EPCOS Product Profile 2018

Power Quality Solutions

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Contents

Power Quality Solutions

Preview	3
PFC capacitor series overview	6
PQS key components overview	8
Important notes	12
PFC capacitors	
● PhaseCap Energy (230 … 690 V, 5.0 … 33 kvar)	13
● PhaseCap Premium (230 … 800 V, 5.0 … 33 kvar)	25
● PhaseCap Compact (230 … 1000 V, 5.0 … 33 kvar)	31
● PhaseCap HD (400 … 525 V, 40 … 60 kvar)	37
● DeltaCap (230 … 525 V, 0.5 … 48 kvar)	40
● PhiCap (230 … 525 V, 0.5 … 30 kvar)	47
PF controllers and measuring devices	
● PF controllers BR604, BR6000 and BR7000 series	54
● Multi Measuring Interfaces	62
● Grid analysis tool MC7000-3	64
Switching devices	
● Capacitor contactors	66
● Thyristor modules for dynamic PFC, TSM series	69
Reactors	
● Reactors – Antiresonance harmonic filter	73
● Discharge reactor	76
Active harmonic filter	
● PQSine S Series	77
● PQvar Series (Static Var Generator, SVG)	85
Fundamentals of Power Factor Correction	97
● Components for Power Factor Correction	98
● Standard values: Selection tables for cables, cable cross sections and fuses	101
● Calculation table for reactive power demand (Qc)	103
● Individual PFC for motors	104
● Individual PFC for transformers	105
● Detuned PFC in general	106
● Detuned PFC: Important facts and instructions	107
● Component selection tables for detuned PFC	108
● Dynamic PFC: Important facts and instructions	113
● Component selection tables for dynamic PFC	114
● PFC basic formulas	118
Cautions	121
Addresses	126

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Preview

General

The increasing demand of electrical power and the awareness of the necessity of energy saving is very up to date these days. Also the awareness of power quality is increasing, and power factor correction (PFC) and harmonic filtering will be implemented on a growing scale. Enhancing power quality – improvement of power factor – saves costs and ensures a fast return on investment. In power distribution, in low- and medium-voltage networks, PFC focuses on the power flow (cos φ) and the optimization of voltage stability by generating reactive power – to improve voltage quality and reliability at distribution level.

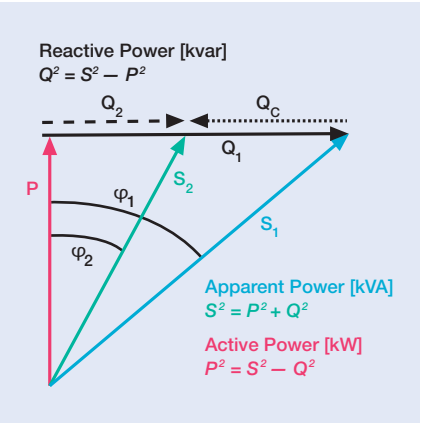
How reactive power is generated

Every electric load that works with magnetic fields (motors, chokes, transformers, inductive heating, arc welding, generators) produces a varying degree of electrical lag, which is called inductance. This lag of inductive loads maintains the current sense (e.g. positive) for a time even though the negative-going voltage tries to reverse it. This phase shift between current and voltage is maintained, current and voltage having opposite signs. During this time, negative power or energy is produced and fed back into the network. When current and voltage have the same sign again, the same amount of energy is again needed to build up the magnetic fields in inductive loads. This magnetic reversal energy is called reactive power.

In AC networks (50/60 Hz) such a process is repeated 50 or 60 times a second. So an obvious solution is to briefly store the magnetic reversal energy in capacitors and relieve the network (supply line) of this reactive energy. For this reason, automatic reactive power compensation systems (detuned/conventional) are installed for larger loads like industrial machinery. Such systems consist of a group of capacitor units that can be cut in and cut out and which are driven and switched by a power factor controller.

Apparent power $S = \sqrt{P^2 + Q^2}$
Active power $P = S * \cos \varphi$
Reactive power $Q = S * \sin \varphi$

With power factor correction the apparent power S can be decreased by reducing the reactive power Q.



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Preview

Power factor
Low power factor (cos φ)

Low cos φ results in

- higher energy consumption and costs,
- less power distributed via the network,
- power loss in the network,
- higher transformer losses,
- increased voltage drop in power distribution networks.

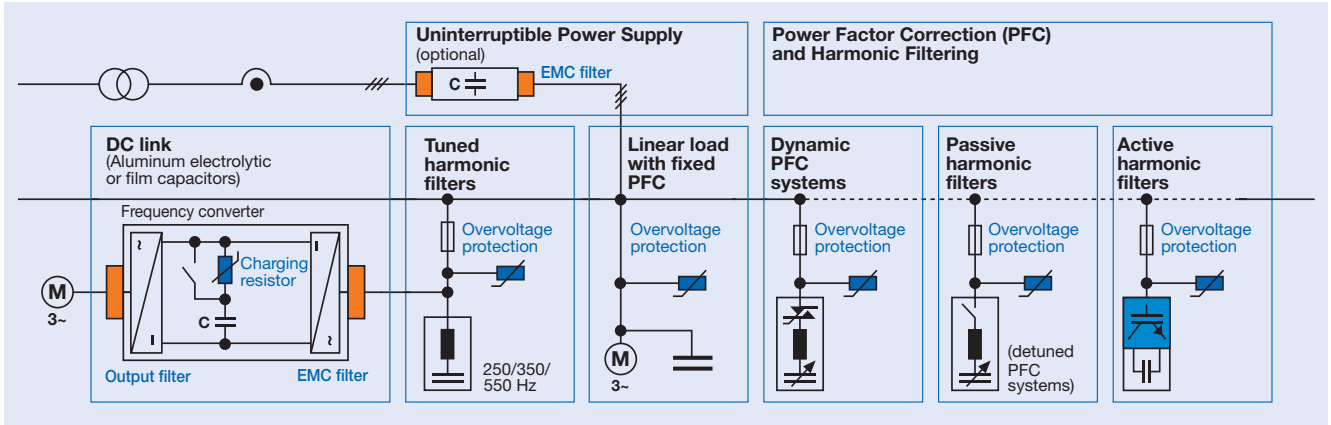
Power factor improvement

Power factor improvement can be achieved by

- compensation of reactive power with capacitors,
- active compensation – using semiconductors,
- overexcited synchronous machine (motor/generator).

Types of PFC
(detuned or conventional)

- individual or fixed compensation (each reactive power producer is individually compensated),
- group compensation (reactive power producers connected as a group and compensated as a whole),
- central or automatic compensation (by a PFC system at a central point),
- mixed compensation.



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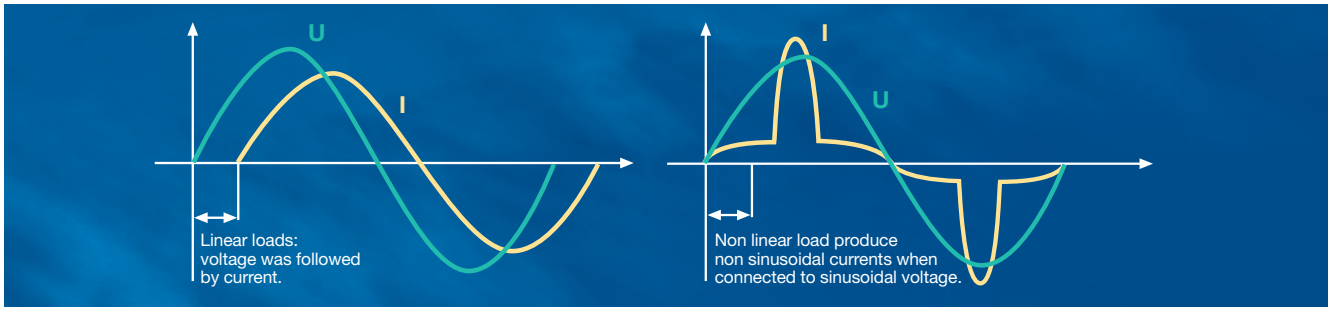
Preview



PQS strategy

Along with the emerging demand for power quality and a growing awareness of the need for environmental protection, the complexity in the energy market is increasing: users and decision-makers are consequently finding it increasingly difficult to locate the best product on the market and to make objective decisions. It is in most cases not fruitful to compare catalogs and data sheets, as many of their parameters are identical in line with the relevant standards. Thus operating times are specified on the basis of tests under laboratory conditions that may differ significantly from the reality in the field. In addition, load structures have changed from being mainly linear in the past to non-linear today. All this produces a clear trend: the market is calling increasingly for customized solutions rather than off-the-shelf products. This is where Power Quality Solutions come into the picture. It offers all key components for an effective PFC system from a single source, together with:

- Application know-how
- Technical skills
- Extensive experience in the field of power quality improvement
- A worldwide network of partners
- Continuous development
- Sharing of information

These are the cornerstones on which Power Quality Solutions are built. On the basis of this strategy, EPCOS is not only the leading manufacturer of power capacitors for PFC applications but also a PQS supplier with a century of field experience, reputation and reliability.

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PFC Capacitor Series Overview

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PFC capacitor series for power factor correction and detuned filter

Parameter		PhaseCap Energy	PhaseCap Premium	PhaseCap Compact
Power	Q_R	5.0 … 33.0 kvar	5.0 … 33.0 kvar	5.0 … 33.0 kvar
Rated voltage	V_R	230 … 690 V AC	230 … 800 V AC	230 … 1000 V AC
Inrush current	I_S	up to 500 · I_R	up to 300 · I_R	up to 400 · I_R
Temperature class		**–40/60:** max. temp. +60 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C	**–40/D:** max. temp. +55 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C	**–40/60:** max. temp. +60 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C **–40/C:** max. temp. +50 °C max. mean 24 h = +40 °C max. mean 1 year = +30 °C lowest temperature = –40 °C
Losses: **– Dielectric** **– Total**[1]	 Q_L Q_L	 < 0.2 W/kvar < 0.45 W/kvar	 < 0.2 W/kvar < 0.45 W/kvar	 < 0.2 W/kvar < 0.45 W/kvar
Max. humidity	H_{rel}	95%	95%	95%
Safety		B25674A*: triple (self-healing, 3-phase overpressure disconnector, dry technology) B25675A*: dual (self-healing, 3-phase overpressure disconnector)	triple (self-healing, overpressure disconnector, dry technology)	dual (self-healing, 3-phase overpressure disconnector)
Impregnation		B25674A*: inert gas B25675A*: semi-dry biodegradable resin	inert gas	semi-dry biodegradable resin
Mean life expectancy	$t_{LD\ (co)}$	B25674A*: up to 180 000 h (temp. class –40/D) up to 160 000 h (temp. class –40/60) B25675A*: up to 200 000 h (temp. class –40/D) up to 180 000 h (temp. class –40/60)	up to 180 000 h (temp. class –40/C) up to 130 000 h (temp. class –40/D)	up to 200 000 h (temp. class –40/C) up to 150 000 h (temp. class –40/60)
Connection		optimized isolated capacitor safety terminals, IP20, (VDE 0106 part 100), for current and connection cable details and terminal type association see terminal and capacitor type list	optimized capacitor safety terminal (IP20), (VDE 0106 part 100), for current and connection cable details and terminal type/capacitor type association see terminal drawings and capacitor type list	optimized capacitor safety terminal (IP20), (VDE 0106 part 100), for current and connection cable details and terminal type/capacitor type association see terminal drawings and capacitor type list
Cooling		natural or forced	natural or forced	natural or forced
Case/shape		aluminum/cylindrical	aluminum/cylindrical	aluminum/cylindrical
Enclosure		IP20, indoor mounting, optionally with terminal cap for IP54 (for diameter 116 and 136 mm)	IP20, indoor mounting, optionally with terminal cap for IP54 (for diameter 116 and 136 mm)	IP20, indoor mounting, optionally with terminal cap for IP54 (for diameter 116 and 136 mm)
Standard		IEC 60831-1+2, Edition 3.0 (2014), UL 810 5th edition, cUL file # E238746 (230 to 660 V AC)	IEC 60831-1+2, UL 810 5th edition, cUL file # E238746, GOST	IEC 60831-1+2, EN 60831-1+2, UL 810 5th edition, cUL file # E238746, GOST
Ordering code		Gas filled: B25674A* Resin filled: B25675A*	B25667C*	B25673A* B25673S*
Page		13	25	31

[1] Without discharge resistor

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PFC Capacitor Series Overview

	PhaseCap HD	DeltaCap	PhiCap
	40.0 ... 60.0 kvar	0.5 ... 48 kvar	0.5 ... 40.0 kvar
	400 ... 525 V AC	230 ... 525 V AC	230 ... 525 V AC
	up to 300 · I_R	up to 200 · I_R	up to 200 · I_R
	–40/D: max. temp. +55 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C	**–40/D:** max. temp. +55 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C **–40/C:** max. temp. +50 °C max. mean 24 h = +40 °C max. mean 1 year = +30 °C lowest temperature = –40 °C	**–40/D:** max. temp. +55 °C max. mean 24 h = +45 °C max. mean 1 year = +35 °C lowest temperature = –40 °C
	< 0.2 W/kvar < 0.45 W/kvar	< 0.2 W/kvar < 0.45 W/kvar	< 0.2 W/kvar < 0.45 W/kvar
	95%	95%	95%
	triple (self-healing, overpressure disconnector, dry technology)	self-healing technology – overpressure disconnector – isolated terminal (IP20) for B32304 series	dual (self-healing, overpressure disconnector)
	inert gas	biodegradable soft resin, semi-dry	biodegradable soft resin, semi-dry
	up to 180 000 h (temp. class –40/C) up to 130 000 h (temp. class –40/D)	up to 150 000 h (temp. class –40/C) up to 115 000 h (temp. class –40/D)	up to 135 000 h (temp. class –40/C) up to 100 000 h (temp. class –40/D)
	optimized capacitor safety terminal with electric shock protection (IP20), (VDE 0106 part 100), max. 35 mm² cable cross section, max. current 130 A	B32300*/B32303*: fast-on terminals B32301*/B32304: screw terminals, max. 25 mm² cable cross-section	**B32340 / B32343 series:** fast-on terminals **B32344 series:** optimized capacitor safety terminal, block-type
	natural or forced	natural or forced	natural or forced
	aluminum/cylindrical	aluminum/cylindrical	aluminum/cylindrical
	IP20	P00 for B32300* and B32303* IP20 for B32301 and B32304*	IP00 for B32340/B32343 series; optionally IP54 for B32344 series with terminal cap
	IEC 60831-1+2, UL 810 5th edition, GOST	IEC 60831-1+2, EN60831-1+2, VDE approval	IEC 60831-1+2, UL 810 5th edition cUL file # E106388 CSA file # C22.2 N°190 MC # 236094, (up to ø 85 mm), GOST
	B25669*	B32300*, B32301* B32303* B32304*	B32340C* B32343C* B32344E*
	37	40	47

PQS Key Components Overview

Power factor controllers

Parameter	BR7000-I BR7000-I/S485	BR7000-I-TH BR7000-I-TH/S485	BR7000/BR7000-HD BR7000-T	BR6000-R BR6000-T	BR604
Supply voltage	110 … 440 V AC ±15%			110 … 230 V AC ±15%	230 V AC
Measurement voltage range	30 … 440 V AC (L-N), 50 … 760 V AC (L-L)	30 … 440 V AC (L-N) 50 … 760 V AC (L-L)	3 · 30 … 440 V AC (L-N), 3 · 50 … 760 V AC (L-L)	30 … 525 V AC (L-N) or (L-L)	230 V AC
Measurement current	X:5A/X:1A selectable	X:5A/X:1A selectable	3 x X:5A/X:1A selectable	X/5 or X:1A selectable	X/5 or X:1A selectable
Frequency	50/60 Hz				
Sensivity	50 mA/10 mA				

Output stages	Relay outputs	Transistor outputs	Interface	Dynamic PFC	Ordering code
BR7000-I	12+1	–	–	no	B44066R7012E230
BR7000-I/S485	12+1	–	RS485	no	B44066R7112E230
BR7000-I-TH	12	12	–	yes	B44066R7412E230
BR7000-I-TH/S485	12	12	RS485	yes	B44066R7612E230
BR7000	15	–	2× RS485	no	B44066R7415E230
BR7000-HD	15	–	2× RS485	no	B44066R7515E230
BR7000-T	–	15	2× RS485	yes	B44066R7615E230
BR604	4	–	–	no	B44066R6004E230
BR6000-R6	6	–	–	no	B44066R6006E230
BR6000-R6/HD	6	–	–	no	B44066R6506E230
BR6000-R12	12	–	–	no	B44066R6012E230
BR6000-R12/HD	12	–	–	no	B44066R6512E230
BR6000-T6	–	6	–	yes	B44066R6106E230
Page	54	54	54	54	54

BR7000

BR6000

BR604

Multi measuring interfaces

Parameter	MMI6000	MMI7000 (V4)	MMI8003
Operating voltage	230 V AC	110 … 440 V AC	24 V DC
Measurement voltage	230 V AC, single-phase	3 · 30 … 440 V AC (L-N) 3 · 50 … 760 V AC (L-L)	3 · 30 … 440 V AC (L-N) 3 · 50 … 690 V AC (L-L)
Measurement current	X/5 or X/1 selectable	Three-phase X:5A/X:1A selectable	Three-phase X:5A/X:1A selectable
Frequency	50/60 Hz	50/60 Hz	10 … 80 Hz
Power consumption	< 4 VA	< 5 VA	< 1 VA
Ordering code	B44066M6 … E230	B44066M7500 E230	B44066M8003E024
Page	62	62	62

MMI6000

MMI7000

MMI8003

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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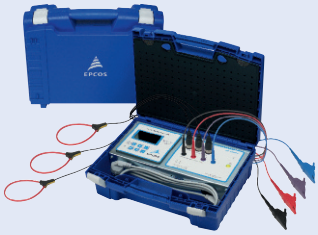
PQS Key Components Overview

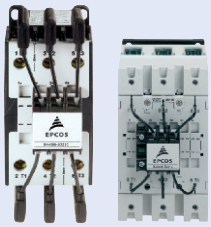
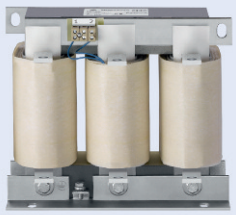
Grid analysis tool MC7000-3

Parameter	MC7000-3
Operating voltage	110 … 230 V AC ±15%
Max. measuring voltage[1] (3-phase)	3 · 30 … 440 V AC (L-N), 50/60 Hz 3 · 50 … 760 V AC (L-L), 50/60 Hz
Max. measuring current (3-phase)	30, 300, 3000 A
Frequency	50/60 Hz
Ordering code	B44066M7777E230
Page	64



[1] Incl. all tolerances and voltages

Switching devices

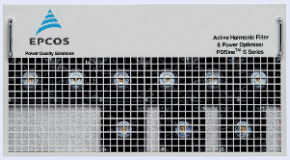
Parameter	Capacitor contactors	Thyristor modules	Reactors – Antiresonance harmonic filter
		Thyristor switch for dynamic PFC systems	
Voltage	230 … 690 V	TSM-LC-I: 230 … 525 V TSM-LC*: 380 … 440 V TSM-LC-S: 200 … 440 V TSM-LC-N690: 380 … 690 V	400 and 440 V
Output range	12.5 … 100 kvar	TSM-LC-I: 10 … 22 kvar, depending on voltage TSM-LC*: 10 … 200 kvar, depending on the voltage	10 … 100 kvar
Frequency	50 /60 Hz	50/60 Hz	50 or 60 Hz
De-tuning		suitable for detuned and conventional systems	factor: 5.67, 7, 14%
Ordering code	B44066S…J230/J110 for all PFC systems	TSM-LC-I: B44066T1022E520 TSM-LC*: B44066T…E402 TSM-LC-N480: B44066T3850E408 TSM-LC-N690: B44066T3050E690	B44066D…
Page	66	69	73
		 	

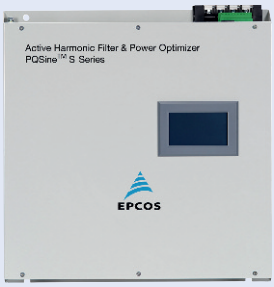
*Available in three versions with 10, 100 or 200 kvar

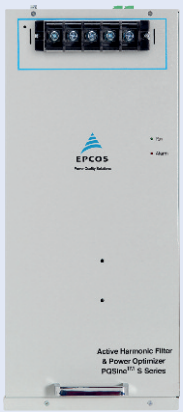
PQSine S Series Overview

Active harmonic filter and power optimizer PQSine S series

Parameter			
Rated voltage	380 V (228 … 456 V)	480 V (384 … 552 V)	690 V (480 … 790 V)
Mains frequency	3 … 62 Hz		
Filter current	25, 35, 50, 60, 100, 150 A	75, 90 A	75, 90 A
Neutral filtering capability	3 times the rated filter current (in case of 4 wire device)		
Harmonic current compensation range	2nd to 50th harmonic order, or specified harmonics 0 to110%		
Rate of harmonic reduction	> 97%*		
Typical power losses	< 3%, depending of the load		
Target power factor	Adjustable from –1 to 1		
Reaction time	Approx. 20 µs		
Overall response time	< 5 ms		
Display	All systems include a 7" TFT color control / display unit (touch screen)		
Communication ports	RS485 and network port (RJ45)		
Communication protocols	Modbus RTU, TCP/IP (Ethernet)		
Fault alarm	Available, max. 500 alarm records		
Operating temperature	–10 to +40 °C without derating, other temperature ranges upon request		
Protection class	IP 20 according to IEC 529 (other IP classes are customizable)		
Ordering code	B44066F…S…		
Page	77		







*For typical harmonic order distortions

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PQvar Series Overview

Static var generator (SVG) – PQvar	
Parameter	
Rated voltage	400 V: –40 … +20%
Mains frequency	50/60 Hz (range: 45 … 63 Hz)
Parallel operation	Unlimited
Response time	< 15 ms
Overall efficiency	> 97%
Power grid structure	3P3W/ 3P4W
Current transformers	150/5 … 10000/5
Circuit topology	3-level
Single-module compensation capacity	30, 50, 100, 200 kvar
Target power factor	Adjustable from –1 to +1
Cabinet mounting	Floor-mounted, wall-mounted
Communication ports	RS485, CAN, and network port
Communication protocols	Modbus and PMBus
Noise level	< 65 dB (depending on the model)
Protection functions	Overvoltage, undervoltage, short-circuit, inverter bridge inverse, over-compensation
Operating temperature	–10 to +40 °C
Protection class	IP20 (other IP classes are customizable)
Ordering code	B44066F…V…
Page	85

Important Notes

The following applies to all products named in this publication:

1. Some parts of this publication contain **statements about the suitability of our products for certain areas of application**. These statements are based on our knowledge of typical requirements that are often placed on our products in the areas of application concerned. We nevertheless expressly point out **that such statements cannot be regarded as binding statements about the suitability of our products for a particular customer application**. As a rule, EPCOS is either unfamiliar with individual customer applications or less familiar with them than the customers themselves. For these reasons, it is always ultimately incumbent on the customer to check and decide whether an EPCOS product with the properties described in the product specification is suitable for use in a particular customer application.
2. We also point out that **in individual cases, a malfunction of electronic components or failure before the end of their usual service life cannot be completely ruled out in the current state of the art, even if they are operated as specified**. In customer applications requiring a very high level of operational safety and especially in customer applications in which the malfunction or failure of an electronic component could endanger human life or health (e.g. in accident prevention or life-saving systems), it must therefore be ensured by means of suitable design of the customer application or other action taken by the customer (e.g. installation of protective circuitry or redundancy) that no injury or damage is sustained by third parties in the event of malfunction or failure of an electronic component.
3. **The warnings, cautions and product-specific notes must be observed**.
4. In order to satisfy certain technical requirements, **some of the products described in this publication may contain substances subject to restrictions in certain jurisdictions (e.g. because they are classed as hazardous)**. Useful information on this will be found in our Material Data Sheets on the Internet (www.epcos.com/material). Should you have any more detailed questions, please contact our sales offices.
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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

General

The series PhaseCap Energy represents a new generation of capacitors for power factor correction (PFC). On basis of the well proven MKK-technology, this follow-on development of the PhaseCap series offers some major enhancements. A service life expectation of up to 200 000 hours, an increased inrush current capability of up to 500 · I_R and reduced can dimensions make the PhaseCap Energy the ideal capacitor for industrial applications that call for high reliability.

PhaseCap Energy is available in two versions: Series B25674A is gas filled, series B25675A with semi-dry biodegradable soft resin. Both series are equipped with self-healing properties and three-phase overpressure disconnector. A voltage range from 230 to 690 V, outputs of 5.0 to 33.0 kvar and four different terminal types allow the selection of the customized capacitor type.

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Tuned and detuned capacitor banks
- Dynamic PFC

Features

- Compact design in cylindrical aluminum can with stud
- Stacked winding
- MKK-technology with wavy cut and heavy edge
- Voltage range 230 V … 690 V
- Output range 5.0 kvar … 33 kvar

Electrical

- Long life expectancy up to 200 000 hours at temperature class –40/60
- High pulse current withstand capability
- High long term stability

Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free
- Highest packing density thanks to compact dimensions

Safety

- Self-healing
- Overpressure disconnector
- Shock hazard protected terminals
- Ceramic discharge resistor pre-mounted

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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

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Technical data and limit values		
Standards IEC 60831-1+2		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.6 … 2.0 · I_R including combined effects of harmonics, overvoltages and capacitance tolerance
Inrush current	I_S	up to 500 · I_R, depending on the particular type
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / +10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_{R1}, AC, 2 s
Test voltage, terminal / case	V_{TC}	3600 V AC / 50 Hz, 2 s up to V_R = 525 V, 6000 V AC / 50 Hz, 2 s above V_R = 525 V
Mean life expectancy	$t_{LD(Co)}$	B25674A: up to 180 000 h (temp. class –40/D); up to 160 000 h (temp. class –40/60) B25675A: up to 200 000 h (temp. class –40/D); up to 180 000 h (temp. class –40/60)
Ambient temperature		–40/60; max. temp. +60 °C; max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright / horizontal
Mounting and grounding		threaded M12 stud on bottom of case
Safety		three-phase overpressure disconnector, self-healing, maximum allowed fault current 10 000 A in accordance with UL 810 standard
Discharge device		ceramic discharge module or discharge module block
Case		extruded aluminum can
Enclosure		IP20, indoor mounting (optionally with terminal cap for IP54)
Dielectric		polypropylene film
Impregnation		B25674A: inert gas B25675A: semi-dry biodegradable resin
Terminals		optimized capacitor safety terminal with electric shock protection (IP20), (VDE 0106 part 100), max. 25 mm² cable cross-section, max. current 80 A
Certification		cUL file # E238746 (230 to 660 V AC)
Number of switching operations		max. 15000 switchings per year

* Without discharge resistor

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Gas filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 230 V AC, 50/60 Hz, delta connection										
MKK230-D-5.0-03	5.0	12.6	6.0	15.1	3 · 100.3	A	75 x 218	0.9	B25674A2052J030	9
MKK230-D-7.5-03	7.5	18.8	9.0	22.6	3 · 150.4	B	100 x 192	1.4	B25674A2072J530	6
MKK230-D-10.0-03	10.0	25.1	12.0	30.1	3 · 200.5	B	100 x 224	1.7	B25674A2102J030	4
MKK230-D-12.5-03	12.5	31.4	15.0	37.7	3 · 250.7	B	116 x 207	2.1	B25674A2122J530	4
MKK230-D-15.0-03	15.0	37.7	–	–	3 · 300.8	B	125 x 207	2.4	B25674A2152J030	4
Rated voltage 400 V AC, 50/60 Hz, delta connection										
MKK400-D-5.0-03	5.0	7.2	6.0	8.7	3 · 33.2	A	75 x 164	0.7	B25674A4052J000	6
MKK400-D-6.3-03	6.3	9.1	7.6	11.0	3 · 41.8	A	75 x 164	0.7	B25674A4062J300	6
MKK400-D-7.5-03	7.5	10.8	9.0	13.0	3 · 49.7	A	75 x 200	0.8	B25674A4072J500	6
MKK400-D-8.3-03	8.3	12.0	10.0	14.4	3 · 55.0	A	75 x 200	0.8	B25674A4082J300	6
MKK400-D-10.4-03	10.4	15.0	12.5	18.0	3 · 69.0	A	75 x 218	0.9	B25674A4102J400	9
MKK400-D-12.5-03	12.5	18.0	15.0	21.7	3 · 82.9	A	85 x 200	1.1	B25674A4122J500	9
MKK400-D-15.0-03	15.0	21.7	18.0	26.0	3 · 99.5	A	85 x 218	1.2	B25674A4152J000	4
MKK400-D-16.7-03	16.7	24.1	20.0	28.9	3 · 110.7	B	100 x 207	1.6	B25674A4162J700	6
MKK400-D-20.0-03	20.0	28.9	24.0	34.6	3 · 132.6	B	100 x 224	1.7	B25674A4202J000	4
MKK400-D-25.0-03	25.0	36.1	30.0	43.3	3 · 165.8	B	116 x 192	1.9	B25674A4252J000	4
MKK400-D-28.1-03	28.1	40.6	–	–	3 · 186.3	B	125 x 192	2.3	B25674A4282J100	4
MKK400-D-30.0-03	30.0	43.3	–	–	3 · 198.9	B	116 x 224	2.3	B25674A4302J000	4
MKK400-D-33.0-03	33.0	47.6	–	–	3 · 218.8	B	125 x 207	2.4	B25674A4332J000	4
Rated voltage 415 V AC, 50/60 Hz, delta connection										
MKK415-D-5.0-03	5.0	7.0	6.0	8.3	3 · 30.8	A	75 x 164	0.7	B25674A4052J015	6
MKK415-D-6.3-03	6.3	8.8	7.6	10.6	3 · 38.8	A	75 x 164	0.7	B25674A4062J315	6
MKK415-D-7.5-03	7.5	10.4	9.0	12.5	3 · 46.2	A	75 x 200	0.8	B25674A4072J515	6
MKK415-D-8.3-03	8.3	11.5	10.0	13.9	3 · 51.1	A	75 x 200	0.8	B25674A4082J315	6
MKK415-D-10.4-03	10.4	14.5	12.5	17.4	3 · 64.1	A	75 x 200	0.8	B25674A4102J415	6
MKK415-D-12.5-03	12.5	17.4	15.0	20.9	3 · 77.0	A	85 x 200	1.1	B25674A4122J515	9
MKK415-D-15.0-03	15.0	20.9	18.0	25.0	3 · 92.4	A	85 x 200	1.1	B25674A4152J015	9
MKK415-D-16.7-03	16.7	23.2	20.0	27.8	3 · 102.9	B	100 x 207	1.6	B25674A4162J715	6
MKK415-D-20.0-03	20.0	27.8	24.0	33.4	3 · 123.2	B	100 x 207	1.6	B25674A4202J015	6
MKK415-D-25.0-03	25.0	34.8	30.0	41.7	3 · 154.0	B	116 x 192	1.9	B25674A4252J015	4
MKK415-D-28.1-03	28.1	39.1	–	–	3 · 173.1	B	116 x 207	2.1	B25674A4282J115	4
MKK415-D-30.0-03	30.0	41.7	–	–	3 · 184.8	B	116 x 207	2.1	B25674A4302J015	4
MKK415-D-33.0-03	33.0	45.9	–	–	3 · 203.3	B	116 x 224	2.3	B25674A4332J015	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Gas filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 440 V AC, 50/60 Hz, delta connection										
MKK440-D-5.0-03	5.0	6.6	6.0	7.9	3 · 27.4	A	75 x 164	0.7	B25674A4052J040	6
MKK440-D-6.0-03	6.0	7.9	7.2	9.4	3 · 32.9	A	75 x 164	0.7	B25674A4062J040	6
MKK440-D-6.3-03	6.3	8.3	7.6	10.0	3 · 34.5	A	75 x 164	0.7	B25674A4062J340	6
MKK440-D-7.0-03	7.0	9.2	8.4	11.0	3 · 38.4	A	75 x 200	0.8	B25674A4072J040	6
MKK440-D-7.5-03	7.5	9.8	9.0	11.8	3 · 41.1	A	75 x 200	0.8	B25674A4072J540	6
MKK440-D-8.0-03	8.0	10.5	9.6	12.6	3 · 43.8	A	75 x 200	0.8	B25674A4082J040	6
MKK440-D-8.3-03	8.3	10.9	10.0	13.1	3 · 45.5	A	75 x 200	0.8	B25674A4082J340	6
MKK440-D-9.0-03	9.0	11.8	10.8	14.2	3 · 49.3	A	75 x 200	0.8	B25674A4092J040	6
MKK440-D-10.0-03	10.0	13.1	12.0	15.7	3 · 54.8	A	75 x 200	0.8	B25674A4102J040	6
MKK440-D-10.4-03	10.4	13.6	12.5	16.4	3 · 57.0	A	85 x 200	1.1	B25674A4102J440	9
MKK440-D-12.0-03	12.0	15.7	14.4	18.9	3 · 65.8	A	85 x 200	1.1	B25674A4122J040	9
MKK440-D-12.5-03	12.5	16.4	15.0	19.7	3 · 68.5	A	85 x 200	1.1	B25674A4122J540	9
MKK440-D-14.2-03	14.2	18.6	17.0	22.3	3 · 77.8	A	85 x 200	1.1	B25674A4142J240	9
MKK440-D-15.0-03	15.0	19.7	18.0	23.6	3 · 82.2	A	85 x 218	1.2	B25674A4152J040	4
MKK440-D-16.7-03	16.7	21.9	20.0	26.2	3 · 91.5	B	100 x 207	1.6	B25674A4162J740	6
MKK440-D-18.8-03	18.8	24.7	22.6	29.7	3 · 103.0	B	100 x 207	1.6	B25674A4182J840	6
MKK440-D-20.0-03	20.0	26.2	24.0	31.5	3 · 109.6	B	100 x 207	1.6	B25674A4202J040	6
MKK440-D-25.0-03	25.0	32.8	30.0	39.4	3 · 137.0	B	116 x 192	1.9	B25674A4252J040	4
MKK440-D-28.1-03	28.1	36.9	–	–	3 · 154.0	B	116 x 207	2.1	B25674A4282J140	4
MKK440-D-30.0-03	30.0	39.4	–	–	3 · 164.4	B	125 x 192	2.3	B25674A4302J040	4
MKK440-D-33.1-03	33.1	43.4	–	–	3 · 181.4	B	116 x 224	2.3	B25674A4332J140	4
Rated voltage 480 V AC, 50/60 Hz, delta connection										
MKK480-D-5.0-03	5.0	6.0	6.0	7.2	3 · 23.0	A	75 x 164	0.7	B25674A4052J080	6
MKK480-D-6.3-03	6.3	7.6	7.6	9.1	3 · 29.0	A	75 x 164	0.7	B25674A4062J380	6
MKK480-D-7.5-03	7.5	9.0	9.0	10.8	3 · 34.5	A	75 x 200	0.8	B25674A4072J580	6
MKK480-D-8.3-03	8.3	10.0	10.0	12.0	3 · 38.2	A	75 x 200	0.8	B25674A4082J380	6
MKK480-D-10.4-03	10.4	12.5	12.5	15.0	3 · 47.9	A	75 x 200	0.8	B25674A4102J480	6
MKK480-D-11.0-03	11.0	13.2	13.2	15.9	3 · 50.7	A	85 x 200	1.1	B25674A4112J080	9
MKK480-D-12.5-03	12.5	15.0	15.0	18.0	3 · 57.6	A	85 x 200	1.1	B25674A4122J580	9
MKK480-D-13.8-03	13.8	16.6	16.6	20.0	3 · 63.5	A	85 x 200	1.1	B25674A4132J880	9
MKK480-D-15.0-03	15.0	18.0	18.0	21.7	3 · 69.1	B	100 x 207	1.6	B25674A4152J080	6
MKK480-D-16.7-03	16.7	20.1	20.0	24.1	3 · 76.9	B	100 x 207	1.6	B25674A4162J780	6
MKK480-D-20.0-03	20.0	24.1	24.0	28.9	3 · 92.1	B	100 x 207	1.6	B25674A4202J080	6
MKK480-D-20.8-03	20.8	25.0	25.0	30.1	3 · 95.8	B	116 x 207	2.1	B25674A4202J880	4
MKK480-D-22.0-03	22.0	26.5	26.4	31.8	3 · 101.3	B	116 x 207	2.1	B25674A4222J080	4
MKK480-D-25.0-03	25.0	30.1	30.0	36.1	3 · 115.1	B	116 x 192	1.9	B25674A4252J080	4
MKK480-D-28.1-03	28.1	33.8	–	–	3 · 129.4	B	116 x 207	2.1	B25674A4282J180	4
MKK480-D-30.0-03	30.0	36.1	–	–	3 · 138.1	B	125 x 192	2.3	B25674A4302J080	4
MKK480-D-31.0-03	31.0	37.3	–	–	3 · 142.7	B	125 x 192	2.3	B25674A4312J080	4
MKK480-D-33.0-03	33.0	39.7	–	–	3 · 152.0	B	116 x 224	2.3	B25674A4332J080	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Gas filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 525 V AC, 50/60 Hz, delta connection										
MKK525-D-5.0-03	5.0	5.5	6.0	6.6	3 · 19.2	A	75 x 164	0.7	B25674A5052J025	6
MKK525-D-6.3-03	6.3	6.9	7.6	8.4	3 · 24.2	A	75 x 164	0.7	B25674A5062J325	6
MKK525-D-7.5-03	7.5	8.2	9.0	9.9	3 · 28.9	A	75 x 185	0.8	B25674A5072J525	6
MKK525-D-8.3-03	8.3	9.1	10.0	11.0	3 · 31.9	A	75 x 200	0.8	B25674A5082J325	6
MKK525-D-10.4-03	10.4	11.4	12.5	13.7	3 · 40.0	A	85 x 185	1.0	B25674A5102J425	9
MKK525-D-12.5-03	12.5	13.7	15.0	16.5	3 · 48.1	A	85 x 200	1.1	B25674A5122J525	9
MKK525-D-13.2-03	13.2	14.5	15.8	17.4	3 · 50.8	A	85 x 200	1.1	B25674A5132J225	9
MKK525-D-15.0-03	15.0	16.5	18.0	19.8	3 · 57.7	A	85 x 218	1.2	B25674A5152J025	4
MKK525-D-16.7-03	16.7	18.4	20.0	22.0	3 · 64.3	B	100 x 207	1.6	B25674A5162J725	6
MKK525-D-20.0-03	20.0	22.0	24.0	26.4	3 · 77.0	B	100 x 224	1.7	B25674A5202J025	4
MKK525-D-20.8-03	20.8	22.9	25.0	27.5	3 · 80.1	B	100 x 224	1.7	B25674A5202J825	4
MKK525-D-25.0-03	25.0	27.5	30.0	33.0	3 · 96.2	B	116 x 207	2.1	B25674A5252J025	4
MKK525-D-26.5-03	26.5	29.1	31.8	35.0	3 · 102.0	B	116 x 207	2.1	B25674A5262J525	4
MKK525-D-28.1-03	28.1	30.9	–	–	3 · 108.2	B	125 x 192	2.3	B25674A5282J125	4
MKK525-D-30.0-03	30.0	33.0	–	–	3 · 115.5	B	125 x 207	2.4	B25674A5302J025	4
MKK525-D-33.1-03	33.1	36.4	–	–	3 · 127.4	B	136 x 192	2.7	B25674A5332J125	4
Rated voltage 600 V AC, 50/60 Hz, delta connection										
MKK600-D-5.3-03	5.3	5.1	6.4	6.2	3 · 15.6	C	75 x 185	0.8	B25674A6052J300	6
MKK600-D-6.2-03	6.2	6.0	7.4	7.1	3 · 18.3	C	75 x 185	0.8	B25674A6062J200	6
MKK600-D-6.9-03	6.9	6.6	8.3	8.0	3 · 20.3	C	75 x 200	0.8	B25674A6062J900	6
MKK600-D-8.3-03	8.3	8.0	10.0	9.6	3 · 24.5	C	75 x 218	0.9	B25674A6082J300	9
MKK600-D-10.4-03	10.4	10.0	12.5	12.0	3 · 30.6	C	85 x 200	1.1	B25674A6102J400	9
MKK600-D-12.5-03	12.5	12.0	15.0	14.4	3 · 36.8	D	100 x 192	1.4	B25674A6122J500	6
MKK600-D-13.9-03	13.9	13.4	16.7	16.1	3 · 41.0	D	100 x 207	1.6	B25674A6132J900	6
MKK600-D-14.6-03	14.6	14.0	17.5	16.8	3 · 43.0	D	100 x 207	1.6	B25674A6142J600	6
MKK600-D-16.7-03	16.7	16.1	20.0	19.2	3 · 49.2	D	100 x 224	1.7	B25674A6162J700	4
MKK600-D-20.0-03	20.0	19.2	24.0	23.1	3 · 58.9	D	116 x 207	2.1	B25674A6202J000	4
MKK600-D-20.8-03	20.8	20.0	25.0	24.1	3 · 61.3	D	116 x 207	2.1	B25674A6202J800	4
MKK600-D-25.0-03	25.0	24.1	30.0	28.9	3 · 73.7	D	125 x 207	2.4	B25674A6252J000	4
MKK600-D-28.0-03	28.0	26.9	–	–	3 · 82.5	D	136 x 192	2.7	B25674A6282J000	4
MKK600-D-30.0-03	30.0	28.9	–	–	3 · 88.4	D	136 x 207	2.9	B25674A6302J000	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Gas filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 690 V AC, 50/60 Hz, delta connection										
MKK690-D-5.3-03	5.3	4.4	6.4	5.4	3 · 11.8	C	75 x 185	0.8	B25674A6052J390	6
MKK690-D-6.2-03	6.2	5.2	7.4	6.2	3 · 13.8	C	75 x 200	0.8	B25674A6062J290	6
MKK690-D-6.9-03	6.9	5.8	8.3	6.9	3 · 15.4	C	75 x 200	0.8	B25674A6062J990	6
MKK690-D-8.3-03	8.3	6.9	10.0	8.4	3 · 18.5	C	75 x 200	0.8	B25674A6082J390	6
MKK690-D-10.4-03	10.4	8.7	12.5	10.5	3 · 23.2	C	75 x 200	0.8	B25674A6102J490	6
MKK690-D-12.5-03	12.5	10.5	15.0	12.6	3 · 27.9	C	85 x 200	1.1	B25674A6122J590	9
MKK690-D-13.9-03	13.9	11.6	16.7	14.0	3 · 31.0	C	85 x 200	1.1	B25674A6132J990	9
MKK690-D-14.6-03	14.6	12.2	17.5	14.6	3 · 32.5	D	100 x 207	1.6	B25674A6142J690	6
MKK690-D-16.7-03	16.7	14.0	20.0	16.7	3 · 37.2	D	100 x 192	1.4	B25674A6162J790	6
MKK690-D-20.0-03	20.0	16.7	24.0	20.1	3 · 44.6	D	100 x 207	1.6	B25674A6202J090	6
MKK690-D-20.8-03	20.8	17.4	25.0	20.9	3 · 46.3	D	100 x 224	1.7	B25674A6202J890	4
MKK690-D-25.0-03	25.0	20.9	30.0	25.1	3 · 55.7	D	116 x 192	1.9	B25674A6252J090	4
MKK690-D-28.0-03	28.0	23.4	–	–	3 · 62.4	D	116 x 207	2.1	B25674A6282J090	4
MKK690-D-30.0-03	30.0	25.1	–	–	3 · 66.8	D	125 x 192	2.3	B25674A6302J090	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Resin filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 230 V AC, 50/60 Hz, delta connection										
MKK230-D-5.0-04	5.0	12.6	6.0	15.1	3 · 100.3	A	75 x 218	1.1	B25675A2052J030	9
MKK230-D-7.5-04	7.5	18.8	9.0	22.6	3 · 150.4	B	100 x 192	1.8	B25675A2072J530	6
MKK230-D-10.0-04	10.0	25.1	12.0	30.1	3 · 200.5	B	100 x 224	2.1	B25675A2102J030	4
MKK230-D-12.5-04	12.5	31.4	15.0	37.7	3 · 250.7	B	116 x 207	2.6	B25675A2122J530	4
MKK230-D-15.0-04	15.0	37.7	–	–	3 · 300.8	B	125 x 207	3.0	B25675A2152J030	4
Rated voltage 400 V AC, 50/60 Hz, delta connection										
MKK400-D-5.0-04	5.0	7.2	6.0	8.7	3 · 33.2	A	75 x 164	0.9	B25675A4052J000	6
MKK400-D-6.3-04	6.3	9.1	7.6	11.0	3 · 41.8	A	75 x 164	0.9	B25675A4062J300	6
MKK400-D-7.5-04	7.5	10.8	9.0	13.0	3 · 49.7	A	75 x 200	1.1	B25675A4072J500	6
MKK400-D-8.3-04	8.3	12.0	10.0	14.4	3 · 55.0	A	75 x 200	1.1	B25675A4082J300	6
MKK400-D-10.4-04	10.4	15.0	12.5	18.0	3 · 69.0	A	75 x 218	1.1	B25675A4102J400	9
MKK400-D-12.5-04	12.5	18.0	15.0	21.7	3 · 82.9	A	85 x 200	1.3	B25675A4122J500	9
MKK400-D-15.0-04	15.0	21.7	18.0	26.0	3 · 99.5	A	85 x 218	1.5	B25675A4152J000	4
MKK400-D-16.7-04	16.7	24.1	20.0	28.9	3 · 110.7	B	100 x 207	1.9	B25675A4162J700	6
MKK400-D-20.0-04	20.0	28.9	24.0	34.6	3 · 132.6	B	100 x 224	2.1	B25675A4202J000	4
MKK400-D-25.0-04	25.0	36.1	30.0	43.3	3 · 165.8	B	116 x 192	2.4	B25675A4252J000	4
MKK400-D-28.1-04	28.1	40.6	–	–	3 · 186.3	B	125 x 192	2.8	B25675A4282J100	4
MKK400-D-30.0-04	30.0	43.3	–	–	3 · 198.9	B	116 x 224	2.8	B25675A4302J000	4
MKK400-D-33.0-04	33.0	47.6	–	–	3 · 218.8	B	125 x 207	3.0	B25675A4332J000	4
Rated voltage 415 V AC, 50/60 Hz, delta connection										
MKK415-D-5.0-04	5.0	7.0	6.0	8.3	3 · 30.8	A	75 x 164	0.9	B25675A4052J015	6
MKK415-D-6.3-04	6.3	8.8	7.6	10.6	3 · 38.8	A	75 x 164	0.9	B25675A4062J315	6
MKK415-D-7.5-04	7.5	10.4	9.0	12.5	3 · 46.2	A	75 x 200	1.1	B25675A4072J515	6
MKK415-D-8.3-04	8.3	11.5	10.0	13.9	3 · 51.1	A	75 x 200	1.1	B25675A4082J315	6
MKK415-D-10.4-04	10.4	14.5	12.5	17.4	3 · 64.1	A	75 x 200	1.1	B25675A4102J415	6
MKK415-D-12.5-04	12.5	17.4	15.0	20.9	3 · 77.0	A	85 x 200	1.3	B25675A4122J515	9
MKK415-D-15.0-04	15.0	20.9	18.0	25.0	3 · 92.4	A	85 x 200	1.3	B25675A4152J015	9
MKK415-D-16.7-04	16.7	23.2	20.0	27.8	3 · 102.9	B	100 x 207	1.9	B25675A4162J715	6
MKK415-D-20.0-04	20.0	27.8	24.0	33.4	3 · 123.2	B	100 x 207	1.9	B25675A4202J015	6
MKK415-D-25.0-04	25.0	34.8	30.0	41.7	3 · 154.0	B	116 x 192	2.4	B25675A4252J015	4
MKK415-D-28.1-04	28.1	39.1	–	–	3 · 173.1	B	116 x 207	2.6	B25675A4282J115	4
MKK415-D-30.0-04	30.0	41.7	–	–	3 · 184.8	B	116 x 207	2.6	B25675A4302J015	4
MKK415-D-33.0-04	33.0	45.9	–	–	3 · 203.3	B	116 x 224	2.8	B25675A4332J015	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Resin filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 440 V AC, 50/60 Hz, delta connection										
MKK440-D-5.0-04	5.0	6.6	6.0	7.9	3 · 27.4	A	75 x 164	0.9	B25675A4052J040	6
MKK440-D-6.0-04	6.0	7.9	7.2	9.4	3 · 32.9	A	75 x 164	0.9	B25675A4062J040	6
MKK440-D-6.3-04	6.3	8.3	7.6	10.0	3 · 34.5	A	75 x 164	0.9	B25675A4062J340	6
MKK440-D-7.0-04	7.0	9.2	8.4	11.0	3 · 38.4	A	75 x 200	1.1	B25675A4072J040	6
MKK440-D-7.5-04	7.5	9.8	9.0	11.8	3 · 41.1	A	75 x 200	1.1	B25675A4072J540	6
MKK440-D-8.0-04	8.0	10.5	9.6	12.6	3 · 43.8	A	75 x 200	1.1	B25675A4082J040	6
MKK440-D-8.3-04	8.3	10.9	10.0	13.1	3 · 45.5	A	75 x 200	1.1	B25675A4082J340	6
MKK440-D-9.0-04	9.0	11.8	10.8	14.2	3 · 49.3	A	75 x 200	1.1	B25675A4092J040	6
MKK440-D-10.0-04	10.0	13.1	12.0	15.7	3 · 54.8	A	75 x 200	1.1	B25675A4102J040	6
MKK440-D-10.4-04	10.4	13.6	12.5	16.4	3 · 57.0	A	85 x 200	1.3	B25675A4102J440	9
MKK440-D-12.0-04	12.0	15.7	14.4	18.9	3 · 65.8	A	85 x 200	1.3	B25675A4122J040	9
MKK440-D-12.5-04	12.5	16.4	15.0	19.7	3 · 68.5	A	85 x 200	1.3	B25675A4122J540	9
MKK440-D-14.2-04	14.2	18.6	17.0	22.3	3 · 77.8	A	85 x 200	1.3	B25675A4142J240	9
MKK440-D-15.0-04	15.0	19.7	18.0	23.6	3 · 82.2	A	85 x 218	1.5	B25675A4152J040	4
MKK440-D-16.7-04	16.7	21.9	20.0	26.2	3 · 91.5	B	100 x 207	1.9	B25675A4162J740	6
MKK440-D-18.8-04	18.8	24.7	22.6	29.7	3 · 103.0	B	100 x 207	1.9	B25675A4182J840	6
MKK440-D-20.0-04	20.0	26.2	24.0	31.5	3 · 109.6	B	100 x 207	1.9	B25675A4202J040	6
MKK440-D-25.0-04	25.0	32.8	30.0	39.4	3 · 137.0	B	116 x 192	2.4	B25675A4252J040	4
MKK440-D-28.1-04	28.1	36.9	–	–	3 · 154.0	B	116 x 207	2.6	B25675A4282J140	4
MKK440-D-30.0-04	30.0	39.4	–	–	3 · 164.4	B	125 x 192	2.8	B25675A4302J040	4
MKK440-D-33.1-04	33.1	43.4	–	–	3 · 181.4	B	116 x 224	2.8	B25675A4332J140	4
Rated voltage 480 V AC, 50/60 Hz, delta connection										
MKK480-D-5.0-04	5.0	6.0	6.0	7.2	3 · 23.0	A	75 x 164	0.9	B25675A4052J080	6
MKK480-D-6.3-04	6.3	7.6	7.6	9.1	3 · 29.0	A	75 x 164	0.9	B25675A4062J380	6
MKK480-D-7.5-04	7.5	9.0	9.0	10.8	3 · 34.5	A	75 x 200	1.1	B25675A4072J580	6
MKK480-D-8.3-04	8.3	10.0	10.0	12.0	3 · 38.2	A	75 x 200	1.1	B25675A4082J380	6
MKK480-D-10.4-04	10.4	12.5	12.5	15.0	3 · 47.9	A	75 x 200	1.1	B25675A4102J480	6
MKK480-D-11.0-04	11.0	13.2	13.2	15.9	3 · 50.7	A	85 x 200	1.3	B25675A4112J080	9
MKK480-D-12.5-04	12.5	15.0	15.0	18.0	3 · 57.6	A	85 x 200	1.3	B25675A4122J580	9
MKK480-D-13.8-04	13.8	16.6	16.6	20.0	3 · 63.5	A	85 x 200	1.3	B25675A4132J880	9
MKK480-D-15.0-04	15.0	18.0	18.0	21.7	3 · 69.1	B	100 x 207	1.9	B25675A4152J080	6
MKK480-D-16.7-04	16.7	20.1	20.0	24.1	3 · 76.9	B	100 x 207	1.9	B25675A4162J780	6
MKK480-D-20.0-04	20.0	24.1	24.0	28.9	3 · 92.1	B	100 x 207	1.9	B25675A4202J080	6
MKK480-D-20.8-04	20.8	25.0	25.0	30.1	3 · 95.8	B	116 x 207	2.6	B25675A4202J880	4
MKK480-D-22.0-04	22.0	26.5	26.4	31.8	3 · 101.3	B	116 x 207	2.6	B25675A4222J080	4
MKK480-D-25.0-04	25.0	30.1	30.0	36.1	3 · 115.1	B	116 x 192	2.4	B25675A4252J080	4
MKK480-D-28.1-04	28.1	33.8	–	–	3 · 129.4	B	116 x 207	2.6	B25675A4282J180	4
MKK480-D-30.0-04	30.0	36.1	–	–	3 · 138.1	B	125 x 192	2.8	B25675A4302J080	4
MKK480-D-31.0-04	31.0	37.3	–	–	3 · 142.7	B	125 x 192	2.8	B25675A4312J080	4
MKK480-D-33.0-04	33.0	39.7	–	–	3 · 152.0	B	116 x 224	2.8	B25675A4332J080	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Resin filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 525 V AC, 50/60 Hz, delta connection										
MKK525-D-5.0-04	5.0	5.5	6.0	6.6	3 · 19.2	A	75 x 164	0.9	B25675A5052J025	6
MKK525-D-6.3-04	6.3	6.9	7.6	8.4	3 · 24.2	A	75 x 164	0.9	B25675A5062J325	6
MKK525-D-7.5-04	7.5	8.2	9.0	9.9	3 · 28.9	A	75 x 185	1.0	B25675A5072J525	6
MKK525-D-8.3-04	8.3	9.1	10.0	11.0	3 · 31.9	A	75 x 200	1.1	B25675A5082J325	6
MKK525-D-10.4-04	10.4	11.4	12.5	13.7	3 · 40.0	A	85 x 185	1.2	B25675A5102J425	9
MKK525-D-12.5-04	12.5	13.7	15.0	16.5	3 · 48.1	A	85 x 200	1.3	B25675A5122J525	9
MKK525-D-13.2-04	13.2	14.5	15.8	17.4	3 · 50.8	A	85 x 200	1.3	B25675A5132J225	9
MKK525-D-15.0-04	15.0	16.5	18.0	19.8	3 · 57.7	A	85 x 218	1.5	B25675A5152J025	4
MKK525-D-16.7-04	16.7	18.4	20.0	22.0	3 · 64.3	B	100 x 207	1.9	B25675A5162J725	6
MKK525-D-20.0-04	20.0	22.0	24.0	26.4	3 · 77.0	B	100 x 224	2.1	B25675A5202J025	4
MKK525-D-20.8-04	20.8	22.9	25.0	27.5	3 · 80.1	B	100 x 224	2.1	B25675A5202J825	4
MKK525-D-25.0-04	25.0	27.5	30.0	33.0	3 · 96.2	B	116 x 207	2.6	B25675A5252J025	4
MKK525-D-26.5-04	26.5	29.1	31.8	35.0	3 · 102.0	B	116 x 207	2.6	B25675A5262J525	4
MKK525-D-28.1-04	28.1	30.9	–	–	3 · 108.2	B	125 x 192	2.8	B25675A5282J125	4
MKK525-D-30.0-04	30.0	33.0	–	–	3 · 115.5	B	125 x 207	3.0	B25675A5302J025	4
MKK525-D-33.1-04	33.1	36.4	–	–	3 · 127.4	B	136 x 192	3.3	B25675A5332J125	4
Rated voltage 600 V AC, 50/60 Hz, delta connection										
MKK600-D-5.3-04	5.3	5.1	6.4	6.2	3 · 15.6	C	75 x 185	1.0	B25675A6052J300	6
MKK600-D-6.2-04	6.2	6.0	7.4	7.1	3 · 18.3	C	75 x 185	1.0	B25675A6062J200	6
MKK600-D-6.9-04	6.9	6.6	8.3	8.0	3 · 20.3	C	75 x 200	1.1	B25675A6062J900	6
MKK600-D-8.3-04	8.3	8.0	10.0	9.6	3 · 24.5	C	75 x 218	1.1	B25675A6082J300	9
MKK600-D-10.4-04	10.4	10.0	12.5	12.0	3 · 30.6	C	85 x 200	1.3	B25675A6102J400	9
MKK600-D-12.5-04	12.5	12.0	15.0	14.4	3 · 36.8	D	100 x 192	1.8	B25675A6122J500	6
MKK600-D-13.9-04	13.9	13.4	16.7	16.1	3 · 41.0	D	100 x 207	1.9	B25675A6132J900	6
MKK600-D-14.6-04	14.6	14.0	17.5	16.8	3 · 43.0	D	100 x 207	1.9	B25675A6142J600	6
MKK600-D-16.7-04	16.7	16.1	20.0	19.2	3 · 49.2	D	100 x 224	2.1	B25675A6162J700	4
MKK600-D-20.0-04	20.0	19.2	24.0	23.1	3 · 58.9	D	116 x 207	2.6	B25675A6202J000	4
MKK600-D-20.8-04	20.8	20.0	25.0	24.1	3 · 61.3	D	116 x 207	2.6	B25675A6202J800	4
MKK600-D-25.0-04	25.0	24.1	30.0	28.9	3 · 73.7	D	125 x 207	3.0	B25675A6252J000	4
MKK600-D-28.0-04	28.0	26.9	–	–	3 · 82.5	D	136 x 192	3.3	B25675A6282J000	4
MKK600-D-30.0-04	30.0	28.9	–	–	3 · 88.4	D	136 x 207	3.6	B25675A6302J000	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Energy PFC Capacitors

Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Resin filled capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 690 V AC, 50/60 Hz, delta connection										
MKK690-D-5.3-04	5.3	4.4	6.4	5.4	3 · 11.8	C	75 x 185	1.0	B25675A6052J390	6
MKK690-D-6.2-04	6.2	5.2	7.4	6.2	3 · 13.8	C	75 x 200	1.1	B25675A6062J290	6
MKK690-D-6.9-04	6.9	5.8	8.3	6.9	3 · 15.4	C	75 x 200	1.1	B25675A6062J990	6
MKK690-D-8.3-04	8.3	6.9	10.0	8.4	3 · 18.5	C	75 x 200	1.1	B25675A6082J390	6
MKK690-D-10.4-04	10.4	8.7	12.5	10.5	3 · 23.2	C	75 x 200	1.1	B25675A6102J490	6
MKK690-D-12.5-04	12.5	10.5	15.0	12.6	3 · 27.9	C	85 x 200	1.3	B25675A6122J590	9
MKK690-D-13.9-04	13.9	11.6	16.7	14.0	3 · 31.0	C	85 x 200	1.3	B25675A6132J990	9
MKK690-D-14.6-04	14.6	12.2	17.5	14.6	3 · 32.5	D	100 x 207	1.9	B25675A6142J690	6
MKK690-D-16.7-04	16.7	14.0	20.0	16.7	3 · 37.2	D	100 x 192	1.8	B25675A6162J790	6
MKK690-D-20.0-04	20.0	16.7	24.0	20.1	3 · 44.6	D	100 x 207	1.9	B25675A6202J090	6
MKK690-D-20.8-04	20.8	17.4	25.0	20.9	3 · 46.3	D	100 x 224	2.1	B25675A6202J890	4
MKK690-D-25.0-04	25.0	20.9	30.0	25.1	3 · 55.7	D	116 x 192	2.4	B25675A6252J090	4
MKK690-D-28.0-04	28.0	23.4	–	–	3 · 62.4	D	116 x 207	2.6	B25675A6282J090	4
MKK690-D-30.0-04	30.0	25.1	–	–	3 · 66.8	D	125 x 192	2.8	B25675A6302J090	4

*Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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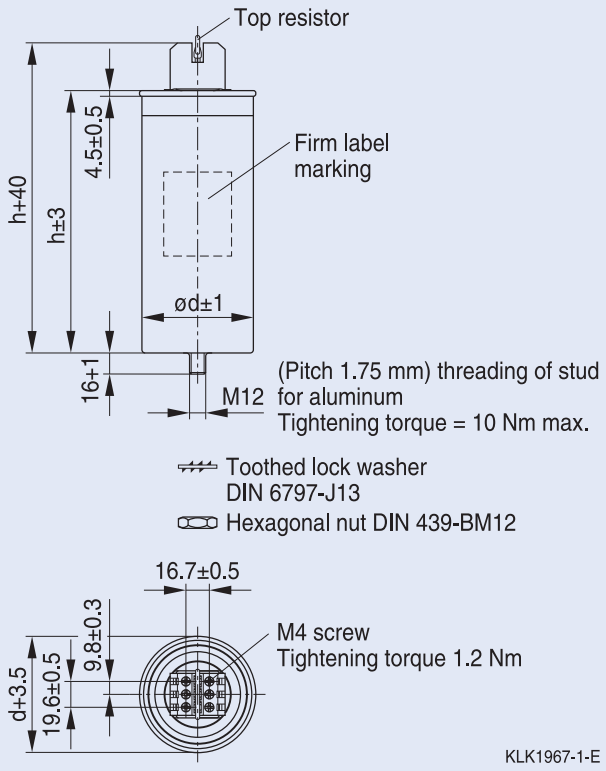
PhaseCap Energy PFC Capacitors

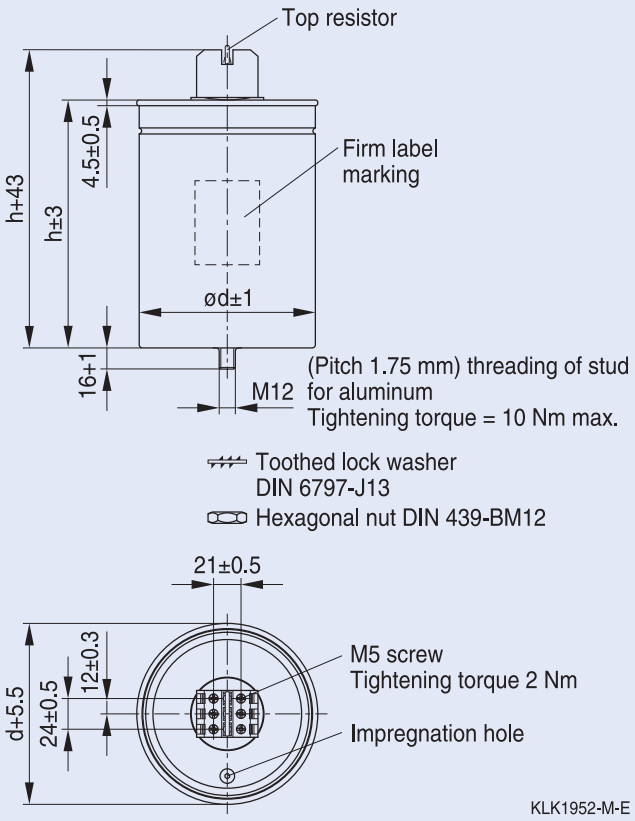
Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Dimensional drawings

Terminal type A



Terminal type B

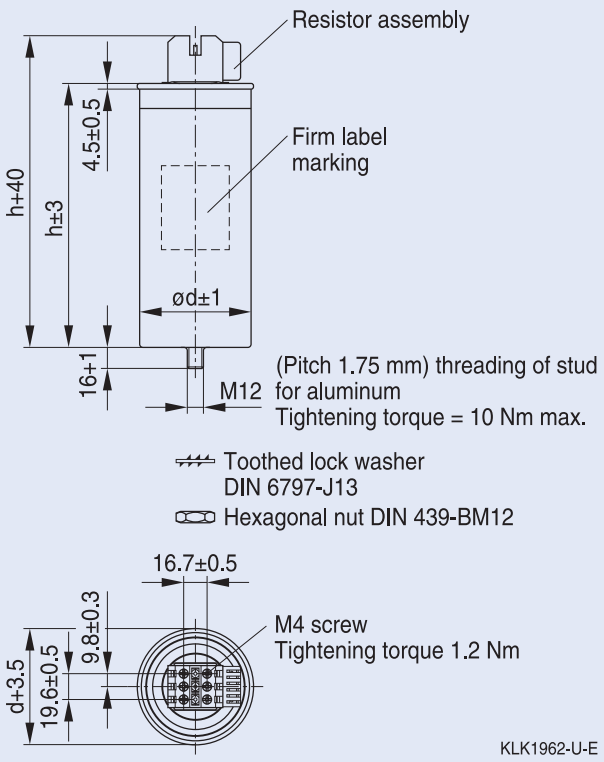


PhaseCap Energy PFC Capacitors

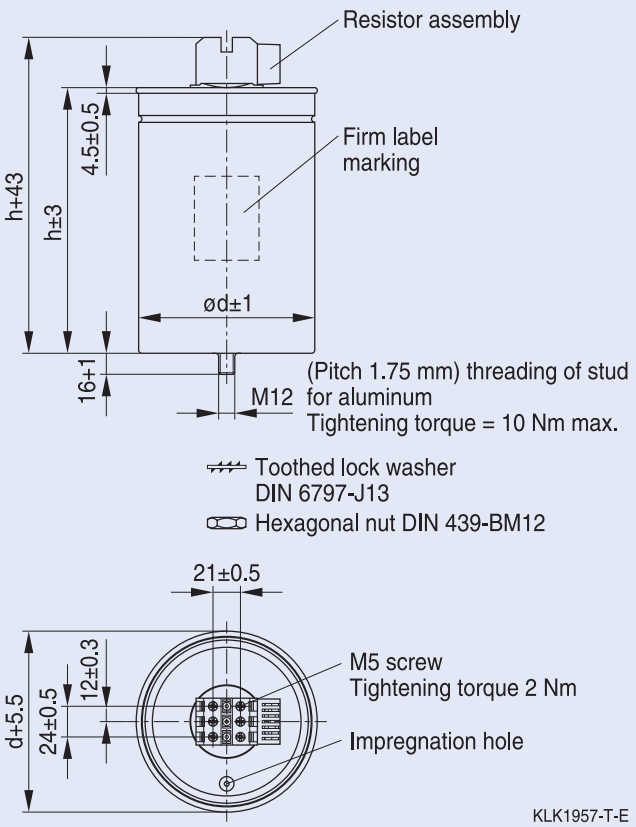
Gas or soft resin impregnated ● Stacked winding ● Wavy cut ● Triple or dual safety system

Dimensional drawings

Terminal type C



Terminal type D



Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

General

PhaseCap capacitors in cylindrical aluminum cases have been designed for power factor correction in low-voltage applications.

Loads like motors and transformers consume active power as well as reactive power.

Generators, supply cables and other electrical distribution equipment, in turn, should be relieved of reactive power.

The MKK (metalized plastic compact) AC series is intended to increase packing density per bank and cut component costs.

Improved thermal response and simplified installation are advantages of the cylindrical aluminum case.

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Tuned and detuned capacitor banks
- Dynamic PFC

Features

- Compact design in cylindrical aluminum can with stud
- Concentric winding
- MKK-technology with wavy cut and heavy edge
- Voltage range 230 V … 800 V
- Output range 5.0 kvar … 33 kvar

Electrical

- Long life expectancy
- High pulse current withstand capability

Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free
- Highest packing density thanks to compact dimensions

Safety

- Self-healing
- Overpressure disconnector
- Shock hazard protected terminals
- Longterm approved
- cUL approval
- Ceramic discharge resistor pre-mounted

Environmental

- Dry design, inert gas
- No oil leakage

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

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Technical data and limit values

Standards IEC 60831-1+2, EN 60831-1+2, UL 810 5th edition		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.6 · I_R including combined effects of harmonics, overvoltages and capacitance tolerance
Inrush current	I_S	up to 300 · I_R
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / +10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_{R1}, AC, 2 s
Test voltage, terminal / case	V_{TC}	up to $V_R \leq$ 660 V: 3000 V AC, 10 s; above V_R = 660 V: 6000 V AC, 10 s
Mean life expectancy	$t_{LD(Co)}$	up to 180 000 h (temp. class –40/C); up to 130 000 h (temp. class –40/D)
Ambient temperature		–40/D; max. temp. +55 °C; max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright / horizontal
Mounting and grounding		threaded M12 stud on bottom of case
Safety		dry technology, overpressure disconnector, self-healing, maximum allowed fault current 10 000 A in accordance with UL 810 standard
Discharge device		ceramic discharge resistor pre-mounted up to 660 V; external discharge module for > 660 V
Case		extruded aluminum can
Enclosure		IP20, indoor mounting (optionally with terminal cap for IP54)
Dielectric		polypropylene film
Impregnation		inert gas, Nitrogen (N_2)
Terminals		optimized capacitor safety terminal with electric shock protection (IP20), (VDE 0106 part 100), max. 25 mm² cable cross-section, max. current 80 A
Certification		cUL file # E238746, GOST
Number of switching operations		max. 7500 switchings per year

* Without discharge resistor

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50 / 60 Hz, delta connection									
MKK230-D-5.0-01	5.0	13	6.0	16	3 · 100	116 x 164	1.3	B25667C3297A375	4
MKK230-D-7.5-01	7.5	19	9.0	23	3 · 150	116 x 164	1.3	B25667C2457A375	4
MKK230-D-10.4-01	10.4	26	12.5	31	3 · 209	116 x 164	1.5	B25667C2627A375	4
MKK230-D-12.5-01[3]	12.5	31	15.0	37	3 · 251	116 x 200	1.7	B25667C2757A375	4
Rated voltage 400 V AC, 50 / 60 Hz, delta connection									
MKK400-D-5.0-01	5.0	7	6.0	9	3 · 32	116 x 164	1.1	B25667C5966A375	4
MKK400-D-7.5-01	7.5	11	9.0	13	3 · 50	116 x 164	1.2	B25667C3147A375	4
MKK400-D-10.0-01	10.0	14	12.0	17	3 · 64	116 x 164	1.2	B25667C4197A375	4
MKK400-D-12.5-01	12.5	18	15.0	22	3 · 83	116 x 164	1.1	B25667C3247A375	4
MKK400-D-15.0-01	15.0	22	18.0	26	3 · 100	116 x 164	1.3	B25667C3297A375	4
MKK400-D-20.0-01	20.0	30	24.0	36	3 · 133	116 x 164	1.5	B25667C3397A375	4
MKK400-D-25.0-01	25.0	36	–	–	3 · 165	116 x 200	1.8	B25667C3497A375	4
Rated voltage 415 V AC, 50 / 60 Hz, delta connection									
MKK415-D-5.0-01	5.0	7	6.0	8	3 · 32	116 x 164	1.1	B25667C5966A375	4
MKK415-D-6.2-01	6.2	8	7.5	10	3 · 39	116 x 164	1.2	B25667C5127A375	4
MKK415-D-10.4-01	10.4	15	12.5	17	3 · 64	116 x 164	1.2	B25667C4197A375	4
MKK415-D-12.5-01	12.5	17	15.0	21	3 · 77	116 x 164	1.3	B25667C4237A375	4
MKK415-D-15.0-01	15.0	21	18.0	25	3 · 93	116 x 164	1.4	B25667C4287A375	4
MKK415-D-16.7-01	16.7	23	20.0	28	3 · 103	116 x 164	1.5	B25667C4307A375	4
MKK415-D-20.0-01	20.8	29	25.0[2]	35[2]	3 · 128	116 x 200	1.7	B25667C4387A375	4
MKK415-D-25.0-01	25.0	35	–	–	3 · 154	136 x 200	2.1	B25667C4467A375	4
Rated voltage 440 V AC, 50 / 60 Hz, delta connection									
MKK440-D-5.0-01	5.0	7	6.0	8	3 · 27	116 x 164	1.2	B25667C4826A375	4
MKK440-D-7.5-01	7.5	10	9.0	12	3 · 41	116 x 164	1.2	B25667C4127A375	4
MKK440-D-10.4-01	10.4	14	12.5	16	3 · 57	116 x 164	1.3	B25667C4177A375	4
MKK440-D-12.5-01	12.5	16	15.0	20	3 · 69	116 x 164	1.4	B25667C4207A375	4
MKK440-D-14.2-01	14.2	19	17.0	22	3 · 77	116 x 164	1.3	B25667C4237A375	4
MKK440-D-15.0-01	15.0	20	18.0	24	3 · 83	116 x 164	1.4	B25667C4247A375	4
MKK440-D-16.7-01	16.7	22	20.0	26	3 · 92	116 x 200	1.8	B25667C4277A375	4
MKK440-D-18.8-01	18.8	25	22.6	30	3 · 103	116 x 164	1.5	B25667C4307A375	4
MKK440-D-20.0-01	20.0	26	24.0	31	3 · 111	116 x 200	1.7	B25667C4337A375	4
MKK440-D-25.0-01	25.0	33	30.0	39	3 · 137	136 x 200	2.0	B25667C4417A375	4
MKK440-D-28.1-01[3]	28.1	37	–	–	3 · 154	136 x 200	2.1	B25667C4467A375	4
MKK440-D-30.0-01[3]	30.0[1]	39[1]	–	–	3 · 164	136 x 200	2.4	B25667C4497A375	4
MKK440-D-33.0-01[3]	33.0[1]	43[1]	–	–	3 · 181	136 x 200	2.5	B25667C4547A375	4

Types for voltages 220 V, 240 V, 600 V, 660 V and other kvar-outputs are available upon request.

[1] Temperature class deviation –40/C max. +50 °C
[2] Temperature class deviation –40/B max. +45 °C
[3] Discharge time ≤ 75 V in 90 s
* Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

EPCOS

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 480 V AC, 50 / 60 Hz, delta connection									
MKK480-D-6.25-01	6.25	8	7.5	9	3 · 29	116 x 164	1.2	B25667C4866A375	4
MKK480-D-8.3-01	8.3	10	10.0	12	3 · 39	116 x 164	1.2	B25667C5127A375	4
MKK480-D-10.4-01	10.4	12	12.5	14	3 · 48	116 x 164	1.3	B25667C5147A375	4
MKK480-D-12.5-01	12.5	15	15.0	18	3 · 58	116 x 164	1.5	B25667C5177A375	4
MKK480-D-15.0-01	15.0	18	18.0	22	3 · 69	116 x 164	1.4	B25667C4207A375	4
MKK480-D-16.7-01	16.7	20	20.0	24	3 · 77	116 x 200	1.8	B25667C5237A375	4
MKK480-D-20.0-01	20.0	24	24.0	29	3 · 92	116 x 200	1.8	B25667C4277A375	4
MKK480-D-25.0-01	25.0	30	30.0	36	3 · 115	136 x 200	2.2	B25667C4347A375	4
MKK480-D-30.0-01[2]	30.0[1]	36[1]	–	–	3 · 138	136 x 200	2.4	B25667C4417A365	4
Rated voltage 525 V AC, 50 / 60 Hz, delta connection									
MKK525-D-8.3-01	8.3	9	10.0	11	3 · 32	116 x 164	1.1	B25667C5966A375	4
MKK525-D-10.0-01	10.0	11	12.0	13	3 · 39	116 x 164	1.2	B25667C5127A375	4
MKK525-D-12.5-01	12.5	14	15.0	17	3 · 48	116 x 164	1.3	B25667C5147A375	4
MKK525-D-15.0-01	15.0	17	18.0	20	3 · 58	116 x 164	1.5	B25667C5177A375	4
MKK525-D-16.7-01	16.7	18	20.0	21	3 · 64	116 x 164	1.6	B25667C5197A375	4
MKK525-D-20.0-01	20.0	22	24.0	26	3 · 77	116 x 200	1.8	B25667C5237A375	4
MKK525-D-25.0-01	25.0	28	30.0	33	3 · 96	136 x 200	2.3	B25667C5287A375	4
MKK525-D-30.0-01[2]	30.0[1]	33[1]	–	–	3 · 115	136 x 200	2.4	B25667C5347A375	4
Rated voltage 570 V AC, 50 / 60 Hz, delta connection									
MKK570-D-27.5-01	27.5	27	33	32.4	3 · 90	136 x 200	2.5	B25667C5277A375	4
Rated voltage 690 V AC, 50 / 60 Hz, delta connection									
MKK690-D-5.0-01	5.0	4.2	6	5.0	3 · 11	116 x 164	1.3	B25667C6336A375	4
MKK690-D-10.0-01	10.0	8.4	12	10.1	3 · 23	116 x 164	1.4	B25667C6676A375	4
MKK690-D-12.5-01	12.5	10.5	15	12.6	3 · 28	116 x 164	1.5	B25667C6836A375	4
MKK690-D-15.0-01	15.0	12.6	18	15.1	3 · 34	116 x 164	1.5	B25667C6107A375	4
MKK690-D-20.8-01	20.8	17.5	25	21.0	3 · 47	136 x 200	2.0	B25667C6137A375	4
MKK690-D-25.0-01	25.0	21.0	30	25.1	3 · 56	136 x 200	2.2	B25667C6167A375	4
Rated voltage 765 V AC, 50 / 60 Hz, delta connection									
MKK765-D-30.0-01	30	23	36	28	3 · 55	136 x 200	2.4	B25667C7167A375	4
Rated voltage 800 V AC, 50 / 60 Hz, delta connection									
MKK800-D-5.0-01	5.0	3.6	6	4.3	3 · 8	116 x 164	1.2	B25667C7246A375	4
MKK800-D-7.5-01	7.5	5.4	9.0	6.5	3 · 12.4	121 x 164	1.2	B25667C7376A375	4
MKK800-D-10.0-01	10.0	7.2	12	8.7	3 · 17	116 x 164	1.3	B25667C7496A375	4
MKK800-D-12.5-01	12.5	9.0	15	11.0	3 · 21	116 x 164	1.4	B25667C7626A375	4
MKK800-D-15.0-01	15.0	11.0	18	13.0	3 · 25	116 x 164	1.5	B25667C7746A375	4
MKK800-D-20.0-01	20.0	14.5	24	17.3	3 · 33	136 x 200	2.0	B25667C7996A375	4
MKK800-D-25.0-01	25.0	18.0	30	22.0	3 · 41	136 x 200	2.3	B25667C7127A375	4
MKK800-D-28.0-01	28.0	20.0	33	24.0	3 · 46	136 x 200	2.4	B25667C7137A375	4

Types for voltages 220 V, 240 V, 600 V, 660 V and other kvar-outputs are available upon request.

[1] Temperature class deviation –40/C max. +50 °C
[2] Temperature class deviation –40/B max. +45 °C
[3] Discharge time ≤ 75 V in 90 s
* Packing units for capacitors equal minimum order quantity.
Orders will be rounded up to packing unit or multiple thereof.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

Single-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50 / 60 Hz									
MKK230-I-5.0-01	5.2	23	6.2	28	313	116 x 164	1.1	B25667C2317A175	4
MKK230-I-6.6-01	6.6	29	7.9	34	397	116 x 164	1.4	B25667C2397A175	4
MKK230-I-7.5-01	7.5	33	9.0	40	457	116 x 164	1.3	B25667C2457A175	4
MKK230-I-8.3-01	8.3	36	10.0	43	502	116 x 164	1.3	B25667C2507A175	4
MKK230-I-9.1-01[1)]	9.1	38	–	–	548	116 x 164	1.4	B25667C2557A175	4
Rated voltage 400 V AC, 50 / 60 Hz									
MKK400-I-10.4-01	10.4	26	12.5	31	207	116 x 164	1.2	B25667C3207A175	4
MKK400-I-12.5-01	12.5	31	15.0	37	249	116 x 164	1.3	B25667C3247A175	4
Rated voltage 440 V AC, 50 / 60 Hz									
MKK440-I-6.9-01	6.9	16	8.3	19	116	116 x 164	1.3	B25667C5117A175	4
MKK440-I-8.3-01	8.3	19	10.0	23	144	116 x 164	1.5	B25667C5147A175	4
Rated voltage 525 V AC, 50 / 60 Hz									
MKK525-I-10.0-01	10.0	19	12.0	23	116	116 x 164	1.3	B25667C5117A175	4
MKK525-I-12.5-01	12.5	24	15.0	29	144	116 x 164	1.5	B25667C5147A175	4
MKK525-I-15.0-01[1)]	15.0	29	18.0	35	173	116 x 200	1.7	B25667C5177A175	4
MKK525-I-18.6-01[1)]	18.6	36	22.3	43	215	136 x 200	2.0	B25667C5217A175	4

Plastic protective terminal cover[2)]

Capacitor d x h	For cable gland	Cable diameter outside	Dimensions Ø d_1	Ø d_2	Ordering code
mm		mm	mm	mm	
116 x 164	PG 13.5	9–13	116	125	B44066K0135A000
116 x 200	PG 16	10–14	116	125	B44066K0160A000
136 x 200	PG 21	14–18	137	145	B44066K0210A000

Types for voltages 220 V, 240 V, 600 V, 660 V and other kvar-outputs are available upon request.

[1)] Discharge time ≤ 75 V in 90 s
[2)] Note: The new terminal covers can be used for B25667B series; the formerly available terminal covers do not fit for the B25667C series
* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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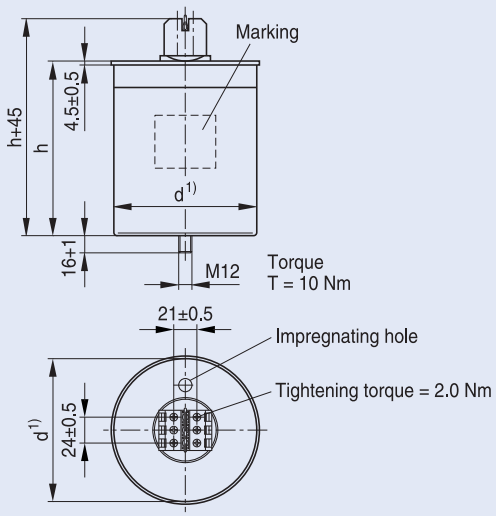
Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Premium PFC Capacitors

Gas-impregnated ● Dry type ● Concentric winding ● Wavy cut ● Triple safety system

Dimensional drawings

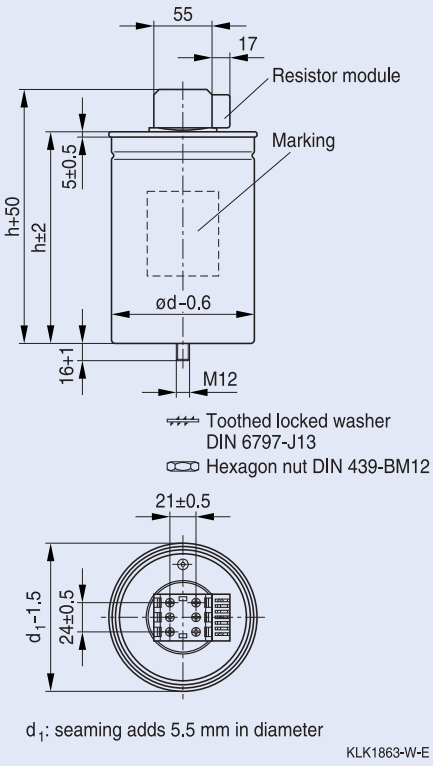
Capacitor up to 660 V AC



1) Seaming adds 5.5 mm in diameter

KLK1841-1-E

Capacitor > 660 V AC



d_1: seaming adds 5.5 mm in diameter

KLK1863-W-E

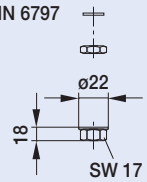
Mounting / Protective cover for terminal

Toothed washer J 12.5 DIN 6797

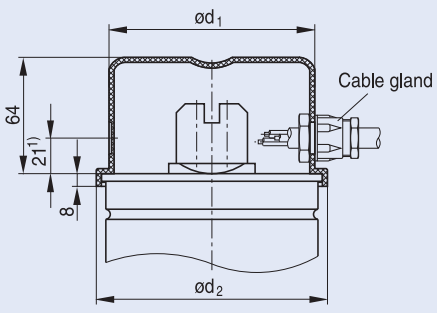
Hex nut BM12 DIN 439

or

nut C61010-A415-C15



KLK1394-V



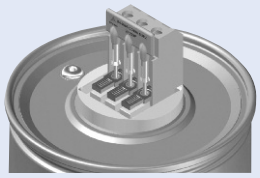
1) Perforation for second cable gland

KLK1837-8-E

Protective terminal cover IP54

Ceramic discharge resistors

Pre-mounted for series B25667, B25673 and B32344; available as spare parts upon request



Please read *Important notes* on page 12 and *Cautions* on page 121–125.

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PhaseCap Compact PFC Capacitors

Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

General

The PhaseCap Compact PFC capacitor is based on the EPCOS MKK technology known for many years from the successful PhaseCap series with its unique concentric windings. Based on years of experience in PFC and millions of sold capacitors, EPCOS presents the next step in PFC capacitor evolution.

Using polypropylene as dielectric and semi-dry biodegradable resin as impregnation agent, the PhaseCap Compact offers higher inrush current capability (up to 400 · I_R) and over current capability (up to 2.0 · I_R) even compared to PhaseCap. With an output of up to 33 kvar at very small height it meets the dimensional requirements of panel builders. Its new enhanced terminals permit the connection of a broader variety of cables and cable sizes. Depending on the operating conditions PhaseCap Compact provides a life expectancy of up to 200 000 hours, more than any other capacitor in the EPCOS PFC capacitor portfolio.

