Modules for Power Factor Correction Systems

Type C...C / C...D / C...D-E

The universal solution for all switchgear systems

- Power Factor Correction Systems without reactors
- Power Factor Correction Systems with reactors
- Power Factor Correction Systems with reactors and thyristor switches
- Compact design for mounting in all common low voltage switchgear systems

Modules for Power Factor Correction Systems

Type C

Description

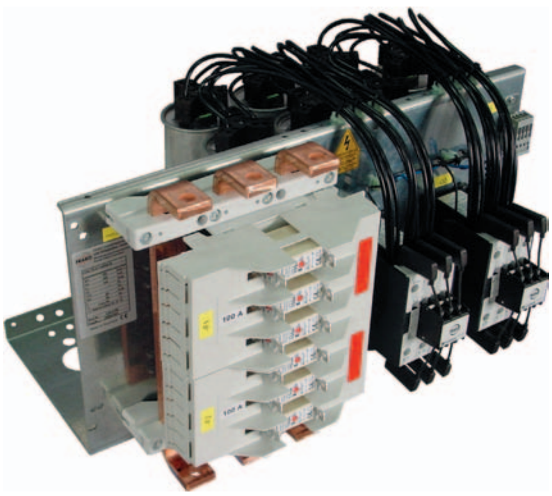
Decisive advantages

- Compact compensation module
  – Ideal for mounting in all common switchgear systems
- High performance in the smallest possible space
  – Up to 100 kvar for each module, optionally choked or unchoked
- Up to 4 modules per cabinet
  – Supplying 400 kvar even with 7 % detuned reactors
- Expandable
  – Power ratings 6.25; 12.5; 25 and 50 kvar
- Easy to service with a common bus bar
  – Upright bus bar and NH fuse elements. No special cable required between the individual modules for systems with two or more units

Design

Mounted and fully-wired galvanized sheet steel chassis consisting of:

- Self-healing power capacitors with a low-loss polypropylene foil dielectic and PCB-free filler, type LKT with discharge resistors acc. to DIN VDE 0560 parts 46 and 47, EN 60831-1 and 2 as well as IEC 831-1 and -2.
- Capacitor contactors with leading resistor contacts attenuate current peaks
- Common mounting rail with locking elements
- Fuse elements, 3-pin, NH00
- low-loss filter reactors with temperature switches for the following series resonance frequencies:



Version	Series resonance frequency	Detuning factor	For mains with utility audiofrequency[1]
-P1	136 Hz	p =13.5 %	≥ 166 Hz
-P7	189 Hz	p = 7 %	≥ 228 Hz

1) Please observe any deviation from utility company requirements.

In addition, also note version specifications given in our Manual of Power Factor Correction.

Quick mounting with multifunctional rails

When designing this series, special attention was given to the simplest way of installing modules in all commonly used switchgear systems. The mounting rails used (shown in grey in the dimensional sketch) can be supplied as an optional accessory. These replace the time-consuming work of installation and drilling. Only the control unit cutout and ventilation holes are required. Once the rails are mounted, the modules are simply inserted and firmly attached by two screws – it couldn't be simpler!

Connection

The cable is connected directly to the busbar. A connecting bracket CU-AW 1 can be supplied as an accessory for vertical connection.

Ideal for all common switchgear systems, e.g.

MT-C8-...	Cabinet type
ABB	MNS
ELEK	Unistar
Hensel	SAS 2008
Moeller	Modan, IVS, ID, GU
Mona	Mona 5000
Rittal	TS, ES, PS
Siemens	SIKUS, Sivacon, 8MF, 8PU
Striebel & John	XA

Accessories / Options

- Complete power factor control relay package **STR-RM 8406, STR-RM 9606, STR-RM 9612 or STR-EMR 1100**
- Control cables from the control terminal strip to the module are included with delivery together with pin connections
- Mounting plate **SB-C8**
- Module rails **MT-C8-...-cabinet depth** (see table)
- Bus connection bracket set **CU AW-1**
- Fan package **LP-LSFD**
- NH isolating switch instead of NH fuse elements for group protection type designation: **-SLT**

