User Manual

REG-DA Relay for Voltage Control & Transformer Monitoring

REGSys™

www.regsys.de

GB

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NOTICE!	Please note that these operating instructions may not always contain the latest information concerning the device. Should you require a more recent version of these instructions or have any questions about the product or how to use it, please contact the REGSys™ Support on: +49 (0)911 628108-101 or via email at regsys-support@a-eberle.de

A. Eberle GmbH & Co. KG

Frankenstrasse 160

D-90461 Nürnberg

Telefon: +49 (0)911 / 62 81 08 0

Telefax: +49 (0)911 / 62 81 08 96

E-Mail: info@a-eberle.de

Internet: www.a-eberle.de

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Contents

1.   User guidance

This user manual contains a summary of the information needed for installation, commissioning and operation.

Read the user manual entirely and do not use the product unless you have understood its content.

1.1   Target group

The user manual is intended for skilled technicians and trained and certified operating personnel.

The contents of this user manual must be accessible to people tasked with the installation and operation of the system.

1.2   Warnings

Structure of the warnings

Warnings are structured as follows:

⚠ SIGNAL WORD!	**Nature and source of the danger.**
	Consequences if instructions are not obeyed.
	➲ Actions to avoid the danger.

Types of warnings

Warnings are distinguished by the type of danger they are warning against:

⚠ DANGER!	Warns of an immediately impending danger that can result in death or serious injuries when not avoided.

⚠ WARNING!	Warns of a potentially dangerous situation that can result in death or serious injuries when not avoided.

⚠ CAUTION!	Warns of a potentially dangerous situation that can result in fairly serious or light injuries when not avoided.

NOTICE!	Warns of a potentially dangerous situation that results in material or environmental damage when not avoided.

1.3   Tips

Tips on the appropriate use of the device and recommendations.

1.4   Other symbols

Instructions

Structure of the instructions:

➲ Instructions for an action.

    ↳ Indication of an outcome, if necessary.

Lists

Structure of unnumbered lists:

- List level 1
  - List level 2

Structure of numbered lists:

1) List level 1
2) List level 1
    1. List level 2
    2. List level 2

1.5   Applicable documentation

For the safe and correct use of the installation, observe the additional documentation that is delivered with the REG-DA, as well as the relevant standards and laws.

1.6   Storage

Store the user manual, including the supplied documentation, readily accessible near the system.

2. Scope of delivery

- Relay for Voltage Control & Transformer Monitoring REG-DA with mounting brackets
- Terminal diagram in English*
- User manual in English
- Programming and configuration software WinREG*
- Null-modem cable or USB cable (depending on order feature I)*
- Spare fuse

Tools on the back of the terminal compartment cover
(3 mm hex key and special screwdriver for the Level 2 terminals)

3.　　　Safety instructions

- ➲ Follow the operating instructions.

- ➲ Keep the operating instructions with the device.

- ➲ Regularly instruct staff in all relevant issues regarding occupational safety, the operating instructions and, in particular, the safety instructions they contain.

- ➲ Ensure that the device is only operated if in perfect condition. Never use a damaged device (physically damaged or malfunctioning).

- ➲ Ensure the device is only operated by qualified personnel.

- ➲ Connect and use the device only as specified.

- ➲ Operate the device only with the recommended accessories.

- ➲ Ensure that the device is operated only in its original condition.

- ➲ Ensure that the device is only operated within the permissible rated data (see technical specifications in the Appendix, Chapter 20).

- ➲ Do not install or operate the device in environments where explosive gases, dust or vapours may be present, i.e. that generally do not meet the requirements mentioned in the technical datasheet.

- ➲ Clean the device only with cleaning products that comply with the manufacturer's specifications.

- ➲ Use only spare parts and auxiliary materials that have been approved by the manufacturer.

- ➲ Maintenance and repair of the REG-DA Relay for Voltage Control & Transformer Monitoring must onbly be carried out by authorised qualified personnel and must satisfy EMC directrives..

4. Intended use

The Relay for Voltage Control & Transformer Monitoring REG-DA is designed as a permanently installed measuring and regulation unit for controlling on-load tap changers, and is exclusively intended for use in electrical power engineering facilities and installations, where professionals carry out the necessary work. Professionals are defined as people who are familiar with the installation, assembly, commissioning and operation of such products. They have qualifications that meet the requirements of their activities.

The Relay for Voltage Control & Transformer Monitoring REG-DA complies with the laws, rules and standards applicable at the time of delivery, in particular with relevant safety and health requirements.

To maintain this condition and ensure safe operation, the operator must follow all the instructions and warnings in the user manual and the technical data must be observed.

A. Eberle GmbH & Co. KG accepts no liability for damage resulting from unauthorized or improper modification or use of the product. Improper modifications of the product without consultation with A. Eberle GmbH & Co. KG can lead to personal injury, property damage and malfunctions.

5. Performance features

The REG-DA Relay for Voltage Control & Transformer Monitoring can be used to perform both simple and complex measurement, control and regulation tasks on tap-changing transformers. Telecontrol connection (DNP3, IEC 60870-5-101 / 103/104, IEC 61850, MODBUS, etc.) can be realized via an integrated telecontrol board module.

The core function of the REG-DA is the regulator function, in which the actual value and a fixed or load-dependent setpoint value are compared. Depending on the setpoint deviation, the comparison determines the correcting variable for the transformer's tap changer. The regulator's parameters can be fine-tuned to the dynamic time behavior of the grid voltage to obtain a high regulation performance via a low number of switching operations.

Moreover, the Relay for Voltage Control & Transformer Monitoring REG-DA is capable of using other Relays for Voltage Control & Transformer Monitoring in the REGSys™ family, with parallel operation of up to 10 transformers without additional components. There are different methods to choose from for the control of transformers, which can be used on site according to the circumstances. It is worth noting that additional components are not required because the regulators contain all of the functional units required for parallel operation.

In addition to the regulator, each REG-DA comes with the current optional features of transformer monitoring, transducer, recorder, statistics and ParaGramer. The Transducer mode displays all of the relevant measured grid quantities. The Recorder mode records the regulated voltage over time as well as two additional selectable quantities. Tap-change position statistics provide a clear overview of all of the tap changer's switching operations, and the ParaGramer displays a single-line diagram of the transformer unit. The ParaGramer is a valuable tool, when setting up parallel operations for several transformers, because it automatically recognizes transformers that are run in parallel.

The REG-DA regulator can be equipped with a powerful transformer monitoring function in conformity with IEC 60354 or IEC 60076. This function enables the operator to view information regarding hot-spot temperature and the transformer's loss of life at any time. If required, the regulator can even activate up to six cooling levels. The oil temperature can either be recorded directly (as a PT100 signal) or through an mA input.

To solve customer-specific requirements, a background program can be loaded into the Relay for Voltage Control & Transformer Monitoring REG-DA. Simple and complex logics can be created, as well as additional custom menus.

As an alternative to direct acquisition, U, I and cos(φ) measurements, as well as the tap position, can be fed to the REG-DA through a serial connection such as an IEC 61850 client function or as a mA signal. Switch positions for use, for example, in ParaGramer can also be made available via GOOSE as an alternative to binary signals wired to the regulator.

6. Operation/Indicators

6.1 Indicators, controls and display
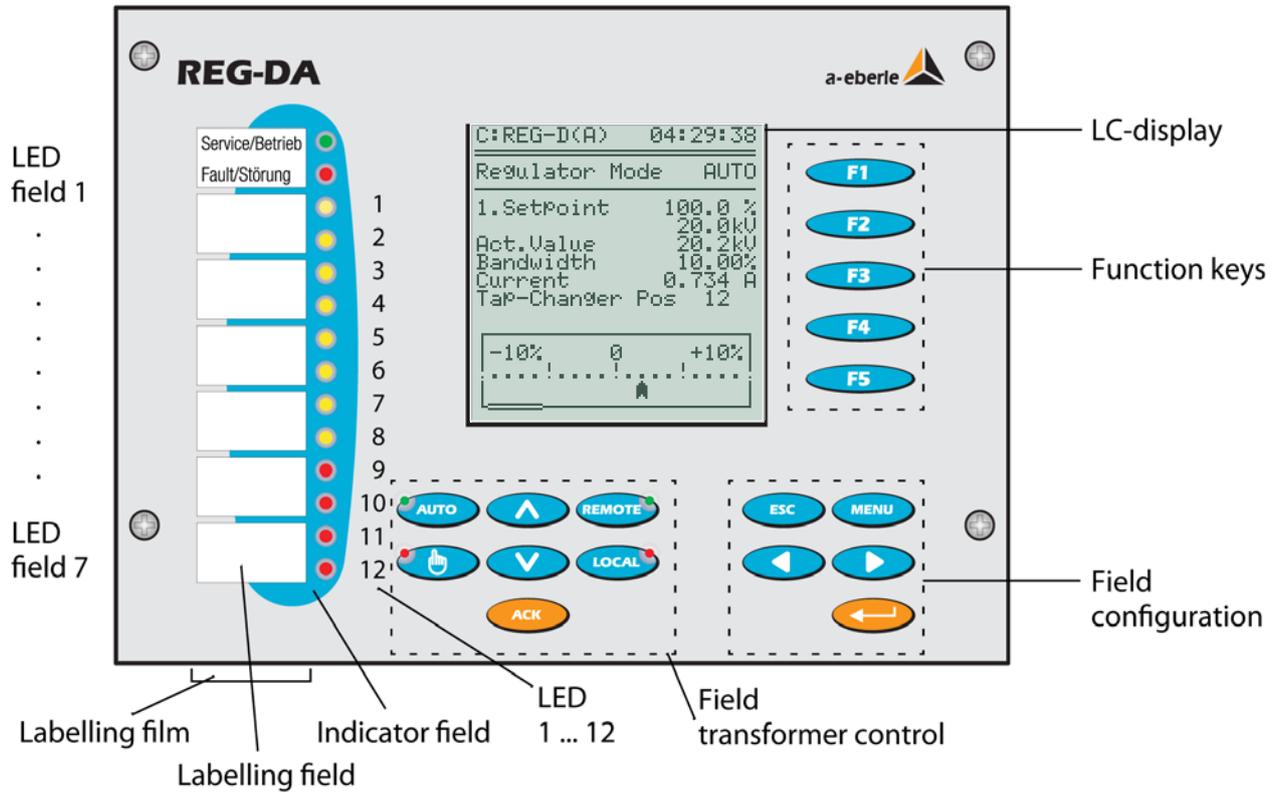
The operating level HMI (Human Machine Interface) of the REG-DA is designed as a membrane keyboard with integrated LEDs.

Indicator and field labels

There are a total of seven indication and seven field labels available. Each label field is intended for two indications (two LEDs)..

The label of each field can be changed at any time by pulling out the labelling strip downwards from the foil pouch with a suitable tool.

Labelling can be carried out with any standard writing device.

Alternatively, a corresponding label can be created on the PC and printed out.

Appropriate templates are found on the WinREG CD or can be downloaded from the A. Eberle website http://www.a-eberle.de.

The indication field 1 (operation/fault) is permanently programmed.

LED operation field 1 (green) lights up when the unit is working normally.

LED fault field 1 (red) lights up when there is a fault on the device.

- LEDs 1 ... 8 field 2 to 5 (yellow) are freely programmable for general indications and are not assigned on delivery.
- LEDs 9 ... 12 field 6 and 7 (red) are freely programmable, intended mainly for fault - messages and are not assigned on delivery.

Transformer control field

The transformer control field has six keys.

● The 'AUTO' key with integrated green LED illuminates when the regulator in operating is automatic mode.

● The 'Man' key with integrated red LED illuminates when the regulator is operating in manual mode.

● The REG-DA comes standard with a local/remote switch that is activated by two keys. The 'Local' key switches the regulator into local mode. This mode suppresses all of the controls that are sent remotely over binary inputs or the SCADA system. The Auto/Man and Up/Down functions can only be used with the keys on the REG-DA.
Remote mode (green), which enables the REG-DA to be controlled remotely, is selected by pressing the 'Remote' key.

● The 'Raise' and 'Lower' keys are used to change the tap on the transformer manually (prerequisite: the regulator is in Man mode and the status is local, or local/remote switching is disabled (feature Localremote = 0)).

Colour scheme of the transformer control field

When designing the operation of REG-DA, it was ensured that all indicator elements of the transformer control field (manual/automatic and local/remote) should glow green whenever the operating personnel leave the control room.

ACK key

The ACK key is currently deactivated.

In future, this key will be used to acknowledge operating and fault messages that the regulator generates itself.

Configuration field

With the following five keys of the configuration field you can configure the Relay for Voltage Control & Transformer Monitoring REG-DA manually.

● MENU is used to switch between different operating modes and select a specific configuration menu (SETUP 1 ... SETUP 6).

● Enter is used to conform a specific parameter in SETUP menus and to activate custom menus (application menus), where these are available.

● ESC is used to leave any menu, while using the two keys and to move the cursor in the SETUP menus.

Modification of important operating parameters

Operationally important configuration changes can only be made while in manual operating mode.

Function keys

The function keys F1 to F5 are designed as softkeys.

The function of the keys is context-controlled and results from the respective menu.

Serial interface COM1
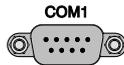
for connection of the Relay for Voltage Control & Transformer Monitoring with a PC or an external device, for example a modem. The COM1 interface can optionally be configured as a USB interface (feature I1).

Operation principle

Operation of the Relay for Voltage Control & Transformer Monitoring REG-DA is completely menu-guided, and, in principle, the same for any SETUP menu item.

If regulation parameters have to be set or changed, the following operating principles apply:

● 'Manual' key   →   the operating mode is set to manual operation.

● 2x 'MENU' key   →   call up display modes 2

● 1x 'MENU' key   →   select the menu item SETUP

By pressing the MENU button one can scroll until the desired parameter appears in the SETUP menu selection.

● Select parameters with the corresponding function key (F1 ... F5).
Set the value of the parameter with the function keys.
F1 increases the value in large steps
F2 increases the value in small steps
F3 is assigned to special functions in some SETUP menus.
F4 decreases the value in small steps
F5 decreases the value in large steps

● When entering a value is finished, the changed value is confirmed with Enter.

● If the entry is password protected, enter the password (see Chapter 6.4 Password protection on page 46).

● Return or exit from the SETUP menus with ESC (abort).
SETUP menus are automatically exited when no key is pressed for about 2 minutes.

Once the desired parameters have been entered, checked and confirmed with Enter, the regulator REG-DA can be switched back to automatic operating mode with AUTO.

Lamp test

To check functioning of the LEDs on the front panel: press F5.

This test is only possible in the display modes Regulator mode and Statistics mode.

Reset of fault indications

To reset pending fault indications the operating mode must be switched from automatic to manual and then switch back to automatic.

Alternatively, the F5 key can be pressed in the display mode Regulator and Statistics.

The reset of fault indications is also possible remotely using a background program or a SCADA system.

6.2 Display modes

Selection of display modes

After pressing MENU, the display modes of the Relay for Voltage Control & Transformer Monitoring REG-DA can be selected.

The following modes, which are explained in detail in the following chapters, are available:

- Regulator
- Transducer mode
- Recorder
- Statistics (monitor)
- ParaGramer
- PQIView
- Logbook

6.2.1   Regulator
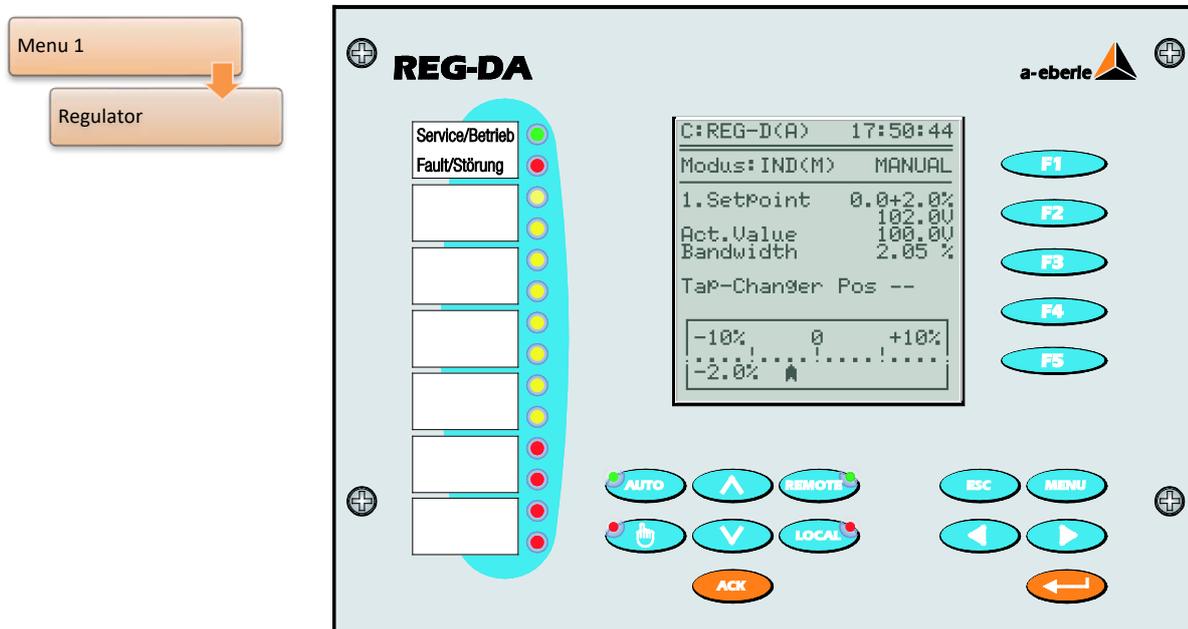
In regulator mode, the setpoint value in V (kV) and in % of nominal voltage, the present actual value, the value of the permissible setpoint deviation (bandwidth) and the current tap position of the tap-changing transformer are displayed.

In addition, the current setpoint deviation is visualised on an analog like gauge with a scale width of ±10% from the setpoint.

If the voltage leaves the tolerance band (bandwidth either the positive or the negative direction), the colour of the scale pointer changes from transparent to black (reverse color scheme).

If necessary, the actual value of the current for the indication may also be selected.

Press the F1 key to switch between the detailed view and the large display. On the large display, the actual measured voltage and tap position are displayed at the top. The graphical display of the actual voltage deviation remains unchanged.

LC display regulator mode

Bus address (station ID)   Station name   Day Time

Identification line →

Status line →

```
C:REG-D(A)      04:29:38
Regulator Mode     AUTO
1.Setpoint        100.0 %
                   20.0kV
Act.Value          20.2kV
Bandwidth          10.00%
Current            0.734 A
Tap-Changer Pos    12

 -10%      0       +10%
 . . . . .!. . . . .!. . . . .
 ▄▄▄
```

Actual value →

Setpoint in %
Setpoint in V/kV
Actual value in V/kV

Progress bar (when active)

Highspeed switching is indicated
by '<--<' or '>-->'

Up or Down switching is indicated by '>>>>'
for Up and '<<<<' for Down

Setpoint deviation

The arrow is transparent when the actual voltage
deviation is within the tolerance band.

The arrow is black when the actual voltage
deviation is greater than tolerance band.

Visualisation of measurement value simulation

If actual value is shown in capital letters as "ACTUAL VALUE" in the display, then the
"Measurement value simulation" is switched on (see Chapter 7.2.5 page 118)!

6.2.2 Transducer

The above figure shows the transducer basic display available in most cases. Here, voltage, current, power values, cos(φ), phase angle, reactive current, frequency and selected nominal current of the current transformer (value in [ ]) are shown.

Additionally or alternatively to this indication, depending on features and parameters, it is possible that additional transducer screens are accessible. Scrolling through screens is done in a loopwise manner. On arriving to the last screen, you can either scroll back (left arrow) or return to the first page by scrolling further (right arrow or, alternatively with the F2 key).

Display of reactive current I*sinφ in the transducer basic display

Only the reactive current I*sinφ of the transformer is shown in the transducer basic display. The component of this current due to the load and the component due to circulating reactive current cannot be seen in this display. To this end, there is another transducer screen, which is available after selecting a parallel program.

Overview of available displays while in transducer mode

	Display screens				
	Basic display	Three-winding trans-former	Three-winding trans-former (S2)	ARON	Circulating reactive current
Standard	✔				
Standard with parallel program	✔				✔
Three-winding transformer		✔			
Three-winding transformer with parallel program		✔			✔
Three-winding transformer with phase angle measurement	✔	✔			
Three-winding transformer with phase angle measurement and parallel program	✔	✔			✔
Three-winding transformer (S2)		✔	✔		
Three-winding transformer (S2) with parallel program		✔	✔		✔
ARON measurement	✔			✔	
ARON measurement with parallel program	✔			✔	✔

✔ Available

The "Three-winding transformer" or "three-winding transformer with phase angle measurement" (measurement input swap) depends on the activation of the feature 3winding.

Three-winding transformer (S2) is available for devices with hardware feature S2 and firmware ≥ 3.23.

Three-winding transformer and ARON measurement cannot be active simultaneously!

Reactive circulating current display

After selecting a parallel program, a further screen in the transducer mode is available. This can be reached using the left or right arrow keys (alternatively key F2).

```
A:REG-D(A)     06:59:10
─────────────────────────
 ← Transducer Mode →
─────────────────────────

Icirc (react.):

-78.098 A
========

Icirc/max.Icirc:
┌───────────────────────┐
│-5        0        +5  │
│....!....!....!....!...│
│          ♦            │
└───────────────────────┘
```
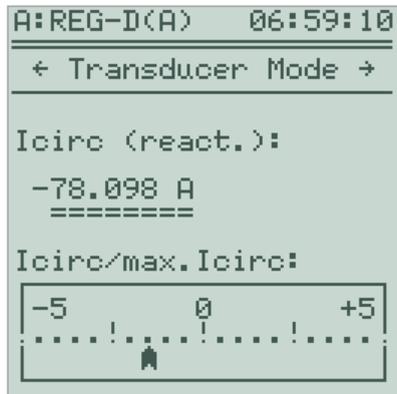
The display of circulating reactive current is used for setting circulating reactive current minimization based on parallel programs, and for the supervision of Master-Follower regulation. The circulating reactive current is the part of the reactive current, which is not generated by the load, but is caused by parallel operation of several transformers.

In the lower part of the screen, the ratio of calculated reactive circulating current to permissible circulating reactive current is indicated graphically in the form of an analog like display.

The fill colour of the pointer changes from transparent to black (reverse color scheme), when the detected reactive circulating current exceeds the set permissible reactive circulating current.

Display of ARON measurement values (feature M2)

If the REG-DA has the M2 feature and the ARON measurement is enabled (parameter "CT/VT Configuration" = ARON), the regulator provides a transducer mode screen on which the readings of ARON measurements (arbitrarily loaded three-phase grid) are displayed.

```
A:REG-D(A)     16:08:02
 ← Transducer Mode →

    ---- ARON ----
 U12 =     20.06 kV
 U23 =     20.02 kV
 U31 =     20.10 kV
  I1 =    605.63 A
  I2 =    603.53 A
  I3 =    601.76 A
   P =     19.68 MW
   Q =      7.25 MVAr
   S =     20.97 MVA
   f =     49.98 Hz
```

Display of power values

On comparing power values from the ARON display and the transducer basic display there may be differences. This is because calculation of power values in the basic display is always based on symmetrical loading, whereas the ARON values take asymmetry into account.

Three-winding transformer display

If the feature three-winding transformer (3Winding) is released and activated, the three-winding transformer screen is available while in transducer mode, which then serves as an entry screen to the transducer instead of the transducer mode basic display screen. Here both measured voltages, frequency and, if desired, both currents (parameter "Current display" = ON) are displayed. Moreover, the selected regulation voltage is indicated with an arrow and a freely definable three-character string (standard assignment {1}, {2}). If a specific configuration of the 3winding transformer feature is used (with phase angle measurement, measurement input swap) the transducer basic display is available as an additional screen for devices without the S2 feature.

```
A:REG-D(A)    16:19:09

 ← Transducer Mode →

{1}

  → U(1) =    20.06 kV
    U(2) =    10.01 kV
    f    =    49.98 Hz



```

Three-winding transformer view without limit monitoring, without current display, U(1) selected for regulation

```
A:REG-D(A)    16:20:57

 ← Transducer Mode →

{2}

    U(1) =    20.04 kV
  → U(2) =    10.01 kV
    I(1) =   605.06 A
    I(2) =   602.32 A
    f    =    49.98 Hz

```

Three-winding transformer view without limit monitoring, with current display, U(2) selected for regulation

If the feature 3winding is used with limit monitoring, the limit value of the monitored voltage (parameter "3Winding limit >Ub") is also displayed in the transducer mode.

```
A:REG-D(A)    16:15:41

 ← Transducer Mode →

{1}

  → U(1) =    20.06 kV
    U(2) =    10.01 kV
    f    =    49.98 Hz

   >U(2) =      5.0 %
             10.50 kV


```

Three-winding view with limit monitoring without current display, U(1) selected for regulation

Three-winding transformer (S2) display (only devices with the S2 feature, from firmware version 3.23)

Instead of the three-winding transformer basic display, devices with the hardware feature S2 have an expanded and detailed screen on which power values, phase angle, reactive currents and frequencies for both measuring inputs can be displayed simultaneously and independent of the measuring input selected for regulation. The selected regulating voltage is visualised by multiple arrows (>>>>XXX<<<<) (e.g. >>>>{1}<<<< for measurement input 1 using the default name).

```
A:REG-D(A)    14:46:02
 ← Transducer Mode →
 >>>{1}<<< │  {2}
U   20.01k│ 10.00k │U
I   599.1 │ 599.2  │A
P   20.76M│ 10.38M │W
Q   65.30k│-35.29k │Var
S   20.76M│ 10.38M │VA
PF   1.00 │  1.00  │
Ψ  -0.18 i│ 0.19 c │°
Iq -1.919 │ 2.039  │A
f   50.00 │ 50.00  │Hz
```

Three-winding transformer (S2) view
U(1) selected for regulation

Further information on the feature 3winding can be found in Chapter 8.3.5 from page 258 onwards.

ℹ **Use of the transducer views when in active simulation mode**

In simulation mode, the left and right arrow keys can be used to adjust the simulated voltage. Therefore they cannot be used to scroll pages in transducer mode. The F2 key also has a different function in this mode (increase the simulated current).

➲ Scroll pages in transducer mode with the F1 key when the simulation mode is active.

6.2.3 Recorder
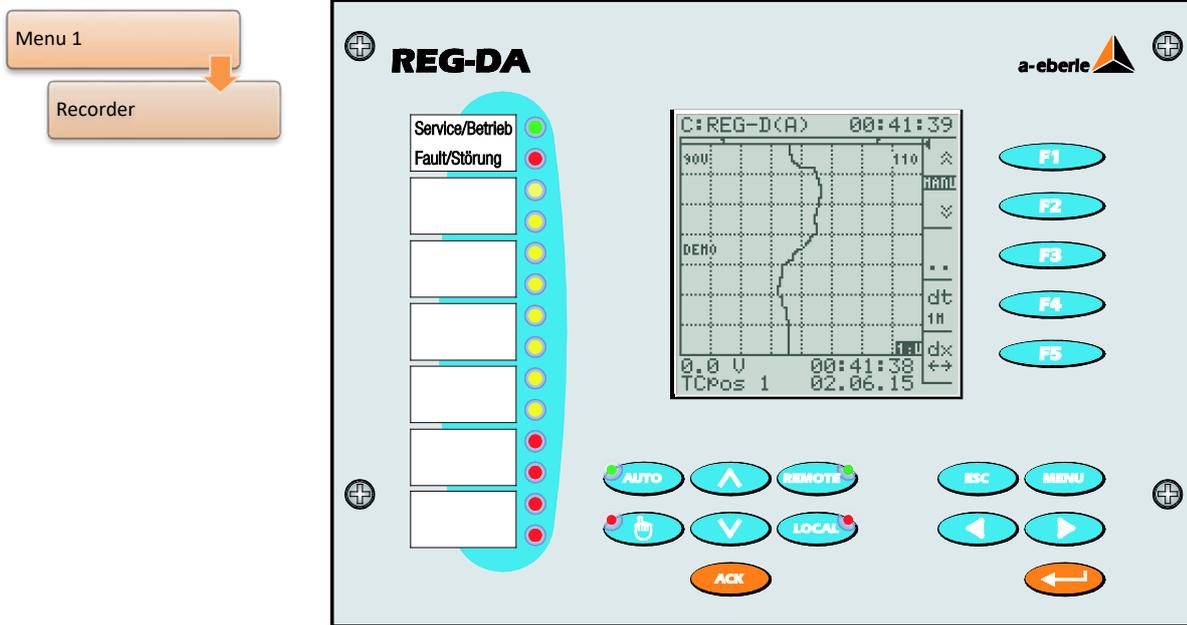
The recorder display mode presents the recorder data of REG-DA order code S1 on the display.

For further information on the recorder function of the REG-DA, see Chapter 8.3.3 page 249.

Recorder demo mode

The recorder is running in demo mode if "DEMO" is displayed in the left of the grid when the recorder is in normal display mode. In this operating mode, the recorder records measured values for a time period of 4 to 6 hours. The oldest values are overwritten at the end of this period. Real process data cannot be read out in demo mode!

6.2.4　Statistics
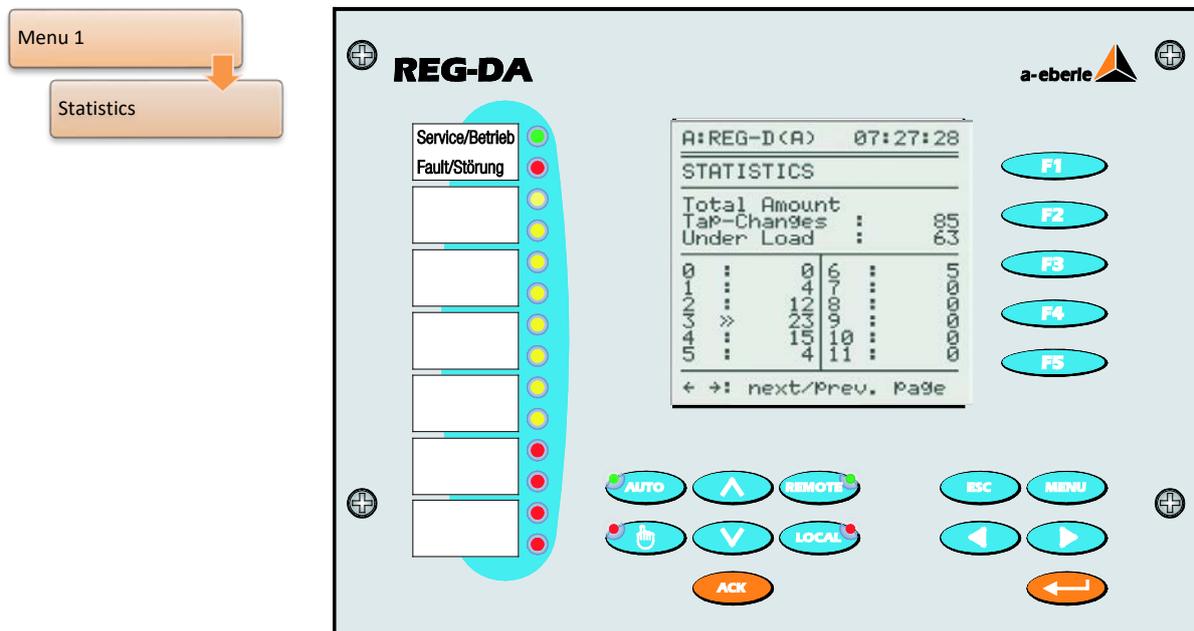
The display shows the total number of tap changes performed since the last reset of the counter. A distinction is made between tap changes under load and tap changes with less than 5% of the nominal current In (1 A or 5 A).

Tap changes under load are also displayed separately for each tap.

If the tap changer operates under load (I > 0.05 · In), the current tap position is indicated by a double arrow >>.

If the load condition is not met, the current tap position is indicated by a single arrow ">".

In conjunction with the recorder, the statistics screen provides valuable clues on the controlled system.

With the parameters time factor and permissible setpoint deviation (bandwidth), an optimum between voltage stability and number of tap changes can be found. This relationship cannot be mathematically ascertained, but is more subject to individual conditions at the respective feeding point.

The statistical data can be read and displayed via the operating software.

Deleting of statistics can be carried out in "Setup menu -6-\General -3-\Delete tap sums" or via the operating software.
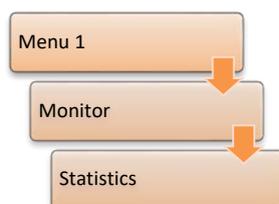
If the regulator has the feature TM (transformer monitoring), this is the F4 key. The statistics mode is then part of the monitor. That is, the monitor must first be selected before statistics mode can be selected.

6.2.5   ParaGramer

Menu 1
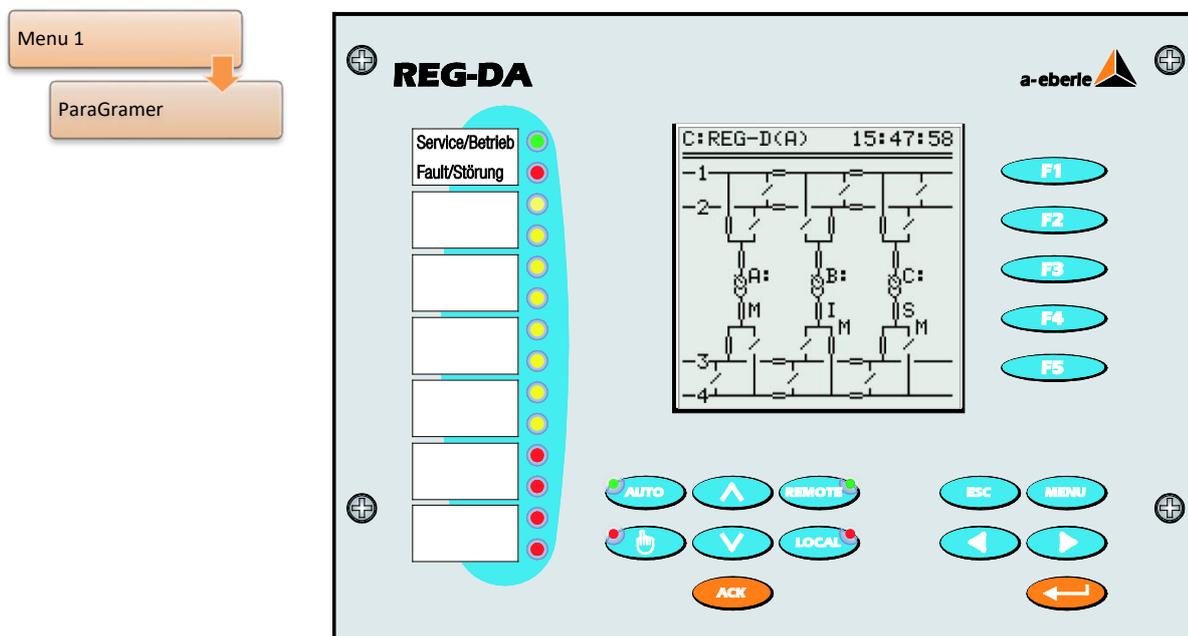
ParaGramer

The ParaGramer serves as an aid for automatic preparation of parallel operation and on-line display of switching status. The coinage ParaGramer is essentially composed of the terms "parallel" and "single-line diagram". The ParaGramer displays the switching status of each of the transformers in an aggregated single-phase diagram.

This function is activated in that each regulator is supplied with a complete busbar replica (circuit breakers, isolators, section and coupling positions) to its busbar portion via binary inputs.

Based on the switching states of all of the regulators involved in parallel operation, the system automatically detects which transformer should work in parallel on a busbar with which other transformer(s). The system treats busbars that are connected through couplings as a single busbar.

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

For a description of the ParaGramer feature, see Chapter 8.3.2 page 237.

6.2.6 Monitor (software feature TM)

Menu 1

Monitor

The transformer's main parameters are monitored in the monitoring module. The oil temperature can also be recorded in addition to the tap-changer statistics. Hot-spot temperature is determined from the oil temperature and the winding current, in accordance with IEC 60354 or IEC 60076, and extrapolated on the transformer's remaining lifetime.

To regulate the temperature, fans can be switched on or off in up to six groups as well as two oil pumps. The oil levels can be monitored and the operating hours of the fans and pumps counted.
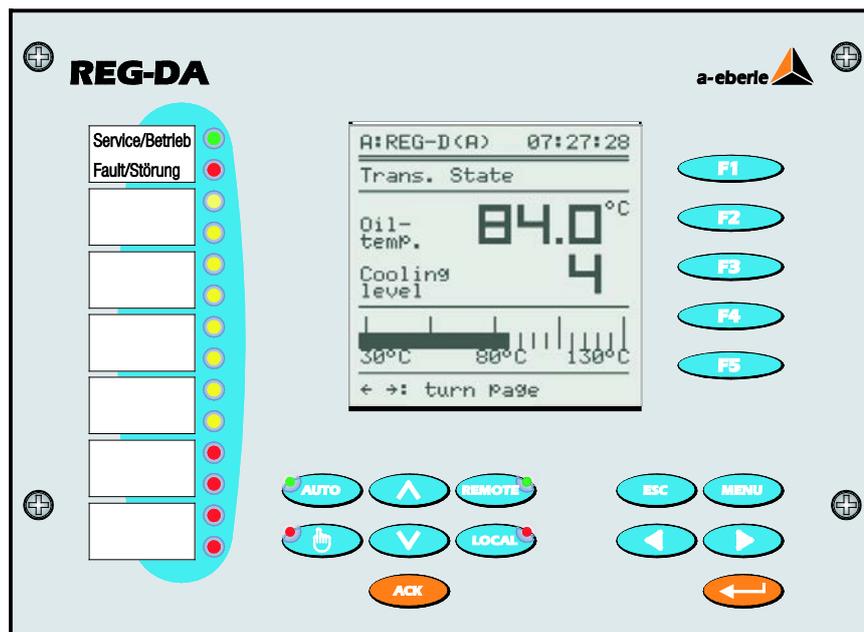
To record the oil temperature, the regulator can be optionally equipped with a PT100 module or an mA input. A total of three slots are available. If required, several temperatures can be recorded through a mA input or PT100.

The feature transformer monitoring (TM) is not part of this manual. The manual for this feature is included in the equipment delivery and can also be downloaded from the website http://www.a-eberle.de.

6.2.7 PQIView

Menu 2

PQIView

In the PQIView mode, readings from PQI-D(A)s located within the same E-LAN group can be shown on the display of the REG-DA.
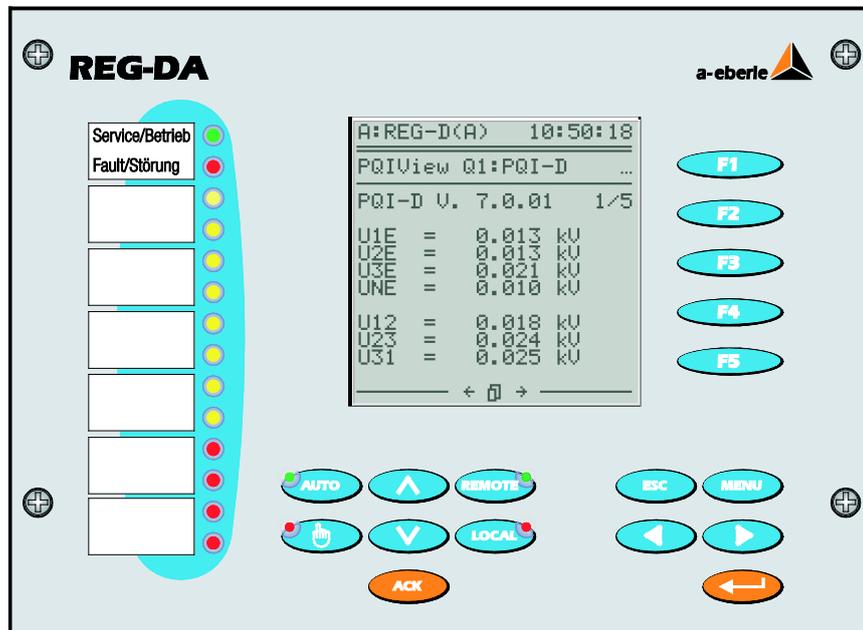
If several PQI-D(A)s are available, use the F1 key to switch between them. The individual pages can be scrolled with F2 ... F5, or the arrow keys ◄ and ►. The number of menu pages and the measurement values displayed differ depending on the device type of the PQI-D(A).

Measurement values and menus on UI devices (devices with current and voltage measurements):

Measurement values and menus on UU devices (devices with voltage measurements):

```
A:REG-D(A)    10:53:20     A:REG-D(A)    10:53:42     A:REG-D(A)    10:54:08
PQIView Q2:PQI-D     …     PQIView Q2:PQI-D     …     PQIView Q2:PQI-D     …
PQI-D V. 4.0.07   1/3     PQI-D V. 4.0.07   2/3     PQI-D V. 4.0.07   3/3
U1E_1 =    0.000 kV       U1E_2 =    0.000 kV       THD12_1 =    0.000 %
U2E_1 =    0.000 kV       U2E_2 =    0.000 kV       THD23_1 =    0.000 %
U3E_1 =    0.000 kV       U3E_2 =    0.000 kV       THD31_1 =    0.000 %
UNE_1 =    0.000 kV       UNE_2 =    0.000 kV
                                                    THD12_2 =    0.000 %
U12_1 =    0.000 kV       U12_2 =    0.000 kV       THD23_2 =    0.000 %
U23_1 =    0.000 kV       U23_2 =    0.000 kV       THD31_2 =    0.000 %
U31_1 =    0.000 kV       U31_2 =    0.000 kV
                                                        f =    0.000 Hz
         ←  →                    ←  →                         ←  →
```

Devices not available

If no PQI-D(A)s are available in the E-LAN, the message "No device found!" is displayed.

We take care of it.

6.2.8   Logbook

Menu 2

Logbook

Predefined events are entered with a time stamp in the logbook and can thus be used for analysing events concerning the Relay for Voltage Control & Transformer Monitoring. The logbook can contain a maximum of 511 entries (up to firmware V2.11 a maximum of 64, devices with feature S2 and firmware ≥ 3.2 2048 entries). If the maximum number of log entries is reached, the oldest logs are deleted in favour of new entries.
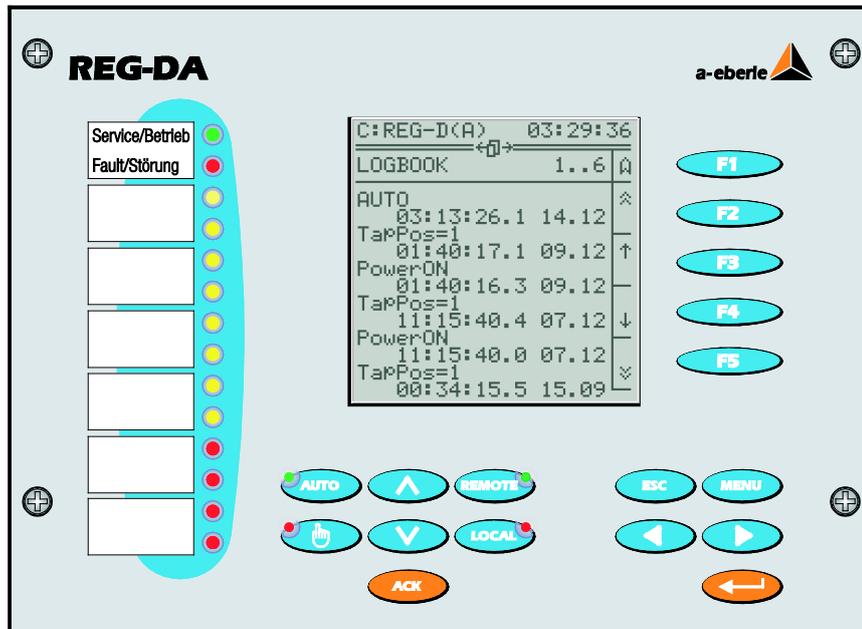
The following system events are recorded by default, but can, if necessary, also be disabled with the help of the configuration software REGPara (part of the software program WinREG).

Event	Logbook entry		Description
PowerOn	PowerOn		Power was turned on, or a power-on reset performed
Automatic	Automatic	Manual	The device was switched to automatic/manual operation
Local_Remote	Local	Remote	Local/remote switchover
Up	Up (or TapLimMa/TapLimMi)		The device issued a raise command. In case of activated tap limitation, with a raise command which would violate the configured tap range, the corresponding logbook entry TapLimMa (maximum reached) or TapLimMi (minimum reached) is made.
Down	Down (or TapLimMa/TapLimMi)		The device issued a lower command.

Event	Logbook entry		Description
			In case of activated tap limitation, with a lower command which would violate the configured tap range, the corresponding logbook entry TapLimMa (maximum reached) or TapLimMi (minimum reached) is made.
Tap	TapPos = xx		Tap position
SP index	SP-Index=x		Setpoint index (setpoint 1 ... 4 activated)
Inhibit high	Inh-High:ON	Inh-High:OFF	Inhibit high
Inhibit low	Inh-Low:ON	Inh-Low:OFF	Inhibit low
Fast-Up	Fast-Up:ON	Fast-Up:OFF	Limit for high-speed forward switching
Fast-Down	Fast-Dwn:ON	Fast-Dwn:OFF	Limit for high-speed backward switching
>U	>U:ON	>U:OFF	Overvoltage limit
<U	<U:ON	<U:OFF	Undervoltage limit
>I	>I:ON	>I:OFF	Overcurrent limit
Simulation	Simul:ON	Simul:OFF	Simulation mode activated/deactivated
Grid breakdown	CNB:ON	CNB:OFF	Creeping Net Breakdown
Hunting	Hunting:ON	Hunting:OFF	Hunting (x taps within a given time)
ClearLog	LOG cleared		Logbook cleared
ClrRecorder	REC cleared		Recorder data cleared
ClearStats	STAT cleared		Statistics data cleared
PanelLogin	PanelLogin-x		User x has logged into the device (password protection)
Status	Status:Error	Status:OK	Status (life contact)
ELanErr	ELANErr:ON	ELANErr:OFF	E-LAN error
TapErr	TapErr:ON	TapErr:OFF	Tap position error (TapErr)
TC-Err	TC-Err:ON	TC-Err:OFF	TC in operation error (TC-Err)
ParErr	ParErr:ON	ParErr:OFF	Parallel operation error (ParErr) from version 2.27/3.27

Additionally, the following system events are always logged at the same time. They cannot be disabled via the configuration software REGPara as with the previous system events (part of the software program WinREG).

Event	Logbook entry	Description
RAM restore	RAMresto	Restoration of RAM by means of an existing RAM-Backup (possible from bootloader V2.12), see also Chapter 7.2.6 from page 121 onwards.
Time restore	RTC=RAMt RTC=EEPt RTC=RBUt RTC=2000	After a PowerOn, false time information was detected and the time information was restored as well as possible according to the available source. Time sources: RAMt = time source was RAM (MRAM) EEPT = time source was the EPROM RBUt = time source was the RAM-image in flash 2000 = the time was set to 01.01.2000 0:00:00
Master reset	MaRESET	The device was completely reset and RAM initialized again.

Moreover, of all relays, binary inputs and LEDs both the rising and falling flank can be separately logged. These logs are disabled by default due to the limited number of recordable events, but can be activated at any time by use of the configuration software.

In addition to these standard events, which are defined by the firmware, custom messages can be entered into the logbook via a background program. These consist of a freely definable text with a length of up to eight characters (e.g. "Custsp_1").

The content of the logbook can be visualised directly on the screen of the REG-DA, and in the provisioning software (e.g. WinREG). It is also possible to save log entries to a file for archiving on a PC. Deleting logbook entries is also possible through the software.

Further logbook entries

REG-DA firmware versions from V2.13 to V2.17 by default log incorrectly transmitted E-LAN telegrams in the form:

Rnxxxxxx or Lnxxxxxx

Where R or L stands for E-LAN-R or E-LAN-L and n is the length of the faulty telegram in bytes. Subsequently, the first three bytes of the telegram are recorded in hexadecimal (e.g. R1AE7H3X). These faulty telegrams are automatically detected and transmitted again or corrected. Therefore, the logbook entries introduced for monitoring purposes are removed again using firmware version 2.18 or greater.

6.3   Status
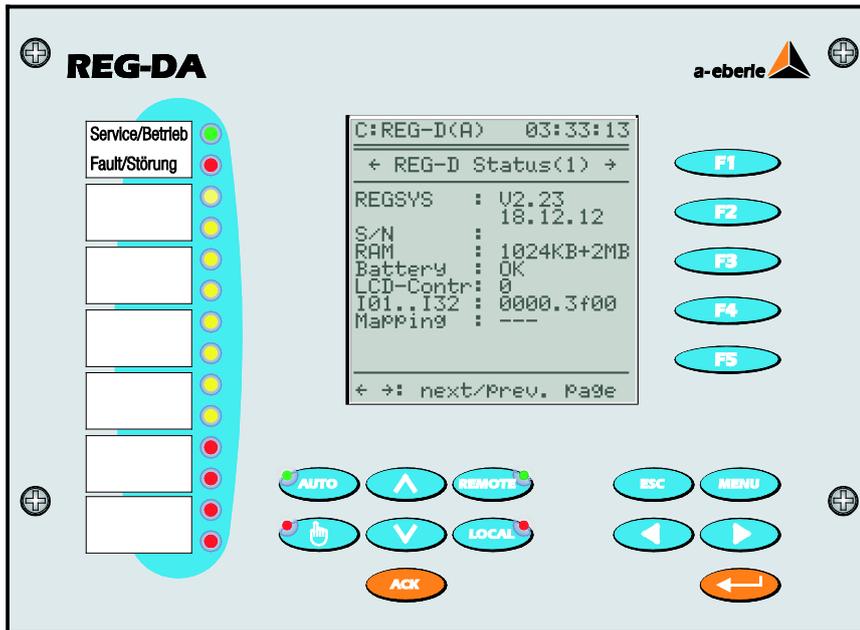
In the status menu information is summarised, which is important for the identification of the system.

REG-DA Status (1)

SETUP -6-

Status

In addition to firmware version, battery state, serial number (S/N), etc., REG-DA status (1) shows the current status of the first 32 binary inputs of the REG-DA. This information is particularly helpful for commissioning.

The inputs 1 through 32 are shown from right to left, in each case 16 binary inputs are shown as a block of four hexadecimal digits. The two blocks are separated by a dot.

By default, the regulator is equipped with 16 inputs. More inputs can be selected with the order code C. Moreover, the binary inputs 17 – 32 can originate from a BIN-D module (COM3 mapping).

The hexadecimal digits are to be interpreted as follows (an example for inputs 1 to 16):

Inputs				Inputs				Inputs				Inputs			
16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
Signal				**Signal**				**Signal**				**Signal**			
x	-	x	-	x	x	x	x	-	x	x	x	x	x	-	x
Value				**Value**				**Value**				**Value**			
8	4	2	1	8	4	2	1	8	4	2	1	8	4	2	1
= HEX A				= HEX F				= HEX 7				= HEX D			
x = ON															
- = OFF															

The binary input situation pictured above would be displayed in the status as 0000.af7d. Display of the status of inputs 17 – 32 is carried out similarly to inputs 1 – 16 before the dot.

In this way, during commissioning of the regulator, it can be unequivocally determined whether a signal is present at the terminals or not.

The point "mapping" indicates whether the channels of a connected ANA-D or BIN D are assigned (mapped) to inputs or outputs of the REG-DA. If the mapping is active the word "active" appears. Otherwise, the symbol "---" indicates that no mapping is active. Further information on the mapping of COM3 devices can be found in Chapter 8.2.6 from page 228 onwards.

REG-DA Status (2)

SETUP -6-
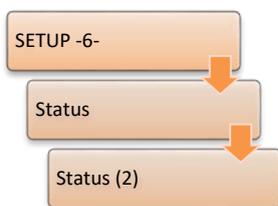
Status

Status (2)

Pressing the right arrow key leads to display status (2), in which the activated additional software features are shown.

A feature affects the regulator in a manner which is not needed for standard operation. If a particular feature is needed, it can be unlocked with the support of A. Eberle service team.

If, for example, in addition to voltage, the regulator needs also to be switched to active and reactive power regulation, the feature PQCTRL must be enabled. After the action is carried out, setpoints 1 and 2 can be used as voltage setpoints, setpoint 3 as active power and setpoint 4 as a reactive power setpoint.

If the regulator is to measure power values according to the ARON configuration, the feature M2 must be enabled, for example. But in this case the hardware requirements of the regulator must also be met (additional current and voltage transformers).

COM status

SETUP -6-

Status

COM status
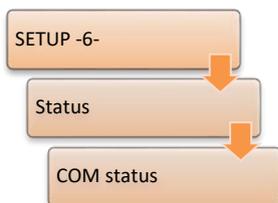
Pressing the right arrow key once more will display the settings of COM1 and COM2 (on the device with feature S2 and version ≥ 3.27 also COM4).

A short overview of the current operating mode is shown, the baudrate used, the parity and the handshake of the two COM interfaces.

E-LAN status

SETUP -6-

Status

ELAN status
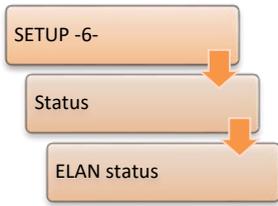
Pressing the right arrow key once again displays the settings of the two bus interfaces E-LAN-R and E-LAN-L and provides information on the total number of devices in the network.

"Users total: 2", for example, shows that only two devices are connected from the assortment in the E-LAN system. In addition to a further REG-DA, the second device could be a Power Quality Interface PQI-D, a Petersen coil regulator REG-DP(A)™, an earth fault-detection-relay EOR-D, etc.

LAN-L users: 0 (0) indicates that at the left E-LAN port there is no other device.

LAN-R users: 1 (1) indicates that the second E-LAN device is directly connected to the right E-LAN port.

The value in brackets shows the type of connection. If devices are directly connected to a port (in bus topology) the value in brackets is always equal to the total number of devices. If several tdevices are connected in line-to-line topology, both numbers differ.

Bus structure

E-LAN-L	E-LAN-L	E-LAN-L
<A>	<B>	<C>

Line-to-line structure

L R	L R	L R
<A>	<B>	<C>

COM-3 status

SETUP -6-
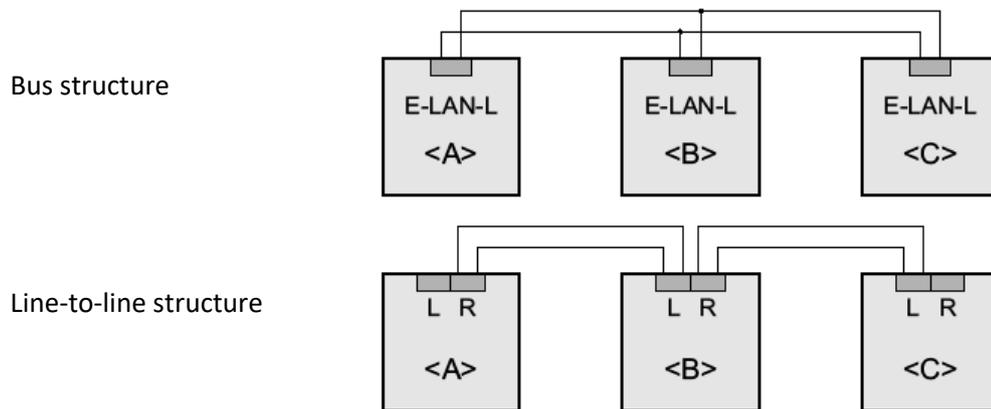
Status

COM-3 status
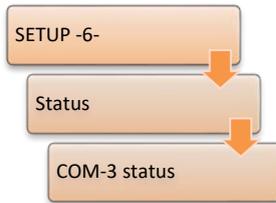
Here the devices connected to the COM3 bus of the REG-DA are displayed, such as ANA-Ds and BIN-Ds.

The address and the type of available devices can be found in the table at the bottom of the screen. With the F5 key you can scroll to addresses 11 to 15. The F4 key allows access to the monitor settings of the COM3 interface.

Time/date

SETUP -6-
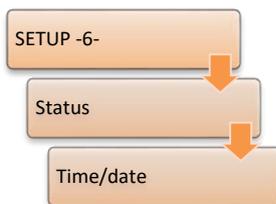
Status

Time/date

Pressing of the right arrow key once more leads to the time/date status menu. Here are shown the current time, date, the set time zone (here: UTC+1) and the summer time (DST) if used are shown.

```
C:REG-D(A)    07:49:23

    ← TIME/DATE →

        12:15:27
        17.11.2015
        UTC+1


        ——————COM1——————
▪DCF TIME:    UTC+1
 12:15:27 17.11.15
▪LAST UPDATE:
 12:15:00 17.11.15
```

If the time of the REG-DA is synchronised via a DCF signal, the status of the DCF signal is also displayed here. Hereby are displayed the source of the DCF signal (TBUS, COM1, COM2), the time, date, and time zone of the DCF signal and the time of the last adjustment of the REG-DA time.

If the DCF signal fails, the DCF time signal is displayed in brackets and the duration of the dropout is displayed in square brackets instead of the time zone. If there is no DCF signal for more than two minutes, the time/date menu changes back to the view without DCF status.

H/P/Q programs

SETUP -6-

Status
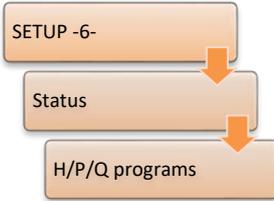
H/P/Q programs

Pressing of the right arrow key once again leads to the H/P/Q program menu. Here the background program of the REG-DA is shown. With the F2 ... 5 keys you can scroll right and left, and, up and down, respectively.

```
C:REG-D(A)      03:39:04

 ← H/P/Q PROGRAMS →

■H-PROGRAMS                 ≫
 CycleTime=0.715s           ≫
H 0='# 119.2100.001         ─
H 1='AnaFU 5+6=1,An         ≪
H 2='1,iff, b47=0.5         ≪
H 3='1,iff,menu.aPPn        ─
H 4='1,iff,menu.aPPn        ≫
H 5='b53,b52,-,0,ma         ≫
H 6='b59,b60,!=,b63         ─
H 7='24000,b58,/,du         ≽
H 8='Ana- 6,duP,b56         ≽
H 9='b46,b57,!=,if,         ─
```

Error status

SETUP -6-

Status
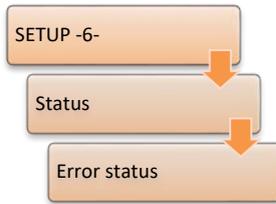
Error status

Pressing of the right arrow key once again leads to the error status menu. Here the errors of the device, the analog channels and the background program are shown.

The following error displays are possible:

Device errors	Description
EEPROM-A error	EEPROM REG-CPU error
EEPROM-B error	EEPROM REG-NETZ error
User error A	Test of the status relay with the command statrel*=0
Internal batt. error	Battery empty
COM3 comm. error	Communication error on the COM3 interface
LAN comm. error	Bus/communications error in H program, e.g. addressed station ID does not exist
LAN/L error	Physical (hardware) error on E-LAN L, e.g. wire missing, missing terminating resistors, address collisions (duplicate station IDs)
LAN/R error	Physical (hardware) error on E-LAN R, e.g. wire missing, missing terminating resistors, address collisions (duplicate station IDs)
LON error	Error during communication via LON protocol

Analog channel error
Communication error
Wire break
Configuration error

Error in H-program
General error
Syntax error
Error: Not enough parameters
Error: Too many parameters
Error: Illegal argument range
Error: Number too large
Error: Division by zero
Error: Too many program interlaces
Error: Too many IF/ELSE interlaces
Error: Too many FOR program interlaces
Error: ALL interlaces not possible
Error: Function not available
Error: Beyond Index range
Error: Assignment not possible
Error: Incorrect time/date statement
Error: Extension not useable
Error: Search term not found
Internal error
Error: Only useable in background programs
No access right
Error: Input line too long
Error: ID incorrect
Error: ECS-LAN user unkown
Error: Timeout
Access denied

6.4 Password protection

SETUP -6-

General -3-
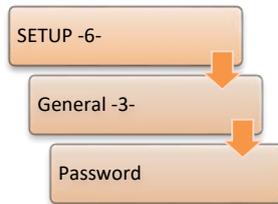
Password

The REG-DA has a password protection feature that prevents altering setup values (parameters) using the keys on the device. Measurement values and parameters can be seen with the active password protection.

A total of five different users are available: Each user has a six digit password. Each digit of the password can have a value between 1 and 5 (1, 2, 3, 4, 5).

When a user logs on the device it is recorded in the logbook.

```
C:REG-D(A)     03:42:19
    NEW                User 1    ◄ F1
 PASSWORD
  Entry              User 2    ◄ F2
 ========
    1.                 User 3    ◄ F3
  Select
 the User              User 4    ◄ F4

                       User 5    ◄ F5
```
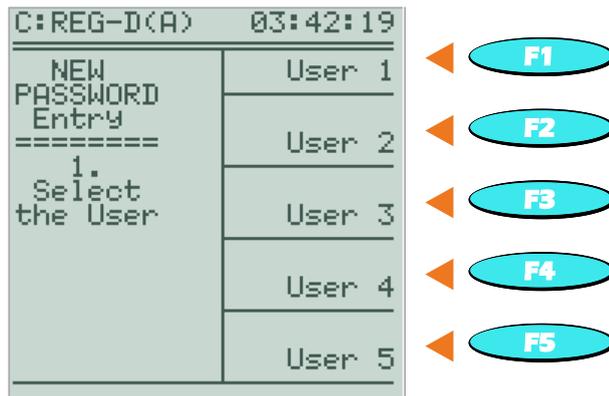
Enabling password protection and setting a password

The password protection is activated as soon as a password is assigned to user 1 (master). Other users are also activated by assigning a password to the corresponding user. When assigning a password it has to be entered twice for security reasons. This is done through two successive input dialogs.

Changing a user password

To change a user password, the corresponding user or user 1 must log in first. After logging in, the user whose password is to be changed can do so by using the keys F1 to F5. Subsequently, the new password is set by double entry.

ℹ️ **Changing passwords**

User 1 can change all passwords (but not see them). All other users can only change their own password.

Disabling password protection or deleting passwords for users 2 ... 5

The password protection is disabled when the password of user 1 is set to "111111". If the passwords of users 2 ... 5 is set to "111111", the password or the corresponding user is deleted. In both cases, user 1 must be logged in to perform the deletion.

Password query (login)

A password query is performed automatically as soon as a password-protected parameter adjustment, or a password protection change, is to be performed. After the selection of a user (only users for which a password has already been assigned can be selected) and entering the correct password, the new value of the parameter is set and the system remains open for five minutes. If any inputs occur during this time, the open time is five minutes. This means that throughout this period further parameter modifications can be performed without re-entering the password. If the REG-DA has no operation performed on for more than five minutes, the system is closed and the user gets logged out automatically.

Instant activation of password protection

Normally, password protection is first activated five minutes after the last operation of the REG-DA. Pressing the "◀" key (left arrow) in the password request menu (SETUP-6-\General -3-\Password) enables password protection immediately.

Deleting the password of user 1

If the password of user 1 is deleted by entering "111111", the entire password protection of the device is disabled. Any existing passwords of users 2 ... 5 are retained. If a password for user 1 is set again, users 2 ... 5 will still be present with their previous passwords.

Forgotten passwords

If you have forgotten the password for the REG-DA, it is possible to disable password protection by entering a device-specific code. For this purpose, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Password protection of COM interfaces

The REG-DA also has the possibility to protect the COM interfaces with a password. Password protection of COM interfaces can be activated and managed e.g. through the service program of WinREG (versions later than 3.9.6). Here there are six users (user 1 (administrator) + users 2 ... 5, + guest) whose permissions can be customized in five stages (no permissions, local read, local read/write, local read/write and E-LAN read, local and E-LAN read/write).

7. Installation and commissioning

7.1 Hardware and connection

7.1.1 System design and description

The REG-DA voltage regulator has a steel sheet housing suitable for wall, panel and DIN rail mounting. The device is mounted with the, partially optional, mounting material that corresponds to each of the mounting methods. Despite the standard housing, the terminal assignment of the REG-DA can vary depending on the selected options. We recommend using the device-specific current and/or terminal diagrams for the wiring. The terminal assignment for the most frequently used versions can also be taken from the folder that is stored in the door of the REG-DA or the technical data (in the Appendix Chapter 20). If you need the device-specific circuit diagrams, please contact the REGSys™ Support (regsys-support@a-eberle.de, +49(0)911/628108-101).

The configuration of the REG-DA is clearly identified by a building code number (item number, for example, 119.2067.002). This number describes the device's hardware and the software and is on the type plate that is mounted on the side and the back of the housing.

The device's unique serial number (e.g., M16115521) is also on the type plate. The serial number can also be found under 'Setup 6-\Status\REG-D Status(1)' in the S/N row. The type plate also contains important technical data such as the auxiliary and control voltage ranges and the configuration (characteristics).

SETUP -6-

Status

REG-D Status (1)

Made in Germany **www.a-eberle.de**	
Typ: REG-DA Nr.: M16115521	Serial number
Art.- Nr. 119.2067.002	Item number
Software - Version: 2.23	Firmware version on delivery

B0 Panel-mounting or wall-mounting version
    (H x W x D) 307 x 250 x 102 mm
I0 Serial Interface COM1 Sub-D
H0 Power supply external max. 33 VA
    AC 85V...110V...264V, 50...60 Hz
    DC 88V...220V... 280V
F1 Input current (rated value) Ir = 1 A
M1 Three-wire three-phase; balanced load

S0 without Recorder function
T1 with Transformer monitoring
K1 with firmware for parallel operation
E91 one PT 100 input

D0 16 digital inputs AC/DC 48 V...250 V (E1...E16)

C00 without additional inputs and outputs

R1 with Interface RS485 (COM 3)
    Integrated Protocol Interface according to:
XW00   without

L1 for connection of one REG-DA only
V11 Copper conductors, two wire operation only
Z20 DNP 3.00
A2 Display language English

Order codes, including technical data

7.1.2 Installation/removal

7.1.2.1 Wall mounting

The supplied wall mounting kit must first be installed on the back of the unit. Use the four countersunk head screws included in the delivery to screw the two fastening rails to the threaded bushes in the back of the REG-DA. If the four side mounting holes of the rails are used for wall mounting, both mounting rails can also be mounted with the upper and lower flaps pointing inwards (see broken line illustration). This reduces the mounting height and the rails do not protrude at the top and the bottom.

The whole unit must be fastened to/on a stable mounting surface with suitable mounting material (screws, dowels, etc.).

Surface /wall mounting
Rear view

mounting rails
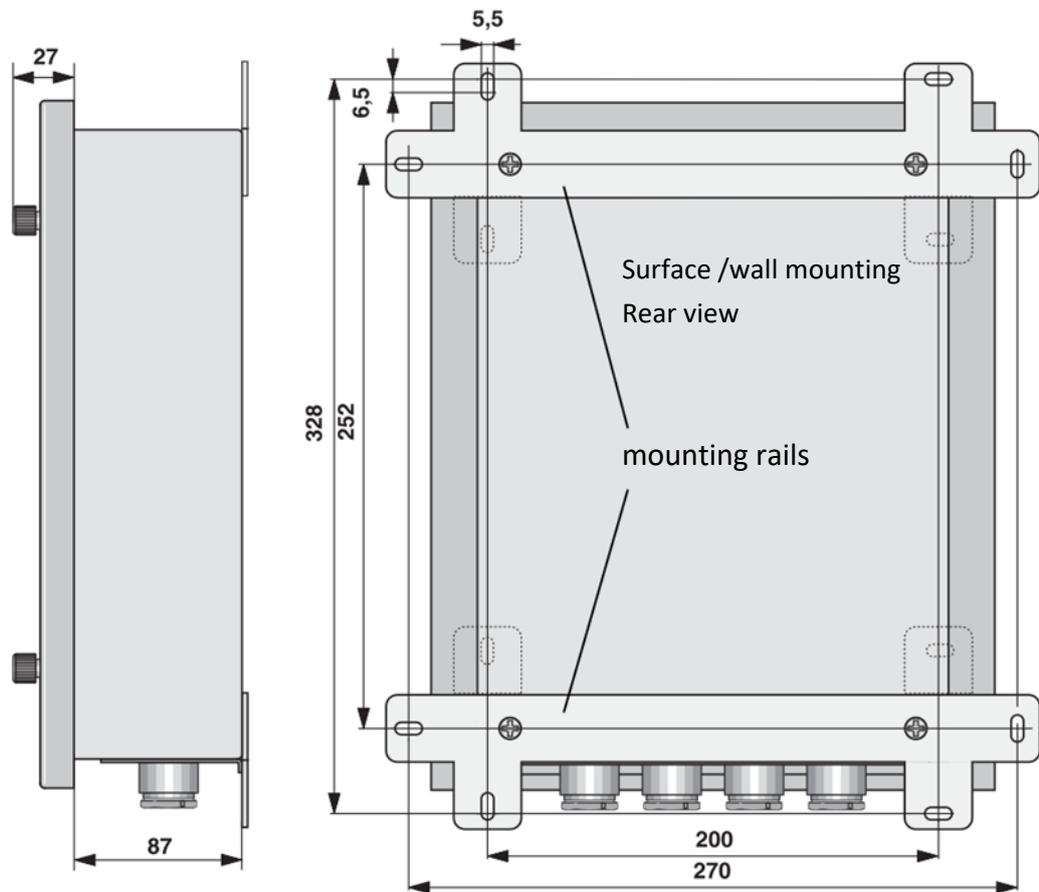
All Dimensions in mm

7.1.2.2 Panel mounting

After the cutout has been made in the mounting panel, the four grub screws (1) must first be screwed into the back of the housing. The device is then pushed through the cutout and fastened with the two clamping brackets (2). This is done by pushing the clamping brackets onto the grub screws and fastening them with the enclosed nuts (3).

For easier assembly, remove the flange plate with the PG threaded connections and insert the REG-DA into the cutout (see Chapter 7.1.2.4).
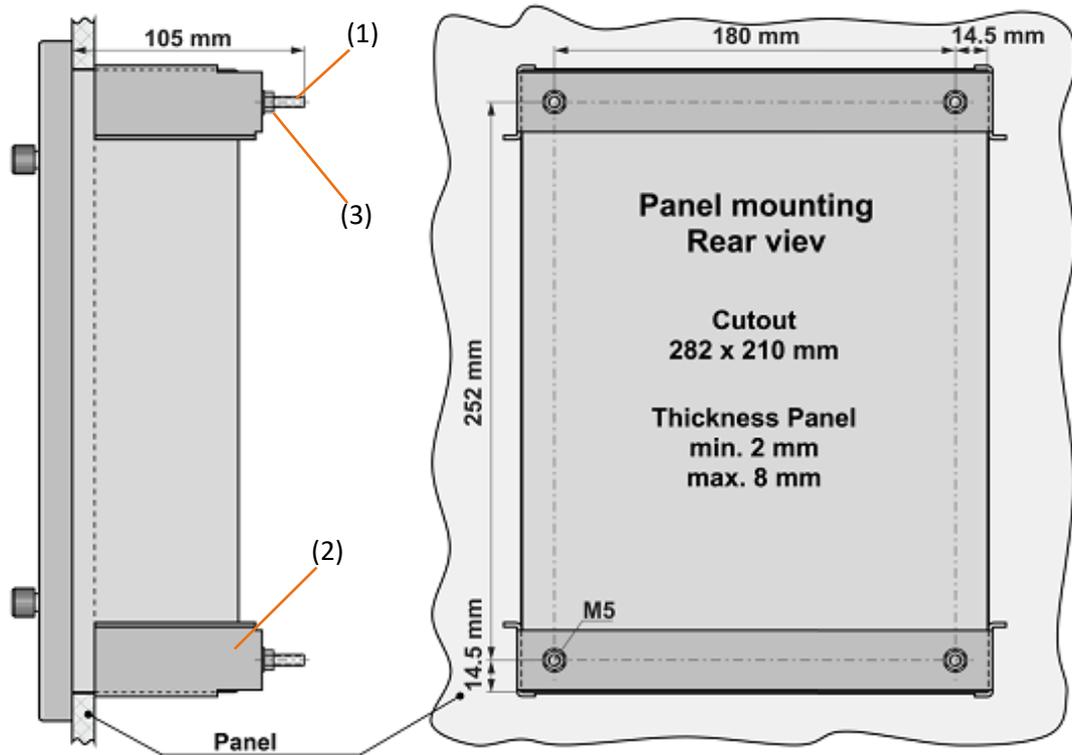
7.1.2.3 DIN-rail mounting (characteristic B1)

The REG-DA is mounted on two 35 mm DIN rails (TS 35) in accordance with EN 50022 by an adapter plate that is fastened to the back of the REG-DA housing. This DIN rail adapter is included with the REG-DA if characteristic B1 was selected.

The DIN rail adapter is fastened with four screws (1) that are supplied with the adapter. To install the REG-DA on the DIN rails, place the adapter's two hooks (2) in the upper DIN rail. Press the REG-DA against the bottom rail until the fastening (3) latches into place.
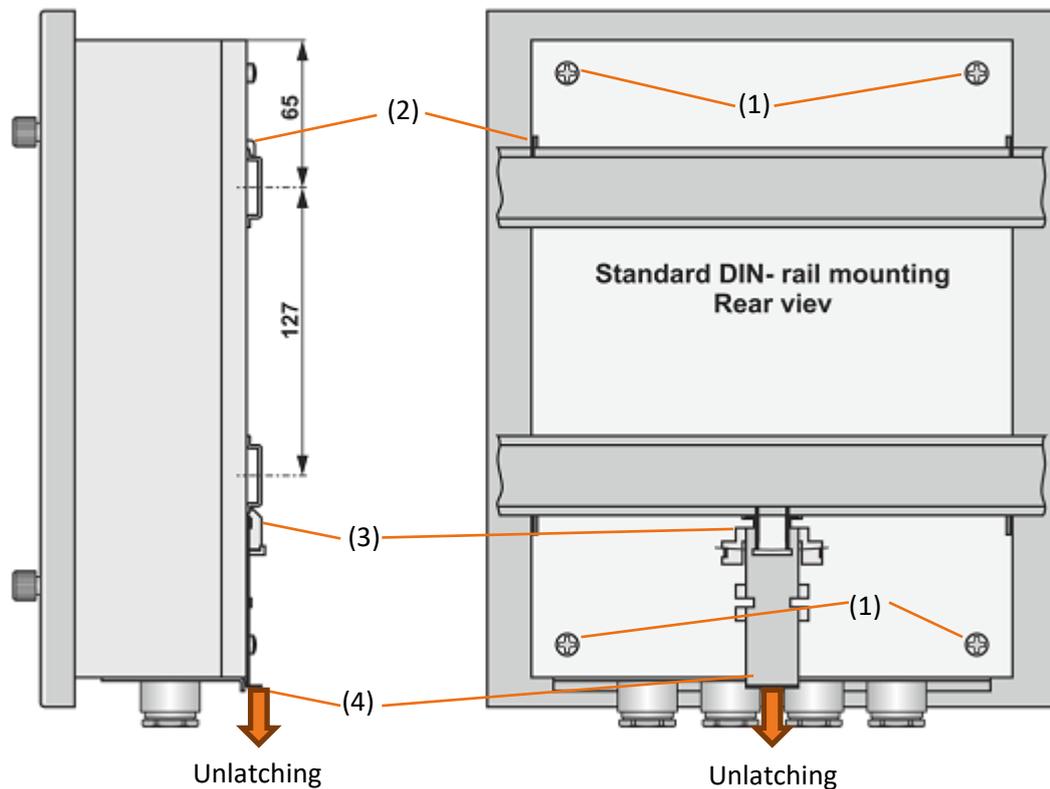
All Dimensions in mm

To remove the REG-DA from the DIN rail, loosen the latch on the lower DIN rail by pulling the locking lever (4) downwards, and pulling the REG-DA slightly forward. The REG-DA can then be removed from the upper brackets.

7.1.2.4   Flange plate

Based on the version, the flange plate on underside of the REG-DA accommodates cable glands to feed in cables and connections for fibre optical cables. The flange plate can be removed to simplify the installation or in the event of a fault. In the event of a failure, this makes it easier to remove the REG-DA because the connectors in the REG-DA do not have to be removed from the cables.

Flange plate with fibre optic connections

To remove the flange plate, loosen the four hex screws (1) that fasten the flange plate to the housing. The right hex key (3 mm) is part of the REG-DA's delivery scope and usually stored inside the terminal compartment cover. After the screws have been loosened, the flange plate can be moved to the left and the screw heads can be threaded out (2). The screws do not have to be fully removed. The flange plate and the cables, if they have already been installed, and the REG-DA's connectors can now be removed by pulling them downward. Connections that do not have a connector (e.g., measuring connections) must be disconnected. The cables can stay in the flange plate.

In the event of a failure, the REG-DA can now be easily replaced by a replacement device.

Panel mounting

To facilitate the installation of the REG-DA in a control panel, the flange plate can be removed and re-installed into the opening after fitting the REG-DA into place.

7.1.2.5 Brush sealing

On, REG-DA devices without fittings in the flange plate, the flange plate can be replaced with a brush sealing. The brush sealing is part of the REG-DA's standard delivery scope.

To install the brush sealing, first remove the flange plate (see Chapter 7.1.2.4). Then push the two halves of the brush sealing onto the edges of the REG-DA's housing.
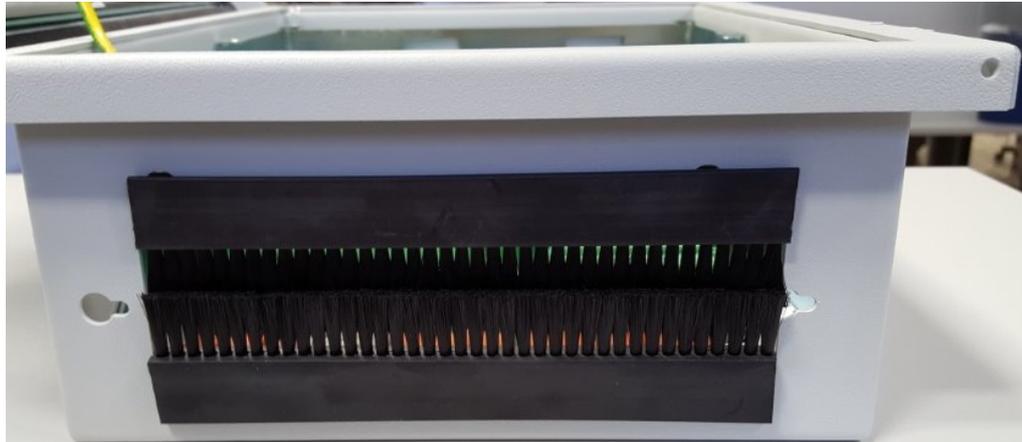
REG-DA with brush sealing

NOTICE!	**Infiltration of moisture and dirt**
	Moisture and dirt can lead to malfunctions or the failure of the device.
	➲ Use the brush sealing only if the REG-DA is not exposed to increased levels of humidity and dirt (e.g. dust). Otherwise, we recommend using the flange plate with the PG threaded connections.

7.1.2.6 Lead sealing

Each regulator can be secured by a password so the parameters cannot be changed.

If you would also like to see whether the regulator has been opened by unauthorized personnel, the REG-DA can also be secured with a lead seal. This is done by pulling safety wire diagonally through the holes in the lower right corner of the housing and securing it with a lead-sealing tool.

Doing this means that the device can only be opened by breaking the wire.

REG-DA with lead seal

7.1.3　Hardware

7.1.3.1　Status contact

The status contact (life contact) is an changeover contact on the REG-DA. This means that the status ok or fault are both available. The status message is output at terminals 54, 55 and 56.

closes
life contact (status)
opens

54 55 56
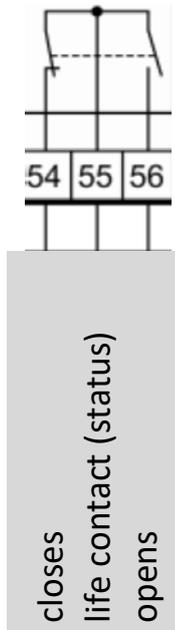
7.1.3.2 Current measurement range

For the REG-DA voltage regulator, the rated current of the current transformer (1/5A) is selected via the software. This means that the hardware does not have to be modified (e.g., jumper does not have to be reconnected).

7.1.3.3 DCF input (TimeBus)

The REG-DA hardware has been equipped with a separate input for connection of a DCF time signal. The input is designed for an RS485 level (5V) and can be wired to several devices as a two-wire bus. This means that multiple REG-DA can be synchronized at the same time from one time source. Time sources can, for example, be a DCF clock, a GPS clock with DCF output, a PQI-D(A) or a REG-PED (NTP to DCF function). The DCF input is only useful with a firmware version V2.22 / V3.22 or later.

If the DCF signal is connected to the DCF input, no further adjustments are necessary.

The status of the DCF signal is shown in the "Setup -6-\Status\Time/Date" menu (Chapter 6.3 page 38).
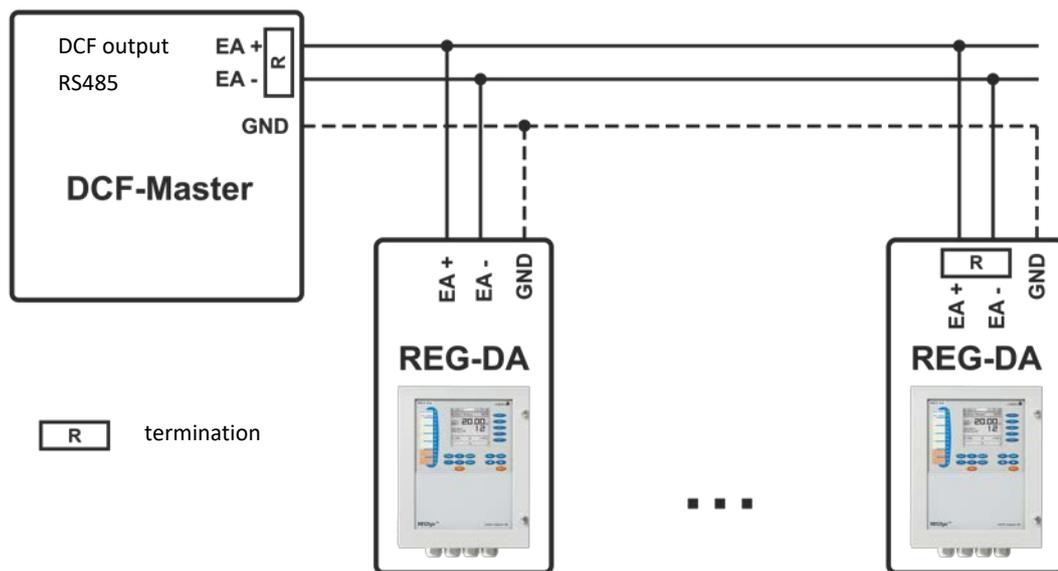
The DCF input has an active termination for the RS-485 bus. It should be connected at the beginning and the end of the RS-485 bus to prevent reflections. The termination is activated through two jumpers. Jumpers (X902, X903) are located under the front panel on the REG-DA's CPU board.

To change the jumpers, loosening the four screws and fold the front panel to the left to remove the front panel. Be careful with the cable to the membrane keyboard. It must not be detached from the connector on the PCB or damaged. Reinstall the front panel after the jumpers have been replaced.
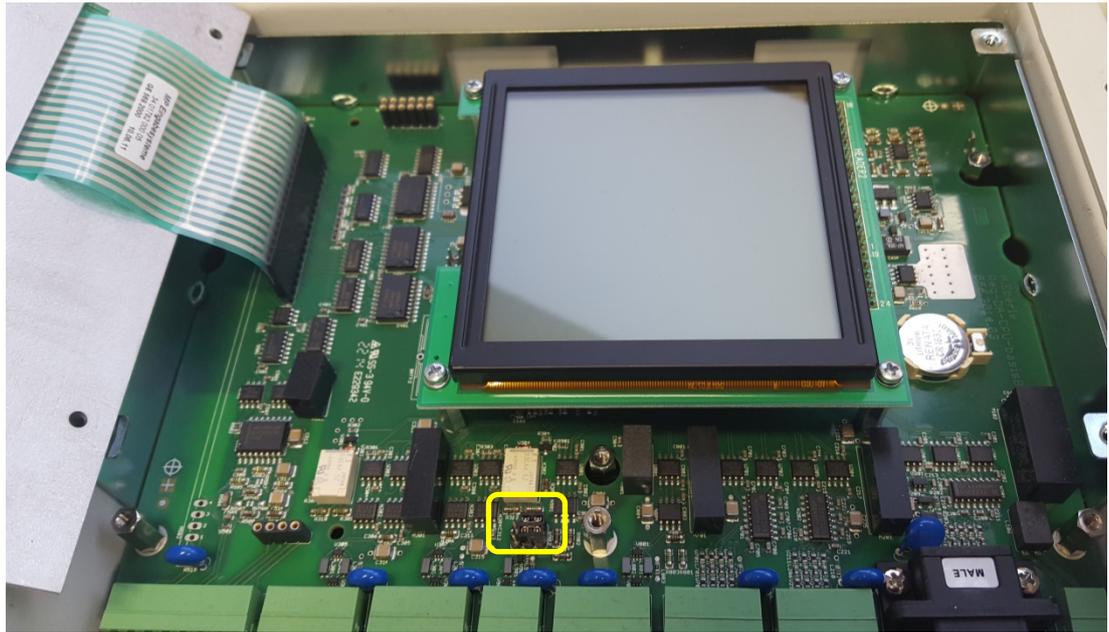
REG-DA with open front panel, DCF jumper position marked

NOTICE!	**Open the front panel with care to avoid malfunctions or damaging the membrane keyboard!**
	Damage to the motherboard, front panel or connection
	⊃ Open the front panel with care.
	⊃ Do not pull on the cable on the front panel

Version with 2-pole jumpers:

Plugged jumpers   -> termination active

Jumpers not plugged   -> termination inactive

DCF termination jumpers, version with 2-pole jumpers

Version with 3-pole jumpers:

Jumper in position A
-> termination active
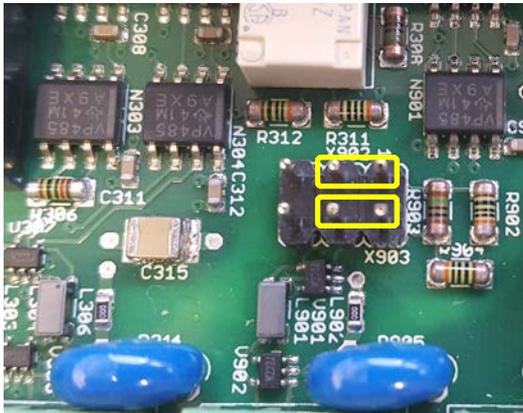
Jumper in position B
-> termination inactive
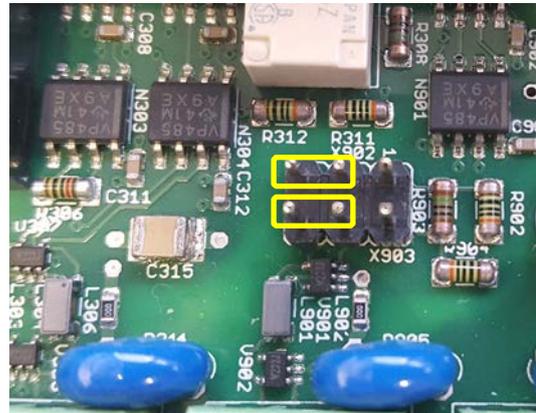
DCF termination jumpers, version with 3-pole jumpers

Jumpers possibly concealed

Depending on the year the REG-DA was manufactured in, the termination jumpers may be concealed by the aluminium strip that runs above the terminals.

