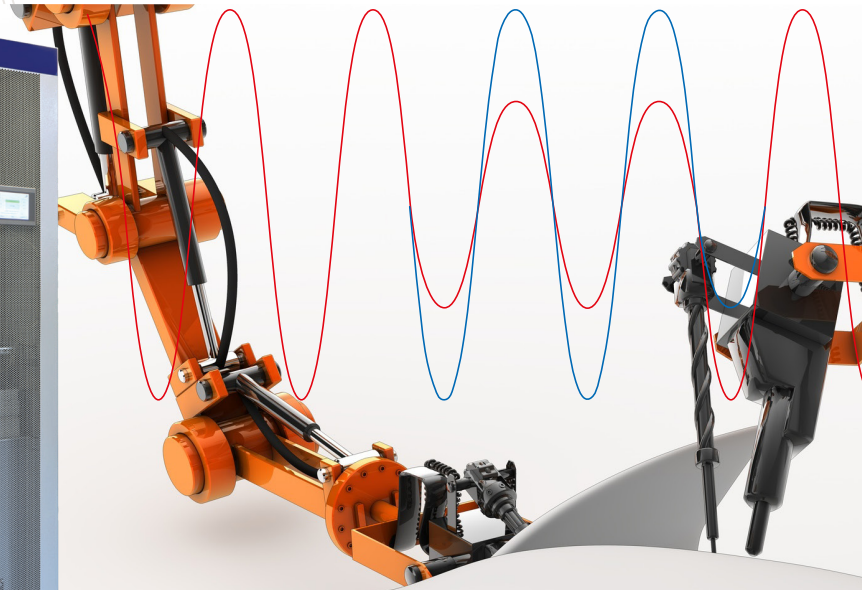
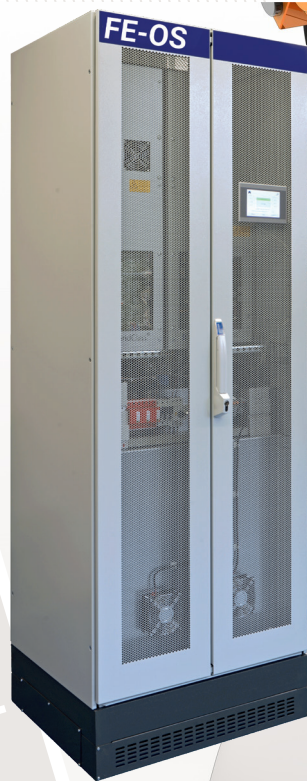