Modules for Power Factor Correction Systems

Type C…C

FRAKO

Technical Data

Design Sheet steel chassis with premounted capacitors, fuses and contactors

Nominal voltage min 440 V / 50 Hz

Nominal power see table (at 400 V mains voltage)

International protection IP 00 acc. to DIN 40 050, for control cabinet mounting

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

Air humidity max. 90 %, no condensation

Discharge With discharge resistors acc. to VDE 0560, part 46

Power loss Capacitors: 0.5 W / kvar

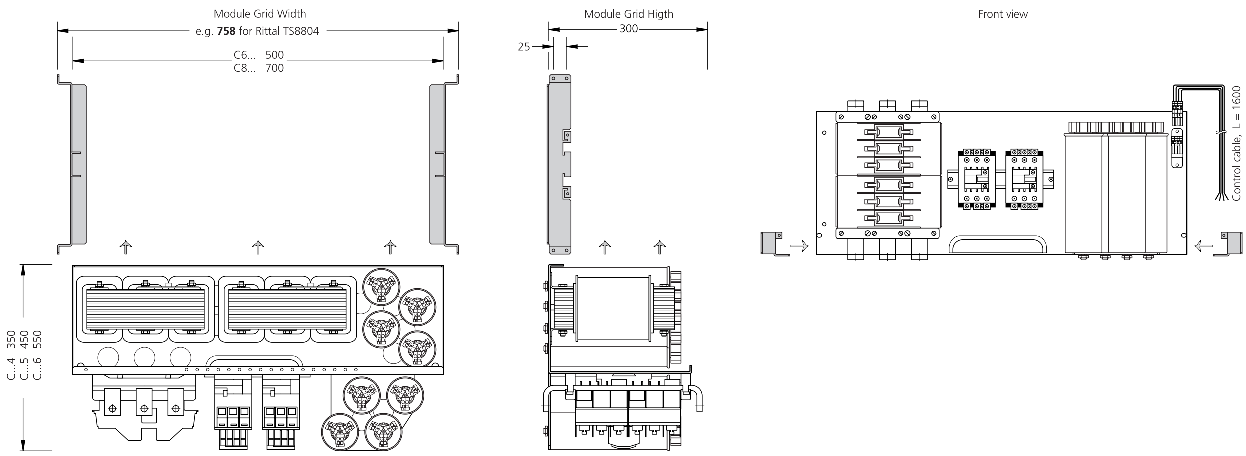
Standards acc. to VDE 0560 Parts 46 and 47, EN 60831-1 and -2 together with IEC 831-1 and -2, VDE 0660 part 500 and EN 60439-1 with type test TSK

