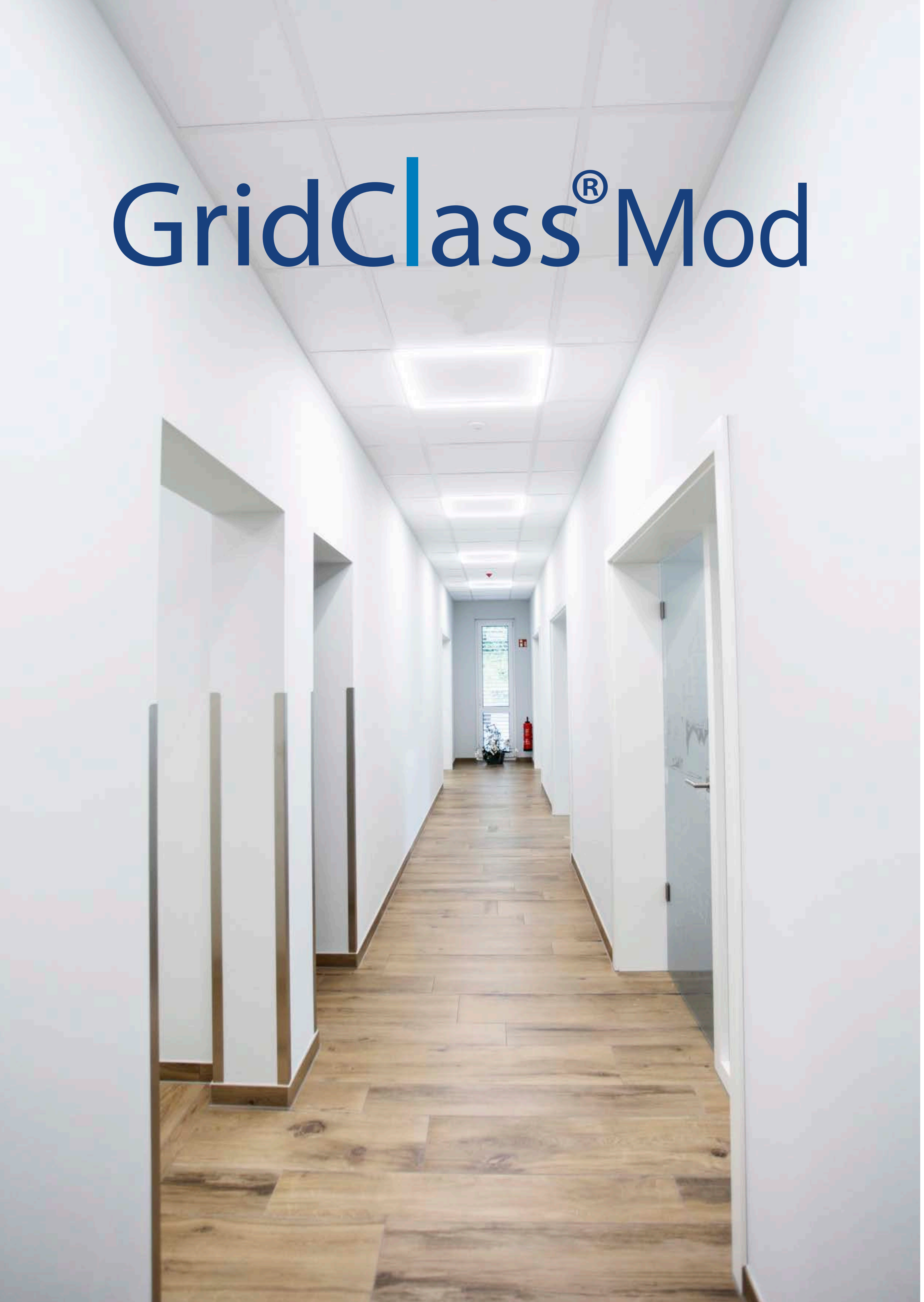
PRODUCT FAMILY GRID CLASS®

2024 - 04

YOUR VOLTAGE – OUR PASSION

Condensator Dominit



Products

Product Family GridClass®-Mod

SIMΩN®

SΦFIA®

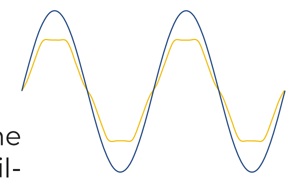
RƐSI

Classic

Overview Power Quality Issues

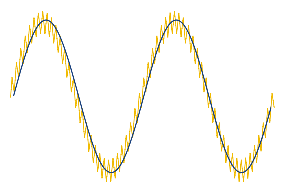
The voltage quality is influenced by various quantities caused by consumption and generation plants. These quantities are generally referred to as system perturbations. They occur as harmonic voltages, voltages at interharmonic frequencies, flicker, voltage changes, voltage change characteristics, voltage fluctuations affecting the sinusoidal level, and voltage unbalances. The maximum permissible compatibility levels of the individual system perturbations are regulated and standardized (among other things) in DIN EN 61000-2-4 'Ambient conditions – Compatibility levels for low-frequency conducted disturbance variables in industrial systems'. This standard is the resilient foundation on which we, with the help of our know-how and our structured product portfolio, provide your power supply safely and in conformity with the standard.

Harmonics



Network feedback in the form of harmonics (oscillations with a multiple of the fundamental frequency) is nowadays an essential component in influencing the voltage quality. Equipment with non-linear U-I characteristics or non-stationary operating behaviour leads to the absorption of a non-sinusoidal current, which in turn leads to correspondingly non-sinusoidal voltage drops and thus to distortion of the voltage supply due to its injection against the existing mains impedance. The consequences include, among others, the destruction of equipment, interference with the correct functioning of electronic controls or the excitation of critical resonances.

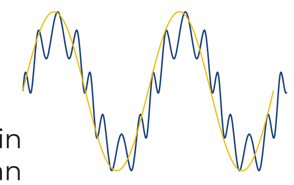
Supra-Harmonics



TRANSIENTS
PULSE FREQUENCIES
COMMUTATION NOTCHES

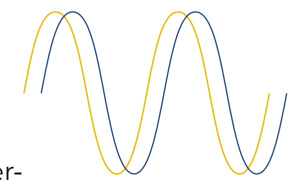
The amount of power electronics in our energy grids is constantly increasing – due to technological advancements. The physical sizes of the power electronics components installed today – such as circuit boards for inverters and rectifiers – are being further reduced. This makes it possible to switch current and voltage faster and in many different steps. However, this also increases occurring voltage phenomena that, especially in the high-frequency / supra-harmonic frequency range (> 2 kHz), energy, supply and industrial networks, immensely burden.

Resonances



Resonances can occur in the energy network if an inductance (e.g. transformer) is connected to such a capacitance (e.g. unmatched capacitors of rectifiers) that an oscillating circuit is formed. When the resonance frequency of this resonant circuit is reached, the resonance of the oscillatable system increases and can swing many times over. The amplitudes of the vibrations can become so large that damage or even destruction of equipment and control elements in the energy network occurs. In this case, as in mechanical engineering and architecture, one speaks of a resonance catastrophe.

Reactive Power



Reactive power is generated by inductive and capacitive equipment in the power grid. In inductive loads, such as motors, the windings generate a magnetic field in each sinusoidal half-cycle. In capacitive equipment, such as cables, an electric field is generated. Current is required for these processes, which is stored as energy in the field and released again when the half-oscillation changes. This results in a phase shift and the current oscillates between load and generation without being consumed (apart from line losses). This so-called reactive current must therefore be provided by the energy supplier and generates costs.