FRANKE[®]
Elektrotechnik

YOUR VOLTAGE – OUR PASSION

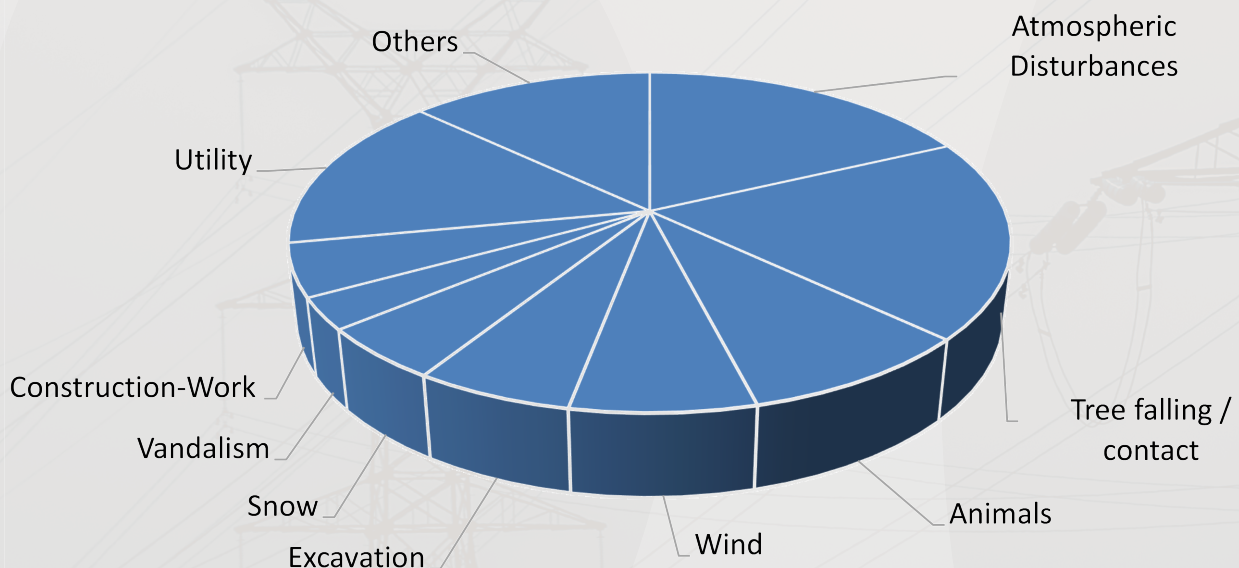
ACTIVE VOLTAGE STABILIZER



FE-OS

► CHALLENGE

- Production down time are in 92% of the cases caused by voltage dips.
- Frequent causes of voltage dips are short circuits in the transmission & distribution grid or faults in the customer's equipment.
- The duration of voltage dips is often depending on the response time of the protection equipment, e.g. Distance relay. The typical duration is greater than 20 ms and less than 1 second.²⁾
- The depth of voltage dips depends on the network topology and the distance from the fault location. Almost all voltage dips are leaving the remaining voltage greater than 40 %. ²⁾
- Quantity and depth of voltage dips differs strongly depending on region and season of the year. ²⁾



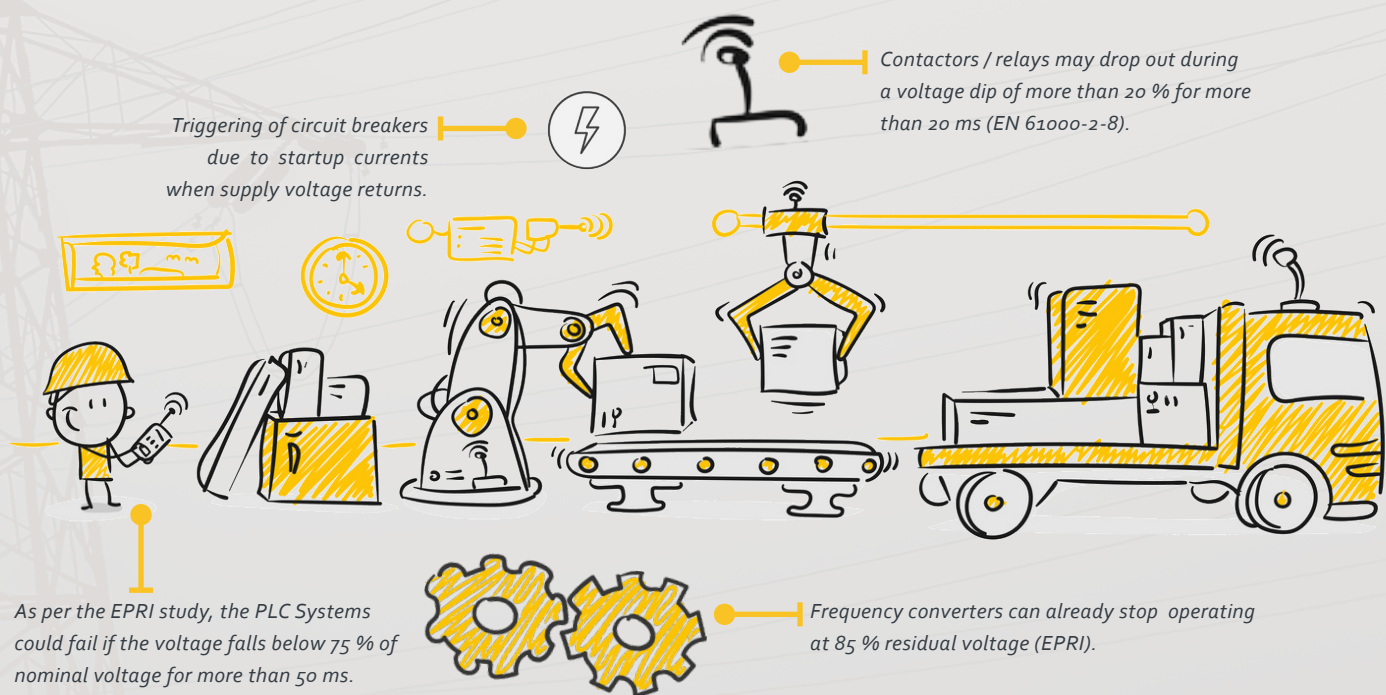
Causes of voltage dips in the transmission and distribution network ¹⁾

