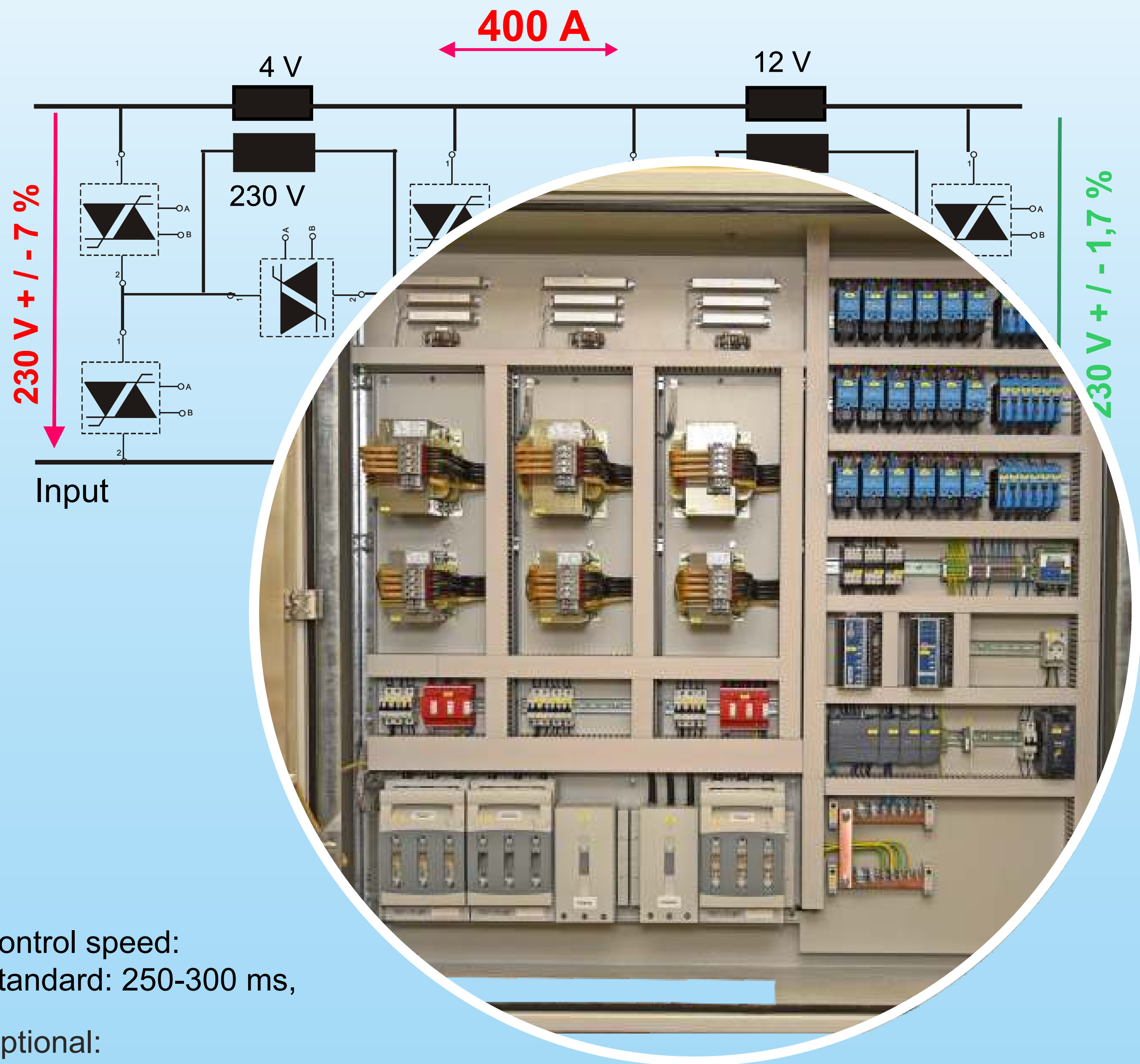
Voltage regulator

For PV-systems, long LV lines
or increasing energy demand



Control speed:
Standard: 250-300 ms,

Optional:
70-120 ms
Surge reduction
< 30 ms

Control system: 3 x single-phase
Control range from +/-7% to +/-30%

34 to 500 kVA

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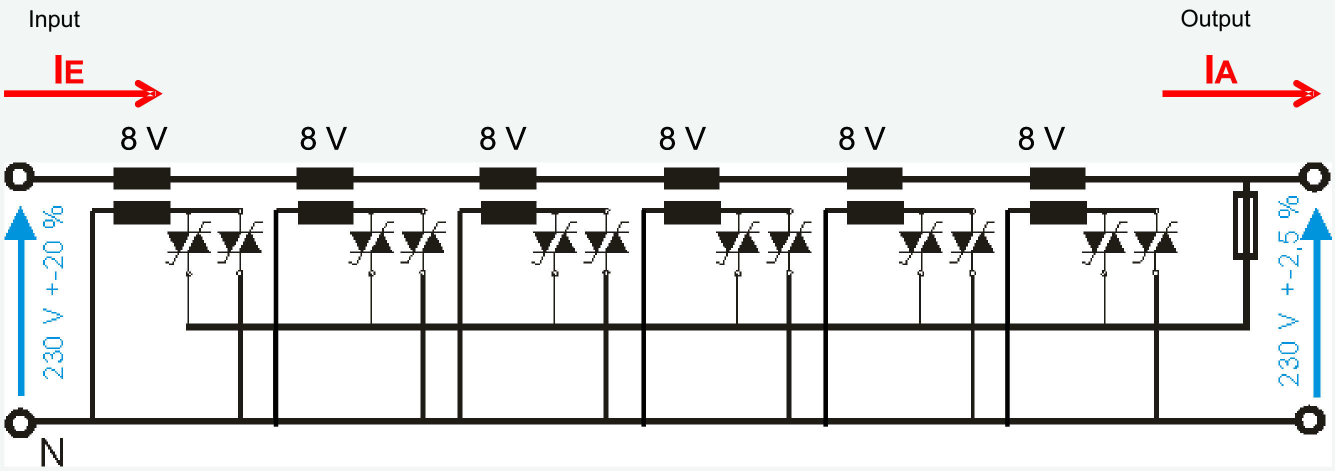
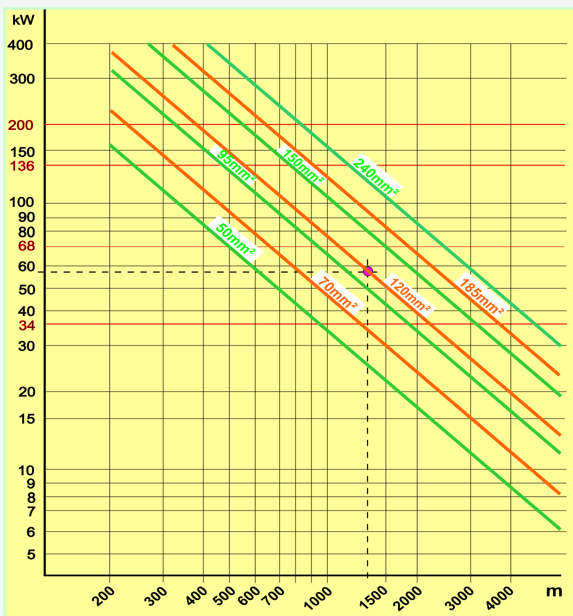
The voltage regulator measures and regulates the 3 phases individually, quickly and independently

When idle, the unneeded transformer stages are bypassed. If due to high loads on the power line, the output voltage of the transformer drops below 225 V, the required transformer stages are calculated and activated via the semiconductor. The bypass of the transformers is suspended and the 230 V coil is switched onto the line voltage.
In case of an excessive input voltage, which can occur due to PV-systems, other feeders or star point shifts, especially under load, the voltage regulator can adjust the voltage, so a symmetrical output voltage of between 235 V and 225 V is always guaranteed.



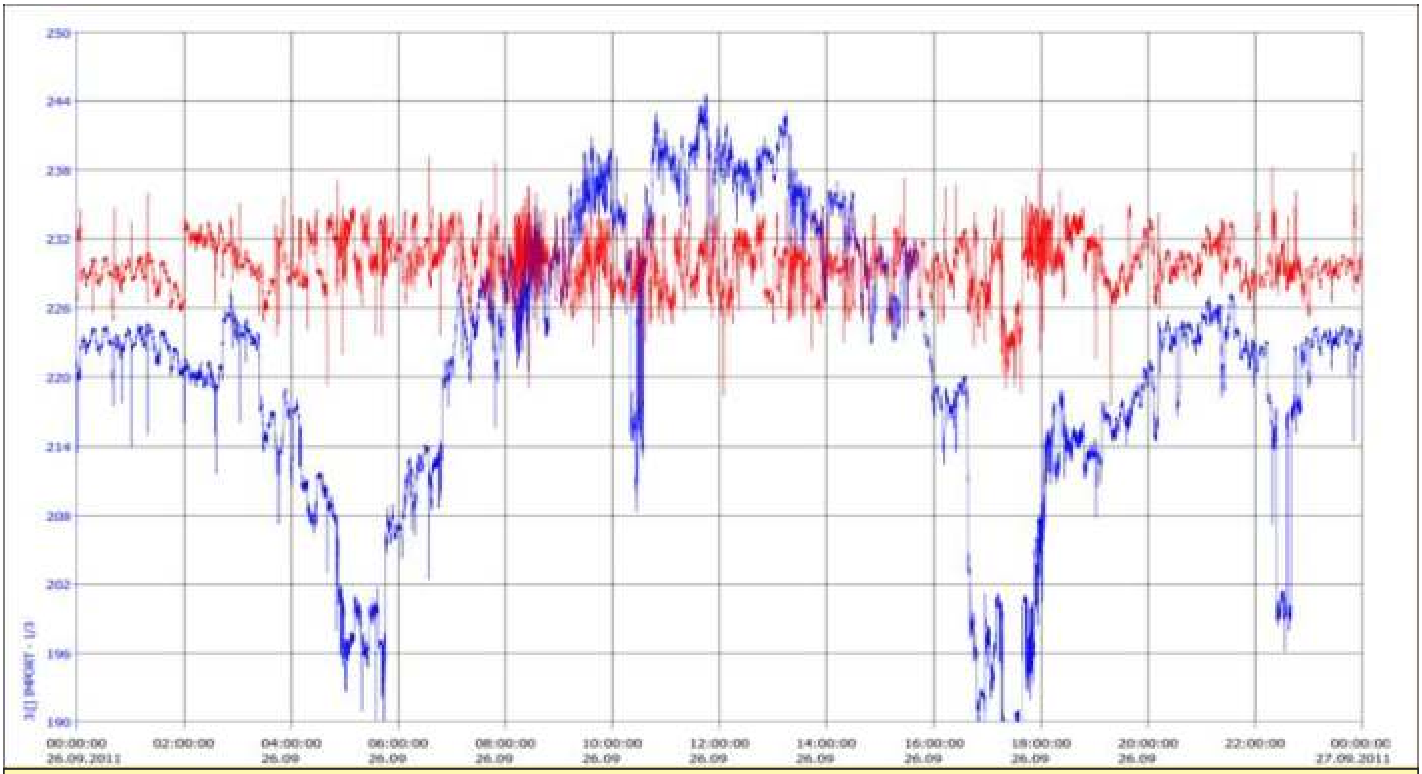
The graphic on the right shows the common aluminum cross sections. The intersect with the km-line provides the greatest possible performance for a range of +/- 48 V per phase for which full regulation to 230/400 V occurs.