Consequences and symptoms of harmonics and supra-harmonics

The total harmonic distortion factor THD is regulated in the standard DIN EN 61000-2-4. If the norm is violated, the following symptoms can occur:

THDu ≈ 10 %

Consequences and symptoms:
- non-standard network
- Failure of equipment, production machines and control systems
- Loss of warranty claims against your machine supplier
- Excitation of critical resonances
- buzzing and vibration noise from overloaded transformers
- thermal load of cables and capacitors

The “GridClass Mod” series is not only highly efficient - with very low losses - but also impresses with its flexible by its flexible modular design. This fact in particular from this fact in particular, since the filter modules can be easily integrated into their own individual control cabinets. The various filter types in this module series can be used to all interference potentials in the network to a tolerable minimum. to a tolerable minimum, so that safe and trouble-free operation can be and trouble-free operation of the customer’s production plants is guaranteed.

THDu ≈ 5 %

Consequences and symptoms:
- Mesh conforms to standards when first viewed
- Mesh nevertheless starts to oscillate
- failure of machine controls due to resonances
- unusual noises of the transformer
- thermal stress of cables and capacitors
- malfunction of complex industrial equipment and electronic controls
- overload of EMC filters, diodes and DC link capacitors of the frequency converters used, resulting in the risk of failure of these (= production stop)
- Overvoltages (voltage rises) and consequent flashovers on windings of motors or transformers
- Destruction of power supply units
- “Whirring“ or “droning“ of the electrical equipment
- Coupling of interference signals (interference oltages) into data connections (data lines), consequence: e.g. electromagnetic Disturbances of the company intranet
- Uncontrolled response (tripping) of protective devices (fuses ...)
- “tripping“ of generator regulators in the stand-lone grid

THDu ≈ 3 %

Perfect AC voltage:
- Standard-compliant, symmetrical, stable, resilient network
- Failure of equipment, production machines and controls are definitely no longer due to the mains voltage
- Warranty claims against your machine supplier continue to exist

The associated essential features of the patented SΦFIA filter technology in combination with the RESI damping element:

- Simple design
- Simple installation
- Simple commissioning
- Simple operation
- Simple monitoring
- Simple maintenance

Robust filter technology for „rough“ industrial networks

GridClass®-Mod

4 MUSKETEERS FOR PERFECT POWER QUALITY

GridClass®-Mod is a product range consisting of innovative, modular filter and compensation systems that enable a broadband filter effect across the entire frequency spectrum, resulting in a significant improvement in the voltage quality of the customer's network. Broadband interference sources require broadband filtering measures in order to achieve an optimized power quality result.

Advantages

- GridClass®-Mod are modular power quality solutions that can be expanded as needed at any time
- Optimal for filtering maritime island grids: Yacht and ship construction
- Optimal for filtering industrial networks with a somewhat lower energy demand
- Switchgear manufacturers only pass on their own company name to their customers.
- The performance and value creation of filter integration remains with the switchgear manufacturer

The "GridClass®-Mod" series is not only highly efficient - with very low losses - but also impresses with its flexible by its flexible modular design. Switchgear builders in particular benefit from our modularly expandable and different filter technologies SΦFIA®-mod, RESI-Mod, SIMΩN®-Mod and CLASSIC-Mod to provide their customers with the perfect filter solution. This means that the filter modules can be easily integrated into their own individual cabinets. The voltage-controlled filter modules are operated in parallel. With the various filter types in this module series, all distortions in the network can be reduced to a tolerable and standard-compliant level over a wide range, ensuring safe and trouble-free operation of customer energy networks. We fundamentally distinguish between our active filter SIMΩN®-Mod and the passive filters SΦFIA®-Mod and RESI-Mod. The patented passive Dominit filter systems impress with their intelligent control, robustness, and plug-and-play network integration.

Our active filter SIMΩN®-Mod offers the advantage of energy recycling and is flexible in its broadband filtering, suitable for any energy grid.

The most cost-effective solution is the use of a hybrid filter, combining the benefits of our passive and active filter systems into an optimized overall solution.

GridClass®-Mod-Products are connected to the mains in parallel with the consumers (see Fig. 3). The voltage-based control method does not require current transformer signals. This eliminates the need for complex installation of current transformers. This means that production processes are not affected during installation and maintenance work.

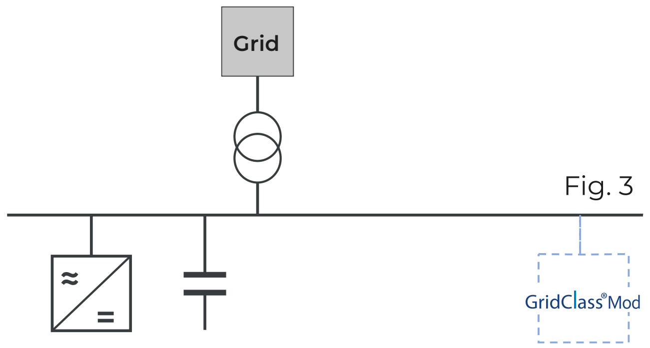
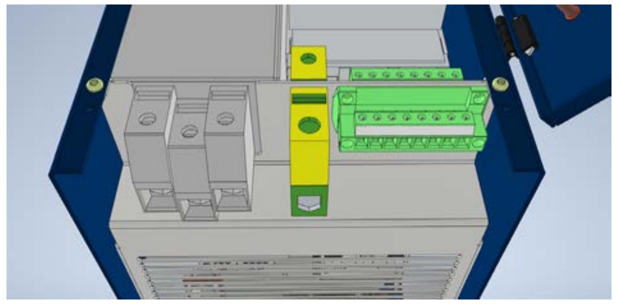


Fig. 3

SIMΩN®-Mod

SIMULATION OF OHMIC NETWORKS



SIMΩN®, the latest development from Condensator Dominit GmbH, is setting new standards in power quality. The heart of the active-, rectifier is a modern and low-loss semiconductor technology based on silicon carbide (SiC).

The SIMΩN® product integrates the following functions.

1. damping function: elimination of resonances and broadband reduction of interference levels

2. filter function: targeted, discrete filtering of the 5th, 7th, 11th 13th, 17th, 19th, 23th and 25 th harmonics

3. Reactive power compensation: low-loss and highly dynamic, capacitive and inductive

SIMΩN® is mainly used when filtering over a wide frequency range is required. The low-loss damping function eliminates in particular higherfrequency distortions of the mains voltage as well as oscillations in the mains. This can be, for example, a network resonance that cannot be eliminated with an ordinary LC-circuit. The resonance point is merely shifted to a higher frequency with such a filter. Even conventional, currentcontrolled active filters cannot effectively counteract resonance-induced voltage levels. The SIMΩN® active rectifier, on the other hand, simulates the behavior of a resistor for all fre-quencies except the fundamental.

This patented control method introduces damping into the power system and can thus eliminate resonances and reduce voltage levels over a wide frequency range. Compared to a real resistor, SIMΩN® does not convert the absorbed active power into dissipated power - i.e. heat. Instead, it is extracted from the harmonics and fed back into the network node in the form of fundamental active power. The patented control method thus effects a local energy recycling directly at the connection point.

THE SCOPE

SIMΩN® is primarily used where classic passive and active filters reach their limits. Figure 1 shows a typical application. The voltage characteristic of frequency inverters characteristic of frequency converters (flat topping) are superimposed with higher-frequencyoscillations are superimposed. By combining broadband damping and discrete filtering, SIMΩN® reduces both low-frequency and higherfrequency oscillations and eliminates resonance-related interference levels. SIMΩN® can also reduce the effects of commutation dips (see Fig. 2).

Capacitances distributed in the network, e.g. long cables, input filters of converters or unchoked compensations, form a resonance together with the feeding transformer. If a resonance point exists, even a small current can lead to high interference voltage levels.