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					Type and order designation				
kvar	kvar		**For enclosure min. (WxD): 600x400 mm**					**For enclosure min. (WxD): 800x400 mm**				
25	3.13	1:1:2:4	**C64C**	**25**	**3.13**	**211**	**400**	**C84C**	**25**	**3.13**	**211**	**400**
25	6.25	1:1:2	**C64C**	**25**	**6.25**	**21**	**400**	**C84C**	**25**	**6.25**	**21**	**400**
25	12.5	1:1	**C64C**	**25**	**12.5**	**2**	**400**	**C84C**	**25**	**12.5**	**2**	**400**
25	25	1	**C64C**	**25**	**25**	**1**	**400**	**C84C**	**25**	**25**	**1**	**400**
31.25	6.25	1:2:2	**C64C**	**31.25**	**6.25**	**12**	**400**	**C84C**	**31.25**	**6.25**	**12**	**400**
34.38	3.13	1:2:4...	**C64C**	**34.38**	**3.13**	**112**	**400**	**C84C**	**34.38**	**3.13**	**112**	**400**
37.5	6.25	1:1:2...	**C64C**	**37.5**	**6.25**	**22**	**400**	**C84C**	**37.5**	**6.25**	**22**	**400**
37.5	12.5	1:2	**C64C**	**37.5**	**12.5**	**11**	**400**	**C84C**	**37.5**	**12.5**	**11**	**400**
43.75	6.25	1:2:4	**C64C**	**43.75**	**6.25**	**111**	**400**	**C84C**	**43.75**	**6.25**	**111**	**400**
46.88	3.13	1:2:4:8	**C64C**	**46.88**	**3.13**	**1111**	**400**	**C84C**	**46.88**	**3.13**	**1111**	**400**
50	3.13	1:1:2:4:8	**C64C**	**50**	**3.13**	**2111**	**400**	**C84C**	**50**	**3.13**	**2111**	**400**
50	6.25	1:1:2:4	**C64C**	**50**	**6.25**	**211**	**400**	**C84C**	**50**	**6.25**	**211**	**400**
50	12.5	1:1:2	**C64C**	**50**	**12.5**	**21**	**400**	**C84C**	**50**	**12.5**	**21**	**400**
50	25	1:1	**C64C**	**50**	**25**	**2**	**400**	**C84C**	**50**	**25**	**2**	**400**
50	50	1	**C64C**	**50**	**50**	**1**	**400**	**C84C**	**50**	**50**	**1**	**400**
62.5	12.5	1:2:2	**C64C**	**62.5**	**12.5**	**12**	**400**	**C84C**	**62.5**	**12.5**	**12**	**400**
68.75	6.25	1:2:4...	**C64C**	**68.75**	**6.25**	**112**	**400**	**C84C**	**68.75**	**6.25**	**112**	**400**
75	12.5	1:1:2...	**C64C**	**75**	**12.5**	**22**	**400**	**C84C**	**75**	**12.5**	**22**	**400**
75	25	1:2	**C64C**	**75**	**25**	**11**	**400**	**C84C**	**75**	**25**	**11**	**400**
87.5	12.5	1:2:4	**C64C**	**87.5**	**12.5**	**111**	**400**	**C84C**	**87.5**	**12.5**	**111**	**400**
93.75	6.25	1:2:4:8	**C64C**	**93.75**	**6.25**	**1111**	**400**	**C84C**	**93.75**	**6.25**	**1111**	**400**
100	12.5	1:1:2:4	**C64C**	**100**	**12.5**	**211**	**400**	**C84C**	**100**	**12.5**	**211**	**400**
100	25	1:1:2	**C64C**	**100**	**25**	**21**	**400**	**C84C**	**100**	**25**	**21**	**400**
100	50	1:1	**C64C**	**100**	**50**	**2**	**400**	**C84C**	**100**	**50**	**2**	**400**

Dimensional sketch



C-Modules

Modules for Power Factor Correction Systems

Type C...D

FRAKO

Technical Data

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)

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

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

Air humidity max. 90 %, no condensation

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

Power loss Capacitors: 0.5 W / kvar, filter reactors: 3.5 – 6 W/kvar (depending on version and harmonic distortion)

