User Manual

LVRSys™ - 3-phase / 1-phase Systems

Low-Voltage-Regulation-System™

Outdoor Al

Outdoor GRP

Pole mounted

Indoor

Systems of the series: 180.1000.2xxx

Content

1. User guidance

This User Manual is a summary of the information needed for the installation, commissioning and operation of the low-voltage regulator.

Read the User Manual in its entirety and do not use the product unless you have understood the User Manual.

1.1 Target group

The User Manual is intended for skilled technicians as well trained and certified operators.

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 of non-compliance. Actions to avoid the danger.

Types of warnings

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

⚠ **DANGER!**	Warns of imminent danger that can result in death or serious injuries if 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 minor injuries when not avoided.
NOTICE:	Warns of a potentially dangerous situation that if not avoided could result in material or environmental damage.

1.3 Tips

Tips on the appropriate device use 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:

0 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 product, observe the additional documentation that is delivered with the system as well as the relevant standards and laws.

1.6 Keeping

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

2. Scope of Delivery/Options (PL1.9)

The LVRSys systems are built up as modular systems. The main components and documents are:

- LVRSys™ control unit
- Transformer block
- Cabinet for out- or indoor installation or pole mount
- LVRSys™ user manual
- LVRSys™ mounting instructions
- Circuit diagram of the LVRSys™ control cabinet
- LVRSys™ test certificate

3. Configuration possibilities

The possibilities of how an LVRSys can be configured cab be found in the Configuration help LVRSys in correspondence with the sales partners:
https://www.a-eberle.de/en/contact/partners

4. Safety instructions

- Observe the operating instructions
- Always keep the operating instructions with the unit.
- Make sure that the device is never operated in a damaged or compromised condition.
- Make sure that only specialized personnel operate the unit.
- The device must be connected according to the manufacturer's installation instructions.
- Make sure that the device is never operated beyond its stated ratings (refer chapter 5, Technical Data)
- Do not operate the unit in any hazardous environment where explosive gases, dust or fumes occur.
- Ensure that protective covers are always in place and are functional
- Ensure that the five safety regulations according to DIN VDE 0105 are always observed.
- Clean the appliance only with commercially available detergents.

5. Technical Data

Rated data		
Rated voltage U_N	400 V / 230 V ±20 % (L-L/LE) 230 V / 133 V ±20 % (L-L/LE)	
Rated current I_N	**3-phase (400 V L-L)** 32 A (22 kVA System) 63 A (44 kVA System) 100 A (70 kVA System) 160 A (110 kVA System) 200 A (144 kVA System) 250 A (175 kVA System) 290 A (200 kVA System) 355 A (250 kVA System) 577 A (400 kVA System) 910 A (630 kVA System) 1005 A (696 kVA System) **1-phase (230 V L-N)** 32 A (7,5 kVA System) 63 A (15 kVA System) 100 A (25 kVA System) 160 A (35 kVA System)	**3-phase (230 V L-L)** 32 A (13 kVA System) 63 A (26 kVA System) 100 A (41 kVA System) 160 A (64 kVA System) 200 A (84 kVA System) 250 A (101 kVA System) 290 A (116 kVA System) 355 A (145 kVA System) 577 A (231 kVA System) 910 A (364 kVA System) 1005 A (400 kVA System)
Rated frequency f_N	50 Hz / 60 Hz	
Efficiency	99.4 % – 99.8 %	
Maximum regulation time	30 ms	
Regulation area	± 6 % from U_N in 9 steps á 1.5 % ± 8 % from U_N in 9 steps á 2.0 % ± 10 % from U_N in 9 steps á 2.5 % up to ± 24 % from U_N (special design)	
Ambient temperature	- 40 °C to + 40 °C (to + 50 °C special design)	
Maximum permissible air temperature in the cabinet	70 °C	
Height of installation (NN)	< 2000 m	
Protection class	IP44- IP55/ electronic IP 66	
Maximum current consumption secondary electronics	200 mA (230 V)	
Short-circuit impedance u_k	ca. 0,3 %	
Cooling	Passive (Convection via cabinet housing)	

Limits		
Rated impulse voltage U_{Imp}	6 kV	
Rated short-time current resistance I_{cw} (1 s)	5 kA (till 160 A) 15 kA (200 A till 1005 A)	
Conditional rated short-circuit current I_{cc}	20 kA (to 160 A) 50 kA (200 A till 1005 A)	
Rated short-circuit current I_{cf} protected by fuse	3 kA (32 A) 5 kA (63 A) 10 kA (100 A) 14 kA (160 A) 16 kA (200 A)	20k A (250 A) 30 kA (355 A) 50 kA (580 A) 50 kA (910 A) 50 kA (1005 A)
Rated impulse current resistance I_{pk}	20 kA (to 160 A) 50 kA (200 to 1005 A)	

Dimensions and weight			
Dimensions cabinet B/T/H ***Aluminium cabinet***	80 cm/40 cm/135 cm	32 A – 100 A	B11
	120 cm/40 cm/135 cm	32 A – 355 A 8 %	B12
	140 cm/50 cm/145 cm	32 A – 580 A	B13
	160 cm/50 cm/155 cm	32 A – 910 A	B14
GRP – Cabinet	113 cm/32 cm/113 cm	32 A – 160 A	B41
	146 cm/32 cm/113 cm	32 A – 355 A 8 %	B42
Indoor cabinet	60 cm/60 cm/160 cm	32 A – 160 A	B21
	90 cm/60 cm/200 cm	200 A – 580 A	B22
Pole mounted 3-phase	80 cm/30 cm/120 cm	32 A – 100 A	PM
Weight cabinet ***Aluminium cabinet***	120 kg	32 A – 100 A	B11
	165 kg	32 A – 355 A 8 %	B12
	220 kg	32 A – 580 A	B13
	250 kg	32 A – 910 A	B14
GRP – Cabinet	100 kg	32 A – 160 A	B41
	155 kg	32 A – 355 A 8 %	B42
Indoor cabinet t	150 kg – 200 kg	32 A – 160 A	B21
	300 kg – 700 kg	200 A – 580 A	B22
Pole mounted 3-phase	110 kg – 130 kg	32 A – 100 A	PM
Pole mounted 1-phase	40 kg – 60 kg	32 A – 160 A	PM
Measurement base B/T/H ***Concrete base***	80 cm/40 cm/100 cm	32 A – 100 A	C11
	120 cm/40 cm/100 cm	32 A – 355 A 8 %	C12
	140 cm/50 cm/100 cm	32 A – 580 A	C13

	160 cm/50 cm/100 cm	32 A – 910 A	C14
GRP - Base	113 cm/32 cm/90 cm	32 A – 160 A	C41
	146 cm/32 cm/90 cm	32 A – 355 A 8 %	C42
Steel base indoor (pre-assembled)	60 cm/60 cm/20 cm	32 A – 160 A	C21
	90 cm/60 cm/20 cm	200 A – 580 A	C22
Weight base	200 kg	32 A – 100 A	C11
Concrete base	260 kg	32 A – 355 A 8 %	C12
	280 kg	32 A – 580 A	C13
	300 kg	32 A – 910 A	C14
GRP – base	30 kg	32 A – 160 A	C41
	40 kg	32 A – 355 A 8 %	C42
Steel base indoor (pre-assembled)	5 kg	32 A – 160 A	C21
	10 kg	200 A – 580 A	C22
Measurement transformer block B/T/H – 3-phase	40 cm/20 cm/ 85 cm	32 A – 160 A	
	50 cm/22 cm/ 85 cm	200 A – 355 A 8 %	
	70 cm/30 cm/ 95 cm	355 A 10 % – 580 A	
	70 cm/39 cm/105 cm	910 A	
Weight transformer block – 3-phase	110 - 125 kg (32 A)	290 - 330 kg (175 kVA)	
	125 - 135 kg (63 A)	315 - 370 kg (355 A)	
	130 - 190 kg (100 A)	370 - 610 kg (580 A)	
	190 - 215 kg (160 A)	400 - 680 kg (910 A)	
	190 - 330 kg (200 A)		

Fulfilled guidelines	
EMC Immunity	DIN EN 61000-6-1
EMC emissions	DIN EN 61000-6-3
Installation instructions	DIN EN 61439-1/5
Low voltage directive	2014/35/EU
Noise emission	< 37 dB(A)
Integrated Power Quality – measurement	 *PQI-DA smart (showing connections)*

6. Intended use

This product is designed exclusively to regulate voltage at the low voltage level (400V L-L and special applications 230 V L-L).

7. Description and Principle of Operation

7.1 Principle of Operation

The LVRSys™ regulator concept is based on a linear regulator. By coupling and uncoupling two transformers with a selected transfer ratio, the output voltage can be regulated in several (e.g. 9) steps. This technique is also referred to as Buck/Boost transformers
The maximum control range depends on the model of LVRSys (e.g. from ±6% up to ±24%).

The switching of the transformers is controlled by thyristors. The regulation steps are determined by the thyristors' various switching settings.

Step	Transformer 1.5%	Transformer 4.5%
+6 %	+1,5 %	+4,5 %
+4,5 %	0 %	+4,5 %
+3 %	-1,5 %	+4,5 %
+1,5 %	+1,5 %	0 %
0 %	0 %	0 %
-1,5 %	-1,5 %	0 %
-3 %	+1,5 %	-4,5 %
-4,5 %	0 %	-4,5 %
-6 %	-1,5 %	-4,5 %

Table 7-1 Generation of the voltage levels in steps

The control signals for the thyristors are generated by driver circuits that switch them intelligently. By monitoring the magnetic flux in the transformers, the transformers can be switched without any voltage dips or current increases occurring or harmonics being generated.

The step change required is output by the controller. The controller can determine the step based on the bus bar voltage or the output currents.

All three phases are regulated independently of one another. This greatly helps improve the symmetry – balancing of the 3 phases of the LV Network.

In the event of a failure the safety contactor activates automatically. This ensures that the transformers are bridged out and as such the low-voltage grid will operate unregulated.

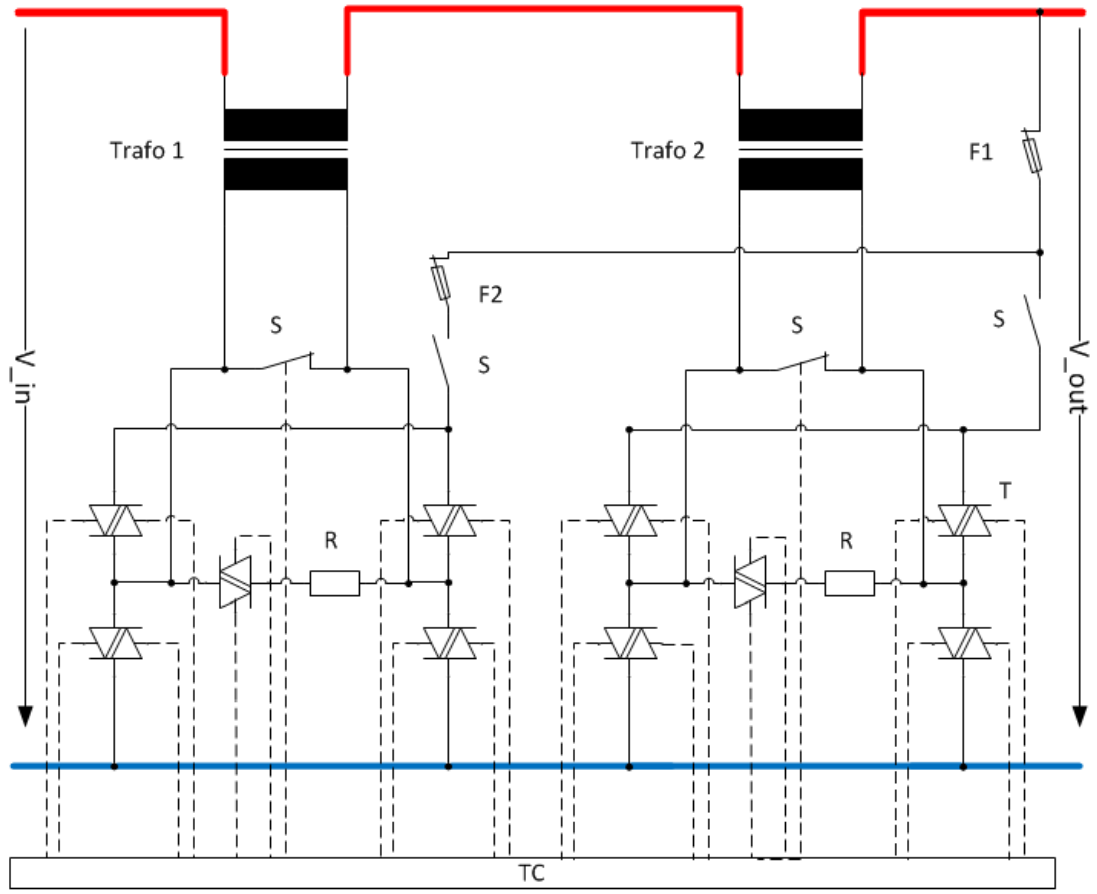


Figure 7-1 Single-phase functional diagram

Trafo 1	Additional transformer 1
Trafo 2	Additional transformer 2
F1, F2	Fuse
S	Safety contactor
R	Switching resistor
T	Thyristors
TC	Thyristors control
V_in	Unregulated input voltage
V_out	Regulated output voltage

Table 7-2 Explanation of the abbreviations

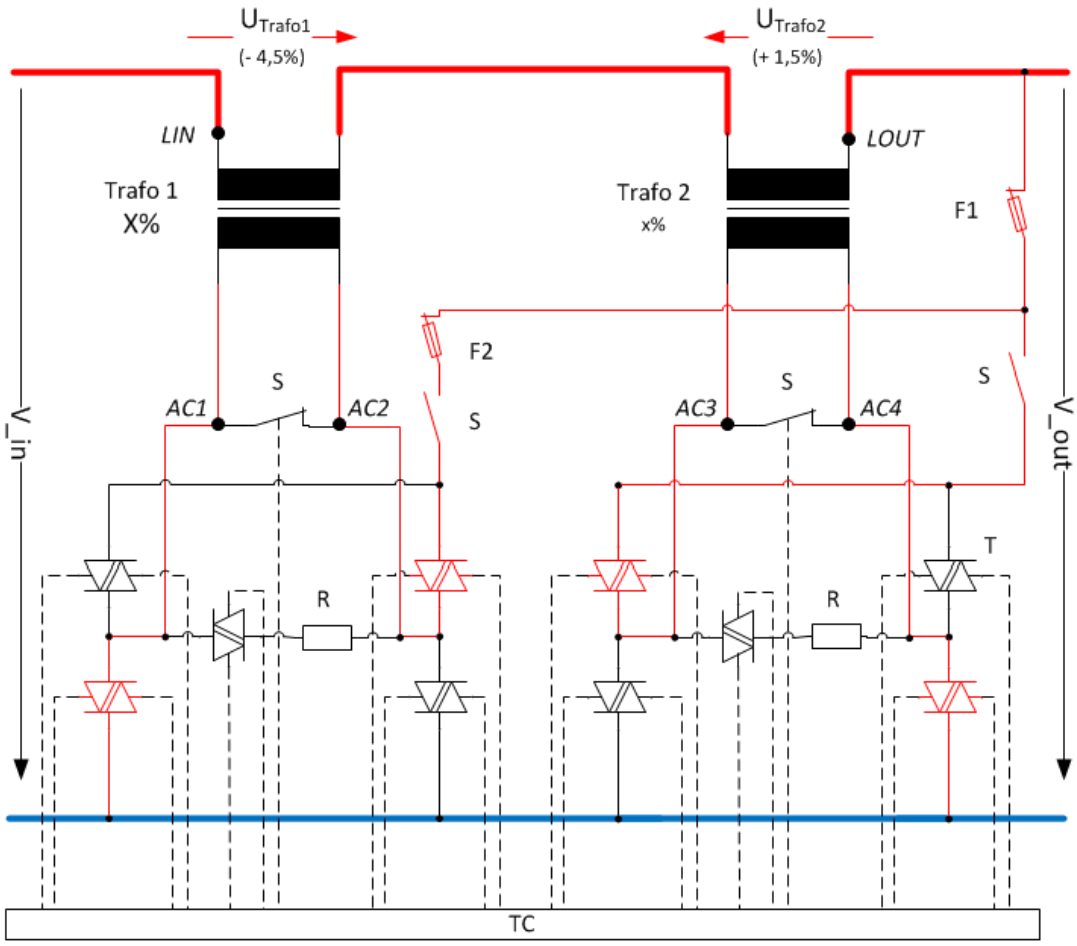


Figure 7-2 Example of 3% voltage reduction

In the example shown in Figure 7-2, the output voltage is reduced by 3% compared with the input voltage.

The transformer *Trafo 1 (-4.5%)* converts the primary voltage, which is switched by thyristors, in a negative direction and subtracts (bucks) 10.35 V (4.5% of 230 V) from the output voltage.

The transformer *Trafo 2 (+1.5%)* converts the primary voltage in a positive direction and adds (boosts) 3.45 V (1.5% of 230 V) to the output voltage.

7.2 Operating behaviour in the low-voltage grid

The low-voltage regulation systems are designed for a long, robust use in the low-voltage grid. In the following, grid scenarios are compared with the behaviour of the low voltage regulation systems.