Example for voltage regulator +/-48 V per phase

Cross section	q =	120 mm²
Line length	l =	1350 m
Intersection results	P =	58 kW

Feel free to request detailed information.
We're happy to help!

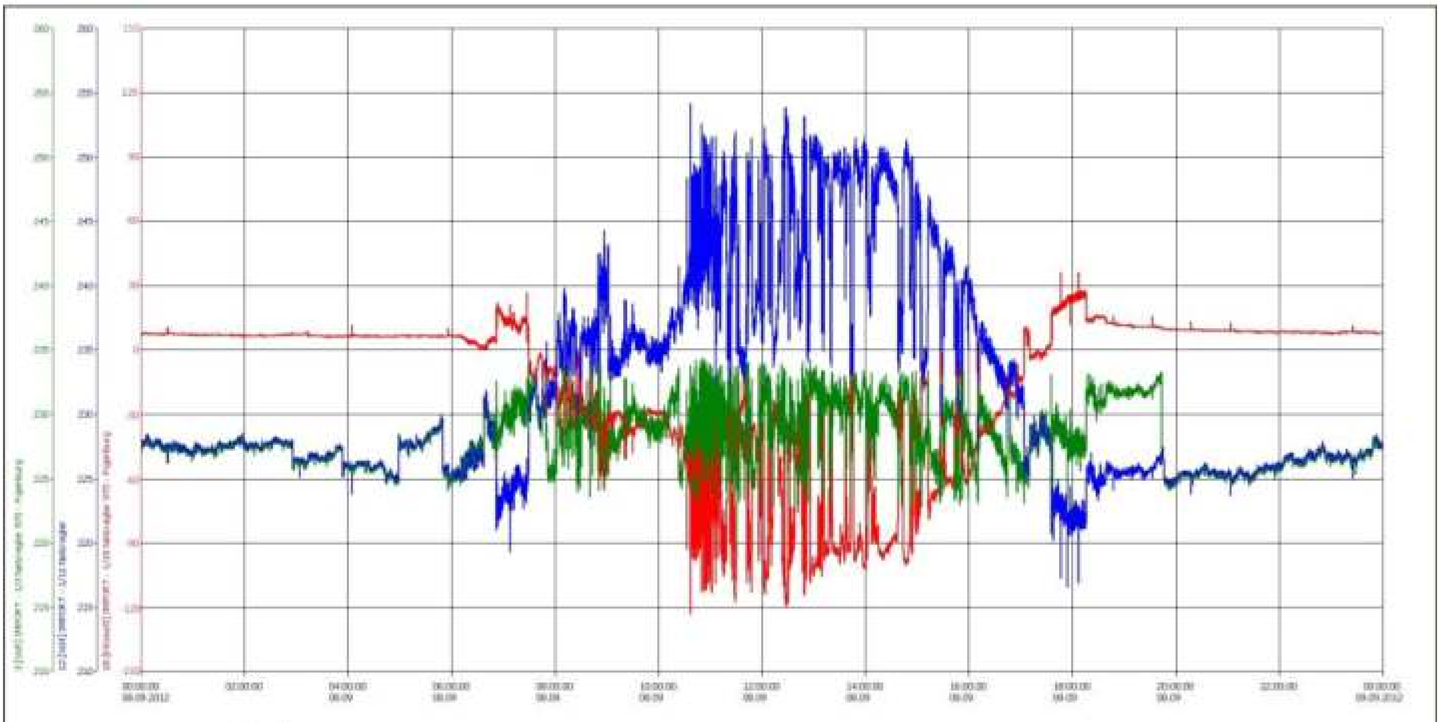


One day's measurement at a 69 kVA voltage regulator, taken every second
Blue = unregulated input voltage
Red = regulated output voltage

Long term measurement with data logger Watch32 Com.

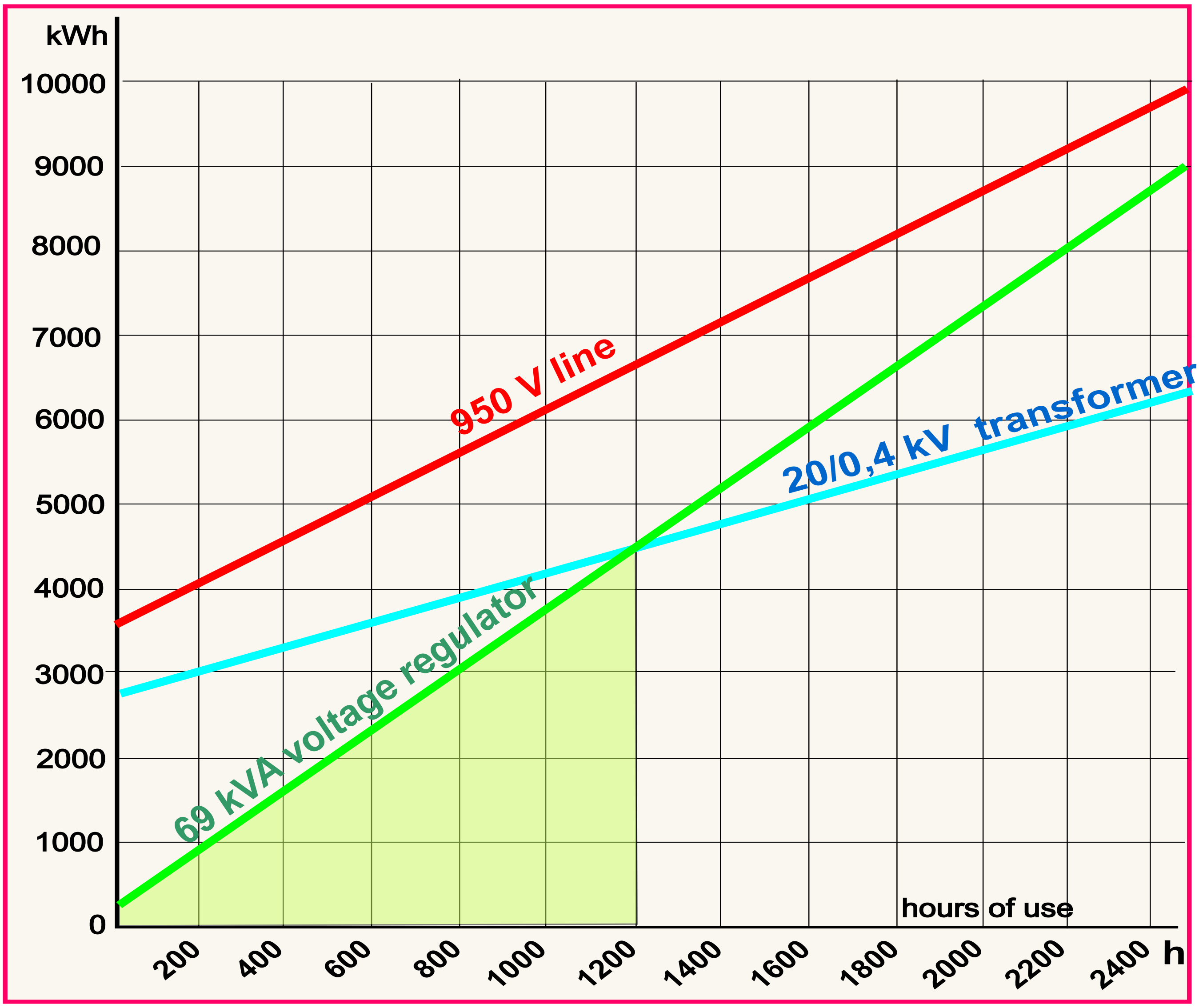
The above graph shows that between 9 am and 3 pm the voltage has been increased by a PV-system, which, as well as voltage dips due to high loads, is compensated by the voltage regulator.

The graph below additionally shows the current with change of direction (import/export).



regulated output voltage
unregulated input voltage
through current
as measured in 150 kVA voltage regulator

The voltage regulator cannot regulate voltage fluctuations shorter than 200ms.



Comparison: Transmission of 69 kVA (100 A) via a voltage regulator, MV 20/0.4 kV, and 950 V transmission distance

To calculate the transmission losses the following has been assumed:
Voltage regulator: Type WA-NRH-69 through current 100 A
Mains transformer: 100 kVA 20/0.4 kV, *Po* = 260W, *Pk = 1750W*
2 isolating transformers 950/400 V, 75 kVA *Po= 210W, Pk=1450W*
Line: Length 1000m NAYY 4x 150mm²

Conclusion: Because of its low idle losses the voltage regulator is the most economic form of transmission for feeder lines with up to 1200 hours of use.

950 V transformers, on the other hand, are more economic after about 2900 hours of use, but a permanent drop in voltage under a load has to be accepted.

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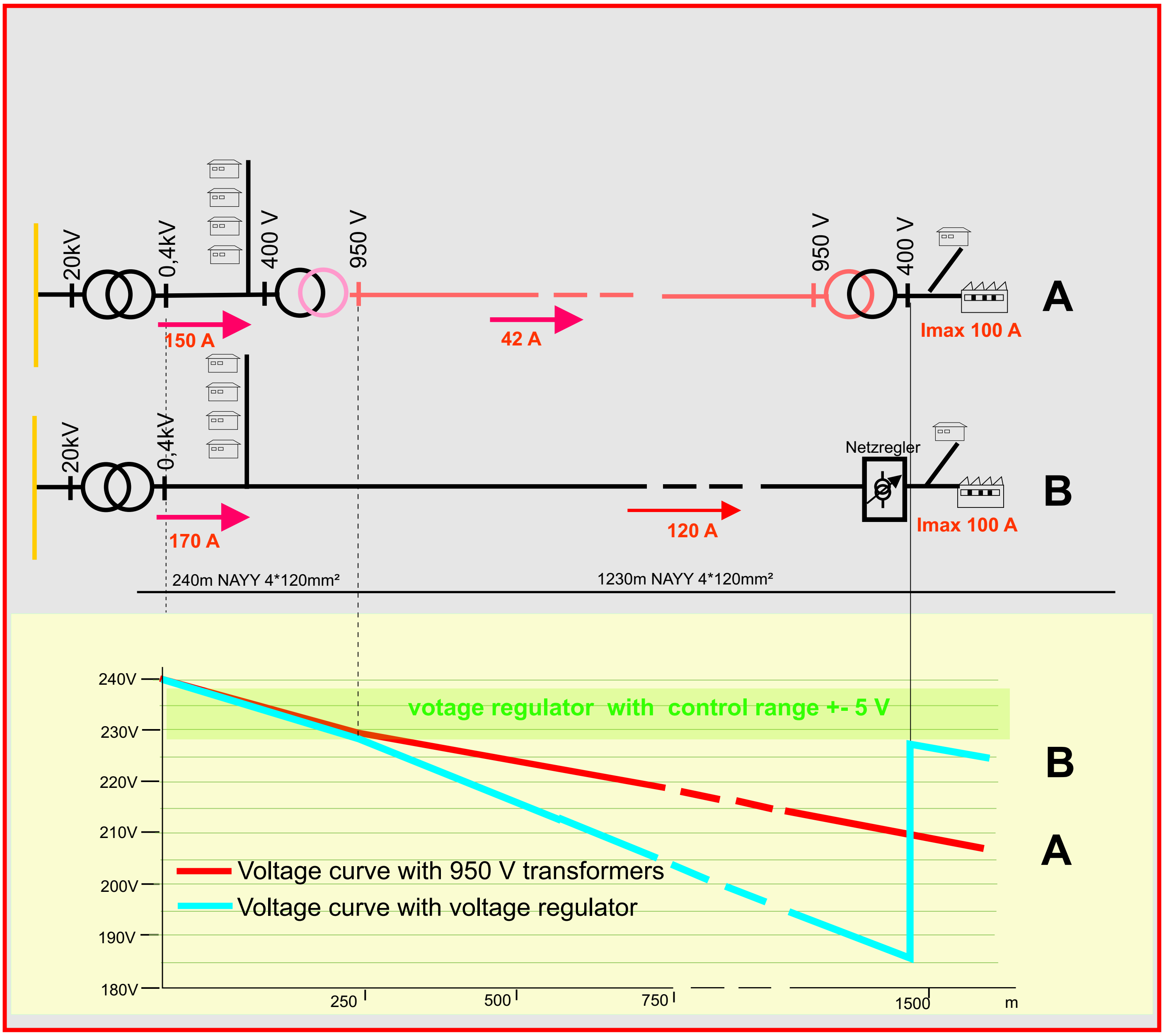
Voltage curve with voltage regulator or 950 V transformers



As can clearly be seen by comparing A and B, supporting the voltage with two 950 V transformers can only be seen as a conditional solution, as the voltage drop is only reduced by 58%.

