EPCOS Product Profile (India) 2013

Power Factor Correction

Power Quality Solutions

www.epcos.com

The Company: EPCOS India Pvt. Ltd.

EPCOS India Private Limited (EIPL) is a Member of TDK-EPC Corporation, Japan.EPCOS emerged in 1999 as a successor to the joint venture Siemens Matsushita Components and the former Siemens passive Components and Electron Tubes Group. The company has been selling electronic components in India since the early 60s. Today, all business activities in India come under the umbrella of EPCOS India Private Limited, having Registered head office at Kalyani Plant in West Bengal and regional offices in Mumbai, Delhi, Bengaluru and Kolkata. In mid-90s EPCOS significantly stepped up its commitment to India by opening new manufacturing facility at Kalyani in West Bengal and Nashik in Maharashtra. And now, EPCOS again reinforced its trust in India by opening up one more manufacturing facility at Bawal in Haryana.

EPCOS in India is involved in design, manufacturing and marketing of a broad range of top quality products such as AC-mfd capacitors, LV Power Factor Correction Capacitors (resin, inert gas and oil filled designs), Key Components required for PF correction system, PF correction systems (APFC Panels), MV Capacitors, MV Capacitor Switch, MV Reactive Power Compensation systems, Power Electronic Capacitors, DC Capacitors, MPP film and high performance ferrite cores. Nashik factory also houses the Global R&D for Film metallisation, AC and PFC Products and Systems while Kalyani is Centre of Excellence for soft ferrites. EPCOS India also services the demands of customers for a wide variety of components from global factories of TDK-EPC.

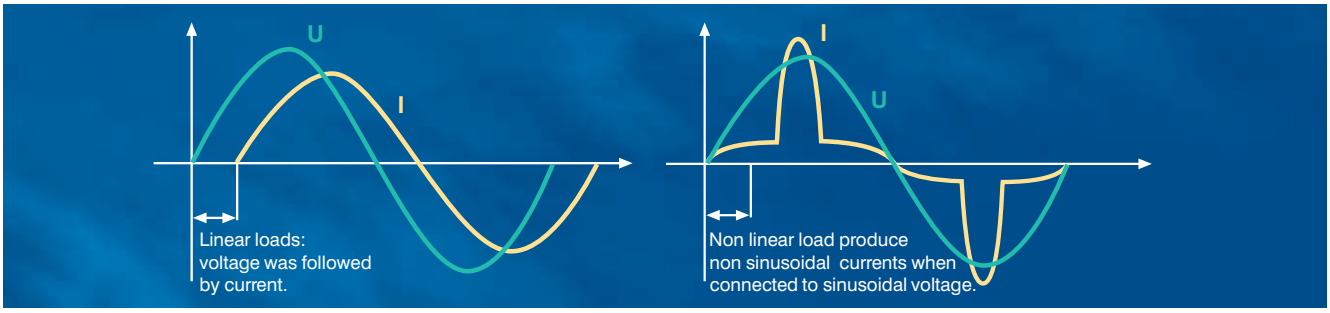
EPCOS India has a strong sales and marketing team spread over the country. Our strength in market is based on the technical competence and marketing experience of our sales force. It is backed up by a very efficient and dedicated Channel Partner network to cover entire India and some neighboring countries.

About TDK-EPC Corporation:
TDK-EPC Corporation(TDK-EPC), a TDK group company, is a leading manufacturer of electronic components, modules and systems, headquartered in Tokyo, Japan. It was established on October 1st 2009. TDK-EPC has emerged from combination of passive electronic components business of TDK and the EPCOS Group and markets its products under the product brands, TDK and EPCOS.

TDK Corporation is the sole shareholder of TDK-EPC Corporation.

Index

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 ⌀) and the optimization of voltage stability by generating reactive power – to improve voltage quality and reliability at distribution level.

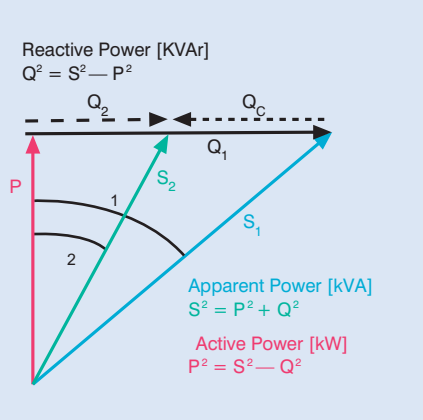
How reactive power is generated

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.



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.

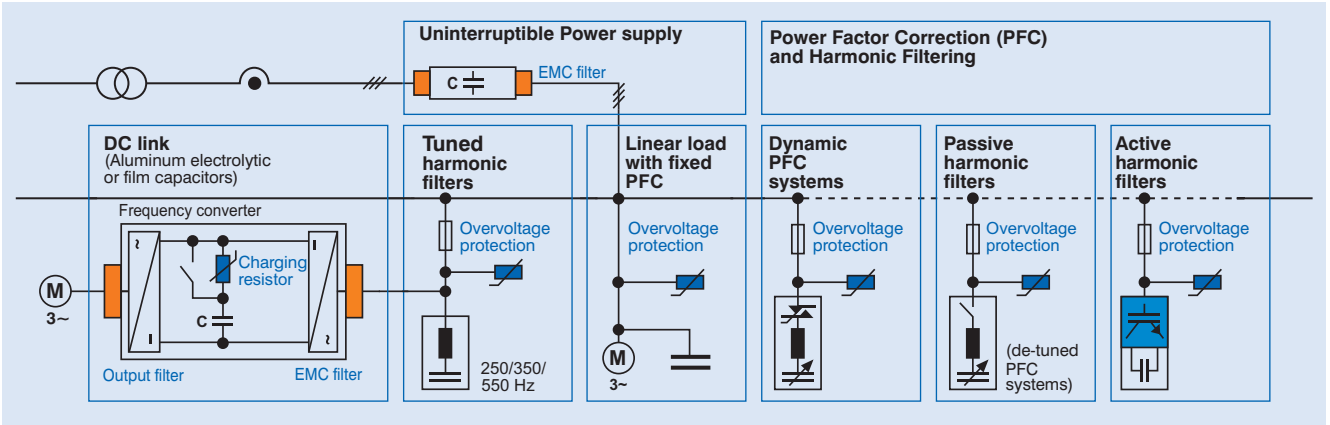
Preview

Power Quality Solution 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.



PFC Capacitor Series Overview

PFC Capacitor series for power factor correction capacitors			
PhaseCap Premium		**B25667L . . .**	
Power	KVAr	5…31	
Voltage range	V	415...800 V*	
Frequency	Hz	50Hz	
Impregnation		Gas-impregnated, dry type, Non-PCB	
Life expectancy	Hrs	Up to 130 000 h for -40/D Up to 180 000 h for -40/C	
Inrush current	A	300 • I_R	
PhaseCap Super Heavy Duty		**B25673L . . .**	
Power	KVAr	5…33	
Voltage range	V	415...1000 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 200 000 h for -40/C Up to 150 000 h for -40/60	
Inrush current	A	400 • I_R	
PhiCap ND		**B32343L . . . /B32344B . . .**	
Power	KVAr	5…30	
Voltage range	V	230...525 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 100 000 hours	
Inrush current	A	200 • I_R	
PhiCap HD		**B32447A . . . /B32448A . . .**	
Power	KVAr	1…30	
Voltage range	V	415...480 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 115 000 hours	
Inrush current	A	250 • I_R	

*Other voltages on request.

PFC Capacitor Series Overview

PFC Capacitor series for power factor correction capacitors			
SquareCap-ENDC		**B32457L . . .**	
Power	KVAr	1…50.0	
Voltage range	V	415…440 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 100 000 hours	
Inrush current	A	200 • I_R	
SquareCap-EHDLL		**B32459L . . .**	
Power	KVAr	1…60.0	
Voltage range	V	415…525 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 125 000 hours	
Inrush current	A	250 • I_R	
SquareCap-ESHDC		**B32455L . . .**	
Power	KVAr	1…50.0	
Voltage range	V	415…525 V*	
Frequency	Hz	50 Hz	
Impregnation		Non-PCB, semi-dry biodegradable resin	
Life expectancy	Hrs	Up to 150 000 hours	
Inrush current	A	350 • I_R	
LT-APP		**B25160 . . .**	
Power	KVAr	1…100	
Voltage range	V	415…525 V*	
Frequency	Hz	50 Hz/ 60Hz	
Impregnation		Non PCB, biodegradable oil	
Life expectancy	Hrs	Up to 300 000 hours	
Inrush current	A	(400 to 500) • I_R	

*Other voltages on request.