Event	reaction LVRSys™
Short circuit Ph1	Fuse blow off Ph1 Automatic bypass activated for all phases Automatic restart of the controller after replacing the fuse
Short circuit Ph2/Ph3	Fuse blow off Ph2/Ph3 Automatic bypass activated for all phases. Automatic operation mode of the controller after replacing the fuse
Lightning strike All phases	Lightning protection activated Only after several lightning strikes releases lightning rod and separates the control system from the main voltage. Automatic restart of the controller after replacement of the lightning arrestor module
Voltage drop Phase 1	No reaction of the controller up to 100 V residual voltage. Below 100 V residual voltage, the controller goes into automatic bypass mode When the voltage returns, the controller automatically switches to operating mode
Voltage drop Phase 2/3	No reaction of the controller to 5% residual voltage. Below 5% residual voltage for> 20 ms, the controller goes into automatic bypass mode. After the voltage has returned to normal, the controller automatically switches to operating mode
Overvoltage Phase 1/2/3	No reaction of the controller up to 170% residual voltage. Over 170% residual voltage for> 30 ms, the controller goes into automatic bypass mode. After the voltage has returned to normal, the controller automatically switches to operating mode
Harmonics	harmonics have no influence on the controller The Controller has no influence on the harmonics.
Flicker	Flicker does not affect the controller The controller does not affect the ripple flicker values.
Ripple control signal	Ripple control signal has no influence on the controller Controller has no influence on ripple control signals

Figure 7-3 System reaction after events

7.3 Voltage drop with load

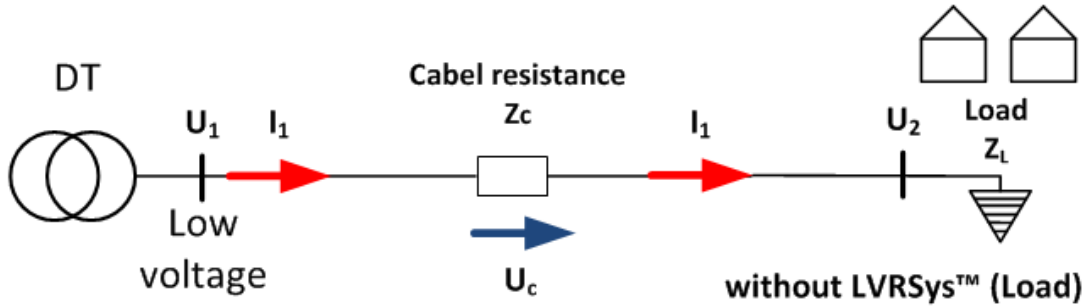


Figure 7-4 Low voltage grid with voltage drop along the cable

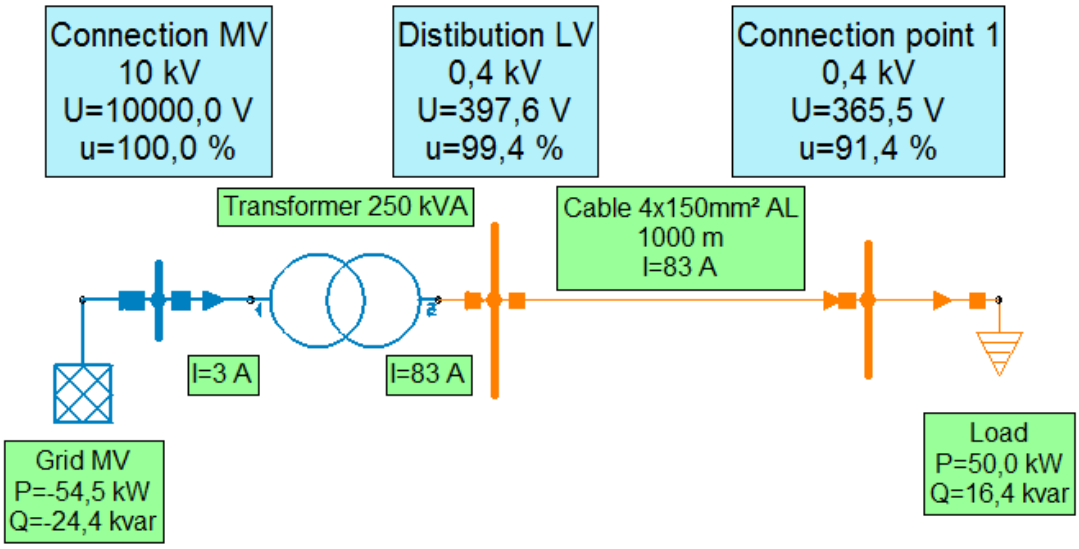


Figure 7-5 Low voltage grid with voltage drop along the cable (example)

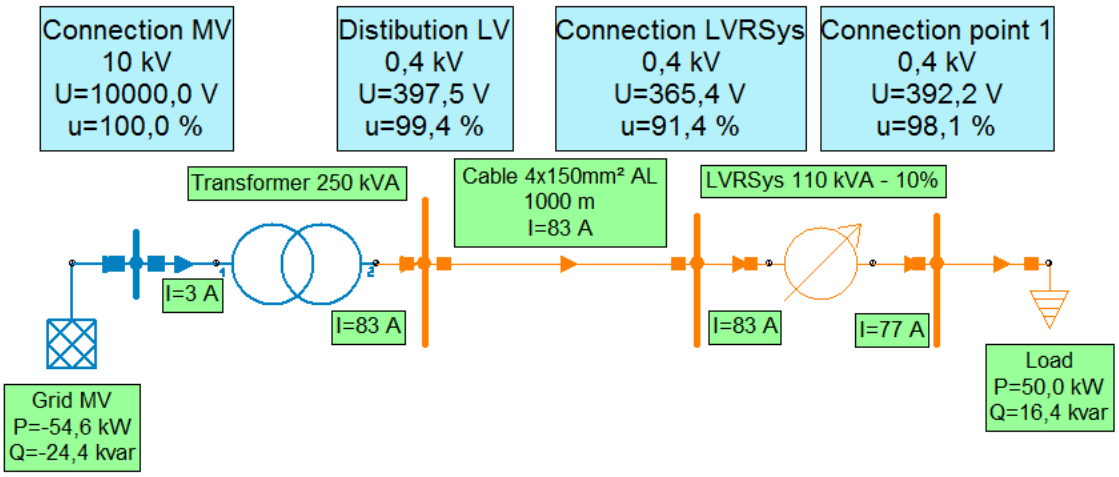


Figure 7-6 Low voltage grid with voltage drop along the cable regulated through LVRSys

[Simulation Screenshots made with Neplan®].

7.4 Voltage boost with generator (e. g. PV feeder)

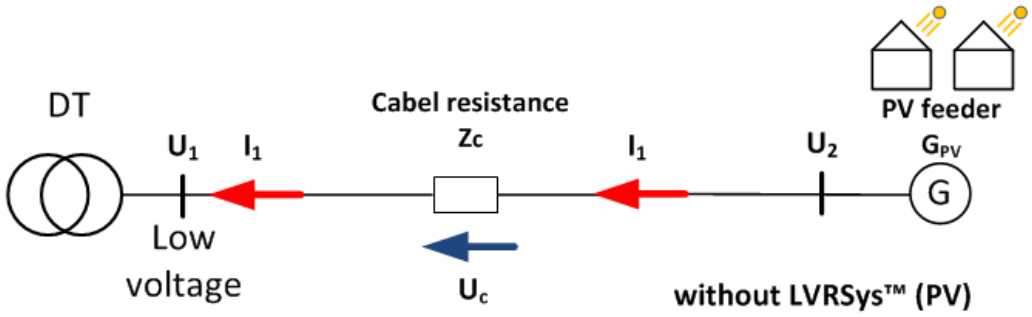


Figure 7-7 Low voltage grid with voltage boost along the cable

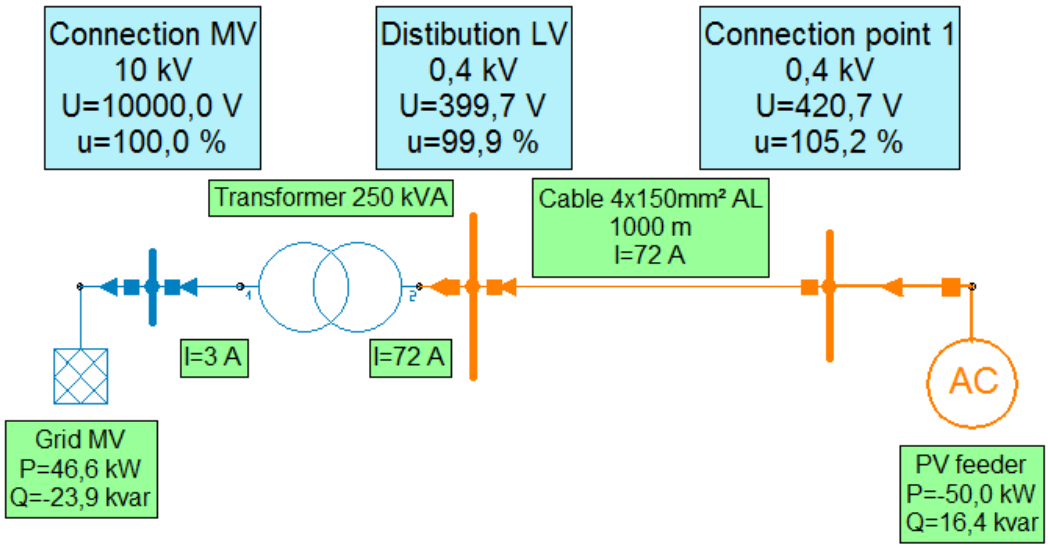


Figure 7-8 Low voltage grid with voltage boost along the cable (example)

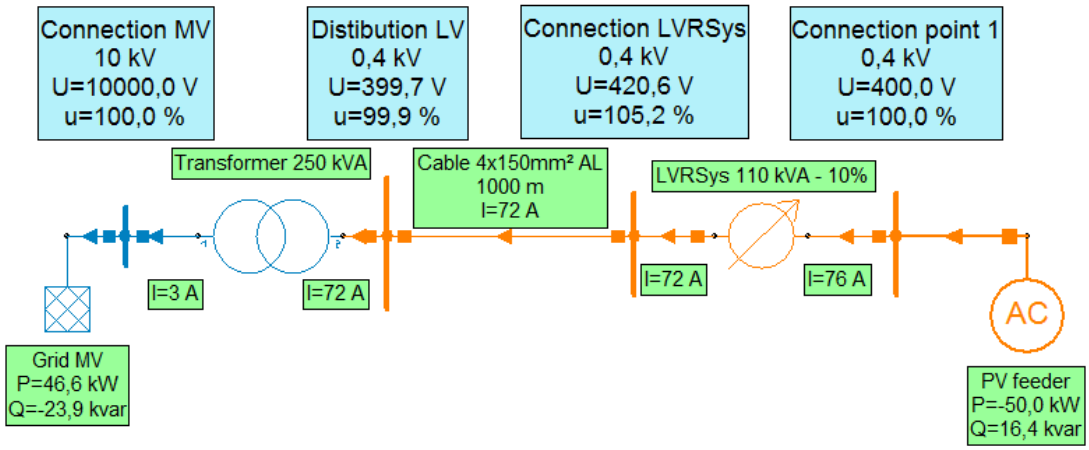


Figure 7-9 Low voltage grid with voltage boost along the cable regulated through LVRSys

[Simulation Screenshots made with Neplan®].

8. Commissioning and Decommissioning LVRSys™

8.1 Indicator lamps & system switch

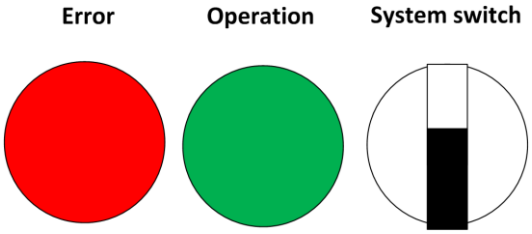


Figure 8-1 Indicator lamps and system switch

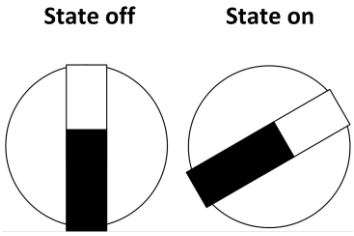


Figure 8-2 Switch position

8.2 Commissioning and decommissioning LVRSys™

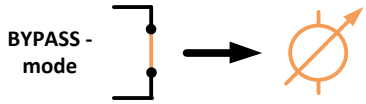
For operating the LVRSysIN, LVRSysOUT and BYPASS switching elements, observe chapter.
The starting position is:

- Closed BYPASS (F3).
- Opened input (F1 / *LVRSys-IN*).
- Opened output (F5 / *LVRSys-OUT*).
- The controller is in the *OFF* state.

⚠ DANGER!	**Danger of electric shock!**
	Ensure that the LVRSys™ is only operated and commissioned by qualified electricians or persons trained in electrical engineering in accordance with VDE 0105-100 or certified with respect to the local wiring and safety regulations applicable in your country. ➲ Never open NH-switch disconnectors/-isolators/circuit breakers partially ➲ Only operate the NH-switch disconnectors/-isolators/circuit breakers by using the handle

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Only switch the LVRSys™ ON or OFF according to the sequence of actions described below. ➲ Never use BYPASS-separation terminals while the system is in CONTROL - mode.

Commissioning LVRSys™



Sequence:

1. Close *LVRSys-IN*
(with knives/fuses).

2. Close *LVRSys-OUT*
(with knives/fuses).

3. Open *BYPASS*
(remove knives).

4. Set the system switch to the ON position.

↳ The regulator starts up automatically.
↳ LVRSys™ is active.
↳ The local network is regulated by the LVRSys™.

Decommissioning LVRSys™ BYPASS

Sequence:

1. Set the systems switch to the OFF position.
↳ Wait until secondary electronics are de-energised.
(Display goes out after approx. 10 s).

2. Close BYPASS (with knives).

3. Open LVRSys OUT (remove knives/fuses).

4. Open LVRSys IN (remove knives/fuses).
↳ The LVRSys™ is completely disconnected from the network.
↳ *BYPASS* is active.
The network is supplied via the *BYPASS*.

↳ Check that there is no voltage present (Chap. 8.3)

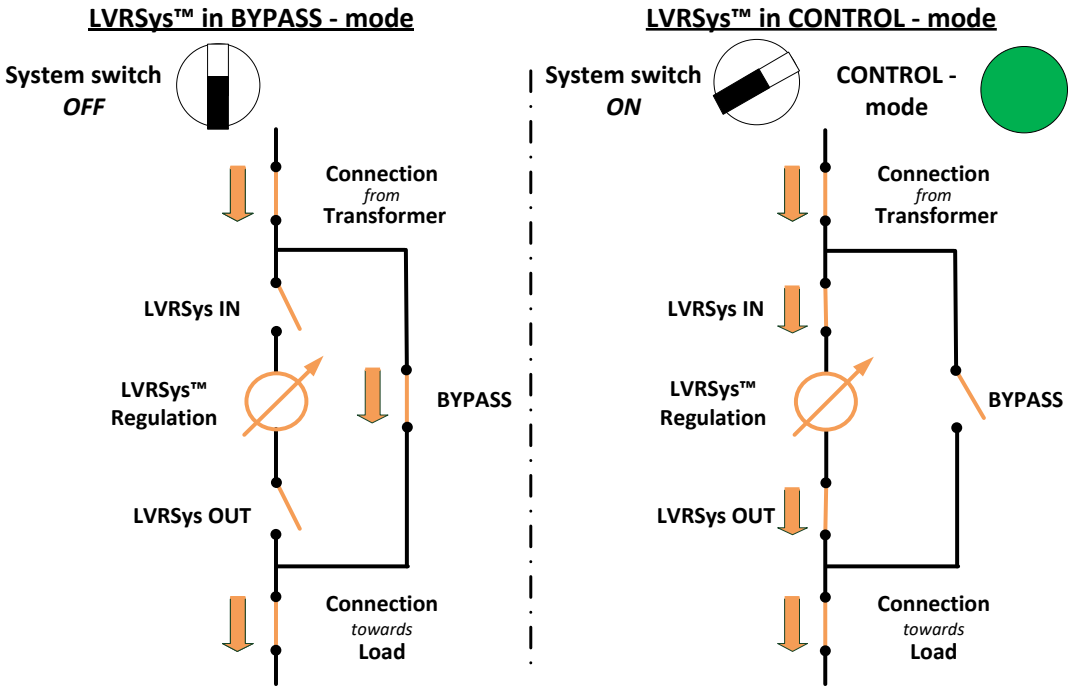


Figure 8-3 Circuit principle Bypass and operation

8.3 Check that there is no voltage present

⚠ DANGER!	**Danger of electric shock!** ➲ Check that there is no voltage on the system input. ➲ Check that there is no voltage on the system output. ➲ Only measure with fused measuring devices with overvoltage category IV.

0 Check there is no voltage at the input *(LVRSys-IN)*.

0 Check there is no voltage at the output *(LVRSys-OUT)*.

0 Systems with circuit breakers:
Check there is no voltage measured on L1/L2/L3 (directly at the circuit breaker) with respect to PEN/PE rail.

0 Systems with NH switch-disconnectors:
Check there is no voltage measured on L1/L2/L3 (directly at the outlet switch-disconnectors) with respect to PEN/PE rail.

0 Systems with NH fuse-switch-disconnectors:
Check there is no voltage on L1/L2/L3 (directly on the outlet switch disconnectors) with respect to PEN/PE rail.

8.4 Operation of circuit breakers and switch-disconnectors

8.4.1 Operation of systems with circuit breakers

When switching the devices, the following must be observed:

➲ Ensure that commissioning, decommissioning and operation are only carried out by qualified electricians or persons trained in electrical engineering in accordance with VDE 0105-100 or certified with respect to the local wiring and safety regulations applicable in your country.

➲ Only operate the circuit breaker using the operating handle.

➲ Fast operation of circuit breakers.

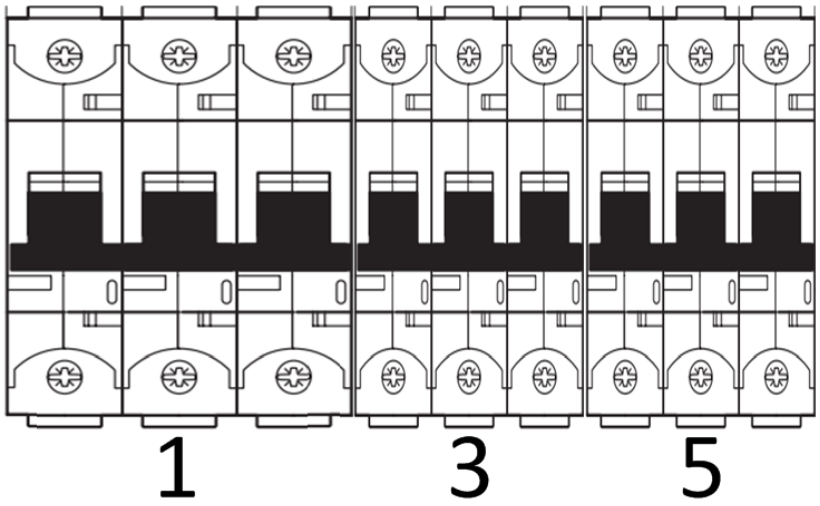


Figure 8-4 Connection and BYPASS function

1	Circuit breaker for **LVRSysIN – F1**
3	Circuit breaker for **BYPASS – F3**
5	Circuit breaker for **LVRSysOUT – F5**

Table 8-3 Explanation of numbering

Figure 8-5 Circuit breaker state OFF

8.4.2 Operation of systems with switch disconnectors

⚠ DANGER!	**Risk of fatal injury from electric shock!**
	Never partially open the LV switch disconnectors.
	Actuate the LV switch disconnectors using the handle.