Using a voltage regulator instead, fully compensates for any voltage drop on the respective phase.

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Diagram NAYY +/- 36V

The diagram shows the possibilities to load NAYY lines by using a voltage regulator with a control range of 6 x 6 V steps (36V/phase)
For the calculation, it was assumed that at the end of the line, after the voltage regulator, the output voltage gets adjusted to 230 / 400V.
The calculation is based on a cos-phi of about 0.9.
The transmissible power can be further increased by using a voltage regulator with pre amplifier or 8 V steps, which can result in control ranges of +48 V or 64 V per phase.

See diagrams +48V and +64V

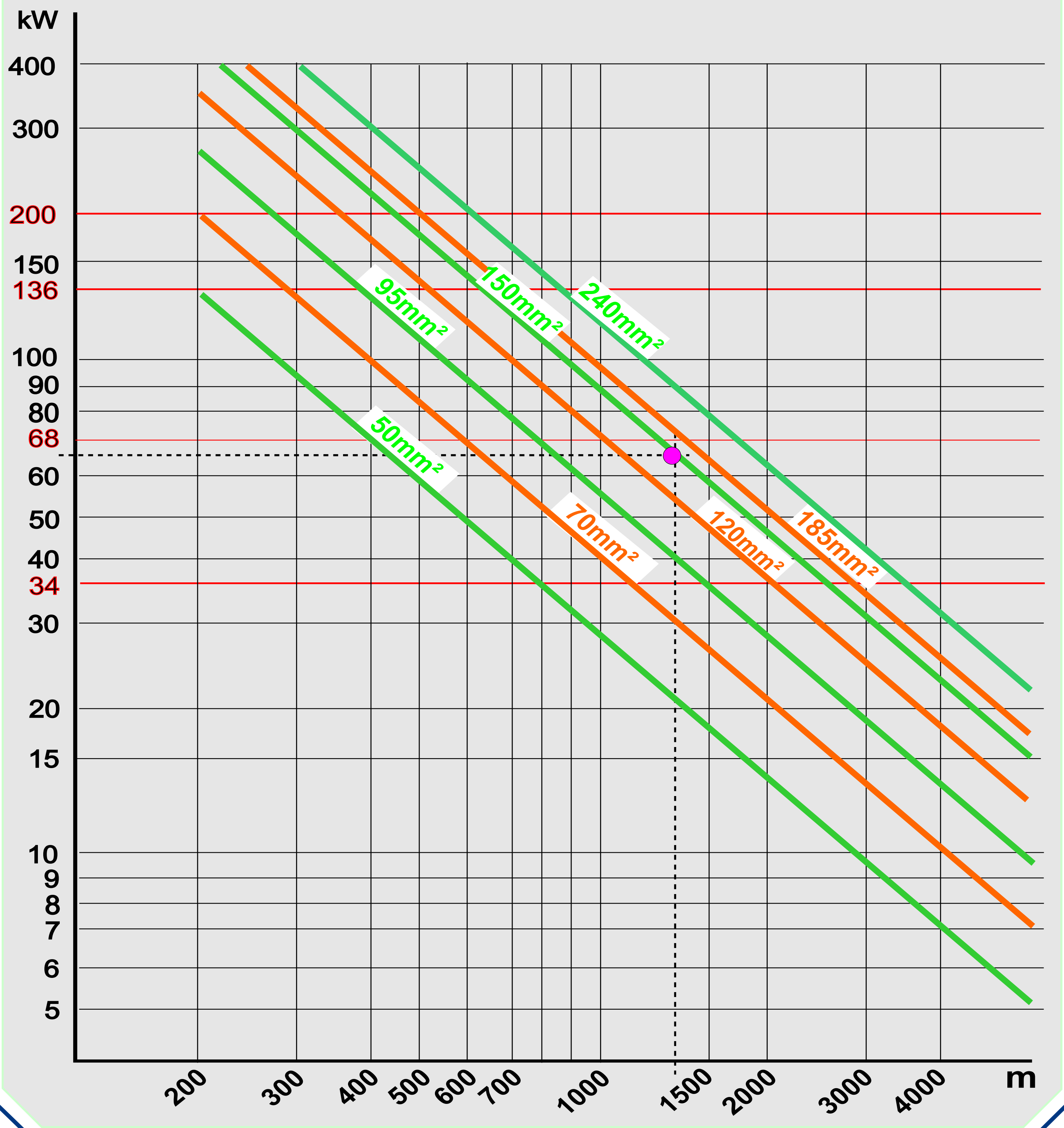

Diagram NAYY +/- 48V

The diagram shows the possibilities to load NAYY lines by using a voltage regulator with a control range of 6 x 8 V steps (48V/phase)
For the calculation, it was assumed that at the end of the line, after the voltage regulator, the output voltage gets adjusted to 230 / 400V.
The calculation is based on a cos-phi of about 0.9.
The transmissible power can be further increased by using a voltage regulator with a pre amplifier, which can result in control ranges of 64 V per phase.
See diagrams +64V