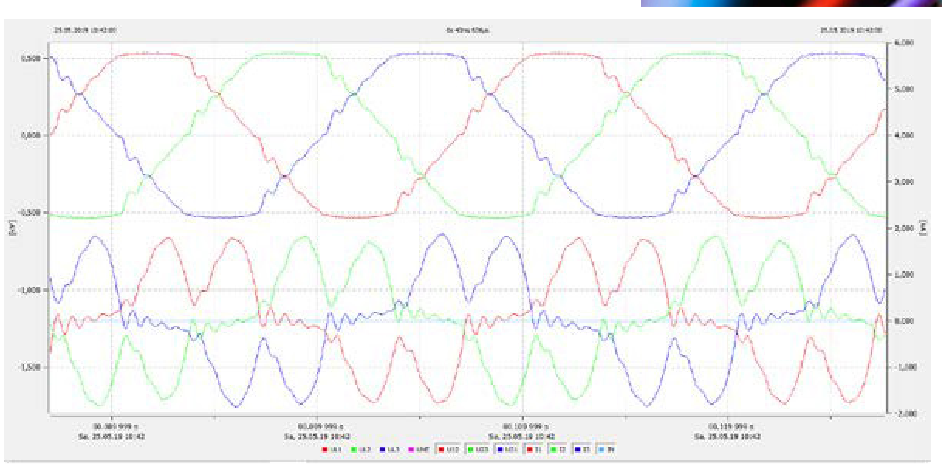


Fig. 1
Typical voltage and current characteristics in a large industrial printing plant

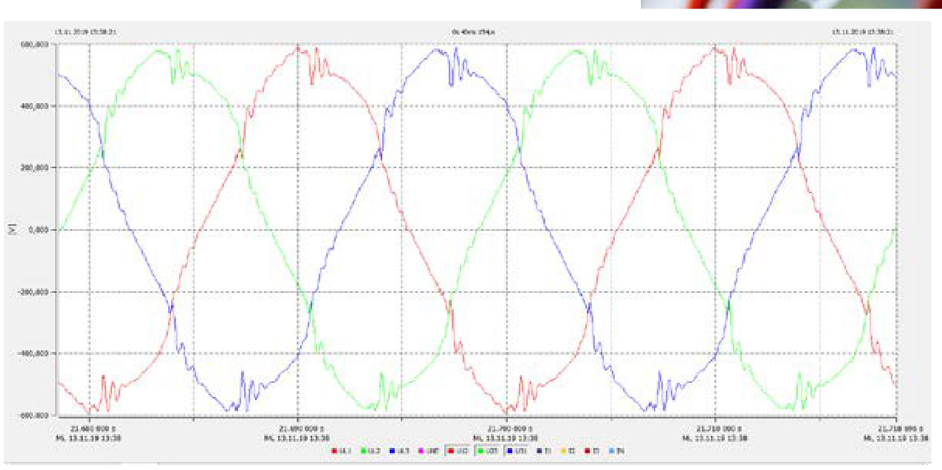
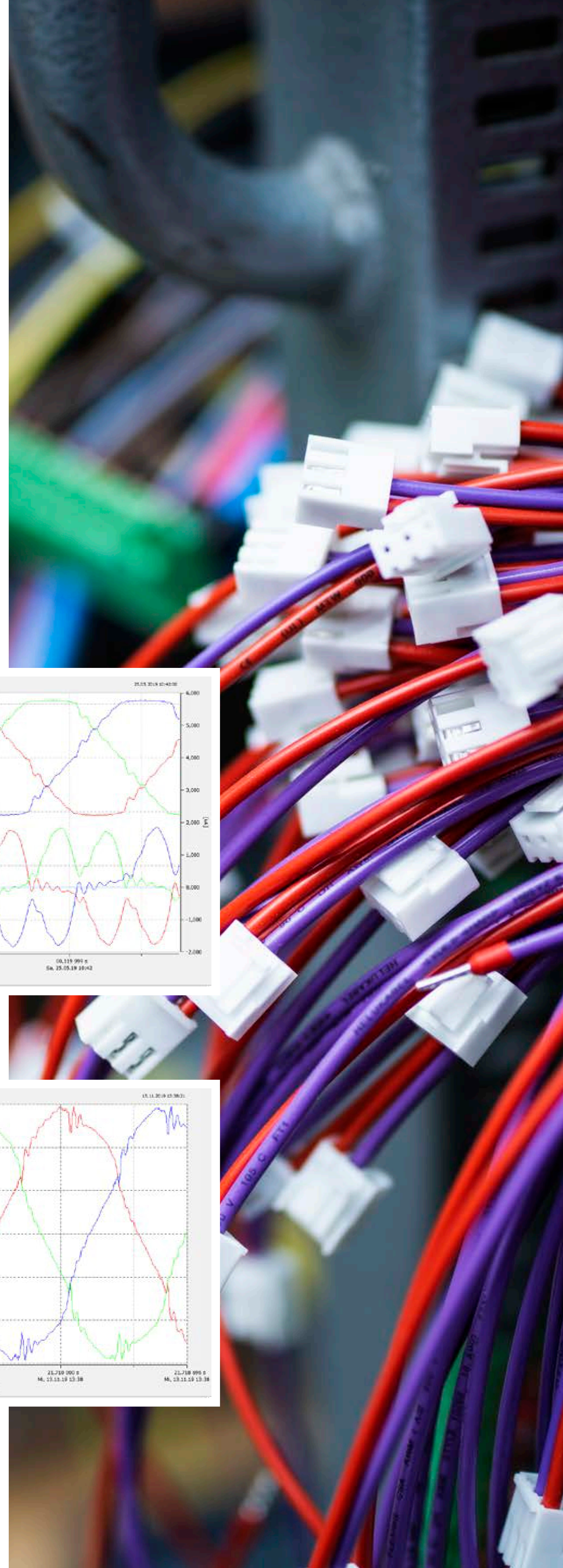


Fig. 2
Commutation notches in an industrial battery factory



SIMΩN®-Mod

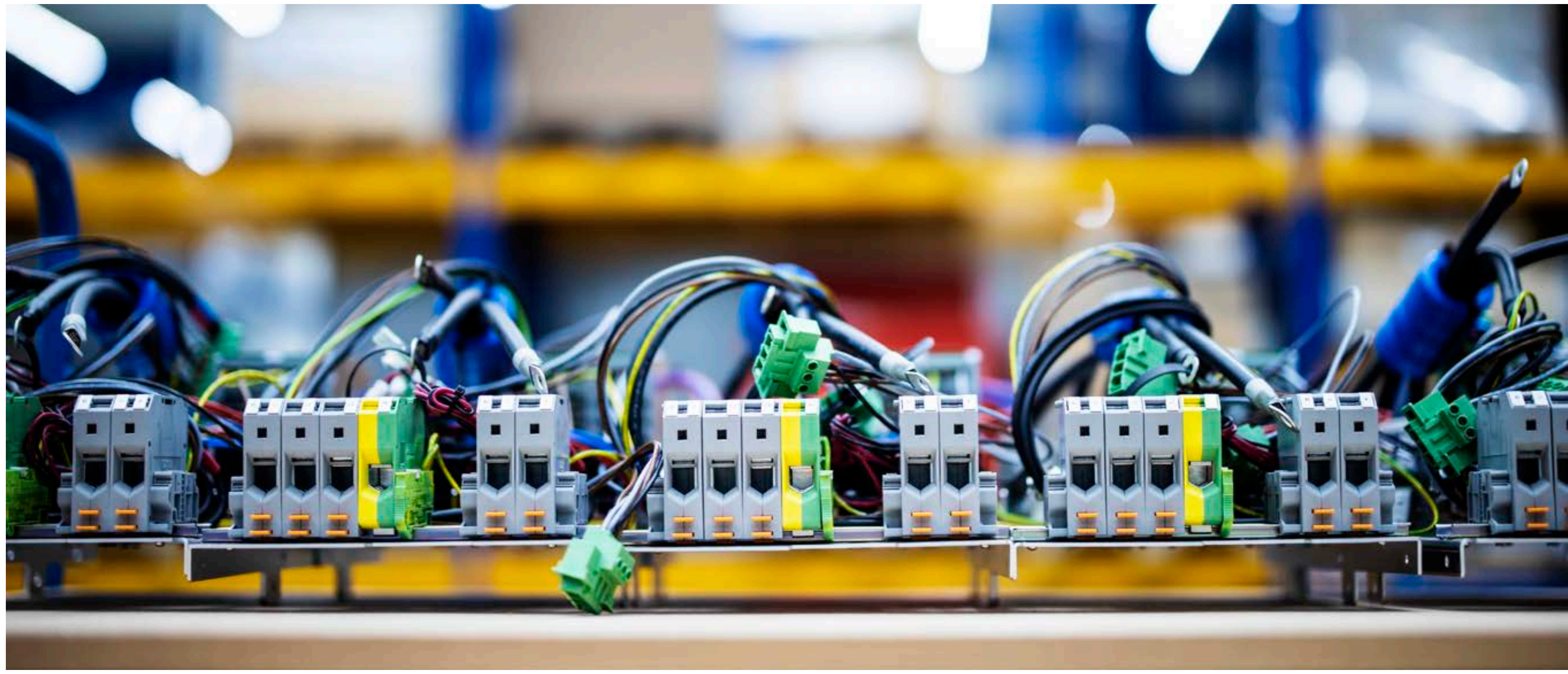
ADVANTAGES OF SILICONCARBIDE (SiC)

