Low Voltage Regulation System LVRSys™

- Power range: 7.5 kVA up to 630 kVA
- Regulation ranges: ± 6 % … ± 20 %
- Number of steps: 9
- Efficiency: 99.4 % to 99.8 %
- Phase independent regulation
- No grid interference
- Increase of the single phase short circuit power

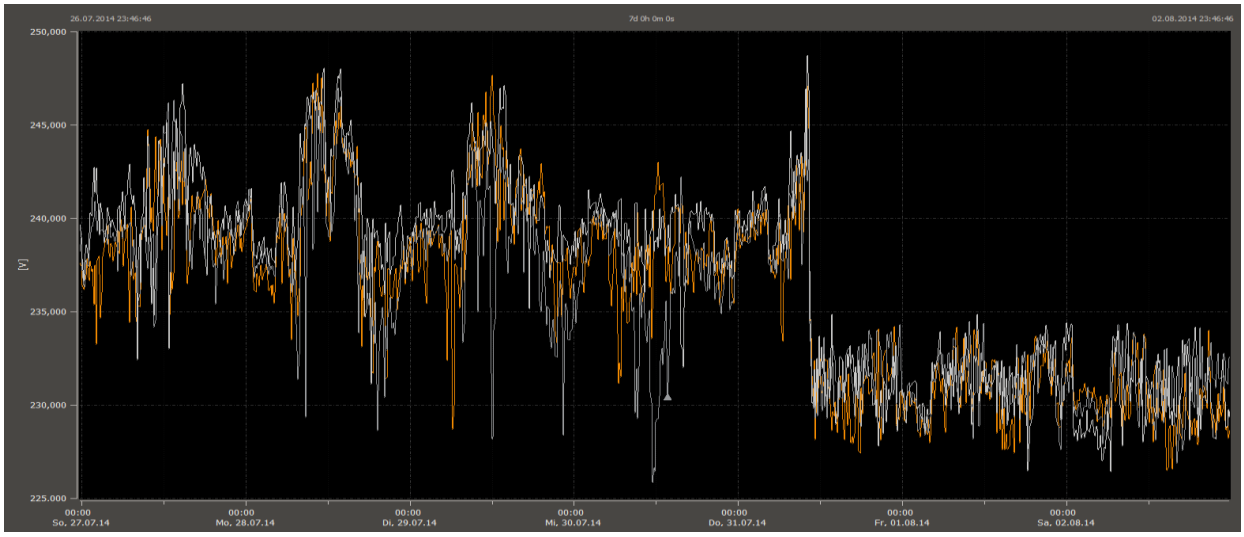
Challenges in the distribution grid

The challenges in the distribution grid are increasing enormously. Voltage band injuries are occuring more often and regular. Photovoltaics in the low-voltage grid raise the voltage level. The increase in heat pumps and electromobility are lowering the voltage level. Voltage increases and voltage decreases are usually staggered in time. PV-systems dominate the voltage level during the day. Heat pumps and electric cars dominate the voltage level in the evening and at night. The majority of electric vehicles is charged at home single-phased. Beside, asymmetries in the 3-phase voltage system are increasing too.

Cost-effective solution for the distribution grid

LVRSys™ postpones and avoids cable and line expansion. Its economical use is worthwhile in almost all low-voltage networks. Investments in new cables and lines tie up the capital invested for decades.

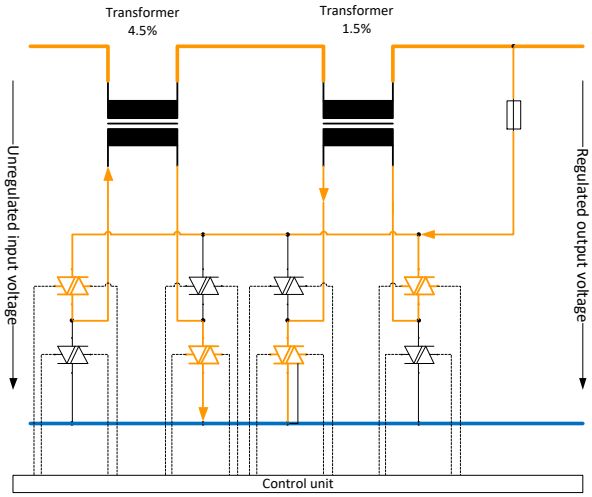
LVRSys™ requires comparatively low investments, which are also flexible and independent of locations. If the conditions in the distribution grid change fundamentally, the LVR-system can simply be moved.