➲ Remove the aluminium strip to access the jumpers.

7.1.4   Connection

All versions of the REG-DA have the same terminal assignment for the standard signals (measurement, E-LAN, auxiliary voltage, etc.). In addition to these standard signals, there are also terminals that are assigned based on the configuration. This is why we also recommend using the specific circuit and/or terminal diagrams for external wiring for the REG-DA. The diagrams are delivered with the REG-DA. If you do not have the circuit diagrams, please contact the REGSys™ Support (regsys-support@a-eberle.de, +49(0)911/628108-101).

The wire cross-sections of the different terminal types and the tightening torques can be found in the technical data in the Appendix, Chapter 20.

⚠ WARNING!	**Danger of electric shock!**
	➲ When connecting wires and devices, always follow the five safety rules.
	➲ Carry out connections according to the applicable regulations and this user manual.

⚠ WARNING!	**Incorrect connection!**
	The device and/or the system can be damaged.
	➲ Also use the diagrams that are delivered with the REG-DA when connecting wires or devices.
	➲ Observe the nominal values of the auxiliary and control voltages.
	➲ Make sure communication ports are not exposed to control or auxiliary voltage.

⚠ WARNING!	**Open current transformer!**
	The device and/or the system can be damaged.
	➲ Short-circuit the current transformer(s) before you disconnect the respective connections from the REG-DA!

7.1.4.1 Earthing

The Relay for Voltage Control & Transformer Monitoring REG-DA must always be grounded with a protective conductor. When connected to an auxiliary power supply with a protective conductor this condition is met. When the auxiliary voltage network has no protective conductor, an additional connection must be established from the protective earth terminal to earth.

⚠ **DANGER!**	**Electric shock due to missing ground in case a live conductor touches a housing.**
	There is danger to life.
	➲ Connect the grounding / protective conductor connection of the housing or the rack to the protective earth.

Module rack ground connection

The REG-DA has a connection point for earthing in the terminal compartment. Earthing is achieved through a spade lug (6.3 x 0.8 mm) or a ring lug (included in the delivery).

Earth connection of the REG-DA

7.1.4.2   Auxiliary voltage

The REG-DA is available with different auxiliary voltage ranges. This is specified by the order code H. The REG-DA is internally equipped with a microfuse (5 x 20 mm, slow) for protection against an internal equipment fault. The nominal value (1A or 2A) of the fuse is determined by the auxiliary voltage range (see the table below).

Auxiliary voltage		
Feature	H0	H2
AC (internal)	85 …264 V	-
DC	88 … 280 V	18 … 72 V
AC power consumption	≤ 35 VA	-
DC power consumption	≤ 25 W	≤ 25 W
Frequency	45 … 400Hz	-
Microfuse	T1 250 V	T2 250 V

The auxiliary voltage is connected to terminals 21 (+) and 22 (-).

NOTICE!	**Incorrect auxiliary voltage!** If one applies an excessive auxiliary voltage, the device may be destroyed. At a too low auxiliary voltage or with reversed polarity (feature H2), the device does not power up. ➲ Pay attention to the auxiliary voltage range (type label and technical data in the Appendix, Chapter 20).

Protection of the auxiliary power supply

It is generally recommended that the auxiliary voltage of the voltage regulation system is provided with a fuse. The rated current of the fuse depends on the number and features of the connected devices. Here, in addition to the operating current, the current surge when switching on the auxiliary voltage also determines the choice of the fuse. Therefore, no fuses or circuit breakers with a too low rated current (1/2 A) should be used. In practice, a B10 circuit breaker has proven effective for protecting a single system with a REG-DA at an auxiliary voltage of 230 VAC.

REG-DA power consumption

Test circuit using 325 VD or 72 VD as an example.

Test condition:
C1 is fully charged.
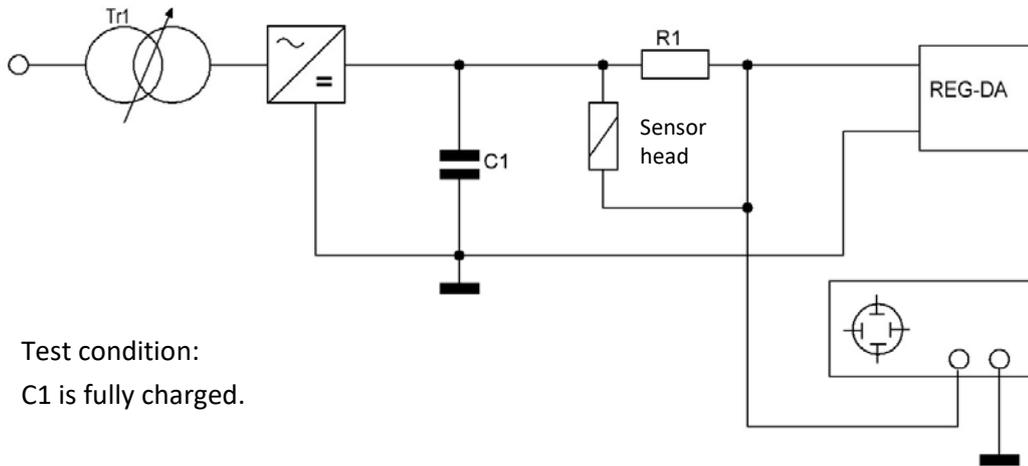
Switch-on spike at 325 V DC
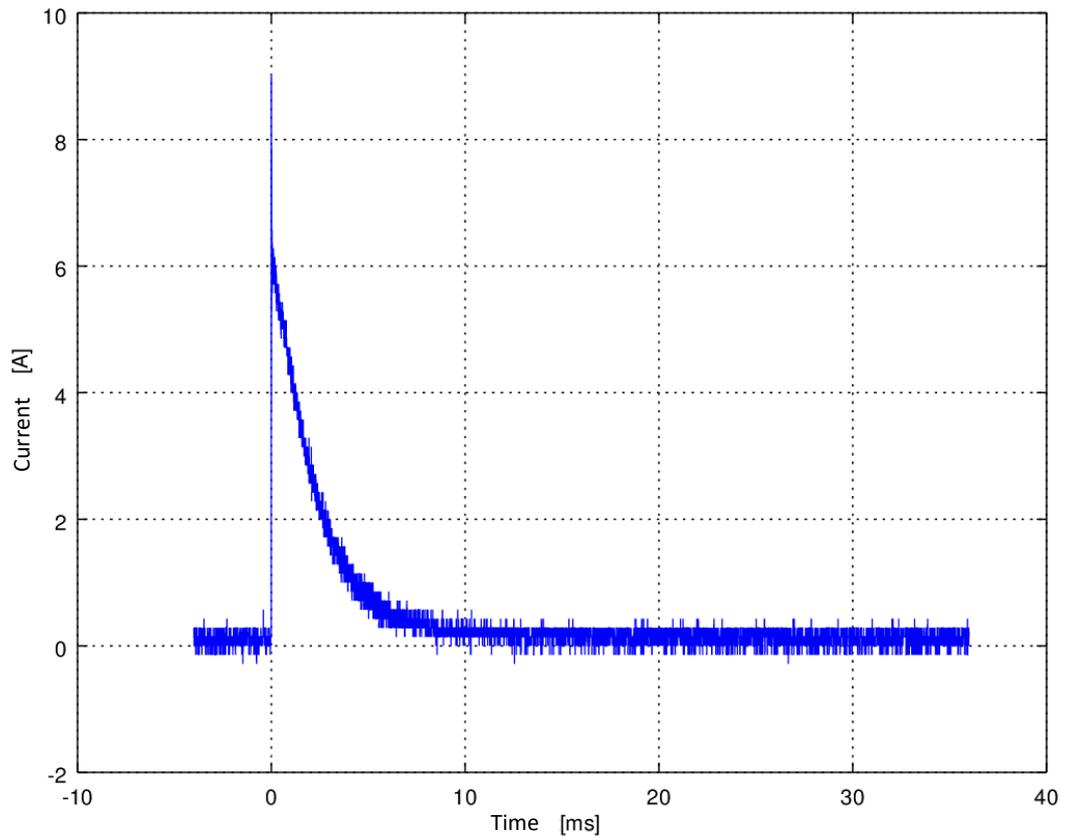
Inrush current for the REG-DA with feature H0

Measurement at	Peak
110 V DC	approx. 3 A
110 V AC	max. 5 A
220 V DC	approx. 6 A
230 V AC	max. 9 A

Values are valid for devices whose power supply components have a room temperature of 20°C.

Switch-on spike at 72 V DC
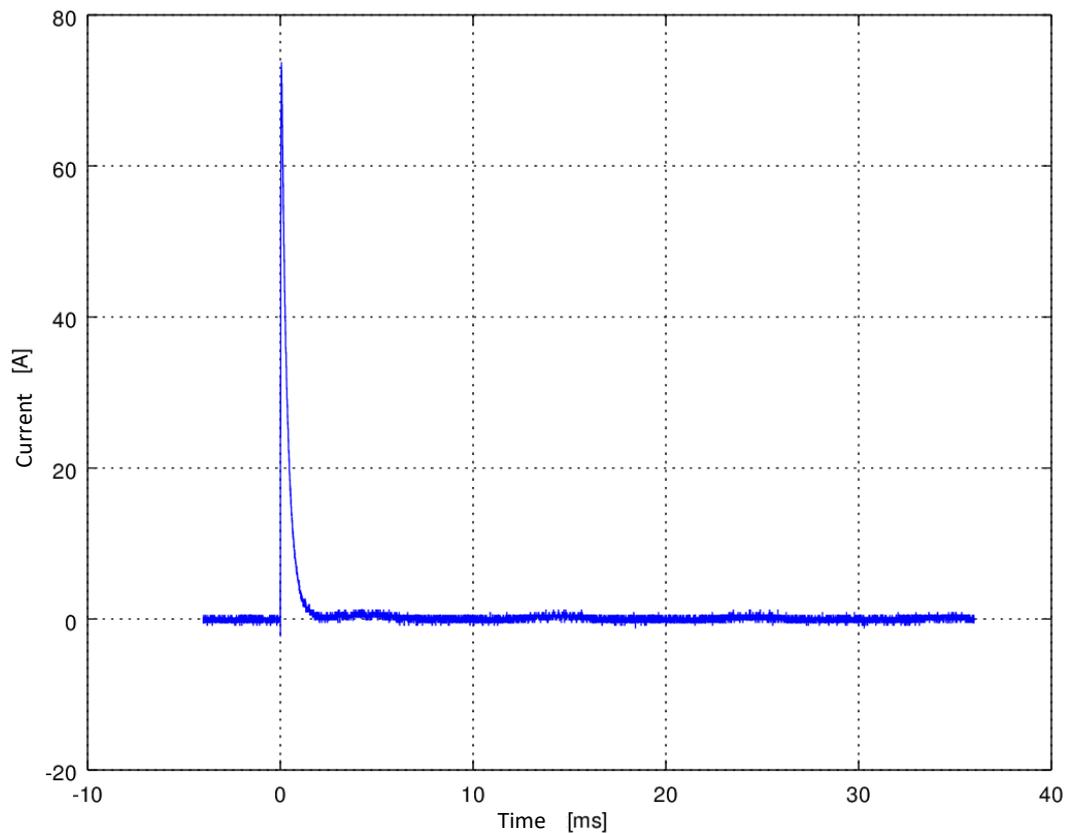
Inrush current for the REG-DA with feature H2

Measurement at	Peak
48 V DC	approx. 50 A
60 V DC	approx. 60 A

Values are valid for devices whose power supply components have a room temperature of 20°C.

7.1.4.3 Binary signals

Binary inputs

The REG-DA can be internally equipped with up to 28 binary inputs. The input cards are available with different voltage levels. The voltage range of the built-in binary inputs can be taken from the circuit diagrams and the type label (features D and C). The terminal numbers for the binary inputs can be found on the circuit diagrams, in the technical data and in the folder that is stored in the door of the REG-DA. The binary inputs on the REG-DA are potential-free binary inputs. This means that they must be triggered by an external control voltage.

U_h
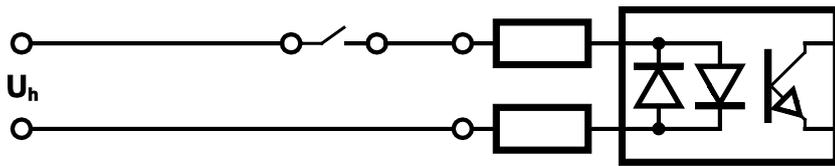
NOTICE!	**Incorrect auxiliary voltage!**
	If one applies an excessive auxiliary voltage, the binary inputs may be destroyed. At a too low control voltage no signal is detected at the inputs.
	➲ Pay attention to the auxiliary voltage range (type label and technical data in the Appendix, Chapter 20).

Binary outputs

The REG-DA can be internally equipped with up to 25 binary outputs (relays). The capacity of the relays can be found on the type plate or in the technical data in the Appendix, Chapter 21. The terminal numbers for the relays can be found on the circuit diagrams, in the technical data and in the folder that is stored in the door of the REG-DA. The relays on the REG-DA are potential-free binary outputs. This means that they must be supplied by an external control voltage.
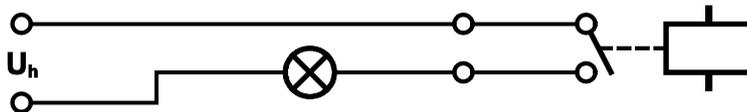
NOTICE!	**Current load on the relay too high**
	The relay could be destroyed if the load is too high.
	➲ Observe the technical data for the relay (type plate and the technical data in the Appendix, Chapter 20).
	➲ Do not switch larger consumers directly through the REG-DA's relays; use coupling relays instead.

NOTICE!	**Switching inductive or capacitive loads**
	Switching inductive or capacitive loads without the appropriate protective measures (series resistors, freewheeling diodes, damping networks, etc.) can destroy the relay.
	➲ Observe the technical data for the relay (type plate and technical data in the Appendix, Chapter 20).
	➲ Use coupling relays equipped with freewheeling diodes or similar protective circuits.

7.1.4.4   Analog signals

The REG-DA can be equipped with analog channels with the following function:

- Analog inputs (-20 … 20 mA, -10 … 10 V)
- Analog outputs (-20 … 20 mA)
- PT100 Temperature measurement
- Resistance measuring device for resistance coded tap position (tap position potentiometer)

Please refer to the circuit diagram or the type plate (features E and C) for the assignment of the REG-DA with analog modules. The terminal numbers for the analog channels can be found on the circuit diagrams, in the technical data and in part in the folder that is stored in the door of the REG-DA.

Analog inputs and outputs (features E92..99, C90+96…99, standard mA input)

The analog inputs are available as mA or low voltage inputs (10 V). The analog outputs are available as mA outputs.
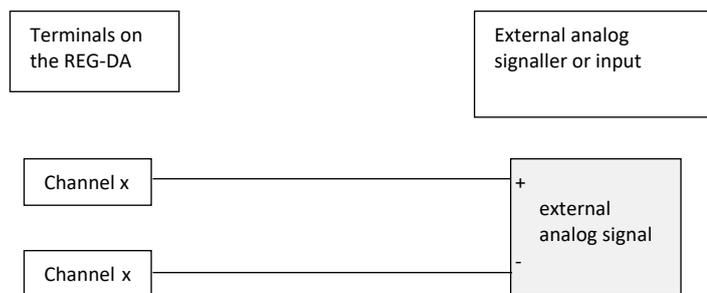
PT100 temperature measurement for features E91, E94, E99

The REG-DA's PT100 module for features E91, E94 and E99 is on Level III (CPU board). It can only be connected to the PT100 resistor in a three-wire circuit.
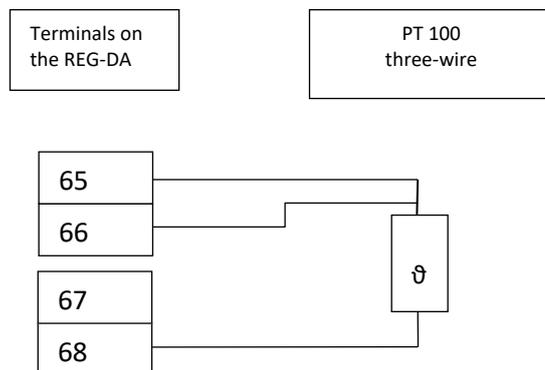
The maximum resistance of the wires may not exceed 10 Ω per wire. Because of the three-wire circuit, the outgoing and return lines must have the same length.

PT100 temperature measurement for features C90

The REG-DA's PT100 module for feature C90 is on Level II (middle PCB). It can be connected to the PT100 resistor in a three or four-wire circuit. The device is delivered standard with a three-wire circuit.

Terminals on the REG-DA	PT 100 three-wire	PT 100 four-wire

Ik+

Ue+

Ue-

Ik-
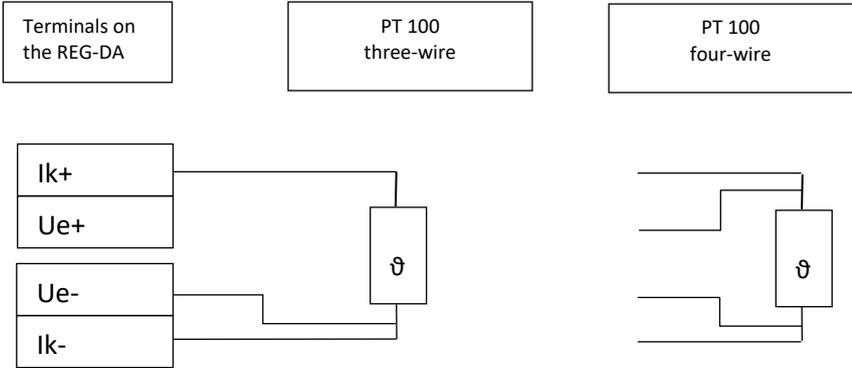
The maximum supply resistance may not exceed 10 Ω per wire.

The switch between three-wire and four-wire circuits is performed by jumpers X102 and X103 on the PT100 temperature measurement module.

3-wire

4-wire
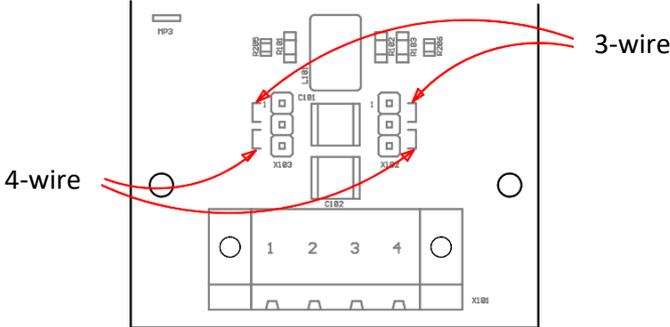
Resistance measuring input for the tap position indicator (tap position potentiometer)

Only one end of the resistor string and the slider are used to measure resistance. The other end remains free. The end of the resistor chain must be chosen such that the resistance between the end and the slider is zero Ω at the lowest tap position (tap 1).

Terminals on the REG-DA feature E/D	Resistance string three-wire	Resistance string four-wire

67 / 25 (Ue-)

65 / 24 (Ue+)

67 / 25 (Ue-)

68 / 26 (Ik-)
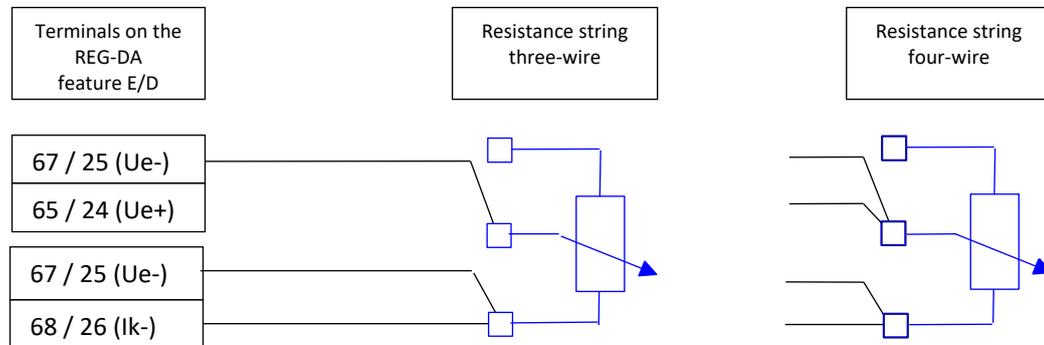
Selecting a three-wire or four-wire circuit
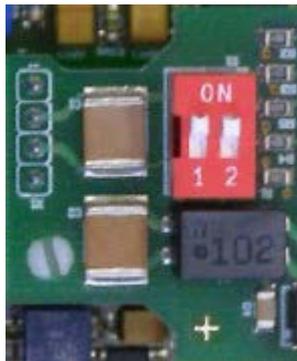
The three-wire or four-wire circuit is selected through two DIP switches on the resistor input module (feature E97/98) or next to terminal 23 (feature D2/3/5/6/8).

The three-wire circuit is preset when the device leaves the factory unless otherwise specified on the order.

Terminal type	Connection 1	Connection 2
Three-wire connection	ON	ON
Four-wire connection	OFF	OFF

The supply resistance of the wires may not exceed 20 Ω per wire.

7.1.4.5 Overview of the hardware configuration for the digital inputs and outputs

The REG-DA has a number of input and output options. The below table provides an overview of the different options. Only one option can be selected at a time!

Quantity, Item / Site, Terminals	One analog input	One analog output	Two analog inputs	Two analog outputs	PT100 Temp. measurement	Resistance measurement for tap position	Binary inputs 1..8	8 binary inputs (BI 9..16)	6 binary inputs	13 binary outputs	6 binary outputs	SCADA connection
ANA 1, 63, 64	STD											
ANA 2, 61, 62	E	E										
ANA 3+4 65, 66, 67, 68			E	E	E	E						
Level I 11 … 20							STD					
Level I 23 … 32							D		D			
Level I 33 … 60										STD		
Level II Slot 1			C	C	C				C		C	
Level II Slot 2			C	C	C				C		C	
Level II Slot 3			C	C	C				C		C	XW, L
Level II Slot 4			C	C	C				C		C	XW, L

STD: Standard configuration, always available
E, D, C: Characteristic for this option
ANA x: Analog channel x
Level II Slot x: Level II has four slots for extension modules. The counting starts left with slot 1 and ends right with slot 4. The SCADA connection always uses two slots and is assigned by default to slots 3 and 4. The integrated monitoring function (feature C10) also uses two slots and is assigned by default to slots 1 and 2.

Slot 1   Slot 2   Slot 3   Slot 4
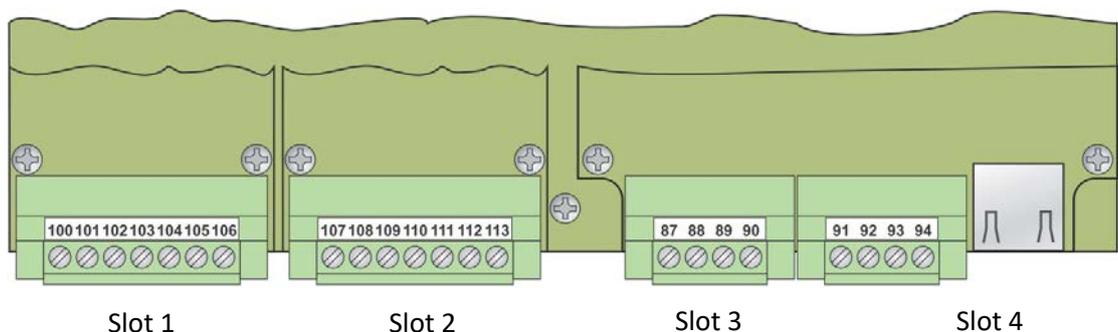
Level II with feature C92 and XW91

7.1.4.6 Process

The connection of the process (transducer, tap changer, etc.) can be done in many different ways. In the following, a simplified diagram of the signals is shown.

ℹ️ Connecting the current and voltage transformers

Any phase to earth or phase to plane voltage can be supplied to the REG-DA for regulating. The current can also be taken from any phase. In order for the phase relationships (phase shift between voltage and current) and thus the power calculation and the load flow direction to be correct, the voltages and currents used have to be set in the VT/CT configuration. In addition, on connecting the transducer ensure that the polarity is correct.

➲ Pay attention to the nominal values of the voltage and current inputs.

➲ Note the A. Eberle definition of power directions (see figure below).

➲ On connecting, note the polarity of the transducer (see figure below).
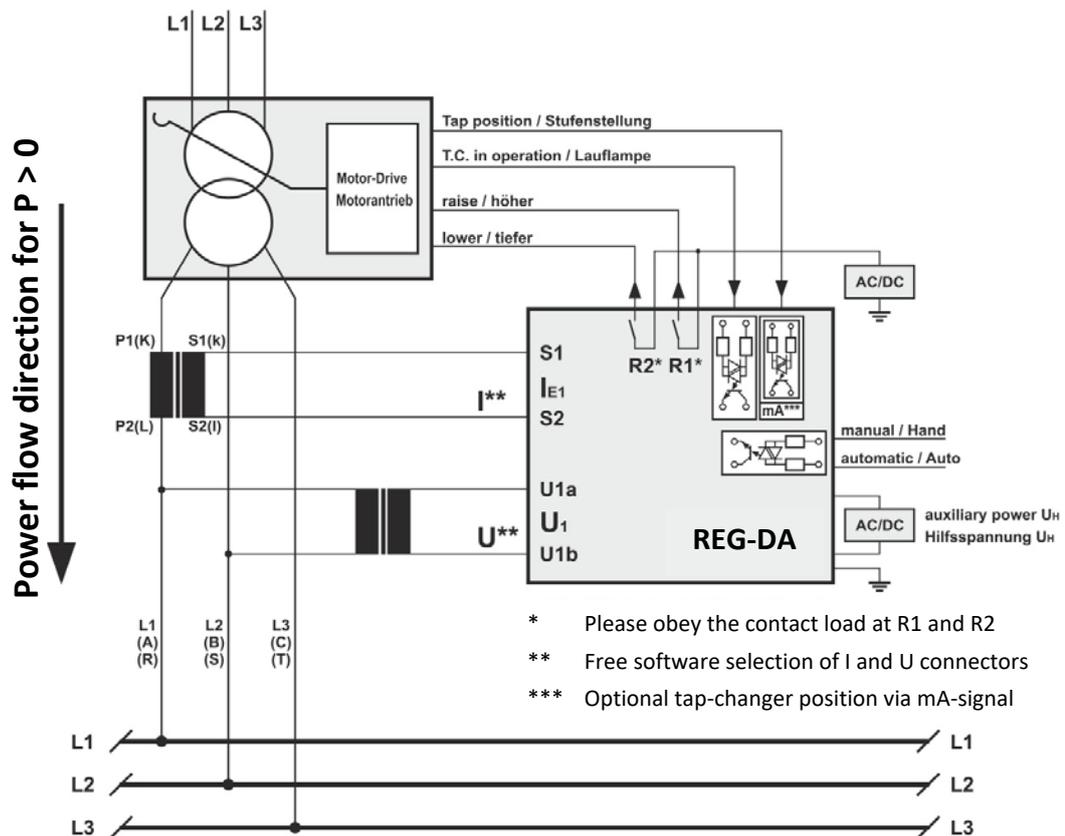
Power flow direction for P > 0

L1 L2 L3	Tap position / Stufenstellung
	T.C. in operation / Lauflampe
Motor-Drive Motorantrieb	raise / höher
	lower / tiefer

* Please obey the contact load at R1 and R2
** Free software selection of I and U connectors
*** Optional tap-changer position via mA-signal

⚠️ WARNING!	Open current transformer!
	The device and/or the system can be damaged.
	➲ Short-circuit the current transformer shortly before you disconnect the respective connections from the REG-DA!

Connecting current and voltage measurement feature M1

(symmetrically loaded three-phase network)

I1 S1   U1a   I1 S2   U1b
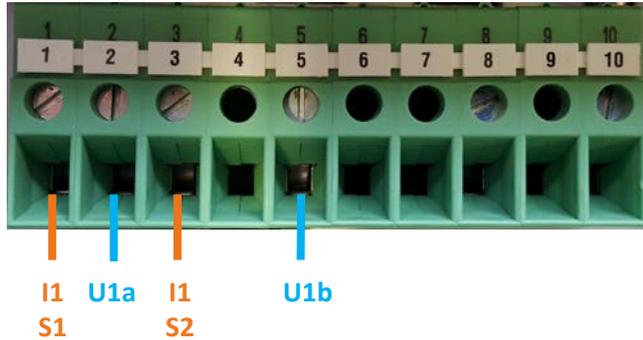
Connecting current and voltage measurement feature M2

(symmetrically loaded three-phase network, ARON circuit)

I_{L1} S1 U_{L1} I_{L1} S2 I_{L3} S1 U_{L2} I_{L3} S2 U_{L3}
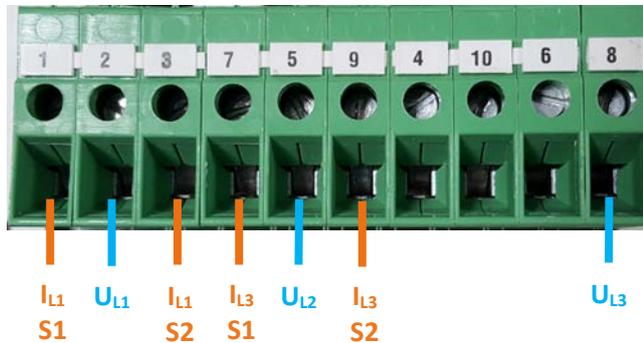
Connecting current and voltage measurement feature M3

(voltage measurement (high voltage), current and voltage measurement (low voltage)

I1 S1   U1a   I1 S2   U1b   U2a   U2b
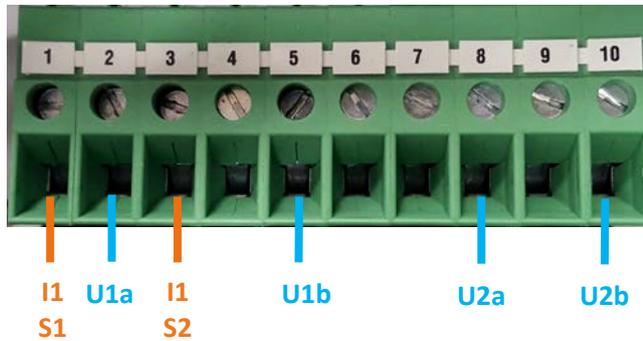
Connecting current and voltage measurement feature M9

(other transformer applications (2 x I, 2 x U, e.g., Three winding transformer)

I1 S1   U1a   I1 S2   I2 S1   U1b   I2 S2   U2a   U2b

7.1.4.7   E-LAN

Characteristics

● Multimaster system architecture, (i.e., each station has access to all data of remote stations).

● Max. 255 stations per network, 16 per segment (bus).

● Addressing needs to be unique, whereby the addresses of A:, A1:, ..., A9:, B:, B1:, to Z4: can be assigned.

● PAN-Ds automatically get the address, whereby the PAN-D address is always one higher than the address of the REG-D(A).
Example:
The address of REG-D(A) is N1: → the PAN-D automatically gets the address N2:

● The connection between REG-D(A) and PAN-D is exclusive (no other devices in this segment or bus).

● Physical interface RS 485

● Free choice of topology without additional devices

● Bus structure (two-wire) with terminating resistors at the bus ends

● Line-to-line structure (two-wire or four-wire) between segments of an open ring, suitable for boosters and FO connection.

● Mix of bus and line structure

● Star connection (with E-LAN router)

● Unused E-LAN interfaces have to be terminated.

Bus

Open ring

Star

■   Terminated
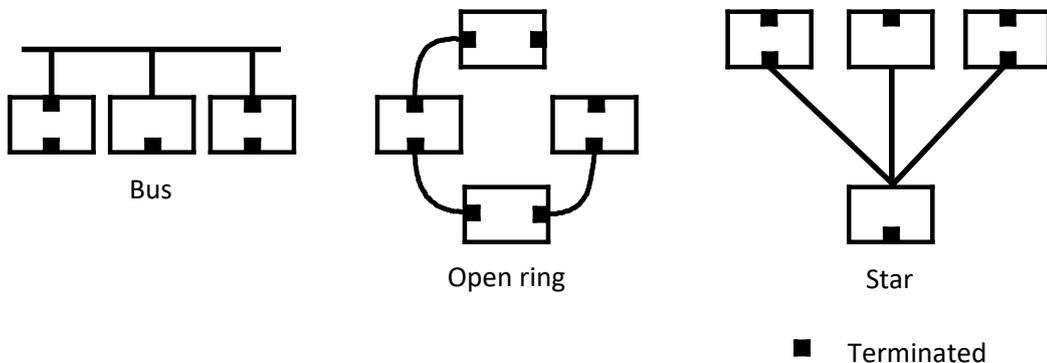
Configuration	Connection	Max. wire length
REG-DA —— REG-DA	two-wire, direct	400 m
REG-DA ⊤ REG-DA REG-DA	two-wire, bus (max. 16 devices)	100 m branch line 10 m
REG-DA —— REG-DA	four-wire, direct	1200 m
REG-DA ▬ Booster ▬ Booster ▬ REG-DA	Four-wire, two boosters	4000 m

Recommended cable type: e.g. 2 x 2 x 0.6 … 0.8 mm², twisted pair

The use of non-twisted control wires may also be possible for short distances. This needs to be checked in each case.

Use of the E-LAN GND

The E-LAN GND terminal is not an earth ground, but a terminal for a potential equalization wire, which is connected to all the GND terminals of the connected E-LAN interfaces.

The potential equalization wire is additionally led to the twisted pair and may be low-resistance grounded at only one point. This is only a functional earth!

With a bundled installation with disturbing wires, an additional shield may be required. This may only be low-resistance grounded at one point.

Grounding at other points via resistors ≥ 100 Ω is allowed, but not necessary.

Connection example for E-LAN: 3 x REG-DA in two-wire bus topology

Terminated
Not terminated
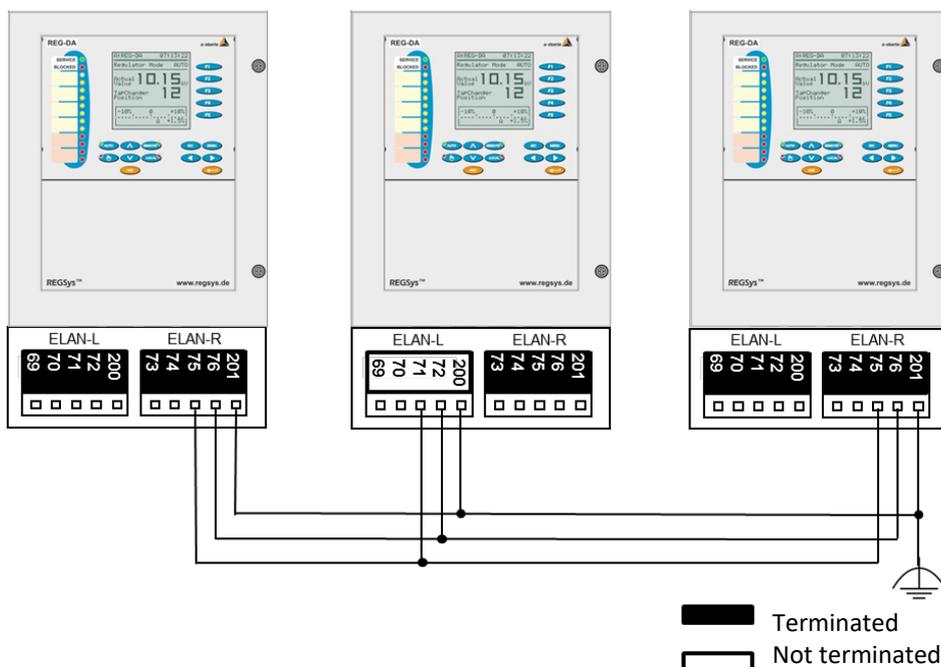
Connection example for E-LAN: 3 x REG-DA with two-wire and four-wire point-to-point connection

Terminated
Not terminated
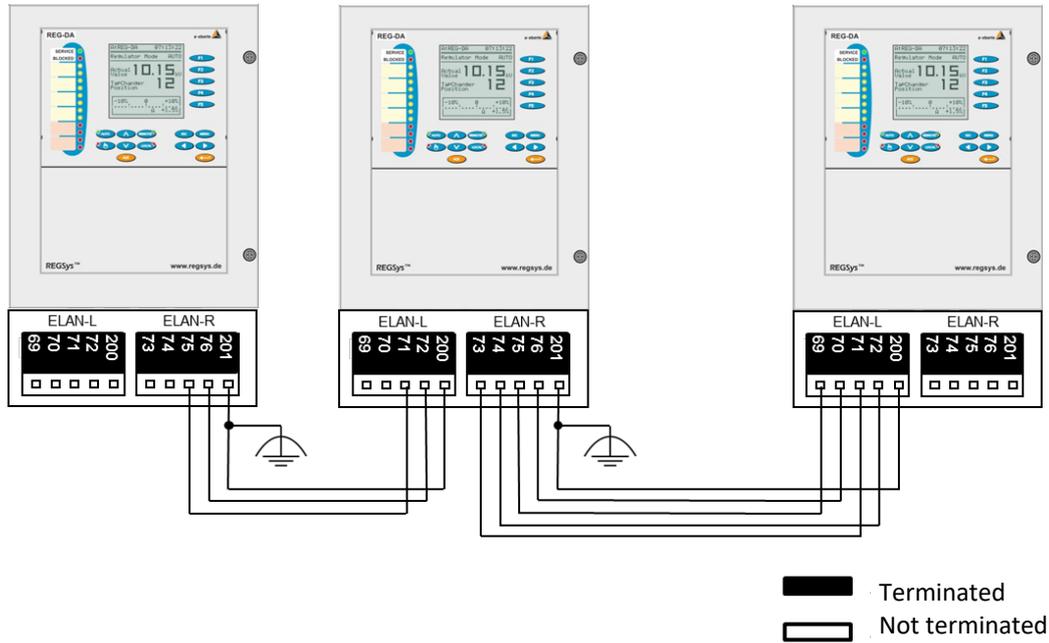
Connection example E-LAN: complex network

Two-wire bus
with GND

two-wire
point-to-point
(exclusive connection
between REG-D™
and the associated
PAN-D)

two-wire
point-to-point

four-wire
point-to-point

Terminated
Not terminated
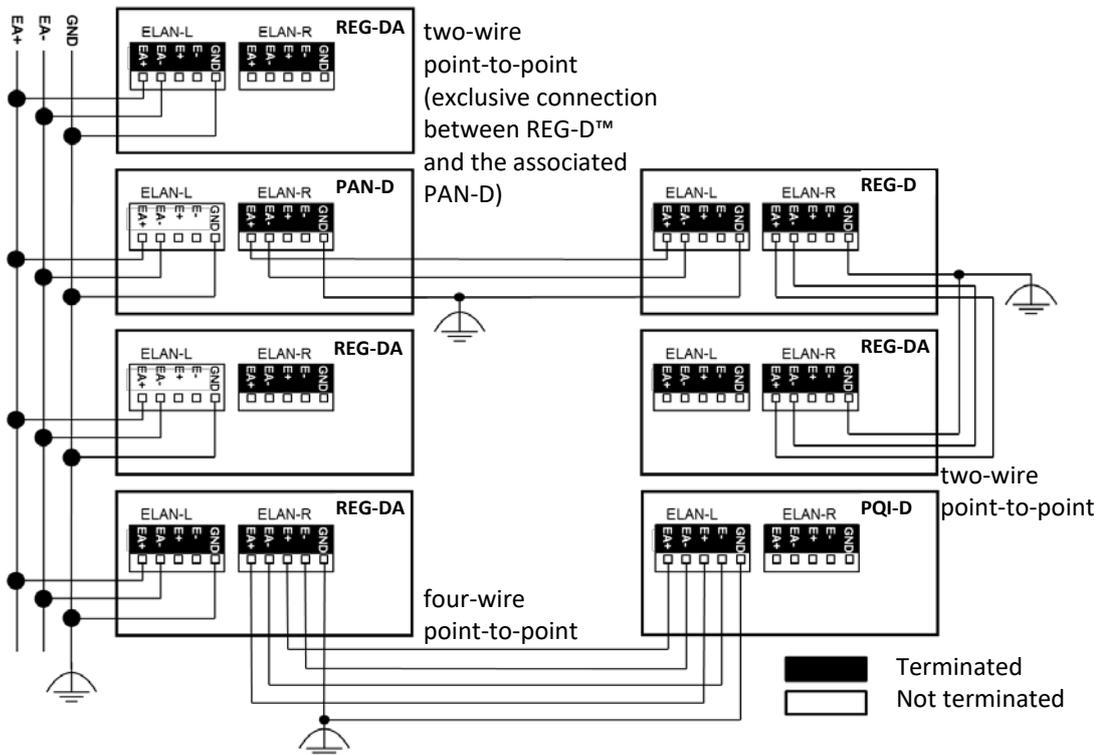
E-LAN router and booster
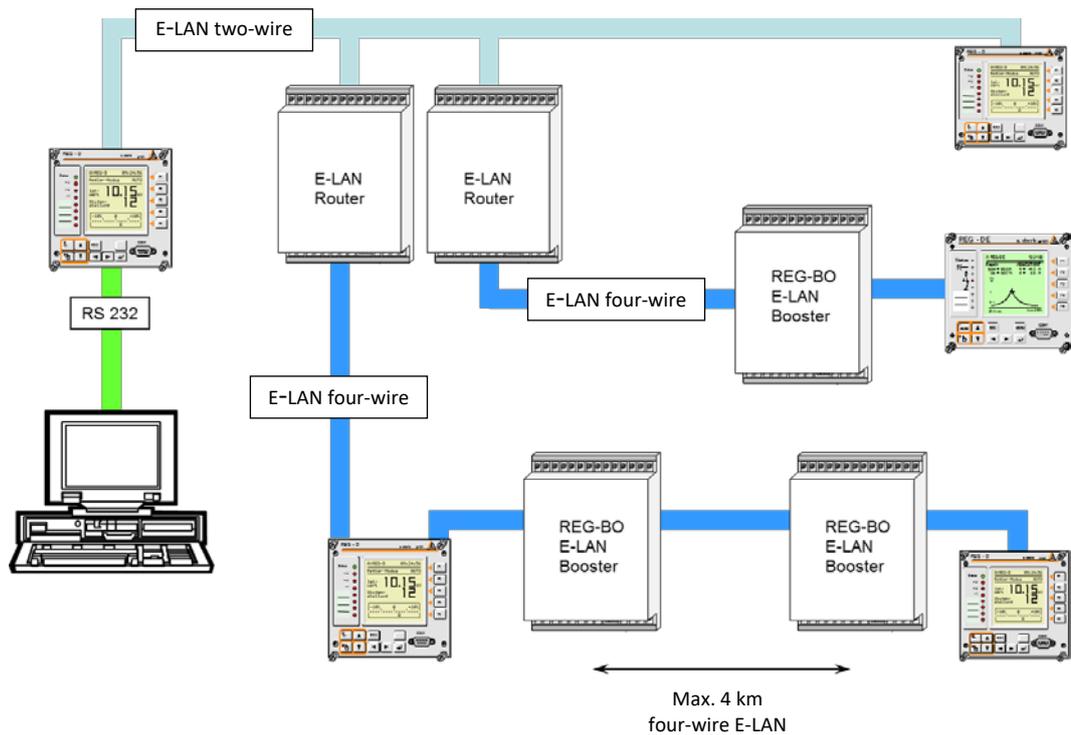
Using other media for the E-LAN

For spanning over longer distances, e.g. between two substations:
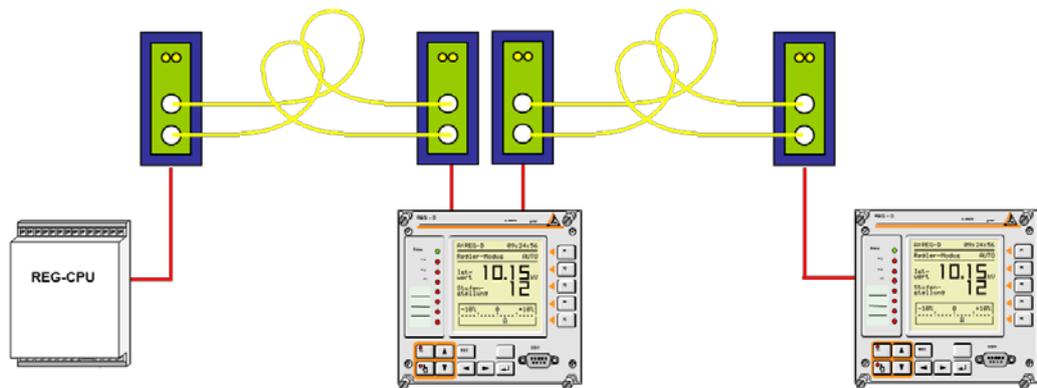
- Integration of fibre optic connections in the E-LAN
- Connection of a fibre optic coupler – REGSys™ device via four-wire bus

alternative:

- Use of ComServers to rerout/redirect the E-LAN via TCP/IP Ethernet

7.1.4.8 COM3 port

The REG-DA COM3 interface is used to connect expansion modules that provide additional inputs and outputs, and is specified via the order code R. The COM3 is operated in master-slave mode. That means, there is a master device (REG-DA) and up to 16 slave devices (ANA-D, BIN-D, COM3/MODBUS converter).

By default, there is a COM3 physically connected to an RS 422 interface using the four-wire- technology, which means that there are separate lines for transmitting and receiving. On request, the COM3 can also be implemented with fibre optic connection. For this purpose, a fibre optic module is installed in the housing. With this topology, a mix between RS 485 and fibre optics can be used. The fibre optic variant makes sense if certain COM3 components are to be placed in a separate housing.
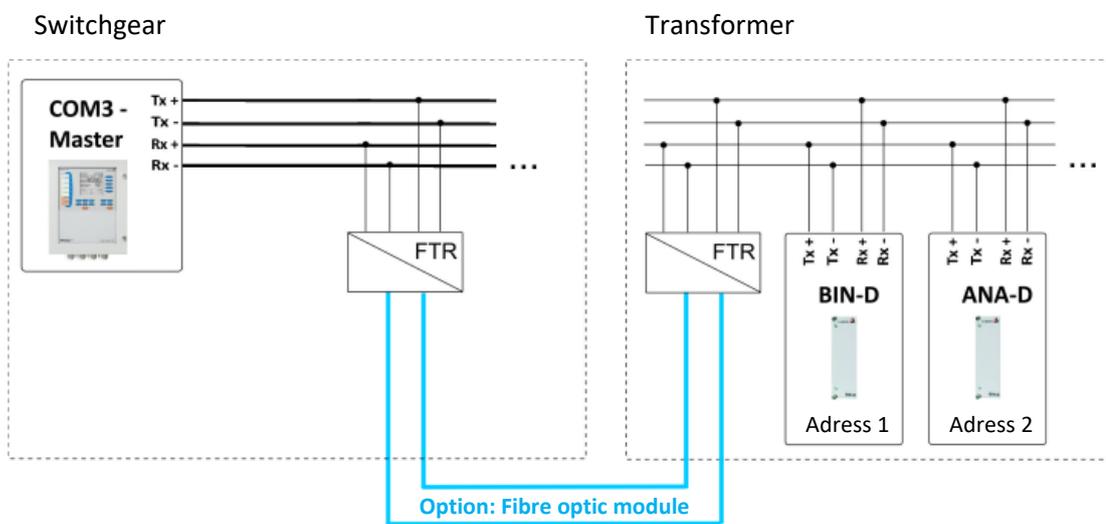
Line lengths:

RS-422   ≤ 1 km

FO: ≤ 2 km

Recommended cable type:

e.g. 2 x 2 x 0.6…0.8 mm^2, twisted pair

The use of non-twisted control wires may also be possible for short distances. This needs to checked in each case.

In a bundled wire installation, an additional shield may be required. This may only be low-resistance grounded at one point.

The COM3 interface requires no external termination resistors.

Connection:

Example for a REG-DA with a BIN-D and an ANA-D module
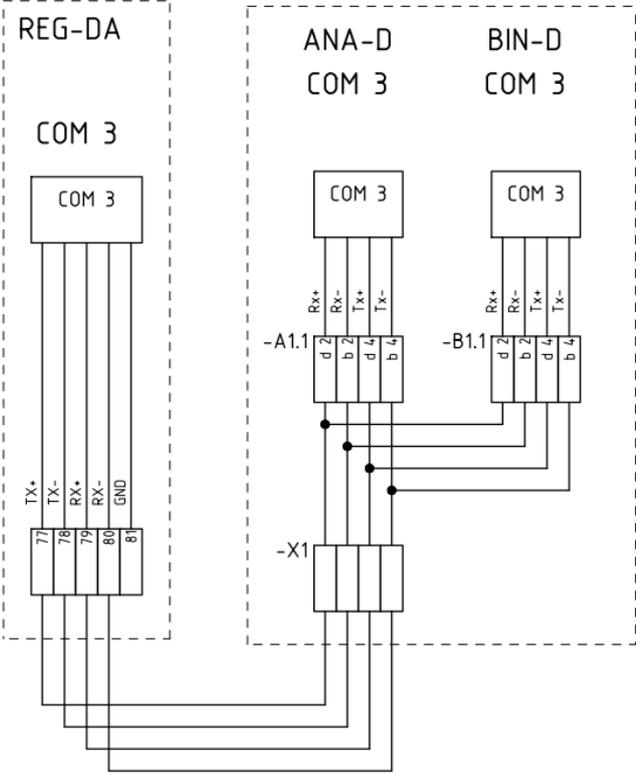
For general information about using the COM3 port and the usable modules, refer to Chapter 9.1.1 from page 290 onwards.

The allocation and use of COM3 resources in REG-DA are explained in Chapter 8.2.6 from page 228 onwards.

7.2 Setup

7.2.1 Update bootloader and firmware

Below the update of the bootloader , the firmware and online help for the REG-DA using the REGUpdate program will be explained in detail. For a successful update, a connection cable (null-modem cable with pin assignment as shown on page 84 or, with order code I1, a mini USB cable) and the PC software REGUpdate (update32.exe) are required.

Firmware package

The current firmware including the current bootloader and the necessary PC software REGUpdate (update32.exe) can be found as "firmware packages" on our website http://www.a-eberle.de under "Downloads / Voltage Regulation & Transformer–Monitoring /Firmware / Current firmware". A change history for the REGSys™ firmware since version V1.99 and a firmware archive is also available from the Download Centre.

⚠ CAUTION!	No control function during bootloader mode
	As long as the regulator is in bootloader mode, which is mandatory for an update, all functions including the control functions of the REG-DA are not available.

Connection

For an update of the bootloader, the firmware or the online help the REG-DA has always to be connected directly to the PC. This means that update over an E-LAN connection is not possible.

Update of the bootloader

SETUP -6-

Status (1)

Press F1 for 5 seconds
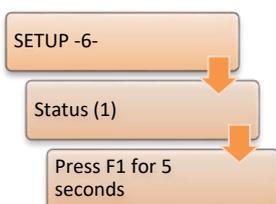
The bootloader is required to perform updates. For a bootloader or firmware update one must always switch to the bootloader mode. Since bootloader version V2.12 there is also the possibility of carrying out a RAM-Backup using the bootloader (see also Chapter 7.2.6 from page 121 onwards). To see the current version of the bootloader, you need to press F1 for 5 seconds in "Setup -6-\Status\".

When is a bootloader update required?

It is recommended to update the bootloader only if it is really necessary. For example, if the RAM-Backup functionality needs to be used, a bootloader >= version V2.12 must be loaded, if it is not already present.

NOTICE!	Downgrading the bootloader
	Never perform a downgrade of the bootloader (e.g. V2.12 to V2.10). The regulator can be permanently damaged by doing so.

To update the bootloader the following steps are necessary:

1.) With the null-modem cable connect the regulator via COM1 to a free COM interface on the PC. If the REG-DA is equipped with a USB interface instead of a SUB-D socket, connect COM1 to the PC via the USB cable.

2.) Starting the PC software

Use the program REGUpdate (update32.exe) under any of the operating systems Windows 95/98/NT/XP/7/8 or 10.

2.1 Select the language

2.2 Select the appropriate COM interface on your PC

2.3 Select the connected device (here: REG-DA)

3.) Loading the new bootloader

In the program REGUpdate under "Update / new Bootloader", select file boot_xxx.mot and click on Open. There is an indication that the bootloader needs to be started via "Setup -6- /Status/" pressing F1 for 5 seconds.
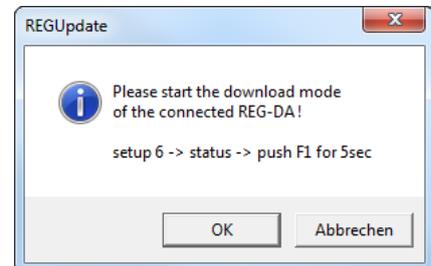
The REG-DA bootloader has its own interface settings. These are visible after starting the bootloader. The baudrate can be set using the F3 key. The settings for flow control (handshake) and parity cannot be selected.

Parameter	Value
Baudrate	115200 (selectable)
Parity	--
Handshake	RTS/CTS

The interfaces (baudrate) must be the same on the PC and the regulator for a successful communication to take place! Compare the settings on the regulator with the settings in the update tool under the menu item: "Configuration/Baudrate".

After starting the bootloader on REG-DA and checking the baudrate, you download the new bootloader by clicking on OK button in the dialog.

A progress bar appears indicating the status of the loading process.

4.) The update has been executed correctly when the following message appears:
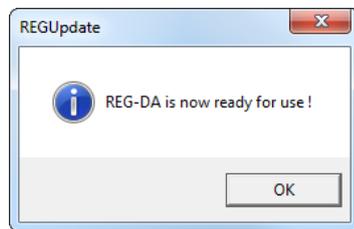
Updating firmware

To update the firmware of the REG-DA the following steps are necessary:

1.) With the null-modem cable connect the regulator via COM1 to a free COM interface on the PC. If the REG-DA is equipped with a USB interface instead of a SUB-D socket, connect COM1 to the PC via the USB cable.

2.) Starting the PC software

Use the program REGUpdate (update32.exe) under any of the operating systems Windows 95/98/NT/XP/7/8 or 10.

2.1 Select the language

2.2 Select the appropriate COM interface on your PC

2.3 Select the connected device (here: REG-DA)

3.) Loading the new firmware

In the program REGUpdate, under "Update / new Firmware", select the file for your firmware and click on "Open".

Bootloader version	Firmware file name
< V2.00	hr_xxx.moc
>= V2.00	hr_xxx_p.moc

There is an indication that the bootloader needs to be started via "Setup -6-/Status/" pressing F1 for 5 seconds.

REGUpdate

Please start the download mode of the connected REG-DA !

setup 6 -> status -> push F1 for 5sec

OK   Abbrechen
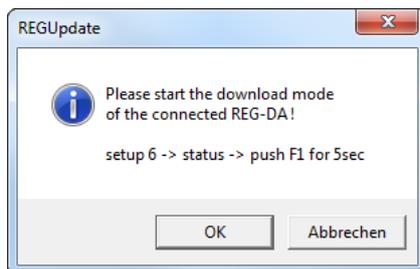
The REG-DA bootloader has its own interface parameters. These are visible after starting the bootloader. The baudrate can be set using the F3 key. The settings for flow control (handshake) and parity cannot be selected.

Parameter	Value
Baudrate	115200 (selectable)
Parity	--
Handshake	RTS/CTS

The interfaces (baudrate) needs to be the same on the PC and the regulator! Compare the settings on the regulator with the settings in the update tool under the menu item: "Configuration/Baudrate".

After starting the bootloader on the REG-DA and checking the baudrate, you can download the new firmware by clicking on the OK button in the dialog. A progress bar appears indicating the status of the loading process.

4.) The update has been executed correctly when the following message appears.

REGUpdate

REG-DA is now ready for use !

OK
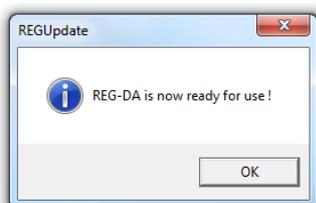
Important notes after an upgrade or downgrade of the REG-DA firmware

1.) After upgrading the firmware of the REG-DA (e.g. V2.10 → V2.20) any pre-existing RAM-Backup should be replaced by a new RAM-Backup. The reason for this is that new parameters that have been added to a recent firmware do not yet exist in the old RAM-Backup. If a RAM-Backup of a lower firmware version is restored, new parameters are initialized with default values.

2.) After a downgrade of the firmware of REG-DA (e.g. V2.22 → V2.15) it is essential to take the following steps:

   a.) The device must be re-initialized (see "Resetting all parameters via the bootloader" in Chapter 7.2.6 RAM backup, from page 125 onwards)

   b.) An existing RAM-Backup must be performed again (see "Performing RAM-Backup" in Chapter 7.2.6 RAM backup, from page 121 onwards), or deleted (see 'Deleting an existing backup file' in Chapter 7.2.6 RAM backup, from page 124 onwards).

Updating online help

To update the online help of the REG-DA the following steps are necessary:

1.) With the null-modem cable connect the regulator via COM1 to a free COM interface on the PC. If the REG-DA is equipped with a USB interface instead of a SUB-D socket, connect COM1 to the PC via the USB cable.

2.) Starting the PC software

Use the program REGUpdate (update32.exe) under any of the operating systems Windows 95/98/NT/XP/7/8 or 10.

2.1 Select the language

2.2 Select the appropriate COM interface on your PC.

2.3 Select the connected device (here: REG-DA)

3.) Downloading the new online help

In the program REGUpdate, under "Update / new Helptext", select the help file for your bootloader and click on Open.

Bootloader version	Help text file name
< V2.00	help_xxx.moc
>= V2.00	help_xxx_p.moc

There is an indication that the bootloader needs to be started via "Setup -6-/Status/" by pressing F1 for 5 seconds.
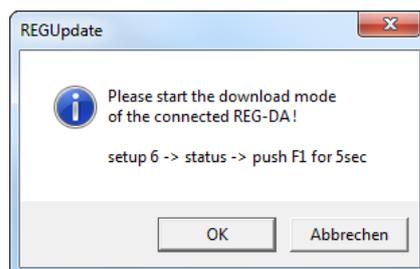
The REG-DA bootloader has its own interface parameters. These are visible after starting the bootloader. The baudrate can be set using the F3 key. The settings for flow control (handshake) and parity cannot be selected.

Parameter	Value
Baudrate	115200 (selectable)
Parity	--
Handshake	RTS/CTS

The interfaces (baudrate) have to be the same on the PC and the regulator! Compare the settings on the regulator with the settings in the update tool under the menu item: "Configuration/Baudrate".

After starting the bootloader on the REG-DA and checking the baudrate, you can download the new help text file by clicking on the OK button in the dialog. A progress bar appears indicating the status of the loading process.

4.) The update has been executed correctly when the following message appears.
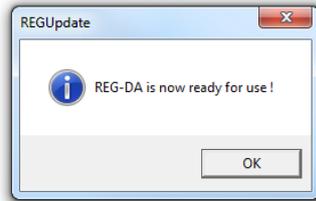
Via the menu item "Update everything" in the Update menu, it is possible to simultaneously start updating the firmware and the help texts. The updates are then successively carried out.

Connection diagram for the null-modem cable

9-pin Sub-D connector   9-pin Sub-D connector
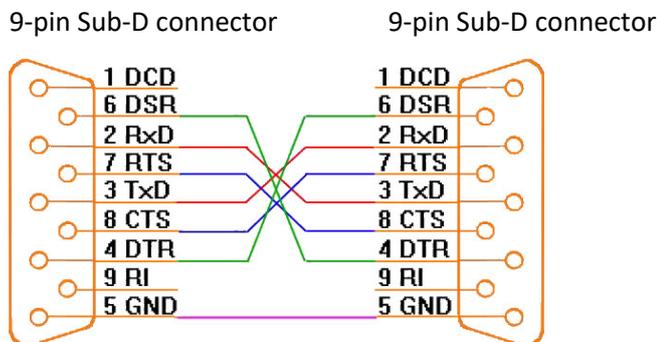
7.2.2   Basic parameter setup

7.2.2.1   System

Menu structure of REG-DA

When powering up, the regulator starts in one of the basic regulator modes.
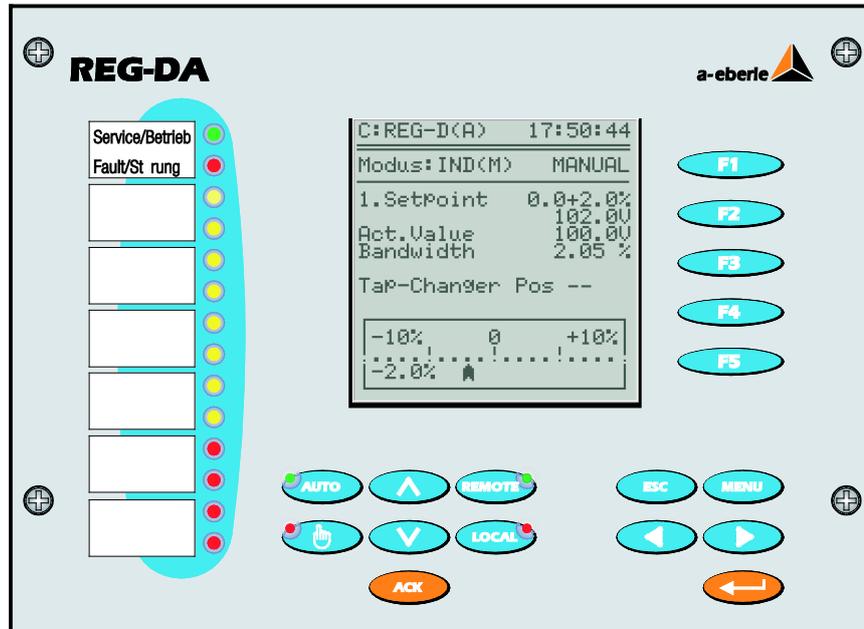
Repeatedly pressing the MENU key leads to the following submenus:

In addition to the MENU key you can also use the arrow keys to move within the menu structure. Using the ESC key you move back to the previous screen without saving changes made to date. The ENTER key is used to confirm entries and save changes.

The modes available in MENU 1 and MENU 2 (regulator, transducer mode, recorder, statistics/monitor, PQIView and logbook) each present a basic display mode, accessed via the keys F1 ... F5. When you select one of these modes, the corresponding screen is displayed permanently and can only be changed by changing the selection in MENU 1 or MENU 2 again.
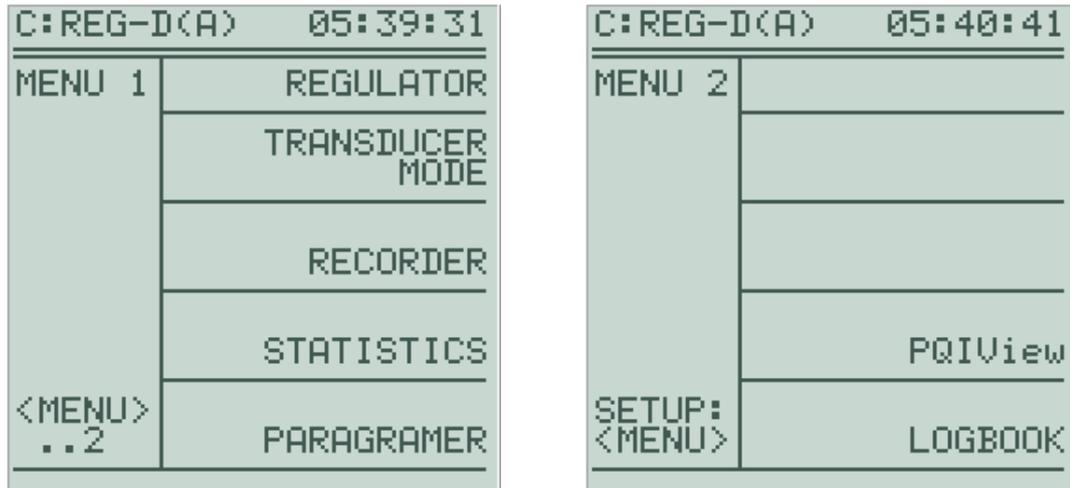
In addition to the available basic display modes, further choices can be made depending on the configuration of the device.

After MENU 1 and MENU 2 you arrive at SETUP 1 to SETUP 6, with which the Relay for Voltage Control & Transformer Monitoring REG-DA can be configured. The various submenus can be selected again with the keys F1 ... F5.
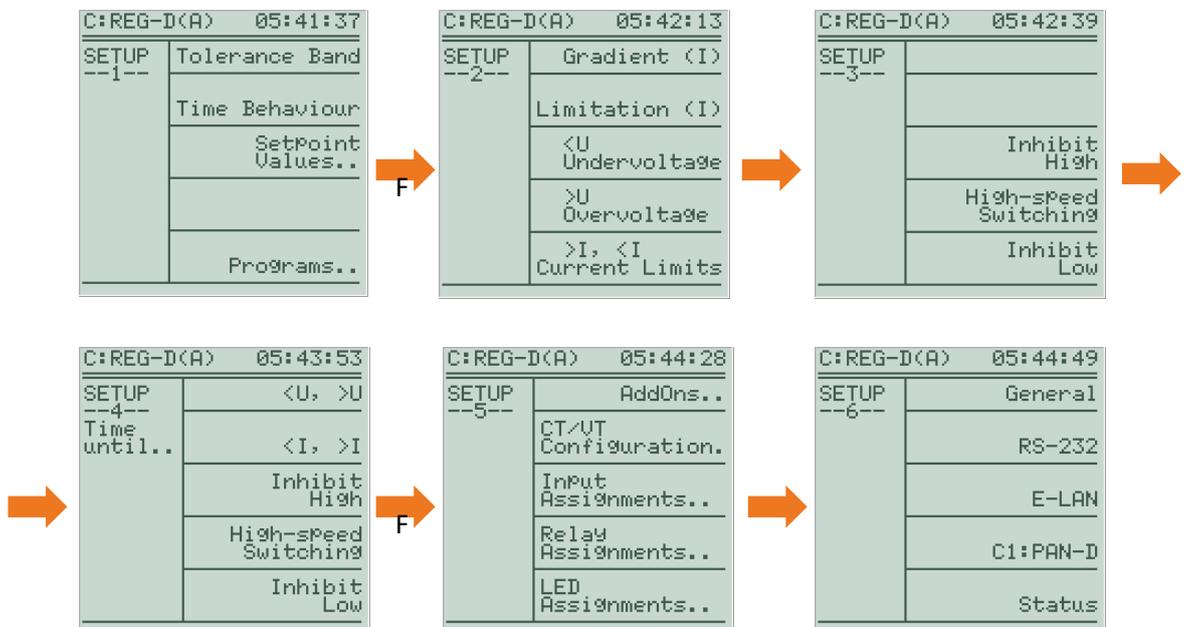
Station ID
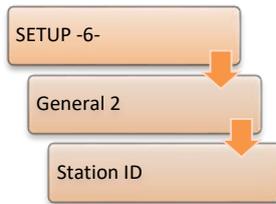
Up to 255 different devices can be addressed via the (E-LAN) bus. However, each device needs to be assigned a unique address (ID).

The address range is from A ... A9, B ... B9, ... up to Z4. The ID can always be read in the upper left corner of the panel. The station ID is the part to the left of the column.

SETUP -6-

General 2

Station ID

PAN-D

If a PAN-D is available, it is automatically assigned the ID of the directly connected REG-D(A) plus one. That is, when the REG-D(A) gets the identifier A: the PAN-D gets the address A1:. This has to be taken into account on addressing the Relay for Voltage Control & Transformer Monitoring.

Please note that a change in the station ID may also involve adaptation of the telecontrol system configuration, because the station ID is set in the configuration file used.

NOTICE!	**Same station ID**
	If several devices are connected via E-LAN and have the same station ID, this can lead to malfunction of the devices.

Station name
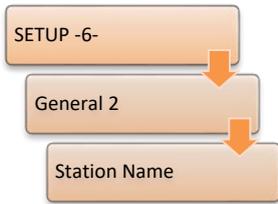
The station name describes the regulator, i.e., the station name, unlike the station ID, is not used for unique identification in the E-LAN. The station name can, for example, be used for allocation to a transformer. The station name is freely selectable and can be up to eight characters long, where spaces are not allowed (but hyphens and underscores are). The station name (e.g. "Trafo12") is displayed together with the terminal ID (e.g. "B:") in the upper left corner of the regulator, and also in the WinREG device selection dialog (in this example, "B:Trafo12"), thus making the identification of the device easier.

The station name can easily be entered in WinREG, or alternatively through the REG-DA panel. In this, the F-keys have the following functions:

F1   Select character set; the four arrow keys are used to select the character that needs to be confirmed with Enter
F2   Switch character case
F3   Clipboard
F4   Insert character at current position
F5   Delete character at current position

COM 1

The COM1 interface is accessible as configuration or programming interface via a SUB-D connector on the front panel. Alternatively, the connection can be made via a mini USB cable (order code I1). By default the COM1 mode is ECL. In this mode, the regulator can be accessed using the software WinREG. BAUDRATE, PARITY and HANDSHAKE must match the settings of the connected end device (e.g. PC) to ensure trouble-free communication. The following communication parameters are recommended:

E-LAN (Energy Local Area Network)

SETUP -6-

E-LAN

Each regulator provides two E-LAN interfaces, an E-LAN LEFT and an E-LAN RIGHT. Each E-LAN interface can be used with a two-wire line or four-wire transmission technology (both RS-485).
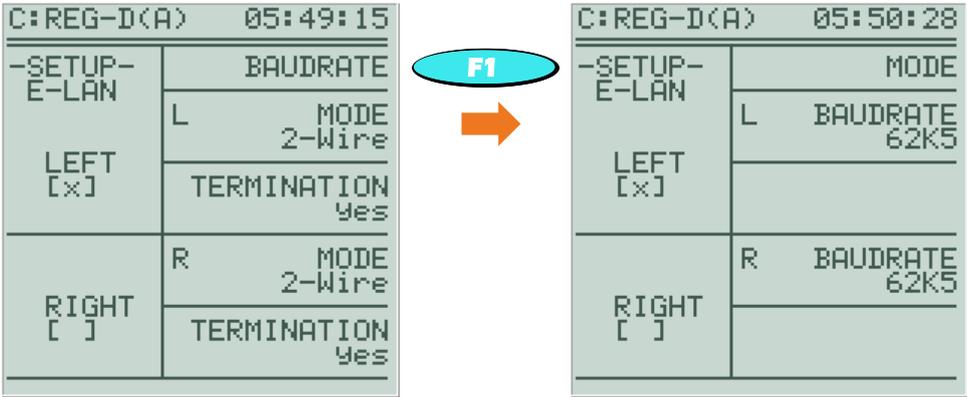
For successful communication, the communication parameters (MODE, BAUDRATE) of the connected devices of a bus needs to match.

The configuration for the terminating resistors (only in two-wire mode) is shown in the following figure. The terminating resistor should be set to "no" when a bus consists of more than two devices and the relevant E-LAN interface is not physically at the beginning or end of the bus. In all other cases, the terminating resistors should be set to guarantee the best possible communication.

■ Terminated
□ Not terminated
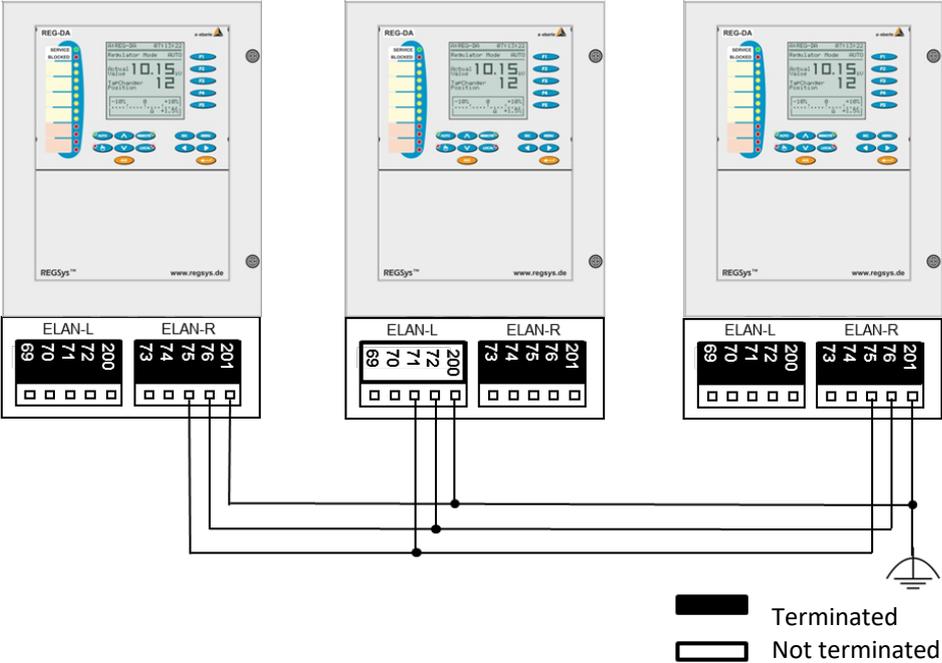
If the communication on the E-LAN interface is successful, a cross [X] will appear in the brackets of the two interconnected E-LAN interfaces. The [X] indicates that the neighboring station is recognized.

If the communication on an E-LAN interface is faulty, this is indicated with a flashing [X].

For more information about communication via E-LAN, see Chapter 7.1.4.7 page 72.

E-LAN between REG-DA and associated PAN-D

If the Relay for Voltage Control & Transformer Monitoring REG-DA is operated together with the monitoring unit PAN-D, the E-LAN/L of the REG-DA needs to be connected with the E-LAN/R of the PAN-D in order to ensure a unique connection between PAN-D and REG-DA. The connection has to be carried out in two-wire technology.

Time settings

SETUP -6-

General 2

Time Setting
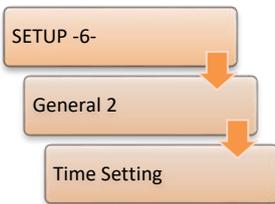
The current date, time, the UTC time zone offset and the summer/winter time swith can be adjusted in this menu. For further information, reference should be made at this point to Chapter 8.1.9 page 209.

7.2.2.2 Taking measurements

CT/VT Configuration

SETUP -5-

CT/VT Configuration

The configuration of the transducer installation is critical for correct calculation and display of the primary readings.

For voltage regulation, it is not generally necessary to feed the regulator with current measurements. However, if the display of power values, current influence, active or reactive power regulation, or parallel operation according to the circulating reactive current minimization method shall be used, the current measurement needs to be connected and configured in the CT/VT Configuration menu.

```
C:REG-D(A)     05:52:14

Transformer        L1L2     ◄ F1
Mounting
VOLTAGE
                   Knu      ◄ F2

Transformer         L2      ◄ F3
Mounting
CURRENT

Nominal Val.:       1A      ◄ F4

                   Kni      ◄ F5
 ← 🗇 →
```
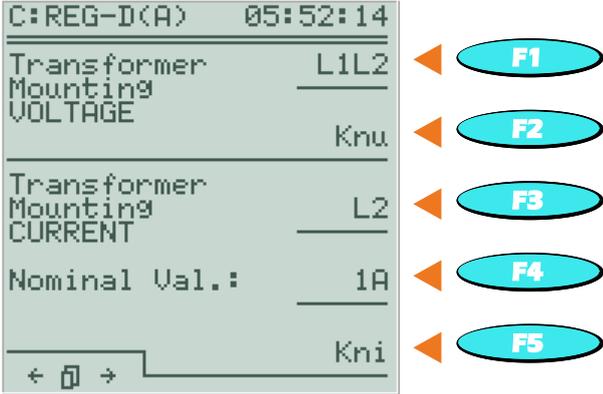
For conversion of the secondary voltage and current measurement values to primary values, the factors Knu and Kni needs to be configured. Knu is to be understood as the ratio of input and output voltage of the voltage transducer. The parameter Kni represents the ratio of input and output current of the current transducer.

Moreover, the nominal value of the current transducer can be set to 1A or 5A in the transducer configuration menu.

Example: Knu = $U_{Nom\ prim}/U_{Nom\ sec}$
            Knu = 20 kV/100 V   = 200
            Knu = 33 kV/110 V   = 300

            Kni = $I_{Nom\ prim}/I_{Nom\ sec}$
            Kni = 2500 A/5A   = 500
            Kni = 2500 A/1A   = 2500

If current measurement is used in addition to the voltage measurement, then the connected phases of the voltage transducers and the current transducers, respectively, need to be configured in order to calculate the phase angle references between voltages and currents correctly.

If the Relay for Voltage Control & Transformer Monitoring REG-DA, for example, has been set up in the menu that the current transducer is installed in the outer conductor L3 and the voltage to be regulated is between L1 and L2, the regulator will internally correct the angle of 90° and supply correct values for all loads and reactive current I*sinφ.

Rotating field

The angle references in the REG-DA are based on a clockwise rotating field. If you use a phase sequence that produces a left rotating field, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Activating current indication in the regulator basic display

SETUP -5-

AddOns-2

To also show the present current measurement next to the present voltage reading on the regulator basic display, the current display can be activated in the menu "functions".

Checking the power calculation

Menu 1
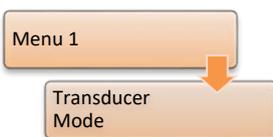
Transducer Mode

If the CT/VT Configuration is set and the voltage and current measurement is wired, the power calculation can be verified. Thus, the settings made can be checked for correctness.

```
C:REG-D(A)    14:01:25          C:REG-D(A)    14:01:25
  ← Transducer Mode →             ← Transducer Mode →

       U =    22.00  kV               U =    22.00  kV
[1A]   I = 2500.00  A        [1A]   I = 2500.00  A

       P =    93.82  MW              P =   -93.82  MW
       Q =    16.54  MVAr            Q =    16.54  MVAr
       S =    95.26  MVA            S =    95.26  MVA
    cosφ =     0.98              cosφ =     0.98

       φ =   -10.0 °  ind            φ =  -170.0 °  ind
 I*sinφ = -434.12  A         I*sinφ = -434.12  A
       f =    50.00  Hz             f =    50.00  Hz
```

Transducer mode (consumption case [left], reverse power flow [right])

The voltage is always displayed as the primary phase-phase voltage, the current as primary current. In case of consumption from the grid, the active power is displayed positively. However,in case of reverse power flow, the active power is negative.

The sign of the phase angle φ is negative for inductive loads and in addition is marked with the Index *ind*. For capacitive loads, the sign of the phase angle φ is positive and the index is *cap*.

Moreover, reactive power, apparent power, cosφ, reactive current I*sinφ and the frequency f are indicated in the transducer.

7.2.2.3   Tap position

Tap position indication

SETUP -5-

AddOns-1

Tap Position
Indication
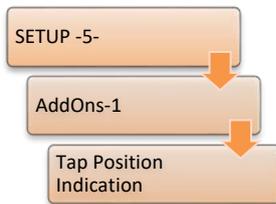
By default, tap position indication in the regulator basic display is shown as "- -". This indicates that the tap position indicator, and thus the tap position evaluation of the Relay for Voltage Control & Transformer Monitoring REG-DA, is disabled. If the tap position of the tap changer, for example, is connected to the regulator via BCD code, the tap position indicator needs to be enabled for correct display and evaluation. For this purpose, the "Tap Position Indication" parameter is set to ON in function menu 1.

BCD-Code configuration

SETUP -5-
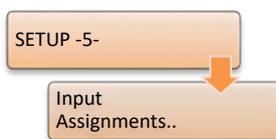
Input
Assignments..

If the tap position of the tap changer is transmitted to the Relay for Voltage Control & Transformer Monitoring REG-DA in BDC-Code, it will be sufficient that the binary inputs are used with the corresponding functions (BCD1, BCD2, BCD4, BCD8, BCD10, BCD20, BCD40, BCDminus). For a brief introduction in the configuration of the digital inputs, see Chapter 7.2.2.6 page 103.

```
C:REG-D(A)    06:18:52        C:REG-D(A)    06:20:18        C:REG-D(A)    06:20:56
     Input           ...       42:up                  ≈     75:PG_H_IS3           ≈
 Assignment      ─────          43:down                       76:PG_H_CP2
                                44:BCD1                        77:PG_H_CP3
    [x] E-9 :        BCD1        45:BCD2               ↑       78:PG_H_SC3          ↑

                                46:BCD4                       82:BCD40
    [x] E-10:        BCD2                              INV                         INV
                                47:BCD8
    [x] E-11:         OFF        48:BCD10                      
                                49:BCD20               ↓                          ↓
                                50:BCDminus
    [x] E-12:         OFF       ↑↓ : Select     ESC: ≫     ↑↓ : Select     ESC: ≫
                                ⏎  : OK        Escape      ⏎  : OK        Escape
```
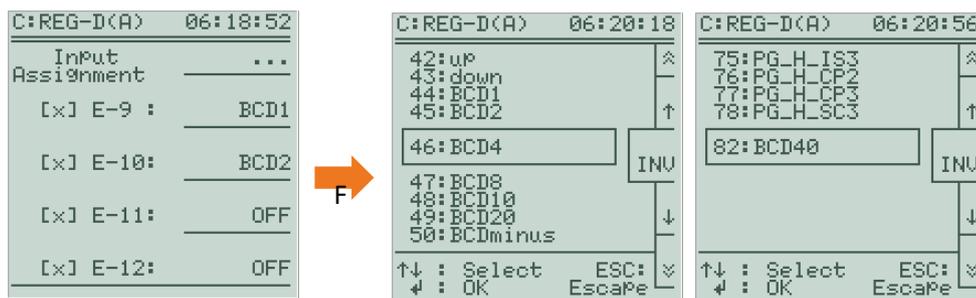
Which binary input is active is shown by means of a cross in square brackets [X] in front of the binary input. After configuration of the BCD-code and activation of tap-position indication, it is recommended that the tap changer also gets tested for correct tap-position indication, if possible.

Instead of a tap-position indication by BCD, the REG-DA can also read the tap position in binary code (BCD1, BCD2, BCD4, BCD8, BIN16, BIN32). Optionally, an mA signal or a resistance-coded tap-position indicator can be used. For the parameter setting of the analog channels, please refer to Chapter 7.2.2.6 page 103.

Configuring the TC in operation signal

SETUP -5-
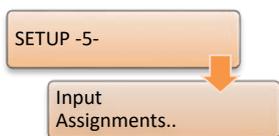
Input
Assignments..

The TC in operation signal indicates that the tap changer is performing a tap change. As in the BCD-code configuration, the "07:TC.i.Op" function must be assigned to one of the binary inputs, so that the regulator interprets the binary input signal as the TC in operation signal.

TC in operation signal with the monitoring unit PAN-D

If the Relay for Voltage Control & Transformer Monitoring REG-DA is operated together with the monitoring unit PAN-D, the TC in operation signal needs to be connected to the PAN-D. On the REG-DA there is no need to set a binary input for the TC in operation signal, because the REG-DA takes over the TC in operation signal (including TC Error) from the PAN-D. If the TC in operation signal is configured on the REG-DA anyway, it will monitor the TC in operation signal (including TC Error) in addition to the PAN-D.

Maximum TC in operation time and TC Error

SETUP -5-

AddOns-1

Maximum Time
TC in Operation
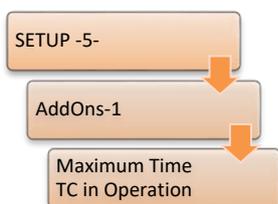
The maximum TC in operation time has two different functions, depending on the configuration.

The tap changer is monitored using this parameter as long as the TC in operation signal is read on to the Relay for Voltage Control & Transformer Monitoring REG-DA as a binary signal. This means that as soon as the TC in operation signal is present for longer than the maximum TC in operation time, a TC Error is raised. The TC Error can, for example, be assigned as a function to a freely programmable relay. The function "14:TC-Err" thereby provides a continuous signal, whereas the function "41:TC-Err+" produces a pulse signal. With this output signal, when required a message can be sent to shut down the motor drive via a relay (emergency stop), or a message placed in the SCADA system.

However, if a binary signal for the TC in operation signal is not used, the parameter maximum TC in operation time has the function that, after a successful tap-change command, no further tap commands are issued for a certain time (Maximum TC in operation time). A new tap command is given at the earliest after expiry of the maximum TC in operation time plus two additional seconds.

