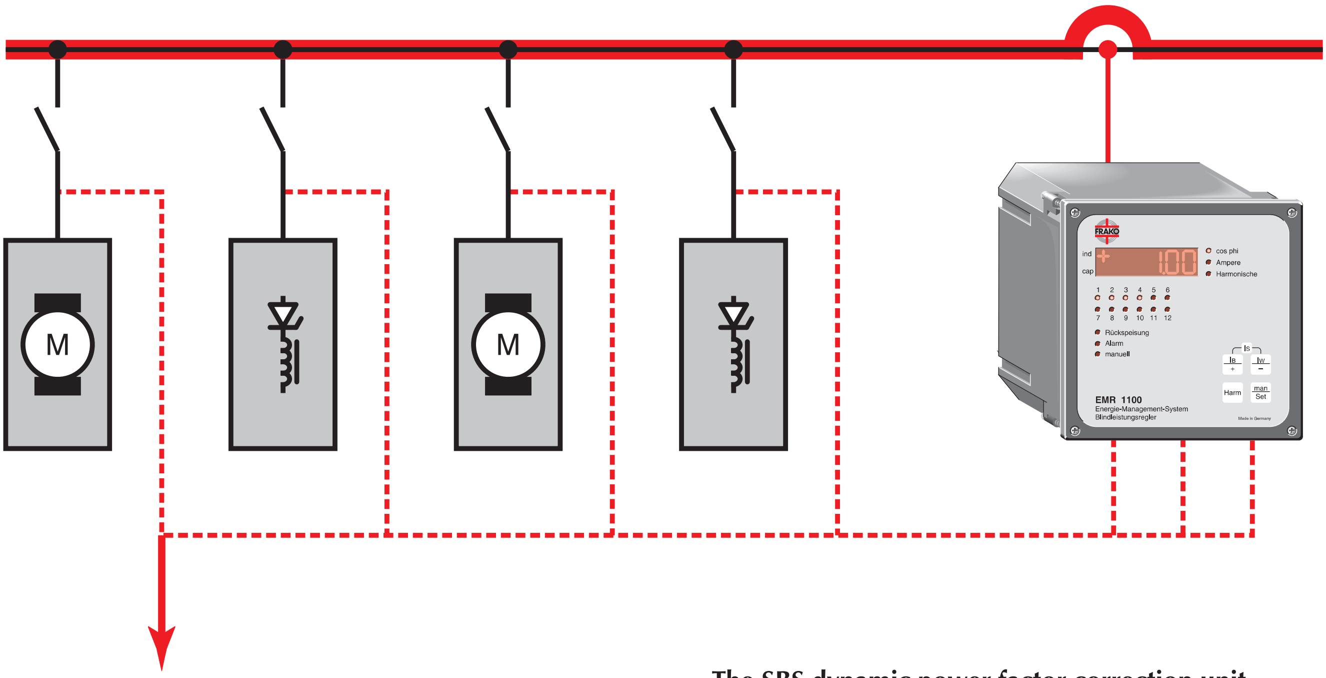
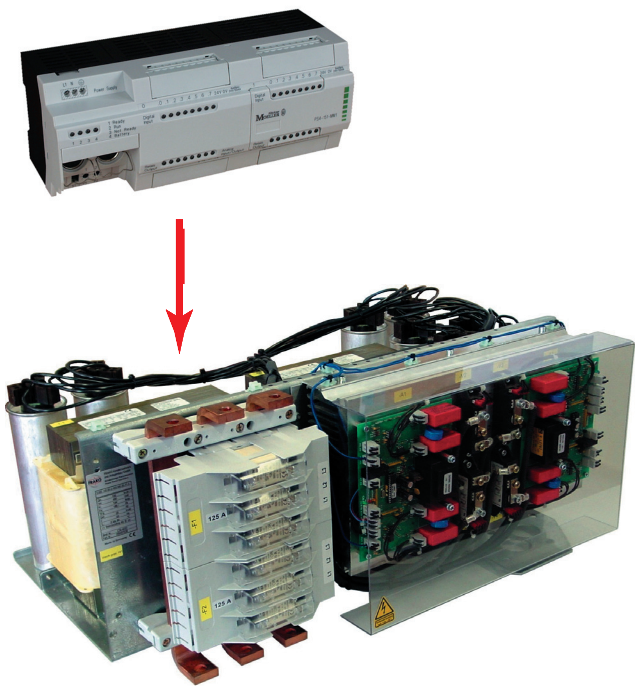
SBS dynamic power factor correction