Standards acc. to 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 50 Hz Version with resonance frequency	
kvar	kvar		**For enclosure min. (WxD): 600x400 mm**					189	136
25	3.13	1:1:2:4	**C64D**	**25**	**3.13**	**211**	**400**	**P7**	
25	6.25	1:1:2	**C64D**	**25**	**6.25**	**21**	**400**	**P7**	**P1**
25	12.5	1:1	**C64D**	**25**	**12.5**	**2**	**400**	**P7**	**P1**
25	25	1	**C64D**	**25**	**25**	**1**	**400**	**P7**	**P1**
31.25	6.25	1:2:2	**C64D**	**31.25**	**6.25**	**12**	**400**	**P7**	
37.5	12.5	1:2	**C64D**	**37.5**	**12.5**	**11**	**400**	**P7**	
43.75	6.25	1:2:4	**C64D**	**43.75**	**6.25**	**111**	**400**	**P7**	
50	12.5	1:1:2	**C64D**	**50**	**12.5**	**21**	**400**	**P7**	
50	25	1:1	**C64D**	**50**	**25**	**2**	**400**	**P7**	
50	50	1	**C64D**	**50**	**50**	**1**	**400**	**P7**	**P1**
75	25	1:2	**C65D**	**75**	**25**	**11**	**400**	**P7** 1)	
100	12.5	1:1:2:4	**C66D**	**100**	**12.5**	**211**	**400**	**P7** 2)	
100	25	1:1:2	**C66D**	**100**	**25**	**21**	**400**	**P7** 2)	
100	50	1:1	**C66D**	**100**	**50**	**2**	**400**	**P7** 2)	**P1** 2)
			For enclosure min. (WxD): 800x400 mm						
25	3.13	1:1:2:4	**C84D**	**25**	**3.13**	**211**	**400**	**P7**	
25	6.25	1:1:2	**C84D**	**25**	**6.25**	**21**	**400**	**P7**	**P1**
25	12.5	1:1	**C84D**	**25**	**12.5**	**2**	**400**	**P7**	**P1**
25	25	1	**C84D**	**25**	**25**	**1**	**400**	**P7**	**P1**
31.25	6.25	1:2:2	**C84D**	**31.25**	**6.25**	**12**	**400**	**P7**	**P1**
34.38	3.13	1:2:4...	**C84D**	**34.38**	**3.13**	**112**	**400**	**P7**	
37.5	6.25	1:1:2...	**C84D**	**37.5**	**6.25**	**22**	**400**	**P7**	**P1**
37.5	12.5	1:2	**C84D**	**37.5**	**12.5**	**11**	**400**	**P7**	**P1**
43.75	6.25	1:2:4	**C84D**	**43.75**	**6.25**	**111**	**400**	**P7**	**P1**
46.88	3.13	1:2:4:8	**C84D**	**46.88**	**3.13**	**1111**	**400**	**P7**	
50	6.25	1:1:2:4	**C84D**	**50**	**6.25**	**211**	**400**	**P7**	
50	12.5	1:1:2	**C84D**	**50**	**12.5**	**21**	**400**	**P7**	**P1**
50	25	1:1	**C84D**	**50**	**25**	**2**	**400**	**P7**	**P1**
50	50	1	**C84D**	**50**	**50**	**1**	**400**	**P7**	**P1**
62.5	12.5	1:2:2	**C84D**	**62.5**	**12.5**	**12**	**400**	**P7**	
68.75	6.25	1:2:4...	**C84D**	**68.75**	**6.25**	**112**	**400**	**P7**	
75	12.5	1:1:2...	**C84D**	**75**	**12.5**	**22**	**400**	**P7**	
75	25	1:2	**C84D**	**75**	**25**	**11**	**400**	**P7**	**P1**
87.5	12.5	1:2:4	**C84D**	**87.5**	**12.5**	**111**	**400**	**P7**	
100	25	1:1:2	**C84D**	**100**	**25**	**21**	**400**	**P7**	
100	50	1:1	**C84D**	**100**	**50**	**2**	**400**	**P7**	
100	50	1:1	**C85D**	**100**	**50**	**2**	**400**	**P1** 1)	**P1** 1)

1) for enclosure depths 500 mm only 2) for enclosure depths 600 mm only

Modules for Power Factor Correction Systems

Type C

Description

Application / Installation

The Power Factor Correction Module Type C is the ideal answer for designing power factor correction systems. It can be choked or unchoked and reach a capacity of up to 400 kvar per enclosure. The enclosure can be up to 2.000 mm high and 400 mm deep. When installing several modules, they should be mounted first at the bottom, working upwards. This enables additional modules to be installed at a later date without disconnecting the cable. If the feed-in is at the top of the enclosure the modules should be mounted from top to bottom. Prewired control cabling can be used for connecting the power factor control relay to the control terminal strip and the individual modules. The mounting rails of the module have folding tabs to which a vertical connecting cable can be attached. To ensure that the system can be extended at a later date, the cable and its protective device as well as any audiofrequency rejector circuit required should be designed to meet the final specifications of the system.