Voltage profile of a grid branch without and with LVRSys™

Operation

The principle of the LVRSys™ control is similar to a linear regulator. By coupling and uncoupling two transformers with selected transfer ratios, it is possible to regulate the output voltage in 9 steps. The thyristors switch intelligently and avoid any current surges, voltage dips and harmonics.



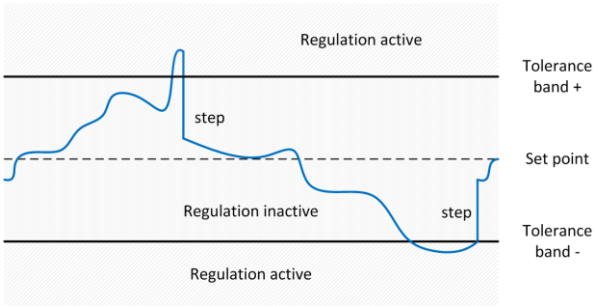
Example of 3 % voltage reduction

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 %**

Generation of the voltage levels in 9 steps, e.g. 6% system

Regulation parameters

- Set point (voltage value, 3-phase)
- Tolerance band +
  (Upper limit value of the tolerance area)
- Tolerance band -
  (Lower limit value of the tolerance area)
- Reaction time
- Line drop compensation (grid impedance)
- Balancing of the 3-phase voltages within the tolerance area

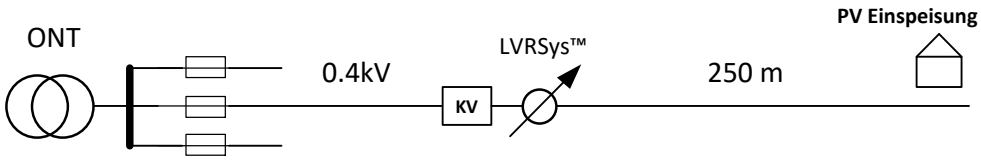


Regulation range

Line drop compensation

The reference voltage value is calculated from the current measurement and the grid impedance. The regulation can thereby be optimized without additional communication devices.

In the load scenario the calculated voltage value is reduced. In the feed-in scenario, the calculated voltage value is increased.



Example: LVRSys™ and PV-system with a line distance of 250m

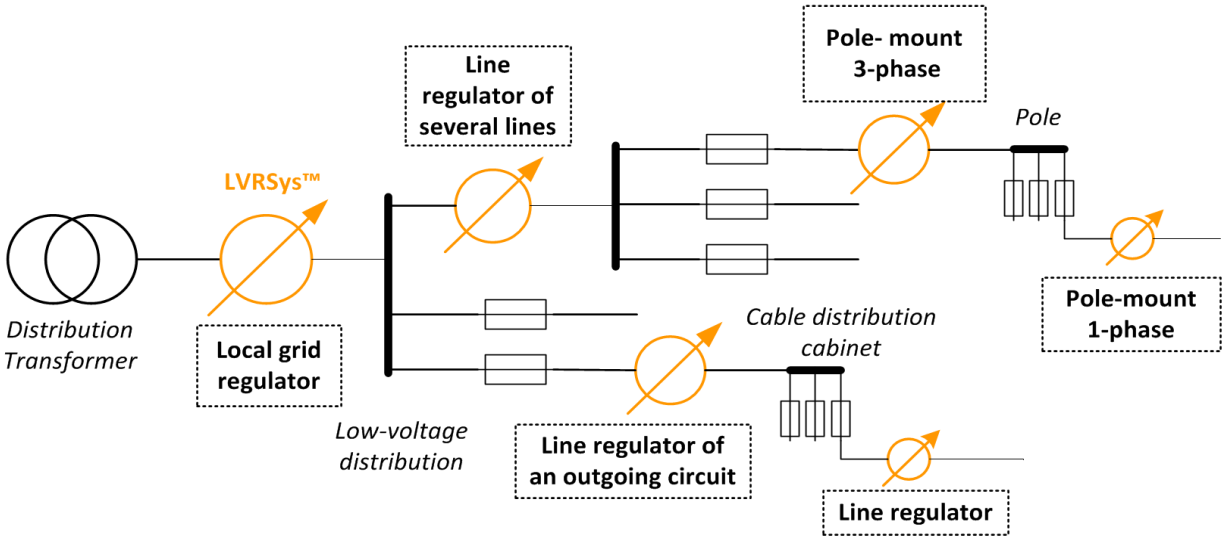
In this line a PV-system feeds current into the grid. The grid impedance regulation calculates the voltage drop of the cable in addition to the measured voltage. The LVRSys™ regulates now the voltage at the end of the cable into the tolerance band. The regulation area is extended and the voltage at the selected point in the grid is regulated.