Silicon carbide is considered a wide bandgap semiconductor. This energy gap between valence and conduction band significantly determines the properties of the semiconductor material. SiC differs from silicon as follows:

Properties	SiC	compared to Si	Effects
Energy band-gap	3,26 eV	Triple	Higher Temperature working range
Electrical breakdown field strength	3 MV /cm	Tenfold	Smaller $R_{DS\,on}$ Lower conduction losses
Saturation drift	2 · 107 cm/s	Double	higher switching speed / lower switching losses
Thermal conductivity	4 . 5 W/cm · K	Triple	Excellent thermal Conductor

Dampingeffect

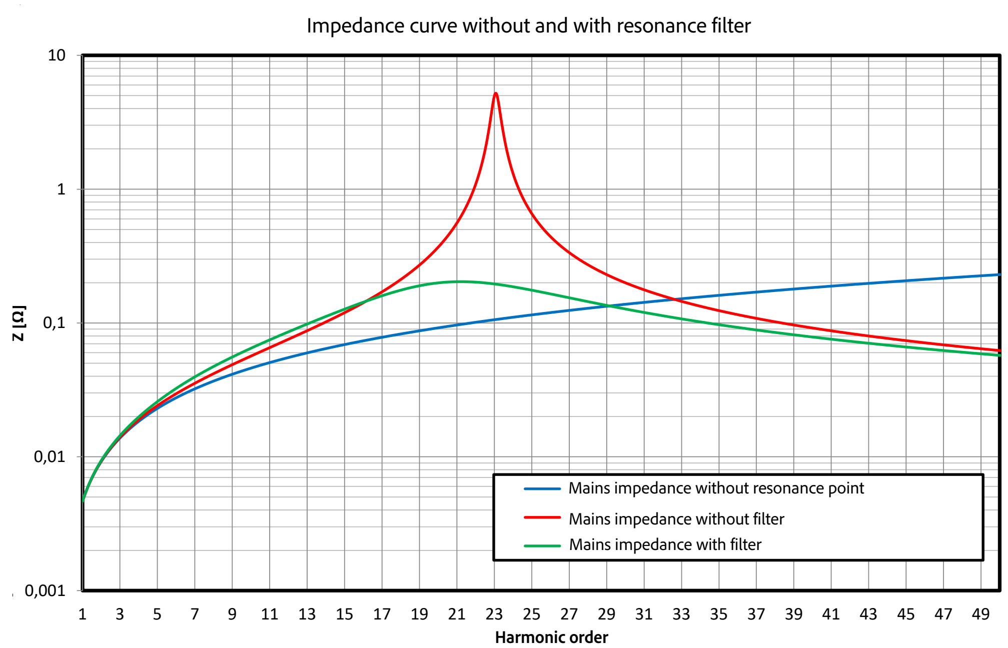
The unique damping function of SIMΩN® simulates the behaviour of a resistor and thus damps resonance-related increases in the network impedance effectively and in a loss-optimized manner, as shown in Figure 4. The red curve shows the impedance of a network (from the perspective of low-voltage distribution) with a 1 MVA transformer and a capacitance of 350 µF. The green curve shows the same network after adding a SIMΩN® filter with a simulated resistance of 300 mΩ.



LOCAL ENERGY RECYCLING FUNCTION

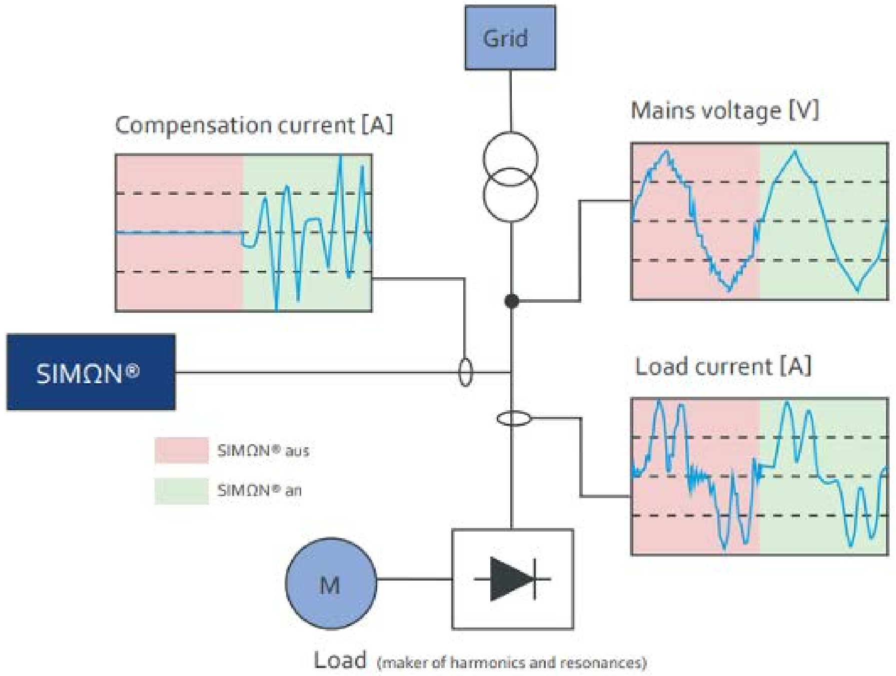
Via the patented control algorithm, a filter current is fed into the network at the connection point, which extracts active power from the harmonics and feeds it back into the network in the form of the fundamental (as fundamental active power). The recovered harmonic power can be calculated as follows:
$P_{SIM\Omega N®} = \sqrt{3} \cdot THD_U \cdot U \cdot I_{SIM\Omega N®}$

For a 400 V grid with a typical THDU (Total Harmonic Distorti on / harmonic distortion, in this case of voltage U) of about 5%, the use of a 120 A SIMΩN® results in about 4.2 kW of recycled harmonic active power. Less the losses of 1 kW, 3.2 kW can be fed back into the grid with the fundamental frequency.



SIMΩN®-Mod

OPERATING PRINCIPLE



Damping function: SIMΩN® records the mains voltage via an integrated measuring device and uses it to calculate the harmonic voltage. Using this harmonic voltage and the simulated SIMΩN® resistance is then used to determine the current that the system must generate in order to achieve the same effect in the effect as a real resistor in the network.

Exactly this current is then fed into the grid by SIMΩN®. The filter is therefore able to actively simulate a passive damping resistor. SIMΩN® not only filters not only filters discrete harmonic orders, but also has a broadband effect on all frequencies. The network is thus damped, resonances and interference levels in the voltage are reduced. In addition voltage distortions are also smoothed out due to this property, not directly caused by a current, such as switching operations or commutation. Switching operations or commutation dips. As this is a purely voltage-controlled filter, no current transformers are required for filter operation. required for filter operation. These are only required if additional dynamically controlled reactive current is to be provided.