The parameter maximum TC in operation time can be determined by measuring the time it takes the tap changer to complete the tap change starting from the time when the tap-change command is issued. The maximum TC in operation time should be set to a value two or three seconds above the measured time to allow a certain tolerance with respect to ageing of the tap changer.

Maximum TC in operation time with the monitoring unit PAN-D

If the Relay for Voltage Control & Transformer Monitoring REG-DA is operated together with the monitoring unit PAN-D, the maximum TC in operation time has to be configured under "Setup -3-/AddOns-1/Maximum time TC in operation" in the PAN-D.

Maximum TC in operation time for tap changer with intermediate tap

If the tap changer has an intermediate tap, the maximum TC in operation time should be selected based on the cycle time of the intermediate tap (+ tolerance time).

Tap Limiter

SETUP -5-

AddOns-8
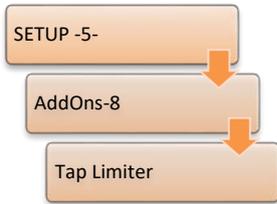
Tap Limiter

If the Relay for Voltage Control & Transformer Monitoring REG-DA receives a tap indication from the tap changer. A software tap limiter can be activated to either issue no commands beyond the end taps after reaching the end taps, or to limit the available tap range for operational reasons. The tap limiter needs to be enabled first before the top and bottom taps are defined. If one tries to execute a tap command beyond the set boundaries in regulator automatic or manual mode, the message "TAP LIMITER MIN" or "TAP LIMITER MAX" is displayed in the display of the regulator.

```
C:REG-D(A)    06:23:27
AddOns-8           ..1
Tap Limiter:
                    ON
Highest Tap Position:
                     1
Lowest Tap Position:
                    17
Tap Position 0 longer
(6s) debounced:    ON
```

```
C:REG-D(A)    15:06:06
         SIM
Modus:IND(M)     AUTO
1.Setpoint     100.0 %
               100.0V
ACT.VALUE      103.0V
Bandwidth       2.05 %
Tap-Changer Pos   1
-10%     0     +10%
*********************
*  TAP-LIMITER MIN  *
*********************
```

```
C:REG-D(A)    15:16:54
         SIM
Modus:IND(M)     AUTO
1.Setpoint     100.0 %
               100.0V
ACT.VALUE       88.0V
Bandwidth       2.05 %
Tap-Changer Pos  17
-10%     0     +10%
*********************
*  TAP-LIMITER MAX  *
*********************
```

Inverse tap changer

When reading the following table, it is assumed that the tap changer is fitted to the primary side of the transformer and the voltage measured on the secondary side.

The default setting of the Relay for Voltage Control & Transformer Monitoring REG-DA is as defined above for a non-inverse tap changer. Using the software WinREG (REGPara), the tap changer can be configured for the REG-DA as inverse without swapped relays or inverse with swapped relays.

Tap changer	Umax LV	Umin LV	Up tap command	Down tap command
Non inverse	Largest tap	Smallest tap	Up relay operates, tap position increases, voltage increases	Down relay operates, tap position decreases, voltage decreases
Inverse without swapped relays	Smallest tap	Largest tap	Up relay operates, tap position decreases, voltage increases	Down relay operates, tap position increases, voltage decreases
Inverse with swapped relays	Smallest tap	Largest tap	Down relay operates, tap position decreases, voltage increases	Up relay operates, tap position increases, voltage decreases

The **inverse tap changer *without* swapped relays** differs from the non-inverse tap changer from the perspective of the REG-DA, in particular with respect to the expected tap position after a tap change. With a "lower" tap-change command, in both cases the "down" relay is energized and the voltage on the low voltage side (LV) decreases. With a non-inverse tap changer, the regulator expects that the tap is reduced by one, with an inverse tap changer, however, the regulator expects that the tap is increased by one. The expected tap change is particularly important for evaluation of the tap-change error "TAPERR", which can be indicated as a SCADA system signal, relay output or LED signal. To prevent false raising of tap-change error "TAPERR", the REG-DA needs to know whether the tap changer is inverse or non-inverse.

The **inverse tap changer *with* swapped relays** differs from the non-inverse tap changer again from the perspective of the REG-DA, in particular with respect to the expected tap change. The expected tap change corresponds to the inverse tap changer without swapped relays. In addition, with the inverse tap changer with swapped relays the "up" and "down" relays are swapped (i.e. on a tap-change lower command the "up" relay operates, and vice versa).

Inverse tap changer

As an alternative to setting the inverse tap changer with swapped relays, the setting of inverse tap changer without swapped relays can be used, whereby either the "up" and "down" relay functions need to be swapped, or the wiring for the "up" and "down" relays switched.

If the Relay for Voltage Control & Transformer Monitoring REG-DA is operated together with the monitoring unit PAN-D, using the function "Inverse with swapped relays" is not possible. The parameter "Inverse tap changer" must be set to the same value in the REG-DA and the PAN-D.

7.2.2.4   Regulation

Setpoint

SETUP -1-

Setpoint
Values..

The Relay for Voltage Control & Transformer Monitoring REG-DA provides up to four setpoints. By default, the first setpoint value is selected. In the setup of setpoint values, the secondary value U_n is shown at the top of the setpoint display, below there is shown the primary value U_{LL} multiplied by the factor Knu. The setpoint can be changed with the keys F1, F2, F4 and F5. Press Enter to confirm the entry.

In addition, the 100%-value of the respective setpoint can be defined. The 100%-value constitutes the basis for the regulation display and for the calculation of the absolute limit values, as these are set as percentage values except for the limit inhibit high.

Example:

The following figure shows an example of the configuration of the first setpoint to 105.0 V = 100.0 %. By default, the setpoint is set to 100.0 V, which simultaneously corresponds to 100.0 %, i.e. 1.0 % corresponds to 1.0 V. In the next step, the setpoint is increased to 105.0 V. It still applies that 1.0 % corresponds exactly to 1.0 V. Therefore, the percentually represented setpoint increases to 105.0 %. In the final step, the new setpoint value of 105.0 V is defined as 100 % of the value with the F3 key. Now the percentual setpoint is again indicated by 100.0 %. Thus, 1.0 % corresponds exactly to 1.05 V.

Changing the setpoint index
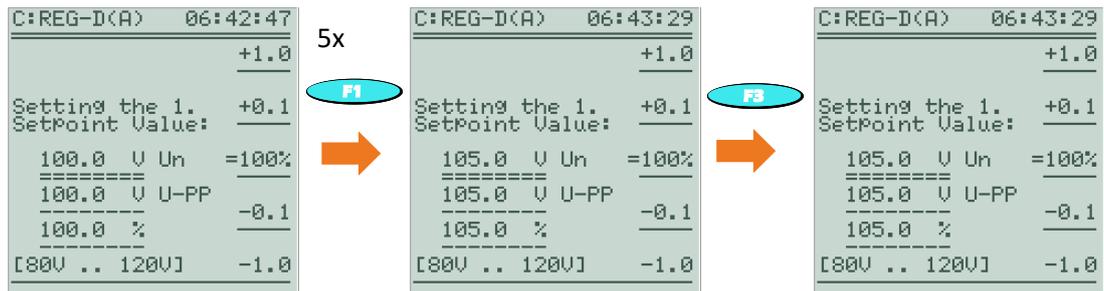
SETUP -1-

Setpoint values..
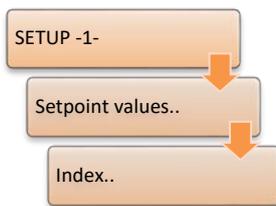
Index..

The active setpoint value is displayed in the regulator's basic display mode. Also, the active setpoint is indicated by an arrow in the menu under Setup 1. The setpoint index can be changed in the relevant menu with the respective F-key behind the associated setpoint.

Permissible setpoint deviation (Bandwidth Xw$_z$)

SETUP -1-

Tolerance Band

The adjustment of the permissible setpoint deviation depends on two limits. Firstly, it is necessary to take the voltage tolerance accepted by consumers into account. Secondly, the minimum setpoint deviation is determined by the tap increment of the transformer.

The permissible setpoint deviation Xw$_z$ is equally applicable in both the positive and negative directions, i.e., the tolerance band, in which the Relay for Voltage Control & Transformer Monitoring REG-DA does not perform any automatic regulation, corresponds to twice the permissible setpoint deviation. The minimum voltage bandwidth is therefore calculated using the following formula:

$$Xw_z[\%] \geq 0,6 * Tap\ increment[\%]$$

Unstable regulation ("hunting")

If a permissible setpoint deviation (bandwith Xw$_z$) is chosen so tight that the tolerance band is smaller than the tap increment of the transformer, the regulator, after having left the tolerance band, will move to the other side of the tolerance band with the next tap change. A stable regulation is not possible in a situation like this, that one speaks about as "hunting". In addition, it should be noted that with decreasing the permissible setpoint deviation, the wear on the tap changer, i.e. the number of tap changes carried out, will generally increase.

Time behavior

SETUP -1-

Time Behaviour

The golden rule for many multiple feeding points is a calm grid. This requires to implement a regulation that as few switching operations as possible are carried out. The slowdown of the regulation can be achieved by increasing the permissible setpoint deviation (bandwidth Xw_z) or the time factor.

However, this procedure will reach its limit as soon as the interests of consumers are unacceptably affected (i.e. due to excessively large or long-lasting voltage deviations).

The default algorithm **INTEGRAL** ensures that small setpoint deviations remain pending for a long time before a tap command is issued, whereas large deviations are corrected faster. The characteristic curve should be selected depending on the set permissible setpoint deviation.
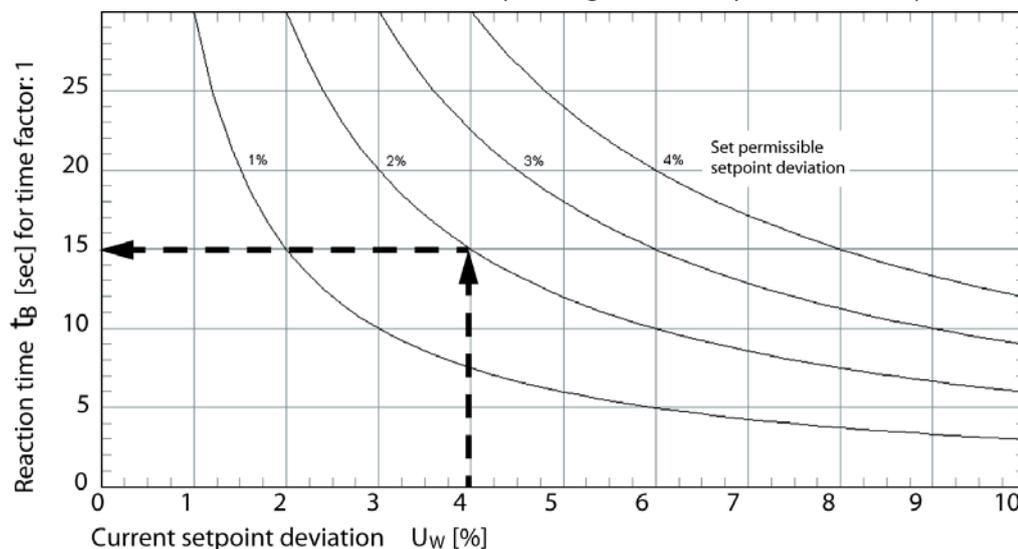
Characteristic curve time response INTEGRAL

To affect the reaction time t_B (y-axis) of the algorithm **INTEGRAL** the time factor (which by default is set to 1), can be changed.

The following applies:

$$t_V = t_B * Time\ factor$$

The resulting reaction time t_V is determined when the response time t_B (depending on the current setpoint deviation and the set permissible setpoint deviation) is read from the diagram above and multiplied by the time factor.

Empirical time factor value

Experience has shown that the time factor for the majority of applications is set to a value between 2 and 3.

However, a general recommendation cannot be given, as the correct time factor arises from the grid topology and the particular application.

Checking the regulation in automatic mode

The selected parameters of permissible setpoint deviation and time behavior can now be tested in interaction, thus checking the settings.

In the lower third of the regulators basic display, the response of regulation in AUTOMATIC mode can be seen next to the current setpoint deviation. If the current setpoint deviation is smaller than the permissible setpoint deviation, the arrow of the current setpoint deviation will not be filled (white) – see the left graph. Once the current setpoint deviation is greater than or equal to the permissible setpoint deviation, the arrow of the current setpoint deviation is filled (black), and a bar indicates the progress of the time behavior – see the middle graph. When the bar is full or has reached the right side, a corresponding tap-change command is issued, which is indicated by four horizontal arrows. At the same time the integration bar is reset – see the right graph below.
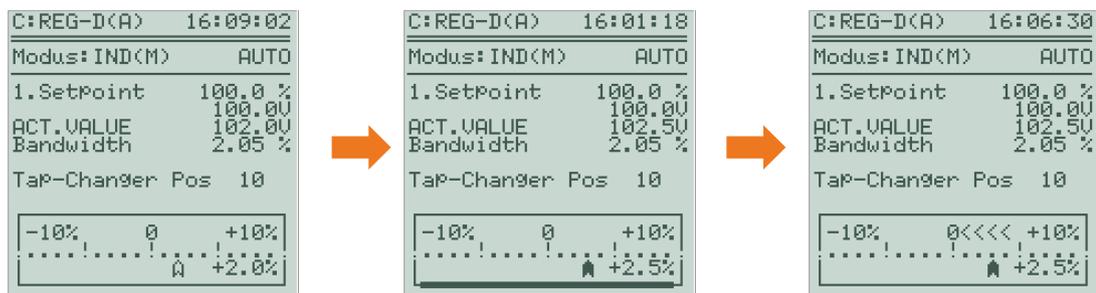
7.2.2.5 Limiting values

The following figure gives an overview of the configurable voltage limits of the REG-DA. Starting from the setpoint, the permissible setpoint deviation forms a tolerance band (positive and negative bandwidth), in which there is no automatic voltage reguation.

Next, follow the limits overvoltage >U [G4], or undervoltage <U [G6]. Both limits are configured by default as a visual alert on the LEDs of the regulator. Upon reaching the limit, tap commands are locked in the corresponding direction. For example, this means that lower commands are suppressed in case of undervoltage. Hereby, it is taken into consideration whether or not it is an inverse tap changer.
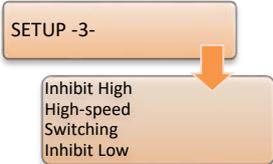
The limits for backward high-speed switching [G2] and forward high-speed switching [G3] are connected. If one of these limits is exceeded, the regulator will perform as many tap changes in the shortest possible time until the voltage is within the tolerance band again.

When the inhibit high limit [G1] is exceeded, or the voltage is below the inhibit low limit [G8], regulation is stopped in AUTOMATIC mode, and "Inhibit High" or "Inhibit Low" respectively appear in the regulator basic display.

Overview of the limits of REG-DA

SETUP -2-
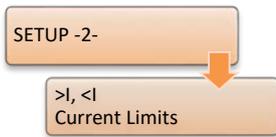
>I, <I Current Limits

In addition to the indicated voltage limits, two more limits for undercurrent <I and overcurrent >I can be configured. The overcurrent limit again is configured by default as a visual alert on the LEDs of the regulator.

SETUP -5-

AddOns-5

Block if <I or >I
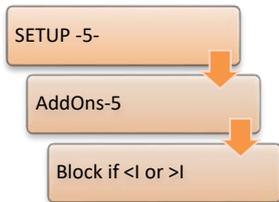
In case of violation of one or both limits, the regulator can also be configured to be blocked if such a case occurs.

Time delays for limits

SETUP -4-

<U, >U <I, >I Inhibit High High-speed Switching Inhibit Low
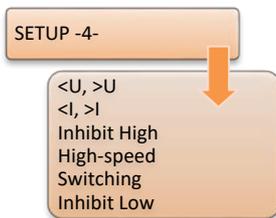
All limits can be applied with a certain time delay to suppress short-term limit exceeding.

The switching delay of all limits is set by default to zero seconds (exception: $t_{\text{forward high-speed switching minimum}}$ = 2s).

Limit base

SETUP -5-

AddOnd-5
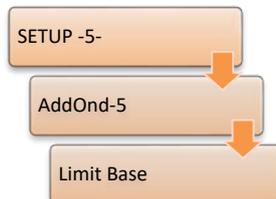
Limit Base

Almost all limits of the regulator REG-DA are set as percentage values and refer to the active setpoint, provided the limit base is set with respect to the default setting "setpoint". Only the inhibit high limit is specified as an absolute value.

In addition to the limit base "setpoint", for the limits undervoltage <U, overvoltage >U, inhibit low and three-winding limit >Ub, the limit base "Un100V" or "Un110V" can be configured. For the calculation of absolute limit [kV] the following formula applies:

$$Limit\,[kV] = \left(Reference\ limit[V] + Limit[\%] * \frac{100\%Value[V]}{100\%} \right) * \frac{Knu}{1000}$$

The 100 % value corresponds to the limit base "setpoint", the 100 % value of the currently selected setpoint. With limit base "Un100V", the 100 % value is equal to 100 V; with limit base "Un110V" it is equal to 110 V.

Application cases for the reference limits Un100V or Un110V are, for example, when one wants to switch between different setpoints, or the active setpoint is incremented or decremented, then the limits <U, > U, inhibit low and three-winding transformer limit >Ub should have independent but fixed absolute values.

7.2.2.6   Input/Output signals

Binary inputs

SETUP -5-

Assigning
inputs

In the menu of the regulator REG-DA there are always at least 32 binary inputs visible, even in the case that only the default 16 binary inputs configuration is used. A binary input that is not set can be seen as empty square brackets [ ] in front of the binary input in question, a set binary input is indicated by a cross in the brackets [X].

If a binary input fulfills a specific function in the regulator, the input needs to have the correct input function assigned. A list of all available input functions and the related functional description are be found in Chapter 8.2.2 from page 212 onwards.

As an example the configuration of the function TC in operation is shown in the following figure. The unassigned binary input E-7 is selected using the F4 key to assign a function to it. Use the F4 key to go to the function "07:TC.i.Op" and confirm the selection with the Enter key. Then the TC in operation function is assigned to the input E-7

If an input function needs to be inverted, this can be accomplished in the function selection menu, using the F3 INV key. An inverted function is marked with a minus sign in front of the specific function.

If a binary input is simply to be transferred to the SCADA system, the input in question does not need to have a function assigned. However, it is recommended that the input is set to "01:PROG" to indicate that the input is used. The function "01:PROG" can be used repeatedly and has no default function.

Each input function can only be assigned to one binary input. If several binary inputs have been set to the same function, the message "Dublicate Assignment" will appear at the bottom of the screen. In this case, only the first binary input the function has been assigned to will carry out the function (count: BI1 -> BI64). If you need to have the same function on multiple binary inputs, you should contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

🛈 **Inputs 5 and 6**

The inputs 5 and 6 are configured by default as automatic [AUTO] and manual [HAND]. For further information regarding the assignment of inputs 5 and 6, see Chapter 8.1.7.1 Manual/automatic from page 189 onwards.

Relays/binary outputs

SETUP -5-

Relay
Assignments..

All available freely-programmable relays of the REG-DA are listed in the relay mapping. This does not include the permanently assigned relays "Manual/Auto" and "Status". The functional assignment of the relays can be performed analogously to the functional assignment of the binary inputs.

A list of all available relay functions with related functional descriptions is given in Chapter 8.2.3 from page 217 onwards.

LEDs

SETUP -5-

LED
Assignments..
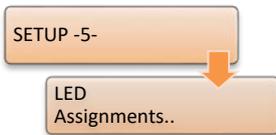
LED mapping contains all freely-programmable LEDs of the regulator. Only the dedicated Service and Fault LEDs are not listed. By default, LED 1 is assigned the undervoltage <U function, LED 2 the overvoltage >U function and LED 3 the overcurrent >I function. The functional assignment of the LEDs can be performed analogously to the functional assignment of the binary inputs.

A list of all available LED functions with related functional descriptions is given in Chapter 8.2.4 LEDs from page 221 onwards.

Analog channels
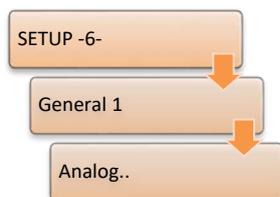
Each regulator can be equipped with up to six analog channels (plus the analog channels added with feature C). Therefore, six analog channels are available in the analog menu by default. Analog modules are available as pure input or output modules, as PT100 modules and resistance input modules, which are briefly explained separately below. For recognition purposes, the different types in the analog menu are given analog module IDs, such as "AI" for analog input or "AO" for analog output. For information regarding connection of the various analog modules, refer to Chapter 7.1.4.4 Analog signals, from page 66 onwards.

Information for retrofitting analog modules can be found in Chapter 10 Retrofit of analog channels, from page 294 onwards.

```
SETUP -6-

General 1

Analog..
```

```
C:REG-D(A)    04:03:49      C:REG-D(A)    04:03:49
┌ANALOG I/O [01..] ↑↓┐      ┌ANALOG I/O [01..] ↑↓┐
│ Ana 1          AI/ANA│    │ Ana 1          TI/ANA│
│ 0.00              ..│      │ -42.73°C          ..│
│ Ana 2          AI/ANA│    │ Ana 2          --/ANA│
│ 0.00              ..│      │ 0.00              ..│
│ Ana 3          AO/ANA│    │ Ana 3          RM/ANA│
│ 0.00              ..│      │ 99                ..│
│ Ana 4          AO/ANA│    │ Ana 4          RM/ANA│
│ 0.00              ..│      │ 1950.6 Ohm        ..│
└──↑↓:C ←→:⎕ ⏎:i──┘        └──↑↓:C ←→:⎕ ⏎:i──┘
```

Input channel AI — (Ana 1, Ana 2)
Output channel AO — (Ana 3, Ana 4)

PT-100 module TI
Resistance input module RM

Input and output modules:

Based on the hardware configuration, the REG-DA is equipped with a certain number of analog channels. The individual channel parameters can be accessed using the F key behind the respective channel.

```
C:REG-D(A)    07:49:23      C:REG-D(A)    07:49:23      C:REG-D(A)    10:39:56
┌ASETUP1│C1:AO/20mA│⎕┐     ┌ASETUP2│C1:AO/20mA│⎕┐     ┌ASETUP3│C1:AO/20mA│⎕┐
│ Analog Function      │    │ Start Point P0-X     │    │ Limit Processing     │
│ = 01:ANA          ..│      │ = 0               ..│      │ = 00:none         ..│
│ Analog Unit          │    │ Start Point P0-Y     │    │                      │
│ = ""              ..│      │ = 0.2             ..│      │                      │
│ Decimal Places       │    │ End Point P2-X       │    │                      │
│ = 2               ..│      │ = 120             ..│      │                      │
│ Parameter Selection  │    │ End Point P2-Y       │    │                      │
│ = 02:P0P2         ..│      │ = 1               ..│      │                      │
└──↑↓:C ←→:⎕ ⏎:i──┘        └──↑↓:C ←→:⎕ ⏎:i──┘        └──↑↓:C ←→:⎕ ⏎:i──┘
```
F1   F1
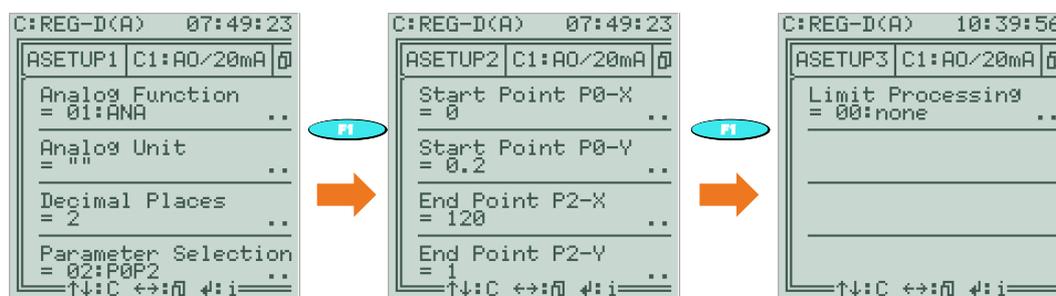
The left graph in the figure shows the first setup page of an analog channel. Under Analog Function a function for an analog channel can be assigned, the same as with the binary inputs, relays and LEDs. A list of all available analog functions with related functional descriptions is given in Chapter 8.2.5 from page 225 onwards. Moreover, the unit and the number of decimal places can be configured. Under Parameter Selection, the type of characteristic curve can be set, which is configured on the next setup page 2 (F1 key).

A start point and an end point are defined for the standard curve P0P2, where the y-coordinate corresponds to the normalized mA value and the x-coordinate corresponds to the reference value (see the middle graph). In the figure above, the mA range 4-20 mA (P0-Y = 0.2, P2-Y = 1) corresponds to the reference value of 0-120 (P0-X = 0, P2-X = 120).

Limit Processing can be set on the third setup page. If for example the mA-output signal should always be at least 4 mA, limit processing needs be set to 02:Low.

PT100 module (feature E)

The PT100 module has only one channel available per module (e.g. channel 3) and is indicated as "TI". The second channel of the module cannot be used and is indicated as "-". If no PT100 sensor is connected, a PT100 module channel indicates a temperature of -42.73°C. Settings such as for the analog inputs or outputs cannot be made in this module as the calibration of each module was done at the factory.

Resistance input module

A resistance input module with the indication "RM" on both module channels, shows the tap position on the first module channel (channel 3 or 5), the measured resistance value in Ω on the second module channel (channel 4 or 6). The parameters are set only through the first module channel.

If the detected tap value of the resistance module provides the regulator with the tap position of the tap changer, The analog function "70: iTapPos" has to be assigned on the first module channel. On the second setup page, in addition to the minimum and maximum tap positions, the resistance value per tap, as well as a possibly existing offset resistance, can be configured.
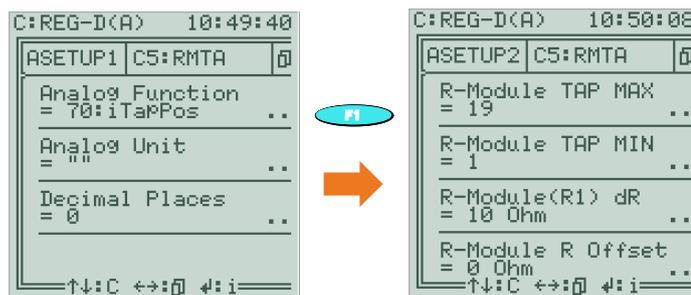
Note firmware version!

Firmware versions below V2.22 or V3.22 can only evaluate a resistance input module by means of a background program.

For questions regarding this matter, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

7.2.2.7 Background programs

Background programs are customized applications written in the A.Eberle internal programming language REG-L and can consist of H-, P- and Q-lines. Further information about the possibilities of the background programs can be found in Chapter 8.4 from page 284 onwards.

The configuration of the REG-DA, including the background program, is read using the software WinREG (subprogram REGPara). Thus, it can be checked whether a background program is present on the regulator, and if so, which one. The name of the background program and corresponding design specification (article number) are always listed in program line H0.

Background programs for the REG-DA have the file extension ".rgl" and can be loaded into the regulator using both the software REGUpdate32 (part of the firmware packages available on the website), and the configuration software WinREG (the Service subprogram).

> **Differences between the original background program and the background program as seen in WinREG**
>
> There is usually a difference between loading a background program (.rgl) and loading a background program read out by means of the software using the software WinREG (subprogram REGPara). Only loading the original background program (.rgl) will ensure that all programming sequences are performed correctly, such as the one-time custom setting of input and output functions. It is therefore advisable to use the original background program (.rgl).

7.2.2.8 SCADA system

General

Communication between the protocol card (e.g. REG-P(ED)) and the REG-DA is performed using the internal A.Eberle "RPS data structure" (e.g. RPS3 or RPS4). The RPS data structure is independent of the firmware versions of the protocol card and the Relay for Voltage Control & Transformer Monitoring, whereby it should be noted that the RPS3 data structure is implemented since REG-DA firmware V2.00, the RPS4 data structure since REG-DA firmware V2.15.

The protocol card (e.g. REG-P(ED)) translates regulator information in accordance with IEC61870-5-101, -103, -104, IEC 61850, MODBUS, SPABUS, PROFI-BUS, DNP 3.0 and LON. Commands from the SCADA system are translated by the protocol card using the regulator's internal programming language REG-L, or updated in the "Client-Structure" and sent to the regulator.

COM 2

SETUP -6-

RS-232
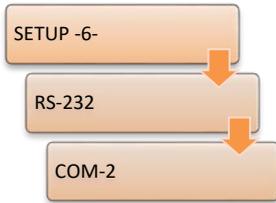
COM-2

The serial communication between the protocol card (e.g. REG-P(ED)) and the Relay for Voltage Control & Transformer Monitoring REG-DA is usually carried out via COM2.

Depending on the protocol, the following COM2 interface settings are default:

Protocol	Mode	Baud rate		Parity	Handshake	
IEC 61870-5-101	ECL	REG-P:	57600	EVEN	REG-P:	XON/XOFF
IEC 61870-5-103	ECL	REG-P: REG-PE: REG-PED:	57600 115200 115200	EVEN	REG-P: REG-PE: REG-PED:	XON/XOFF XON/XOFF --
IEC 61870-5-104	ECL	REG-PE: REG-PED:	115200 115200	EVEN	REG-PE: REG-PED:	XON/XOFF --
IEC 61850	ECL	REG-PE: REG-PED:	115200 115200	EVEN	REG-PE: REG-PED:	XON/XOFF --
MODBUS	ECL	REG-PM: REG-PE: REG-PED:	57600 115200 115200	EVEN	REG-PM: REG-PE: REG-PED:	XON/XOFF XON/XOFF --
SPABUS	ECL	REG-PM:	57600	EVEN	REG-PM:	XON/XOFF
PROFI-BUS	PROFI	Profi-DP:	57600	EVEN	Profi-DP:	--
DNP 3.0	ECL	REG-P: REG-PE: REG-PED:	57600 115200 115200	EVEN	REG-P: REG-PE: REG-PED:	XON/XOFF XON/XOFF --
LON	ECL	REG-LON:	115200	EVEN	REG-LON:	XON/XOFF
COMServer (CS) COMServer only (CSO)	ECL	REG-P: REG-PE: REG-PED:	115200 115200 115200	--	REG-P: REG-PE: REG-PED:	RTS/CTS RTS/CTS RTS/CTS*
E-LAN extension (CSE)	ELAN-R ELAN-L	REG-PE: REG-PED:	115200 115200	--	REG-PE: REG-PED:	-- --

* in COMServer only mode over COM2, use REG-PED handshake - -.

SCADA system parameters

SETUP -6-

General 4
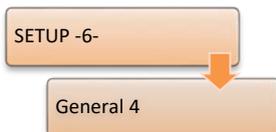
Depending on the SCADA protocol used, protocol-specific parameters such as IP address, subnet mask, gateway settings, etc. can be set in this menu. On changing this parameter, depending on the protocol, a replication is carried out between the REG-DA and REG-PE(D), the REG-PE(D) is updated and restarted (see also Chapter 8.1.8 SCADA system, from page 207 onwards).

7.2.3   Parallel operation

General and conditions

All parallel programs are intended to minimize the circulating reactive current of parallel-connected transformers. Which parallel program is useful and can be applied due to conditions on the site is explained in detail in Chapter 8.1.5.2 from page 171 onwards. Parallel program-specific parameters are also described in Chapter 8.1.5.3 from page 174 onwards.

In principle, with all parallel programs (except dcos(φ)) an E-LAN communication is required between the participating Relays for Voltage Control & Transformer Monitoring so that relevant data for parallel operation can be exchanged between the regulators involved.

Further, for the parallel programs dcos(φ), dIsin(φ) and dIsin(φ)[S], in addition to measurement of the regulation voltage, also a current measurement associated with the regulation voltage is required to be able to determine the phase angle and the circulating reactive current.

With the parallel programs Master-Follower, MSI and MSI2 the circulating reactive current can be monitored optionally. However, the determination of the circulating reactive current is not required for these parallel programs, as the circulating reactive current is implicitly minimized by the tap positions (e.g. for identical transformers).

Sign conventions

To understand the calculation of the circulating reactive current and its influence on the voltage regulation, the following sign conventions should be observed:

	Positive sign	Negative sign
Active Power P	Consumption case	Reverse power flow case
Reactive power Q	Inductive reactive power consumption	Capacitive reactive power consumption
Phase angle φ	Capacitive reactive power consumption	Inductive reactive power consumption
Reactive current I*sinφ	Capacitive reactive power consumption	Inductive reactive power consumption
Circulating reactive current Icirc	Capacitive reactive power consumption	Inductive reactive power consumption

NOTICE!	**Wiring and configuration**
	⮫ It needs to be ensured that the voltage and current measurements are correctly configured and wired, so that with active power consumption of the grid (consumption case) the active power P in the transducer has a positive value, and with active power flow feed back of the grid (reverse power flow case), the active power P takes on a negative value in the transducer. In addition, pay attention to the correct wiring of raise and lower relays and correct configuration of the inverse tap changer, so that raise commands always increase the voltage and lower commands always reduce the voltage.
	⮫ If these conventions are not consistently obeyed, it may result in unequal taps on the tap changer, and thus an increase of the circulating reactive current which may go as far as tripping the transformer.

Choice of parallel program

SETUP -1-

Programs..

Parallel program

The corresponding parallel program needs to be selected for all involved relays. The parallel programs MSI and MSI2 are only available with the feature ParaGramer activated.

Group list

SETUP -1-

Programs..

Par.Parameter..
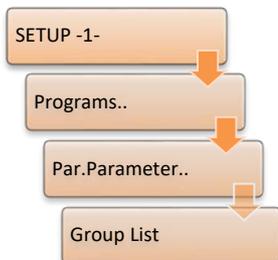
Group List

All regulators operating in parallel are defined in the group list. The group list has to be identical in all participating regulators and may not have any gaps. For the parallel program dcos(φ), which is normally used without E-LAN, the group list is only required if an E-LAN between the participating regulators is available and either the ParaGramer is used or a maximum tap difference of the regulators concerned is to be monitored.

Parallel program activation

SETUP -5-

AddOns-7

Parallel Prog. Activation
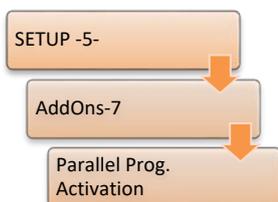
The parallel program activation needs to be set for all regulators that are to participate in the parallel operation.

An exception is the Master-Follower parallel program. With ParaGramer, the first regulator in the group list with activated parallel program activation becomes master. Without the use of ParaGramer, one of the regulators in the group list with an enabled parallel program activation becomes master (the one that first defines itself as master, regardless of placement in the group list).

In addition to permanent activation/deactivation of a parallel program, the parameter can also be set to level or pulse so that parallel program activation/deactivation can be done via binary input using the function "08:Par-Prog". If activation/deactivation is carried out by a SCADA system, the parameter will be actively changed with corresponding SCADA commands.

ParaGramer activation

SETUP -5-

AddOns-6

PARAGRAMER
Activation
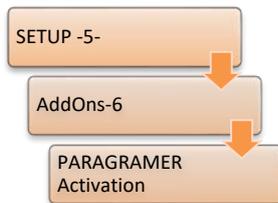
When using the ParaGramer function, the parameter "ParaGramer activation" always needs to be set to ON (to the number of the paralleled transformers).

If the feature ParaGramer is enabled, the ParaGramer can be activated. The number of transformers to be placed in ParaGramer is defined using the parameter "ParaGramer activation".

Configuration of ParaGramer

SETUP -5-

Input
Assignments..
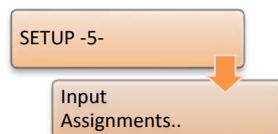
The ParaGramer can be used for the display of parallel operation of transformers. Moreover, using the ParaGramer, parallel operation is automatically detected based on switch positions in all parallel programs except for MSI and MSI2. There are various standard switches available to the ParaGramer, which need to be configured in the input assignments in order to be displayed and evaluated by the ParaGramer. For a detailed explanation of the operation and configuration of ParaGramer, see Chapter 8.3.2 from page 237 onwards. An overview of the binary input functions of the ParaGramer is also given in the table of Chapter 8.2.2 from page 212 onwards.

Specific configuration of the parallel program dcosφ

SETUP -1-

Programs..

Par.Parameter..

Permiss. Icirc
Limitation
Net-cosφ
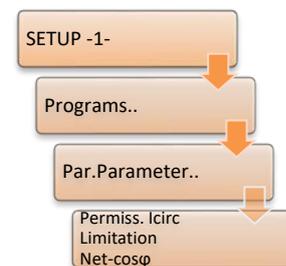
The parallel program dcosφ necessarily requires configuration of the Net-cosφ, the Permissible Icirc (permissible circulating reactive current), and the Limitation .

The parameter Net-cosφ has to be configured according to the present grid. When the actual cosφ is equivalent to the parameter Net-cosφ, the regulator assumes that no circulating reactive current is present in parallel operation, but that the total reactive current is consumed in the grid downstream. The circulating reactive current is calculated from the difference between Net-cosφ and the actual measured cosφ.

The determination of the parameter Permissible Icirc (permissible circulating reactive current) is explained in detail on page 114.

The parameter Limitation limits the influence of the parallel program dcosφ in the regulation of the tap changer. The value of limitation multiplied by the permissible setpoint deviation (bandwidth Xw_z) gives the maximum influence of the parallel program dcos(φ).

Example:

permissible setpoint deviation Xw_z: 2.0 %

Limitation: 3

→   maximum influence of the parallel program dcos(φ) = 3 * ±2.0% = ±6%

Parameters dependent on the parallel program dcos(φ)

The parameters Permissible Icirc, Limitation and Net-cosφ of the parallel program dcos(φ) are available only when the corresponding parallel program is selected in the previous menu.

Specific configuration of parallel programs dIsin(φ) and dIsin(φ)[S]

SETUP -1-

Programs..

Par.Parameter..

Permiss. Icirc
Limitation
Transformer
Nominal Power
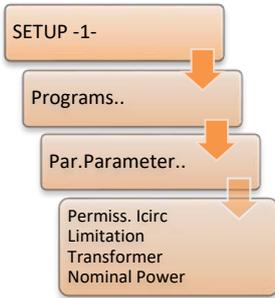
For the parallel programs dIsin(φ) and dIsin(φ)[S] the parameter Permissible Icirc is available and can be used for defining the permissible circulating reactive current. The determination of the Permissible Icirc parameter is explained in detail on page 114.

The parameter Limitation is set to 20 by default and is not visible in the menu.

Moreover, different nominal transformer powers can be configured for the parallel program dIsin(φ)[S]. In the parallel program dIsin(φ), it is assumed that the nominal transformer powers are the same, therefore the corresponding parameter in this parallel program is dropped.

Parameters dependent on the parallel programs dIsin(φ) and dIsin(φ)[S]

The parameters Permissible Icirc and Limitation of the parallel programs dIsin(φ) and dIsin(φ)[S] are only available when one of the corresponding parallel programs is selected in the previous menu. The nominal transformer power parameter is only available for the parallel program dIsin(φ)[S].

Specific configuration of the parallel programs Master-Follower, MSI and MSI2

SETUP -1-

Programs..

Par.Parameter..
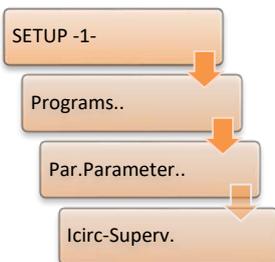
Icirc-Superv.

In the parallel programs Master-Follower, MSI and MSI2 an excessively high circulating reactive current can be supervised by using the parameter Icirc-Supervision. In contrast to the parallel regulation procedures dcos(φ), dIsin(φ) and dIsin(φ)[S], the circulating reactive current is not directly included in the regulation, but only represents a limit. If the parameter Icirc-Supervision is exceeded, the regulator switches over to manual mode.

Example: Two identical transformers are operated in the Master-Follower parallel program. If a cable break occurs at the master regulator with the currently active signal BCD04, the tap position feedback will change, for example, from tap 14 to tap 10. The master regulator then drags the slave to its supposed tap, thereby resulting in a real tap difference of four taps, which causes a high circulating reactive current. If the parameter Icirc-Supervision is correspondingly configured, retracing of the slave until the Icirc monitoring limit is reached can be interrupted, since the master and slave switch to manual mode.

Parameters dependent on the parallel programs Master-Follower, MSI and MSI2

The parameter Icirc-Supervision of the parallel programs Master-Follower, MSI and MSI2 is only available when one of the corresponding parallel programs is selected in the previous menu.

SETUP -5-

Input Assignments..
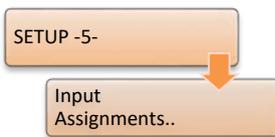
In the parallel program MSI, for each Relay for Voltage Control & Transformer Monitoring the status master, slave or independent can be assigned. In addition, in the parallel program MSI2 two separate master-slave groups (master 1&2 and slave 1&2) can be defined. An evaluation of switch position is not provided in these parallel programs in the regulator itself, but can, for example, be supplied externally.

The allocation of master, slave and independent can be done either in ParaGramer itself (the F1 key in ParaGramer), or by means of binary signals, whereby the last positive slope of the selected function is always decisive.

The binary input functions available:

MSI:	64:MSI_Ma	(master)
	65:MSI_Sl	(slave)
	66:MSI_Ind	(independent)
MSI2:	67:MSI_Ma1	(master 1)
	68:MSI_Ma2	(master 2)
	69:MSI_Sl1	(slave 1)
	70:MSI_Sl2	(slave 2)
	66:MSI_Ind	(independent)

The choice of master, slave or independent can also be adjusted via the SCADA system.

Emergency program dcos(φ)!! for parallel programs dIsin(φ) and dIsin(φ)[S]

SETUP -1-

Programs..

Par.Parameter..

Permiss. Icirc Limitation
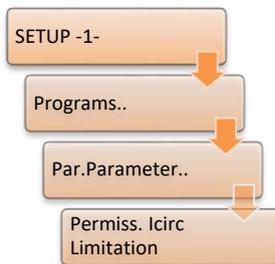
If there is a failure of the E-LAN connection during active parallel programs dIsin(φ) and dIsin(φ)[S] in AUTOMATIC mode, the E-LAN error and the emergency program dcos(φ)!! are activated after approximately 30 seconds.

The parameters Permissible Icirc and Limitation of the regular dcos(φ) parallel program are used in the emergency program dcos(φ)!!.

On the other hand, for the parameter Net-cosφ, the cosφ measured at the time of the E-LAN error is used.

It is therefore assumed that the circulating reactive current was perfectly minimized at the time of the failure of the E-LAN bus.

Parameter settings for the parallel emergency program dcos(φ)!!

In order to be able to adjust the parameters Permissible Icirc and Limitation for the emergency program dcos(φ)!! in the Relay for Voltage Control & Transformer Monitoring REG-DA, the parallel program dcos(φ) needs to be temporarily activated for the configuration. Only in this case the parameters will be visible under Par.Parameter.

Determining the regulation influence parameter

SETUP -1-

Programs

Par.Parameter..

Permiss. Icirc
or Icirc-Superv.
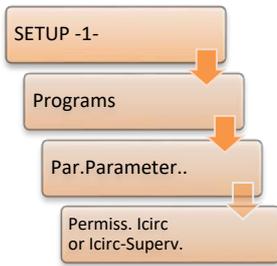
As a decision basis for the configuration of Permissible $Icirc_x$, the circulating reactive current change has to be determined per tap of the tap changer involved.

In this first step, the current tap position and the current circulating reactive current for each transformer are noted down in the first step. The actual calculated circulating reactive current of each Relay for Voltage Control & Transformer Monitoring REG-DA can be viewed on the second page of the transducer display using the arrow keys.

In the second step, a transformer is stepped by one tap, and then the current tap positions and the current circulating reactive currents are noted down. From the difference between the circulating reactive currents of the transformers, the circulating reactive current change per tap can then be determined from the noted values.

In the next step, the procedure is repeated for all other transformers, so that the difference in the circulating reactive current per tap is seen for each tap changer.

The minimum permissible circulating reactive current $Icirc_z$ (Permissible Icirc) is then calculated from the difference of the circulating reactive current per tap according to the following formula:

$$Icirc_z[A] \geq 0.6 * \Delta Icirc\ [A]$$

The permissible circulating reactive current should not be chosen to be less, because the circulating reactive current can otherwise never be compensated, leading to fluctuation of the tap changer ("hunting").

Example: Two non-identical transformers are adjusted by one tap and the differences in the circulating reactive currents determined.

TapPos Transf. 1	TapPos Transf. 2	Icirc Transf. 1	Icirc Transf. 2
10	12	-20 A	+20 A
11	12	- 50 A	+ 50 A
11	13	-10 A	+ 10 A

ΔIcirc Transf. 1 = 30 A   ΔIcirc Transf. 2 = 40 A

➔ Minimum value of the parameter Permissible Icirc:
$$Icirc_{z-Transf.\ 1}[A] \geq 0.6 * \Delta Icirc_{z-Transf.\ 1}\ [A] = 0.6 * 30\ A = 18\ A$$
$$Icirc_{z-Transf.\ 2}[A] \geq 0.6 * \Delta Icirc_{z-Transf.\ 2}\ [A] = 0.6 * 40\ A = 24\ A$$

7.2.4 Current-dependent setpoint

General

With the current-dependent setpoint influence on power flow to the grid below (consumption), the setpoint is increased in order to compensate the voltage drop on the line. However, if power from the grid below is feeded back (reverse power flow), the setpoint should be reduced.

On the regulator basic display mode, the current-dependent setpoint influence is displayed accordingly. The percentaged setpoint indication is divided into two parts. First, the percentual basic setpoint is given, behind it the current-dependent setpoint influence. However, the absolute setpoint indication represents the basic setpoint value plus the current influence.

```
C:REG-D(A)      17:50:44

Mode:             MANUAL

1.SetPoint  100.0+2.0%
                  102.0V
Act.Value         100.0V
Bandwidth         2.05 %

Tap-Changer Pos   2

┌─10%       0       +10%┐
│....¦....!....¦....¦....│
│-2.0%   ♠              │
└───────────────────────┘
```
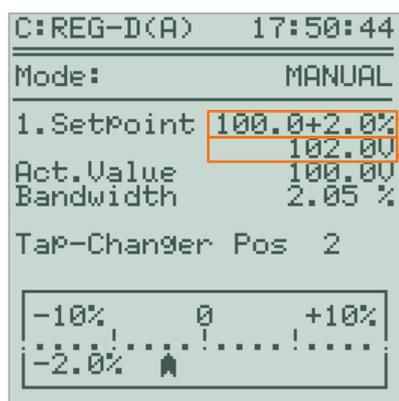
Percentaged setpoint indication with separate current influence

Absolute setpoint indication including current influence

Choice of current influence program

SETUP -1-

Programs..
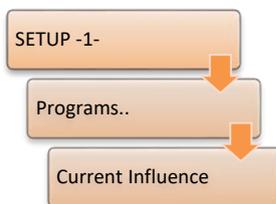
Current Influence

The following current influence programs are available:

- Apparent current
- Active current
- Reactive current
- LDC (Line Drop Compensation)

With the current program apparent current, the complete apparent current has an effect on the setpoint value in the range of $-90° (ind) \leq \varphi \leq +90°(cap)$. With the current programs active current and reactive current, only the active or reactive component of the apparent current has an effect on the setpoint value in the range of $-180° (ind) \leq \varphi \leq +180°(cap)$. For all three current programs, the parameters Gradient (I) and Limitation (I) need to be configured.

In contrast, the current influence program LDC requires beside the parameter Limitation (I) the parameters resistance and reactance. From the line data, this current influence program determines the voltage drop and therefor the current-dependent setpoint influence.

Gradient and Limitation

SETUP -2-
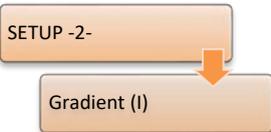
Gradient (I)

The gradient can be defined separately for the positive range (consumption case) and the negative range (reverse power flow case). The unit of the gradient is volts per nominal current [V/In], whereby the value is understood for the voltage as normalized to 100 V, and for the nominal current normalized to 1.0, which corresponds to the measuring range of the regulator (1/5 A) multiplied by the transducer factor Kni.

SETUP -2-

Limitation (I)

The limitation is used for limiting the current-dependent setpoint influence. A maximum and minimum limit can be specified. This is specified in volts [V], normalized to 100 V.

The graph below shows the influence of the parameters Gradient (I) and Limitation (I) for the current influence programs for apparent power, active power and reactive power on the setpoint and the tolerance band as a function of the normalized current.
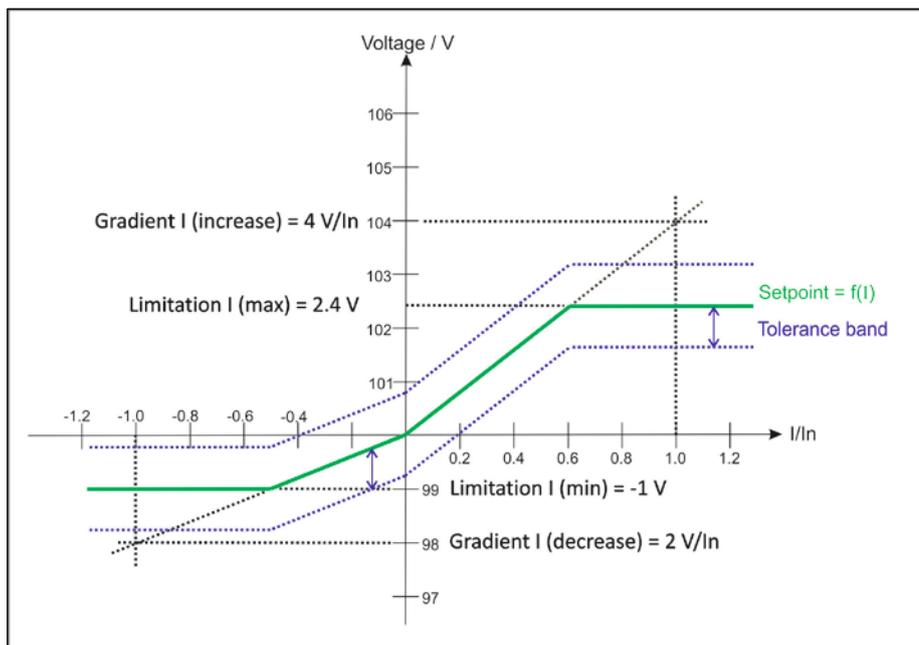
Note signs

Both the parameters negative and positive Gradient (I) always have a positive sign. The minimum Limitation (I) is configured in the regulator with a <u>negative</u> value, the maximum limitation in the regulator is usually a positive value.

The available parameters depend on the firmware version!

From REG-DA firmware V2.19 the Limitation (I) can be set separately for the minimum and maximum range. In previous firmware versions a Limitation (I) is configurable which applies to both limits.

From REG-DA firmware V2.22, the negative and positive gradients are separately adjustable. In previous firmware versions only one Gradient (I) could be configured, which was used for both the consumption case and the reverse power flow case.

Resistance and reactance (LDC procedure)

SETUP -1-

Programs..
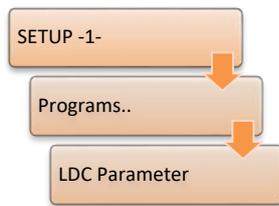
LDC Parameter

If the current influence program LDC is selected, the menu item LDC Parameter is visible. Here, the resistance (R) and reactance (X) of the compensated line can be specified. From the given values the REG-DA calculates the corresponding setpoint influence based on the current and phase angle.

For more information, see Chapter 8.1.4 from page 159 onwards.

7.2.5   Measurement value simulation

Activating measurement value simulation

SETUP -6-

Status

The simulation of measurement values can be used for testing, presentation or commissioning of the REG-DA.

To prevent the simulation from being turned on accidentally, some operating steps are required, which should ensure that the work with the simulation can only proceed when it is explicitly desired.

Three different configurations of measurement value simulation are possible, which will be explained in the following. The value of the feature Simmode can be checked in the status menu (scrolling with the arrow keys).

1. Feature Simmode = 0
    In this mode, a measurement value simulation is not possible. The feature is not listed in the status menu (2) of the regulator.

2. Feature Simmode = 1
    In this mode, a measurement value simulation is only possible in manual mode. On switching from manual mode to automatic mode, the simulation is terminated. Simulation needs to be activated separately in status menu (1) by pressing F5.

3. Feature Simmode = 2
    In this mode, a measurement value simulation is possible in both manual and automatic mode. Simulation needs to be activated separately in the status menu (1) by pressing F5.

By default, the simulation mode is activated on delivery of the regulator, in a way that only allows simulation in manual mode (feature Simmode = 1). If a different kind of measurement value simulation is wanted, this can be changed at any time via the terminal program (subprogram of the configuration software WinREG), using the appropriate commands (e.g. "feature Simmode = 2") .

If the simulation is active, it can be disabled via the F5 key in the status menu (1). Simulation terminates automatically 15 minutes after the last key press.

⚠ **DANGER!**	**Real tap changing!**
	In active simulation mode it is to be noted that tap-change commands are issued via the raise or lower relays in real time and the tap changer can really be tapped. In particular, during active simulation in automatic mode (Simmode = 2), this can lead to a significant tap change within a short time and thus violate certain voltage limits, which are not regulated by the REG-DA due to the simulation mode.

Display of active measured value simulation

If simulation is active, the word "SIM" will be visible (from REG-DA firmware V2.22) in the regulator basic display mode and in the transducer mode. Moreover, in the regulator basic display mode the words "Actual value" are written in capital letters with the active simulation mode ("ACTUAL VALUE"), and in status menu (1) the note "Input Simulation" is shown in the lower left corner.

Active simulation mode →

```
C:REG-D(A)    17:50:44
           :SIM:
Mode:         MANUAL

1.Setpoint 100.0+2.0%
                102.0V
ACT.VALUE       100.0V
Bandwidth       2.05 %

Tap-Changer Pos  2

 -10%      0      +10%
 :::::::::::!::::::!:::::
 -2.0%  █
```
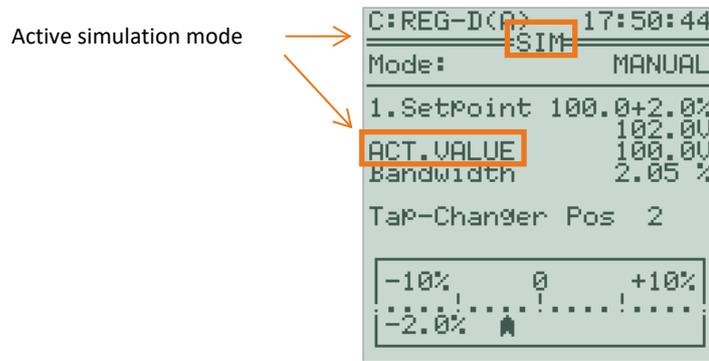
Measurement value simulation with PAN-D present

If the Relay for Voltage Control & Transformer Monitoring REG-DA is used in conjunction with the monitoring unit PAN-D (connected via E-LAN), in simulation mode it should be noted that the simulated voltage is also transmitted to the PAN-D and that during simulation time the PAN-D sees only the simulated voltage and not the real system voltage.

Setting the simulated voltage, current and phase angle

Transducer

Simulated voltage can be adjusted in the regulator basic display mode, in the transducer mode and in the recorder mode by using the arrow keys. The left arrow key reduces the voltage by 0.5 V, the right arrow key increases the voltage by 0.5 V (voltage data normalized to 100 V).

In the transducer, by using the key F2 the simulated current can be increased by 5% of the nominal current, or by using the key F3 be reduced by 5% of the nominal current.

In the transducer mode, by using the key F4 the simulated phase angle can likewise be increased by 1°, or by using the key F5 be reduced by 1°.

Activation of tap simulation

SETUP -6-

Status

If the simulation mode is enabled, then in addition to the simulation of voltage, current and phase angle, simulation of tap position can also be added. To do this, the key F4 needs to be pressed in the status menu (1). Tap simulation is indicated with two "++" signs behind the term "Input Simulation".

```
C:REG-D(A)    09:41:03

 ← REG-D Status(1) →

REGSYS    : V2.23
            18.12.12
S/N       :
RAM       : 1024KB+2MB
Battery   : OK
LCD-Contr: 0
I01..I32  : 0000.3f00
Mapping   : ---

Input Simulation

← →: next/prev. page
```

F4

```
C:REG-D(A)    09:42:51

 ← REG-D Status(1) →

REGSYS    : V2.23
            18.12.12
S/N       :
RAM       : 1024KB+2MB
Battery   : OK
LCD-Contr: 0
I01..I32  : 0000.3f00
Mapping   : ---

Input Simulation    ++

← →: next/prev. page
```

NOTICE!	**Simulation mode via WinREG**
	The simulation mode can also easily be enabled or disabled and controlled with the software WinREG.

7.2.6 RAM backup

General

The parameters of the Relay for Voltage Control & Transformer Monitoring REG-DA are kept in the memory (RAM) by an internal battery, and are thus available unchanged after any interruption of the supply voltage. If the battery life is exhausted, the RAM loses data after any interruption of the supply voltage and the regulator will start with default parameters.

To save the parameters independently of the regulator battery, since bootloader firmware version V2.12 it is possible to perform a RAM-Backup of the regulator. Hereby, parameters from the volatile memory (RAM) are secured in the non-volatile memory (flash) of the regulator.

If, in addition, a REG-DA firmware newer than V2.22 is used, the RAM-Backup is automatically restored in the RAM in case of loss of the parameters, and hence the parameters are restored too. In addition to automatic restoration, there is always the option of manually restoring a RAM-Backup regardless of the firmware of the REG-DA.

> **ℹ️ Data backup**
>
> It is recommended to carry out a RAM-Backup at the end of commissioning so that the parameters are saved on the spot in case of failure of the internal battery.

> **ℹ️ REG-DA devices with MRAM (as of 08/2014**
>
> In REG-DA Relays for Voltage Control & Transformer Monitoring manufactured since 08/2014 a non-volatile RAM (MRAM) is used. In these devices no RAM-Backup is necessary, and for devices with the feature S2 this is not available in the bootloader.

Performing a RAM-Backup

SETUP -6-
↓
Status (1)
↓
Bootloader (press F1 for 5s)
↓
RAM BACKUP
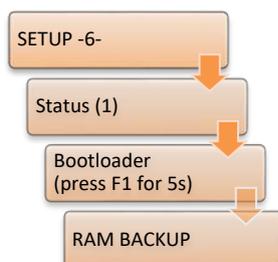
The RAM-Backup can easily be performed from the software WinREG (subprogram Service) , but alternatively also carried out directly on the regulator.

For a manual RAM-Backup, the bootloader first needs to be started by pressing the F1 key in the status menu for 5 seconds.

> ⚠️ **WARNING!** | **Control function**
>
> While the regulator is in bootloader mode, all functions including the control functions of the REG-DA are inoperative.

```
Loader v2.14 09:03:41          ◄ (F1)

>
>                              ◄ (F2)

COM1 : 8/1/P-
H/S  : RTS/CTS
Baudrate :      115200         ◄ (F3)

              RESET            ◄ (F4)

<MENU>
RAM Backup    BREAK            ◄ (F5)
```
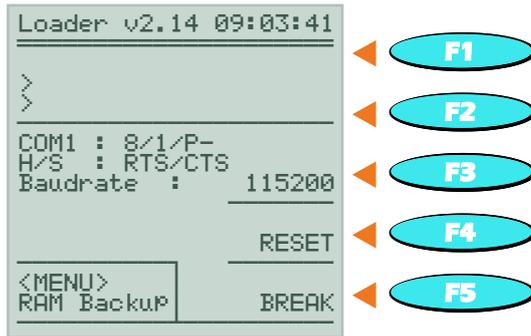
By pressing the MENU key one gets into the RAM-Backup menu. If the REG-DA has a second flash memory, the screen will appear as shown on the left in the following picture. If the REG-DA has no second flash memory (or the device already has an MRAM), the screen appears as shown in the following screen on the right. In the latter case, a backup of REG-DA parameters using the bootloader is not possible.

```
Loader v2.14 09:03:41   ◄(F1)    Loader v2.14 09:03:41   ◄(F1)


       RAM BACKUP        ◄(F2)                           ◄(F2)
         to FLASH

                        ◄(F3)                           ◄(F3)


RAM INIT ==             ◄(F4)    RAM INIT ==             ◄(F4)
MASTER-RESET                     MASTER-RESET

          back          ◄(F5)              back          ◄(F5)
```
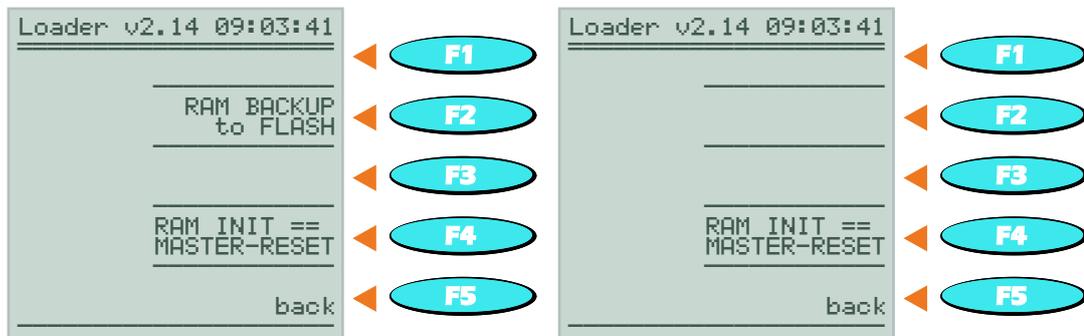
Press F2 to start "RAM-BACKUP to FLASH", (i.e., to save the parameters). Confirm with "YES" (F1 key) on the next screen that you wish to perform a backup, and wait until the screen shows the message "RAM-BACKUP: OK".

```
Loader v2.14 09:03:42   ◄(F1)    Loader v2.14 09:03:42   ◄(F1)

RAM BACKUP?      YES             RAM BACKUP: OK
                                        RAM BACKUP      ◄(F2)
              NO        ◄(F2)              to FLASH

                        ◄(F3)    09:03:47  RAM RESTORE  ◄(F3)
                                 2015-07-23 from FLASH
                                 -UTC-
                        ◄(F3)    RAM INIT ==            ◄(F4)
                                 MASTER-RESET

          back          ◄(F5)              back          ◄(F5)
```
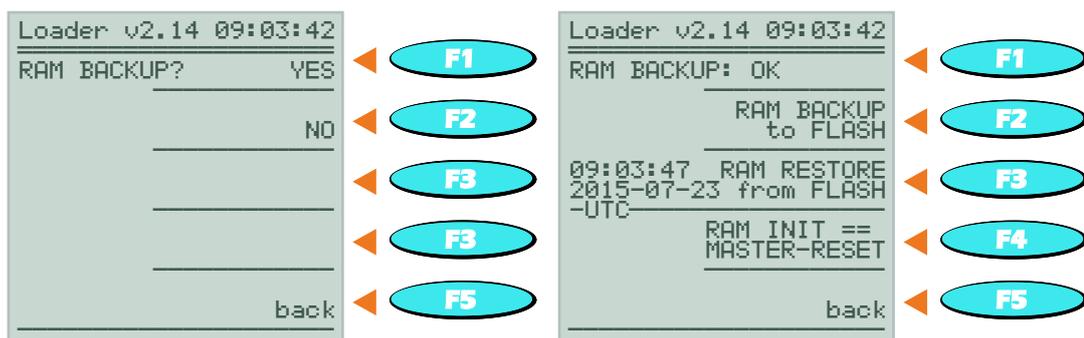
The current RAM-BACKUP is displayed with a UTC time stamp under F3. To exit the bootloader mode, press "back" (F5) and then "RESET" (F4).

Restoring RAM-Backup
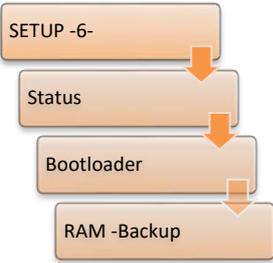
The Restoration of a RAM-Backup can easily be done from the software WinREG (subprogram Service), but can also be carried out directly on the regulator.

For manual restoration of a RAM-Backup, the bootloader needs to be started first by pressing the key F1 for 5 seconds in the status menu.

NOTICE!	Control function
	While the regulator is in bootloader mode, all functions including the control functions of the REG-DA are inoperative. In addition, by restoring the RAM-Backup all parameter changes made since the last RAM-Backup are irretrievably deleted.

By pressing the MENU key one gets into the RAM-Backup menu. The backup of the RAM is shown at the level of the F3 key including the backup time (in UTC time).

The restoring of the parameters is triggered via the key F3 "RAM RESTORE from FLASH" and confirmed with the F1 key. When "RAM RESTORE: OK" appears at the level of the F1 key, the RAM-Backup has been successfully restored.

The parameters are now fully restored. To exit the bootloader mode, press "back" (F5) and then "RESET" (F4).

> **Checking the time setting**
>
> If the restoration of a RAM-Backup is performed due to an empty buffer battery, it will be necessary to check the time setting of the Relay for Voltage Control & Transformer Monitoring REG-DA, and to correct it if necessary.

Deleting an existing backup file

If an existing backup file is to be deleted completely and not only overwritten, the following steps need to be taken.

In bootloader mode, switch to the RAM-Backup menu with the MENU key. After a renewed "BACKUP RAM to FLASH" via the F2 key has been triggered, the indicator "BUSY ..." appears in the panel of the regulator. If the RAM-Backup using the F5 key is cancelled, the current RAM-BACKUP is deleted and is then no longer visible.

```
Loader v2.14 09:03:42
─────────────
         RAM BACKUP
           to FLASH
─────────────
09:03:47  RAM RESTORE
2015-07-23 from FLASH
-UTC─────────
         RAM INIT ==
       MASTER-RESET

              back
─────────────
```

```
Loader v2.14 09:03:42
─────────────
BUSY......




          ─────────
              Cancel
```

```
Loader v2.14 09:03:42
RAM BACKUP: cancelled
         RAM BACKUP
          ins FLASH
─────────────


─────────────
         RAM INIT ==
       MASTER-RESET

              back
```

Resetting all parameters via the bootloader

1.) IMPORTANT: If a RAM INIT is performed, all parameters are reset to default. Any existing backup is not removed thereby.

2.) To reset all parameters, a master reset can be performed using the bootloader. Start the bootloader, press MENU and then "RAM INIT == MASTER-RESET" (F4). The master reset using the bootloader is equivalent to the REG-L command "sysreset = 590".
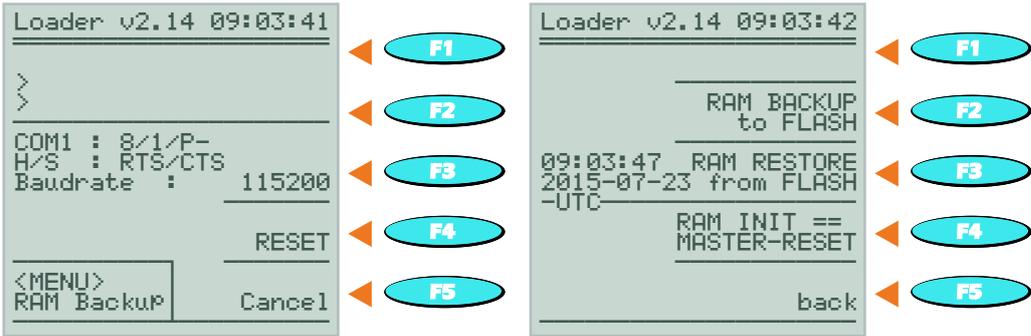
3.) After confirming RAM-INIT with "YES" (F1), a successful reset to default setup is confirmed with RAM INIT: OK.
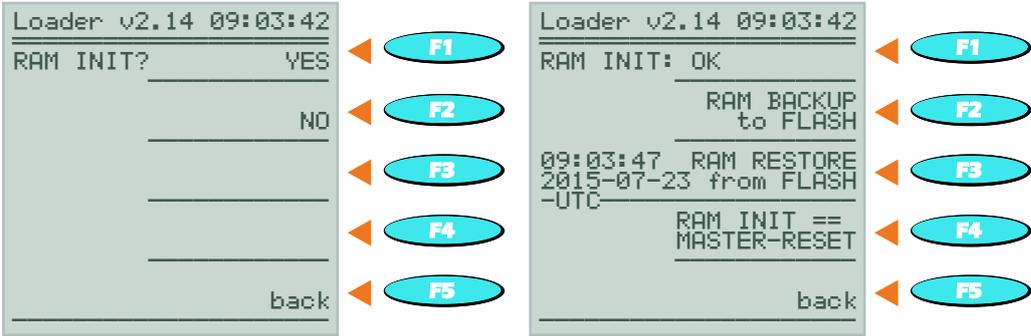
8. Parameters, functions and software features

8.1 Parameter

8.1.1 System

8.1.1.1 Station ID

SETUP -6-

General 2

Station ID
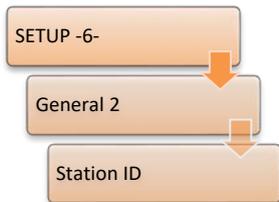
Up to 256 different devices can be addressed via the A. Eberle internal communications bus (E-LAN). However, each device must be assigned a unique address (identifier).

The address space ranges from A ... A9, B ... B9, ... up to Z4.

Using F1 and F2 a letter can be selected, with F2 and F4 an additional digit (e.g. A2).

8.1.1.2 Station name

SETUP -6-

General 2

Station Name
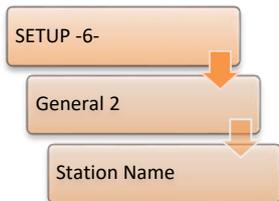
The regulator name is preferably entered via WinREG, but can also be set according to the following procedure via the regulator keyboard.

After using the arrow keys to select the corresponding location for the terminal name, the character set can be selected with F1.

The arrow keys are used to select a particular character that is confirmed with ENTER.

With F2 you can switch between upper and lower case.

With F4 and F5 characters can be inserted or removed.

8.1.1.3 RS 232

SETUP -6-

RS 232

```
C:REG-D(A)      08:01:15

-SETUP-              COM-1/2      ◄ F1
RS232
                        MODE
COM-1                    ECL      ◄ F2

                    BAUDRATE
                      115200      ◄ F3

                      PARITY
                          --      ◄ F4

                   HANDSHAKE
                     RTS/CTS      ◄ F5
```

COM-1

SETUP -6-

RS-232
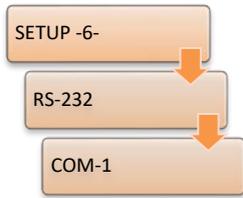
COM-1

The COM1 interface is accessible as both a configuration and programming interface via a SUB-D connector (with the feature I via the mini USB connector) located on the front panel.

The default setting is selected as ECL. In this mode, the regulator can be accessed using e.g. WinREG.

Alternatively, instead of ECL the following mode can be selected:

● With the setting DCF77, and a simultaneous connection to an appropriate recipient, time synchronization can be carried out via DCF77.

● In the PROFI mode, a Profibus module can be addressed.

● With the setting ELAN-L or ELAN-R, the information of the system bus E-LAN can be redirected to COM1.

● The ECLADR mode can be compared to the ECL mode, however it differs by fixing the TX/RX checksum application. Online operation is not possible with this setting. This parameter is only used if several regulators must be interconnected to one COM line by means of a star coupler. ECLADR should only be used by a system specialist from A. Eberle.

BAUDRATE, PARITY and HANDSHAKE must match the setting of the connected end terminal (computer) to ensure an interference-free communication.

COM-2

SETUP -6-

RS-232
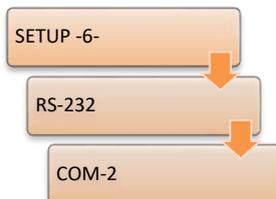
COM-2

The COM2 interface is normally used to communicate with the instrumentation and the SCADA system equipment.

For communication with a SCADA system, an integrated protocol card (see feature list XW90 … XW99 or L1, L9) is also required.

The traffic between the regulator and the protocol interface is realized via the COM2 interface. The protocol card translates regulator information according to IEC 61870-5-101, -103, -104, IEC 61850, MODBUS, SPABUS, PROFI-BUS, DNP 3.0, LON into the standarized language, otherwise information from the control centre is translated into an understandable regulator "dialect".

The default mode is ECL, which is usually used for communication with the SCADA system.

Moreover, the following modes can be set:

- If time synchronization is to be realized via DCF77, the setting DCF77 must be selected. In this case, a suitable receiver must be connected to the COM2 interface.

- The setting ECL+HP opens up the possibility that an output, generated via an H-program, in addition to COM1, is also issued via COM2.

- The mode ECLADR can be compared to the mode ECL, however it differs by setting the TX/RX checksum application. Online operation is not possible with this setting. This parameter is only used if several regulators must be interconnected to one COM line by means of a star coupler. ECLADR should only be used by system specialists from A. Eberle.

- If E-LAN (ELAN-L, ELAN-R) information is to be redirected to the serial interface to carry out modem transmissions at the E-LAN level, the setting must be ELAN-L or ELAN-R. Further detailed descriptions will be omitted at this point, because such connections should in any case be implemented in cooperation with the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

- PROFI is always the right setting for COM2 if a PROFIBUS-DP connection is to be implemented. In this case, an external PROFIBUS-DP module can be controlled via COM2.

- OFF switches off the interface.

BAUDRATE, PARITY and HANDSHAKE must match the setting of the connected end terminal (computer) to ensure interference-free communication.

8.1.1.4 E-LAN

Each regulator provides two complete E-LAN interfaces.

E-**LAN LEFT** refers to the settings for the left bus

(terminals 69 to 72 and 200, see technical data in the Appendix, Chapter 20).

E-**LAN RIGHT** refers to the settings for the right bus

(terminals 73 to 76 and 201, see technical data in the Appendix, Chapter 20).

Each E-LAN interface can be used with a two-wire or four-wire transmission technology (RS-485).

Bus-L terminal	Bus-R terminal	Function	Two-wire	Four-wire
72	76	EA+	Input and output '+'	Output '+'
71	75	EA-	Input and output '-'	Output '-'
70	74	E+	No function	Input '+'
69	73	E-	No function	Input '-'

Normally a two-wire connection is used, because only thus it is possible to have a bus configuration with multiple devices on the same bus line. For this purpose, the integrated terminating resistor must be switched on at the first and the last device on the bus (selection: "terminated").

If the terminating resistors are set improperly, reflections can occur at the cable ends, which make secure data transmission impossible.

For long transmission distances, or if boosters (amplifiers for increasing the signal level for very long transmission paths) must be used, four-wire transmission technology is required. In this case, the necessary terminating resistors are automatically activated. The "terminated" selection is no longer necessary in this case.

If the terminations (only possible with two-wire operation!) and the baud rate are set correctly, and the wiring is done properly, a bracketed [X] will appear in the two mutually connected devices. The [X] signifies that the neighbouring station is recognized.

If the connection cannot be made completely or stably, the devices will respond with a flashing [X].

The following causes may be involved:

1. Wiring error; open or wrong connection.

2. Identical station identifiers (each regulator must be assigned a unique address in the E-LAN group, see Chapter 7.1.4.7 from page 72 onwards)

3. The baudrate between interconnected regulators is not identical.

    Example:

    The right E-LAN bus terminal of regulator "A:" is connected to the left E-LAN bus terminal of regulator "B:". Then the condition applies that the same baudrate must be set for the right E-LAN of regulator "A:" as the left E-LAN of regulator "B:".

4. Incorrect termination

    Only the first and last device of a bus segment may be terminated (also see Chapter 7.1.4.7 from page 72 onwards). With a four-wire connections this termination occurs automatically.

8.1.2 Basic values

8.1.2.1 Permissible setpoint deviation (bandwidth Xw$_z$)

The current setpoint deviation Xw is the difference between the actual value X of the control value and the reference value W (setpoint value). The sign of the setpoint deviation can thus be positive or negative.

To minimize the number of switching operations of the tap changer, deviation of the mains voltage from the setpoint value is tolerated within certain limits, that is, a certain deviation is permissible.

This **permissible setpoint deviation** (bandwidth Xw$_z$) is given as ±n% of the setpoint value and sets the limits for the maximum permissible relative fluctuation range of the mains voltage below and above the setpoint. Thus, the total tolerance band corresponds to twice the bandwidth Xw$_z$.

The absolute limits of this tolerance band depend on the magnitude of the setpoint. If the mains voltage dips into this tolerance band, the regulation process, in automatic mode, is stopped, and the counter (integrator) for the time delay is set to zero, so that after each dip of the mains voltage the regulation/integration only starts again, when the mains voltage violates the limits of the tolerance band. Thus, mains voltage fluctuations within the permissible deviation do not trigger a controled tap operation.
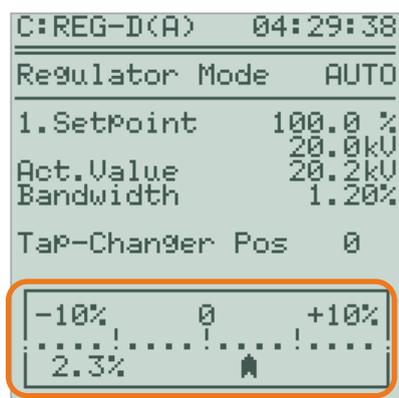
Deviation of the mains voltage X from the setpoint value is displayed on the scale of the regulator in an analog manner and in plain text (e.g. +2.3%). The fill colour of the pointer changes from light to dark when the voltage lies outside the permissible setpoint deviation (bandwidth Xw$_z$).

The tolerance band determined by the permissible setpoint deviation Xw_z (in ±n% of the reference value W) must be greater than the percentage tap increment of the transformer, because otherwise, after execution of a tap command, the changed output voltage of the transformer would again violate the opposite limit of the permissible setpoint deviation. After the time delay interval has expired, a tap command would be issued to reset the tap to the previous transformer tap position. This process would constantly reiterate (hunting) (i.e., lead to frequent tap-changes of the transformer and thus result in unwanted fluctuations of the mains voltage (see the figure below)).
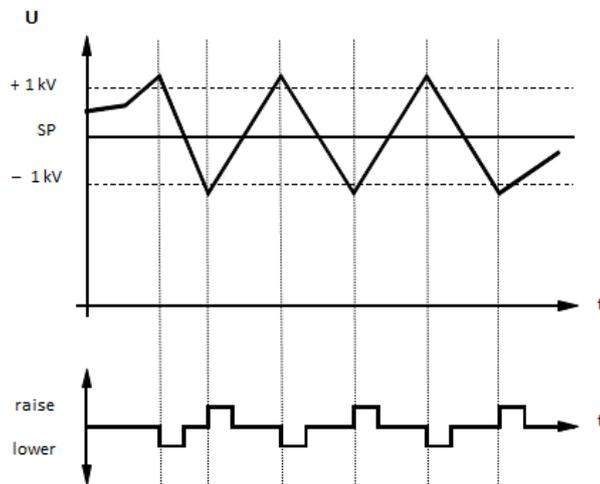
Example 1: tap change ratio from one step to
            another step: 2.2 kV
            setpoint deviation: 1 kV

A too narrowly set permissible setpoint deviation results in a hunting process.

Therefore, to obtain a sufficient distance from the upper and lower limits of the setpoint deviation, the tolerance band must be greater than the voltage swing caused by a tap change:

$$2 \cdot |\pm Xw_z\ [\%]| > \Delta U\ \text{tap}\ [\%]$$

or

$$|\pm Xw_z\ [\%]| > 0.5\ \Delta U\ \text{tap}\ [\%]$$

The permissible setpoint deviation can be set in the range of 0.10% to 10.00% and is independent of the limit base parameter.

Guideline for the permissible setpoint deviation

Normally, the following is recommended as a guideline for the minimum permissible setpoint deviation Xw_z:

$$|\pm Xw_z\ [\%]| \geq 0.6\ x\ \Delta U\ \text{tap}\ [\%]$$

Since the setting of permissible deviation, besides affecting voltage quality, also decisively affects wear of the tap changer, a setting is generally selected that does not correspond to the minimum value (depending on the application). This means that a generally larger value is selected.

Permissible setpoint deviation (bandwidth) for the simultaneous use of a parallel regulation with the circulating reactive current minimization procedure

If, in addition to pure voltage regulation, another circulating reactive current minimization procedure (dIsin(φ), dIsin(φ)[S] or dcos(φ)) is performed, it may be necessary to increase the permissible setpoint deviation.

The reason for this is indicated in the following graph. The resulting influence Xw that leads to tap commands in automatic mode arises from a part Xw_U, of the voltage regulation itself (influence parameter: permissible setpoint deviation), and a part Xw_P of the circulating reactive current regulation (influence parameters: permissible circulating reactive current Icirc + limitation).
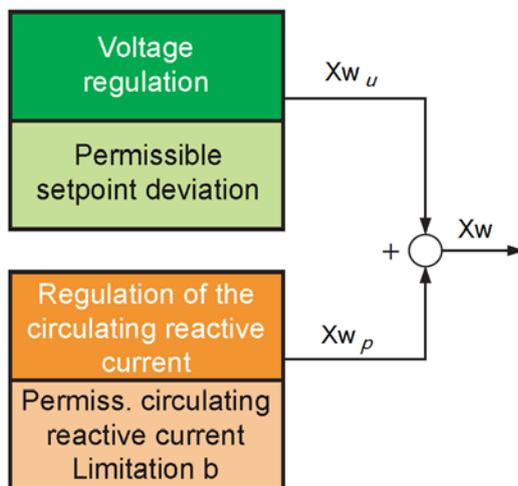
If a parallel program is used by means of a circulating reactive current minimization procedure, situations may arise in regulation on the grid in which the circulating reactive current regulation adds to the voltage regulation so that the minimum permissible setpoint deviation will be too small according to the above formula (permissible setpoint deviation at least 60% of a tap change ratio). As a result, this may lead to the oscillations described above.

A general recommendation for the minimum permissible setpoint deviation that must be set cannot be given, since this is heavily dependent on grid and transformer specific circumstances. For questions regarding this matter, please contact the A. Eberle REGSys™ support team at regsys-support@a-eberle.de, +49(0)911/628108-101.

Example for determining the permissible setpoint deviation:

Power transformer 115 kV / 21 kV:

Number of taps ± 9 (tap positions 1..19)

Range (specification for primary side) 96.6 kV … 133.6 kV

Tap increment: (133.4 - 96.6 kV) 18 taps = 2.0 kV/tap

Assuming that the measured nominal voltage of 100V = 100% (setting of the setpoint deviation, parameter setpoint 1..4 on page 145) corresponds to the low voltage side nominal voltage of 21 kV or the high voltage side nominal voltage of 115 kV, the following formula is obtained for the permissible deviation Xw_z:

$$Xw_z \geq 0{,}6 * \left(2{,}04 \; kV * \frac{100 \; V}{115 \; kV} * \frac{100 \; \%}{100 \; V}\right)$$

$$Xw_z \geq 1{,}06 \; \%$$
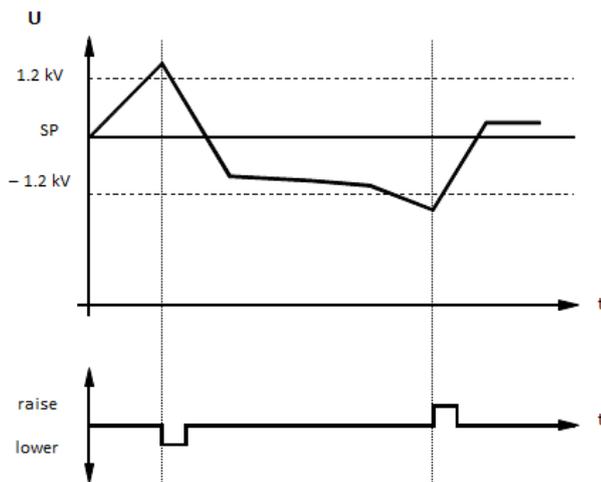
Example 2:   tap change ratio: 2 kV
              setpoint deviation according to the rule: 1.2 kV

Correctly set permissible setpoint deviation

8.1.2.2 Time behaviour
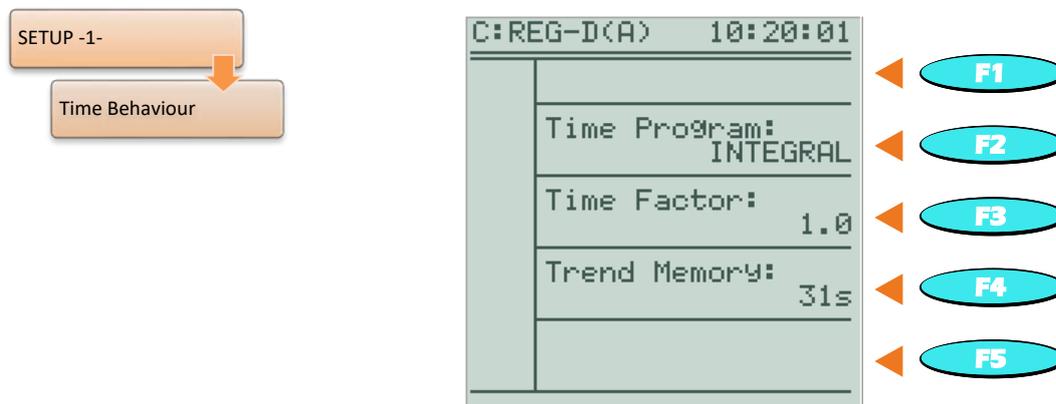
The golden rule for multiple feeding points is a calm network.

This requirement leads to a regulation that has as result few switching operations ordered. Reduced regulation can be achieved by increasing the permissible setpoint deviation (Xw$_z$) or the reaction time.

However, this procedure will reach its limit as soon as the interests of consumers are unduly prejudiced, (i.e., because of excessively large or long-lasting voltage deviations).

The REG-DA reaction time in automatic mode depends, beside the current permissible setpoint deviation, on some parameters, which are explained below.