PQS Key Components Overview

PF controllers

BR6000

	BR6000-R06	BR6000-R12	BR6000-T06	BR6000-T12
Supply voltage	245 V AC (±20%; L-N)	245 V AC (±20%; L-N)	245 V AC (±20%; L-N)	245V AC (±20%; L-N)
Measurement voltage range	30-525 V AC (L-N) or (L-L)	30-525 V AC (L-N) or (L-L)	30-300 V AC (L-N) -	30-300 V AC (L-N) -
Measurement current	X/5 or X1/A selectable	X/5 or X1/A selectable	X/5 or X1/A selectable	X/5 or X1/A selectable
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz

BR5000

	BR5000-R08	BR5000-R16	BR5000-T16
Supply voltage	415V AC (-40% to +20%; L-L)	415V AC (-40% to +20%; L-L)	415V AC (-40% to +20%; L-L)
Measurement voltage range	3Ph 3wire 415V AC (-40% to +20%)	3Ph 3wire 415V AC (-40% to +20%)	3Ph 3wire 415V AC (-40% to +20%)
Measurement current	X/5 or X1/A selectable	X/5 or X1/A selectable	Only 5Amp CT secondary
Frequency	45Hz to 62.5Hz	45Hz to 62.5Hz	45 Hz to 55 Hz

BR4000

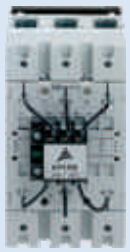
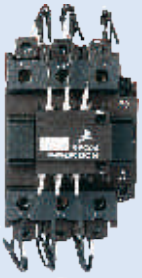
	BR4904	BR4008
Supply voltage	230V AC (-25% to +20%; L-N)	230V AC (-25% to +20%; L-N)
Measurement voltage range	230V AC (-25% to +20%; L-N)	230V AC (-25% to +20%; L-N)
Measurement current	X/5 or X1/A externally selectable	X/5 or X1/A externally selectable
Frequency	47Hz to 53 Hz	47Hz to 53 Hz

BR Series and Ordering Details

Output stages	Relay outputs	Transistor outputs	Interface	Ordering code
BR6000-R06	6	-		B44066R6006R230N 1
BR6000-R12	12	-		B44066R6012R230N 1
BR6000-R12	12	-	RS232	B44066R6312R230N 1
BR6000-R12	12	-	RS485	B44066R6412R230N 1
BR6000-T06	-	6	-	B44066R6106R230N 1
BR6000-T12	-	12	-	B44066R6112R230N 1
BR5000-R08	8	-	RS232 and RS485	B44066R5908A415N 1
BR5000-R16	16	-	RS232 and RS485	B44066R5916A415N 1
BR5000-T16	-	16	RS232 and RS485	B44066R5716A415N 1
BR4904	4	-	-	B44066R4904A230N 1
BR4008	8	-	-	B44066R4808A230N 1

BR7000	15 relay outputs PF controller for 3 phase measuring and controlling	B44066R7415E230
MC7000-3	Grid analysis tool for 3 phase measuring, display and storage of electric parameters	B44066M1301E230

PQS Key Components Overview

Switching devices and detuned filters			
Parameter	**Capacitor contactors**	**Thyristor modules**	**Reactors - Antiresonance harmonic filter**
	With Pre-closing resistor	Thyristor switch for dynamic PFC systems	For detuning application with high linearity
Voltage	230...690 V	TSM-LC: 3 x 440 V TSM-HV: 3 x 690 V	230...1000 V
Output range	12.5...100 KVAr for B...J230 7...60 KVAr for B...C240	TSM-LC: 10...50 KVAr TSM-HV: 50 KVAr	5...100 KVAr
Frequency	50/60 Hz	50/60 Hz	50 or 60 Hz
Detuning	Suitable for detuned and conventional systems	Suitable for detuned and conventional systems	Factor: 5.67%, 7%, 14%
Ordering code	B44066S...J230 for all PFC systems B44066S...C240 for all PFC systems	TSM-LC: B44066T...R440 TSM-HV: B44066T...R690	B44066D...
	   		 

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.
5. We constantly strive to improve our products. Consequently, **the products described in this publication may change from time to time.** The same is true of the corresponding product specifications. Please check therefore to what extent product descriptions and specifications contained in this publication are still applicable before or when you place an order.

   We also reserve the right to discontinue production and delivery of products. Consequently, we cannot guarantee that all products named in this publication will always be available.

   The aforementioned does not apply in the case of individual agreements deviating from the foregoing for customer-specific products.
6. Unless otherwise agreed in individual contracts, **all orders are subject to the current version of the "General Terms of Delivery for Products and Services in the Electrical Industry" published by the German Electrical and Electronics Industry Association (ZVEI).**
7. The trade names EPCOS, BAOKE, Alu-X, CeraDiode, CSMP, CSSP, CTVS, DeltaCap, DigiSiMic, DSSP, FormFit, MiniBlue, MiniCell, MKD,MKK, SquareCap, AgriCap, PoleCap, MLSC, MotorCap, PCC, PhaseCap, PhaseCube, PhaseMod, PhiCap, SIFERRIT, SIFI, SIKOREL, SilverCap, SIMDAD, SiMic, SIMID, SineFormer, SIOV, SIP5D, SIP5K, ThermoFuse, WindCap are **trademarks registered or pending** in Europe and in other countries. Further information will be found on the Internet at www.epcos.com/trademarks.

PhaseCap Premium PFC Capacitors

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

EPCOS

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.

PoleCap Capacitors:
A modified version of PhaseCap capacitor with connection cable, suitable for long-term out door applications and for mounting on the pole.

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Detuned capacitor banks
- Filter applications
- 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 … 33 KVAr

Electrical

- Long life expectancy
- High pulse current withstand capability

Mechanical and maintenance

- Reduced mounting costs
- Mounting position upright/ horizontal
- Maintenance-free
- Highest packing density thanks to compact dimensions

Safety

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

Environmental

- Dry design, inert gas
- No oil leakage

PhaseCap Premium PFC Capacitors

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

EPCOS

Technical data : PhaseCap Premium PFC Capacitors	
Series Type	B25667L
Power-KVAr	5….31KVAr
Rated voltage-V (AC)	415...800 V*
Frequency	50 Hz
Transient peak current maximum permissible	300 • I_R
Maximum permissible temperature category	-40/D
Losses (without discharge resistors)	≤0.5W/KVAr
Maximum Permissible voltage	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)**
Maximum Permissible current	Up to 1.6 • I_R***
Safety	Self-healing, overpressure disconnector
Impregnation	Gas-impregnated, dry type, Non-PCB
Life expectancy	Up to 130 000 h for -40/D Up to 180 000 h for -40/C
Cooling	Natural or forced
Case shape/finish	Extruded round aluminium can with stud
Terminal	Optimized capacitor safety terminals
Mounting and grounding	Threaded stud at bottom of can (max. torque for M12=10Nm)
Enclosure	IP 20, indoor mounting (optionally with terminal cap for IP54)
Discharge resistor	Provided with discharge resistor
Connection	Delta
Casing of capacitor cell	Extruded round aluminium can with stud
Dielectric	Polypropylene film (metallised)
No. of switching per annum	Max. 7500 switching
Reference standard	IEC60831–1/2, UL 810-5th edition

* Other voltages available on request
** V_R rated voltage
*** I_R : RMS line current that occurs at rated sinusoidal voltage and rated frequency, excluding transients.
Note: for capacitors with different features/parameters than above, please check with our nearest sales office

PhaseCap Premium PFC Capacitors

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

EPCOS

PhaseCap Premium PFC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**d x h mm**	**Packing units**	**MOQ**	**Approx weight Kg**
PhaseCap - 415 V(AC) 3PH, 50Hz (Series B25667)								
5	415	B25667L4926A375	7.0	3 x 30.8	116 x 164	1	4	1.1
6.3	415	B25667L4117A375	8.8	3 x 38.5	116 x 164	1	4	1.2
10	415	B25667L4197A375	13.9	3 x 64.1	116 x 164	1	4	1.2
12.5	415	B25667L4237A375	17.4	3 x 77	116 x 164	1	4	1.3
15	415	B25667L4277A375	20.9	3 x 92.5	116 x 164	1	4	1.4
16.7	415	B25667L4307A375	23.2	3 x 102.9	116 x 164	1	4	1.5
20	415	B25667L4387A375	27.8	3 x 128.2	116 x 200	1	4	1.7
25	415	B25667L4467A375	34.8	3 x 154.1	136 x 200	1	4	2.1
PhaseCap - 440 V(AC) 3PH, 50Hz (Series B25667)								
5	440	B25667L4826A375	6.6	3 x 27.4	116 x 164	1	4	1.2
7.5	440	B25667L4127A375	9.8	3 x 41.1	116 x 164	1	4	1.2
10.4	440	B25667L4177A375	13.7	3 x 57	116 x 164	1	4	1.3
12.5	440	B25667L4207A375	16.4	3 x 68.5	116 x 164	1	4	1.4
14.2	440	B25667L4237A365	18.6	3 x 77.9	116 x 164	1	4	1.4
15	440	B25667L4247A375	19.7	3 x 82.2	116 x 164	1	4	1.5
20	440	B25667L4347A375	26.2	3 x 114.1	136 x 200	1	4	2.0
25	440	B25667L4417A375	32.8	3 x 137.1	136 x 200	1	4	2.1
PhaseCap - 480 V(AC) 3PH, 50Hz (Series B25667)								
5	480	B25667L4696A375	6.0	3 x 23	116 x 164	1	4	1.2
6.25	480	B25667L4866A375	7.5	3 x 28.3	116 x 164	1	4	1.2
7.5	480	B25667L4107A375	9.0	3 x 34.6	116 x 164	1	4	1.3
8	480	B25667L4117A365	9.6	3 x 38.4	116 x 164	1	4	1.3
10	480	B25667L4147A375	12.0	3 x 47.9	116 x 164	1	4	1.4
12.5	480	B25667L4177A365	15.0	3 x 57.6	116 x 164	1	4	1.5
15	480	B25667L4207A365	18.0	3 x 69.1	116 x 200	1	4	1.5
16.7	480	B25667L4237A355	20.1	3 x 76.9	116 x 200	1	4	1.8
20	480	B25667L4287A375	24.1	3 x 95.8	136 x 200	1	4	2.2
25	480	B25667L4347A365	30.1	3 x 115.2	136 x 200	1	4	2.5
31	480	B25667L4427A375	37.3	3 x 143	136 x 200	1	4	3.0
PhaseCap - 525 V(AC) 3PH, 50Hz (Series B25667)								
6.25	525	B25667L5726A375	7.0	3 x 24.1	116 x 164	1	4	1.1
8	525	B25667L5966A375	8.8	3 x 32.1	116 x 164	1	4	1.1
10	525	B25667L5127A375	11.0	3 x 40.1	116 x 164	1	4	1.2
12.5	525	B25667L5147A375	13.8	3 x 48.1	116 x 164	1	4	1.3
15	525	B25667L5177A375	16.5	3 x 57.1	116 x 200	1	4	1.8
16.7	525	B25667L5197A375	18.4	3 x 64.3	116 x 200	1	4	1.8
20	525	B25667L5247A375	22.0	3 x 80.1	136 x 200	1	4	2.2
25	525	B25667L5287A375	27.5	3 x 96.3	136 x 200	1	4	2.5
30	525	B25667L5347A375	33.0	3 x 115.5	136 x 200	1	4	2.8