¹⁾ Based on EPRI, Electric Power Research Institute, Palo Alto CA

²⁾ Source: EN 50160, Voltage characteristics of electricity supplied by public distribution networks, Edition February 2011

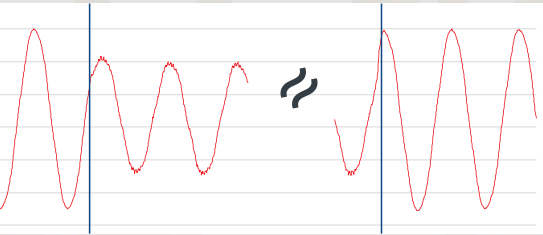
► SOLUTION

- The most important production factor is the electrical power, FE-OS reduces significantly the risks of improper power quality:
- Prevention of production downtimes and downtime expenses
- Effective reduction of setup costs and reject rates
- Compliance with production criteria for industrial goods and testing guidelines
- Reduction of maintenance- and repair costs
- Ensuring of quality and reproducibility



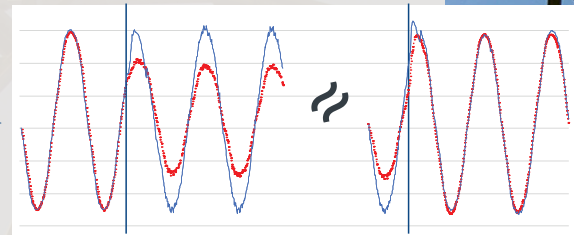


Voltage and phase correction ...



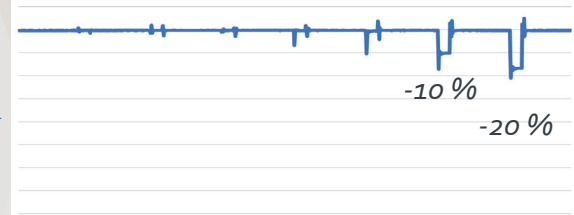
INPUT

in real time



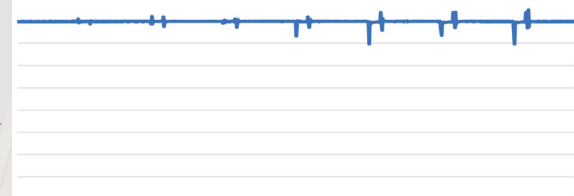
OUTPUT

40 % correction capability 3-phase



OUTPUT

60 % correction capability 1-phase



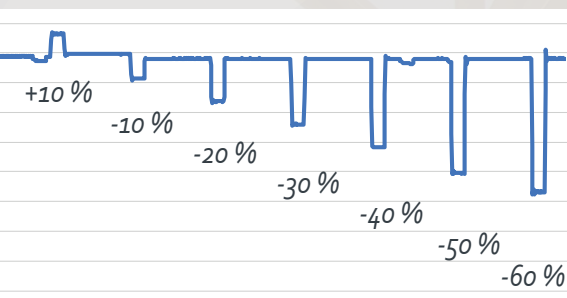
OUTPUT

min. $\pm 10 \%$



OUTPUT

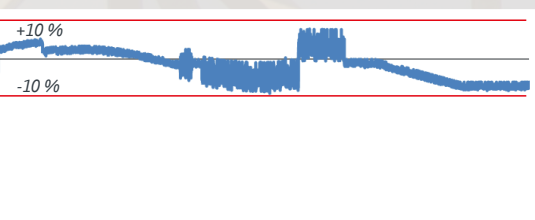
Voltage correction ...



INPUT

Measurement
Half cycle RMS

Continuous control range ...



INPUT

► FE-OS – PERFORMANCE FEATURES

- $\pm 10\%$ continuous correction capability

- Short circuit power remains unchanged
No adjustment of protection equipment required