Fast-acting power factor control units





The SBS dynamic power factor correction unit from FRAKO features:

- No delay in switching in capacitance thanks to FRAKO's fast-acting control system
- Fastest possible direct compensation by SBS unit with superposed power factor control loop
- No additional active power losses through discharge reactors
- Continuous rating, no auxiliary contactors in parallel
- Compact design achieved by new cooling technique
- Solid-state switches mean no limit on number of switching cycles and no wear and tear
- Patented control principle offers excellent price/performance ratio

The benefits:

- Optimum network utilization
- Improved power quality, hence best product quality
- Reduced energy costs
- Modular design, the same construction as FRAKO C Modules
- Predictive control with superposed feedback control
  Nothing could be faster!

Typical applications

The SBS dynamic power factor correction unit finds application in low voltage networks:

- With low short-circuit capacities where disruptions occur when large consumers are switched on
- Where a fast-acting power factor correction system and a large number of switching cycles are necessary
- Where power factor correction is required for only a few supply cycles at a time

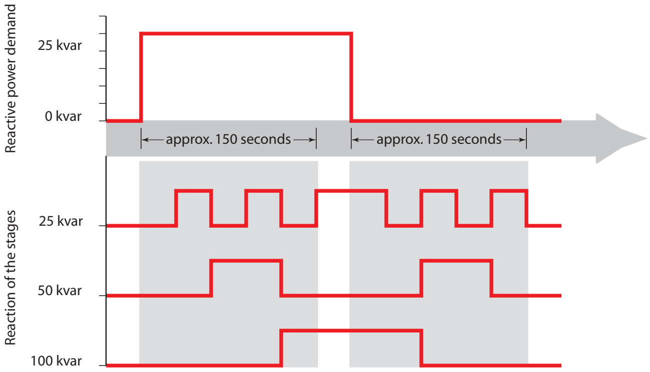
Typical low voltage networks are those supplying:

- Spot welding machines
- Motors with high power ratings
- Rolling mills, kneading machine drives, etc

SBS dynamic power factor correction
The fastest solution for problem networks

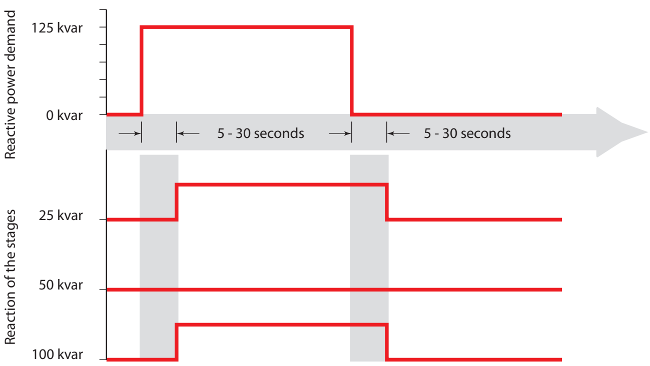
Control methods

a) The classical reactive power control relay using using step-by-step progressive switching