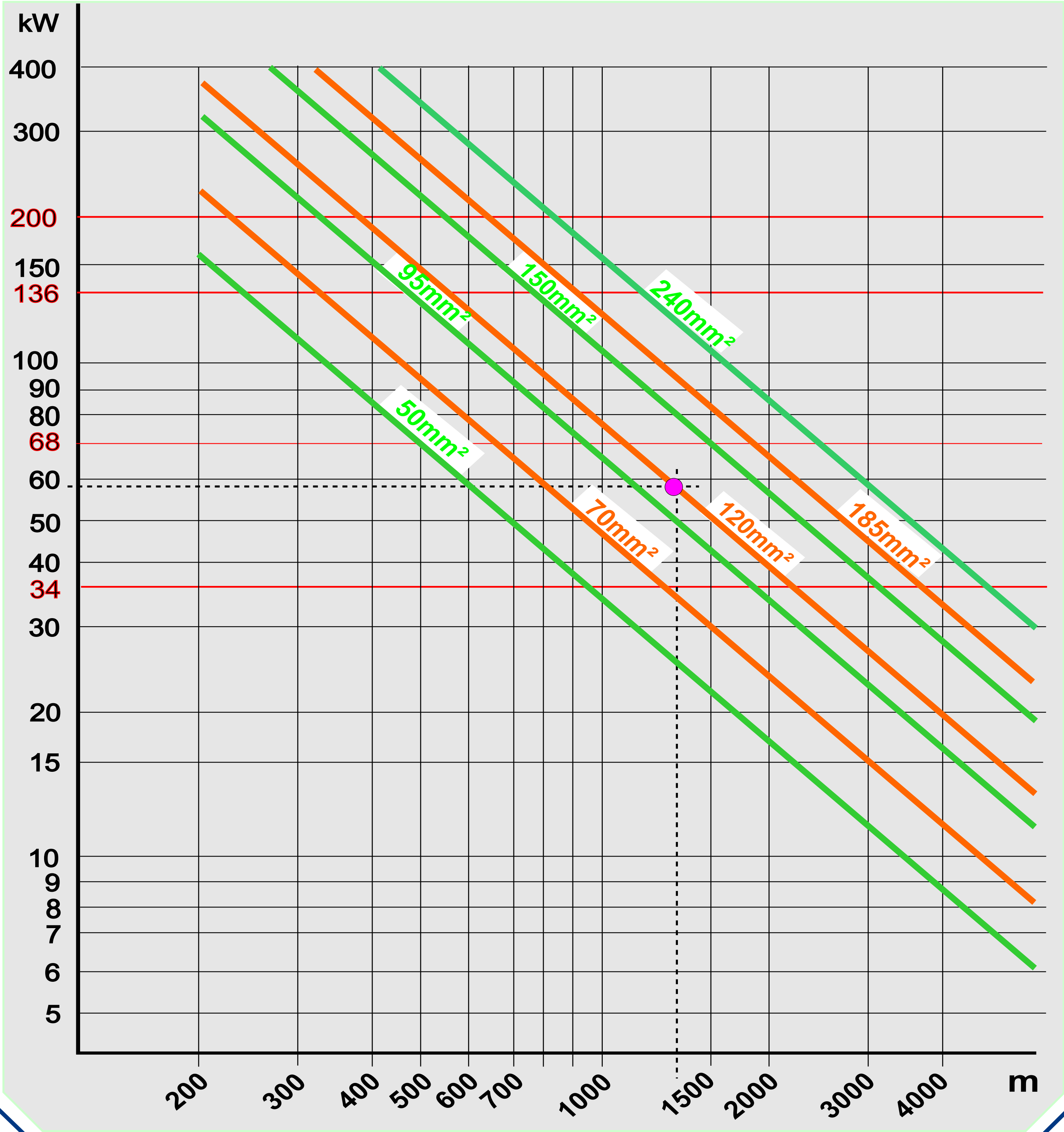

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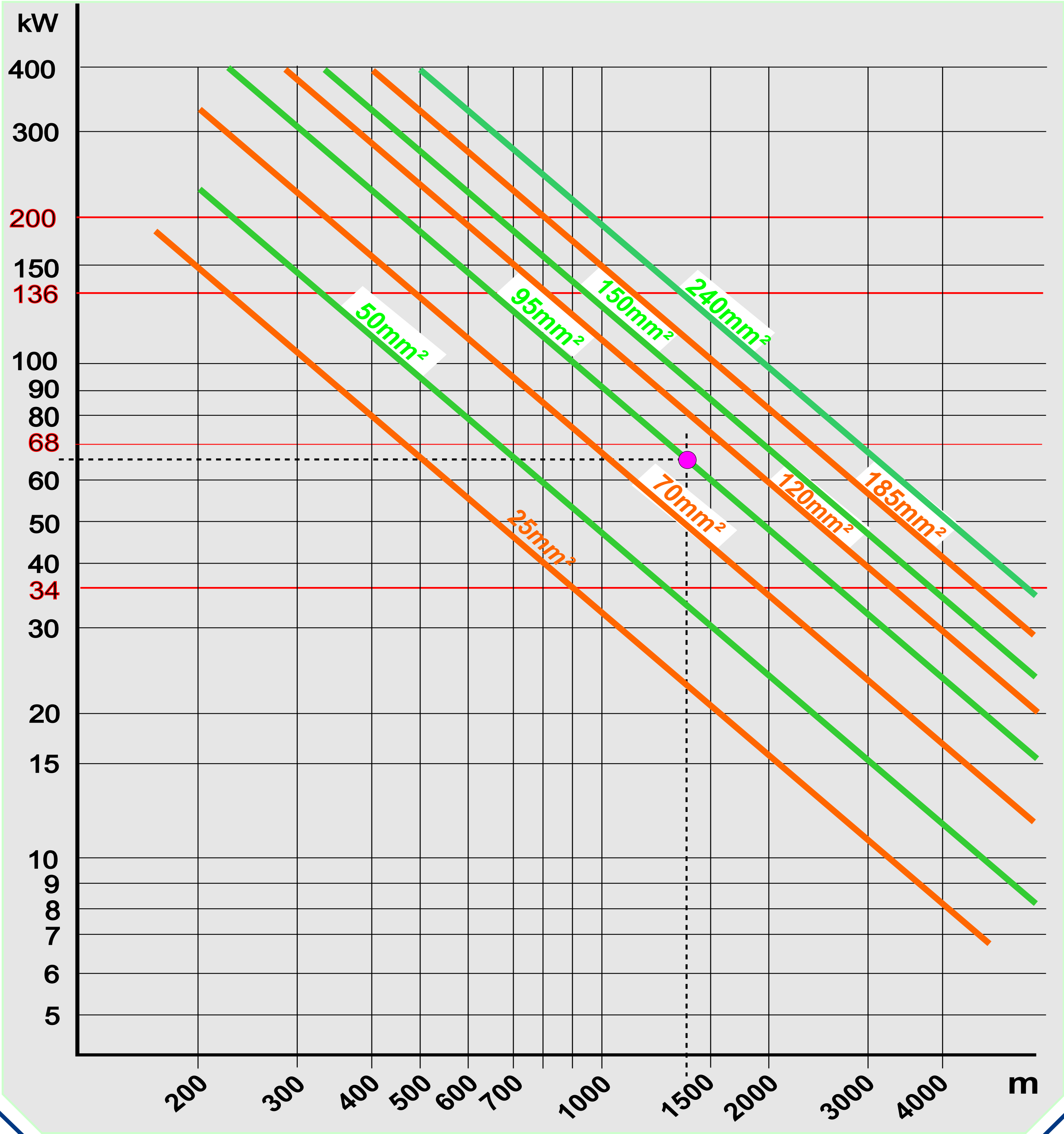
Diagram NAYY + 64, -48V

The diagram shows the possibilities to load NAYY lines by using a voltage regulator with a control range of 6 x 8 V steps and a pre amplifier of 16V (64V/phase)
For the calculation, it was assumed that at the end of the line, after the voltage regulator, the output voltage gets adjusted to 230 / 400V.
The calculation is based on a cos-phi of about 0.9.

The transmissible power can be further increased by using voltage regulators with further pre amplifiers.



Design and mode of operation

The voltage regulator is designed to compensate for any voltage drops or excessive voltage on the LV network and keeping the voltage output at a constant level of +/-5V or +/-6V, depending on the size of the transformers.

The Walcher voltage regulator was originally developed in 1959 and due to its weatherproof design is suitable for installation outdoors.

The most common models are designed for through currents of 50 A to 630 A. The control range usually amounts to +/-36V or +/-48V per phase with 6 steps of 6V or 8V per phase.

Voltage regulators with a reduced control range: Type WA-NRE-red

According to VDE-AR-N 4105, the voltage fluctuations caused by generating plants with a grid connection to an LV network cannot exceed +3% on any given connection point in comparison to the voltage in the same network without generating plants.

Therefore, to be cost efficient, it is usually sufficient to install a voltage regulator with a reduced control range of +/- 16 V per phase or alternatively +/-20 V per phase.

Should you be experiencing any problems in your network, do not hesitate to contact us for a free consultation.

Design of the voltage regulator

Every three-phase current voltage regulator consists of three independently regulated transformer cascades. The output voltage is consistently monitored. In the case of voltage fluctuations, the difference is calculated and will be regulated in just one step, whereby standard regulating periods of 250-300 ms are achieved. Alternatively, the voltage regulators can be delivered with a regulating speed of 70-120ms.

The individual transformers are operated via solid-state relays, which practically reduces the noise outside the cabinet to zero.

Unneeded transformers are short-circuited on the primary side (230V coil). By this short-circuited transformers do not have magnetization losses at all, which further increases the efficiency of the voltage regulator.

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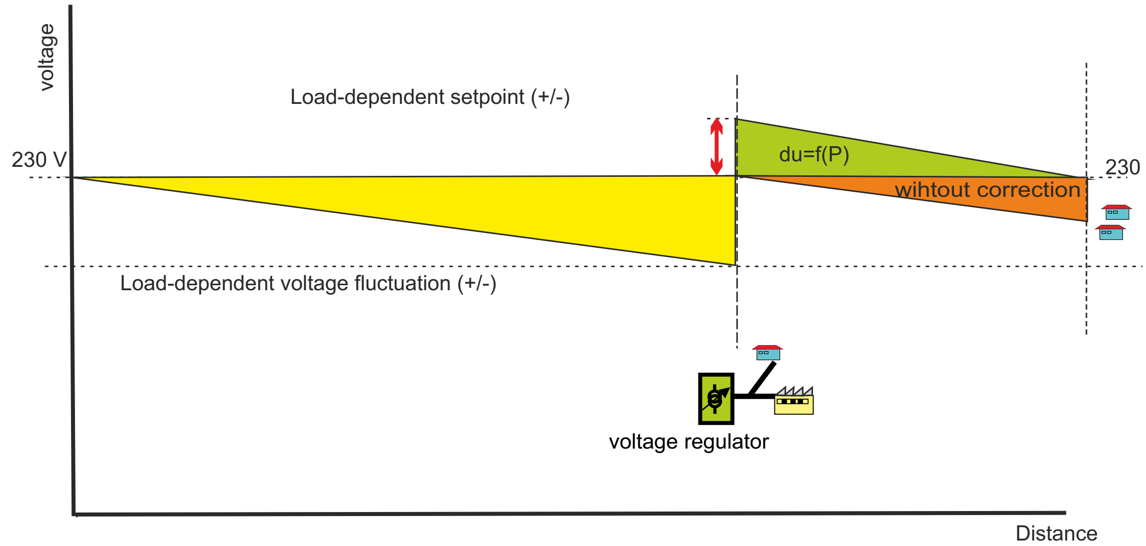
Load-dependent setpoint correction

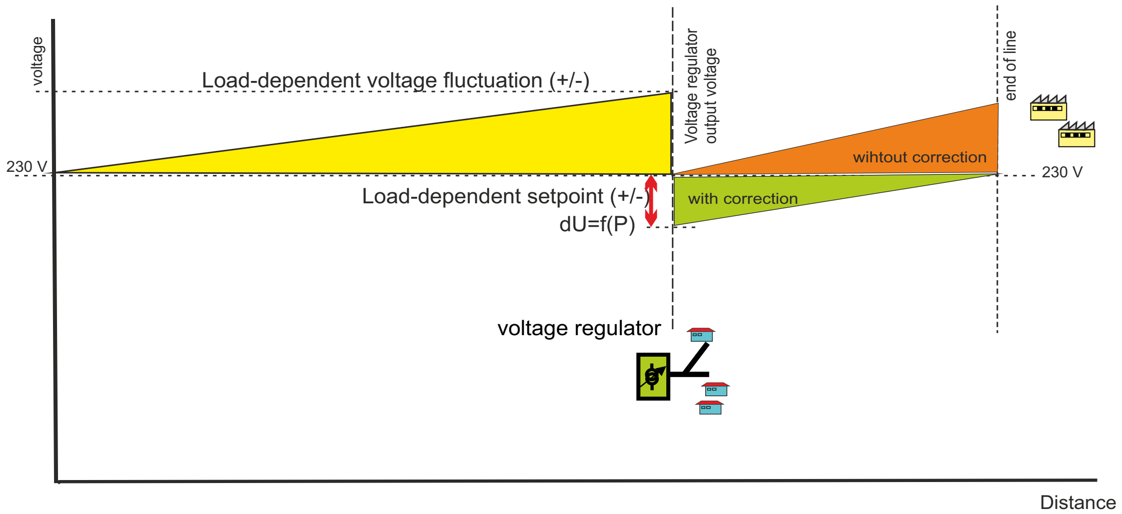
Voltage curve for energy consumption



Alternatively, the voltage regulator can be equipped with a load-dependent software for power measurement.

This is particularly interesting if there are further remote consumers after the voltage regulator. Because further voltage fluctuations occur after the voltage regulator due to impedances on the line, the voltage regulator can be parameterised to fully or partly compensate these (dU). For low loads, there will, therefore, be a smaller dU at the voltage regulator output.

Voltage curve for energy supply



Front and rear view of a 4 door voltage regulator, prepared for installation on a concrete base

Voltage regulator for installation on a foundation base

The pictured 4 door voltage regulator (GFK) with 8V steps is used for a throughput power of 150 kVA or more.

Smaller voltage regulators and types with a reduced control range (WA-NRE-red) are delivered with two doors.

The upper picture shows the electronic control unit of a 150 kVA voltage regulator.

All parts are designed for an ambient temperature of -25°C to +45°C.

The lower picture shows the power section with 6 transformers per phase, respectively.

Connecting the voltage regulator is very simple. It is just coupled into the open line, which means only the incoming and outgoing cable have to be opened once.

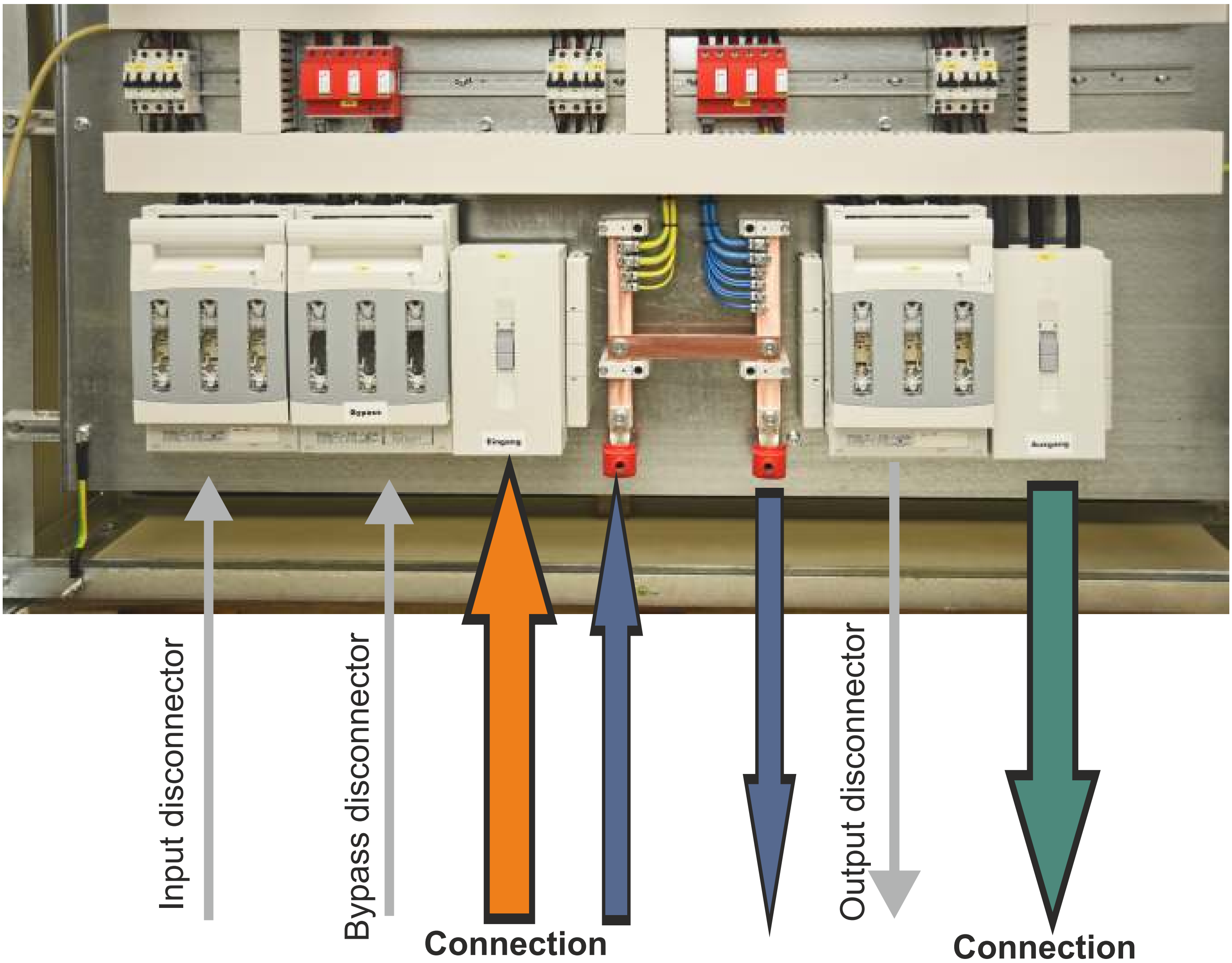
The connection clamps are designed for a cable cross section of 3 x 300 / 150mm² max..