- Robust overload capability
150% overloading for approx. 30 seconds

- Economical solution
No battery storage required = very low maintenance costs

Very high Efficiency =
very low operating costs

- Highly scalable
Modular system, adaptable for required power levels

Customized output voltages available

System power extension through parallel connection

Flexible adaption of short circuit capability



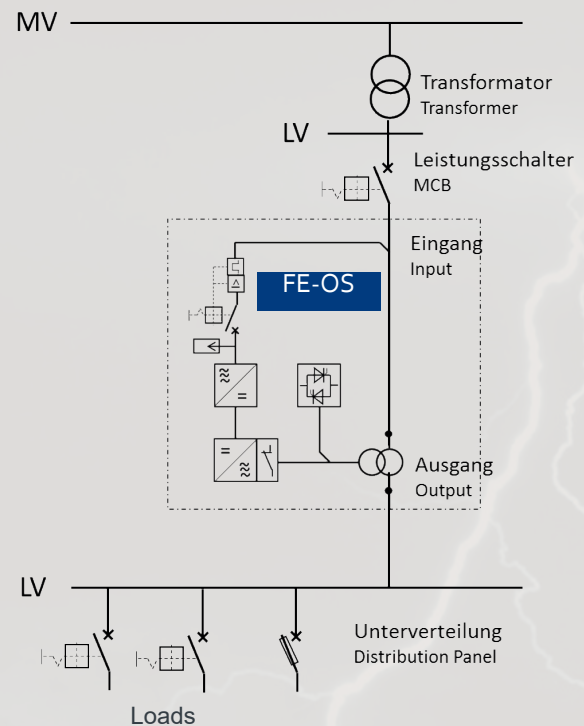
300 kVA + 300 kVA = 600 kVA

► FE-OS INSTALLATION

FE-OS is connected in series between the upstream distribution transformer and the equipment.

Overload and short circuit settings of the upstream circuit breaker can be adjusted as usual corresponding to the rated power of FE-OS.

The protection of the loads remains usually unchanged, because of the minimal changes of the short circuit current.



► FE-OS BASIC SETUP

FE-OS is delivered in one or more standard control cabinets.

The basic setup consists of the components rectifier, inverter with integrated overloadable bypass, short circuit protection and the serial transformer.

As additional safety features, FE-OS is equipped with an overvoltage protection and depending on the requirements also includes a temperature monitor for the serial transformer.

This combination and the elaborated interaction are ensuring a very high level of supply security, an optimal voltage quality and therefore the best possible conditions for sophisticated equipments and production processes.

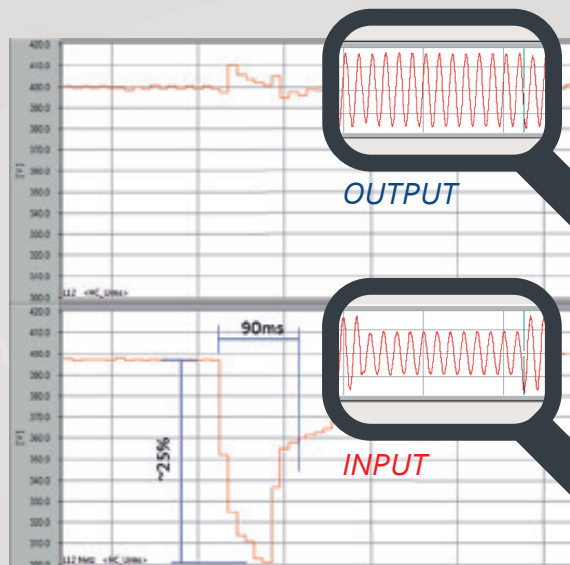
► FE-OS WORKING PRINCIPLE

FE-OS is an active three phase voltage stabilizing system which corrects the source voltage in magnitude and phase to the desired level with the help of state-of-the-art power electronics. The supply of the correction voltage through a robustly designed low-impedance serial transformer is significant for the rugged and overload capable design of the voltage stabilizer, while the power electronics enable an almost instantaneous correction of the output voltage.

To serve also regenerative loads, the full power converter is a 4-Quadrant operation converter equipped with an Active Front End converter which ensures the bi-directional power flow between the source and the load.



► FE-OS APPLICATION EXAMPLE



The real-time measurements shown are actual effective voltage values.

As clearly visible in the detailed view, the first half-wave of the effective voltage is already within the standard range.

