2 kΩ, min 5Ω/step) and 8 binary inputs AC/DC 48V...250V	D2
● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 10V…50V	D3
● Resistor input R1 (total resistance 180...2 kΩ, min 5Ω/step) and 8 binary inputs AC/DC 10V…50V	D5
● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 48V...250V	D6
● Resistor input R3 (total resistance 2k...20kΩ, min 50Ω/step) and 8 binary inputs AC/DC 80V…250V	D8

Level II: additional inputs and outputs as well as the monitoring function PAN-A2 (not in combination with PB1...4)	
● 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)	C92
● 6 x relays (BO12…BO17)	C93
● 12 x relays (BO12…BO23)	C94
● 6 x AC/DC 48...250V (BI17…BI22) and 6 x relays (BO12…BO17)	C95
● 2 x mA-inputs	C96
● 4 x mA-inputs	C97
● 2 x mA-outputs	C98
● 4 x mA-outputs	C99
● Monitoring function (PAN-A2)	C10
● 2 x PT 100 inputs	C9.1
● 6 x AC/DC 80…250V (BI17…BI22) and 1 x PT 100 input	C9.2
● 1 x PT 100 input	C9.4
● 6 x relays (BO12…BO17) and 2 x mA-outputs	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)	C9.9
● 6 x AC/DC 48…250V (BI17…BI22) and 1 x PT 100 input	C9.10
● 1 x PT 100 input and 2 x mA-inputs	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	C9.13
● 2 x mA-outputs and 1 x PT 100 input	C9.14
● 2 x mA-outputs and 2 x mA-inputs	C9.16
● 6 x AC/DC 48…250V (BI17…BI22) and 2 x mA-inputs	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
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! **In case of four Ethernet ports (characteristic PB1…4) the feature C00 is mandatory at the moment.**	
COM3 interface	
● with RS485 (standard, feature may be omitted)	R1
● with RS485 and for remote components fibre optic interface (fibre glass) with ST connector	R2
Note: COM3 is needed for ANA-D, BIN-D and COM3/Modbus converter.	

Integrated SCADA connection for Ethernet based protocols (e.g. IEC 61850) without cyber security option		WITHOUT Cyber Security
• without ethernet based protocols without cyber security option (continue with charact. group 'CS')	XW00	
• IEC 60870-5-104 with 1x RJ 45 (continue with characteristic group 'G')	XW90	
• IEC 60870-5-104 with 1x FO-ST connection (continue with characteristic group 'G')	XW92	
Note: Please specify the target SCADA system for connections in conformity with IEC 60850-5-104.		
• IEC 61850 with 1x RJ 45 connection (continue with characteristic group 'G')	XW91	
• IEC 61850 with 1x FO-ST connection (continue with characteristic group 'G')	XW93	
• IEC 61850 with 1x FO-LC connection (continue with characteristic group 'G')	XW93.1	
• IEC 61850 with 2x RJ45 connection (continue with characteristic group 'G')	XW94	
• IEC 61850 with 2x FO-ST connection (continue with characteristic group 'G')	XW95	
• IEC 61850 with 2x FO-LC connection (continue with characteristic group 'G')	XW95.1	
• IEC 61850 with 1x RJ45 and 1x FO-ST connection (continue with characteristic group 'G')	XW96	
• IEC 61850 with 1x RJ45 and 1x FO-LC connection (continue with characteristic group 'G')	XW96.1	
Note: Please specify the target SCADA system for connections in conformity with IEC 61850.		
• DNP 3.0 over Ethernet with 1x RJ45 connection (continue with characteristic group 'G')	XW97	
• DNP 3.0 over Ethernet with 2x RJ45 connection (continue with characteristic group 'G')	XW94.1	
• DNP 3.0 over Ethernet with 1x FO-ST connection (continue with characteristic group 'G')	XW98	
• DNP 3.0 over Ethernet with 1x FO-LC connection (continue with characteristic group 'G')	XW98.1	
• DNP 3.0 over Ethernet with 2x FO-ST connection (continue with characteristic group 'G')	XW95.2	
• DNP 3.0 over Ethernet with 2x FO-LC connection (continue with characteristic group 'G')	XW95.5	
• DNP 3.0 over Ethernet with 1x RJ45 and 1x FO-ST connection (continue with characteristic group 'G')	XW96.4	
• DNP 3.0 over Ethernet with 1 x RJ45 and 1 x FO-LC connection (continue with characteristic group 'G')	XW96.5	
Note: Please specify the target SCADA system for connections in conformity with DNP 3.0.		
• MODBUS TCP/IP with 2x RJ45 connection (continue with code "G")	XW94.2	
• MODBUS RTU with RS485 and with 1x RJ45 and 1x FO-ST) connection (continue with code "G")	XW96.2	
• SPABUS with 1x RJ 45 (continue with code "Gx")	XW91.2	
• SPABUS with 1x FO-ST-connection (continue with code "Gx")	XW93.2	
• SPABUS with 1x FO-LC-connection (continue with code "Gx")	XW93.3	
• SPABUS with 2x RJ 45 (continue with code "Gx")	XW94.4	
• SPABUS with 1x RS485 and with 2x RJ45 (continue with code "Gx")	XW94.5	
• SPABUS with 2x FO-ST-connection (continue with code "Gx")	XW95.3	
• SPABUS with 2x FO-LC-connection (continue with code "Gx")	XW95.4	
• other SCADA protocols on demand	XW99	