PhaseCap Premium PFC Capacitors

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

EPCOS

PhaseCap Premium PFC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**d x h mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
PhaseCap - 690 V(AC) 3PH, 50Hz (Series B25667)								
5	690	B25667C6336A375	4.2	3 x 11	116 x 164	6	6	1.3
10	690	B25667C6676A375	8.4	3 x 23	116 x 164	6	6	1.4
12.5	690	B25667C6836A375	10.5	3 x 28	116 x 164	6	6	1.5
15	690	B25667C6107A375	12.6	3 x 34	116 x 164	6	6	1.5
20.8	690	B25667C6137A375	17.5	3 x 47	136 x 200	4	4	2.0
25	690	B25667C6167A375	21	3 x 56	136 x 200	4	4	2.2
PhaseCap - 800 V(AC) 3PH, 50Hz (Series B25667)								
5	800	B25667C7246A375	3.6	3 x 8	116 x 164	6	6	1.2
7.5	800	B25667C7376A375	5.4	3 x 12.4	116 x 164	6	6	1.2
10	800	B25667C7496A375	7.2	3 x 17	116 x 164	6	6	1.3
12.5	800	B25667C7626A375	9	3 x 21	116 x 164	6	6	1.4
15	800	B25667C7746A375	11	3 x 25	116 x 164	6	6	1.5
20	800	B25667C7996A375	14.5	3 x 33	136 x 200	4	4	2.0
25	800	B25667C7127A375	18	3 x 41	136 x 200	4	4	2.3
28	800	B25667C7137A375	20	3 x 46	136 x 200	4	4	2.4

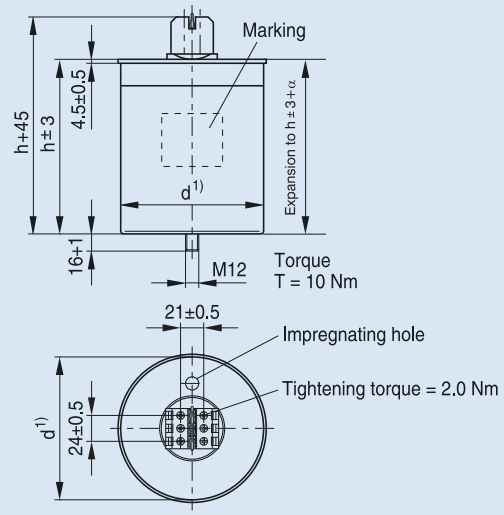
Other voltages available on request.
Packing units for capacitors equal minimum order quantity .
Orders will be rounded up to packing unit or multiple thereof .

PhaseCap Premium PFC Capacitors

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

Dimensional drawings

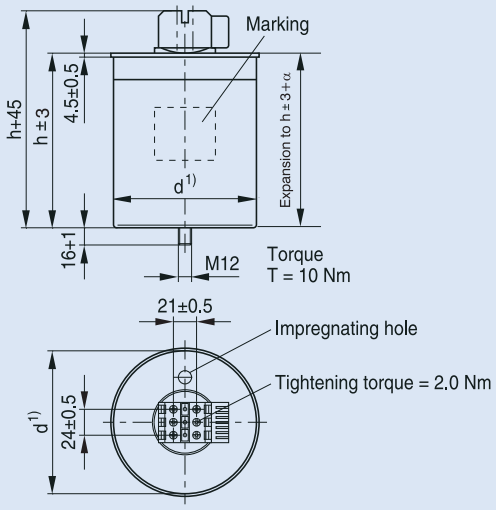
Capacitor up to 690 V AC



KLK1841-1-E

1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

Capacitor > 690 V AC



KLK1834-I-E

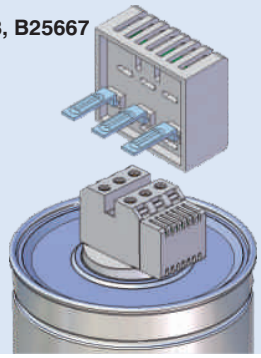
1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

Discharge resistor

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

Discharge resistor module

Side mounted discharge resistor module for B25673, B25667 and B25669 series



PhaseCap Super Heavy Duty PFC Capacitors

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

General

The new PhaseCap Super Heavy Duty (SHD) 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 Super Heavy Duty (SHD) offers higher inrush current capability (up to 400 • I_R) and over current capability (up to 2 • 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 besides MKV .

Applications

- Automatic PFC equipment, capacitor banks
- Individual fixed PFC (e.g. motors, transformers, lighting)
- Group fixed PFC
- Detuned capacitor banks
- Filter applications
- Dynamic PFC

Features

- Compact design in cylindrical aluminum can with stud
- Concentric 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

Safety

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

PhaseCap Super Heavy Duty PFC Capacitors

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

EPCOS

Technical data : PhaseCap Super Heavy Duty PFC Capacitors	
Series type	B25673L
Power-KVAr	5….33KVAr
Rated voltage-V (AC)	415...1000 V*
Frequency	50 Hz
Transient peak current maximum permissible	400 • I_R
Maximum permissible temperature category	-40°C to 60°C
Losses (without discharge resistors)	≤0.45W/KVAr
Maximum permissible voltage	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)**
Maximum permissible current	Up to 1.6 • I_R***
Safety	Self-healing, overpressure disconnector
Impregnation	Non-PCB, semi-dry biodegradable resin
Life expectancy	Up to 200 000 h for -40/C Up to 150 000 h for -40/60
Cooling	Natural or forced
Case shape/finish	Extruded round aluminium can with stud
Terminal	Optimized capacitor safety terminals
Mounting and grounding	Threaded stud at bottom of can (max. torque for M12=Nm)
Enclosure	IP 20, indoor mounting (optionally with terminal cap for IP54)
Discharge resistor	Provided with discharge resistor
Connection	Delta
Casing of capacitor cell	Extruded round aluminium can with stud
Dielectric	Polypropylene film (metallised)
No. of switching per annum	Max. 10 000 switching
Reference standard	IEC60831–1/2, UL 810-5th edition

* Other voltages available on request
** V_R rated voltage
*** I_R : RMS line current that occurs at rated sinusoidal voltage and rated frequency, excluding transients.
Note : for capacitors with different features/parameters than above, please check with our nearest sales office

PhaseCap Super Heavy Duty PFC Capacitors

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

EPCOS

PhaseCap Super Heavy Duty PFC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**d x h mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
PhaseCap Super Heavy Duty - 415 V(AC) 3PH, 50Hz (Series B25673)								
5	415	B25673L4052A 10	7	3 x 30.8	85 x 125	1	1	0.7
6.2	415	B25673L4062A 10	8.6	3 x 38.2	85 x 162	1	1	1.0
7.5	415	B25673L4072A510	10.4	3 x 46.2	85 x 162	1	1	1.0
10.4	415	B25673L4102A 10	14.5	3 x 64.1	100 x 162	1	1	1.4
12.5	415	B25673L4122A510	17.4	3 x 77	100 x 200	1	1	1.7
15	415	B25673L4152A 10	20.9	3 x 92.5	100 x 200	1	1	1.7
20.8	415	B25673L4202A810	28.9	3 x 128.2	116 x 200	1	1	2.2
25	415	B25673L4252A 11	35	3 x 154	136 x 200	1	1	3.2
PhaseCap Super Heavy Duty - 440 V(AC) 3PH, 50Hz (Series B25673)								
5	440	B25673L4052A 40	6.6	3 x 27.4	85 x 125	1	1	0.8
7.5	440	B25673L4072A540	9.8	3 x 41.1	85 x 162	1	1	1.0
10.4	440	B25673L4102A 40	13.6	3 x 57	100 x 162	1	1	1.4
12.5	440	B25673L4122A540	16.4	3 x 68.5	100 x 162	1	1	1.4
15	440	B25673L4152A 40	19.7	3 x 82.2	100 x 200	1	1	1.7
20	440	B25673L4202A 40	26.3	3 x 109.7	116 x 200	1	1	2.2
25	440	B25673L4252A 40	32.8	3 x 137.1	116 x 200	1	1	2.2
30	440	B25673L4302A 41	39.2	3 x 164	136 x 200	1	1	3.2
33	440	B25673L4332A 41	43.3	3 x 181	136 x 200	1	1	3.2
PhaseCap Super Heavy Duty - 480 V(AC) 3PH, 50Hz (Series B25673)								
5.5	480	B25673L4052A580	6.6	3 x 25.3	85 x 125	1	1	0.7
6.3	480	B25673L4062A380	7.6	3 x 29	85 x 162	1	1	1.0
8.3	480	B25673L4082A380	10	3 x 38.2	85 x 162	1	1	1.0
11	480	B25673L4112A 80	13.2	3 x 50.7	100 x 162	1	1	1.7
13.8	480	B25673L4132A880	16.6	3 x 63.6	100 x 200	1	1	1.7
16.7	480	B25673L4162A780	20.1	3 x 76.9	100 x 200	1	1	1.7
22	480	B25673L4222A 80	26.5	3 x 101.4	116 x 200	1	1	2.2
28	480	B25673L4282A 81	33.4	3 x 128	136 x 200	1	1	3.2
PhaseCap Super Heavy Duty - 525 V(AC) 3PH, 50Hz (Series B25673)								
6.6	525	B25673L5062A620	7.3	3 x 25.4	85 x 162	1	1	1.0
10	525	B25673L5102A 20	11	3 x 38.5	100 x 162	1	1	1.7
13.2	525	B25673L5132A220	14.5	3 x 50.8	100 x 200	1	1	1.7
16.7	525	B25673L5162A720	18.4	3 x 64.3	116 x 200	1	1	2.2
20	525	B25673L5202A 20	22	3 x 77	116 x 200	1	1	2.2
26.5	525	B25673L4262A581	29.2	3 x 102.1	136 x 200	1	1	3.2