Other application areas:

- automotive industry
- pharmaceutical and chemical industry
- automated processes (Industry 4.0)
- food industry
- medical technology

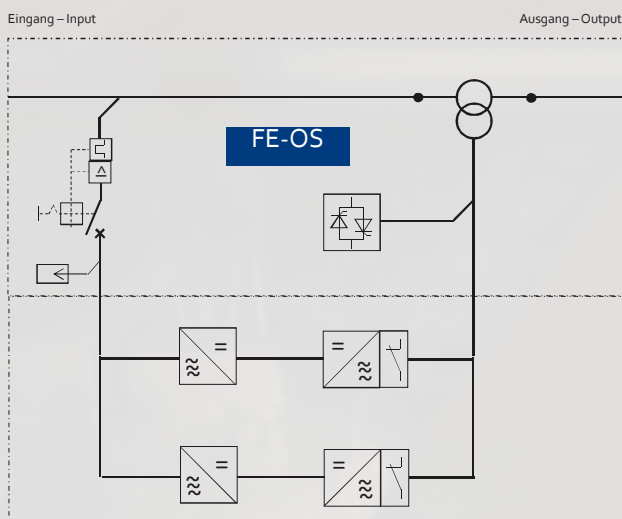
The above real time measurements give an impression of a 400V network, prone to voltage fluctuation and how the active voltage stabilizer FE-OS is correcting the voltage.

► FE-OS MODULAR AND EXPANDABLE

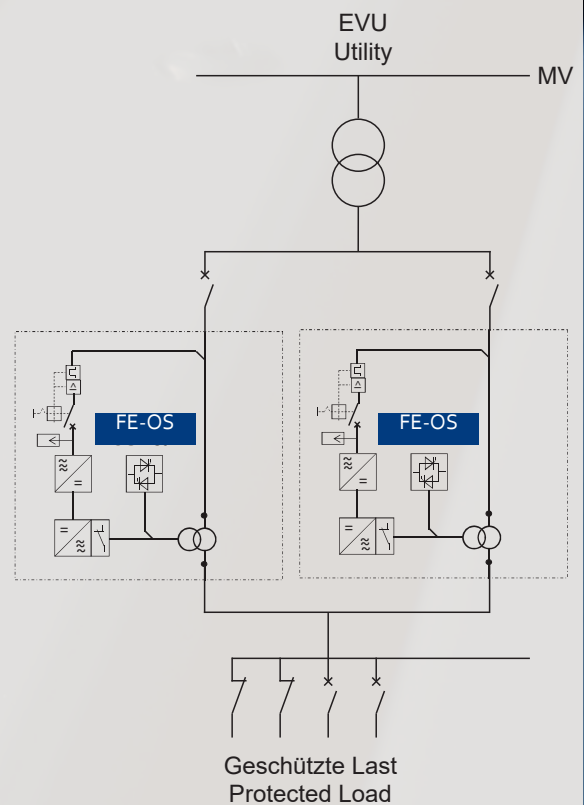
The system power of FE-OS can be extended for different power requirements by paralleling the power electronic modules. Based on the fundamental sizing of the modules, the most economical solution would result in the multiples of 300kVA for 40% voltage correction or the multiples of 400kVA for 30% voltage correction.

One of the most unique feature offered by FE-OS is the scalability. FE-OS systems with the same power ratings can be operated in parallel. This feature has been developed keeping future expansions in mind.

Due to its easy parallel connection, FE-OS is also the perfect solution whenever a parallel supply through two or more transformers is present.



Scalable FE-OS-Power



Paralleling of FE-OS systems with equal power rating

► ROBUST SHORT-CIRCUIT AND OVERLOAD PROTECTION

When protecting critical industrial production processes, under no circumstances the supply of the process must be interrupted if a fault within FE-OS occurs.

On the other side, the high-tech power electronic modules in FE-OS must not be damaged if there is an overload or a fault within the connected equipment.

Also, short circuits at the connected loads or in the distribution panel should not only be bypassed by FE-OS, but should also be guided in a way that the protection equipment on the customers side is tripping safely.

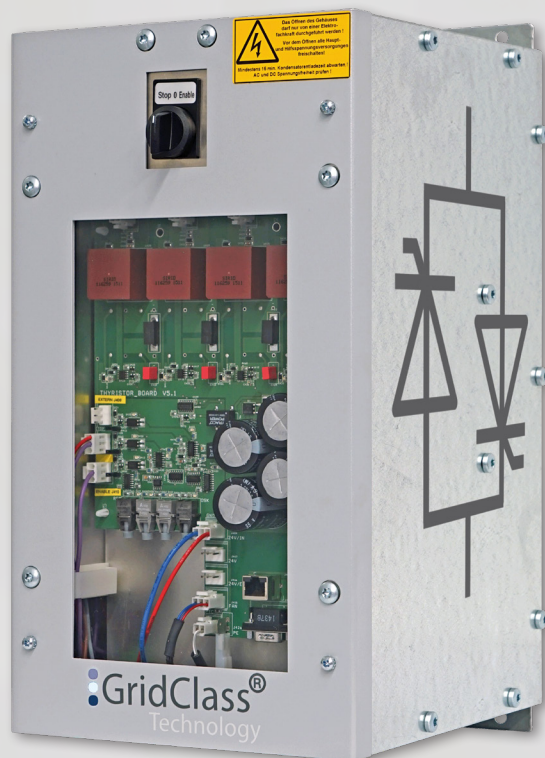
We call such a system robust. Only a robust system is suitable for applications in industrial processes.