All time programs have in common that the setpoint deviations are summed up to a specified integral value before the regulator outputs a tap command. Thus, an integration (summation) takes place only when the voltage lies outside the permissible setpoint deviation.

The current setpoint deviation is weighted for the summation according to the selected time program (Integral, Fast Integral, LINEAR, CONST). Depending on the chosen time program, the value the integrator sums up depending on either non-linear, linear or stepped on the amount of the current setpoint deviation.

The mapping rules of the time programs are selected so that large setpoint deviations (voltage deviations) are compensated more rapidly than small ones. With the time program CONST, this compensation can be actively influenced by the choice of the delay times T1 and T2. This means that it is possible to compensate all deviations by the same time.

```
C:REG-D(A)      04:29:38

Regulator Mode      AUTO

1.SetPoint        100.0 %
                  20.0kV
Act.Value         20.2kV
Bandwidth         10.00%
Current           0.734 A
Tap-Changer Pos     12

-10%        0       +10%
 : . . . . ! . . . . ! . . . ! . . . .
                    ▲
```
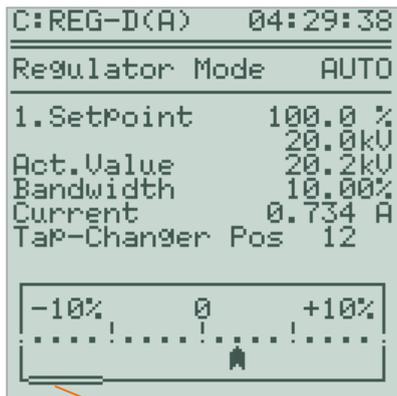
Progress bar

The "filling level" of the integrator is indicated in the regulator basic display through of a quasi-analog display. Once the voltage leaves the tolerance band, the bar starts to run from the left to right. The speed at which the bar runs depends on the current setpoint deviation and the settings for the time behavior. When the bar reaches the right side of the screen, a tap command is issued.

If the mains voltage drops into the tolerance band ($\pm$ Xw$_z$) before reaching the right edge of the screen, the integrator is reset, i.e., no tap command is issued.

Under certain conditions no tap commands are issued on reaching the right screen edge:

- The TC in operation signal is active or the maximum TC in operation time has not expired (if no TC in operation signal is present/detected).

- A tap command was issued shortly before (5s lock time).

- Tap commands are blocked via REG-L (background program).

Under certain circumstances (for example, overvoltage) it may be necessary to accelerate the reaction time of the regulator. To this end, the "High-speed switching function" (see Chapter 8.1.3.6 from page 154 onwards) can be used.

Moreover, with small setpoint deviations or oscillations of the voltage about the tolerance band limits, it may be necessary to perform a tap change. To this end, the "Trend memory" function can be used (see trend memory from page 143 onwards).

Time program

SETUP -1-

Time Behaviour
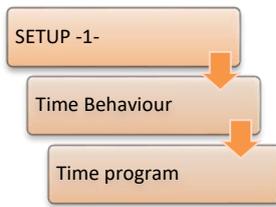
Time program

The time program parameter defines the relationship between the current setpoint deviation and the reaction time of the regulator. The user can specify whether the response time is dependent linearly, hyperbolically or in steps on the setpoint deviation.

A reaction time independent of the setpoint deviation is also feasible. In order to realize these different possibilities, the REG-DA has four time programs.

Time program	Characteristic
0:Integral	With increasing setpoint deviation, the reaction time decreases hyperbolically, the time factor is used.
1:Fast_Integral	As with Integral, faster response time corresponds to the time behavior of the analog voltage regulator REG-5 A/E, the time factor is used.
2:Linear	With increasing setpoint deviation, the reaction time decreases linearly, the time factor is used.
3:CONST	The reaction time is up to twice the permissible setpoint deviation T1 and then T2, the time factor is not used.

Please note that the actual switching delay can be up to 2s greater than the configured switching delay. The difference is due to the selected measurement value averaging procedure.

Time program Integral

With the time program "Integral" there is a non-linear (hyperbolic) relationship between the setpoint deviation and the reaction time. The basic reaction time at constant setpoint deviation can be read from the following chart. Depending on the set permissible setpoint deviation, different characteristics are seen in the diagram.
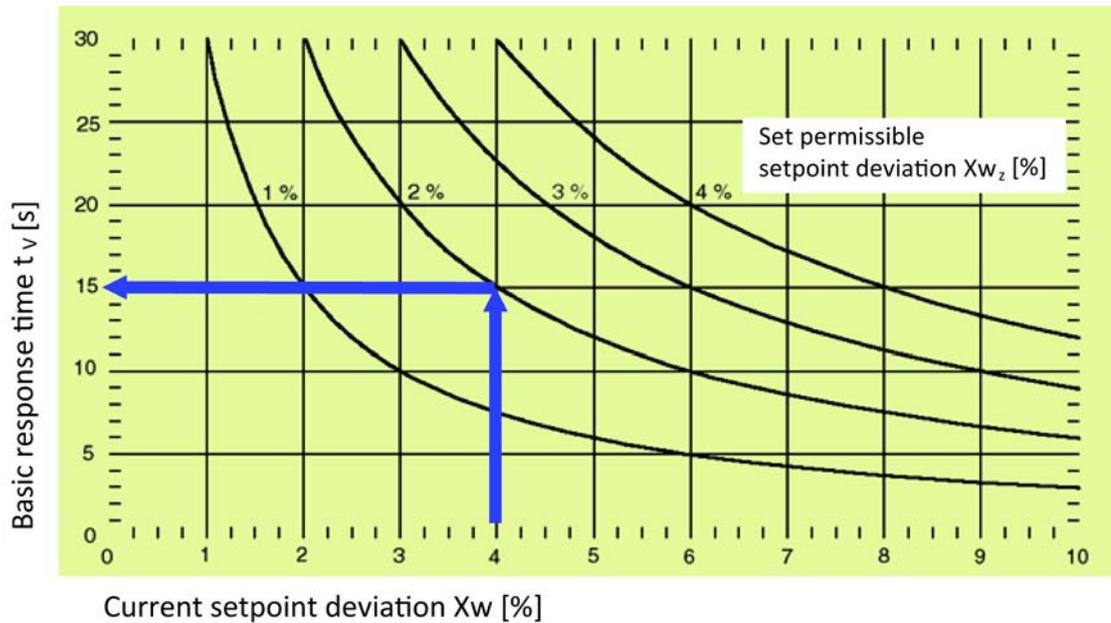
Example:

Current setpoint deviation Xw = 4.0%

Set permissible setpoint deviation Xw_z = 2.0%

Basic response time t_V = 15s (with time factor = 1)

Time program Fast Integral

With the time program Fast Integral there is also a hyperbolic relationship between the setpoint deviation and the reaction time. Compared to the time behavior of Integral, the response times with the Fast Integral program are lower. This time behavior corresponds to the analog voltage regulator REG-5 A/E. The basic reaction time at constant setpoint deviation can be taken from the following chart. Depending on the set permissible setpoint deviation, different characteristics are seen in the diagram.
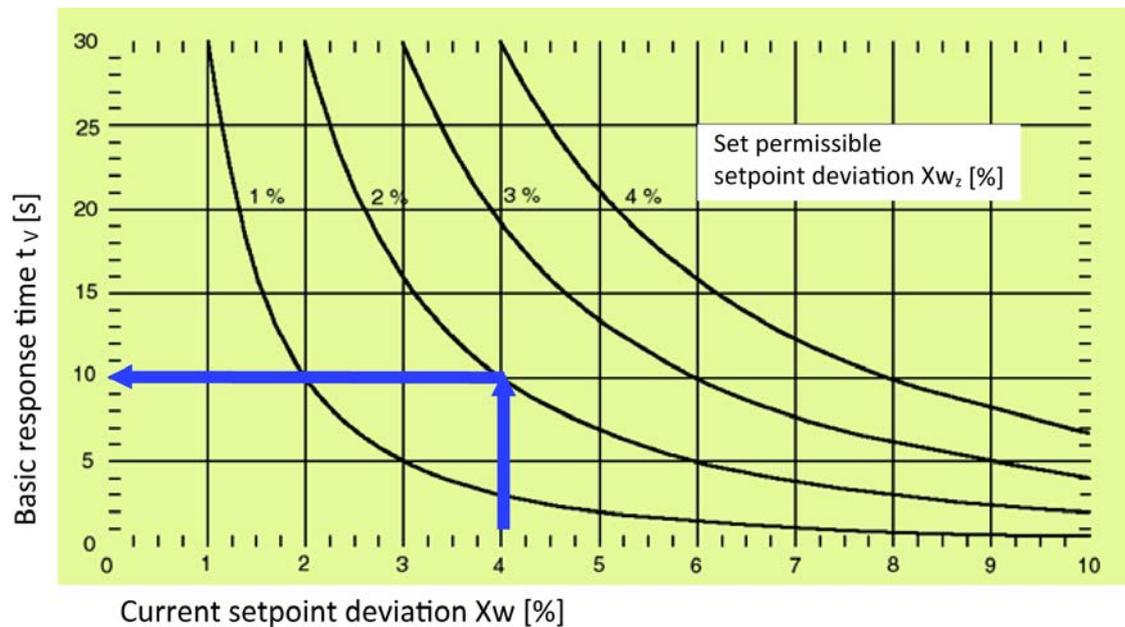
Example:

Current setpoint deviation Xw = 4.0%

Set permissible setpoint deviation Xw_z = 2.0%

Basic response time t_V = 10s (with time factor = 1)

Time program LINEAR

With the time program LINEAR, there is a linear relationship between response time and setpoint deviation. Thus, the influence of the momentary setpoint deviation on reaction time is less than with the hyperbolic curves defining the Integral and Fast Integral behavior. The basic reaction time at constant setpoint deviation can be taken from the following chart. Depending on the set permissible setpoint deviation, different characteristics are seen in the diagram.
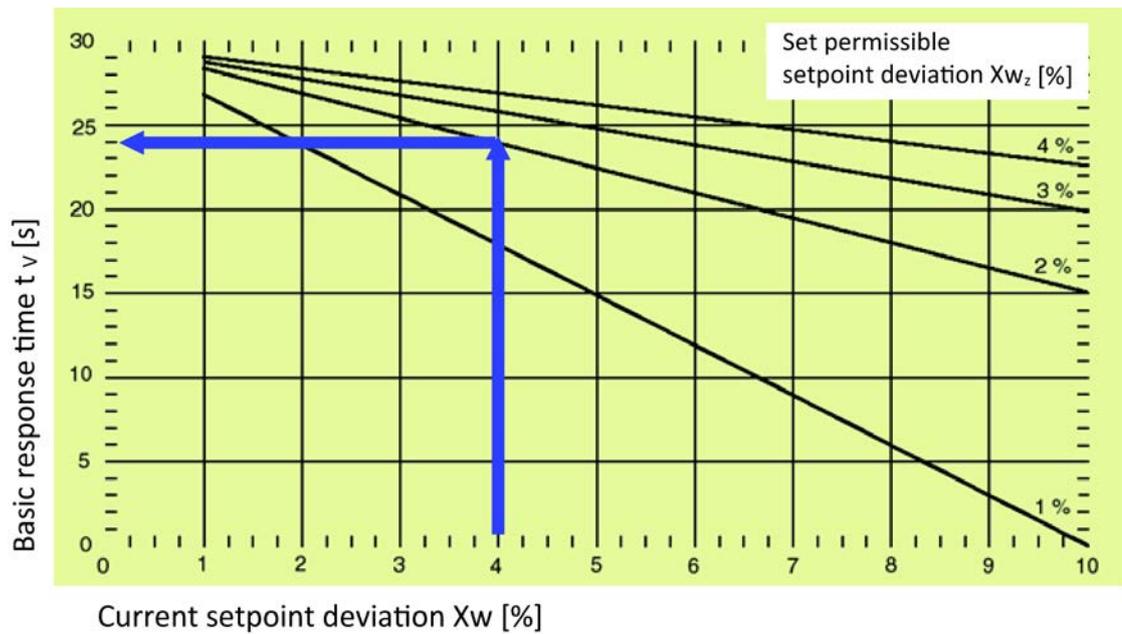
Example:

Current setpoint deviation Xw = 4.0%

Set permissible setpoint deviation Xw_z = 2.0%

Basic response time t_V = 24 s (with time factor = 1)

Time program CONST

As regards the time behavior with CONST, the reaction time depends on the setpoint deviation, either the time T1 or the time T2.

|setpoint deviation| < 2 x permiss. setpoint deviation, then reaction time is equal to T1

|setpoint deviation| ≥ 2 x permiss. setpoint deviation, then reaction time is equal to T2

> **ℹ️ No time factor!**
> The time factor is not used in this time program!

Example:

Permissible setpoint deviation 2.0 %
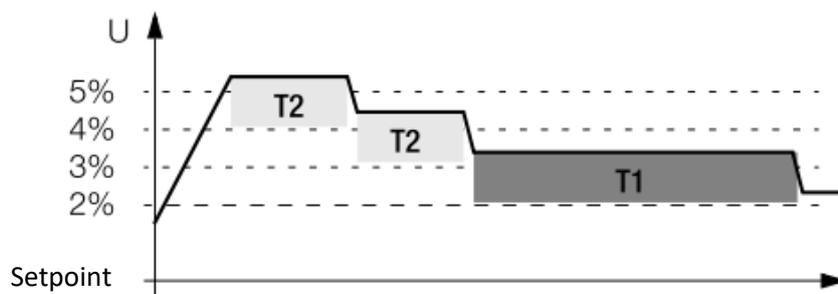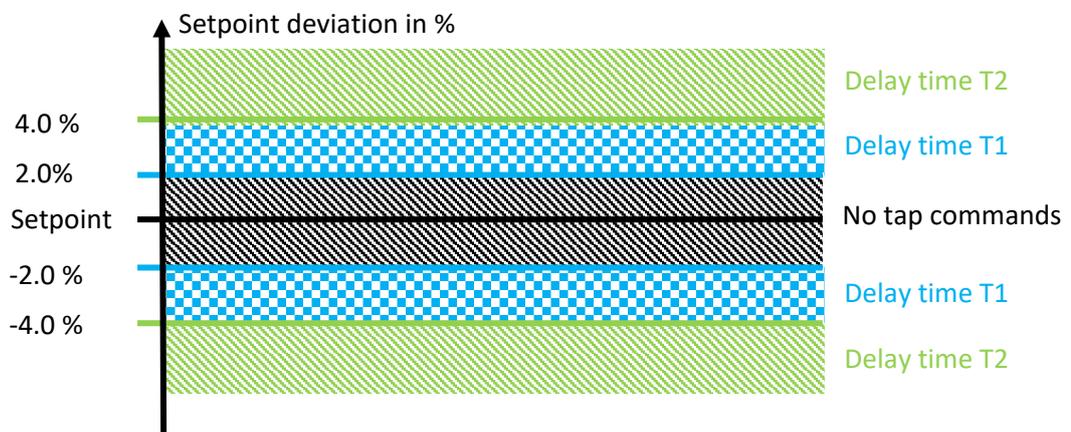
> **ℹ️ Typical setting for T1/T2**
> A general recommended setting can be that the time T2 should be shorter than the time T1, since large setpoint deviations must be corrected faster than small setpoint deviations.

If the times T1 and T2 are set equal, then the response time will always be the same regardless of the current setpoint deviation.

Time factor

SETUP -1-

Time Behaviour:
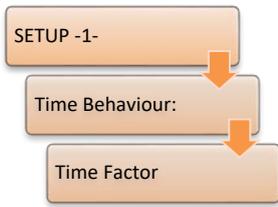
Time Factor

The time factor is used in the following time programs for adjusting the response time to the requirements of the installation or customer.

- Integral
- Fast Integral
- LINEAR

Taking into account the time factor, the reaction time of the regulator is given by:

$$t_V = t_B \times Time\ factor$$

t_v: reaction time

t_B: basic reaction time of the time program

The time factor can be set in the range of 0.1 to 30. That is, it is possible to speed up the basic reaction time by a factor of 10 (time factor 0.1) or slow down the delay time by a factor of 30 (time factor 30).

Typical setting of the time factor

In practice, one usually works with a time factor of 2 to 3. A general recommendation cannot be given at this point, since the correct time factor results from the existing grid and customer situation, respectively.

Time factor in the time program CONST

The time factor parameter is not available in the time program CONST.

T1/T2

SETUP -1-

Time Behaviour
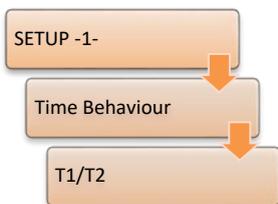
T1/T2

In the menu T1/T2, the reaction times T1 and T2 can be set for the time program CONST. Switching between T1 and T2 is done with the F3 key.

The delay times T1 and T2 can be set in the range 1 to 600s.

Available only with the time program CONST

The parameters T1/T2 are only available with the time program CONST.

Trend memory

SETUP -1-

Time Behaviour
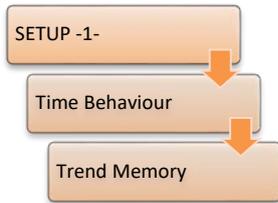
Trend Memory

Using the parameter "Trend memory" all time programs can be provided with a "short-term memory" of setpoint deviation, the trend memory operates in the following manner:

When the voltage leaves the tolerance band, the integration process is started. The regulator changes the tap position after a certain time determined by various parameters (set permissible setpoint deviation, actual setpoint deviation, time factor).

However, if the voltage returns to the preset band and the regulator could not issue a tap command, the integrator is not immediately set to zero, but it reduces its stored value at a constant pace.

If the voltage leaves the tolerance band again a short time later, the tap command tends to be issued earlier, because the integrator has not yet been emptied and can therefore be completely filled more rapidly.

In contrast, if a tap command is issued, the memory will be reset to zero.

Thus, using the parameter "Trend memory" one can achieve that the integrator is not immediately reset when the voltage returns to the permissible tolerance band. If the voltage leaves the band at a time when the memory is not completely discharged, the regulation algorithm will be able to respond earlier because the integration or filling process does not start from zero, but from a higher level.

The general rule is: For the memory charging process that triggers a tap command in the case of a 100% charge, the time according to the selected time program is used. However, for complete discharge of the memory at 100% charge, the time configured as trend memory time is used.

The trend memory can be set in the range of 0 to 60s. A setting of zero is indicated with "---" and means that the function is turned off.

```
C:REG-D(A)       04:29:38

Regulator Mode     AUTO

1.SetPoint       100.0 %
                  20.0kV
Act.Value         20.2kV
Bandwidth         10.00%
Current          0.734 A
Tap-Changer Pos    12


 -10%      0      +10%
 . . . . ! . . . . ! . . . .
              ♠

```
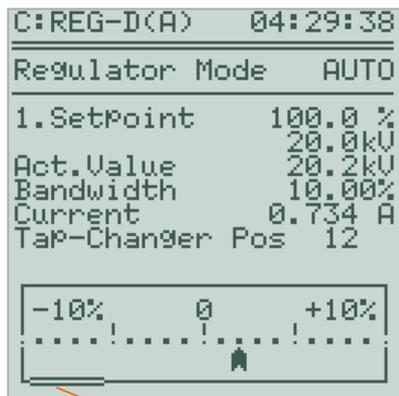
As long as the memory is being filled – the voltage thus being outside the tolerance band – the progress bar is shown as a black bar. If the voltage returns within the tolerance band, the middle of the bar will be highlighted while emptying the trend memory.

The progress bar runs backwards (according to the set trend memory time).

Example:

The Operation of the trend memory will be explained with an example.

Time program: CONST

T1: 40 seconds

Trend memory: 40 seconds

Permissible setpoint deviation: ±1%
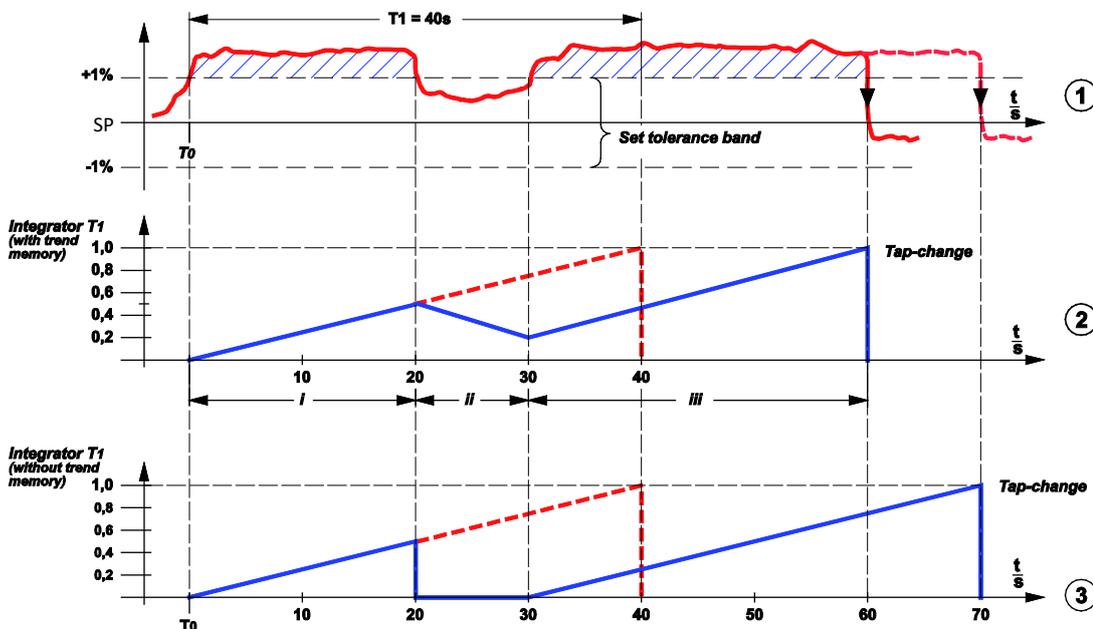
The overall status is illustrated by the three graphs above.

Graph 1 shows the curve of voltage over time. At the time T0 the voltage leaves the tolerance band to return to the band after 20 seconds.

After another 10 seconds, the voltage again leaves the permissible tolerance band to be returned after another 30 seconds due to a down tap command from the regulator, if the trend memory is used.

Without a trend memory, the tap change would be performed only after 40s (see graph 3).

Graph 2 describes filling of the trend memory. When the fill level reaches the normalized value 1, the regulator makes a tap change. However, if the curve reaches the x-axis (value 0) the memory is emptied.

Graph 3 shows the temporal relations without the trend memory. After 20 seconds the integrator for T1 is set to zero, to be recharged after another 10 seconds, starting from zero charge. Now a total of 40 seconds (T1) are needed to fill the memory to such an extent that a tap change process can be initiated.

Functioning of the trend memory can best be explained with the aid of graph 2. In order to explain the individual steps better, the diagram is divided into three sections (i ... iii).

Section i: The voltage lies outside the voltage band, the integrator for the time T1 is running. If the voltage remained for 40 seconds outside the tolerance band, the regulator would issue a tap command, but since the voltage returns to the tolerance band already within 20 seconds, integration is interrupted at this point.

Section ii: The integrator for T1 is half charged (with a total of 50%, or 20 seconds!). Now the discharge starts according to the time setting given for the trend memory (100% => 40 seconds).

Section iii: The voltage only remains within the permissible tolerance band for 10 seconds and then again exceeds the allowable voltage range. In this period, the integrator could only be emptied from a fill level of 50% to 25% (25% => 10 seconds). If the voltage remains for 30 seconds outside the band, the regulator will initiate a command process. With the voltage curve selected in the example, the time up to initiation of the control algorithm is shortened from 70 to 60 seconds by use of the trend memory (see graph 3).

8.1.2.3   Setpoints 1 - 4

SETUP -1-

Setpoint Values..

Setpoint Value 1-4
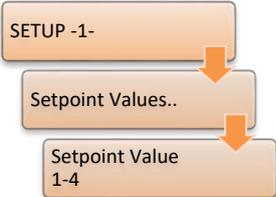
The setpoints make the reference value for regulating the tap changer (further details regarding reference value W can be found at the end of the chapter). The active setpoint is located in the middle of the tolerance band (setpoint ± permissible setpoint deviation).

The REG-DA has four adjustable setpoints.

Generally there are two ways to change a setpoint for regulation. The first is changing the setpoint index. This switches between the four predefined setpoints without changing the value of the setpoint itself. The second way is to leave the setpoint index, and adjust the value of the setpoint. Thus, modification of the individual setpoint can take place via menu, H-program, SCADA system, WinREG, arrow keys (only for setpoint 1) and binary inputs (only setpoint 1). Also a combination of changing the setpoint value and changing the setpoint index is possible. For example, setpoint 2 can be used for regulation while setpoint 1 is adjusted. When adjustment has been completed, setpoint 1 is activated through the set point index.
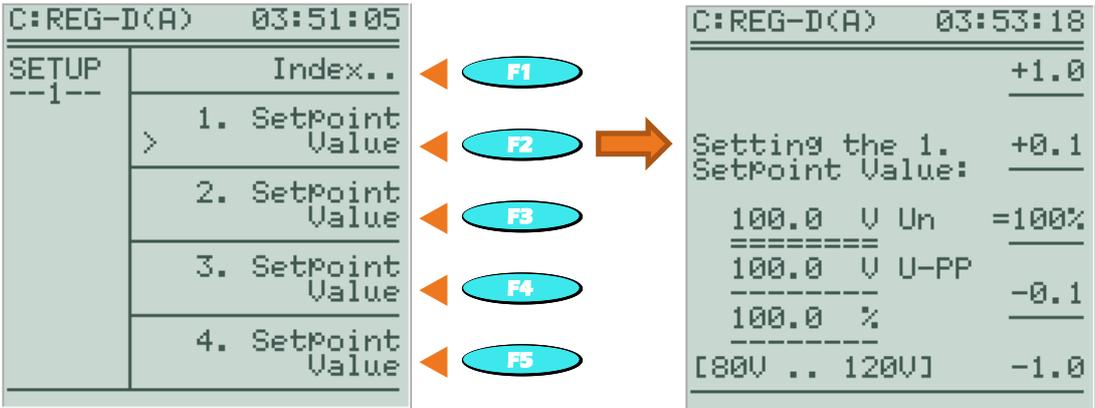
Setting of the setpoint is done with a secondary value (e.g. 101.5 V). This also applies to a setting via REG-L (H-program, WinREG, SCADA system). In addition, indication of the setpoint (phase-to-phase voltage Upp) as a primary value (e.g. 20.3 kV) takes place. For scaling of the primary value, the ratio (Knu) of the voltage transformer is used (see Chapter 8.1.7.20 CT/VT configuration, from page 202 onwards). When using the three-winding transformer function with two different VT ratio (see Chapter 8.3.5 Feature 3winding (three-winding transformer) [protected], from page 258 onwards), scaling is performed with the VT ratio of the currently active winding.

For voltage regulation, the setting range for setpoints is 60 to 140 V. With power regulation, the range is from -140 to 140% of the nominal power (for more information see Chapter 8.3.7. Feature PQCtrl [protected], from page 266 onwards.

The 100%-value for each setpoint can be defined using the F3 key. Thereby, the currently set setpoint value (e.g. 101.5 V) is defined to be 100%. The 100%-value (also called setpoint deviation) sets the reference value for all limits, which are set as a percentage (so long as the parameter limit base is set to 0:setpoint, see Chapter 8.1.7.13 Limit base, from page 197 onwards). That is, if the 100%-value is set to 110 V, for example, 1 % = 1.1 V corresponds for all indications and limits. Since this setting is possible for each setpoint, depending on the setting, switching of the setpoint index (e.g. 1st setpoint -> 2nd setpoint) has an influence on the absolute magnitude (voltage value in volts) of the limits.

The size of the following limit and calculated values depend on the 100%-value:

- Permissible setpoint deviation (tolerance band)
- Current setpoint deviation (display and regulation)
- High-Speed Switching
- Undervoltage <U
- Overvoltage >U
- Inhibit low

Example based on permissible setpoint deviation:

1. Setpoint = 100 V = 100 %	1. Setpoint = 100 V = 90,9 % (110 V = 100 %)
Permissible setpoint deviation = 1.2 %	Permissible setpoint deviation = 1.2 %
lower tolerance limit = 98.8 % = 98.8 V	lower tolerance limit = 89.7 % = 98.68 V
upper tolerance limit = 101.2 % = 101.2 V	upper tolerance limit = 92.1 % = 101.32 V

Permissible setpoint deviation —————— 1.2% (100%=110V)=1.32V
—————— 1.2% (100%=100 V)=1.20 V

Setpoint ———————— 100 V

Permissible setpoint deviation —————— 1.2% (100%=100 V)=1.20 V
—————— 1.2% (100%=110V)=1.32V
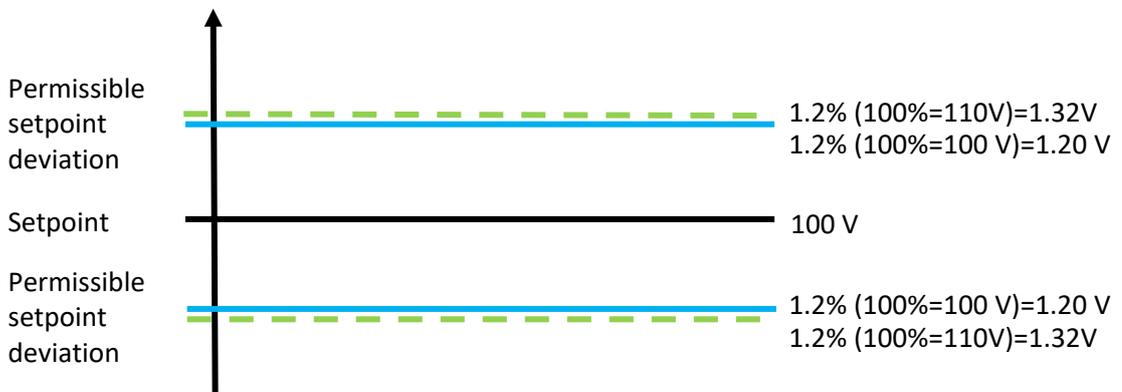
With power regulation (P-/Q-regulation) always apply:

100%-value = 100 V for voltage limits

100%-value = nominal power for power limits (e.g. tolerance band)

High-speed switching for setpoint changes

By default, high-speed switching is activated after changing the setpoint. This serves to bring the voltage as quickly as possible to the new setpoint. If this behavior is not desired, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Reference value W

The reference value W for the voltage of the tap-changing transformer can be either a fixed value (setpoint) or a variable value (setpoint + variable component). A variable reference value can, for example, consist of a fixed setpoint and the current influence, for example, to regulate a remote network point with variable load and variable primary voltage. In addition to a fixed or variable reference value W, an active parallel program based on the circulating reactive current minimization procedure (dIsin(φ), dIsin(φ)[S] or dcos(φ)) can influence the integration of the selected time program (time delay), and hence the issueing of of setting tap commands. The interaction is illustrated in the following function diagram.

8.1.2.4   Setpoint index

SETUP -1-
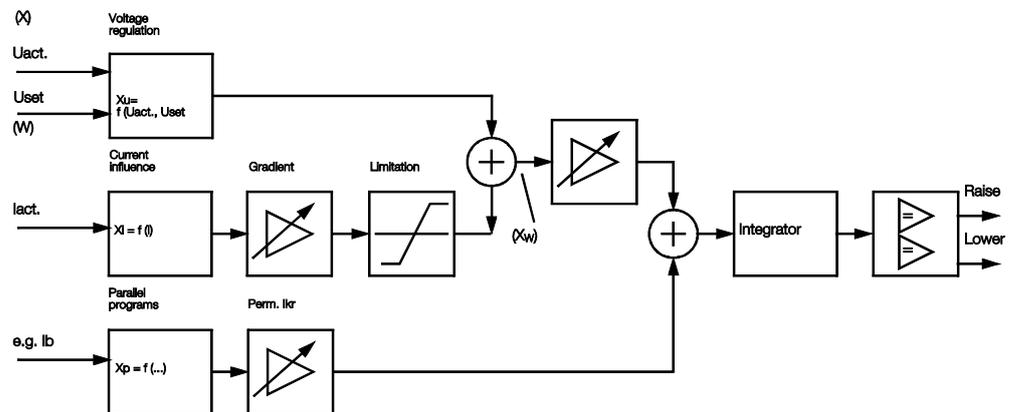
Setpoint Values..
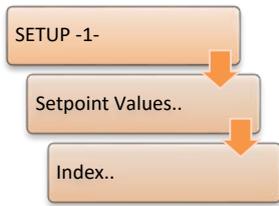
Index..

The setpoint used for regulation can be selected via the setpoint index menu. You can choose between the four pre configured setpoint values 1 – 4. In the selection, the secondary and the primary values are shown for each setpoint.

```
C:REG-D(A)      04:19:16
────────────────────────
SETUP  Select Index:       ◄ F1
--1--
       -1-     101.5 V      ◄ F2
       >        20.30 kV
       -2-     103.0 V      ◄ F3
                20.60 kV
       -3-     100.0 V      ◄ F4
                20.00 kV
       -4-     100.0 V      ◄ F5
                20.00 kV
```
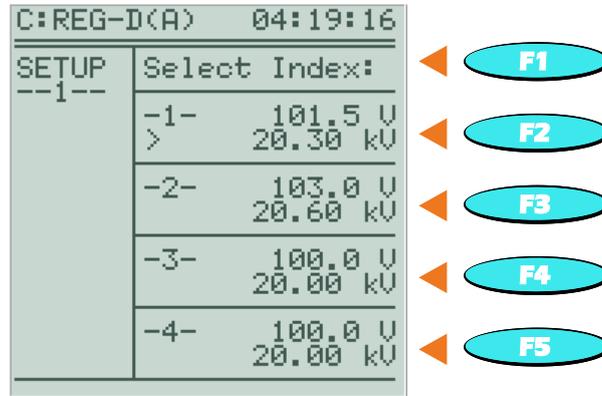
The setpoint index is selected with keys F2 to F5. The currently active setpoint is marked by an angle bracket '>'.

Additional ways to select the setpoint index

Besides selection via the setpoint index menu, the setpoint index can be switched via binary inputs (see Chapter 8.1.7.18 Setpoint adjustment with binary inputs, from page 200 onwards), the arrow keys (see Chapter 8.1.7.17 Setpoint adjustment with ←→ keys, from page 200 onwards), the background program, the service module of WinREG and via the SCADA system.

By default, high-speed switching is activated after changing the setpoint This serves to bring the voltage as quickly as possible to the new setpoint. If this behavior is not desired, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.1.3 Limit values

8.1.3.1 General

The REG-DA limit values allow monitoring and reaction to specific events in the power grid (e.g. undervoltage). The following graph shows the standard available voltage limit values.

Switching hysteresis, switching difference X$_{sd}$

The difference in the input value between switching the limit signal on and off after vanishing of the limit violation is referred to as switching differential. The switching differential X$_{sd}$ has a standard value of 0.5% of the nominal value of the monitored measured value. It can be customized if necessary, to do so, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

The high-speed switching limit and the limit value >Ub use no hysteresis, because here limit values for activating and deactivating the signal vary (e.g. activation on reaching the high-speed forward switching limit and deactivation on reaching the lower tolerance band limit).

Assignment of the limit signal indicator

Each of the limits listed below is monitored by a respective limit signal indicator. For certain limit signal types a special additional function is activated (e.g. high-speed switching).

You can select via a menu whether a limit violation activates a binary output or drives an LED. The assignment is carried out via the menu item "Relay/LED assignment" (see Chapter 8.2.3 Relays, page 217, or Chapter 8.2.4 LEDs, page 221). The signals can also be passed on via the SCADA system.

> **ℹ** **Additional limit values**
>
> Any number of additional limit signal indicators can be created using the programming language REG-L (as a background program).

NOTICE!	**Correctness of limits!**
	Incorrect function of limit value monitoring or influence on regulation.
	⮑ For each limit signal indicator, the limit value can be set arbitrarily within a predetermined range. The user must therefore check the logical relations of the values with each other.

8.1.3.2   <U undervoltage (G6)

SETUP -2-

<U Undervoltage

The undervoltage <U is a limit value, which only influences regulation in special operating circumstances, and can be configured to a LED or an output relay, if necessary.

If the voltage goes below the limit value <U all down commands are suppressed.

The reference value (Setpoint/100 V/110 V) for undervoltage can be selected with the parameter "Limit base" (see Chapter 8.1.7.13 Block if <I or >I, page 197). Especially when working with multiple setpoints, by selecting a fixed reference value (100 V / 110 V) the limit can be fixed for undervoltage, independent of the setpoint used.

```
C:REG-D(A)    05:15:31
─────────────────────
                 +1.0    ◀ F1

Setting the      +0.1    ◀ F2
Undervoltage <U        ──────

  -10.0  %               ◀ F3
========               ──────

[-25% .. +10%]   -0.1    ◀ F4

                 -1.0    ◀ F5
─────────────────────
```

ℹ️   **Suppression of the undervoltage message <U**

From firmware version 2.00, the <U message is suppressed when the measured voltage is less than 20 V.

8.1.3.3 >U overvoltage (G4)

SETUP -2-

>U Overvoltage

The overvoltage >U is a limit value which only influences regulation in special operating circumstances, and can be configured to a LED or an output relay, if necessary.

If the voltage exceeds the limit >U, all up commands are suppressed.

The reference value (setpoint/100 V / 110 V) for overvoltage can be selected with the parameter "Limit base" (see Chapter 8.1.7.13 Limit base, page 197). Especially when working with multiple setpoints, by selecting a fixed reference value (100 V / 110 V) the limit can be fixed for overvoltage, independent of the setpoint used.

```
C:REG-D(A)    05:18:11

                    +1.0   ◄ F1

Setting the         +0.1   ◄ F2
Overvoltage >U

    10.0   %              ◄ F3
    ========

[0% .. +25%]        -0.1   ◄ F4

                    -1.0   ◄ F5
```

8.1.3.4 Over- and undercurrent limit (>I, <I)

SETUP -2-

>I, <I
Current Limits
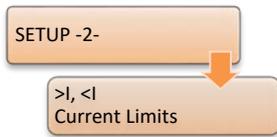
The limits overcurrent and undercurrent are used to monitor the transformer current. The regulator can be optionally inhibited on exceeding or falling below the corresponding limit (no issuing of tap commands.). However, the Inhibit function is only activated if it has been activated previously with the "Block at <I or >I" parameter (see also Chapter 8.1.7.14 Block if <I or >I, page 198).

The selected nominal value (1 A or 5 A) always applies as a limit base.

The limit signal can be set to a binary output, if needed. The limit violation can also be signalled by a freely programmable LED. Transmission via the SCADA system is also possible.

```
C:REG-D(A)    05:19:12
                    +10    ◀ F1

Setting the         +1     ◀ F2
Limit >I
  100.0  %        ..<I     ◀ F3
  ========
[0% .. 135%]        -1     ◀ F4

                    -10    ◀ F5
```
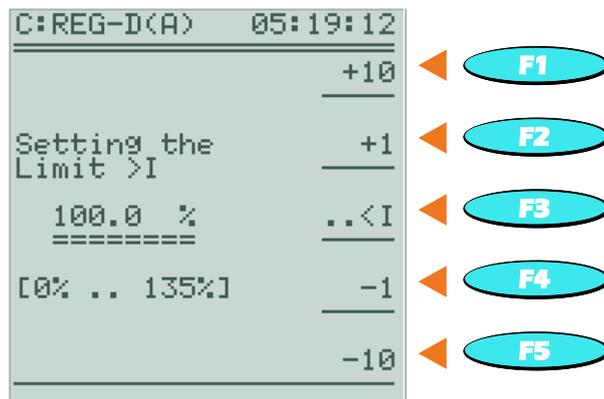
Change between the setting values for overcurrent (>I) and undercurrent (<I) is done by pressing the F3 key.

⚠ WARNING!	**Overcurrent limit as protection against transient overcurrents, e.g. short circuits!**
	Damage to the tap changer and/or the transformer.
	➲ Use the overcurrent limit only for protection of the tap changer against stationary overcurrents, which last more than one second. Due to the measured value averaging procedure, the limit switch is not suitable for short-circuit protection.

8.1.3.5   Inhibit high (G1)

SETUP -3-
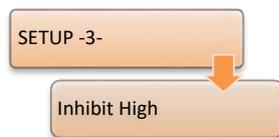
Inhibit High

The limit "Inhibit high" is an upper absolute voltage limit, which causes the regulator not to tap further. Exceeding the limit is indicated as plain text on the screen, and, if necessary, can activate a relay that either triggers a protective element or only transmits this as information to the central control. If the voltage becomes lower than the limit (minus hysteresis), the regulator operates in the usual manner. The setting range for Inhibit high is 65 V to 150 V. The voltage is understood as the secondary-side output voltage of the voltage transformer and can only be entered as an absolute value.

```
C:REG-D(A)      05:23:25
                     +1.0      ◄  F1

Setting the          +0.1      ◄  F2
Inhibit High
   135.0  V                    ◄  F3
   ========
   135.0  V
   --------            -0.1    ◄  F4

[65V..+135V]           -1.0    ◄  F5
```
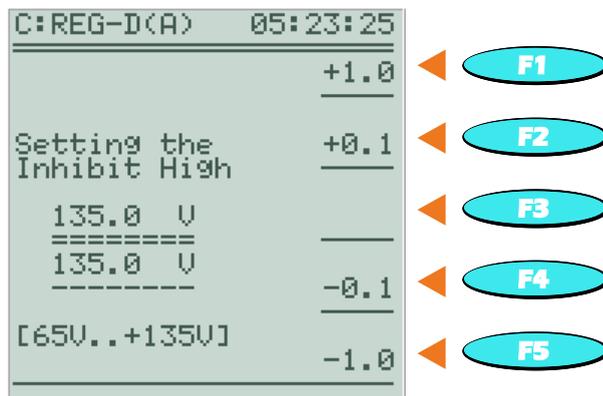
ℹ The Inhibit high limit as an absolute value

The Inhibit high limit is definable as the only limit set as an absolute value (therefore not as a relative value). The reason for this is that the Inhibit high limit is considered to be the maximum tolerable voltage, beyond which the regulator is stopped and possibly a protective element is triggered. Relative values that relate, for example, to the current setpoint, can, however, cause wandering of this limit on switching between different setpoints. Therefore, the inhibit high limit can only be set as an absolute value.

8.1.3.6 High speed switching at over-/undervoltage (G2 or G3)

SETUP -3-

High-speed
Switching
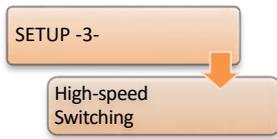
When the voltage leaves the tolerance band, a particular time program will run. The time program determines after which time the regulator issues the first and possibly the next tap commands.

All time programs are based on the consideration that large voltage deviations are corrected rapidly and small voltage deviations slowly.

The high-speed switching limit marks the voltage beyond which the time program is ignored, and the regulator returns the transformer to the voltage band in fast time, which is described by the permissible setpoint deviation parameter.

The high-speed switching time is determined by the TC in operation time of the transformer per switching process. With the TC in operation signal connected, the regulator waits with the next tap change until the TC in operation signal switches off. If no TC in operation signal is connected, the switching frequency adjusts itself to the parameter "TC in operation signal maximum time" (see Chapter 8.1.6.1 Maximum TC in operation time (run time of motor drive), page 185).

The limit base for the high-speed switching limit is always the setpoint. High-speed switching is enabled when the corresponding limit value is reached. High-speed switching is disabled when the voltage returns to the tolerance band (within the permissible setpoint deviation), or the device is switched to MANUAL mode.

```
C:REG-D(A)    05:25:12

                    +1.0    ◄  F1

 Setting the
 Fwd High-speed
 switching at       +0.1    ◄  F2

                    Fwd/
  -10.0  %          Bwd     ◄  F3
 ========

[-35% .. 0%]        -0.1    ◄  F4

                    -1.0    ◄  F5
```
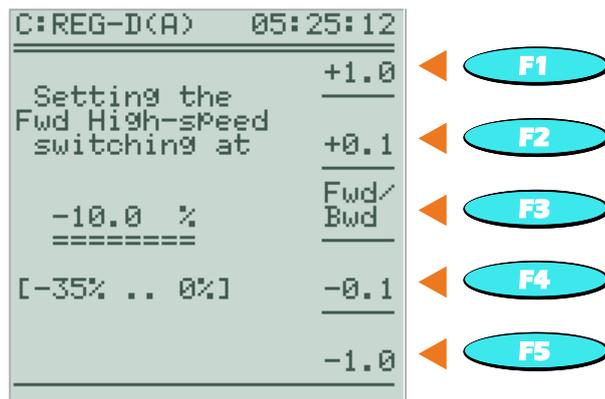
Switching between the setting values for high-speed forward switching (undervoltage) and high-speed backward switching (overvoltage) is accomplished by pressing the F3 key.

8.1.3.7   Inhibit low (G8)

SETUP -3-

Inhibit Low

If the voltage goes below the limit for Inhibit low, the regulator shuts down. This means that automatic regulation is blocked and no more tap commands are issued. If the voltage exceeds the limit (plus hysteresis), the regulator operates in the usual manner.

The reference value (Setpoint/100 V/110 V) for Inhibit low can be selected with the parameter "Limit base" (see Chapter 8.1.7.13 Limit base, page 197). In particular, when working with multiple setpoints, the Inhibit low limit can be fixed regardless of the setpoint used by selecting a fixed reference value (100 V / 110 V).

```
C:REG-D(A)     05:26:40

                   +1.0     ◄  F1

Setting the        +0.1     ◄  F2
Inhibit Low

   -27.0  %                 ◄  F3
  ========

[-75% .. 0%]       -0.1     ◄  F4

                   -1.0     ◄  F5
```

8.1.3.8   Three-winding limit >Ub (monitoring non-regulated voltage)

SETUP -3-

Dreiwickler
Limit >Ub

The limit >Ub is used to monitor the non-regulated voltage in an application with a three-winding transformer which has only one tap changer. Here, in general one of the two secondary voltages is selected for regulation. The other voltage can be monitored for exceeding an adjustable limit (>Ub). If the limit is reached, then up commands are blocked.

Reaching the limit can be reported via LED, relay or the SCADA system. Moreover, in the transducer display the limit >Ub is prefixed by two exclamation marks (for example, !! >U(2) = 5.0%).

The reference value (Setpoint/100 V/110 V) for shutdown can be selected with the parameter "Limit base" (see Chapter 8.1.7.13 Limit base, page 197).

The limit >Ub is activated when the limit value is reached and deactivated when the monitored voltage reaches a defined limit value as follows, or the device is switched into the manual mode. Evaluation of the limit >Ub occurs only in AUTOMATIC mode.

Limit value for deactivation of >Ub:

The monitored voltage must be less than the value obtained from adding the reference value (secondary value) to the permissible setpoint deviation (in secondary volts).

Example: Three-winding transformer limit >Ub:

Three-winding transformer:	110 KV -> 20 kV / 10 kV;
VT ratios:	20 kV -> 200; 10 kV -> 100
Permissible setpoint deviation	1.5 %
Setpoint value 1:	101 V
100%-value:	100 V
	(Limit base setpoint -> 100%-value of the active setpoint)
	(Limit base 100 V -> fix 100 V)
	(Limit base 110 V -> fix 110 V)
>Ub limit value:	5 %
Limit base:	setpoint (reference value)

The 20 kV level is regulated, the 10 kV level is monitored.

Activation >Ub:

$>Ub_{active}$ = reference value + (>Ub limit * 100%-value/100%) = 101 V + (5% * 100V / 100%) = 106 V -> 10.60 kV

The limit> Ub becomes active as soon as the 10 kV level reaches a voltage of 10.6 kV.

Deactivation >Ub:

$>Ub_{inactive}$ = reference value + (bandwidth * 100%-value/100%) = 101 V + (1.5% * 100V / 100%) = 102.5 V -> 10.25 kV

The limit >Ub becomes inactive as soon as the 10 kV level drops below a voltage of 10.25 kV.

```
C:REG-D(A)     13:11:16
═══════════════════════
                  +1.0      ◄ ( F1 )
───────
--Dreiwickler--
  Setting the     +0.1      ◄ ( F2 )
   Limit >Ub             ───────

  5.0    %                   ◄ ( F3 )
  ========            ───────
  10.50 kV
  --------          -0.1     ◄ ( F4 )
                         ───────
[0% .. +25%]
                  -1.0       ◄ ( F5 )
───────────────────────
```

> **Three-winding transformer application and availability of the parameter "Three-winding transformer limit> Ub"**
>
> For a three-winding transformer application, the REG-DA must have the corresponding hardware equipment (feature M9) and the software feature 3winding activated.
>
> The parameter >Ub is only available when the software feature 3winding with limit monitoring is used (see Chapter 8.3.5 Feature 3winding (three-winding transformer) [protected], page 258).

8.1.3.9 Time delay of limit values

SETUP -4-
Time until..

...

The time difference between reaching the limit value and the signal output is referred to as switching delay.

An separate switching delay can be configured for each of the following limit signal indicators:

- <U undervoltage
- >U overvoltage
- Inhibit high
- Inhibit Low
- High-speed forward switching (not shorter than 2s adjustable)
- High-speed backward switching
- Over- and undercurrent (only one time delay)

The setting of time delay takes place partly in a common menu (<U and >U, high-speed switching, >I and <I). Here, switching between the individual settings is done with the F3 key.

```
C:REG-D(A)     05:34:50
                      +10   ◄ F1

Setting the
Time Delay <U         +1    ◄ F2
Undervoltage:
                            ───
   0       s          ..>U  ◄ F3
========

[0 .. 999]            -1    ◄ F4

                      -10   ◄ F5
```
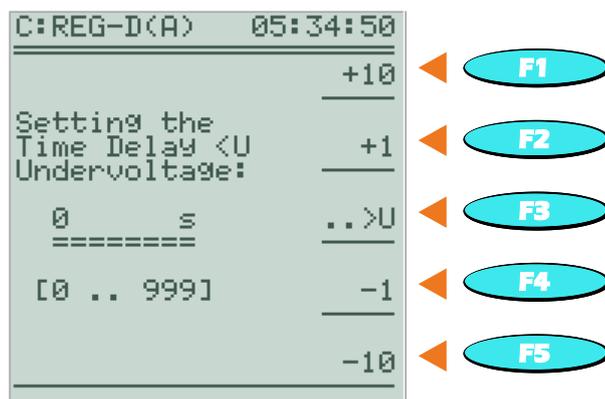
Actual switching delay

Please note that the actual switching delay can be up to 2s greater than the configured switching delay. The difference is due to the selected measurement value averaging procedure.

8.1.4   Current influence
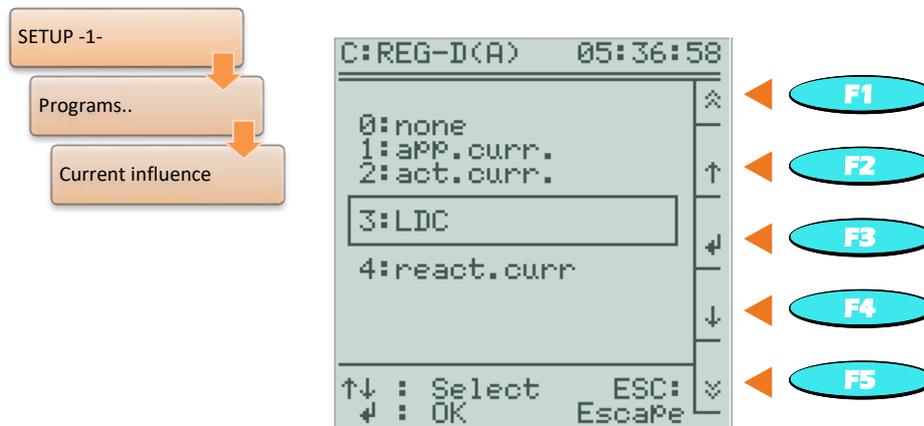
Current-dependent setpoint influence, setpoint = f (I)

The current-dependent setpoint influence allows dynamic adjustment of setpoint by the load current of the transformer. This, for example, permits compensation of voltage drop on the supply line to the consumers. Moreover, by lowering the voltage setpoint at the transformer, it is possible to oppose voltage increases caused by decentralized generation plants.

Displaying the current influence

For a representation of the regulator basic display with current influence, see Chapter 7.2.4 Current-dependent setpoint, page 115.

Total current (only relevant with active parallel operation)

By means of networking the REG-DA in the case of all transformers connected in parallel via a bus, the currents of all transformers can be summed in one regulator. This total current and the selected slope of the Uf/I_L-characteristic gradient serves as a uniform basis for the current-dependent influence of the reference value W for all regulators.

Due to the use of the normalized total current, setting of the gradient of the $Uf/_L$-characteristic curve can be performed regardless of the number and also the different characteristic data (nominal power, short circuit voltage) of the parallel-switched transformers, so that changes in these parameters require no readjustment of the gradient St_{Nom}.

Current programs

In general, the following programs for current-dependent influencing of the setpoint are available:

● Apparent current-dependent setpoint influence
In this program, the apparent current is used to determine the voltage boost. Raising of the setpoint only takes place when the active power is positive. Lowering of the setpoint in case of a reverse power flow does not take place. The current program only uses the parameters "Gradient (I) pos." and "Limitation (I) max."
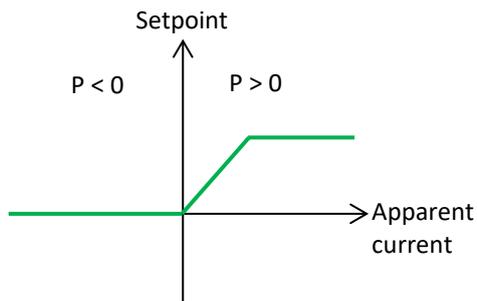
● Active current-dependent setpoint influence
This program uses the active current to determine setpoint change. If a positive active current flows (P > 0, consumption), the setpoint is increased. If a negative active current flows (P < 0, reverse power flow), the setpoint is decreased. The current program will use the parameters "Gradient (I) pos.", "Gradient (I) neg.", "Limitation (I) max." and "Limitation (I) min.".
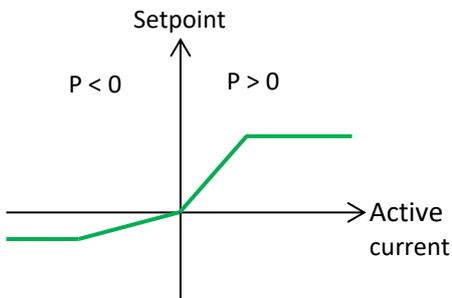
● Reactive-current dependent setpoint influence
The reactive current is used to modify the setpoint. The boost/drop is independent of the sign of the active power. With inductive reactive current, a boost takes place, with capacitive reactive current, a drop of the setpoint occurs. The current program will use the parameters "Gradient (I) pos.", "Gradient (I) neg.", "Limitation (I) max." and "Limitation (I) min.".
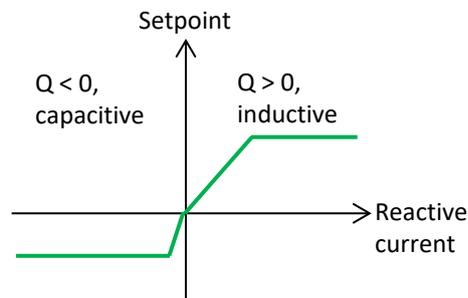
● LDC (Line Drop Compensation)
Is used to compensate the voltage drop on a line whose active and reactive resistance is known. Here, the voltage drop on the line is calculated using a simplified line equation. The parameters "Gradient (I) pos." and "Gradient (I) neg." are not used in this procedure.

The parameters "Limitation (I) min." and "Limitation (I) max." remain effective.

NOTICE!	**Incorrect power direction!**
	Incorrect function of the current influence and thereby deterioration of the mains voltage.
	➲ Correct connection and configuration of the current and voltage transformers (control in transducer mode possible).
	➲ Compliance with A. Eberle definitions, such as the active power direction (supply: P>0, see Chapter 7.2.2.2 Taking measurements, page 91)

Characteristic curve with Gradient (I) and Limitation (I)

The figure below shows the basic course of the setpoint characteristic curve as a function of transformer current for the example of a 20 kV grid (current transformer 2500 A/1A) and the current-influence program active current.
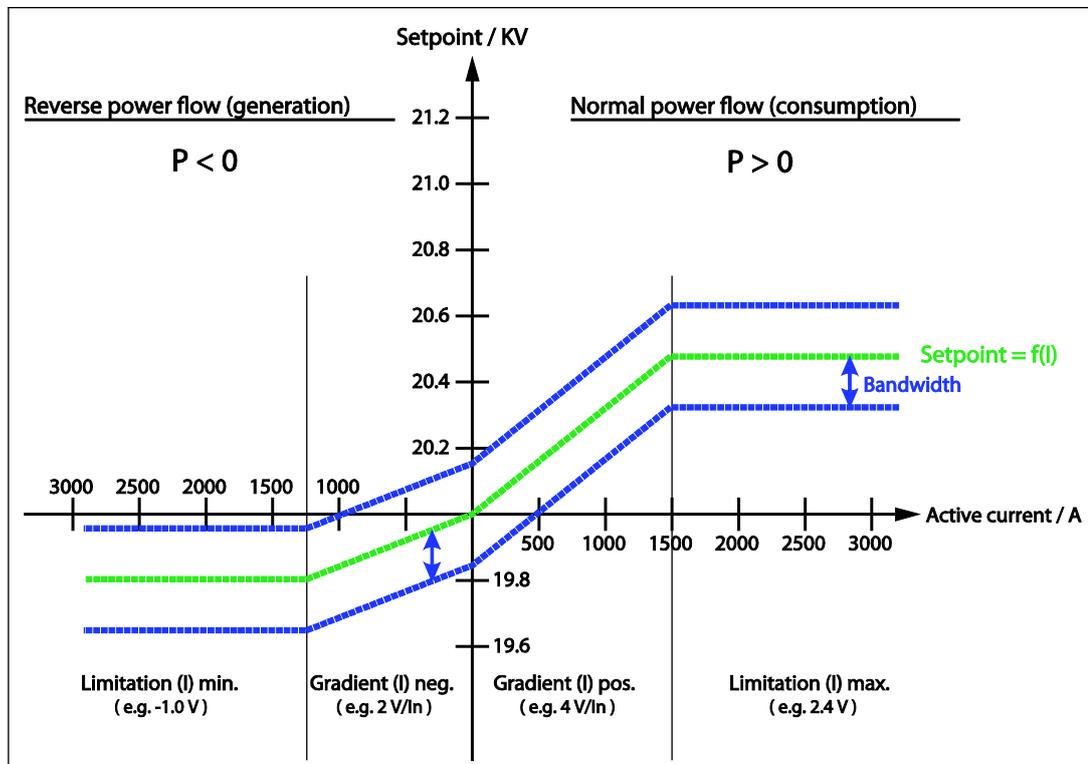
The basic setpoint of 20.0 kV (setpoint with no active current) is increased or decreased according to the settings for the gradient and the limitation, depending on current and the active power direction measured by the regulator. The size of the tolerance band hereby remains constant and moves up and down with the setpoint value.

Gradient (I) for the current programs apparent current, active current and reactive current

The influence of current on the setpoint can be set via the parameter Gradient (I). The characteristic curve "Setpoint = f (I)" describes a line through the origin. The origin thereby forms the configured setpoint, which is used for regulation at I = 0. The two parameters "Gradient (I) pos." and "Gradient (I) neg." always have a positive sign as they describe rising straight lines. The setting of the Gradients indicates by how many volts (secondary value) the setpoint is raised or lowered on reaching the nominal current of the current transformer. A value of "Gradient (I) pos." of 4 V/In in the above example means an increase in the nominal value by 4 V (corresponding to 800 V primary) at I = In = 2500 A.

"Gradient (I) pos." is used in raising the setpoint. "Gradient (I) neg." is used in lowering the setpoint. Depending on the selected current-influence program, the setpoint is raised or lowered due to the apparent current (only increase), active current or reactive current. Both Gradient settings are not used with the LDC program.

The Gradient (I) can be calculated using the following formula:

$$St = \frac{\Delta U}{Knu \times I_{xd}}$$

$$[St] = \frac{V_{sec}}{I_n}$$

Where:

St: Gradient (I) for lowering (neg.) or raising (pos.)

ΔU: lowering or raising of the setpoint as primary value (e.g. 800 V)

Knu: Factor of the voltage transformer

I_{xd}:   Current for which ΔU is to be achieved, as a multiple or fraction of the nominal current of the current transformer

$$I_{xd} = \frac{I}{I_n} \times I_n$$

$$[I_{xd}] = I_n$$

SETUP -2-

Gradient (I)

```
C:REG-D(A)      05:40:32

                     +1.0    ◄  F1

Setting the
Gradient [I]         +0.1    ◄  F2
(Pos.)
                     Pos/
     0.0   V/In      neg     ◄  F3
 ------------
     0.00 kV/In
 ============        -0.1    ◄  F4

 [0..400 V/In]       -1.0    ◄  F5
```
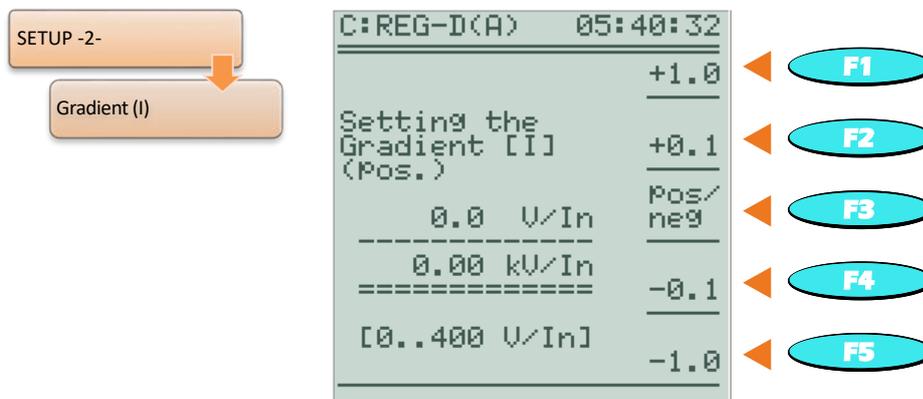
Switching between "Gradient (I) pos." and "Gradient (I) neg." is done with the F3 key.

Limitation (I)

In order to prevent unwanted high or low setpoints from occurring when modifying the setpoint via the current-influence, raising or lowering the setpoint can be restricted via the Limitation (I). After reaching the limitation, the characteristic curve runs horizontally (i.e., the setpoint is no longer being lowered or raised). A value of "Limitation (I) max." of 2.4 V in the above example means limitation of setpoint increase to 2.4 V (corresponding to 20.48 kV primary) at I = In = 1500 A.

In general, a negative value or zero is chosen for the parameter "Limitation (I) min.", a positive value for the parameter "Limitation (I) max.". The limitations are active in all current-influence programs.

$$B = \frac{\Delta B_{prim}}{Knu} \qquad\qquad [B] = V_{sec}$$

Where:

B: Limitation (I) for lowering (neg.) or raising (pos.)

ΔB_{prim}: Limitation (I) for lowering/raising as primary value (e.g. 0.5 kV)

Knu   factor of the voltage transformer

Switching between "Limitation (I) max." and "Limitation (I) min." is done with the F3 key.

Example of an active current program

Specifications:

Voltage transformer:	20 kV / 100 V
Current transformer:	2500 A / 5 A
Setpoint without current influence:	20.4 kV

Consumption (P > 0): Raising the setpoint to 20.8 kV with 800 A active current, max. setpoint = 21.0 kV

$$I_{xdB} = \frac{I}{I_n} \times I_n = \frac{800A}{2500A} \times I_n = 0{,}32 I_n$$

$$St_{pos} = \frac{\Delta U}{KNU \times I_{xdB}} = \frac{400V}{200 \times 0{,}32 I_n} = 6{,}25 \tfrac{V}{I_n}$$

$$B_{max} = \frac{\Delta B_{prim}}{KNU} = \frac{600V}{200} = 3V$$

Reverse power flow (P < 0): Lowering the setpoint to 20.0 kV with 100 A active current, min. setpoint = 20.0 kV

$$I_{xdR} = \frac{I}{I_n} \times I_n = \frac{100A}{2500A} \times I_n = 0{,}04 I_n$$

$$St_{neg} = \frac{\Delta U}{KNU \times I_{xdR}} = \frac{400V}{200 \times 0{,}04 I_n} = 50 \tfrac{V}{I_n}$$

$$B_{min} = \frac{\Delta B_{prim}}{KNU} = \frac{-400V}{200} = -2V$$
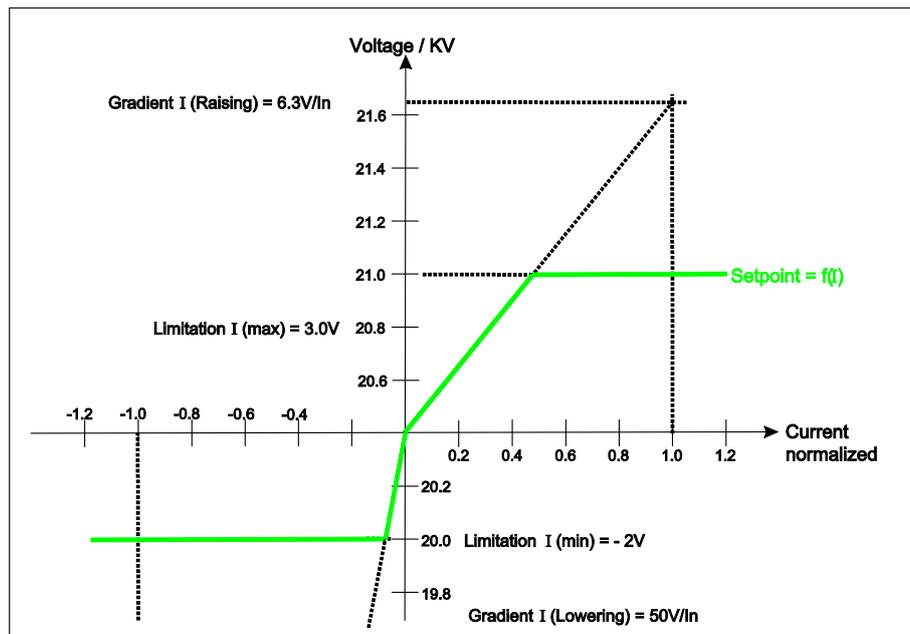
LDC (Line drop compensation)

The LDC program recreates, based on a line model (R and X_L) the line in the regulator, and determines the voltage difference of the effective values between the beginning of the line (transformer) and the selected load point, depending on the current and the cosφ and uses it as a correction value for the setpoint.

The LDC program is based on the following simplified line model:
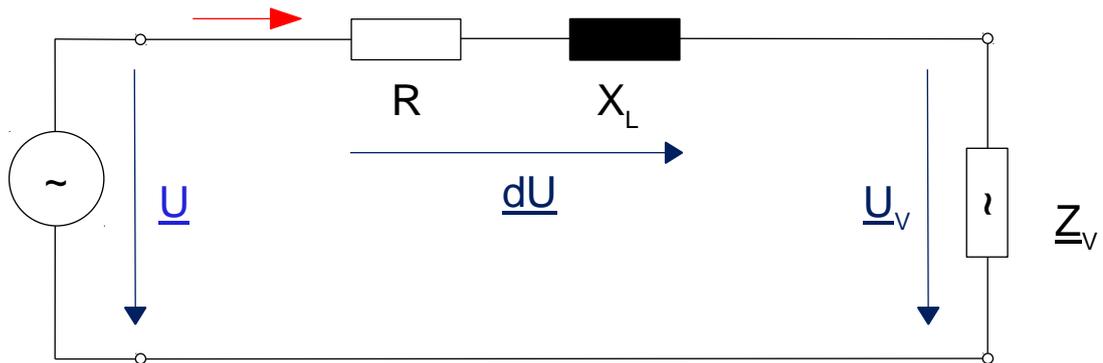
The above circuit diagram gives:

$$-\underline{U} + R * \underline{I} + jX_L * \underline{I} + \underline{U}_V = 0$$
$$\underline{U} - \underline{U}_V = R * \underline{I} + jX_L * \underline{I}$$

with $\underline{U} - \underline{U}_V = \Delta\underline{U}$
and $\underline{I} = I * \cos(\varphi) + j * I * \sin(\varphi)$

$$\Delta\underline{U} = R * I * \cos(\varphi) + j * R * I * \sin(\varphi) + j * X_L * I * cos(\varphi) - X_L * I * \sin(\varphi)$$
$$\Delta\underline{U} = R * I * \cos(\varphi) - X_L * I * \sin(\varphi) + j * [X_L * I * cos(\varphi) + R * I * \sin(\varphi)]$$

$\underbrace{\qquad\qquad\qquad\qquad}_{Real\ part\ (R)}$ $\underbrace{\qquad\qquad\qquad\qquad}_{Imaginary\ part\ (I)}$

Since the REG-DA always uses phase-to-phase voltages as a control value, the voltages $\underline{U}$ and $\underline{U}_V$ of the above figure can be interpreted as phase-to-phase voltages. Since the voltage ΔU is a phase to earth voltage, it must be multiplied by the factor $\sqrt{3}$.

In addition, the following assumptions are made:
$\underline{U}$ is real ("Position of the pointer" freely selectable). This corresponds to $U = U_R$.

The angle at the load point is designated with φ. The difference between φ at the transformer and φ at the load point can usually be ignored. Therefore: φ_Load = φ_Trafo

For the real and imaginary parts this results in:

$$U_{VR} = U_R - \sqrt{3} * \Delta U_R = U - \sqrt{3} * (R * I * \cos(\varphi) - X_L * I * \sin(\varphi))$$
$$U_{VI} = U_I - \sqrt{3} * \Delta U_I = -\sqrt{3} * (X_L * I * \cos(\varphi) + R * I * \sin(\varphi))$$
$$U_V = \sqrt{U_{VR}^2 + U_{VI}^2}$$

Hereby the setpoint influence is given as a secondary value with the factor Knu of the voltage transformer:

$$x_i = \frac{U - U_V}{Knu} \qquad\qquad [x_i] = V_{sec}$$

Example:

The following values are configured in the regulator or can be measured:

$U = 20\ kV$
$I = 100\ A$
$\cos(\varphi) = 0 \quad inductive$
$Knu = 200$
$R = 0\ \Omega$
$X = 5\ \Omega$

The voltage U_V is given by:

$U_{VR} = U_R - \sqrt{3} * \Delta U_R = 20\ kV - \sqrt{3} * (100\ A * 5\ \Omega) = 19{,}134\ kV$
$U_{VI} = U_I - \sqrt{3} * \Delta U_I = 0$
$U_V = U_{VR} = 19{,}134\ kV$

The setpoint influence x_i (raising) as a secondary voltage is given by:

$$x_i = \frac{U - U_V}{Knu} = \frac{20\ kV - 19{,}134\ kV}{200} = 4{,}33\ \text{v}$$

Calculating the voltage drop on a line

The Excel program "Spannungsfall" for calculating the voltage drop on a line is available for download on the A. Eberle Homepage (http://www.a-eberle.de).

LDC parameter

The LDC program uses the parameter R, X, "Limitation (I) min." and "Limitation (I) max." The menu entry LDC parameter is only available after selecting the LDC program.
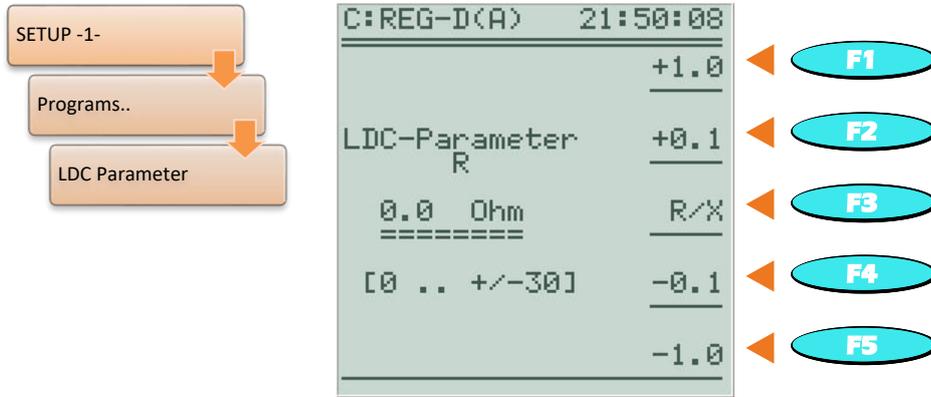
Switching between R and X is done with the F3 key.

8.1.5 Parallel operation

8.1.5.1 General

If parallel coupled transformers do not have the same data (uk, vector group, number of taps, tap change ratio) or identical transformers stand at different taps, within such a parallel circuit there always flows a reactive current, which is independent of the load current. This current increases the transformer load, causes losses, and must therefore be avoided.

With parallel operation on a busbar, the terminal voltage of all transformers – even with different tap positions – is forcibly set to the same value. Therefore the voltage of transformers connected in parallel cannot be a regulation criterion by itself. In order to set parallel transformers on a busbar with different parameters to the required voltage and optimum tap position, voltage regulation must be supplemented by circulating reactive current regulation (parallel program dIsin(φ), dIsin(φ)[S] or dcos(φ)). However, if the transformers are the same, a stable parallel operation can be implemented using the voltage and tap position (parallel programs Master-Follower, MSI or MSI2).

A parallel operation of several transformers must always be prepared. As a rule, first the tap positions of the transformers involved in the parallel scheme must be equalized, and the circuit breakers and isolators placed in the appropriate positions. Finally, these switching states must be passed on to the Relay for Voltage Control & Transformer Monitorings involved in the parallel circuit.

The Relay for Voltage Control & Transformer Monitoring REG-DA is also equipped with the so-called ParaGramer, which is independently able to recognize the switching states of the individual transformers, and which groups regulators automatically according to the switching states, so that only the regulators that supply a common busbar work together in parallel. For a detailed description of the ParaGramer function, see Chapter 8.3.2 from page 237 onwards.

> **Total current**
> **(only relevant when using current influence, see Chapter 8.1.4 page 159)**
>
> Through networking of all REG-DA of the parallel coupled transformers via a bus, the currents from all transformers connected in parallel are summed in a regulator for evaluation of the current influence. This total current serves as a uniform basis for the current-dependent influence on the setpoint for all regulators.

Publication "Parallel Regulation of Transformers"

A Publication "Parallel Regulation of Transformers" with further information can be found on the A. Eberle Homepage (http://www.a-eberle.de) in the Download Centre under Publications

⚠ CAUTION!	**Please note that only REG-DA Relays for Voltage Control & Transformer Monitoring with the same firmware version may be run in parallel operation. Otherwise, malfunctions may appear in the course of this operation.**
	The current firmware version can be queried via the HMI of the regulator. Please press the Menu key until you reach SETUP 6. You can now select the status page of the regulator with F5. In the first and second line appears the firmware version, for example, V2.23 of 18.12.12 (18 December 2012).
	In case different versions are currently loaded, please download the required firmware from our homepage (http://www.a-eberle.de) or contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.1.5.2 Parallel programs

```
SETUP -1-
    │
    ▼
Programs..
    │
    ▼
Parallel Program
```

```
C:REG-D(A)     06:45:53   ◄ F1

  0:none                  ◄ F2
  1:dI*sin(phi)
 ┌─────────────┐
 │2:dcos(phi)  │          ◄ F3
 └─────────────┘
  4:dI*sin(phi)[S]        ◄ F4
  6:MASTER-FOLLOWER
  7:MSI
  8:MSI2
 ↑↓ : Select     ESC: ◄ F5
  ↵ : OK        Escape
```
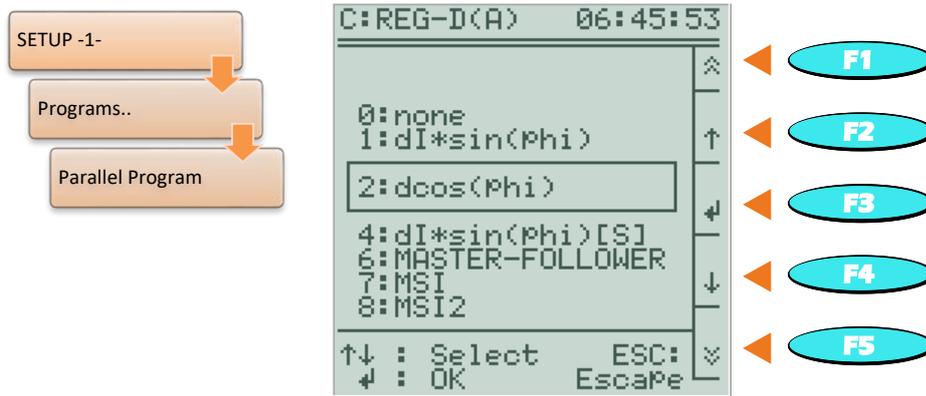
All parallel programs are intended to minimize the circulating reactive current in parallel-connected transformers. Depending on the characteristics of the parallel working transformers (nominal power, tap size, number of taps) and the information made available to the REG-DA (tap position feedback, E-LAN communication, current measurement), there are several parallel programs to choose from. Using the following table, an initial preselection can be made as to which parallel programs are basically eligible, or what requirements need to be considered for a certain parallel program.

Process	Equal nominal power	Unequal nominal power	Same tap size and number	Different tap size and number	Tap position required	Current measurement required	E-LAN communication required
dcos(φ)	yes	yes	yes	yes	O	yes	O
dIsin(φ)	yes	no	yes	yes	O	yes	yes
dIsin(φ)[S]	yes	yes	yes	Yes	O	yes	yes
Master-Follower, MSI/MSI2	yes	yes	yes	no	yes	O	yes

O: Optional for monitoring purposes

In the following the choices for the parameter parallel program are shown at a glance:

Parallel program	Description
0:no	**No parallel operation**
1:dIsin(φ)	**Circulating reactive current minimization procedure for transformers with the same nominal power** The regulators exchange the respective calculated power values with each other via the communication bus E-LAN and then calculate the circulating reactive current. The circulating reactive current acts on the command variable W as configured.
2:dIcos(φ)	**Circulating reactive current minimization procedure which does not require E-LAN communication** A net-cos(φ) must be defined for each regulator. Deviations from this net cos(φ) will be interpreted as circulating reactive current and act as configured on the reference variable W.
4:dIsin(φ)[S]	**Circulating reactive current minimization procedure for transformers with the same and different nominal power** The parallel program is based on the procedure of dIsin(φ). In addition, the nominal transformer power of the associated transformer must be defined in each Relay for Voltage Control & Transformer Monitoring REG-DA so that this can be properly included in the calculation of circulating reactive current.
6:Master-Follower	**Master-slave parallel program which works according to the principle of tap equality** The parallel program is usually the first choice, so long as it regards parallel operation of transformers, which are identical or have the same tap change ratio. The master and slave(s) are always at the same tap level or have a permanent tap offset (from firmware V2.24 onwards).
7:MSI	**Master-Slave-Independent parallel program** Corresponds to the Master-Follower parallel procedure, only selection of the function (master, slave, independent) is done explicitly for each regulator (only selectable with activated ParaGramer feature).
8:MSI2	**Master-Slave-Independent parallel program with two busbars** Corresponds to the Master-Follower parallel procedure, only selection of the function (master 1, master 2, slave 1, slave 2, independent) is done explicitly for each regulator (only selectable with activated ParaGramer feature).

Emergency program "dcos(φ)!!!" in case of an E-LAN communication failure of the parallel programs dIsin(φ) and dIsin(φ)[S]

The dcos(φ) parallel program acts as an emergency program in the event of an E-LAN communication failure between the regulators. This is indicated by the text "dcos(φ)!!!" in the basic regulator display. Hereby the last measured cos(φ) is accepted as Net-cos(φ). This function is only available with the parallel programs dIsin(φ) and dIsin(φ)[S]. When using the parallel programs Master-Follower, MSI and MSI2, the dcos(φ) emergency program is inactive, since the current measurement is not absolutely necessary with these programs, and therefore the conditions for the emergency program are not met.

8.1.5.3 Parallel parameter
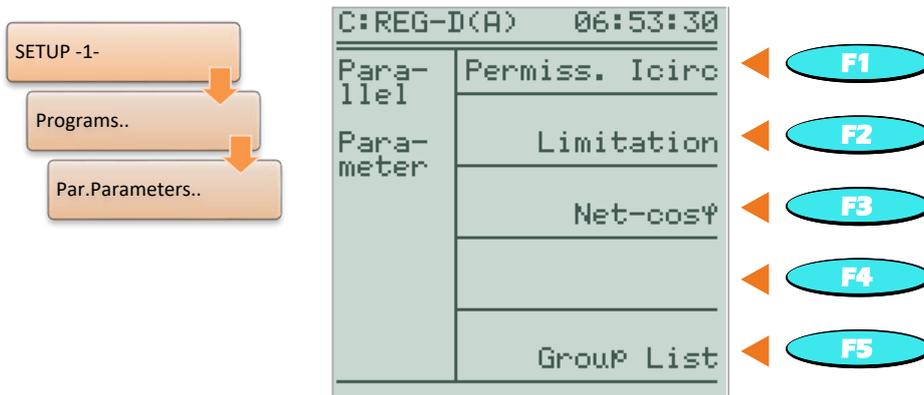
The parallel parameter specifies how much the parallel programs are to engage in regulation and which regulators can participate in the parallel operation.

Different parameters are available depending on the program for transformer parallel regulation:

● Permissible Icirc (influence of circulating reactive current regulation) or Icirc Supervision

● Limitation of the influence of circulating reactive current regulation

● Net-cos(φ) – setpoint of cos(φ) of the grid

● Nominal transformer power

● Transformer group list (identifiers of regulators that can potentially participate in the parallel operation)

Regulation influence or Icirc monitoring
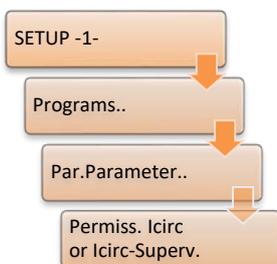
The menu item "Permissible Icirc" and "Icirc Supervision" usually appears when one of the programs dIsinφ, dcos(φ) or dIsin(φ)[S] have been selected. "Permissible Icirc" is critical for the influence of circulating reactive current regulation. Details for determining the Permissible Icirc parameter can be found at the end of Chapter 7.2.3 Parallel operation, from page 109 onwards.

With the programs Master-Follower, MSI and MSI2 selected, the menu item "Icirc Supervision" appears instead of the menu item "Permiss. Icirc". In contrast to the parallel regulatory procedures dcos(φ), dIsin(φ) and dIsin(φ)[S], the circulating reactive current is not directly included in the regulation, but merely represents a limit. If the parameter Icirc Supervision is exceeded, the parallel operation error ParErr will be triggered, which by default causes switching into manual mode of the regulator and the entire parallel group with it.

Limitation

| SETUP -1- |
| Programs.. |
| Par.Parameter.. |
| Limitation |
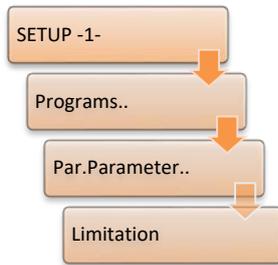
The menu item Limitation appears when the program "dcos(φ)" is selected. The influence of circulating reactive current regulation in the parallel program "dcos(φ)" can be constrained to the reference value W by means of limitation. This determinable maximum influence of the parallel program dcos(φ) can, for example, be used for security purposes, so that a strongly differing phase angle in the low load range cannot alter the setpoint without a limit, and hence no great lasting variations in voltage can occur.

Setting Limitation

If the parameter Limitation is set to zero, then parallel regulation has no influence on voltage regulation. Thus, parallel regulation is disabled. If the value of the limitation is set very large, then with deviations between the configured and actual net-cosφ, a large effect on voltage stability via the parallel regulation can occur.

⮑ For the Limitation setting, choose a meaningful value for the application (such as: 1.5 to 3.0).

Limitation in the case of parallel programs dIsin(φ) and dIsin(φ)[S]

With the selected parallel programs dIsin(φ) and dIsin(φ)[S], since firmware V2.05 the parameter "Limitation" is no longer available by default. The parameter Limitation is set to the value 20 in the background (i.e., it has practically no influence). If the default value of 20 per terminal (REG-L command RegBGDS) is changed to a value between 0 and 19, or is still set to a value dissimilar to 20 after a firmware update, the parameter Limitation also appears in the menus of the parallel programs dIsin(φ) and dIsin(φ)[S].

Net-cosφ

| SETUP -1- |
| Programs.. |
| Par.Parameter.. |
| Net-cosφ |
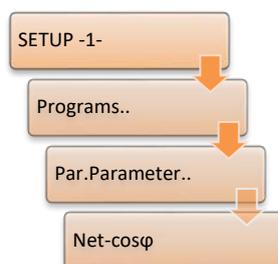
The menu item "Net-cos(φ)" appears when the parallel program "dcos(φ)" is chosen. "Net-cos(φ)" is set to a cos(φ) which prevails in the grid. If the current cos(φ) measured by the Relay for Voltage Control & Transformer Monitoring REG-DA is equivalent to the configured Net-cos(φ), REG-DA assumes that no circulating reactive current is present. Should the current cos(φ) measured by the Relay for Voltage Control & Transformer Monitoring REG-DA deviate from the configured Net-cos(φ), this deviation is interpreted as circulating reactive current.

Nominal transformer power

SETUP -1-

Programs..

Par.Parameter..

Transformer Nominal Power
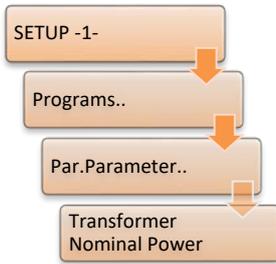
The menu item "Transformer Nominal Power" only appears when the program "dIsin(φ)[S]" has been selected. With the aid of this parameter any REG-DA can obtain the nominal power of the associated transformer, whereby it can be properly taken into account for the calculation of circulating reactive current. Nominal transformer power is not available to the parallel program dIsin(φ), because the same nominal transformer power is assumed in this case by default.

Group list (of possible parallel-coupled transformers)

SETUP -1-

Programs..