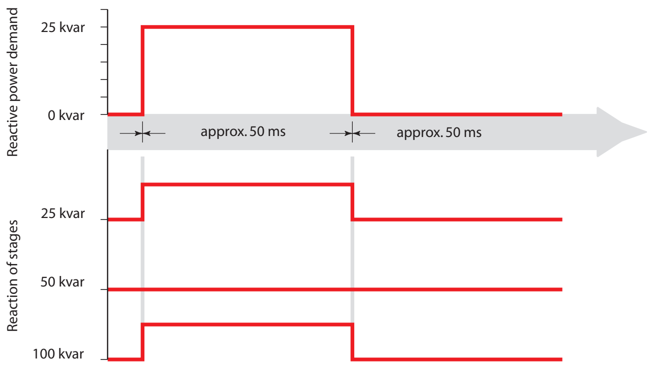
Power factor correction as our grandfathers knew it: the classical reactive power control relay using contactors to switch capacitor stages of different sizes in and out in a progressive sequence. It requires some 30 seconds per switching step until the target power factor is achieved. The contactor serving the smallest capacitor stage has the shortest working life due to its frequent switching.

b) FRAKO RM 9606 or EMR 1100 reactive power control relays



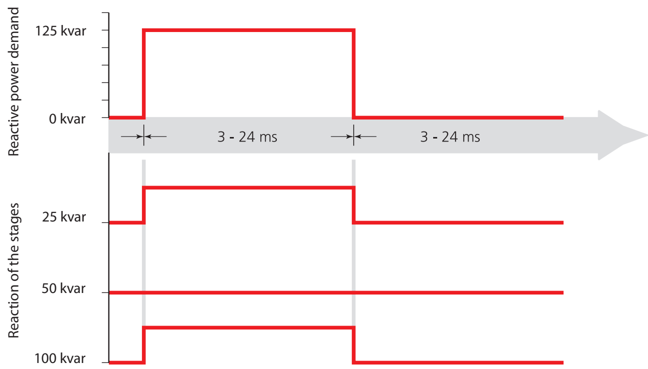
FRAKO reactive power control relays adjust the switching delay to suit the power demand. Large changes of load are compensated for quickly, minor load variations more slowly. Capacitor stages of different sizes are switched in selectively to match the power demand, the number of switching operations minimized by computation, and all equally sized capacitor stages are used in rotation. These control characteristics combine to give a uniform utilization of the capacitor contactors and the lowest possible number of switching cycles, thus reducing wear and tear in the power factor correction system. At the same time, critical network constellations are avoided – unlike in the classical step-by-step switching process – by rapidly adjusting the capacitor allocation to match demand precisely when major load changes occur.

c) Dynamic correction with the Frako RM 2012 reactive power control relay



The FRAKO RM 2012 reactive power control relay has all the monitoring functions necessary incorporated in it, since stable control characteristics are a prime concern. As soon as the control relay detects reactive power demand, it computes the sequences requiring the least number of switching operations, verifies the selected setting in an additional measurement operation and initiates switching. This makes the control characteristics absolutely stable with no hunting. With classical power factor correction systems this process protects the contactors. With dynamic correction systems it reduces the number of switching operations in the network. It effectively suppresses network fluctuations better than switching too quickly and hence overshooting and undershooting several times. This variant represents the best solution for power factor correction in installations such as rolling mills or kneading machines, where a switching delay of 0.5 – 1.0 seconds is acceptable.

d) Dynamic correction with the **FRAKO SBS**



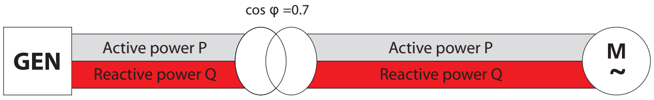
Just as quick as individual power factor correction for each load, but considerably less expensive, due to the intelligent control system, which converts the reactive power demand from all loads into the capacitor stage allocation for the power factor correction system. The fast-acting control system ensures that the required power factor correction is achieved within 3 – 24 ms, depending on the phase angle of the switching signal. **Just as accurate as feedback control**, since a superposed reactive power control relay compensates for the remaining reactive power demand not covered by the predictive control system.