Example

Design of a power factor correction system with reactors in an enclosure (Rittal TS8804) with dimensions 800 x 2000 x 400 mm (HxWxD), with a nominal capacity of 300 kvar, with 6 steps each of 50 kvar, switching sequence 1:1:2...

Components required:

- 1 complete power factor control relay package **STR-EMR 1100**, consisting of EMR 1100, RKL-EMR 1100 and RK EMR 1100-1150
- 1 mounting plate **SB-C8**
- 3 capacitor choke modules **C84D 100-50-2-400-P...**
  The control cable from the control terminal strip to the modules together with pin connections are included in delivery.
- 10 mounting rails **MT-C8-Rittal TS8-400**
- 1 connecting bracket set **CU AW-1**
- 1 fan package **LP-LSFC**

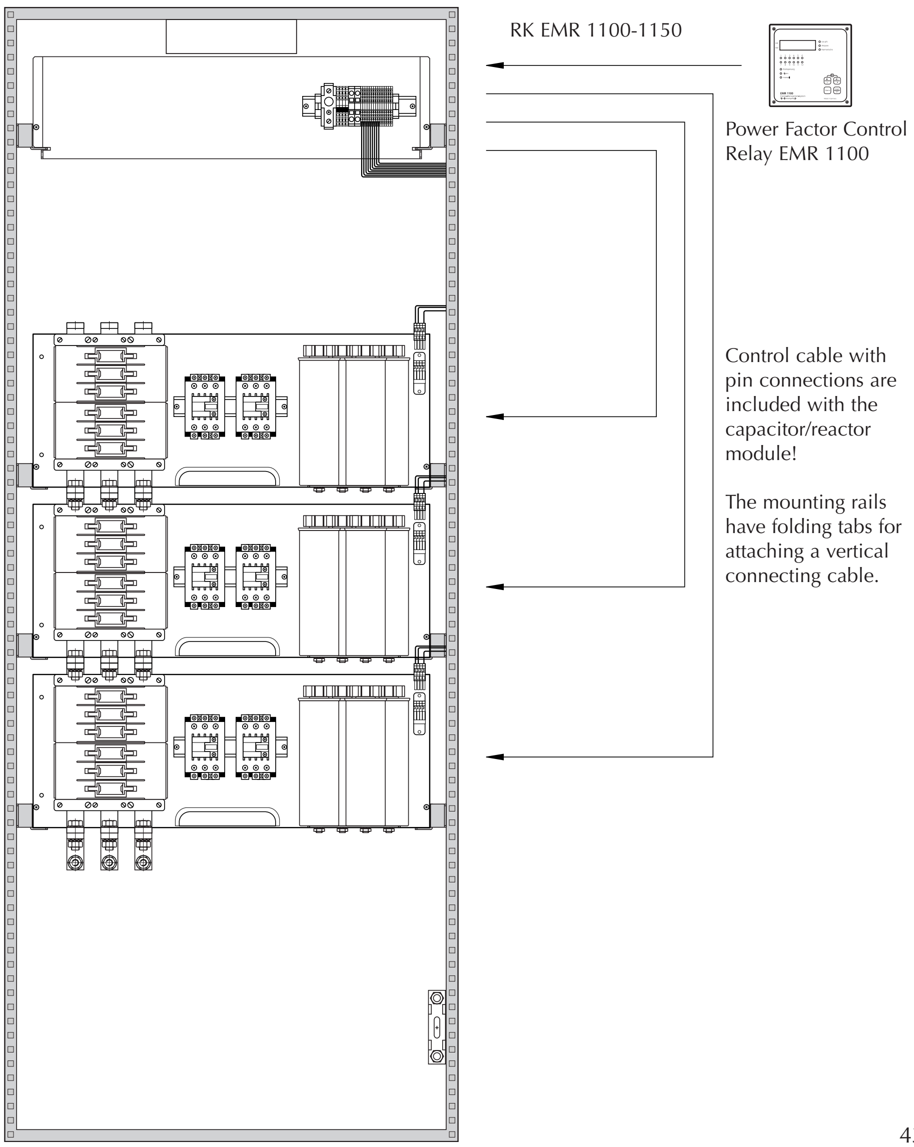
Slot 5:
Space for the control unit. The mounting plate SB... has room for the control terminal strip RKL... with control transformer and thermostat if required.