Its intended that LV fuses are to be used only by qualified electricians or persons trained in electrical engineering, e.g. IEC 60269-2 or certified with respect to the local wiring and safety regulations applicable in your country.

When switching the devices, the following must be observed:

- Ensure that commissioning, decommissioning and operation are only carried out by qualified electricians or persons trained in electrical engineering in accordance with VDE 0105-100 or certified with respect to the local wiring and safety regulations applicable in your country.
- Ensure that only fuse links with silver-plated knives or silver-plated disconnection knives are used.
- The switch disconnectors must only be operated using the handle.
- Actuate the switch disconnectors quickly.

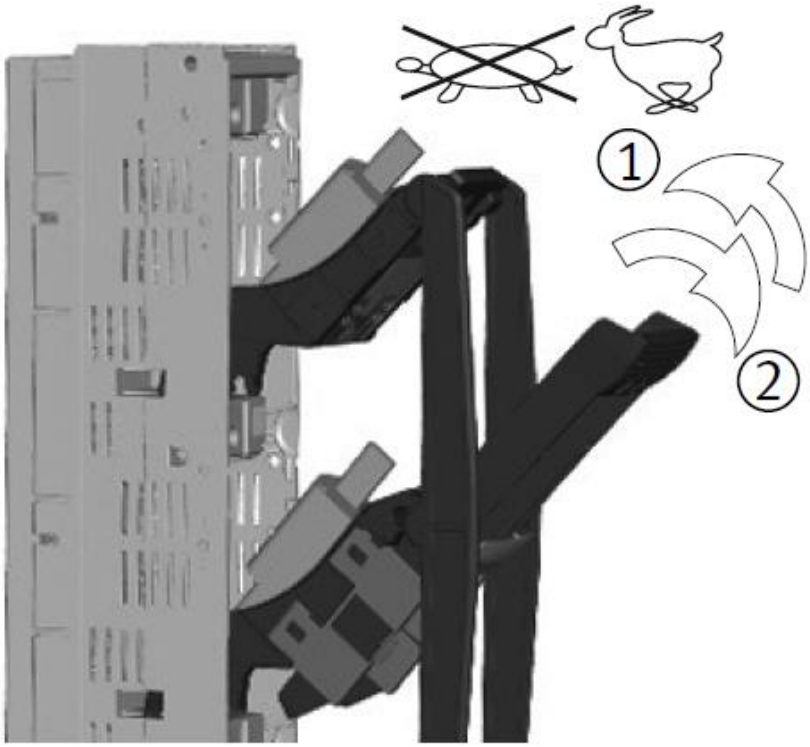


Figure 8-6 Operation switch disconnectors

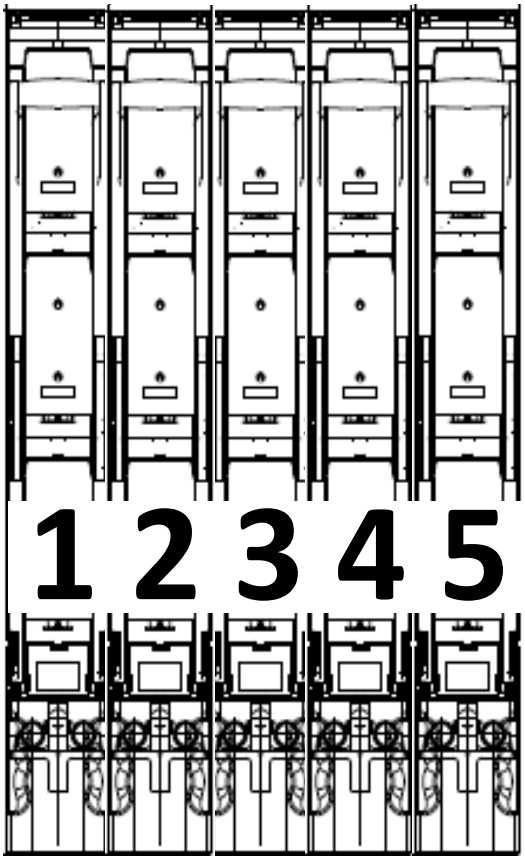


Figure 8-7 NH switch disconnectors

⚠ **CAUTION!**	**Voltage interruption in the low voltage network!** (2) Contact strip LV mains input, never switch! (4) Contact strip LV mains output, never switch!

1	Connection switch disconnectors for **LVRSysIN – F1** (internal/transformer block secondary line input)
2	Connection of switch disconnectors for external input cables (mains connection transformer – F2)
3	Coupling strip **BYPASS – F3**
4	Connection of switch disconnectors for external output cables (mains connection load – F4)
5	Connection switch disconnectors for **LVRSysOUT – F5** (internal/transformer block secondary line output)

Table 8-4 Explanation of numbering

8.4.3 Operation of systems with LV fuse-switch-disconnectors

⚠ DANGER!	**Risk of fatal injury from electric shock!**
	Never partially open LV fuse switch disconnectors
	Operate the LV fuse switch disconnectors on the handle.

Its intended that LV fuses are only used by qualified electricians or persons trained in electrical engineering e.g.: IEC 60269-2 or certified with respect to the local wiring and safety regulations applicable in your country.

When switching the devices, the following must be observed:

- Ensure that commissioning, decommissioning and operation are only carried out by qualified electricians or persons trained in electrical engineering in accordance with VDE 0105-100 or certified with respect to the local wiring and safety regulations applicable in your country.
- Ensure that only fuse links with silver-plated knives or silver-plated disconnection knives are used.
- Only operate LV fuse switch disconnectors by the operating handle.
- Always operate LV fuse switch disconnectors quickly.

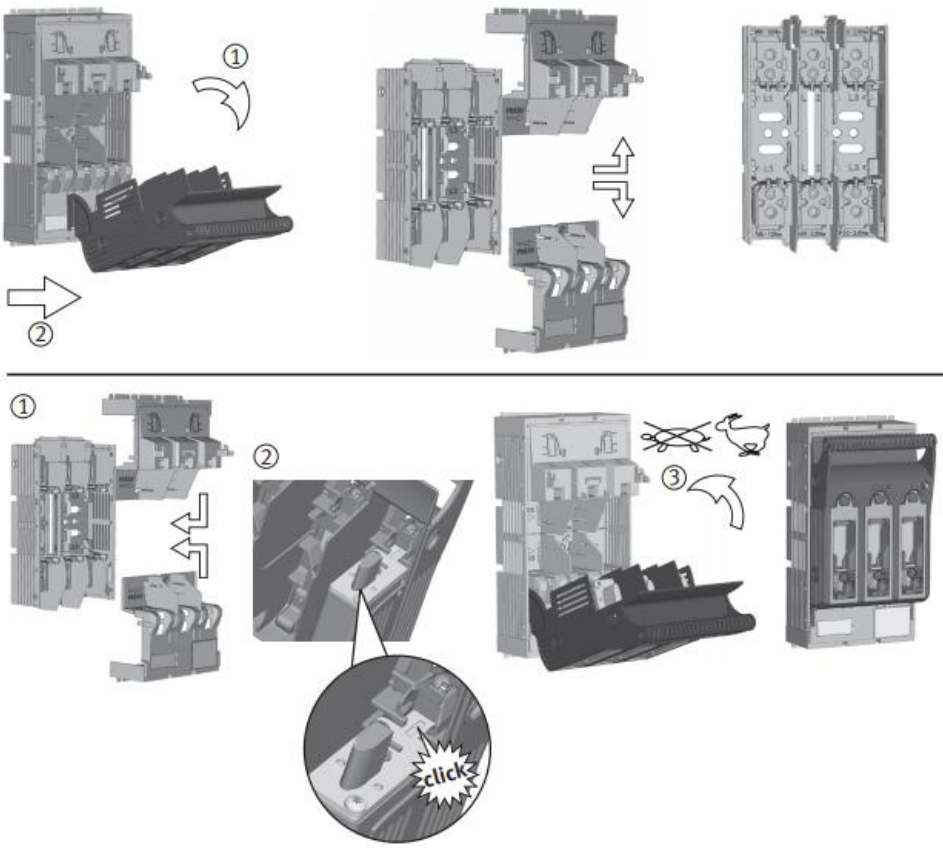


Figure 8-8 Operation fuse switch disconnectors

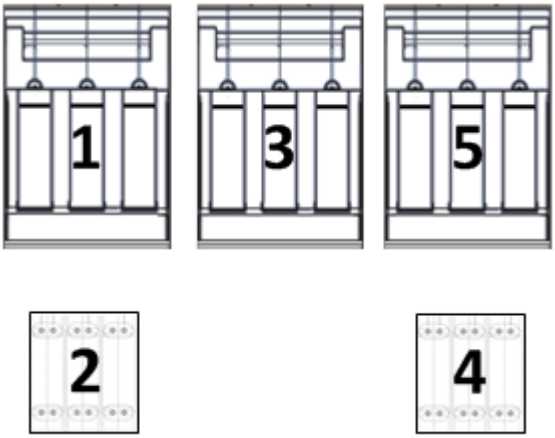


Figure 8-9 LV fuse switch disconnectors

⚠ **CAUTION!**	**Voltage interruption on the low voltage network!** (1/5) Operate fuse switch disconnectors according to instructions! (3) Operate BYPASS fuse switch disconnectors according to instructions! See chapter 8 Commissioning and Decommissioning LVRSys™.

1	Connection fuse switch disconnectors for **LVRSysIN – F1** (internal/transformer block secondary line input)
2	Connection terminal block for external input cables (mains connection transformer)
3	Fuse switch disconnectors **BYPASS – F3**
4	Connection terminal block for external output cables (mains connection load)
5	Connection fuse switch disconnectors for **LVRSysOUT – F5** (internal/transformer block secondary line output)

Table 8-5 Explanation of numbering

9. Operation/Operation regulator

9.1 Indicator lamps/System switches

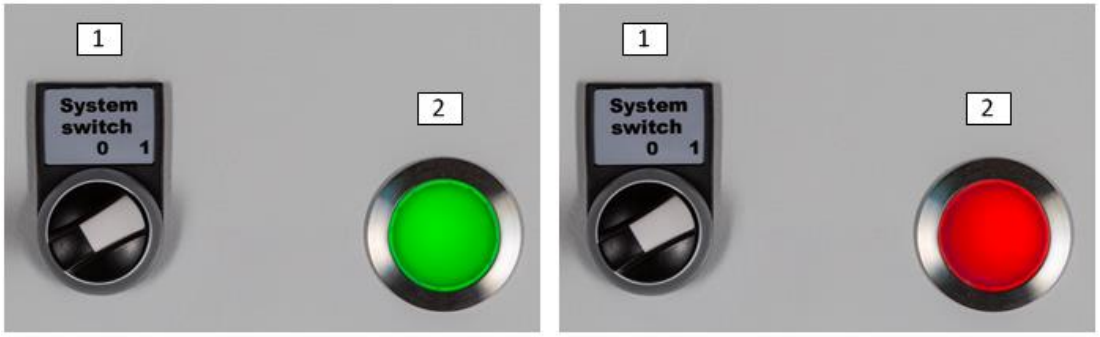


Figure 9-1: Description system switch lamps control cabinet

1) *System switch*
2) Indicator lamp *Operation (green) / error (red)*

9.2 Indicator lamps & switch service – CPU board (A7)

Figure 9-2: Slide switch service / lamp status

Description:

1) *Service* switch
2) *Status* lamp
3) *Contactor status* lamp (first from left) and *service switch status* lamp (second from left)

9.3 Indicator lamps – Control cabinet

The indicator lamps *red* and *green* indicate the status of the system:

- *Red*: Error state; system is in automatic *BYPASS*.
- *Green*: Operating state; system is in faultless operation.

➲ If the indicator lamp is *red*, follow the instructions in the service manual.

➲ Note down the error code (See chapter 9.12.6).

➲ If the error cannot be resolved, A. Eberle support team must be contacted.

9.4 Switches

The switch positions lead to the following states:

- System switch:

Figure 9-3: System switch (system on)

  - Switch position right: System on
  - Switch position top: System off

- Service switch:

Figure 9-4: service switch

  - Switch position *on*: Service switch active
  - Switch position *off*: Service switch inactive

    ↳ Service switch in position *on* indicator lamp changes from *green* to *red.*
    ↳ When the switch is in the *on* position, the *service switch status lamp* and the *status lamp* on the CPU board (A7) changes to *red*.
    ↳ Automatic *BYPASS* active, regulator is not in operation.

The *service switch* is only used for the firmware update process.

9.5 Boot process

➲ Activate the switch *System switch (1)* automatically starts the boot process of the regulator.

- After approx. 25 seconds, the display shows *Boot...*.
- After the boot process is completed (approx. 45 seconds), the regulator is now in automatic mode.

The boot process must be completed in order to carry out all activities such as setting the LVRSys up, changing the display pages, etc.

9.6 Menu navigation

In normal operation, the regulator is in automatic mode by default.

The main window shows the 3 phase voltages of the phase conductors and the current stage of the respective phase.

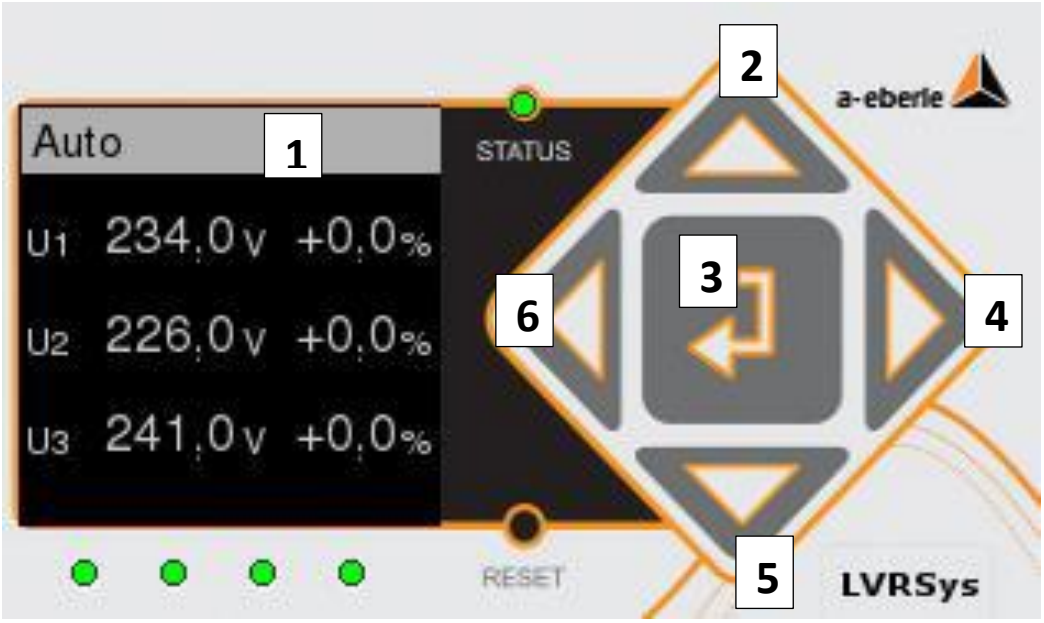


Figure 9-5 Regulator display

1	Mode
2	Browse *up* (only in the user menu or active manual mode)
3	*Enter key* (confirm)
4	Browse *right*
5	Browse *down* (only in the user menu or active manual mode)
6	Browse *left*

Table 9-1 Explanation of numbering

9.7 Automatic mode

After the boot process (applying the supply voltage) is completed, the controller switches to *Automatic mode*. In *Automatic mode*, the controller is active.

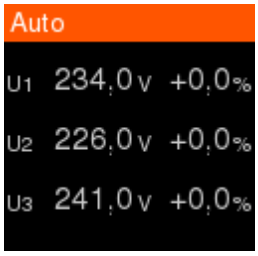


Figure 9-6 Display Automatic mode

The display shows:

0 three phase voltages

0 current step positions of the phases

9.8 Manual mode

The regulator is not active in *Manual mode*. One-step change per second is possible.

Change steps manually:

➲ To select *Manual* mode, press the *Enter key* in *Automatic mode*. (See chapter9.9 Overview display).

➲ To switch to a lower tap, press the *down* key.

➲ To switch to a high tap, press the *up* key.

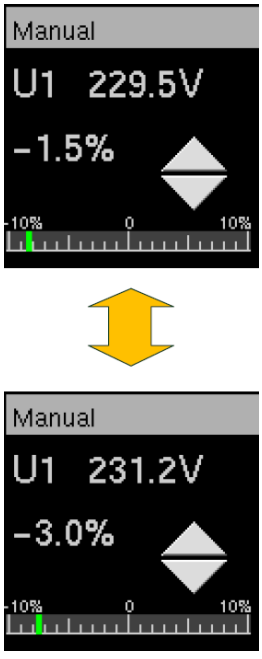


Figure 9-7 Manual mode display

9.9 Overview display

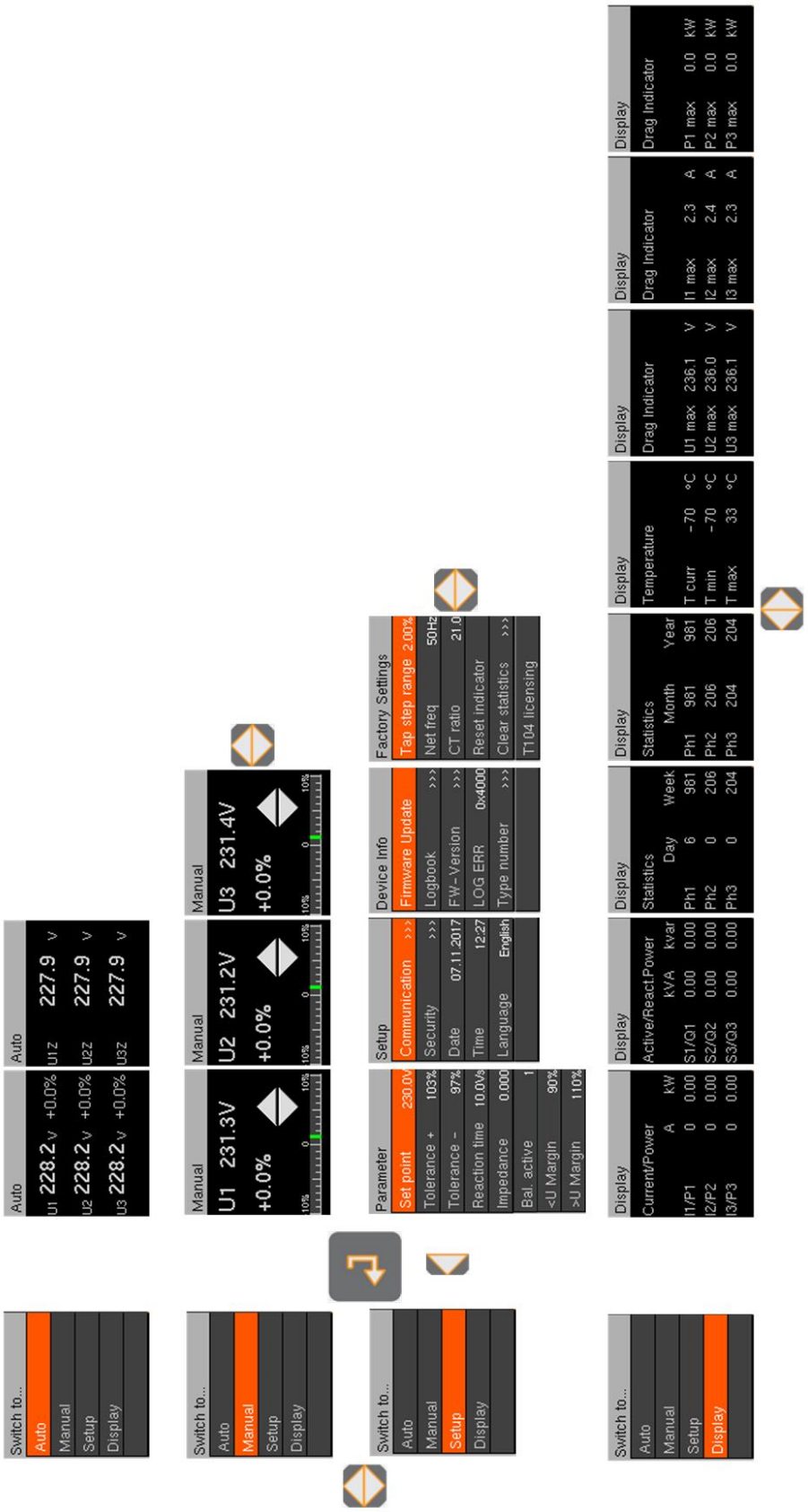


Figure 9-8 Overview of menu navigation

9.10 Parameters

The individual controller parameters are described in detail below.