SBS dynamic power factor correction

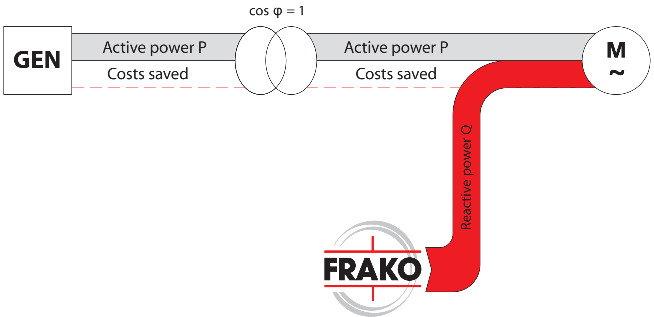
The fastest solution for problem networks

Power factor correction

All electrical consumers that make use of a magnetic field in order to function, such as induction motors, chokes and transformers, draw not only active current from the supply network but also reactive current. This current is necessary to create and reverse the magnetic field, and it flows back and forth between the generator (at the power station) and the load.
As the electrical supply network must be dimensioned to carry the total current, the goal is always to keep the reactive current as low as possible.



The reactive power flowing between the generator and the load is converted into heat in the supply lines.
This represents an additional load on generators, transformers, cabling and switchgear. Power losses and voltage drops also result. With a high proportion of reactive current, the installed conductor cross sections cannot be fully utilized for power transmission or need to be overdimensioned to cope. From the point of view of the power supply company, poor power factors increase the investment and maintenance costs for the supply network. These additional costs are charged to the consumers causing the problem, i.e. those drawing a high proportion of reactive current.
If suitably sized capacitors are installed in parallel to the loads, the reactive current flows back and forth between the capacitors and the loads. There is then no additional load on the rest of the supply network. If a power factor of 1 is achieved by means of these corrective measures, only active current is carried by the network.



The most cost-effective and easily monitored method for power factor correction is the central system. With this variant the entire capacitor bank is installed at a central location, for example the low voltage main distribution board. The required capacitance is divided into several switchable stages, which are switched in and out by special capacitor contactors controlled by an automatic reactive power control relay to suit load conditions. When motors are switched on, there is a transient reactive current peak, which can result in serious voltage dips, depending on the short-circuit capacity of the network.
Modern production lines require machinery of ever-increasing power and therefore necessitate more stable low voltage networks.

Typical applications include rolling mills, in which great load fluctuations occur, and the drives for kneading machines, shredders and large presses. The starting inrush currents can cause major upsets, particularly in production lines with spot welding machines.
The conventional approach has been to design the supply networks for installations of this type with extremely high short-circuit capacities. Increasing the transformer capacity or interconnecting several transformers at the low voltage side is not always economically viable. The most cost-effective solution is therefore to compensate for the reactive current with response times in the order of milliseconds.
Conventional power factor correction systems switch in the capacitor stages by means of contactors with a service life up to a maximum of 80,000 switching cycles. A reactive power control relay switches the stages in when the capacitors are in a discharged condition. This usually results in a delay of some 60 seconds before the capacitors can be switched in again.
Even when using a reactive power control relay that measures reactive power demand within 1 or 2 supply cycles, it may not be possible to reduce the delay in correcting the inductive reactive power below 100 to 200 ms because of the required stability of the control loop. This is too slow for those applications in which voltage dips and flicker must be corrected. In order to suppress the above disruptions to the network effectively, the required corrective capacitance must be switched in within a few milliseconds.
Problems of this type can be solved optimally with a FRAKO SBS fast-acting power factor control unit.

Act or react?

Feedback control means:
Measure – switch – measure – correct – measure – correct – and so on until the difference between the target and actual power factors is less than the correction provided by one capacitor stage. At a supply frequency of 50 Hz, each measurement takes at least one to two cycles to carry out, i.e. 20 to 40 ms. In order to avoid instability, a classical control relay always switches in only a part (40 to 60%) of the capacitor allocation computed from the first measurement. Several hundred milliseconds or as much as a second can then elapse until the corrective action is complete.