Slot 4:
Space for an additional capacitor/reactor module.

Slot 3:
Space for the third capacitor/reactor module.

Slot 2:
Space for the second capacitor/reactor module.

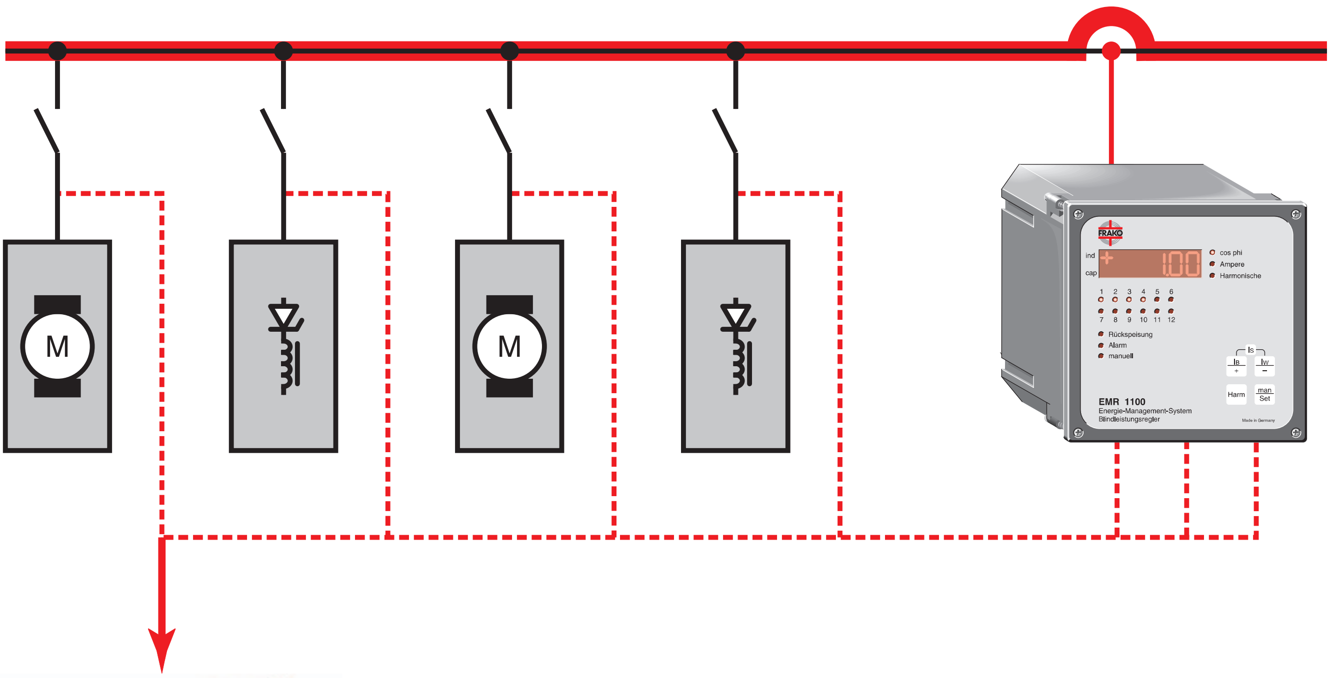
Slot 1:
Space for the first module. The busbar set CU AW-1 enables the first capacitor choke module to be connected vertically if required.