The voltage regulator can always be taken off the network by activating the bypass disconnector.

Voltage regulator WA-NRE-F92

Voltage regulator WA-NRE-M69

Connection of the voltage regulator



Connection

unregulated voltage
from the transforme

Connection

regulated voltage
to the consumer
(PV-system)

Switching on of the voltage regulator: Putting the cable onto the connection clamps and PEN clamps, switching on the NH disconnector for the input and output, switching on all fuses! Check whether the green LED is on (ready after 10 sec max.). Done!

Taking it out of operation: If the voltage regulator should be galvanically isolated from the network, the input and output disconnectors have to be operated. After doing so, NH-fuses can be put into the bypass disconnector and the bypass disconnector can be activated. The voltage regulator is now galvanically isolated from the network.

Status request

For a status request you can access the control unit of the voltage regulator via the ethernet port.
A detailed description can be found in the manual.
The following information can be retrieved:

Status overview

The status of each switching step can be seen in a table.
Thereby a conclusion of the control mode and the life expectancy can be made.

Parameter

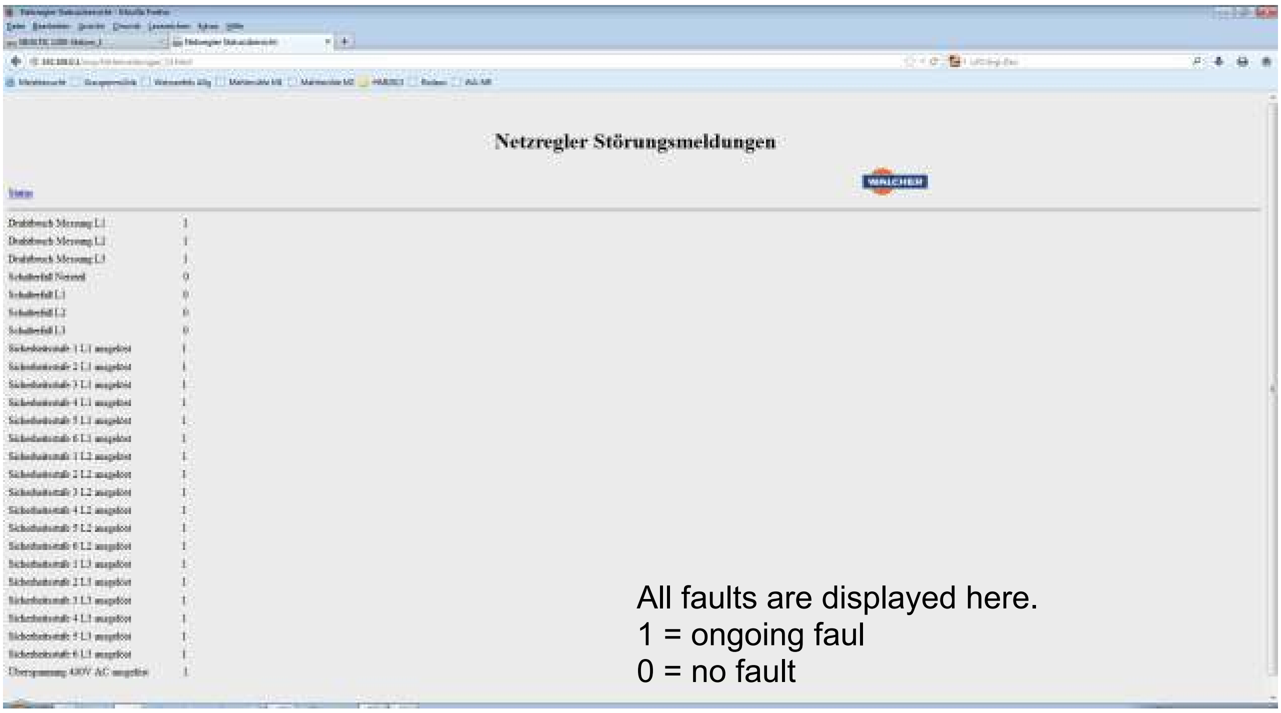
The set parameters can be seen and changed.
The following parameters can be changed:

Nominal voltage [V]:	230
Dead zone +/- [V]:	type dependent either 3,5,6 or 8
Delay time:	200ms (shown as T#200ms)

Phase voltage

Display of 3 phase voltages at the voltage regulators output (regulated side).
These must be within the set dead zone when in operation.

Fault reports



Voltage Regulator Type WA-NR red...

For shorter spur lines the standard control range of +/-36 V per phase or higher is not always needed.

For these cases, the cost-efficient type WA-NR red was developed by Walcher.

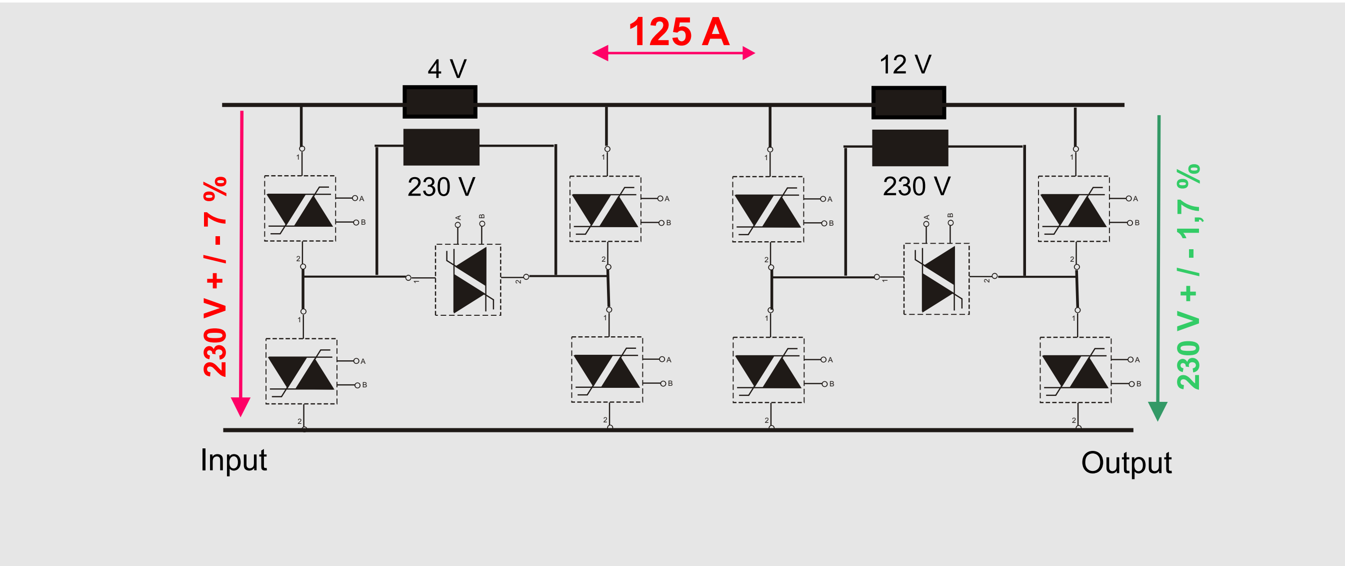
By using two coordinated transformers, 4 individual steps per phase can be regulated upwards or downwards.

A 4 V and a 12 V transformer are used as standard, which results in a control range of +/-16 V per phase. The voltage is regulated in 4 V steps.

The dead zone, for which the voltage regulator does not regulate the voltage, in this case, is 230 V +/- 3 V.

This simplified approach drastically reduces the price of this range.

Greater control ranges can be achieved by adjusting the transformers. By using 5.8 V per step a control range of +/- 10% can be achieved.



unipolar diagram of the working principle of WA-NRE-red

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Monitoring and remote controlling

The voltage regulator is internally monitored by the SPS. Fault reports are shown in plain texts via the respective HTML site and can be displayed via browser or external laptop.

Remote control unit for 104-protocol

GSM Router

Alternatively, GSM router can be installed within the voltage regulator to retrieve technical information. The parameterisation can be changed via the 104-protocol.

Additionally, the 3 regulated output voltages L1 to L3, as well as the currently active transformers, can be displayed.

Furthermore, any fault reports are being sent to the control room.