In order to meet these challenges, our R&D engineers have designed a multi-redundant bypass system which ensures that the connection between source and load remains intact if any kind of fault occurs.

The key part is a short-circuit protection with a bypass based on thyristor modules. These modules become active in short-circuit or under any other fault conditions.

The bypass module is shielded by mechanical bypass switches, integrated into the inverter module, offering a backup protection in case the bypass module fails. Those mechanical bypass switches are designed for twice the rated current of the system. Therefore, these mechanical switches are ensuring all forms of redundancy for guaranteeing the protection of the load.

Now that's what we call ROBUST!

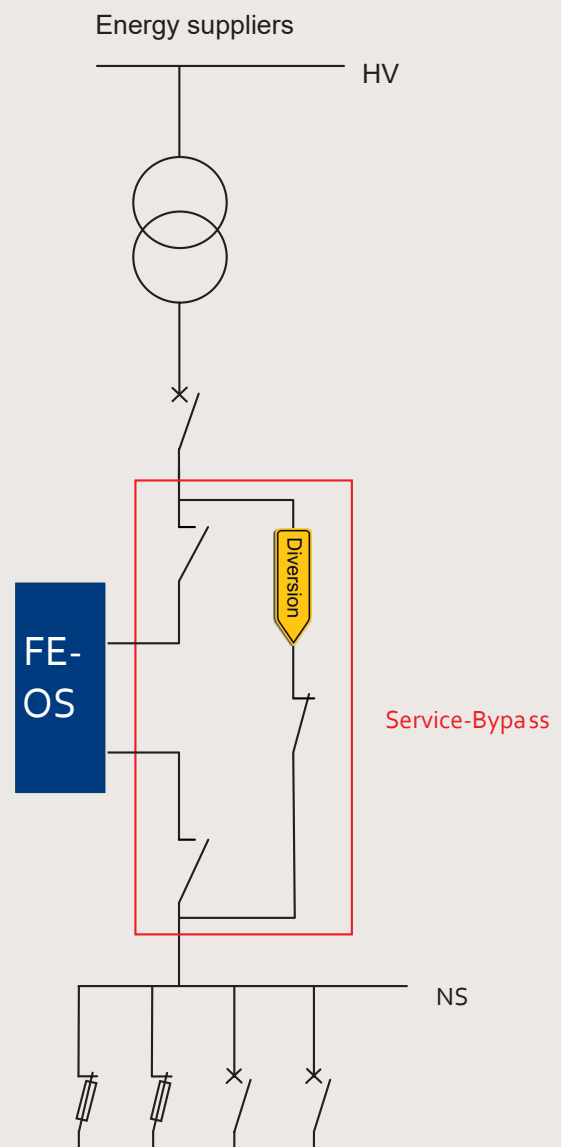


FE-OS-Short-circuit-protection

► SERVICE BYPASS – MAINTENANCE WITHOUT DOWNTIME

Although FE-OS runs with only little maintenance, it must be possible to isolate it from the connected electrical system for inspection or maintenance purposes. To avoid any production downtime, it is possible to bypass the complete system with an additional service bypass.

The biggest advantage of it, especially in the continuous process industry, is that the production lines which are protected by FE-OS do not have to be interrupted or switched off even during maintenance, ultimately resulting in zero downtime.



► FE-OS COMPARED

	UPS	VARIABLE TRANSFORMER / VOLTAGE REGULATOR	FE-OS
SHORT CIRCUIT POWER	—	□	□
CONTROL SETTLING TIME	1 half wave (< 10 ms)	1,5 – 2,5 sec.	1 half wave (< 10 ms)
EFFICIENCY	94 %	98 – 99 %	98,5 %
SPACE REQUIREMENTS AT 300 kVA	1,0 m ²	2,4 m ²	0,5 m ²
WEIGHT	1.170 kg	2.300 kg	900 kg
WEAR	high-maintenance (loss of power of the energy storage)	high-maintenance (mechanical wear)	low-maintenance (no use of energy storage and mechanical components)

Values of the above comparison table are based on data sheets of third parties.