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Tuned and detuned capacitor banks
- Dynamic PFC

Features

- Compact design in cylindrical aluminum can with stud
- Concentric winding (S-types with stacked winding)
- MKK-technology with wavy cut and heavy edge
- Voltage range: 230 … 1000 V
- Output range: 5.0 … 33.0 kvar

Electrical features

- Very high life expectancy
- High inrush current capability (up to 400 · I_R)
- High overcurrent capability (up to 2.0 · I_R)

Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free
- Compact dimensions
- Mounting position upright/ horizontal

Safety

- Self healing
- Overpressure disconnector
- Shock hazard protected terminals
- Pre-mounted ceramic discharge resistor

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Compact PFC Capacitors

Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

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Technical data and limit values

Standards IEC 60831-1+2, EN 60831-1+2, UL 810 5th edition		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.6 … 2.0 · I_R (including combined effects of harmonics, overvoltages and capacitance tolerance) depending on the individual type
Inrush current	I_S	up to 400 · I_R
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / +10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_{R1}, AC, 2 s
Test voltage, terminal / case	V_{TC}	up to $V_R \leq$ 660 V: 3000 V AC, 10 s; above V_R = 660 V: 6000 V AC, 10 s
Mean life expectancy	$t_{LD(Co)}$	up to 200 000 h (temperature class –40/C) up to 150 000 h (temperature class –40/60)
Ambient temperature		Temperature class –40/60: Max. short time +60 °C, max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C Temperature class –40/C: Max. short time +50 °C, max. mean 24 h = +40 °C; max. mean 1 year = +30 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright / horizontal
Mounting and grounding		threaded bolt M12
Safety		self-healing, overpressure disconnector
Discharge device		ceramic discharge resistor pre-mounted up to 690 V; external discharge module for > 690 V; discharge time ≤ 75 V or less in 60 s; types marked with[1)] ≤ 75 V or less in 90 s
Case		extruded aluminum can with stud
Enclosure		IP20, indoor mounting (optionally with terminal cap for IP54)
Dielectric		polypropylene film
Impregnation		semi-dry biodegradable resin
Terminals		optimized capacitor safety terminal with electric shock protection (IP20), (VDE 0106 part 100), for current and connection cable details and the terminal type – capacitor type association please refer to terminal drawings and capacitor type list
Certification		cUL file #E238746 / GOST
Number of switching operations		max. 10 000 switchings operations per year

* Without discharge resistor

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Compact PFC Capacitors

Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 230 V AC, 50/60 Hz, delta connection										
MKK230-D-5.0-02	5.0	13.0	6.0	15.0	3 · 100	A	85 x 200	1.2	B25673A2052A040	4
MKK230-D-7.5-02	7.5	19.0	9.0	23.0	3 · 150	B	100 x 200	1.7	B25673A2072A540	4
MKK230-D-10.0-02	10.0	25.0	12.0	30.0	3 · 201	B	116 x 200	2.2	B25673A2102A040	4
MKK230-D-12.5-02[1]	12.5	31.0	15.0	38.0	3 · 251	B	116 x 200	2.2	B25673A2122A540	4
Rated voltage 400 V AC, 50/60 Hz, delta connection										
MKK400-D-5.0-02	5.0	7.0	6.0	9.0	3 · 33	A	85 x 125	0.7	B25673A4052A000	9
MKK400-D-7.5-02	7.5	11.0	9.0	13.0	3 · 50	A	85 x 162	1.0	B25673A4072A500	9
MKK400-D-10.0-02	10.0	14.0	12.0	17.0	3 · 66	A	85 x 162	1.0	B25673A4102A000	9
MKK400-D-12.5-02	12.5	18.0	15.0	22.0	3 · 83	B	100 x 162	1.4	B25673A4122A500	4
MKK400-D-15.0-02	15.0	22.0	18.0	26.0	3 · 99	B	100 x 162	1.4	B25673A4152A000	4
MKK400-D-20.0-02	20.0	29.0	24.0	35.0	3 · 133	B	100 x 200	1.7	B25673A4201A000	4
MKK400-D-25.0-02	25.0	36.0	30.0	43.0	3 · 166	B	116 x 200	2.2	B25673A4252A000	4
Rated voltage 415 V AC, 50/60 Hz, delta connection										
MKK415-D-5.0-02	5.0	7.0	6.0	8.0	3 · 31	A	85 x 125	0.7	B25673A4052A010	9
MKK415-D-6.2-02	6.2	9.0	7.4	10.0	3 · 38	A	85 x 162	1.0	B25673A4062A010	9
MKK415-D-10.4-02	10.4	15.0	12.5	17.0	3 · 64	B	100 x 162	1.4	B25673A4102A010	4
MKK415-D-12.5-02	12.5	18.0	15.0	21.0	3 · 77	B	100 x 200	1.7	B25673A4122A510	4
MKK415-D-15.0-02	15.0	21.0	18.0	25.0	3 · 93	B	100 x 200	1.7	B25673A4152A010	4
MKK415-D-20.0-02	20.8	29.0	25.0	35.0	3 · 128	B	116 x 200	2.2	B25673A4202A810	4
MKK415-D-25.0-02	25.0	35.0	–	–	3 · 154	B	136 x 200	3.2	B25673A4282A140	4
MKK415-D-25.0-02A[2]	25.0	35.0	–	–	3 · 154	B	116 x 224	2.7	B25673S4282A140	4
Rated voltage 440 V AC, 50/60 Hz, delta connection										
MKK440-D-5.0-02	5.0	7.0	6.0	8.0	3 · 27	A	85 x 125	0.7	B25673A4052A040	9
MKK440-D-7.5-02	7.5	10.0	9.0	12.0	3 · 41	A	85 x 162	1.0	B25673A4072A540	9
MKK440-D-10.4-02	10.4	14.0	12.5	16.0	3 · 57	B	100 x 162	1.4	B25673A4102A040	4
MKK440-D-12.5-02	12.5	16.0	15.0	20.0	3 · 69	B	100 x 162	1.4	B25673A4122A540	4
MKK440-D-15.0-02	15.0	20.0	18.0	24.0	3 · 82	B	100 x 200	1.7	B25673A4152A040	4
MKK440-D-20.0-02	20.0	26.0	24.0	31.0	3 · 110	B	116 x 200	2.2	B25673A4202A040	4
MKK440-D-25.0-02	25.0	33.0	30.0	39.0	3 · 137	B	116 x 200	2.2	B25673A4252A040	4
MKK440-D-28.1-02[1]	28.1	37.0	–	–	3 · 154	B	136 x 200	3.2	B25673A4282A140	4
MKK440-D-28.1-02A[1) 2)]	28.1	37.0	–	–	3 · 154	B	116 x 224	2.7	B25673S4282A140	4
MKK440-D-30.0-02[1]	30.0	39.0	–	–	3 · 164	B	136 x 200	3.2	B25673A4302A040	4
MKK440-D-30.0-02A[1) 2)]	30.0	39.0	–	–	3 · 164	B	116 x 224	2.7	B25673S4302A040	4
MKK440-D-33.0-02[1]	33.0	43.0	–	–	3 · 181	B	136 x 200	3.2	B25673A4332A040	4
MKK440-D-33.0-02A[1) 2)]	33.0	43.0	–	–	3 · 181	B	116 x 248	3.0	B25673S4332A040	4

* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

[1] Discharge time ≤ 75 V in 90 s
[2] Stacked winding

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Compact PFC Capacitors

Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 480 V AC, 50/60 Hz, delta connection										
MKK480-D-6.3-02	6.3	8.0	7.6	9.0	3 · 29	A	85 x 162	1.0	B25673A4062A380	9
MKK480-D-8.3-02	8.3	11.0	10.0	12.0	3 · 38	B	100 x 162	1.4	B25673A5102A020	4
MKK480-D-10.0-02	10.4	14.0	12.0	15.0	3 · 48	B	100 x 200	1.7	B25673A5122A520	4
MKK480-D-12.5-02	12.5	15.0	15.0	18.0	3 · 58	B	100 x 200	1.7	B25673A4122A580	4
MKK480-D-15.0-02	15.0	18.0	18.0	22.0	3 · 69	B	100 x 200	1.7	B25673A4152A080	4
MKK480-D-20.0-02	20.0	24.0	24.0	29.0	3 · 92	B	116 x 200	2.2	B25673A4202A080	4
MKK480-D-25.0-02	25.0	30.0	30.0	36.0	3 · 115	B	136 x 200	3.2	B25673A4252A080	4
MKK480-D-25.0-02A[2]	25.0	30.0	30.0	36.0	3 · 115	B	116 x 224	2.7	B25673S4252A080	4
MKK480-D-28.0-02[1]	28.0	34.0	–	–	3 · 129	B	136 x 200	3.2	B25673A4282A080	4
MKK480-D-28.0-02A[1,2]	28.0	34.0	–	–	3 · 129	B	116 x 248	3.0	B25673S4282A080	4
MKK480-D-30.0-02[1]	30.0	36.0	–	–	3 · 138	B	136 x 200	3.2	B25673A4302A080	4
MKK480-D-30.0-02A[1,2]	30.0	36.0	–	–	3 · 138	B	116 x 248	3.0	B25673S4302A080	4
MKK480-D-33.0-02	33.0	40.0	–	–	3 · 154	B	136 x 200	3.2	B25673A4332A080	4
Rated voltage 525 V AC, 50/60 Hz, delta connection										
MKK525-D-8.3-02	8.3	9.0	10.0	11.0	3 · 32	B	100 x 162	1.4	B25673A5082A320	4
MKK525-D-10.0-02	10.0	11.0	12.0	13.0	3 · 38	B	100 x 162	1.4	B25673A5102A020	4
MKK525-D-12.5-02	12.5	14.0	15.0	16.0	3 · 48	B	100 x 200	1.7	B25673A5122A520	4
MKK525-D-15.0-02	15.0	16.0	18.0	20.0	3 · 58	B	100 x 200	1.7	B25673A5152A020	4
MKK525-D-16.7-02	16.7	18.0	20.0	22.0	3 · 64	B	116 x 200	2.2	B25673A5162A720	4
MKK525-D-20.0-02	20.0	22.0	24.0	26.0	3 · 77	B	116 x 200	2.2	B25673A5202A020	4
MKK525-D-25.0-02[1]	25.0	28.0	30.0[2]	–	3 · 96	B	136 x 200	3.2	B25673A5252A020	4
MKK525-D-25.0-02A[1,2]	25.0	28.0	30.0	33.0	3 · 96	B	116 x 224	2.7	B25673S5252A020	4
MKK525-D-30.0-02[1]	30.0	33.0	–	–	3 · 115	B	136 x 200	3.2	B25673A5302A020	4
MKK525-D-30.0-02A[1,2]	30.0	33.0	–	–	3 · 115	B	116 x 248	3.0	B25673S5302A020	4

* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

[1] Discharge time ≤ 75 V in 90 s
[2] Stacked winding
[3] Temperature class deviation –40/B max. +45 °C

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap Compact PFC Capacitors

Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	Terminal type	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF		mm	kg		
Rated voltage 690 V AC, 50/60 Hz, delta connection										
MKK690-D-5-02	5.0	4.2	6.0	5.0	3 · 11.2	C	116 x 164	2.1	B25673A6052A090	4
MKK690-D-7.5-02	7.5	6.3	9.0	7.5	3 · 16.7	C	116 x 164	2.1	B25673A6072A590	4
MKK690-D-10-02	10.0	8.4	12.0	10.1	3 · 22.5	C	116 x 164	2.1	B25673A6102A090	4
MKK690-D-12.5-02	12.5	10.5	15.0	12.6	3 · 27.9	C	116 x 164	2.1	B25673A6122A590	4
MKK690-D-15-02	15.0	12.6	18.0	15.1	3 · 33.5	C	116 x 164	2.2	B25673A6152A090	4
MKK690-D-20.8-02	20.8	17.4	25.0	20.9	3 · 46.5	C	136 x 200	3.2	B25673A6202A890	4
MKK690-D-25-02	25.0	20.9	30.0	25.1	3 · 55.7	C	136 x 200	3.2	B25673A6252A090	4
Rated voltage 800 V AC, 50/60 Hz, delta connection										
MKK800-D-5-02	5.0	3.6	6.0	4.3	3 · 8.3	C	116 x 164	2.1	B25673A8052A000	4
MKK800-D-7.5-02	7.5	5.4	9.0	6.5	3 · 12.4	C	116 x 164	2.1	B25673A8072A500	4
MKK800-D-10-02	10.0	7.2	12.0	8.7	3 · 16.6	C	116 x 164	2.1	B25673A8102A000	4
MKK800-D-12.5-02	12.5	9.0	15.0	10.8	3 · 20.7	C	116 x 164	2.1	B25673A8122A500	4
MKK800-D-15-02	15.0	10.8	18.0	13.0	3 · 24.9	C	116 x 164	2.1	B25673A8152A000	4
MKK800-D-20-02	20.0	15.0	25.0	18.0	3 · 33.2	C	136 x 200	3.2	B25673A8202A000	4
MKK800-D-25-02	25.0	18.0	30.0	21.7	3 · 41.4	C	136 x 200	3.2	B25673A8252A000	4
MKK800-D-28-02	28.0	20.2	33.6	24.2	3 · 46.4	C	136 x 200	3.2	B25673A8282A000	4
Rated voltage 900 V AC, 50/60 Hz, delta connection										
MKK900-D-10.4-02	10.4	6.7	12.5	8.0	3 · 13.6	C	116 x 164	2.0	B25673A9102A400	4
MKK900-D-12.5-02	12.5	8.0	15.0	9.6	3 · 16.4	C	116 x 164	2.0	B25673A9122A500	4
MKK900-D-15-02	15.0	9.6	18.0	11.5	3 · 19.7	C	116 x 200	2.4	B25673A9152A000	4
MKK900-D-20-02	20.0	12.8	24.0	15.4	3 · 26.2	C	136 x 200	3.1	B25673A9202A000	4
MKK900-D-25-02	25.0	16.0	30.0	19.4	3 · 32.7	C	136 x 200	3.1	B25673A9252A000	4
Rated voltage 1000 V AC, 50/60 Hz, delta connection										
MKK1000-D-10.4-02	10.4	6.0	12.5	7.2	3 · 11.0	C	116 x 164	2.0	B25673A0102A400	4
MKK1000-D-12.5-02	12.5	7.2	15.0	8.7	3 · 13.3	C	116 x 164	2.0	B25673A0122A500	4
MKK1000-D-15-02	15.0	8.7	18.0	10.4	3 · 15.9	C	116 x 200	2.4	B25673A0152A000	4
MKK1000-D-20-02	20.0	11.6	24.0	13.9	3 · 21.2	C	136 x 200	3.1	B25673A0202A000	4
MKK1000-D-25-02	25.0	14.4	30.0	17.3	3 · 26.5	C	136 x 200	3.1	B25673A0252A000	4

Plastic protective terminal cover[1)]

Capacitor d x h	For cable gland	Cable diameter outside	Dimensions Ø d_1	Ø d_2	Ordering code
mm		mm	mm	mm	
116 x 164	PG 13.5	9–13	116	125	B44066K0135A000
116 x 200	PG 16	10–14	116	125	B44066K0160A000
136 x 200	PG 21	14–18	137	145	B44066K0210A000

[1)] Note: The new terminal covers can be used for B25667B series; the formerly available terminal covers do not fit for the B25667C series

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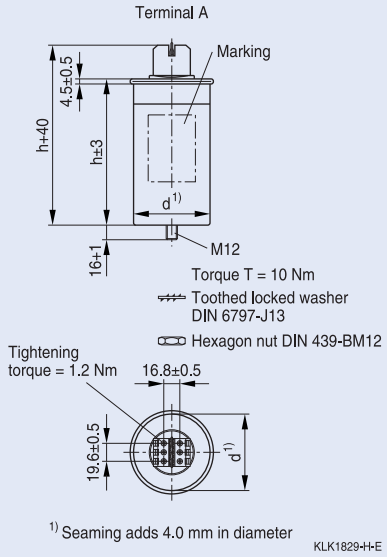
Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap Compact PFC Capacitors

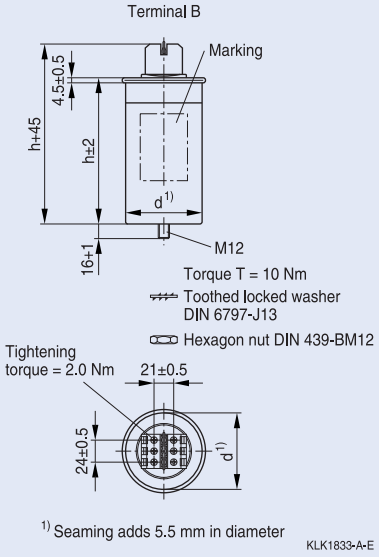
Semi-dry biodegradable resin ● Concentric winding ● Wavy cut ● Dual safety system

Dimensional drawings

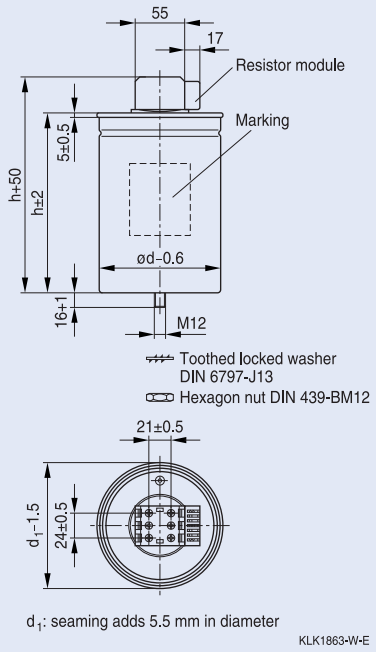
Terminal type A, current up to 50 A
Terminal cross section 16 mm² (without cable end lug)



Terminal type B, current up to 80 A
Terminal cross section 25 mm² (without cable end lug)



Terminal type C, up to 80 A (discharge module)
Terminal cross section 25 mm² (without cable end lug)



Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap HD PFC Capacitors

High density type ● Up to 60 kvar ● Gas-impregnated ● Wavy cut ● Triple safety system

General

The PhaseCap HD series is a follow-on development of the MKK AC series, covering the power range above 40 through 60 kvar with just one capacitor in a cylindrical aluminum case.

The PhaseCap HD is especially intended for industrial applications with demands for long life, constant capacitance and high inrush current withstand capability up to 300 · I_R.

Such applications require typical power steps of 25 or 50 kvar switched by a PFC controller via each capacitor contactor.

This MKK AC series was developed to increase packing density per bank and cut component costs.

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Tuned and detuned capacitor banks
- Dynamic PFC
- PFC systems with space constraints

Features

- Compact design in cylindrical aluminum can with stud
- Stacked winding
- MKK-technology with wavy cut and heavy edge
- Voltage range 400 V … 525 V
- Output range 40 kvar (50 Hz) … 60 kvar (60 Hz)

Electrical

- Low losses
- High pulse current withstand capability (up to 300 · I_R)

Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free

Safety

- Self-healing
- Overpressure disconnector
- Shock hazard protected terminals
- Long-term approved
- Pre-mounted discharge resistor module

Environmental

- Dry design, inert gas
- No oil leakage

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PhaseCap HD PFC Capacitors

High density type ● Up to 60 kvar ● Gas-impregnated ● Wavy cut ● Triple safety system

EPCOS

Technical data and limit values

Standards IEC 60831-1+2, EN 60831-1+2, UL 810 5th edition		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.5 · I_R including combined effects of harmonics, overvoltages and capacitance tolerance
Inrush current	I_S	up to 300 · I_R
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / +10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_{R1}, AC, 2 s
Test voltage, terminal / case	V_{TC}	up to $V_R \leq$ 660 V: 3000 V AC, 10 s
Mean life expectancy	$t_{LD(Co)}$	up to 180 000 h (temperature class –40/C) up to 130 000 h (temperature class –40/D)
Ambient temperature		–40/D; max. temp. +55 °C; max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright
Mounting and grounding		threaded M12 stud on bottom of case
Safety		dry technology, overpressure disconnector, self-healing, maximum allowed fault current 10 000 A in accordance with UL 810 standard
Discharge device		pre-mounted discharge module
Case		extruded aluminum can
Enclosure		IP20, indoor mounting
Dielectric		polypropylene film
Impregnation		inert gas, Nitrogen (N_2)
Terminals		optimized capacitor safety terminal with electric shock protection (IP20), (VDE 0106 part 100), max. 35 mm² cable cross section, max. current 130 A
Number of switching operations		max. 5000 switchings per year according to IEC 60831-1+/2

* Without discharge resistor

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PhaseCap HD PFC Capacitors

High density type ● Up to 60 kvar ● Gas-impregnated ● Wavy cut ● Triple safety system

Three-phase capacitors

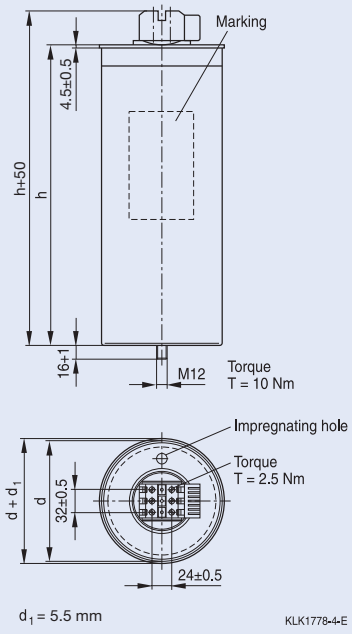
Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit[2]
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 400 V AC, 50 / 60 Hz, delta connection									
MKK400-D-40.0-21	40.0	58	48.0	69	3 · 265	136 x 317	4.4	B25669A3796J375	2
MKK400-D-50.0-21	50.0	72	60.0[1]	87[1]	3 · 332	136 x 355	4.7	B25669A3996J375	2
(Suitable also for 415 V with 7.6% higher output)									
Rated voltage 440 V AC, 50 / 60 Hz, delta connection									
MKK440-D-40.0-21	40.0	52	48.0	63	3 · 219	136 x 317	4.4	B25669A4657J375	2
MKK440-D-50.0-21	50.0	66	60.0[1]	79[1]	3 · 274	136 x 355	4.7	B25669A4827J375	2
MKK440-D-56.0-21	56.0	74	–	–	3 · 307	136 x 355	4.7	B25669B4927J375	2
Rated voltage 525 V AC, 50 / 60 Hz, delta connection									
MKK525-D-40.0-21	40.0	44	48.0	53	3 · 154	136 x 355	4.7	B25669A5467J375	2

Customized products available upon request.

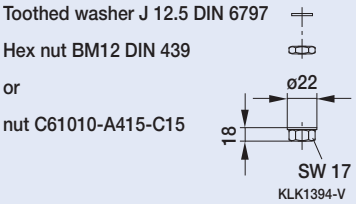
[1] Temperature class deviation –40/B max. +45 °C
[2] Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

Dimensional drawings

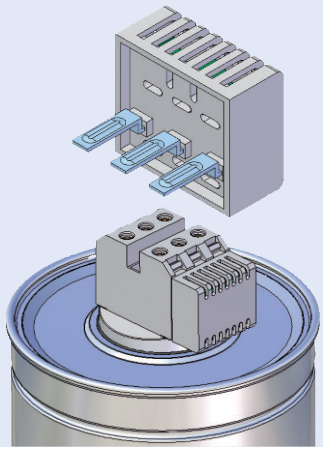
Capacitor



Mounting



Discharge resistor



DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

General

Based on the well-proven MKP technology with stacked windings, DeltaCap capacitors are especially developed for LV-PFC applications in industrial installations. The cost-effective design offers abroad output range from 0.5 to 33.0 kvar. The voltage range covers 230 to 525 V.

Applications

- Power Factor Correction
- Automatic capacitor banks
- Fixed PFC applications, e.g. motor compensation
- AC power electronics
- Tuned and detuned PFC systems

Features

- Compact design in cylindrical aluminum can with stud
- MKD technology with stacked windings
- Output range 0.5 … 33 kvar
- Voltage range 230 … 525 V

Safety

- Self-healing technology
- Overpressure disconnector
- Isolated terminal (IP20) for B32301 and B32304 series

Electrical

- Up to 33 kvar per capacitor for three-phase applications
- Long life expectancy up to 150 000 hours (at temperature class –40/C)
- High inrush current withstand ability (up to 200 · I_R)

Mechanical and maintenance

- Reduced mounting costs, easy installation and connection
- Low weight and compact volume
- Maintenance-free

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

EPCOS

Technical data and limit values		
Standards IEC 60831-1+2, IS: 13340/41		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.3 · I_R (up to 1.5 · I_R including combined effects of harmonics, overvoltages and capacitance)
Inrush current	I_S	up to 200 · I_R
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / +10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_R, AC, 2 s
Test voltage, terminal / case	V_{TC}	3000 V AC, 10 s
Mean life expectancy	$t_{LD(Co)}$	up to 150 000 h (temperature class –40/C) up to 115 000 h (temperature class –40/D)
Ambient temperature		–40/D; max. temp. +55 °C; max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C –40/C; max. temp. +50 °C; max. mean 24 h = +40 °C; max. mean 1 year = +30 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright
Mounting and grounding		threaded M12 (10 Nm) for case size diameter ≥ 50 mm
Safety		self-healing technology, overpressure disconnector, max. allowed fault current 10 000 A in accordance with UL 810 standard
Discharge resistor		discharge resistor included in the delivery for B32300*/B32303*, pre-mounted for B32301* and B32304*
Case		extruded aluminum can
Enclosure		IP00 for B32300 and B32303 IP20 for B32301 and B32304
Dielectric		polypropylene film
Impregnation		biodegradable soft resin, semi-dry
Terminals		screw terminal for B32304 series, max. 25 mm^2 cable cross-section; fast-on terminals for B32300, B32301 and B32303 series
Number of switching operations		max. 5000 switchings per year according to IEC 60831-1+/2

* Without discharge resistor

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

EPCOS

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit**
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50/60 Hz, delta connection									
MKD230-D-0.5	0.5	1.3	0.6	1.6	3 · 10	50 x 150	0.4	B32303A2002A530	50
MKD230-D-0.7	0.7	1.8	0.8	2.2	3 · 14	50 x 150	0.4	B32303A2002A730	50
MKD230-D-1.0	1.0	2.5	1.2	3.0	3 · 20	50 x 150	0.4	B32303A2012A030	50
MKD230-D-1.5	1.5	3.8	1.8	4.6	3 · 30	63.5 x 150	0.6	B32303A2012A530	12
MKD230-D-2.0	2.0	5.0	2.4	6.0	3 · 40	63.5 x 150	0.6	B32303A2022A030	12
MKD230-D-2.5	2.5	6.3	3.0	7.6	3 · 50	63.5 x 150	0.8	B32303A2022A530	12
MKD230-D-5.0	5.0	12.6	6.0	15.1	3 · 100	75 x 200	1.1	B32304A2052#030*	6
MKD230-D-7.5	7.5	18.8	9.0	22.6	3 · 151	75 x 275	1.4	B32304A2072#530*	6
MKD230-D-10.0	10.0	25.1	12.0	30.1	3 · 201	85 x 275	1.7	B32304A2102#030*	4
MKD230-D-12.5	12.5	31.4	15.0	37.7	3 · 251	85 x 350	2.2	B32304A2122#530*	4
MKD230-D-15.0	15.0	37.7	18.0	45.2	3 · 301	85 x 350	2.2	B32304A2152#030*	4
Rated voltage 400 V AC, 50/60 Hz, delta connection									
MKD400-D-1.0	1.0	1.4	1.2	1.7	3 · 6.6	50 x 150	0.4	B32303A4012A000	50
MKD400-D-1.5	1.5	2.2	1.8	2.6	3 · 10	50 x 150	0.4	B32303A4012A500	50
MKD400-D-2.0	2.0	2.9	2.4	3.5	3 · 13	50 x 150	0.4	B32303A4022A000	50
MKD400-D-2.5	2.5	3.6	3.0	4.3	3 · 17	50 x 150	0.4	B32303A4022A500	50
MKD400-D-5.0	5.0	7.2	6.0	8.6	3 · 33	63.5 x 150	0.6	B32303A4052A000	12
MKD400-D-6.3	6.3	9.1	7.6	10.9	3 · 42	75 x 163	0.8	B32304A4071#500*	6
MKD400-D-7.5	7.5	10.8	9.0	13.0	3 · 50	75 x 163	0.9	B32304A4072#500*	6
MKD400-D-8.3	8.3	12.0	10.0	14.4	3 · 55	75 x 200	1.1	B32304A4101#000*	6
MKD400-D-10.0	10.0	14.4	12.0	17.3	3 · 66	75 x 200	1.1	B32304A4102#000*	6
MKD400-D-12.5	12.5	18.0	15.0	21.6	3 · 83	75 x 275	1.4	B32304A4122#500*	6
MKD400-D-15.0	15.0	21.7	18.0	26.0	3 · 100	75 x 275	1.4	B32304A4152#000*	6
MKD400-D-16.7	16.7	24.1	20.0	28.9	3 · 111	85 x 275	1.8	B32304A4201#000*	4
MKD400-D-20.0	20.0	28.9	24.0	34.7	3 · 133	85 x 275	1.8	B32304A4202#000*	4
MKD400-D-25.0	25.0	36.1	30.0	43.3	3 · 166	85 x 350	2.2	B32304A4252#000*	4
MKD400-D-30.0	30.0	43.3	–	–	3 · 199	96 x 275	2.4	B32304A4302#000*	4
Rated voltage 415 V AC, 50/60 Hz, delta connection									
MKD415-D-1.0	1.0	1.4	1.2	1.7	3 · 6.2	50 x 150	0.4	B32303A4012A010	50
MKD415-D-1.5	1.5	2.1	1.8	2.5	3 · 9.2	50 x 150	0.4	B32303A4012A510	50
MKD415-D-2.0	2.0	2.8	2.4	3.4	3 · 12	50 x 150	0.4	B32303A4022A010	50
MKD415-D-2.5	2.5	3.5	3.0	4.2	3 · 15	63.5 x 150	0.6	B32303A4022A510	12
MKD415-D-5.0	5.0	7.0	6.0	8.4	3 · 31	63.5 x 150	0.8	B32303A4052A010	12
MKD415-D-6.3	6.3	8.8	7.6	10.6	3 · 39	75 x 200	1.0	B32304A4071#510*	6
MKD415-D-7.5	7.5	10.4	9.0	12.5	3 · 46	75 x 200	1.1	B32304A4072#510*	6
MKD415-D-10.0	10.0	13.9	12.0	16.7	3 · 62	75 x 275	1.4	B32304A4102#010*	6
MKD415-D-12.5	12.5	17.4	15.0	20.9	3 · 77	75 x 275	1.4	B32304A4122#510*	6
MKD415-D-15.0	15.0	20.9	18.0	25.1	3 · 93	85 x 275	1.7	B32304A4152#010*	4
MKD415-D-20.0	20.0	27.8	24.0	33.4	3 · 123	85 x 275	2.2	B32304A4202#010*	4
MKD415-D-20.8	20.8	28.9	25.0	34.7	3 · 128	85 x 350	2.4	B32304A4251#010*	4
MKD415-D-25.0	25.0	34.8	30.0	41.8	3 · 154	85 x 350	2.4	B32304A4252#010*	4
MKD415-D-30.0	30.0	41.7	36.0	50.0	3 · 185	96 x 350	2.7	B32304A4302#010*	4

* Available either as B32304A****A*** series (3-terminal design, integrated resistor) or B32304A****B*** series (6-terminal design, pluggable ceramic resistor). Please replace # with the right character before ordering.

** Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit**
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 440 V AC, 50/60 Hz, delta connection									
MKD440-D-0.9	0.9	1.2	1.1	1.4	3 · 5.2	50 x 127	0.4	B32303A4011A040	50
MKD440-D-1.0	1.0	1.3	1.2	1.6	3 · 5.5	50 x 127	0.4	B32303A4012A040	50
MKD440-D-1.2	1.2	1.6	1.4	1.9	3 · 6.6	50 x 127	0.4	B32303A4011A540	50
MKD440-D-1.5	1.5	2.0	1.8	2.4	3 · 8.8	50 x 127	0.4	B32303A4012A540	50
MKD440-D-2.0	2.0	2.6	2.4	3.1	3 · 11	50 x 150	0.5	B32303A4022A040	50
MKD440-D-2.1	2.1	2.8	2.5	3.4	3 · 12	50 x 150	0.5	B32303A4021A540	50
MKD440-D-2.5	2.5	3.3	3.0	4.0	3 · 14	63.5 x 150	0.7	B32303A4022A540	12
MKD440-D-4.2	4.2	5.5	5.0	6.6	3 · 23	63.5 x 150	0.7	B32303A4051A040	12
MKD440-D-5.0	5.0	6.6	6.0	7.9	3 · 27	63.5 x 150	0.8	B32303A4052A040	12
MKD440-D-6.3	6.3	8.3	7.6	10.0	3 · 35	75 x 163	0.8	B32304A4071#540*	6
MKD440-D-7.5	7.5	9.8	9.0	11.8	3 · 41	75 x 200	1.1	B32304A4072#540*	6
MKD440-D-8.3	8.3	10.9	10.0	13.1	3 · 46	75 x 200	1.1	B32304A4101#040*	6
MKD440-D-10.0	10.0	13.1	12.0	15.7	3 · 55	75 x 275	1.4	B32304A4102#040*	6
MKD440-D-10.4	10.4	13.6	12.5	16.3	3 · 57	75 x 275	1.4	B32304A4121#540*	6
MKD440-D-12.5	12.5	16.4	15.0	19.7	3 · 69	75 x 275	1.4	B32304A4151#040*	6
MKD440-D-15.0	15.0	19.7	18.0	23.6	3 · 82	85 x 275	1.7	B32304A4152#040*	4
MKD440-D-16.7	16.7	21.9	20.0	26.3	3 · 92	85 x 275	1.7	B32304A4201#040*	4
MKD440-D-20.0	20.0	26.2	24.0	31.5	3 · 110	85 x 275	1.9	B32304A4202#040*	4
MKD440-D-20.8	20.8	27.3	25.0	32.8	3 · 114	85 x 350	2.2	B32304A4251#040*	4
MKD440-D-25.0	25.0	32.8	30.0	39.4	3 · 137	85 x 350	2.2	B32304A4252#040*	4
MKD440-D-28.0	28.0	36.7	33.6	44.0	3 · 154	85 x 350	2.2	B32304A4282#040*	4
MKD440-D-30.0	30.0	39.0	–	–	3 · 164	85 x 350	2.7	B32304A4302#040*	4
MKD440-D-33.0	33.0	43.3	–	–	3 · 181	85 x 350	2.7	B32304A4332#040*	4
MKD440-D-33.8	33.8	44.4	–	–	3 · 185	85 x 350	2.7	B32304A4332#840*	4
Rated voltage 480 V AC, 50/60 Hz, delta connection									
MKD480-D-1.5	1.5	1.8	1.8	2.2	3 · 6.9	50 x 127	0.4	B32303A4012A580	50
MKD480-D-2.0	2.0	2.4	2.4	2.9	3 · 9.2	50 x 150	0.5	B32303A4022A080	50
MKD480-D-2.5	2.5	3.0	3.0	3.6	3 · 12	63.5 x 150	0.7	B32303A4022A580	12
MKD480-D-5.0	5.0	6.0	6.0	7.2	3 · 23	75 x 163	0.8	B32304A4052#080*	6
MKD480-D-6.3	6.3	7.6	7.6	9.1	3 · 29	75 x 163	0.8	B32304A4071#580*	6
MKD480-D-7.5	7.5	9.0	9.0	10.8	3 · 35	75 x 200	1.1	B32304A4072#580*	6
MKD480-D-8.3	8.3	10.0	10.0	12.0	3 · 38	75 x 200	1.1	B32304A4101#080*	6
MKD480-D-10.4	10.4	12.5	12.5	15.0	3 · 48	75 x 275	1.4	B32304A4121#580*	6
MKD480-D-12.5	12.5	15.0	15.0	18.0	3 · 58	75 x 275	1.4	B32304A4151#080*	6
MKD480-D-15.0	15.0	18.0	18.0	21.6	3 · 69	85 x 275	1.7	B32304A4152#080*	6
MKD480-D-16.7	16.7	20.1	20.0	24.1	3 · 77	85 x 275	1.8	B32304A4162#780*	6
MKD480-D-20.0	20.0	24.1	24.0	28.9	3 · 92	85 x 350	2.2	B32304A4201#080*	4
MKD480-D-20.8	20.8	25.0	25.0	30.0	3 · 96	85 x 350	2.2	B32304A4202#080*	4
MKD480-D-25.0	25.0	30.1	30.0	36.1	3 · 115	85 x 350	2.2	B32304A4252#080*	4
MKD480-D-30.0	30.0	36.0	36.0	43.0	3 · 138	96 x 350	2.7	B32304A4302#080*	4
MKD480-D-33.0	33	39.7	–	–	3 · 152	96 x 350	2.7	B32304A4332#080*	4

* Available either as B32304A****A*** series (3-terminal design, integrated resistor) or B32304A****B*** series (6-terminal design, pluggable ceramic resistor). Please replace # with the right character before ordering.

** Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit**
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 525 V AC, 50/60 Hz, delta connection									
MKD525-D-1.0	1.0	1.1	1.2	1.3	3 · 3.9	50 x 150	0.4	B32303A5012A020	50
MKD525-D-1.5	1.5	1.6	1.8	1.9	3 · 5.8	50 x 150	0.4	B32303A5012A520	50
MKD525-D-2.0	2.0	2.2	2.4	2.6	3 · 7.7	63.5 x 150	0.6	B32303A5022A020	12
MKD525-D-2.5	2.5	2.7	3.0	3.2	3 · 9.6	63.5 x 150	0.6	B32303A5022A520	12
MKD525-D-5.0	5.0	5.5	6.0	6.6	3 · 19	75 x 163	0.8	B32304A5061#020*	6
MKD525-D-6.3	6.3	6.9	7.6	8.3	3 · 24	75 x 200	1.0	B32304A5071#520*	6
MKD525-D-8.3	8.3	9.1	10.0	10.9	3 · 32	75 x 275	1.4	B32304A5101#020*	6
MKD525-D-10.4	10.4	11.4	12.5	13.7	3 · 40	75 x 275	1.4	B32304A5121#520*	6
MKD525-D-12.5	12.5	13.7	15.0	16.4	3 · 48	75 x 275	1.4	B32304A5151#020*	6
MKD525-D-16.7	16.7	18.4	20.0	22.1	3 · 64	85 x 275	1.8	B32304A5201#020*	4
MKD525-D-20.8	20.8	22.9	25.0	27.5	3 · 80	85 x 350	2.2	B32304A5202#020*	4
MKD525-D-25.0	25.0	27.5	30.0	33.0	3 · 96	85 x 350	2.2	B32304A5252#020*	4
MKD525-D-30.0	30.0	33.0	36.0	39.0	3 · 115	96 x 350	2.7	B32304A5302#020*	4
MKD525-D-40.0	40.0	44.0	48.0	52.8	3 · 150	136 x 255	4.2	B32304A5402B025	4

* Available either as B32304A****A*** series (3-terminal design, integrated resistor) or B32304A****B*** series (6-terminal design, pluggable ceramic resistor). Please replace # with the right character before ordering.

** Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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DeltaCap PFC Capacitors

LV-PFC in industrial applications ● Stacked winding ● Dual safety system

Single-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit**
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50/60 Hz, single phase									
MKD230-I-0.8	0.8	3.5	1.0	4.2	48	63.5 x 64.5	0.3	B32300A2002A830	12
MKD230-I-1.7	1.7	7.4	2.0	8.9	102	63.5 x 102	0.4	B32300A2012A730	12
MKD230-I-2.5	2.5	10.9	3.0	13.1	151	63.5 x 127	0.5	B32300A2022A530	12
Rated voltage 250 V AC, 50/60 Hz, single phase									
MKD250-I-0.8	0.8	3.2	1.0	3.8	41	50 x 77	0.2	B32300A2002A850	50
MKD250-I-1.7	1.7	6.8	2.0	8.2	87	63.5 x 92	0.4	B32300A2012A750	12
MKD250-I-2.0	2.0	7.8	2.4	9.4	100	63.5 x 92	0.4	B32300A2022A050	12
MKD250-I-2.5	2.5	10.0	3.0	12.0	127	63.5 x 102	0.5	B32300A2022A550	12
MKD250-I-5.0	5.0	20.0	6.0	24.0	255	75 x 166	0.7	B32301A2052#050*	6
MKD250-I-7.5	7.5	30.0	9.0	36.0	382	85 x 196	1.1	B32301A2072#550*	4
MKD250-I-10	10	40.0	12	48.0	510	85 x 216	1.2	B32301A2102#050*	4
Rated voltage 400 V AC, 50/60 Hz, single phase									
MKD400-I-0.8	0.8	2.0	1.0	2.4	16	50 x 64.5	0.2	B32300A4002A800	50
MKD400-I-1.7	1.7	4.3	2.0	5.2	34	63.5 x 62.5	0.3	B32300A4012A700	12
MKD400-I-2.5	2.5	6.3	3.0	7.6	50	63.5 x 77	0.3	B32300A4022A500	12
MKD400-I-3.3	3.3	8.3	4.0	10.0	66	63.5 x 102	0.4	B32300A4032A300	12
MKD400-I-4.2	4.2	10.5	5.0	12.6	84	63.5 x 102	0.4	B32300A4051A000	12
MKD400-I-5.0	5.0	12.5	6.0	15.0	100	63.5 x 127	0.5	B32300A4052A000	12
Rated voltage 415 V AC, 50/60 Hz, delta connection									
MKD415-I-0.8	0.8	1.9	1.0	2.3	15	50 x 64.5	0.2	B32300A4082A310	50
MKD415-I-1.7	1.7	4.0	2.0	4.8	31	63.5 x 64.5	0.3	B32300A4012A710	12
MKD415-I-2.5	2.5	6.0	3.0	7.2	46	63.5 x 102	0.4	B32300A4022A510	12
MKD415-I-3.3	3.3	8.0	4.0	9.6	61	63.5 x 102	0.4	B32300A4032A310	12
MKD415-I-5.0	5.0	12.0	6.0	14.4	92	63.5 x 127	0.6	B32300A4052A010	12
Rated voltage 440 V AC, 50/60 Hz, single phase									
MKD440-I-0.7	0.7	1.6	0.8	1.9	12	50 x 64.5	0.2	B32300A4001A840	50
MKD440-I-1.4	1.4	3.2	1.7	3.8	23	63.5 x 64.5	0.3	B32300A4011A740	12
MKD440-I-2.1	2.1	4.8	2.5	5.8	35	63.5 x 77	0.3	B32300A4021A540	12
MKD440-I-2.8	2.8	6.4	3.4	7.7	46	63.5 x 102	0.4	B32300A4031A340	12
MKD440-I-3.3	3.3	7.5	4.0	9.0	54	63.5 x 102	0.4	B32300A4032A340	12
MKD440-I-4.2	4.2	9.5	5.0	11.4	69	63.5 x 127	0.5	B32300A4051A040	12
MKD440-I-5.0	5.0	11.4	6.0	13.7	82	63.5 x 127	0.5	B32300A4052A040	12
Rated voltage 480 V AC, 50/60 Hz, single phase									
MKD480-I-0.7	0.7	1.5	0.8	1.8	10	50 x 64.5	0.2	B32300A4001A880	50
MKD480-I-1.4	1.4	2.9	1.7	3.5	19	63.5 x 64.5	0.3	B32300A4011A780	12
MKD480-I-2.1	2.1	4.4	2.5	5.3	29	63.5 x 77	0.3	B32300A4021A580	12
MKD480-I-2.8	2.8	5.8	3.4	7.0	39	63.5 x 102	0.4	B32300A4031A380	12
Rated voltage 525 V AC, 50/60 Hz, single phase									
MKD525-I-1.4	1.4	2.7	1.7	3.2	16	63.5 x 64.5	0.3	B32300A5011A730	12
MKD525-I-2.8	2.8	5.3	3.4	6.4	32	63.5 x 102	0.4	B32300A5031A320	12
MKD525-I-3.3	3.3	6.3	4.0	7.6	38	63.5 x 102	0.4	B32300A5032A320	12
MKD525-I-4.2	4.2	8.0	5.0	9.6	49	63.5 x 127	0.5	B32300A5051A020	12
MKD525-I-25.0	25.0	47.6	30.0	57.1	289	116 x 200	1.9	B32301A5252#025*	4

* Available either as B32301A****A*** series (2-terminal design, integrated resistor) or B32301A****B*** series (4-terminal design, pluggable ceramic resistor). Please replace # with the right character before ordering.

** Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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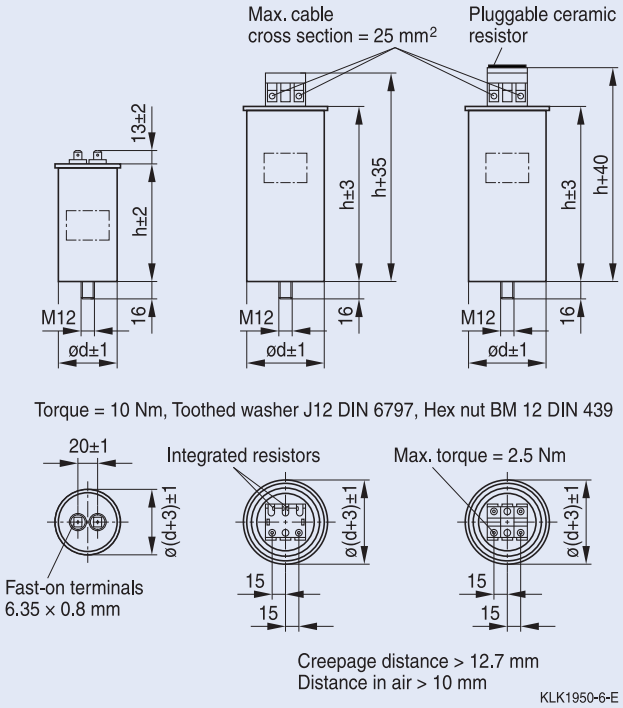
Please read *Important notes* on page 12 and *Cautions* on page 121–125

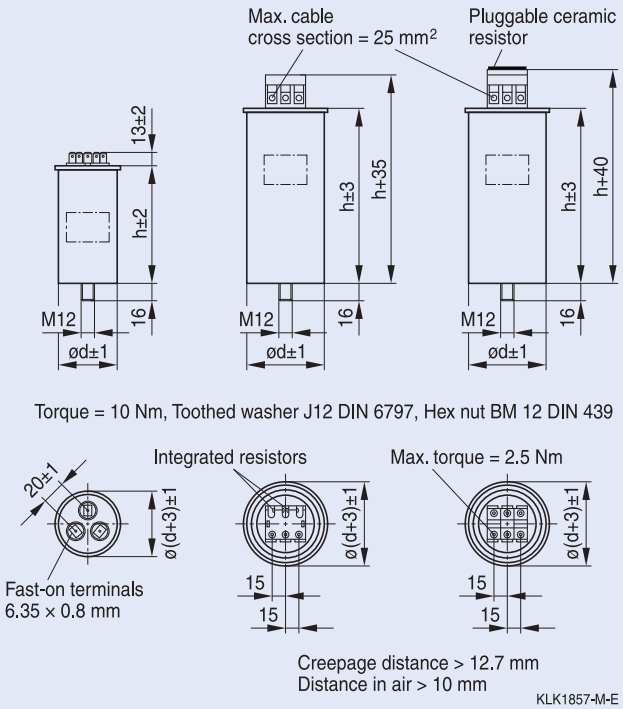
Dimensional drawings: 1-phase capacitors

B32300A/B32301A****A***/B32301A****B***



Dimensional drawings: 3-phase capacitors

B32303A****A***/B32304A****A***/B32304A****B***



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PhiCap PFC Capacitors

Biodegradable soft resin impregnated ● Stacked winding ● Dual safety system

General

PhiCap capacitors are a tried and tested series of MKP (metalized polypropylene) capacitors from EPCOS which have been used for PFC applications for more than 15 years.

The power range varies from 0.5 to 30.0 kvar and 0.7 to 6.0 kvar per single capacitor can, depending on a three-phase or single-phase capacitor design.

The PhiCap capacitor is especially intended for power factor correction in industrial applications.

The capacitors are manufactured using metalized polypropylene film as the dielectric and housed in a cylindrical aluminum case.

Applications

- Power Factor Correction (PFC)
- Automatic capacitor banks
- Fixed PFC applications, e.g. motor compensation
- Detuned PFC systems
- Dynamic PFC systems

Features

- Compact design in cylindrical aluminum can with stud
- Stacked winding
- MKP technology
- Voltage range 230 … 525 V
- Output range 0.5 … 30 kvar

Electrical

- Up to 30 kvar per case for three-phase applications
- Up to 6 kvar per case for single-phase applications
- Long life expectancy of up to 135 000 hours
- High pulse current withstand capability (up to 200 · I_R)

Mechanical and maintenance

- Reduced mounting costs, easy installation and connection
- Low weight and compact volume
- Maintenance-free

Safety

- Self-healing
- Overpressure disconnector
- Shock hazard protected optimized capacitor safety terminal for B32344 series

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

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Technical data and limit values

Standards IEC 60831-1+2, IS: 13340/41, GOST		
Overvoltage	V_{max}	V_R + 10% (up to 8 h daily) / V_R + 15% (up to 30 min daily) / V_R + 20% (up to 5 min daily) / V_R + 30% (up to 1 min daily)
Overcurrent	I_{max}	up to 1.5 · I_R including combined effects of harmonics, overvoltages and capacitance
Inrush current	I_S	up to 200 · I_R
Losses: **– Dielectric** **– Total***		 < 0.2 W/kvar < 0.45 W/kvar
Rated frequency	f	50/60 Hz
Capacitance tolerance		–5% / 10%
Test voltage, terminal / terminal	V_{TT}	2.15 · V_R, AC, 2 s
Test voltage, terminal / case	V_{TC}	3000 V AC, 10 s
Mean life expectancy	$t_{LD(Co)}$	up to 135 000 h (temperature class –40/C) up to 100 000 h (temperature class –40/D)
Ambient temperature		–40/D; max. temp. +55 °C; max. mean 24 h = +45 °C; max. mean 1 year = +35 °C; lowest temperature = –40 °C
Cooling		natural or forced
Humidity	H_{rel}	max. 95%
Altitude		max. 4000 m above sea level
Mounting position		upright
Mounting and grounding		threaded M12 (10 Nm) for case size diam. > 53 mm M8 (4 Nm) for case size diam. ≤ 53 mm
Safety		self-healing technology, overpressure disconnector, maximum allowed fault current 10 000 A in accordance with UL 810 standard
Discharge device		discharge resistor included; pre-mounted for B32344 series
Case		extruded aluminum can
Enclosure		IP00 for B32340/B32343, indoor mounting (IP54 for B32344 with plastic terminal cap; for other series please refer to page 53)
Dielectric		polypropylene film
Impregnation		biodegradable soft resin, semi-dry
Terminals		optimized capacitor safety terminals for B32344 series, max. current 50 A, max. 16 mm^2 cable cross section, fast-on terminals for B32340 and B32343 series
Number of switching operations		max. 5000 switchings per year according to IEC 60831-1+/2

* Without discharge resistor

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Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50 / 60 Hz, delta connection									
MKP230-D-0.5	0.5	1.3	0.6	1.6	3 · 10	53 x 114	0.3	B32343C2002A530	12
MKP230-D-0.7	0.7	1.9	0.9	2.3	3 · 15	53 x 114	0.3	B32343C2002A730	12
MKP230-D-1.0	1.0	2.5	1.2	3.0	3 · 20	63.5 x 129	0.3	B32343C2012A030	12
MKP230-D-1.5	1.5	3.8	1.8	4.6	3 · 30	63.5 x 129	0.4	B32343C2012A530	12
MKP230-D-2.0	2.0	5.0	2.4	6.0	3 · 42	75 x 138	0.4	B32344E2022A030	6
MKP230-D-2.5	2.5	6.3	3.0	7.5	3 · 50	75 x 138	0.4	B32344E2022A530	6
MKP230-D-5.0	5.0	12.6	6.0	15.1	3 · 100	75 x 198	0.6	B32344E2052A030	4
MKP230-D-7.5	7.5	18.8	9.0	22.6	3 · 150	85 x 198	0.8	B32344E2072A530	4
MKP230-D-10.0	10.0	25.1	12.0	30.2	3 · 200	85 x 273	1.2	B32344E2102A030	4
MKP230-D-12.5	12.5	31.4	15.0	37.7	3 · 250	85 x 348	1.5	B32344E2122A530	4
MKP230-D-15.0	15.0	37.7	–	–	3 · 300	85 x 348	1.5	B32344E2152A030	4
Rated voltage 400 V AC, 50 / 60 Hz, delta connection									
MKP400-D-1.0	1.0	1.4	1.2	1.7	3 · 7	53 x 114	0.3	B32343C4012A000	12
MKP400-D-1.5	1.5	2.2	1.8	2.6	3 · 10	53 x 114	0.3	B32343C4012A500	12
MKP400-D-2.0	2.0	2.9	2.4	3.5	3 · 13	63.5 x 129	0.4	B32343C4022A000	12
MKP400-D-2.5	2.5	3.6	3.0	4.3	3 · 17	63.5 x 129	0.4	B32343C4022A500	12
MKP400-D-5.0	5.0	7.2	6.0	8.6	3 · 33	63.5 x 129	0.4	B32343C4052A000	12
MKP400-D-6.3	6.3	9.1	7.5	11.0	3 · 42	75 x 160	0.5	B32344E4071A500	6
MKP400-D-7.5	7.5	10.8	9.0	13.0	3 · 50	75 x 160	0.5	B32344E4072A500	6
MKP400-D-8.3	8.3	12.0	10.0	14.5	3 · 55	75 x 160	0.5	B32344E4101A000	6
MKP400-D-10.0	10.0	14.5	12.0	17.3	3 · 67	75 x 198	0.6	B32344E4102A000	4
MKP400-D-12.5	12.5	18.1	15.0	21.7	3 · 83	85 x 198	0.8	B32344E4122A500	4
MKP400-D-15.0	15.0	21.7	18.0	26.0	3 · 100	85 x 198	0.8	B32344E4152A000	4
MKP400-D-16.7	16.7	24.1	20.0	28.9	3 · 111	85 x 198	0.8	B32344E4201A000	4
MKP400-D-20.0	20.0	28.9	24.0	34.7	3 · 133	85 x 273	1.1	B32344E4202A000	4
MKP400-D-25.0	25.0	36.1	–	–	3 · 166	85 x 273	1.5	B32344E4252A000	4
MKP400-D-30.0	30.0	43.3	–	–	3 · 199	90 x 348	2.5	B32344E4302A000	4
Rated voltage 415 V AC, 50 / 60 Hz, delta connection									
MKP415-D-1.0	1.0	1.4	1.2	1.6	3 · 6	53 x 114	0.3	B32343C4012A010	12
MKP415-D-1.5	1.5	2.1	1.8	2.4	3 · 9	53 x 114	0.3	B32343C4012A510	12
MKP415-D-2.0	2.0	2.8	2.4	3.4	3 · 12	53 x 114	0.4	B32343C4022A010	12
MKP415-D-2.5	2.5	3.5	3.0	4.2	3 · 15	63.5 x 129	0.4	B32343C4022A510	12
MKP415-D-5.0	5.0	7.0	6.0	8.4	3 · 31	63.5 x 154	0.4	B32343C4052A010	12
MKP415-D-6.3	6.3	8.8	7.5	10.6	3 · 39	75 x 160	0.5	B32344E4071A510	6
MKP415-D-7.5	7.5	10.4	9.0	12.5	3 · 46	75 x 198	0.6	B32344E4072A510	4
MKP415-D-10.0	10.0	13.9	12.0	16.7	3 · 62	75 x 198	0.6	B32344E4102A010	4
MKP415-D-12.5	12.5	17.4	15.0	20.9	3 · 77	85 x 198	0.8	B32344E4122A510	4
MKP415-D-15.0	15.0	20.9	18.0	25.1	3 · 92	85 x 273	1.2	B32344E4152A010	4
MKP415-D-20.0	20.0	27.9	24.0	33.4	3 · 123	85 x 273	1.2	B32344E4202A010	4
MKP415-D-25.0	25.0	34.8	–	–	3 · 154	85 x 348	1.5	B32344E4252A010	4
Rated voltage 440 V AC, 50 / 60 Hz, delta connection									
MKP440-D-0.9	0.9	1.2	1.0	1.3	3 · 5	53 x 114	0.3	B32343C4011A040	12
MKP440-D-1.0	1.0	1.3	1.2	1.6	3 · 6	53 x 114	0.3	B32343C4012A040	12
MKP440-D-1.2	1.2	1.6	1.5	2.0	3 · 7	53 x 114	0.3	B32343C4011A540	12

Types for voltages 220, 240, 480, 600, 660 V and other kvar-values available upon request.

* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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PhiCap PFC Capacitors

Biodegradable soft resin impregnated ● Stacked winding ● Dual safety system

Three-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 440 V AC, 50 / 60 Hz, delta connection									
MKP440-D-1.5	1.5	2.0	1.8	2.3	3 · 8	53 x 114	0.3	B32343C4012A540	12
MKP440-D-2.1	2.1	2.7	2.5	3.3	3 · 11	53 x 114	0.4	B32343C4021A540	12
MKP440-D-2.5	2.5	3.3	3.0	3.9	3 · 14	63.5 x 129	0.3	B32343C4022A540	12
MKP440-D-4.2	4.2	5.5	5.0	6.6	3 · 23	63.5 x 129	0.4	B32343C4051A040	12
MKP440-D-5.0	5.0	6.5	6.0	7.8	3 · 27	63.5 x 154	0.5	B32343C4052A040	12
MKP440-D-6.3	6.3	8.3	7.5	9.9	3 · 34	75 x 160	0.5	B32344E4071A540	6
MKP440-D-7.5	7.5	9.9	9.0	11.8	3 · 41	75 x 160	0.5	B32344E4072A540	6
MKP440-D-8.3	8.3	10.9	10.0	13.1	3 · 46	75 x 198	0.6	B32344E4101A040	4
MKP440-D-10.0	10.0	13.1	12.0	15.8	3 · 55	75 x 198	0.6	B32344E4102A040	4
MKP440-D-10.4	10.4	13.7	12.5	16.4	3 · 57	75 x 198	0.6	B32344E4121A540	4
MKP440-D-12.5	12.5	16.4	15.0	19.7	3 · 69	85 x 198	0.8	B32344E4151A040	4
MKP440-D-15.0	15.0	19.7	18.0	23.6	3 · 82	85 x 273	1.2	B32344E4152A040	4
MKP440-D-16.7	16.7	21.9	20.0	26.3	3 · 92	85 x 273	1.2	B32344E4201A040	4
MKP440-D-20.8	20.8	27.3	25.0	32.8	3 · 114	85 x 273	1.2	B32344E4251A040	4
MKP440-D-25.0	25.0	32.8	30.0	40.0	3 · 138	85 x 348	1.5	B32344E4252A040	4
MKP440-D-28.0	28.0	36.8	–	–	3 · 154	85 x 348	1.5	B32344E4282A040	4
MKP440-D-30.0	30.0	39.0	–	–	3 · 165	85 x 348	1.6	B32344E4302A040	4
Rated voltage 480 V AC, 50 / 60 Hz, delta connection									
MKP480-D-1.5	1.5	1.8	1.8	2.2	3 · 7	63.5 x 129	0.4	B32343C4012A580	12
MKP480-D-2.0	2.0	2.4	2.4	2.9	3 · 9	63.5 x 129	0.4	B32343C4022A080	12
MKP480-D-2.5	2.5	3.0	3.0	3.6	3 · 11	63.5 x 129	0.4	B32343C4022A580	12
MKP480-D-4.2	4.2	5.1	5.0	6.1	3 · 19	63.5 x 154	0.5	B32343C4051A080	12
MKP480-D-5.0	5.0	6.0	6.0	7.2	3 · 23	75 x 160	0.5	B32344E4052A080	6
MKP480-D-6.3	6.3	7.6	7.6	9.1	3 · 29	75 x 160	0.5	B32344E4071A580	6
MKP480-D-7.5	7.5	9.0	9.0	10.8	3 · 35	75 x 198	0.6	B32344E4072A580	4
MKP480-D-8.3	8.3	10.0	10.0	12.0	3 · 38	75 x 198	0.6	B32344E4101A080	4
MKP480-D-10.4	10.4	12.5	12.5	15.0	3 · 48	85 x 198	0.8	B32344E4121A580	4
MKP480-D-12.5	12.5	15.1	15.0	18.1	3 · 58	85 x 198	0.8	B32344E4151A080	4
MKP480-D-15.0	15.0	18.1	18.0	21.7	3 · 69	85 x 273	1.2	B32344E4152A080	4
MKP480-D-16.7	16.7	20.1	20.0	24.1	3 · 77	85 x 273	1.2	B32344E4162A780	4
MKP480-D-20.8	20.8	25.0	25.0	30.1	3 · 96	85 x 273	1.2	B32344E4202A080	4
MKP480-D-25.0	25.0	30.1	30.0	36.1	3 · 115	85 x 348	1.5	B32344E4252A080	4
MKP480-D-30.0	30.0	36.1	–	–	3 · 138	90 x 348	1.5	B32344E4302A080	4
Rated voltage 525 V AC, 50 / 60 Hz, delta connection									
MKP525-D-1.0	1.0	1.1	1.2	1.3	3 · 4	53 x 114	0.3	B32343C5012A020	12
MKP525-D-1.5	1.5	1.6	1.8	2.0	3 · 6	53 x 114	0.3	B32343C5012A520	12
MKP525-D-2.0	2.0	2.2	2.4	2.6	3 · 8	63.5 x 129	0.4	B32343C5022A020	12
MKP525-D-2.5	2.5	2.7	2.7	3.0	3 · 9	63.5 x 129	0.4	B32343C5022A520	12
MKP525-D-5.0	5.0	5.5	6.0	6.6	3 · 19	75 x 160	0.3	B32344E5061A020	6
MKP525-D-6.3	6.3	6.9	7.6	8.3	3 · 24	75 x 160	0.5	B32344E5071A520	6
MKP525-D-8.3	8.3	9.1	10.0	11.0	3 · 32	75 x 198	0.6	B32344E5101A020	4
MKP525-D-10.4	10.4	11.5	12.5	13.7	3 · 40	85 x 198	0.8	B32344E5121A520	4
MKP525-D-12.5	12.5	13.8	15.0	16.5	3 · 48	85 x 273	1.2	B32344E5151A020	4
MKP525-D-16.7	16.7	18.3	20.0	21.9	3 · 64	85 x 273	1.2	B32344E5201A020	4
MKP525-D-20.8	20.8	22.9	25.0	27.5	3 · 80	85 x 348	1.5	B32344E5202A020	4
MKP525-D-25.0	25.0	27.5	30.0	33.0	3 · 96	85 x 348	1.5	B32344E5252A020	4

Types for voltages 220, 240, 480, 600, 660 V and other kvar-values available upon request.

* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

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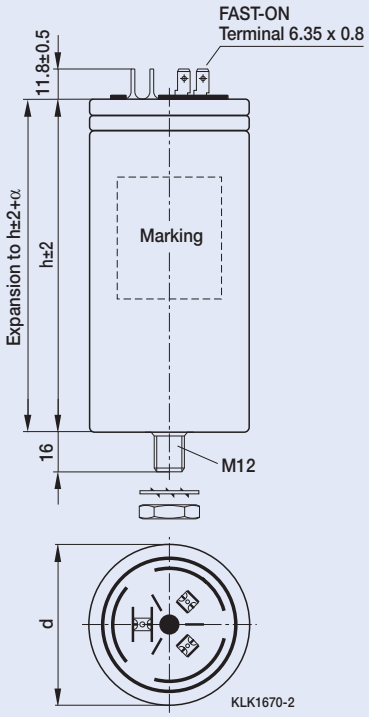
PhiCap PFC Capacitors

Biodegradable soft resin impregnated ● Stacked winding ● Dual safety system

Dimensional drawings: three-phase capacitors

Capacitor B32343 series

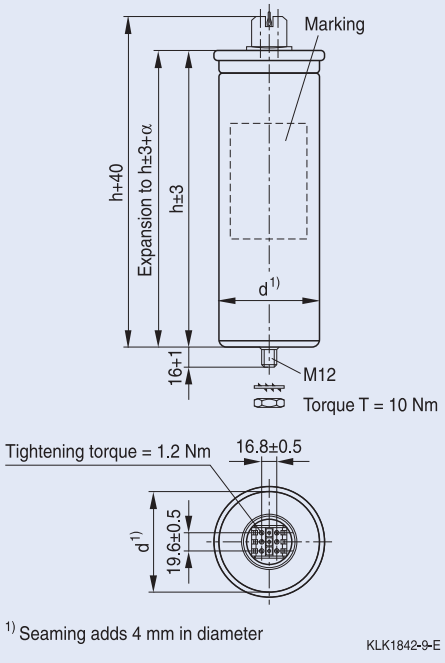


Creepage distance	10.5 mm (ø 53) 10.0 mm (ø 63.5)
Clearance	13.0 mm (ø 53) 16.5 mm (ø 63.5)
Diameter (ø)	53.0 mm 63.5 mm
Expansion α	max. 12 mm

Mounting

	M12 (ø 63.5 mm)	M8 (ø 53.0 mm)
Torque	T = 10 Nm	T = 4 Nm
Toothed washer	J12.5 DIN 6797	J8.0 DIN 6797
Hex nut	BM12 DIN 439	BM 8 DIN 439

Capacitor B32344 series



Creepage distance	9.6 mm
Clearance	12.7 mm
Diameter d (ø)	75.0 mm / 85.0 mm
Expansion α	max. 13 mm

Mounting

	M12
Torque	T = 10 Nm
Toothed washer	J12.5 DIN 6797
Hex nut	BM12 DIN 439

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PhiCap PFC Capacitors

Biodegradable soft resin impregnated ● Stacked winding ● Dual safety system

Single-phase capacitors

Type	50 Hz		60 Hz		C_R	d x h	Weight	Ordering code	Packing unit*
	Output kvar	I_R A	Output kvar	I_R A	µF	mm	kg		
Rated voltage 230 V AC, 50 / 60 Hz									
MKP230-I-0.8	0.8	3.6	1.0	4.3	50	63.5 x 105	0.30	B32340C2002A830	12
MKP230-I-1.7	1.7	7.2	2.0	8.7	100	63.5 x 142	0.40	B32340C2012A730	12
MKP230-I-2.5	2.5	10.9	3.0	13.1	150	63.5 x 142	0.50	B32340C2022A530	12
Rated voltage 400 V AC, 50 / 60 Hz									
MKP400-I-0.8	0.8	2.0	1.0	2.3	15	63.5 x 68	0.30	B32340C3001A880	12
MKP400-I-1.7	1.7	4.2	2.0	5.0	33	63.5 x 68	0.30	B32340C4012A700	12
MKP400-I-2.5	2.5	6.3	3.0	7.5	50	63.5 x 105	0.40	B32340C4022A500	12
MKP400-I-3.3	3.3	8.4	4.0	10.0	66	63.5 x 105	0.40	B32340C4032A300	12
MKP400-I-4.2	4.2	10.4	5.0	12.5	84	63.5 x 142	0.40	B32340C4051A000	12
MKP400-I-5.0	5.0	12.4	6.0	15.0	99	63.5 x 142	0.50	B32340C4052A000	12
Rated voltage 415 V AC, 50 / 60 Hz									
MKP415-I-0.8	0.8	2.0	1.0	2.4	15	63.5 x 68	0.35	B32340C4082A810	12
MKP415-I-1.7	1.7	4.0	2.0	4.8	31	63.5 x 105	0.45	B32340C4012A710	12
MKP415-I-2.5	2.5	6.0	3.0	7.2	46	63.5 x 105	0.50	B32340C4022A510	12
MKP415-I-3.3	3.3	8.0	4.0	9.7	62	63.5 x 142	0.50	B32340C4032A310	12
MKP415-I-5.0	5.0	12.0	6.0	14.5	91	63.5 x 142	0.60	B32340C4052A010	12
Rated voltage 440 V AC, 50 / 60 Hz									
MKP440-I-0.7	0.7	1.6	0.8	1.9	11	63.5 x 68	0.30	B32340C4001A840	12
MKP440-I-1.4	1.4	3.2	1.7	3.8	23	63.5 x 68	0.30	B32340C4011A740	12
MKP440-I-2.1	2.1	4.7	2.5	5.7	34	63.5 x 105	0.40	B32340C4021A540	12
MKP440-I-2.8	2.8	6.4	3.3	7.6	46	63.5 x 105	0.40	B32340C4031A340	12
MKP440-I-3.3	3.3	7.6	4.0	9.1	55	63.5 x 142	0.50	B32340C4032A340	12
MKP440-I-4.2	4.2	9.5	5.0	11.4	68	63.5 x 142	0.50	B32340C4051A040	12
MKP440-I-5.0	5.0	11.4	6.0	13.6	82	63.5 x 142	0.60	B32340C4052A040	12
Rated voltage 480 V AC, 50 / 60 Hz									
MKP480-I-0.7	0.7	1.5	0.8	1.7	10	63.5 x 105	0.30	B32340C4001A880	12
MKP480-I-1.4	1.4	2.9	1.7	3.5	19	63.5 x 105	0.30	B32340C4011A780	12
MKP480-I-2.1	2.1	4.3	2.5	5.2	29	63.5 x 105	0.50	B32340C4021A580	12
MKP480-I-2.8	2.8	5.8	3.3	6.9	38	63.5 x 142	0.50	B32340C4031A380	12
Rated voltage 525 V AC, 50 / 60 Hz									
MKP525-I-1.4	1.4	2.6	1.7	3.1	16	63.5 x 105	0.30	B32340C5011A720	12
MKP525-I-2.8	2.8	5.2	3.3	6.2	31	63.5 x 142	0.50	B32340C5031A330	12
MKP525-I-3.3	3.3	6.3	4.0	7.6	38	63.5 x 142	0.60	B32340C5032A320	12
MKP525-I-4.2	4.2	8.0	5.0	9.5	48	63.5 x 142	0.70	B32340C5051A020	12

Types for voltages 220, 240, 600, 660 V and other kvar-values available upon request.

* Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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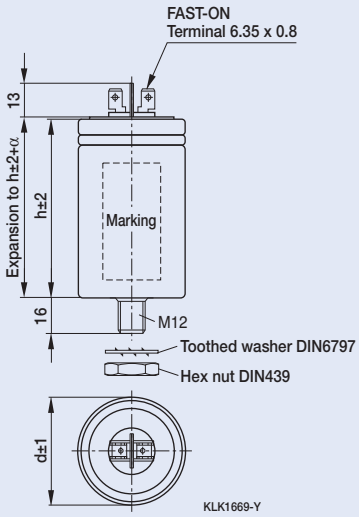
PhiCap PFC Capacitors

Biodegradable soft resin impregnated ● Stacked winding ● Dual safety system

Dimensional drawings: single-phase capacitors

Capacitor B32340 series

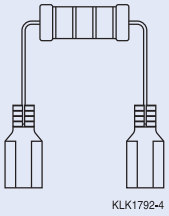


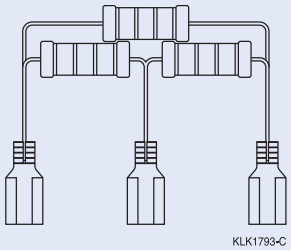
Creepage distance	10.0 mm
Clearance	16.5 mm
Diameter (ø)	63.5 mm
Expansion α	max. 12 mm

Mounting

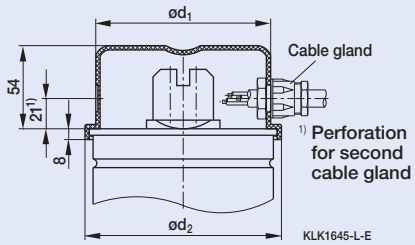
	M12
Torque	T = 10 Nm
Toothed washer	J12.5 DIN 6797
Hex nut	BM12 DIN 439

Discharge resistors for B32340 and B32343 series





Protective cover for terminal, protection class IP54



Ø in mm	Ordering code
53.0	B44066K0530A000*
63.5	B44066K0635A000*
75	B44066K0795A000
85	B44066K0895A000

* For B32340 and B32343 series (diameter 53.0 and 63.5 mm), terminal covers with cable entry on top

For IP54 additional cable gland at cable entry required.

Discharge resistor for B32344 series refer to page 30.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PF Controllers BR604, BR6000 and BR7000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

General

Controllers for PFC are of major importance in the compensation system. They measure the actual power factor and connect or disconnect capacitor stages to achieve specific desired values (cos φ).

All types of the BR604, BR6000 and BR7000 series feature menu-driven handling in plain language, various languages available. They are all panel-mounted types with an illuminated full graphic display (not for BR604), HD-versions with OLED-display.

BR604

BR7000-I

BR6000

BR7000

State-of-the-art controllers of today feature a microprocessor that analysis the signal from a current transformer and delivers a command to switch the contactor – or in dynamic PFC – the thyristor to add or remove capacitor steps. This ensures a well-balanced utilization of the capacitor steps, reduces the number of switchings and in the long run will extent the service life of the PFC system.

The number of steps is determined by the required capacitor output to select the particular PF controller. In general, the number of steps depends on the number of loads. The higher the quantity of small loads, the higher the number of controller-steps should be.

The range of PF controllers offers a broad variety of types that allow to select the perfect device for the customer's requirements. Starting with 4 outputs in the smallest version of BR604, BR6000-series up to 15 outputs for the BR7000-series, a tailor made solution will satisfy the demands.

EPCOS is offering PF controllers for standard applications with slowly changing loads and for dynamic PFC for applications with rapidly changing loads, such as elevators, welding machines, cranes or presses. The dynamic types are designed to switch thyristor modules of the TSM series, also available from EPCOS (see page 69). Particular types are suited for hybrid applications, e.g. standard and dynamic.

Overview of series

BR604: 4 relay outputs, standard compensation
BR6000-R6: relay outputs, standard compensation (BR6000-R6/HD with OLED-display)
BR6000-R12: 12 relay outputs, standard compensation (BR6000-R12/HD with OLED display)
BR6000-T6: 6 transistor outputs for dynamic compensation
BR7000-I: 12 relay outputs for standard compensation
BR7000-I/S485: 12 relay outputs for standard compensation plus interface RS485
BR7000-I-TH: 12 relay and 12 transistor outputs for standard, mixed and dynamic compensation
BR7000-I-/TH/S485: 12 relay and 12 transistor outputs for standard, mixed and dynamic compensation plus interface RS485
BR7000: 15 relay outputs for standard compensation (BR7000-HD with OLED-display) with two independent RS485-interfaces
BR7000-T: 15 transistor outputs for dynamic PFC with two independent RS485-interfaces

Types featuring a RS85-interface can be connected to a PC for an easy and comfortable evaluation with Windows-based software BR7000-SOFT, included in the delivery. More accessories for PF controllers please see page 60.

Technical details, measured values, dimensions and other features please see tables on page 56.

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PF Controllers BR604, BR6000 and BR7000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

Features

- Display
  - Multifunctional LCD
  - Graphic and alphanumeric
  - LCD illumination*
- Intelligent control
- Menu-driven handling (plain language)
- Self-optimizing control capability
- Recall function of recorded values
- Four-quadrant operation (e.g. stand-by generator)
- Large measuring voltage range*
- Powerful alarm output*
- Display of numerous of system parameters
  - System voltage (V AC)
  - Reactive power (kvar)
  - Active power (kW)
  - Frequency*
  - Energy
  - THD-V, THD-I*
  - Individual harmonics up to 19th*
  - Monitoring of individual capacitor currents*
  - Apparent power (kVA)
  - Apparent current (A)
  - Temperature (°C)*
  - Real-time cos φ
  - Target cos φ
  - kvar value to target cos φ

*) Not for BR604
**) Only for T-types

- Alarm output*
  - Insufficient compensation
  - Overcompensation
  - Undercurrent
  - Overcurrent
  - Overtemperature
  - Harmonics exceeded
  - Threshold value programmable
  - Internal error storage
  - Programming of 2nd signal relay random
- Recall recorded values
  - Number of contactor switching operations*
  - Maximum voltage V (V_{max})
  - Maximum reactive power, Q (kvar)
  - Maximum value of harmonic*
  - Maximum active power, P (kW)
  - Maximum apparent power, S (kVA)
  - Maximum temperature (°C)*
  - Operation time of all capacitors*
- Automatic initialization*
- Dynamic PFC (transistor output)**
  - Thyristor switching

⚠ Cautions:

1. Discharge time: Make sure that the discharge time set in controller matches the capacitor discharge time. See page 123.
2. Number of switchings: LV PFC capacitors according to standard IEC 60831 are designed for up to 5000 switching operations. Make sure that 5000 switching operations per year are not exceeded.
3. Controller hunting must be avoided at any case (see page 125)!

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PF Controllers BR604 and BR6000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

Selection table

	BR604	BR6000-R6	BR6000-R12	BR6000-T6
Ordering code	B44066R6004E230	B44066R6006E230	B44066R6012E230	B44066R6106E230
		HD-version	**HD-version**	
Ordering code		B44066R6506E230	B44066R6512E230	
Supply voltage	230 V AC	110 … 230 V~ 50/60 Hz	110 … 230 V~ 50/60 Hz	110 … 230 V~ 50/60 Hz
Measurement voltage	= supply voltage 230 V AC (L-N)	30 … 525 V~ (L-N) or (L-L)	30 … 525 V~ (L-N) or (L-L)	30 … 525 V~ (L-N) or (L-L)
Power consumption	< 5 VA	< 5 VA	< 5 VA	< 5 VA
Operating temperature	–10 … +50 °C	–20 … +60 °C, HD-version –40 … +60 °C	–20 … +60 °C, HD-version –40 … +60 °C	–20 … +60 °C,
Display	display 2 x 16 characters	illuminated display 2 x 16 characters HD-version OLED character display, yellow	illuminated display 2 x 16 characters HD-version OLED character display, yellow	illuminated display 2 x 16 characters
Plain language	E/ES/GER/PT	CZ/E/ES/F/GER/ NL/PL/PT/RU/TR	CZ/E/ES/F/GER/ NL/PL/PT/RU/TR	CZ/E/ES/F/GER/ NL/PL/PT/RU/TR
Number of relay outputs	4	6	12	–
Number of transistor outputs	–	–	–	6
Alarm/Message relay	–	1/0	1/1	1/0
Additional separate fan relay	–	–	–	–
Interface	–	–	–	–
Input 2nd parameter set switchover target PF	–	–	–	–
Measuring	single-phase	single-phase	single-phase	single-phase
Controlling	three-phase	three-phase	three-phase	three-phase
Automatic initialization	–	yes	yes	–
Test run of complete PFC-system	–	yes	yes	–
Number of control series	23 series pre-set	20 series pre-set	20 series pre-set	20 series pre-set
Control series editor for free programming	–	yes	yes	yes

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PF Controllers BR604 and BR6000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

Selection table

	BR604	BR6000-R6	BR6000-R12	BR6000-T6
Ordering code	B44066R6004E230	B44066R6006E230	B44066R6012E230	B44066R6106E230
		HD-version	**HD-version**	
Ordering code		B44066R6506E230	B44066R6512E230	
Parameters displayed				
Voltage (V)	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Apparent current (A)	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Reactive power (kvar)	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Active power (kW)	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Apparent power (kVA)	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
kvar-value to targt cos-φ	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Energy	–	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Frequency	–	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Temperature	–	alphanumeric: real value °C/°F	alphanumeric: real value °C/°F	alphanumeric: real value °C/°F
Real-time cos-φ	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Target cos-φ	yes	alphanumeric: real value	alphanumeric: real value	alphanumeric: real value
Individual harmonics up to	–	19^{th}	19^{th}	–
TDV-THD-I	–	yes	yes	–
Recall recorded values				
Min. and max. voltage	only max.	yes	yes	yes
Maximum active power	yes	yes	yes	yes
Maximum reactive power	yes	yes	yes	yes
Maximum apparent power	yes	yes	yes	yes
Maximum value THD-V, THD-I	–	yes	yes	–
Maximum temperature (°C)	–	yes	yes	yes
Operation time of all capacitors	–	yes	yes	–
Number of contactor switching operations	–	yes	yes	–
Others				
Switching time	1 … 255 s	1 … 1200 s	1 … 1200 s	20 … 1000 ms
Weight	0.5 kg	1 kg	1 kg	1 kg
Dimensions	100 x 100 x 40 mm	144 x 144 x 55 mm	144 x 144 x 55 mm	144 x 144 x 55 mm
Suitable for dynamic PFC	no	no	no	yes

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PF Controllers BR7000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

Selection table

	BR7000	**BR7000-I**	**BR7000-I-TH**
Ordering code	B44066R7415E230	B44066R7012E230	B44066R7412E230
	HD-version	**BR7000-I/S485**	**BR7000-I-TH/S485**
Ordering code	B44066R7515E230	B44066R7112E230	B44066R7612E230
	BR7000-T		
Ordering code	B44066R7615E230		
Supply voltage	110 … 440 V~ 50/60 Hz	110 … 440 V~ 50/60 Hz	110 … 440 V~ 50/60 Hz
Measurement voltage	3 x 30 … 440 V AC (L-N) 3 x 50 … 760 V AC (L-L)	30 … 440 V AC (L-N) 50 … 760 V AC (L-L)	30 … 440 V AC (L-N) 50 … 760 V AC (L-L)
Power consumption	< 3 VA	< 5 VA	< 5 VA
Operating temperature	–20 … +60 °C, HD-version –40 … +60 °C	–20 … +60 °C	–20 … +60 °C
Display	illuminated graphic display, 128 x 64 dots; HD-version OLED graphic display, yellow	illuminated graphic display, 128 x 64 dots	illuminated graphic display, 128 x 64 dots
Large display of 3 grid parameters	selection in display editor	selection in display editor	selection in display editor
Plain language	GER/E/ES/RU/TR	CZ/E/ES/F/GER/ NL/PL/PT/RU/TR	CZ/E/ES/F/GER/ NL/PL/PT/RU/TR
Number of relay outputs	BR7000: 15 relay outputs, freely programmable for switching of 1- or 3-phase capacitors	12 … 13 switching outputs	12
Number of transistor outputs	BR7000-T: 15 transistor outputs, freely programmable for switching of 1- or 3-phase capacitors	–	12
Alarm/Message relay	1/1	1 alarm 1 message (version with interface)	1 alarm 1 message (version with interface)
Additional separate fan relay	yes	–	–
Interface	2 independent isolated RS485	RS485 with version BR7000-I/S485	RS485 with version BR7000-I-TH/S485
Input 2nd parameter set switchover target PF	yes	version /S only	version /S only
Measuring	three-phase	single-phase	single-phase
Controlling	single-phase, three-phase, mixed mode	three-phase	three-phase
Automatic initialization	–	yes	–
Test run of complete PFC-system	only BR7000 and BR7000-HD	yes	–
Internal timers	yes	–	–
Oscilloscope (graphical display) mode	yes	–	–
Display editor	yes	yes	yes
Backward navigation ESCAPE button	yes	yes	yes
HELP button for interactive help text	yes	yes	yes
Number of control series	23 series pre-set	20 series pre-set	20 series pre-set
Control series editor for free programming	yes	yes	yes

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PF Controllers BR7000 Series

Various types of PF controllers ● User-friendly ● Customized solutions

Selection table

	BR7000	**BR7000-I**	**BR7000-I-TH**
Ordering code	B44066R7415E230	B44066R7012E230	B44066R7412E230
	HD-version	**BR7000-I/S485**	**BR7000-I-TH/S485**
Ordering code	B44066R7515E230	B44066R7112E230	B44066R7612E230
	BR7000-T		
Ordering code	B44066R7615E230		
Parameters displayed			
Voltage (V)	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Apparent current (A)	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Reactive power (kvar)	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Active power (kW)	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Apparent power (kVA)	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
kvar-value to targt cos-φ	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Energy	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Frequency	alphanumeric: real value / large display	alphanumeric: real value / large display	alphanumeric: real value / large display
Temperature	real value / large display °C/°F	real value / large display °C/°F	real value / large display °C/°F
Real-time cos-φ	real value / large display	real value / large display	real value / large display
Target cos-φ	real value / large display	real value / large display	real value / large display
Individual harmonics up to	up to 31st real value / in % / bar graph	odd up to 33rd/ even and odd up to 17th; real value / in % / bar graph	odd up to 33rd/ even and odd up to 17th; real value / in % / bar graph
TDV-THD-I	real value / in % / bar graph	real value / in % / bar graph	real value / in % / bar graph
Time/Date	yes	only BR7000-I/S485	only BR7000-I-TH/S485
Recall recorded values			
Min. and max. voltage	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum current	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum active power	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum reactive power	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum apparent power	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum value THD-V, THD-I	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Maximum temperature (°C)	yes, with time stamp	yes, version /S with time stamp	yes, version /S with time stamp
Operation time of all capacitors	only BR7000 and BR7000-HD	yes	–
Number of contactor switching operations	only BR7000 and BR7000-HD	yes	–
Others			
Switching time	20 … 1000 ms (version T) 1 … 1200 s (standard)	1 … 1200 s	dynamic part: 20 … 1000 ms relay part: 1 … 1200 s
Weight	1 kg	1 kg	1 kg
Dimensions	144 x 144 x 50 mm	144 x 144 x 55 mm	144 x 144 x 55 mm
PC-software included	yes	only version BR7000-I/S485	only version BR7000-I-TH/S485
Suitable for dynamic PFC	only BR7000-T	no	yes
Suitable for TSM-LC-S via interface	no	no	only version BR7000-I-TH/S485

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Accessories for PF Controller Series BR6000 and BR7000

BR7000-SOFT

BR7000-SOFT Windows-based software
This program offers the possibility for a comfortable parameterization, recording, analysis and visualization of grid parameters in online operation via a PC. It is compatible with PF controller series BR7000. The software allows the recording and a graphical evaluation of all values including export- and print function. The spectrum of harmonics can be displayed as bar chart. The configuration manager is used for a complete read out, editing, storing and writing of all parameters of the PF controller via PC. All data can be stored in a configuration file.

Features

- Connection to RS485-bus
- Administration of several PF controllers possible
- Convenient analysis of recorded values
- Direct connection to USB port of a PC via USB adapter
- CD-ROM included in the delivery of PF controller BR7000

IF8000 Interface-Module

IF8000 Interface-Module for BR7000-I (Version 4 onwards) and MMI8003 for devices with service interface to add an additional interface (RS485 – Modbus-RTU). The PF controller BR7000-I will automatically identify the second interface and will extend the internal menus. Remote read-out of grid parameters; compatible with energy storage device MMI-energy. Storage and display via PC-software in online operation. Potential free, for alignment of up to 255 devices. Control LED Tx and Rx. Power supply via basic devices (no external feed-in required). Integrated switchable termination.
Ordering code: B44066R7013E230

DataLogSD

DataLogSD in compact plastic casing for recording, visualisation and evaluation for grid parameters. Comfortable evaluation of accquired data (recorded on SD-card) via Windows-based software.
Ordering code: B44066R1311E230

USB to RS485 converter

USB to RS485 converter to connect the PF controllers BR7000, BR7000-I/S485 and BR7000-I-TH/S485 or other devices with interface RS485 to a PC with USB interface. Connection of several devices at RS485 possible.
Ordering code: B44066R3333E230

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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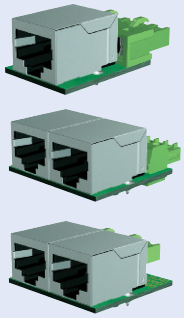
Accessories for PF Controller Series BR6000 and BR7000

RJ45 adapter



RJ45 adapter, connectors for PF controller series BR7000 and BR7000-I-TH/S485 as well as for the MMI6000 multi-measuring interface. Three different versions of the adapter connectors enable the following configurations:

- Terminal to RJ45 converter
- To connect the interface terminal of BR7000 and BR7000-I-TH/S485 or MMI6000 via a RJ45-standard cable (1:1)
- Connection of several devices at the RS485 bus with simple connection (one click)
- Example:
  Connection of several BR7000, BR7000-I/S485 and BR7000-I-TH/S485 to a PC with BR7000-SOFT, coupling of several BR7000-I/S485 with each other

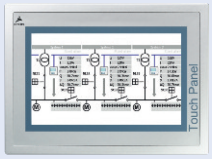
Variants

1 x RJ45 for BR7000, BR7000-I/S485 and BR7000-I-TH/S485
Ordering code: B44066R1611E230

2 x RJ45 for BR7000, BR7000-I/S485 and BR7000-I-TH/S485
Ordering code: B44066R1711E230

2 x RJ45 for MMI6000
Ordering code: B44066R1811E230

Touch panel VIP-X-TP



Touch panel VIP-X-TP, comfortable control device for intelligent coupling of 3 to 5 compensation systems. Enables operation of compensation systems in parallel for 3 to 5 coupled feeding transformers without any retroactivity. The control device VIP-X-TP realizes the coupling with PF controllers BR7000-I/S485 and at the same time offers a comfortable visualization of the measured values, switching states and of the actual system state. To achieve this, the device is connected to the PF controllers via patch-cables only (RS485-interface). All possibilities of coupling are supported:

- Coupling with coupling switches
- Ring coupling
- Coupling via separate coupling bus bars

Variants

VIP-3-TP

Coupling of 3 compensation systems
Ordering code: B44066R1703E230

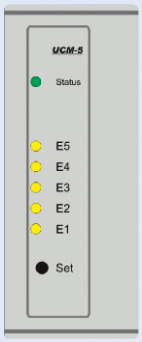
VIP-4-TP

Coupling of 4 compensation systems
Ordering code: B44066R1704E230

VIP-5-TP

Coupling of 5 compensation systems
Ordering code: B44066R1705E230

UCM-5



UCM-5, bus compatible S0-impulse module for software MMI-energy for conversion of counter impulses (Q+, Q–, P+, P–, synchronic) on RS485 (Modbus RTU protocol)

- Accessory for processing of counter values in PF controller (controlling of reactive power related to counter impulses instead of current transformer)
- Allows processing of counter values via Windows-software MMI-energy (included in the delivery): cost center management, visualization and evaluation
- Cross-linking of up to 32 devices (UCM-5, MMI6000, MMI7000, MMI8003, BR7000) at Modbus
- Compact design in plastic case
- Mounting on DIN-rail possible
- Evaluation software included in the delivery

Ordering code: B44066R1411E230

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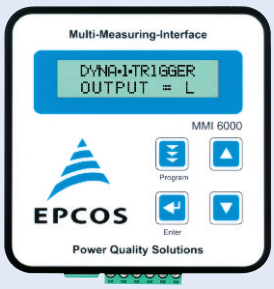
Please read *Important notes* on page 12 and *Cautions* on page 121–125

Multi Measuring Interfaces

Stand-alone device as trigger ● Accessory for PF controller BR-series

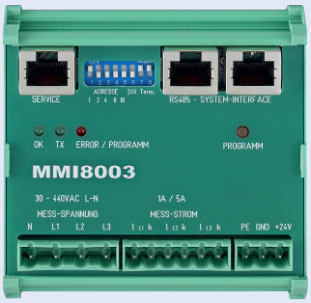
General

The MMI6000, MMI7000 and MMI8003, universal measuring devices, display and record a large number of key grid parameters. Harmful conditions in the grid (e.g. a high harmonic content) with a negative impact on the system are thus revealed immediately.



MMI6000

MMI7000



MMI8003

MMI6000

Measuring device for single-phase measuring. It is an external meter combining many devices in one. Combined with a PF controller with interface the MMI6000 monitors the input lead of the PFC system.

Versions:
– MMI6000-R with relay output
– MMI6000-T with transistor output
All versions are with an interface RS485.

Applications

Coupling MMI6000 – BR7000 via RS485 interface

- Genuine monitoring of the particular capacitor currents offers additional protection for the whole PFC system.

MMI6000 / Modbus RTU

- Usage as separate measuring device allows display of all network parameters and delivery via Modbus RTU protocol.

MMI6000 / ASCII OUT

- Measured values are provided in ASCII code via interface; usage also as a trigger relay.

MMI6000-T Dyna-I-trigger

- Triggering of TSM thyristor switches in real time, providing the switching within 1 ms.

MMI7000 (V4)

Supported by the BR7000-SOFT (Windows-based software) if connected to a RS485 bus, the measured values from all connected devices can be displayed via a PC.

Features

- Power supply 110 to 440 V AC
- SD card for recording all grid parameters
- 2 independent interfaces RS485
- 4 relay outputs freely programmable

Applications

Three-phase measuring device in panels

- Grid measurements
- Power measurements
- Measurement of harmonics
- Energy counter (sub-counter)
- Display device in incoming supply or all outgoing lines
- Triggering of messages or switching operations
- Four relay outputs
- Storage of all grid parameters – long-term monitoring via SD card
- Transmitter for external systems
- Coupling with PF controllers with interface for 3-phase external monitoring of the capacitor currents – additional protection for the whole PFC system

MMI8003

Genuine measuring device for three-phase measuring. Supported by the BR7000-SOFT (windows-based software) it has to connect to a RS485 bus, the measured values from all connected devices can be displayed and processed via a PC or an external control system.

– without display
– for using inside a cabinet
– interface 1x RS485 (Modbus RTU)
– mounting on hut rail

Applications

Three-phase measuring device in panels

- Grid measurements
- Power measurements
- Measurement of harmonics
- Energy counter (sub-counter)
- Display device in incoming supply or all outgoing lines

All values can be read out via Modbus in real time.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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Multi Measuring Interfaces

Stand-alone device as trigger ● Accessory for PF controller BR-series

Technical data

	MMI6000	MMI7000	MMI8003
Weight	0.5 kg	1.0 kg	0.5 kg
Dimensions (h x w x d)	panel mounting instrument 100 x 100 x 45 mm	panel mounting instrument 144 x 144 x 60 mm	plastic casing for hut rail mounting, 92 x 90 x 38 mm
Interface	1× RS485 (4-pole terminal); Modbus RTU	2× RS485; Modbus RTU	1× RS485; Modbus RTU
Windows-software BR7000-soft	–	included in the delivery	included in the delivery, additional PC-software for parametrization
Output capacity	MMI6000-R: 250 V AC, 1000 W MMI6000-T: 60 V DC, 150 mA	MMI7000: 250 V AC, 1000 W	n/a
Display	graphical, 2 x 16 characters, illuminated	graphical, 128 x 64 dots, illuminated	n/a
Menu languages	English/German	English/German/Russian/ Spanish/Turkish	n/a
Measuring and display	single-phase V, I, F, Q, P, S, cos-φ, W, temperature	three-phase V, I, F, Q, P, S, cos-φ, THD-V, THD-I, W, harmonic of voltage up to 51st, harmonic of current up to 51st, temperature	three-phase V, I, Q, P, S, F, THD-V, THD-I, W, cos-φ, single harmonics of voltage and current. All values can be read out via Modbus in real time
Operating voltage	230 V AC	110 … 440 V AC ±15 %	24 V DC (via external terminal)
Measuring voltage	230 V AC	three-phase 3 · 30 … 440 V AC (L-N) 3 · 50 … 760 V AC (L-L)	three-phase 3 · 30 … 440 V~ (L-N) 3 · 50 … 690 V~ (L-L)
Frequency	50/60 Hz	50/60 Hz	10 … 80 Hz
Power consumption	< 4 VA	< 5 VA	< 1 VA
Measurement current	X:5A and X:1A	3 × X:5A / X:1A	3 × X:5A / X:1A selectable
Measuring temperature range	0 … +100 °C	–20 … +100°C	n/a
Ambient temperature range	–10 … +55 °C	–10 … +50 °C	–10 … +55 °C
Storage temperature range	–20 … +75 °C	–20 … +60 °C	–20 … +75 °C
Overvoltage class	II	II	II
Pollution degree	2	2	2
Humidity class	15 … 95% without dew	15 … 95% without dew	15 … 95% without dew
Mounting position	any	any	any
Protection class to IEC 60529	front IP54, rear IP20	front IP54, rear IP20	IP20
Safety guidelines	IEC 61010-1:2001, EN 61010-1:2001	IEC 61010-1:2001, EN 61010-1:2001	IEC 61010-1:2001, EN 61010-1:2001
Sensitivity to interferences (industrial areas)	IEC 61000-4-2:8 kV, IEC 61000-4-4:4 kV	IEC 61000-4-2:8 kV, IEC 61000-4-4:4 kV	IEC 61000-4-2:8 kV, IEC 61000-4-4:4 kV
Ordering code	MMI6000-R: B44066M6000E230 MMI6000-T: B44066M6100E230	B44066M7500E230	B44066M8003E024

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Grid Analysis Tool MC7000-3

Three-phase measuring ● Easy evaluation of data ● Memory card included

General

The measuring device MC7000-3 has been developed for three-phase measuring, display and storage of electric parameters in low-voltage grids. The Windows-based software (included in the delivery) allows a fast and comfortable evaluation of the measured data. Based on the findings of this evaluation the optimum design for a tailormade PFC solution or the inspection of an existing one is easily performed. The collected data is available in Excel-format giving the user further processing options. As an additional feature the MC7000-3 is equipped with an SD memory card slot. A memory card for data storage and easy passing on to a PC is already included in the delivery.
Featuring an illuminated 128 x 64 graphic display and a large number of configuration options for data collection, display and storage the new standard measuring tool is flexible and easy to use in the field. Additionally its compact design and the light weight suitcase make it easy to transport. A further benefit for very user is the availability of not only English, but also German, Spanish, Russian and Turkish as menu languages.