TECHNICAL DATA – SIMΩN®-Mod

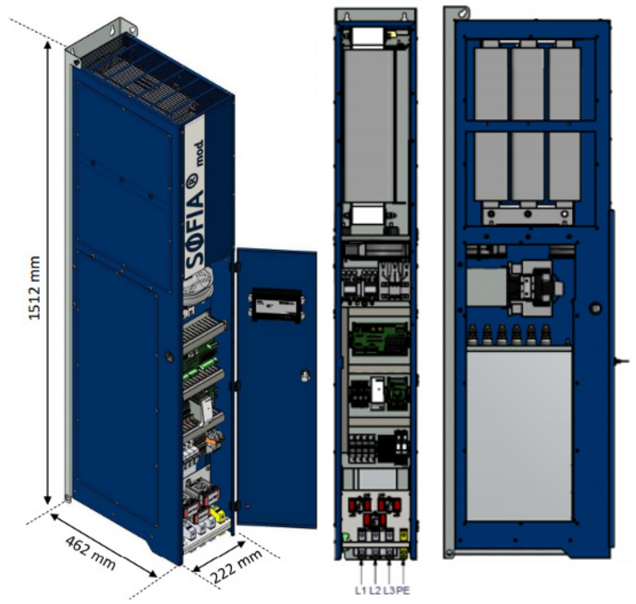
Rated voltage	400 V	
Rated frequency	50 Hz	
Filter current	120 A	
Rated Power	83 kVA	
Peak current	400 A	
Crest factor	3,3	
Functions	Damping of resonances, commutation notches and transients Reduction of THD_U Discrete filtering of typical harmonics: - H5, H7, H11, H13, H17, H19, H23, H25 Reactive Power Compensation (cap & ind) Local Recycling of Harmonic Power	
	Active filter	**Reactive power operation**
Efficiency *over the entire load range*	>98%	>99%
Power losses *Maximum losses for cooling design*	< 1660 W	< 830 W
Topology	2-level active rectifier	
Semiconductors	Silicon carbide (MOSFETs)	
DC-Link	Film capacitors	
Switching frequency	20 kHz	
Reaction time	< 50 µs	
Ambient temperature	0 °C (min.), 40 °C (max.)	
Noise Level	< 67 dB(A)	
Cooling mode	forced air cooling	
Protection class	IP20	
Dimensions	228 mm x 450 mm x 1512 mm	
Weight	100 Kg	
Color	RAL 5017	
Type of mains	3 Phases + PE, without N conductor (TN-/TT-Netz)	
Cable infeed	from bottom	
Interfaces	Web server Modbus (TCP/IP) HTTP API- endpoint	
Combination possibilities	Parallel operation possible GridClass-Mod Product series: SΦFIA®-Mod, RΣSI-Mod, Classic-Mod, SIMΩN®-Mod	
On-site fuse protection	160 A gG	
Connection cross-section	3 x 50 mm² + 1x 35 mm² (NSHXAFÖ)	
optional	with internal fuse protection 160 A gG on-site fuse protection 200 A gG	