Balancing of the three-phase voltage

The phase-independent regulation enables the *balancing* of the three-phase voltages and thus improves the power quality of the grid. Three-phase loads, such as motors, operate with a symmetrical voltage more efficiently and have in consequence a longer product life cycle.

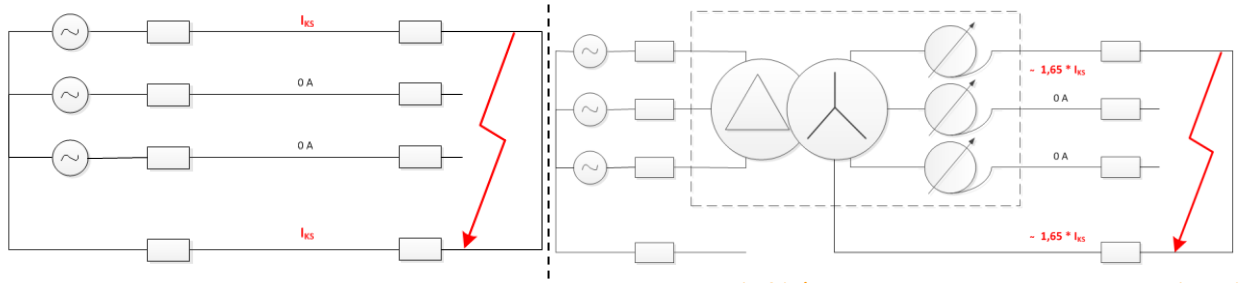
Perfect scaling for the low voltage grid

Power classes from 22 kVA to 630 kVA (3-phase) or 7.5 to 35 kVA (1-phase) are available especially for the low-voltage grid.



Possible application locations of LVRSys™

Increase the single-phase short-circuit power



Single-pole short-circuit power without LVRSys™+ preliminary stage (left) / with LVRSys™+ preliminary stage (right)

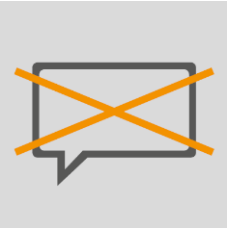
At the end of very long cables the single-phase short-circuit power is very low. The triggering criteria of the fuses cannot be fulfilled in case of a single-phase short-circuit.

LVRSys™, in combination with a preliminary stage, increases the short-circuit power by approx. 65 %. Through this, grid expansion caused by low short-circuit power can be avoided.

LVRSys™ flexible and robust for every application

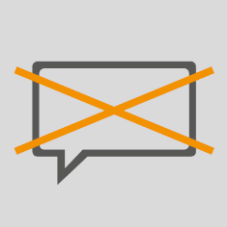
Robust

- Twenty billions of switches
- Short circuit proofed up to 50 kA
- High resistance to over voltages, direct and indirect lightning strikes
- Overloading (as NH-Fuse)



Grid compatibility

- No grid interference, causes no flicker or harmonics
- Balancing of the voltage via phase-independent regulation
- Existing fuse concept can be maintained
- Interruption-free power supply guaranteed (*Automatic Bypass*)