PhaseCap Super Heavy Duty PFC Capacitors

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

EPCOS

PhaseCap Super Heavy Duty PFC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**d x h mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
PhaseCap Super Heavy Duty - 690 V(AC) 3PH, 50Hz (Series B25673)								
5	690	B25673L6052A 90	4.2	3 x 11.2	116 x 164	1	1	2.1
7.5	690	B25673L6072A590	6.3	3 x 16.7	116 x 164	1	1	2.1
10	690	B25673L6102A 90	8.4	3 x 22.5	116 x 164	1	1	2.1
12.5	690	B25673L6122A590	10.5	3 x 27.9	116 x 164	1	1	2.1
15	690	B25673L6152A 90	12.6	3 x 33.5	116 x 164	1	1	2.2
20.8	690	B25673L6202A890	17.4	3 x 46.5	136 x 200	1	1	3.2
25	690	B25673L6252A 90	20.9	3 x 55.7	136 x 200	1	1	3.2
PhaseCap Super Heavy Duty - 800 V(AC) 3PH, 50Hz (Series B25673)								
5	800	B25673L8052A000	3.6	3 x 8.3	116 x 164	1	1	2.1
7.5	800	B25673L8072A500	5.4	3 x 12.4	116 x 164	1	1	2.1
10.0	800	B25673L8102A000	7.2	3 x 16.6	116 x 164	1	1	2.1
12.5	800	B25673L8122A500	9	3 x 20.7	116 x 164	1	1	2.1
15	800	B25673L8152A000	10.8	3 x 24.9	116 x 164	1	1	2.1
20	800	B25673L8202A000	15	3 x 33.2	136 x 200	1	1	3.2
25	800	B25673L8252A000	18	3 x 41.4	136 x 200	1	1	3.2
28	800	B25673L8252A000	20.2	3 x 46.4	136 x 200	1	1	3.2
PhaseCap Super Heavy Duty - 900 V(AC) 3PH, 50Hz (Series B25673)								
10.4	900	B25673L9102A400	6.7	3 x 13.6	116 x 164	1	1	2.0
12.5	900	B25673L9122A500	8	3 x 16.4	116 x 164	1	1	2.0
15	900	B25673L9152A000	9.6	3 x 19.7	116 x 200	1	1	2.4
20	900	B25673L9202A000	12.8	3 x 26.2	136 x 200	1	1	3.1
25	900	B25673L9252A000	16	3 x 32.7	136 x 200	1	1	3.1
PhaseCap Super Heavy Duty - 1000 V(AC) 3PH, 50Hz (Series B25673)								
10.4	1000	B25673L0102A400	6	3 x 11.0	116 x 164	1	1	2.0
12.5	1000	B25673L0122A500	7.2	3 x 13.3	116 x 164	1	1	2.0
15	1000	B25673L0152A000	8.7	3 x 15.9	116 x 200	1	1	2.4
20	1000	B25673L0202A000	11.6	3 x 21.2	136 x 200	1	1	3.1
25	1000	B25673L0252A000	14.4	3 x 26.5	136 x 200	1	1	3.1

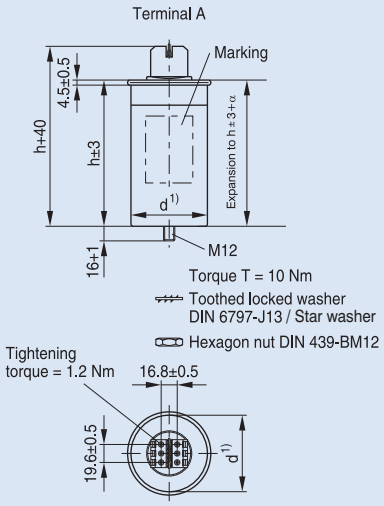
Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

PhaseCap Super Heavy Duty PFC Capacitors

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

Dimensional drawings

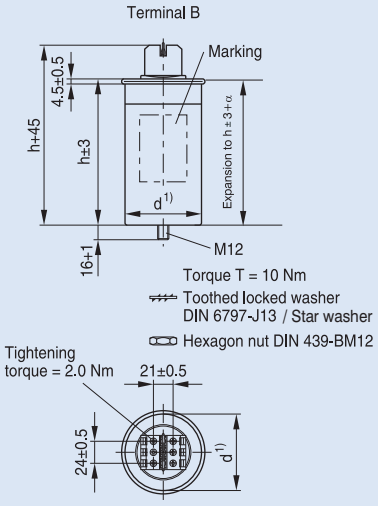
Terminal type A, current up to 50 A
Terminal cross section 16 mm² (without cable end lug)



1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

KLK1829-H-E

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



1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

KLK1833-A-E

PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

EPCOS

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.

Available in two designs

- Normal Duty (ND) for linear inductive loads.
- Heavy Duty (HD) for loads having some amount of non-linearity (with detuning reactor) .

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 115 000 hours
- High pulse current withstand capability (up to 200 • I_R)

Mechanical and maintenance

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

Safety

- Self-healing
- Overpressure disconnector

PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

EPCOS

Technical data : PhiCap PFC Capacitors		
	PhiCap-ND	**PhiCap-HD**
Series type	B32343L (plastic top up to 5 KVAr) B32344B (metal top- 6 KVAr and onwards)	B32447 series (1and 2 KVAr) B32448 series (3 KVAr and onwards)
Power-KVAr	0.5 to 30 KVAr	1.0....30 KVAr
Rated voltage-V (AC)	230...525 V*	415...480 V*
Frequency	50 Hz	50 Hz
Transient peak current maximum permissible	200 • I_R	250 • I_R
Maximum permissible temperature category	-10/D	-10/D
Losses (without discharge resistor)	≤0.5 W/KVAr	≤0.5 W/KVAr
Maximum permissible voltage	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)**	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)**
Maximum permissible current	1.3 to 1.5 • I_R***	1.5 to 1.8 • I_R***
Safety	Self-healing, overpressure disconnector	Self-healing, overpressure disconnector
Impregnation	Non-PCB, semi-dry biodegradable resin	Non-PCB, semi-dry biodegradable resin
Life expectancy	Up to 100 000 hours	Up to 115 000 hours
Cooling	Natural or forced	Natural or forced
Case shape/finish	Extruded round aluminium can with stud	Extruded round aluminium can with stud
Terminal	6.3 mm fast-on terminals for plastic top -1 to 5 KVAr Screw terminal for metal top 6 KVAr and above	6.3 mm fast-on terminals for plastic top - 1 and 2 KVAr Optimized capacitor safety terminals 3 KVAr onwards
Mounting and grounding	Threaded stud at bottom of can (max. torque 4 Nm for M8 and 10Nm for M12)	Threaded stud at bottom of can (max. torque 4 Nm for M8 and 10Nm for M12)
Enclosure	IP 00, indoor mounting (optionally with terminal cap for IP54)	IP 00, indoor mounting (optionally with terminal cap for IP54)
Discharge resistor	Provided with discharge resistor	Provided with discharge resistor
Connection	Delta	Delta
Casing of capacitor cell	Extruded round aluminium can with stud	Extruded round aluminium can with stud
Dielectric	Polypropylene film (metallised)	Polypropylene film (metallised)
No. of switching per annum	Max. 5000 switching	Max. 6000 switching
Reference standard	IS : 13340/41(ISI mark applicable for 415 and 440V)	IS : 13340/41(ISI mark applicable for 415 and 440V)

* Other voltages available on request
** V_R rated voltage
*** I_R : RMS line current that occurs at rated sinusoidal voltage and rated frequency, excluding transients.
Note : for capacitors with different features/parameters than above, please check with our nearest sales office

PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

EPCOS

PhiCap Normal Duty (ND) Capacitors - 3 Phase

Rating KVAr	Voltage V (AC)	Material code	I_R A	C_N F	d x h mm	Packing units	MOQ	Approx. weight Kg
PhiCap Normal Duty - 415 V(AC) 3PH, 50Hz (Series B32343 and B32344)								
0.5	415	B32343L4002A510	0.7	3 x 3	53 x 117	12	12	0.3
1	415	B32343L4012A 10	1.4	3 x 6.5	53 x 117	12	12	0.3
1.5	415	B32343L4012A510	2.0	3 x 9.5	53 x 117	12	12	0.3
2	415	B32343L4022A 10	2.7	3 x 12.5	53 x 117	12	12	0.4
2.5	415	B32343L4022A510	3.4	3 x 15.5	63.5 x 129	12	12	0.4
3	415	B32343L4032A 10	4.1	3 x 18.5	63.5 x 129	12	12	0.4
4	415	B32343L4042A 10	5.5	3 x 25	63.5 x 152	12	12	0.4
5	415	B32343L4052A 10	6.9	3 x 31	63.5 x 152	12	12	0.5
6.3	415	B32344B4071A510	8.8	3 x 39	75 x 195	1	6	0.6
7.5	415	B32344B4072A510	10.4	3 x 46.5	75 x 195	1	6	0.7
8.3	415	B32344B4082A310	11.5	3 x 51.5	75 x 195	1	6	0.7
9	415	B32344B4092A 10	12.5	3 x 55.5	75 x 195	1	6	0.7
10	415	B32344B4102A 10	13.9	3 x 62	85 x 195	1	4	0.7
12.5	415	B32344B4122A510	17.3	3 x 77	85 x 270	1	4	1.0
15	415	B32344B4152A 10	20.8	3 x 92.5	85 x 270	1	4	1.8
20	415	B32344B4202A 10	27.8	3 x 123.5	85 x 345	1	4	1.8
25	415	B32344B4252A 10	34.7	3 x 154	85 x 345	1	4	2.0
PhiCap Normal Duty - 440 V(AC) 3PH, 50Hz (Series B32343 & B32344)								
1	440	B32343L4012A 40	1.3	3 x 5.5	53 x 117	12	12	0.3
1.5	440	B32343L4012A540	1.9	3 x 8.5	53 x 117	12	12	0.3
2	440	B32343L4021A540	2.8	3 x 11.5	53 x 117	12	12	0.4
2.5	440	B32343L4022A540	3.2	3 x 14	63.5 x 129	12	12	0.4
3	440	B32343L4032A 40	3.9	3 x 16.5	63.5 x 129	12	12	0.5
4.2	440	B32343L4051A 40	5.5	3 x 23	63.5 x 129	12	12	0.5
5	440	B32343L4052A 40	6.5	3 x 27.5	63.5 x 152	12	12	0.6
5.6	440	B32343L4052A640	7.3	3 x 31	63.5 x 188	12	12	0.6
6	440	B32344B4071A540	7.8	3 x 33	75 x 195	1	6	0.6
7	440	B32344B4072A 40	9.2	3 x 38.5	75 x 195	1	6	0.6
7.5	440	B32344B4072A540	9.8	3 x 41	75 x 195	1	6	0.6
8.3	440	B32344B4101A 40	10.8	3 x 45.5	75 x 195	1	6	0.6
9	440	B32344B4092A 40	11.8	3 x 49.5	75 x 195	1	6	0.6
10	440	B32344B4102A 40	13.1	3 x 55	85 x 195	1	4	0.6
11.2	440	B32344B4112A240	14.6	3 x 61.4	85 x 195	1	4	0.8
12.5	440	B32344B4151A 40	16.4	3 x 68.5	85 x 270	1	4	0.8
14	440	B32344B4142A 40	18.3	3 x 76.4	85 x 270	1	4	1.0
15	440	B32344B4152A 40	19.6	3 x 82.5	85 x 270	1	4	1.2
16.7	440	B32344B4201A 40	21.9	3 x 91.5	85 x 345	1	4	1.2
19	440	B32344B4192A 40	24.9	3 x 104.5	85 x 345	1	4	1.2
20	440	B32344B4202A 40	26.2	3 x 110	85 x 345	1	4	1.2
20.8	440	B32344B4251A 40	27.3	3 x 114	85 x 345	1	4	1.2
25	440	B32344B4252A 40	32.8	3 x 137.5	90 x 345	1	4	1.5
28	440	B32344B4282A 40	36.7	3 x 153.5	90 x 345	1	4	1.6
30	440	B32344B4302A 40	39.4	3 x 164.5	90 x 345	1	4	1.8

PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

EPCOS

PhiCap Normal Duty (ND) Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**d x h mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
PhiCap Normal Duty - 480 V(AC) 3PH, 50Hz (Series B32344)								
5	480	B32344B4052A 80	6.0	3 x 23	75 x 195	1	6	0.6
8.3	480	B32344B4082A380	10	3 x 28.2	75 x 270	1	6	0.6
10.4	480	B32344B4121A580	12.5	3 x 48	85 x 270	1	4	0.8
11.1	480	B32344B4112A180	13.4	3 x 51.1	75 x 270	1	6	0.9
12.5	480	B32344B4151A 80	15.0	3 x 58	85 x 345	1	4	0.9
13.8	480	B32344B4132A880	16.6	3 x 63.6	85 x 270	1	4	1.0
15	480	B32344B4152A 80	18.0	3 x 69	85 x 345	1	4	1.5
16.6	480	B32344B4162A680	20	3 x 76.5	85 x 345	1	4	1.5
20.8	480	B32344B4251A 80	25.0	3 x 96	85 x 345	1	4	1.5
22.1	480	B32344B4222A180	26.6	3 x 101.8	90 x 345	1	4	1.8
25	480	B32344B4252A 80	30.0	3 x 115	90 x 345	1	4	1.8
27.7	480	B32344B4272A780	33.3	3 x 127.6	90 x 345	1	4	1.8
30	480	B32344B4302A 80	36.0	3 x 138	90 x 345	1	4	1.9
PhiCap Normal Duty - 525 V(AC) 3PH, 50Hz (Series B32344)								
5	525	B32344B5052A 20	5.5	3 x 19	75 x 195	1	6	0.4
6.3	525	B32344B5071A520	6.9	3 x 24	75 x 195	1	6	0.5
8.3	525	B32344B5082A320	9.1	3 x 32	85 x 270	1	4	0.6
9.9	525	B32344B5092A920	10.9	3 x 38.1	75 x 270	1	6	0.6
10.4	525	B32344B5102A420	11.4	3 x 40	85 x 270	1	4	0.8
12.5	525	B32344B5151A 20	13.7	3 x 48	85 x 270	1	4	1.2
13.2	525	B32344B5132A220	14.5	3 x 50.8	85 x 270	1	4	1.3
16.7	525	B32344B5162A720	18.3	3 x 64	85 x 345	1	4	1.3
20.8	525	B32344B5202A820	22.8	3 x 80	90 x 345	1	4	1.5
26.5	525	B32344B5262A520	29.5	3 x 102.1	116 x 325	1	2	1.8
33.1	525	B32344B5332A120	36.4	3 x 127.5	116 x 325	1	2	2.0

Other voltages available on request.
Packing units for capacitors equal minimum order quantity. Orders will be rounded up to packing unit or multiple thereof.

PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

EPCOS

Rating KVAr	Voltage V (AC)	Material code	I_R A	C_N F	d x h mm	Packing units	MOQ	Approx. weight Kg
PhiCap Heavy Duty (HD) Capacitors - 3 Phase								
PhiCap Heavy Duty - 415 V(AC) 3PH, 50Hz (Series B32447 & B32448)								
1	415	B32447A4012B 10	1.39	3 x 6.5	53 x 129	12	12	0.4
2	415	B32448A4022B 10	2.78	3 x 12.5	78.4 x 195	1	6	0.8
3	415	B32448A4032B 10	4.17	3 x 19	78.4 x 195	1	6	1.0
4	415	B32448A4042B 10	5.56	3 x 25	78.4 x 195	1	6	1.1
5	415	B32448A4052B 10	6.96	3 x 31	88.4 x 195	1	4	1.3
8	415	B32448A4082B 10	11.13	3 x 49.5	88.4 x 270	1	4	1.8
9	415	B32448A4092B 10	12.52	3 x 55.5	88.4 x 270	1	4	1.9
10	415	B32448A4102B 10	13.91	3 x 62	88.4 x 345	1	4	2.1
12.5	415	B32448A4122B510	17.39	3 x 77	88.4 x 345	1	4	2.3
PhiCap Heavy Duty - 440 V(AC) 3PH, 50Hz (Series B32447 & B32448)								
1	440	B32447A4012B 40	1.3	3 x 5.5	53 x 117	12	12	0.5
2	440	B32447A4022B 40	2.62	3 x 12.5	63.5 x129	12	12	0.8
3	440	B32448A4032B 40	3.94	3 x 16.5	75 x 195	1	6	1.1
4	440	B32448A4042B 40	5.25	3 x 22	75 x 195	1	6	1.1
5	440	B32448A4052B 40	6.56	3 x 27.5	75 x 195	1	6	1.2
6	440	B32448A4062B 40	7.8	3 x 33	85 x 195	1	4	1.3
7.5	440	B32448A4072B540	9.84	3 x 41.5	85 x 270	1	4	1.7
8	440	B32448A4082B 40	10.5	3 x 44	85 x 270	1	4	1.8
9	440	B32448A4092B 40	11.8	3 x 49.5	85 x 270	1	4	1.8
10	440	B32448A4102B 40	13.12	3 x 55	85 x 270	1	4	1.9
12.5	440	B32448A4122B540	16.4	3 x 68.5	95 x 270	1	4	2.0
15	440	B32448A4152B 40	19.68	3 x 82.5	100 x 280	1	4	2.5
20	440	B32448A4202B840	26.24	3 x 109.6	116 x 280	1	2	2.9
25	440	B32448A4252B 40	32.8	3 x 137	116 x 325	1	2	3.8
30	440	B32448A4302B 40	39.4	3 x 164.5	136 x 325	1	2	5.0
PhiCap Heavy Duty - 480 V(AC) 3PH, 50Hz (Series B32448)								
5	480	B32448A4052B 80	6.01	3 x 23	75 x 195	1	6	1.2
5.5	480	B32448A4052A580	6.6	3 x 25.3	75 x 195	1	6	1.2
8.3	480	B32448A4082A380	10	3 x 38.2	85 x 270	1	4	1.5
10	480	B32448A4102B 80	12.03	3 x 46	85 x 270	1	4	1.8
11.1	480	B32448A4112A180	13.4	3 x 51.1	85 x 270	1	4	1.9
12.5	480	B32448A4122B580	15.04	3 x 58	85 x 270	1	4	2.0
13.8	480	B32448A4132A880	16.6	3 x 63.6	90 x 270	1	4	2.0
14.5	480	B32448A4142B580	17.44	3 x 67	90 x 270	1	4	2.0
16.6	480	B32448A4162A680	20	3 x 76.5	85 x 345	1	4	2.3
20	480	B32448A4202B880	24.06	3 x 95.8	116 x 280	1	2	2.8
22.1	480	B32448A4222A180	26.6	3 x 101.8	116 x 280	1	2	2.8
25	480	B32448A4252B 80	30.07	3 x 115.1	116 x 325	1	2	3.1
27.7	480	B32448A4272A780	33.3	3 x 127.6	116 x 325	1	2	3.7
30	480	B32448A4302B 80	36.09	3 x 138.1	116 x 325	1	2	4.6

