CONDENSATOR DOMINIT

SIMULATION OF OHMIC NETWORKS

SIMΩN®

GridClass® Technology

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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® filter integrates the following two functions.

1. **Damping of power supply networks for the reduction of harmonics**

2. **Low-loss and highly dynamic reactive power compensation (capacitive and inductive)**

SIMΩN® is mainly used when filtering over a wide frequency range is required. The low-loss damping effect eliminates in particular higher-frequency 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, current-controlled 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 frequencies 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 mainly used for higher frequency voltage levels. Figure 1 shows a typical application. Higher-frequency oscillations are superimposed on the voltage characteristic of frequency converters (flat topping). SIMΩN® reduces low-frequency oscillations (5th and 7th order) and completely eliminates higher-frequency oscillations (up to 2.5 kHz). SIMΩN® can also reduce the effects of commutation dips (see Fig. 2).

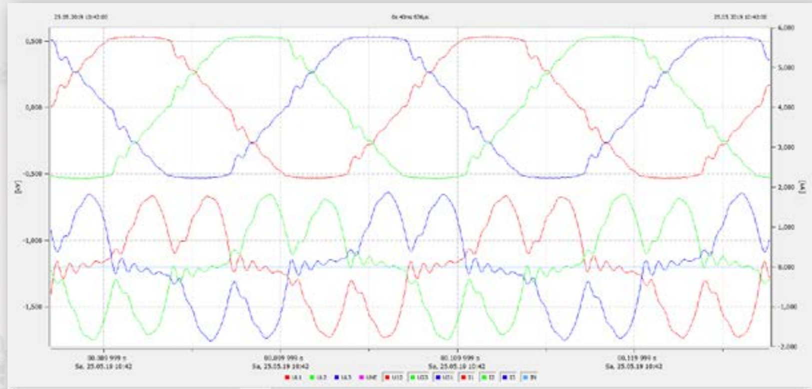


Fig. 1

Typical voltage and current characteristics in a large industrial printing plant

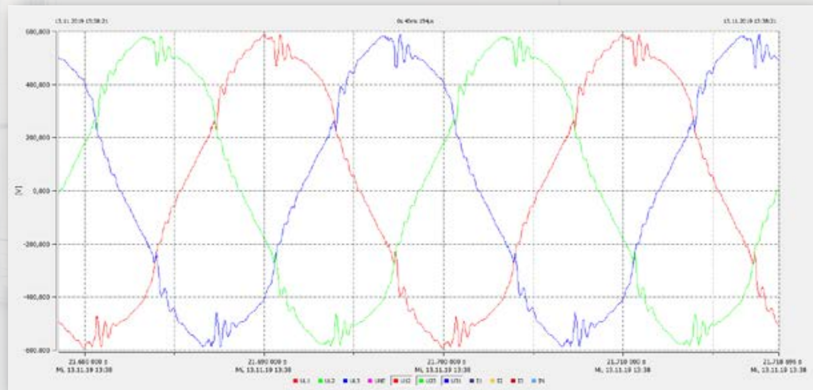


Fig. 2

Commutation notches in an industrial battery factory

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.

GRID INTEGRATION

SIMΩN® is 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.

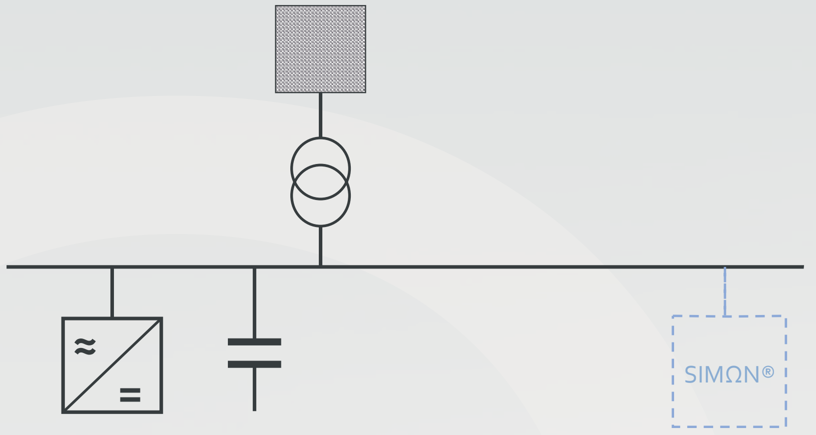


Fig. 3

ADVANTAGES OF SILICON CARBIDE (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 bandgap	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

THE SOLUTION

The SIMΩN® active control method simulates the behavior of a resistor and thus influences the network impedance. Efficient damping allows the resonance to be eliminated, as shown in Fig. 4. The red curve shows the impedance of a network (from a low-voltage distribution point of view) 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.