Intuitive and secure

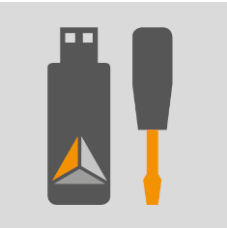
- Installation as a cable distribution cabinet
- Common connection via NH-switch disconnectors
- Commissioning via NH-switch disconnectors or Circuit breakers
- Fully encapsulated system for maximum touch protection

Reliable and economical

- High efficiency
- Passive cooling even in direct sunlight
- Operation temperature -40 °C up to +50 °C ambient temperature
- Electronics moisture-proof housed in the internal control cabinet (IP66)

Flexible and fast

- Adjustable response time of the controller < 30 ms up to 100 s
- Adaption of the control algorithms to different applications
- Line drop compensation, without additional communication
- Independent tolerance bands



Easy

- Data export via USB-Stick into e. g. MS Excel
- Firmware update via USB-Stick or SCADA Systems
- Common communication interfaces *Modbus TCP, IEC 60870-5-104*
- Drag indicator in the Display

Design and installation

Grid operators of low voltage grids can choose from several housing variants:

- GRP-housing + GRP
- Aluminum-housing + Concrete base
- Pole Mount

Design of the cabinet variants: GRP distribution cabinet; Aluminum distribution cabinet; Pole mounting

Transport and installation of the systems

The control cabinets, which are placed on an earth base, are equipped with crane lugs. The crane lugs are located under the weather protection roof in the case of aluminium enclosures.

The mast mounting systems are equipped with crane lugs and mounting clamps.

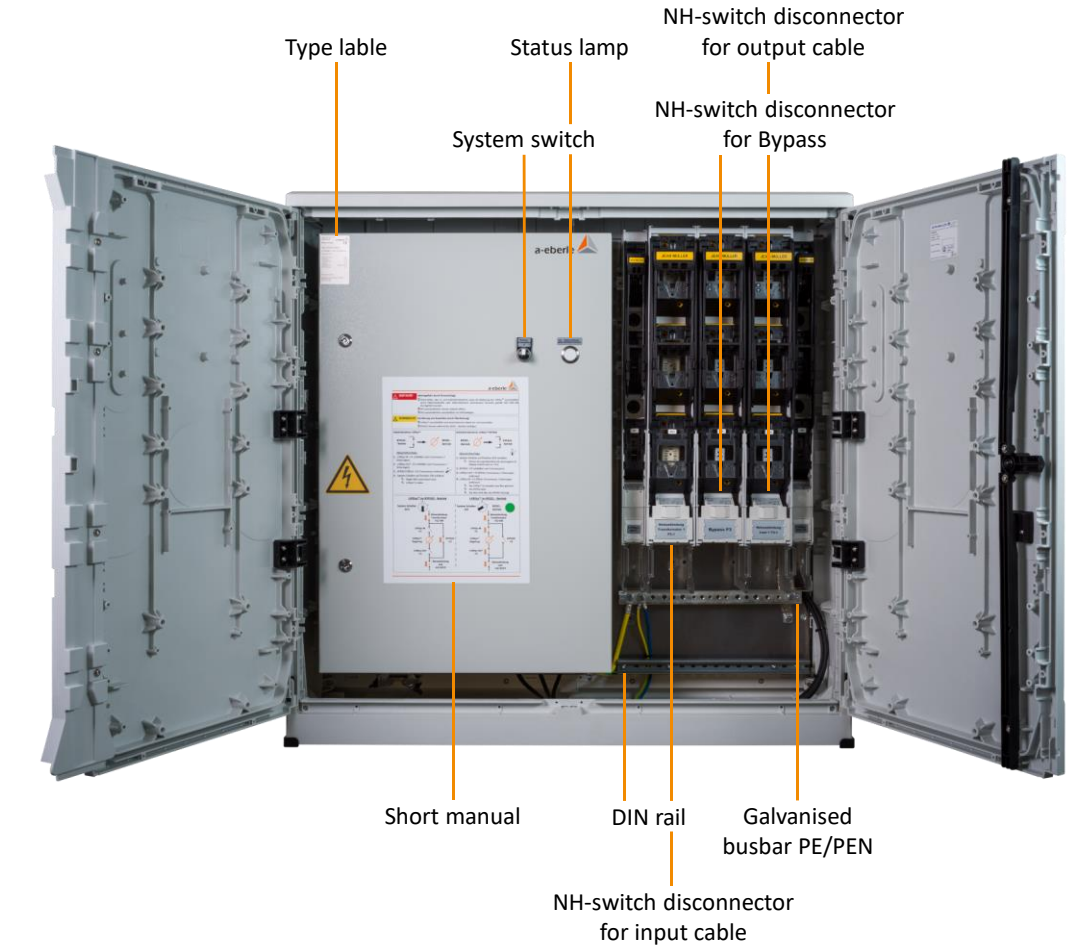
The fixing clamps are adapted to the mast thickness.