Par.Parameter..
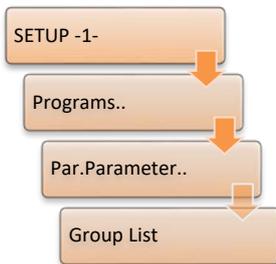
Group List

For all programs, except the "dcos(φ)" procedure, the group list must definitely be entered. The group list must be entered equally in all participating devices that are in parallel operation, i.e., for example, one defines in group list location 1 the device identifier "A:", in group list location 2 the device identifier "B:", in group list location 3 the device identifier "C:" for all devices. Through the group list, each REG-DA is informed of which regulator available in E-LAN is potentially suitable for parallel regulation.

The current parallel state is also indicated by various prefixes in front of the device identifiers registered in the group list. If, for example, a star is shown before the identifiers "A:" and "B:", but not in front of the identifier "C:", it means that the regulators "A:" and "B:" are participating in parallel operation and regulator "C:" is not.

Group lists with the parallel program dcos(φ)

For the parallel program "dcos(φ)", which is normally used without E-LAN, the group list is only required if an E-LAN between the participating regulators is available, and either the ParaGramer is used or a maximum tap difference of the regulators concerned is to be monitored.

Parallel Prog. Activation

SETUP -5-

AddOns 7

Parallel Prog.
Activation
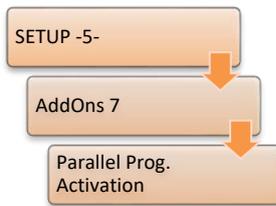
The parameter „Parallel Prog. Activation" determines how the parallel operation will be activated, (i.e., how to switch between single and parallel operation). If the parameter is set to OFF, no parallel operation will take place.

The "ON" setting activates parallel operation. Thus, in the default case (no ParaGramer and no background program), parallel operation can be switched on and off locally on the device. As a rule the "ON" setting must also be selected when using the ParaGramer, because, in this case, parallel operation is initiated over the ParaGramer.

Selecting "LEVEL" causes the selected parallel program to remain active as long as the signal level at the selected binary input is present. By selecting "Pulse" parallel operation can be switched on and off via pulses on the selected binary input. Hereby, a pulse activates parallel operation and the next disables it, and so on. For selection of "Level" and "Pulse" a freely configurable binary input must be assigned the function "08:Par-Prog".

Setting	Behavior
0:OFF	**Parallel operation off**
1:ON	Parallel operation (also switch on with the use of ParaGramer)
2:LEVEL	Activation of parallel operation via a continuous signal to a binary input
3:PULSE	Activation/deactivation of parallel operation by pulses to a binary input

ℹ️ **Activation at all parallel devices (exception: Master-Follower without ParaGramer)**

The parallel program activation parameter determines how the parallel mode is enabled, that is, recognized. Selection of the parallel program itself is carried out in "Setup -1-\ Program". Activation is independent of the selected parallel program and must always be performed on all regulators working in parallel. Excepted regulators operating without ParaGramer in the Master-Follower program. Here, activation of the regulator parallel program which is to be master is sufficient. If activation is still carried out at several regulators, the one where activation was done first becomes master.

1. ParErr after n * TC in Operation time (parallel operation monitoring)

SETUP -5-

AddOns 7

1. ParErr after
n*TCinOperation
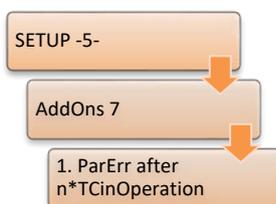
For monitoring tap equality in "Master-Follower" parallel operation, basically two different operating states in automatic mode must be considered.

In the case of an already active parallel operation, the system assumes that tap equality between master and slave(s) in the parallel program Master-Follower after a master tap change will be re-established at the latest after the time interval "2.5 * maximum TC in operation time". This means that the slave should follow suit within this time interval.

In addition to tap alignment of an already active parallel group after a master tap-change command, the tap alignment of a recently started or changed parallel system must be considered separately. Under changed parallel system is to be understood, for example, the selection of a transformer to an existing parallel group, which was supplied by a different busbar or which worked in standby mode. The parameter "1.ParErr after n * TC in operation

time" can be used to determine by how many taps a newly selected transformer may differ from the existing transformers running in parallel**,** or which tap difference is permissible when restarting a Master-Follower parallel regulation.

The following applies to starting parallel operation:

- Activation of parallel operation in automatic mode
- Changing the master regulator in automatic mode
- Switching from manual to automatic

When you add a transformer to an existing Master-Follower parallel regulation, the transformer will be introduced tapwise as soon as possible to the group already operating in parallel (status: follower) and finally added to it (status: slave). If alignment is not achieved during the preselected time, parallel coupling is stopped and a parallel operation error (ParErr) triggered. In the standard configuration, this leads to switching the regulator to manual mode.

"1 ParErr after n * TC in operation time" is a time interval, not a maximum tap difference

The parameter "1 ParErr after n * TC in operation time" (default value = **4**) does not specify the number of taps that the slave/follower can be separated by at the start or selection of the transformer into parallel regulation of the master! In contrast, the parameter indicates a permissible time interval (n * maximum TC in operation time), after which ParErr is triggered due to tap inequality.

Availability of parameters

The parameter "1 ParErr after n * TC in operation time" is only available in the regulator menu if one of the parallel programs Master-Follower, MSI or MSI2 is selected.

It is possible to determine the parameter "1 ParErr after n * TC in operation time" so that a certain number of taps is possible. The following formula is used to determine the parameter "1 ParErr after n * TC in operation time" on the basis of permissible number of taps which can be followed:

$$1. ParErr\ after\ n * TC\ in\ operation\ time \geq \left[\left(\frac{T_{TCinOp} + x \times T_{TCinOp-eff} + (x-1) \times 4s}{T_{TCinOp}} \right) - 0{,}6 \right]$$

where:

x :   taps that can be followed before a ParErr is issued

T_{TCinOp}:   maximum TC in operation time

$T_{TCinOp-eff}$:   effective run time of the tap changer in seconds

Example:

The transformer/regulator to be switched in stands in rest position at tap 5. The group operating in parallel is currently working on tap 8 (x = 3), the motor run time between two taps is 7 seconds (T_{TCinOp_eff} = 7s) and the "maximum TC in operation time" is 8 seconds (T_{TCinOp} = 8s).

If, regardless of occuring circulating reactive currents, one wishes to switch in a transformer which is at level 5 to the parallel working group, the parameter "1 ParErr after n * TC in operation time " must be set to at least 5 according to the following calculation:

$$1. ParErr\ after\ n * TC\ in\ operation\ time \geq \left[\left(\frac{8s + 3 \times 7s + (3-1) \times 4s}{8s} \right) - 0{,}6 \right]$$

$$1. ParErr\ after\ n * TC\ in\ operation\ time \geq 4{,}025$$

$$1. ParErr\ after\ n * TC\ in\ operation\ time = 5$$

The monitoring algorithm of the parallel program thus waits 5 times the "maximum TC in Operation time" (5 x 8 seconds = 40 seconds) for the connected transformer before a parallel error (ParErr) is triggered. During this time, the new transformer can be "pulled" to the tap of the group under normal circumstances. If it does not participate, the error flag ParErr is set and the whole group switched to manual mode.

Permissible Difference of Taps (monitoring parallel operation)

SETUP -5-

AddOns 7

Permissible Difference of Taps
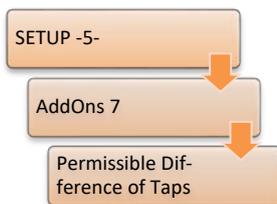
The parameter Permissible Difference of Taps is available with the parallel programs dIsin(φ), dIsin(φ)[S] and dcos(φ). The function is only active when an E-LAN connection exists between the regulators. In the Master-Follower program, no tap difference is allowed (except for a fixed tap offset between the regulators – from firmware V2.24), so the parameter is not displayed here.

The maximum tap difference parameter indicates how many taps transformers working in parallel may run separated from each other. If the permissible difference is exceeded, the parallel operation error (ParErr) is triggered. In the standard configuration, this leads to switching the regulator to MANUAL mode. The parameters can be adjusted in the range from 0 to 6. The setting value 0 is shown as "---" and turns off the monitoring. That is, with a setting of 0 no monitoring of the tap difference takes place.

Availability of the parameter

This parameter is available with the use of the parallel programs dIsin(φ), dIsin(φ)[S] and dcos(φ). The function is only active when an E-LAN connection exists between the regulators. In the Master-Follower program no tap difference is permitted, so the parameter will not be displayed here.

Manual/automatic balance at Master-Follower start:

SETUP -5-

AddOns 7

Manu/Auto Balance at M/F Start
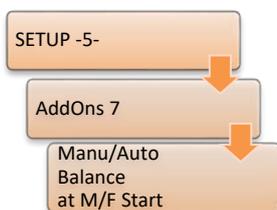
The manual/automatic state of a group working according to the Master-Follower principle is always the same. This means that when a regulator is switched to manual mode, all regulators in this group switch to manual mode. Switching to automatic mode can only be done from the master regulator.

On connecting a transformer to a parallel group of transformers working on the master-follower principle, matching of the manual/automatic state must take place in case of a manual/automatic state of the group that is different from the other transformer. For this purpose, via the parameter "Manual/automatic balance at Master-Follower start: " you can define which state is dominant.

The setting "MasterPrio" leads to matching the manual/automatic state of the additional transformer with the state of the master regulator of the group.

The selection "HandPrio" means that the whole group is switched to MANUAL, if at least one transformer of the new group is set to MANUAL.

Special behavior: different manual/automatic state in a parallel group

Manual/automatic matching was introduced in firmware version 2.00. The original behavior (up to firmware V1.99), which allowed a different manual/automatic state between regulators, can be activated again on request. For questions regarding this matter, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.1.5.4 Detailed explanation of the parallel program "dcos(φ)"

In the following the calculation of circulating reactive current and the effect of the parameters "Permiss. Icirc" and "Limitation" on the parallel program "dcos(φ)" is explained further.

The current circulating reactive current is calculated from the configured "Net-cos(φ)" and the actual cos(φ). It is assumed that with the Net-cos(φ) the circuit reactive current is equal to zero.

$$Icirc_{current}\ [A] =\ I_{current}[A] * (sin(\varphi) - sin(\varphi_{net-cos\varphi}))$$

The ratio of current and permissible circulating reactive current forms the basis for the influence of the parallel program dcos(φ) on voltage regulation. The following formula can be used to determine the setpoint influenced by the parallel program dcos(φ) (virtual setpoint):

$$virtual\ SW\ [V] =\ curr.SW\ [V] + \left(Xw_z[\%] * \frac{Icirc_{current}[A]}{Icirc_{permiss.}[A]} * \frac{100\%Value_{SPcurr.}\ [V]}{100\%}\right)$$

Example:

Current setpoint SP$_{current}$:   100 V (=100%)

Permissible setpoint deviation Xw$_z$:   2.0%

Permissible circulating reactive current Icirc$_{permiss.}$: 50 A

Current circulating reactive current Icirc$_{current}$:   -75 A (inductive)

$$virtual\ SP\ [V] =\ 100\ V + \left(2,0\ \% * \frac{-75\ A}{50\ A} * \frac{100\ V}{100\ \%}\right) =\ 97\ V$$

→   The setpoint drops virtually to 97 V. This provokes lower tap, which reduce the inductive circulating reactive current.

The ratio of current and permissible circulating reactive current in the above formula can be limited using the parameter "Limitation". Thus, the parameter "Limitation" specifies which maximum influence the parallel program can have on voltage regulation. The maximum and minimum virtual setpoint can be calculated using the following formula:

$$virt.\ SP_{min/max}\ [V] =\ SP_{curr.}\ [V] \pm \left(Xw_z[\%] * Limitation * \frac{100\%Value_{SPcurr.}\ [V]}{100\%}\right)$$

Example:

Current setpoint:	100 V (=100%)
Permissible setpoint deviation Xw$_z$:	2.0%
Limitation:	3

$$virt.\ SW_{min/max}\ [V] =\ 100\ V \pm \left(2,0\ \% * 3 * \frac{100\ V}{100\ \%}\right) =\ 100\ V\ \pm 6\ V$$

→ The setpoint changes maximum ± 6 V due to the influence of the parallel program dcos(φ).

8.1.5.5 Detailed explanation of the parallel programs dIsin(φ) and dIsin(φ)[S]

The following describes in detail the effect of the parameters "Permiss. Icirc" and Transformer Nominal Power on parallel regulation of the parallel programs dIsin(φ) and dIsin(φ)[S].

The current circulating reactive current is determined based on the number of parallel transformers and the nominal transformer power of regulators participating in parallel operation. With the parallel program dIsin(φ)[S], the respective nominal transformer powers are freely programmable; with the parallel program dIsin(φ) all nominal transformer powers are assumed to be equal, whereby input of nominal transformer power can be eliminated. Below follows the method for calculating circulating reactive current in two parallel transformers:

$$Icirc_{current}\ [A] =\ I_1[A] * sin(\varphi_1) - \frac{S_{N1}}{S_{N1} + S_{N2}} * Iq_{Ltot}\ [A]$$

$$with \qquad Iq_{Ltot}\ [A] =\ I_1[A] * sin(\varphi_1) - I_2[A] * sin(\varphi_2)$$

where:

Icirc$_{current}$:	current circulating reactive current
S$_{N1}$:	nominal power trafo 1
S$_{N2}$:	nominal power trafo 2
Iq$_{Ltot}$:	total reactive current without circulating reactive current

The ratio of current and permissible circulating reactive current forms the basis for the effect of the parallel programs dIsin(φ) and dIsin(φ)[S] on voltage regulation. The calculation formula for virtual setpoint corresponds to that of the parallel program dcos(φ), see previous Chapter 8.1.5.4 from page 181 onwards.

8.1.5.6 Detailed explanation of the parallel programs "Master-Follower", "MSI" and "MSI2"

The parallel programs Master-Follower, MSI and MSI2 do not differ in their parallel procedures, but only in the way the parallel programs are activated. While the Master-Follower procedure can be used with or without ParaGramer, the parallel programs MSI and MSI2 can only be used with ParaGramer. For more information on ParaGramer see Chapter 8.3.2 ParaGramer including extensions [protected], from page 237 onwards.

For the parallel programs Master-Follower, MSI and MSI2, the circulating reactive current is used for monitoring purposes only, in contrast to the remaining parallel programs. Therefore, the menu item for configuration of permissible circulating reactive current is not designated as "Permiss. Icirc" but "Icirc-Superv.". Calculation of circulating reactive current is carried out according to the calculation of the parallel program dIsin(φ), see Chapter 8.1.5.5 Detailed explanation of the parallel programs dIsin(φ) and dIsin(φ)[S], from page 182 onwards. If the permissible circulating reactive current is exceeded, the regulator switches to manual, and with it the parallel group as well.

If the parallel mode is enabled, one of the regulators of the parallel group becomes master and the others slaves. If several masters are possible, that regulator becomes master which occupies the lowest place in the group list. (The exception is Master-Follower without ParaGramer: Here the regulator who first recognized the parallel operation becomes master.) If the manual/automatic states of the new parallel group are different, the resulting manual/automatic state depends on the parameter "Manual/automatic balance at Master-Follower start", see Chapter 8.1.5.3 from page 174 onwards.

If the parallel group is in manual mode, tap-change commands at the master will lead to tap changes for the entire parallel group. In contrast, tap-change commands at a slave result in no tap changes in the entire parallel group, but only changes in the corresponding slave tap.

If the parallel group is in automatic mode, differentiation must be made between whether it is a just launched or modified parallel system (through activation of parallel operation in automatic mode, change of master regulator in automatic mode, switching from manual to automatic mode), or it is an already active parallel coupling.

In a just started or modified parallel system, if the slaves are on a different tap than the master, the slaves change into follower mode and tap towards the tap position of the master. If the followers reach the tap position of the master within the predetermined time interval "1 ParErr after n * TC in operation time" (see Chapter 8.1.5.3 from page 174 onwards), they switch into slave mode again. If the tap position of the master is not reached within the time interval "1 ParErr after n * TC in operation time ", the parallel operation error (ParErr) is issued, which leads by default to a change of the parallel group to manual mode.

From the time of reaching tap equality, in automatic mode, the system is already an active parallel coupling. From this point, the slaves are tapped together from the master. It is assumed that the slaves have reached the tap setting of the master after a maximum "2.5 * maximum TC in operation time ". Should this not be the case, the parallel operation error (ParErr) will be issued.

The parameters "Parameter Base Tap Position" and "Sync mode" (firmware V2.24)

From firmware V2.24 it is possible to define a tap offset between regulators participating in parallel operation using the parameter "Parameter Base Tap Position". Later, this option is indicated for the parallel programs Master-Follower, MSI and MSI2 by the text "(Including tap offset)".

Also new from firmware V2.24 is the so-called "Sync mode". If at the beginning of parallel operation slaves are on a different tap than the master, the slaves and the master switch to sync mode. In this mode, in contrast to previous firmware versions, slaves are not necessarily pulled to the tap of the master (including tap offset), but the current voltage of the master is also taken into account. This means that either one of the slaves or the master is tapped, depending on the current voltage, so that, with optimum adherence of the setpoint of the master, tap equality is restored (including tap offset).

8.1.6 Tap changer

This chapter describes the settings that are directly related to the tap changer or its motor drive unit.

> **Normal or inverse tap changer**
>
> By default, the REG-DA assumes that for a too low voltage an up command is necessary, leading to a higher tap position. If a different behavior is required, this can be accomplished by using the function "Inverse tap changer" or the feature "Invers".
>
> More information about dealing with an inverse tap changer and the feature "Invers" is provided in Chapter 8.3.12 from page 272 onwards.
>
> Setting of the inverse feature is only possible via the control software.

8.1.6.1 Maximum TC in operation time (run time of motor drive)

SETUP -5-

AddOns 1

Maximum Time
TC in Operation:
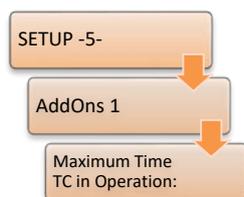
The run time of the motor drive (tap changer) can be monitored with the regulator. On exceeding the set time a signal is issued. This signal can be used to switch off the motor drive. In this way, the tap changer can be protected against overrun.

The first step is to enter the maximum TC in operation time per tap in AddOns-1. As a second step, the TC in operation signal can be assigned to an input (see Chapter 8.2.2 Binary inputs, from page 212 onwards). Finally, via a relay output (see Chapter 8.2.3 Relays, from page 217 onwards) the message " tap changer error" can be placed (relay function "14:TC-Err").

The "maximum TC in operation time" can be set between 3 and 40 seconds.

> **Setting maximum TC in operation time**
>
> Measure the run time of the tap changer and enter a value two to three seconds higher for the "maximum TC in operation time".

> **Maximum TC in operation time on using a PAN-D**
>
> If a PAN-D is used in addition to the REG-DA, the former takes over monitoring of the TC in operation signal. This means that the signal is connected to the PAN-D and the corresponding setting is made there and then passed on to the REG-DA. Setting the maximum TC in operation time on the REG-DA is then not possible.

8.1.6.2   Tap position indication

SETUP -5-

AddOns-1

Tap position
Indication
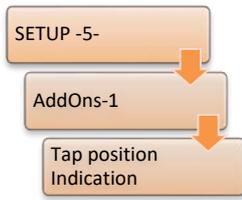
If no signals are available for displaying the tap position, the setting "Off" is selected. In regulator mode, the tap position will be displayed as two hyphens "--".

If, for example, BCD coded signals are available for tap position indication, the setting "ON" is chosen. In regulator mode, the tap position will be shown on the regulator display.

Note

If an error occurs, (e.g.: BCD signals are applied and the parameter tap position is set to "ON"), check the connections and the selected "Input assignment".

If the software switch for the tap position is set to "ON", even though there is no tap position information available, the regulator shows a tap position 0. This display can lead to a wrong conclusions by the operating personnel.

Please also note that the regulator will automatically check the tap position for correctness. However, a prerequisite is that the tap position is switched on. The error indicator TapErr was introduced to signal wrong position settings. The TapErr becomes active as soon as an illogical tap change is reported. However, since proper display of the tap position is not absolutely necessary for regulation of individual transformers, the default TapErr is only informative. For more information about TapErr see Chapter 8.2.7.5 Tap change error (TAPErr), from page 233 onwards.

8.1.6.3 Tap limiter

```
SETUP -5-
   ↓
AddOns-8
   ↓
Tap Limiter
```

```
C:REG-D(A)      07:00:30
─────────────────────────
AddOns-8       |      ..1    ◄ F1
─────────────────────────
Tap Limiter:
                  ON         ◄ F2
─────────────────────────
Highest Tap Position:
                    1        ◄ F3
─────────────────────────
Lowest Tap Position:
                   17        ◄ F4
─────────────────────────
Tap Position 0 longer
(6s) debounced:    ON        ◄ F5
```
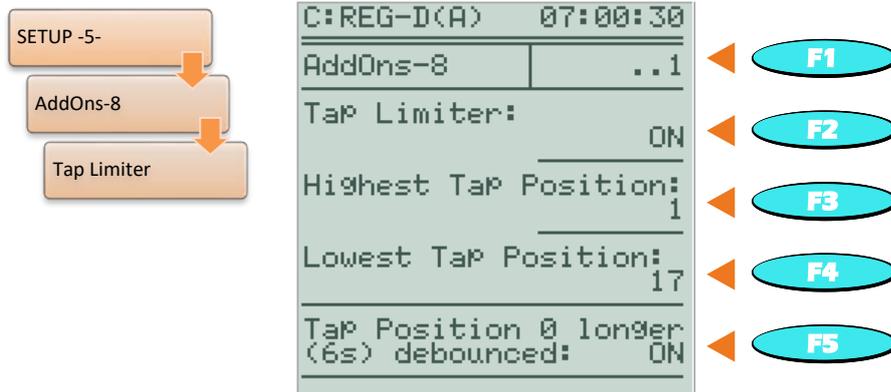
With this function the tap range in which the REG-DA can allow the tap changer to operate can be adjusted. In general, the physically available range of the tap changer is to be set (for example, tap 1 to 19). If the upper tap is reached, then up commands are blocked. If the lower tap is reached, then down commands are blocked. With an inverse tap changer (the feature Invers is set on REG-DA), on reaching the lowest tap, up commands are blocked, as are down commands on reaching the highest tap.

Blocking of tap commands works in the MANUAL and the automatic modes.

If a tap change beyond a tap limit is to be performed, a message appears on the screen that the lowest or highest tap has already been reached.

Setting	Behavior
OFF	**Tap limitation off (no blocking of tap commands on reaching the lowest or highest tap)**
ON	Tap limitation on

Function depends on tap position indication

The tap limitation function will only work if the parameter "Tap Position Indication" ("Setup -5-/AddOns-1") is set to ON. If the tap position indication is disrupted (indication 99 on the display), the tap limitation will be inactive. This means that tap changes are possible in both directions.

SETUP -5-

AddOns-8

Highest Tap
Position
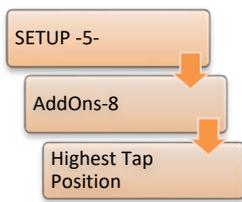
Highest tap position

Here the highest tap position of the tap limitation is set. The range is from -63 to
63.

SETUP -5-

AddOns-8

Lowest Tap
Position
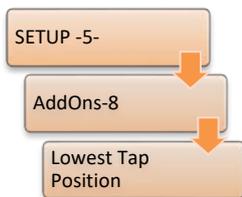
Lowest tap position

Here the lowest tap position of the tap limitation is set. The range is from -63 to
63.

8.1.6.4   Tap 0 longer (6s) debounced

SETUP -5-

AddOns-8

Tap Position 0
longer (6s)
debounced
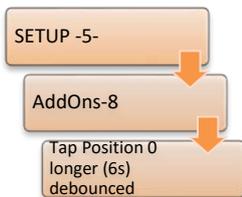
The REG-DA tap position display has a debouncing functionality. This suppresses
invalid tap position indications during tap changes of the tap changer. Usually, the
tap position display is interrupted during the tap changing process and the
regulator will be reporting tap 0 during the switchover time. To suppress a false
tap indication during this time, tap 0 has a longer debounce time (6s). This means
that tap indication 0 is only assumed after it has been on for at least 6 seconds.
For all other tap positions this time is 1s.

But there are application cases in which tap 0 is a normal operating tap, making a longer
debounce impractical. With the "Tap 0 debounced longer (6s)" parameter, the longer
debounce of tap 0 can be switched off.

Setting	Behavior
OFF	Tap position 0 is used as a normal tap position (e.g. tap indication from -9 to 9) and must therefore not be debounced longer.
ON	The tap position 0 is used as an interruption of the signal, for example, occuring during switchover times, and is thus debounced longer (6s).

Debouncing when using a TC in operation signal

If a TC in operation signal is used, debouncing of the tap position is of little
importance, since in this case the tap position will only be considered valid when
the TC in operation signal has dropped.

8.1.7 Configurations and functions

In this chapter all parameters are described that are associated with configuration of the system as well as special functions that have not been described in the area of fundamental values, limits, current influence, or parallel operation.

8.1.7.1 Manual/automatic

SETUP -5-

AddOns-1
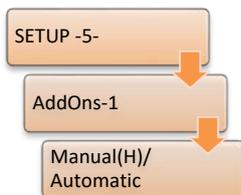
Manual(H)/
Automatic

The regulator provides two different ways for switching operating mode (manual/AUTOMATIC) via the binary inputs. In addition to the possibilities described via binary signal below, the manual/automatic state can also be switched serially via a COM interface or via a SCADA system.

Switchover flip/flop

With the E5-PULS setting, a pulse causes the input E5 to switch from MANUAL to AUTOMATIC, a further pulse at this input causes a reverse shift from AUTOMATIC to MANUAL, i.e., each pulse switches the operating mode.

In this mode, manual mode can be switched to via input 6 (Hand-DLY) with a delay. For this purpose, a signal is required that is present at least for the duration of the delay time. The delay time can range between 0 and 60s, and can be set using a REG-L command (RegHandDelay) via a terminal program. By default, this function is inactive (delay time setting = -1) and thus input 6 has no function in the default case.

Bistable switchover

With the setting E5-A/E6-H, a pulse or continuous signal on input E5 causes a switch from MANUAL to AUTOMATIC mode. Further signals to this input do not change the operating mode, i.e., the regulator remains in AUTOMATIC mode.

The changeover from AUTOMATIC to MANUAL is carried out by a pulse or a continuous signal to the input E6. Further signals to this input do not change the operating mode, i.e., the regulator remains in MANUAL mode. The inputs 5 and 6 work flank-oriented, i.e., application of a continuous signal does not lead to fixing the regulator in the corresponding operating mode.

> **Changeover via binary inputs only in remote mode**
>
> If the "Local/Remote" function is used on the regulator, the manual/automatic switchover via the inputs 5 (and 6) only works in the remote operating mode.

Using inputs 5 and 6 **not** for a manual/automatic switchover and share them with the background program

The selection E5 + 6-PROG disables the switchover of the manual/automatic state via inputs 5 (and 6). This allows use of the inputs 5 and 6 in the background program. Remote manual/automatic switchover can then, for example, be effected via a SCADA system (e.g. IEC 61850).

8.1.7.2   Self-conduct (Manual/Auto remains unchanged after reset)

SETUP -5-

AddOns-1

Self-conduct
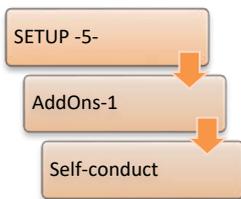
Using the "WITH" setting, the operating mode of the regulator is stored before any failure of the auxiliary voltage, i.e., after restoration of voltage, the regulator is set to AUTOMATIC if it was on AUTOMATIC before the voltage failure, or MANUAL if it was on MANUAL before the voltage failure.

Using the "WITHOUT" setting, the operating mode of the regulator is not stored on an auxiliary voltage failure, (i.e., after voltage recurrence, the regulator is always set to MANUAL).

8.1.7.3   Current display

SETUP -5-

AddOns-2
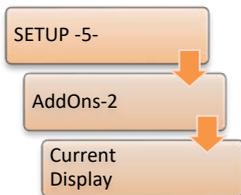
Current Display

With the setting "ON", current is also indicated in the basic regulator display (detail display).

In the setting "OFF" , no indication of current is given in the regulator basic display. The setting can be used to suppress the value 0.000 A in the display in the absence of a current connection or measurement.

8.1.7.4   LCD saver

SETUP -5-

AddOns-2

LCD Saver
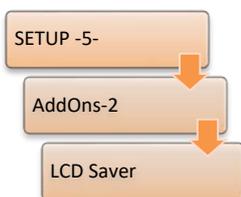
If the parameter "ON" is set, the display shuts off one hour after the last keystroke. The backlight switches off about 15 minutes after the last keystroke.

The setting "OFF" means that the display always remains on and only the backlight switches off about 15 minutes after the last keystroke.

8.1.7.5 LCD contrast

| SETUP -6- |
| General 2 |
| LCD Contrast |
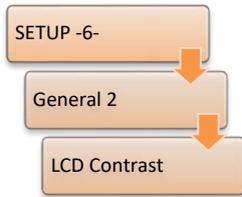
Using the contrast setting, the regulator display can be controlled so that it is easy to read from different viewing angles.

8.1.7.6 Regulator-Mode Large Display

| SETUP -5- |
| AddOns-2 |
| Regulator-Mode Large Display: |
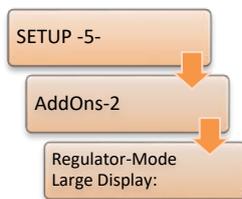
The Regulator-Mode Large Display switches the regulator basic display between detail and large display. When set to "OFF", the detail view of the regulator basic display appears. The setting "ON" selects the large display, which only displays current voltage and tap position.

Note:

In regulator mode, switching back and forth from the normal to the large display is done by pressing F1.

8.1.7.7 Language

| SETUP -5- |
| AddOns-2 |
| Language |
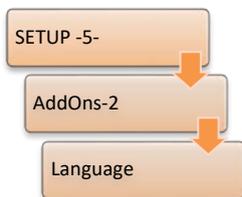
In the submenu Language, the display language of the REG-DA can be set.

The following languages are available:

1. German
2. English
3. Español (Spanish)
4. Italiano (Italian)
5. Français (French)
6. Nederl. (Dutch)
7. Cesky (Czech)
8. Russki (Russian)
9. Polski (Polish)
10. Portug. (Portuguese)

Order feature

The delivery language set depends on order feature A.

8.1.7.8   Up/down relay on-time

SETUP -5-

AddOns-3

Up/Down Relay
ON Time
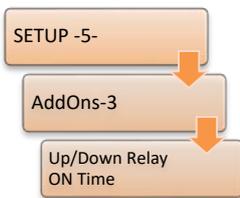
If the regulator issues a tap-change command, the default time of the pulse is **2s**. Especially older motor drives require a longer switch-on time to accept the signal.

Using this menu item, the switch-on time for up and down pulses can be set from 0.5s to 6s in 0.1 s increments.

8.1.7.9   Manual locked at E-LAN error

SETUP -5-

AddOns-3

MANUAL locked if
ELAN-Error
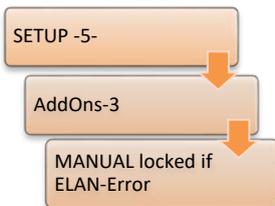
If the "Manual locked at E-LAN error" function is active and an E-LAN error is recognized by a regulator during parallel operation of several transformers, the regulator concerned switches the operating mode from AUTOMATIC to MANUAL. Recognition of the regulator, which must be available in E-LAN, is accomplished via the group list. That is, if an identifier is registered in the group list and not available in E-LAN, locking of MANUAL mode is performed.

In addition, the "Manual locked at E-LAN error" ensures that a return to AUTOMATIC mode is only possible if either the problem is solved or the setting of "Manual locked at E-LAN error" is set from "ON" to "OFF".

8.1.7.10   Block high-speed switching

SETUP -5-

AddOns-3

Block high-speed
Switching
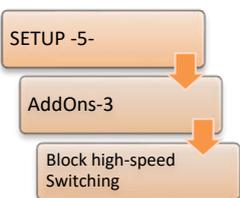
With this parameter it is possible to block high-speed switching. That means that the regulator always uses the reaction time predetermined by the time behavior without considering the high-speed switching limit of the voltage.

By default, high-speed switching is active, i.e., the parameter "Block high-speed switching" is "OFF".

The parameter "Block high-speed switching" only acts on the limits of fast backward and high-speed forward switching

Moreover, high-speed switching can be activated via a binary input or the background program. Furthermore, the 30-second activation of high-speed switching remains active on changing the setpoint.

8.1.7.11　Three-winding activation

SETUP -5-

AddOns-3

Dreiwickler Activation
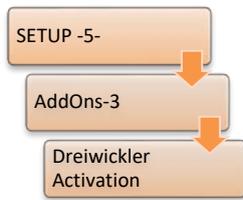
With the three-winding transformer activation, use of the three-winding transformer functionality of the REG-DA can be switched on and off when the REG-DA has the feature "3winding". If the three-winding function is activated, the voltage to be regulated can be switched via the corresponding binary inputs or via a background program between the measuring inputs 1 and 2. This means that the voltage U1 or U2 can be used for regulation. The respective other voltage can be monitored on a limit. If the three-winding transformer activation is set to "OFF", this switchover possibility is not available.

Required software and hardware features

This parameter is only available when the software feature "3winding" (see Chapter 8.3.5 Feature 3winding (three-winding transformer) [protected], from page 258 onwards) is activated, and REG-DA has the corresponding hardware feature (M9, see Technical Data in the supplement of Chapter 20). Otherwise this menu position is empty.

8.1.7.12 Creeping Net Breakdown

The "Creeping Net Breakdown" function is mainly used where it can be expected that the high voltage side voltage drops over a certain period due to the grid.

Normally in this case, a Relay for Voltage Control & Transformer Monitoring initially responds with tap changes in the direction of higher voltage to keep the secondary voltage constant. This action may increase the drop on the high voltage side further, because at a higher voltage generally more power is taken from the feeding grid. If the voltage on the primary side suddenly reverses back to its starting value, the transformer will be at a too high tap (overvoltage) and must now be regulated in the direction of lower voltage. Under some circumstances, this behavior can result in the voltage exceeding the triggering limit of protective devices, or that the Inhibit high limit of the regulator is reached, blocking the regulator.

To avoid such situations, the "Creeping Net Breakdown" function was implemented. Basically, there are two operating modes to choose from, with the operating mode PRIM being an extension of the operating mode SEC.

Generally, recognition of Creeping Net Breakdown is based on registering tap change up commands within a specific time window. That is, if the regulator issues an adjustable number of up tap commands within an adjustable time window, the state of Creeping Net Breakdown becomes active. This means that the regulator is either blocked for a certain time or switched to MANUAL mode (depending on the configuration). Once the lock time has passed, or if the voltage has become too high, the regulator will start again with normal regulation. If the regulator has been switched to MANUAL mode due to Creeping Net Breakdown, it must be explicitly set to AUTOMATIC again from outside.

Mode	Function
0:Off	The function "Creeping Net Breakdown" is inactive
1:SEC	The "Creeping Net Breakdown" function uses only voltage measuring input 1 (secondary-side voltage of the transformer and regulation voltage) for evaluation of grid status. Detection is performed by counting the number of up tap-change commands within a defined time window. This operating mode is possible with all hardware equipment. However, here a distinction between disturbances in the feeding grid and load-related voltage fluctuations is not always unambiguously possible.
2:PRIM	In addition to voltage input 1 (regulation voltage), the "Creeping Net Breakdown" function also uses voltage measuring input 2, to which the primary-side voltage of the transformer must be connected for evaluation of grid status. That is, in addition to counting up tap-change commands within a defined time window, the primary voltage is also considered. A prerequisite for recognition of a Creeping Net Breakdown is that the primary voltage has dropped at least 0.1% between two up commands with the PRIM setting.
	To use these operating modes, the Relay for Voltage Control & Transformer Monitoring requires the hardware feature M3 or M9 (two galvanically isolated voltage measuring inputs).

The behavior that is executed upon detection of the Creeping Net Breakdown can be selected with the "Lock Time" parameter. Generally, there are two different kinds of behavior.

1. The regulator issues no further tap commands, leaving the AUTOMATIC operating mode and remaining in the MANUAL operating mode until a changeover to AUTOMATIC occurs, either by use of the AUTO key or a remote control command.

2. For a selectable lock time (1 min ... 20 min) the regulator blocks all other up tap commands. The lock is released automatically when:

- the selected lock time has expired, or

- the first down tap command is issued (that is, if the upper limit of the setpoint deviation is violated).

The time window parameter allows you to specify the time period within which the number of tap changes must occur. The adjustment is possible in the range 15 to 120 seconds in 15s steps. The "Number of Changes" parameter specifies how many time a up tap command must occur within the time window for a Creeping Net Breakdown to be detected. The value range is from 2 to 6.

If the state of Creeping Net Breakdown is detected, this is shown via a message (CREEPING NBD) in the lower part of the display.

Example:

With the settings: mode = PRIM, time window = 60s, number of tap changes = 4 and lock time = 15 min, a Creeping Net Breakdown is detected when the regulator issues an up command four times within 60 seconds and the primary voltage decreases simultaneously. The state of Creeping Net Breakdown is cancelled after 15 minutes or the first down command is issued.

Suppressing the function "High-speed forward switching" (voltage limit)

The "Creeping Net Breakdown" function suppresses high-speed forward switching via the voltage limit. High-speed switching via the binary input and by changing the setpoint remains active. During these high-speed switchings no Creeping Net Breakdown evaluation is performed.

8.1.7.13 Limit base
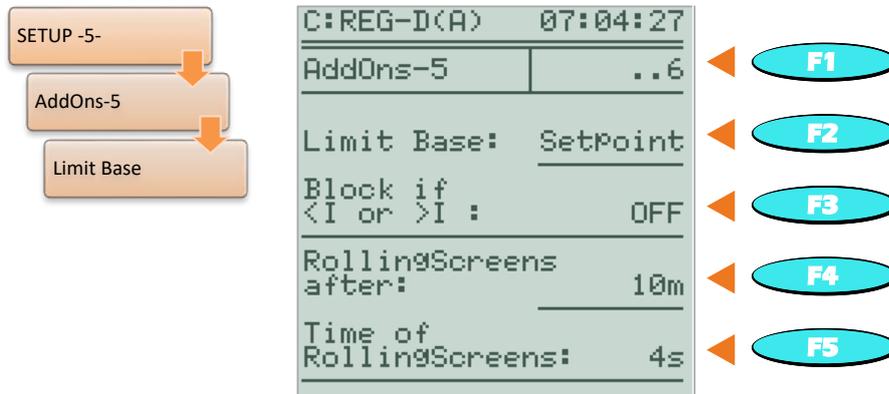
The limit base for the limits undervoltage (<U), overvoltage (>U) and Inhibit low can be selected. The remaining limits are either absolute values or always dependent on the setpoint.

If setpoint is chosen as a reference value, the limits change with the respectively set setpoint value. This means that if the setpoint is adjusted, the limits will follow suit.

Example:

Limit base: setpoint
setpoint: 102 V
limit: ± 10%
→ lower limit   92 V
→ upper limit   112 V

If the limit base Un100V or Un110V is selected, the percentages of the limits always refer fixedly to 100 V or 110 V, i.e., a change in the setpoint does not affect the limits <U, >U and Inhibit low.

Example:

Limit base: Un100 V
Setpoint: 102 V
Limit: ± 10%
→ lower limit   90 V
→ upper limit   110 V

In addition to the basic value, also the underlying 100%-value of the active setpoint is decisive for the calculation of absolute limit. The 100%-value is to be understood as the basis of the percentage calculation. In the above examples, it is always true that the 100%-value is equal to 100 V and thus 1% is equal to 1 V. However, 1% can also correspond to 1.10 V, for example, so long as the 100%-value of the active setpoint is equal to 110 V or the limit base is set to Un110V. The 100%-value for limit base Un100V is always 100 V.

Example:

Setpoint 1 = 102 V, 100%-value = 100 V, limit >U = 10%, limit base = setpoint
Setpoint 2 = 102 V, 100%-value = 110 V, limit >U = 10%, limit base = setpoint

Active setpoint = setpoint 1: limit >U [V]= 102 V + (10 % $\times \frac{100\,V}{100\,\%}$) = 112 V

Active setpoint = setpoint 2: limit >U [V]= 102 V + (10 % $\times \frac{110\,V}{100\,\%}$) = 113 V

Limit base with P- and Q-setpoints

In the case of regulation on active or reactive power (software feature PQCtrl), 100 V always applies as the limit base as well as 100%-value.

8.1.7.14 Block if <I or >I

SETUP -5-

AddOns-5
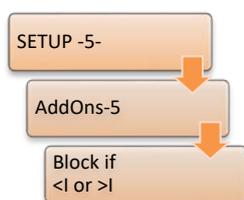
Block if
<I or >I

The "Block if <I or >I" parameter, can be used to select the behavior of the regulator in the case of under- or overcurrent.

Setting of "Block if <I or >I"	Action
Off	**No blocking at under- or overcurrent**
>I+<I	Blocking at under- and overcurrent
>I	Blocking at overcurrent
<I	Blocking at undercurrent

The selected nominal value (1 A or 5 A, or as a primary value 1/5 A x Kni) always applies as limit base (100%-value) for the current limits.

The limits under- or overcurrent can be set in the menu "Setup -2-".

8.1.7.15 Rolling Screens

SETUP -5-

ADDOns-5

RollingScreens
after
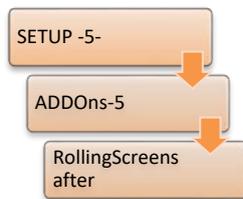
The RollingScreens function provides an automatic scrolling/changing of the display screens. This means that the most important measured values about the transformer are shown cyclically without inputs sent to the device.

Included in RollingScreens are the following display screens:

- Regulator basic display (large display)
- Transducer mode
- Transducer (U, I, f)
- Transducer (P, Q, S)
- Operating hours (transformer, tap-changer)*
- Temperatures of the transformer monitor (oil and windings) and lifetime consumption*
- Operating status (on/off) of the fan groups and oil pumps*
- Water and gas content*
- CO and H2 content*
- Overload prediction (possible overload and time since excess temperature)*

* These screens are only displayed if the regulator has the feature TM1 (with transformer monitoring).

The rolling screens parameter specifies the time the traversal of display screens starts after no entries on the device were made. The delay time can be adjusted between 0 to 10 minutes in one minute increments. The setting of 0 minutes means that the function is disabled. When RollingScreens is active, scrolling can be done manually back and forth between the individual screens using the left and right arrow keys.

8.1.7.16 Time of RollingScreens

SETUP -5-

AddOns-5

Time of
RollingScreens
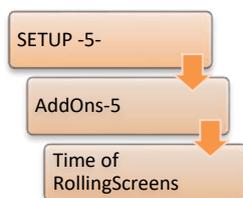
The "Time of RollingScreens" parameter defines how long a screen within the RollingScreens is displayed before it moves to the next screen.

The time can be set to between 3 and 15 seconds.

8.1.7.17 Setpoint adjustment with ← → keys

SETUP -5-

AddOns-6

Setpoint Adjustment with ← → keys
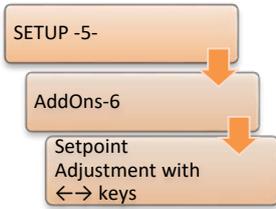
The arrow keys ← and → of REG-DA can be used to adjust the setpoint. This feature must be activated with the parameter "Setpoint adjustment with ← → keys".

The setpoint (index) is decreased with the left arrow key (◄) and increased with the right arrow key (►).

Setting	Action
0:OFF	**No adjustment of setpoint 1**
1:0.1%	Adjustment of setpoint 1 by 0.1%
2:0.2%	Adjustment of setpoint 1 by 0.2 %
3:0.5%	Adjustment of setpoint 1 by 0.5 %
4:1.0%	Adjustment of setpoint 1 by 1.0 %
5:1.5%	Adjustment of setpoint 1 by 1.5 %
6:2.0%	Adjustment of setpoint 1 by 2.0 %
10:PROG	The arrow keys can trigger functions in the background program.
11:SPIndex	Adjusting the setpoint index, for example, switching from SP 1 to SP 2.

Setpoint adjustment only with active setpoint 1

Adjustment of the setpoint in % increments only works when setpoint 1 is active. For setpoint 2 ... 4 there is no adjustment.

8.1.7.18 Setpoint adjustment with binary inputs

SETUP -5-

AddOns-6

Setpoint Adjustment with inputs
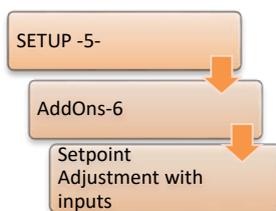
Setpoint 1 can be increased or decreased in % increments via two binary inputs. The increment can be selected via the parameter "Setpoint adjustment with binary inputs ". In addition, the binary input functions "20:SP-incr." and "21:SP-decr." must be assigned to any freely programmable digital inputs. The adjustment works flank-oriented (i.e., with each rising flank on one of the inputs an adjustment of the setpoint is carried out in the appropriate direction).

Setting	Action
1:0.1%	Adjustment of setpoint 1 by 0.1%
2:0.2%	Adjustment of setpoint 1 by 0.2 %
3:0.5%	Adjustment of setpoint 1 by 0.5 %
4:1.0%	**Adjustment of setpoint 1 by 1.0 %**
5:1.5%	Adjustment of setpoint 1 by 1.5 %
6:2.0%	Adjustment of setpoint 1 by 2.0 %

Setpoint adjustment always active for setpoint 1

Adjustment of setpoint 1 in 1% increments works even if setpoint 1 is not active. For example, if setpoint 2 is used for regulation and commands arrive for adjusting setpoint 1 at the binary inputs, the latter are placed in the background. For setpoints 2 ... 4 no adjustment via the binary inputs is possible by default.

8.1.7.19   ParaGramer Activation

SETUP -5-

AddOns-6

PARAGRAMER Activation
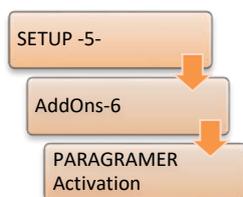
In the event that a system of several transformers/regulators is to decide autonomously which transformer will run in parallel with which other(s), the ParaGramer must be enabled and the maximum number of parallel operating transformers ("ON-1" to "ON-10") entered.

Software feature ParaGramer required

The parameter "ParaGramer Activation" is only available when the software feature ParaGramer is enabled. If the feature is not active, the DEMO display of ParaGramer can be activated here. The menu item is then "PARAGRAMER demo activity".

For more information on ParaGramer see Chapter 8.3.2 ParaGramer including extensions [protected], from page 237 onwards.

8.1.7.20   CT/VT configuration
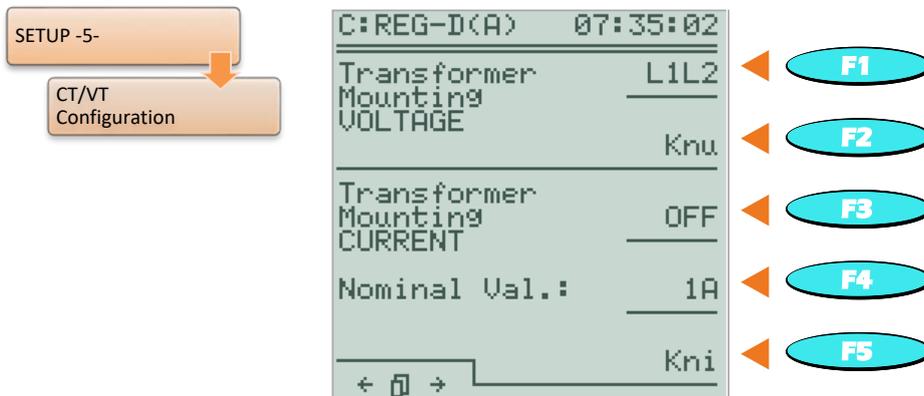
In this menu one can determine which phase-to-phase and current will be used for measurement.

In addition, the ratios of external voltage and current transformers, and the nominal value of current can be chosen.

Since the grids at the connection point of a Relay for Voltage Control & Transformer Monitoring are usually considered equally loaded, all power values of the grid can be calculated with sufficient accuracy using just one voltage and current.

Prerequisite: The regulator is informed which external conductors the measurement voltage is measured between, and on which line current is measured.

Connecting the measurement inputs

To connect the measurement inputs to the measurement transformers, use the specific circuit diagram of the corresponding REG-DA. This specific circuit diagram is supplied with the voltage regulator. If you do not have the schematics, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Transformer Mounting Voltage

To use the REG-DA hardware it is not necessary to assign voltage measurement connections to a particular position in the network (e.g. U12). Regardless of which external conductors the voltage is measured between, the regulator determines the correct angular relationship when the actual connection is set in the CT/VT Configuration menu.

In case the regulator is connected to an asymmetrically loaded grid and correct measured values for active and reactive power is needed, the regulator can also be operated in an Aron measuring circuit (feature M2).

For this purpose, the parameters "Transformer Mounting Voltage" and "Transformer Mounting Current" must each be set to ARON. The connection must be carried out in a correct manner.

Please employ the following circuit diagram.

With an Aron connection the following applies:
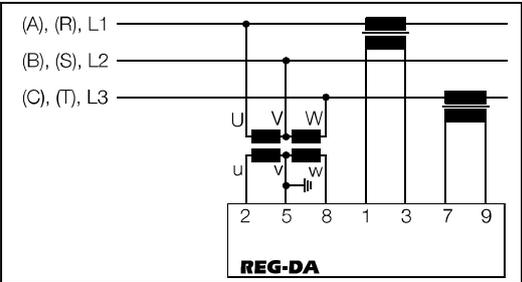
or
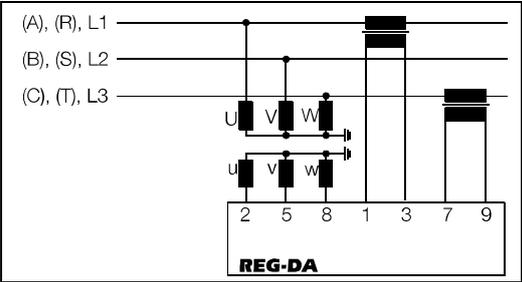
The hardware connection for Aron measurement can be found in Chapter 7.1.4.6 on page 70.

Voltage used for regulation with Aron measurement

Only one delta voltage (U12) is used for regulation even though the regulator measures with an Aron connection.

Factor of the voltage transformer (Knu)

If the primary value of the voltage is to be displayed, the factor Knu for the voltage transformer must be entered.

Example:

20 kV / 100 V → Knu = 200

Please note that the scale for the input of the transformer factor can be switched by pressing F3 and thus adapted to the requirements.

Transformer Mounting Current

To use the REG-DA, it is not necessary to assign the current measurement terminals a specific location in the grid in terms of hardware (e.g. I1). Regardless of which phase the current is measured in, the regulator determines the correct angular relationship when the actual connection is set in the CT/VT Configuration menu.

In case the regulator is connected to an asymmetrically loaded grid and correct measured values for active and reactive power is needed, the regulator can also be operated in an Aron measuring circuit (feature M2).

For this purpose, the parameters "Transformer Mounting voltage" and "Transformer Mounting current" must each be set to ARON. The connection must be carried out in a correct manner (see previous point "Transformer Mounting Voltage").

Factor of the current transformer (Kni)

If the primary value of the current is to be displayed, the factor Kni for the current transformer must be entered.

Example:

1000 A / 1 A → Kni = 1000

Please note that the scale for the input of the transformer factor can be switched by pressing F3 and thus adapted to the requirements.

Interchanging the measurement transformer connections

In some applications, it turns out that after commissioning the system, measurement of active powers gives the wrong sign. The erroneous indication is generally due to a faulty connection. For example, if the energy flow direction is to be changed, the connections of the current transducer can be exchanged.

The mechanical reversal of the connections should only be performed when the current transformers are short-circuited on the secondary side, or the system is switched off.

To work around this limitation, the polarity can also be rotated using the menu.

SETUP -5-

CT/VT
Configuration

Transformer
Mounting
Inversion
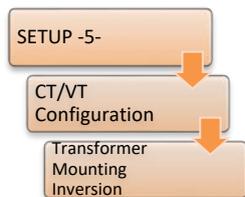
Inversion (180 degree rotation) of voltage and current measurement inputs can be done on page two of the transducer installation menu. This second page is reached by pressing the left arrow key or the right arrow key in the transducer installation menu.

```
C:REG-D(A)      07:42:22

Transformer           U1  ◄  F1
Mounting             ───
VOLTAGE,  Inversion:
(U1↔U2)               U2  ◄  F2

Transformer
Mounting             -I1  ◄  F3
CURRENT,             ───
Inversion:
                      I2  ◄  F4
                     ───
                          ◄  F5

← 🗓 →
```
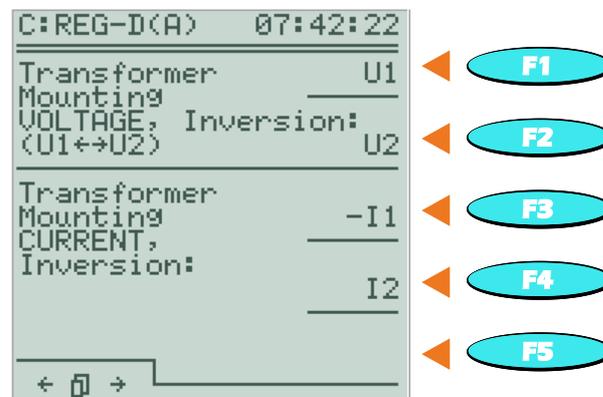
Inversion of individual measurement inputs is accomplished via the keys F1 to F4. Inverted measurement inputs are displayed with a minus sign (e.g. -I1).

ℹ️ Left rotary field

The angle references in the REG-DA are based on a clockwise rotating field. If you use a phase sequence that produces a left rotating field, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.1.7.21 Actual value correction of measurement voltage U_E

SETUP -6-

General 3

Actual Value
Correction
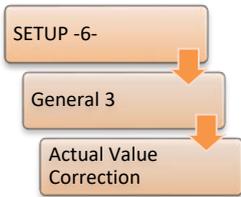
The actual voltage value correction serves to compensate voltage drops on the line and for correcting transducer error between the voltage transformer and REG-DA.

8.1.7.22 Actual value correction of measurement current I_E

SETUP -6-

General 3

Actual Value
Correction
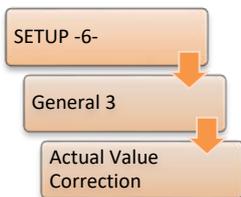
The actual current value correction is mainly used for correcting transducer error of the current transformer.

Actual value correction not via WinREG up to version 3.9

Correction values for voltage and current are not transmitted when a parameter file is read with WinREG.

8.1.8   SCADA system
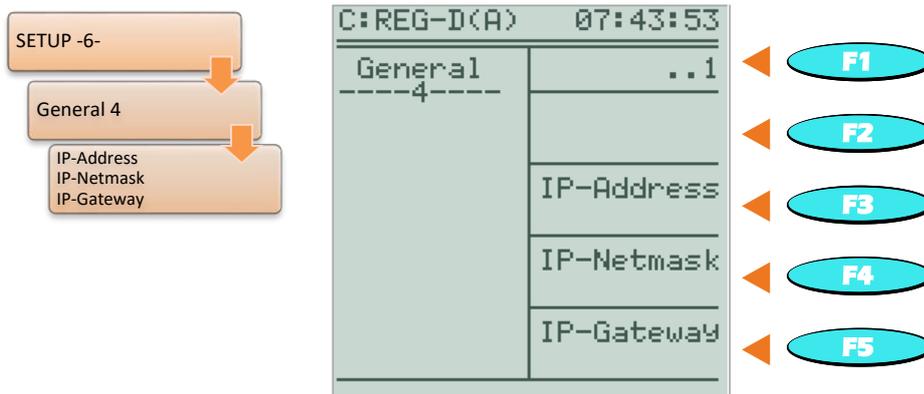
Settings in this menu are required only when the regulator is connected along with an interface card (REG-PE or REG-PED) to SCADA systems via Ethernet. These settings only engage when used with IEC 61850 or IEC 60870-5-104.

> **Use/takeover of parameters in the SCADA system coupling module**
>
> After a certain time, the SCADA system parameters set in REG-DA are adopted by the telecontrol board module. That is, the telecontrol board module changes the settings and restarts. The settings in REG-DA are dominant and always causes the connected telecontrol board module to take over these settings. Change of the SCADA system parameters via the software WinConfig or the WebServer of the SCADA system card is not possible in this case. The parameters must be always modified in the REG-DA.
> If the SCADA system parameters in the REG-DA are set to 0.0.0.0, the telecontrol board module will manage its own settings. The settings can then be changed, for example, via the WinConfig software or the WebServer of the telecontrol board module. The SCADA system parameters adjusted in this way are not taken over by REG-DA.

> **Configuration of the SCADA system coupling modules**
>
> The SCADA system coupling modules can quite easily be configured with the software WinConfig.

IP address and IP subnet mask

SETUP -6-

General 4

IP-Address
IP-Netmask
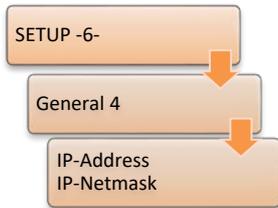
The IP address is the logical address of a device. It is 32 bits or four bytes long and is written separately for easier readability with dots between the four bytes.

A subnet mask is always associated with an IP address, which together with the IP address is a unique identifier of a device within a network. The subnet mask separates physically connected networks into logical networks. Thus, the subnet mask defines how many bytes or bits define the network part and how many belong to the host part. The larger the network part the smaller the available number of possible hosts/devices in the network.

It is recommended to use a class C network with a private IP address (e.g. 192.168.xx), so that up to 254 devices in a network can be addressed (e.g. a transformer station). The associated subnet mask would be 255.255.255.0, so all hosts on the network should have the first three bytes identical (e.g. 192.168.1.) and differ in the last byte (e.g. values between .1 and .254).

IP gateway

SETUP -6-

General 4
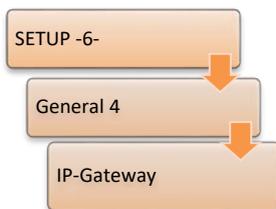
IP-Gateway

A gateway is the interface for communication with other networks, including the Internet (public IP address, as opposed to private IP addresses), to connect to the control room. Here, for example, the IP address of a router is given, which includes both the private network of the installation as well as the public network.

8.1.9   Time setting

SETUP -6-

General 2

Time Setting

Time

Date

Daylight saving time

Changing daylight saving time (DST)

Time zone

```
C:REG-D(A)     07:49:23
TIME/DATE SETTING     +
   TIME: 07:49:23
   DATE: 15 10 2015     -
  UTC TZ: +1 (+1)     ←
    DST: RULE LIST
   from: 29.03 02:00     →
     to: 25.10 03:00
 ↵ : OK              LIST
 ←→: Select
```
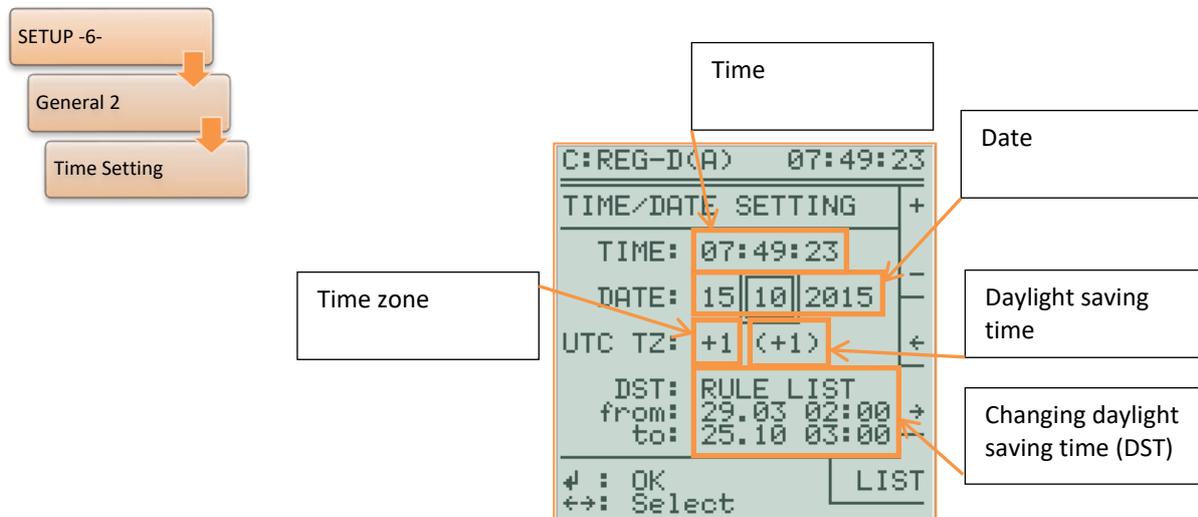
Time, date, time zone (offset from UTC time) and the rules for daylight saving time can be set in the time menu. Use the F1 and F2 keys to change the values.

With the F3 and F4 keys one can switch between the individual values. The F5 key has different functions depending on the selected setting value. If seconds is selected to be set, the F5 key is used to zero the seconds. If a different setting is selected, the F5 key serves as access to the daylight saving time rules.

Summer time (Daylight**S**aving**T**ime**):**

Daylight saving time is activated in the "Time Setting" menu via the DST parameter. If OFF is selected, there is no daylight saving time.

The time for summer/winter time changeover can be defined in the menu for the daylight saving time rule definition. By default, the rules for Central Europe (DST from 02:00 the last Sunday in March to 03:00 the last Sunday in October) are set here.

The changeover times (date and time) for the selected year are displayed in each case.

Rules for daylight saving time change are already available for certain regions and countries. These can be selected using the wizard (F5 key).

If the daylight saving time change is required at a time, which is not present in a predefined list, the rules can be freely configured. For this purpose, the keys F1 and F2 are used to modify the value and the F3 and F4 keys to select the value. The DST rules can be set separately for each year. While editing a rule, the individual constituents are generally represented as a number. The meaning of the selected editing number is displayed in plain text in square brackets below the heading "DST rule list". If an invalid rule is defined, the message "Error in Rule!" appears.

The DST rule list can be exited with the ESC key.

With the rule definitions the following value ranges for the individual parameters can be selected:

Year: 1990 to 2078
Weekday: Monday … Sunday (from), exact date, Monday … Sunday before
Day: Last weekday (0), 1. … 5. weekday, 1 … 31
Month: January … December
Hour: -3 days 23h, -2 days 0…23h, -1 day 0…23h,
                  0…23h, +1 day 0.23h, +2 days 0..2h
Minutes: 0, 15, 30, 45 min

Example:

Daylight saving time begins next Friday after 1 April, at 02:00 and ends on Saturday before the last Sunday in October at 22:00.

Start of DST: Friday (5), 1, April(4), 02h, 00min

End of DST: Sunday(7), last (0), October(10), 22:00h-1day(98), 00min

Once the rules are defined, they can be saved with the ENTER key. Then a menu appears where you can choose whether the rules defined apply only to the selected year, from the selected year to 2078, or for all years.

Simple setup via WinREG

Rule setting can also be performed easily via the service program of WinREG.

8.2 Inputs and outputs

8.2.1 General

In its default configuration, the REG-DA provides 16 binary inputs (14 freely configurable), 13 relays (11 freely programmable), 14 LEDs (12 freely programmable) and an analog input (-20 ... 20 mA). The freely configurable inputs and outputs can be explicitly switched off, made available to the background program or assigned a preconfigured function.

Configuration of the freely configurable binary inputs, relays, LEDs and analog channels is described in Chapter 7.2.2.6 Input/Output signals, from page 103 onwards.

This Chapter contains a detailed explanation of all available input and output functions, as well as input and output expansion options of the REG-DA via COM3. In addition to a description of the function, the firmware version of REG-DA after which the function is available is also given, as well as availability of functions depending on a software feature. For further information, reference is made at this point to Chapter 8.3 Features (software) from page 235 onwards.

Status information and control of binary inputs and outputs via a SCADA system

In general, the status (on or off) of a binary input or relay can be transferred independently of the assigned function via a SCADA system. In order to control a relay from a SCADA system, it must have the function 01:PROG.

8.2.2   Binary inputs

Binary input function	Description	FW version	Only available with feature
00:OFF	The input has no firmware function	≥ 1.00	
01:PROG	The input is used in background program	≥ 1.00	
02:SP2Level	Switchover to setpoint 2, level input, when active SP2 otherwise SP1	≥ 1.15	
03:SP-1	Switchover to setpoint 1, pulse input	≥ 1.23	
04:SP-2	Switchover to setpoint 2, pulse input	≥ 1.23	
05:SP-3	Switchover to setpoint 3, pulse input	≥ 1.23	to 1.99: 4setpoints
06:SP-4	Switchover to setpoint 4, pulse input	≥ 1.23	to 1.99: 4setpoints
07:TC.i.Op	TC in operation signal from tap changer	≥ 1.15	
08:Par-Prog	Parallel program activation via binary input, the parameter Parallel Program Activation must be set to level or pulse	≥ 1.21	
09:3Winding	Switchover of regulation from U1 to U2	≥ 1.22	3winding
10:SP-Bin0	Setpoint index switchover binary coded, bit 0	≥ 2.03	
11:SP-Bin1	Setpoint index switchover binary coded, bit 1	≥ 2.03	
13:Trans1	Passthrough function 1, input state can be reflected on relay/LED	≥ 1.27	
14:Trans2	Passthrough function 2, input state can be reflected on relay/LED	≥ 1.27	
15:BuchAlm	Buchholz relay alarm	≥ 2.03	TM

Binary input function	Description	FW version	Only available with feature
16:BuchTrip	Buchholz relay trip	≥ 2.03	TM
17:OilPump	Oil pump 1 running	≥ 2.03	TM
20:SP-incr.	Increase setpoint 1, step size adjustable	≥ 1.32	
21:SP-decr.	Decrease setpoint 1, step size adjustable	≥ 1.32	
22:Manual+	Manual+ input for software feature NLK	≥ 1.33	NLK
23:lower+	lower+ input for software feature NLK	≥ 1.33	NLK
24:Inh.Low	Inhibit, automatic regulation is blocked, manual tap command available	≥ 1.00	
25:Quick	Activate high-speed switching, high-speed switching stops in contrast to limit high-speed switching as soon as signal no longer present	≥ 1.19	
26:PG_CB	Circuit breaker, low voltage side (to 1.81: 26:MV_LS)	≥ 1.77	ParaGramer [4]
27:PG_IS1	Isolator busbar 1, low voltage side (to 1.81: 27:MV_TRa)	≥ 1.77	ParaGramer [4]
28:PG_IS2	Isolator busbar 2, low voltage side (to 1.81: 28:MV_TRb)	≥ 1.77	ParaGramer [4]
29:PG_CP	Coupling busbar 1 on busbar 2, low voltage side (to 1.81: 29:MV_QK)	≥ 1.77	ParaGramer [4] + no 991191
30:PG_SC1	Section busbar 1, low voltage side (to 1.81: 30:MV_LKra)	≥ 1.77	ParaGramer [1+3+4]
31:PG_SC2	Section busbar 2, low voltage side (to 1.81: 30:MV_LKrb)	≥ 1.77	ParaGramer [1+3+4]
32:PG_CBa	Coupling for feature 991101, low voltage side	≥ 1.85	ParaGramer + 991101 [1+3+4]
33:PG_CBb	Coupling b for feature 991101, low voltage side	≥ 1.85	ParaGramer + 991101 [1+3+4]
34:PG_H_CB	Circuit breaker, high voltage side	≥ 1.85	ParaGramer [4]
35:PG_H_IS1	Isolator busbar 1, high voltage side	≥ 1.85	ParaGramer [4]
36:PG_H_IS2	Isolator busbar 2, high voltage side	≥ 1.85	ParaGramer [4]

Binary input function	Description	FW version	Only available with feature
37:PG_H_CP	Coupling busbar 1 on busbar 2, high voltage side	≥ 1.85	ParaGramer [4] + no 991191
38:PG_H_SC1	Section busbar 1, high voltage side	≥ 1.85	ParaGramer [2+3+4]
39:PG_H_SC2	Section busbar 2, high voltage side	≥ 1.85	ParaGramer [2+3+4]
40:PG_H_CBa	Monitoring signal for feature 991101, high voltage side	≥ 1.85	ParaGramer + 991101 [4]
41:PG_H_CBb	Monitoring signal for feature 991101, high voltage side	≥ 1.85	ParaGramer + 991101 [4]
42:up	Issue of an up tap command, only in remote and manual mode	≥ 1.85	
43:down	Issue of a down tap command, only in remote and manual mode	≥ 1.85	
44:BCD1	Tap position feedback BCD 1	≥ 1.85	
45:BCD2	Tap position feedback BCD 2	≥ 1.85	
46:BCD4	Tap position feedback BCD 4	≥ 1.85	
47:BCD8	Tap position feedback BCD 8	≥ 1.85	
48:BCD10	Tap position feedback BCD 10	≥ 1.85	
49:BCD20	Tap position feedback BCD 20	≥ 1.85	
50:BCDminus	Tap position feedback sign	≥ 1.85	
51:BIN16	Binary coded tap position indication value 16, value 1..8 are covered via the BCD input functions	≥ 1.85	
52:BIN32	Binary coded tap position indication value 32, value 1..8 are covered via the BCD input functions	≥ 1.85	
53:LR_AH	Manual/automatic input of additional component REG-LR, 0:Manual 1:Auto	≥ 1.97	
54:LR_STAT	Input status of additional component REG-LR, 0:Fault 1:OK	≥ 1.97	
55:PG_C1a	Section busbar 1 left from the coupling, low voltage side	≥ 1.91	ParaGramer + Crosslink=1/3 [4]
56:PG_C1b	Section busbar 1 right from the coupling, low voltage side	≥ 1.91	ParaGramer + Crosslink=1/3 [4]
57:PG_C2a	Section busbar 2 left from the coupling, low voltage side	≥ 1.91	ParaGramer + Crosslink=1/3 [4]
58:PG_C2b	Section busbar 2 right from the coupling, low voltage side	≥ 1.91	ParaGramer + Crosslink=1/3 [4]

Binary input function	Description	FW version	Only available with feature
59:PG_H_C1a	Section busbar 1 left from the coupling, high voltage side	≥ 1.91	ParaGramer + Crosslink=2/3 [4]
60:PG_H_C1b	Section busbar 1 right from the coupling, high voltage side	≥ 1.91	ParaGramer + Crosslink=2/3 [4]
61:PG_H_C2a	Section busbar 2 left from the coupling, high voltage side	≥ 1.91	ParaGramer + Crosslink=2/3 [4]
62:PG_H_C2b	Section busbar 2 right from the coupling, high voltage side	≥ 1.91	ParaGramer + Crosslink=2/3 [4]
63:LR_LR	Local/remote input from additional component REG-LR, 0:Remote - 1:Local	≥ 1.97	
64:MSI_Ma	Master selection	≥ 2.02	ParaGramer (+MSI)
65:MSI_Sl	Slave selection	≥ 2.02	ParaGramer (+MSI)
66:MSI_Ind	Independent selection	≥ 2.02	ParaGramer (+MSI / MSI2)
67:MSI_Ma1	Master group 1 selection	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
68:MSI_Ma2	Master group 2 selection	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
69:MSI_Sl1	Slave group 1 selection	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
70:MSI_Sl2	Slave group 2 selection	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
71:PG_IS3	Isolator busbar 3, low voltage side	≥ 2.12	ParaGramer [1+2]
72:PG_CP2	Coupling busbar 2 after busbar 3, low voltage side	≥ 2.12	ParaGramer [1+2]
73:PG_CP3	Coupling busbar 3 after busbar 1, low voltage side	≥ 2.12	ParaGramer [1+2]
74:PG_SC3	Section busbar 3, low-voltage side	≥ 2.12	ParaGramer [1+2]
75:PG_H_IS3	Isolator busbar 3, high voltage side	≥ 2.12	ParaGramer [2+3]
76:PG_H_CP2	Coupling busbar 2 after busbar 3, high voltage side	≥ 2.12	ParaGramer [2+3]
77:PG_H_CP3	Coupling busbar 3 after busbar 1, high voltage side	≥ 2.12	ParaGramer [2+3]
78:PG_H_SC3	Section busbar 3, high voltage side	≥ 2.12	ParaGramer [2+3]
79:OilPump2	Oil pump 2 running	≥ 2.15b	TM
82:BCD40	Tap position feedback BCD 40	≥ 2.22	

[1] not available with the feature Crosslink = 1 (Crosslink low voltage side)

[2] not available with the feature Crosslink = 2 (Crosslink high voltage side)

[3] not available with the feature Crosslink = 3 (Crosslink low and high voltage side)

[4] not available with the parallel program MSI or MSI2

8.2.3   Relays
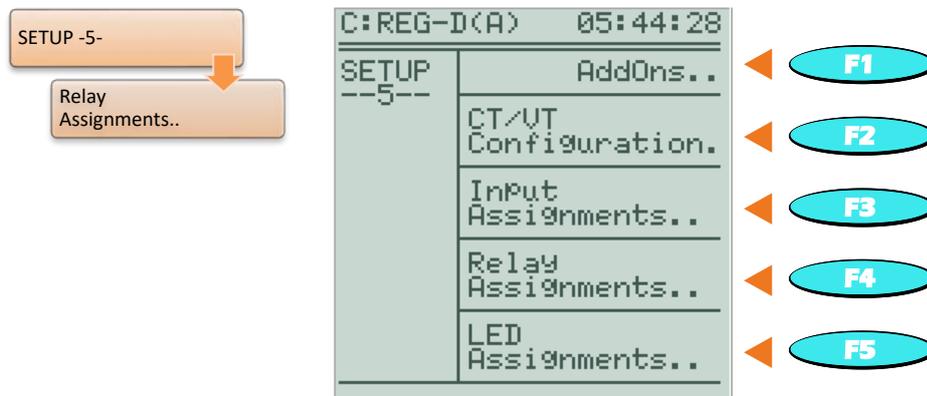
Relay output function	Description	FW version	Only available with feature
00:OFF	The relay has no function and is switched off	≥ 1.00	
01:PROG	The relay is controlled from the background program	≥ 1.00	
02:ON	Relay is active, for example, to test the wiring	≥ 1.00	
03:<U	Undervoltage, below limit <U	≥ 1.00	
04:>U	Overvoltage, limit >U exceeded	≥ 1.00	
05:>U+<U	Under- or overvoltage	≥ 1.00	
06:>I	Overcurrent, limit >I exceeded	≥ 1.33	
07:SP-1	Setpoint 1 active	≥ 1.23	
08:SP-2	Setpoint 2 active	≥ 1.23	
09:SP-3	Setpoint 3 active	≥ 1.23	to 1.99: 4setpoints
10:SP-4	Setpoint 4 active	≥ 1.23	to 1.99: 4setpoints
11:Inh.High	Inhibit high	≥ 1.00	
12:Quick	High-speed switching active	≥ 1.19	
13:Inhibit	General inhibit (inhibit low, inhibit high, block if <I or >I)	≥ 1.00	
14:TC-Err	TC in operation signal error	≥ 1.19	
15:creepNBD	Creeping Net Breakdown	≥ 1.15	
16:Manual	MANUAL operation	≥ 1.16	
17:ELAN-Err	ELAN error	≥ 1.24	

Relay output function	Description	FW version	Only available with feature
18:Par-Prog	Regulator is in active parallel operation (excluding if regulator is a slave; see also relay function "88:ParProg+")	≥ 1.21	
19:3Winding	Monitored voltage has exceeded limit >Ub	≥ 1.22	3Winding
20:PhasFail	Phase drop recognized	≥ 1.27	
21:Com3Err	Communication error COM3	≥ 2.15	
22:TapMiMa	Min. or max. tap limit reached	≥ 2.22	
23:Trans1	Passthrough function 1	≥ 1.27	
24:/Trans1	Passthrough function 1 negated	≥ 1.27	
25:Trans2	Passthrough function 2	≥ 1.27	
26:/Trans2	Passthrough function 2 negated	≥ 1.27	
27:OilAlarm	Oil temperature alarm	≥ 2.03	TM
28:WndAlarm	Winding temperature alarm	≥ 2.03	TM
29:WndTrip	Winding temperature trip	≥ 2.03	TM
30:ParErr	Parallel error	≥ 1.32	
31:up	Up tap command	≥ 1.31	
32:down	Down tap command	≥ 1.31	
33:SP-incr.	Setpoint increment	≥ 1.32	BBN 4.4.3
34:SP-decr.	Setpoint decrement	≥ 1.32	BBN 4.4.3
35:TapMin	Min. tap limit reached	≥ 2.22	
36:TapMax	Max. tap limit reached	≥ 2.22	
37:Manual+	Regulator set to manual by input function 22:Manual+	≥ 1.33	NLK
38:<I	Undercurrent, below limit <I	≥ 1.33	
39:InputErr	Several binary inputs with SP-n functions active	≥ 1.36	
40:AUTO	AUTOMATIC operation	≥ 1.36	
41:TC-Err+	TC in operation fault, wiper	≥ 1.39	
42:PANmiss	PAN-D not available	≥ 1.50	
43:LV_Check	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
44:HV_Check	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
45:HV_Err	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
46:HV_Fail	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
47:Local	Local operation	≥ 1.99	

Relay output function	Description	FW version	Only available with feature
48:Remote	Remote operation	≥ 1.99	
49:Heater	Heating active	≥ 2.00	TM
50:Cooler1	Cooler 1 on	≥ 2.00	TM
51:Cooler2	Cooler 2 on	≥ 2.00	TM
52:Cooler3	Cooler 3 on	≥ 2.00	TM
53:Cooler4	Cooler 4 on	≥ 2.00	TM
54:Cooler5	Cooler 5 on	≥ 2.00	TM
55:Cooler6	Cooler 6 on	≥ 2.00	TM
56:TempTC	Overtemperature tap changer	≥ 2.00	TM
57:OillvTC-	Tap changer oil level too low	≥ 2.00	TM
58:OillvTC+	Tap changer oil level too high	≥ 2.00	TM
59:OillvTr-	Transformer oil level too low	≥ 2.00	TM
60:OillvTr+	Transformer oil level too high	≥ 2.00	TM
61:Water	Water limit exceeded	≥ 2.00	TM
62:Gas	Gas limit exceeded	≥ 2.00	TM
63:BuchAlm	Buchholz alarm	≥ 2.00	TM
64:BuchTrip	Buchholz triggering	≥ 2.00	TM
65:COM2Act	Communication on COM2 active	≥ 2.00	
66:MSI_Ma	MSI: Master selected	≥ 2.00	ParaGramer (+MSI)
67:MSI_Sl	MSI: Slave selected	≥ 2.00	ParaGramer (+MSI)
68:MSI_Ind	MSI: Independent selected	≥ 2.00	ParaGramer (+MSI / MSI2)
69:TAPERR	Tap change error	≥ 2.00	
70:HvLvDiff	Different parallel states between high- and low voltage sides	≥ 2.00	HVLVCONTROL
71:T60s/1s	Every 60 sec for 1 sec on (second pulse)	≥ 2.00	
72:Inh.Low	Inhibit low	≥ 2.00	
73:HUNTING	Hunting detected (hunting function can only be configured via REG-L)	≥ 2.00	
74:OilPump	Actuation of oil pump	≥ 2.00	TM
75:MSI_Ma1	MSI2: Master 1 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
76:MSI_Ma2	MSI2: Master 2 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
77:MSI_Sl1	MSI2: Slave 1 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)

Relay output function	Description	FW version	Only available with feature
78:MSI_Sl2	MSI2: Slave 2 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
79:T1h/1s	Every 60 min for 1 sec on (hourly second pulse)	≥ 2.10f	
80:H2	Limit H2 exceeded	≥ 2.11	
81:CO	CO limit exceeded	≥ 2.11	
82:dCosEmgy	dcos(φ) emergency program active	≥ 2.11	
83:PG_INERR	Monitoring of ParaGramer inputs; Prerequisite: same ParaGramer input function 1x normal + 1x inverse used	≥ 2.13c	ParaGramer
84:OilPump2	Actuating oil pump 2	≥ 2.15b	TM
85:AMaster	Active master (master with at least one slave)	≥ 2.22	
86:ASlave	Active slave	≥ 2.22	
87:Ind	Independent (also master without slave)	≥ 2.22	
88:ParProg+	Regulator is in active parallel operation (including if regulator is a slave; see also relay function "18:ParProg")	≥ 2.22	
89:BCD1	Tap position BCD value 1	≥ 2.22	
90:BCD2	Tap position BCD value 2	≥ 2.22	
91:BCD4	Tap position BCD value 4	≥ 2.22	
92:BCD8	Tap position BCD value 8	≥ 2.22	
93:BCD10	Tap position BCD value 10	≥ 2.22	
94:BCD20	Tap position BCD value 20	≥ 2.22	
95:BCD40	Tap position BCD value 40	≥ 2.22	
96:BCDminus	Tap position BCD minus	≥ 2.22	
101:Input-01	Binary input 1	≥ 2.10f	
102:Input-02	Binary input 2	≥ 2.10f	
…	…	…	
131:Input-31	Binary input 31	≥ 2.10f	
132:Input-32	Binary input 32	≥ 2.10f	

8.2.4 LEDs

LED - output function	Description	FW version	Only available with feature
00:OFF	The LED has no function and is switched off	≥ 1.00	
01:PROG	The LED is controlled from the background program	≥ 1.00	
02:up	Up tap command	≥ 1.15	
03:down	Down tap command	≥ 1.15	
04:up/down	Up or down tap command	≥ 1.15	
05:SP-1	Setpoint 1 active	≥ 1.23	
06:SP-2	Setpoint 2 active	≥ 1.23	
07:SP-3	Setpoint 3 active	≥ 1.23	
08:SP-4	Setpoint 4 active	≥ 1.23	
09:Inh. High	Inhibit high	≥ 1.00	
10:Quick	High-speed switching active	≥ 1.19	
11:Inhibit	General inhibit (inhibit low, inhibit high, block if <I or >I)	≥ 1.00	
12:TC-Err	TC in operation error	≥ 1.19	
13:creepNBD	Creeping Net Breakdown	≥ 1.15	
14:ELAN-L	E-LAN-L is used	≥ 1.24	
15:ELAN-R	E-LAN-R is used	≥ 1.24	
16:ELAN-Err	E-LAN error	≥ 1.24	
17:Par-Prog	Regulator is in active parallel operation (excluding if regulator is a slave; see also LED function "88:ParProg+")	≥ 1.21	
18:3Winding	Monitored voltage has exceeded limit >Ub	≥ 1.22	3Winding
19:PhasFail	Phase drop recognized	≥ 1.27	

LED - output function	Description	FW version	Only available with feature
20:TapMiMa	Min. or max. tap limit reached	≥ 2.22	
21:Com3Err	Communication error COM3	≥ 2.15	
22:Trans1	Passthrough function 1	≥ 1.27	
23:/Trans1	Passthrough function 1 negated	≥ 1.27	
24:Trans2	Passthrough function 2	≥ 1.27	
25:/Trans2	Passthrough function 2 negated	≥ 1.27	
26:OilAlarm	Oil temperature alarm	≥ 2.03	TM
27:WndAlarm	Winding temperature alarm	≥ 2.03	TM
28:WndTrip	Winding temperature trip	≥ 2.03	TM
29:ParErr	Parallel error	≥ 1.32	
30:SP-incr.	Setpoint increment	≥ 1.32	BBN 4.4.3
31:SP-decr.	Setpoint decrement	≥ 1.32	BBN 4.4.3
32:TapMin	Min. tap limit reached	≥ 2.22	
33:TapMax	Max. tap limit reached	≥ 2.22	
34:Manual+	Regulator set to manual by input function 22:Manual+	≥ 1.33	NLK
35:<I	Undercurrent below limit <I	≥ 1.33	
36:InputErr	Several binary inputs with SP-n functions active	≥ 1.36	
37:PANmiss	PAN-D not available	≥ 1.50	
38:TC.i.Op	TC in operation	≥ 1.81	
39:LV_Check	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
40:HV_Check	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
41:HV_Err	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
42:HV_Fail	Monitoring of parallel switching for customer specific scheme	≥ 1.85	991101
43:Local	Local operation	≥ 1.99	
44:Remote	Remote operation	≥ 1.99	
45:<U	Undervoltage, below limit <U	≥ 2.00	
46:>U	Overvoltage, limit exceeded >U	≥ 2.00	
47:>I	Overcurrent, limit exceeded >I	≥ 2.00	
48:Heater	Heating active	≥ 2.00	TM
49:Cooler1	Cooler 1 on	≥ 2.00	TM

LED - output function	Description	FW version	Only available with feature
50:Cooler2	Cooler 2 on	≥ 2.00	TM
51:Cooler3	Cooler 3 on	≥ 2.00	TM
52:Cooler4	Cooler 4 on	≥ 2.00	TM
53:Cooler5	Cooler 5 on	≥ 2.00	TM
54:Cooler6	Cooler 6 on	≥ 2.00	TM
55:TempTC	Overtemperature tap changer	≥ 2.00	TM
56:OillvTC-	Tap changer oil level too low	≥ 2.00	TM
57:OillvTC+	Tap changer oil level too high	≥ 2.00	TM
58:OillvTr-	Transformer oil level too low	≥ 2.00	TM
59:OillvTr+	Transformer oil level too high	≥ 2.00	TM
60:Water	Water limit exceeded	≥ 2.00	TM
61:Gas	Gas limit exceeded	≥ 2.00	TM
62:BuchAlm	Buchholz alarm	≥ 2.00	TM
63:BuchTrip	Buchholz triggering	≥ 2.00	TM
64:COM1Act	COM1 is used	≥ 2.00	
65:COM2Act	COM2 is used	≥ 2.00	
66:MSI_Ma	MSI: Master selected	≥ 2.00	ParaGramer (+MSI)
67:MSI_Sl	MSI: Slave selected	≥ 2.00	ParaGramer (+MSI)
68:MSI_Ind	MSI: Independent selected	≥ 2.00	ParaGramer (+MSI / MSI2)
69:TAPERR	Tap change error	≥ 2.00	
70:HvLvDiff	Different parallel states between high- and low voltage sides	≥ 2.00	HVLVCONTROL
71:T60s/1s	Time synchronisation pulse, every 60 sec for 1 sec on	≥ 2.00	
72:Inh.Low	Inhibit low	≥ 2.00	
73:HUNTING	Hunting detected (the Hunting function can only be configured via REG-L)	≥ 2.17	
74:OilPump	Oil pump in	≥ 2.07	TM
75:MSI_Ma1	MSI2: Master 1 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
76:MSI_Ma2	MSI2: Master 2 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
77:MSI_Sl1	MSI2: Slave 1 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)
78:MSI_Sl2	MSI2: Slave 2 selected	2.02f / ≥ 2.10f	ParaGramer (+MSI2)

LED - output function	Description	FW version	Only available with feature
79:T1h/1s	Time synchronisation pulse, every 60 min for 1 sec on	≥ 2.10f	
80:H2	H_2 limit exceeded	≥ 2.11	TM
81:CO	CO limit exceeded	≥ 2.11	TM
82:dCosEmgy	dcos(φ) emergency program active	≥ 2.11	
83:PG_INERR	Monitoring of ParaGramer inputs; Prerequisite: same ParaGramer input function 1x normal + 1x inverse used	≥ 2.13c	ParaGramer
84:OilPump2	Oil pump actuated or running	≥ 2.15b	TM
85:AMaster	Active master (master with at least one slave)	≥ 2.22	
86:ASlave	Active slave	≥ 2.22	
87:Ind	Independent (also master without slave)	≥ 2.22	
88:ParProg+	Regulator is in active parallel operation (including if regulator is a slave; see also the LED function "17:ParProg")	≥ 2.22	
89:BCD1	Tap position BCD value 1	≥ 2.22	
90:BCD2	Tap position BCD value 2	≥ 2.22	
91:BCD4	Tap position BCD value 4	≥ 2.22	
92:BCD8	Tap position BCD value 8	≥ 2.22	
93:BCD10	Tap position BCD value 10	≥ 2.22	
94:BCD20	Tap position BCD value 20	≥ 2.22	
95:BCD40	Tap position BCD value 40	≥ 2.22	
96:BCDminus	Tap position BCD minus	≥ 2.22	
101:Input-01	Binary input 1	≥ 2.10f	
102:Input-02	Binary input 2	≥ 2.10f	
...	...	...	
131:Input-31	Binary input 31	≥ 2.10f	
132:Input-32	Binary input 32	≥ 2.10f	

8.2.5   Analog inputs and outputs
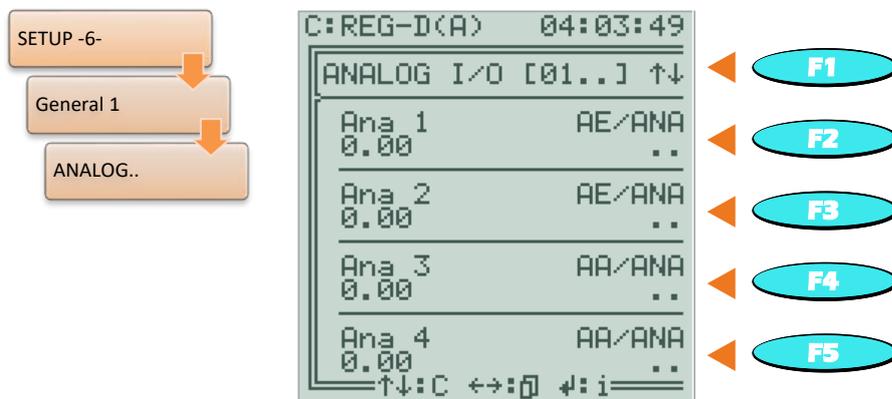
Analog function	Description	FW version	Only available with feature
00:OFF	No function	≥ 2.00	
01:ANA	Analog channel is used by the background program	≥ 2.00	
04:oZero	Output on 0	≥ 2.00	
05:o+FullRng	Output on positive end value (e.g. +20 mA)	≥ 2.00	
06:o-FullRng	Output on negative end value (e.g. -20 mA)	≥ 2.00	
07:oU	Output: Regulation voltage [primary value in V, (e.g. 20,000 V)]	≥ 2.00	
08:oP	Output: Active power corresponding to the display in the transducer [primary value in W, (e.g. 40,000,000 W)]	≥ 2.00	
09:oQ	Output: Reactive power corresponding to the display in the transducer [primary value in VAR, (e.g. 25,000,000 VAR)]	≥ 2.00	
10:oS	Output: Apparent power corresponding to the display in the transducer [primary value in VA, (e.g. 40,000,000 VA)]	≥ 2.00	
11:oU1	Output: Delta voltage of the first voltage measurement input [primary value in V, (e.g. 20,000 V)]	≥ 2.00	
12:oU2	Output: Delta voltage of the second voltage measurement input [primary value in V, (e.g. 20,000 V)]	≥ 2.00	
13:oI1	Output: Current of the first current measurement input or with ARON measurement the current I1,	≥ 2.00	

Analog function	Description	FW version	Only available with feature
	corresponding to the display in the transducer [primary value in A, (e.g. 1200 A)]		
14:oI2	Output: Current of the second current measurement input or with ARON measurement the current I2, corresponding to the display in the transducer [primary value in A, (e.g. 1200 A)]	≥ 2.00	
15:oI3	Output: With ARON measurement, the current I3 corresponding to the display in the transducer [primary value in A, (e.g. 1200 A)]	≥ 2.00	
16:oPHIDEG	Output: Angle PHI [-180 ... 0 ... +180°]	≥ 2.00	
17:oCOSPHI	Output: Cos(φ)[-1 ... 1]	≥ 2.00	
18:oFREQ	Output: Frequency [Hz]	≥ 2.00	
19:oOilTemp	Output: Oil temperature [°C]	≥ 2.00	
20:oWindTemp	Output: Winding temperature [°C]	≥ 2.00	
21:oArU12	Output: With ARON measurement the voltage U12 corresponding to the display in the transducer [primary value in V, (e.g. 20,000 V)]	≥ 2.00	M2
22:oArU23	Output: With ARON measurement the voltage U23 corresponding to the display in the transducer [primary value in V, (e.g. 20,000 V)]	≥ 2.00	M2
23:oArU31	Output: With ARON measurement the voltage U31 corresponding to the display in the transducer [primary value in V, (e.g. 20,000 V)]	≥ 2.00	M2
24:oArP	Output: With ARON measurement, the active power corresponding to the display in the transducer [primary value in W, (e.g. 40,000,000 W)]	≥ 2.00	M2
25:oArQ	Output: With ARON measurement, the reactive power corresponding to the display in the transducer [primary value in VAR, (e.g. 25,000,000 VAR)]	≥ 2.00	M2
26:oArS	Output: With ARON measurement, the apparent power corresponding to the display in the transducer [primary value in VA, (e.g. 40,000,000 VA)]	≥ 2.00	M2

Analog function	Description	FW version	Only available with feature
27:oTapPos	Output: Tap position [1]	≥ 2.07	
28:oSP-1	Output: Setpoint 1 [secondary value in V, (e.g. 101.5 V)]	≥ 2.07	
29:oSP-2	Output: Setpoint 2 [secondary value in V, (e.g. 101.5 V)]	≥ 2.07	
30:oSP-3	Output: Setpoint 3 [secondary value in V, (e.g. 101.5 V)]	≥ 2.07	
31:oSP-4	Output: Setpoint 4 [secondary value in V, (e.g. 101.5 V)]	≥ 2.07	
32:oSP	Output: Active setpoint value [secondary value in V, (e.g. 101.5 V)]	≥ 2.22	
33:oSPINF	Output: Active setpoint value with current influence [secondary value in V, (e.g. 101.5 V)]	≥ 2.22	
64:iOilTp-TR	Input: Transformer temperature	≥ 2.00	
65:iOilTp-TC	Input: Tap changer temperature	≥ 2.00	
66:iOilL-TR	Input: Transformer oil level	≥ 2.00	
67:iOilL-TC	Input: Tap changer oil level	≥ 2.00	
68:iWater	Input: Water content	≥ 2.00	
69:iGas	Input: Gas content	≥ 2.00	
70:iTapPos	Input: Tap position	≥ 2.00	
71:iCO	Input: CO content	≥ 2.11	
72:iH2	Input: H2 content	≥ 2.11	
73:iWndTp-TR	Input: Transformer winding temperature	≥ 2.19	

Output of primary values

Correct output of calculated primary values (e.g. of the analog function "07:oU") requires configuration of the measurement transformer factors Knu and Kni.