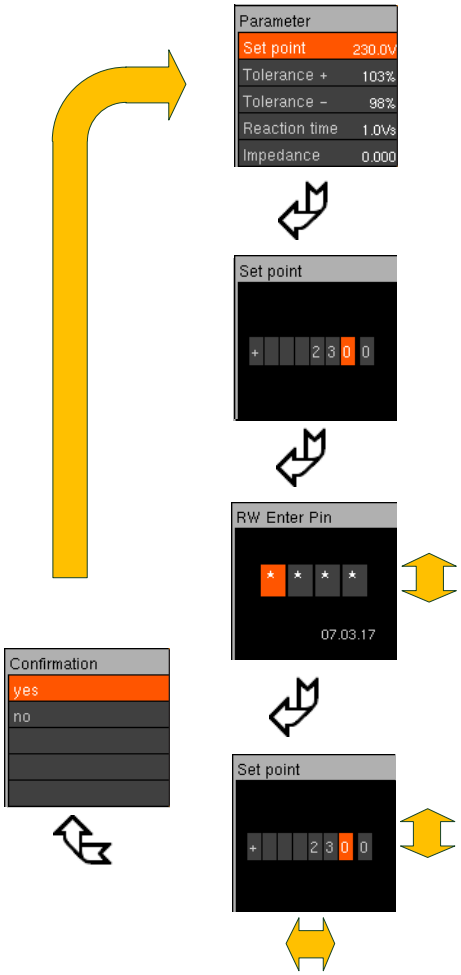


Figure 9-9 Setting the regulator parameters

- Select the *Parameter* menu (See Section 9.9 Overview display).
- To select sub items, press the *up* or *down* key.
- Press the *Enter key*.

Configuration:

- PIN input by pressing the *up/down and left/right* keys.
- Press *Enter* to confirm the PIN.
- Set the parameters by pressing the *up*/*down* and *left*/*right* keys.
- Press *Enter* to confirm the selection.

On delivery the PIN is set to *0000* (four times zero)
NOTE: The PIN can be changed as described in section 11 IT-Security.

9.10.1 Set point

The default is:

- 230 V (400 V phase - phase) or
- 133 V (230 V phase - phase)

➲ Set the set point (100 V – 260 V).

9.10.2 Tolerance band + and tolerance band -

The defaults are:

- 97% for tolerance band – (*Tolerance* -)
- 103% for tolerance band + (Tolerance +)

➲ Set the tolerance bands if necessary (80 % - 98 % & 102% - 120 %).

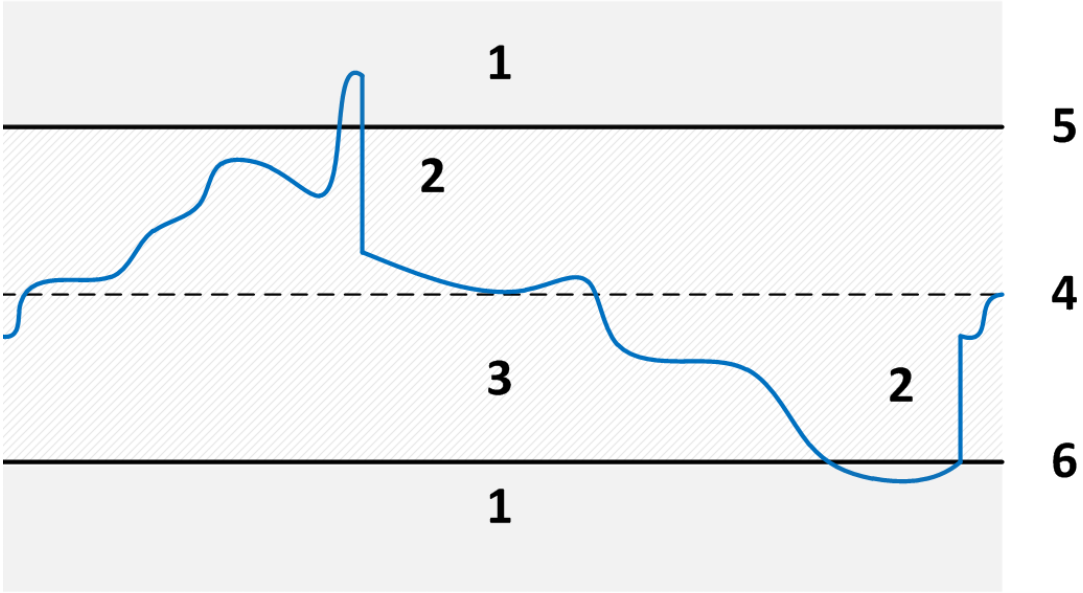


Figure 9-10 Tolerance band zone

1	Regulator active
2	Phasing process
3	Regulator inactive
4	Set point
5	Tolerance band +
6	Tolerance band -

Table 9-2 Explanation of numbering

If the voltage is in the range between the tolerance bands + and -, the control is inactive. If the tolerance bands + and – are exceeded, the control becomes active and steps the voltage back to being inside the tolerance according to the parameters set.

9.10.3 Reaction time

The default is 10 Vs.

- ➲ Reaction time adjustable from 1 Vs to 100 Vs in 0.1 steps
- ➲ Reaction time adjustable from 0 Vs to 100 Vs in 0.1 steps (FW 12.01.00)

NOTICE!	Reaction time 0 Vs is the high speed option < 30 ms feature (E2 – E5). This option is only possible in combination with specially designed transformers Selection of Reaction Time 0 Vs without special transformers can damage the system.

The reaction time can be used to set up the control speed of the system.

Example: Injury of tolerance bands with response time set to 1 Vs.

(see Figure 9-11 Tolerance band zone)

- ↳ Tolerance band + exceeded by 1 V -> Stepping process after 1 s (2.1)
- ↳ Tolerance band – underrun by 0.5 V -> Stepping process after 2 s (2.2)

The reaction time describes the time that elapses between the moments the tolerance band violation is detected until the step process occurs (see Sec. 9.10.2).

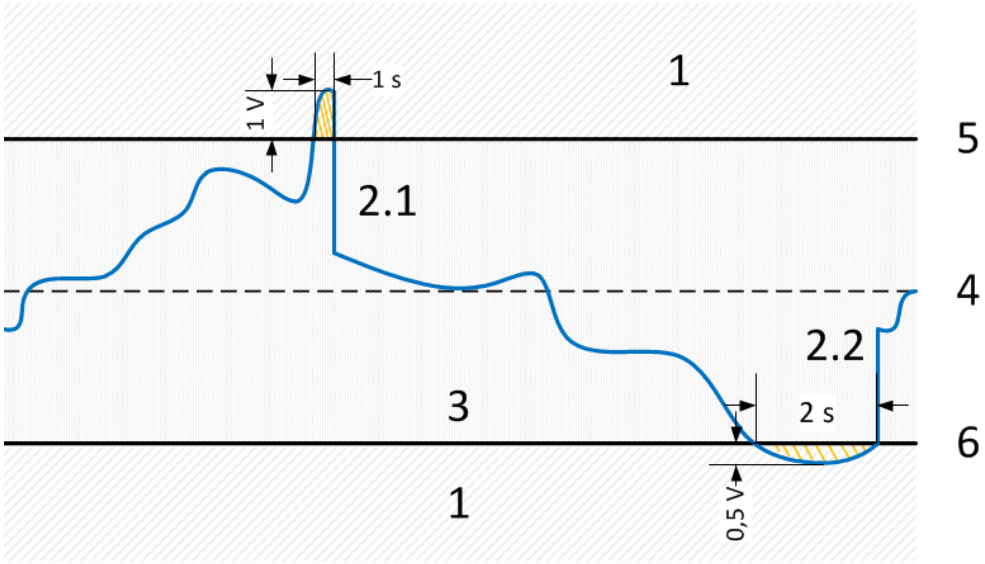


Figure 9-11 Tolerance band zone reaction time

1	Regulator active
2.1	Phasing process exceed tolerance band + by 1 V
2.2	Phasing process underrun tolerance band - by 0.5 V
3	Regulator inactive
4	Set point
5	Tolerance band +
6	Tolerance band -

Table 9-3 Explanation of numbering

9.10.4 Impedance

The *Impedance* function can only be used if the *Current measurement* option has been integrated (Sec.3).

The default impedance is 0 Ω:

- ↳ Impedance is inactive.

- ➲ Impedance adjustable in 0.01 Ω steps from zero to 0.5 Ω.
- ➲ Max. Influence on local voltage measurement 5 V (20 V with FW 12.01.00).

When the impedance is inactive:

- ↳ Current-dependent regulation is inactive.

When the impedance is active:

- ↳ Current values are included in regulation.
- ↳ Resistance symbol appears in the status window.

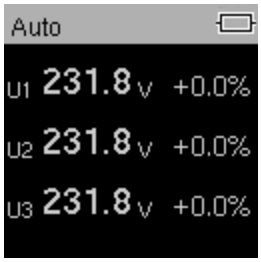


Figure 9-12 Display impedance active

When the impedance is selected, the load current is included in the regulation algorithm.

Example:

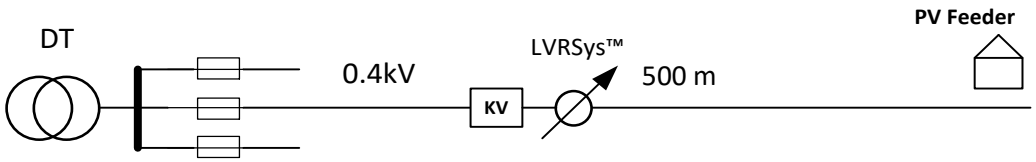


Figure 9-13 Example grid branch with 500 m cable section

Cable data	Values
Cable	NA2X2Y 4 x 150 mm²
Cable length	500 m
Cable resistance	0.5 km x 0.206 Ω/km = 0.05 Ω

Table 9-4 Cable data

In the example, the calculated voltage value of the regulator is reduced by -100 A x 0.05 Ω = -5 V for a feeding current of the PV system of 100 A. As a result, the desired voltage set point is regulated at the end of the cable.

When the *impedance* is selected, the regulator permanently calculates the voltage from the voltage value at the controller + impedance x grid current..

$$U_{Imp} = U_{Regulator} + Z_{Grid} * I_{Grid}$$

Type of wire	spec. cable resistance Ω/km
NAYY-J 4 x 70 mm²	0.453
NAYY-J 4 x 95 mm²	0.321
NAYY-J 4 x 120 mm²	0.255
NAYY-J 4 x 150 mm²	0.208
NAYY-J 4 x 185 mm²	0.167
NAYY-J 4 x 240 mm²	0.131
Overhead line AL 4 x 50 mm²	0.662
Overhead line AL 4 x 70 mm²	0.519
Overhead line AL 4 x 95 mm²	0.432

Table 9-5: Specific cable resistance

9.10.5 Balancing (Bal. active) – from FW 12.00.05

The default is 1 (active).

➲ *Set balancing 1 (active)* or *0 (inactive).*

Function for balancing the three phase voltages within tolerance band +/-.

0 Balancing by steps toward set point.

0 Regulation ensure the optimum balance between the three phases depending to the step width.

0 Regulation within the tolerance band.

0 Activated impedance function is taken into account during balancing.

Example of unbalanced phase voltages:

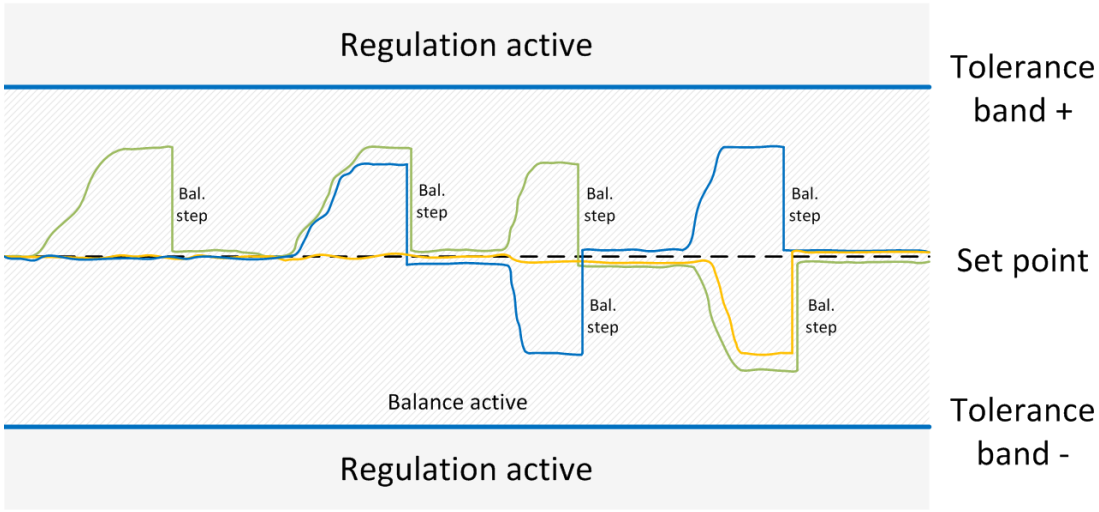


Figure 9-14 Example of unbalanced phase voltages

9.10.6 Overvoltage warning – from FW 12.00.06

The default is 110 % (related to set point). Adjustable from 105% to 150%.

Overvoltage warning is active when the 10 seconds mean value of the voltage is above the set threshold.

The overvoltage warning is transmitted via communication protocols and stored in the log-book under Event data.

9.10.7 Undervoltage warning – from FW 12.00.06

The default is 90 % (related to set point). Adjustable from 0% to 95%.

Undervoltage warning is active when the 10 seconds mean value of the voltage is below the set threshold.

The undervoltage warning is transmitted via communication protocols and stored in the logbook under Event data.

9.11 Setup

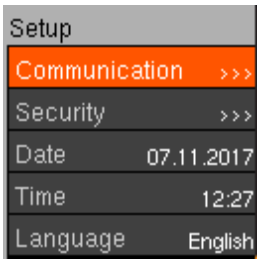


Figure 9-15 Setup Display

➲ Select the *Setup* menu (See Section 9.9 Overview display)

➲ To select the submenu items, press the *up* or *down* key.

➲ Press the *Enter key*.

Configuration:

➲ PIN input by pressing the *up/down and left/right* keys.

➲ Press *Enter* to confirm the PIN.

➲ Set the parameters by pressing the *up*/*down* and *left*/*right* keys.

➲ Press *Enter* to confirm the selection.

9.11.1 Communication

See section 10 Communication.

9.11.2 Security

See section 11 IT-Security.

9.11.3 Date

➲ Set the date.

9.11.4 Time

➲ Set the Time.

If NTP time synchronisation is activated (see section 10.6) the date and time will be updated automatically.

9.11.5 Language

Possible languages:

0 German

0 English

9.12 Device Info

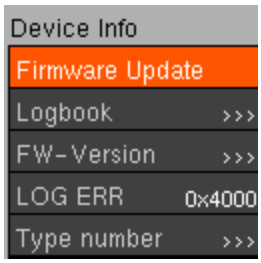


Figure 9-16 Device info display

- Select the *Device info* menu (see section 9.9 Overview display).
- To select the submenu items, press the *up* or *down* key.
- Press the *Enter key*.

Configuration:

- Set up the *PIN* number by pressing the *up/down and left/right* keys.
- Press *Enter* to confirm the PIN.
- Set the parameters by pressing the *up*/*down* and *left*/*right* keys.
- Press *Enter* to confirm the selection.

9.12.1 USB

USB interface is used for firmware update and logbook backup.

Figure 9-17 USB interface

9.12.2 Firmware update

⚠ **CAUTION!**	**Destruction of components due to overload!**
	Start the update only when the service switch is activated.

Activating the service switch isolates the thyristors from the mains voltage and bridges out the transformers. The control function is no longer in operation.
A secure update process can be started.

Copying the update files to a USB stick:

- Extract the zip file (from email or download:
  https://www.a-eberle.de/de/download-center-categories/firmware-1).
- Save the files on a *FAT32* formatted USB stick

➲ The folder structure below is mandatory, no parent folders on the USB stick (*USB stick*:*unpacked files; e.g. E:*\...).