Integrated SCADA connection for Ethernet based protocols (e.g. IEC 61850) with cyber security option		WITH Cyber Security
• without (continue with code 'L')	CS00	
• IEC 60870-5-104 with 1x RJ 45 (continue with code "SN")	CS90	
• IEC 60870-5-104 with 1x FO-ST connection (continue with code "SN")	CS92	
Note: Please specify the target SCADA system for connections in conformity with IEC 60850-5-104.		
• IEC 61850 with 1x RJ 45 (continue with code "SN")	CS91	
• IEC 61850 with 1x FO-ST connection (continue with code "SN")	CS93	
• IEC 61850 with 1x FO-LC connection (continue with code "SN")	CS93.1	
• IEC 61850 with 2x RJ45 connection (continue with code "PB")	CS94	
• IEC 61850 with 2x FO-ST connection (continue with code "PB")	CS95	
• IEC 61850 with 2x FO-LC connection (continue with code "PB")	CS95.1	
• IEC 61850 with 1x RJ45 and 1x FO-ST connection (continue with code "PB")	CS96	
• IEC 61850 with 1x RJ45 and 1x FO-LC connection (continue with code "PB")	CS96.1	
Note: Please specify the target SCADA system for connections in conformity with IEC 61850.		
• DNP 3.0 over Ethernet with 1x RJ45 connection (continue with code "SN")	CS97	
• DNP 3.0 over Ethernet with 2x RJ45 connection (continue with code "PB")	CS94.1	
• DNP 3.0 over Ethernet with 1x FO-ST connection (continue with code "SN")	CS98	
• DNP 3.0 over Ethernet with 1x FO-LC connection (continue with code "SN")	CS98.1	
• DNP 3.0 over Ethernet with 2x FO-ST connection (continue with code "PB")	CS95.2	
• DNP 3.0 over Ethernet with 2x FO-LC connection (continue with code "PB")	CS95.5	
• DNP 3.0 over Ethernet with 1x RJ45 and 1 x FO-ST connection (continue with code "PB")	CS96.4	
• DNP 3.0 over Ethernet with 1x RJ45 and 1 x FO-LC connection (continue with code "PB")	CS96.5	
Note: Please specify the target SCADA system for connections in conformity with DNP 3.0.		
• MODBUS TCP/IP with 2x RJ45 connection (continue with code "PB")	CS94.2	
• MODBUS RTU with RS485 and with 1x RJ45 and 1x FO-ST connection (continue with code "PB")	CS96.2	
• SPABUS with 1x RJ 45 (continue with code "SN")	CS91.2	
• SPABUS with 1x FO-ST connection (continue with code "SN")	CS93.2	
• SPABUS with 1x FO-LC connection (continue with code "SN")	CS93.3	
• SPABUS with 2x RJ 45 (continue with code "PB")	CS94.4	
• SPABUS with 1x RS485 and with 2x RJ45 (continue with code "PB")	CS94.5	
• SPABUS with 2x FO-ST connection (continue with code "PB")	CS95.3	
• SPABUS with 2x FO-LC connection (continue with code "PB")	CS95.4	
• other SCADA protocols on demand	CS99	
Add. Ethernet ports (4 in total) e.g. Process bus according to IEC 61850-9-2LE:		
• without (continue with code "SN")	PB0	
• 2 x RJ45 (100/1000 Mbit) (continue with code "SN")	PB1	
• 1 x RJ45 and 1 x FO- LC (1 GBit, Multimode, SX) (continue with code "SN")	PB4SX	
• 1 x RJ45 and 1 x FO- LC (1 GBit, Multimode, LX) (continue with code "SN")	PB4LX	
• 1 x RJ45 and 1 x FO- LC (100 MBit, Multimode) (continue with code "SN")	PB4	
• 2 x FO- LC (1000 MBit, Multimode, SX) (continue with code "SN")	PB3SX	
• 2 x FO- LC (1000 MBit, Multimode, LX) (continue with code "SN")	PB3LX	
• 2 x FO- LC (100 MBit, Multimode) (continue with code "SN")	PB3	
Note: If the feature PB is used for sampled values (IEC 61850-9-2LE) the feature S2 is mandatory! At the moment it's not possible to combine characteristic PB 1..4 with characteristic H2! 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.		