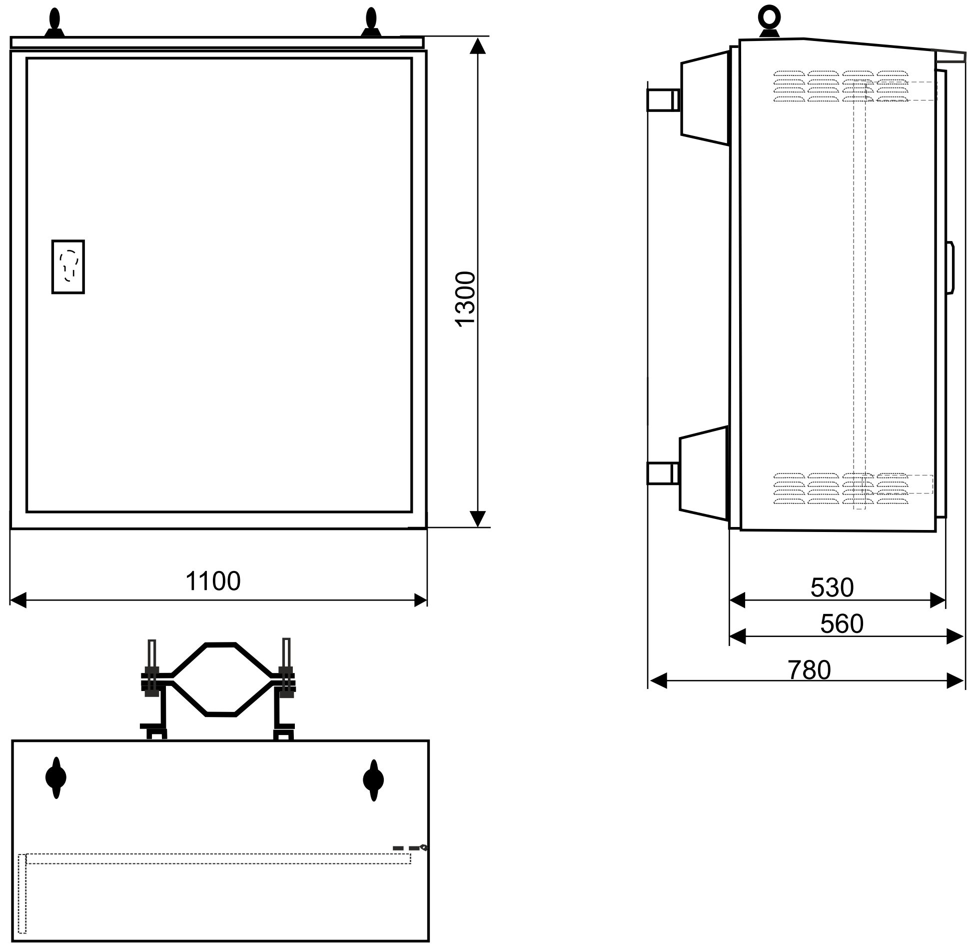
Option: Remote monitoring via signal contact and watchdog relay

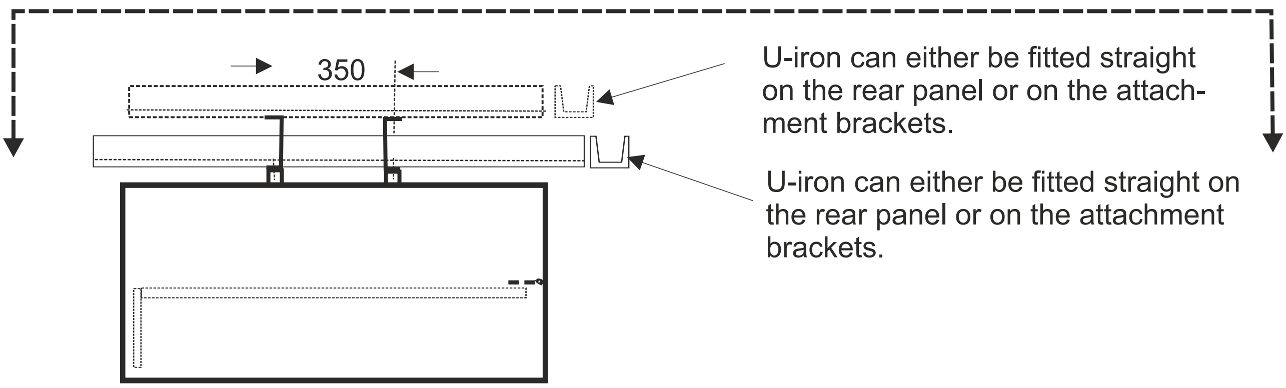
Fault messages are available to the SPS as a control signal and if necessary can be sent to a watchdog relay, independent from the SPS (order option).

For signaling to the control system, this relay provides a potential-free fault signaling contact.

At the same time, the relay monitors the “OK state” of the SPS and, in the event of an SPS failure, issues a fault message as a potential free contact.

Cabinet M – for mast mounting



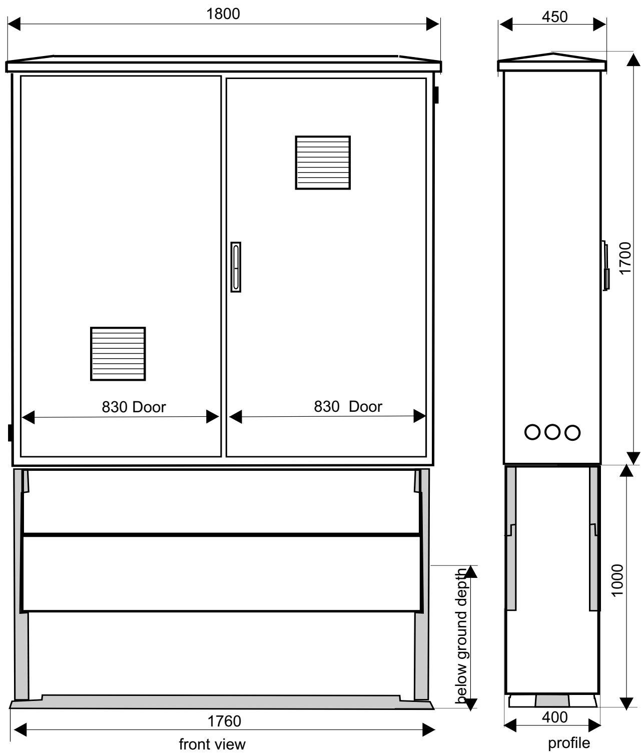


The cabinet is designed to be mounted on a mast or lattice mast. Two mast clamps are included in the scope of delivery to allow easy and quick mounting.

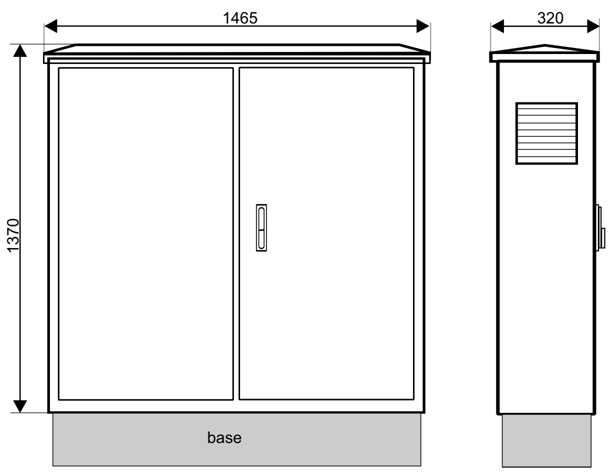
It is advised to secure the mast clamps and the cabinet by using appropriate screws or bolds to avoid it falling off or getting out of place.

There can also be u-profiles be mounted on the attachement brackets or the cabinet itself to allow installation on a wall.

Cabinet F – for foundation base



GFK 2T



GFK-red-87

Material: Fibreglass reinforced polyester, protection class IP22, designed to hold 1 security lock with single profile cylinder

All electrical components are accessible from the front.

The base is not included in the standard scope of delivery.

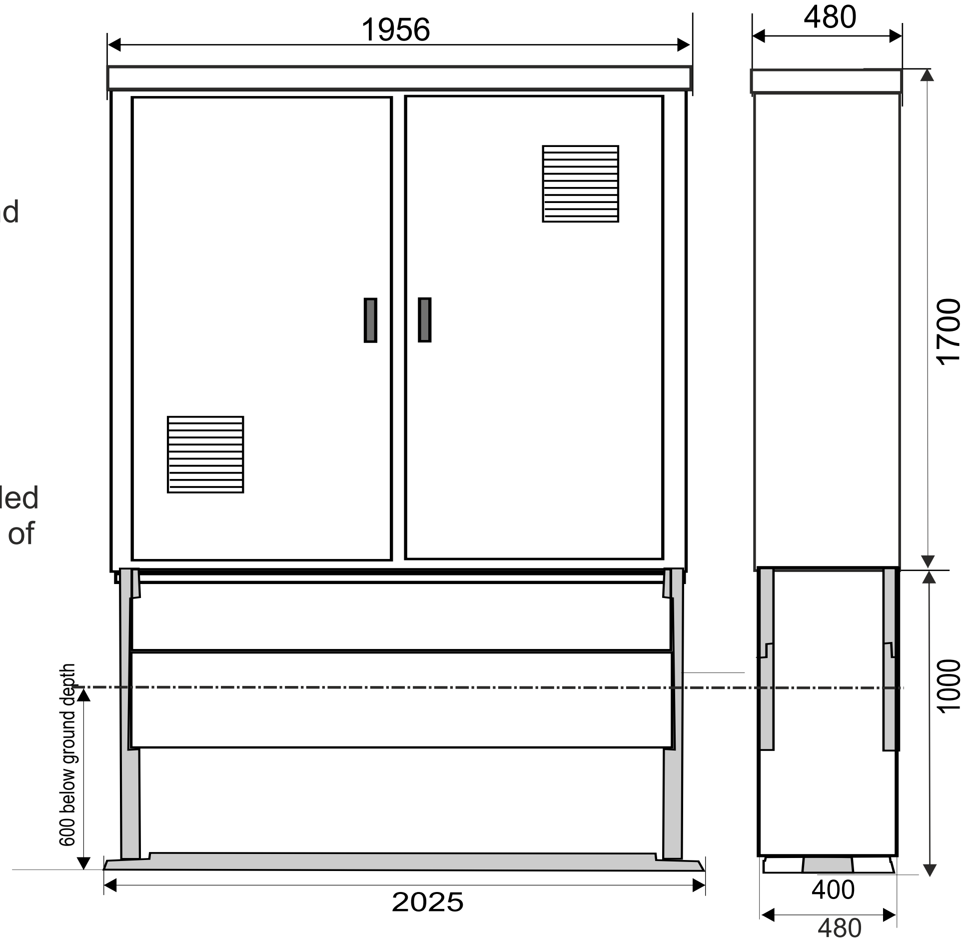
(available as an option)

Type ES-2T

Steel cabinet with protective isolation and two doors at the front. Designed to fit two security locks.

Protection class IP22, optional Ip44

The base is not included in the standard scope of delivery. (available as an option)



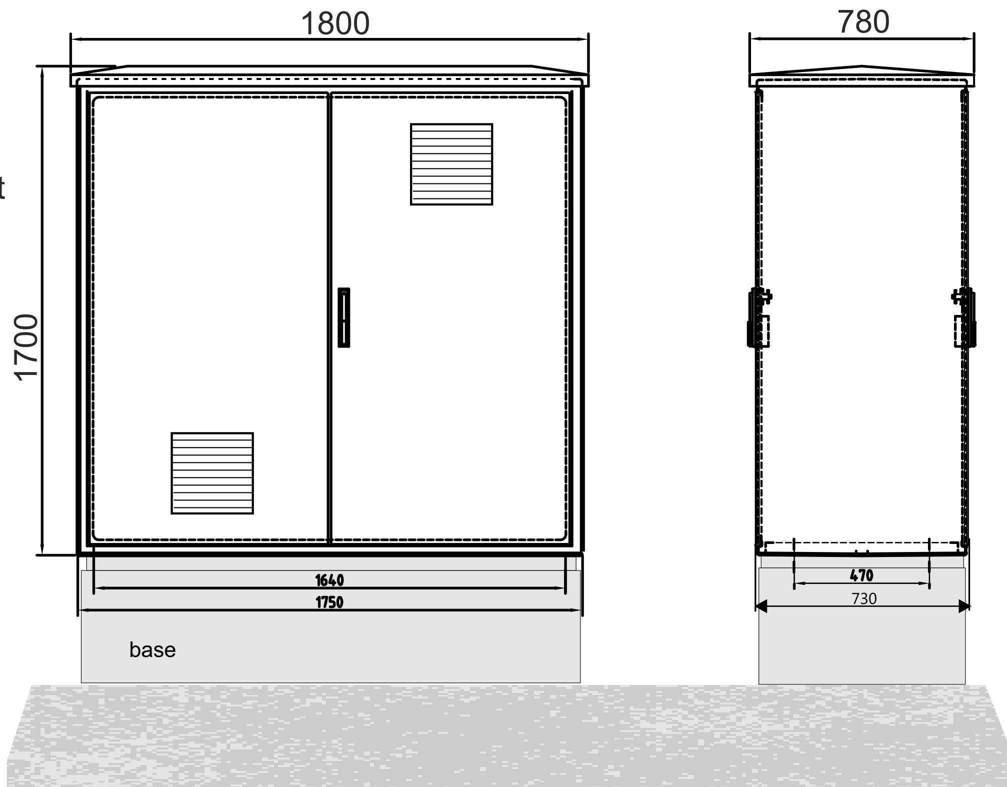
front view

Typ GfK2

Fiber-reinforced polyester cabinet with 2 hinged doors on the front as well as on the back. Isolated and designed to fit two security locks.