Features

- Measuring, display and storage of numerous parameters
  - Voltage (3-phase)
  - Current (3-phase)
  - Frequency (3-phase)
  - Active power (3-phase)
  - Reactive power (3-phase)
  - Apparent power (3-phase)
  - Power factor (3-phase)
  - Active, reactive and apparent energy
  - Voltage harmonics (up to 51st)
  - Harmonics of current (up to 51st)
  - TDH-V (3-phase)
  - THD-I (3-phase)
  - Temperature
- Comfortable programming of recording interval and duration via timers
- Display and internal storage of maximum values with time stamp
- Display of date and time
- Display of harmonics, bar diagram available
- Large number of display options e.g. rotating display and adjustment of font size

PC software included

- Software for evaluation of grid parameters for Windows operating system
- Administration of several projects possible
- Graphical display
  - Several pre-configured graphical display of standard values
  - Graphical display of selected grid values, large number of configuration options
  - Comfortable editing of parameters and time interval
  - Display as line graph or bar diagram
  - Copy into clipboard and print function available
- Mathematical evaluation of measured values
  - Automatic calculation of required kvar (target-cos-φ to be set by user)
  - Evaluation of measured harmonics and recommendation of detuning factor of a PFC system of calculated size
  - Influence of detuning on the harmonics for the calculated detuning factor and system size is provided

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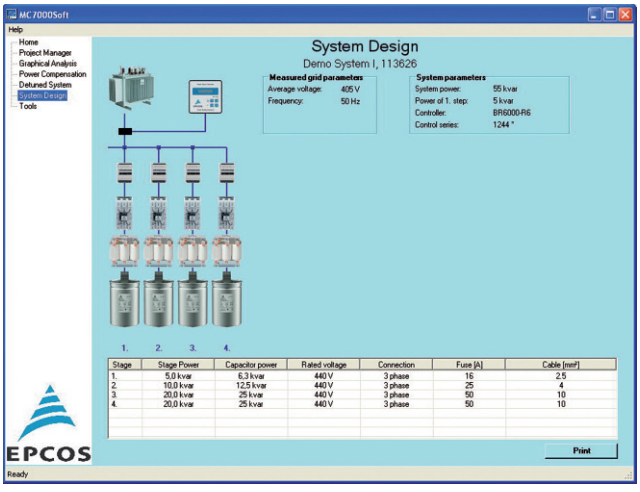
Grid Analysis Tool MC7000-3

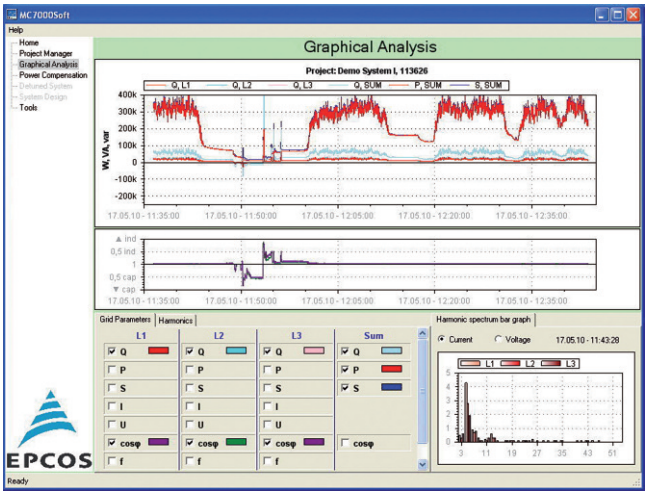
Three-phase measuring ● Easy evaluation of data ● Memory card included

Technical data

Weight	approx. 4 kg
Dimensions (h x w x d)	compact light weight plastic suitcase 390 x 310 x 147 mm (outside dimensions)
Operating voltage (auxiliary voltage)	110 … 230 V AC ±15%
Power consumption	< 5 VA
Frequency	50/60 Hz
Max. measuring voltage[1] (3-phase)	3 · 30 … 440 V AC (L-N), 50/60 Hz 3 · 50 … 760 V AC (L-L), 50/60 Hz
Measuring current (3-phase)	30, 300, 3000 A (MiniFlex flexible current clamps, to be ordered separately)
Display	illuminated, full graphic, 128 x 64 dots
Menu	D / E / ES / RU / TR
Ambient temperature range (operation)	–10 ... +50 °C
Storage temperature range	–20 ... +60 °C
Pollution degree	2
Overvoltage class	CAT III
Protection degree accord. IEC 60529	IP40
Connection	N connection mandatory, PE in case N not available
Security	IEC 61010-1 : 2001, EN 61010-1 : 2001
Ordering code	B44066M7777E230
Accessories included	3 safety voltage measuring cables 2 m (black, red, violet), 1000 V, CAT IV, incl. high power fuse 1 safety voltage measuring line 2 m, blue, 1000 V, CAT III 4 safety dolphin clips 1000 V, CAT III, black, red, violet, blue Windows-based software CD-ROM low power device connection
Accessory mandatory, but not included	3 flexible MiniFlex current clamps, cable 2.8 m, 600 V_{rms} (CAT IV), 1000 V_{rms} (CAT III) max. 3000 A, sensor 400 mm
Ordering code	1 piece: B44066M1301E230
Ordering code	3 pieces: B44066M1303E230

[1] Incl. all tolerances and overvoltages





Switching Devices – Capacitor Contactors

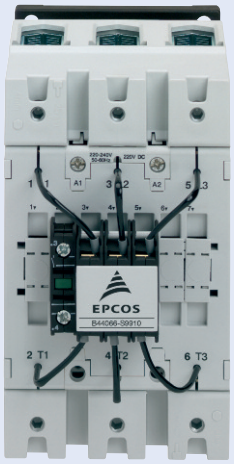
Specially designed for damping of inrush current in LV PFC systems

General

When a capacitor is switched to an AC voltage, the result is a resonant circuit damped to a greater or lesser degree. The switching of capacitors can cause high inrush currents, particularly when they are switched in parallel to others already activated in the power line, and if high short-circuit powers are present on the line.

Capacitor contactors with damping resistors make use of pre-switching auxiliary contacts. They close before the main contacts and pre-load the capacitor thus avoiding current peak values.

This influences positively the life expectancy of the capacitor significantly in addition to the positive impact on the power quality (avoiding transients and voltage sags that otherwise may be caused by switching in capacitors).



Applications

- Damping of inrush current in low-voltage PFC systems
- For PFC systems with and without reactors

Features

- Excellent damping of inrush current
- Improved power quality (e.g. avoidance of voltage sags)
- Longer useful service life of main contacts of capacitor contactor
- Soft switching of capacitor and thus longer useful service life
- Enhanced mean life expectancy of PFC system
- Reduced ohmic losses
- Leading contacts with wiper function
- Tamper-proof and protected resistors
- Easy access for cable connection
- Voltage range: 400 … 690 V
- Output range: 12.5 … 100 kvar
- AC6b utilization category

Approvals

- cUL file 224924
- CCC
  (Certificate for China Compulsory Product Certification)

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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Switching Devices – Capacitor Contactors

Specially designed for damping of inrush current in LV PFC systems

Technical data

Type Main contacts			B44066*****J230/J110 S1810	S2410	S3210	S5010	S6210	S7410	S9010	S9910
Rated insulation voltage V_I **Admissible frequency of operation** **Contact life**	V_{IS}	[V AC] 1/h million operations	690[1)] 120 0.25	690[1)] 120 0.15	690[1)] 120 0.15	690[1)] 120 0.15	690[1)] 120 0.15	690[1)] 80 0.12	1,000[1)] 80 0.12	1,000[1)] 80 0.12
Cable cross section solid or standard		[mm²]	1.5–6	2.5–25	2.5–25	4–50	4–50	4–50	0.5–95/10–120	0.5–95/10–120
flexible		[mm²]	1.5–4	2.5–16	2.5–16	10–35	10–35	10–35	0.5–70/10–95	0.5–70/10–95
flexible with multicore cable end		[mm²]	1.5–4	2.5–16	2.5–16	6–35	6–35	6–35	0.5–70/10–95	0.5–70/10–95
Cables per clamp			2	1	1	1	1	1	2	2
Operating range of magnet coils in multiples of control voltage	V_S		0.85–1.1	0.85–1.1	0.85–1.1	0.85–1.1	0.85–1.1	0.85–1.1	0.85–1.1	0.85–1.1
Auxiliary contacts[1)] **Rated insulation voltage V_I**	V_{IS}	[V AC]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]
Rated current I_{th} at ambient temperature max. 40 °C		I_{coth} [A]	16	10	10	10	10	10	10	10
max. 60 °C		I_{coth} [A]	12	6	6	6	6	6	6	6
Utilization category AC15 220 to 240 V		I_{coth} [A]	12	3	3	3	3	3	3	3
380 to 440 V		I_{coth} [A]	4	2	2	2	2	2	2	2
Short circuit protection Highest fuse rating slow, gL (gG) Auxiliary contacts		I_{coth} [A] NO / NC	25 1 / 0	20 1 / 0	20 1 / 0	20 1 / 0	20 1 / 0	20 1 / 0	20 1 / 0	20 1 / 0

IEC 947-4-1, IEC 947-5-1, EN 60947-4-1, EN 60947-5-1, VDE 0660. Dimensional drawing: see datasheet

[1)] Applies to networks with grounded star point, overvoltage category I to IV, pollution severity 3 (industrial standard), V_{imp} = 8 kV. Values for other conditions on request.

Switching Devices – Capacitor Contactors

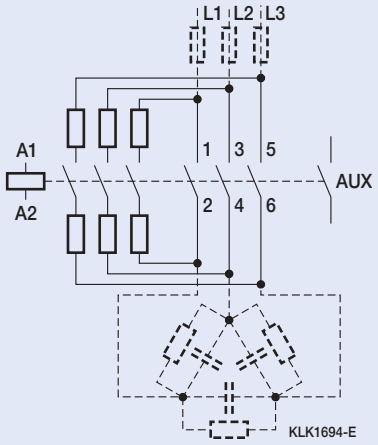
Specially designed for damping of inrush current in LV PFC systems

Main technical parameters

Capacitor power at ambient temperature, voltage, 50 / 60 Hz						Rated current		Weight	Ordering code
380 … 400 V		415 … 440 V		660 … 690 V					
+50 °C kvar	+60 °C kvar	+50 °C kvar	+60 °C kvar	+50 °C kvar	+60 °C kvar	+50 °C A	+60 °C A	kg	
110 V coil									
0–12.5	0–12.5	0–13	0–13	0–20	0–20	18	18	0.34	B44066S1810J110
10–20	10–20	10.5–22	10.5–22	17–33	17–33	28	28	0.60	B44066S2410J110
10–25	10–25	10.5–27	10.5–27	17–41	17–41	36	36	0.60	B44066S3210J110
20–50	20–50	23–53	23–53	36–82	36–82	72	72	1.10	B44066S6210J110
20–75	20–60	23–75	23–64	36–120	36–100	108	87	1.10	B44066S7410J110
33–80	33–75	36–82	36–77	57–120	57–120	115	108	2.30	B44066S9010J110
33–100	33–90	36–103	36–93	57–148	57–148	144	130	2.30	B44066S9910J110
230 V coil									
0–12.5	0–12.5	0–13	0–13	0–20	0–20	18	18	0.34	B44066S1810J230
10–20	10–20	10.5–22	10.5–22	17–33	17–33	28	28	0.60	B44066S2410J230
10–25	10–25	10.5–27	10.5–27	17–41	17–41	36	36	0.60	B44066S3210J230
20–33.3	20–33.3	23–36	23–36	36–55	36–55	48	48	1.10	B44066S5010J230
20–50	20–50	23–53	23–53	36–82	36–82	72	72	1.10	B44066S6210J230
20–75	20–60	23–75	23–64	36–120	36–100	108	87	1.10	B44066S7410J230
33–80	33–75	36–82	36–77	57–120	57–120	115	108	2.30	B44066S9010J230
33–100	33–90	36–103	36–93	57–148	57–148	144	130	2.30	B44066S9910J230

Connection diagrams

All types B44066S**J*** (with preload resistors), B44066S1810J230 and B44066S1810J110 with wires on the bottom, B44066S9010J230 and B44066S9910J230 with resistors inside housing**



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Switching Devices – Thyristor Modules for Dynamic PFC, TSM-Series

General

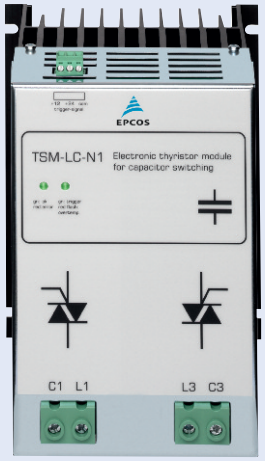
Conventional systems for power factor correction are used to optimize the power factor and reduce the level of harmonics in the grid. The usage of new technologies in modern industry has negative impacts on electric power quality of the main supply networks, e.g. frequent high load fluctuations and harmonic oscillation.

Excessive currents, increased losses and flickering will not only influence the supply capacity but will also have a significant impact on the operation of sensitive electronic devices.

The solution for this are dynamic power factor correction systems.

With the thyristor module series TSM-LC, we provide the main component – "the electronic switch" – for dynamic power factor correction.

The TSM module series offers fast electronically controlled, self-observing thyristor switches for capacitive loads up to 200 kvar, that are capable to switch PFC capacitors within a few milliseconds nearly without a limitation to the number of switchings during the capacitor lifetime.



Applications

- Main supply networks with high load fluctuations for dynamic PFC systems
- Presses
- Welding machines
- Elevators
- Cranes
- Wind turbines

Features

- Easy installation: it can be used similar to a contactor
- All the intelligence needed is offered within the thyristor module itself
- Reaction time: 5 milliseconds only
- Permanent self-controlling of:
  - voltage parameter
  - phase sequence
  - capacitor output
- Display of
  - operation
  - faults
  - activation
- TSM-LC-I: Single-phase, for direct 2-phase switching of capacitive loads (L-N) or (L-L)
- TSM-LC-S: Triggering of the module via system bus (patch cable) from PF-controller BR7000-I-TH/S485
  - Up to 32 devices at supported by controller
  - Display and monitoring of V, I, Q, temperature, switching state
  - Error display and evaluation via bus directly at PF-controller
  - Direct monitoring of temperature switch of filter reactor
- Voltage range:
  TSM-LC-I: 230 … 525 V AC
  TSM-LC*: 380 … 440 V AC
  TSM-LC-S: 200 … 440 V AC
  TSM-LC-N480: 380 … 480 V AC
  TSM-LC-N690: 380 … 690 V AC
- Output range:
  TSM-LC-I: 10 … 22 kvar, depending on the voltage
  TSM-LC: 10, 25, 50, 100, 200 kvar, depending on the voltage

*Available in three versions with 10, 100 or 200 kvar

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Switching Devices – Thyristor Modules for Dynamic PFC, TSM-Series

Selection table TSM-series

	TSM-LC-I[1]	TSM-LC10	TSM-LC-N1	TSM-LC-N480	TSM-LC-N690
Ordering code	B44066T1022E520	B44066T0010E402	B44066T3850E402	B44066T3850E408	B44066T3050E690
Rated voltage	230 … 525 V AC	380 … 400 V AC	380 … 440 V AC	380 … 480 V AC	380 … 690 V AC
Max. grid voltage: – in conventional PFC systems (without reactors)	525 V AC	440 V AC	440 V AC	480 V AC	690 V AC
– in detuned PFC system (7% detuning)	525 V AC	440 V AC	440 V AC	480 V AC	690 V AC
– in detuned PFC system (14% detuning)	525 V AC	400 V AC	max. 440 V AC	480 V AC	max. 690 V AC
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Maximum power / at nominal voltage	10 to 22 kvar depending on the voltage	12.5 kvar	25 to 50 kvar depending on the voltage	50 kvar depending on the voltage	40 to 75 kvar depending on the voltage
Power circuit	connection via plug connector; conductor cross section steep or flexible max 2 x 35 mm^2)	direct connection 4 pole via terminal clamps (D = 6 mm^2 resp. 4 mm^2)	direct connection via terminal clamps from the bottom	direct connection via terminal clamps from the bottom	direct connection via high current plug; connection from the bottom
Neutral required	no	no	no	no	no
Aux. supply voltage required	24 V DC	no	no	230 V AC/10 VA	230 V AC/10 VA
Connection	from front	from bottom	from bottom	from bottom	from bottom
Losses (PD in W)	Pv (in W) = 1.0 x I (in A); at nominal power: approx. 45 W (thermal)	Pv (in W) = 2.0 x I (in A); at 400 V/ 12.5 kvar approx. 35 W (thermal)	Pv (in W) = 2.0 x I (in A); at nominal voltage approx. 150 W thermal	Pv (in W) = 2.0 x I (in A); at nominal voltage approx. 150 W thermal	Pv (in W) = 2.4 x I (in A); appr. 150 W thermal at nominal current
Recommended fuses "superfast"	1× electronic fuse (NH00 AC 690 V) 63 A	3× electronic fuse (NH00 AC 690 V) 35 A	3× electronic fuse (NH00 AC 690 V) 50 kvar: 125 A 25 kvar: 63 A	3× electronic fuse (NH AC 690 V) 50 kvar: 125 A 25 kvar: 63 A	3× electronic fuse (NH00 AC 690 V) 125 A
Dimensions in mm (w x h x d)	70 x 200 x 150	163 x 152 x 75	157 x 200 x 180	157 x 200 x 180	157 x 200 x 190
Weight	1.5 kg	1.75 kg	approx. 4.8 kg	approx. 4.8 kg	approx. 4.8 kg
Display per phase	3 LED	2 LED	2 LED	2 LED	2 LED
Ambient temperature	–10 … +55 °C	–10 … +55 °C	–10 … +55 °C	–10 … +55 °C	–10 … +55 °C
Discharge resistors EW-22 needed	not needed	1	1	1	2
Current limitation reactor BD… needed[2]	1	2	2 x BD100	2 x BD100	2 x BD100

[1] Only for operation with single-phase capacitors.
[2] For PFC systems without detuning reactors mandatory.

Accessories for TSM modules

	BD050[1]	BD050/480[1]	BD100	BD100/480[1]	BD200[2]
Ordering code	B44066T0050E400	B44066T0050E480	B44066T0100E400	B44066T0100E480	B44066T0200E400
Nominal voltage	400/440 V	480 V	400/440 V	480 V	400/440 V
Nominal current	50 A	50 A	85 A	85 A	170 A
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Dimensions (w x d x h)	56 x 71 x 70 mm	65 x 58 x 82 mm	75 x 75 x 88 mm	75 x 75 x 88 mm	104 x 114 x 125 mm
Weight	approx. 1.5 kg	approx. 1.5 kg	approx. 2 kg	approx. 2 kg	approx. 6 kg

[1] Production only after ordering. [2] Only suitable for TSM-LC100.

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Switching Devices – Thyristor Modules for Dynamic PFC, TSM-Series

	TSM-LC-S	TSM-LC100	TSM-LC200
	B44066T1050E402	B44066T0100E402	B44066T0200E402
	200 … 440 V AC	380 … 400 V AC	380 … 400 V AC
	440 V AC	440 V AC	440 V AC
	440 V AC	440 V AC	440 V AC
	max. 440 V AC	400 V AC	400 V AC
	50/60 Hz	50/60 Hz	50/60 Hz
	15 to 55 kvar depend-ding on the voltage	100 kvar	200 kvar
	direct connection via high current plug; connection from the bottom	direct connection 4 pole via busbar (cable lug 70 mm², D = 10 mm)	direct connection 4 pole via busbar (cable lug 185 mm², D = 12 mm)
	no	no	no
	24 V DC via power supply module ESP24	230 V AC (needed for fan) via terminal clamp	230 V AC
	from bottom	from bottom	from top
	Pv (in W) = 2.0 x I (in A); at nominal voltage approx. 150 W thermal	Pv (in W) = 2.0 x I (in A); typical 300 W (thermal)	Pv (in W) = 2.0 x I (in A); at 400 V/200 kvar approx. 580 W (thermal)
	3× electronic fuse (NH00 AC 690 V) 125 A	3× NH1 (AC 690 V) 250 A	3× NH2 (AC 690 V) 125 kvar: 315 A 150 kvar: 350 A 200 kvar: 450 A
	157 x 200 x 180	157 x 240 x 195	250 x 480 x 160
	approx. 5 kg	5.5 kg	11.5 kg
	OLED-display 2 x 16 characters	2 LED	2 LED
	–10 … +55 °C	–10 … +55 °C	–10 … +55 °C
	1	1–2 in parallel	2–4 in parallel
	2 x BD100	standard applica-tions require a special current limitation reactor	standard applica-tions require a special current limitation reactor

	BD200/480[2)]
	B44066T0200E480
	480 V
	170 A
	50/60 Hz
	104 x 114 x 125 mm
	approx. 6 kg

Accessories for TSM modules

Type / Description	
Discharge resistors EW-22 at least 1 piece per step to be used for all types of TSM if fast re-switching time is required.[1)] For higher rated steps please contact our local sales office.	
EW-22:	
Dimensions (w x d x h):	90 x 50 x 100 mm
Weight (approx.):	0.3 kg
Design panel:	for mounting on heat sink/fitting
Connection:	screw terminal, ready for three-phase connection to the capacitor

Ordering code
B44066T0022E400

[1)] Consisting of two single resistors of 22 kΩ each

EW-22

BD100

BD-Series:
Single-phase current limitation reactor for thyristor modules TSM series in conventional dynamic PFC systems without reactor

- Used for limitation of the pace of current increase dI/dT in the thyristors to the maximum permissible value
- Protection of thyristor modules series TSM-LC

Accessories PF controller

Features

- ESP-24 Feed-in module (power supply) for TSM-LC-S
- For feed-in of operating voltage 24 V DC into the network
- 1 module per max. 10 thyristor switches required
- Mounting on DIN rack (top hat rail)
- Mounting position random

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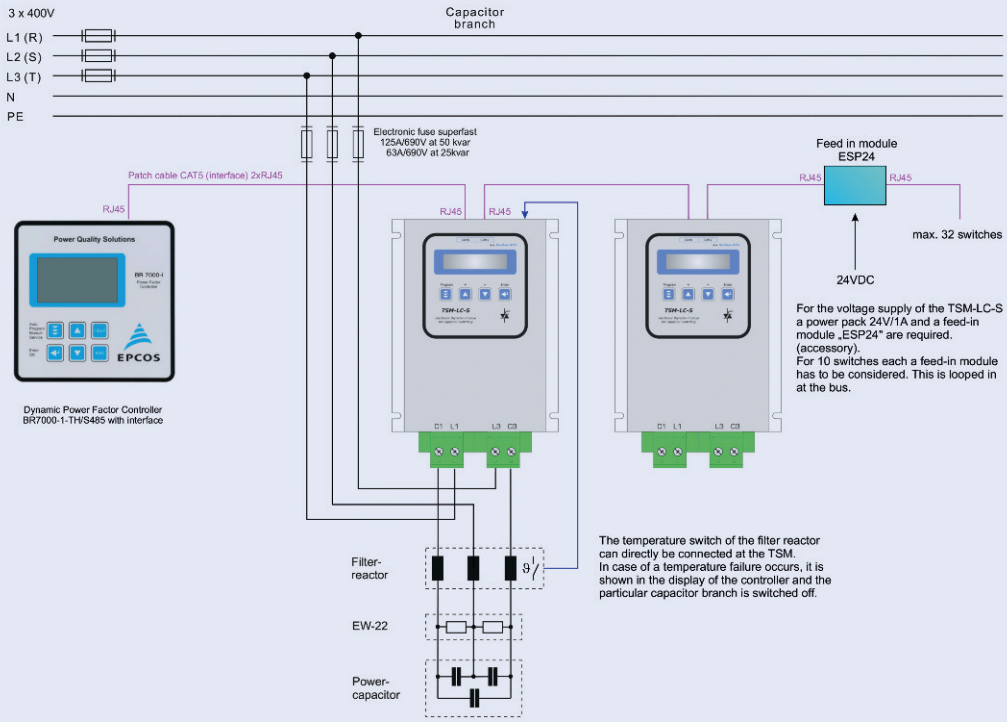
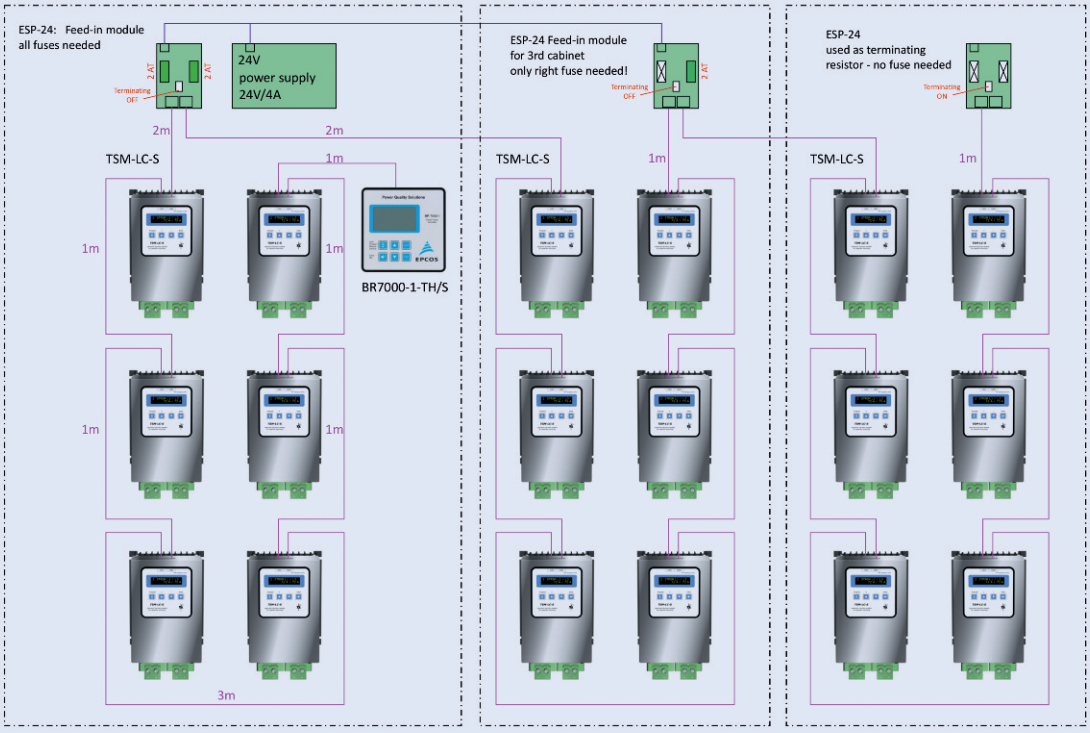
Switching Devices – Thyristor Modules for Dynamic PFC, TSM-Series

Dynamic PFC network with TSM-LC-S



Dynamic PFC network: complete system; easy connection with standard patch-cable



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Reactors – Antiresonance Harmonic Filter

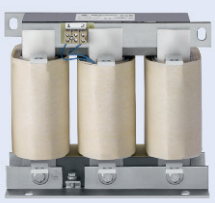
General

The increasing use of modern power electronic apparatus (drives, uninterruptible power supplies, etc) produces nonlinear current and thus influences and loads the network with harmonics (line pollution).

The power factor correction or capacitance of the power capacitor forms a resonant circuit in conjunction with the feeding transformer. Experience shows that the self-resonant frequency of this circuit is typically between 250 and 500 Hz, i.e. in the region of the 5th and 7th harmonics.

Such a resonance although can lead to the following undesirable effects:
– overloading of capacitors,
– overloading of transformers and transmission equipment,
– interference with metering and control systems, computers and electrical gear,
– resonance elevation, i.e. amplification of harmonics,
– voltage distortion.

These resonance phenomena can be avoided by connecting capacitors in series with filter reactors in the PFC system. These so called "detuned" PFC systems are scaled in a way that the self-resonant frequency is below the lowest line harmonic. The detuned PFC system is purely inductive seen by harmonics above this frequency. For the base line frequency (50 or 60 Hz usually), the detuned system on the other hand acts purely capacitive, thus correcting the reactive power.



Applications

- Avoidance of resonance conditions
- Tuned and detuned harmonic filters
- Reduction of harmonic distortion (network clearing)
- Reduction of power losses

Features

- High harmonic loading capability
- Very low losses
- High linearity to avoid choke tilt
- Low noise
- Convenient mounting
- Long expected life time
- Temperature protection (NC contact)

Technical data and limit values	
Filter reactors	
Harmonics*	V_3 = 0.5% V_R (duty cycle = 100%) V_5 = 6.0% V_R (duty cycle = 100%) V_7 = 5.0% V_R (duty cycle = 100%) V_{11} = 3.5% V_R (duty cycle = 100%) V_{13} = 3.0% V_R (duty cycle = 100%)
Effective current	$I_{rms} = \sqrt{(I_1^2+I_3^2 \ldots I_{13}^2)}$
Fundamental current	$I_1 = 1.06 \cdot I_R$ (50 Hz or 60 Hz current of capacitor)
Temperature protection	microswitch (NC)
Dimensional drawings and terminals	see specific datasheets
Three-phase filter reactors to VDE 0532 / EN 60289	
Frequency	50 Hz or 60 Hz
Voltage	400, 440
Output	10 … 100 kvar
Detuning	5.67%, 7%, 14%
Cooling	natural
Ambient temperature	+40 °C
Class of protection	I
Enclosure	IP00

* According to DIN ENV VV61000-2-2

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Reactors – Antiresonance Harmonic Filter

Characteristics

Power kvar	Δ capacitance 3 · µF	Inductance mH	I_{rms} (I_{eff}) A	Losses[1)] W	Weight kg	Terminal	Ordering code
Rated voltage V = 400 V, f = 50 Hz, p = 5.67% (f_r = 210 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 2.08 · I1							
10	62	3.06	18.5	95	6.4	10 mm² Kl.	B44066D5010*400
12.5	78	2.45	23.0	120	8.4	10 mm² Kl.	B44066D5012*400
20	125	1.53	36.9	100	13	16 mm² Kl.	B44066D5020*400
25	156	1.23	46.1	135	17	16 mm² Kl.	B44066D5025*400
40	250	0.77	73.7	150	23	M6 Al-flat	B44066D5040*400
50	312	0.61	92.1	240	31	M6 Al-flat	B44066D5050*400
75	496	0.41	138.2	260	35	M8 Al-flat	B44066D5075*400
100	625	0.31	183.8	360	47	M8 Al-flat	B44066D5100*400
Rated voltage V = 400 V, f = 50 Hz, p = 7% (f_r = 189 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.73 · I1							
10	61	3.84	16.4	70	5.9	10 mm² Kl.	B44066D7010*400
12.5	77	3.01	20.5	75	8.6	10 mm² Kl.	B44066D7012*400
20	123	1.92	32.7	120	18	Cu bars Ø 9 mm	B44066D7020*400
25	154	1.53	40.9	180	18	Cu bars Ø 9 mm	B44066D7025*400
40	246	0.96	65.4	230	26	Cu bars Ø 9 mm	B44066D7040*400
50	308	0.77	81.8	270	27	Cu bars Ø 9 mm	B44066D7050*400
75	462	0.51	122.7	330	39	Cu bars Ø 9 mm	B44066D7075*400
100	617	0.38	163.3	390	50	Cu bars Ø 11 mm	B44066D7100*400
Rated voltage V = 400 V, f = 50 Hz, p = 14% (f_r = 135 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.37 · I1							
10	57	8.29	15.4	80	9.4	10 mm² Kl.	B44066D1410*400
12.5	71	6.64	19.2	95	12	10 mm² Kl.	B44066D1412*400
20	114	4.15	30.8	150	22	Cu bars Ø 9 mm	B44066D1420*400
25	142	3.32	38.5	200	26	Cu bars Ø 9 mm	B44066D1425*400
40	228	2.07	61.6	270	38	Cu bars Ø 9 mm	B44066D1440*400
50	285	1.66	77	290	40	Cu bars Ø 9 mm	B44066D1450*400
75	427	1.11	115.5	380	58	Cu bars Ø 9 mm	B44066D1475*400
100	570	0.83	153.9	470	66	Cu bars Ø 11 mm	B44066D1499*400
Rated voltage V = 440 V, f = 50 Hz, p = 5.67% (f_r = 210 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 2.08 · I1							
10	51	3.71	16.8	100	7	10 mm² Kl.	B44066D5010*440
12.5	64	2.97	21.0	120	9	10 mm² Kl.	B44066D5012*440
25	129	1.48	42.0	110	16.5	16 mm² Kl.	B44066D5025*440
50	258	0.74	83.8	200	25	M6 Al-flat	B44066D5050*440
75	387	0.49	125.6	370	36	M8 Al-flat	B44066D5075*440
100	517	0.37	168.0	320	50	M8 Al-flat	B44066D5100*440

[1)] Total max. losses, considering max. specified overvoltage and harmonic currents

* EPCOS offers reactors with slightly different specifications (e.g. dimensions) that can be used for the same application although sometimes with slightly different resulting performances. These types are distinguished by different letters at digit 12 of the product code. Thus this digit is not specified here.

Other voltages upon request

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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Reactors – Antiresonance Harmonic Filter

Characteristics

Power	Δ capacitance	Inductance	I_{rms} (I_{eff})	Losses[1)]	Weight	Terminal	Ordering code
kvar	3 · µF	mH	A	W	kg		
Rated voltage V = 440 V, f = 50 Hz, p = 7% (f_r = 189 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.73 · I1							
10	50	4.64	14.9	70	6.5	10 mm² Kl.	B44066D7010*440
12.5	63	3.71	18.7	65	8.5	10 mm² Kl.	B44066D7012*440
25	127	1.87	37.2	170	18	Cu bars Ø 9 mm	B44066D7025*440
50	254	0.93	74.3	250	33	Cu bars Ø 9 mm	B44066D7050*440
75	382	0.62	111.4	340	43	Cu bars Ø 9 mm	B44066D7075*440
100	509	0.46	148.7	410	49	Cu bars Ø 9 mm	B44066D7100*440
Rated voltage V = 440 V, f = 50 Hz, p = 14% (f_r = 135 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.37 · I1							
10	47	10.04	14.0	90	10	10 mm² Kl.	B44066D1410*440
12.5	58	8.03	17.5	100	13	10 mm² Kl.	B44066D1412*440
25	117	4.02	35.0	160	27	Cu bars Ø 9 mm	B44066D1425*440
50	235	2.01	70.0	300	40	Cu bars Ø 9 mm	B44066D1450*440
75	353	1.34	105.0	440	53	Cu bars Ø 9 mm	B44066D1475*440
100	471	1.00	140.0	490	65	Cu bars Ø 9 mm	B44066D1499*440
Rated voltage V = 440 V, f = 60 Hz, p = 5.67% (f_r = 252 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 2.08 · I1							
25	107	1.24	42.0	140	16	16 mm² Kl.	B44066D5025*441
50	215	0.62	83.8	210	25	M6 Al-flat	B44066D5050*441
75	323	0.41	126.0	340	33	M8 Al-flat	B44066D5075*441
100	431	0.31	167.4	310	47	M8 Al-flat	B44066D5100*441
Rated voltage V = 440 V, f = 60 Hz, p = 7% (f_r = 227 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.73 · I1							
25	106	1.55	37.2	130	18	Cu bars Ø 9 mm	B44066D7025*441
50	212	0.77	74.4	250	27	Cu bars Ø 9 mm	B44066D7050*441
75	318	0.52	111.4	320	39	Cu bars Ø 9 mm	B44066D7075*441
100	424	0.39	148.6	380	44	Cu bars Ø 9 mm	B44066D7100*441
Rated voltage V = 440 V, f = 60 Hz, p = 14% (f_r = 162 Hz) / Linearity: L ≥ 0.95 · L_R for current up to 1.37 · I1							
25	98	3.35	34.8	180	22	Cu bars Ø 9 mm	B44066D1425*441
50	196	1.67	69.5	290	34	Cu bars Ø 9 mm	B44066D1450*441
75	294	1.12	104.3	380	45	Cu bars Ø 9 mm	B44066D1475*441
100	392	0.84	139.1	480	54	Cu bars Ø 9 mm	B44066D1499*441

[1)] Total max. losses, considering max. specified overvoltage and harmonic currents

* EPCOS offers reactors with slightly different specifications (e.g. dimensions) that can be used for the same application although sometimes with slightly different resulting performances. These types are distinguished by different letters at digit 12 of the product code. Thus this digit is not specified here.

Other voltages upon request

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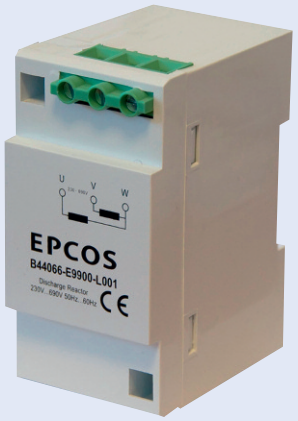
Discharge Reactor

General

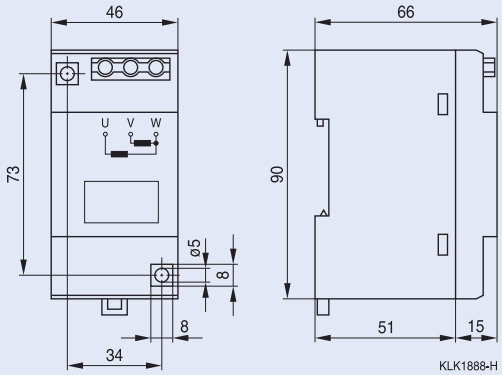
The losses of discharge reactors are substantially lower than those of discharging resistors. They satisfy the requirement for permanently connected discharging device and for a discharge time of a few seconds. Fast discharging allows a fast re-switching in automatic PFC equipment. However, max. 5000 switching operations (according to IEC 60831) should not be exceeded.

Features and dimensional drawings

- Fast discharge for fast reconnection of capacitors
- Reduced losses
- Shockproof case for DIN rail mounting



Dimensions in mm



Technical data

Ordering code		**B44066E9900L001**
Voltage	V_R	230 ... 690 V
Frequency	f	50 / 60 Hz
Internal configuration		2 windings in V arrangement
Resistance	R	7.5 kΩ
Discharge time	t	230 V up to 25 kvar < 10 s / up to 50 kvar < 20 s / up to 100 kvar < 40 s 400 ... 525 V up to 25 kvar < 5 s / up to 50 kvar < 10 s / up to 100 kvar < 20 s 525 ... 690 V up to 25 kvar < 3 s / up to 50 kvar < 6 s / up to 100 kvar < 12 s
Power loss	P_{LOSS}	< 1.6 W
Free-wheeling current	I	< 3.4 mA
Accepted discharge number		1× / minute and 100 kvar
Insulation class	R_{INS}	Ta = +40 °C/B
Cable diameter	ø	0.75 ... 2 x 2.5 mm²
Terminals		fixing torque 0.5 Nm
Installation location		indoor
Ambient temperature		–25 ... +55 °C
Cooling		natural
Dimensions	h x w x d	90 x 46 x 66 mm
Weight		0.5 kg

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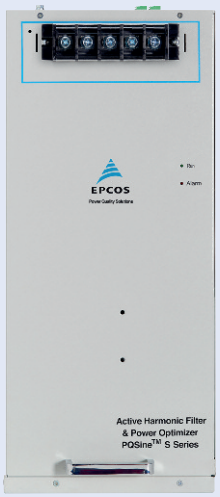
PQSine S Series
Active Harmonic Filter and Power Optimizer

General information

The PQSine S Series is an active harmonic filter system designed to eliminate harmonic oscillations and consequently reduce costs. AHF PQSine S Series monitors the current signal and compensates the unwanted elements of the measured current. Thus, the filter ensures harmonic suppression independently of the number of loads. It also corrects the power factor, improving the system efficiency while reducing harmonic pollution.



Features

- Harmonic compensation up to 50th harmonic (individually selectable)
- Ultra-fast reactive power compensation (inductive and capacitive)
- Load balancing between phases and unloaded neutral wire
- Compact design, three level topology
- Modular system extendable
- Grid resonance detection
- Digital Control of FFT algorithm, intelligent FFT algorithm, instantaneous reactive algorithm
- Ethernet and Ethercat system for interconnection
- User-friendly menu operation
- High performance and reliability
- Insensitive to network conditions

Typical applications

Fast current harmonics and reactive power suppression e.g. for:

- Data centers
- UPS systems
- Green power generation (e.g. photovoltaics and wind turbines)
- Sensitive equipment manufacturing (e.g. silicon wafer production, semiconductor production)
- Industrial production machines
- Electrical welding systems
- Plastic industry machinery (extruders, injection molders)
- Office buildings and shopping centers (3rd and triple harmonic cancellation and neutral conductor unloading)

Safety features

- Highest safety and reliability
- Overload protection
- Internal short-circuit protection
- Overheating protection
- Overvoltage and undervoltage protection
- Inverter bridge protection
- Resonance protection
- Fan fault alarm

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PQSine S Series
Active Harmonic Filter and Power Optimizer

Active harmonic filter

Figure 1: Principle of an active filter

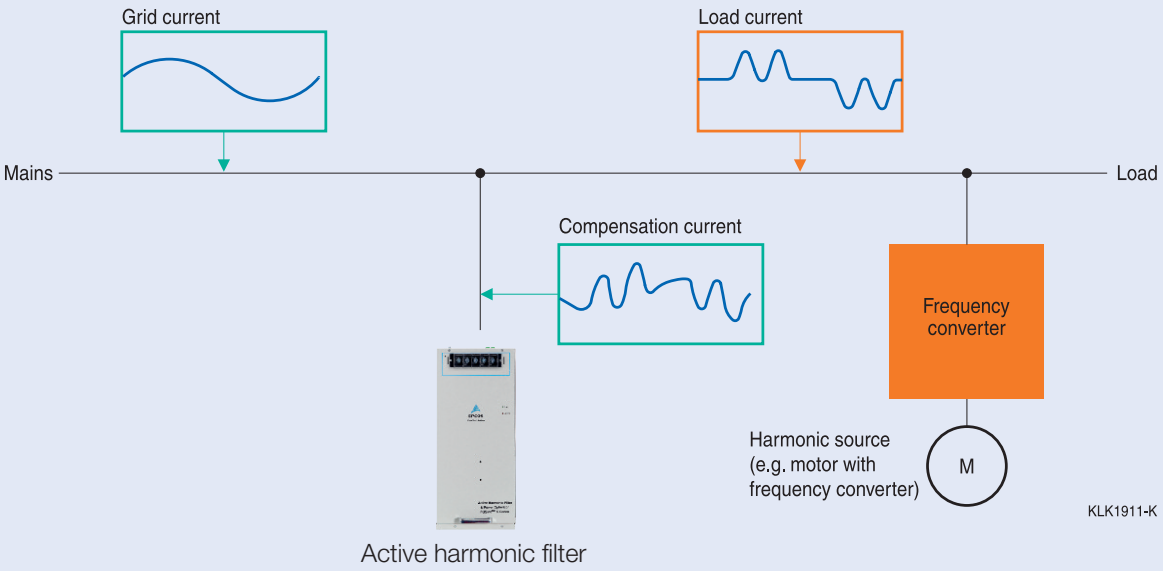


Figure 2: Total harmonic current distortion without active filter

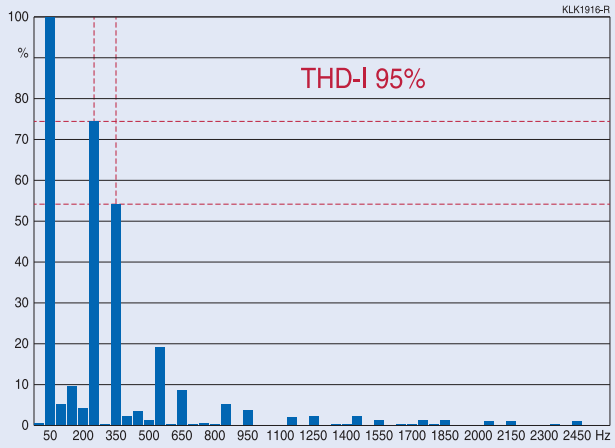
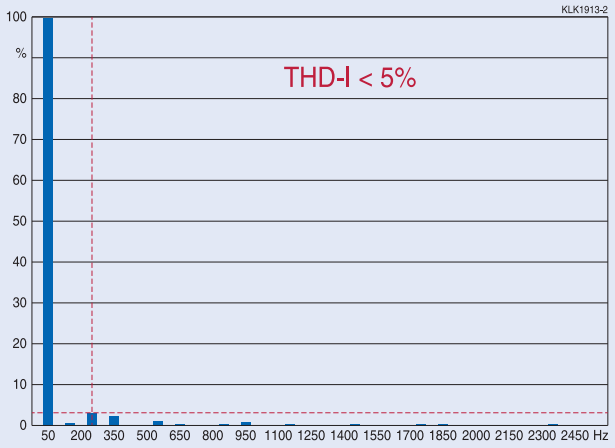


Figure 3: Total harmonic current distortion with activated active filter



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PQSine S Series
Active Harmonic Filter and Power Optimizer

Technical data

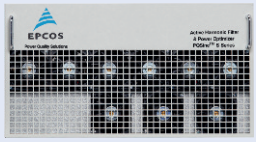
Rated voltage	380 V (228 … 456 V)	480 V (384 … 552 V)	690 V (480 … 790 V)
Mains frequency	43 … 62 Hz		
Filter current	25, 35, 50, 60, 100, 150 A	75, 90 A	75, 90 A
Neutral filtering capability	3 times the rated filter current (in case of 4 wire device)		
Harmonic current compensation range	2nd to 50th harmonic order, or specified harmonics 0 to110%		
Rate of harmonic reduction	> 97%[1)]		
Typical power losses	< 3% (depending of the load)		
Target power factor	Adjustable from –1 to 1		
Switching / Control frequency	20 kHz/20 kHz		
Reaction time	Approx. 20 µs		
Overall response time	< 5 ms		
Harmonic compensation	Available		
Reactive power compensation	Available		
Unbalance compensation	Available		
Display	All systems include a 7" TFT color control / display unit (touch screen)		
Communication ports	RS485 and network port (RJ45)		
Communication protocols	Modbus RTU, TCP/IP (Ethernet)		
Fault alarm	Available, max. 500 alarm records		
Noise level	< 56dB (depending on the model)	< 65dB (depending on the model)	
Protection functions	Overvoltage, undervoltage, short-circuit, inverter bridge inverse, overcompensation		
Operating temperature	–10 to +40 °C without derating		
Relative humidity	5 to 95%, non-condensation		
Cooling	75,151,300,405 L/sec (25-35,50-60,75-100, 150 A)	359 L/sec	
Protection class	IP 20 according to IEC 529 (customizable)		
Panel color	RAL7035 light grey		
Altitude	1500; 1% up 1500 m. Between 1500 to 4000 m, according to GB/T3859.2, the power decreases by 1% for every additional 100 m		
Qualifications	CE, IEEE 61000	CE, ETL (UL 508 and CSA C22.2 # 2014), IEEE 61000	
Compliance with standards	IEEE 519, ER G5/4		

[1)] For typical harmonic order distortions

Wall-mounted panel

Floor-mounted panel

Horizontal module



Vertical module

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

PQSine S Series
Active Harmonic Filter and Power Optimizer

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400 V PQSine S Series – 3P4W systems[1)]							
Type	**Rated filter current A**	**System min./max. voltage V**		**Mounting variant**	**Approx. weight kg**	**Approx. dimensions (w x d x h) mm**	**Ordering code**
PQSW4025S344	25	228	456	Wall-mounted	18	440 x 150 x 470	B44066F4025S344
PQSW4035S344	35	228	456	Wall-mounted	18	440 x 150 x 470	B44066F4035S344
PQSW4050S344	50	228	456	Wall-mounted	35	440 x 190 x 610	B44066F4050S344
PQSW4060S344	60	228	456	Wall-mounted	35	440 x 190 x 610	B44066F4060S344
PQSW4100S344	100	228	456	Wall-mounted	46	440 x 232 x 625	B44066F4100S344
PQSW4150S344	150	228	456	Wall-mounted	48	500 x 270 x 585	B44066F4150S344
Vertical mounting variant							
PQSF4100S310	100	228	456	Floor-mounted	270	1000 x 600 x 2200	B44066F4100S310
PQSF4150S310	150	228	456	Floor-mounted	305	1000 x 600 x 2200	B44066F4150S310
PQSF4200S310	200	228	456	Floor-mounted	310	1000 x 600 x 2200	B44066F4200S310
PQSF4250S310	250	228	456	Floor-mounted	345	1000 x 600 x 2200	B44066F4250S310
PQSF4300S310	300	228	456	Floor-mounted	350	1000 x 600 x 2200	B44066F4300S310
Horizontal mounting variant							
PQSF4100S315	100	228	456	Floor-mounted	276	600 x 1000 x 2200	B44066F4100S315
PQSF4150S315	150	228	456	Floor-mounted	278	600 x 1000 x 2200	B44066F4150S315
PQSF4200S315	200	228	456	Floor-mounted	313	600 x 1000 x 2200	B44066F4200S315
PQSF4250S315	250	228	456	Floor-mounted	324	600 x 1000 x 2200	B44066F4250S315
PQSF4300S315	300	228	456	Floor-mounted	326	600 x 1000 x 2200	B44066F4300S315
PQSF4350S315	350	228	456	Floor-mounted	361	600 x 1000 x 2200	B44066F4350S315
PQSF4400S315	400	228	456	Floor-mounted	372	600 x 1000 x 2200	B44066F4400S315
PQSF4450S315	450	228	456	Floor-mounted	374	600 x 1000 x 2200	B44066F4450S315
PQSF4500S315	500	228	456	Floor-mounted	392	600 x 1000 x 2200	B44066F4500S315
PQSF4550S315	550	228	456	Floor-mounted	420	600 x 1000 x 2200	B44066F4550S315
PQSF4600S315	600	228	456	Floor-mounted	422	600 x 1000 x 2200	B44066F4600S315

[1)] All systems include a 7" TFT color control / display unit (touch screen). External current transformers are not included.