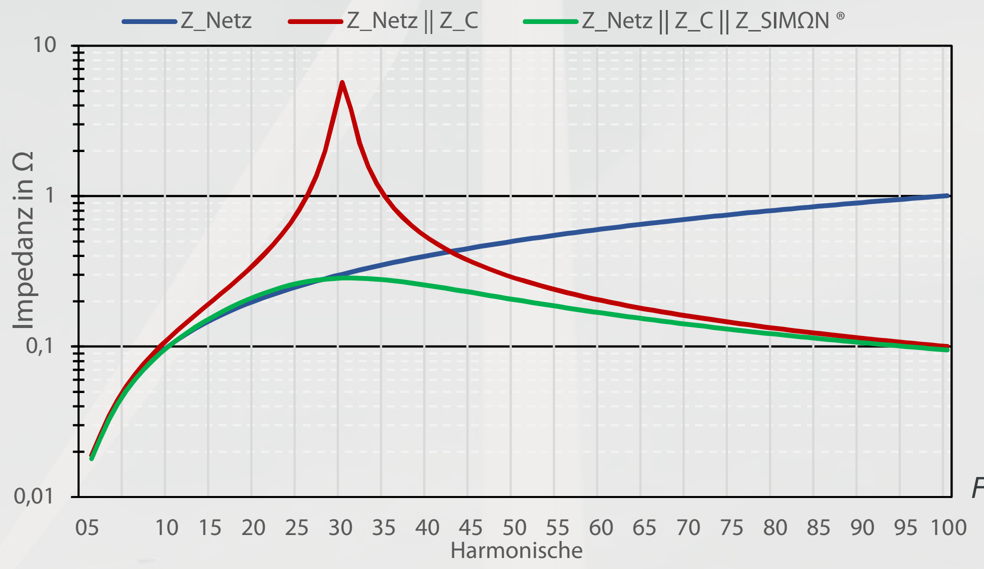


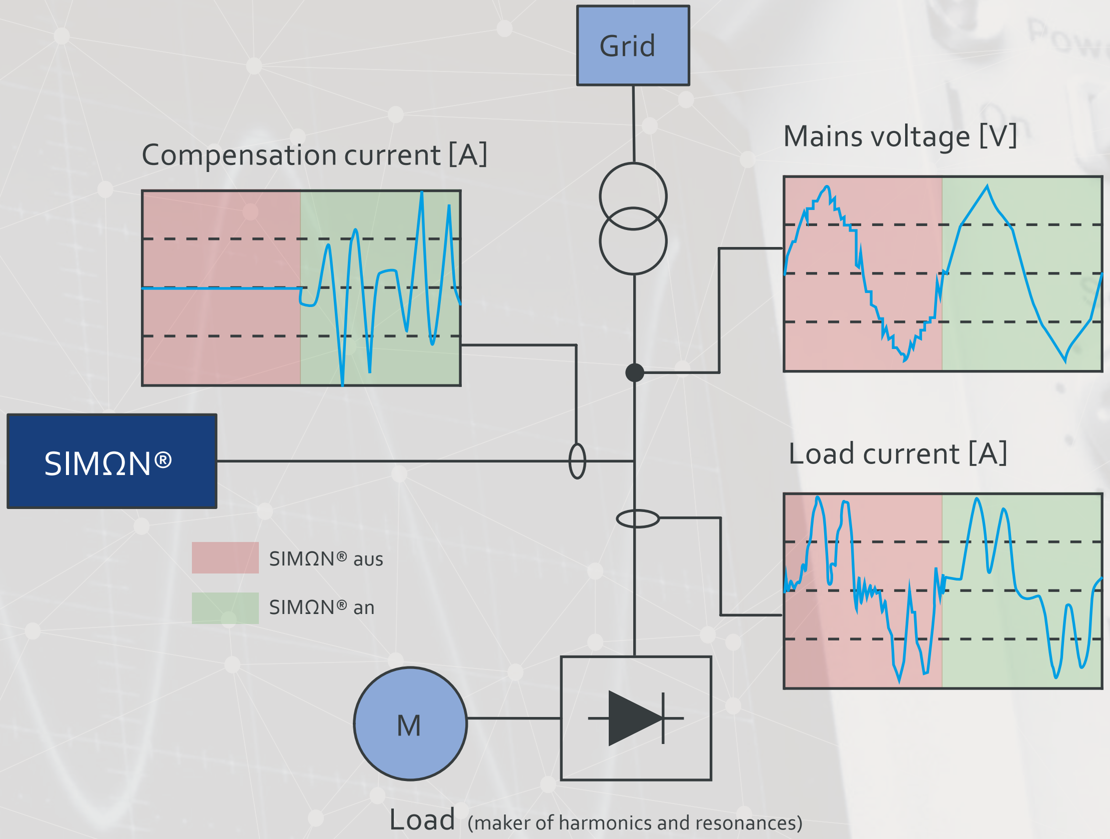
Fig. 4

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:

$$P_{SIMΩN®} = \sqrt{3} \,.\, THD_U \,.\, U \,.\, I_F$$

For a 400 V grid with a typical THD_U (Total Harmonic Distortion / 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.