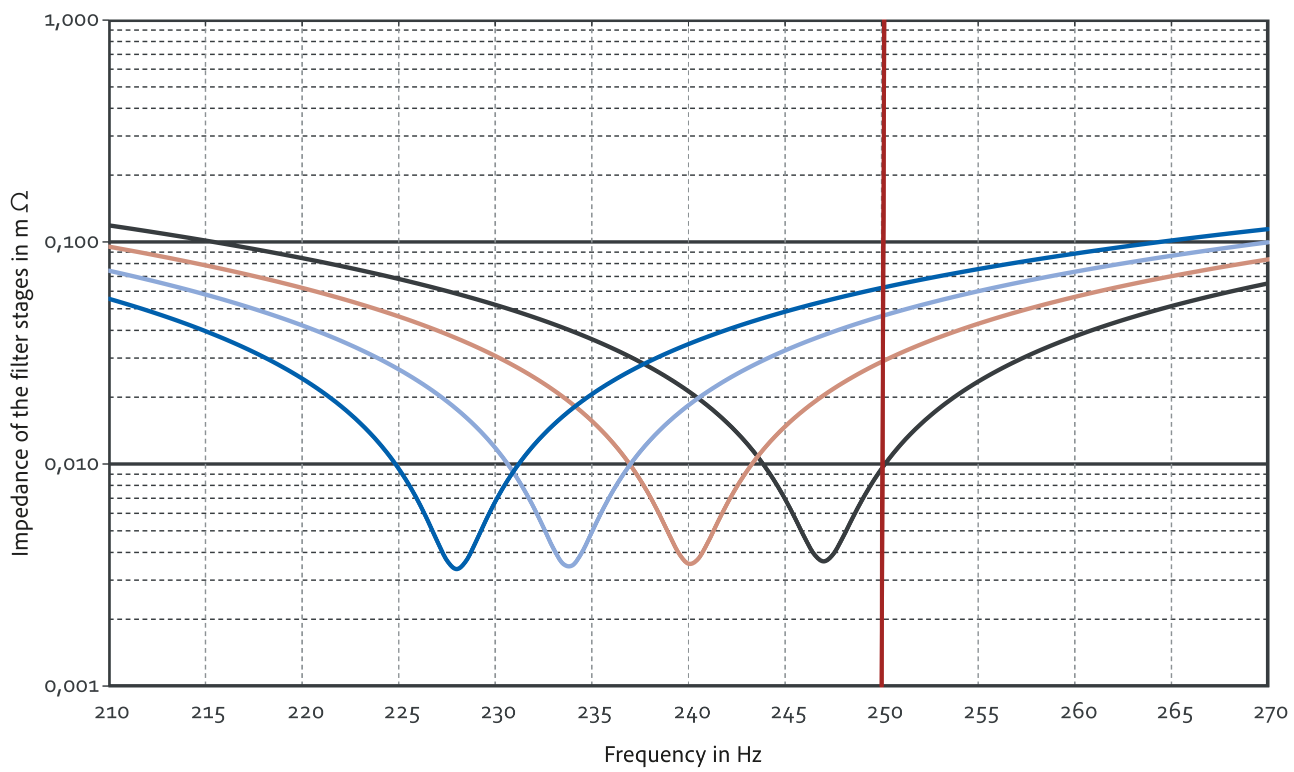
SΦFIA®-Mod

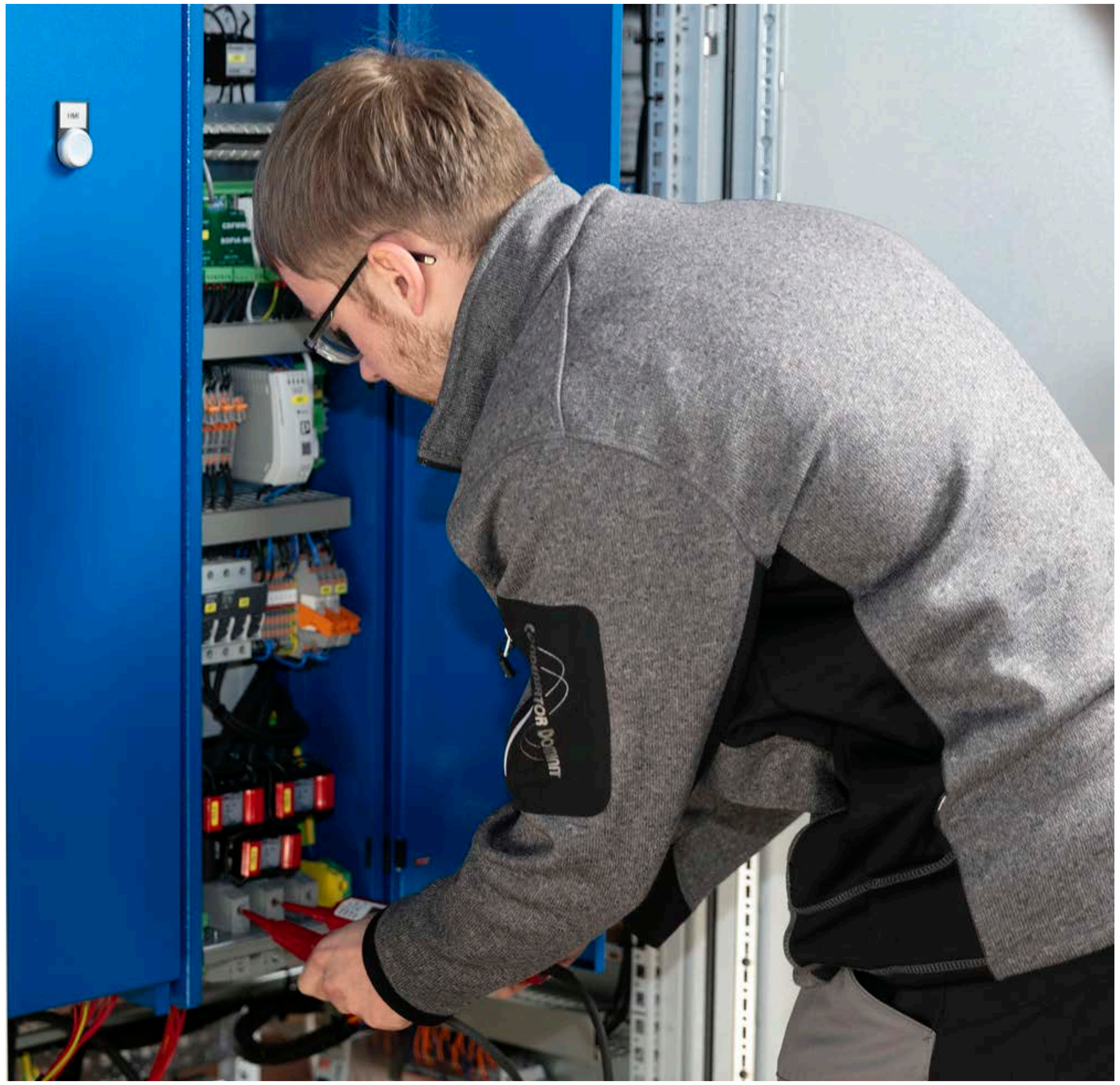
VOLTAGE CONTROLLED HARMONIC FILTER WITH INTELLIGENT ADAPTATION

SΦFIA®-Mod is an actively controlled harmonic filter in modular design. It features automatic impedance control, with which the filter independently adjusts the suction effect exerted on the network. Previously, it was necessary to know all of the customer's network data and have the filter designed by an expert in order to design voltage-controlled filters. Condensator Dominit has integrated this expert knowledge into the control electronics.

In contrast to classic passive filters, which use a fixed combination of a capacitor and an inductor to achieve a certain absorption effect at defined frequencies, the SΦFIA® filter adjusts its current consumption depending on the load and taking other framework conditions into account.
In this way, subsequent changes in the networks and rising or falling levels are readjusted so that an optimum filter result is always achieved. SΦFIA® filters can overcome the major disadvantage of classic passive filters, which switch off in the event of an overload, i.e. when they are needed most.

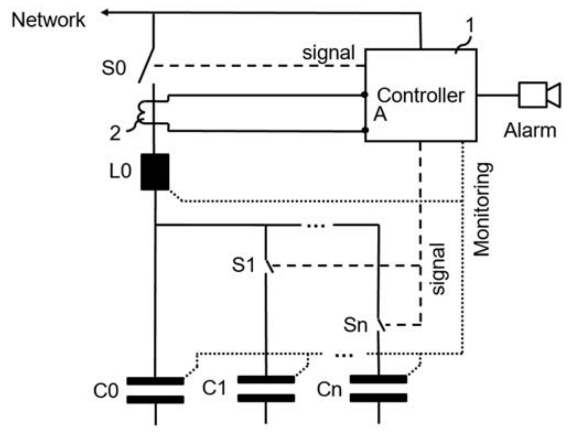






Operating Principal SΦFIA®-Mod

In the operation of a filter stage (e.g. in Fig. 3: SΦFIA®-Mod H5), in the event of changes in the harmonic load, the filter is regulated by uninterrupted switching between the tuning frequencies (dark blue <=> light blue <=> orange <=> black) in such a way that over a very wide range the filter current is almost constant. The stages are designed in such a way that only when the permissible voltage levels for industrial networks (class 3 according to IEC/EN 61000-2-4) are exceeded for a longer period of time, a protection-related switch-off (self-protection of the filter) occurs with the filter switched on. To avoid a system failure in case of short-term overload events, the filter can be overloaded to a certain extent. For this purpose, a corresponding current-time characteristic is stored in the control program.



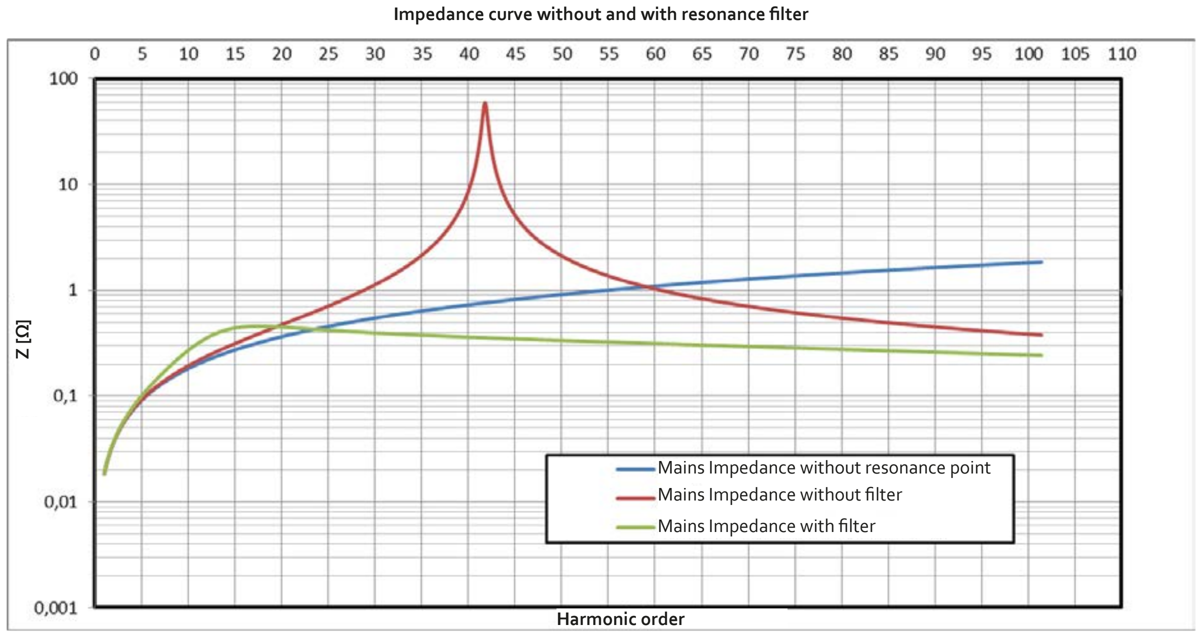


Fig. 5
Impedance curve of a RESI filter example: Mains 50 MVA, transformer 630 kVA, cable 100 µF + RESI-Mod-400/50-25-kvar