Predictive control means:
Not first measuring, but immediately switching in capacitance. The signal to switch on an inductive load is simultaneously an input signal to the FRAKO SBS, causing it to compensate directly for the reactive power demand of that load. The corrective action is effective at the latest 3 to 24 ms after the switching signal.

Nothing could be faster!
This is the solution for low voltage networks with fast-switching inductive loads to:

- Suppress flicker and
- Stabilize the supply voltage.

SBS dynamic power factor correction

Detuned Module Type C for every switchgear system

Design Sheet steel chassis with premounted capacitors, filter reactors, fuses and contactors

Nominal voltage min. 440 V / 50 Hz

Nominal power see table (at 400 V mains voltage)

Schutzart IP 00 acc. to DIN 40 050, for cabinet mounting

Ambient temperature -5 ° to +60 °C acc. DIN VDE 0660 Part 500 Sect. 6.1.1.1 (when assembled)

Air humidity max. 90 %, no condensation

Discharge With discharge resitors acc. to VDE 0560, Part 46

Power loss Capacitors: 0.5 W / kVAr
Reactors: 3.5-6 W/kVAr
(depending on version and harmonic distortion)

Standards acc. VDE 0560 Parts 46 and 47, EN 60831-1 and -2 as well as IEC 831-1 and -2, VDE 0660 Part 500 and EN 60439-1 with type test TSK

Nominal capacity determination see FRAKO Manual of Power Factor Correction

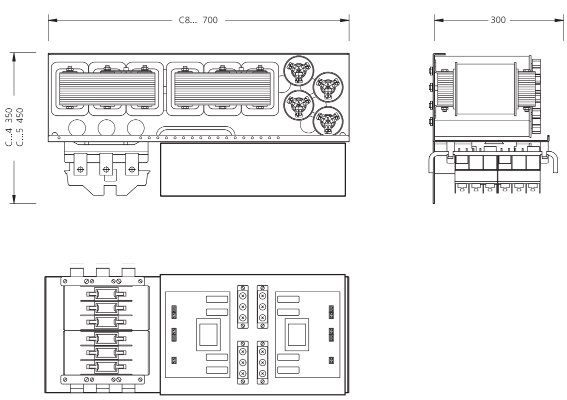
Minimum nominal voltage of capacitors 440 V / 50 Hz · **Nominal capacity at 400 V / 50 Hz mains voltage** · other voltages on request

Nominal capacity	Step rating	Switching sequence	Type and order designation	Nom. voltage of capacitors min. /...V at 50Hz Version with resonance frequency				
kVAr	kVAr		**For enclosure min. (WxD): 800x400mm**	210	189	177	136	
12.5	12.5	-	**C84D 12.5– 12.5– 1 –400**	**–P5**	**–P7**	**–P8**		**–E**
25	25	-	**C84D 25– 25– 1 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**
37.5	12.5	1:2	**C84D 37.5– 12.5– 11 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**
50	25	1:1	**C84D 50– 25– 2 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**
50	50	-	**C84D 50– 50– 1 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**
75	25	1:2	**C85D 75– 25– 11 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**
100	50	1:1	**C85D 100– 50– 2 –400**	**–P5**	**–P7**	**–P8**	**–P1**	**–E**

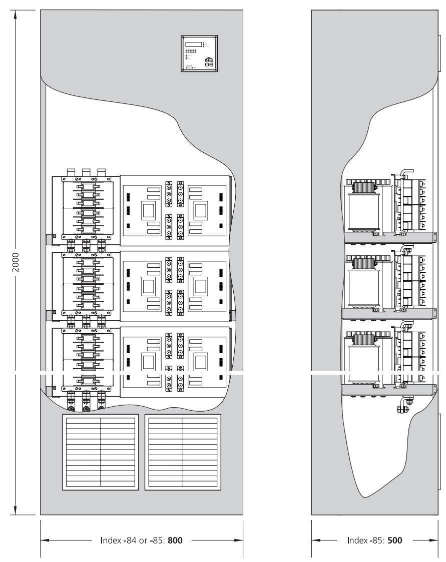
Dimensions **C84D–E**: WxHxD 700x300x350 mm (for cabinet min. W / D: 800 x 400 mm)
Dimensions **C85D–E**: WxHxD 700x300x450 mm (for cabinet min. W / D: 800 x 500 mm)