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

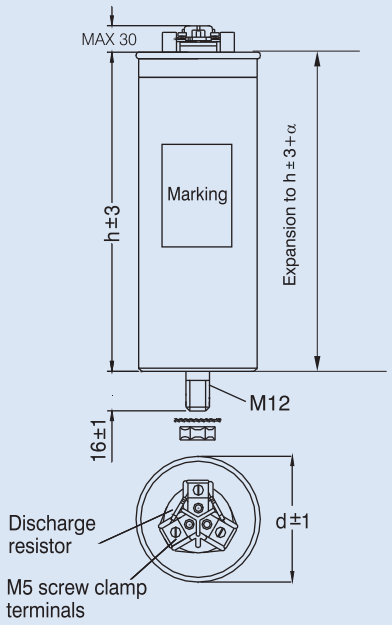
PhiCap PFC Capacitors

Semi-dry biodegradable resin • Stacked winding • Dual safety system

Dimensional drawings:

Capacitor B32344 series

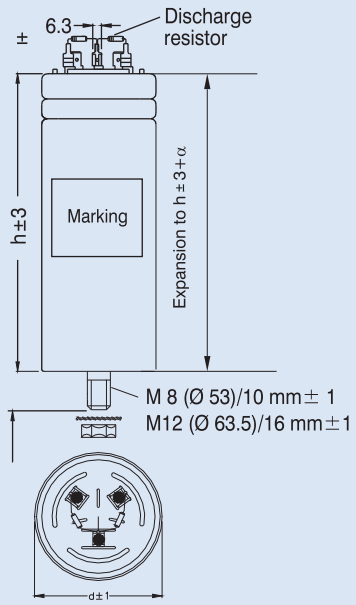
Capacitors with metal top



1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

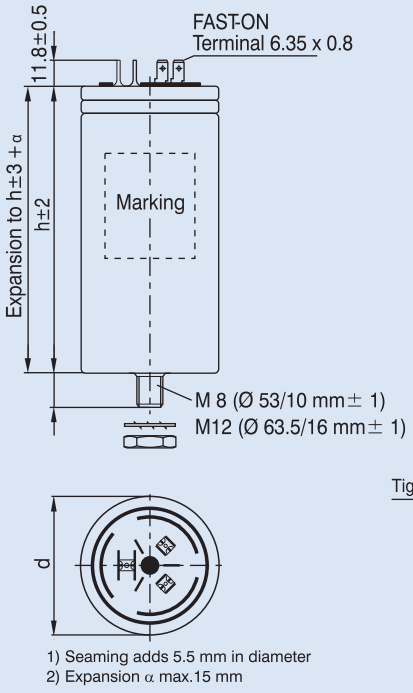
Capacitor B32343 series

Capacitors with plastic top



Capacitor B32447 series

Capacitors with plastic top

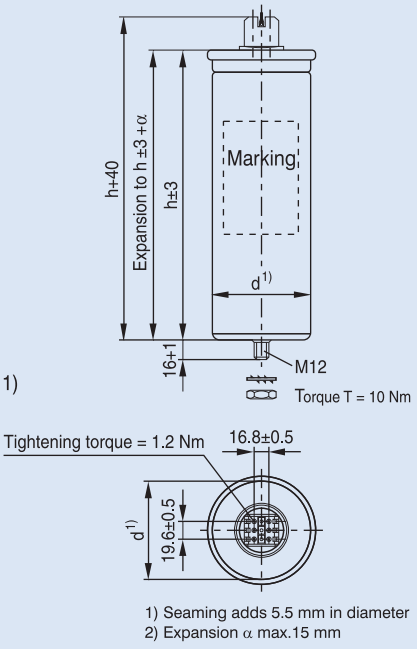


1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

Capacitor B32448 series

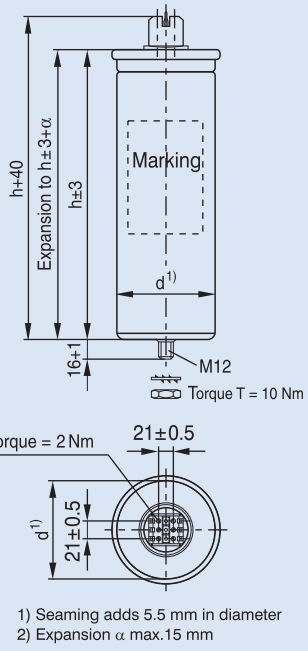
Capacitors with metal top

Can diameter up to 90 mm



1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

Can diameter above 90 mm



1) Seaming adds 5.5 mm in diameter
2) Expansion α max.15 mm

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

General

The SquareCap box type capacitor is self standing in nature and is having modular construction (above 6KVAr) in a sheet metal enclosure.

It is a very popular capacitor design in India for many decades.

The SquareCap series is especially intended for use in industrial applications and locations such as commercial complexes, malls etc. The internal construction comprises of single phase basic capacitors cells connected to form delta construction externally within the enclosure. The terminal arrangement is of stud type.

SquareCap series is available in three designs:

ENDC: EPCOS Normal Duty Capacitor for normal inductive loads.

EHDLL: EPCOS Heavy Duty Long life Capacitor for loads exhibiting some amount of non-linearity.(Preferably with detuning reactor).

ESHDC: EPCOS Super Heavy Duty Capacitor for non linear arduous and fluctuating loads and systems containing higher degree of harmonics.(Preferably with detuning reactor).

Applications

- Stand alone capacitors (Fixed Compensation)
- Capacitor banks
- Detuned capacitor banks
- Dynamic PFC

Features

- Box Type self standing Design
- Voltage Range:415V ….525V
- Range: 1kVAr to 60kVAr
- Resin Impregnated
- Available in three designs Viz. ENDC, EHDLL and ESHDC

Electrical

- High pulse current withstand capability
- Very high life expectancy

Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free

Safety

- Self-healing
- Overpressure disconnector
- Sheet metal enclosure

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

EPCOS

Technical data : SquareCap PFC Capacitors			
	SquareCap-ENDC	**SquareCap-EHDLL**	**SquareCap-ESHDC**
Series type	B32457L	B32459L	B32455L
Power-KVAr	1…50 KVAr	1…50 KVAr	1…50 KVAr
Rated voltage-V (AC)	415…440 V*	415…525 V*	415…525 V*
Frequency	50 Hz	50 Hz	50 Hz
Transient peak current maximum permissible	upto 200 • I_R	upto 250 • I_R	upto 350 • I_R
Maximum permissible temperature category	-10/D	-10/D	-10/D
Losses (without discharge resistors)	≤0.5 W/KVAr	≤0.5 W/KVAr	≤0.5 W/KVAr
Maximum permissible voltage	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)**	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)**	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)**
Maximum permissible current	1.3 • I_R***	1.5 • I_R***	1.6 • I_R***
Safety	Self-healing, overpressure disconnector	Self-healing, overpressure disconnector	Self-healing, overpressure disconnector
Impregnation	Non PCB, semi-dry biodegradable resin	Non PCB, semi-dry biodegradable resin	Non PCB, semi-dry biodegradable resin
Life expectancy	Up to 100 000 hours	Up to 125 000 hours	Up to 150 000 hours
Cooling	Natural or forced	Natural or forced	Natural or forced
Case shape/finish	Rectangular/powder coated Siemens grey colour	Rectangular/powder coated Siemens grey colour	Rectangular/powder coated Siemens grey colour
Terminal	Threaded stud terminals with ceramic bushing	Threaded stud terminals with ceramic bushing	Threaded stud terminals with ceramic bushing
Mounting and grounding	Self standing with mounting plates and screws for grounding	Self standing with mounting plates and screws for grounding	Self standing with mounting plates and screws for grounding
Enclosure	IP 20	IP 20	IP 20
Discharge resistor	PCB mounted -included	PCB mounted -Included	PCB mounted -included
Connection	Delta	Delta	Delta
Casing of capacitor cell	Extruded aluminium can (hermetically sealed)	Extruded aluminium can (hermetically sealed)	Extruded aluminium can (hermetically sealed)
Dielectric	Polypropylene film (metallised)	Polypropylene film (metallised)	Polypropylene film (metallised)
No. of switching per annum	Max. 5000 switching	Max. 6000 switching	Max. 7500 switching
Reference standard	IS: 13340/41 (ISI mark applicable for 415 and 440V)	IS: 13340/41 (ISI mark applicable for 415 and 440V)	IS: 13340/41 (ISI mark applicable for 415 and 440V)