RƐSI-Mod

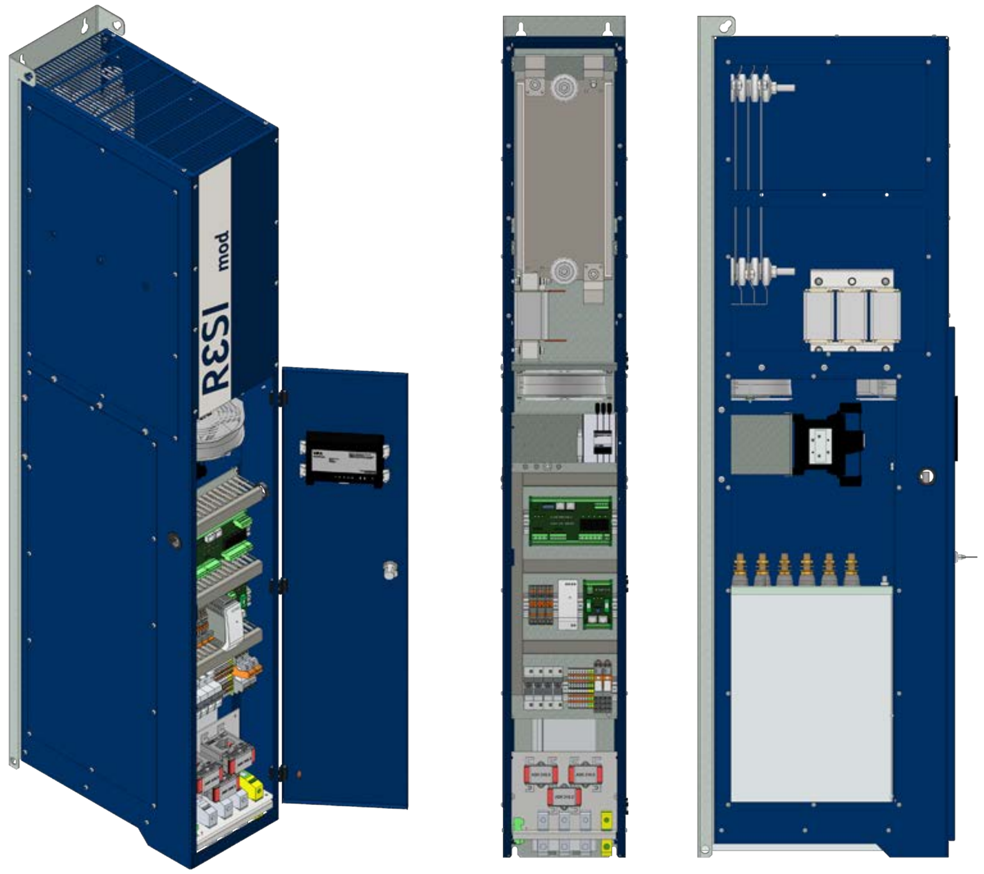
RESONANCE ELIMINATION SYSTEM

Physically, the only technical possibility for reducing resonance-related voltage levels is the introduction of damping.

In a network with existing or threatening resonances, higher-frequency interference levels such as clock frequencies or commutations, the GridClass® system is easily extended by a modular RƐSI filter (resonance elimination system) in addition to the SΦFIA® filter. This, by removing energy, introduces the necessary damping and stability into the network and significantly reduces the interference levels.

Figure 5 illustrates the effectiveness of an RƐSI filter in damping a re sonance point.

The blue line shows the impedance curve of a network, mainly characterized by the transformer (630 KVA, uk 6%). For the upstream network level, a short-circuit power of 50 MVA was considered. The interaction of the ohmic-inductive impedance characteristic of the transformer and a capacitance of 100 µF, which is present in 10-km-long cables, for example, creates a resonance point -also called pole pointbetween the 40th and 45th order (red line) without the use of filters. Now the interference potential already exists and a small harmonic current with corresponding frequency is sufficient for this point to be excited and the network to start oscillating. This results in resonance-induced voltage levels. The green line shows the resulting network impedance when a resonant damping filter is used. By using RƐSI, the corresponding resonance point is strongly damped and thus loses the potential danger described before.



TECHNICAL DATA – SΦFIA®-Mod and RƐSI-Mod

Rated voltage	400 V
Rated frequency	50 Hz
Filter current, frequency	H5: 100 A, 250 Hz H7/H11: 50/30A, 350/550 Hz HP: 40A, from approx. 1KHz depending on the network
Power losses	H5 < 1000 W H7/H11 < 1000 W HP < 1500 W
Ambient temperature	0 °C (min.), 35 °C (max.)
Steuerspannung	230 V extern
Cooling mode	forced air cooling
Protection class	IP20
Dimensions	228 mm x 450 mm x 1512 mm
Weight	H5: ca. 150 Kg H7/H11: ca. 100 Kg HP(RƐSI): ca.80 Kg
Color	RAL 5017
Type of mains	3 Phases + PE, without N conductor (TN- / TT-Netz)
Cable infeed	from bottom
Combination possibilities	Parallel operation possible “GridClass-Mod” Product series: SΦFIA®-Mod, RƐSI-Mod, Classic-Mod, SIMΩN®-Mod
On-site fuse protection and recommended Connection cross-section	H5: 160 A gG [3 x 50 mm² + 1x 35 mm² (NSHXAFÖ)] H7/H11: 100 A gG [3 x 50 mm² + 1x 35 mm² (NSHXAFÖ)] HP: 80 A gG [3 x 35 mm² + 1x 35 mm² (NSHXAFÖ)]
Different Designs	
SOF-AIM	SΦFIA®-Mod-400 / 50-100A-H5-MASTER-4”
SOf-ZAA	SΦFIA®-Mod-400 / 50-100A-H5-MASTER-7”
SOF-AIX	SΦFIA® -Mod-400 / 50-100A-H5-MASTER
SOF-AIS	SΦFIA® -Mod-400 / 50-100A-H5-SIAVE
SOF-CNS	SΦFIA® -Mod-400 / 50-50/30 A-H7/H11-SIAVE
RES-AIM	RƐSI-Mod-400 / 50- 40A-HP-MASTER-4”
RES-AIS	RƐSI-Mod-400 / 50- 40A-HP- SIAVE

Note: The modules are also available in other voltage levels 480/60Hz 690 V/60 Hz.

Classic-Mod

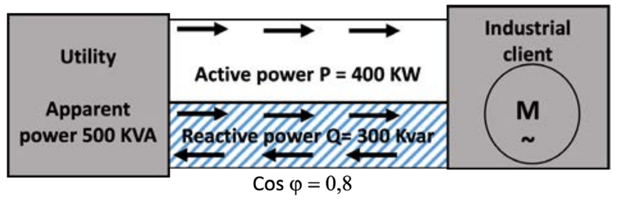
CLASSIC POWER FACTOR CORRECTION

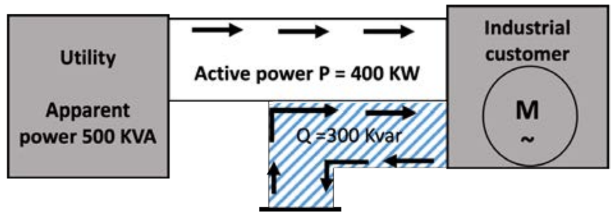
Real loads typically behave ohmic/inductive, resulting in a phase shift φ between the current and voltage, or between the respective components of active and reactive power.

To deliver a specific active power, all transmission components must be rated higher due to the phase shift. This elevated rating increases system costs. As a result, utility companies typically charge for reactive power demand beyond a certain threshold, which varies depending on the utility. This charge is typically reflected separately on the energy invoice by indicating the reactive energy consumption. Usually, customers are required to pay for reactive energy that exceeds half the amount of active energy purchased, corresponding to a power factor of cosφ = 0.9
the power flow without and at full compensation is as shown in the diagram

Capacitormodule acc. EN 61439, IEC 61439 and VDE 0660 part 600 for mounting into a switchboard for reactive power compensation in grids with harmonic levels acc. EN/IEC 61000-2-4 class 2 and 100% duty cycle.

Each module is equipped with HRC fuses, threepole contactors, anti.-resonance reactors, capacitors and discharge devices. The mounting is foreseen with two rails which will be fixed at the sides of the cubicle. The module can be pushed in like a drawer.
Capacitor unit according EN 60831, IEC 60 831, VDE 560 part 46 consisting of a number of single-phase capacitor units made of metallized polypropylene foil. Each element contains an internal fuse according to the IPE principle. The individual self-healing capacitors are installed together with cooling plates in a common sheet steel enclosure with fireproof granulate filling.