Protection class IP22, optional IP44

The base is not included in the standard scope of delivery. (available as an option)



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Technical data

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General technical data for all voltage regulators

Nominal voltage:	3x230/400V 50-60Hz
input and output voltage:	see table of load dependent data
regulation:	3x single phase, with 13 voltage steps per phase
standard control range:	+/- 18V , 36V , 48V , 60V per phase
control accuracy:	+/- 3V , 5V , 6V , 8V according to control range
Phase = control speed / phase:	typically: 0,3s max. 0,7s
reaction time:	adjustable from 0.1s to 10s (default 0.2s)
measurement method:	r.m.s. measurement of output voltage
control method:	step switch, Walcher system
short circuit resistance Ik max	34 bis 69 kVA = 4 kA 92 bis 150 kVA = 8 kA 207 bis 300 kVA = 10 kA
locking system:	designed to hold a security lock with a single profile cylinder
standards:	DIN EN 60204-1, DIN EN 61439-1
EMC directives according to:	DIN EN 61000-6-1, DIN EN 61000-6-3
temperature range:	Ta = -25°C bis +45°C

F:Prospekte/Netzregler/deutsch/Datenblatt1_2014_05

TÜV PROFI CERT ISO 9001 73 100 3437

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Performance related characteristics for voltage regulators

Voltage regulator 34kVA

	control range	nominal power	type power	input voltage	output voltage	no-load losses	nominal load losses	η nominal load	Zk * [Ohm]	weight [kg]
WA-NRE-x34	(+-36V)	34kVA	5,4kVA	189-277V	230+-5V	ca. 20W	580W	98,3%	0,0527	250
WA-NRE-x34	(+-48V)	34kVA	7,2kVA	177-288V	230+-6V	ca. 20W	760W	97,8%	0,0527	285
WA-NRE-x34	(+-60V)	34kVA	9,0kVA	165-295V	230+-8V	ca. 20W	890W	97,4%	0,0527	320
WA-NRE-xV34	(+48-24V)	34kVA	7,2kVA	177-259V	230+-5V	ca. 80W	740W	97,7%	0,0614	280
WA-NRE-xV34	(-48+24V)	34kVA	7,2kVA	201-283V	230+-5V	ca. 80W	740W	97,7%	0,0614	280
WA-NRE-xV34	(+64-32V)	34kVA	9,6kVA	161-267V	230+-6V	ca.130W	1010W	97,1%	0,0614	360
WA-NRE-xV34	(-64+32V)	34kVA	9,6kVA	193-299V	230+-6V	ca.130W	1010W	97,1%	0,0614	360

Voltage regulator 69kVA

	control range	nominal power	type power	input voltage	output voltage	no-load losses	nominal load losses	η nominal load	Zk * [Ohm]	weight [kg]
WA-NRE-x69	(+-36V)	69kVA	10,8kVA	189-277V	230+-5V	ca. 20W	960W	98,6%	0,0213	350
WA-NRE-x69	(+-48V)	69kVA	14,4kVA	177-288V	230+-6V	ca. 20W	1100W	98,4%	0,0213	410
WA-NRE-x69	(+-60V)	69kVA	18,0kVA	165-295V	230+-8V	ca. 20W	1300W	98,4%	0,0213	410
WA-NRE-xV69	(+48-24V)	69kVA	14,4kVA	177-259V	230+-5V	ca.140W	1300W	98,2%	0,0249	410
WA-NRE-xV69	(-48+24V)	69kVA	14,4kVA	201-283V	230+-5V	ca.140W	1300W	98,2%	0,0249	490
WA-NRE-xV69	(+64-32V)	69kVA	19,2kVA	161-267V	230+-6V	ca.180W	1460W	97,9%	0,0249	490
WA-NRE-xV69	(-64+32V)	69kVA	19,2kVA	193-299V	230+-6V	ca.180W	1460W	97,9%	0,0249	490

Voltage regulator 92kVA

	control range	nominal power	type power	input voltage	output voltage	no-load losses	nominal load losses	η nominal load	Zk * [Ohm]	weight [kg]
WA-NRE-x92	(+-36V)	92kVA	14,4kVA	189-277V	230+-5V	ca. 20W	1150W	98,7%	0,0159	410
WA-NRE-x92	(+-48V)	92kVA	18,0kVA	177-288V	230+-6V	ca. 20W	1200W	98,6%	0,0159	410
WA-NRE-x92	(+-60V)	92kVA	24,0kVA	165-295V	230+-8V	ca. 20W	1300W	98,6%	0,0159	560
WA-NRE-xV92	(+48-24V)	92kVA	19,2kVA	177-259V	230+-5V	ca.240W	1500W	98,4%	0,0186	490
WA-NRE-xV92	(-48+24V)	92kVA	19,2kVA	201-283V	230+-5V	ca.240W	1500W	98,4%	0,0186	490
WA-NRE-xV92	(+64-32V)	92kVA	24,0kVA	161-267V	230+-6V	ca.240W	1600W	98,3%	0,0186	490
WA-NRE-xV92	(-64+32V)	92kVA	24,0kVA	193-299V	230+-6V	ca.240W	1600W	98,3%	0,0186	490

* The short circuit impedance Zk contains ohmic and inductive components.
These are calculated as follows: **Rk = Zk * 0,96** und **Xk = Zk * 0,28**

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Technische Daten

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Performance related characteristics for voltage regulators

	control range	nominal power	type power	input voltage	output voltage	no-load losses	nominal load losses	η nominal load	Zk * [Ohm]	weight [kg]

Voltage regulator 150kVA

WA-NRE-x150	(+-36V)	150kVA	23,4kVA	189-277V	230+-5V	ca. 40W	1600W	98,9%	0,0095	540
WA-NRE-x150	(+-48V)	150kVA	31,1kVA	177-288V	230+-6V	ca. 40W	2050W	98,6%	0,0095	570
WA-NRE-x150	(+-60V)	150kVA	39,6kVA	165-295V	230+-8V	ca. 40W	2150W	98,5%	0,0095	610
WA-NRE-xV150	(+48-24V)	150kVA	31,2kVA	177-259V	230+-5V	ca.220W	1700W	98,8%	0,0111	640
WA-NRE-xV150	(-48+24V)	150kVA	31,2kVA	201-283V	230+-5V	ca.220W	1700W	98,8%	0,0111	640
WA-NRE-xV150	(+64-32V)	150kVA	42,0kVA	161-267V	230+-6V	ca.250W	2700W	98,2%	0,0111	750
WA-NRE-xV150	(-64+32V)	150kVA	42,0kVA	193-299V	230+-6V	ca.250W	2700W	98,2%	0,0111	750

Voltage regulator 207kVA

This can be done by simply changing the 230V primary connections.

WA-NRE-x207	(+-36V)	207kVA	32,4kVA	189-277V	230+-5V	ca. 50W	1900W	99,0%	0,0062	715
WA-NRE-x207	(+-48V)	207kVA	43,2kVA	177-288V	230+-6V	ca. 50W	2250W	98,9%	0,0062	770
WA-NRE-x207	(+-60V)	207kVA	54,0kVA	165-295V	230+-8V	ca. 50W	2800W	98,6%	0,0062	770
WA-NRE-xV207	(+48-24V)	207kVA	43,2kVA	177-259V	230+-5V	ca.300W	2500W	98,8%	0,0072	865
WA-NRE-xV207	(-48+24V)	207kVA	43,2kVA	201-283V	230+-5V	ca.300W	2500W	98,8%	0,0072	865
WA-NRE-xV207	(+64-32V)	207kVA	57,6kVA	161-267V	230+-6V	ca.300W	3000W	98,6%	0,0072	883
WA-NRE-xV207	(-64+32V)	207kVA	57,6kVA	193-299V	230+-6V	ca.300W	3000W	98,6%	0,0072	883

Voltage regulator 300kVA

WA-NRE-x300	(+-36V)	300kVA	47,0kVA	189-277V	230+-5V	ca. 60W	2500W	99,1%	0,0041	735
WA-NRE-x300	(+-48V)	300kVA	62,5kVA	177-288V	230+-6V	ca. 60W	4100W	98,6%	0,0041	860
WA-NRE-x300	(+-60V)	300kVA	78,2kVA	165-295V	230+-8V	ca. 60W	5500W	98,2%	0,0041	1040
WA-NRE-xV300	(+48-24V)	300kVA	62,5kVA	177-259V	230+-5V	ca.240W	3300W	98,9%	0,0047	903
WA-NRE-xV300	(-48+24V)	300kVA	62,5kVA	201-283V	230+-5V	ca.240W	3300W	98,9%	0,0047	903
WA-NRE-xV300	(+64-32V)	300kVA	83,3kVA	161-267V	230+-6V	ca.240W	5400W	98,2%	0,0047	1070
WA-NRE-xV300	(-64+32V)	300kVA	83,3kVA	193-299V	230+-6V	ca.240W	5400W	98,2%	0,0047	1070

* The short circuit impedance Zk contains ohmic and inductive components.
These are calculated as follows: **Rk = Zk * 0,96** und **Xk = Zk * 0,28**