* other voltages available on request
** V_R rated voltage
*** I_R : RMS line current that occurs at rated sinusoidal voltage and rated frequency, excluding transients.
Note : for capacitors with different features/parameters than above, please check with our nearest sales office

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

EPCOS

SquareCap ENDC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F (Basic cells x F)**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
SquareCap ENDC - 415 V(AC) 3PH, 50Hz (Series B32457)								
1	415	B32457P4001A 11	1.3	3 x 6.3	95 x 125 x 45	1	25	0.8
2	415	B32457P4002A 11	2.7	3 x 12.5	120 x 125 x 45	1	25	0.8
3	415	B32457P4003A 11	4.1	3 x 19	120 x 145 x 55	1	25	1.4
4	415	B32457P4004A 11	5.5	3 x 25	140 x 145 x 55	1	25	1.5
5	415	B32457L4005A 11	6.9	3 x 31	215 x 185 x 60	1	1	1.6
6	415	B32457L4006A 11	8.3	3 x 37.5	300 x 240 x 80	1	1	2.4
7	415	B32457L4007A 11	9.7	3 x 44	300 x 240 x 80	1	1	2.6
7.5	415	B32457L4007A511	10.4	3 x 46.5	300 x 240 x 80	1	1	2.7
8	415	B32457L4008A 11	11.1	3 x 49.5	300 x 240 x 80	1	1	2.8
9	415	B32457L4009A 11	12.5	3 x 56	300 x 240 x 80	1	1	3.0
10	415	B32457L4010A 11	13.9	3 x 62	300 x 240 x 80	1	1	3.1
12.5	415	B32457L4012A511	17.3	3 x 77	300 x 240 x 80	1	1	3.6
15	415	B32457L4015A 11	20.8	3 x 92.5	300 x 240 x 80	1	1	3.8
20	415	B32457L4020A 11	27.8	6 x 62	300 x 240 x 160	1	1	6.5
25	415	B32457L4025A 11	34.7	6 x 77	300 x 240 x 160	1	1	7.2
30	415	B32457L4030A 11	41.7	6 x 92.5	300 x 240 x 160	1	1	7.9
50	415	B32457L4050A 11	69.5	12 x 77	350 x 240 x 320	1	1	12.5
SquareCap ENDC - 440 V(AC) 3PH, 50Hz (Series B32457)								
1	440	B32457P5001A 11	1.3	3 x 5.5	95 x 125 x 45	1	25	0.8
2	440	B32457P5002A 11	2.6	3 x 11	120 x 125 x 45	1	25	0.8
3	440	B32457P5003A 11	3.9	3 x 16.5	120 x 145 x 55	1	25	1.4
4	440	B32457P5004A 11	5.2	3 x 22	140 x 145 x 55	1	25	1.5
5	440	B32457L5005A 11	6.6	3 x 27.5	215 x 185 x 60	1	1	1.6
6	440	B32457L5006A 11	7.9	3 x 33	300 x 240 x 80	1	1	2.2
7	440	B32457L5007A 11	9.2	3 x 38.5	300 x 240 x 80	1	1	2.4
7.5	440	B32457L5007A511	9.84	3 x 41.5	300 x 240 x 80	1	1	2.5
8	440	B32457L5008A 11	10.5	3 x 44	300 x 240 x 80	1	1	2.6
9	440	B32457L5009A 11	11.8	3 x 49.5	300 x 240 x 80	1	1	2.8
10	440	B32457L5010A 11	13.1	3 x 55	300 x 240 x 80	1	1	3.0
12	440	B32457L5012A 11	15.7	3 x 66	300 x 240 x 80	1	1	3.2
12.5	440	B32457L5012A511	16.4	3 x 69	300 x 240 x 80	1	1	3.3
15	440	B32457L5015A 11	19.6	3 x 82.5	300 x 240 x 80	1	1	3.8
20	440	B32457L5020A 11	26.2	6 x 55	300 x 240 x 160	1	1	6.1
25	440	B32457L5025A 11	32.8	6 x 69	300 x 240 x 160	1	1	7.0
35	440	B32457L5035A 11	45.9	12 x 48	350 x 240 x 320	1	1	8.0
40	440	B32457L5040A 11	52.5	12 x 54.8	350 x 240 x 320	1	1	8.8
50	440	B32457L5050A 11	65.6	12 x 69	350 x 240 x 320	1	1	12.4

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

EPCOS

SquareCap EHDLL Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F (Basic cells x F)**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
SquareCap EHDLL - 415 V(AC) 3PH, 50Hz (Series B32459)								
1	415	B32459L4001A 11	1.3	3 x 6.3	170 x 125 x 45	1	20	1.0
2	415	B32459L4002A 11	2.7	3 x 12.5	170 x 125 x 45	1	20	1.1
3	415	B32459L4003A 11	4.1	3 x 19	215 x 185 x 60	1	20	1.5
4	415	B32459L4004A 11	5.5	3 x 25	215 x 185 x 60	1	20	1.6
5	415	B32459L4005A 11	7.0	3 x 31	215 x 185 x 60	1	1	1.8
7	415	B32459L4007A 11	10.4	3 x 46.5	300 x 240 x 80	1	1	3.2
7.5	415	B32459L4007A511	10.4	3 x 49.5	300 x 240 x 80	1	1	3.3
10	415	B32459L4010A 11	13.9	3 x 62	300 x 240 x 80	1	1	3.4
12.5	415	B32459L4012A511	17.3	3 x 77	300 x 240 x 80	1	1	3.5
15	415	B32459L4015A 11	20.8	3 x 92	300 x 240 x 80	1	1	4.0
20	415	B32459L4020A 11	27.8	6 x 62	300 x 240 x 160	1	1	6.1
25	415	B32459L4025A 11	34.7	6 x 77	300 x 240 x 160	1	1	6.5
30	415	B32459L4030A 11	41.7	6 x 92.4	300 x 240 x 160	1	1	7.5
40	415	B32459L4040A 11	55.6	12 x 61.6	350 x 240 x 320	1	1	11.0
50	415	B32459L4050A 11	69.5	12 x 77	350 x 240 x 320	1	1	11.8
SquareCap EHDLL - 440 V(AC) 3PH, 50Hz (Series B32459)								
1	440	B32459L5001A 11	1.3	3 x 5.5	170 x 125 x 45	1	20	0.9
2	440	B32459L5002A 11	2.6	3 x 11	170 x 125 x 45	1	20	0.9
3	440	B32459L5003A 11	3.9	3 x 16.5	215 x 185 x 60	1	20	1.5
4	440	B32459L5004A 11	5.2	3 x 22	215 x 185 x 60	1	20	1.5
5	440	B32459L5005A 11	6.5	3 x 27.5	215 x 185 x 60	1	1	1.6
6	440	B32459L5006A 11	7.9	3 x 33	300 x 240 x 80	1	1	2.7
7	440	B32459L5007A 11	9.2	3 x 38.5	300 x 240 x 80	1	1	3.0
7.5	440	B32459L5007A511	9.8	3 x 41.5	300 x 240 x 80	1	1	3.0
8	440	B32459L5008A 11	10.5	3 x 44	300 x 240 x 80	1	1	3.2
9	440	B32459L5009A 11	11.8	3 x 50	300 x 240 x 80	1	1	3.3
10	440	B32459L5010A 11	13.1	3 x 55	300 x 240 x 80	1	1	3.3
12	440	B32459L5012A 11	15.8	3 x 67.5	300 x 240 x 80	1	1	3.4
12.5	440	B32459L5012A511	16.4	3 x 69	300 x 240 x 80	1	1	3.4
15	440	B32459L5015A 11	19.6	3 x 82.5	300 x 240 x 80	1	1	3.5
20	440	B32459L5020A 11	26.2	6 x 55	300 x 240 x 160	1	1	6.1
25	440	B32459L5025A 11	32.8	6 x 69	300 x 240 x 160	1	1	6.3
30	440	B32459L5030A 11	39.4	6 x 82.2	300 x 240 x 160	1	1	6.5
40	440	B32459L5040A 11	52.5	12 x 54.8	350 x 240 x 320	1	1	11.0
50	440	B32459L5050A 11	65.6	12 x 69	350 x 240 x 320	1	1	12.1
60	440	B32459L5060A 11	78.7	12 x 82.2	350 x 240 x 320	1	1	12.1