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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PQSine S Series
Active Harmonic Filter and Power Optimizer

400 V PQSine S Series – 3P3W systems[1)]

Type	Rated filter current A	System min./max. voltage V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSW3025S344	25	228	456	Wall-mounted	18	440 x 150 x 470	B44066F3025S344
PQSW3035S344	35	228	456	Wall-mounted	18	440 x 150 x 470	B44066F3035S344
PQSW3050S344	50	228	456	Wall-mounted	35	440 x 190 x 610	B44066F3050S344
PQSW3060S344	60	228	456	Wall-mounted	35	440 x 190 x 610	B44066F3060S344
PQSW3100S344	100	228	456	Wall-mounted	46	440 x 232 x 625	B44066F3100S344
PQSW3150S344	150	228	456	Wall-mounted	48	500 x 270 x 585	B44066F3150S344
Vertical mounting variant							
PQSF3100S310	100	228	456	Floor-mounted	270	1000 x 600 x 2200	B44066F3100S310
PQSF3150S310	150	228	456	Floor-mounted	305	1000 x 600 x 2200	B44066F3150S310
PQSF3200S310	200	228	456	Floor-mounted	310	1000 x 600 x 2200	B44066F3200S310
PQSF3250S310	250	228	456	Floor-mounted	345	1000 x 600 x 2200	B44066F3250S310
PQSF3300S310	300	228	456	Floor-mounted	350	1000 x 600 x 2200	B44066F3300S310
Horizontal mounting variant							
PQSF3100S315	100	228	456	Floor-mounted	276	600 x 1000 x 2200	B44066F3100S315
PQSF3150S315	150	228	456	Floor-mounted	278	600 x 1000 x 2200	B44066F3150S315
PQSF3200S315	200	228	456	Floor-mounted	313	600 x 1000 x 2200	B44066F3200S315
PQSF3250S315	250	228	456	Floor-mounted	324	600 x 1000 x 2200	B44066F3250S315
PQSF3300S315	300	228	456	Floor-mounted	326	600 x 1000 x 2200	B44066F3300S315
PQSF3350S315	350	228	456	Floor-mounted	361	600 x 1000 x 2200	B44066F3350S315
PQSF3400S315	400	228	456	Floor-mounted	372	600 x 1000 x 2200	B44066F3400S315
PQSF3450S315	450	228	456	Floor-mounted	374	600 x 1000 x 2200	B44066F3450S315
PQSF3500S315	500	228	456	Floor-mounted	392	600 x 1000 x 2200	B44066F3500S315
PQSF3550S315	550	228	456	Floor-mounted	420	600 x 1000 x 2200	B44066F3550S315
PQSF3600S315	600	228	456	Floor-mounted	422	600 x 1000 x 2200	B44066F3600S315

[1)] All systems include a 7" TFT color control / display unit (touch screen). External current transformers are not included.

690 V PQSine S Series – 3P3W systems[1)]

Type	Rated filter current A	System min./max. voltage V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSF3150S615	150	480	790	Floor-mounted	325	600 x 1000 x 2200	B44066F3150S615
PQSF3225S615	225	480	790	Floor-mounted	425	600 x 1000 x 2200	B44066F3225S615
PQSF3300S615	300	480	790	Floor-mounted	500	600 x 1000 x 2200	B44066F3300S615

[1)] All systems include a 7" TFT color control / display unit (touch screen). External current transformers are not included.

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PQSine S Series
Active Harmonic Filter and Power Optimizer

EPCOS

400 V PQSine S Series – modules							
Type	**Rated filter current A**	**System min./max. voltage V**		**Connection variant**	**Approx. weight kg**	**Approx. dimensions (w x d x h) mm**	**Ordering code**
Vertical mounting variant							
PQSM4025S303	25	228	456	3P4W	18	150 x 440 x 450	B44066F4025S303
PQSM4035S303	35	228	456	3P4W	18	150 x 440 x 450	B44066F4035S303
PQSM4050S303	50	228	456	3P4W	35	190 x 440 x 540	B44066F4050S303
PQSM4060S303	60	228	456	3P4W	35	190 x 440 x 540	B44066F4060S303
PQSM4100S303	100	228	456	3P4W	46	230 x 440 x 550	B44066F4100S303
PQSM4150S303	150	228	456	3P4W	48	270 x 500 x 510	B44066F4150S303
Horizontal mounting variant							
PQSM4025S300	25	228	456	3P4W	18	484 x 490 x 150	B44066F4025S300
PQSM4035S300	35	228	456	3P4W	18	484 x 490 x 150	B44066F4035S300
PQSM4050S300	50	228	456	3P4W	35	484 x 590 x 190	B44066F4050S300
PQSM4060S300	60	228	456	3P4W	35	484 x 590 x 190	B44066F4060S300
PQSM4100S300	100	228	456	3P4W	46	484 x 600 x 230	B44066F4100S300
PQSM4150S300	150	228	456	3P4W	48	540 x 560 x 270	B44066F4150S300
Vertical mounting variant							
PQSM3025S303	25	228	456	3P3W	18	150 x 440 x 450	B44066F3025S303
PQSM3035S303	35	228	456	3P3W	18	150 x 440 x 450	B44066F3035S303
PQSM3050S303	50	228	456	3P3W	35	190 x 440 x 540	B44066F3050S303
PQSM3060S303	60	228	456	3P3W	35	190 x 440 x 540	B44066F3060S303
PQSM3100S303	100	228	456	3P3W	46	230 x 440 x 550	B44066F3100S303
PQSM3150S303	150	228	456	3P3W	48	270 x 500 x 510	B44066F3150S303
Horizontal mounting variant							
PQSM3025S300	25	228	456	3P3W	18	484 x 490 x 150	B44066F3025S300
PQSM3035S300	35	228	456	3P3W	18	484 x 490 x 150	B44066F3035S300
PQSM3050S300	50	228	456	3P3W	35	484 x 590 x 190	B44066F3050S300
PQSM3060S300	60	228	456	3P3W	35	484 x 590 x 190	B44066F3060S300
PQSM3100S300	100	228	456	3P3W	46	484 x 600 x 230	B44066F3100S300
PQSM3150S300	150	228	456	3P3W	48	540 x 560 x 270	B44066F3150S300

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PQSine S Series
Active Harmonic Filter and Power Optimizer

480 V PQSine S Series ETL approved modules[1)]

Type	Rated filter current A	System min./max. voltage V		Connection variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
Horizontal mounting variant							
PQSM4075S408	75	384	552	3P4W	66	544 x 640 x 250	B44066F4075S408
PQSM4090S408	90	384	552	3P4W	66	544 x 640 x 250	B44066F4090S408
PQSM3075S408	75	348	552	3P3W	66	544 x 640 x 250	B44066F3075S408
PQSM3090S408	90	348	552	3P3W	66	544 x 640 x 250	B44066F3090S408
Wall-mounted variant							
PQSM4075S448	75	384	552	3P4W	66	504 x 250 x 665	B44066F4075S448
PQSM4090S448	90	384	552	3P4W	66	504 x 250 x 665	B44066F4090S448
PQSM3075S448	75	348	552	3P3W	66	504 x 250 x 665	B44066F3075S448
PQSM3090S448	90	348	552	3P3W	66	504 x 250 x 665	B44066F3090S448

[1)] The products have been tested by ETL according to UL 508 and CSA C22.2 # 2014.

600 V PQSine S Series ETL approved modules[1)]

Type	Rated filter current A	System min./max. voltage V		Connection variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
Horizontal mounting variant							
PQSM4075S608	75	420	690	3P4W	66	544 x 640 x 250	B44066F4075S608
PQSM4090S608	90	420	690	3P4W	66	544 x 640 x 250	B44066F4090S608
PQSM3075S608	75	420	690	3P3W	66	544 x 640 x 250	B44066F3075S608
PQSM3090S608	90	420	690	3P3W	66	544 x 640 x 250	B44066F3090S608
Wall-mounted variant							
PQSM4075S648	75	420	690	3P4W	66	504 x 250 x 665	B44066F4075S648
PQSM4090S648	90	420	690	3P4W	66	504 x 250 x 665	B44066F4090S648
PQSM3075S648	75	420	690	3P3W	66	504 x 250 x 665	B44066F3075S648
PQSM3090S648	90	420	690	3P3W	66	504 x 250 x 665	B44066F3090S648

[1)] The products have been tested by ETL according to UL 508 and CSA C22.2 # 2014.

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PQSine S Series
Active Harmonic Filter and Power Optimizer

690 V PQSine S Series ETL approved modules[1)]

Type	Rated filter current A	System min./max. voltage V		Connection variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
Horizontal mounting variant							
PQSM4075S708	75	483	793	3P4W	66	544 x 640 x 250	B44066F4075S708
PQSM4090S708	90	483	793	3P4W	66	544 x 640 x 250	B44066F4090S708
PQSM3075S708	75	483	793	3P3W	66	544 x 640 x 250	B44066F3075S708
PQSM3090S708	90	483	793	3P3W	66	544 x 640 x 250	B44066F3090S708
Wall-mounted variant							
PQSM4075S748	75	483	793	3P4W	66	504 x 250 x 665	B44066F4075S748
PQSM4090S748	90	483	793	3P4W	66	504 x 250 x 665	B44066F4090S748
PQSM3075S748	75	483	793	3P3W	66	504 x 250 x 665	B44066F3075S748
PQSM3090S748	90	483	793	3P3W	66	504 x 250 x 665	B44066F3090S748

[1)] The products have been tested by ETL according to UL 508 and CSA C22.2 # 2014.

Accessories ordering codes

Product description	Ordering code
7" TFT HMI Color control/Display unit, touch screen	B44066F9999S230

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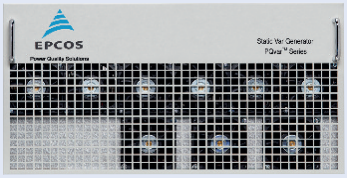
Static Var Generator (SVG) PQvar Series

General information

SVG PQvar Series is a product which has rewritten the conventional approach of power factor correction. It is designed to compensate the rapid reactive power requirement, thereby improving the power factor and consequently reducing the costs. SVG PQvar Series monitors the current signal and utilizes three levels inverter topology which generate the reactive part of the measured current to compensate dynamically in order to improve the power factor. It can dynamically compensate power factor from –1 to 1.



Features

- SVG PQvar Series can be considered as a controllable reactive current source, which helps to improve the system power factor to a target value of more than > 0.99 without any over or under compensation.
- SVG PQvar Series has extremely rapid dynamic compensation reaction time, which is less than 50 µs and a state response time of less than15 ms.
- SVG PQvar Series is an active compensation device, which doesn't need capacitor or reactor for reactive power compensation which will avoid the condition of resonance caused by the traditional capacitor banks.
- SVG PQvar Series can compensate both inductive and capacitive reactive power and also provide load balancing.
- SVG PQvar Series can compensate reactive power in any scope and can be installed together with traditional capacitor banks.
- The grid voltage has no influence on the SVG PQvar Series compensation capacity. So even if the system voltage drops down, the required reactive power can be compensated by monitoring its requirement.
- SVG PQvar Series can compensate for the same capacity equivalent to the installed capacity, therefore it requires 20 to 30% lower capacity in comparison with the conventional capacitor banks.
- SVG PQvar Series has been designed to provide highest safety and reliability features.

Typical applications

Some typical applications which require rapid reactive power compensation includes the following:

- Data centers
- UPS systems
- Renewable power generation (e.g. photovoltaics and wind turbines)
- Sensitive equipment manufacturing (e.g. silicon wafer production, semiconductor production)
- Industrial production machines
- Electrical welding systems
- Plastic industry machinery (e.g. extruders, injection molders)

Safety features

- Overload protection
- Internal short-circuit protection
- Overheating protection
- Overvoltage and undervoltage protection
- Inverter bridge protection
- Fan fault alarm

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Low-Voltage Static Var Generator (SVG)
PQvar LV-Series

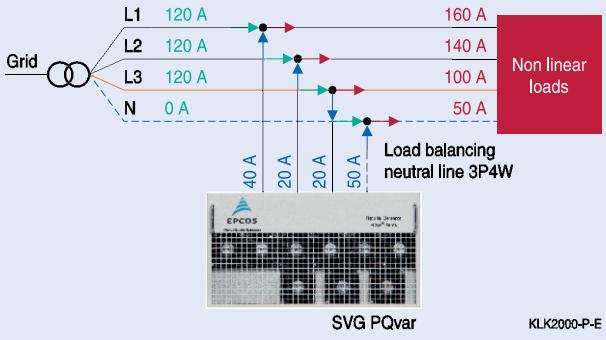
Wall-mounted panel

Floor-mounted panel

Horizontal module

Depending on the customer needs, EPCOS offers either complete panels, wall mounted cabinets or even modules. The state of the art modular design of SVG PQvar Series offers the advantage of having a minimum downtime in case of a service or maintenance requirement.

SVG PQvar Series load balancing for 3P3W and 3P4W



SVG PQvar Series can balance load between phases and unloaded neutral wire for input voltage connection systems such as three phase three wires (3P3W) and three phase four wires (3P4W). Therefore, it will be a perfect solution with applications having reactive power requirements along with unbalanced loads, which is the case with the electricity distribution in rural areas, some industrial applications and much more.

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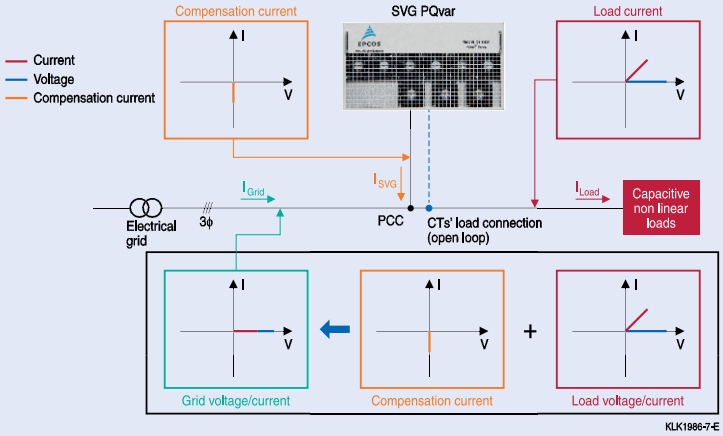
Low-Voltage Static Var Generator (SVG) PQvar LV-Series

Static Var Generator (SVG) PQvar Series

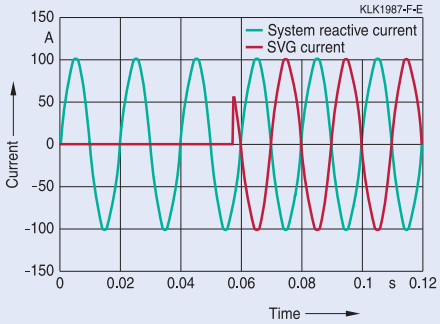
Compensation of reactive power with SVG PQvar Series



SVG PQvar Series compensation performance

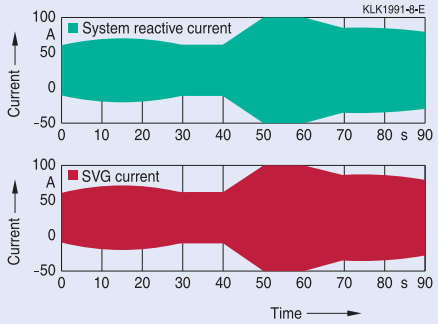
Fast reaction

Extremely rapid reactive power generation, in order to achieve target PF, right at the SVG PQvar Series switch on.



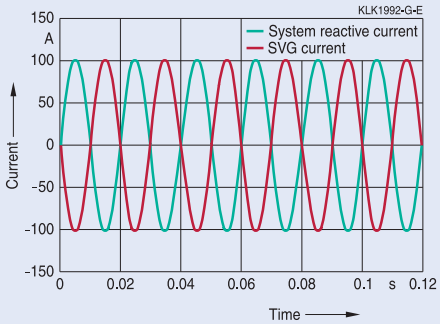
Real-time tracking

While system reactive current changes, SVG PQvar Series also can generate dynamic real time compensation current to satisfy the changing power system requirement.



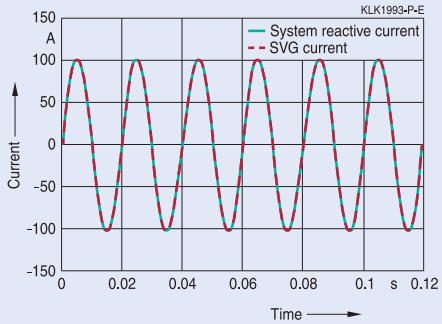
Perfect compensation

SVG PQvar Series identifies the system reactive power requirement and generates a reactive current same in magnitude but opposite in phase to ensure perfect compensation result.



Reverse and overlapping

The reversed waveform of reactive current generated by SVG PQvar Series overlaps with the power system reactive current.



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Low-Voltage Static Var Generator (SVG)
PQvar LV-Series

Technical data and specifications of low-voltage SVG PQvar Series – 400 V

Rated voltage	400 V; –40 … +20%	
Mains frequency	50/60 Hz (range: 45 … 63 Hz)	
Parallel operation	Unlimited	
Response time	< 15 ms	
Overall efficiency	> 97%	
Power grid structure	3P3W / 3P4W	
Current transformers	150/5 … 10000/5	
Circuit topology	3 level	
Single-module compensation capacity	30/50 kvar	100/200 kvar
Module net weight	21/35 kg	48/66 kg
Dimensions (W × D × H)	30 kvar: 440 × 445 × 150 mm (module) 50 kvar: 500 × 510 × 190 mm (module)	100 kvar: 500 × 470 × 270 mm (module) 200 kvar: 500 × 650 × 350 mm (module)
Cooling mode	Smart air cooling: 220 L/sec	Smart air cooling: 405 L/sec
Target power factor	Adjustable from –1 … +1	
Cabinet mounting	Floor-mounted, wall-mounted	
Communication ports	RS485, CAN, and network port	
Communication protocols	Modbus and PMBus	
Noise level	< 65 dB (depending on the model)	
Protection functions	Overvoltage, undervoltage, short-circuit, inverter bridge inverse, over-compensation	
Operating temperature	–10 … +40 °C, other temperature ranges upon request	
Relative humidity	5 … 95%, non-condensing	
Protection class	IP20 (other IP classes are customizable)	
Panel color	RAL7035 light grey	
Altitude	1500 m, 1% derating per 100 m plus	
General safety requirements for SVG PQvar Series use and operation area	EN 50178:1997/ IEC 50178:1997	
SVG PQvar Series EMC requirements	EN 61000_6_2(2005)/ EN55011, GROUP1, CLASS A IEC 61000_6_2(1999)/ CISPR11, GROUP1, CLASS A	
SVG PQvar Series performance requirements	EN 50091-3/ IEC 62040-3/ AS 62040-3(VFI SS 111)	

400 V SVG PQvar Series – 3P4W systems[1)]

Type	Reactive power kvar	System voltage min./max. V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSW8030V344	30	240	480	Wall-mounted	35	440 × 150 × 445	B44066F8030V344
PQSW8050V344	50	240	480	Wall-mounted	35	500 × 190 × 560	B44066F8050V344
PQSW8100V344	100	240	480	Wall-mounted	48	504 × 267 × 545	B44066F8100V344
PQSW8200V344	200	240	480	Wall-mounted	66	500 × 350 × 650	B44066F8200V344
PQSF8100V315	100	240	480	Floor-mounted	308	600 × 1000 × 2200	B44066F8100V315
PQSF8200V315	200	240	480	Floor-mounted	356	600 × 1000 × 2200	B44066F8200V315
PQSF8250V315	250	240	480	Floor-mounted	391	600 × 1000 × 2200	B44066F8250V315
PQSF8300V315	300	240	480	Floor-mounted	404	600 × 1000 × 2200	B44066F8300V315
PQSF8400V315	400	240	480	Floor-mounted	452	600 × 1000 × 2200	B44066F8400V315
PQSF8500V315	500	240	480	Floor-mounted	500	600 × 1000 × 2200	B44066F8500V315
PQSF8600V315	600	240	480	Floor-mounted	458	600 × 1000 × 2200	B44066F8600V315
PQSF8800V315	800	240	480	Floor-mounted	524	600 × 1000 × 2200	B44066F8800V315

Other types/designs upon request

[1)] In case of floor mounted systems include a 7" TFT color control display. In case of wall mounted systems include a 4.3" LCD touch color screen. External current transformers are not included.

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Low-Voltage Static Var Generator (SVG)
PQvar LV-Series

400 V SVG PQvar Series – 3P3W systems[1)]

Type	Reactive power kvar	System voltage min./max. V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSW6030V344	30	240	480	Wall-mounted	35	440 × 150 × 445	B44066F6030V344
PQSW6050V344	50	240	480	Wall-mounted	35	500 × 190 × 560	B44066F6050V344
PQSW6100V344	100	240	480	Wall-mounted	48	504 × 267 × 545	B44066F6100V344
PQSW6200V344	200	240	480	Wall-mounted	66	500 × 350 × 650	B44066F6200V344
PQSF6100V315	100	240	480	Floor-mounted	308	600 × 1000 × 2200	B44066F6100V315
PQSF6200V315	200	240	480	Floor-mounted	356	600 × 1000 × 2200	B44066F6200V315
PQSF6250V315	250	240	480	Floor-mounted	391	600 × 1000 × 2200	B44066F6250V315
PQSF6300V315	300	240	480	Floor-mounted	404	600 × 1000 × 2200	B44066F6300V315
PQSF6400V315	400	240	480	Floor-mounted	452	600 × 1000 × 2200	B44066F6400V315
PQSF6500V315	500	240	480	Floor-mounted	500	600 × 1000 × 2200	B44066F6500V315
PQSF6600V315	600	240	480	Floor-mounted	458	600 × 1000 × 2200	B44066F6600V315
PQSF6800V315	800	240	480	Floor-mounted	524	600 × 1000 × 2200	B44066F6800V315

400 V SVG PQvar Series – modules

Type	Reactive power kvar	System voltage min./max. V		Connection variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSM8030V300	30	240	480	3P4W	35	440 × 445 × 150	B44066F8030V300
PQSM8050V300	50	240	480	3P4W	35	500 × 510 × 190	B44066F8050V300
PQSM8100V300	100	240	480	3P4W	48	500 × 470 × 270	B44066F8100V300
PQSM8200V300	200	240	480	3P4W	66	500 × 650 × 350	B44066F8200V300
PQSM6030V300	30	240	480	3P3W	35	440 × 445 × 150	B44066F6030V300
PQSM6050V300	50	240	480	3P3W	35	500 × 510 × 190	B44066F6050V300
PQSM6100V300	100	240	480	3P3W	48	500 × 470 × 270	B44066F6100V300
PQSM6200V300	200	240	480	3P3W	66	500 × 650 × 350	B44066F6200V300

Accessories ordering codes

Product description	Ordering code
Extra-large HMI Color LCD display, 7", including 4 m connection cable	B44066F9999V230

Other types/designs upon request

[1)] In case of floor mounted systems include a 7" TFT color control display. In case of wall mounted systems include a 4.3" LCD touch color screen. External current transformers are not included.

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Low-Voltage Static Var Generator (SVG) PQvar LV-Series

Technical data and specifications of low-voltage SVG PQvar Series – 690 V

Rated voltage	690 V; –30 … +15%	
Mains frequency	50/60 Hz (range: 45 … 63 Hz)	
Parallel operation	Unlimited	
Response time	< 15 ms	
Overall efficiency	> 97%	
Power grid structure	3P3W / 3P4W	
Current transformers	150/5 … 10000/5	
Circuit topology	3 level	
Single-module compensation capacity	50/75 kvar	95/110 kvar
Module net weight	66/66 kg	66/66 kg
Dimensions (W × D × H)	50 kvar: 544 × 640 × 250 mm (module) 75 kvar: 544 × 640 × 250 mm (module)	95 kvar: 544 × 640 × 250 mm (module) 110 kvar: 544 × 640 × 250 mm (module)
Cooling mode	Smart air cooling: 220 L/sec	Smart air cooling: 405 L/sec
Target power factor	Adjustable from –1 … +1	
Cabinet mounting	Floor-mounted, wall-mounted	
Communication ports	RS485, CAN, and network port	
Communication protocols	Modbus and PMBus	
Noise level	< 65 dB (depending on the model)	
Protection functions	Overvoltage, undervoltage, short-circuit, inverter bridge inverse, over-compensation	
Operating temperature	–10 … +40 °C, other temperature ranges upon request	
Relative humidity	5 … 95%, non-condensing	
Protection class	IP20 (other IP classes are customizable)	
Panel color	RAL7035 light grey	
Altitude	1500 m, 1% derating per 100 m plus	
General safety requirements for SVG PQvar Series use and operation area	EN 50178:1997/ IEC 50178:1997	
SVG PQvar Series EMC requirements	EN 61000_6_2(2005)/ EN55011, GROUP1, CLASS A IEC 61000_6_2(1999)/ CISPR11, GROUP1, CLASS A	
SVG PQvar Series performance requirements	EN 50091-3/ IEC 62040-3/ AS 62040-3(VFI SS 111)	

690 V SVG PQvar Series – 3P4W systems[1)]

Type	Reactive power kvar	System voltage min./max. V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSW8050V644	50	483	794	Wall-mounted	66	504 × 253 × 640	B44066F8050V644
PQSW8075V644	75	483	794	Wall-mounted	66	504 × 253 × 640	B44066F8075V644
PQSW8095V644	95	483	794	Wall-mounted	66	504 × 253 × 640	B44066F8195V644
PQSW8110V644	110	483	794	Wall-mounted	66	504 × 253 × 640	B44066F8110V644
PQSF8110V615	110	483	794	Floor-mounted	326	600 × 1000 × 2200	B44066F8110V615
PQSF8220V615	220	483	794	Floor-mounted	392	600 × 1000 × 2200	B44066F8220V615
PQSF8330V615	330	483	794	Floor-mounted	458	600 × 1000 × 2200	B44066F8330V615
PQSF8440V615	440	483	794	Floor-mounted	524	600 × 1000 × 2200	B44066F8440V615
PQSF8550V615	550	483	794	Floor-mounted	850	2× 600 × 1000 × 2200	B44066F8550V615
PQSF8660V615	660	483	794	Floor-mounted	916	2× 600 × 1000 × 2200	B44066F8660V615
PQSF8770V615	770	483	794	Floor-mounted	982	2× 600 × 1000 × 2200	B44066F8770V615
PQSF8880V615	880	483	794	Floor-mounted	1048	2× 600 × 1000 × 2200	B44066F8880V615

Other types/designs upon request

[1)] In case of floor mounted systems include a 7" TFT color control display. In case of wall mounted systems include a 4.3" LCD touch color screen. External current transformers are not included.

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Low-Voltage Static Var Generator (SVG)
PQvar LV-Series

690 V SVG PQvar Series – 3P3W systems[1)]

Type	Reactive power kvar	System voltage min./max. V		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSW6050V644	50	483	794	Wall-mounted	66	504 × 253 × 640	B44066F6050V644
PQSW6075V644	75	483	794	Wall-mounted	66	504 × 253 × 640	B44066F6075V644
PQSW6095V644	95	483	794	Wall-mounted	66	504 × 253 × 640	B44066F6195V644
PQSW6110V644	110	483	794	Wall-mounted	66	504 × 253 × 640	B44066F6110V644
PQSF6110V615	110	483	794	Floor-mounted	326	600 × 1000 × 2200	B44066F6110V615
PQSF6220V615	220	483	794	Floor-mounted	392	600 × 1000 × 2200	B44066F6220V615
PQSF6330V615	330	483	794	Floor-mounted	458	600 × 1000 × 2200	B44066F6330V615
PQSF6440V615	440	483	794	Floor-mounted	524	600 × 1000 × 2200	B44066F6440V615
PQSF6550V615	550	483	794	Floor-mounted	850	2× 600 × 1000 × 2200	B44066F6550V615
PQSF6660V615	660	483	794	Floor-mounted	916	2× 600 × 1000 × 2200	B44066F6660V615
PQSF6770V615	770	483	794	Floor-mounted	982	2× 600 × 1000 × 2200	B44066F6770V615
PQSF6880V615	880	483	794	Floor-mounted	1048	2× 600 × 1000 × 2200	B44066F6880V615

690 V SVG PQvar Series – modules

Type	Reactive power kvar	System voltage min./max. V		Connection variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSM8050V600	50	483	794	3P4W	66	544 × 640 × 250	B44066F8050V600
PQSM8075V600	75	483	794	3P4W	66	544 × 640 × 250	B44066F8075V600
PQSM8095V600	95	483	794	3P4W	66	544 × 640 × 250	B44066F8095V600
PQSM8110V600	110	483	794	3P4W	66	544 × 640 × 250	B44066F8110V600
PQSM6050V600	50	483	794	3P3W	66	544 × 640 × 250	B44066F6050V600
PQSM6075V600	75	483	794	3P3W	66	544 × 640 × 250	B44066F6075V600
PQSM6095V600	95	483	794	3P3W	66	544 × 640 × 250	B44066F6095V600
PQSM0110V600	110	483	794	3P3W	66	544 × 640 × 250	B44066F6110V600

Accessories ordering codes

Product description	Ordering code
Extra-large HMI Color LCD display, 7", including 4 m connection cable	B44066F9999V230

Other types/designs upon request

[1)] In case of floor mounted systems include a 7" TFT color control display. In case of wall mounted systems include a 4.3" LCD touch color screen. External current transformers are not included.

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Hybrid PFC-Solution – SVG PQvar and Classic PFC Managed by Advanced Multi Controller (AMC)

Technical data and specifications of SVG PQvar Series Advanced Multi Controller (AMC) unit	
Operating voltage	24 V DC
Compensation performance	
Target PF	–1 … +1
Reactive power compensation rate	> 99% (target PF is 1)
Response time	< 15 ms
Reaction time	< 50 µs
Capacitor switching performance	
Compensation method	Three-phase/ split/ mixed compensation
Capacitance coding method	Optional
Capacitor switching method	Stack/ normal/ cycle/ individual
Switching manner	Auto/ manual
External ports	
RS485 port 1	Communication with SVG modules
RS485 port 2	External communication port
Network port	External communication port
USB port	Code upgrading port
Temperature detection	Measuring system's operating temperature or ambient temperature
Fan controlling dry contact	Controlling SVC cooling fan
Alarm indicator dry contact	For reserved external alarm indicator
Control output contact	Control outputs, up to 18 at most Contact support: 120 V AC / 10 A, 220 V AC / 8 A, 400 V AC / 3 A, 110 V DC / 0.2 A, 60 V DC / 0.6 A, 24 V DC / 5 A Level signal: 12 V DC / 30 mA
Reserved dry contact	One input / one output
Communication protocol	Modbus
Protection functions	Undervoltage, overvoltage, underfrequency, overfrequency, phase failure, high harmonic voltage, SVG overload, SVG overtemperature
Display	7" touch screen
Installation requirements	
Power consumption	< 25 W
Protection class	IP41 for the front panel, and IP20 for the rear panel
Operating environment	
Operating temperature	–20 … +60 °C
Altitude	≤ 2500 m
Humidity	≤ 95%
Storage temperature	–40 … +70 °C
CT ratio	150/5 … 10000/5

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Hybrid PFC-Solution – SVG PQvar and Classic PFC Managed by Advanced Multi Controller (AMC)

SVG PQvar Series AMC (Advanced Multi Controller)

Product description	Ordering code
Advanced Multi Controller (AMC) unit – HMI colour display 7" for switching thyristors	B44066F9989V230
Advanced Multi Controller (AMC) unit – HMI colour display 7" for switching contactors	B44066F9988V230

Component selection table for de-tuned PFC (classic)

De-tuning factor %	Effect. filter output kvar	Capacitor quantity and ordering code	Reactor[1] ordering code	Contactor ordering code	Cable[2] cross section mm²	Fuse[2] rating A
Grid voltage: 400 V – 50 Hz detuned filters components selection table						
5.67	12.5	1x B25667C4237A375	B44066D5012*400	B44066S1810J260	6	35
5.67	25	1x B25667C4467A375	B44066D5025*400	B44066S3210J230	16	63
5.67	50	2x B25667C4467A375	B44066D5050*400	B44066S6210J230	50	125
5.67	100	4x B25667C4467A375	B44066D5100*400	B44066S9910J230	120	250
7	25	1x B25667C4467A375	B44066D7025*400	B44066S3210J230	16	63
7	50	2x B25667C4467A375	B44066D7050*400	B44066S6210J230	50	125
7	10	4x B25667C4467A375	B44066D7100*400	B44066S9910J230	120	250
14	20	1x B25667C4347A375	B44066D1420*400	B44066S2410J230	10	50
14	25	1x B25667C4417A365	B44066D1425*400	B44066S3210J230	16	63
14	50	2x B25667C4417A365	B44066D1450*400	B44066S6210J230	50	125
14	100	4x B25667C4417A365	B44066D1499*400	B44066S9910J230	120	250

[1] EPCOS offers reactors with slightly different specifications (e.g. dimensions) that can be used for the same application although sometimes with slightly different resulting performances. These types are distinguished by different letters at digit 12 of the product code.

[2] The above mentioned values are guidelines for operation in normal conditions at ambient temperatures up to +35 °C. Various parameters such as temperature inside the cabinet, cable quality, maximum cable insulation temperature, single or multi core cable, cable length and laying system have to be considered for a proper selection. Upgrade/ downgrade accordingly if conditions differ. Additionally, do not forget to consider the regulations and standards which are valid for your country.

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Hybrid PFC-Solution – SVG PQvar and Classic PFC Managed by Advanced Multi Controller (AMC)

Component selection table for dynamic PFC (classic)

De-tuning factor %	Effect. filter output kvar	Capacitor[3] quantity and ordering code	Reactor[1] quantity and ordering code	Thyristor ordering code	Cable[2] cross section mm²	Fuse[2] rating A
Grid voltage: 400 V – 50 Hz detuned filters components selection table						
5.67	25	2x B25667C5237A375	1x B44066D5025*400	1x B44066T0025E402	16	63
5.67	50	2x B25667C5347A375	1x B44066D5050*400	1x B44066T0050E402	50	125
7	12.5	2x B25667C5237A375	1x B44066D7012*400	1x B44066T0010E402	10	35
7	25	2x B25667C5237A375	1x B44066D7025*400	1x B44066T0025E402	16	63
7	50	2x B25667C5347A375 1x B25667C5237A375	1x B44066D7050*400	1x B44066T0050E402	50	125
7	100	4x B25667C5347A375 2x B25667C5237A375	1x B44066D7100*400	1x B44066T0100E402	120	250
14	12.5	1x B25667C5966A375 1x B25667C5127A375	1x B44066D1412*400	1x B44066T0010E402	10	35
14	25	1x B25667C5167A375 1x B25667C5237A375	1x B44066D1425*400	1x B44066T0025E402	16	63
14	50	3x B25667C5287A375	1x B44066D1450*400	1x B44066T0050E402	50	125
14	100	5x B25667C5347A375	1x B44066D1499*400	1x B44066T0100E402	120	250

[1] EPCOS offers reactors with slightly different specifications (e.g. dimensions) that can be used for the same application although sometimes with slightly different resulting performances. These types are distinguished by different letters at digit 12 of the product code.
[2] The above mentioned values are guidelines for operation in normal conditions at ambient temperatures up to +35 °C. Various parameters such as temperature inside the cabinet, cable quality, maximum cable insulation temperature, single or multi core cable, cable length and laying system have to be considered for a proper selection. Upgrade/ downgrade accordingly if conditions differ. Additionally, do not forget to consider the regulations and standards which are valid for your country.
[3] In some cases special interconnection of the single-phase capacitors needed; in case you are not familiar please contact our sales office for further details.

SVG PQvar Series Advanced Multi Controller (AMC) unit

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Medium-Voltage Static Var Generator (SVG) PQvar MV-Series

Technical data and specifications of medium voltage SVG PQvar MV-series

Rated voltage[1)]	6 × (1 ±20%) kV	10 × (1 ±20%) kV	35 × (1 ± 20%) kV
Mains frequency	50 Hz (±2 Hz) / 60 Hz (±2 Hz) (not adaptive)		
Parallel operation	It is available to meet the demand of larger capacity		
Overall efficiency	> 99.2% (excluding transformer)		
Power grid structure	Three-phase, three-wire (3P3W)		
Circuit topology	2 level H-bridge series		
Single-module capacity (Mvar)	2, 3, 4, 5, 6, 7	2, 3, 4, 5, 6, 7, 8, 9, 10, 12	2, 3, 4, 5, 6, 7, 8, 9, 10, 12
Full response time	< 5 ms (10 … 90%)		
Target power factor	Meet design requirements within capacity range		
Active power loss	< 0.8% rated power		
Mounting	Cabinet		
Cooling mode	Air cooling		
Communication interface / protocol	RS485 or Ethernet / Modbus TCP/IP or RTU		
Noise level	< 70 dB (A)		
Operation mode	Constant power factor, constant reactive and constant voltage control are optional		
Operation display	Operation parameter setting, touch key-press operation, multiple parameter display, operation data recording, fault recording and broadcasting, parameter and record data backup, remote control and parameter downloading, remote update of controller software		
Display accuracy	±2% FS		
Expansion capability	Parallel operation is available to meet the demand of larger capacity		
Protection functions	Overvoltage, undervoltage, fault-phase and default phase of power grid, equipment overcurrent, overvoltage of DC busbar, automatic current limiting protection in case of overload, overcurrent protection of power module, control power supply anomaly protection, communication fault protection, controller anomaly protection, control system power-off protection		
Operating temperature	–10 … +45 °C, other temperature ranges upon request		
Storage temperature	–20 … +65 °C		
Relative humidity	< 90% (when the temperature is +25 °C)		
Protection class	IP20		
Panel color	RAL7035 light grey		
Altitude	< 2500 m		
General safety requirements for SVG use and operation	EN ISO 13849-1		
SVG EMC requirements	IEC 61000-4-5:2005		

[1)] Other voltages upon request

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Medium-Voltage Static Var Generator (SVG) PQvar MV-Series

6 kV SVG PQvar Series – 3P3W systems

Type	Rated module reactive power kvar	Voltage class kV	Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSF6020X061	2000	6	Floor-mounted	2600	3400 × 1200 × 2200	B44066F6020X061
PQSF6030X061	3000	6	Floor-mounted	2600	5400 × 1200 × 2200	B44066F6030X061
PQSF6040X061	4000	6	Floor-mounted	4500	5400 × 1200 × 2200	B44066F6040X061
PQSF6050X061	5000	6	Floor-mounted	4500	5400 × 1200 × 2200	B44066F6050X061
PQSF6060X061	6000	6	Floor-mounted	6000	5400 × 1200 × 2600	B44066F6060X061
PQSF6070X061	7000	6	Floor-mounted	6000	5400 × 1200 × 2600	B44066F6070X061

10 kV SVG PQvar Series – 3P3W systems

Type	Rated module reactive power kvar	Voltage class kV	Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
PQSF6020X101	2000	10	Floor-mounted	3500	4800 × 1200 × 2200	B44066F6020X101
PQSF6030X101	3000	10	Floor-mounted	3500	4800 × 1200 × 2200	B44066F6030X101
PQSF6040X101	4000	10	Floor-mounted	3500	7000 × 1200 × 2200	B44066F6040X101
PQSF6050X101	5000	10	Floor-mounted	3500	7000 × 1200 × 2200	B44066F6050X101
PQSF6060X101	6000	10	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6060X101
PQSF6070X101	7000	10	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6070X101
PQSF6080X101	8000	10	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6080X101
PQSF6090X101	9000	10	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6090X101
PQSF6100X101	10000	10	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6100X101
PQSF6120X101	12000	10	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6120X101

35 kV SVG PQvar Series – 3P3W systems[1)]

Type	Rated module reactive power kvar	Voltage class kV	Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h)[2)] mm	Ordering code
PQSF6020X351	2000	35	Floor-mounted	3500	4800 × 1200 × 2200	B44066F6020X351
PQSF6030X351	3000	35	Floor-mounted	3500	4800 × 1200 × 2200	B44066F6030X351
PQSF6040X351	4000	35	Floor-mounted	3500	7000 × 1200 × 2200	B44066F6040X351
PQSF6050X351	5000	35	Floor-mounted	3500	7000 × 1200 × 2200	B44066F6050X351
PQSF6060X351	6000	35	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6060X351
PQSF6070X351	7000	35	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6070X351
PQSF6080X351	8000	35	Floor-mounted	5500	7000 × 1200 × 2200	B44066F6080X351
PQSF6090X351	9000	35	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6090X351
PQSF6100X351	10000	35	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6100X351
PQSF6120X351	12000	35	Floor-mounted	7200	7000 × 1200 × 2600	B44066F6120X351

[1)] Transformer must be used additionally (35/6 kV or 35/10 kV)
[2)] Dimensions are only for SVG modules without transformers

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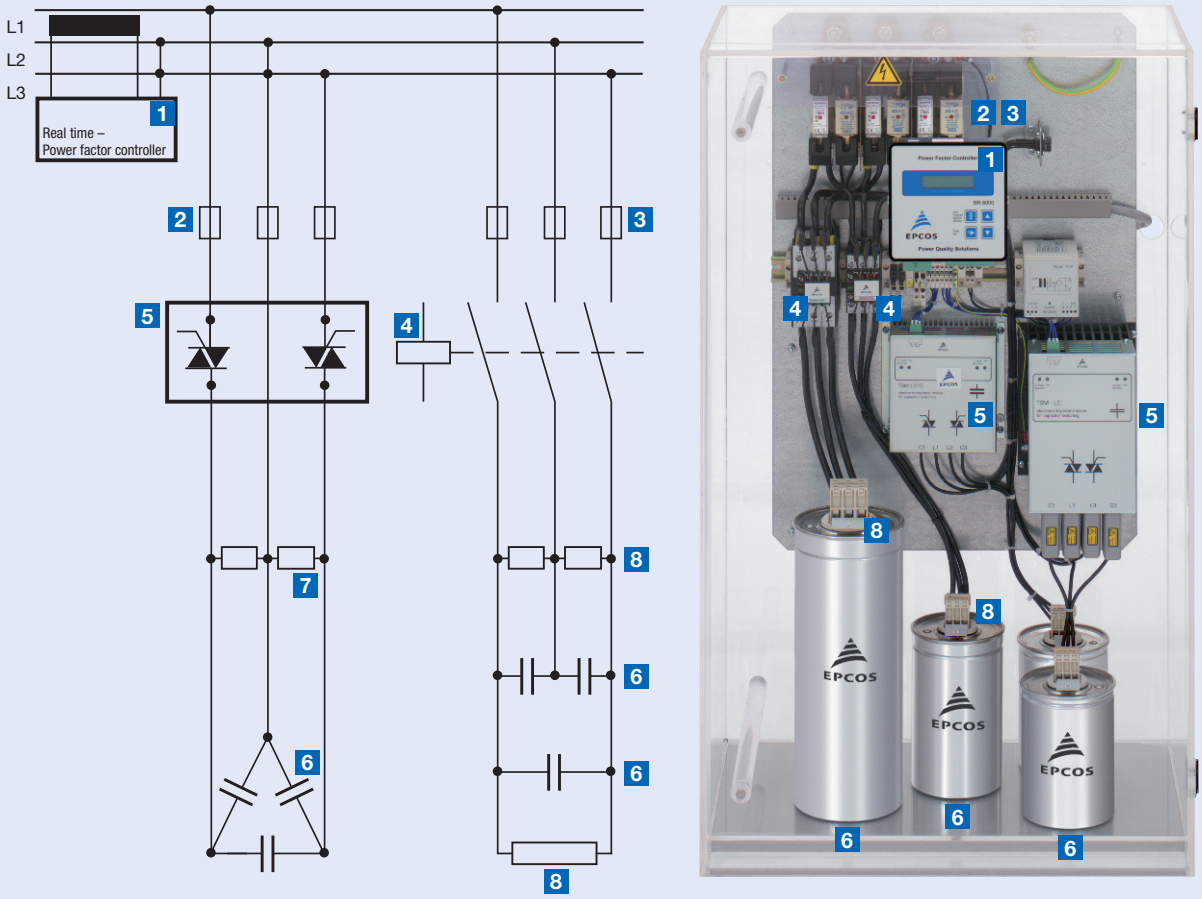
Fundamentals of Power Factor Correction

Application example



1 Power factor controller
2 Semiconductor fuses
3 Fuses
4 Contactor
5 Thyrisor module
6 Capacitor
7 Discharge resistor
8 Discharge resistor (plug in)

The rational use of electrical energy calls for economical generation, transmission and distribution with little losses. That means restricting all factors in electrical networks that cause losses. One of these factors is lagging reactive power. Loads in industrial and public power grids are primarily of an ohmic-inductive nature. The purpose of systems for power factor correction in networks is to compensate the generated lagging reactive power by leading reactive power at defined nodes. This also serves to avoid impermissibly high voltage drops and additional ohmic losses. The necessary leading power is produced by capacitors parallel to the supply network, as close as possible to the inductive load. Static capacitive compensation devices reduce the lagging reactive power component transmitted over the network. If grid conditions change, the required leading reactive power can be matched in steps by adding or taking out single power capacitors (automatic PFC) to compensate the lagging reactive power.