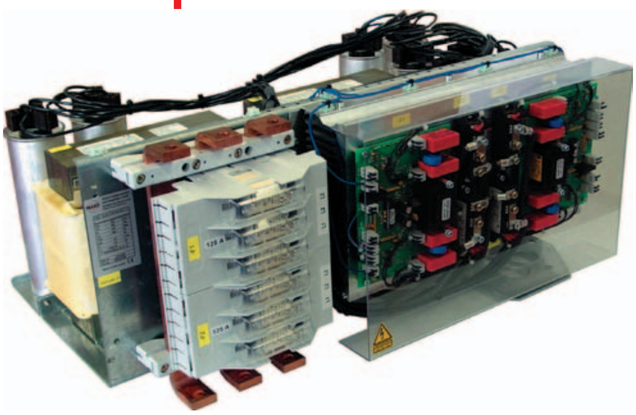


C-Modules

Modules for Dynamic Power Factor Correction Systems

Type C…D-E





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:

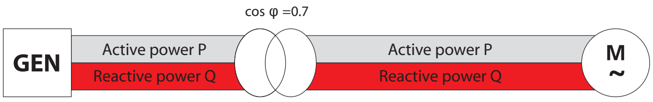
- Spot welding machines
- Motors with high power ratings
- Rolling mills, kneading machine drives, etc.

Modules for Dynamic Power Factor Correction Systems

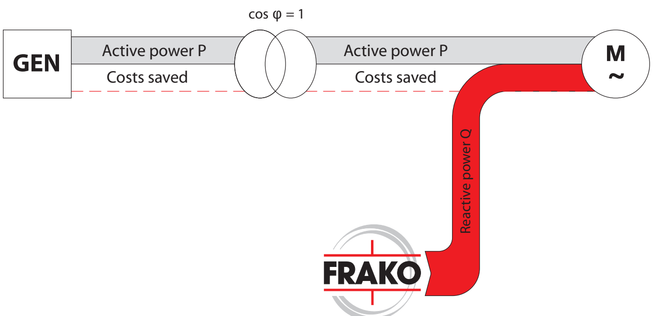
Type C…D-E

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:

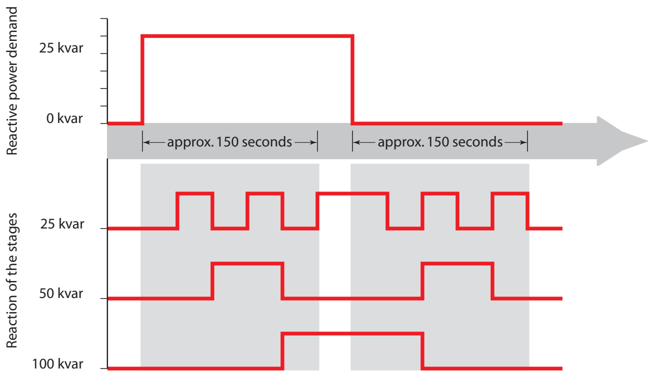
- Suppress flicker and
- Stabilize the supply voltage.