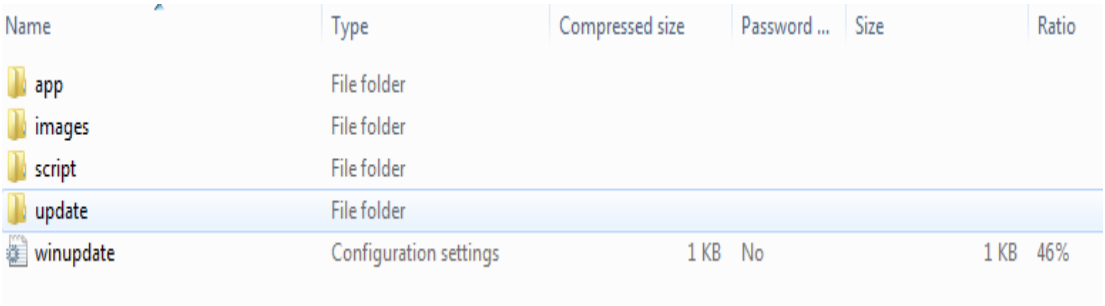


Figure 9-18 Folder structure of the update on USB stick

Complete update procedure:

➲ Activate the service switch to *on* (see section. 9.2).

↳ Regulator changes to error state.

➲ Insert the USB stick.

➲ Select the menu item *Firmware update*.

➲ Enter the PIN number by pressing the *up/down and left/right* keys.

➲ Press *Enter* to confirm the PIN.

➲ Press *Yes* to confirm the selection.

↳ *Please wait* appears in the display.

➲ Do not press any buttons or activate the service switch during the update process.

↳ Regulator needs about 5 minutes until the update process is completed.

↳ The regulator reinitializes itself.

↳ When the update is completed, the regulator remains in error state.

➲ Deactivate the service switch to *off*.

➲ Remove the USB stick.

↳ The regulator changes to *automatic* mode.

↳ The update procedure is finished.

9.12.3 Logbook

The logbook contains following items:

Event data

Event data list contains:

0 Parameters

0 New settings

0 State (Automatic/Manual)

- Change of state (*Automatic-Manual*)
- Over- / Undervoltage warnings
- Error.

Measurement data

Measurement data list contains:

- U1 to U3 (10 minutes average values in V)
- U1Z to U3Z (10 minutes average values in V, only with option *Current transformer* and *Impedance* is set)
- I1 to I3 (10 minutes average values in A; only with option *Current transformer*)
- P1 to P3 (10 minutes average values in kW; only with option *Current transformer*)
- Q1 to Q3 (10 minutes average values in kvar; only with option *Current transformer*)
- S1 to S3 (10 minutes average values in kVA; only with option *Current transformer*)
- T1 to T3 (10 minutes average values in °C)
- Tap 1 to Tap 3 (current tap position Ph1-Ph3 at the time)
- Taps/Period 1-3 (number of steps within 10 minutes Ph1-Ph3).

Service data

Service data is intended exclusively for the A. Eberle GmbH & Co. KG. support team.

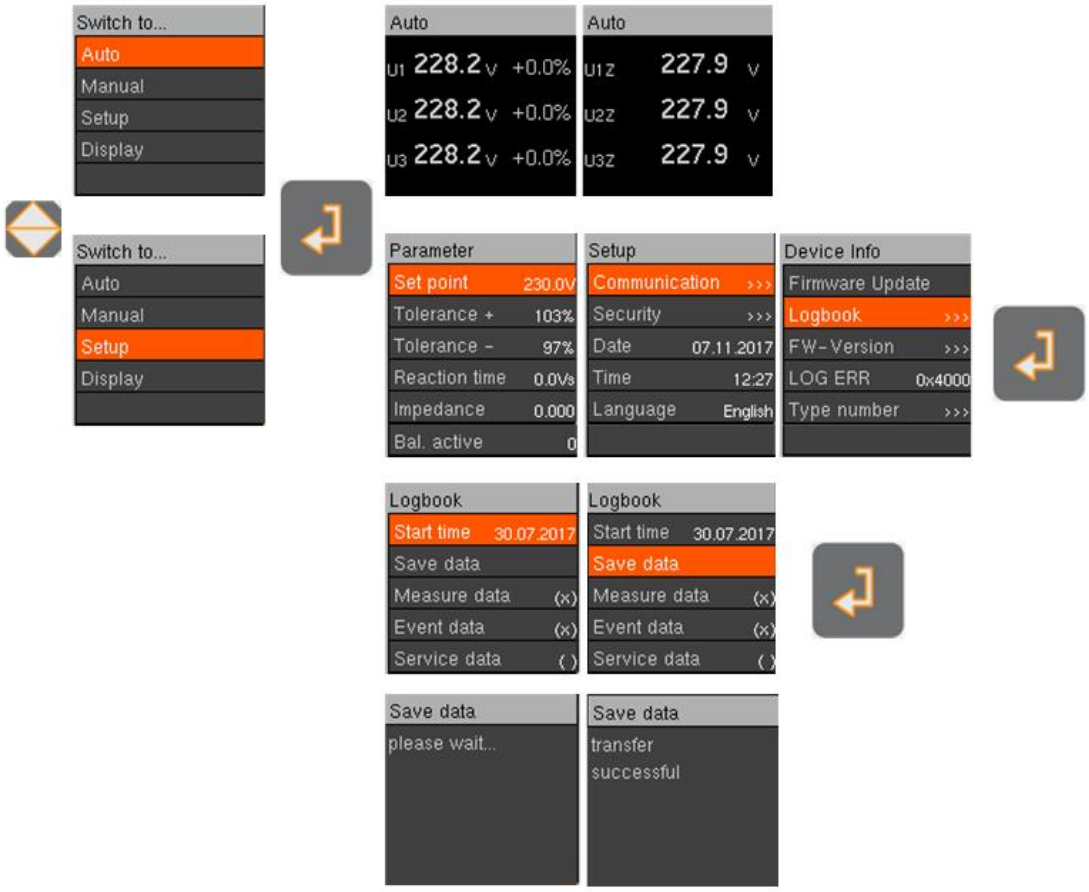


Figure 9-19 Overview read logbook

9.12.3.1 Download Logbook via USB stick

To download the logbook via USB stick you have to be in front of the LVRSys and follow these steps.

- ➲ Insert the USB stick.
- ➲ Select menu item *Logbook*.
- ➲ Select submenu item *Start time*.
  - ↳ Data beginning from the start time up to now is saved.

The data Event data, measurement data, service data must be selected for storage.

0 ( ) Selection inactive

0 (x) Selection active

- ➲ Select the submenu item Event data, measurement data and service data.
- ➲ Select with the *up* or *down* key.
- ➲ Enter the PIN number by pressing the *up/down and left/right* keys.

- ➲ Press *Enter* to confirm the PIN.
- ➲ Press *Yes* to confirm the selection.
- ➲ Select the submenu item *Archive data*.
- ➲ Press *Yes* to confirm the selection.
  - ↳ *Please wait* appears in the display.
  - ↳ Regulator stores data on the USB stick.

9.12.3.2 Download via LVRSysUpdater

See chapter 12.6 Logbook Download.

9.12.3.3 Evaluating the logbook (m*easurement data*) with Microsoft Excel

(alternative spreadsheet programs can also be used).

A. Eberle provides an Excel macro and a descriptive video on the homepage.
https://www.a-eberle.de/en/downloads/low-voltage-regulation/analysis-support

Evaluation without macro

- ➲ Open the *Measurement data* in Excel.
- ➲ Select the first column (A).

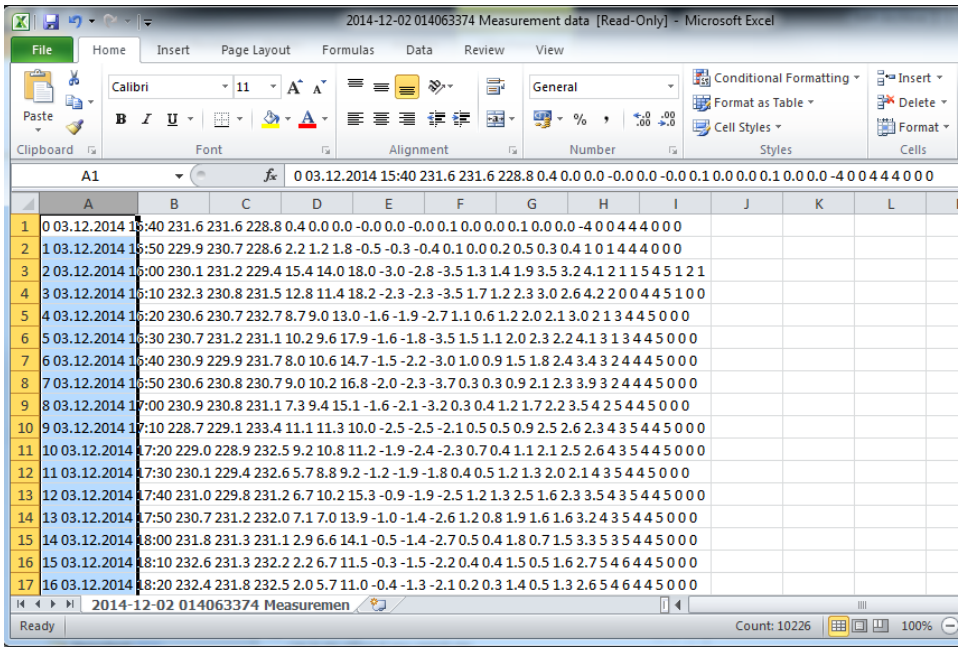


Figure 9-20 Select the first column

- ➲ Under menu item *Data*, select the item *Text in columns.*

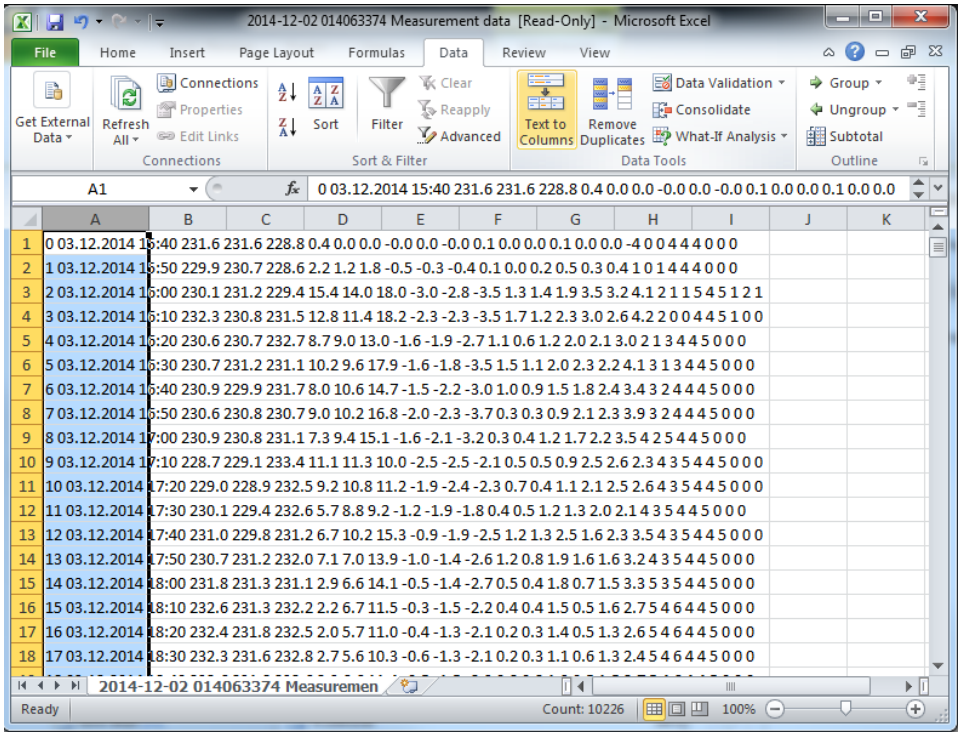


Figure 9-21 Selecting data and text in columns

- Convert Text to Columns Wizard - Step 1 of 3 select *Delimited.*
- Press *Next* to confirm.

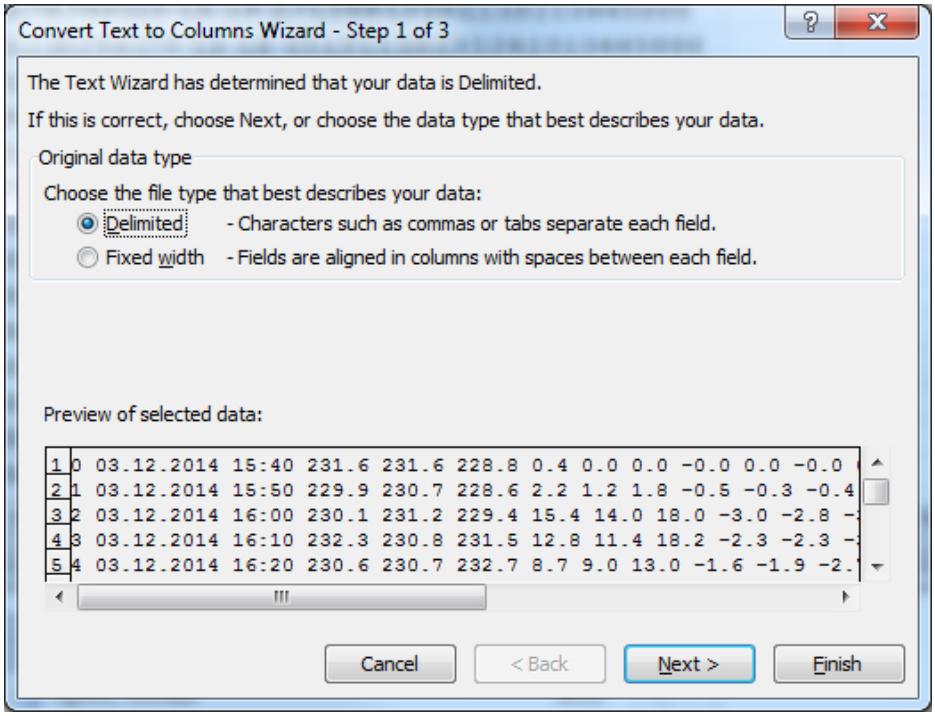


Figure 9-22 Text conversion wizard - Step 1 of 3

- Convert Text to Columns Wizard - Step 2 of 3 select *Space.*
- Press *Next* to confirm.

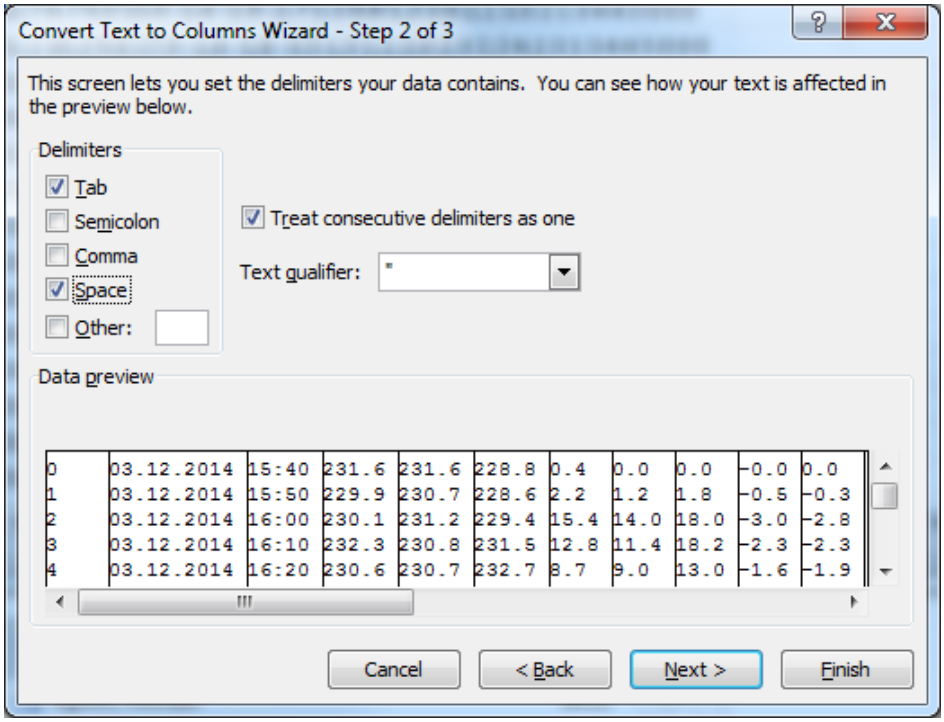


Figure 9-23 Text conversion wizard - Step 2 of 3

➲ Convert Text to Columns Wizard - Step 3 of 3 press on *Advanced...*

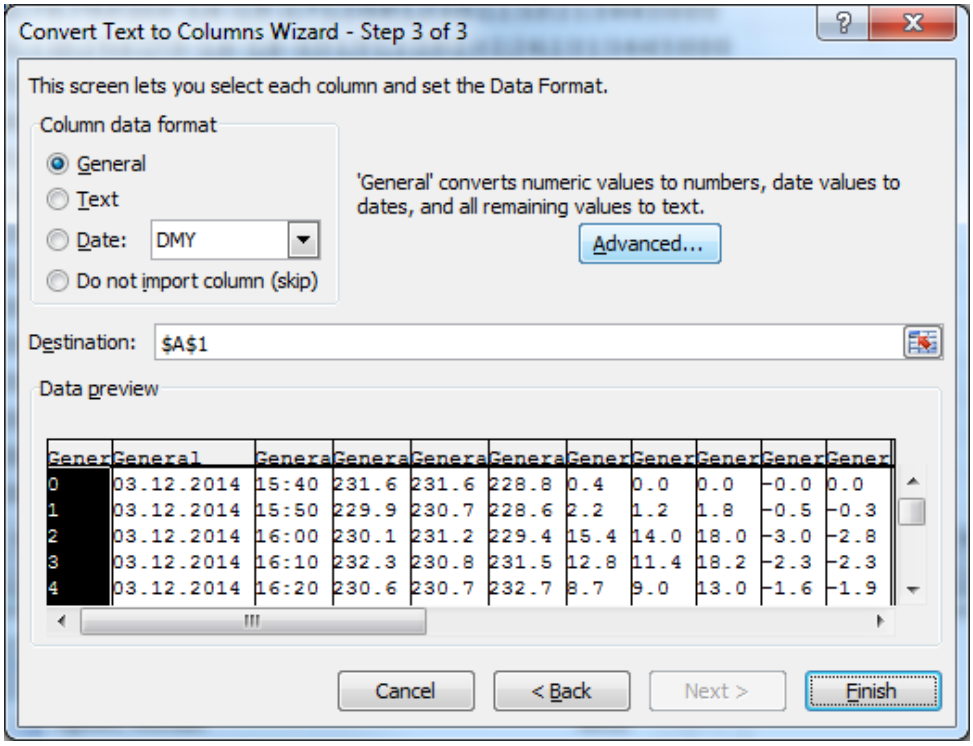


Figure 9-24 Text conversion wizard - Step 3 of 3

➲ Decimal separator: Select *Point.*

➲ Press *OK* to confirm.