TÜV PROFI CERT ISO 9001 73 100 3437

F:Prospekte/Netzregler/deutsch/Datenblatt2 2014_05

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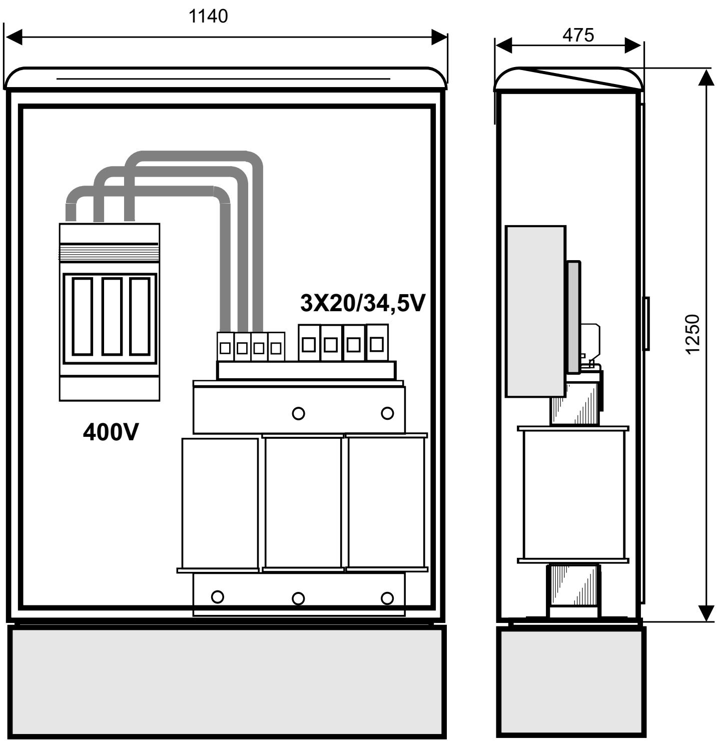
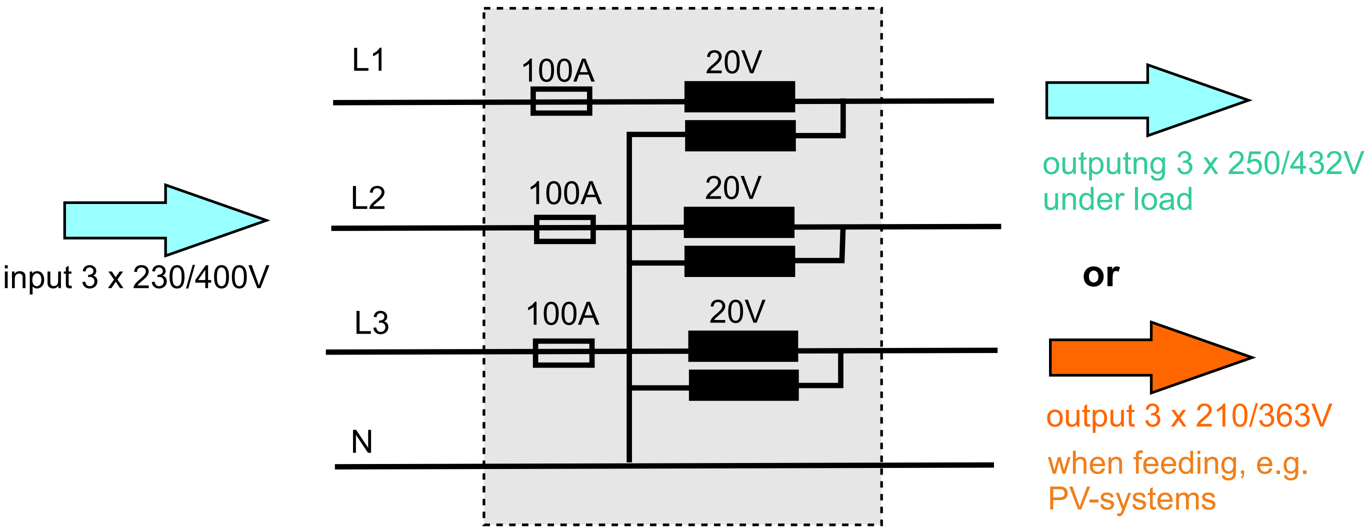
Pre amplifier 20/34V
WA-NVK-69



Technical changes reserved

This can be done by simply changing the 230V primary connections.

20/34.5V step transformer in a cabinet with NH fuse switch disconnector on the supply side



Usually, the pre amplifier is used to increase the voltage at the beginning of the line. The increased voltage then will be reduced by the voltage regulator again. For predominant loads due to PV-systems, it can make sense to reduce the voltage.

This can be done by simply changing the 230V primary connections.

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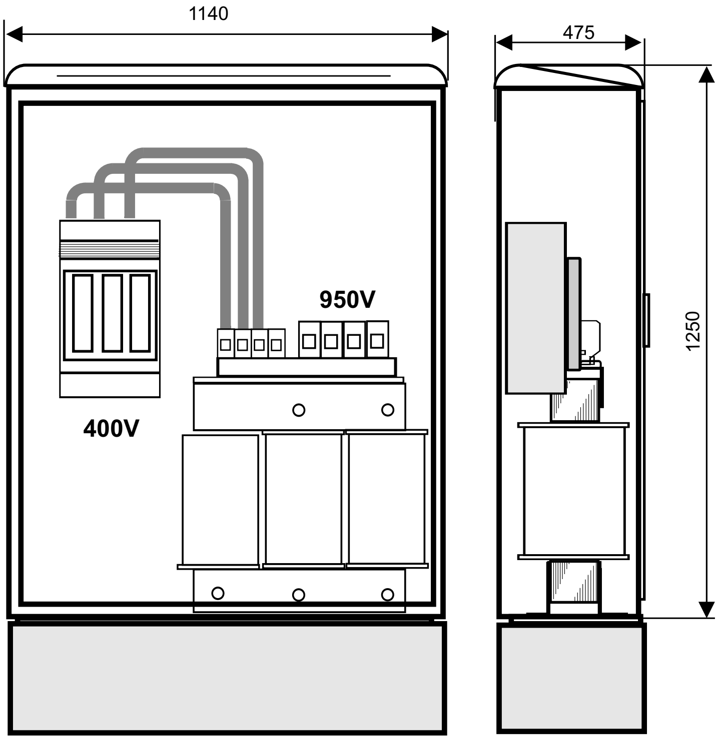
Mains transformer 95
WA-NTF



950V mains transformer in a cabinet with protection on the 400V side

950V mains transformers are used to reduce voltage dips to about ¼ for long spur lines. Especially when symmetrical loads and three-phase consumers can be assumed and the consistent voltage dip is not disturbing, the 950V line can be an alternative to voltage regulators or a reinforced spur line.
However, it should be considered, that the short-term price advantage can be exhausted quickly, considering the higher own consumption and higher mounting costs compared to a voltage regulator.

The consistent voltage dip should be considered during planning.

Technical changes reserved

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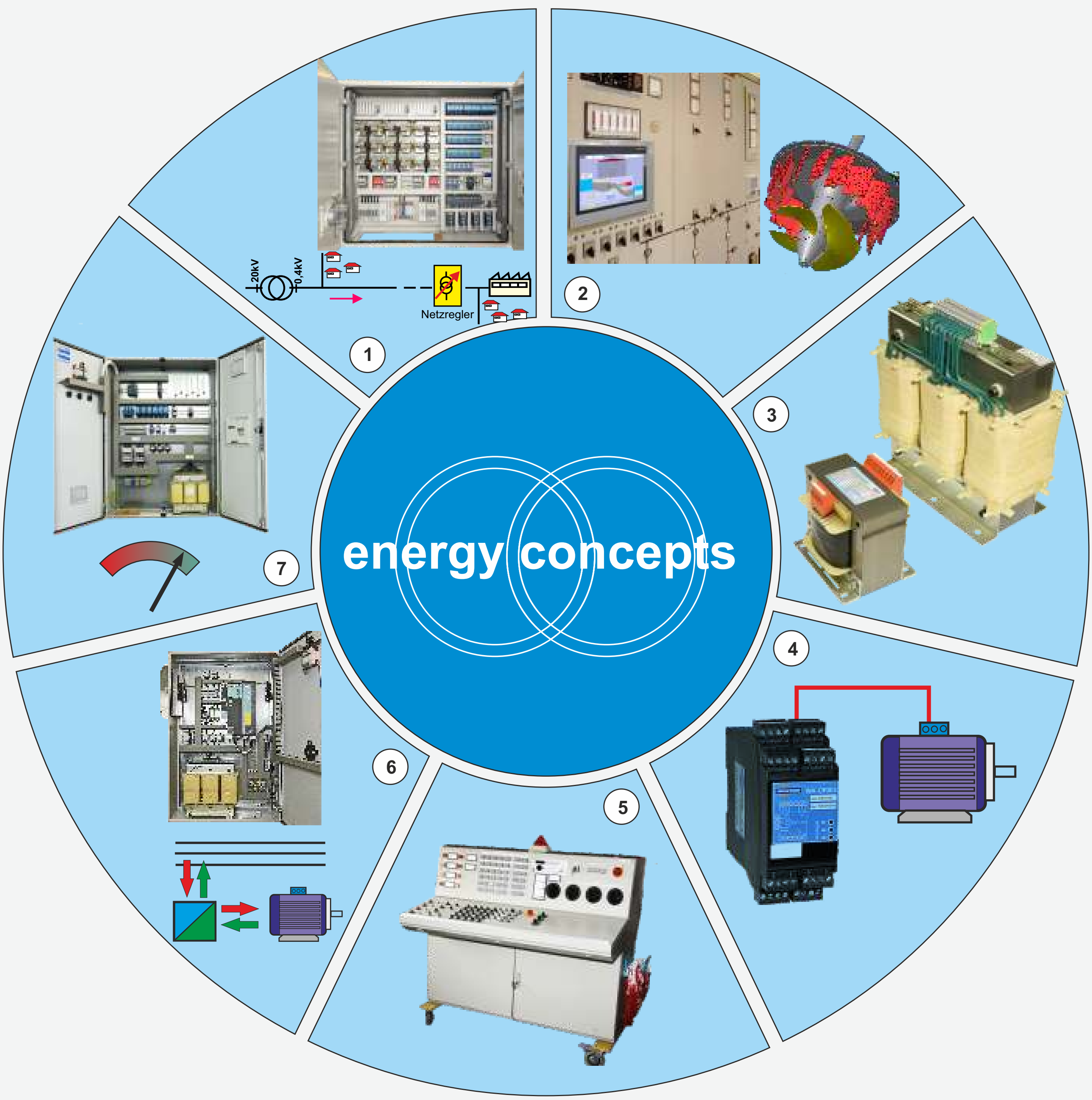
Production programme



① voltage regulator 150 kVA ② power plant technology ③ construction of transformers

④ speed measurement from remanence voltage ⑤ test facilities

⑥ = regenerating units ⑦ energy saving control units

F:\Prospekte\Produktübersicht\Fertigungsprogramm 17-4-V2

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Produktionsprogramm

WALCHER

1 Voltage regulators

Voltage regulators are used in 400V LV networks. They automatically compensate voltage fluctuations caused by high loads or feeders, e.g. PV-systems and keep a constant nominal voltage of 230V/400V. The control speed is between 70-120ms. Voltage regulators are maintenance free.

2 Hydropower plants

Walcher automates hydropower plants from 5kW to 10MV since 1960.
We are happy to guide you through consultation, concept development, project planning, software development and switchgear construction and commissioning all the way to the hand over of your plant.
We also offer to maintain equipment from other manufacturers.

3 Manufacturing of transformers

We manufacture many different models of transformers from 0.2VA up to 30kVA.
Due to our flexibility, custom made solutions are realised quickly and cost-efficient. Visit our transformer shop on shop.walcher.com

4 Speed relais – residual voltage

Our electronic speed relay WA-DR8G gets its measurement from induction machines as well as from synchronous generators!
Therefore no further rotation speed measurements or sensors are required..

5 Test facilities: Control and measuring desks

In line with our control systems and in combination with the manufacturing of transformers and the software development for automation technology, we manufacture and deliver control units for test facilities and production lines.
Computer-based or conventional, your wish is our command.

6 Resupply of energy

If moving or rotating masses are electrically decelerated, the existing energy can be fed back into the supply network via regenerative frequency inverters, which significantly reduces the electricity procurement costs. This is particularly effective the shorter the intervals between acceleration and braking.

7 Energy saving regulator WA-ES-xxx

Energy saving regulator WA-ES-xxx

Energy saving regulators reduce energy costs by reducing the mains voltage. Not every consumer constantly need the provided 231/400V.

By reducing the mains voltage accordingly and simultaneously protecting against undervoltage, these regulators can reduce energy costs drastically.

New concepts/solutions

If you have an energetical or control related issue, do not hesitate to contact us. We are looking forward to challenging any issue together with your engineers and technicians. Just give us a call or drop us an email.

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