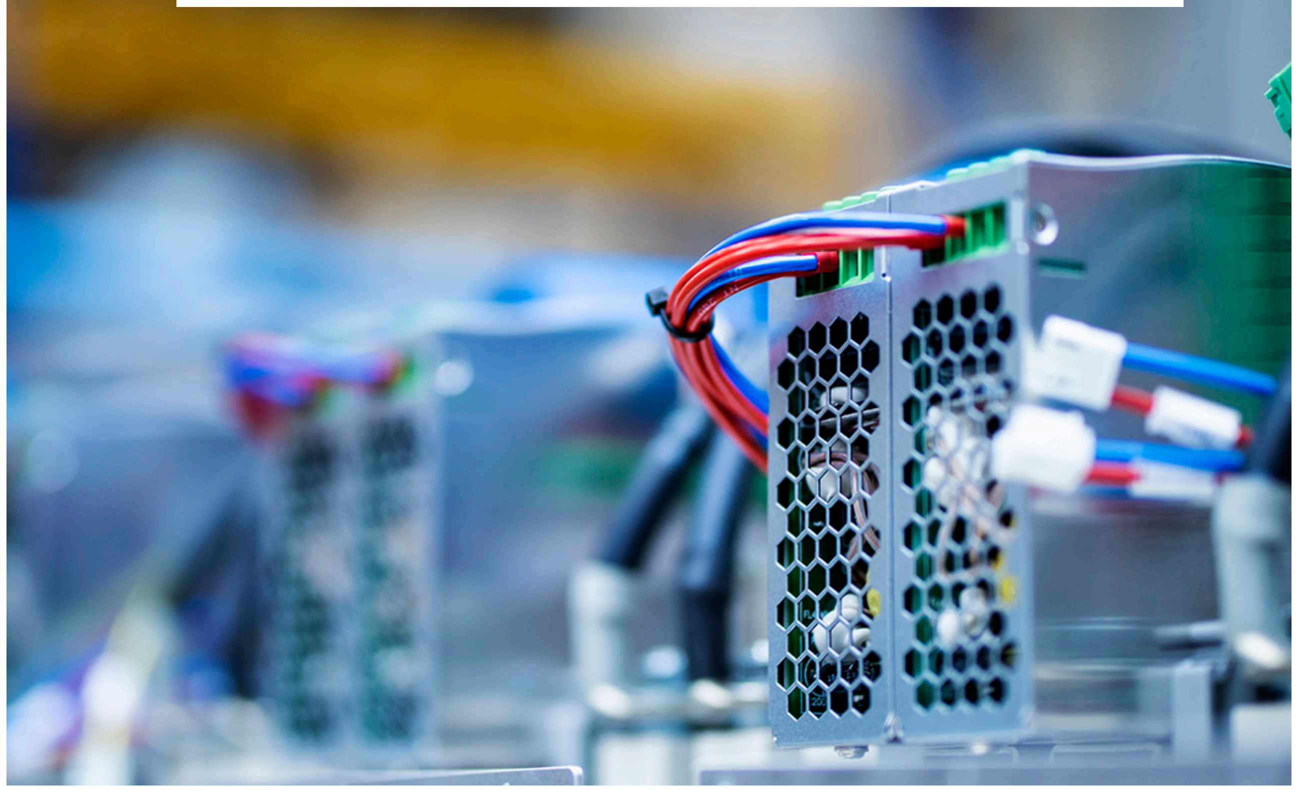


TECHNICAL DATA – Classic-Mod-400/50-25+50-L070

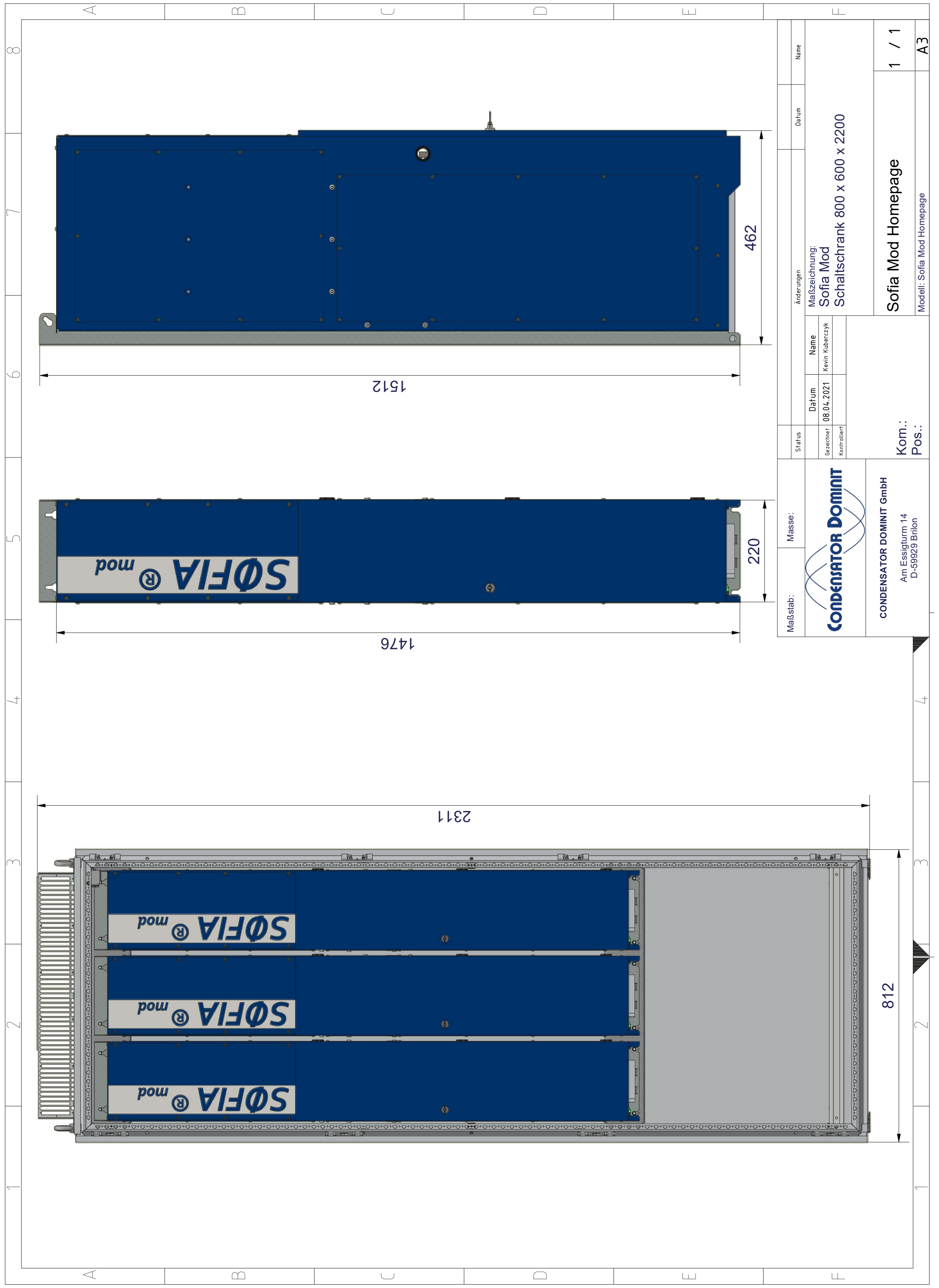
Rated power	75 kvar
Steps	25 + 50 kvar
Rated voltage	400 V / 50 Hz / threephase
Control voltage (external)	230 V / 50 Hz
Degree of protection	IP20 / Indoor use
Cooling	AF (with fan)
Dimensions (WxDxH)	228 x 470 x 1512 mm
Weight (app.)	150 kg
Colour	RAL 5017
Infeed	3P + PE(N) / from bottom

Recommendation for on-site connection

Protection	3x 160 A gG
Min. cross section	4x 50 mm² (NYY) / or
	3x 50 mm² + 1x 35 mm²



MECHANICAL DRAWING
GridClass®-Mod TYPE-NEUTRAL



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