Modules for Dynamic Power Factor Correction Systems

Type C…D-E

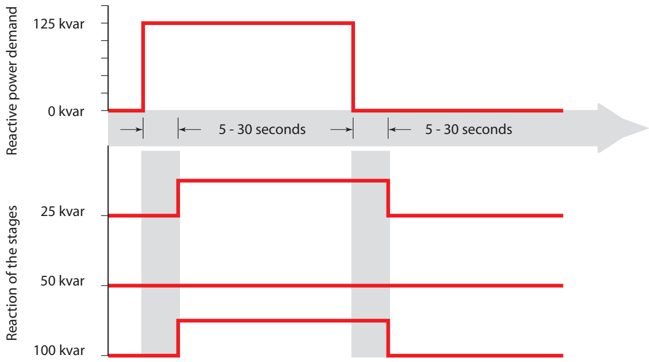
Control Methods

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



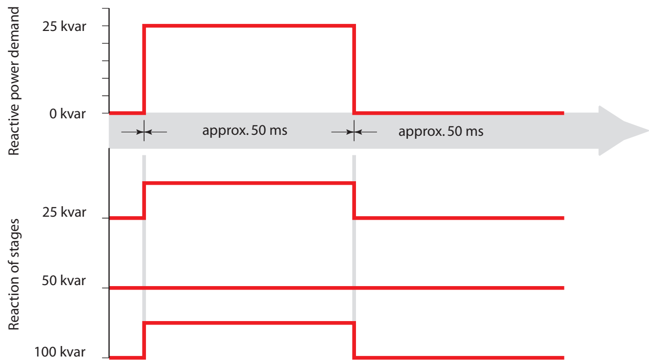
Power factor correction as our grandfathers knew it: the classical reactive power control relay using contactors to switch capacitor stages of different sizes in and out in a progressive sequence. It requires some 30 seconds per switching step until the target power factor is achieved.
The contactor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



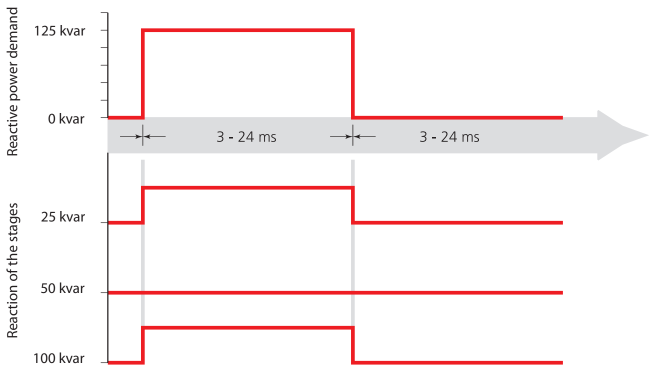
FRAKO reactive power control relays adjust the switching delay to suit the power demand. Large changes of load are compensated for quickly, minor load variations more slowly. Capacitor stages of different sizes are switched in selectively to match the power demand, the number of switching operations 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.

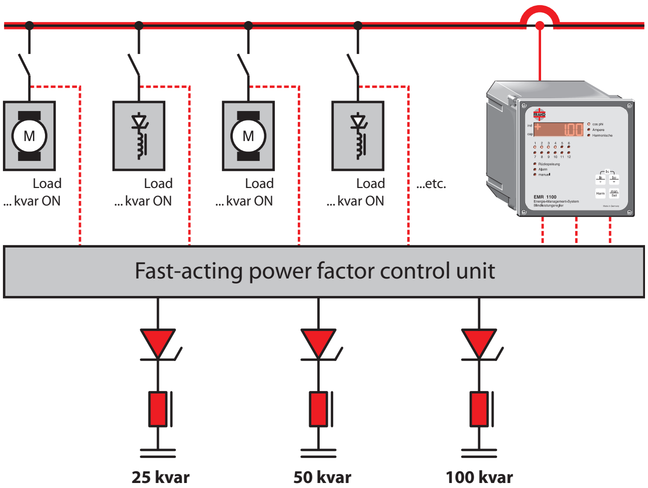
Modules for Dynamic Power Factor Correction Systems

Type C…D-E

FRAKO

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.

Modules for Dynamic Power Factor Correction Systems

Type C…D-E

FRAKO

Technical Data

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)

Protection 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 50 Hz Version with resonance frequency			
kvar	kvar		**For enclosure min. (WxD): 800x400mm**					189	136	
12.5	12.5		C84D	12.5	12.5	1	400	P7		E
25	25		C84D	25	25	1	400	P7	P1	E
37.5	12.5	1:2	C84D	37.5	12.5	11	400	P7	P1	E
50	25	1:1	C84D	50	25	2	400	P7	P1	E
50	50		C84D	50	50	1	400	P7	P1	E
75	25	1:2	C84D	75	25	11	400	P7	P1	E
100	50	1:1	C84D	100	50	2	400	P7	P1	E

Dimensions C84DE: WxHxD 700x300x350 mm (for cabinet min. W / D: 800 x 400 mm)
Dimensions C85DE: 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