8.2.6   I/O extensions (COM3)

In addition to the standard inputs and outputs of the REG-DA, additional modules (BIN-Ds or ANA-Ds) can be connected to the REG-DA via the COM3 communication interface to expand the binary and analog inputs and outputs.

BIN-Ds make additional binary signals available (binary inputs, relays, LEDs), ANA-Ds provide additional analog signals (milliamp inputs or outputs).

Furthermore is the COM3 interface on the REG-DA also used to integrate the internal I/O extensions (characteristic C) into the input and output management. That means that e.g. the six additional binary inputs of the characteristic C91 are physically connected via the COM3 interface.

For a detailed description of the hardware side, see Chapter 7.1.4.8 COM3 port from page 76 nowards.

Switchgear   Transformer

COM3 - Master
Tx +
Tx -
Rx +
Rx -

FTR

FTR

Tx + Tx - Rx + Rx -
BIN-D
Adress 1

Tx + Tx - Rx + Rx -
ANA-D
Adress 2

Option: Fibre optic module
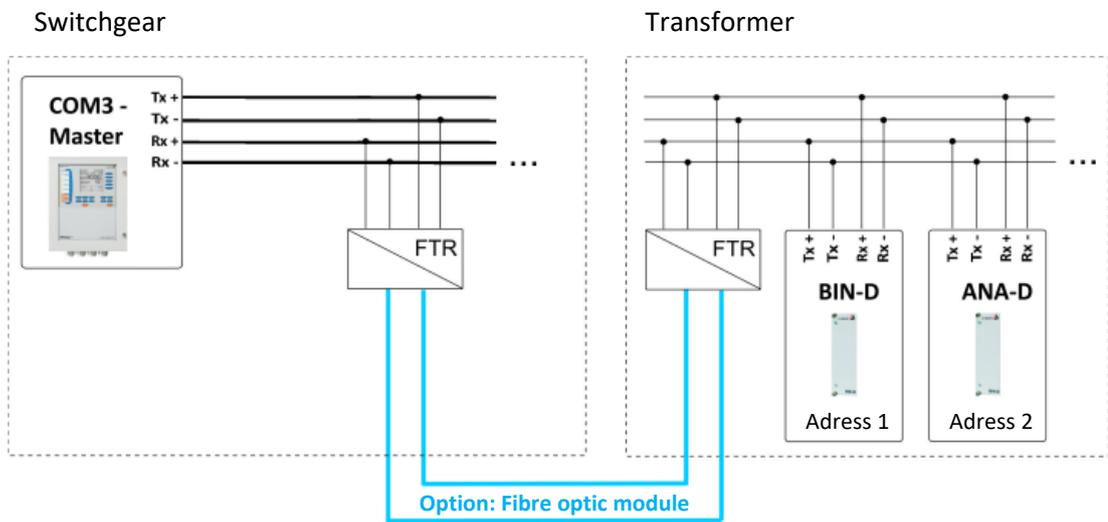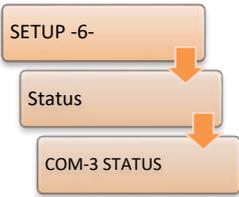
Successful detection of connected COM3 modules can be seen via the REG-DA status menu. For this, each module must have a unique address. The example below shows two BIN-Ds with the address 0 (16 binary inputs [BI16]), and the address 1 (8 relays [REL8]), as well as an ANA-D with address 2 (8 analog inputs [AI8]).

Also integrated I/O extensions like additionally binary inputs (C91,92,95,90) or PT100 inputs (C90) are shown here.

```
A:REG-D(A)    17:08:49

 ←   COM-3 STATUS   →      ◄  F1

Users     : 3
Format    : F123456        ◄  F2
Interval  : 1s_RUN
Memory    : 163 Rec.
Fill level: 100%           ◄  F3

00:BI16   05:---  |ERR
01:REL8   06:---  |TST      ◄  F4
02:AI8    07:---  |
03:---    08:---  |
04:---    09:---  |↑↓        ◄  F5
```

The COM3 interface has a mechanism for error monitoring.

Activation and adjustment can be made in the menu "COM-3 Error Check", which can be reached by pressing the F4 key in the menu "COM3 status".
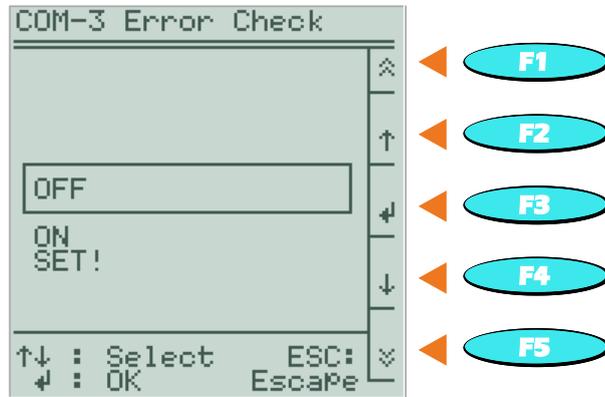
The following settings are available:

Setting	Description
OFF	Disable monitoring of the COM3 interface.
ON	Enable monitoring of the COM3 interface.
SET!	The current configuration of COM3 (number, address and type of connected device) are stored as a target state and COM3 monitoring is activated.

Monitoring of the COM3 interface is based on the number, the address and the type of devices connected. If at least one of the three above-mentioned properties of the current COM3 configuration does not match the stored COM3 configuration for monitoring, a COM3-Err is triggered. This means that if, for example, at the time of setting COM3 monitoring, two BIN-Ds (16 binary inputs, address 0, and 8 relays, address 1) and one ANA-D (AI8, address 2) are connected to COM3, COM3-Err is triggered when, for example, only two devices can be reached.

Changes to the COM3 configuration

Any change in the number, address or type of devices connected to COM3 triggers an error when COM3 monitoring is enabled. Therefore, after each change of the configuration of COM3, the target state for monitoring must be reset (SET! in the COM-3 Error Check).

COM3 mapping (assignment of the COM3 resources)

Apart from the basic detection of BIN-Ds, ANA-Ds and integrated I/O extensions, mapping is important for a successful use. Any physical input or output must be assigned to a logical (software) input or output. That is, the inputs and outputs connected via COM3 are managed and displayed as internal resources by the REG-DA. It is specified, for example, that relay 1 of the BIN-D with address 0 is associated with relay 14 of the REG-DA. This software-based mapping between I/O expansion cards and the Relay for Voltage Control & Transformer Monitoring REG-DA can be read out using the configuration software WinREG (subprogram REGPara), or even changed, if required (via the subprogram Service).

General use of COM3 resources

Use of devices connected to COM3 resources can generally be done in two ways. If the additional inputs and outputs are connected via COM3 mapping with logical (software) inputs and outputs of the firmware, they can be used or set with predefined functions in the menu or via WinREG in the normal way as inputs and outputs of REG-DA, or used in the background program.

In addition, direct access to the resources of COM3 devices is possible via the background program without COM3 mapping. This type of access is mainly used with older firmware versions (≤ 2.15), which do not support COM3 mapping.

If both types of access are mixed, it may cause a malfunction!

Assignment of the 16 binary inputs of a BIN-D to binary inputs 17 to 32 of the REG-DA using DIL switches

Use of a BIN-D with 16 binary inputs, which are to be mapped to the binary inputs 17... 32 of the REG-DA, constitutes an exception to the normal flow. This function can be selected with DIL switch 7 of the BIN-D.

The following applies:

DIP switch 7 = ON -> no assignment to E17 ... 32

DIP switch 7 = OFF -> assignment to E17 ... 32

A COM3 mapping or a background program is not necessary for this purpose. Combination with the normal COM3 mapping is not possible. That is, if more than one BIN-D is to be assigned, total allocation must be carried out via the COM3 mapping mechanism. The DIL switch cannot be used then.

8.2.7   Operating states and error messages

8.2.7.1   General

The REG-DA comes standard with some functions which serve to monitor the communication, the tap-changer motor drive unit and the parallel operation. The respective status and fault messages can be reported by relay, LED and the SCADA system. If additional monitoring functions or status messages are necessary, this can be effected via a background program.

Generation of collective messages (group indication)

A collective message of the following signals as well as other standard or customer- and application-specific reports can be generated via the background program. For this purpose, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.2.7.2   E-LAN error (ELANErr)

The E-LAN error indicates a communication interruption on the E-LAN interfaces. The E-LAN error applies only if there is active parallel operation between the regulators, or if the ParaGramer is used. The display of the E-LAN error is delayed about 30 seconds by default. The delay time is adjustable. To do so, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Termination of unused E-LAN interfaces

Unused E-LAN interfaces that are configured for two-wire operation must be terminated. If that is not the case, false E-LAN errors can be triggered.

8.2.7.3   COM3 error (COM3Err)

The COM3 error indicates a communication interruption to a device (feature C90 … 99, ANA-D, BIN-D) connected to the COM3. In order that communication failure of one of the COM3 devices can be recognized, COM3 monitoring must be activated (see Chapter 8.2.6 I/O extensions (COM3), from page 228 onwards). The COM3 error is also indicated by blinking of the REG-DA service LED. As soon as the current configuration of COM3 devices again corresponds to the stored situation, the COM3 error is automatically reset.

8.2.7.4 TC in operation signal error (TCErr)

The "TC in operation error" is triggered when the TC in operation time detected via the TC in operation signal of the motor drive exceeds the configured "maximum TC in operation time". This function is used to monitor the run time of the motor drive and can be used as run through protection. The output function TC-Err is used to permanently display TC in operation error.

The signal is confirmed as soon as the regulator is switched from manual to automatic, one more error-free tap change is performed, or the F5 key is pressed in regulator or transducer mode. If the error cause is not remedied after confirmation (TC in operation signal is still on), the TC in operation error is activated again after the "maximum TC in operation time" has elapsed. In order to trip the motor circuit breaker, the wiping relay output function "41:TC-Err+" can also be used.

8.2.7.5 Tap change error (TAPErr)

The tap-change error is used to monitor tap feedback after issue of a tap command. The following tap-change errors are monitored:

● Tap change in the wrong direction (the tap position did not change in the expected direction after a tap-change command)

● Change of tap position by more than one tap, or no change (the tap position did not change to the previously calculated tap after a tap-change command)

The signal is confirmed as soon as the regulator is switched from manual to automatic, or the F5 key is pressed in regulator or transducer mode.

8.2.7.6 Tap position indication error

An error in tap position detection is indicated by the tap position 99. Possible causes for this error are:

● Invalid BCD code, for example, the binary inputs for eight and four are active simultaneously.

● The mA signal for the tap position message lies outside the configured limits (e.g. smaller than 4 mA).

● Too large total resistance or line discontinuity on detecting tap position via resistance measurement.

Once a correct tap feedback is detected, it will be displayed again instead of the 99. Confirmation is unnecessary.
The fault indication (tap position 99) in most SCADA connections is displayed at tap 0 (zero).

8.2.7.7 Parallel operation error (ParErr)

The following situations lead to triggering of a parallel operation error:

● The occurrence of a tap difference, which cannot be compensated by the follower (Master-Follower procedure). To reach the tap of the master regulator, the follower regulator has a time window available that is 2.5 times the "maximum TC in operation time". Immediately after activation of parallel operation, the time defined by the parameter "1 ParErr after n * TC in operation time" is available.

● Exceeding the circulating reactive current limit (Icirc supervision) in Master-Follower parallel operation.

● Exceeding the set "maximum allowable tap difference" in the circulating reactive current minimization procedured (dIsin(φ) and dIsin(φ)[S]).

The parallel operation error is acknowledged as soon as the regulator is switched from manual to automatic, or parallel operation is disabled.
By default, appearance of the parallel operation error leads to switching the regulators involved to MANUAL mode.

8.2.7.8 ParaGramer input error (PG_INERR)

The ParaGramer input error is used to monitor switch feedback for the ParaGramer function. It is only applicable if detection of the switch position is double pole. That is, for each switch position, a respective binary signal for "Switch open" and "Switch closed" is being used. The ParaGramer input error becomes active if both binary signals are on or off, (i.e., the switch is in fault position or there is a broken cable). The faulty input status is also indicated by rotation of the corresponding switch in the ParaGramer display.
As soon as the incorrect position feedback is resolved, the ParaGramer input error is automatically confirmed.

Using the ParaGramer input error

The function ParaGramer input error is only available if, for the corresponding switch, both the input function (e.g. "26: PG_CB") and the inverse input function (e.g. "26:-PG_CB") are used on one binary input each.

8.2.7.9 dcos(φ) emergency program (dCosEmgy)

The message dcos(φ) emergency program becomes active when communication between the parallel operating regulators is interrupted in parallel operation with dIsin(φ) or dIsin(φ)[S] and the regulator switches to the dcos(φ) emergency program. As soon as communication between the regulators is established again, and the devices switch back into the original parallel program after about 10s, the message is automatically deactivated.

8.3 Features (software)

8.3.1 General and overview

The software features allow customization of REG-DA functionality based on the customer's and the installation's requirements. This means that they switch certain functions of the REG-DA on and off without needing to change firmware. Certain features have password protection (protected feature) since they enable either very specific functions or are chargeable.
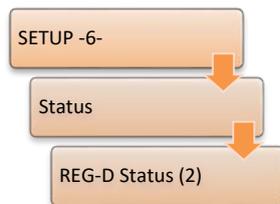
Switching features on and off is done via a terminal program (e.g. the terminal of the WinREG software). For questions regarding this matter, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Activated features appear in the REG-DA menu and the WinREG software.

NOTICE!	**Switching on and off and changing features may lead to unintended behavior of the device.**
	➲ Features may be only be adjusted after consultation with the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Overview of all features

Feature	Description	Dependencies
991101	Customer-specific expansion of the ParaGramer	FW ≥ 1.85
3winding	Three-winding transformer functionality, changeover between measurement inputs U1, I1 and U2, I2	Hardware feature M9 from FW 1.22 to FW 1.97 "3winding"
Adapt	Adaptation of system indications	from FW 2.09 and 2.02d/f
BBN4.4.3	Custom feature	FW ≥ 1.32
Bootload	Enables remote starting of the bootloader	FW ≥ 2.22
COM2FIX	Fixing the COM2 interface settings	FW ≥ 2.00
Crosslink	Expansion of ParaGramer, crosswise connection of busbars, cannot be used with a third busbar	FW ≥ 1.91
DELTAI	Parallel program	FW ≥ 1.98
EMHAGEN	Custom feature	FW ≥ 1.30
EnBW	Custom feature	FW ≥ 1.68
ESB	Custom feature	FW ≥ 1.77
HVLVControl	Expansion of ParaGramer, parallel operation is additionally determined on the switch	FW ≥ 1.98

Feature	Description	Dependencies
	positions of the primary side (i.e. high voltage side)	
Invers	Adjustment of expected tap feedback and the tap commands to an inverse tap changer	FW ≥ 1.88
LEW	Custom feature	FW ≥ 1.46
LocalRemote	Activates the local/remote key	FW ≥ 1.97
M2	ARON measurement for asymmetric grids	Hardware feature M2 FW ≥ 2.00
MISWAP	Swapping of physical measurement inputs	FW ≥ 2.00
NLK	Custom feature	FW ≥ 1.55
ParaGramer	Automatic recognition of parallel operation via the substation topology (i.e. feedback of switch positions)	FW ≥ 1.77
PG_SCHEME_1	Expansion of ParaGramer, special busbar layout with generator	FW ≥ 2.08
PQCtrl	Active and reactive power regulation, for example, phase-shifting transformer	FW ≥ 1.86
PrimCtrl	Control of the tap changer based on primary voltage	FW ≥ 1.73
Qsigned	Reactive power with sign, FW ≥ 2.03 reactive power is displayed by default with sign.	FW ≥ 1.30
Recorder	Recorder function	from FW 1.62 up to 1.97 recorder RAM > 256KB
Ringlink	Expansion of ParaGramer, annular busbar, not usable with Crosslink	FW ≥ 2.19
SimMode	Simulation mode	FW ≥ 2.00
SYSCTRL	Adaptation of system behavior part 1	FW ≥ 2.00
SYSCTRL2	Adaptation of system behavior part 2	FW ≥ 2.00
TM	The Transformer monitoring function	FW ≥ 1.99
ULC	Adaptation of the LDC current program	FW ≥ 1.91
VEW	Custom feature	FW ≥ 1.58

8.3.2 ParaGramer including extensions [protected]

8.3.2.1 Feature ParaGramer [protected]

The ParaGramer is a function of the REG-DA for the purpose of automatic recognition of parallel operation of transformers based on switch positions. The switch positions are transferred via binary signals to the Relays for Voltage Control & Transformer Monitoring and they evaluate what transformers are electrically connected together and thus connected in parallel.
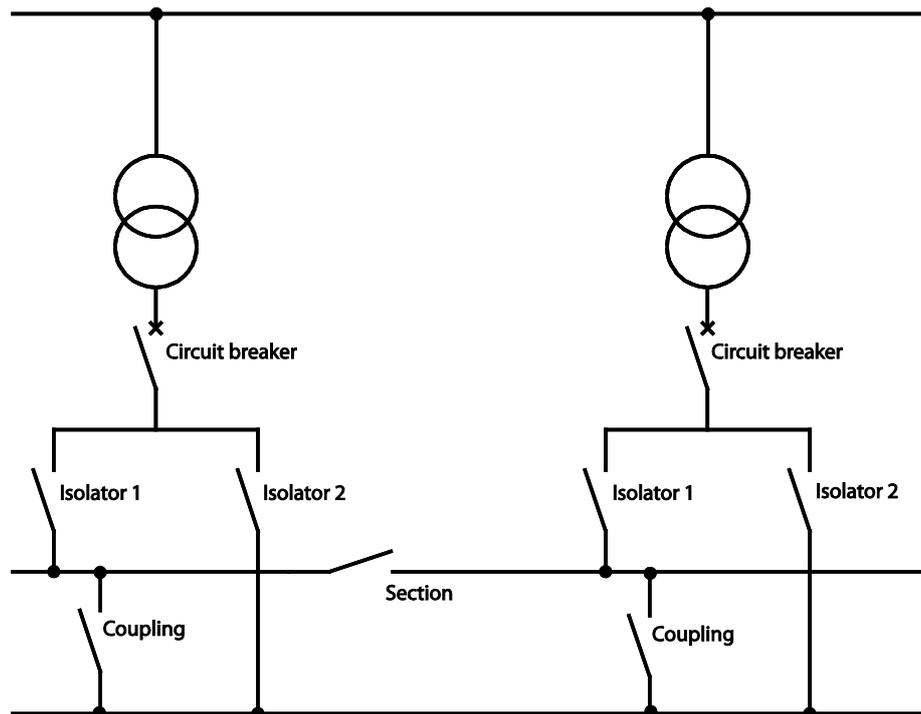
Example of a single-line diagram convertible in ParaGramer

For this purpose, a number of selectable switch positions are available, including, among others, circuit breakers, isolators, sections and couplings.

In addition, several special configurations are available, for example, to take into account both the high voltage as well as the low voltage side, to connect crossed busbars (Crosslink), or ring-like busbars (Ringlink). These configurations are activated by other features. Prerequisite for these features is always that the feature ParaGramer is activated.

A total of three high voltage and low voltage side busbars, and up to ten transformers can be indicated and also shown on the display in ParaGramer.

These open switches are shown as diagonal single lines. Closed switches are displayed as a double line. Switches in fault position are displayed by a rotating line.
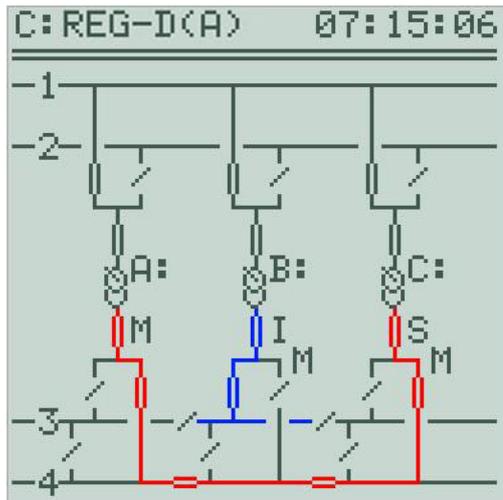
Example configuration with two busbars, respectively. All transformers are connected on the high voltage side to busbar 1, A: and C: are connected to the low voltage side via busbar 4, and thus parallel to each other, while transformer B: is fedding busbar 3.

The parallel state is presented differently, depending on the parallel program: With the circulating reactive current programs dIsin(φ) and dIsin(φ)[S], parallel operation is displayed with a "P" and single operation with an "I" (independent), while in Master-Follower, MSI and MSI2, depending on the state, "M" for Master, "S" for slave and "I" for independent operation are displayed. In addition, when the regulator could become master, this is indicated by an "M" placed lower (sub index).

The regulator occupying the first/lowest place in the group list is always selected as master.

Prerequisites

In principle, the following prerequisites must be met to be able to use ParaGramer:

● Each transformer to be regulated must be assigned to a separate Relay for Voltage Control & Transformer Monitoring.

● Each regulator must have the feature ParaGramer enabled, possibly also the special features (e.g. Crosslink), as required.

● A functioning E-LAN connection is required between all regulators.

● There must be a sufficient number of binary inputs available to map the switch positions. Here, each regulator is connected to the switch positions of its "own" transformers. An exception is transmission via a SCADA system, (e.g. via GOOSE).

Input/output functions

SETUP -5-

Input/Relay Assignments..

These switch settings are always available. Although the high voltage side input functions (with "_H_") can be selected and displayed, they are only evaluated for parallel operation when the feature HVLVControl is enabled.

Input function	Meaning	Comment
26:PG_CB	Low voltage – circuit breaker	
27:PG_IS1	Low voltage – isolator busbar 1 (BB 1)	
28:PG_IS2	Low voltage – isolator (BB 2)	
29:PG_CP	LV – coupling between BB 1 and BB 2	
30:PG_SC1	Low voltage – section BB 1	Not available with Crosslink=1/3
31:PG_SC2	Low voltage – section BB 2	Not available with Crosslink=1/3
34:PG_H_CB	Low voltage – circuit breaker	
35:PG_H_IS1	High voltage – isolator BB 1	
36:PG_H_IS2	High voltage – isolator BB 2	
37:PG_H_CP	HV – coupling between BB 1 and BB 2	
38:PG_H_SC1	High voltage – section BB 1	Not available with Crosslink=2/3
39:PG_H_SC2	High voltage – section BB 2	Not available with Crosslink=2/3
71:PG_IS3	Low voltage – isolator BB 3	
72:PG_CP2	LV – coupling between BB 2 and BB 3	
73:PG_CP3	LV – coupling between BB 1 and BB 3	
74:PG_SC3	Low voltage – section BB 3	
75:PG_H_IS3	High voltage – isolator BB 3	
76:PG_H_CP2	HV – coupling between BB 2 and BB 3	
77:PG_H_CP3	HV – coupling between BB 1 and BB 3	
78:PG_H_SC3	High voltage – section BB 3	

Output function	Meaning	Comment
83:PG_INERR	Disruption of ParaGramer inputs*	from 2.13

* The ParaGramer makes available testing of switch feedback. For this purpose, the regulator is supplied with a bipolar switch feedback (1x normally closed, 1x normally open). As soon as the switch feedback is invalid (both binary inputs either on or off), the output function PG_INERR is activated with a time delay. The monitoring function is activated as soon as the same ParaGramer input function is used on two binary inputs, once non-inverse and once inverse.

Parameter

The following parameters must be considered:

Parameter	Description
Parallel Program Activation SETUP -5- ↓ AddOns-7 ↓ Parallel Prog. Activation	On using the ParaGramer, as a rule parallel program activation is set to 01:ON, because the ParaGramer detects by itself which transformers are in parallel.
ParaGramer Activation SETUP -5- ↓ AddOns-6 ↓ PARAGRAMER Activation	With ParaGramer activation, the number of transformers that, in principle, can and should be connected in parallel with each other must be set. Exactly this number of transformers are shown in the display.
Parallel Program SETUP -1- ↓ Programs.. ↓ Parallel Program	A parallel program must be selected. The following parallel programs can be used with ParaGramer: dIsin(φ) dIsin(φ)[S] dcos(φ) Master-Follower MSI MSI2
Group List SETUP -1- ↓ Programs.. ↓ Par.Parameter.. ↓ Group List	All regulators that will be used with ParaGramer must be configured in the group list.
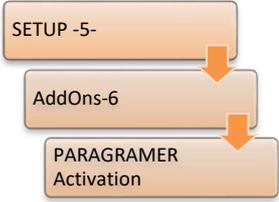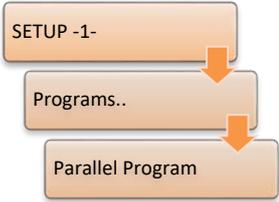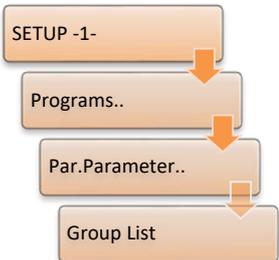
On/off switching

Feature ParaGramer = 0   Feature ParaGramer disabled

Feature ParaGramer = 1   Feature ParaGramer enabled

8.3.2.2 Feature Crosslink [protected]

With the Crosslink feature it is possible to connect two busbars across. Instead of sections 1 and 2, respectively a left and a right segment are available. The connection between busbars 1 and 2 is established by the coupling.

For example, it is possible to connect the left part of busbar 1 with the right part of busbar 2.
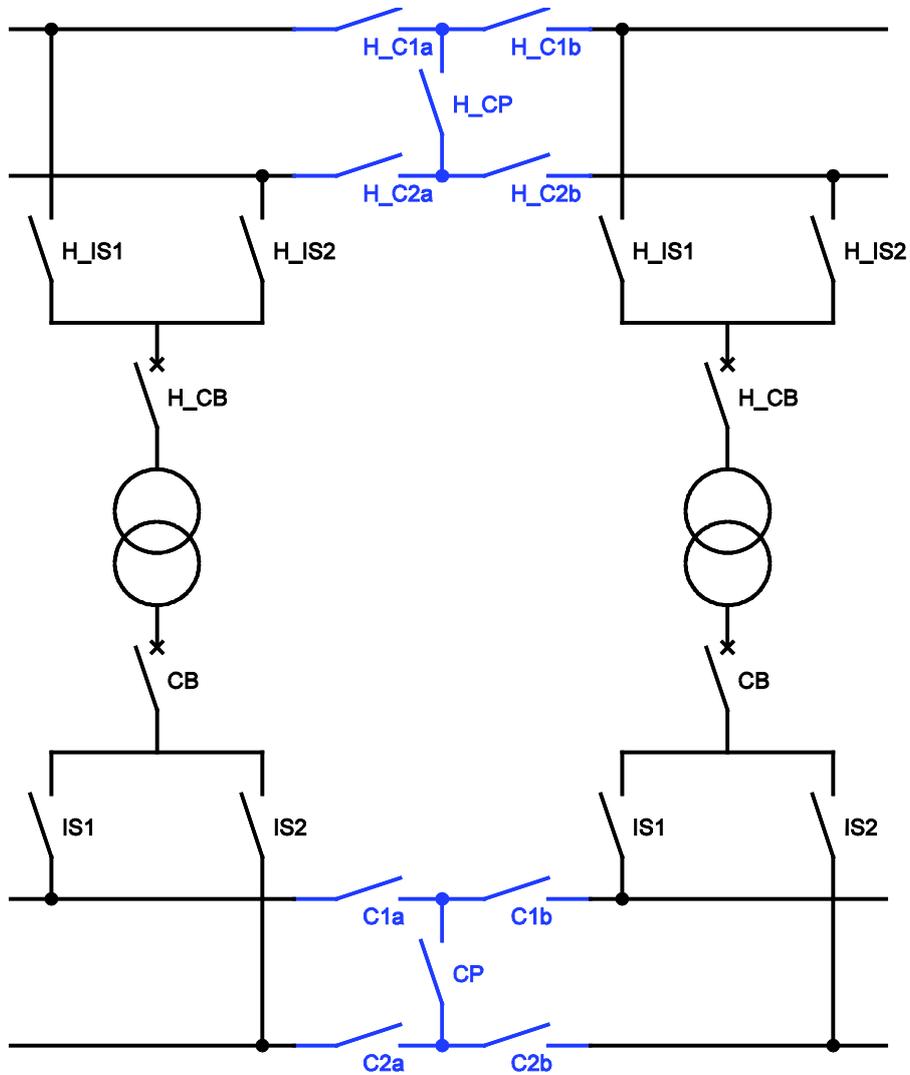
Crosslink configuration with both the high voltage and low voltage side.

Input functions

SETUP -5-
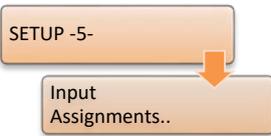
Input
Assignments..

These switch settings are only available with the feature Crosslink activated. Again, the restriction that the high voltage side input functions are not used, for recognition of parallel operation without the feature HVLVControl, is active. Then they are only displayed.

Input function	Meaning	Comment
55:PG_C1a	Low voltage – section BB 1, left segment	Instead of PG_SC1 Crosslink = 1/3
56:PG_C1b	Low voltage – section BB 1, right segment	Instead of PG_SC1 Crosslink = 1/3
57:PG_C2a	Low voltage – section BB 2, left segment	Instead of PG_SC2 Crosslink = 1/3
58:PG_C2b	Low voltage – section BB 2, right segment	Instead of PG_SC2 Crosslink = 1/3
59:PG_H_C1a	High voltage – section BB 1, left segment	Instead of PG_H_SC1 Crosslink = 2/3
60:PG_H_C1b	High voltage – section BB 2, right segment	Instead of PG_H_SC1 Crosslink = 2/3
61:PG_H_C2a	High voltage – section BB 1, left segment	Instead of PG_H_SC2 Crosslink = 2/3
62:PG_H_C2b	High voltage – section BB 2, right segment	Instead of PG_H_SC2 Crosslink = 2/3

Feature coding

<value>	Meaning
1	Only on the low voltage side
2	Only on the high voltage side
3	Both high- and low voltage sides

On/off switching

Activation by: Feature Crosslink = <value>

Deactivation by: Feature Crosslink = 0

Instruction:
Crosslink cannot be combined with Ringlink. Moreover, with the use of Crosslink the third busbar is dropped.

8.3.2.3 Feature Ringlink [protected]

With the Ringlink feature it is possible to connect two busbars in a ring. The connection between the busbars is carried out by an optional coupling, which acts as a section. If needed, a coupling can be configured on both the first and the last, and even both regulators.

Thus it is possible, for example, to couple the transformers A: and C: in parallel, without the need for separate isolators and/or sections.
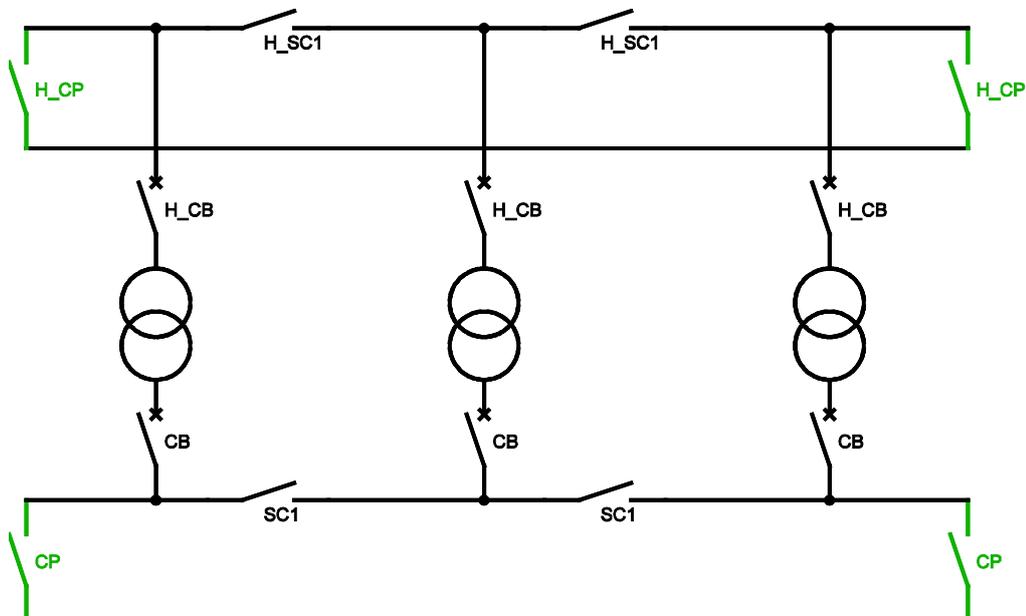
Ringlink configuration with both the high voltage and low voltage side.

Feature coding

<value>	Meaning
1	Only on the low voltage side
2	Only on the high voltage side
3	Both high- and low voltage sides

On/off switching

Activation by: Feature Ringlink = <value>

Deactivation by: Feature Ringlink = 0

> **Instruction:**
> Ringlink cannot be combined with Crosslink. Moreover, use of Ringlink excludes the possibility of using a third busbar.

8.3.2.4   Feature HVLVControl [protected]

By default, only the low voltage side is taken into account for the automatic detection of parallel operation. If input functions are selected for the high voltage side, these will be displayed, but not taken into account. If you also wish to consider the switch positions on the high voltage side, the feature HVLVControl must be enabled.

These restrictions also apply to the special configurations Crosslink and Ringlink.

Output functions

SETUP -5-

Relay
Assignments..

Output functions	Meaning	Comment
70:HvLvDiff	Different parallel states between high- and low voltage sides	FW ≥ 2.00

On/off switching

Activation by: Feature HVLVControl = 1
Deactivation by: Feature HVLVControl = 0

8.3.2.5   Feature PG_SCHEME_1 [protected]

The PG_SCHEME_1 feature is a special configuration with a generator in the illustration. It cannot be combined with other ParaGramer features.

Only the following combination is possible:
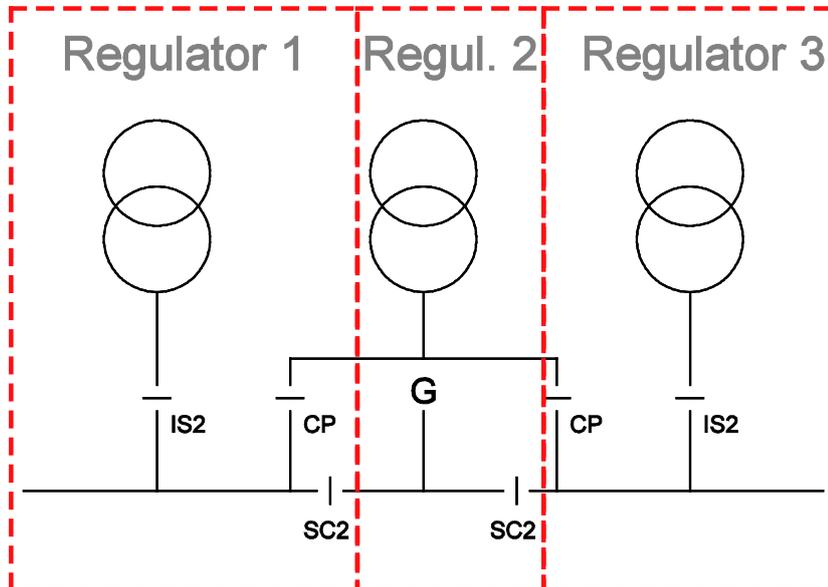
Configuration of ParaGramer with the feature PG_SCHEME_1.

If an input function is configured wrongly, the switch in question is shown by a rotating bar. In addition, the display will show a message indicating that the input configuration is incorrect.

On/off switching

Activation by: Feature PG_SCHEME_1 = 0
Deactivation by: Feature PG_SCHEME_1 = 1

8.3.2.6   Processing of additional switch positions

If you would like to use switch positions that do not exist in the standard, the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101) can usually help out with an H-program. In this case, for example, two switch positions can be combined and "virtually" mapped as a switch (e.g. two switches used as one isolator).

Alternatively, there is the possibility to create logic through external wiring that combines several signals into one.

For the ParaGramer, it is only important that the transformers be electrically connected, switches can also be "misused" thereby. For more complex mappings, it may also be necessary to use another busbar to detect the electrical switching states correctly.

8.3.2.7 Feature 991101 [protected]

The custom feature 991101 is an extension of the ParaGramer function. With this feature, certain switch positions for monitoring purposes are redundantly assigned to different regulators.

Input/output functions

SETUP -5-

Input/Relay
Assignments..

Input function	Meaning	Comment
32:PG_CBa	Monitoring signal for feature 991101, coupling a	
33:PG_CBb	Monitoring signal for feature 991101, coupling b	
40:PG_H_CBa	Monitoring signal for feature 991101, high voltage side coupling a	
41:PG_H_CBb	Monitoring signal for feature 991101, high voltage side coupling b	

Output functions	Meaning	Comment
43:LV_Check	Monitoring of parallel switching for custom scheme	
44:HV_Check	Monitoring of parallel switching for custom scheme	
45:HV_Err	Monitoring of parallel switching for custom scheme	
46:HV_Fail	Monitoring of parallel switching for custom scheme	

On/off switching

Activation by: Feature 991101 = 0
Deactivation by: Feature 991101 = 1

8.3.2.8   ParaGramer via SCADA

ParaGramer via IEC-61850 GOOSE *light*

With a GOOSE-capable state of the REG-PE(D) firmware for IEC 61850, it is also possible to transmit all switch positions via GOOSE to the Relay for Voltage Control & Transformer Monitoring.

For this purpose, a small addition to the background program is necessary.

To have the switch positions received via GOOSE incorporated in ParaGramer, previously the binary inputs 33 ... 64 were used. Since these are not usually available in hardware, they are used as "virtual binary inputs" for GOOSE messages. If hardware already exists for the binary inputs 33 ... 64, use of GOOSE for ParaGramer is either not available or available only to a limited extent.

If you are interested in the GOOSE application, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Further applications

If you would like a different method of switch position transmission via SCADA, the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101) will be glad to advise you.

8.3.2.9 Overview of ParaGramer input functions
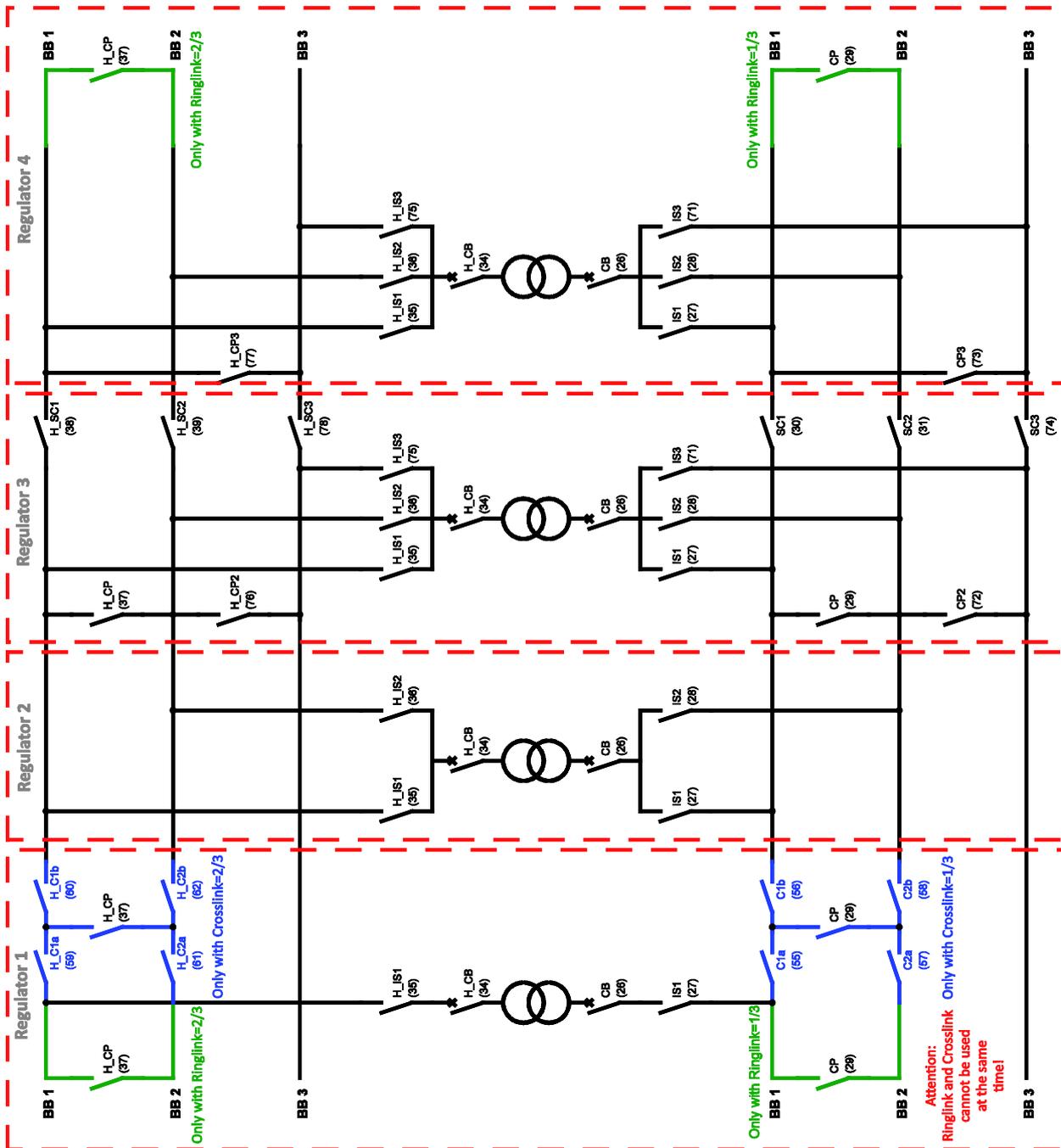
Overview of all existing ParaGramer switch settings and their configuration. The number of the according binary input function is shown in brackets.

8.3.3 Feature Recorder [protected]

With this feature the recorder function will be activated. Without activation the recorder is only available as a demo.

Recorder demo mode!

The recorder is running in demo mode if "DEMO" is displayed in the left of the grid when the recorder is in normal display mode. In this operating mode, the recorder records measured values for a time domain of 4 to 6 hours. The oldest values are overwritten at the end of this period. Data cannot be read out in demo mode!

The recorder feature (characteristic S1) serves for registration and display of up to three selectable measured values. Besides the measured values, the current tap position*, the setpoint value*, the tolerance band* and the manual/automatic state*, as well as the time and date are recorded. The time resolution for the recording is adjustable.

The recorder shows the continuous time course of up to two selectable measured values on the display as a line graph. The current date and time (timestamp) are also recorded. This enables correlated data to be queried by date and time. The average storage time for a channel (e.g. voltage and tap) is about six weeks (recording time < 18.7 days with continuous change of the measured value and the parameter "absolute deviation" = 0).

The stored values can be retrieved and displayed via the keyboard or the operating software.

(*requires the recording of voltage (function 01:U) on channel 1)

Recorder display

Bus address (station ID)   Name of regulator   Current time

Identification line

Back
Manual/Auto mode
Forward
Recorder menu
Feed speed
Scale stretching

Selected curve

Current voltage

Tap position   Date   Time

Set permissible setpoint deviation

Current voltage
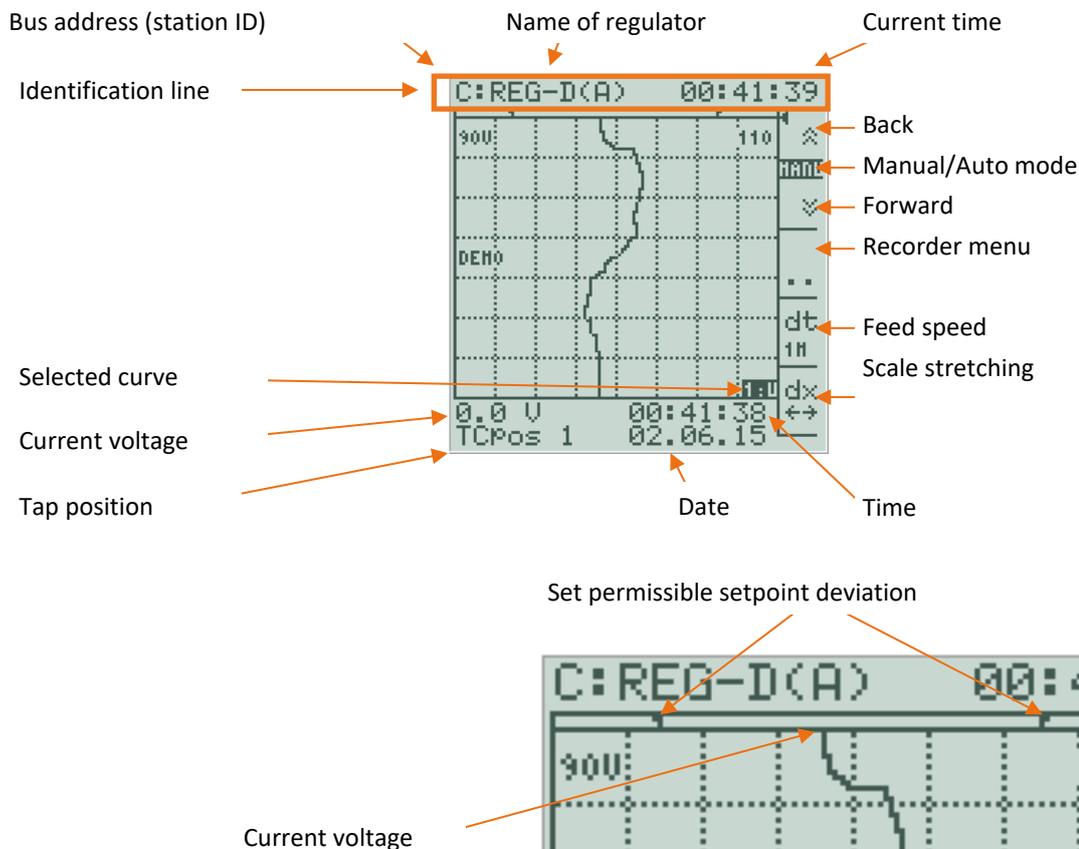
Operation

Press F1 and F2 to access historical data in the recorder's menu. You can view the timestamp for a specific event by pressing F1 and F2 to browse the voltage-time-diagram back to the time reference line (beginning of the grid (top)) and then by reading at the bottom of the grid, time, date, voltage and tap position.

"HIST" is displayed at the bottom of the grid when historical data are displayed. Press ESC to exit display of measured value history at any time.

Time grid

In the recorder basic display, use F4 to select the recorder's feed rate. You can choose from five different times: 14s, 1 min, 2 min, 5 min, 10 min. The "dt" values are related to the time that must pass before a scale division is depicted. Seven available divisions are displayed on the screen. This enables a maximum time domain of 7 x 10 min (70 min) to be displayed on the screen. The shortest time domain with the highest optical resolution is 7 x 14 s (98 seconds).

Regardless of the selected time grid dt (temporal resolution of the display), all of the measured values are stored in an adjustable time step (standard = 1s).

Display value range (dx)

Use 'dx' (F5) to change the value range displayed for the active channel. In dual display mode always the value of the left channel is changed.

The display is enlarged (zoom in) with the F4 key, while the F5 key reduces the display (zoom out). The F3 key provides different types of scaling.

The settings "SP Auto setup" and "SP-centred" can only be used effectively when the voltage to be regulated has been selected on channel 1.

- SP automatic setup:

  One-time automatic adjustment of the display to the full range of the historic measurement data with the setpoint in the middle of the display area. Scaling then switches to the mode SP-centred.

- SP-centred:

  The setpoint is placed in the middle of the scale and kept there. The graph can be enlarged (zoom in) or reduced (zoom out) with the F4 and F5 keys.

- Manual:

  Use F1, F2, F4 and F5 to change the graph

- Auto setup:

  One-time automatic adjustment of the display to the full range of the historic measurement data. Scaling then switches to manual mode.

- Upper limit:

  Enables a fixed end value to be entered for the scale (upper limit)

- Lower limit:

  Enables a fixed start value to be entered for the scale (lower limit)

- Lower limit = 0:

  Sets the start value of the scale to zero

If the scaling type "Manual" is selected, the graph can be scaled using the F1 to F5 keys. Here, the keys have the following function:

F1:   Right shift the graph   F2: Left shift the graph

F4:   Zoom in (enlarge)   F5: Zoom out (reduce)

Scrolling

Menu 1

RECORDER

Recorder 1
(F3 key)
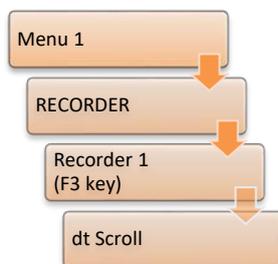
dt Scroll

Under Scrolling you can set the step size for searching with F1 and F2 in recorder mode. This accelerates the search process.

PAN-D recorder

Menu 1

Recorder

Recorder 1
(F3 key)
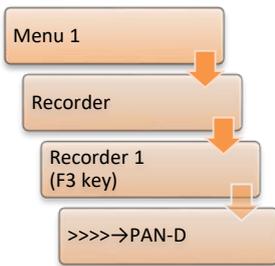
>>>>→PAN-D

If the connected PAN-D also has the recorder function S1, the recorded data can be displayed on the LCD of the REG-DA. Setup of the PAN-D recorder is also possible. Access to the PAN-D recorder is via the F2 key (>>>>→PAN-D).

Curve selection

Menu 1

Recorder

Recorder 1
(F3 key)
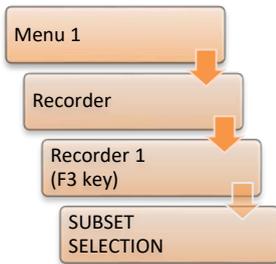
SUBSET
SELECTION

With the parameter subset selection it can be chosen which of the recorded measured values are display on the LCD. This parameter does not affect the recording.

Time search

Menu 1

Recorder

Recorder 2 (F3)
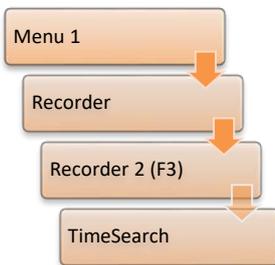
TimeSearch

A specific search date and a specific search time can be set using the item "TimeSearch". After returning to the recorder mode by pressing F3, the time-line diagram for the selected time is displayed.

MMU-Display (multi transducer display, display of derived values)

Menu 1

Recorder

Recorder 2 (F3)
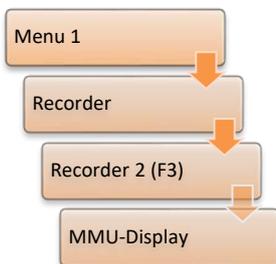
MMU-Display

In the recorder 2 menu, display of variables derived from the current cursor value (at the top) can be switched on and off with the F2 key, using "MMU display". This function requires recording of current and voltage, and, optionally, the phase angle. Apparent, active and reactive power can be derived.

If only two measured values are selected for recording (U + I), I and S are displayed numerically.

If all three measured values (U + I + φ) are active, I, φ, S, P and Q are displayed numerically.

Dual display

| Menu 1 |
| Recorder |
| Recorder 2 (F3) |
| DUAL DISPLAY |
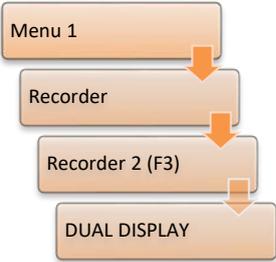
With the menu item "Dual display" (F4), the recorder display can be switched between single and dual channel display. The left and right arrow keys are used to toggle between the displayed channels.

Grid display

| Menu 1 |
| Recorder |
| Recorder 2 (F3) |
| GRID DISPLAY |
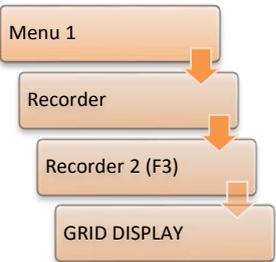
The F5 key toggles the grid, which is represented in the recorder basic display for showing scale divisions, on and off.

The Recorder-1 and Recorder-2 menus display the current storage level as a percentage. In addition, the recording duration of data stored in memory is shown in days. This allows an estimation of how long the device can record with the current settings at that operating site before historical data will be overwritten.

Number of channels

| Menu 1 |
| Recorder |
| Recorder 1 (F3 key) |
| SETUP |
| CHANNEL NUMBER |
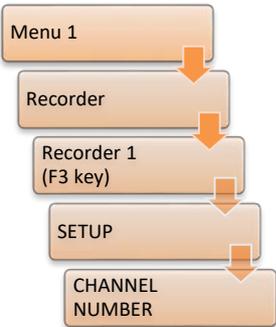
The channel number specifies how many channels are to be recorded. A total of three channels can be recorded.

Depending on the channel number, the following parameters for each channel x are separately available.

START/STOP

| Menu 1 |
| Recorder |
| Recorder 1 (F3 key) |
| SETUP |
| START/STOP |
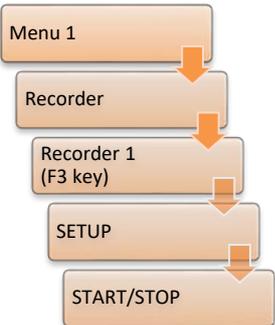
Pressing F3 starts or stops recording of the measured values.

Selection
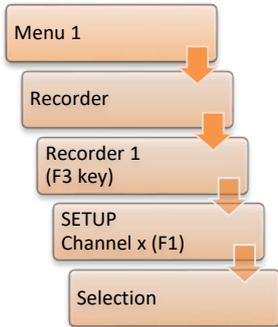
Here you can select which measured value is to be recorded on which channel. If the measured value is scaled with a factor, it is displayed in front of the F3 key (range + factor).

Menu 1

Recorder

Recorder 1 (F3 key)

SETUP Channel x (F1)

Selection

Function	Range	Scaling* (factor)	Description
01:U	0 ... 150V	Knu	Voltage
02:I**	+/- 10A	KNI	Current
03:PHI	+/- 180°	1	Phase angle Phi
05:U1	+/- 3200V	Knu 1	Voltage U1
06:U2	+/- 3200V	Knu 2	Voltage U2
07:OilTp-TR	+/- 3200°C	1	Transformer oil temperature
08:WindTemp	+/- 3200°C	1	Winding temperature
101:A1_ANA	Selectable	1	Analog channel 1
102:A2_ANA	Selectable	1	Analog channel 2
103:A3_ANA	Selectable	1	Analog channel 3
104:A4_ANA	Selectable	1	Analog channel 4
105:A5_ANA	Selectable	1	Analog channel 5
106:A6_ANA	Selectable	1	Analog channel 6
...			
AMAX_ANA***	Selectable	1	Analog channel max.

*   Scaling is used for the display. This means that specific values are stored, for example, as secondary values and scaled for the display by this value.

**   The current is recorded relative to the set nominal value (1/5 A). This means that the value 1 A is recorded if 5 A current is flowing through a 5A transducer. The effective transducer factor (5 x KNI) is used for the display. This behavior must be taken into account when setting the absolute deviation.

***   The number of analog channels available in the recorder depends on the number of analog channels it has. The max number of channels is 32. The max number of channels with feature S2 is 64.

The function that is allocated to the analog function is contained in the name in the allocation menu. For example, if analog channel 4 is allocated output function oSP (output of the active setpoint), the description is A4_oSP.

Change of a channel assignment!

Once a selection has been made it should only be changed if the stored data have been transferred to a PC. After changing the channel assignment, the recorder function cannot correctly interpret the remaining data. It is therefore recommended to delete the "old data" in this case.

Step distance

Menu 1

Recorder

Recorder 1 (F3 key)

SETUP Channel x (F1)
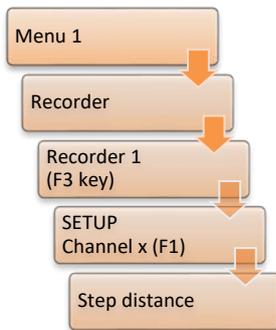
Step distance

The step distance parameter specifies which value range can be recorded and how many decimal places are stored.

For the measured quantities U, I, Phi, U1, U2, OilTp-Tr and WindTmp, the range of values is fixed and automatically set when the measured value is selected. When an analog channel is recorded, the value range for the measured values is not fixed, which is why the step distance can be selected. The step distance determines the number of decimals used to record the measured values. Because each of the recorder channels can record ±32000 values, setting the number of decimal places defines a specific value range (step distance 0.01 -> value range ±320.00; step distance 0.1 -> value range ±3200.0). The available value range is displayed in front of the F3 key.

Absolute deviation

Menu 1

Recorder

Recorder 1 (F3 key)

SETUP Channel x (F1)

Absolute deviation
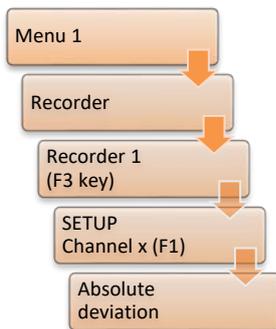
The absolute deviation defines a dead band for the recording of measured values. This means that a new value is only recorded when the change to the last recorded value is greater than the absolute deviation. This parameter enables the storage space to be reduced for strongly fluctuating measured values.

Deleting recorder data

SETUP -6-

General 3

Erase Recorder Data
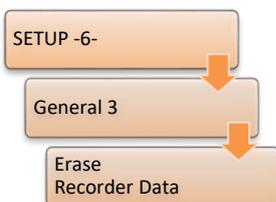
Recorder data can be deleted in the menu "Setup-6\General-3" by pressing F3 "Erase Recorder Data".

On/off switching

Activation by: Feature RECORDER = 1
Deactivation by: Feature RECORDER = 0

Activation of the recorder feature

After changing the feature, the regulator must be switched off and on again, or the command SYSRESET= 0 (PowerOn reset, switching on/off) must be executed via REG-L.

Recorder mode (feature S2)

The recorder mode S2 provides another four recorders, each with 64 channels, in addition to the three channels of recorder S1. The recording interval can be set separately for each.

The data can only be configured and displayed with the operating software. Stored values cannot be displayed on the screen of the REG-DA.

The S2 recorder is only available at REG-DA devices with the hardware feature S2.

8.3.4   Feature TM (Transformer Monitoring) [protected]

Menu 1

Monitor

With the TM feature the transformer's main parameters are monitored. The oil temperature is recorded in addition to tap-changer statistics and current. The hot-spot temperature is determined from the oil temperature and the current in accordance with IEC 60354 or IEC 60076, and extrapolated to the transformer's service life consumption. Up to six cooling stages and two oil pumps can be activated depending on the oil or winding temperature. The system monitors the operating times of the fans and controls the individual fan groups, so that an operating time which is as balanced as possible is achieved over the whole operating life. If desired, individual fans can also be permanently assigned to a specific cooling stage.

Additional alarms such as Buchholz alarm and/or Buchholz trip can be fed into the regulator as digital signals, displayed and sent to a SCADA system for further processing.

For function scope and description of the parameters, please refer to the user manual of the Transformer Monitor Module.

On/off switching

Activation by: Feature TM = 1
Deactivation by: Feature TM = 0

8.3.5 Feature 3winding (three-winding transformer) [protected]

Originally, this feature was developed in order to regulate and monitor three-winding transformers.

Moreover, it is possible to use the feature for other applications, which require a second voltage (U1, U2) and current measurement (I1, I2).

In these cases, the three-winding software feature is usually combined with a background program to implement customer-specific requirements.

Properties of the three-winding transformer feature

● The same or a different configuration of voltage transformers (VTs) which are assigned to the voltage measuring channels (U1, U2). This means that three-winding transformers with different secondary voltages can be regulated easily. The configuration of current transformers (CTs), which are wired to the current measurement inputs, can also be adjusted separately from one another with the exception of the nominal current of the transformer (1/5 A).

● Display of both secondary voltages in the transducer display mode.

● Voltage, current, cosφ, apparent, active and reactive power can be shown for the respective active measurement input pair (U1, I1 or U2, I2) in the transducer display mode (with hardware feature S2 simultaneous display of all calculated values is also possible).

● The voltage to be regulated on can be selected via binary input, SCADA system or using a background program. For example, selection of the voltage to be regulated on depending on the load of both windings can be done with a background program. This means that regulation is carried out on the voltage of the winding with the higher load, and the other winding is still monitored in parallel (standard solution with three-winding transformers, as long as the currents of the windings are measured).

● The currently regulated busbar or secondary voltage (voltage measuring channel U1 or U2) is indicated on the REG-DA screen with "{1}" or "{2}", which can also be output via a SCADA system or relay output.

● All parallel programs and current influence algorithms (Z compensation or LDC) can also be used with three-winding applications.

● Even if only the voltages (U1, U2) are measured, the winding to be controlled can be freely selected. It is also possible to make selection dependent on user-definable voltage limits. For this purpose, a background program is used again.

Regulation of three-winding transformers
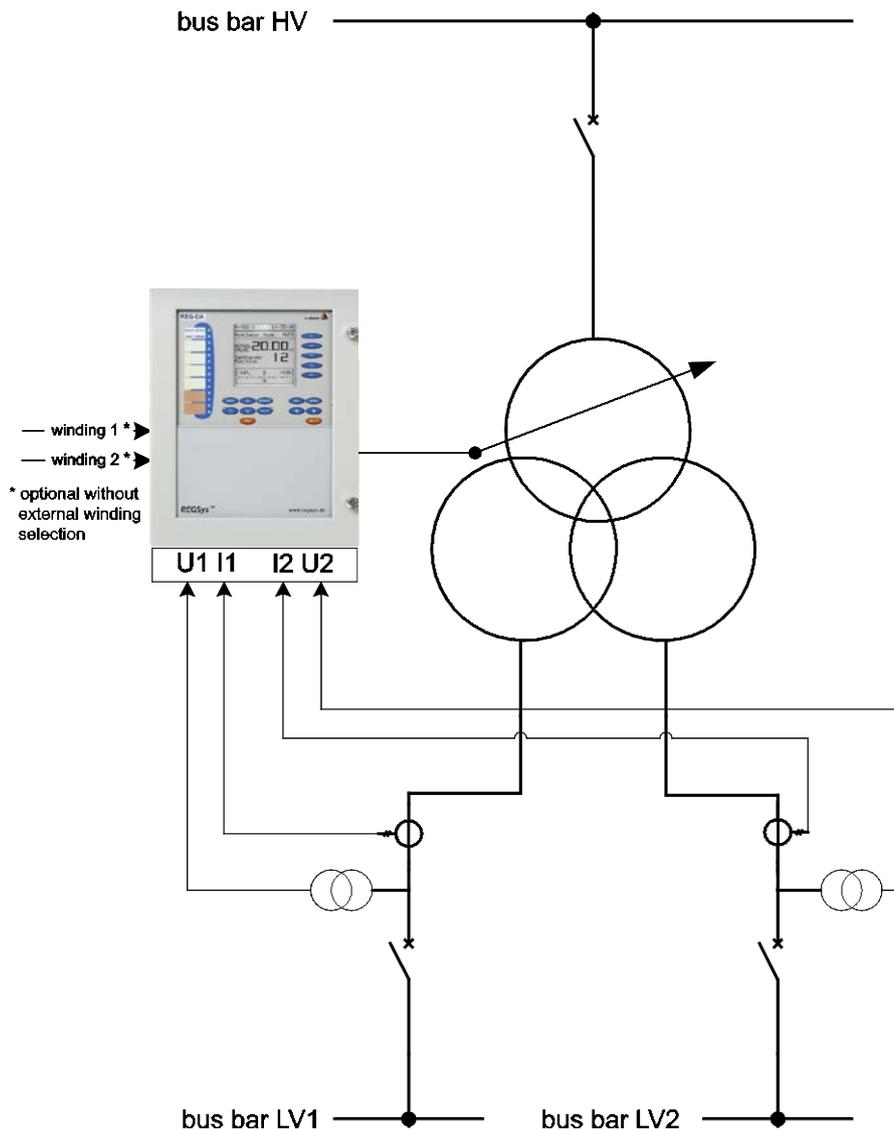
Wiring diagram for the regulation of three-winding transformers

The voltage to be regulated on can be selected via binary inputs, SCADA system or using a background program. It is possible to supervise the unregulated voltage in parallel to ensure that it remains within certain voltage limits. If a current measurement at the transformer or on the incoming feeder is present, the REG-DA can automatically select the regulation voltage depending on the load. For this purpose, a background program is used. Generally, it is possible to adapt selection of regulation voltage to each customer request.

Regulation of grid-coupling transformers
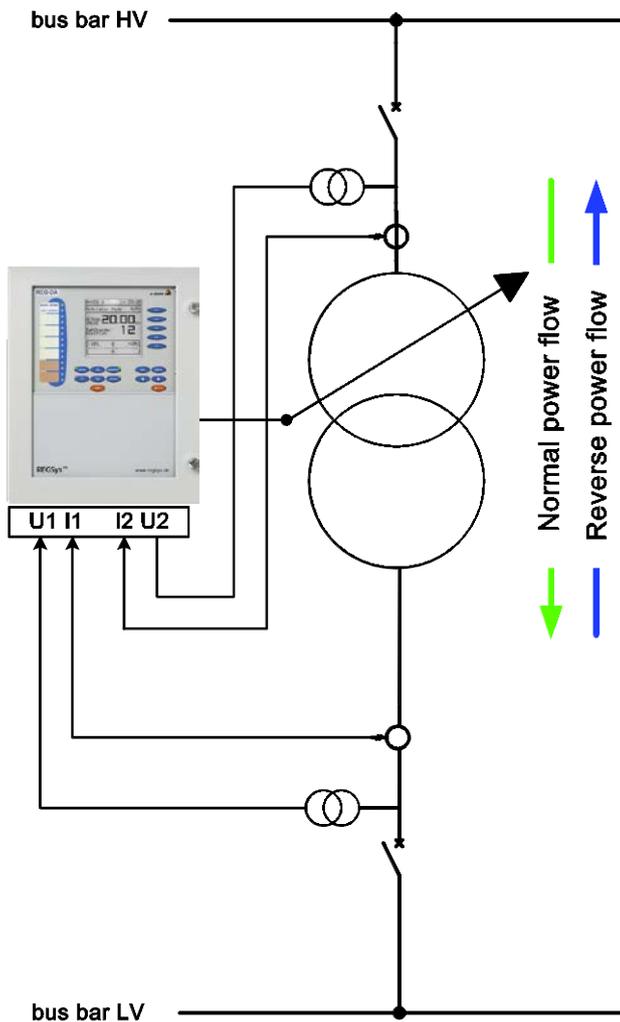
Wiring diagram for the regulation of grid-coupling transformers

In this application, on reverse power flow direction, regulation of the other voltage level or the other grid must be performed. In normal operation the power flow is from the primary to the secondary side of the transformer. Voltage and current are measured on the secondary side, and this side is also regulated.

With a reverse power flow, the primary side is regulated. For this purpose, in addition to the voltage and current transformers of the secondary side, the measurement transformers of the primary side are also connected to the REG-DA. Changeover of regulation between the primary and secondary side is performed automatically via the power flow direction, which is determined from the measured values. To regulate the primary side, the up/down tap commands are reversed, so that tap changes are made in the right direction.

General

- The voltage used for regulation is displayed on the LC display of the Relay for Voltage Control & Transformer Monitoring. A "{1}" for voltage input 1 and a "{2}" for voltage input 2 are shown in the standard configuration in the regulator basic display.

- Moreover, the index – "{1}" or "{2}" – can also be defined individually (with a maximum three character string).

- In the transducer display can be read both secondary voltages, the frequency and the configured limit for the unregulated voltage being monitored. Monitoring of the unregulated voltage can be activated or deactivated by an adaptation of the feature "3winding". On the one hand, the index of the regulated voltage is shown in the upper left corner with a string corresponding to the basic regulator display. On the other hand, an arrow in front of the corresponding measurement voltage indicates the instantaneously regulated voltage.

- On the second page of the transducer mode, voltage, current, phase angle, and apparent, active and reactive power of the currently regulated measuring input are shown. To activate this display, the feature 3winding needs to be expanded with phase angle measurement (measurement input swap). That is, performance measurement is only possible in the "3winding" mode with special measurement input swap (bit B3 = 1). (With hardware feature S2, a simultaneous display of all calculated values is possible.)

```
C:REG-D(A)      06:35:31

 ↤ Transducer Mode  →

(1)  U =    22.00   kV
[1A] I = 2500.00    A

     P =    93.82  MW
     Q =    16.54  MVAr
     S =    95.26  MVA
  cosφ =     0.98

     φ =   -10.0 °  ind
I*sinφ =  -434.12   A
     f =    50.00   Hz
```

- The menu ("Setup -3-\ Dreiwickler Limit >Ub ") for entering the limit of >Ub is only available after feature activation, the limit can be set in the range 0 ... +25%. The limit depends on the setpoint; exceeding the limit (and thus triggering the message) is not possible in MANUAL mode.
  If the unregulated voltage exceeds the limit value >Ub, up commands of the REG-DA will be blocked to prevent further increase of the voltage.

- With the feature set, the three-winding transformer functionality can be switched on and off. This is done via the menu ("Setup -5-\AddOns-3") or a REG-L command.

- If the feature is selected and the three-winding transformer is active, a current-dependent setpoint influence should only be set if the special three-winding transformer operating mode with measuring input swap (bit B3 = 1) is selected.

- The feature is shown under in the status with "3WINDING" (in parentheses with 3winding transformer activation = 0).

Prerequisites

In principle, the following prerequisites must be met to be able to use the feature 3winding:

- The regulator must at least have the hardware feature M3 (two galvanically isolated voltage measurement inputs, one current measurement input), or at best be equipped with hardware feature M9 (two galvanically isolated voltage measurement inputs and two current measurement inputs).

Input/output functions

SETUP -5-

Input/Relay Assignments..
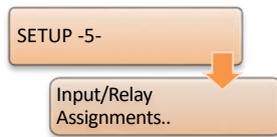
Input function	Meaning	Comment
09:3Winding	Selection of the voltage to be regulated*	FW ≥ 1.22

* The input function "09:3Winding" (this setting is only available after feature 3Winding is released) is level-oriented:
Input = off → regulation on U1; Input = on → regulation on U2.

If the input function is not used, the voltage to be regulated on can be selected with REG-L:

Reg3WSELU = 1:   regulated on U1

Reg3WSELU = 2:   regulated on U2

Output function	Meaning	Comment
19:3Winding	The limit >Ub is exceeded. The message = ON remains until the monitored voltage again lies within the tolerance band. In MANUAL operating mode the three-winding output remains OFF. If the limit >Ub is exceeded, up commands of the regulator are also blocked.	FW ≥ 1.22, only in case of 3winding with limit monitoring (bit B2=0).

Parameters

The following parameters must be considered:

Parameter	Description
Activation of three-winding transformer SETUP -5- AddOns-3 Dreiwickler Activation	Switches use of the three-winding transformer function on and off.
Three-winding transformer limit >Ub SETUP -3- Dreiwickler Limit >Ub	Limit value for monitoring the unregulated voltage (only for three-winding transformers with limit value monitoring).
Knu2 SETUP -5- CT/VT Configuration Knu/Kni	Transducer factor for the second voltage measurement input.
KNI2 SETUP -5- CT/VT Configuration Knu/Kni	Transducer factor for the second current measurement input.
Designation of busbars	Designation of the two busbars (measurement inputs) using the REG-L commands "Reg3WBusStr 1" or "Reg3WBusStr 2". This may be three characters long. "{1}" or "{2}" are shown as standard.
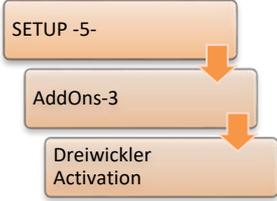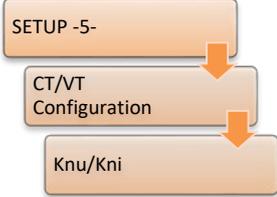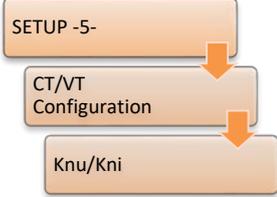
Feature coding

Bit	Function (when bit is set)	Note
B0	3winding Plus	
B1	3winding (only set bit if no other bit is set)	
B2	No limit monitoring	FW ≥ V2.00
B3	Use measurement input swap (3winding special)	FW ≥ V2.00
B4	Use Knu/I 1+2	FW ≥ V2.00
B5	Select busbar 1 fixed, use no display of busbar	FW ≥ V2.00

The following values are added for the determination of <bits>:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1

Examples:

3winding mode	<bits>	Note:
3winding deactivated	0	
3winding Plus (see Chapter 8.3.6 Feature 3winding Plus (three-winding transformer) [protected], page 266) with limit monitoring	1	
3winding with limit monitoring	2	
3winding with limit monitoring Use Knu/I 1+2	16 or 18	FW ≥ V2.00
3winding without limit monitoring	4	FW ≥ V2.00
3winding Plus (see below) without limit monitoring	5	FW ≥ V2.00
3winding Special (measurement input swap) with limit monitoring	8	FW ≥ V2.00
3winding Special (measurement input swap) with limit monitoring, with Knu/I 1+2 use	24	FW ≥ V2.00
3winding Special (measurement input swap) without limit monitoring, with Knu/I 1+2 use	28	FW ≥ V2.00
3winding Special (measurement input swap) without limit monitoring, with Knu/I 1+2 use, busbar 1 selected fixed	60	FW ≥ V2.00

On/off switching

Activation by: Feature 3winding = <bits>
Deactivation by: Feature 3winding = 0

8.3.6   Feature 3winding Plus (three-winding transformer) [protected]

This feature is like the feature 3winding, however with a fixed assignment of the binary input 8 on relay 3.

This feature is represented in the status screen with "3winding+" (in brackets with 3winding activation = 0).

On/off switching

Activation by: Feature 3winding = 1
Deactivation by: Feature 3winding = 0

8.3.7   Feature PQCtrl [protected]

The feature PQCtrl was developed for regulation of phase shifting transformers, but can also be used for other applications. In case of P/Q regulation, the active and reactive power is controlled rather than the voltage.

Properties of the PQCtrl feature

- The feature PQCtrl can be activated independently of hardware and used with all REG-DA. Hereby, the date of manufacture of the unit is irrelevant. It may be necessary to update the firmware, depending on the existing firmware version in the original REG-DA hardware.

- Four setpoints are available: two voltage setpoints, one active power and one reactive power setpoint.

- Whether the REG-DA will operate as a voltage, active power or reactive power regulator, can easily be determined by selecting the appropriate setpoint. For certain applications, selection of setpoints can be limited via a background program.

- Regulation on P or Q in accordance with the setpoint index SPI:

  SPI = = 1 :   Standard regulation on the voltage RegUN with SP 1.

  SPI = = 2 :   Standard regulation on the voltage RegUN with SP 2.

  SPI = = 3 :   Regulation on P with SP 3 (SP is a power value normalized to 100).

                 The basic regulator display shows the P-value instead of the voltage value.

  SPI = = 4 :   Regulation on Q with SP 4 (SP is a power value normalized to 100).

                 The basic regulator display shows the Q-value instead of the voltage value.

- The menus for setting setpoints and indication in the regulator display are adjusted accordingly. No units can be shown on the large regulator display when using P or Q regulation, because of lack of space (except k for kilo).

```
C:REG-D(A)      06:17:10

Regulator Mode MANUAL

P-Setpoint       96.2 %
                40.00MW
Act.Value       39.08MW
Bandwidth        5.0 %

Tap-Changer Pos    9


-10%       0      +10%
.. .. .  . . . . ! . . . . ! . . . .
-2.2%  A
```
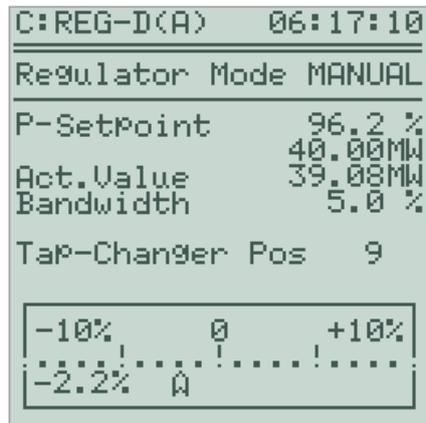
Regulator basic display with P setpoint

● The active and reactive power setpoints can be set in the range from -140% to +140% of the nominal power. The nominal power is calculated using the following formula:

$$P_r = Q_r = \sqrt{3} \times 100V \times Knu \times I_r \times Kni$$

Pr, Qr: Nominal power for setpoint

Knu: Transformer factor of the voltage transformer

Kni: Transformer factor of the current transformer

Ir: Nominal current of the current transformer (1 A or 5 A)

● All limits of the REG-DA are also available with the PQCtrl feature. Thereby, the limits undervoltage <U, overvoltage >U, inhibit low, inhibit high and high-speed switching depend on the measured voltage. As a basis for percentage limits, U-nominal is always used (default: U-nominal=100 V, also when the limit base is set to the setpoint). If the limit base is set to U-nominal = 110 V, the limit base applies in this case not only for the limits undervoltage <U, overvoltage >U and inhibit low. The limits overcurrent and undercurrent are derived from the measured current.

● If a monitoring unit PAN-D is being used in addition to the REG-DA, it will always receive a setpoint of 100 V from REG-DA. This only has an effect if the limit base of the PAN-D is set to setpoint.

● The key functions of REG-DA as a Relay for Voltage Control & Transformer Monitoring, such as transducer mode, recorder, statistics, transformer monitoring, logbook, and, of course, free programmability via background programs will also remain intact with the feature PQCtrl.