Benefits of power factor correction

- Fast return on investment through lower power costs
  – Power factor correction reduces the reactive power in a system.
  – Power consumption and thus power costs drop in proportion.
- Effective use of installation
  An improved power factor means that an electrical installation operates more economically (higher effective power for the same apparent power).
- Improved voltage quality
- Reduced voltage drops
- Optimum cable design
  – Cable cross-sections can be reduced with improvement of power factor (less current). In existing installations for instance, extra or higher power can be transmitted.
- Reduced transmission losses
  The transmission and switching devices carry less current, i.e. only the effective power, meaning that the ohmic losses in the leads are reduced.

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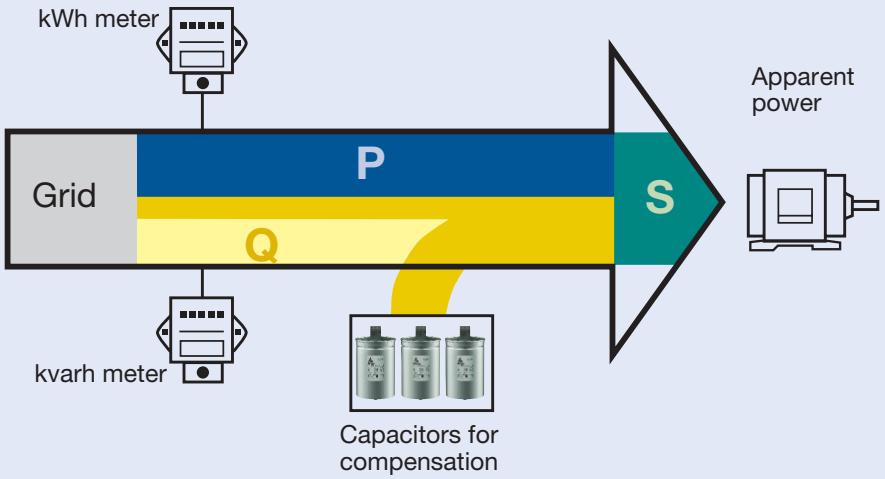
Components for Power Factor Correction

Conventional power factor correction



1. Capacitor

Power factor correction (PFC) capacitors produce the necessary leading reactive power to compensate the lagging reactive power. They should be capable of withstanding high inrush currents caused by switching operations (>100 · I_R). If they are connected in parallel, i.e. as banks, the inrush current will increase (≥150 · I_R) because the charging current comes from the power line as well as from other capacitors connected in parallel.

Design of capacitors

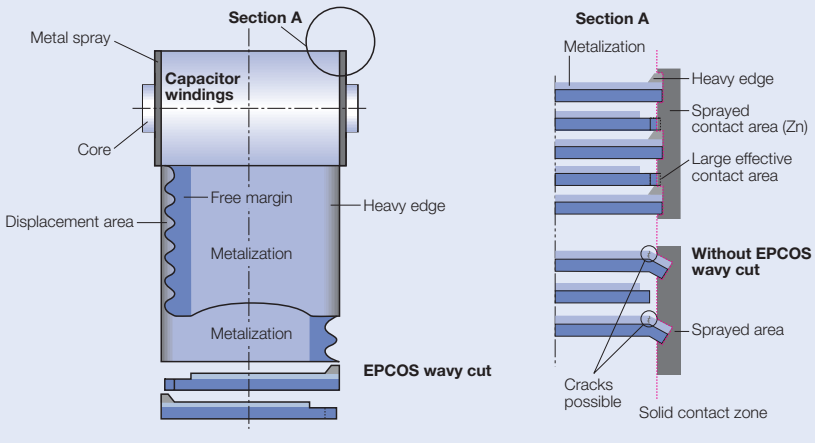
MKK/MKP/MKD technology

Metalized plastic compact capacitors with self-healing properties and a polypropylene dielectric. Film metallization with zinc/aluminum alloy results in high performance and a low film thickness allowing significantly more compact dimensions and a lower weight.

A heavy edge and special film-cutting technique (optimized combination of wavy and smooth cuts) produces a maximum effective surface for the metal spraying or contacting process.

- Series PhaseCap Energy – with gas impregnation (dry technology) or with semi-dry biodegradable soft resin.
- Series PhaseCap and PhaseCap HD dry technology – impregnation with an inert gas (nitrogen N2).
- Series PhaseCap Compact – semi-dry biodegradable resin.
- Series DeltaCap – impregnation with semi-dry biodegradable soft resin.
- Series PhiCap – impregnation with semi-dry biodegradable soft resin.

Wavy cut design



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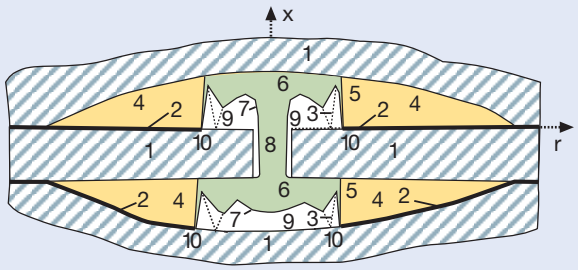
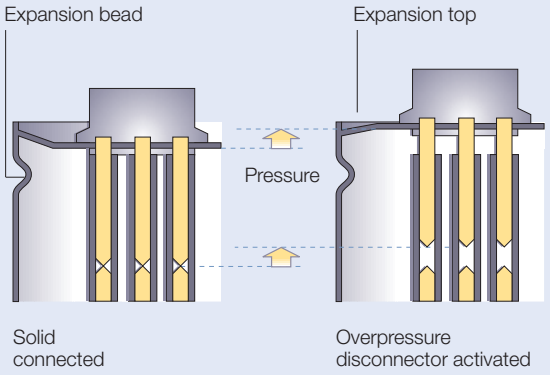
Components for Power Factor Correction

Self-healing



1 Dielectric
2 Metalized electrodes
3 Material displacing shock wave
4 Air gap with metal vapor
5, 6 Plasma zone
7 Boundary layer between gas phase dielectric and plasma
8 Breakdown channel
9 Gas phase dielectric
10 Zone of displaced metalization and dielectric (isolating region)

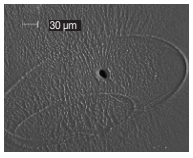
Overpressure disconnector

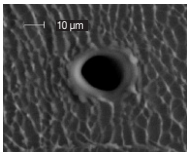


Safety

Self-healing properties

In the event of thermal or electrical overload, an electric breakdown occurs. The dielectric in the breakdown channel is broken down into highly compressed plasma that explodes out of the breakdown channel and pushes the dielectric layers apart. The discharge continues within the spreading plasma via the metal layers so that the metal surrounding the faulty area is completely burnt out. This produces perfect isolation of the faulty area within microseconds. The self-healing process results in negligible capacitance loss – less than 100 pF per event. The capacitor remains fully functional during the entire process.





Overpressure disconnector

At the end of the capacitor's service life or when a high pressure forms inside the can, the overpressure disconnector is activated.

The specially designed cover with an expansion bead moves upwards. Expansion beyond a certain degree will separate the wires and disconnect the capacitor safely from the line. The disconnector is separated at its break point (small notch) and the flow of current to the capacitor windings is interrupted.

⚠ Caution:
To ensure full functionality of an overpressure disconnector, the following is required:

1. The elastic elements must not be hindered, i.e.
   – connecting lines must be flexible leads (cables),
   – there must be sufficient space (at least 20 mm) for expansion above the connections (specified for the different models),
   – folding beads must not be retained by clamps.
2. The maximum permissible fault current of 10 000 A to the UL 810 standard must not be exceeded.
3. Stress parameters of the capacitor must be within the IEC 60831 specification.

Dry technology/ vacuum impregnation

The active winding elements are heated and then dried for a defined period. Impregnation is performed under vacuum. In this way, air and moisture are extracted from the inner capacitor, and oxidation of the electrodes as well as partial discharges are avoided. Afterwards, the capacitor elements are hermetically sealed in cases (e.g. aluminum). This elaborate process ensures excellent capacitance stability and long useful life.

2. Power factor controller

Modern PF controllers are microprocessor-based. The microprocessor analyzes the signal from a current transformer and produces switching commands to control the contactors that add or remove capacitor stages.

Intelligent control by microprocessor-based PF controllers ensures even utilization of capacitor stages, a minimized number of switching operations and an optimized life cycle of the capacitor bank.

After the required capacitor output has been determined, the number of steps should be defined. The broad product range of controllers from EPCOS allows customized solutions: the BR604 is suited to small PFC systems with four steps. The BR6000 series is available for conventional, dynamic and mixed compensation with six and twelve steps for medium and large systems respectively; BR6000-T6 for dynamic compensation with 6 steps. The PF controller BR7000 with its 15 outputs offers a broad range of applications, e.g. 15 conventional steps (each for one three-phase capacitor), 15 steps for single-phase capacitors or mixed operation (see page 56).

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Components for Power Factor Correction

Version BR7000-T with 15 transistor outputs is suitable for dynamic PFC. Series BR7000-I is designed for single-phase controlling.
BR7000-I/TH and BR7000-I/TH/S485 are designed for dynamic and mixed systems, each with 12 relays and 12 transistor outputs.
Rule of thumb: the number of steps depends on the number of loads, i.e. the more small inductive loads, the higher the number of steps should be. The switching time is also of major importance here: the more frequently a capacitor is switched, the more stress is placed on it and its contactors.

3. Multi measuring device

An external meter combining several features in a single device. Combined with the appropriate PF controller, it allows the monitoring, display and storage of various grid parameters. It provides additional protection for the capacitor and the PFC system. As a standalone solution, it acts as a meter, a signal trigger for thyristor modules or as a switch.

4. MC7000-3 grid analyzer

Offering three-phase measuring, display and storage of electric parameters in LV-grids, the MC7000-3, housed in a light-weight suitcase, is the optimum grid analysis tool for evaluation of new PFC-system-design or inspection of existing ones. A variety of accessories that come along with the device such as SD memory card, Windows-based software and several cables and clamps make the MC7000-3 a valuable instrument for PQS.

5. Switching devices

Two types of switching devices are available from EPCOS: capacitor contactors and thyristor modules. Before choosing a switching device for a PFC system, the user must consider the number of switching operations.

Capacitor contactor

Contactors are electromechanical switching elements used to switch capacitors or reactors and capacitors in standard or detuned PFC systems. The pre-switching auxiliary contacts of EPCOS capacitor contactors close before the main contact and avoid peak current values by pre-loading the capacitor. Note: Even when using capacitor contactors, it is important not to exceed the annual switching capability of the particular capacitor series.

Thyristor modules

Fast-changing loads of any kind require technologies that act in real time. In dynamic PFC systems, thyristor modules replace slow-acting electromechanical switches. This not only allows them to react within a few milliseconds, but also increases the life expectancy of all components without any mechanical wear out of the thyristor module.
Note: A dynamic PF controller is required, e.g. of the BR6000-T or BR7000-T series.

6. Reactors (compensation and filtering)

Power distribution networks are increasingly subjected to harmonic pollution from modern power electronics devices, known as non-linear loads, e.g. drives, uninterruptible power supplies and electronic ballasts. Harmonics are dangerous for capacitors connected in the PFC circuit, especially if they operate at a resonant frequency. The series connection of a reactor and capacitor to detune the series resonant frequency (the capacitor's resonant frequency) helps to prevent capacitor damage. The most critical frequencies are the 5th and 7th harmonics (250 and 350 Hz at 50 Hz grid frequency). Detuned capacitor banks also help to reduce the harmonic distortion level and clean the network.

7. Active Filter PQSine S series

Active harmonic filters and power optimizers of the PQSine S Series help to reduce harmonic pollution in the grid. By offering dynamic VAR compensation, active load balancing and elimination of harmonics power quality can be optimized, leading to a more efficient and reliable usage of energy. Depending on the customer needs or application, EPCOS offers complete panels, wall mounted cabinets and modules with voltages 380 V, 400 V and 690 V. Based on the latest state of the art technology, the AHF are installed in parallel to the polluting loads. They analyze the line current and the related harmonics. By generating a compensation current , the harmonic currents are neutralized, leading to an almost sinusoidal waveform.

8. PQvar

PQvar is a modular static var generator (SVG) for active stepless power factor correction and load balancing e.g. in industrial grids and large commercial buildings. With a fast response time of less than 15 ms and a dynamic reaction time of less than 50 µs, PQvar offers significantly faster compensation than conventional systems.

9. Discharge devices

Discharge resistors

- Discharge resistors are required to discharge capacitors and protect human beings against electric shock hazards as well as to switch capacitors in automatic PFC equipment (opposing phase).
- EPCOS discharge resistors are designed to discharge capacitors to 75 V or less within 60 seconds. Specific types < 75 V in 90 seconds; please refer to table of ordering codes.
- Before switching on again, capacitors must be discharged to 10% or less of their nominal voltage.
- Discharge resistors are included in the scope of delivery, pre-mounted for the PhaseCap Premium, PhaseCap Compact, PhaseCap HD, DeltaCap and PhiCap B32344 series.

⚠ Caution:
Discharge and short-circuit the capacitor before handling it!

Discharge reactor

Whenever fast discharge of a capacitor is required, a discharge resistor is not sufficient. Discharge reactors must be used to allow a discharge of within a few seconds. Also, the various steps in a PFC system can then be switched much faster, minimizing losses at the same time.

10. Protection

An HRC fuse or MCCB acts as a safety device for short-circuit protection.

- HRC fuses do not protect a capacitor against overload – they are designed for short-circuit protection only.
- The HRC fuse rating should be 1.6 to 1.8 times the nominal capacitor current.

⚠ Caution:
Do not use HRC fuses for switching (risk of arcing!).

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Standard Values: Selection Tables for Cables, Cable Cross Sections and Fuses

Selection table

Power kvar	Current A	Section mm²	Fuse A
Rated voltage 230 V, 60 Hz			
2.5	6.3	1.5	10
5.0	12.6	4.0	25
7.5	18.8	6.0	35
10.0	25.1	10.0	50
12.5	31.4	16.0	50
15.0	37.7	16.0	63
20.0	50.2	25.0	80
25.0	62.8	35.0	100
30.0	75.3	50.0	125
40.0	100.4	70.0	160
50.0	125.5	95.0	200
75.0	188.3	185.0	315
100.0	251.0	2× 120.0	400
125.0	–	–	–
150.0	–	–	–
175.0	–	–	–
200.0	–	–	–
Rated voltage 400 V, 50 Hz			
2.5	3.6	1.5	10
5.0	7.2	2.5	16
7.5	10.8	2.5	16
10.0	14.4	4.0	25
12.5	18.0	6.0	35
15.0	21.6	6.0	35
20.0	28.8	10.0	50
25.0	36.0	16.0	63
30.0	43.2	25.0	80
40.0	57.6	35.0	100
50.0	72.0	50.0	125
75.0	108.3	70.0	160
100.0	144.3	120.0	250
125.0	180.3	185.0	315
150.0	216.5	2× 95.0	350
175.0	252.6	2× 95.0	400
200.0	288.0	2× 120.0	500
Rated voltage 440 V, 60 Hz			
2.5	3.3	1.5	10
5.0	6.6	2.5	16
7.5	10.0	2.5	16
10.0	13.2	4.0	25
12.5	16.8	4.0	25
15.0	19.8	6.0	35
20.0	26.4	10.0	50
25.0	33.0	16.0	63
30.0	39.6	25.0	80
40.0	52.8	35.0	100
50.0	66.0	50.0	125
75.0	99.0	70.0	160
100.0	132.0	95.0	200
125.0	165.0	185.0	315
150.0	198.0	2× 95.0	350
175.0	231.0	2× 95.0	400
200.0	264.0	2× 120.0	500

The above mentioned values are guidelines for operation in normal conditions at ambient temperatures up to +35 °C.
Upgrade accordingly if conditions differ, e.g. temperature or hamonics differ. The internal wiring of a capacitor bank is sometimes possible with a smaller cross section. Various parameters such as temperature inside the cabinet, cable quality, maximum cable insulation temperature, single or multi core cable, cable length and laying system have to be considered for a proper selection. The local panelbuilder/installer is responsible for a proper selection of the cable sizes and fuses according to the valid regulations and standards in the specific country where the PFC panels are installed.

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Standard Values: Selection Tables for Cables, Cable Cross Sections and Fuses

Selection table

Power kvar	Current A	Section mm²	Fuse A
Rated voltage 480 V, 60 Hz			
2.5	3.0	1.5	10
5.0	6.0	2.5	16
7.5	9.0	2.5	16
10.0	12.0	4.0	25
12.5	18.0	6.0	35
15.0	21.0	6.0	35
20.0	24.0	10.0	50
25.0	30.0	10.0	50
30.0	36.0	16.0	63
40.0	48.0	25.0	80
50.0	60.0	35.0	100
75.0	90.0	70.0	160
100.0	120.0	95.0	200
125.0	150.0	120.0	250
150.0	180.0	185.0	315
175.0	210.0	2× 95.0	350
200.0	240.0	2× 95.0	400
Rated voltage 525 V, 50 Hz			
2.5	2.7	1.5	10
5.0	5.5	1.5	10
7.5	6.9	2.5	16
10.0	11.0	2.5	16
12.5	13.7	4.0	25
15.0	16.5	4.0	25
20.0	22.0	6.0	35
25.0	27.5	10.0	50
30.0	33.0	16.0	63
40.0	44.0	25.0	80
50.0	55.0	35.0	100
75.0	82.5	70.0	160
100.0	110.0	95.0	200
125.0	137.5	95.0	200
150.0	165.0	185.0	300
175.0	193.0	2× 95.0	350
200.0	220.0	2× 95.0	350
Rated voltage 690 V, 50 Hz			
2.5	2.1	1.5	10
5.0	4.2	1.5	10
7.5	6.3	1.5	10
10.0	8.4	2.5	16
12.5	10.5	2.5	16
15.0	12.6	4.0	25
20.0	16.7	4.0	25
25.0	20.9	6.0	35
30.0	25.1	10.0	50
40.0	33.5	16.0	63
50.0	41.8	25.0	80
75.0	62.8	50.0	125
100.0	83.7	70.0	160
125.0	105.0	70.0	160
150.0	126.0	95.0	200
175.0	146.0	120.0	250
200.0	167.0	128.5	315

The above mentioned values are guidelines for operation in normal conditions at ambient temperatures up to +35 °C.
Upgrade accordingly if conditions differ, e.g. temperature or hamonics differ. The internal wiring of a capacitor bank is sometimes possible with a smaller cross section. Various parameters such as temperature inside the cabinet, cable quality, maximum cable insulation temperature, single or multi core cable, cable length and laying system have to be considered for a proper selection. The local panelbuilder/installer is responsible for a proper selection of the cable sizes and fuses according to the valid regulations and standards in the specific country where the PFC panels are installed.

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Calculation Table for Reactive Power Demand (Qc)

Current (ACTUAL) tan φ	cos φ	Achievable (TARGET) cos φ 0.80	0.82	0.85	0.88	0.90	0.92	0.94	TARGET cos φ = 0.96	0.98	cos φ ≤ 1 1.00
						Faktor F					
3.18	0.30	2.43	2.48	2.56	2.64	2.70	2.75	2.82	2.89	2.98	3.18
2.96	0.32	2.21	2.26	2.34	2.42	2.48	2.53	2.60	2.67	2.76	2.96
2.77	0.34	2.02	2.07	2.15	2.23	2.28	2.34	2.41	2.48	2.56	2.77
2.59	0.36	1.84	1.89	1.97	2.05	2.10	2.17	2.23	2.30	2.39	2.59
2.43	0.38	1.68	1.73	1.81	1.89	1.95	2.01	2.07	2.14	2.23	2.43
2.29	0.40	1.54	1.59	1.67	1.75	1.81	1.87	1.93	2.00	2.09	2.29
2.16	0.42	1.41	1.46	1.54	1.62	1.68	1.73	1.80	1.87	1.96	2.16
2.04	0.44	1.29	1.34	1.42	1.50	1.56	1.61	1.68	1.75	1.84	2.04
1.93	0.46	1.18	1.23	1.31	1.39	1.45	1.50	1.57	1.64	1.73	1.93
1.83	0.48	1.08	1.13	1.21	1.29	1.34	1.40	1.47	1.54	1.62	1.83
1.73	0.50	0.98	1.03	1.11	1.19	1.25	1.31	1.37	1.45	1.63	1.73
1.64	0.52	0.89	0.94	1.02	1.10	1.16	1.22	1.28	1.35	1.44	1.64
1.56	0.54	0.81	0.86	0.94	1.02	1.07	1.13	1.20	1.27	1.36	1.56
1.48	0.56	0.73	0.78	0.86	0.94	1.00	1.05	1.12	1.19	1.28	1.48
1.40	0.58	0.65	0.70	0.78	0.86	0.92	0.98	1.04	1.11	1.20	1.40
1.33	0.60	0.58	0.63	0.71	0.79	0.85	0.91	0.97	1.04	1.13	1.33
1.30	0.61	0.55	0.60	0.68	0.76	0.81	0.87	0.94	1.01	1.10	1.30
1.27	0.62	0.52	0.57	0.65	0.73	0.78	0.84	0.91	0.99	1.06	1.27
1.23	0.63	0.48	0.53	0.61	0.69	0.75	0.81	0.87	0.94	1.03	1.23
1.20	0.64	0.45	0.50	0.58	0.66	0.72	0.77	0.84	0.91	1.00	1.20
1.17	0.65	0.42	0.47	0.55	0.63	0.68	0.74	0.81	0.88	0.97	1.17
1.14	0.66	0.39	0.44	0.52	0.60	0.65	0.71	0.78	0.85	0.94	1.14
1.11	0.67	0.36	0.41	0.49	0.57	0.63	0.68	0.75	0.82	0.90	1.11
1.08	0.68	0.33	0.38	0.46	0.54	0.59	0.65	0.72	0.79	0.88	1.08
1.05	0.69	0.30	0.35	0.43	0.51	0.56	0.62	0.69	0.76	0.85	1.05
1.02	0.70	0.27	0.32	0.40	0.48	0.54	0.59	0.66	0.73	0.82	1.02
0.99	0.71	0.24	0.29	0.37	0.45	0.51	0.57	0.63	0.70	0.79	0.99
0.96	0.72	0.21	0.26	0.34	0.42	0.48	0.54	0.60	0.67	0.76	0.96
0.94	0.73	0.19	0.24	0.32	0.40	0.45	0.51	0.58	0.65	0.73	0.94
0.91	0.74	0.16	0.21	0.29	0.37	0.42	0.48	0.55	0.62	0.71	0.91
0.88	0.75	0.13	0.18	0.26	0.34	0.40	0.46	0.52	0.59	0.68	0.88
0.86	0.76	0.11	0.16	0.24	0.32	0.37	0.43	0.50	0.57	0.65	0.86
0.83	0.77	0.08	0.13	0.21	0.29	0.34	0.40	0.47	0.54	0.63	0.83
0.80	0.78	0.05	0.10	0.18	0.26	0.32	0.38	0.44	0.51	0.60	0.80
0.78	0.79	0.03	0.08	0.16	0.24	0.29	0.35	0.42	0.49	0.57	0.78
0.75	0.80		0.05	0.13	0.21	0.27	0.32	0.39	0.46	0.55	0.75
0.72	0.81			0.10	0.18	0.24	0.30	0.36	0.43	0.52	0.72
0.70	0.82			0.08	0.16	0.21	0.27	0.34	0.41	0.49	0.70
0.67	0.83			0.05	0.13	0.19	0.25	0.31	0.38	0.47	0.67
0.65	0.84			0.03	0.11	0.16	0.22	0.29	0.36	0.44	0.65
0.62	0.85				0.08	0.14	0.19	0.26	0.33	0.42	0.62
0.59	0.86				0.05	0.11	0.17	0.23	0.30	0.39	0.59
0.57	0.87					0.08	0.14	0.21	0.28	0.36	0.57
0.54	0.88					0.06	0.11	0.18	0.25	0.34	0.54
0.51	0.89					0.03	0.09	0.15	0.22	0.31	0.51
0.48	0.90						0.06	0.12	0.19	0.28	0.48
0.46	0.91						0.03	0.10	0.17	0.25	0.46
0.43	0.92							0.07	0.14	0.22	0.43
0.40	0.93							0.04	0.11	0.19	0.40
0.36	0.94								0.07	0.16	0.36
0.33	0.95									0.13	0.33

$Q_C = P_A \cdot (\tan \varphi 1 - \tan \varphi 2)$
Q_C [kvar] = $P_A \cdot F$ = active power [kW] · factor "F"
$P_A = S \cdot \cos \varphi$ = apparent power · $\cos \varphi$
$\tan \varphi 1 + \varphi 2$ according to $\cos \varphi$ values ref. table

Example:

Actual motor power	P = 100 kW
ACTUAL cos φ	0.61
TARGET cos φ	0.96
Factor F from table	1.01
Capacitor reactive power Q_C	
$Q_C = 100 \cdot 1.01 = 101.0$ kvar	

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Individual PFC for Motors

Approximate values (specified by the German Electricity Association VDEW) for fixed PFC of motors

Motor nominal rating kW	Capacitor power rating (1500 r.p.m.*) kvar	Capacitor power rating (1000 r.p.m.*) kvar	Capacitor power rating (750 r.p.m.*) kvar
1 ... 1.9	0.5	0.5	0.6
2 ... 2.9	1	1.1	1.2
3 ... 3.9	1.5	1.6	1.7
4 ... 4.9	2	2.1	2.3
5 ... 5.9	2.5	2.6	2.9
6 ... 7.9	3	3.2	3.5
8 ... 10.9	4	4.2	4.6
11 ... 13.9	5	5.3	5.8
14 ... 17.9	6	6.3	6.9
18 ... 21.9	7.5	8.0	8.6
22 ... 29.9	10	10.5	11.5
30 ... 39.9	approx. 40% of the motor power		
40 and above	approx. 35% of the motor power		

*r.p.m.: revolutions per minute

The capacitor output should be approx. 90% of the apparent power of the motor when idle.

This means a power factor of 0.9% at full load and 0.95 to 0.98 during idling. Important: The capacitor output must not be rated too high for individual compensated machines where the capacitor is directly connected with the motor clamp. This especially applies when the machine has a big oscillating weight and still continues to rotate after switching off.

The capacitor placed in parallel may act as generator for the motor which will cause serious overvoltages. The consequence could be heavy damage to the capacitor as well as to the motor.

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Individual PFC for Transformers

Standard values for transformer power factor correction		
Rated apparent power of transformer	**Rated capacitor power for oil immersed transformers**	**Rated capacitor power for cast resin transformers**
kVA	**kvar**	**kvar**
10	1.0	1.5
20	2.0	1.7
50	4.0	2.0
75	5.0	2.5
100	5.0	2.5
160	7.0	4.0
200	7.5	5.0
250	8.0	7.5
315	10.0	8.0
400	12.5	8.5
500	15.0	10.0
630	17.5	12.5
800	20.0	15.0
1000	25.0	16.7
1250	30.0	20.0
1600	35.0	22.0
2000	40.0	25.0
2500	50.0	35.0
3150	60.0	50.0

For an exact calculation of the right capacitor value, following formula can be used:

$$Q_C = I_0\% \cdot \frac{A_N}{100}$$

Q_C = needed capacitor (kvar)
$I_0\%$ = magnetising current of the transformer ($A_S\%$)
A_N = apparent rated power of the transformer in kVA

There are regional differences in the guidelines of power suppliers concerning the admissible size of capacitors directly connected with a transformer. Therefore a consultation with the respective power supplier is recommended before installation of a compensation bank. Modern transformers have laminations which only need low capacity to reverse the magnetism. In case the capacitor output is too high, stress increase may occur during idling.

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Detuned PFC in General

When installing capacitors for PFC purpose, the problem of dealing with harmonics has to be faced. They have to be taken into account when designing the PFC system in order to prevent parallel and / or series resonance conditions that would damage the whole electrical system.

When PFC capacitors are connected, the inductance of the transformer together with the capacitors forms a resonant circuit that could be excited by a harmonic current generated by the load. This resonant circuit has a resonance frequency, and if a harmonic current of this frequency (or close to it) exists, it will lead the circuit into a resonance condition where high current will flow through the branches (L: the transformer, and C: the capacitor bank), overloading them and raising the voltage across them and across the whole electrical system that is connected in parallel.

PFC detuned filtering is a technique to correct the power factor avoiding the risk of resonance condition performed by shifting the resonance frequency to lower values where no harmonic currents are present.

This is achieved by modifying the basic LC circuit formed by the transformer and the capacitor bank, introducing a filter reactor in series with the capacitors, making this way a more complex resonant circuit but with the desired feature of having a resonance frequency below the first existing harmonic. This way it's not possible to have a real resonance condition.

Besides this main objective, the reactor connected in series with capacitors form a series resonant circuit with a certain tuning frequency at which the branch will offer a low impedance path. Filtering of harmonic currents and "cleaning" of the grid will be achieved.

Components for PFC detuned filters must be carefully selected according to the desired PFC purpose, to the harmonics present in the system, to some features of the system like short circuit power and impedances, to the desired filtering effect and to the characteristics of the resonant circuit configured.

For example, the voltage across the capacitors will be higher than the nominal grid voltage when they have a reactor connected in series.

The reactors must be selected in line with the inductance value to obtain the desired tuning frequency and current capability high enough for the harmonic current absorption that can be expected. The tuning frequency is usually indirectly referred to as the detuning factor p and expressed as a percentage.

$$p = 100 \cdot \frac{X_L}{X_C} = \left(\frac{f}{f_{RES}}\right)^2 \cdot 100$$

PFC detuned filtering is an engineering speciality that takes experienced know-how to implement it in a satisfying and safe way.

The design-instructions for detuned PFC systems on page 107 have to be followed to ensure an optimum performance of the PFC system.

Note: The recommendations given in the selection tables are meant as a support tool. EPCOS does not take over any responsibility for the design as apart from the theoretical conditions the prevailing circumstances in the application have to be taken into account.

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Detuned PFC: Important Facts and Instructions

Important design instructions to be followed for detuned PFC Systems

1. Determine the necessary effective power (kvar) of the capacitor bank in order to obtain the desired PF.
2. Design the capacitor stages in such a way that the sensibility of the bank is around 15–20% of the total available power. It's not useful to have a more sensitive bank that reacts with a 5 or 10% of the total power because this would lead to a high amount of switching operations, wasting the equipment unnecessarily when the real objective is to have a high average PF.
3. Try to design the bank with standard kvar values of effective power steps, preferably multiples of 25 kvar.
4. Measure the presence of harmonic currents in the main feeder cable of the system without capacitors at all possible load conditions. Determine frequency and maximum amplitude for every harmonic that could exist.
   Calculate the Total Harmonic Distortion of Current $THD\text{-}I = 100 \cdot SQR\,[(I_3)^2 + (I_5)^2 + \ldots + (I_R)^2]/I_I$
   Calculate every existing value for $THD\text{-}I_R = 100 \cdot I_R/I_I$
5. Measure the presence of harmonic voltages that might come from outside your system, if possible measure the HV side.
   Calculate the Total Harmonic Distortion of Voltage $THD\text{-}V = 100 \cdot SQR\,[(V_3)^2 + (V_5)^2 + \ldots + (V_N)^2]/V_I$
6. Are there harmonics such as $THD\text{-}I > 10\%$ or $THD\text{-}V > 3\%$ (measured without capacitors)?
   If YES → use PFC-DF and go to consideration 7.
   If NO → use standard PFC and skip considerations 7, 8 and 9.
7. Is there 3rd harmonic content, $I_3 > 0.2 \cdot I_5$?
   If YES → use PFC-DF with p = 14% and skip consideration 8.
   If NO → use PFC-DF with p = 7% or 5.67% and go to consideration 8.
8. THD-V is:
   3–7% → use PFC-DF with p = 7%
   >7% → use PFC-DF with p = 5.67%
   >10% → ask for special filter design
9. Select the proper components using EPCOS tables for PFC-DF and standard values for effective power, the voltage and frequency of your grid, and the determined detuned factor p.
10. Always use genuine EPCOS application-specific designed components for PFC-DF. Please observe that reactors are specified for their effective power at grid voltage and frequency. This power will be the real effective power of the whole LC set at fundamental frequency. Capacitors for PFC-DF must be selected for a higher rated voltage than the grid's because of the overvoltage caused by the series connection with the reactor. Contactors for capacitors are designed as application-specific to reduce inrush capacitors currents and to handle capacitive loads in a reliable way.

Note: These are general instructions. Conditions may differ depending on the application.
In case of doubts, please contact our local sales-office.

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Please read *Important notes* on page 12 and *Cautions* on page 121–125

Component Selection Tables for Detuned PFC

EPCOS

Selection table

Detuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Contactor ordering code	Cable cross-section mm²	Fuse rating A
400 V – 50 Hz						
5,67	10	1× B25675A4132J880	B44066D5010*400	B44066S1810J230	4	25
5,67	12,5	1× B25675A4142J240	B44066D5012*400	B44066S1810J230	6	35
5,67	20	1× B25675A4282J180	B44066D5020*400	B44066S2410J230	10	50
5,67	25	1× B25675A4282J140	B44066D5025*400	B44066S3210J230	16	63
5,67	40	1× B25675A4202J040 1× B25675A4252J040	B44066D5040*400	B44066S6210J230	35	100
5,67	50	2× B25675A4282J140	B44066D5050*400	B44066S6210J230	50	125
5,67	75	3× B25675A4282J140	B44066D5075*400	B44066S7410J230	70	160
5,67	100	4× B25675A4282J140	B44066D5100*400	B44066S9910J230	120	250
7	10	1× B25675A4132J880	B44066D7010*400	B44066S1810J230	4	25
7	12,5	1× B25675A4142J240	B44066D7012*400	B44066S1810J230	6	35
7	20	1× B25675A4282J180	B44066D7020*400	B44066S2410J230	10	50
7	25	1× B25675A4282J140	B44066D7025*400	B44066S3210J230	16	63
7	40	1× B25675A4202J040 1× B25675A4252J040	B44066D7040*400	B44066S6210J230	35	100
7	50	2× B25675A4282J140	B44066D7050*400	B44066S6210J230	50	125
7	75	3× B25675A4282J140	B44066D7075*400	B44066S7410J230	70	160
7	100	4× B25675A4282J140	B44066D7100*400	B44066S9910J230	125	250
14	10	1× B25675A4122J580	B44066D1410*400	B44066S1810J230	4	25
14	12,5	1× B25675A4152J080	B44066D1412*400	B44066S1810J230	6	35
14	20	1× B25675A4252J080	B44066D1420*400	B44066S2410J230	10	50
14	25	1× B25675A4312J080	B44066D1425*400	B44066S3210J230	16	63
14	40	2× B25675A4252J080	B44066D1440*400	B44066S6210J230	35	100
14	50	2× B25675A4312J080	B44066D1450*400	B44066S6210J230	50	125
14	75	3× B25675A4312J080	B44066D1475*400	B44066S7410J230	70	160
14	100	4× B25675A4312J080	B44066D1499*400	B44066S9910J230	125	250
400 V – 60 Hz						
5,67	10	1× B25675A4112J080	B44066D5010*401	B44066S1810J230	4	25
5,67	12,5	1× B25675A4122J040	B44066D5012*401	B44066S1810J230	6	35
5,67	20	1× B25675A4182J840	B44066D5020*401	B44066S2410J230	10	50
5,67	25	1× B25675A4102J040 1× B25675A4142J240	B44066D5025*401	B44066S3210J230	16	63
5,67	40	2× B25675A4182J840	B44066D5040*401	B44066S6210J230	35	100
5,67	50	2× B25675A4142J240 1× B25675A4182J840	B44066D5050*401	B44066S6210J230	50	125
5,67	75	1× B25675A4202J040 2× B25675A4252J040	B44066D5075*401	B44066S7410J230	70	160
5,67	100	1× B25675A4202J040 3× B25675A4252J040	B44066D5100*401	B44066S9910J230	120	250
7	10	1× B25675A4092J040	B44066D7010*401	B44066S1810J230	4	25
7	12,5	1× B25675A4122J040	B44066D7012*401	B44066S1810J230	6	35
7	20	1× B25675A4182J840	B44066D7020*401	B44066S2410J230	10	50
7	25	2× B25675A4122J040	B44066D7025*401	B44066S3210J230	16	63
7	40	2× B25675A4182J840	B44066D7040*401	B44066S6210J230	35	100
7	50	2× B25675A4142J240 1× B25675A4182J840	B44066D7050*401	B44066S6210J230	50	125
7	75	1× B25675A4202J040 2× B25675A4252J040	B44066D7075*401	B44066S7410J230	70	160
7	100	1× B25675A4182J840 3× B25675A4252J040	B44066D7100*401	B44066S9910J230	120	250

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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Component Selection Tables for Detuned PFC

Selection table

Detuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Contactor ordering code	Cable cross-section mm²	Fuse rating A
400 V – 60 Hz						
14	10	1× B25675A4102J480	B44066D1410*401	B44066S1810J230	4	25
14	12,5	1× B25675A4122J580	B44066D1412*401	B44066S1810J230	6	35
14	20	1× B25675A4202J880	B44066D1420*401	B44066S2410J230	10	50
14	25	1× B25675A4252J080	B44066D1425*401	B44066S3210J230	16	63
14	40	2× B25675A4202J880	B44066D1440*401	B44066S6210J230	35	100
14	50	2× B25675A4252J080	B44066D1450*401	B44066S6210J230	50	125
14	75	3× B25675A4252J080	B44066D1475*401	B44066S7410J230	70	160
14	100	4× B25675A4252J080	B44066D1499*401	B44066S9910J230	120	250
440 V – 50 Hz						
5,67	10	1× B25675A4112J080	B44066D5010*440	B44066S1810J230	4	25
5,67	12,5	1× B25675A4132J880	B44066D5012*440	B44066S1810J230	4	35
5,67	20	1× B25675A4222J080	B44066D5020*440	B44066S2410J230	10	50
5,67	25	1× B25675A4282J180	B44066D5025*440	B44066S3210J230	16	63
5,67	40	2× B25675A4222J080	B44066D5040*440	B44066S6210J230	35	100
5,67	50	2× B25675A4282J180	B44066D5050*440	B44066S6210J230	50	125
5,67	75	3× B25675A4282J180	B44066D5075*440	B44066S7410J230	70	160
5,67	100	4× B25675A4282J180	B44066D5100*440	B44066S9910J230	95	200
7	10	1× B25765A4112J080	B44066D7010*440	B44066S1810J230	4	25
7	12,5	1× B25675A4132J880	B44066D7012*440	B44066S1810J230	4	25
7	20	1× B25675A4222J080	B44066D7020*440	B44066S2410J230	10	50
7	25	1× B25675A4282J180	B44066D7025*440	B44066S3210J230	16	63
7	40	2× B25675A4222J080	B44066D7040*440	B44066S6210J230	35	100
7	50	2× B25675A4282J180	B44066D7050*440	B44066S6210J230	50	125
7	75	3× B25675A4282J180	B44066D7075*440	B44066S7410J230	70	160
7	100	4× B25675A4282J180	B44066D7100*440	B44066S9910J230	95	200
14	10	1× B25675A5122J525	B44066D1410*440	B44066S1810J230	4	25
14	12,5	1× B25675A5152J025	B44066D1412*440	B44066S1810J230	4	25
14	20	1× B25675A5252J025	B44066D1420*440	B44066S2410J230	10	50
14	25	1× B25675A5302J025	B44066D1425*440	B44066S3210J230	16	63
14	40	2× B25675A5252J025	B44066D1440*440	B44066S6210J230	35	100
14	50	2× B25675A5302J025	B44066D1450*440	B44066S6210J230	50	125
14	75	3× B25675A5302J025	B44066D1475*440	B44066S7410J230	70	160
14	100	4× B25675A5302J025	B44066D1499*440	B44066S9910J230	95	200
440 V – 60 Hz						
5,67	10	1× B25675A6142J200	B44066D5010*441	B44066S1810J230	4	25
5,67	12,5	1× B25675A4112J080	B44066D5012*441	B44066S1810J230	4	25
5,67	20	1× B25675A4082J380 1× B25675A4102J480	B44066D5020*441	B44066S2410J230	10	50
5,67	25	1× B25675A4112J080 1× B25675A4122J580	B44066D5025*441	B44066S3210J230	16	63
5,67	40	1× B25675A4162J780 1× B25675A4202J880	B44066D5040*441	B44066S6210J230	35	100
5,67	50	1× B25675A4222J080 1× B25675A4252J080	B44066D5050*441	B44066S6210J230	50	125
5,67	75	1× B25675A4202J880 2× B25675A4252J080	B44066D5075*441	B44066S7410J230	70	160
5,67	100	1× B25675A4202J080 3× B25675A4252J080	B44066D5100*441	B44066S9910J230	95	200

Component Selection Tables for Detuned PFC

Selection table

Detuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Contactor ordering code	Cable cross-section mm²	Fuse rating A
440 V – 60 Hz						
7	10	1× B25675A5102J425	B44066D7010*441	B44066S1810J230	4	25
7	12,5	1× B25675A5132J225	B44066D7012*441	B44066S1810J230	4	25
7	20	1× B25675A4082J380 1× B25675A4102J480	B44066D7020*441	B44066S2410J230	10	50
7	25	1× B25675A4222J080	B44066D7025*441	B44066S3210J230	16	63
7	40	1× B25675A4162J780 1× B25675A4202J080	B44066D7040*441	B44066S6210J230	35	100
7	50	1× B25675A4202J880 1× B25675A4252J080	B44066D7050*441	B44066S6210J230	50	125
7	75	2× B25675A4222J080 1× B25675A4252J080	B44066D7075*441	B44066S7410J230	70	160
7	100	3× B25675A4222J080 1× B25675A4252J080	B44066D7100*441	B44066S9910J230	95	200
14	10	1× B25675A5102J425	B44066D1410*441	B44066S1810J230	4	25
14	12,5	1× B25675A5122J525	B44066D1412*441	B44066S1810J230	4	25
14	20	1× B25675A5202J825	B44066D1420*441	B44066S2410J230	10	50
14	25	1× B25675A5262J525	B44066D1425*441	B44066S3210J230	16	63
14	40	1× B25675A5202J025 1× B25675A5202J825	B44066D1440*441	B44066S6210J230	35	100
14	50	1× B25675A5252J025 1× B25675A5262J525	B44066D1450*441	B44066S6210J230	50	125
14	75	2× B25675A5252J025 1× B25675A5262J525	B44066D1475*441	B44066S7410J230	70	160
14	100	3× B25675A5252J025 1× B25675A5262J525	B44066D1499*441	B44066S9910J230	95	200
480 V – 60 Hz						
5,67	10	1× B25675A6122J500	B44066D5010*441	B44066S1810J230	4	25
5,67	12,5	1× B25675A6142J200	B44066D5012*441	B44066S1810J230	4	25
5,67	20	1× B25675A6252J000	B44066D5020*441	B44066S2410J230	10	50
5,67	25	1× B25675A5082J325 1× B25675A5152J025	B44066D5025*441	B44066S3210J230	16	63
5,67	40	1× B25675A5162J725 1× B25675A5202J825	B44066D5040*441	B44066S6210J230	35	100
5,67	50	1× B25675A5202J825 1× B25675A5252J025	B44066D5050*441	B44066S6210J230	50	125
5,67	75	1× B25675A5202J825 2× B25675A5252J025	B44066D5075*441	B44066S7410J230	70	160
5,67	100	1× B25675A5202J025 3× B25675A5252J025	B44066D5100*441	B44066S9910J230	95	200
7	10	1× B25675A6122J500	B44066D7010*441	B44066S1810J230	4	25
7	12,5	1× B25675A6142J200	B44066D7012*441	B44066S1810J230	4	25
7	20	1× B25675A6252J000	B44066D7020*441	B44066S2410J230	10	50
7	25	1× B25675A5082J325 1× B25675A5152J025	B44066D7025*441	B44066S3210J230	16	63
7	40	1× B25675A5162J725 1× B25675A5202J025	B44066D7040*441	B44066S6210J230	35	100
7	50	1× B25675A5202J825 1× B25675A5252J025	B44066D7050*441	B44066S6210J230	50	125
7	75	1× B25675A5202J025 2× B25675A5252J025	B44066D7075*441	B44066S7410J230	70	160
7	100	1× B25675A5162J725 3× B25675A5252J025	B44066D7100*441	B44066S9910J230	95	200

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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Component Selection Tables for Detuned PFC

Selection table

Detuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Contactor ordering code	Cable cross-section mm²	Fuse rating A
480 V – 60 Hz						
14	10	1× B25675A6142J690	B44066D1410*441	B44066S1810J230	4	25
14	12,5	1× B25675A6132J900	B44066D1412*441	B44066S1810J230	4	25
14	20	1× B25675A6102J400 1× B25675A6122J500	B44066D1420*441	B44066S2410J230	10	50
14	25	2× B25675A6132J900	B44066D1425*441	B44066S3210J230	16	63
14	40	1× B25675A6202J000 1× B25675A6252J000	B44066D1440*441	B44066S6210J230	35	100
14	50	1× B25675A6142J200 2× B25675A6202J800	B44066D1450*441	B44066S6210J230	50	125
14	75	1× B25675A6082J300 3× B25675A6252J000	B44066D1475*441	B44066S7410J230	70	160
14	100	1× B25675A6122J500 4× B25675A6252J000	B44066D1499*441	B44066S9910J230	95	200
690 V – 50 Hz						
5,67	10	1× B25673A8122A500	B44066D5010*690	B44066S1810J230	4	25
5,67	12,5	1× B25673A9202A000	B44066D5012*690	B44066S1810J230	4	25
5,67	20	1× B25673A8252A000	B44066D5020*690	B44066S1810J230	10	50
5,67	25	1× B25673A8072A500 1× B25673A8252A000	B44066D5025*690	B44066S2410J230	16	63
5,67	40	2× B25673A8252A000	B44066D5040*690	B44066S3210J230	35	100
5,67	50	1× B25673A8072A500 2× B25673A8282A000	B44066D5050*690	B44066S5010J230	50	125
5,67	75	1× B25673A8102A000 3× B25673A8282A000	B44066D5075*690	B44066S6210J230	70	160
5,67	100	1× B25673A8122A500 4× B25673A8282A000	B44066D5100*690	B44066S7410J230	95	200
7	10	1× B25673A8122A500	B44066D7010*690	B44066S1810J230	4	25
7	12,5	1× B25673A8152A000	B44066D7012*690	B44066S1810J230	4	25
7	20	1× B25673A8252A000	B44066D7020*690	B44066S1810J230	10	50
7	25	2× B25673A8152A000	B44066D7025*690	B44066S2410J230	16	63
7	40	2× B25673A8252A000	B44066D7040*690	B44066S3210J230	35	100
7	50	3× B25673A8202A000	B44066D7050*690	B44066S5010J230	50	125
7	75	1× B25673A8102A000 3× B25673A8282A000	B44066D7075*690	B44066S6210J230	70	160
7	100	4× B25673A8282A000 1× B25673A8122A500	B44066D7100*690	B44066S7410J230	95	200
14	10	1× B25673A9152A000	B44066D1410*690	B44066S1810J230	4	25
14	12,5	1× B25673A0102A400 1× B25673A0122A500	B44066D1412*690	B44066S1810J230	4	25
14	20	2× B25673A9152A000	B44066D1420*690	B44066S1810J230	10	50
14	25	1× B25673A9152A000 1× B25673A9202A000	B44066D1425*690	B44066S2410J230	16	63
14	40	4× B25673A9152A000	B44066D1440*690	B44066S3210J230	35	100
14	50	3× B25673A9252A000	B44066D1450*690	B44066S5010J230	50	125
14	75	1× B25673A9122A500 4× B25673A9252A000	B44066D1475*690	B44066S6210J230	70	160
14	100	1× B25673A9202A000 5× B25673A9252A000	B44066D1499*690	B44066S7410J230	95	200

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Component Selection Tables for Detuned PFC

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Selection table

Detuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Contactor ordering code	Cable cross-section mm²	Fuse rating A
690 V – 60 Hz						
5,67	10	1× B25673A8102A000	B44066D5010*690	B44066S1810J230	4	25
5,67	12,5	1× B25673A0202A000	B44066D5012*690	B44066S1810J230	4	25
5,67	20	1× B25673A9102A400 1× B25674A8122A500	B44066D5020*690	B44066S1810J230	10	50
5,67	25	1× B25673A8122A500 1× B25673A8152A000	B44066D5025*690	B44066S2410J230	16	63
5,67	40	1× B25673A8152A000 1× B25673A8282A000	B44066D5040*690	B44066S3210J230	35	100
5,67	50	1× B25673A8252A000 1× B25673A8282A000	B44066D5050*690	B44066S5010J230	50	125
5,67	75	2× B25673A8252A000 1× B25673A8282A000	B44066D5075*690	B44066S6210J230	70	160
5,67	100	2× B25673A8252A000 2× B25673A8282A000	B44066D5100*690	B44066S7410J230	95	200
7	10	1× B25673A8102A000	B44066D5010*690	B44066S1810J230	4	25
7	12,5	1× B25673A8122A500	B44066D5012*690	B44066S1810J230	4	25
7	20	1× B25673A8202A000	B44066D5020*690	B44066S1810J230	10	50
7	25	1× B25673A8252A000	B44066D5025*690	B44066S2410J230	16	63
7	40	2× B25673A8202A000	B44066D5040*690	B44066S3210J230	35	100
7	50	2× B25673A8252A000	B44066D5050*690	B44066S5010J230	50	125
7	75	2× B25673A8252A000 1× B25673A8282A000	B44066D5075*690	B44066S6210J230	70	160
7	100	3× B25673A8252A000 1× B25673A8282A000	B44066D5100*690	B44066S7410J230	95	200
14	10	1× B25673A9122A500	B44066D5010*690	B44066S1810J230	4	25
14	12,5	1× B25673A9152A000	B44066D5012*690	B44066S1810J230	4	25
14	20	1× B25673A9252A000	B44066D5020*690	B44066S1810J230	10	50
14	25	2× B25673A9152A000	B44066D5025*690	B44066S2410J230	16	63
14	40	2× B25673A9252A000	B44066D5040*690	B44066S3210J230	35	100
14	50	1× B25673A9102A400 2× B25673A9252A000	B44066D5050*690	B44066S5010J230	50	125
14	75	1× B25673A9152A000 3× B25673A9252A000	B44066D5075*690	B44066S6210J230	70	160
14	100	5× B25673A9252A000	B44066D5100*690	B44066S7410J230	95	200

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Dynamic PFC: Important Facts and Instructions

General

Conventional PFC systems quickly reach their limits when they have to deal with fast changing loads. Applications like rolling mills, steel presses, wind turbines, container cranes and large buildings include a huge amount of electric consumers that require a reactive power adjustment on the ms scale. Production equipment, elevators, chillers, and other electric devices not only require such dynamic reactions of the power factor compensation equipment, they also lead very soon to a total number of switchings that exceeds the specifications of standard electromechanical contactors by far.