Integrated SCADA connection for serial protocols like IEC 60870- 5-101/...-103, DNP3.0, …		
● without integrated protocol interface for serial protocol (continue with code "G")	L0	
● with integrated SCADA interface for serial prot. for connection of one REG-DA (cont. with code "V")	L1	
● with integrated SCADA interface for serial protocol for connection of more than one system (REG-D/DA/DP etc.) (continue with code "V")	L9	
Note: L9 can only be combined with characteristics Z01, Z15 to Z19 and Z91.		
Connection type		
● Copper		
– RS232	V10	
– RS485 2-wire operation only	V11	
● Fibre optic cable with FSMA connection technology		
– Fibreglass (Wave length 800...900 nm, range 2000 m)	V13	
– All-plastic (Wave length 620...680 nm, range 50 m)	V15	
● Fibre optic cable with ST connection technology		
– Fibreglass (Wave length 800...900 nm, range 2000 m)	V17	
– All-plastic (Wave length 620...680 nm, range 50 m)	V19	
● Fibre optic cable with VL connection technology		
– All-plastic (Wave length 620...680 nm for SPABUS)	V22	
(continue with code "Z or CZ")		
Protocol (without cyber security) **Attention! Select only Z or CZ**		WITHOUT Cyber Security
● IEC60870-5-103 Standard	Z03	
● IEC60870-5-103 for ABB	Z10	
● IEC60870-5-103 for SAT	Z12	
● IEC60870-5-103 for Siemens (LSA/SAS)	Z13	
● IEC60870-5-103 for Sprecher Automation	Z14	
● IEC60870-5-103 for others	Z90	
● IEC60870-5-101 Standard	Z01	
● IEC60870-5-101 for ABB	Z15	
● IEC60870-5-101 for IDS	Z17	
● IEC60870-5-101 for SAT	Z18	
● IEC60870-5-101 for Siemens (LSA/SAS)	Z19	
● IEC60870-5-101 for others	Z91	
● DNP 3.00 (serial only)	Z20	
● SPABUS	Z22	
● MODBUS RTU	Z23	
(continue with code "G")		
Protocol (with cyber security) **Attention! Select only Z or CZ**		WITH Cyber Security
● IEC60870-5-103 Standard	CZ03	
● IEC60870-5-103 for ABB	CZ10	
● IEC60870-5-103 for Alstom/Schneider-Electric/GE	CZ11	
● IEC60870-5-103 for SAT	CZ12	
● IEC60870-5-103 for Siemens (LSA/SAS)	CZ13	
● IEC60870-5-103 for Sprecher Automation	CZ14	
● IEC60870-5-103 for others	CZ90	
● IEC60870-5-101 Standard	CZ01	
● IEC60870-5-101 for ABB	CZ15	
● IEC60870-5-101 for IDS	CZ17	
● IEC60870-5-101 for Siemens (SAT)	CZ18	
● IEC60870-5-101 for Siemens (LSA/SAS)	CZ19	
● IEC60870-5-101 for others	CZ91	
● DNP 3.00	CZ20	
● SPABUS	CZ22	
● MODBUS RTU	CZ23	
(continue with code "SN")		
Note: Cyber security is not yet available for all serial protocols, please contact A. Eberle.		

SNMPv3 (Simple Network Management Protocol Version 3)	
● without SNMPv3 (continue with code "G")	SN0
● with SNMPv3 (continue with code "G")	SN1
Operating instructions	
● German	G1
● English	G2
● Other (on demand)	G9
Display language	
● German	A1
● English	A2
● French	A3
● Spanish	A4
● Italian	A5
● Russian	A6
● Portuguese	A7
● Czech	A8
● Dutch	A9
● Polish	A10

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

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)	356.2010.00
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: 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 ● For DIN-rail 35 mm, size 98 x 27 x 144 mm **Note:** external 24 V DC power supply necessary	**Profibus-DP** B0
TCP/IP adapter (COMServer) ● 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 (RS485) to the transformer monitoring module. For example, to analyse the gas-in-oil ratio online, directly measure the winding temperature, etc., ● Auxiliary voltage AC 120 V...230 V, DC 90 … 250 V, bundle of COM3 converter H2 and a power supply ● Auxiliary voltage DC 18 … 72 V	**COM3-MOD** H1 H2

Notes

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