Parameters

Parameter	Description
Setpoint 3 SETUP -1- Setpoint Values.. P- Setpoint Value	Active power setpoint P The setpoint can be set in the range -140% ... +140%. The absolute setpoint based on Knu, Kni and the nominal current of the current transformer is also displayed in the menu.
Setpoint 4 SETUP -1- Setpoint Values.. Q- Setpoint Value	Reactive power setpoint Q The setpoint can be set in the range -140% ... +140%. The absolute setpoint based on Knu, Kni and the nominal current of the current transformer is also displayed in the menu.
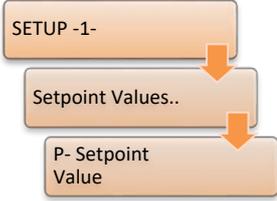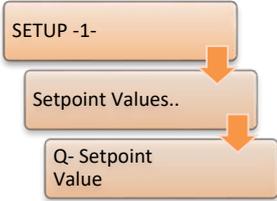
On/off switching

Activation by:	Feature PQCTRL = 1
Deactivated by:	Feature PQCTRL = 0

8.3.8   Feature Adapt

This feature is available as of firmware from V2.09 / 17.06.2005 onwards, also in V2.02d/f.

This feature must be set if one of the following REG-LON versions are used:

- H1_10U
- H1_11P

On/off switching

Activation by: Feature ADAPT = 1
Deactivation by: Feature ADAPT = 0

8.3.9   Feature Bootload

NOTICE!	**As long as the unit is in bootloader mode, no regulation and other actions may take place. Moreover, no communication via E-LAN or to the SCADA system is possible.** ➲ Only activate remote starting of the bootloader when it is absolutely necessary. If the bootloader is not quit, the unit stays in the bootloader mode for 30 minutes.

The Bootload feature allows remote starting of the bootloader. This means that if the feature is set (= 1), the bootloader can be started via REG-L (e.g. the terminal program or the Service program of WinREG).
The feature exists as of firmware V2.22.

On/off switching

Activation by: Feature Bootload = 1
Deactivation by: Feature Bootload = 0

8.3.10   Feature COM2FIX

From firmware version V2.00, with this feature the COM2 interface can be set so that it is no longer adjustable via the panel or REG-L.

Coding of the feature

Bit	Function with B0 = 1	Function with B0 = 0
B0	1: use B1 … B7	0: Fixation on current setting
B1	0: Mode ECL 1: Mode PROFI	always = 1
B2	always = 0 (reserved)	0: SETCOM2 conditionally blocked 1: SETCOM2 completely blocked
B3	0: Baudrate 57600 1: Baudrate 115200	always = 0 (reserved)
B4	always = 0 (reserved)	always = 0 (reserved)
B5	0: Parity OFF 1: Parity EVEN	always = 0 (reserved)
B7 / B6	0/0: Handshake OFF 0/1: Handshake XON/XOFF 1/0: Handshake RTS/CTS 1/1: reserved	always = 0/0 (reserved)

The following values are added for the determination of <bits>:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1

Examples:

- COM2 fixed on current setting: <bits> = 2
- COM2 fixed on ECL / 57K6 / PE / XON :   <bits> = 0b01100001 = 97
- COM2 fixed on PROFI / 57K6 / PE /H- :   <bits> = 0b01100001 = 35
- COM2 fixed on ECL / 115200 / PE /H- :   <bits> = 0b01100001 = 41

On/off switching

Activation by: Feature COM2FIX = <bits>

Deactivation by: Feature COM2FIX = 0

8.3.11 Feature DELTAI

With the feature set, the parallel program "3: dI" is available (as of firmware V1.98).

Parameters

Parameter	Description
Permiss. Icirc Setup -1- ↓ Programs.. ↓ Par.Parameter.. ↓ Permiss. Icirc	Permissible circulating current of the parallel program "dI"
Nominal transformer power Setup -1- ↓ Programs.. ↓ Par.Parameter.. ↓ Transformer Nominal Power	Nominal transformer power of the parallel program "dI"
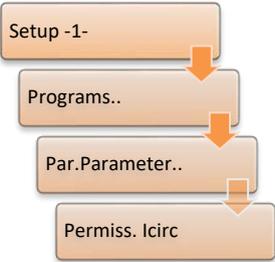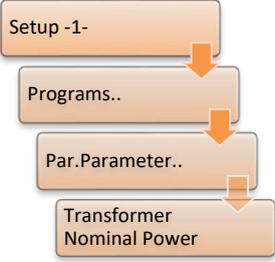
On/off switching

Activation by: Feature DELTAI = 1
Deactivation by: Feature DELTAI = 0

8.3.12   Feature Invers

INVERS without exchanging the raise/lower relay

When the feature is activated, on up tap changes the regulator expects a decreasing tap position number, on down tap changes an increasing tap position number.

On/off switching

Activation by: Feature INVERS = 1
Deactivation by: Feature INVERS = 0

INVERS with exchange of raise/lower relays

When the feature is activated, on up tap changes the regulator expects a decreasing tap position number, versus on down tap changes an increasing tap position number.

In addition, an exchange of the relay outputs for up/down tap changes takes place. The relay and LED functions for up or down and the display of tap-change direction in the basic regulator display are also exchanged.

This feature variant is available from version V1.88; use with a PAN-D is not possible.

On/off switching

Activation by: Feature INVERS = 2
Deactivation by: Feature INVERS = 0

More information about the Invers feature and its use can be found in Chapter 7.2.2.3 Tap position, from page 93 onwards.

Effect of the Invers feature

Tap changing is triggered by commands in AUTOMATIC or MANUAL / REG-L.
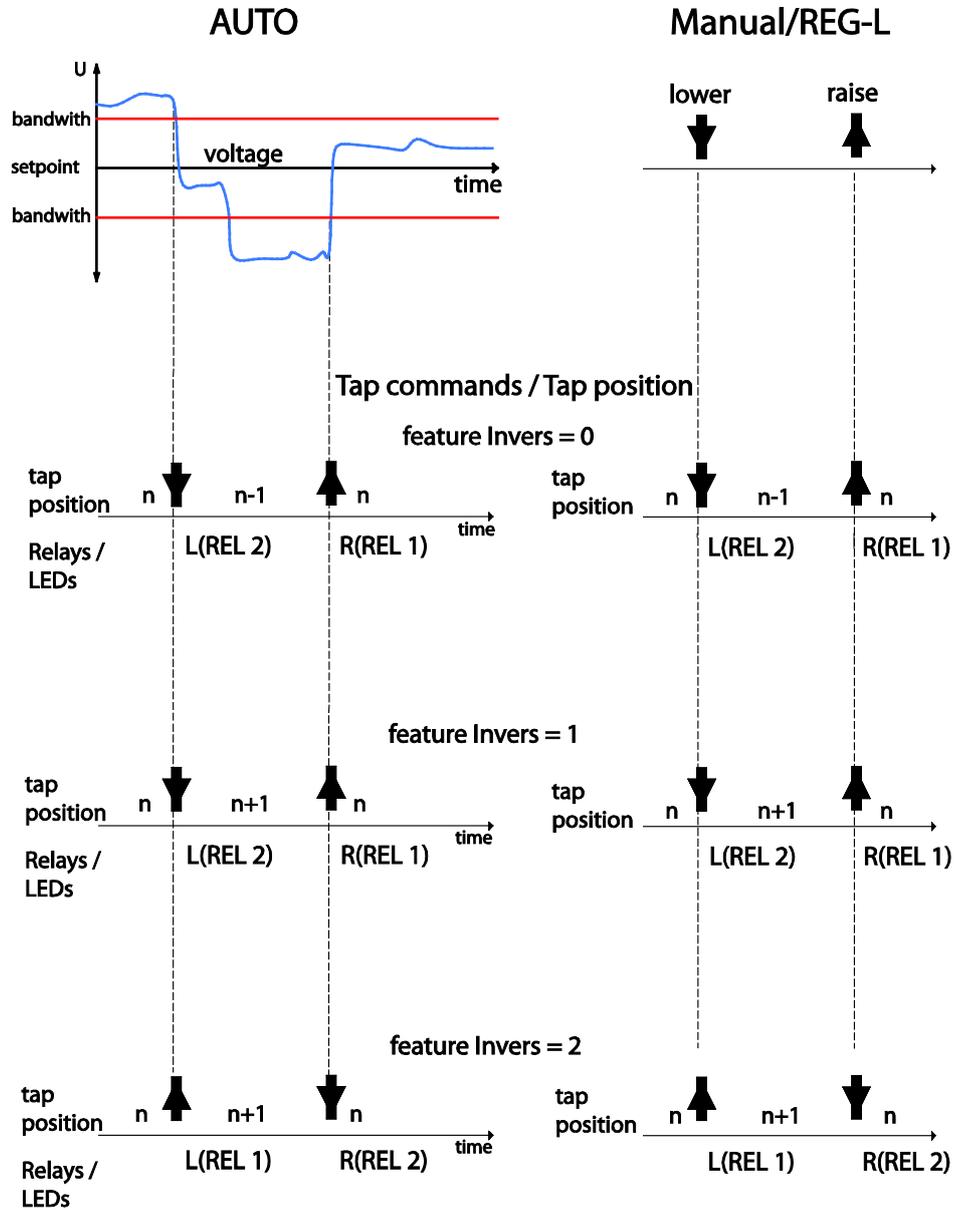
Effect of the Invers feature on the expected tap feedback and use of the up and down relays

8.3.13   Feature M2 [protected]

The M2 feature, available from firmware V2.00 onwards, allows also for the measurement of an asymmetric grid using an ARON measurement circuit , with the appropriate measurement inputs (hardware feature M2).

The following measured values must be connected: the L1, L2 and L3 should be connected to the voltage input transducers U1 and U2, I1 to current input transducer 1 and I3 to current input transducer 2. It is essential to ensure correct polarity or these connections.

```
A:REG-D(A)    16:08:02

  ← Transducer Mode →

    ---- ARON ----
  U12 =    20.06 kV
  U23 =    20.02 kV
  U31 =    20.10 kV
   I1 =   605.63 A
   I2 =   603.53 A
   I3 =   601.76 A
    P =    19.68 MW
    Q =     7.25 MVAr
    S =    20.97 MVA
    f =    49.98 Hz
```
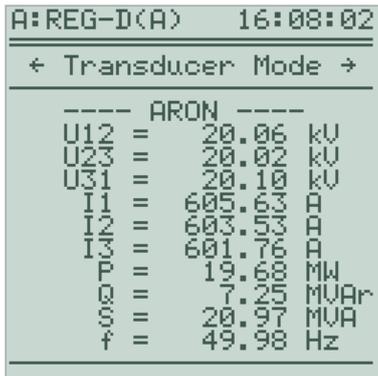
Display of ARON readings in transducer mode

Parameters

Parameter	Description
Transducer mounting voltage SETUP -5- → CT/VT Configuration	For the ARON measurement, the transducer mounting voltage and current must be configured for ARON.
Transducer mounting current SETUP -5- → CT/VT Configuration	For the ARON measurement, the transducer mounting voltage and current must be configured for ARON.
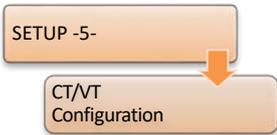
On/off switching

Activation by: Feature M2 = 1
Deactivation by: Feature M2 = 0

Notes

- There is Special case "exchanged current measurement inputs":
  Unless I3 is connected to the current input 1, and I1 to the current input 2, the M2 feature must be = 2. If this feature is already activated, assignment can also be done without access enabling / license code (feature M2 = 2).

- With M2 = 2, the feature MISWAP is deactivated!

8.3.14 Feature MISWAP

From version V2.00, the open feature MISWAP is available to exchange the measurement input wiring U1, U2 and I1, I2 without any hardware modification.

The inversion (polarity reversal) of U1, U2, I1, I2 can also be selected by menu as of firmware V2.17 (inversion of the measuring inputs).

Coding of the feature

7	6	5	4	3	2	1	0	Function
x	x	x	x	0	0	0	0	No exchange
x	x	x	x	0	0	0	1	Exchange of U1 ← → U2
x	x	x	x	0	0	1	0	Exchange of I1 ← → I2
x	x	x	x	0	0	1	1	Exchange of U1 ← → U2 and I1 ← → I2
x	x	x	1	x	x	x	x	Inversion of the 1st voltage transformer U1
x	x	x	0	x	x	x	x	Voltage transformer U1 normal
x	x	1	x	x	x	x	x	Inversion of the 2nd voltage transformer U2
x	x	0	x	x	x	x	x	Voltage transformer U2 normal
x	1	x	x	x	x	x	x	Inversion of the 1st current transformer I1
x	0	x	x	x	x	x	x	Current transformer I1 normal
1	x	x	x	x	x	x	x	Inversion of the 2nd current transformer I2
0	x	x	x	x	x	x	x	Current transformer I2 normal

The following values are added for the determination of <bits>:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1

On/off switching

Activation by: Feature MISWAP = <bits>
Deactivation by: Feature MISWAP = 0

Limited function in conjunction with feature M2 = 2

If the feature M2 = 2 is set, the effect of the feature MISWAP is cancelled and only the exchange I1 ← → I2 is performed.

8.3.15 Feature Qsigned

According to DIN, the reactive power is an unsigned entity: $Q = \sqrt{s^2 - p^2}$

With the aid of the feature Qsigned, the sign of the reactive power can be activated or deactivated. (The sign always corresponds to the opposite sign of the angle φ.)

Firmware	<bits>=0 (Default)	<bits> = 1	<bits> = 2
V1.30 – V2.02	Q unsigned	Q signed	-
from V2.03	Q signed	Q signed	Q unsigned

On/off switching

Activation by: Feature Qsigned = <bits>
Deactivation by: Feature Qsigned = 0

8.3.16 Feature LocalRemote

The REG-DA keyboard allows you to switch between local and remote, provided the feature LocalRemote is set accordingly. The input functions "54:LR_STAT" and "53:LR_AH", which, in particular, are employed for using a REG-LR, may not be configured.

Switching between local and remote is done with the local and remote key, the selected state being shown with LEDs. The functionality of the local and remote key corresponds to local/remote switching with a binary input. In case of an auxiliary power interruption, the last selected state is maintained.

Moreover, with the Reg-L command RegLR_KEY the local/remote state can be changed in addition to a key operation:

RegLR_KEY = 0 → local

RegLR_KEY = 1 → remote

On/off switching

Activation by: Feature LocalRemote = 1
Deactivation by: Feature LocalRemote = 0

Notes

● If the feature LOCALREMOTE = 2, then you can switch between Local(0)/Remote(1)/Off(2); Off means that neither local nor remote blocks are applied, the local/remote display is suppressed.

● If the feature is not activated, the local/remote display is omitted.

8.3.17   Feature SimMode

⚠ DANGER!	**Tap commands which are triggered in simulation mode are actually output over the relays.**
	Since measured voltage is not used in simulation mode, this can lead to impermissible changes in the actual voltage at the transformer!
	➲ If the transformer, the regulator is connected to, is in operation, the simulation mode should only be used under extreme caution. Here, tap commands from the regulator to the tap changer must be separated in terms of hardware (e.g. opening of the terminals is required).

SETUP -6-
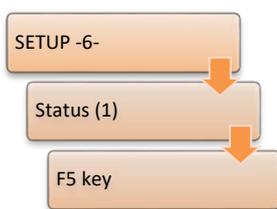
Status (1)

F5 key

From V2.00, switching on measurement value simulation is controlled by means of the feature SIMMODE. The simulation mode can be activated in "Setup -6-/Status/REG-D status (1)" by pressing the F5 key.

Coding of the feature

<value>	Meaning
1	Simulation / tap simulation is allowed, but quit with AUTOMATIC mode
2	Simulation / tap simulation, independent of AUTOMATIC and MANUAL mode, is allowed

On/off switching

Activation by: Feature SimMode = <value>

Deactivation by: Feature SimMode = 0

ℹ	**Note:**
	The simulation mode automatically terminates 15 minutes after the last key press on the panel of the REG-DA.

8.3.18 Feature SYSCTRL

This is a bit-specific feature for general modification of system features.

Coding of the feature

7	6	5	4	3	2	1	0	Function	Note
x	x	x	x	x	x	x	**1**	**ShowParLimits** ON	
x	x	x	x	x	x	x	**0**	OFF	
x	x	x	x	x	x	**1**	x	**AllowSlaveParChanges** ON	
x	x	x	x	x	x	**0**	x	OFF	
x	x	x	x	x	**1**	x	x	**NoApplicationMenuPasswordProtection** ON	
x	x	x	x	x	**0**	x	x	OFF	
x	x	x	x	**1**	x	x	x	**VirtualTapChangerIndicator** ON	from V2.00
x	x	x	x	**0**	x	x	x	OFF	
x	x	x	x	**1**	x	x	x	**NoStepCommandDuringIndicator** ON	only V1.99
x	x	x	x	**0**	x	x	x	OFF	
x	x	x	**1**	x	x	x	x	**AllowTapSimu** ON	from V2.00
x	x	x	**0**	x	x	x	x	OFF	
x	x	**1**	x	x	x	x	x	**DisableGroupTappingDuringHAND** ON	from V2.00
x	x	**0**	x	x	x	x	x	OFF	
x	**1**	x	x	x	x	x	x	**HandAtParErr** ON	from V2.00
x	**0**	x	x	x	x	x	x	OFF	
1	x	x	x	x	x	x	x	**HandAtTapErr** ON	from V2.00
0	x	x	x	x	x	x	x	OFF	

- **B0: ShowParLimits:**
  With this bit set, the parallel program limitation for all parallel programs (where appropriate) can be entered via the control panel. If the bit is not set, the limitation can only be entered via the control panel when the limit value is not the standard value (20.0). With the dcos(φ) program the limitation can always be entered.

- **B1: AllowSlaveParChanges:**
  With this bit set, the regulator can also be configured during slave operation.

- **B2: NoApplicationMenuPasswordProtection:**
  With this bit set, the application menus are not password protected, i.e., all menu items can be performed without an optional password. A single menu item in the customer-specific application menu can be freed of the password prompt, where the application name (REG-L: MenuAppN) begins with a tilde "~". This tilde is not shown in the menu.

● **B3: VirtualTapChangerIndicator:**
During the up/down relay switching phase and during TC in operation signal activity, further pending up or down tap commands are generally deleted from V2.00. The bit functionality introduced with V1.99 NoStepCommandDuringIndicator is therefore no longer necessary.
But if the regulator or the corresponding PAN-D is not supplied with TC in operation information, the up/down tap command lock will only engage during the up/down relay switching phase. On setting the VirtualTapChangerIndicator bit, the TC in operation signal activity is simulated, so that the tap command lock can engage during the imaginary TC in operation signal activity in this case.
The parameter "maximum time TC in operation" determines the activity duration of the virtual TC in operation, there can be no TC in operation failure in the virtual mode. Note: Connection of a TC in operation on the REG-DA or the PAN-D lead to deactivation of the virtual TC in operation functionality.

● **B4 : AllowTapSimu:**
In the AddOns menu, with bit 4 set, tap position can be selected besides 0:OFF and 3:ON and also 4:TapSimu.
If "4:TapSimu" is selected, the tap position is non-volatilely simulated (up commands increment, down commands decrement the tap value, change of tap with REG-L command RegTapNV). The INVERS feature is observed (i.e., with the feature set, up commands reduce the tap value).
The value range is limited to +/-40. The value from RegTAPNV is debounced like a normal input value at 1s, hence the new tap value will only appear after 1s.

● **B5 : DisableGroupTappingDuringHAND:**
With the bit not set the entire group is tap changed by the master in the manual mode. If the bit is set, tap commands from the master in manual mode are not routed to the group (behavior as in V1.99).

● **B6 : HandAtParErr:**
With this bit set, the regulator switches to MANUAL mode as soon as a parallel error is present.

● **B7 : HandAtParErr:**
With this bit set, the regulator switches to MANUAL mode as soon as a tap error is present.

The following values are added for the determination of <bits>:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1

On/off switching

Activation by: Feature SYSCTRL = <bits>
Deactivation by: Feature SYSCTRL = 0

8.3.19 Feature SYSCTRL2

This is a bit-specific feature for general modification of system characteristics.

Coding of the feature

7	6	5	4	3	2	1	0	Function	Note:
x	x	x	x	x	x	x	1	**noAutomaticHandAuto** ON	from
x	x	x	x	x	x	x	0	OFF	V2.04
x	x	x	x	x	x	1	x	**RegLonExtendedMasterSlaveInfo** ON	from
x	x	x	x	x	x	0	x	OFF	V2.09
x	x	x	x	x	1	x	x	**NoFastOnSPchangeIfVoltageReg** ON	from
x	x	x	x	x	0	x	x	OFF	V2.10
x	x	x	x	1	x	x	x	**NoFastOnSPchangeIfPowerReg** ON	from
x	x	x	x	0	x	x	x	OFF	V2.10
x	x	x	1	x	x	x	x	**NoQuickInhibitLow** ON	from
x	x	x	0	x	x	x	x	OFF	V2.11
x	x	1	x	x	x	x	x	**NoInhibitHighEvaluation** ON	from
x	x	0	x	x	x	x	x	OFF	V2.11
x	1	x	x	x	x	x	x	**NoInputRelayLedFunctionInversion** ON	from
x	0	x	x	x	x	x	x	OFF	V2.14

● **B0 : noAutomaticHandAuto**:
If the bit is set, the manual/automatic state is not aligned (behavior as in V1.99) in parallel operation.

● **B1 : RegLonExtendedMasterSlaveInfo** (available from REG-DA V2.09 and V2.02e):
If the bit is set, the following data points in the REGLON structure are modified as follows:

Data point	B1 = 0	B1 = 1
REGLON.TC_Single_Parallel	ParallelProgramActive	IsActiveMaster OR IsSlave
REGLON.TC_Master	(NOT IsSlave) AND ParallelProgramActive AND (ParProg = Master or MasterFollower)	IsActiveMaster

● **B2 : NoFastOnSPchangeIfVoltageReg**:
Normally (B2 = 0) with voltage regulation and a setpoint change, high-speed switching mode is automatically activated until the voltage value lies wihtin the tolerance band again. If bit B2 is set (B2 = 1), high-speed switching is NOT activated in the case just described.

● **B3 : NoFastOnSPchangeIfPowerReg**:
Normally (B3 = 0) with power regulation and a setpoint change (setpoint 3 or 4 + software feature PQCtrl), high-speed switching is automatically activated until the power value again lies within the tolerance band. If bit B3 is set (B3 = 1), high-speed switching is NOT activated.

● **B4 : NoQuickInhibitLow:**
If this bit is set (B4 = 1), no quick inhibit low detection with undervoltage (U <60 V) is carried out, so the appropriate time delay must pass before shutdown occurs (inhibit low).
Processing of the inhibit low input or the REG-L inhibit low command is not affected by this bit.

● **B5 : NoInhibitHighEvaluation:**
If this bit is set (B5 = 1), no inhibit high request is evaluated and the menu item disappears (the associated REG-L commands can still be used, but without an effect).

● **B6 : NoInputRelayLedFunctionInversion:**
If this bit is set (B6 = 1), input, relay and LED functions cannot be inverted, the related list boxes correspond to the list boxes used up to V2.12 with F3:ENTER instead of F3:INV. Reason: Forcing the behavior up to and including V2.12.

The following values are added for the determination of <bits>:

Bit	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Value	128	64	32	16	8	4	2	1

On/off switching

Activation by: Feature SYSCTRL2 = <bits>
Deactivation by: Feature SYSCTRL2 = 0

8.3.20 Feature PrimCtrl [protected]

The regulator should set specific taps, depending on the primary voltage.

For this purpose, the tap position is indicated with a mapping rule in the usual 100 V (or 110 V) regulation range and processed as an actual value. The primary voltage, which is measured, is used as setpoint. The setpoint setting on the REG-DA is processed as an additive override to the primary voltage.

On/off switching

Activation by: Feature PRIMCTRL = 1

Deactivation by: Feature PRIMCTRL = 0

8.3.21 Feature ULC [protected]

This is a special current program made according to the wishes of the customer. The parameters X and L known from the LDC are no longer entered in Ohms, but in percentages. In particular, it is possible to enter negative values. It is also necessary to enter the parameters nominal voltage and nominal power, since the nominal current which enters into the calculation is derived from them. After activating the ULC feature, the ULC current program is available. Moreover, all of the above parameters can be entered in the ULC menu.

On/off switching

Activation by: Feature ULC = 1

Deactivated by: Feature ULC = 0

8.3.22 Custom features [protected]

If you have any questions about any of the custom features, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.4 Background programs and the programming language REG-L

8.4.1 Programming language REG-L

REG-L is the programming language for all devices of the A. Eberle REGSys™ family:

REG-D™, PAN-D, REG-DA, REG-DP, MMU-D, EOR-D, REG-DMA and REG-DM.

The language is used:

- For communication between REGSys™ devices via E-LAN
- For reading measured values, device states and parameters
- For configuring REGSys™ devices
- In H-programs (background programs) in order to realize customer-specific additional functions
- For communication with the configuration software WinREG

REG-L is an interpreted language, which uses the inverted Polish notation. This type of notation allows a very effective and short notation. There is a general instruction set which is supported by all devices. In addition to the general instruction set each device knows more commands that are specific to the device.

Instruction syntax

An instruction consists of:

<identifier:><instruction><extension> <parameter1> <para.2> ... =<parameter1> <para.2> ...

- A comma (or ;) separates instructions
- A space separates parameters
- Upper/lower case is not distinguished
- All REG-DA specific instructions begin with the prefix "Reg..."
  (e.g. RegAuto, RegREL, ...)
- further prefixes: "Esp..." for REG-DP; "mmu..." for MMU-D; "Eor..." for EOR-D;
- Help: Is called with "?" and the search term via Terminal (e.g. "? analog" or "? syntax")
- With "? book" the entire help text of the REGSys™ device is issued.

Examples:

RegTappos   =>   returns the current tap position

RegRel 3   =>   returns the state of relay 3

RegRel 3,A1:RegE 1   =>   returns the state of relays 3 and from device A1: the state of input 1

Important instructions

Instruction	Description
hlist	Output of the H program lines
plist	Output of the P program lines
qlist	Output of the Q program lines
err	Error check of the background program
hbreak	Interruption of H-program execution
Help or ?	Online help for a command (e.g. ? regauto)
abs, sin, cos, sqrt, exp, log,**	Mathematical functions
if (iff), else, endif	Program branches
fori, nexti	Program loops
meld "string"	Generate message on the display
htd	loop time
Reg…	REG-DA specific instructions (e.g.: RegU, RegAuto, RegE, RegRel,...)

A complete instruction reference and training materials, with examples are available on request from the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

8.4.2 Background programs

Background programs (H-programs) consist of program lines, each with a number of REG-L instructions. A background program consists of the following components:

- H-lines (executed cyclically)
- P-lines (only executed with an explicit call)
- Q-lines (only executed with an explicit call)
- Application menus to enter and display user-specific parameters and values
- User variables to store and transfer user-specific parameters
- User-Definable-Menu (UDM) for creating fully customized screens and complement the background programs. UDMs are only supported by devices with the S2 feature.

In general, background programs created by A. Eberle are delivered as ASCII text files. Each background program includes a description of the functions and the resources used in the form of a PDF file or another ASCII text file. The background programs have device-specific file extensions (*.rgl for REG-DA, *.pnl for PAN-D, *.dpl for REG-DP, *.mml for MMU-D, *.eol for EOR-D). That is, a background program for a REG-DA is, for example, called "REG-L_example_for_UserManual_V01.rgl".

UDM files are also ASCII text files and can be used on devices with the S2 feature, in addition to, or as a substitute for, the classic background program (e.g. *.rgl). They have the file extension *.udm.

8.4.2.1 Loading H-programs in a device

General

- Establish a connection between the REG-DA and the PC.
- Set the interface on the regulator under: "Setup -6-\RS232\COM1" or COM2
- The interface (baudrate) used in the program must be set the same as for the regulator!
- Instructions on how to load the background program into the regulator, including allocation of the serial cable are found in the readme file of the background program.

Loading with the software REGUpdate (update32.exe), (classic H-program, no UDM)

- Setting the interface under Configuration
- Selection of H-program under Update -> REG-L Download
- Sending the H-program (only possible on directly connected devices)
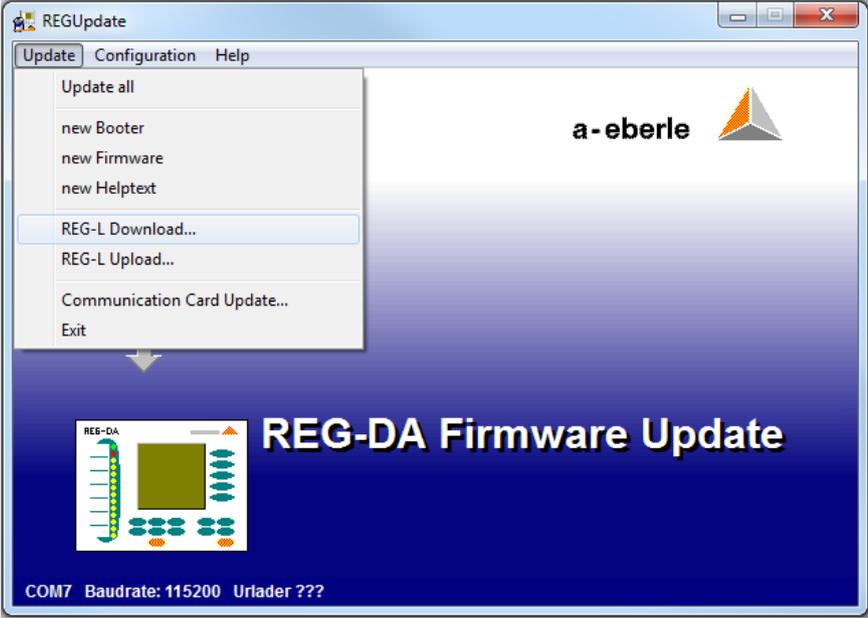
After a successful transfer, a message appears that the REG-DA is now ready for use again.
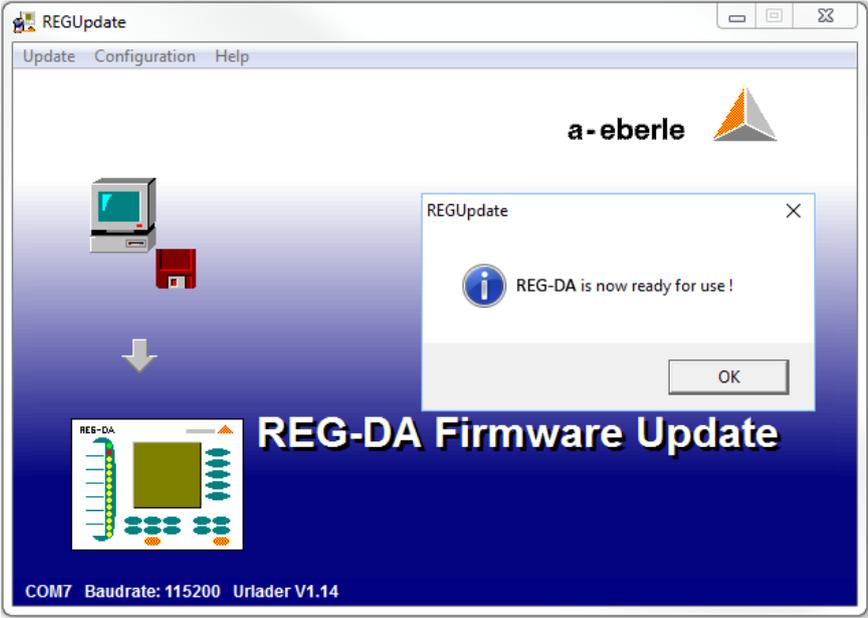
Loading with the service module of WinREG (classical H-program & UDM)

- Set the interface in the WinREG control program under Options -> Connections.
- Start the service and select the H-program (displayed in the green box) in the REG-L tab.
- Send the H-program (possible for all devices in the E-LAN network).
- The progress of the H-program can be followed in the turquoise window (there may appear error messages).
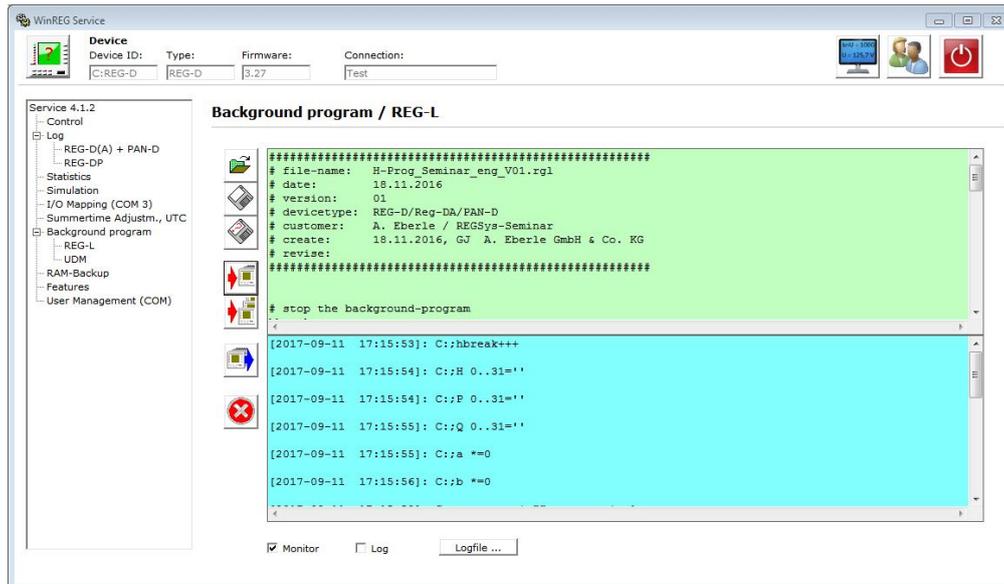
From firmware versions 2.22/3.22, the background program currently running on the device can also be seen in the status menu ('Setup -6-\Status\H/P/Q' programs). UDM files are not displayed here.

8.4.2.2 Reading H-programs from a device

To read the H-program from the device, the PC software REGUpdate (update32.exe, Update -> REG-L Upload), or the service module of WinREG (REG-L tab) can be used.

The use of the original background program is recommended!

The read out background program file no longer contains any comments, and any REG-L commands executed besides the H/P/Q lines during the download cannot be restored! Therefore, it is always advisable to load the original background program (e.g. the *.rgl file).

8.4.2.3 Deleting H-programs

The background program is deleted by loading an empty background program, as well as via a terminal program. For this purpose, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

From WinREG version 3.9.7, the REG-L tab in the Service module has a function to delete the background program.

9. External components

9.1 Additional components REGSys™

In addition to the REG-DA, the voltage regulation system REGSys™ provides a wide range of components for expansion, monitoring, adaptation and a SCADA system connection. These components are presented in this chapter. Please note that each of these devices has its own user manual or datasheet and the details regarding these devices can be found in these sources.

9.1.1 I/O extension modules BIN-D & ANA-D

The interface components BIN-D (binary inputs and outputs) and ANA-D (analog inputs and outputs) serve to expand the inputs and outputs of the REG-DA. The modules are connected to the REG-DA via the COM3 interface. Further information on physical connection can be found in Chapter 7.1.4.8 COM3 port from page 76 onwards. Use of the additional inputs and outputs by the REG-DA is described in Chapter 8.2.2 Binary inputs, from page 212 onwards and in Chapter 8.2.5 Analog inputs and outputs, from page 225 onwards (Analog inputs and outputs).
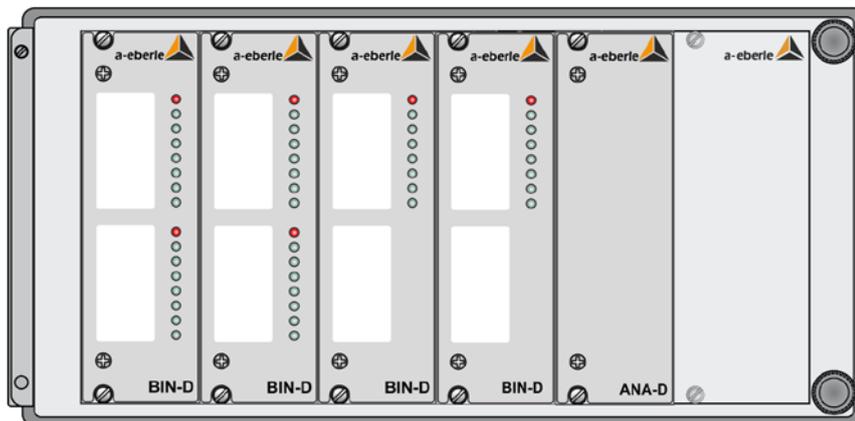
BIN-D variants
- 16 binary inputs (with or without LEDs)
- 8 relays (with or without LEDs)
- 16 LEDs

ANA-D variants
- 8 analog inputs (optionally also with LEDs)
- 8 analog outputs (optionally also with LEDs)

9.1.2 COM3/MODBUS converter

The COM3/MODBUS converter allows connection of MODBUS RTU compatible devices having RS485 interfaces to the COM3 interface of the REGSys™ devices REG-D™, REG-DA and PAN-D. This allows direct access to all the information made available to the device via MODBUS. This data can be processed and stored in the REG-DA and passed on to the SCADA system.
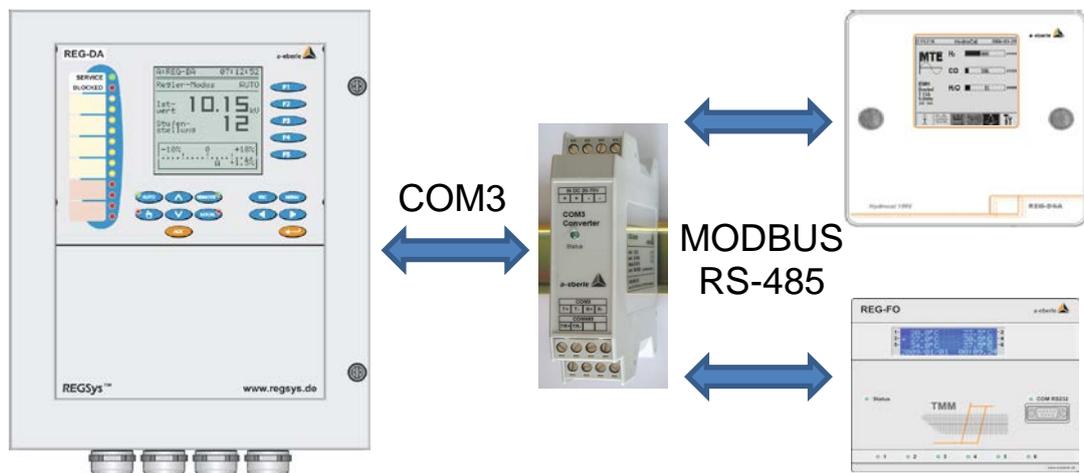
Schematic representation of COM3/MODBUS communication.

9.1.3 Monitoring units

The monitoring units are used to monitor voltage and partly the function of the tap changer and the regulator. They constitute a monitoring unit for the voltage to be regulated that is independent of the Relay for Voltage Control & Transformer Monitoring. If the voltage leaves certain adjustable limits, tap commands are interrupted physically in the corresponding direction and messages are generated.

The C10 feature enables the REG-DA to integrate this monitoring function by installing a special version of the PAN-A2 monitoring unit on the REG-DA's Level 2.

If the functionality of the integrated monitoring unit is not sufficient and the monitoring unit can be installed in its own housing, also the monitoring units with 19" technology can be used together with the REG-DA.

Moreover, PAN-D provides monitoring functions for the motor drive of the tap changer as well as the REG-DA.

The PAN-D is based on the same platform as the Relay for Voltage Control & Transformer Monitoring REG-D™, and therefore provides the same options as regards configuration, programming and SCADA systems are concerned. Moreover, PAN-D offers the possibility of being configured via the REG-DA.

The PAN-A1 is the simplest of the monitoring modules and provides one-step monitoring of regulation voltage (specific limits for overvoltage and undervoltage). The settings are made locally on the device using keys. No configuration software is necessary.

In addition to the PAN-A1, the PAN-A2 offers two-stage monitoring of the regulation voltage and is configured using the software "PAN-A2 Control".

PAN-D   PAN-A1   PAN-A2
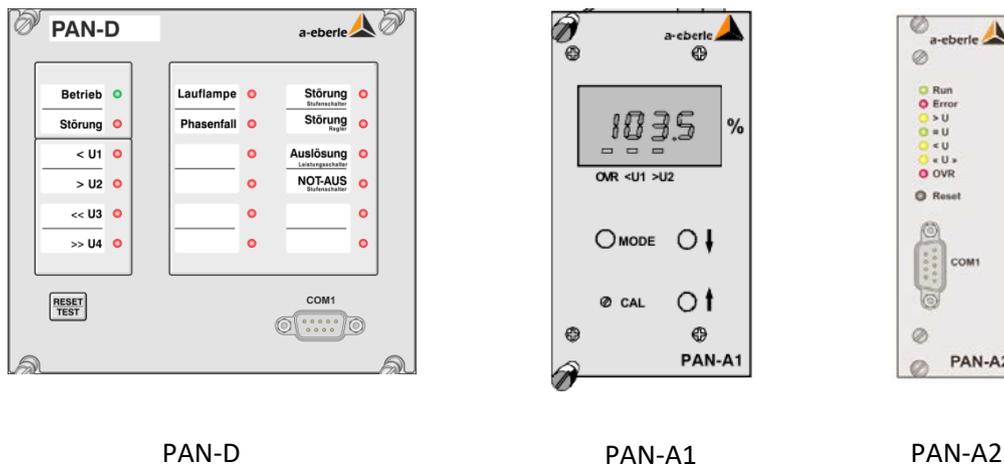
9.1.4   Tap position interfaces

The tap position interfaces have the task of adjusting tap position feedback of the motor drive of the tap changer to the inputs of the REG-DA. The modules partially also provide output of tap positions on potential-free contacts, and a tap position indicator. Depending on the module, this is available as a 19" plug-in module, a wall-mount and panel-mount versions.

Device	Description
REG-F	Implementation of contact row to BCD code, additional output of BCD-code to potential-free contacts.
REG-F BCD	Display of BCD-coded tap position by means of a seven-segment display
REG-FA	Implementation of AWZ-code to BCD code, additional output of BCD-code to potential-free contacts.
REG-FB	Implementation of contact row to BCD code, additional output of tap position as binary code to potential-free contacts.
REG-FD	Passes on the message of the contact row of a tap changer with BCD-code to the voltage regulation system REGSys™. Parallel to this, the signal is available on potential-free contacts.
REG-FG	Implementation of Gray-code to BCD code, additional output of BCD-code to potential-free contacts.
REG-FI	Implementation of mA-signals to BCD code, additional output of BCD-code to potential-free contacts.
REG-FR	Implementation of resistance value to BCD code, additional output of BCD-code to potential-free contacts.
REG-S	Implementation of contact row to BCD code
REG-SK1	Implementation of contact row to BCD code, compact design, for example, for use in a motor drive

9.2   SCADA system

The SCADA system connection of the REG-DA is implemented via a telecontrol board module. This module can be installed internally or externally, depending on the protocol used, the resulting type of coupling module, and customer request.

Configuration of the telecontrol board module is carried out with the WinConfig software.

For questions regarding the SCADA please contact the A. Eberle SCADA System Support under +49 (0)911/628108-104 or comms-support@a-eberle.de.

10. Retrofit of analog channels

The REG-DA has a slot for an analog module on the CPU board (Level III, analog channels 3 and 4). It can be retrofitted on site. The other analog channels with which the REG-DA can be equipped cannot be retrofitted on site.

We recommend contacting the manufacturer to install additional or replace existing components!

The analog slots on the CPU board can be fit with the following modules:

- 2 x analog input (-20 … 20 mA, -10 … 10 V)
- 2 x analog output (-20 … 20 mA)
- 1 x PT 100 temperature measurement
- 1 x resistance measurement for tap position

The analog modules are the same as those for the REG-D™.

⚠ DANGER!	**Danger of electric shock!**
	Injury or death
	⮒ Disconnect the device from all power supplies (auxiliary voltage, control voltages) before opening the front panel.

NOTICE!	**Incorrect work!**
	Damage to the CPU board, analog panel, front module or connection
	⮒ Open the front panel with care.
	⮒ Do not pull on the front panel's connection cable.
	⮒ Follow the EMC directive when working.
	⮒ Only use suitable and safe tools.
	⮒ Make sure no parts (e.g., screws) fall into the device.
	⮒ If you are not sure that you can perform the work correctly, send the device to the manufacturer for retrofitting.

To reach the slot for the analog module, the front panel must be loosened and swung to the side. This is done by loosening the four screws on the front panel and swinging it to the left. Make sure that the front panel is loose but that the connection cable of the membrane keyboard is still connected to the CPU board. Make sure that the cable does not get damaged!

Loosen the front panel of the REG-DA

Open front panel and position of the connectors (orange selection)

The analog module can be placed on the corresponding connectors to the left of the display. Make sure that all of the connections are securely in and click the printed circuit board holder into place.

Installed analog module

The front panel can be closed and fastened.

The analog channels on the analog module have the numbers 3 and 4. The connection is established on terminals 65 to 68. The exact terminal assignment depends on the analog module used and can be taken from the technical data in the Appendix or the device-specific circuit diagram.

The analog channels are automatically detected by the firmware after you restart the device, and can then be configured from the menu 'Setup -6-\General\Analog' or the configuration software.

11.   Maintenance/Cleaning

11.1   Cleaning instructions

Use a soft, slightly damp and lint-free cloth. Make sure no liquid gets in the housing. Do not use window cleaner, household cleaners, sprays, dissolvent, cleaners that contain alcohol, ammonia solutions or abrasive cleaning agents.

If the inside is very dirty due to improper use, it is recommended that the device be returned to the manufacturer. Indeed, if a lot of dust has accumulated on the printed circuit board, this may lead to insulation coordination failure.

Dust is generally hygroscopic and can bridge creepage distances. For this reason, if the device has a housing cover, it is recommended that it be operated with this closed.

NOTICE!	**Do not clean the device with unsuitable products!**
	This can damage the surface of the device and remove markings
	➲ Please follow the cleaning instructions above.

11.2   Fuse replacement

The REG-DA has a replaceable microfuse (20 mm) that is installed on LEVEL I (bottom PCB) with an appropriate fuse holder. There is a replacement fuse on the mounting support of the terminal compartment cover or the Level II PCB.

Required fuse

Auxiliary voltage feature H0:   Microfuse T1 L 250 V, 1 A   (Order No. 582.1002)

Auxiliary voltage, feature H2:   Microfuse T2 L 250 V, 2 A   (Order No. 582.1019)

⚠ **DANGER!**	**Danger of electric shock!**
	Injury or death
	⮑ When replacing the fuse, disconnect the device from all power supplies (auxiliary voltage, control voltages).

Replacement fuse
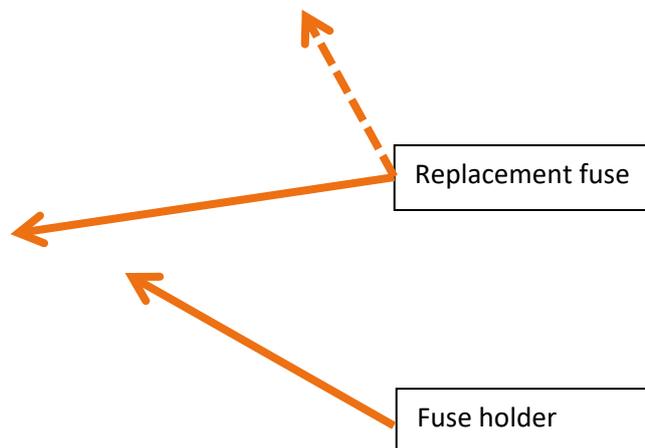
Fuse holder

Fuse holder and replacement fuse in the REG-DA

11.3 Replacing the battery

The REG-DA uses two versions of buffer batteries with three different connectors. The batteries are used for different purposes depending on the version and year of manufacture of the device (see case studies in this chapter). The battery is not actively used as long as the device is powered by auxiliary voltage. The battery serves as a backup if the auxiliary voltage fails.

In general, the battery voltage is monitored and an alarm (status relay or Service/fault LED) or message (output function for weak batteries with firmware version 2.24/3.24 or later (devices with characteristic S2)) is issued if the battery has low remaining capacity. This means that regular replacement of the battery is not necessary. Battery replacement may also be event-based.

The delivery time-frames below are approximate. Due to repairs, for example, old devices can require a new CPU circuit board. Please check the battery type in the device.

Regardless of the type of battery incorporated, in the event of a battery failure, the parameters should be saved as soon as possible, and always before the device is separated from the supply voltage. In devices fitted with MRAM, this is not necessary, but it is possible. Further notes on saving and restoring parameters are to be found in Chapter 7.2.6 RAM backup, from page 121 onwards, or in the document "Backup and restore parameters of REG-D(A) via Bootloader V02.pdf". Alternatively, parameters can be backed up with the WinREG software.

⚠ **DANGER!**	**Danger of electric shock!**
	Injury or death
	⮌ When replacing the battery, disconnect the device from all power supplies (auxiliary voltage, control voltages).

To replace the battery, first remove the front panel by loosening the four screws and folding the front panel to the left. Be careful with the cable to the membrane keyboard. It must not be detached from the connector on the PCB or damaged. Reinstall the front panel after the battery has been replaced.

REG-DA with open front panel

NOTICE!	**Open the front panel with care to avoid malfunctions or damaging the membrane keyboard!**
	Damage to the CPU board, front panel or connection
	⮑ Open the front panel with care.
	⮑ Do not pull on the cable on the front panel

REG-DA devices with MRAM (from 08/2014)

These devices have a button cell battery to buffer the real-time clock. This means that no data are lost when the battery is removed. The time may have to be adjusted when the new battery is installed.

Required battery:

Lithium button cell 3 V Type CR1632 (order no. 570.0005)

Service life:

when the REG-DA (no auxiliary voltage) is in storage	> 6 years
when the REG-DA is in operation at a duty cycle of > 50%	> 6 years

The battery is installed on the outside of the CPU board in a suitable holder. To change the battery, pull the existing battery out of the holder and insert a new one. If you use tools to remove the battery, be careful not to damage the PCB.

NOTICE!	**Do not use pointed or sharp tools to remove the button cell!**
	Damage to the CPU board
	➲ Remove the button cell with your fingers and not with a tool.
	➲ If you have to use a tool, do not use a screwdriver or similar pointed or sharp objects.
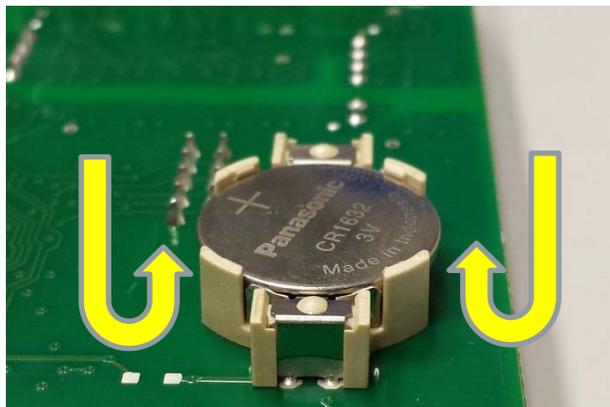
Remove the button cell
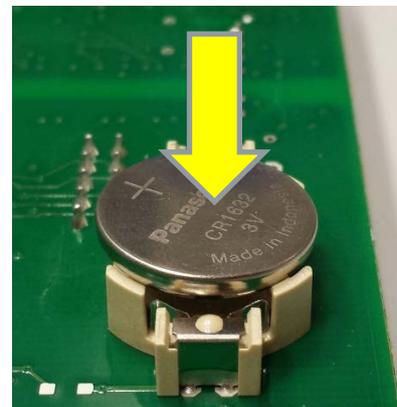
Insert the button cell

REG-DA devices with SDRAM, plug-in battery and <u>dual</u> connection (from 10/2009)

In these devices, the battery is a buffer for the SDRAM and the real-time clock. Parameters are lost when the battery is removed, which is why the devices have a dual connection for the buffer battery. This means that the new battery can be connected before the spent one is removed.

For safety reasons, it is recommended to back up the parameters for these devices.

Required battery:

Lithium 3 V or 3.6 V type CR14250 1/2AA with cable and connector (Order No. 570.0003.00)

Service life:

when the REG-DA (no auxiliary voltage) is in storage	> 6 years
when the REG-DA is in operation at a duty cycle of > 50%	> 10 years

Removing the battery erases the parameters!

➲ Connect the new battery before removing the spent one.

➲ Back up the parameters before replacing the battery (see Chapter 7.2.6 page 121).

The battery is on the right side of the CPU board. There are two connection points for the battery. To prevent losing the parameters, place the replacement battery in the empty connection point. Lift the battery that needs replacing and loosen the hold down bracket to remove it. You can then fasten the new battery with the hold down bracket.
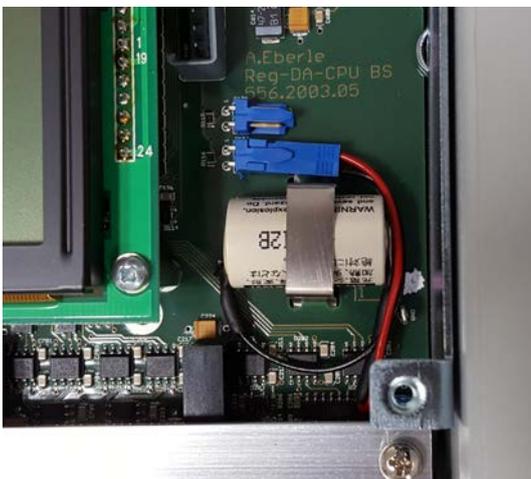
Plug connection points and hold down bracket on the PCB
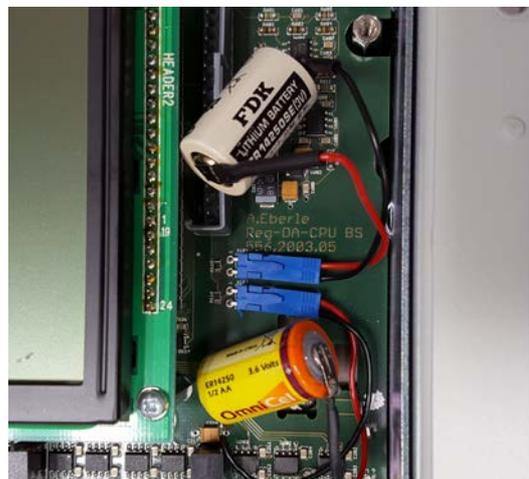
Parallel plugged batteries; hold down bracket removed

REG-DA devices with SDRAM, plug-in battery and <u>single</u> connection (from 2004)

In these devices, the battery is a buffer for the SDRAM and the real-time clock. Parameters are lost when the battery is removed, which is why the parameters have to be backed up before replacing the battery.

Required battery:

Lithium 3 V or 3.6 V type CR14250 1/2AA with cable and connector (Order No. 570.0003.00)

Service life:

when the REG-DA (no auxiliary voltage) is in storage	> 6 years
when the REG-DA is in operation at a duty cycle of > 50%	> 10 years

Removing the battery erases the parameters!

⮕ Back up the parameters before replacing the battery (see Chapter 7.2.6 RAM backup page 121).

⮕ Do not disconnect the auxiliary voltage before backing up the parameters!

The battery is on the right side of the CPU board. There is one connection point for the battery. Lift the plug of the battery that needs replacing and remove it carefully by removing the hold down bracket. You can then fasten the new battery with the hold down bracket and reconnect the plug.
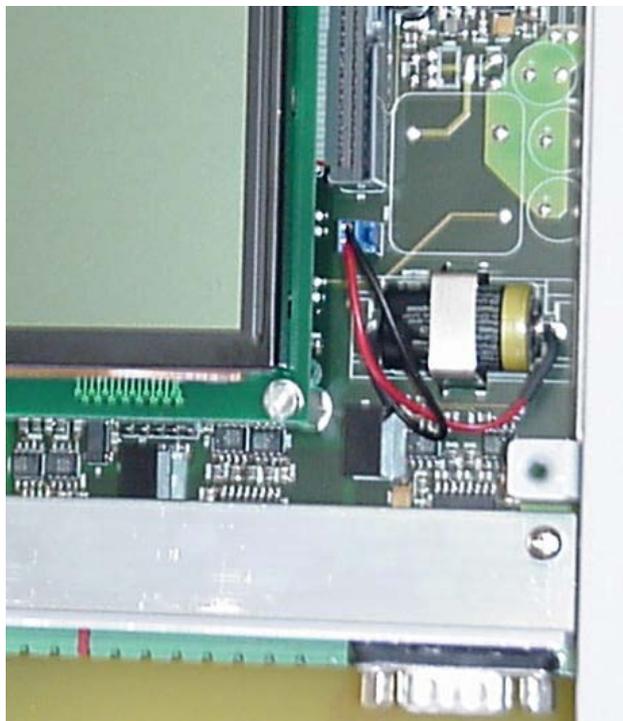
Plug connection point and hold down bracket on the PCB

12. Standards and laws

- 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
- IEC 61000-6-5/EN 61000-6-5 (in preparation)

$C\epsilon$

UL Certificate Number 050505 - E242284

13.   Disposal

Disposal note for EU member states

To preserve and protect the environment, prevent pollution, and improve the recycling of raw materials, the European Commission issued a directive according to which manufacturers take back electrical and electronic devices so they can be properly disposed of or recycled.

The devices with this symbol are not allowed to be disposed along with normal solid household waste within the European Union.

Special note for customers in Germany

The electronic devices manufactured by A. Eberle are intended for commercial use. These devices may not be disposed of at municipal recycling centres for electrical devices, but are taken back by A. Eberle.

If you have question, please contact us by phone or email:

+49(0)911-628 108-0

info@a-eberle.de

If the device is not operated within the European Union, the national waste-disposal regulations in the respective country must be respected.

14. Product warranty

The warranty period is three years starting from the delivery date.

15.   Storage

The devices and related spare components must be stored in rooms that are dry and clean.

For storage of the device or its replacement modules, the temperature range -25°C to +65°C applies.

The relative humidity may not result in the creation of condensation or ice.

It is recommended to limit the storage temperature to a range of from -10°C and +55°C to prevent the electrolytic capacitors from ageing prematurely.

It is also recommended to connect the device to the auxiliary voltage every two years to condition the electrolytic capacitors. This should also be done before the device is put in service. In extreme climatic conditions (in the tropics), this also "preheats" the device and prevents condensation.

Before voltage is applied to the device for the first time, it should be left in the operating location for at least two hours to equalise the temperature difference and thus prevent humidity and condensation.

16.   Troubleshooting

16.1   General

In this chapter frequently occurring problems and their solutions are discussed. For further assistance, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101). The support team often requires the regulator's parameter file in order to analyse a problem; this can be read out with REGPara (part of WinREG). Processes can also be very satisfactorily traced with the help of the logbook, which can be saved with the service (also part of WinREG).

To help us process your request for support as quickly as possible, please send us the parameters and logbook along with it.

⚠ DANGER!	When troubleshooting electrical installations, you may be exposed to the following hazards:
	▶ **electric shock**
	▶ **fire**
	▶ **electric arcs, etc.**
⮎ When troubleshooting, observe the relevant safety regulations	

Serial number/design specification?

Where can I find the serial number and design specification for my REG-DA?

All the components of Relay for Voltage Control & Transformer Monitoring systems have type labels. "Nr.:" refers to the serial number and "Art-Nr." to the design specification or part number of the Relay for Voltage Control & Transformer Monitoring system/Relay for Voltage Control & Transformer Monitoring.

Made in Germany	**www.a-eberle.de**

Typ: REG-DA Nr.: M16115521
Art.- Nr. 119.2067.002
Software - Version: 2.23

B0 Panel-mounting or wall-mounting version
    (H x W x D) 307 x 250 x 102 mm
I0 Serial Interface COM1 Sub-D
H0 Power supply external max. 33 VA
    AC 85V...110V...264V, 50...60 Hz
    DC 88V...220V... 280V
F1 Input current (rated value) Ir = 1 A
M1 Three-wire three-phase; balanced load

S0 without Recorder function
T1 with Transformer monitoring
K1 with firmware for parallel operation
E91 one PT 100 input

D0 16 digital inputs AC/DC 48 V...250 V (E1...E16)

C00 without additional inputs and outputs

R1 with Interface RS485 (COM 3)
    Integrated Protocol Interface according to:
XW00   without

L1 for connection of one REG-DA only
V11 Copper conductors, two wire operation only
Z20 DNP 3.00
A2 Display language English

⚠ CE EAC

The status LED of the REG-DA is off

`SETUP -6-` → `Status`

- This may be the REG-DA battery warning. In the REG-DA status menu, the battery status has changed from "OK" to "Error".

  When the warning first appears, the battery voltage is still sufficient to store the parameters of the REG-DA in the main memory in the event of a supply voltage failure. To prevent losing the parameters, please back them up using the WinREG software, or perform a RAM-Backup using bootloader V2.12 or later, (see also Chapter 7.2.6 RAM backup, from page 121 onwards).
  It is recommended that the battery be replaced at the A. Eberle head office.

- The REG-DA may have an internal fault (watchdog).
  For questions regarding this matter, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

Must REG-DA and PAN-D have the same firmware versions?

- Yes, the REG-DA and PAN-D firmware versions must match one another. For both systems to function properly, the same firmware must be used.

Can I update REG-DA Relays for Voltage Control & Transformer Monitoring with more recent firmware?

- Yes, firmware upgrades can be installed on all REG-DA Relays for Voltage Control & Transformer Monitoring. Please refer to the "**Important notes after an upgrade or downgrade of REG-DA firmware**" in Chapter 7.2.1 Update bootloader and firmware, from page 78 onwards.

The REG-DA does not always behave as expected or as described in the operating instructions

- Please check the software features that have been configured for the regulator. For example, the software features "SysCtrl" and "SysCtrl2" can significantly affect its behavior. For more information about the various features, please refer to Chapter 8.3 Features (software), from page 235 onwards.

- The behavior of the REG-DA can be modified via customer-specific programming (background programs). Please use the WinREG software to check whether a background program is available on the regulator (REG-L tab in the REGPara program). The name of the background program and corresponding design specifications are listed in program line H00. The background program, and a readme file describing its function, are available on the CD supplied.

16.2   Measurement

The measured voltages/currents are incorrect

- If there is no measurement voltage or measurement current, please check the wiring for any open disconnect terminals or any short circuit terminals.

- In the case of incorrect measuring voltage or measuring current readings, please check the parameters in the "CT/VT-Configuration" menu. The selected assignment for current and voltage measurement must correspond to the actual voltages and currents connected.

SETUP -6-

General 3

Actual Value
Correction
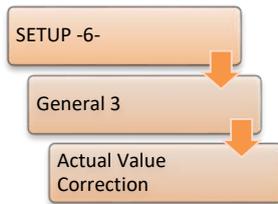
- Even if the transducer is correctly adjusted, impedance on the power supply lines for the measuring voltage or measuring current can lead to variations in the measured quantities recorded. In order to compensate for such variations, the measuring voltages or measuring currents can be proportionally adjusted via the menu item "Actual Value Correction".

The calculated power values are incorrect.

SETUP -5-

CT/VT
Configuration

- In the case of incorrect power values, please check the parameters in the "CT/VT-Configuration" menu.

- If a "Left rotary field" is present, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

The sign of the active power does not match the display in a protection device or bay controller.

- Please note the A. Eberle sign definition (see Chapter 7.2.3 Parallel operation, page 109)

SETUP -5-

CT/VT
Configuration
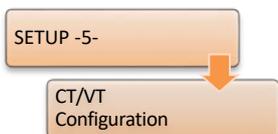
- Check the polarities of the voltage transformer and current transformer, as well as the inversion parameter of the voltage or current on page 2 of the "CT/VT-Configuration" menu. You can access page 2 of the menu with the left or right arrow keys.

16.3 Process signals (e.g. binary signals)

A signal is detected at the REG-DA binary input, even though there is no wanted signal from the process side.

‒ This is probably caused by voltage being induced in the binary signal's power supply line. In order to minimise this induced voltage, and thus prevent the binary input from responding as a result, a 220 nF capacitor (630 V, polarity-independent, e.g. film capacitor, not an electrolytic capacitor) can be connected in parallel to the binary input terminals. This measure can be used when the wanted signal is a DC signal.
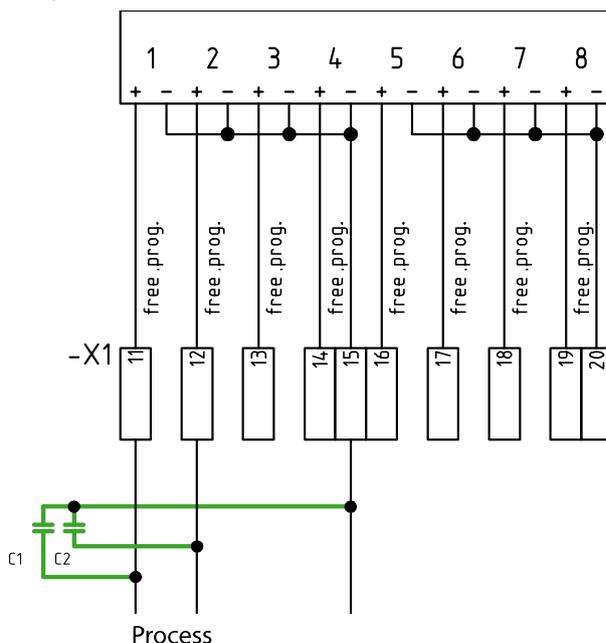
Moreover, input cards with different response thresholds are available for the REG-DA. The highest possible response threshold is recommended. This means that if, for example, an auxiliary voltage of 110 VDC is used, binary inputs with a response threshold of 80 V should be chosen.

The message "Duplicate Assignment" appears in the analog channels menu after allocation of the analog function "70:iTapPos".

SETUP -6-

General 1
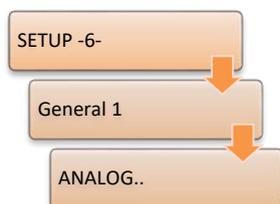
ANALOG..

‒ With new devices, certain binary inputs may already be configured with the input functions for BCD-code by default. If an mA-signal is provided to the regulator for tap-position indication, the analog function "70:iTapPos" must be assigned to the corresponding analog channel. For this, all of the BCD-functions in the "Input assignment" menu must be deleted in order to avoid a duplicate assignment. (Duplicate assignment will also come about if the analog function "70:iTapPos" is simultaneously assigned to two analog channels.)

SETUP -5-
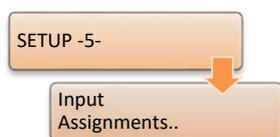
Input Assignments..

‒ If the tap-change position is determined by measuring the resistance, it is also necessary to delete the BCD-functions in the "Input assignment" menu. For details on setting a resistor module see Chapter 7.2.2.6 Input/Output signals, from page 103 onwards.

16.4   E-LAN

No communication between two or more devices connected via E-LAN

SETUP -6-

E-LAN

- Please check the communication line for damage and ensure that it is properly connected (no open terminals).
- If the E-LAN communication line has a ring topology, it must be opened at one point, since ring topologies are not supported via E-LAN. For example, the ring can be opened between two physically connected E-LAN interfaces by configuring different baudrates. However, physical separation (disconnected terminals) is preferable.
- If the devices in E-LAN do not have a unique identifier (i.e., several devices have the same ID, e.g. "A:"), communication via E-LAN is not possible. Please also note that PAN-Ds assigned to a REG-DA are automatically assigned an ID. This is always one higher than the ID of the REG-DA, for example, "B1:" if the ID for the associated REG-DA is "B:".
- Please check the baudrate setting of all involved E-LAN interfaces. The baudrate within a direct E-LAN connection or within an E-LAN bus must always be the same.
- Moreover, the settings for two- or four-wire operation within a direct E-LAN connection or within an E-LAN bus must correspond.
- If a two-wire connection is used, please check the termination resistors of all the E-LAN interfaces. For more information on proper termination, see Chapter 7.1.4.7 E-LAN from page 72 onwards.
- If an FOC/RS485 converter is used, four-wire technology must be implemented for the connection.

The PAN-D does not appear in "Setup -6-" of the REG-DA

- Please check the physical E-LAN connection between PAN-D and REG-DA. For a PAN-D to be assigned to an unambiguous REG-DA, the left E-LAN interface of the REG-DA must always be exclusively connected to the right E-LAN interface of the PAN-D (no bus topology, no other devices).

16.5 Regulation in general

The tap-changer moves back and forth

| SETUP -1- |
| Tolerance Band |

– If the permissible setpoint deviation is set too low, the tap changer may oscillate, because the tolerance band is completely skipped by a single tap change. Please compare with Chapter 7.2.2.4 Regulation (permissible setpoint deviation deviation Xw_Z), from page 97 onwards.

In automatic mode, the tap-changer is off-scale; the voltage is further and further away from the setpoint value.

– The wiring of the regulator's up/down relay is reversed. As a result, the tap-change commands are always in the wrong direction.

| SETUP -6- |
| Status |
| REG-D Status(2) |
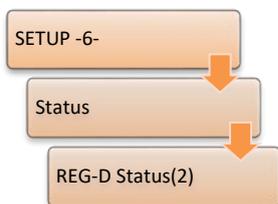
– The "Invers" feature is equal to 2, whereby the software reverses the up/down relays. The wiring must be adjusted to the set feature Invers=2 (see Chapter 8.3.12 Feature Invers, from page 272 onwards).

The tap-changer carries out too many tap changes

| SETUP -1- |
| Tolerance Band |

– The permissible setpoint deviation may be set too low for this particular application. In particular, in the case of regularly high load variations (e.g. steel works), the permissible setpoint deviation can be increased to reduce the number of tap changes. The limit of the permissible setpoint deviation constitutes the tolerable voltage fluctuations for specific applications.

| SETUP -1- |
| Time Behaviour |
| Time Factor |
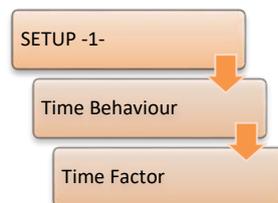
– One of the time programs "Integral", "Fast Integral" or "Linear" is used and the time factor parameter is set too low. Even brief violations of the permissible setpoint deviation result in a switching process.

| SETUP -1- |
| Time Behaviour |
| T1/T2 |
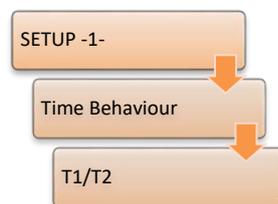
– The time program "Const" is used and parameters T1/T2 of the "Const" time program are set too low. Even brief violations of the permissible setpoint deviation result in a switching process.

After a higher or lower tap-change in automatic operating mode, the regulator switches to manual mode

SETUP -6-

Status

REG-D Status(2)
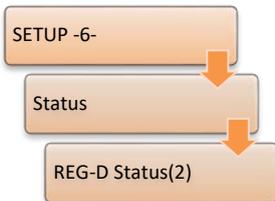
– If the tap position is activated in the REG-DA, after a tap change, the regulator checks whether the new tap matches the expected tap. If this is not the case, a tap-change error is generated, also see Chapter 8.2.7.5 Tap change error (TAPErr), from page 233 onwards). In connection with the set bit 7 of the software feature 'SysCtrl' (see Chapter 8.3.18 Feature SYSCTRL, from page 279 onwards), the regulator switches to manual mode. Please also see the Inverse feature in this connection (see Chapter 8.3.12 Feature Invers, from page 272 onwards).

– If the regulator is in an active parallel program and a parallel error (ParErr, see also Chapter 8.2.7.7 Parallel operation error (ParErr), page 234) is generated, the regulator switches into manual mode if bit 6 of the software feature SysCtrl is set (see Chapter 8.3.18 Feature SYSCTRL, from page 279 onwards).

In auto mode, high-speed switching is always activated

SETUP -3-

High-speed Switching

– Please check the set values of the forward and backward high-speed switching parameters. Pay particular attention to the sign for the forward high-speed switching, which should normally be negative. Between forward high-speed switching (e.g. -10%) and backwards high-speed switching (e.g. +10%), there must be a voltage range (percentual) in which high-speed switching is deactivated.

SETUP -5-

Input Assignments..
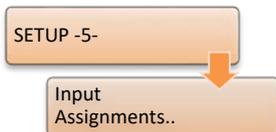
– Please check whether a binary input with the function "25:Quick" is in use and whether this input is active in auto mode. If this input is active, and the regulator in auto mode, it will be forced into high-speed switching mode.

The regulator sends no down tap command in auto mode and the message <U is activated

SETUP -2-
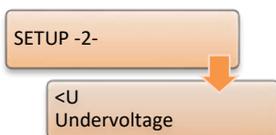
<U Undervoltage

– The undervoltage threshold is above the current measurement voltage. This can happen, for example, if the limit value for <U was set without a minus sign (e.g. +5% instead of -5%). When the <U limit is reached, down commands are blocked.

A current program, gradients (except LDC) and limitation have been configured to influence the current-dependent setpoint value. The setpoint value changes, but not in accordance with the current applied.

SETUP -2-
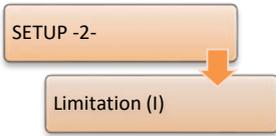
Limitation (I)

‒ Please check the signs for the minimum and maximum limitation parameters. In particular, the minimum limitation parameter should be given a negative sign.

16.6 Parallel operation

Must the REG-DA have the same firmware version for parallel operation?

SETUP -6-

Status

— Yes, several REG-DA operating in parallel must have the same firmware version in order to ensure proper communication between the devices with regard to the parallel programs.

Group switching of manual/automatic mode is not possible in Master-Follower parallel operation.

SETUP -6-

Status

REG-D Status(2)
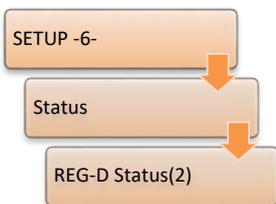
— A set bit 0 of the SysCtrl2 feature ensures that group switching of manual/automatic mode is terminated in master-follower parallel mode. Please check whether the feature bit is set for the appropriate regulator (also see Chapter 8.3.19 Feature SYSCTRL2, from page 281 onwards).

SETUP -1-

Programs..

Par.Parameter..
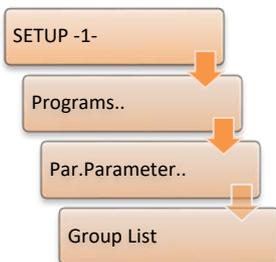
Group List

— No group list or an incorrect group list is configured in the slave regulator. In general, the group list must be set the same in **all** of the regulators involved in parallel operation.

In Master-Follower parallel operation, the transformers diverge in follower mode (in the event of a tap difference).

SETUP -6-

Status

REG-D Status(2)
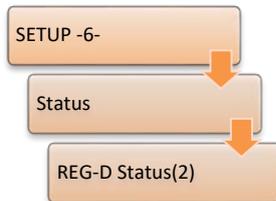
− This is possibly due to transformers behaving inversely but without the "Invers" feature having been set. During normal operation, the master regulates voltage, the slave is adjusted accordingly, and there is no tap-change divergence in the transformers since an up command results in a higher voltage and a down command in a lower voltage. However, if there is a tap difference between master and slave, the slave goes into follower mode and it now carries out tap changes according to the tap difference (and not the voltage!). Without the "Invers" feature being set, the follower now always carries out tap changes in the wrong direction, because it assumes that an up command also involves a Up tap change and a down command involves a Down tap change.

Please check if one of the transformers involved is inverted and whether or not the "Invers" feature is set (also see Chapter 8.3.12 Feature Invers, page 272). Transformers also diverge when the 'Inverse' feature is mistakenly set for a non-inverted transformer.

In Master-Follower parallel operation, ParErr is triggered without a tap difference having occurred.

SETUP -1-

Programs..

Par.Parameter..
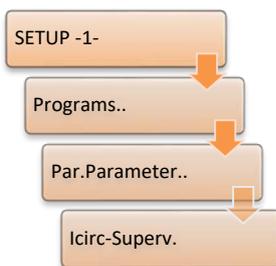
Icirc-Superv.

− In addition to the tap difference, the master-follower parallel program monitors circulating reactive current via Icirc-Supervision. If the Icirc limit is exceeded, the parallel error ParErr is generated. (also see Chapter 8.2.7.7 Parallel operation error (ParErr), page 234)

The circulating reactive current minimisation programs (dIsin(φ), dIsin(φ)[S], dcos(φ)) do not work (no influence on regulation).

SETUP -1-

Programs..

Par.Parameter..

Permiss. Icirc
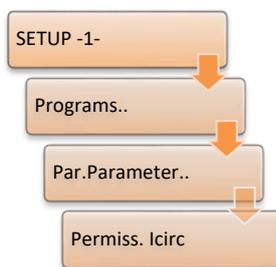
− The default value of the regulation influence for the circulating reactive current minimisation programs dIsin(φ), dIsin(φ)[S] and dcos(φ) is 9999 A. With this default value, the parallel programs have virtually no impact on regulation. Details for determining the parameter Permiss. Icirc can be found in Chapter 7.2.3 Parallel operation, from page 109 onwards.

SETUP -1-

Programs..

Par.Parameter..
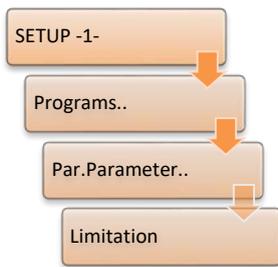
Limitation

‒ The limitation parameter of the relevant reactive current minimisation program, whose default setting is 20, is configured to 0. By doing this, the programs dIsin(φ), dIsin(φ)[S] and dcos(φ) have no influence on regulation.

The transformers diverge when a reactive current minimisation program (dIsin(φ), dIsin(φ)[S], dcos(φ)) is used.

SETUP -5-

CT/VT Configuration
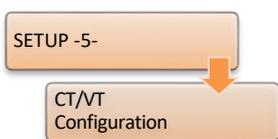
‒ Please check the wiring of the voltage and current transformers (Chapter 7.1.4.6 Process, page 70), and the measurement settings (see Chapter 7.2.2.2 Taking , page 91) as well as the sign definitions (see Chapter 7.2.3 Parallel operation, from page 109 onwards) for the REG-DA. A divergence of the transformers in the circulating reactive current minimization programs dIsin(φ), dIsin(φ)[S] and dcos(φ) suggests that the calculation of the circulating reactive current is faulty due to wiring or configuration.

The transformers operating in parallel are tapping back and forth (hunting), yet the permissible setpoint deviation and permissible Icirc parameters are correctly set.

SETUP -1-

Tolerance Band

SETUP -1-

Programs..

Par.Parameter..

Permiss. Icirc

‒ In the event that the permissible setpoint deviation and the permissible Icirc have been set close to the recommended minimum value, the parameters may nevertheless be set with too narrow range and thus result in an oscillating tap-change position. The reason for this is that the two permissible deviations (voltage and Icirc) are interdependent. In this case, it is recommended that the permissible setpoint deviation and permissible Icirc parameters be set with a slightly wider range. (See also the explanatory notes in Chapter 8.1.2.1 Permissible setpoint deviation (bandwidth Xw_z), page 131)
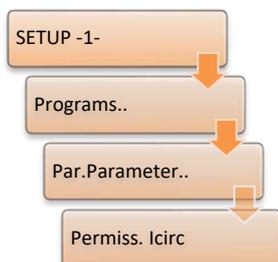
16.7 WinREG

There is no communication between WinREG and the connected device.

- The selected COM interface may still be blocked by another program, is unavailable or does not match the COM interface used. All COM interfaces are available, for example, via the Windows 7 operating system under "Control Panel/System/Device Manager".

- No null-modem cable is in use or the cable used is defective. It is recommended that the original A. Eberle null-modem cable is used.

- Check the WinREG and device interface settings. The baudrates, parity and handshakes of these must match.

- In the WinREG connection settings, several interfaces may be defined, and one of these connections will be defined as default. Check that the connection that you are using corresponds to the default connection.

- The connection between the PC and the device may be too slow, whereby the communication timeout (5s default) is activated. The communication timeout can be modified in WinREG's central control program in "Options/Configuration".

It is not possible to communicate via the PQServer

- Please check that "Communication with WinPQ" is activated in "Options/Settings" in WinREG's central control program.

- For a connection to be established, WinPQ's RS232Server must be started (see the tray icon). Since the WinREG cannot start the RS232 server, it is advisable in this operating case to switch the RS232 server of WinPQ to continuous operation. This is done by setting the AUTOCLOSE parameter in PQRS232Server.ini to zero (AUTOCLOSE=0).

- Check whether the registry entry for WinREG has been set in PQManager.

The WinREG 3.9 panel does not start up and instead an error message appears

- If all of the other WinREG 3.9 program modules can connect to the device, yet the WinREG 3.9 panel does not start, Microsoft DotNet Framework 3.5 must be installed. A DotNet Framework 3.5 installation file is included as standard on the WinREG 3.9 CD.

16.8 REGUpdate (update32.exe)

The firmware update aborts and the message "Wrong S-record" appears.

- The PC's native RS232 interface or the USB/RS232 converter does not support hardware handshaking (RTS/CTS). Hardware handshaking is vital to perform a successful update.
- No null-modem cable is in use or the cable used is defective. It is recommended that the original A. Eberle null-modem cable is used.
- The bootloader's firmware version is older than V2.00. Please update the bootloader to version V2.00 or later before updating the firmware.

The firmware update aborts and the message "Wrong version" appears.

- Please use a firmware file with "_p" in the filename.

The firmware update aborts and the message "Bootloader version too low" appears.

- The bootloader's firmware version is V1.05. To update this bootloader, a special version of REGUpdate software is required.
  For questions regarding this matter, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).

An error message is displayed when downloading or uploading the H-Program.

- It is recommended that both the regulator's COM1 baudrate and that of the REGUpdate be set to 9600 baud, as higher speeds can lead to transmission problems.

16.9 SCADA system

Internal communication between the REG-DA and the telecontrol board module is disrupted (the COM2 fault LED (red) is blinking).

- − The baudrate of the COM2 interface of the REG-DA does not correspond to the communication module setting. (Note also the default settings of the various telecontrol cards and protocols, see Chapter 7.2.2.8 SCADA system, from page 107 onwards.)

- − The REG-DA identifier does not correspond to the configured device identifier of the telecontrol board module REG-P(E)(D). Enter "AA:" for the device identifier in order to address the device that is directly connected to COM2. In this case, the REG-DA identifier is irrelevant.

- − The telecontrol board module REG-P(ED) uses the P1 method for internal data transfer (only REG-Ps with old SCADA system parameter settings or "Alstom/Areva/Schneider" profile). Please check that the REG-DA has a background program that supports the P1 method, as a corresponding background program is absolutely necessary for the P1 method.

The REG-P telecontrol board module cannot be loaded or read out via REG-DA.

- − The PC's native RS232 interface or the USB/RS232 converter does not support hardware handshaking (RTS/CTS). Hardware handshaking is vital for successful data transfer.

- − If the bootloader version of the REG-DA is lower than V1.14, loading or read out of the REG-P telecontrol board module via REG-DA cannot take place. Should this be the case, please update the bootloader.

- − If you are using a REG-DA with an internal REG-P (feature XW1), the REG-DA and REG-P must be simultaneously put into bootloader mode using the following procedure:

  1. Switch off the supply voltage of the REG-DA.
  2. Switch the supply voltage back on, holding down the REG-DA F1 key at the same time until → the REG-DA automatically starts up in bootloader mode.
  3. Wait approximately 40s, until the internal REG-P also appears in the serial bootloader, before you begin to load or read out the REG-P.

- Some versions of the REG-P telecontrol board module cannot be read out.
  For further information, please contact the SCADA support (comms-support@a-eberle.de, +49 (0)911 628108-104).

There is no physical communication with the control system

- Please check the communication line for damage and ensure that it is properly connected (e.g. no open terminals).
- Physical communication cannot be established for telecontrol board modules of REG-P with IEC 103, and REG-PM with Modbus or SpaBUS if the internal communication between the REG-DA and the telecontrol board module is disrupted. In such cases, it is advisable to start by checking that the internal communication is in proper working order.
- The baudrate of the telecontrol board module REG-P(ED) must correspond to the SCADA system settings.
- The Ethernet network uses a transfer rate of 10 Mbit/s. However, the telecontrol board module REG-P(ED) supports a transfer rate of 100 Mbit/s.
- Check that the LINK-layer addressing (link or IP address) is set correctly.
- If the IEC 101 protocol is used, please check the following:
  1. Does the length of the link, ASDU and data object addresses of the telecontrol board module REG-P correspond to the control system?
  2. Does the communication mode (balanced or unbalanced) corresponds to the control system settings?
  3. Do the settings for the use of the originator address correspond?
- If a serial FOC communication line (not Ethernet) is used, the idle state of the telecontrol board module REG-P(ED) must correspond to the idle state of the control system (TK400 REG-P idle state with "non-inverted" setting -> light on).
- When using an FOC communication line, the fibre optic cables should be cross-connected between the control system and the telecontrol board module, because otherwise there is no receive signal, or there is no activity.
- When using RS485, please check the following:
  1. Is the polarity correct (e.g. two-wire: RX- with TX- and RX+ with TX+)?
  2. Is the RS485 bus terminated correctly at the start and end (120 Ohm termination resistor)?

There is physical communication, but no valid data is available or no data is transferred.

- Please check the internal communication between the REG-DA and the telecontrol board module REG-P(ED).
- Please check the physical-to-logical device assignment according to IEC 61850 protocol ("Logical device instance" parameter in the Devices folder). This only applies to IEC 61850 for WinCONFIG 9.9 or later (e.g. version 6).
- Check the ASDU address of the telecontrol card in IEC 103/101/104.
- Check the address configuration of the individual data points/objects.

No stable connection can be established when using two control systems according to protocol IEC 61850.

- Please check that both control systems are not using the same report control block (URCB). It is essential that two different report control blocks are used for control system.