➲ Press *Finish* in the Convert Text to Columns Wizard to confirm.

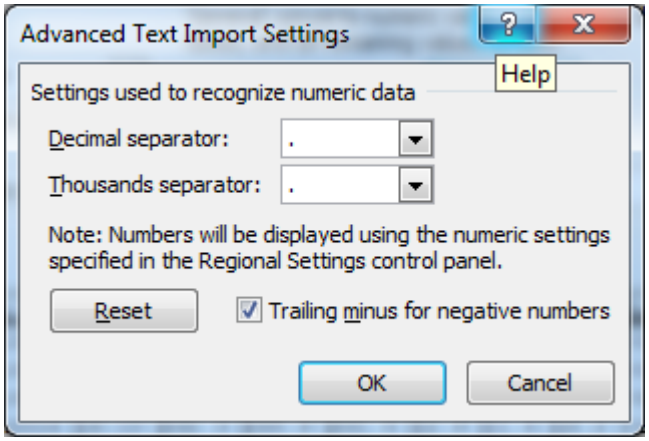


Figure 9-25 Further text import settings

↳ Measurement data is divided into columns.

9.12.3.4 Evaluating the logbook (*Event data*) in Notepad++

(alternative text editing programs can also be used).

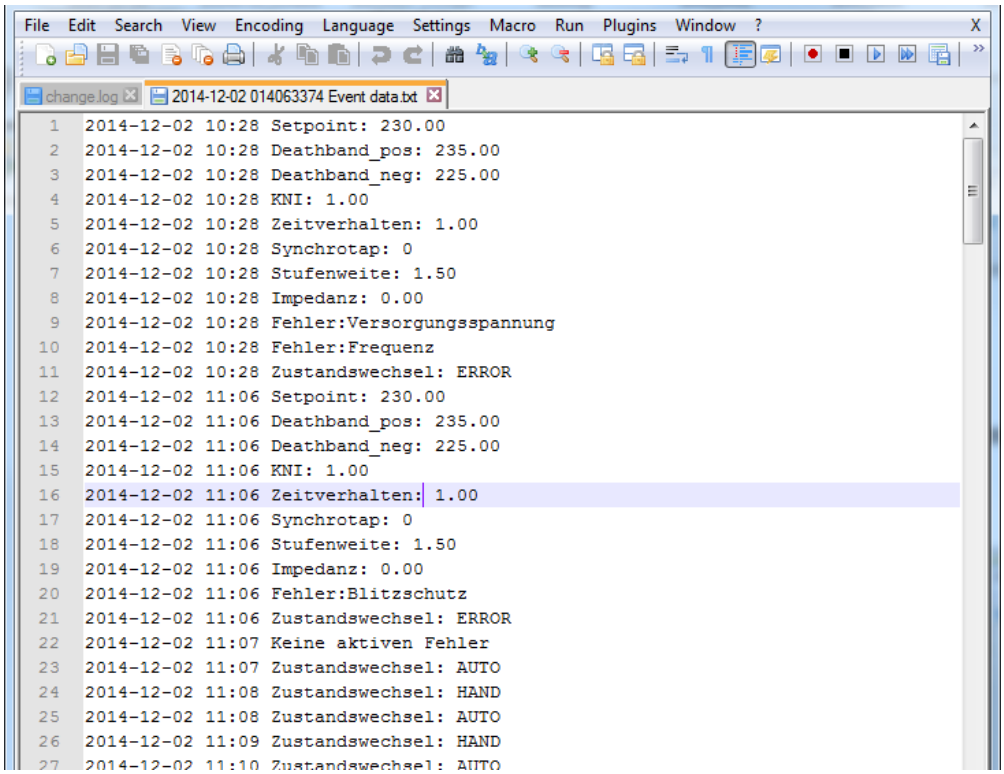


Figure 9-26 Event data opened with Notepad++

9.12.4 Evaluating the logbook (*Event data*) in WinPQ mobil

For Evaluation of Event data with WinPQ mobil you have to follow these steps:

- Installation of software WinPQ mobil.
  - https://www.a-eberle.de/de/download-center-categories/f%C3%BCr-mobile-analysatoren
- Download of Event data in .csv-format (See Section 9.12.3.1 or 9.12.3.2).
- Start of Program LVRSys WinPQ mobil.
  - Contact the support team of A. Eberle GmbH & Co. KG.
- *Open* of *Event data* in .csv-format.
- Choose control range LVRSys with dropdown menu (6 – 24 %).
- Confirm the control range with *OK.*
  - WinPQ mobil opens a window *Evaluation period* for the period of Evaluation.
- Choose the period of Evaluation, confirm with *OK.*
  - Event data Evaluation in WinPQ mobil

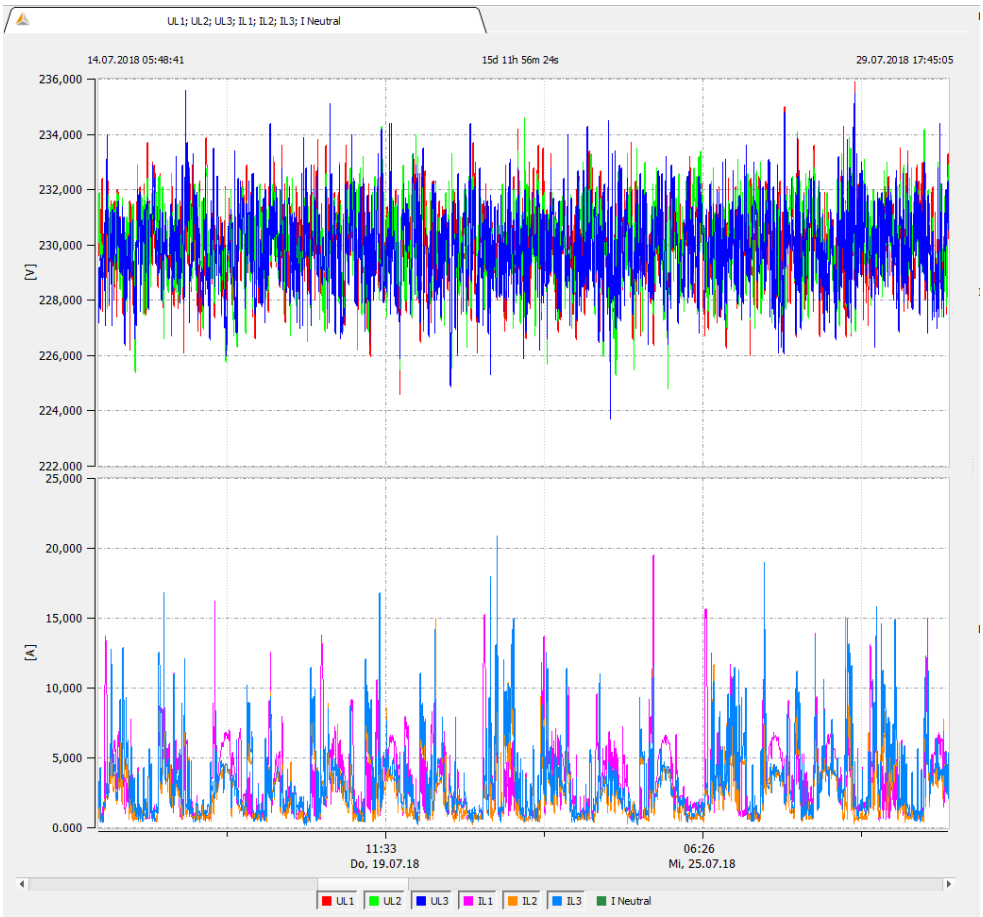


Figure 9-27 Event data opened with WinPQ mobil

Table of data points

WinPQ-mobil		LVRSys
Ueff	UL1	U1_V
	UL2	U2_V
	UL3	U3_V
	U12	U1_V_Input
	U23	U2_V_Input
	U31	U2_V_Input
Ieff	IL1	I1_A
	IL2	I2_A
	IL3	I3_A
Real power	P L1	P1_kW
	P L2	P2_kW
	P L3	P3_kW
	P total	P_total
Reactive power	Q L1	Q1_kvar
	Q L2	Q2_kvar
	Q L3	Q3_kvar
	Q total	Q_total
Apparent power	S L1	S1_kVA
	S L2	S2_kVA
	S L3	S3_kVA
	S total	S_total
Phase angle u1E -i1	PHL1	Phasenwinkel_Phi1
	PHL2	Phasenwinkel_Phi2
	PHL3	Phasenwinkel_Phi3
Power factor	PF L1	Tap_Ph1_%
	PF L2	Tap_Ph2_%
	PF L3	Tap_Ph3_%
Reactive factor	QFL1	Taps_per_period_Ph1
	QFL2	Taps_per_period_Ph2
	QFL3	Taps_per_period_Ph3
Voltage/THD	THDNE	T_°C
Ueff max (10ms)	UL1 max	UZ1_V
	UL2 max	UZ2_V
	UL3 max	UZ3_V

Table 9-6 Referencing data points between measurement data LVRSys and WinPQ-mobil

9.12.5 Firmware-Version

Menu item *FW-Version* contains information about:

- Firmware - version
- Cortex-firmware - version
- Kernel - version
- File system - version

The version number is determined automatically.

↳ No changes possible.

9.12.6 LOG ERR

Display of the last occurred error.

➲ If the system malfunctions, note the fault.

➲ Contact the support team of A. Eberle GmbH & Co. KG.

Error	Error code
Contactor	0x00001
Overvoltage	0x00002
Under voltage	0x00004
Internal regulation error	0x00008 0x00010 0x00020 0x00040 0x00080 0x00100 0x00400 0x01000
EEPROM	0x00020
Service switch	0x00200
Invalid serial number	0x00800
Thyristor board A1 A2 A3 A4 A5 A6	0x02000 0x04000 0x08000 0x10000 0x20000 0x40000
Transformer temperature	0x80000

Table 9-7 Error code table

The individual error codes add up as follows:

Error	Error code
Internal regulation error	0x01000
Service switch	0x00200
Internal regulation error	0x00080
Under voltage	0x00004
LOG ERR	**0x1284**

Table 9-8 Menu tab LOG ERR

The zeros after the x are not displayed.

9.12.7 Type number

Menu item *Type number* contains information about:

- Device number
- Type number CPU board
- Type number Thyristor boards

The device number is set at the factory.

↳ Do not change the device number.

The type number of CPU board and thyristors boards are determined automatically by the system.

↳ No changes possible.

9.13 Factory settings

⚠ CAUTION!	**Malfunction of the regulator due to incorrect settings !**
	Do not change factory settings.

The factory settings are only set when the system is set up for the first time and are directly coordinated with the installed hardware. These must not be changed by the user.

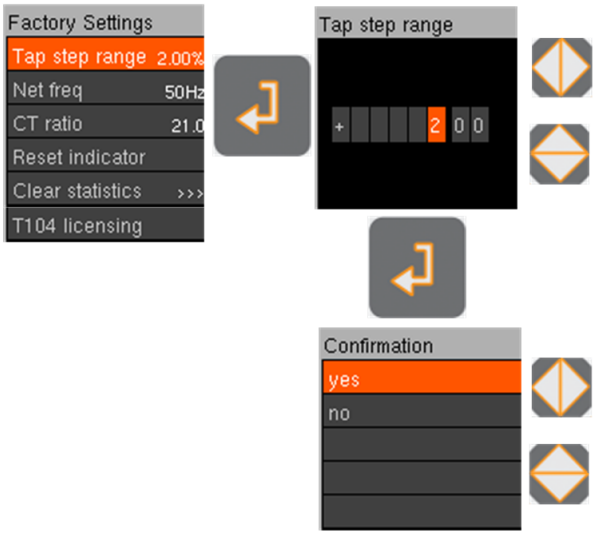


Figure 9-28 Setting the factory parameters

- Select the Setup menu (See Section 9.9 Overview display).
- To select the item submenu, press the *up* or *down* key.
- Press the *Enter key*.

Configuration:

- Enter the *PIN* number by pressing the *up/down and left/right* keys.
- Press *Enter* to confirm the PIN.
- Set the parameters by pressing the *up*/*down* and *left*/*right* keys.
- Press *Enter* to confirm the selection.

9.13.1 Step width

The step width is set at the factory.

- Do not change the step width.

9.13.2 Network frequency

The frequency is set at the factory

- Do not change the network frequency.

9.13.3 CT ratio (current transformer ratio)

Using current transformers from A. Eberle GmbH & Co. KG. the transfer ratio is set at the factory.

When using external current transformer:

- Enter the conversion ratio.

9.13.4 Resetting the indicator

The *Indicator or Drag indicator* sets 15 min average values for the:

- Maximum voltages (Phase 1-3)
- Maximum currents (Phase 1-3)
- Maximum power values (Phase 1-3)
- Maximum and minimum temperature in the switch cabinet in °C (T).

Reset indicator:

➲ Select *Reset indicator*.

➲ Enter the *PIN* number by pressing the *up/down and left/right* keys.

➲ Press *Enter* to confirm the PIN.

➲ Confirm selection.

↳ All indicators are reset to their initial state.

9.13.5 Clear statistics

The statistics can be cleared as required:

- Everything
- Day
- Week
- Month
- Year.

Clear individual statistical values:

➲ Select.

➲ PIN input by pressing the *up/down and left/right* keys.

➲ Press *Enter* to confirm the PIN.

➲ Confirm selection.

↳ Selected statistical value is cleared.

9.13.6 T104 licensing

See section 10.5.1 Unlock IEC 60870-5-104 .

10. Communication

10.1 Ethernet

Ethernet interface serves as communication interface for Modbus and IEC 60870-5-104 applications.

Figure10-29 Ethernet interface

10.2 Overview communication settings

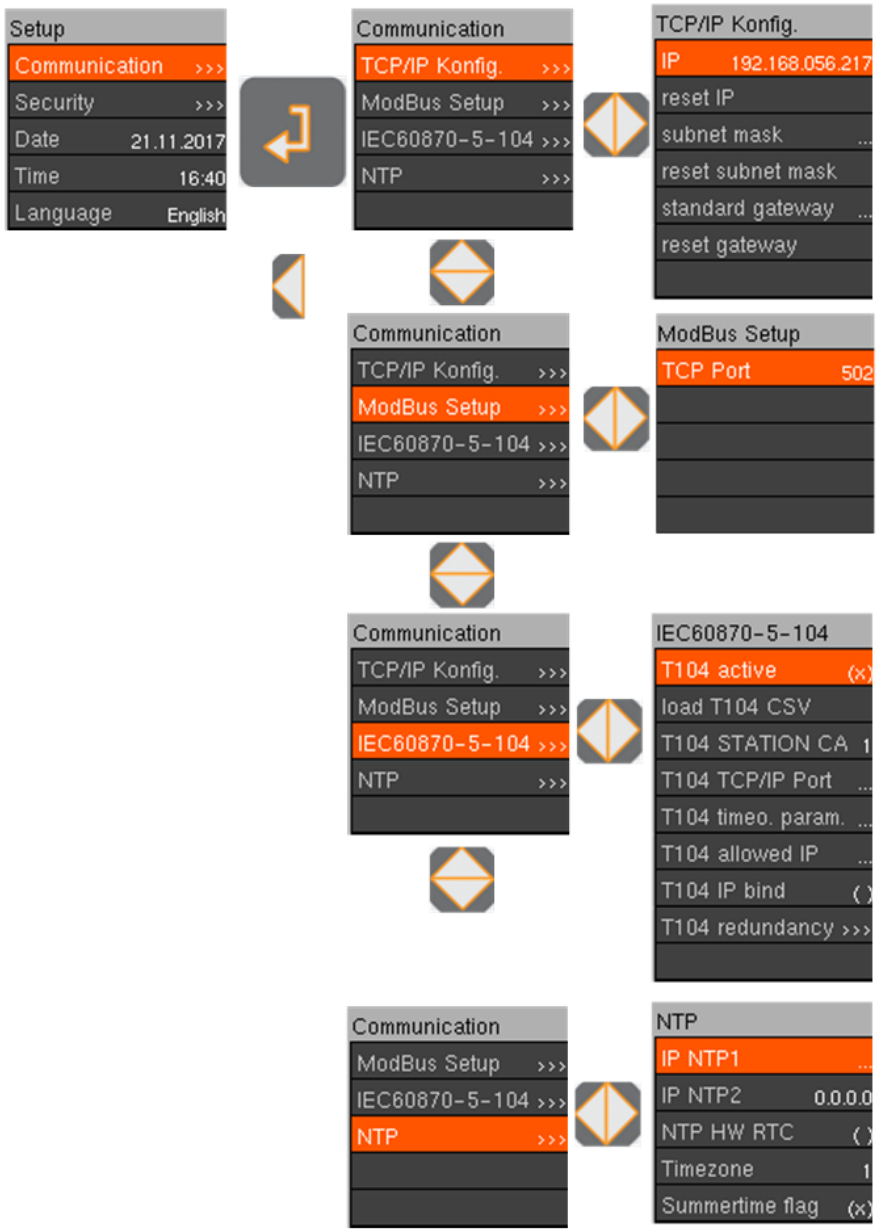


Figure 10-30 Overview of the communication settings

10.3 TCP/IP Configuration via Ethernet

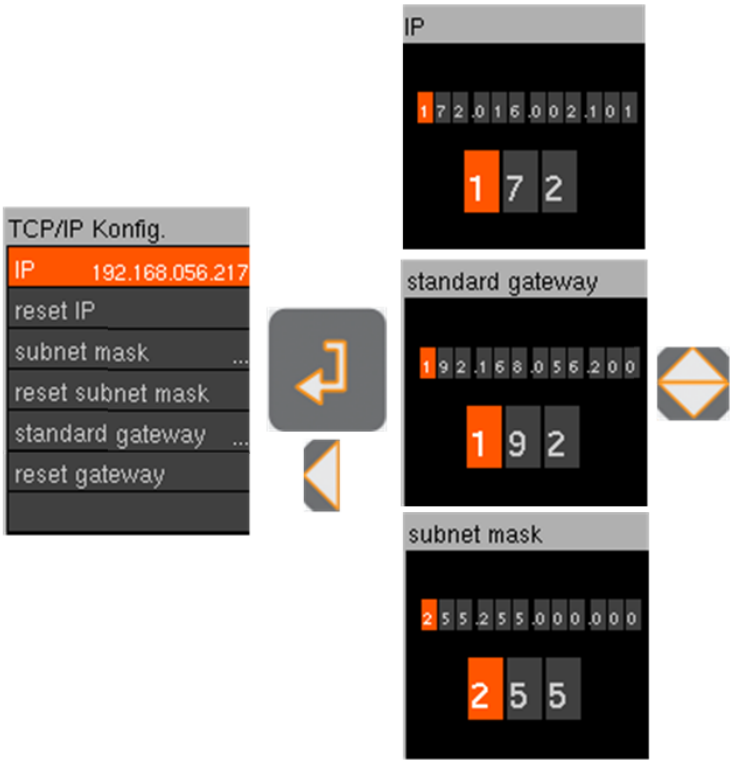


Figure 10-31 Overview of the TCP/IP configuration

The TCP/IP interface is the basis for all communication protocols and must be set according to the remote station.