The background of the top half of the page is a faded, grayscale image of a landscape. It features a large, multi-arched bridge spanning a deep valley. In the background, several high-voltage electrical transmission towers are visible, with power lines stretching across the sky. The terrain appears rugged and rocky.

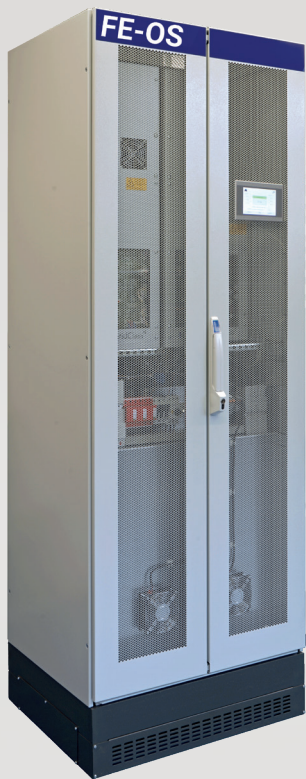
► OS-FE® DIGITAL

WEB product over view:

<https://www.franke-electric.de/produkte/>



► FE-OS DESIGN EXAMPLE



◀ Voltage stabilizing for
300 kVA loads with
40% voltage correction



▲ Voltage stabilizing for
600 kVA loads with
40% voltage correction



◀ Voltage stabilizing for
2.400 kVA loads with
30% voltage correction

► FE-OS – technical details

POWER RANGE	20 % correction range	30 % correction range	40 % correction range
E1	600 kVA	400 kVA	300 kVA
E2	1.200 kVA	800 kVA	600 kVA
E3	1.800 kVA	1.200 kVA	900 kVA
E4	2.400 kVA	1.600 kVA	1.200 kVA
E5	3.000 kVA	2.000 kVA	1.500 kVA
E6	3.600 kVA	2.400 kVA	1.800 kVA
Bigger rated power can be achieved by paralling of systems with the same rated power			

NOMINAL VOLTAGE	FE-OS			FE-OS HV	
Ur	220 V	400 V	480 V	6 kV	11 kV
rated frequency	50 Hz and 60 Hz				

PERFORMANCE	Input		Output	Correction time
	30 % Nominal correction	40 % Nominal correction		
Three-phase correction of voltage dips	70 %	60 %	100 %	30 s
	60 %	50 %	90 %	20 s
	35 %	30 %	55 %	5 s
Single-phase correction of voltage dips	55 %	40 %	100 %	30 s
	5 %	0 %	55 %	5 s
Correction of Overvoltage events	120 %	120 %	100 %	60 s
	110 %	110 %	100 %	60 s
Continuous correction range	90 %	90 %	100 %	∞
	110 %	110 %	100 %	∞
Reaction time	0,2 ms			
Control settling time	1 half-wave			
Efficiency	> 98,5 %			
control accuracy at voltage dips	< 3 %			

(480 V Typ)

OVERLOAD CAPACITY	Peak current / Crest factor:	3
	Effective power:	150 % (30 s)

SHORT-CIRCUIT CURRENT (peak) TYPE	400 V	220 V	480 V	6 kV	11 kV
up to 800 kVA / 30 %	50 kA	90 kA	40 kA	24 kA	13,1 kA
more than 800 kVA / 30 %	120 kA	200 kA	100 kA		
up to 600 kVA / 40 %	35 kA	60 kA	30 kA	18 kA	9,8 kA
more than 600 kVA / 40 %	85 kA	150 kA	70 kA		

OPERATION	Parameterization / Analysis:	Touch Panel / Log-SD-Card / Mail
	Communication:	Ethernet (RJ45) / FTP-Server / Mail-Server / Modbus

All listed designs are sample layouts. Other versions on request.

YOUR VOLTAGE – OUR PASSION



FRANKE Elektrotechnik e.K.

Stadtforststraße 99

06120 Halle/Saale, GERMANY

Phone: +49 345-5504313

E-Mail: mail@franke-electric.de

Web: www.franke-electric.de