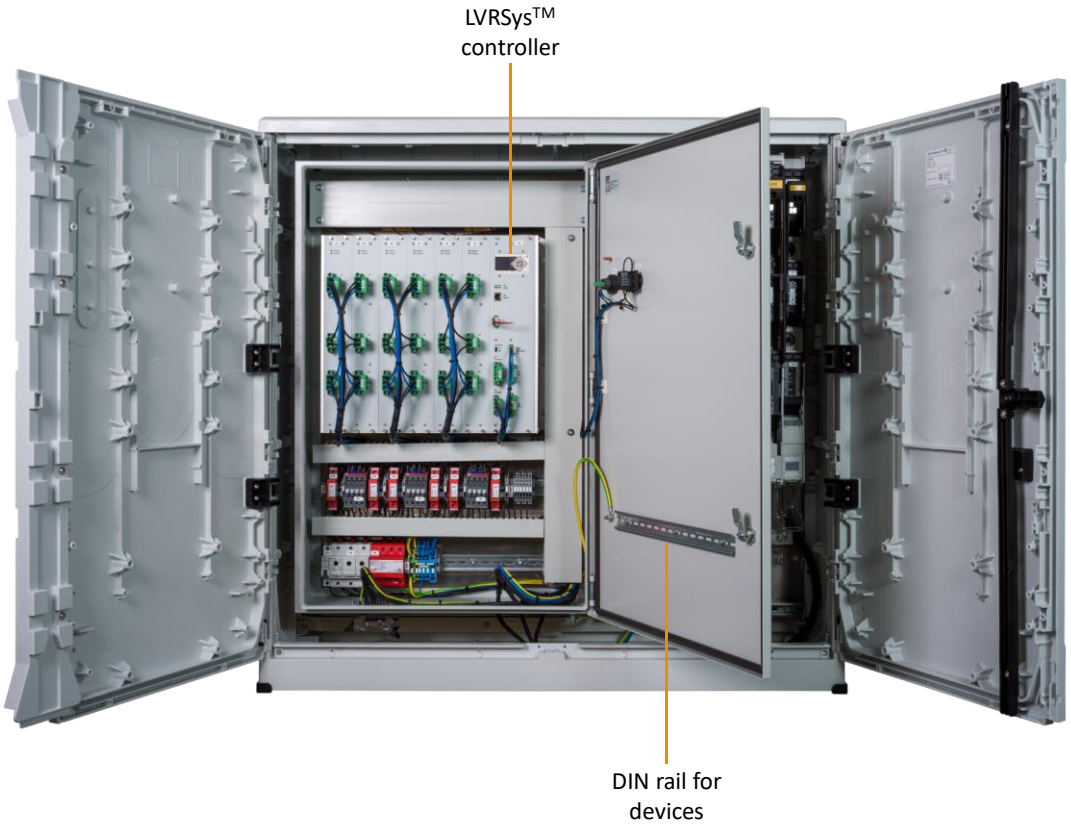
Installation and commissioning

The installation of the system is similar to a conventional unregulated cable distribution cabinet:

1. Disconnect cable
2. Insert LVRSys™ cable distribution cabinet
3. Connect desired cables to NH-switch disconnector
4. Reconnect mains power
5. Switch to control mode via bypass switch-disconnector
6. Set system switch to ON (system controls with factory-set parameters, sufficient in 90% of cases)

The internal design with switch-disconnector-fuses identical for GRP and aluminium housings. For pole-mounted systems, the connection is made via terminals. The bypass is realized via circuit breakers.