10.4 Modbus

10.4.1 Modbus Setup

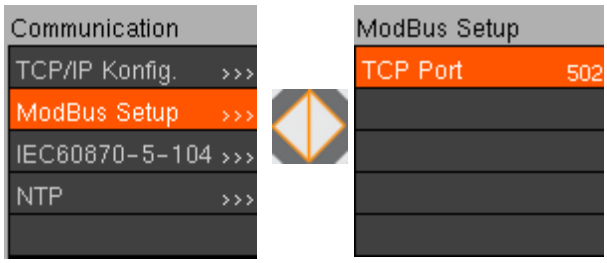


Figure 10-32 Modbus Setup

- Select menu *communication* (See section 9.9 Overview display)
- To select submenu items, press the *up* or *down* key
- Press the *Enter key*.

Configuration:

- Set the parameters by pressing the *up*/*down* and *left*/*right* keys.
- Enter the PIN number by pressing the *up/down and left/right* keys.
- Press *Enter* to confirm the PIN.
- Press *Enter* to confirm the selection.

Standard parameters for the Modbus Communication are:

0 TCP-Port 502

10.4.2 Modbus register assignment

Input register (16-Bit data, read only)			
Name	permitted values	Standard	Addressing
Status	2 - Operation, 1 - Error	2	101

Table 10-9 Status

Input register (16-Bit data, read only)			
Name	permitted values	Standard	Addressing
LOG-ERR	0 - 65000	0 (Hex)	102

Table 10-10 Log error

Input register (16-Bit data, read only)			
Name	permitted values	Standard	Addressing
Firmware	0 - 999999	1 (32-bit-float)	103-104

Table 10-11 Firmware version

Input register (16-Bit data, read only)			
Name	permitted values	Standard	Addressing
Overvoltage L1 *	0 – No Overvoltage warning, 1 – Overvoltage warning	0	105
Overvoltage L2 *	0 – No Overvoltage warning, 1 – Overvoltage warning	0	106
Overvoltage L3 *	0 – No Overvoltage warning, 1 – Overvoltage warning	0	107
Undervoltage L1 *	0 – No Undervoltage warning, 1 – Undervoltage warning	0	108
Undervoltage L2 *	0 – No Undervoltage warning, 1 – Undervoltage warning	0	109
Undervoltage L3 *	0 – No Undervoltage warning, 1 – Undervoltage warning	0	110

(* from FW – 12.00.06)

Table 10-12 Warnings

Holding registers (16-Bit data, read and write)			
Name	permitted values	Standard	Addressing
Operating status	0 - *Auto*, 1 - *Manual*	0	201
Ph1 Step up	0/1 1 - Command *Step up*	0	202
Ph2 Step up	0/1 1 - Command *Step up*	0	203
Ph3 Step up	0/1 1 - Command *Step up*	0	204
Ph1 Step down	0/1 1 - Command *Step down*	0	205
Ph2 Step down	0/1 1 - Command *Step down*	0	206
Ph3 Step down	0/1 1 - Command *Step down*	0	207
Clear statistics	0/1 1 - Command *Clear statistics*	0	208
Reset indicator	0/1 1 - Command *Reset indicator*	0	209

Table 10-13 Operating status and regulator commands

Input register (16-Bit data, read only)			
Name	permitted values	Unit	Addressing
Step size	0 - 1000	0.01	301
Step phase 1	0 - 8	1	302
Step phase 2	0 - 8	1	303
Step phase 3	0 - 8	1	304
Voltage phase 1	0 - 65000	0.1 V	305
Voltage phase 2	0 - 65000	0.1 V	306
Voltage phase 3	0 - 65000	0.1 V	307
Current phase 1	0 - 65000	0.1 A	308
Current phase 2	0 - 65000	0.1 A	309
Current phase 3	0 - 65000	0.1 A	310
Active power phase 1	-32767 - 0 - 32767	0.1 kW	311
Active power phase 2	-32767 - 0 - 32767	0.1 kW	312
Active power phase 3	-32767 - 0 - 32767	0.1 kW	313
Apparent power phase 1	0 - 65565	0.1 kVA	314
Apparent power phase 2	0 - 65565	0.1 kVA	315
Apparent power phase 3	0 - 65565	0.1 kVA	316
Reactive power phase 1	0 - 65000	0.1 kvar	317
Reactive power phase 2	0 - 65000	0.1 kvar	318
Reactive power phase 3	0 - 65000	0.1 kvar	319
Number of steps day Ph1	0 - 99999999	1	320
Number of steps day Ph2	0 - 99999999	1	321
Number of steps day Ph3	0 - 99999999	1	322
Number of steps week Ph1	0 - 99999999	1	323
Number of steps week Ph2	0 - 99999999	1	324
Number of steps week Ph3	0 - 99999999	1	325
Number of steps month Ph1	0 - 99999999	1	326
Number of steps month Ph2	0 - 99999999	1	327

Input register (16-Bit data, read only)			
Name	permitted values	Unit	Addressing
Number of steps month Ph3	0 - 99999999	1	328
Number of steps year Ph1	0 - 99999999	1	329
Number of steps year Ph2	0 - 99999999	1	330
Number of steps year Ph3	0 - 99999999	1	331
Temperature cabinet	-35000 - 0 - 35000	0.1°C	332
Drag indicator U1 max.	0 - 65000	0.1 V	333
Drag indicator U2 max.	0 - 65000	0.1 V	334
Drag indicator U3 max.	0 - 65000	0.1 V	335
Drag indicator I1 max.	0 - 65000	0.1 A	336
Drag indicator I2 max.	0 - 65000	0.1 A	337
Drag indicator I3 max.	0 - 65000	0.1 A	338
Drag indicator P1 max.	-32767 - 0 - 32767	0.1 kW	339
Drag indicator P2 max.	-32767 - 0 - 32767	0.1 kW	340
Drag indicator P3 max.	-32767 - 0 - 32767	0.1 kW	341
Drag indicator T max.	-35000 - 0 - 35000	0.01°C	342
Drag indicator T min.	-35000 - 0 - 35000	0.01°C	343

Table 10-14 Measurement and informational values register

Holding registers (16-Bit data, read and write)				
Name	permitted values	Standard	Unit	Addressing
Set point	10000 - 26000	23000	0,01 V	401
Tolerance band +	10000 - 12000	10300	0,01 %	402
Tolerance band -	8000 – 10000	9700	0,01 %	403
Impedance	0 - 500	0	0,001 Ω	404
Reaction Time	10 - 1000	100	0,1 Vs	405
Balancing *	0 - 1	1	0	406
Overvoltage warn.*	10500 - 15000	11000	0,01 %	407
Undervoltage warn.*	0 - 9500	9000	0,01 %	408

(* from FW – 12.00.06)

Table 10-15 Set up register

10.5 IEC 60870-5-104

IEC 60870-5-104 is a communication protocol that communicates over the TCP/IP interface. In LVRSys™ the IEC 60870-5-104 can be activated via the license manager.
If this communication protocol is subsequently required, please contact the A. Eberle support team.

10.5.1 Unlock IEC 60870-5-104 License

This chapter can be skipped if the protocol was already activated by A-Eberle on delivery.

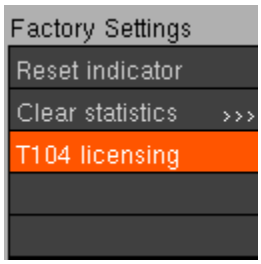


Figure 10-33 T104 licensing

The license file is transmitted by the A. Eberle support team and is linked to the serial number of the system.

- ➲ Save the license file on a USB stick (FAT32 formatted).
- ➲ Plug the USB stick into LVRSys™
- ➲ Select menu item *T104 licensing*.
- ➲ Confirm with *Yes*.
  - ↳ IEC 60870-5-104 is unlocked.
- ➲ Change to the parameterization of T104.

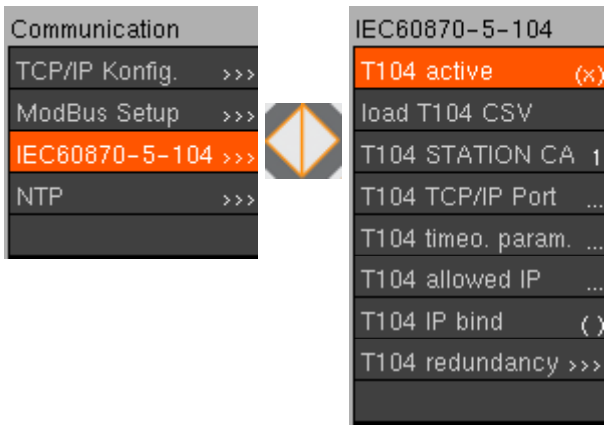


Figure 10-34 Setup 60870-5-104

10.5.2 CSV configuration of the IEC 60870-5-104 Slave

The LVRSys™ IEC 60870-5-104 slave can be configured through a CSV file.

When the system is started, the CSV file is loaded and the IEC 60870-5-104 slave is then ready for operation.

All possible configurations are described in the standard *lvrsys_t104_target.csv.*
The desired changes must be made directly in the file, using the following steps:

- Obtain the CSV file template *lvrsys_t104_target.csv* from A. Eberle support team.
- Adjust CSV file as desired with Editor or MS Excel.
- Save CSV file as lvrsys_t104_target.csv (MS-DOS file if MS Excel is used) on FAT32 formatted USB stick.
- Insert the USB-stick in the LVRSys.
- Select menu item Communication->IEC60870-5-104->T104 CSV load.
  - IEC 60870-5-104 configuration adapted.

10.5.3 IEC 60870-5-104 Parameters

0 *T104 active* (deactivated – all configurations 0 / activated – configurations are loaded)
  - New configurations of the IEC 60870-5-104 slave are loaded when changing from deactivated->activated.

0 *T104 Station CA* is the IP address of the approved station (ASDU)

0 Default is 1 (Each station allowed).

0 *T104 TCP/IP Port* address of the 1st. instance of the T104

0 Default is 2404.

0 Timeout (T104 Timeout parameter)

Parameter	Default	Notice
t0	30 s	Timeout of connection establishment
t1	15 s	Timeout of transmit or test ASDUs
t2	10 s	Timeout for acknowledgments without data telegrams $t_2 < t_1$
t3	20 s	Timeout for sending test frames during long idle time
K	12	Maximum number of unacknowledged telegrams
W	8	Acknowledge after w telegrams

Table 10-16 Timeout parameter

0 *T104 IP Bind* (activated, only with redundancy system)

- LVRSys™ IEC 60870-5-104 slave can be bound to a system IP address in the first instance. This is useful if redundancy systems are used for communication or there is an additional connection via other networks such as WLAN or UMTS. LVRSys™ IEC 60870-5-104 slave then only listens to the first instance.
  - For redundancy systems with different IP addresses and the same port address, *T104 IP Bind* must be activated.
- T104 Redundancy (see section 10.5.4)

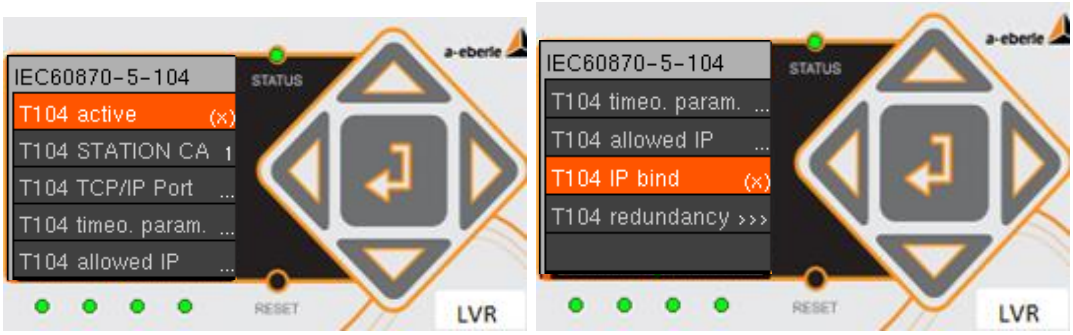


Figure 10-35 Parameter overview IEC 60870-5-104

10.5.4 Redundancy System

- LVRSys™ IEC 60870-5-104 slave can use five IEC 60870-5-104 connections simultaneously.
- Each instance has its own IEC 60870-5-104 process illustrations and messages.
- LVRSys™ IEC 60870-5-104 slave does not hold any events or messages in the queue. Messages are transmitted and process mappings are refreshed when the connection returns.
  - If there is no connection, the LVRSys™ IEC 60870-5-104 slave will not renew process mappings and will not collect messages. As soon as the connection re-established, the LVRSys™ IEC 60870-5-104 slave compares the process images and sends new messages.
  - The redundant instances are always connected to the set IP addresses! If no IP address is set, the instances connect to all networks (IP = 0.0.0.0).
  - For redundancy systems with different IP addresses and the same port address, *T104 IP Bind* must be activated. Otherwise, the first instance will connect to all networks and the other instances will not be able to connect.

10.5.5 Process information for monitoring

Process information implemented as standard for monitoring:

Type identification	Process information
01	Single message
03	Double message
13	Measured value, shorted floating point number
30	Single message with time stamp
31	Double message with time stamp
36	Measured value, shorted floating point number with time stamp

Table 10-17 Process information for monitoring

10.5.6 Process information for control

By default implemented process information for control:

Type identification	Process information
45	Single command
46	Double command
50	Set point command, floating point number
58	Single command with time stamp
59	Double command with time stamp
63	Set point command, floating point number with time stamp
100	Query command
103	Time synchronization command
107	Test command with time stamp

Table 10-18 Process information for control

10.5.7 IEC 60870-5-104 register assignment

The register assignment is valid for firmware version 12.00.04 in combination with the CSV configuration (# T104 csv file for LVRSys V1.3 – 9U #).

Values Description: ON -> OFF -> 0

Alarms/Message				
Name	Permitted values	Standard	IEC60870-104 Addressing	IEC60870-104 Type
Operation mode Auto	ON -> Auto / OFF -> Off	-	350	30
Operation mode Manual	ON -> Manual / OFF -> Off	-	351	30
Clear statistics	ON -> Statistic cleared	-	352	30
Clear drag indicators	ON -> Drag indicators cleared	-	353	30
Status Operation	ON -> Operation	-	354	30
Status Error	ON -> Error	-	355	30
Error 1 (Contactor)	ON -> Alarm / OFF -> Normal	-	356	30
Error 2 (Transformer contact)	ON -> Alarm / OFF -> Normal	-	357	30
Error 3 (Service switch)	ON -> Alarm / OFF -> Normal	-	358	30
Error 4 (Over temperature)	ON -> Alarm / OFF -> Normal	-	359	30
Warning 1 (Overvoltage L1) *	ON -> Alarm / OFF -> Normal	-	360	30
Warning 2 (Overvoltage L2) *	ON -> Alarm / OFF -> Normal	-	361	30
Warning 3 (Overvoltage L3) *	ON -> Alarm / OFF -> Normal	-	362	30
Warning 4 (Undervoltage L1) *	ON -> Alarm / OFF -> Normal	-	363	30
Warning 5 (Undervoltage L2) *	ON -> Alarm / OFF -> Normal	-	364	30
Warning 6 (Undervoltage L3) *	ON -> Alarm / OFF -> Normal	-	365	30

(* from FW – 12.00.06)

Table 10-19 Alarm/Message register

Commands				
Name	Permitted values	Standard	IEC60870-104 Addressing	IEC60870-104 Type
Ph1 switch step	ON -> Increase / OFF -> Decrease	-	550	59
Ph2 switch step	ON -> Increase / OFF -> Decrease	-	551	59

Ph3 switch step	ON -> Increase / OFF -> Decrease	-	552	59
Operating status Automatic	ON -> Automatic	-	450	58
Operating status Manual	ON -> Manual	-	451	58
Clear statistics	ON -> Clear Statistics	-	452	58
Reset drag indicators	ON -> Reset Drag Indicators	-	453	58

Table 10-20 Commands register

Measured values + counter				
Name	Permitted val-ues	Standard	IEC60870-104 Addressing	IEC60870-104 Type
Step size	0 – 1000	100	100	36
Step Phase 1	0 - 8	0	101	36
Step Phase 2	0 - 8	0	102	36
Step Phase 3	0 - 8	0	103	36
Voltage Phase 1	0	0	104	36
Voltage Phase 2	0	0	105	36
Voltage Phase 3	0	0	106	36
Current Phase 1	0	0	107	36
Current Phase 2	0	0	108	36
Current Phase 3	0	0	109	36
Active Power Phase 1	0	0	110	36
Active Power Phase 2	0	0	111	36
Active Power Phase 3	0	0	112	36
Apparent Power Phase 1	0	0	113	36
Apparent Power Phase 2	0	0	114	36
Apparent Power Phase 3	0	0	115	36
Reactive Power Phase 1	0	0	116	36
Reactive Power Phase 2	0	0	117	36
Reactive Power Phase 3	0	0	118	36
Number of steps day Ph1	0	0	119	36
Number of steps day Ph2	0	0	120	36
Number of steps day Ph3	0	0	121	36
Number of steps week Ph1	0	0	122	36
Number of steps week Ph2	0	0	123	36
Number of steps week Ph3	0	0	124	36
Number of steps month Ph1	0	0	125	36
Number of steps month Ph2	0	0	126	36
Number of steps month Ph3	0	0	127	36
Number of steps year Ph1	0	0	128	36

Number of steps year Ph2	0	0	129	36
Number of steps year Ph3	0	0	130	36
Temperature cabinet	0	0	131	36
Drag indicator U1 max.	0	0	132	36
Drag indicator U2 max.	0	0	133	36
Drag indicator U3 max.	0	0	134	36
Drag indicator I1 max.	0	0	135	36
Drag indicator I2 max.	0	0	136	36
Drag indicator I3 max.	0	0	137	36
Drag indicator P1 max.	0	0	138	36
Drag indicator P2 max.	0	0	139	36
Drag indicator P3 max.	0	0	140	36
Drag indicator Temp. cabinet max.	0	0	141	36
Drag indicator Temp. cabinet min.	0	0	142	36

Table 10-21 Measured values +counter register

Regulation parameters actual values				
Name	Permitted values	Standard	IEC60870-104 Addressing	IEC60870-104 Type
Log Error	0	0	143	36
FW Version	0	0	144	36
Set point	0	0	145	36
Tolerance band +	0	0	146	36
Tolerance band -	0	0	147	36
Reaction time	0	0	148	36
Impedance	0	0	149	36

Table 10-22 Regulation parameters actual values + system information register

Set parameters				
Name	Permitted values	Standard	IEC60870-104 Addressing	IEC60870-104 Type
Set point	100 - 260	230	200	63
Tolerance band +	102 - 120	103	201	63
Tolerance band -	80 - 98	97	202	63
Reaction time	0.1 - 10	10	203	63
Impedance	0 - 0.5	0	204	63
Balancing *	0 - 1	1	205	63
Overvoltage warning *	105 – 150	110	206	63
Undervoltage warning *	0 – 95	90	207	63

(* from FW – 12.00.06)

Table 10-23 Set regulation parameters register

10.6 NTP Time Synchronization

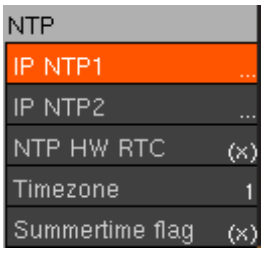


Figure 10-1 NTP Display

NTP time synchronization takes place via the connection to an NTP server.