In conventional PFC systems, standard capacitor contactors are used to switch capacitor steps on and off. These electromechanical devices offer between 100 000 and 200 000 switching operations in total during their life time which means that in such an application they reach their life expectancy after 1 to 2 years already. It has to be mentioned that capacitors are much stricter limited with regard to the permitted annual number of switching operations (IEC 60831). This typically results in destruction of their inrush current damping capability and may also damage the contacts in the main power circuit. Burnt main contacts may produce oscillation or “unclean” (re-bouncing) switching operations. This massive overload not only shortens the life expectancy of the capacitor, but also increases the risk of premature failure and in the worst case represents a potential safety risk.

But furthermore the capacitor itself is specified for a limited number of switching operations per year. The standard IEC 60831 gives an acceptable value of 5000 switching operations per year, a value far below switching numbers up to 100 000 that may be required per year in dynamic applications. Such large switching numbers and the respective overvoltages and overcurrents during each switching operation are likely to damage the capacitor and may lead to a very early capacitor failure.

In dynamic PFC systems, the capacitor contactors are replaced by thyristor modules that are suitable for a nearby unlimited number of switching operations as there is no mechanical wear-off. Thyristor modules feature electronic semiconductor switches that are able to react to a changing reactive power demand on the ms scale and that can switch capacitors without additional stress. The EPCOS TSM-thyristor switches keep the capacitors at the peak value of the grid voltage and connect them only when the grid reaches this peak voltage value. Thus the capacitors are switched current free and inrush currents that can reach values of 200 times the nominal current for conventional contactors are avoided. Additionally capacitor discharge times up to 75 s as necessary for conventional PFC are not required here.

In summary dynamic PFC does not only prevent wear-off of the capacitors and the switches and increases thus the lifetime of a PFC system and its safety. It also increases the power quality in the grid essentially as it can almost react in real time to reactive power demands. Fast enough for example, to take care of motor start up effects or spot welding requirements.

EPCOS offers all necessary key components to set up a dynamic PFC systems as the thyristor modules (TSM, see page 69), the required fast transistor output controllers (BR6000-T, page 54ff), and the EPCOS standard reactor (page 73) and of course capacitor series (page 13ff). A further help to compose such a system for a large number of situations is given by the dynamic PFC selection tables on page 108ff.

Note: The recommendations given in the selection tables are meant as a support tool. EPCOS does not take over any responsibility for the design as apart from the theoretical conditions the prevailing circumstances in the application have to be taken into account.

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Component Selection Tables for Dynamic PFC

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Component selection table for dynamic LV PFC antiresonance filter circuits

De-tuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Thyristor module ordering code	Discharge resistor ordering code	Cable cross-section mm²	Fuse rating A
400 V – 50 Hz							
5,67	10	1× B25675A5162J725	1× B44066D5010*400	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	12,5	1× B25675A5202J025	1× B44066D5012*400	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	20	1× B25675A5332J125	1× B44066D5020*400	1× B44066T3850E402	1× B44066T0022E400	10	50
5,67	25	2× B25675A5202J025	1× B44066D5025*400	1× B44066T3850E402	1× B44066T0022E400	16	63
5,67	40	2× B25675A5332J125	1× B44066D5040*400	1× B44066T3850E402	1× B44066T0022E400	35	100
5,67	50	3× B25675A5282J125	1× B44066D5050*400	1× B44066T3850E402	1× B44066T0022E400	50	125
5,67	75	4× B25675A5302J025	1× B44066D5075*400	1× B44066T0100E402	1× B44066T0022E400	70	160
5,67	100	5× B25675A5332J125	1× B44066D5100*400	1× B44066T0100E402	1× B44066T0022E400	120	250
7	10	1× B25675A5162J725	1× B44066D7010*400	1× B44066T0010E402	1× B44066T0022E400	10	35
7	12,5	1× B25675A5202J025	1× B44066D7012*400	1× B44066T0010E402	1× B44066T0022E400	10	35
7	20	1× B25675A5332J125	1× B44066D7020*400	1× B44066T3850E402	1× B44066T0022E400	10	50
7	25	2× B25675A5202J025	1× B44066D7025*400	1× B44066T3850E402	1× B44066T0022E400	16	63
7	40	2× B25675A5332J125	1× B44066D7040*400	1× B44066T3850E402	1× B44066T0022E400	35	100
7	50	3× B25675A5262J525	1× B44066D7050*400	1× B44066T3850E402	1× B44066T0022E400	50	125
7	75	4× B25675A5302J025	1× B44066D7075*400	1× B44066T0100E402	1× B44066T0022E400	70	160
7	100	5× B25675A5332J125	1× B44066D7100*400	1× B44066T0100E402	1× B44066T0022E400	125	250
14	10	1× B25675A5152J025	1× B44066D1410*400	1× B44066T0010E402	1× B44066T0022E400	10	35
14	12,5	1× B25675A6252J000	1× B44066D1412*400	1× B44066T0010E402	1× B44066T0022E400	10	35
14	20	1× B25675A5302J025	1× B44066D1420*400	1× B44066T3850E402	1× B44066T0022E400	10	50
14	25	1× B25675A5162J725 1× B25675A5202J025	1× B44066D1425*400	1× B44066T3850E402	1× B44066T0022E400	16	63
14	40	2× B25675A5302J025	1× B44066D1440*400	1× B44066T3850E402	1× B44066T0022E400	35	100
14	50	3× B25675A5252J025	1× B44066D1450*400	1× B44066T3850E402	1× B44066T0022E400	50	125
14	75	4× B25675A5282J125	1× B44066D1475*400	1× B44066T0100E402	1× B44066T0022E400	70	160
14	100	5× B25675A5302J025	1× B44066D1499*400	1× B44066T0100E402	1× B44066T0022E400	125	250
400 V – 60 Hz							
5,67	10	1× B25675A5132J225	1× B44066D5010*401	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	12,5	1× B25675A5162J725	1× B44066D5012*401	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	20	1× B25675A5262J525	1× B44066D5020*401	1× B44066T3850E402	1× B44066T0022E400	10	50
5,67	25	2× B25675A5162J725	1× B44066D5025*401	1× B44066T3850E402	1× B44066T0022E400	16	63
5,67	40	2× B25675A5262J525	1× B44066D5040*401	1× B44066T3850E402	1× B44066T0022E400	35	100
5,67	50	2× B25675A5202J825 1× B25675A5252J025	1× B44066D5050*401	1× B44066T3850E402	1× B44066T0022E400	50	125
5,67	75	4× B25675A5252J025	1× B44066D5075*401	1× B44066T0100E402	1× B44066T0022E400	70	160
5,67	100	5× B25675A5262J525	1× B44066D5100*401	1× B44066T0100E402	2× B44066T0022E400	120	250
7	10	1× B25675A5132J225	1× B44066D7010*401	1× B44066T0010E402	1× B44066T0022E400	10	35
7	12,5	1× B25675A5162J725	1× B44066D7012*401	1× B44066T0010E402	1× B44066T0022E400	10	35
7	20	1× B25675A5262J525	1× B44066D7020*401	1× B44066T3850E402	1× B44066T0022E400	10	50
7	25	2× B25675A5162J725	1× B44066D7025*401	1× B44066T3850E402	1× B44066T0022E400	16	63
7	40	2× B25675A5262J525	1× B44066D7040*401	1× B44066T3850E402	1× B44066T0022E400	35	100
7	50	2× B25675A5202J825 1× B25675A5252J025	1× B44066D7050*401	1× B44066T3850E402	1× B44066T0022E400	50	125
7	75	4× B25675A5252J025	1× B44066D7075*401	1× B44066T0100E402	1× B44066T0022E400	70	160
7	100	5× B25675A5262J525	1× B44066D7100*401	1× B44066T0100E402	2× B44066T0022E400	120	250

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Component Selection Tables for Dynamic PFC

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Component selection table for dynamic LV PFC antiresonance filter circuits

De-tuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Thyristor module ordering code	Discharge resistor ordering code	Cable cross-section mm²	Fuse rating A
400 V – 60 Hz							
14	10	1× B25675A5122J525	1× B44066D1410*401	1× B44066T0010E402	1× B44066T0022E400	10	35
14	12,5	1× B25675A5152J025	1× B44066D1412*401	1× B44066T0010E402	1× B44066T0022E400	10	35
14	20	1× B25675A5252J025	1× B44066D1420*401	1× B44066T3850E402	1× B44066T0022E400	10	50
14	25	2× B25675A5152J025	1× B44066D1425*401	1× B44066T3850E402	1× B44066T0022E400	16	63
14	40	2× B25675A5252J025	1× B44066D1440*401	1× B44066T3850E402	1× B44066T0022E400	35	100
14	50	3× B25675A5202J825	1× B44066D1450*401	1× B44066T3850E402	1× B44066T0022E400	50	125
14	75	2× B25675A5202J825 2× B25675A5252J025	1× B44066D1475*401	1× B44066T0100E402	1× B44066T0022E400	70	160
14	100	5× B25675A5252J025	1× B44066D1499*401	1× B44066T0100E402	1× B44066T0022E400	120	250
440 V – 50 Hz							
5,67	10	1× B25675A5132J225	1× B44066D5010*440	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	12,5	1× B25675A5162J725	1× B44066D5012*440	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	20	1× B25675A5262J525	1× B44066D5020*440	1× B44066T3850E402	1× B44066T0022E400	10	50
5,67	25	1× B25675A5332J125	1× B44066D5025*440	1× B44066T3850E402	1× B44066T0022E400	16	63
5,67	40	2× B25675A5262J525	1× B44066D5040*440	1× B44066T3850E402	1× B44066T0022E400	35	100
5,67	50	2× B25675A5332J125	1× B44066D5050*440	1× B44066T3850E402	1× B44066T0022E400	50	125
5,67	75	3× B25675A5332J125	1× B44066D5075*440	1× B44066T0100E402	1× B44066T0022E400	70	160
5,67	100	4× B25675A5332J125	1× B44066D5100*440	1× B44066T0100E402	1× B44066T0022E400	120	250
7	10	1× B25675A5132J225	1× B44066D7010*440	1× B44066T0010E402	1× B44066T0022E400	10	35
7	12,5	1× B25675A5162J725	1× B44066D7012*440	1× B44066T0010E402	1× B44066T0022E400	10	35
7	20	1× B25675A5262J525	1× B44066D7020*440	1× B44066T3850E402	1× B44066T0022E400	10	50
7	25	1× B25675A5332J125	1× B44066D7025*440	1× B44066T3850E402	1× B44066T0022E400	16	63
7	40	2× B25675A5262J525	1× B44066D7040*440	1× B44066T3850E402	1× B44066T0022E400	35	100
7	50	2× B25675A5332J125	1× B44066D7050*440	1× B44066T3850E402	1× B44066T0022E400	50	125
7	75	3× B25675A5332J125	1× B44066D7075*440	1× B44066T0100E402	1× B44066T0022E400	70	160
7	100	4× B25675A5332J125	1× B44066D7100*440	1× B44066T0100E402	1× B44066T0022E400	120	250
440 V – 60 Hz							
5,67	10	1× B25675A6132J900	1× B44066D5010*441	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	12,5	1× B25675A5132J225	1× B44066D5012*441	1× B44066T0010E402	1× B44066T0022E400	10	35
5,67	20	1× B25675A5102J425 1× B25675A5122J525	1× B44066D5020*441	1× B44066T3850E402	1× B44066T0022E400	10	50
5,67	25	1× B25675A5122J525 1× B25675A5152J025	1× B44066D5025*441	1× B44066T3850E402	1× B44066T0022E400	16	63
5,67	40	1× B25675A5202J825 1× B25675A5252J025	1× B44066D5040*441	1× B44066T3850E402	1× B44066T0022E400	35	100
5,67	50	1× B25675A5162J725 2× B25675A5202J025	1× B44066D5050*441	1× B44066T3850E402	1× B44066T0022E400	50	125
5,67	75	4× B25675A5202J825	1× B44066D5075*441	1× B44066T0100E402	1× B44066T0022E400	70	160
5,67	100	1× B25675A5122J525 4× B25675A5252J025	1× B44066D5100*441	1× B44066T0100E402	1× B44066T0022E400	120	250
7	10	1× B25675A6132J900	1× B44066D7010*441	1× B44066T0010E402	1× B44066T0022E400	10	35
7	12,5	1× B25675A5132J225	1× B44066D7012*441	1× B44066T0010E402	1× B44066T0022E400	10	35
7	20	1× B25675A5102J425 1× B25675A5122J525	1× B44066D7020*441	1× B44066T3850E402	1× B44066T0022E400	10	50
7	25	1× B25675A5262J525	1× B44066D7025*441	1× B44066T3850E402	1× B44066T0022E400	16	63
7	40	1× B25675A5202J025 1× B25675A5252J025	1× B44066D7040*441	1× B44066T3850E402	1× B44066T0022E400	35	100
7	50	2× B25675A5262J525	1× B44066D7050*441	1× B44066T3850E402	1× B44066T0022E400	50	125
7	75	4× B25675A5202J825	1× B44066D7075*441	1× B44066T0100E402	1× B44066T0022E400	70	160
7	100	4× B25675A5262J525	1× B44066D7100*441	1× B44066T0100E402	1× B44066T0022E400	120	250

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Component Selection Tables for Dynamic PFC

Component selection table for dynamic LV PFC antiresonance filter circuits

De-tuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Thyristor module ordering code	Discharge resistor ordering code	Cable cross-section mm²	Fuse rating A
690 V – 50 Hz							
5,67	10	1× B25673A0202A000	1× B44066D5010*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
5,67	12,5	1× B25673A0252A000	1× B44066D5012*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
5,67	20	2× B25673A0202A000	1× B44066D5020*690	1× B44066T3050E690	2× B44066T0022E400	4	25
5,67	25	2× B25673A0252A000	1× B44066D5025*690	1× B44066T3050E690	2× B44066T0022E400	6	35
5,67	40	4× B25673A0202A000	1× B44066D5040*690	1× B44066T3050E690	2× B44066T0022E400	16	63
5,67	50	4× B25673A0252A000	1× B44066D5050*690	1× B44066T3050E690	2× B44066T0022E400	25	80
5,67	75	6× B25673A0252A000	1× B44066D5075*690	1× B44066T3050E690	2× B44066T0022E400	50	125
5,67	100	8× B25673A0252A000	2× B44066D5050*690	2× B44066T3050E690	4× B44066T0022E400	25	80
7	10	1× B25673A0202A000	1× B44066D7010*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
7	12,5	1× B25673A0252A000	1× B44066D7012*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
7	20	2× B25673A0202A000	1× B44066D7020*690	1× B44066T3050E690	2× B44066T0022E400	4	25
7	25	2× B25673A0252A000	1× B44066D7025*690	1× B44066T3050E690	2× B44066T0022E400	6	35
7	40	4× B25673A0202A000	1× B44066D7040*690	1× B44066T3050E690	2× B44066T0022E400	16	63
7	50	4× B25673A0252A000	1× B44066D7050*690	1× B44066T3050E690	2× B44066T0022E400	25	80
7	75	6× B25673A0252A000	1× B44066D7075*690	1× B44066T3050E690	2× B44066T0022E400	50	125
7	100	8× B25673A0252A000	2× B44066D7050*690	2× B44066T3050E690	4× B44066T0022E400	25	80
14	10	1× B25673A0202A000	1× B44066D1410*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
14	12,5	1× B25673A0102A400 1× B25673A0122A500	1× B44066D1412*690	1× B44066T3050E690	2× B44066T0022E400	2.5	16
14	20	1× B25673A0152A000 1× B25673A0202A000	1× B44066D1420*690	1× B44066T3050E690	2× B44066T0022E400	4	25
14	25	1× B25673A0202A000 1× B25673A0252A000	1× B44066D1425*690	1× B44066T3050E690	2× B44066T0022E400	6	35
14	40	2× B25673A0152A000 2× B25673A0202A000	1× B44066D1440*690	1× B44066T3050E690	2× B44066T0022E400	16	63
14	50	2× B25673A0202A000 2× B25673A0252A000	1× B44066D1450*690	1× B44066T3050E690	2× B44066T0022E400	25	80
14	75	3× B25673A0202A000 3× B25673A0252A000	1× B44066D1475*690	1× B44066T3050E690	2× B44066T0022E400	50	125
14	100	4× B25673A0202A000 4× B25673A0252A000	2× B44066D1450*690	2× B44066T3050E690	4× B44066T0022E400	25	80

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Component Selection Tables for Dynamic PFC

Component selection table for dynamic LV PFC antiresonance filter circuits

De-tuning factor %	Effective filter output kvar	Capacitor ordering code	Reactor ordering code	Thyristor module ordering code	Discharge resistor ordering code	Cable cross-section mm²	Fuse rating A
690 V – 60 Hz							
5,67	10	1× B25673A0152A000	1× B44066D5010*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
5,67	12,5	1× B25673A0202A000	1× B44066D5012*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
5,67	20	1× B25673A0122A500 1× B25673A0202A000	1× B44066D5020*691	1× B44066T3050E690	2× B44066T0022E400	4	25
5,67	25	2× B25673A0202A000	1× B44066D5025*691	1× B44066T3050E690	2× B44066T0022E400	6	35
5,67	40	2× B25673A0122A500 2× B25673A0202A000	1× B44066D5040*691	1× B44066T3050E690	2× B44066T0022E400	16	63
5,67	50	4× B25673A0202A000	1× B44066D5050*691	1× B44066T3050E690	2× B44066T0022E400	25	80
5,67	75	6× B25673A0202A000	1× B44066D5075*691	1× B44066T3050E690	2× B44066T0022E400	50	125
5,67	100	8× B25673A0202A000	2× B44066D5050*691	2× B44066T3050E690	4× B44066T0022E400	25	80
7	10	1× B25673A0152A000	1× B44066D7010*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
7	12,5	1× B25673A0202A000	1× B44066D7012*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
7	20	1× B25673A0122A500 1× B25673A0202A000	1× B44066D7020*691	1× B44066T3050E690	2× B44066T0022E400	4	25
7	25	2× B25673A0202A000	1× B44066D7025*691	1× B44066T3050E690	2× B44066T0022E400	6	35
7	40	2× B25673A0122A500 2× B25673A0202A000	1× B44066D7040*691	1× B44066T3050E690	2× B44066T0022E400	16	63
7	50	4× B25673A0202A000	1× B44066D7050*691	1× B44066T3050E690	2× B44066T0022E400	25	80
7	75	6× B25673A0202A000	1× B44066D7075*691	1× B44066T3050E690	2× B44066T0022E400	50	125
7	100	8× B25673A0202A000	2× B44066D7050*691	2× B44066T3050E690	4× B44066T0022E400	25	80
14	10	1× B25673A0152A000	1× B44066D1410*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
14	12,5	1× B25673A0202A000	1× B44066D1412*691	1× B44066T3050E690	2× B44066T0022E400	2.5	16
14	20	2× B25673A0152A000	1× B44066D1420*691	1× B44066T3050E690	2× B44066T0022E400	4	25
14	25	1× B25673A0122A500 1× B25673A0252A000	1× B44066D1425*691	1× B44066T3050E690	2× B44066T0022E400	6	35
14	40	4× B25673A0152A000	1× B44066D1440*691	1× B44066T3050E690	2× B44066T0022E400	16	63
14	50	3× B25673A0252A000	1× B44066D1450*691	1× B44066T3050E690	2× B44066T0022E400	25	80
14	75	1× B25673A0122A500 4× B25673A0252A000	1× B44066D1475*691	1× B44066T3050E690	2× B44066T0022E400	50	125
14	100	6× B25673A0252A000	2× B44066D1450*691	2× B44066T3050E690	4× B44066T0022E400	25	80

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PFC Basic Formulas

The following electrical formulas may be used to calculate basic PFC values.

Active power

The amount of input power converted to output power is the active power.

$$P = \sqrt{3} \cdot V \cdot I \cdot \cos \varphi \quad [W]$$

Formula 1

Reactive power

The reactive power is the power consumed in an AC circuit due to the expansion and collapse of magnetic (inductive) and electrostatic (capacitive) fields.

$$Q = \sqrt{3} \cdot V \cdot I \cdot \sin \varphi \quad [VAr]$$

Formula 2

Apparent Power

The apparent power is the power delivered to an electric circuit.

$$S = \sqrt{3} \cdot V \cdot I \quad [VA]$$

Formula 3

Power factor

The power factor of an AC electrical power system is defined as the ratio of the real (active) power to the apparent power.

$$\text{Power factor} = \frac{\text{Active power}}{\text{Apparent power}} = \frac{P}{S}$$

Formula 4

Power Factor Correction

When the AC load is partly capacitive or inductive, the current waveform is out of phase with the voltage. This requires additional AC current to be generated that is not consumed by the load, creating I^2R losses in power cables. Capacitors are used to supply reactive energy to inductive loads. Reactive energy must be produced as closely as possible to the loads to prevent unnecessary flow of current in the network. This is known as power factor correction.

$$Q_C = P \cdot (\tan \varphi_1 - \tan \varphi_2) \quad [VAr]$$

Formula 5

Q_C: reactive power needed
P: total active power
φ_1: actual angle of cos φ actual
φ_2: target angle of cos φ target

Connection and rating of capacitors

The reactive power of the capacitor is a function of its rated voltage and current.

$$Q_C = V_C \cdot I_C \quad [VAr]$$

Formula 6

$$Q_C = \frac{V_C \cdot V_C}{X_C} = \frac{(V_C)^2}{X_C}$$

Formula 7

$$X_C = \frac{1}{\omega \cdot C} = \frac{1}{2\pi \cdot f \cdot C}$$

Formula 8

f: frequency of network
X_C: impedance of capacitor
C: capacitance value

Formula (7) and (8) together

$$Q_C = (V_C)^2 \cdot \omega \cdot C = (V_C)^2 \cdot 2\pi \cdot f \cdot C$$

Formula 9

Please read *Important notes* on page 12 and *Cautions* on page 121–125.
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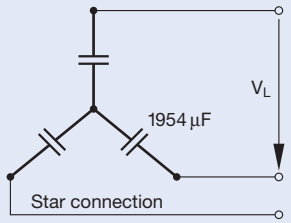
PFC Basic Formulas

Capacitor in three-phase PFC application

Three-phase PFC applications have two types of capacitor connections: star and delta.

● STAR connection



$$Q_{TOT} = 3 \cdot Q_C$$

Formula 10

$$V_C = V_L / \sqrt{3}$$

Formula 11

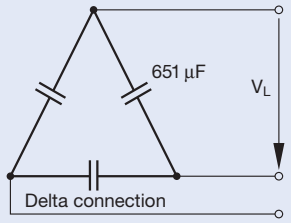
From formulas (9), (10) and (11)

$$Q_{TOT} = 3 \cdot \frac{(V_L)^2}{(\sqrt{3})^2} \cdot \omega \cdot C_{STAR}$$

$$C_{STAR} = \frac{Q_{TOT}}{(V_L)^2 \cdot \omega} = \frac{Q_{TOT}}{(V_L)^2 \cdot 2\pi \cdot f}$$

Formula 12

● DELTA connection



$$V_C = V_L$$

Formula 13

From formulas (9), (10) and (13)

$$Q_{TOT} = 3 \cdot (V_L)^2 \cdot \omega \cdot C_{DELTA}$$

$$C_{DELTA} = \frac{Q_{TOT}}{3 \cdot (V_L)^2 \cdot \omega} = \frac{Q_{TOT}}{3 \cdot (V_L)^2 \cdot 2\pi \cdot f}$$

Formula 14

As a conclusion formula (12) and (14)

$$C_{DELTA} = \frac{C_{STAR}}{3}$$

Formula 15

Capacitor output kvar:

From the formula (9), if we find the Q_{new} with ratio: C will be constant.

$$Q_{New} = \left(\frac{V_{New}}{V_C}\right)^2 \cdot \frac{f_{New}}{f_R} \cdot Q_C$$

Formula 16

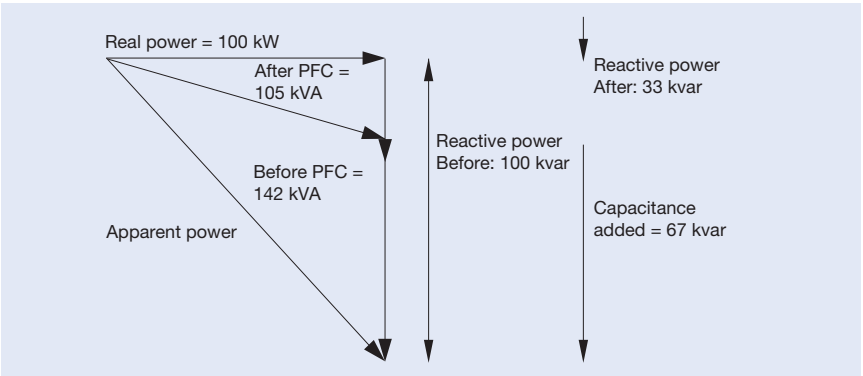
These values are operating conditions:
Q_{new}: new reactive power
V_{new}: new voltage
f_{new}: new frequency

These values are the values capacitor is designed:
Q_C: rated capacitor reactive power
V_C: rated capacitor voltage
f_R: rated frequency

Calculation examples

Example 1:
The relationship between active, reactive and real power and cos φ.

In the diagram below, the power triangle shows an initial power factor of 0.70 for a 100 kW (real power) inductive load. The reactive power required by the load is 100 kvar. By installing a 67-kvar capacitor, the apparent power is reduced from 142 to 105 kvar, resulting in a 26% reduction in current. The power factor is improved to 0.95.



Formulas used (1), (2), (3) and (4).

Power factor calculations:
Before PFC: 100/142 = 0.70 or 70%

After PFC: 100/105 = 0.95 or 95%

PFC Basic Formulas

Example 2:
Calculation of capacitor rating for industrial installation

● Given parameters:

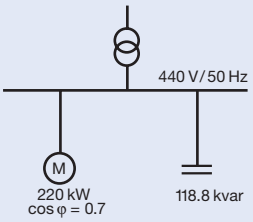
Induction motor	220 kW
Network (line delta)	440 V AC, 3-phase
Frequency	50 Hz
Power factor	
– Current cos φ	0.7
– Target cos φ	0.9

Target to correct the power factor to 0.9:

$\cos \varphi 1 = 0.7$ $\quad \tan \varphi 1 = 1.02$

$\cos \varphi 2 = 0.9$ $\quad \tan \varphi 2 = 0.48$

$$Q_C = P (\tan \varphi 1 - \tan \varphi 2)$$
$$= 220 \cdot 1000 (1.02 - 0.48)$$
$$= 118.8 \text{ kvar}$$



Example 3:
Calculating capacitor ratings for DELTA and STAR connections in example 2

● STAR connection:

$$V_C = \frac{V_L}{\sqrt{3}} = \frac{440}{\sqrt{3}} = 254 \text{ V}$$

$$C_{STAR} = \frac{Q_{TOT}}{(V_L)^2 \cdot \omega} = \frac{Q_{TOT}}{(V_L)^2 \cdot 2\pi \cdot f}$$

$$C_{STAR} = \frac{118.8 \cdot 1000}{(440)^2 \cdot 2\pi \cdot 50}$$
$$= 1\,954 \text{ µF / Line (phase)}$$

$C_{TOT} = 5862$ µF

● DELTA connection:

$$V_C = V_L = 440 \text{ V}$$

$$C_{DELTA} = \frac{Q_{TOT}}{3 \cdot (V_L)^2 \cdot \omega} = \frac{Q_{TOT}}{3 \cdot (V_L)^2 \cdot 2\pi \cdot f}$$

$$C_{DELTA} = \frac{118.8 \cdot 1000}{3 \cdot (440)^2 \cdot 2\pi \cdot 50}$$
$$= 651 \text{ µF / Line (phase)}$$

$C_{TOT} = 1954$ µF

Example 4:
Calculating apparent power reduction (S1–S2) in example 2

$S_1 = P / \cos \varphi 1 = 220 / 0.7$
$= 314$ kVA

$S_2 = P / \cos \varphi 2 = 220 / 0.9$
$= 244$ kVA

$S_1 - S_2 = 70$ kVA

Thus, additional power of $70 \cdot (0.9) = 63$ kW can be supplied and transferred via the existing network.

Cable cross section calculation

Line current drawn by the motor:

I_1 uncompensated load (0.7):

$$I_1 = \frac{220 \cdot 1000}{\sqrt{3} \cdot 440 \cdot (0.7)} = 412 \text{ A}$$

I_2 compensated load (0.9):

$$I_2 = \frac{220 \cdot 1000}{\sqrt{3} \cdot 440 \cdot (0.9)} = 320 \text{ A}$$

Thus, the cable can carry an additional load of 92 A, or the designer can reduce the cable cross section.

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Cautions

Temperature class of capacitors (according IEC 60831-1)

Temperature class	Temperature of capacitor surrounding air		
	Maximum	Maximum mean for 24 h	Maximum mean for 1 year
B	+45 °C	+35 °C	+25 °C
C	+50 °C	+40 °C	+30 °C
D	+55 °C	+45 °C	+35 °C

Enclosure of capacitors (IPxx)

Enclosure	First digit	Second digit
IP00	No protection against finger touch and ingress of solid foreign bodies	No protection against ingress of water
IP20	Protection against finger touch and solid foreign bodies ≥ 12.5 mm diameter	No protection against ingress of water
IP41	Protection against tool touch and solid foreign bodies ≥ 1 mm diameter	Drip-water protection
IP54	Protection against tool touch and solid foreign bodies ≥ 1 mm diameter, protection against dust deposit	Splash water protection

Maximum admissible overvoltage

Frequency (50 / 60 Hz)	Max. voltage (V_{RMS})	Max. duration	Remarks
Line frequency	1.00 · V_R	Continuous duty	Highest mean during entire operating time of capacitor; exceptions (see below) are admissible for times of < 24 h
Line frequency	1.10 · V_R	8 h daily	Line voltage fluctuations
Line frequency	1.15 · V_R	30 min daily	Line voltage fluctuations
Line frequency	1.20 · V_R	5 min daily	Line voltage fluctuations
Line frequency	1.30 · V_R	1 min daily	Line voltage fluctuations
Line frequency with harmonics	Such that current does not exceed maximum admissible figure ($I_{max.}$ = 1.3 · I_R)		

Temperature class of capacitors to standard IEC 60831-1

Capacitors are divided into temperature classes. Each class is represented by a number followed by a letter, e.g. –40/D. The number is the lowest ambient temperature at which a capacitor may operate. The upper limit temperature is indicated by the letter (see table above).

The useful life of a capacitor depends very much on temperature. Proper cooling of a capacitor must ensure that the maximum temperature is not exceeded, otherwise useful life is degraded. When configuring a circuit, one should make sure that capacitors are not subjected to heat from adjacent components (reactors, bus bars, etc). Forced cooling is preferable for compact designs. And it is highly inadvisable to arrange capacitors directly above reactors. Exceeding specified temperature limits may set in worst case the safety device out of operation.

Cautions

Enclosure of capacitors (IPxx)

For different models there are different types of enclosure. The type of enclosure is indicated by a designation consisting of the two letters IP followed by two digits.

Current rating / maximum admissible overcurrent

The rated current (I_R) is the current resulting for rated voltage (V_R) and frequency (in Hz), excluding transients. Maximum permitted rms current for each particular capacitor is specified in the data sheet. Continuously exceeding of the nominal current will lead to increased self-heating of the capacitor and reduce life time. The maximum admissible overcurrent (I_{max}) of $1.3 \cdot I_R$ to IEC 60831 standard is maintained or overachieved by all capacitors in this catalog. The figures for overcurrent allow for the combined effects of harmonics, overvoltage and capacitance tolerance.

Maximum admissible overvoltage

Capacitors from EPCOS are suitable for operation on overvoltages quoted by IEC 60831 (see table). Overvoltages higher than $1.15 \cdot V_R$ reduce life time of the capacitor and must not occur more than 200 times during life time of capacitor. Overvoltages above $1.3 \cdot V_R$ must not occur at all, appropriate overvoltage protection (e.g. against lightning strikes) must be ensured.

Mean life expectancy

The mean life expectancy of power capacitors is mainly governed by the following factors:
– duration of overload,
– ambient temperature and the resulting case temperature,
– maximum rms current and the resulting case temperature,
– voltage height and duration.

The calculated life expectancy of the various series is stated for nominal operating conditions. If components are stressed less than the IEC 60831 factors, longer useful life can be expected, and a correspondingly shorter one or increased failure rate if nominal parameters are exceeded.

Fuse protection

Power capacitors have to be protected against short circuits by fuses or thermal magnetic overcurrent relays. Slow-blow, low-voltage high-breaking-capacity fuses (HRC) are preferable. The fuse rating should be 1.6 to 1.8 times the rated current of the capacitor. Magnetic short circuit relays should be set to between 9 and 12 times rated current to prevent them responding to high inrush currents. Maximum allowed fault current of 10 000 A in accordance with UL 810 standard must be ensured by the application design.

⚠ HRC fuses must not be used for switching. Resulting electric arcing can cause death! It may also cause capacitor failures, and result, worst case, in capacitor bursting and fire.

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Cautions

Switching of capacitors

When a capacitor is switched to an AC system, the result is a resonant circuit damped to a greater or lesser degree. In addition to the rated current, the capacitor accepts a transient current that is a multiple of (up to 200 times) its rated current. Fast switching, low-bounce contactors should be used, and have the switching capacity for capacitive currents stated by the producer. Special capacitor contactors with leading contacts that feature precharging resistors to damp inrush currents are recommended. As per IEC 60831 standard, a maximum of 5000 switching operations per year is acceptable. Before considering a higher number of switching operations, please contact our sales office.

Discharging

Capacitors must be discharged to a maximum of 10% of rated voltage before they are switched in again. This prevents an electric impulse discharge in the application, influences the capacitor's useful life in PFC systems, and protects against electric shock. The capacitor must be discharged to 75 V or less within 3 min. There must not be any switch, fuse or any other disconnecting device in the circuit between the power capacitor and the discharging device. EPCOS supplies capacitor discharge resistors to all series, alternatively discharge reactors are available.

⚠ Caution: Discharge and short circuit capacitor before handling!

Capacitors in networks with harmonics

Harmonics are produced in the operation of electric loads with a nonlinear voltage / current characteristic (e.g. rectifiers and inverters for drives, welding apparatus and uninterruptible power supplies). Harmonics are sinusoidal voltages and currents with higher frequencies of a multiple of the 50 or 60 Hz line frequency. In low-voltage three-phase systems the 5^{th} and 7^{th} harmonics are especially troublesome. Detuned PFC should be used in systems subject to harmonics. This represents a series resonant circuit of power capacitor and reactor. The circuit is tuned so that the series resonant frequency is below the lowest harmonics appearing in the system. This produces an inductive response to all frequencies above the series resonant frequency, avoiding resonances with system inductances. Depending on the selected series resonant frequency, part of the harmonic current is taken up by the detuned PFC system. The remainder of the harmonic current flows into the superordinate system. The use of detuned PFC thus contributes to reducing voltage distortion through harmonics and lessens the disturbing effect on proper operation of other electric loads.

Most international standards limit THD-V on LV side to 5%. However it has to be noted that in many grids these levels are exceeded and even lower distortion, e.g. 3 to 4% THD-V can generate extreme overcurrents in case of resonance condition.

Maximum overcurrents as specified under technical data of each series must not be exceeded.

Resonance must be avoided by appropriate panel design. Resonance may cause very high overcurrents which can lead to capacitor failures, and worst case, to explosion and fire.

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Cautions

Mechanical damage

In case of dents or any other mechanical damage, capacitors must not be used at all.

Vibration resistance

The resistance to vibration of capacitors corresponds to IEC 68, part 2 to 6.

Max. test conditions:

Test duration	2 h	
Frequency range	10 ... 55 Hz	corresponding to max. 0.7 g
Displacement amplitude	0.75 mm	

Because the fixing and the terminals may influence the vibration properties, it is necessary to check stability when a capacitor is built in and exposed to vibration. Irrespective of this, you are advised not to locate capacitors where vibration amplitude reaches the maximum in strongly vibrating equipment.

Connection

Make sure connection cables are of flexible type or flexible copper bands are used. This is mandatory to allow the overpressure disconnector work and avoid mechanical stress on the terminals and feedthroughs.

The connection cables to the capacitor should be designed for a current of at least 1.5 times the rated current so that no heat is conducted into the capacitor. If reactors are used in an application, the distance between reactor and capacitor must be great enough so that no heat of the reactors, which are operating at a much higher temperature level, is conducted via connection cable to the capacitors.

Avoid bending cable lugs, cables or other mechanical force on the terminals. Otherwise leakages may set the safety device out of operation.

Ensure firm fixing of terminals, fixing torque to be applied as per individual specification.

Maximum specified terminal current (please refer to technical data of specific series) must not be exceeded at any case.

Grounding

The threaded bottom stud of the capacitor has to be used for grounding. In case grounding is done via metal chassis that the capacitor is mounted to, the layer of varnish beneath the washer and nut should be removed.

Storage and operating conditions

Do not use or store capacitors in corrosive atmosphere, especially where chloride gas, sulfide gas, acid, alkali, salt or the like are present. In dusty environments regular maintenance and cleaning especially of the terminals is required to avoid conductive path between phases and / or phases and ground.

Installation

Specifications like IEC 61921, VDE 0100, VDE 0101, VDE 0560 part 4 and 46, EN 60831 and IEC 60831 apply to the installation and operation of power capacitors. Capacitors should be sited in cool and well ventilated locations away from other heat-radiating elements. Natural heat dissipation is generally sufficient for cooling purposes if enough air is able to flow to and away from them and the capacitors are spaced at least 20 mm apart. Otherwise, in a less well ventilated environment, forced cooling (fans) will be necessary, scaled so that the maximum admissible ambient temperature is not exceeded.

Useful life of capacitors strongly depends on the operating temperature (refer to page 121, temperature classes of capacitors).

Exceeding maximum allowed temperature may set the safety device out of operation.

Please read the *Installation and Maintenance Instructions* on the Internet at www.epcos.com/pfc.

Note

Products shown in this catalog reflect typical specifications. You are kindly requested to approve our product specifications or request our approval for your specification before ordering.

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Cautions

Reactors – Antiresonance harmonic filter

During operation, all electrically active parts of this equipment such as windings, electronic components, leads, fuses and terminals carry a dangerous voltage which can lead to burns or electric shock.

Covers which protect these electrically active parts from being touched must not be opened or removed during operation.

Before any assembly or maintenance work is started, all installations and equipment must be disconnected from the power source.

Noncompliance with these instructions may lead to death, serious injury or major damage to equipment.

In order to exclude impermissible temperatures and thus overload of the insulation system, the following directions must additionally be observed:

1. Only those protective devices specified on the type plates, such as fuses and motor protection switches, may be used. It is mandatory to observe the set values specified for the motor protection switches. Any temperature-sensitive protective devices such as temperature switches and temperature sensors must be connected in accordance with the installation instructions.
2. High temperatures are permissible for the surfaces under rated operating conditions, and especially in the event of overload. Depending on the temperature class and type of loading, these may attain values of up to 260 °C and may also affect adjacent components which have been packed too densely.
3. The insertion position should be selected so that any cooling ducts present within the winding are arranged vertically and that the current of cooling air is not impeded by adjacent components, connecting leads etc.
4. The maximum voltage of the insulating system specified on the type plate must not be exceeded.

Noncompliance with these instructions may lead to considerable damage to equipment or fire due to impermissibly high temperatures.

Thyristor modules (TSM-series)

- Live parts in the PFC equipment must not be touched!
- Warning signs in the PFC systems are required!
- Wait 10 minutes after the main switch is turned off – until the voltage in the system has dropped to an uncritical value.
- In non-detuned systems (400 V grid) capacitors with a higher voltage rating (e.g. 440 V) are needed.
- In detuned systems (400 V grid) capacitors with a voltage of 525 V are needed.
- For discharging the capacitors, special high-voltage resistors type EW-22 are required. Standard resistors cannot be used!
- In dynamic PFC systems discharge reactors cannot be used (this would be a short circuit of the highvoltage DC)!
- In PFC systems without filter circuit reactors current limiting reactors are required (e.g. BD-series) for the TSM.
- For short circuit protection, superfast electronic fuses for protection of the thyristor are required, standard HRC fuses are not suitable. See selection table on pages 101 and 102.
- Failure to follow cautions may result, worst case, in premature failures or physical injury.

Capacitor contactors

In case auxiliary contacts are used for switching of discharge resistors (not in accordance with IEC 60831 standard), make sure that the current of the discharge resistors is not higher than the rated current of the auxiliary contacts.

Only flame-resistant and self-extinguishing materials may be used in the proximity of capacitor contactors because abnormal temperatures cannot be ruled out in the area near the resistance spirals.

PF controllers (BR604, BR6000 and BR7000 series)

Controller hunting: When putting the capacitor bank into operation, it is required to avoid needless switching cycles (means permanent switching on and off of steps without significant change of consumer loads). This so called “controller hunting” would increase the number of switching operations of the connected contactors and capacitors, decrease the expected life cycle (wear out) and result, in worst case, in bursting and fire etc. This can be avoided by a proper programming of the PF controllers with the actual system parameters (current transformer prim. and sec., first kvar step, control series, switching time).

The “ZVEI General safety recommendations for power capacitors” must be observed in addition to the safety instructions given in this catalogue and in the particular data-sheets. They are available on the EPCOS website in the various product groups. They may also be called up from the ZVEI website.

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