Type lable
Status lamp
NH-switch disconnector
for output cable
System switch
NH-switch disconnector
for Bypass
Short manual
DIN rail
Galvanised
busbar PE/PEN
NH-switch disconnector
for input cable


LVRSys™
controller
DIN rail for
devices

Technical data

Rated data		
Rated voltage U_N	400 V / 230 V ±20 % (L-L/LE)	
Rated current I_N 3-phase/1-phase	**3-phase**	**1-phase**
	32 A (22 kVA System)	32 A (7,5 kVA System)
	63 A (44 kVA System)	63 A (15 kVA System)
	100 A (70 kVA System)	100 A (25 kVA System)
	160 A (110 kVA System)	160 A (35 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)	
	909 A (630 kVA System)	
Rated frequency f_N	50 Hz / 60 Hz	
Efficiency	99.4 % – 99.8 %	
Maximum switching duration	30 ms	
Regulation ranges	± 6 % von U_N in 9 steps á 1.5 %	
	± 8 % von U_N in 9 steps á 2.0 %	
	± 10 % von U_N in 9 steps á 2.5 %	
	up to ± 24 % von U_N (Special design)	
Operating temperature	- 40 °C up to + 40 °C (up to + 50 °C special design)	
Maximum permitted air temperature in the switch cabinet	70 °C	
Altitude of the installation (NN)	< 2000 m	
Safety class	IP44 - IP55/ Electronic IP 66	
Max. power consumption of secondary electronics	200 mA (230 V)	
Short-circuit impedance u_k	ca. 0.3 %	
Cooling	passive (convection via switch cabinet housing)	

Limits		
Rated impulse voltage U_{Imp}	6 kV	
Short time current resistance I_{cw} (1 s)	5 kA (up to 70 kVA)	
	15 kA (110 kVA up to 630 kVA)	
Rated conditional short-circuit current I_{cc}	20 kA (up to 70 kVA)	
	50 kA (110 kVA up to 630 kVA)	
Rated conditional short-circuit current I_{cf} protected with fuses	3 kA (22 kVA)	20 kA (175 kVA)
	5 kA (44 kVA)	25 kA (200 kVA)
	10 kA (70 kVA)	30 kA (250 kVA)
	14 kA (110 kVA)	50 kA (400 kVA)
	16 kA (144 kVA)	50 kA (630 kVA)
High rated peak withstand currents I_{pk}	20 kA (up to 70 kVA)	
	50 kA (110 up to 630 kVA)	

	Measurements w/d/h	Weight	Power
Aluminium cabinet	120 cm/40 cm/135 cm	165 kg	up to 250 kVA 8 %
	140 cm/50 cm/145 cm	220 kg	up to 400 kVA
	160 cm/50 cm/155 cm	250 kg	up to 630 kVA
GRP – Cabinet	113 cm/32 cm/113 cm	100 kg	up to 110 kVA
	146 cm/32 cm/113 cm	155 kg	up to 250 kVA 8 %
Pole Mount	80 cm/30 cm/120 cm	110 kg – 130 kg	up to 70 kVA
Concrete base	120 cm/40 cm/100 cm	260 kg	up to 250 kVA 8 %
	140 cm/50 cm/100 cm	280 kg	up to 400 kVA
	160 cm/50 cm/100 cm	300 kg	up to 630 kVA
GRP - Base	113 cm/32 cm/90 cm	30 kg	up to 110 kVA
	146 cm/32 cm/90 cm	40 kg	up to 250 kVA 8 %
Transformer block	40 cm/20 cm/ 85 cm	110 - 215 kg	22 – 110 kVA
	50 cm/22 cm/ 85 cm	190 - 370 kg	144 – 250 kVA 8%
	70 cm/30 cm/ 95 cm	315 - 610 kg	250 kVA 10% - 400 kVA
	70 cm/39 cm/105 cm	400 - 680 kg	630 kVA

Directives	
EMC stability	DIN EN 61000-6-1
EMC interference emission	DIN EN 61000-6-3
Assembly instructions	DIN EN 61439-1/5
Low voltage directive	2014/35/EU
Noise emissions	< 37 dB(A)

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