- Connection to network or Internet required.
- Set the desired server IP *NTP IP1, NTP IP2*.
  - Possible IP for Internet connection 192.53.103.108 (PTB, Braunschweig)
- *NTP HW RTC* (x) -> Time is synchronized via the HW RTC (hardware clock), if NTP-Server is not available.
  ( ) -> Time is not synchronized with HW RTC (hardware clock), if NTP IP is not available.
- *Summertime flag* (x) -> Automatic changeover to summertime.
  ( ) -> No automatic changeover to summertime.
- Set *Time zone* relative to GMT (Germany +1).

10.7 Further protocols

- For implementation of further communication protocols, please contact A. Eberle GmbH & Co. KG.

11. IT-Security

Figure 11-1 Overview security parameters

➲ Selection of the sub item security for setting security-relevant parameters.

0 Change and adjust the PIN.

0 Shut down and allow protocols.

0 Shut down and allow remote access.

0 Encrypt TCP/IP packets.

0 Shut down and activate Ethernet interface.

12. Software Remote LVRSysUpdater (from Ver. 1.1.26)

12.1 Hardware and software requirements

Hardware requirements (minimum)

- Intel or AMD Dual Core CPU
- Graphics card with at least 512 MB RAM, screen resolution 1280 x 800 or higher recommended
- 1 GB RAM
- Network connection 100 MBit/s

Supported operating systems

- Microsoft® Windows® Vista (32-bit and 64-bit*)
- Microsoft® Windows® 7 (32-bit and 64-bit*)
- Microsoft® Windows® 8 (32-bit and 64-bit*)
- Microsoft® Windows® 10 (32-bit and 64-bit*)

* On a 64-bit operating system, the application runs in 32-bit mode.

12.2 First registration (login data)

➲ Execute installation file (.exe).

➲ Log on as *admin user* (default when first run)

NOTE!	**Login data (admin user)**	
	Username:	admin
	Password:	Su8Tj6rm

➲ Create new *admin user* (see chapter 12.3.1)

➲ Create new user if necessary (see chapter 12.3.1)

- **Admin user (Administrator):** Unrestricted access rights.
- **User (operator):** Limited access rights (firmware update / logbook download).
- **Default user:** Automatically logged in when starting LVRSysUpdater.

12.3 User administration

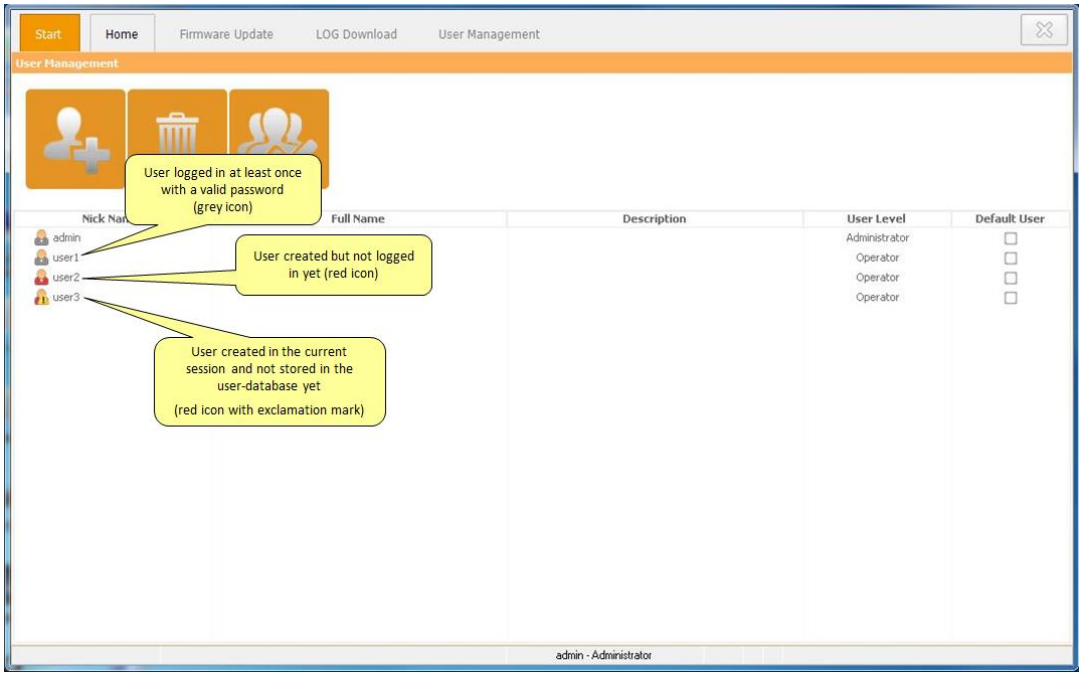


Figure 12-1 Overview of user administration

12.3.1 Creating a New User

- Open User Management.
- Click on New User.
- Enter user.
- Confirm with Next.
- Set user rights.
- If necessary, define default users (set a check mark).
- If necessary, reset the password (tick the box).
  - Only visible if user has already logged in once.
- Confirm with OK.
- Click Save user settings.

12.3.2 Set user password

- Set password at first login or after resetting the password.

12.3.3 Delete user

- Open User Management.
- Select the user to be deleted and click.

12.3.4 Change user data

- Open User Management.
- Double-click on the user to be changed.
- Change settings (see section 12.3.1).
- Confirm with OK.

12.3.5 Reset user password

- Open User Management.
- Double-click on User.
- Click Next.
- Select the Reset password checkbox.
- Confirm with OK.
  - Enter a new password at the next login.

12.3.6 Save user settings

- Click  Save user settings.
  - User symbol with warning signs  have not yet been saved.

12.4 Connection LVRSys

LVRSysUpdater requires TCP port 3002 and the FTP ports 21 and 22.
Check your firewall settings if necessary.

- Establish TCP connection from PC to LVRSys (see chapter 10.3 TCP/IP Configuration via Ethernet)
- Start LVRSysUpdater.
- Select Firmware Update or Logbook Download.
- Enter username and password. Confirm with OK.
- Enter IP address LVRSys.
- Perform 

ping test.
- Confirm with OK.
- Enter device PIN.

NOTE!	Device PIN: Factory setting 0000 (4 times zero)

- Confirm with OK.

Figure 12-2 Entering the device PIN

☑ Summary of the LVRSys system information.

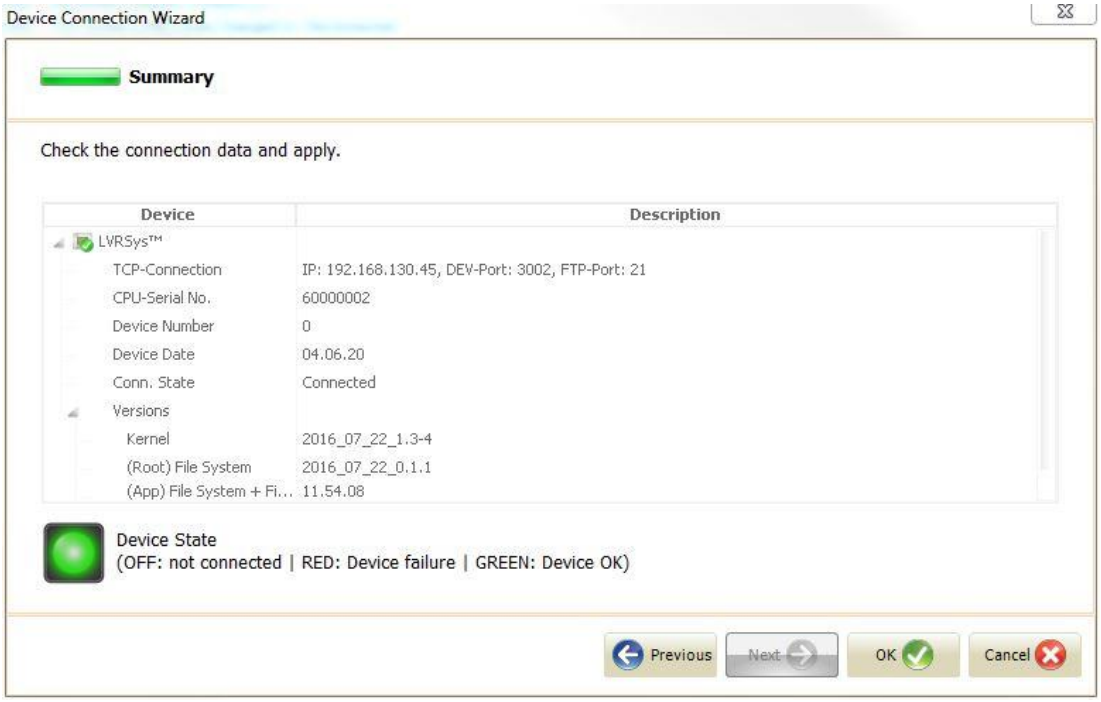


Figure 12-3 Summary of system information

➲ Confirm with OK.

➲ Continue with Firmware Update (see 12.5) or download logbook (see 12.6).

12.5 Remote firmware update

NOTE!	During the update process the power supply of the computer and LVRSys terminal device must not be interrupted.

➲ Download TCP update. Please contact the A. Eberle support team.

➲ Unpack the .zip file.

➲ Starting the firmware update described in 12.4 Connection LVRSys

➲ Select the directory with unpacked TCP update.

↳ Select directory level see Figure 12-4 below.

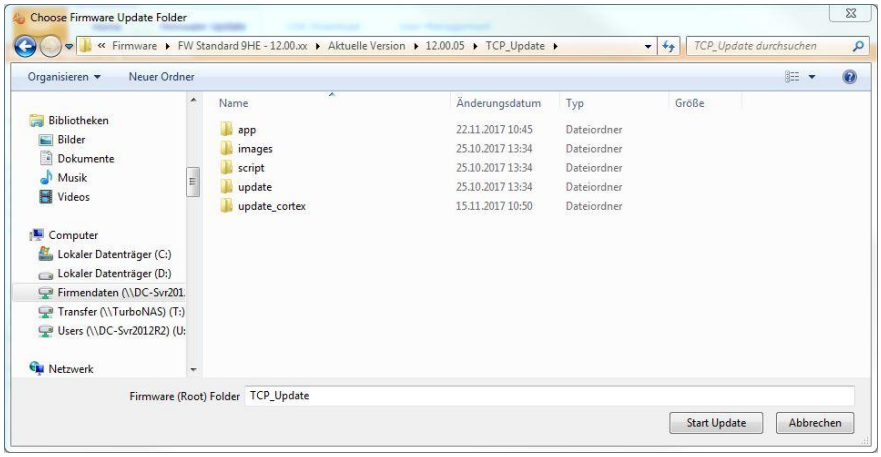


Figure 12-4 Directory level for TCP update

➲ Confirm with OK.

↳ Comparison of the firmware versions PC and LVRSys.

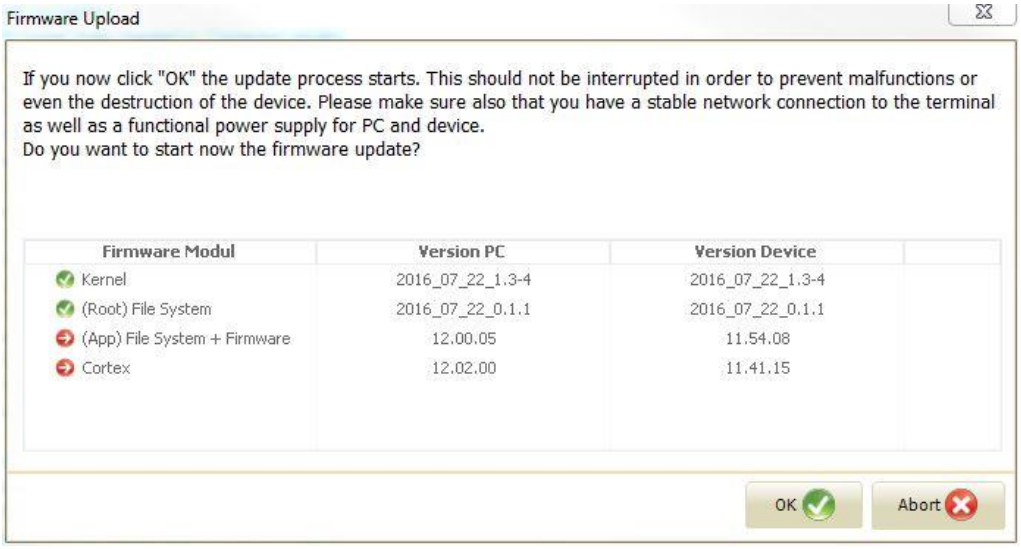


Figure 12-5 Comparison firmware versions

Green Check: Firmware module versions PC and device identical. No update necessary.
Red Cross: Firmware module versions PC and device different. Update necessary.

➲ Confirm with OK.

↳ LVRSys restarts during the update process.
↳ Dialog window with successful update.
↳ Log-File shows the progress of the update.

12.6 Logbook Download

➲ Start the logbook download as described in 12.4 Connection LVRSys

➲ Selection Type of the exported data:

- 0 Measurement data (CSV)
- 0 Event data (TXT)

➲ Select destination folder for exporting data.

➲ Select start date for exporting data.

↳ (Download always takes place from the start date until today/day of the download)

➲ Confirm with OK.

↳ Measurement data or event data are stored in the destination folder.

Figure 12-6 Selection of data to be exported

12.7 Menu functions

12.7.1 Change program language

➲ Click Start.

➲ Change language.

12.7.2 Change visual program style

➲ Click Start.

➲ Change visual style.

12.8 License information

If you have any questions about licenses, please contact A. Eberle.

13. External devices & modifications

An installation space of WxDxH 400x100x300 mm in the controller cabinet is available for external devices.

Larger installation space is possible after consultation with A. Eberle.

13.1 External devices

External devices can be installed and wired by A. Eberle GmbH & Co. KG by arrangement.

External devices are e. g.:

- Communication Modems
- Remote control systems

13.2 PQI-DA *smart*

- With the optional voltage quality measurement at the input (feature I2, I21, I22, I23, I24, I25, I3), fuse terminals for the voltage taps and current transformers for the current measurement at the input bus bar are installed.
- With the option voltage quality measurement at the input (feature I1, I11, I12, I13, I14, I15, I3), fuse terminals for the voltage taps and current transformers for the current measurement at the output bus bar are installed.

⚠ **DANGER!**	**Danger of electric shock!** Establish BYPASS operation.

⚠ **WARNING!**	To ensure there is no voltage on the PQI-DA *smart*, the LVRSys must be in BYPASS mode.

14. Servicing/Cleaning/Spare parts

- The service interval depends on the operating and environmental conditions.
- The service interval can be determined by the customer himself.
  An interval of 5 years is recommended.
- For service purposes A. Eberle provides a separate service manual.
  Please contact the A. Eberle support team for a copy

15. Standards and Laws (all based on European standards)

- Low voltage directive 2014/35/EU
- DIN EN 61439-1 Low-voltage switchgear and control gear assemblies - Part 1: General rules
- DIN EN 61439-5 Low-voltage switchgear and control gear assemblies - Part 5: Assemblies for power distribution in public networks
- DIN EN 0298-4 Application of cables and cords in power installations - Part 4: Recommended current-carrying capacity for sheathed and non-sheathed cables for fixed wirings in buildings and for flexible cables and cords
- DIN EN 61000-6-1 Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
- DIN EN 61000-6-3 Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
- DIN EN 50160 Voltage characteristics of electricity supplied by public distribution networks
- DIN EN 82079-1 Preparation of instructions for use - Structuring, content and presentation - Part 1: General principles and detailed requirements

16. Disassembly & disposal

⚠ **DANGER!**	**Danger of electric shock!**
	Only disassemble the LVRSys™ when it is de-energised

➲ Make sure the LVRSys™ is completely de-energised.

➲ Remove low voltage cables.

➲ Remove local cabinet grounding.

The disposal of the LVRSys™ is carried out by A. Eberle GmbH & Co. KG.

➲ Send all components to:

A. Eberle GmbH & Co. KG

Frankenstraße 160

D-90461 Nuremberg

17. Warranty

A. Eberle GmbH & Co. KG. warrants that this product and accessories will be free from defects in materials and workmanship for a period of three years from the date of purchase.

Warranty does not apply to damage caused by:

- Accidents
- Misuse
- Abnormal operating conditions

To make a warranty claim, please contact your local A. Eberle distributor or alternatively contact A. Eberle GmbH & Co KG in Nuremberg, Germany

Notes

A. Eberle GmbH & Co. KG

Frankenstraße 160
D-90461 Nuremberg

Tel.: +49 (0) 911/62 81 08-0
Fax: +49 (0) 911/62 81 08 96
Email: info@a-eberle.de

http://www.a-eberle.de

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