Accessories:	Type and order designation
Power supply 24 VDC / 2.5 A - for thyristor switches, built on the mounting plate and wired up to the control terminal	**SBS-PS 24VDC-2.5A**
Power factor control relay with reaction time **20 to 40 milliseconds** (with control terminals, temperature switch, cable l = 1150 mm)	**STR-RM 2012**

Dimensional sketch



C-Module



LSFC-E

SBS dynamic power factor correction

Detuned LSFC-E series for PFC systems in steel cabinets

FRAKO

Nominal voltage	400 V / 50 Hz
Nominal voltage of capacitors	min. 440 V / 50 Hz
Overcurrent	min. 2.0 x nominal current at 400 V / 50 Hz continuous and 300 x nominal current for transient peaks
Protection	IP 40, if required IP 54, EN 60529
Ambient temperature	-5 ° to +40 °C to VDE 0660 Part 500 (IEC 60439-1)
Air humidity	max. 90 %, no condensation
Capacitor discharge	With discharge resitors acc. to VDE 0560, Part 46
Construction	sheet steel freestanding cabinet with eyebolts for lifting, door hinged at right
Cabinet colour	DIN shade RAL 7032
Compliance with standard	VDE 0560 Parts 46 and 47, IEC 60831-1 and -2 (EN 60831-1 and -2), type-tested LV switchgear as per VDE 0660 Part 500 and EN 60439-1

Version	Series resonance frequency	Detuning factor	For mains with utility audiofrequency[1)]
-P1	136 Hz	p = 13,5 %	^{3} 166 Hz
-P8	177 Hz	p = 8 %	^{3} 217 Hz
-P7	189 Hz	p = 7 %	^{3} 228 Hz
-P5	210 Hz	p = 5,67%	^{3} 270 Hz

[1)] Please observe any deviation from utility company requirements.
In addition, also note version specifications given in our Manual of Power Factor Correction.

Nominal power rating at 400 V / 50 Hz mains voltage · other voltages on request

Nominal capacity	Step rating	Switching sequence	Type and order designation	Nom. voltage of capacitors min. /...V at 50Hz Version with resonance frequency			
kVAr	kVAr		**For enclosure min. (WxD): 800x500mm**	189	177	136	
200	25	1:1:2...	**LSFC 200– 25– 23 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
200	50	1:1:1...	**LSFC 200– 50– 4 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
225	25	1:2:2...	**LSFC 225– 25– 14 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
250	25	1:1:2...	**LSFC 250– 25– 24 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
250	50	1:1:1...	**LSFC 250– 50– 5 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
275	25	1:2:2...	**LSFC 275– 25– 15 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**
300	50	1:1:1...	**LSFC 300– 50– 6 –400 –85 –606**	**–P7**	**–P8**	**–P1**	**–E**

Extension units without control relays · connected to the control terminal strip in the basic unit using control cable (supplied with ext. unit)

Nominal capacity	Step rating	Switching sequence	Type and order designation	Nom. voltage of capacitors min. /...V at 50Hz Version with resonance frequency			
kVAr	kVAr		**For enclosure min. (WxD): 800x500mm**	189	177	136	
100	50	1:1	**LSFCZ 100– 50– 2 –400 –85**	**–P7**	**–P8**	**–P1**	**–E**
150	50	1:1:1	**LSFCZ 150– 50– 3 –400 –85**	**–P7**	**–P8**	**–P1**	**–E**
200	50	1:1:1...	**LSFCZ 200– 50– 4 –400 –85**	**–P7**	**–P8**	**–P1**	**–E**
250	50	1:1:1...	**LSFCZ 250– 50– 5 –400 –85**	**–P7**	**–P8**	**–P1**	**–E**
300	50	1:1:1...	**LSFCZ 300– 50– 6 –400 –85**	**–P7**	**–P8**	**–P1**	**–E**

Dimensions **LSFC–85**: WxHxD 800x2000x500 mm (without socket)

Description:
Dynamic PFC systems are made in steel cabinets with forced ventilation (IP40). Thyristor switches (-E) are used instead of capacitor contactors. The switching delay with standard PFC relay (RM 9606 or EMR 1100) is 5 to 30 seconds.