Must the telecontrol board module REG-P(ED) firmware also be upgraded when updating the REG-DA firmware?

- If the communication standard that has been used between the REG-DA and REG-P(ED) up to now (RPS or P1 method) remains unchanged, the REG-P(ED) firmware version does not need to be updated. The RPS communication standard has been available since REG-DA firmware V2.00.

17. Abbreviation list

Abbreviation	Meaning
OFF	OFF
Inhibit High	Over voltage blocking The regulator stops further control operations until the limit value violation is removed.
AUTO	Automatic
3Winding	Three-winding transformer application
ELAN-Err	E-LAN error (bus error)
ELAN-L	Left E-LAN
ELAN-R	Right E-LAN
up/down	LED indicates up or down tap command
InputErr	Input error Generated at the binary input of setpoint switching (SP1 to SP2), InputErr becomes active if both signals are present at the same time. The regulator keeps the old value and generates InputErr.
TC-Err+	Runtime exceeding of the tap changer as a wiping signal (impulse output)
TC-Err	Runtime exceeding of the tap changer as a continuous signal
TC.i.Op.	TC in operation, Time required for a motor drive, to move from one tap to another
LDC	Line drop compensation
Par-Prog	Activate or activated parallel program
ParErr	ParErr generally stands for a faulty parallel operation (parallel error) and automatically switches parallel-working groups from automatic mode to manual mode. If this behavior is undesirable, a different behavior can be selected via the SysCtrl feature. To do this, please contact the A. Eberle REGSys™ support team (regsys-support@a-eberle.de, +49(0)911/628108-101).
PhasFail	The function can only be selected in PAN-D and regulators with the M2 feature. PhasFail becomes active when one of the three phases has failed.

Abbreviation	Meaning
TapErr	TapErr is a message that indicates a tap change problem. The designation was derived from the English term "Tap Error".
	Unlike ParErr, TapErr acts locally, it is therefore only shown on the regulator where the tap-change error occurred, but with master-follower or MSI mode operation, the parallel working group can be switched to manual mode.
LEVEL	Level-triggered function
PROG	Function triggered by a background program
creepNBD	Creeping Net Breakdown
Quick	High-speed switching, the regulator switches in the tolerance band in the fastest possible time.
Inhibit	Inhibit, the regulator stops further control operations until the limit value violation or the signal is removed
SP-1	Setpoint 1
SP-2	Setpoint 2
SP-3	Setpoint 3
SP-4	Setpoint 4
SP-decr.	Decrement setpoint via binary input
SP-incr.	Increment setpoint via binary input
SP2Level	Level-controlled changeover to setpoint 2
Trans1	
/Trans1	Transit channel 1, binary input signal can be "passed through" to a freely programmable relay.
	Examples:
	BE 1 to Trans 1
	Rel 3 to Trans 1
	→ BE 1 = 1 → REL 3 = 1
	BE 1 = 0 → REL 3 = 0
	BE 1 to Trans 1
	Rel 3 to /Trans 1
	→ BE 1 = 1 → REL 3 = 0
	BE 1 = 0 → REL 3 = 1
Trans2	

Abbreviation	Meaning
Trans2	see Trans1 analogously
PG_CB	ParaGramer, low voltage side, circuit breaker
PG_IS1	ParaGramer, low voltage side, isolator 1
PG_IS2	ParaGramer, low voltage side, isolator 2
PG__CP	ParaGramer, low voltage side, coupling
PG_SC1	ParaGramer, low voltage side, section 1
PG_SC2	ParaGramer, low voltage side, section 2
PG_H_CB	ParaGramer, high voltage side, circuit breaker
PG_H_IS1	ParaGramer, high voltage side, isolator 1
PG_H_IS2	ParaGramer, high voltage side, isolator 2
PG_H_CP	ParaGramer, high voltage side, coupling
PG_H_SC1	ParaGramer,high voltage side, section 1
PG_H_SC2	ParaGramer,high voltage side, section 2
BCD1	BCD/BIN code, value 1
BCD2	BCD/BIN code, value 2
BCD4	BCD/BIN code, value 4
BCD8	BCD/BIN code, value 8
BCD10	BCD/BIN code, value 10
BCD20	BCD/BIN code, value 20
BCDminus	BCD/BIN code, "-" sign
BIN16	BIN code, value 16
BIN32	BIN code, value 32
PANmiss	Set when the associated PAN-D is not present.
LR_AH	Local/remote operation with the REG-LR device is activated when the input functions "LR_AH" and "LR_STAT" are used. These inputs are connected to the corresponding outputs of the REG-LR device. So long as the REG-LR device keeps the status line LR_STAT active (1), the AUTOMATIC/MANUAL mode

Abbreviation	Meaning
	of the regulator is determined via the input LR_AH (1:AUTOMATIC, 0:MANUAL). Up/down commands can only arrive from the regulator (with AUTOMATIC mode). As soon as the LR_STAT status of the REG-LR device drops off (0), the regulator assumes the AUTOMATIC/MANUAL mode which was valid 1s prior to the LR_STAT signal fall, and operates as a normal regulator. Special case: "LR_STAT" is not used (i.e., only the input function "LR_AH" is activated. In this case LR_STAT is assumed as being always active).
LR_STAT	If only the input function "LR-STATUS" is used, then the following applies: "LR_STAT" active (1): Remote operation, (i.e., MANUAL/AUTOMATIC and up/down only via inputs or REG-L). "LR_STAT" inactive (0): Remote operation, (i.e., MANUAL/AUTOMATIC and up/down only via the keyboard).
T60s/1s	Emits a 1s pulse every 60s (relay) or displays it (LED)
COM2ACT	Provides information on the state of the COM2 interface (1: busy, 0: not busy)

18. Symbol list

Symbol	Meaning
> I [%]	Upper current limit (of the transformer)
< I [%]	Lower current limit (of the transformer)
> U [%]	Upper voltage limit (of the transformer)
< U [%]	Lower voltage limit (of the transformer)
ΔI [A]	Difference between any two current values
ΔU [V]	Difference between any two voltage values
AO1 ... AOn	Analog output (mA)
AI1 ... AIn	Analog input (mA)
BA1 ... BAn	Binary output (USt. : 10 V ... 50 V)
E1 ... En	Binary input (USt. : 48 V ... 230 V)
F_t [1]	Time factor for regulator time behavior
I1n [A]	Nominal value for current transformer, primary (of the transformer)
I2n [A]	Nominal value for current transformer, secondary (of the transformer)
Icirc [A]	Circulating current in parallel-connected transformers
Icirc sinφ[A]	Reactive component of the circulating current Icirc
I [A]	Given load current of the transformer
I sinφ = Ib [A]	Reactive part of the load current I (short, reactive current Ib)
Kni [1]	Transformer factor for current transformer
Knu [1]	Transformer factor for voltage transformer
R1 ... Rn	Relay outputs
S [VA]	Apparent power
Sn [VA]	Nominal transformer power
St [%]	Gradient of Uf/I characteristic curve
St_{Nom} [%]	Nominal value for gradient of Uf/(I) characteristic curve

Symbol	Meaning
tb [s]	Base time; normal value for tb = 30s for Xwb = 1%
t_V [s]	Tap command delay
U1N [kV]	Nominal value voltage transformer, primary
U2N [V]	Nominal value voltage transformer, secondary
Uf [V]	Voltage drop (amount) on the line
<u>U</u>f [V]	Voltage drop (complex) on the line
U_{act}	Actual voltage value
u_k [%]	Short-circuit voltage of the transformer; fraction of the nominal voltage, which drives the nominal current in the short-circuited secondary winding
U_{Sp}	Setpoint value for voltage
U_T [V]	Transformer voltage (effective value)
U_V [V]	Voltage to user (effective value)
W [V]	Reference value ($X_R + X_K$)
X [V]	Actual control value (of voltage)
X_0	Reference value for limit (setpoint or 100/110 V)
Xd [V, %]	Control difference (negative setpoint deviation: Xd = - Xw)
X_K [V]	Correction value (Uf)
X_R [V]	Setpoint, set on regulator
X_{R100} [V]:	Setpoint, defined as 100%-value
Xw [%] (relative)	Setpoint deviation [(X - W) / W] 100%
Xw [V] (absolute)	Setpoint deviation (X - W)
Xwb [%]	Evaluated relative setpoint deviation; tap commands are activated at Xwb = 1%
Xwz [%]	Permitted setpoint deviation, set on the regulator. Specification in ± n% based on W
Y [1]	Setting value 1 tap
Yh [1]	Setting range for number of tap positions
Z [V]	Disturbance value

19. Index

20.   Appendix

The following pages contain:

20.1 Technical Data

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
- IEC 61000-6-5 / EN 61000-6-5 (in preparation)

CE

UL Certificate Number 050505 - E242284

AC voltage inputs (U$_E$)	
Measuring voltage U$_E$	0 ... 160 V
Shape of the curve	sinusoidal
Frequency range	16....50....60....65 Hz
Internal consumption	$\leq U^2$ / 100 kΩ
Overload capacity	230 V AC continuous

AC input (I$_E$)	
Measuring current In	1 A / 5 A software selectable
Shape of the curve	sinusoidal
Frequency range	16....50....60....65 Hz
Control range	0 ... In ... 2.1 In
Internal consumption	$\leq$ 0.5 VA

AC input (I$_E$)	
Overload capacity	10 A continuous 30 A for 10 s 100 A for 1 s 500 A for 5 ms

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	$\leq$ 1.5 V
Potential isolation	Optocoupler
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.

The inputs can be continuously short-circuited or open circuited. All inputs are galvanically isolated from all of the other circuits.

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
Potential isolation	Optocoupler
Line compensation	No compensation required
Transmission behaviour	linear

Resistance input (tap change potentiometer)	
Quantity	See order specifications
Connection	Three-wire, convertible to four-wire
Total resistance in the resistor chain	R1: 180 Ω ... 2 kΩ R3: 2 kΩ ... 20 kΩ
Tap resistance	adjustable R1: 5...100 Ω/tap R3: 50...2000 Ω/tap
Number of taps	$\leq$ 38
Potential isolation	Optocoupler
Current through resistor chain	max. 25 mA

The measuring device has an open circuit monitoring.

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
Potential isolation	Optocoupler
Load range	0 ≤ R ≤ 8 V / Y2
Alternating component	<0.5% of Y2

The outputs can be continuously short-circuited or open circuited. All outputs are galvanically isolated from all of the other circuits.

Binary inputs (BI)	
Inputs E1 ... E16 (... E22, ... E28)	
Control signals U_{st}	in the AC/DC range 48 V ... 250 V, 10 V ... 50 V, 80 V ... 250 V, 190 V ... 250 V in accordance with characteristic Dx
Shape of the curve, permissible	Rectangular, sinusoidal
48 V...250 V H - Level L - Level	≥ 48 V < 10 V
10 V...50 V H - Level L - Level Input resistance	≥ 10 V < 5 V 6.8 kΩ
80 V ... 250 V H - Level L - Level	≥ 80 V < 40 V
190 V ... 250 V H - Level L - Level	≥ 176 V < 88 V
Signal frequency	DC, 40 ... 70 Hz
Input resistance	108 kΩ, except 10...50 V
Potential isolation	Optocoupler; groups of four, each galvanically isolated from each other.
Anti-bounce filter	Software filter, with 50Hz AC input filter
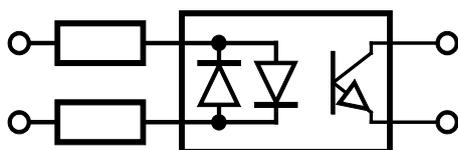
Simplified diagram of a binary input

Binary outputs (BO)	
R 1 ... R13 (... R19, ... R25) 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

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

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

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.

Analog/Digital Conversion	
Type	12 bit successive-approximation converter
A/D bit resolution	+/- 11 bit
Sampling rate	24 samples per period, e.g. 1.2 kHz at a 50Hz signal *

*The measurement inputs are equipped with an Anti-Aliasing filter.

Device real time clock	
Accuracy	+/- 20 ppm

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

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

Reference conditions	
Reference temperature	23°C $\pm$ 1 K
Input quantities	U_E = 0 ... 160 V I_E = 0 ... 1A / 0 ... 5A
Auxiliary voltage	H = Hn $\pm$ 1%
Frequency	45 Hz...65 Hz
Shape of the curve	Sinusoidal, form factor 1.1107
Load (only for characteristics E91...E99)	Rn = 5 V / Y2 $\pm$ 1%
Other	IEC 60688 - Part 1

Transmission behaviour of the analogue outputs	
Error limit	0.05% / 0.25% / 0.5% / 1% related to Y2 (see 'Measured quantities')
Measurement cycle time	$\le$ 10 ms

Electrical safety		
Safety class	I	
Degree of pollution	2	
Measurement category	IV/150 V	
Measurement category	III/300 V	

Operating voltages		
50 V	150 V	230 V
E-LAN, COM1 ... COM3 Analogue in/outputs Inputs 10...50 V	Voltage inputs, current inputs	Auxiliary voltage, binary inputs, relay outputs

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

Test voltages*	Description	Test voltage / kV	Counter circuits
Auxiliary voltage	U_h	2.3	COMs, AI, AO
Auxiliary voltage	U_h	2.3	BI, BO
Measuring voltage	U_e	2.3	COMs, AI, AO
Measuring voltage	U_e	3.3	U_h, BI, BO
Measuring voltage	U_e	2.2	I_e
Measuring current	I_e	2.3	COMs, AI, AO
Measuring current	I_e	3.3	U_h, BI, BO
Interfaces, COMs	COMs	2.3	BI, BO
Analogue outputs	AO	2.3	BI, BO
Analogue outputs	AO	0.5	COMs, AI
Analogue inputs	AI	2.3	BI, BO
Analogue inputs	AI	0.5	COMs, AO
Binary inputs	BI	2.3	BI
Binary inputs	BI	2.3	BO
Binary outputs	BO	2.3	BO

*All test voltages are AC voltages in kV, which may be applied for 1 minute. The COM interfaces are tested against each other with 0.5kV.

Auxiliary Voltage		
Characteristic	H0	H2
AC	85 ... 264 V	–
DC	88 ... 280 V	18 ... 72 V
AC Power consumption	≤ 35 VA	–
DC Power consumption	≤ 25 W	≤ 25 W
Frequency	45 ... 400Hz	–
Microfuse	T1 250 V	T2 250 V

The following applies to all characteristics:
Voltage dips of ≤ 25 ms result neither in data loss nor malfunctions. Fuses are time lag (slow blow) type.

Ambient conditions	
Temperature range	
Function	-15°C ... +60 °C
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, unpackaged
Vibration	IEC 60255-21-1, Class 1
Shock	IEC 60255-21-2, Class 1
Earthquake resistance	IEC 60255-21-3, Class 1

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

The button cell on these devices is used to buffer the real time clock if the aux. power supply is off.

Mechanical design

Housing	Sheet steel, RAL 7035 light-grey
Height	325 mm incl. PG connectors
Width	250 mm
Total depth	114 mm
Mounting depth	87 mm
Weight	≤ 6.0 kg
Housing door	with silicate glass
Front panel	Plastic, RAL 7035 grey on aluminium brackets
Control panel cut-out	
Height	282 mm
Width	210 mm
Protection type	IP 54
Protection type with brush sealing	IP 12

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 XW90..93+97+98), 87...98	0,5	0,5	---
II	SCADA interface (only XW90..93+97+98) 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...209	1,5	1,5	0,25
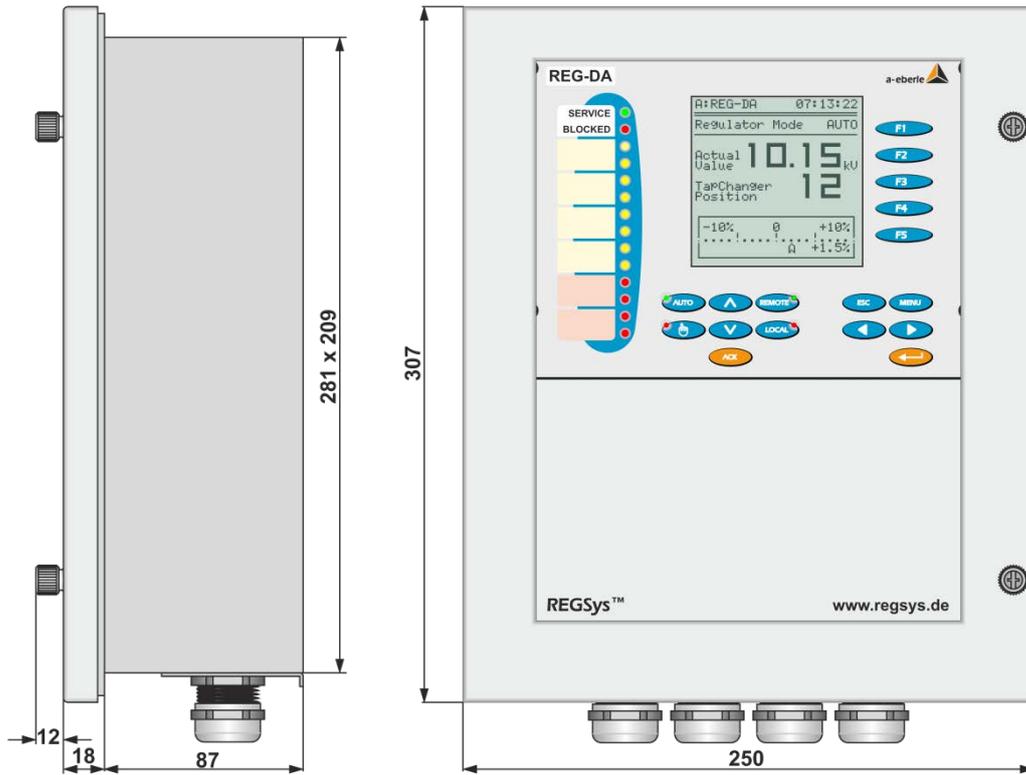
Mechanical dimensions, in mm
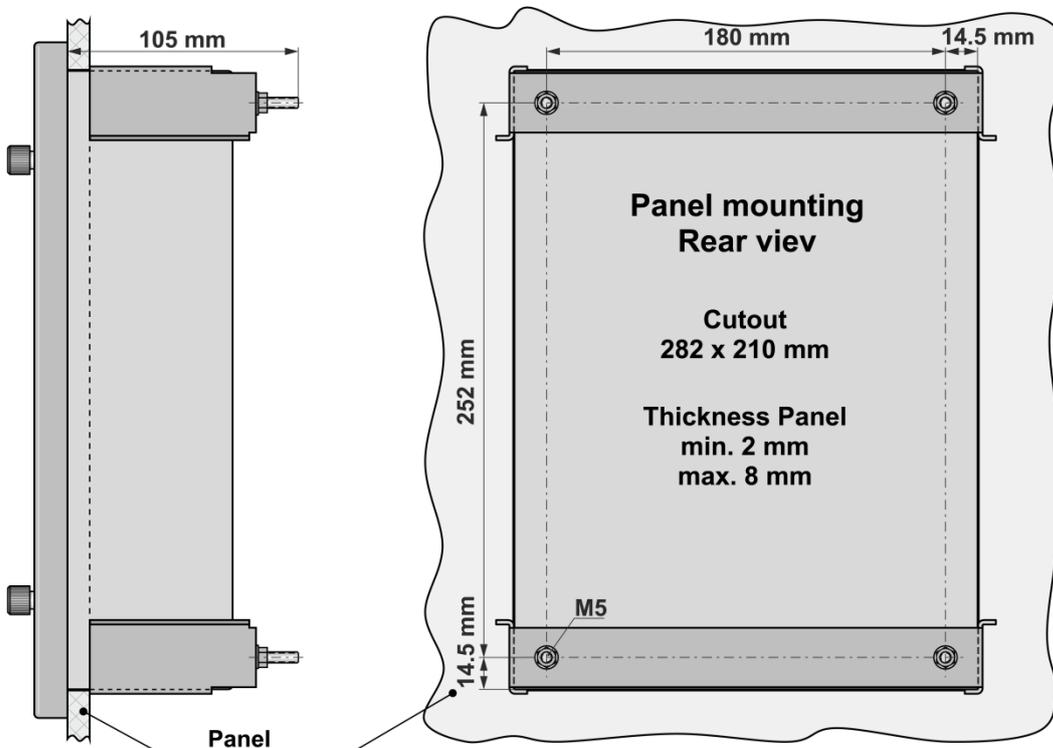
Mechanical dimensions, panel mounting
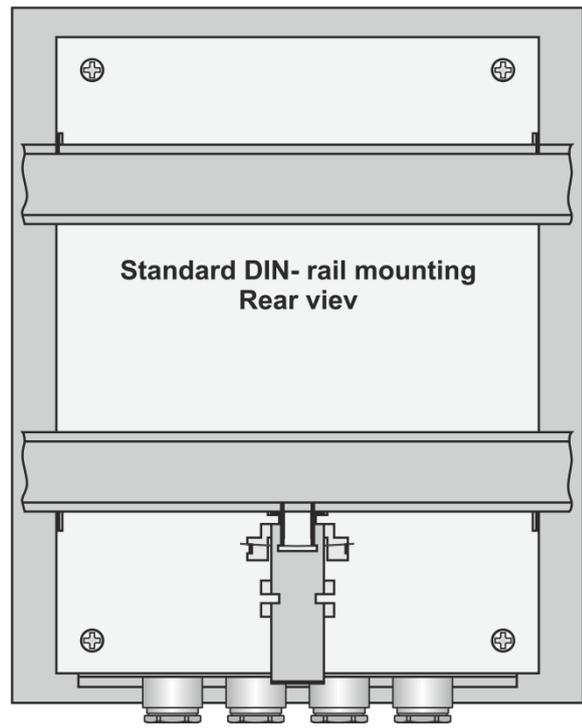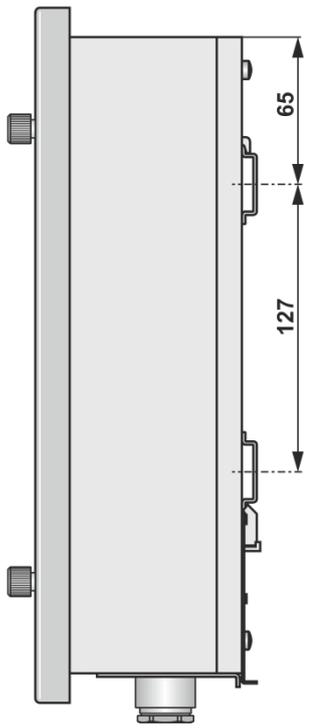
Mechanical dimensions, DIN rail mounting, in mm

Standard DIN- rail mounting
Rear viev

65

127
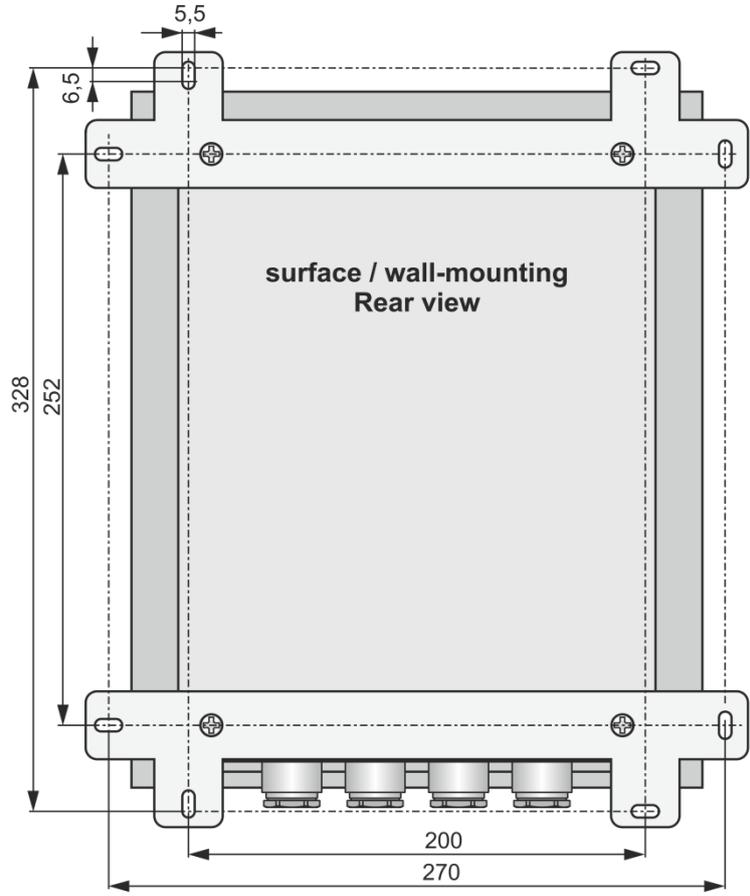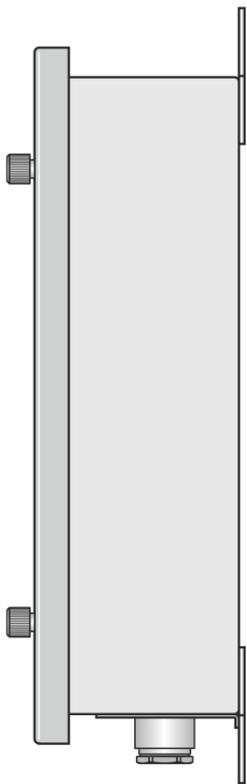
Mechanical dimensions, wall mounting, in mm

surface / wall-mounting
Rear view

5,5

6,5

328

252

200

270

General information about the connection technology

The regulator has three printed circuit boards or connection levels.
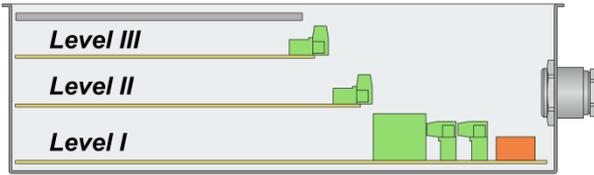
The auxiliary voltage, the VT & CT inputs, as well as the relay outputs, binary inputs etc., are all connected on **Level I**.

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

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 also accessible on Level II (RJ45 and/or ST/LC fibreglass).

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

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**.

Fibre optical connection (1 x Ethernet-ST, XW93) at Level II; REG-DA Com ports at Level III

Optical Serial Protocol Interfaces

For fibre optic serial connections up to a baud rate of 19200 (e.g. DNP, IEC 60870-5-101 or 103), ST or FSMA 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)

Optical transmitter

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

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

Communication over Ethernet 100 Mbit (100Base Fx)
(characteristics XW92, XW93.x, XW95.x, XW96.1 and XW98)

Product	Wave length	Fibre	Pmin [dBm] [1]	Pmax [dBm] [1]
Fibreglass ST Fibreglass LC	1310 nm	62.5/125 µm NA=0.275	-20	-14

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

Optical receiver

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

Product	Wave length	Fibre	Pmin [dBm] [2]	Pmax [dBm] [2]
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

Communication over Ethernet 100 Mbit (100Base Fx)
(characteristics XW92, XW93.x, XW95.x, XW96.1 and XW98)

Product	Wave length	Fibre	Pmin [dBm] [2]	Pmax [dBm] [2]
Fibreglass ST Fibreglass LC	1310 nm	62.5/125 µm NA=0.275	-14	-32

2) TA = 0...70°C, VCC = 5 V±5%, output level LOW (active)

Terminal configuration

	No.	Option	M1*	M2*	M9*
Level I	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	

	No.			
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	$R_6...R_{11}$
	54		closes in the event of fault	
	55		Life contact (status)	
	56		opens in the event of fault	
	57		MANUAL	
	58		MAN/AUTO	
	59		AUTO	
Level III	69	E-		
	70	E+	E-LAN (L)	
	71	EA-		
	72	EA+		
	200	GND		
	73	E-		
	74	E+	E-LAN (R)	
	75	EA-		
	76	EA+		
	201	GND		
	77	Tx+		
	78	Tx-		
	79	Rx+	COM3 (RS485)	
	80	Rx-		
	81	GND		
	82	TxD		
	83	RxD		
	84	RTS	COM2 (RS232)	
	85	CTS		
	86	GND		
	202	DCF-		
	203	DCF+	DCF 77 ***	
	204	GND		
	205	TxD		
	206	RxD		
	207	RTS	COM1 - S	
	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
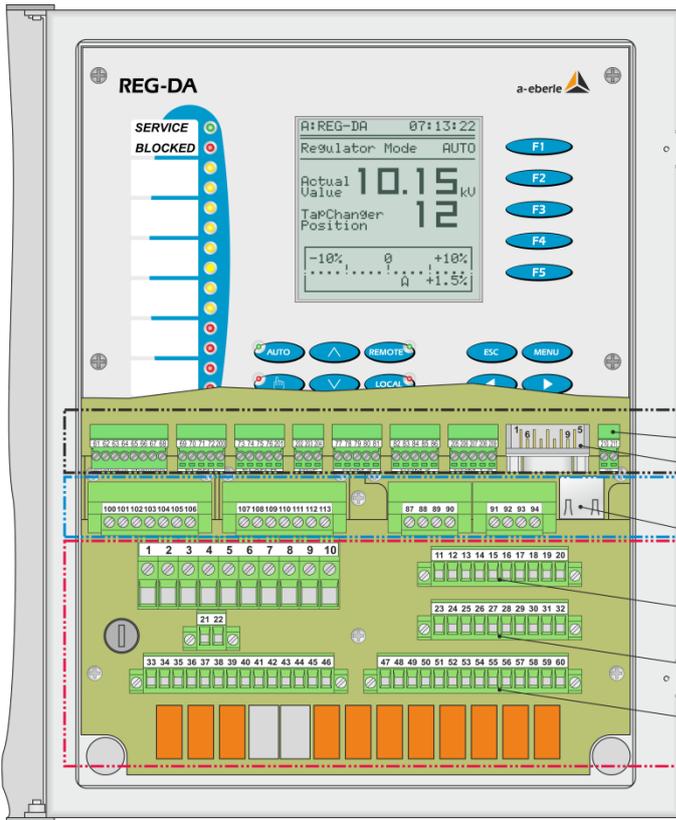
Position of the terminal connections
Characteristics D0, D1, D4, D7, D9
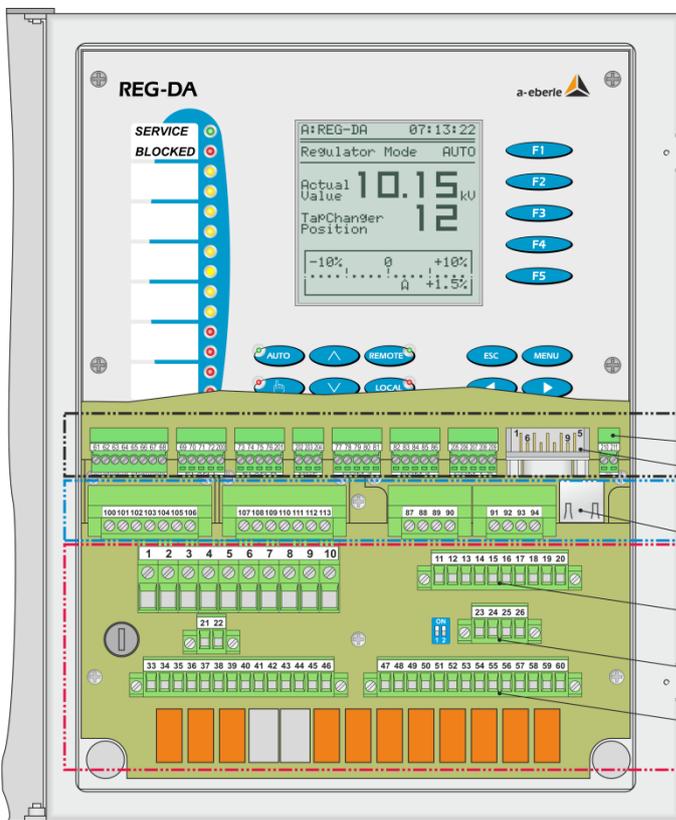
VCC
COM 1
Level III

Ethernet connection *Level II*
(IEC 61850, IEC 60870-5-104)

Level I

Binary inputs

Binary inputs

Relay outputs

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

VCC
COM 1
Level III

Ethernet connection *Level II*
(IEC 61850, IEC 60870-5-104)

Level I

Binary inputs

Tap-change
potentiometer input

Relay outputs

Terminal Configuration Level II

Characteristics: C10, C90...C99

Characteristic C10 – Standalone monitoring function

	No.			
Module 6	100		lower command in-terlock	
	101			
	102		raise command in-terlock	
	103			
	104		Overvoltage >U	
	105		Root	
	106		Undervoltage <U	
	107		Measuring voltage	U1a
	108			U1b
	109		COM 1	COM1 / RxD
	110		COM 1	COM1 / TxD
	111		COM 2	COM1/2/GND
	112		RS 232	COM2 / RxD
	113			COM2 / TxD

Characteristic C90 – (e.g. 2 x PT100, other combinations are possible)

	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		-	

Terminal Configuration for SCADA interface on Level II

Characteristics: Z10..15, 17..21, 90, 91, 99, XW90...98

Characteristics Z10..15, 17..20, 90, 91–REG-P communication interface

	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
	96	Fibre optic Out
	97	Fibre optic GND
	98	Fibre optic VCC
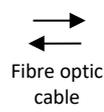
For terminals 95–98: Fibre optic module → Fibre optic cable

Characteristic Z21–REG-LON communication interface

	No.	
Fibre optic		Fibre optic cable In
		Fibre optic cable Out
		Fibre optic cable GND
		Fibre optic cable VCC
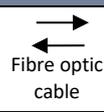
Fibre optic module → Fibre optic cable

Characteristic Z99–Profibus-DP communication interface

	No.	
PARAM (RJ11)	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 communication interf.

	No.	
PARAM1	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)
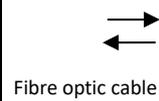
Characteristics XW94..96–REG-PED communication interface

	No.	
COM1	87	RS485-P (A)
	88	RS485-N (B)
	89	RS232-TxD
	90	RS232-RxD
	91	RS232-RTS
	92	RS232-CTS
	93	RS232-GND
PE	94	PE/Shield
PARAM	95	PARAM-RxD
	96	PARAM-TxD
	97	PARAM-GND
Ethernet 1	RJ45 connector	or — Fibre optic cable (ST or LC)
Ethernet 2	RJ45 connector	or — Fibre optic cable (ST or LC)
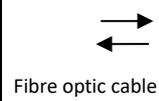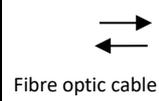
Block diagram - Characteristics D0, D1, D4, D7, D9
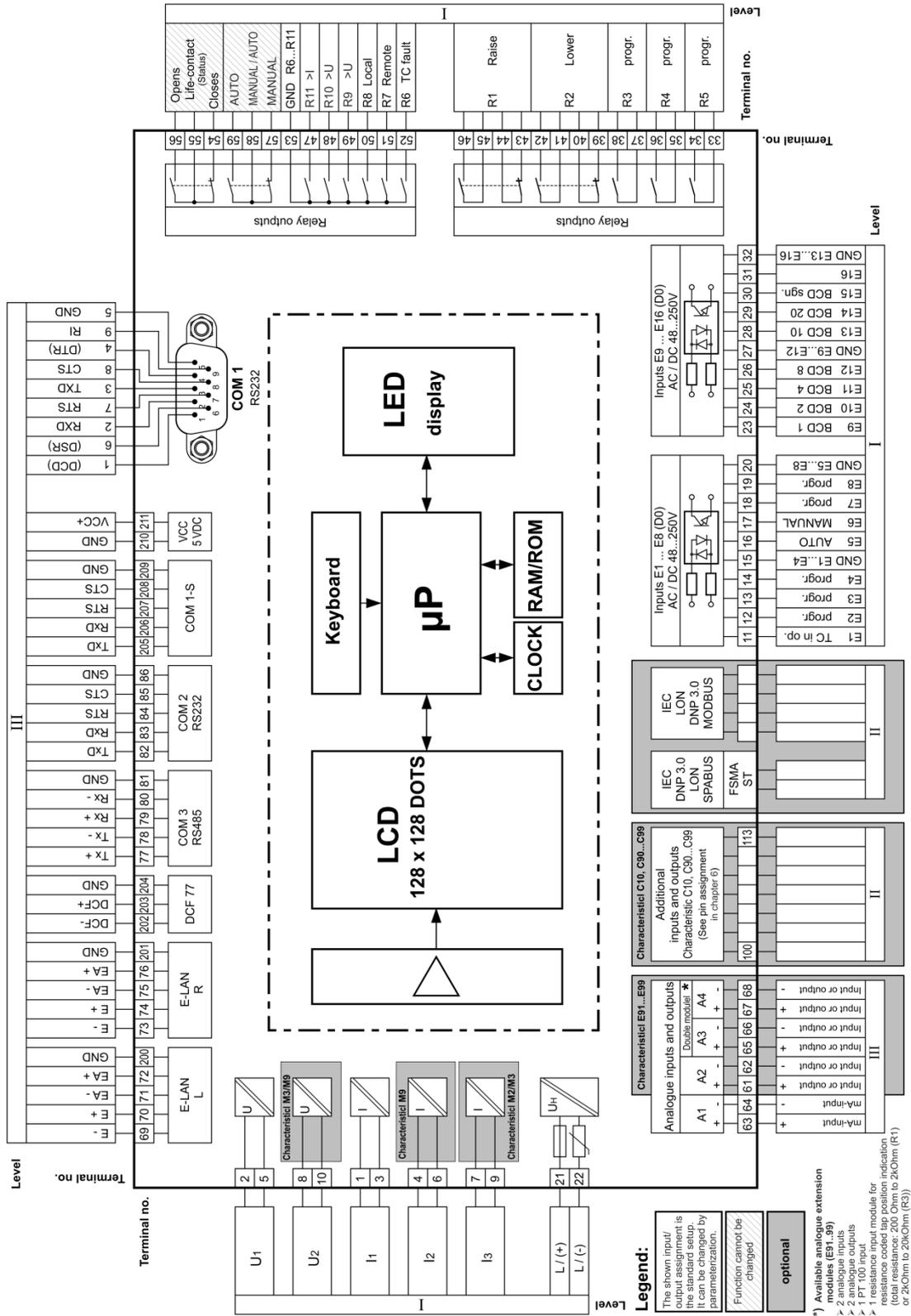
*) The dual module comes as a dual mA input module or a dual mA output module. The position is occupied by a PT100 module if the temperature is to be recorded directly.

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.

REGSys™ - Overview
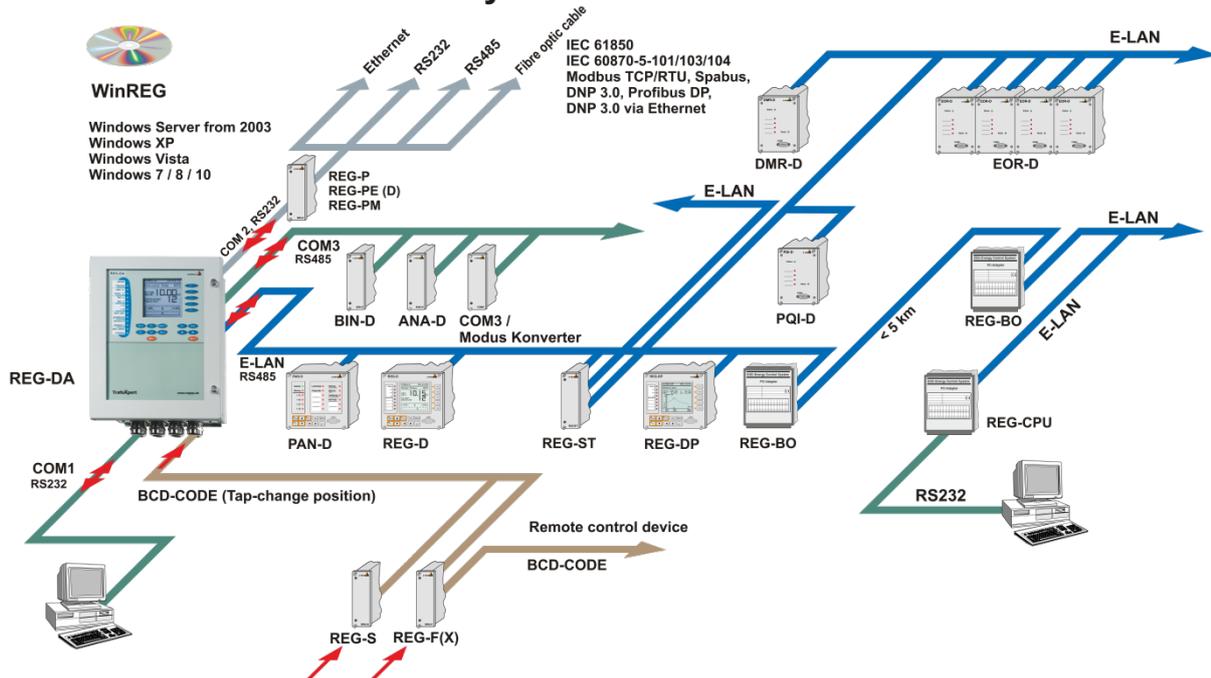
Interfaces and software

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.

Serial interfaces

The REG-DA has two RS232 serial interfaces with three connections (COM1, COM1-S, 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. 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	Terminal connection at Level III
COM2	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
HANDSHAKE	RTS / CTS, XON / XOFF, delay, none

ELAN (Energy - Local Area Network)

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 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 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.

Time synchronisation input is not supported until firmware version 2.22.

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.

WinREG runs on the following operating systems:
Windows XP, Vista, Windows 7 / 8 / 10
Windows Server from 2003 onwards

All 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.

REG-DA Parameters (selection)

Parameter	Setting range
Permissible voltage deviation	± 0.1 ... 10 %
Time factor	0.1 ... 30
Setpoint value 1..2	60.0 ... 140.0 V
Setpoint value 3..4	60.0 ... 140.0 V or -140 ... 140% 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 ... ± 30 Ω X : 0 ... ± 30 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

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.

Order specifications

- Only one code of the same capital letter is possible
- When the capital letter is followed by number 9, further details are necessary
- The code can be omitted when the capital letter is followed by zero or one option is marked as standard
- X characteristics such as XE91 cannot be combined with all of the other characteristics. Please read the notes and explanations.

CHARACTERISTIC	CODE
REG-DA relay for voltage control • with dual ELAN interface COM2, COM3 and **one mA input channel,** for example, to measure the oil temperature or get the tap position via mA signal • with 16 binary inputs and 12 relay outputs plus a status output, and includes the parameterisation software WinREG to set parameters, program and view all regulator data and connection cables. **Note**: COM2 is only freely accessible when operated without SCADA interface.	REG-DA
Model • In-panel mounting or wall mounting (H x W x D) 307 x 250 x 102 mm including flange plate with brush element • with DIN rail adapter	B0 B1
Serial interface COM1 • RS232 with SUB-D connector (9-pin male), standard if characteristic I is not specified • USB	I0 I1
Power supply • external AC 85 V ... 110V ... 264 V / DC 88 V ... 220V ... 280V • external DC 18 V ... 60V ... 72V	H0 H2
Input current (can be changed at a later stage) • I_{EN} 1A • I_{EN} 5A	F1 F2
Voltage and current measurement • Three-wire three-phase system with balanced load • Three-wire three-phase system with unbalanced load (ARON connection) • Voltage measurement (high voltage), current and voltage measurement (low voltage) • other transducer applications (2 x I, 2 x U, e.g. triple-wound)	M1 M2 M3 M9
Recorder function for network quantities incl. REGView evaluation software • without • with max. 3 channels • with max. 256 channels and 108 MB internal memory and upgraded CPU (better performance for e.g. the PLC functionality)	S0 S1 S2
Transformer monitoring • without • with transformer monitoring in accordance to IEC 60354 and IEC 60076 • additional calculation of the moisture in cellulose and the risk of bubble formation (TM+, Moisture Assessment Module) **Note:** The feature T2 is only available in combination with the features S2 and T1	T0 T1 T2
Parallel operation • without firmware for parallel operation • with firmware for parallel operation	K0 K1
additional analogue inputs and outputs • without • with one PT100 input • with two mA inputs • with two mA outputs • with one PT100 input and one mA output • with two mA inputs and one mA output • with three mA outputs • Tap potentiometer input total resistance 180 Ω ... 2 kΩ, min. 5 Ω/tap • Tap potentiometer input total resistance 2 kΩ ... 20 kΩ, min. 50 Ω/tap	E00 E91 E92 E93 E94 E95 E96 E97

CHARACTERISTIC	CODE
● other combinations of inputs and outputs	E98
	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
● 1 tap potentiometer input (total resistance 180 ... 2 kΩ) and 8 binary inputs AC/DC 48...250 V	D2
● 1 tap potentiometer input (total resistance >2 ... 20 kΩ) and 8 binary inputs AC/DC 10...50 V	D3
● 1 tap potentiometer input (total resistance 180 ... 2 kΩ) and 8 binary inputs AC/DC 10...50 V	D5
● 1 tap potentiometer input (total resistance >2 ... 20 kΩ) and 8 binary inputs AC/DC 48...250V	D6
● 1 tap potentiometer input (total resistance >2 ... 20k Ω) and 8 binary inputs AC/DC 80...250 V	D8
Level II: additional inputs and outputs as well as the standalone monitoring function PAN-A2	
● without	C00
● with 6 binary inputs AC/DC 48 V...250 V	C91
● with 12 binary inputs AC/DC 48 V...250 V	C92
● with 6 relay outputs	C93
● with 12 relay outputs	C94
● with 6 binary inputs and 6 relay outputs	C95
● with 2 analogue inputs	C96
● with 4 analogue inputs	C97
● with 2 analogue outputs	C98
● with 4 analogue outputs	C99
● with standalone monitoring function (PAN-A2)	C10
● other combinations 6 inputs, 6 outputs, 2 analogue inputs, 2 analogue outputs or PT100 input	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.	
COM3 interface	
● RS485 (standard, feature may be omitted)	R1
● 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 in conformity with: IEC61850, IEC 60870- 5-104, DNP 3.0 or MODBUS	
● without (continue with characteristic group 'L')	XW00
● IEC 60870-5-104/RJ 45 (continue with characteristic group 'G')	XW90
● IEC 60870-5-104 with fibre optic 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/RJ 45 (continue with characteristic group 'G')	XW91
● IEC 61850 with fibre optic with ST connection (continue with characteristic group 'G')	XW93
● IEC 61850 with fibre optic with LC connection (continue with characteristic group 'G')	XW93.1
● IEC 61850 with 2 x RJ45 connection (continue with characteristic group 'G')	XW94
● IEC 61850 with 2 x fibre optic with ST connection (continue with characteristic group 'G')	XW95
● IEC 61850 with 2 x fibre optic with LC connection (continue with characteristic group 'G')	XW95.1
● IEC 61850 with 1 x RJ45 and 1 x fibre optic with ST connection (continue with characteristic group 'G')	XW96
● IEC 61850 with 1 x RJ45 and 1 x fibre optic with 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 1 x RJ45 connection (continue with characteristic group 'G')	XW97
● DNP 3.0 over Ethernet with 2 x RJ45 connection (continue with characteristic group 'G')	XW94.1
● DNP 3.0 over Ethernet with 1 x fibre optic with ST connection (continue with characteristic group 'G')	XW98
● DNP 3.0 over Ethernet with 1 x fibre optic with LC connection (continue with characteristic group 'G')	XW98.1
● DNP 3.0 over Ethernet with 2 x fibre optic with ST connection (continue with characteristic group 'G')	XW95.2
● DNP 3.0 over Ethernet with 2 x fibre optic with LC connection (continue with characteristic group 'G')	XW95.5
● DNP 3.0 over Ethernet with 1 x RJ45 and 1 x fibre optic with ST connection (continue with characteristic group 'G')	XW96.4
	XW96.5

CHARACTERISTIC	CODE
● DNP 3.0 over Ethernet with 1 x RJ45 and 1 x fibre optic with LC connection (continue with characteristic group 'G') **Note**: Please specify the target SCADA system for connections in conformity with DNP 3.0.	XW94.2
● MODBUS TCP/IP with 2 x RJ45 connection (continue with code "G")	XW96.2
● MODBUS RTU with RS485 (and with 1x RJ45/1x FO) connection (continue with code "G")	XW91.2
● SPABUS/ RJ 45 (continue with code "Gx")	XW93.2
● SPABUS/ FO-ST-connection (continue with code "Gx")	XW93.3
● SPABUS/ FO-LC-connection (continue with code "Gx")	XW94.4
● SPABUS/ 2x RJ 45 (continue with code "Gx")	XW94.5
● SPABUS/ 1x RS485 with 2x RJ 45 (continue with code "Gx")	XW95.3
● SPABUS/ 2x FO-ST-connection (continue with code "Gx")	XW95.4
● SPABUS/ 2x FO-LC-connection (continue with code "Gx")	
● other SCADA protocols on demand	XW99
Integrated SCADA connection in conformity with: IEC 60870- 5-101/ ..-103,…DNP… ● without (continue with characteristic group 'G') ● to connect the REG-DA to a control centre ● to connect several systems to a control centre (REG-D/DA/DP etc.) **Note**: L9 can only be combined with characteristics Z15 to Z19 and Z91.	L0 L1 L9
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
Protocol ● IEC60870-5-103 for ABB	Z10
● IEC60870-5-103 for Areva	Z11
● 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 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	Z20
● LONMark (on request)	Z21
● Profibus-DP (always with V11!)	Z99
Operating instructions ● German	G1
● English	G2
● French	G3
● Spanish	G4
● Italian	G5
● Russian	G6
● Portuguese	G7
● Czech	G8
● other	G9

CHARACTERISTIC	CODE
Display language ● German ● English ● French ● Spanish ● Italian ● Russian ● Portuguese ● Czech ● Dutch ● Polish	A1 A2 A3 A4 A5 A6 A7 A8 A9 A10
Use of IEC 61850 GOOSE applications	GOOSE
IEC 61850 with bonding in broadcast mode (only available with two Ethernet ports)	Bonding
IEC 61850 with Parallel Redundancy protocol (PRP) V1 (only available with two Ethernet ports)	PRP
IEC 61850 with Rapid Spanning Tree Protocol (RSTP) (only available with two Ethernet ports)	RSTP
DCF simulation over NTP and ELAN extension over Ethernet (CSE) **Note:** Only in combination with XW94.x, XW95.x, XW96.x	DCF/ELAN

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:	
PC connection cable (zero-modem cable)	582.020B
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 ELAN-FO: RS485/FO (ELAN → FO or FO→ ELAN) FO-connector ST Note: 2 units required per line	111.9030.10
Interface ELAN-FO: RS485/FO (ELAN → FO or FO→ ELAN) FO-connector LC Note: 2 units required per line	111.9030.11
ELAN booster, Uh: DC 20..75 V, DIN rail housing 22.5 mm width, if necessary with power supply adapter H1 111.9030.36	111.9027.02
ELAN router, one outgoing circuit with booster, Uh: DC 20..75 V, DIN rail housing 22.5 mm width, if necessary with power supply adapter H1 111.9030.36	111.9027.03
Time synchronisation:	
Radio clock (DFC 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:	

REG-DA accessories	ID-No.
Develo MicroLink 56Ki analogue modem, table top device incl. 230 V AC power supply adapter	111.9030.02
Develo MicroLink 56Ki analogue modem, DIN-rail device incl. 230 V AC power supply adapter	111.9030.03
Industrial analogue modem that can be used as dial-up modem or dedicated line; (Uh: AC 20..260 V/DC 14 V..280 V) with DIN-rail adapter; can be used with the PC and the device!	111.9030.17
Insys industrial analogue modem that can be as a dedicated line; supply voltage DC: 10…60 V, can be used with the PC and the device!	111.9030.20
ISDN modem for DIN-rail mount; Uh: DC 10 … 60 V	111.9030.27
ISDN modem as table top device; incl. 230 V AC mains adapter	111.9030.37
GPRS modem (Insys) for DIN-rail mount; incl. magnet foot antenna and parameterisation software; Uh: DC 10 ..60 V	111.9030.29
Power supply:	
Phoenix power supply adaptor for DIN-hat rail mounting: In: AC 120 V...230 V, DC 90 … 250 V, Out: DC 24 V	111.9005.02
Power supply for DIN-rail mounting: In: AC 80 V...250 V; Out: DC 24 V	111.9030.31
Power supply for DIN-rail mounting: In: DC 18 V...60 V...72 V; Out: DC 24 V	111.9030.32
Power supply for ELAN router or booster: In: AC 100 to 240 V, Out: 24 V/1.3 A	111.9030.36
UPS HighCAP2403-1AC, In: 230 V AC Out: 24 V DC, max. 3 A, 1000 Joule (1 kW), DIN-Rail	111.9030.38
Additional input and output module:	
Analogue input module (2 inputs)	320.0004.00
Analogue output module (2 outputs)	320.0003
Input module for tap-potentiometer total resistance 180 ...2 kΩ, min. 5 Ω/tap	320.0002.01
Input module for tap-potentiometer total resistance 2 ...20 kΩ, min. 50 Ω/tap	320.0002.03
Input module for PT100 in conformity with DIN 43760 in three-wire circuit	320.0005.01
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 Windows programming user interface for WinREG
  − Analogue module with two inputs for the temperature transducer
  − Input for PT100 in a three-wire circuit in conformity with DIN 43760
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 ● Mountable on DIN-rail (120 x 75 x 27) mm with ext. 24 V power supply adapter	**Profi-DP**

General Add-ons	CODE
TCP/IP adapter	**REG-COM**
● 10 Mbit mountable on DIN rail with power supply adapter for Uh AC 230 V	A01
● 100 Mbit	A90
COM3 converter	**COM3-MOD**
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	
– AC 85…264 V, DC 88 … 280 V, DC 18 … 72 V	H1
– DC 18 … 72 V	H2
IRIG-DCF77 converter	**IRIG-DCF**
● AC 85 V … 110 V …264 V / DC 88 V … 220 V … 280 V	H1
● DC 18 V … 60 V … 72 V	H2
● as wall-mounting housing 20 HP	B2

20.2 List of parameters incl. factory settings

The following tables show the parameters of the REG-DA, the ranges and the according factory settings (not the settings after a master reset). The settings on delivery may deviate based on customer or order specific requirements. The settings given in the column Range can vary based on age or variant of the hard- and firmware. In the column Value your current settings or device configuration can be noted. Alternatively, it is possible to print the current settings in WinREG.

Basic values

No.	Parameter	Range	Step size	Default	Value
1	Permissible deviation	± 0.1 ... 10 %	±0.05 %	2.0 %	
2	Setpoint 1	60.0 ... 140.0 V	±0.1 V	100.0 V	
3	Setpoint 2	60.0 ... 140.0 V	±0.1 V	100.0 V	
4	Setpoint 3	60.0 ... 140.0 V or -140 ... 140 % at P-regulation	±0.1 V	100.0 V or 100%	
5	Setpoint 4	60.0 ... 140.0 V or -140 ... 140 % at Q-regulation	±0.1 V	100.0 V or 100%	
6	100% value of setpoint 1	60.0 ... 140.0 V	±0.1 V	100.0 V	
7	100% value of setpoint 2	60.0 ... 140.0 V	±0.1 V	100.0 V	
8	100% value of setpoint 3	60.0 ... 140.0 V	±0.1 V	100.0 V	
9	100% value of setpoint 4	60.0 ... 140.0 V	±0.1 V	100.0 V	
10	Time behaviour	ΔU*t = const REG 5A/E LINEAR CONST		ΔU*t = const	
11	Time factor	0.1 ... 30	0.1	1	
12	Time delay T1	1 ... 600s	1 s	1s	
13	Time delay T2	1 ... 600s	1 s	1s	
14	Trend memory	0 ... 60 s	1 s	0 s (OFF)	

Current influence

No.	Parameter	Range	Step size	Default	Value
15	Current influence	Apparent curr. Active current Reactive curr. LDC		none	
16	Gradient (I) (pos.)	0 … 400 V/In	0.1 V/In	0 V/In	
17	Gradient (I) (neg.)	0 … 400 V/In	0.1 V/In	0 V/In	
18	Limitation(I) (max.)	-40 … 40 V	0.1 V	0 V	
19	Limitation(I) (min.)	-40 … 40 V	0.1 V	0 V	
20	LDC resistance R	-30 … 30 Ω	±0.1 Ω	0 Ω	
21	LDC reactance X	-30 … 30 Ω	±0.1 Ω	0 Ω	

Parallel operation

No.	Parameter	Range	Default	Value
22	Parallel program	None dIsin(φ) dcos(φ) dIsin(φ)[S] Master-Follower MSI MSI2	None	
23	Parallel program activation	OFF ON LEVEL PULSE	OFF	
24	ParaGramer activation	0 … 10 Transf.	0	
25	Grouplist member 1	---, A:, A1:, … , Z4:	---	
26	Grouplist member 2	---, A:, A1:, … , Z4:	---	
27	Grouplist member 3	---, A:, A1:, … , Z4:	---	
28	Grouplist member 4	---, A:, A1:, … , Z4:	---	
29	Grouplist member 5	---, A:, A1:, … , Z4:	---	
30	Grouplist member 6	---, A:, A1:, … , Z4:	---	
31	Grouplist member 7	---, A:, A1:, … , Z4:	---	
32	Grouplist member 8	---, A:, A1:, … , Z4:	---	
33	Grouplist member 9	---, A:, A1:, … , Z4:	---	
34	Grouplist member 10	---, A:, A1:, … , Z4:	---	

No.	Parameter	Range	Default	Value
35	Permissible Icirc	0 … 9999 A	9999 A	
36	Max. tap difference	0 … 6	0, No super-vision	
37	cos (φ) net	0 … 1 ind/cap.	0	
38	Trafo nominal power	10 k … 9999 MVA	10 kVA	
39	Limitation dcos(φ)	0 … 20	20	
40	Manual/Auto Balance at M/F start	MasterPrio ManualPrio	MasterPrio	
41	Master-Follower: First ParErr after n*TC in operation time	0 … 15	4	

Limits

No.	Parameter	Range	Step size	Default	Value
42	Inhibit high	65 … 150 V	±0.1 V	125 V	
43	Fast backward switch-ing	0 … 35 %	±0.1 %	10.0 %	
44	Overvoltage	0 … 25 %	±0.1 %	10.0 %	
45	Undervoltage	-25 … 10 %	±0.1 %	-10.0 %	
46	Fast forward switching	-35 … 0 %	±0.1 %	-10.0 %	
47	Inhibit low	- 75 … 0 %	±0.1 %	- 25.0 %	
48	Overcurrent	0 … 210 %	±1 %	100.0 %	
49	Undercurrent	0 … 100 %	±1 %	0.0 %	
50	Threewinding limit >Ub	0 … 25 %	±0.1 %	5.0 %	
51	Delay inhibit high	0 … 999 s	±1 s	0 s	
52	Delay fast backward sw.	0 … 999 s	±1 s	0 s	
53	Delay overvoltage	0 … 999 s	±1 s	0 s	
54	Delay undervoltage	0 … 999 s	±1 s	0 s	
55	Delay fast forward sw.	0 … 999 s	±1 s	2 s	
56	Delay inhibit low	0 … 999 s	±1 s	0 s	
57	Delay over-/undercur-rent	0 … 999 s	±1 s	0 s	

Tapchanger

No.	Parameter	Range	Default	Value
58	Tap position (indication)	OFF ON	OFF	
59	Max. TC in operation time	3 … 40 s	5 s	
60	Tap 0 debounced longer (6s)	OFF ON	ON	
61	Tap limiter	OFF ON	ON	
62	Lower tap limit	- 63 … 63	0	
63	Upper tap limit	- 63 … 63	0	
64	Inverse tapchanger *	No Yes Yes with relay swap	No	

* Parameter selectable only via WinREG

Configuration

No.	Parameter	Range	Step size	Default	Value
65	Latch type (auto/manual latched after reset)	WITH WITHOUT		WITH	
66	Auto/manual switch	E5-A/E6-H E5-PULSE E5+6-PROG		E5-A/E6-H	
67	Current display	OFF ON		OFF	
68	LCD saver	OFF ON		OFF	
69	LCD contrast*	-15 … 15	±1	0	
70	Large display	OFF ON		OFF	
71	Auto locked on ELAN error	OFF ON		OFF	

No.	Parameter	Range	Step size	Default	Value
72	Configuration VT	L1L2 L2L3 L3L1 L1N L2N L3N ARON		L1L2	
73	VT factor 1 (KNU 1)	0.01 … 9000	0.01	1	
74	VT factor 2 (KNU 2)	0.01 … 9000	0.01	1	
75	Polarity VT 1 inverted	NO YES		NO	
76	Polarity VT 2 inverted	NO YES		NO	
77	Actual value correction VT*	-20 … 20 %	±0.1 %	0 %	
78	Configuration CT	L1 L2 L3 ARON OFF		L1	
79	Nominal current	1 / 5 A		Order code F	
80	CT factor 1 (KNI 1)	0.01 … 90000	0.01	1	
81	CT factor 2 (KNI 2)	0.01 … 90000	0.01	1	
82	Polarity CT 1 inverted	NO YES		YES	
83	Polarity CT 2 inverted	NO YES		NO	
84	Actual value correction CT*	-20 … 20 %	±0.1 %	0 %	

* Parameter can be set only at the REG-DA itself, not in WinREG.

Functions

No.	Parameter	Range	Default	Value
85	Creeping net breakdown	OFF PRIM SEC	OFF	
86	Lock Time	Manual 1 min 3 min 5 min 10 min 15 min 20 min	15 min	
87	Time slice	15 … 120s, in 15 s steps	30 s	
88	Number of changes	2 … 6	2	
89	Limit base	Setpoint Un=100V Un=110V	Setpoint	
90	R/L relay: ON time	0.5 … 6 s	2,0 s	
91	Setpoint adjustment with <> keys	OFF 0.1 % 0.2 % 0.5 % 1.0 % 1.5 % 2.0 % PROG SPIndex	OFF	
92	Setpoint adjustment with binary inputs	0.1 % 0.2 % 0.5 % 1.0 % 1.5 % 2.0 %	1.0 %	
93	Block if <I or >I	OFF >I+<I >I <I	OFF	
94	Block highspeed switching	OFF ON	OFF	

No.	Parameter	Range	Default	Value
95	Language	German	Order code A	
		English		
		Spanish		
		Italian		
		French		
		Dutch		
		Czech		
		Russian		
		Polish		
		Portuguese		
96	Rolling Screens after *	0 … 10 min	0 (off)	
97	Time for Rolling Screens *	3 … 15 s	5 s	

* Parameter can be set only at the REG-DA itself, not in WinREG.

System

No.	Parameter	Range	Default	Value
98	Station ID (Address in E-LAN)	A:, A1:, … , Z4:	A:	
99	Name	8 Characters	REG-D	
100	Group*	8 Characters	REG	
101	COM1 Mode	ECL	ECL	
		ECLADR		
		PROFI		
		ELAN-L		
		ELAN-R		
		DCF77		
102	COM1 Baudrate	1200	115200	
		2400		
		4800		
		9600		
		19200		
		38400		
		57600		
		115200		
		230400 (S2)		
		460800 (S2)		
		921600 (S2)		
103	COM1 Parity	NONE (--)	NONE	
		EVEN		

No.	Parameter	Range	Default	Value
104	Handshake COM1	NONE (--) XON/XOFF RTS/CTS DELAY	RTS/CTS	
105	COM2 Mode	OFF ECL ECL+HP ECLADR PROFI ELAN-L ELAN-R DCF77	ECL	
106	COM2 Baudrate	1200 2400 4800 9600 19200 38400 57600 115200 230400 (S2) 460800 (S2) 921600 (S2)	9600, or dependent on the connected telecontrol card	
107	COM2 Parity	NONE (--) EVEN	None, or dependent on the connected telecontrol card	
108	COM2 Handshake	NONE (--) XON/XOFF RTS/CTS DELAY	XON/XOFF, or dependent on the con- nected telecontrol card	
109	ELAN left Mode	2- wire 4- wire	2-wire	
110	ELAN left Baudrate	15K6 31K2 62K5	62K5	

No.	Parameter	Range	Default	Value
		125K		
		375K		
111	ELAN left termination	ON OFF	ON	
112	ELAN right Mode	2- wire 4- wire	2-wire	
113	ELAN right Baudrate	15K6 31K2 62K5 125K 375K	62K5	
114	ELAN right termination	ON OFF	ON	

* Parameter selectable only via WinREG
(S2) only available with order code S2

Binary in-/outputs

No.	In-/Output	Range	Default		Value	
			Function	Inverted	Function	Invert.
115	Binary input 1	Input functions	TC.i.OP	No		
116	Binary input 2		OFF	No		
117	Binary input 3		OFF	No		
118	Binary input 4		OFF	No		
119	Binary input 5		[AUTO]	No		
120	Binary input 6		[MANUAL]	No		
121	Binary input 7		OFF	No		
122	Binary input 8		OFF	No		
123	Binary input 9		BCD1	No		
124	Binary input 10		BCD2	No		
125	Binary input 11		BCD4	No		
126	Binary input 12		BCD8	No		
127	Binary input 13		BCD10	No		
128	Binary input 14		BCD20	No		
129	Binary input 15		BCDminus	No		
130	Binary input 16		OFF	No		
131	Binary input 17		OFF	No		

No.	In-/Output	Range	Default		Value	
			Function	**Inverted**	**Function**	**Invert.**
132	Binary input 18		OFF	No		
133	Binary input 19		OFF	No		
134	Binary input 20		OFF	No		
135	Binary input 21		OFF	No		
136	Binary input 22		OFF	No		
137	Binary input 23		OFF	No		
138	Binary input 24		OFF	No		
139	Binary input 25		OFF	No		
140	Binary input 26		OFF	No		
141	Binary input 27		OFF	No		
142	Binary input 28		OFF	No		
143	Binary input 29		OFF	No		
144	Binary input 30		OFF	No		
145	Binary input 31		OFF	No		
146	Binary input 32		OFF	No		
147	Binary output 1		Raise	No		
148	Binary output 2		Lower	No		
149	Binary output 3		OFF	No		
150	Binary output 4		OFF	No		
151	Binary output 5		OFF	No		
152	Binary output 6		TC-Err	No		
153	Binary output 7		Remote	No		
154	Binary output 8		Local	No		
155	Binary output 9		>U	No		
156	Binary output 10	Relay functions	<U	No		
157	Binary output 11		>I	No		
158	Binary output 12		OFF	No		
159	Binary output 13		OFF	No		
160	Binary output 14		OFF	No		
161	Binary output 15		OFF	No		
162	Binary output 16		OFF	No		
163	Binary output 17		OFF	No		
164	Binary output 18		OFF	No		
165	Binary output 19		OFF	No		

No.	In-/Output	Range	Default		Value	
			Function	Inverted	Function	Invert.
166	Binary output 20		OFF	No		
167	Binary output 21		OFF	No		
168	Binary output 22		OFF	No		
169	Binary output 23		OFF	No		
170	LED 1		<U	No		
171	LED 2		>U	No		
172	LED 3		>I	No		
173	LED 4		OFF	No		
174	LED 5		OFF	No		
175	LED 6	LED functions	OFF	No		
176	LED 7		OFF	No		
177	LED 8		OFF	No		
178	LED 9		OFF	No		
179	LED 10		OFF	No		
180	LED 11		OFF	No		
181	LED 12		OFF	No		

Analog channels

No.	Parameter	Range	Default	Value		
				Channel 1	Channel 2	Channel 3
				Channel 4	Channel 5	Channel 6
182	Analog function	Analog functions see chapter 8.2.5	ANA			
183	Scaling (parameter selection)	ALL Fac+Off P0P2 P0P1P2 ModBus	P0P2			
184	Limitation at	None High Low High+Low	None			
185	Resolution	100 … 10000	2000			

No.	Parameter	Range	Default	Value		
				Channel 1	Channel 2	Channel 3
				Channel 4	Channel 5	Channel 6
186	Datapoint 0 X-Value (ModBus-Address if parameter selection = ModBus)	$-10^{12} \dots 10^{12}$	0			
187	Datapoint 0 Y-Value (standardised)	- 2 … 2	0			
188	Datapoint 1 X-Value (ModBus-function if parameter selection= ModBus)	$-10^{12} \dots 10^{12}$	20			
189	Datapoint 1 Y-Value (standardised)	- 2 … 2	1			
190	Datapoint 2 X-Value (ModBus-register ad-dress if parameter selection = ModBus)	$-10^{12} \dots 10^{12}$	20			
191	Setpoint 2 Y-Value (standardised)	- 2 … 2	1			
192	Analogue-Unit	8 characters	Depends on func-tion			
193	Decimal places	0 … 10	2			

SCADA/Time

No.	Parameter	Range	Default	Value
194	IP address	0.0.0.0 ... 255.255.255.255	0.0.0.0	
195	Subnetmask	0.0.0.0 ... 255.255.255.255	0.0.0.0	
196	Gateway	0.0.0.0 ... 255.255.255.255	0.0.0.0	
197	Daylight saving time settings (summertime rules)	See manual	Settings for CET	
198	UTC timezone	- 13.75 ... 13.75 h	0 h*	
199	Automatic DST switch	OFF ON	ON	

* setting depends on the country of delivery (deliveries for Germany -> 1h)

Logbook

No.	Parameter	Range	Default	Value
200	Relay events*	Logbook events see manual	all OFF	
201	Input events*		all OFF	
202	LED events*		all OFF	
203	System events*		all ON	

* Parameter selectable only via WinREG

E/A Extensions (COM3), Assignment of ANA-Ds and BIN-Ds

No.	Parameter	Range	Default	Value
204	Number of analog channels	0, 7 … 32*	0 6 default channels	
205	Number of entries	0, 17 … 64*	0 32 default in-puts	
206	Number of relays	0, 10 … 64*	0 11 default re-lays	
207	Assignment of analog chan-nels**	0.00 … 15.08	0.00	
208	Assignment of inputs**	0.00 … 15.16	0.00	
209	Assignment of relays**	0.00 … 15.08	0.00	

* with order code S2: analog channels 0, 7 … 64, binary inputs 0, 7 … 64, relays 0, 7 … 64
** Value = „Address of ANA/BIN-D.Channel on ANA/BIN-D"; E.g. The binary input 1 of a BIN-D with address 0 shall be assigned to binary input 17. The assignment will be: Channel 17 of the binary inputs = 0.01

Recorder (order code S1)

No.	Parameter	Range	Default	Value
210	Number of channels	Ch 1 Ch 1+2 Ch 1+2+3	Ch 1	
211	Assignment of channel 1		U	
212	Assignment of channel 2	See manual	I	
213	Assignment of channel 3		PHI	
214	Absolute deviation channel 1	$0 … 10^{12}$	0	
215	Absolute deviation channel 2	$0 … 10^{12}$	0	
216	Absolute deviation channel 3	$0 … 10^{12}$	0	
217	Step size channel 1	0.001 0.01 0.1 1 10 100 1000	0.1, can vary with the selected measurand	

No.	Parameter	Range	Default	Value
218	Step size channel 2	0.001 0.01 0.1 1 10 100 1000	0.1, can vary with the selected measurand	
219	Step size channel 3	0.001 0.01 0.1 1 10 100 1000	0.1, can vary with the selected measurand	
220	Scan width	1 … 60 s	1 s	
221	Dual display	OFF ON	OFF	
222	MMU display	OFF ON	OFF	
223	Grid display	OFF ON	ON	
224	Dt Scroll	1 Pixel 1-Div. 3-Div. 5-Div. 1min 1h 24h	1 Pixel	
225	Time resolution dt	14 s 1 Min 2 Min 5 Min 10 Min	14 s	

Software Features

No.	Feature	Range	Default	Value
226	991101	0; 1	0	
227	3winding	0 … 63	Order code M9 + 3winding	
228	4Setpoints (nur bis FW 1.99)	0; 1	Order code	
229	Adapt	0; 1	0	
230	BBN4.4.3	0; 1	0	
231	Bootload	0; 1	0	
232	COM2FIX	0 … 255	Depends on SCADA card	
233	Crosslink	0; 1; 2; 3	0	
234	DELTAI	0; 1	0	
235	EMHAGEN	0; 1	0	
236	EnBW	0; 1; 2; 3	0	
237	ESB	0; 1	0	
238	HVLVControl	0; 1	0	
239	Invers	0; 1; 2	0	
240	LEW	0; 1	0	
241	LocalRemote	0; 1; 2	Order code Y	
242	M2	0; 1; 2	Order code M	
243	MISWAP	0 … 255	0	
244	NLK	0; 1	0	
245	ParaGramer	0; 1	Order code K + ParaGramer	
246	PG_SCHEME_1	0; 1	0	
247	PQCtrl	0; 1	0	
248	PrimCtrl	0; 1	0	
249	Qsigned	0; 1	0	
250	Recorder	0; 1	Order code S	
251	Ringlink	0; 1; 2; 3	0	
252	SimMode	0; 1; 2	1	
253	SR192	0; 1; 2	0	
254	SYSCTRL	0 … 255	64	
255	SYSCTRL2	0 … 255	0	

No.	Feature	Range	Default	Value
256	TM	0; 1	Order code TM	
257	ULC	0; 1	0	
258	VEW	0; 1	0	

Background program and UDM (UserDefineableMenu)

No.	Resource	used program
259	Background program	.rgl
260	UDM (only with order code S2)	.udm

20.3   REG-DA Menu structure

[MENU 1]
- [REGULATOR]
- [TRANSDUCER MODE]
- [RECORDER]
- [STATISTIK/MONITOR]
- [PARAGRAMER]

[MENU 2]
- [PQIView]
- [LOGBOOK]

[SETUP]
- [SETUP--1--]
- [SETUP--2--]
- [SETUP--3--]
- [SETUP--4--
  Time until]
- [SETUP--5--]
- [SETUP--6--]
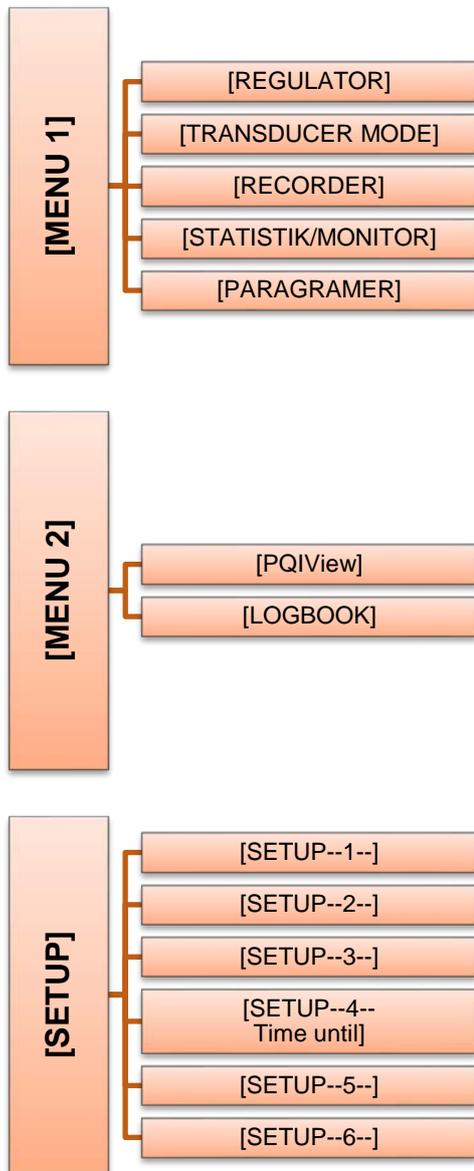
20.3.1 Menu 1

20.3.1.1 Regulator

```
                    ┌─────────────────────────────────────┐
                    │  Key Menu - Menu Application*        │
                    ├─────────────────────────────────────┤
                    │  Key F1 - Normal display            │
                    ├─────────────────────────────────────┤
                    │  Key F1 - Large display             │
  [REGULATOR]       ├─────────────────────────────────────┤
                    │  Key F2 - Transducer                │
                    ├─────────────────────────────────────┤
                    │  Key F3 - Recorder                  │
                    ├─────────────────────────────────────┤
                    │  Key F4 - Statistics                │
                    ├─────────────────────────────────────┤
                    │  Key F5 - Lamp test                 │
                    └─────────────────────────────────────┘
```
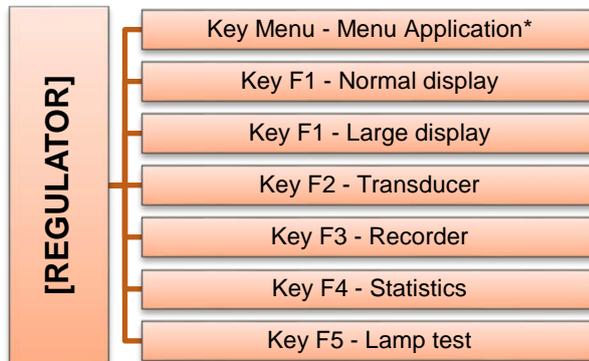
* if available

20.3.1.2 Transducer

```
                    ┌─────────────────────────────────────┐
                    │  Key F1 - Regulatorr                │
                    ├─────────────────────────────────────┤
                    │  Key F2 - Transducer 3W             │
                    ├─────────────────────────────────────┤
  [TRANSDUCER]      │  Key F2 - Transducer 1              │
                    ├─────────────────────────────────────┤
                    │  Key F2 - Transducer ARON           │
                    ├─────────────────────────────────────┤
                    │  Key F2 - Transducer 2              │
                    ├─────────────────────────────────────┤
                    │  Key Menu - Application*            │
                    └─────────────────────────────────────┘
```
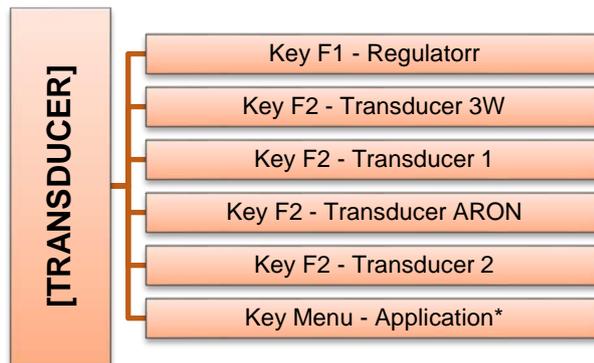
* if available

20.3.1.3 Recorder

```
                    ┌─────────────────────────────────────┐
                    │  Key F3 - Setup                     │
  [SCHREIBER]       ├─────────────────────────────────────┤
                    │  Key Menu - Application*            │
                    └─────────────────────────────────────┘
```

* if available

20.3.1.4 ParaGramer

```
[PARAGRAMER]
    ├── Key F1 - ParaGramer Functions*
    ├── Key F2 - Information i
    └── Key F5 - Overview
```
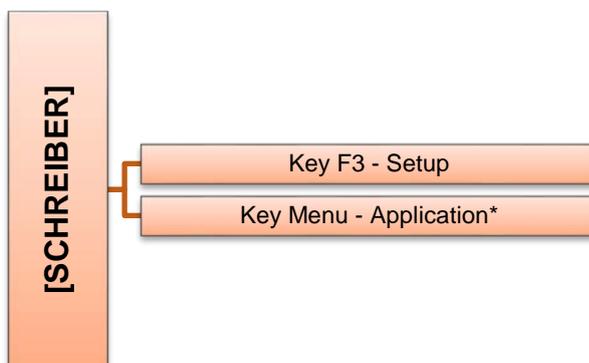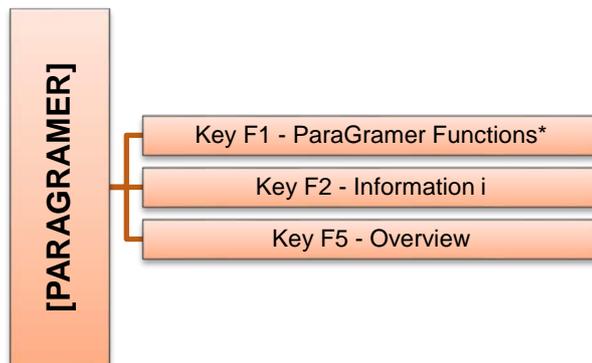
* e.g. MSI-selection i

20.3.1.5 Statistik / Monitor

without Transformator Monitoring (Code TM = 0)

```
[STATISTIK]
    ├── Key F1 - Regulator
    ├── Key F2 - Transducer
    ├── Key F3 - Recorder
    ├── Key F5 - Lamp test
    └── Key Menu - Menu Application*
```

* if available

with Transformator Monitoring (Code TM = 1)

```
[STATISTICS]
    ├── Key F1 - Monitor
    ├── Key F2 - Service life
    ├── Key F3 - Statistics
    └── Key F5 - Setup Transformer Monitoring
```

* if available

20.3.2 Menu 2

20.3.2.1 PQIView

[PQIView]
- Key F1 - Device selectionl
- Key F2 ... F5 - scroll
- Key Menü - Menu Application*

* if available

20.3.2.2 Logbuch

[LOGBOOK]
- Key Menü - Menu Application*

* if available

20.3.3   Setup

20.3.3.1   Setup 1

```
[Setup 1]
├── [Tolerance Band] ──────────┐
│                              └── [                    ]
├── [time Behaviour]
│   ├── [Time Program]
│   ├── [Time Factor]
│   └── [Trend Memory]
├── [Setpoint Values]
│   ├── [Index..]
│   ├── [1.Setpoint Value]
│   ├── [2.Setpoint Value]
│   ├── [3.Setpoint Value]
│   └── [4.Setpoint Value]
└── [Programs..]
    ├── [Par.Parameter]
    │   (Parameter depending on
    │   the actual parallel
    │   program)
    │   ├── [Permiss.Icirc]
    │   ├── [Icirc-Superv.]
    │   ├── [Limitation]
    │   ├── [Net-cosφ]
    │   ├── [Transf. Nominal Power]
    │   └── [Group List]
    ├── [ParallelProgramm] ────┐
    │                          └── [                    ]
    └── [Current Influence]
```

20.3.3.2 Setup 2

```
                ┌─────[Gradient (I)]─────────[pos/neg]
                │
                ├─────[Limitation (I)]───────[max/min]
                │
   [Setup 2]────┼─────[<U Undervoltage]
                │
                ├─────[>U Overvoltage]
                │
                └─────[>I, <I Current Limits]───[..<I] & [..>I]
```

20.3.3.3 Setup 3

```
                ┌─────[Dreiwickler Limit >Ub]
                │
                ├─────[Inhibit High]
   [Setup 3]────┤
                ├─────[High-Speed Switching]───[Fwd/Bwd]
                │
                └─────[Inhibit Low]
```

20.3.3.4 Setup 4

```
                          ┌─────[<U, >U]─────────[..>U] & [..<U]
                          │
                          ├─────[<I, >I]
   [Setup 4]              │
   Time until..───────────┼─────[Inhibit High]
                          │
                          ├─────[High-Speed Switching]───[Fwd/Bwd]
                          │
                          └─────[Inhibit Low]
```

20.3.3.5　Setup 5

```
[Setup 5]
├── [AddOns..]
│   ├── [AddOns-1]
│   │   ├── [Maximum Time TC in Operation]
│   │   ├── [Manual (H) / Automatic]
│   │   ├── [Tap Position Indication]
│   │   └── [Self-conduct]
│   ├── [AddOns-2]
│   │   ├── [Current Display]
│   │   ├── [LCD Saver]
│   │   ├── [Regulator-Mode Large Display]
│   │   └── [Language]
│   ├── [AddOns-3]
│   │   ├── [Up/Down Relay ON Time]
│   │   ├── [MANUAL locked if ELAN-Error]
│   │   ├── [Block high-speed Switching]
│   │   └── [Dreiwickler Activation] (dep. on feature Dreiwickler)
│   ├── [AddOns-4]
│   │   ├── [Creeping Net Breakdown]
│   │   ├── [Lock Time]
│   │   ├── [Time Slice]
│   │   └── [Number of Changes]
│   ├── [AddOns-5]
│   │   ├── [Limit Base]
│   │   ├── [Block if <I or >I]
│   │   ├── [RollingScreens after]
│   │   └── [Time of RollingScreens]
│   ├── [AddOns-6]
│   │   ├── [Setpoint Adjustment with ←–→ Keys]
│   │   ├── [Setpoint Adjustment with Inputs]
│   │   └── [PARAGRAMER Activation]
│   ├── [AddOns-7]
│   │   ├── [Parallel Prog. Activation]
│   │   ├── [1. ParErr after n*TCinOperation] (dep. on parallel prog.)
│   │   ├── [Permissible Dif. of Taps] (dep. on parallel prog.)
│   │   └── [Manu/Auto Balance at M/F Start]
│   └── [AddOns-8]
│       ├── [Tap Limiter]
│       ├── [Highest Tap Position]
│       ├── [Lowest Tap Position]
│       └── [Tap Position 0 longer (6s) debounced]
├── [CT/VT Config..]
│   ├── [Transformer Mounting VOLTAGE]
│   └── [Transformer Mounting CURRENT]
├── [Input Assignments]
├── [Relay Assignments]
└── [LED  Assignments]
```

20.3.3.6 Setup 6

```
[Setup 6]
├── [General]
│   ├── [General 1] ──── [Analog..]
│   ├── [General 2] ──┬── [Station ID]
│   │                 ├── [Station Name]
│   │                 ├── [Time Setting]
│   │                 └── [LCD-Contrast]
│   ├── [General 3] ──┬── [Password]
│   │                 ├── [Erase Recorder Data]
│   │                 ├── [Erase Tap-Change Sums]
│   │                 └── [Actual Value Correction]
│   └── [General 4] ──┬── [IP-Adresse]
│                     ├── [IP-Netmask]
│                     └── [IP-Gateway]
├── [RS-232] ──┬── [COM-1]
│              └── [COM-2]
├── [E-LAN] ──┬── [E-LAN Left]
│             └── [E-LAN Right]
├── [PAN-D] (if available)
└── [Status] ──┬── [REG-D Status (1)]
               ├── [REG-D Status (2)]
               ├── [COM-Status]
               ├── [LAN-Status]
               ├── [COM-3 Status]
               ├── [Time/Date]
               ├── [H/P/Q Programs]
               └── [Error Status]
```

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