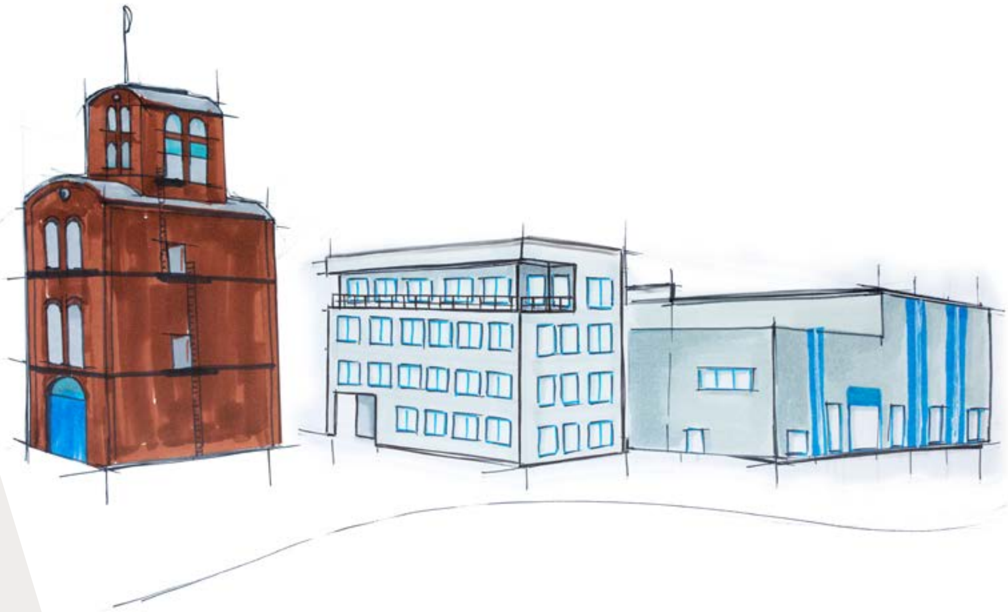
SIMΩN® OPERATING PRINCIPLE

SIMΩN® records the mains voltage via an integrated measuring device and calculates the harmonic voltage from it. This harmonic voltage and the simulated resistor SIMΩN® are then used to determine the current that the system must generate to achieve the same effect in the network as a real resistor. Exactly this current is then fed into the network by SIMΩN®. The filter is thus able to actively simulate a passive damping resistor. SIMΩN® not only filters discrete harmonic orders, but has a broadband effect on all frequencies. The network is thus damped, resonances are combated and interference levels in the voltage are reduced. In addition, due to this property, voltage distortions that are not directly caused by a current, such as switching operations or communication dips, are also smoothed. Since this is a purely voltage-controlled filter, no current transformers are required for filter operation. These are only required if additional dynamically controlled reactive current needs to be provided.

TECHNICAL DATA – SIMΩN®

System design	modular
Rated mains voltage	3 x 400 V (+/- 10 %)
Mains frequency	50 Hz (+/- 5 %)
Filter/compensation current	120 A
Functions	- Harmonic reduction by introduction of damping - local energy recycling function at the SIMΩN®-coupling point - Power factor correction static/dynamic (with dynamic current transformers on the customer side - in 2 phases - necessary)
Peak current	320 A
Rated power	82,8 kVA
Mains form	3-phase, TN, TT
Topology	2-level active rectifier with Silicon carbide semiconductors
Switching frequency	20 kHz (ripple current RMS into the mains ≤ 2 % of rated current)
Power loss	≤ 1200 W
Efficiency	> 98,6 %
Protection class	IP 20
Ambient temperature	0 °C (min.), 40 °C (max.) continuous
Cooling mode	forced air cooling
Dimensions	228 mm x 450 mm x 1512 mm (W x D x H)
Weight	180 kg
Power supply	from below
Combination possibilities	Can be combined with the other GridClass-Modules: SΦFIA® mod, RεSI mod and MιA®
On-site fuse protection	160 A gG

Technical changes and errors excepted.



YOUR VOLTAGE – OUR PASSION

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