Options:	Type and order designation
Dynamic PFC system with **RM 2012**-relay, reaction time **20 to 40 milliseconds**	Index **–212–** instead of -606-
SBS-fast acting control unit for reaction time **3 to 24 milliseconds** complete built in and wired up. Consists of: - Power supply - 16 digital inputs, wired up to terminals - 14 digital outputs - nonvolatile program memory - programming according to previous planning	Type addition: **–SBS**
SBS-extension module for further 16 digital inputs, complete built in and wired up	Type addition: **–SBS2**

SBS dynamic power factor correction

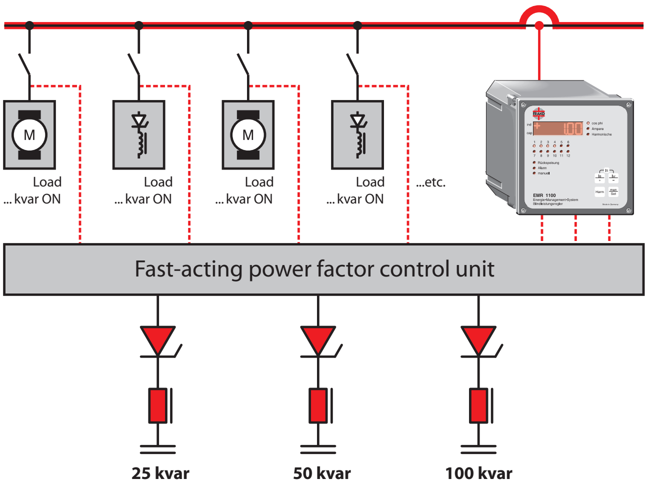
Fast-acting power factor control units

The ideal formula

- The SBS dynamic power factor correction unit from FRAKO switches without delay at the next voltage zero at the thyristor switch and thus avoids any peak inrush current.
- Any desired frequency of switching with no contact wear and tear and no additional loss of active power. The solid-state switches function without any problems even when the capacitors are not discharged and without causing peak inrush currents.
- Power circuits are designed for a continuous rating, i.e. no parallel auxiliary contactor is needed to reduce the load on the thyristors. The switching delay of at least 50 ms when using auxiliary contactors is therefore also not necessary.

Power factor correction and network stabilization

- An innovative cooling technique makes the unit particularly compact.
- The service life of capacitor contactors is normally limited to a maximum of 80,000 switching cycles. In the case of installations with frequent switching, such as welding systems, it is necessary to cater for at least 10^8 switching cycles. The FRAKO SBS unit is designed for duties of this type.
- FRAKO's patented predictive control principle enables the reactive power to be compensated for as quickly as possible for as much switched load capacity as desired. The reactive power demand from loads of any power rating is converted without delay into the optimum allocation of capacitor stages for that load.



- The greater part of the reactive power is compensated for without delay. This eliminates major voltage dips that could result in flicker. The superposed reactive power control relay then compensates for the remaining reactive power demand. These signals are also processed by the control unit, which determines the required capacitor allocation from their sum total.
- Until now, a comparable response without delay was only possible when correcting the power factor for large reactive loads by assigning a rapidly switched-in capacitor stage to each individual load. In contrast, the SBS is a variant that cuts costs and offers the fastest possible switching response. Numerous inputs with widely differing reactive power demands are converted into the equivalent capacitor allocation for the power factor correction system.

Reliable energy solutions.

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Your representative:

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