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

EPCOS

SquareCap EHDLL Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F (Basic cells x F)**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight**
SquareCap EHDLL - 480 V(AC) 3PH, 50Hz (Series B32459)								
5	480	B32459L8005A 61	6.0	3 x 23	215 x 185 x 60	1	1	1.8
5.5	480	B32459L8005A561	6.6	3 x 25.3	215 x 185 x 60	1	1	2.3
6	480	B32459L8006A 61	7.2	3 x 28	300 x 240 x 80	1	1	2.6
7.5	480	B32459L8007A561	9.0	3 x 34.5	300 x 240 x 80	1	1	2.8
8.3	480	B32459L8008A361	10	3 x 38.2	300 x 240 x 80	1	1	2.9
9	480	B32459L8009A 61	10.8	3 x 41.5	300 x 240 x 80	1	1	3.0
10	480	B32459L8010A 61	12.0	3 x 46.5	300 x 240 x 80	1	1	3.1
11.1	480	B32459L8011A161	13.4	3 x 51.1	300 x 240 x 80	1	1	3.2
12	480	B32459L8012A 61	14.4	3 x 55.5	300 x 240 x 80	1	1	3.3
12.5	480	B32459L8012A561	14.4	3 x 58	300 x 240 x 80	1	1	3.3
13.8	480	B32459L8013A861	16.6	3 x 63.6	300 x 240 x 80	1	1	3.4
14.5	480	B32459L8014A561	17.4	3 x 67.5	300 x 240 x 80	1	1	3.4
15	480	B32459L8015A 61	18.0	3 x 69	300 x 240 x 80	1	1	3.5
16.6	480	B32459L8016A661	20	3 x 76.4	300 x 240 x 160	1	1	3.5
18	480	B32459L8018A 61	21.6	6 x 41.5	300 x 240 x 160	1	1	5.8
20	480	B32459L8020A 61	24.0	6 x 46.5	300 x 240 x 160	1	1	6.0
22.1	480	B32459L8022A161	26.6	6 x 51.1	300 x 240 x 160	1	1	6.2
25	480	B32459L8025A 61	30.0	6 x 58	300 x 240 x 160	1	1	6.3
27.7	480	B32459L8027A761	33.3	6 x 63.6	300 x 240 x 160	1	1	6.5
29	480	B32459L8029A 61	34.8	6 x 67.5	300 x 240 x 160	1	1	6.7
50	480	B32459L8050A 61	60.1	12 x 58	350 x 240 x 320	1	1	11.2
55	480	B32459L8055A 61	66.1	12 x 63.5	350 x 240 x 320	1	1	11.4
SquareCap EHDLL - 525 V(AC) 3PH, 50Hz (Series B32459)								
6.6	525	B32459L6006A611	7.3	3 x 25.4	300 x 240 x 80	1	1	1.8
10	525	B32459L6010A 11	11	3 x 38.5	300 x 240 x 80	1	1	3.0
12.5	525	B32459L6012A511	13.7	3 x 48	300 x 240 x 80	1	1	3.2
13.2	525	B32459L6013A211	14.5	3 x 50.8	300 x 240 x 80	1	1	3.3
15	525	B32459L6015A 11	16.5	3 x 58	300 x 240 x 80	1	1	3.4
16.6	525	B32459L6016A611	18.3	3 x 63.9	300 x 240 x 160	1	1	3.5
19.9	525	B32459L6019A911	22	3 x 76.6	300 x 240 x 160	1	1	3.6
20	525	B32459L6020A 11	21.9	6 x 38.5	300 x 240 x 160	1	1	5.8
25	525	B32459L6025A 11	27.4	6 x 48	300 x 240 x 160	1	1	6.5
26.5	525	B32459L6026A511	29.1	6 x 50.8	300 x 240 x 160	1	1	6.5
30	525	B32459L6030A 11	32.9	6 x 58	300 x 240 x 160	1	1	6.8
33.1	525	B32459L6033A111	36.4	6 x 63.9	300 x 240 x 160	1	1	7.0
50	525	B32459L6050A 11	55	12 x 48	350 x 240 x 320	1	1	11.0

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

EPCOS

SquareCap ESHDC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F (Basic cells x F)**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
SquareCap ESHDC - 415 V(AC) 3PH, 50Hz(Series B32455)								
1	415	B32455L4001A 11	1.3	3 x 6.5	270 x 170 x 55	1	10	2.1
2	415	B32455L4002A 11	2.7	3 x 12.5	270 x 170 x 55	1	10	2.1
3	415	B32455L4003A 11	4.1	3 x 19	300 x 240 x 80	1	10	2.8
4	415	B32455L4004A 11	5.5	3 x 25	300 x 240 x 80	1	10	2.9
5	415	B32455L4005A 11	6.9	3 x 31	300 x 240 x 80	1	1	3.2
7.5	415	B32455L4007A511	10.4	3 x 46.5	405 x 225 x 80	1	1	4.6
8	415	B32455L4008A 11	11.1	3 x 49.5	405 x 225 x 80	1	1	4.7
10	415	B32455L4010A 11	13.9	3 x 62	405 x 225 x 80	1	1	5.0
12.5	415	B32455L4012A511	17.3	3 x 77	405 x 225 x 80	1	1	5.8
15	415	B32455L4015A 11	20.8	6 x 46.5	400 x 225 x 155	1	1	8.2
20	415	B32455L4020A 11	27.8	6 x 62	400 x 225 x 155	1	1	8.5
25	415	B32455L4025A 11	34.7	6 x 77	400 x 225 x 155	1	1	8.8
30	415	B32455L4030A 11	41.7	12 x 46.2	450 x 325 x 225	1	1	14.0
40	415	B32455L4040A 11	55.6	12 x 61.6	450 x 325 x 225	1	1	15.5
50	415	B32455L4050A 11	69.5	12 x 77	450 x 325 x 225	1	1	17.0
SquareCap ESHDC - 440 V(AC) 3PH, 50Hz (Series B32455)								
1	440	B32455L5001A 11	1.3	3 x 5.5	270 x 170 x 55	1	10	2.0
2	440	B32455L5002A 11	2.6	3 x 11	270 x 170 x 55	1	10	2.0
3	440	B32455L5003A 11	3.9	3 x 16.5	300 x 240 x 80	1	10	2.7
4	440	B32455L5004A 11	5.2	3 x 22	300 x 240 x 80	1	10	2.9
5	440	B32455L5005A 11	6.5	3 x 27.5	300 x 240 x 80	1	1	3.1
6	440	B32455L5006A 11	7.9	3 x 33	405 x 225 x 80	1	1	4.2
7	440	B32455L5007A 11	9.2	3 x 38.5	405 x 225 x 80	1	1	4.4
7.5	440	B32455L5007A511	9.8	3 x 41.5	405 x 225 x 80	1	1	4.5
8	440	B32455L5008A 11	10.5	3 x 44	405 x 225 x 80	1	1	4.6
9	440	B32455L5009A 11	11.8	3 x 49.5	405 x 225 x 80	1	1	4.7
10	440	B32455L5010A 11	13.1	3 x 55	405 x 225 x 80	1	1	4.8
12	440	B32455L5012A 11	15.7	3 x 67	405 x 225 x 80	1	1	5.2
12.5	440	B32455L5012A511	16.4	3 x 69	405 x 225 x 80	1	1	5.5
15	440	B32455L5015A 11	19.6	6 x 41.5	400 x 225 x 155	1	1	8.1
20	440	b32455L5020A 11	26.24	6 x 55	400 x 225 x 155	1	1	8.4
25	440	B32455L5025A 11	32.8	6 x 69	400 x 225 x 155	1	1	9.5
30	440	B32455L5030A 11	39.4	12 x 41.1	450 x 325 x 225	1	1	14.5
35	440	B32455L5035A 11	45.9	12 x 48	450 x 325 x 225	1	1	15.0
40	440	B32455L5040A 11	52.5	12 x 54.8	450 x 325 x 225	1	1	15.5
50	440	B32455L5050A 11	65.6	12 x 69	450 x 325 x 225	1	1	17.5

SquareCap PFC Capacitors

Semi-dry biodegradable resin • Modular construction • Triple safety system

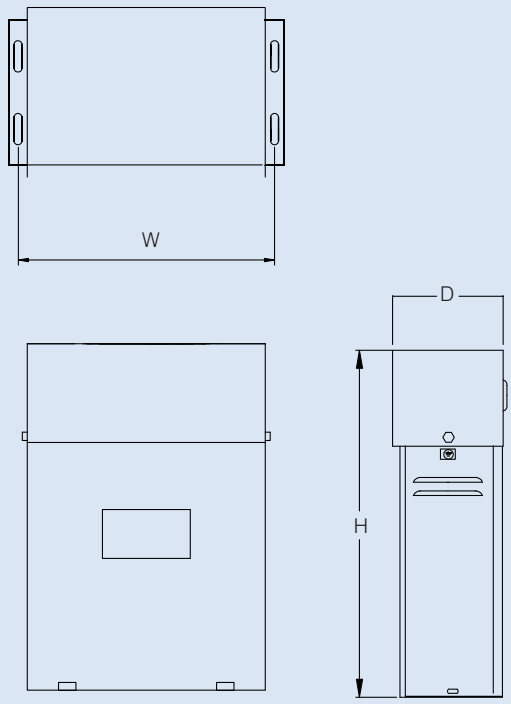
EPCOS

SquareCap ESHDC Capacitors - 3 Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F (Basic cells x F)**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
SquareCap ESHDC - 480 V(AC) 3PH, 50Hz (Series B32455)								
5	480	B32455L8005A 11	6.0	3 x 23	300 x 240 x 80	1	1	2.9
5.5	480	B32455L8005A561	6.6	3 x 25.3	300 x 240 x 80	1	1	3.1
6	480	B32455L8006A 11	7.2	3 x 28	405 x 225 x 80	1	1	4.0
7.5	480	B32455L8007A511	9.0	3 x 34.5	405 x 225 x 80	1	1	4.3
8	480	B32455L8008A 11	9.6	3 x 37	405 x 225 x 80	1	1	4.4
8.3	480	B32455L8008A361	10	3 x 38.2	405 x 225 x 80	1	1	4.4
9	480	B32455L8009A 11	10.8	3 x 41.5	405 x 225 x 80	1	1	4.5
10	480	B32455L8010A 11	12.0	3 x 46	405 x 225 x 80	1	1	4.5
11.1	480	B32455L8011A161	13.4	3 x 51.1	405 x 225 x 80	1	1	4.6
12	480	B32455L8012A 11	14.4	3 x 55.5	405 x 225 x 80	1	1	4.6
12.5	480	B32455L8012A511	15.0	3 x 58	405 x 225 x 80	1	1	4.8
13.8	480	B32455L8013A861	16.6	3 x 63.5	405 x 225 x 80	1	1	5.2
14.5	480	B32455L8014A511	17.4	6 x 33.5	400 x 225 x 155	1	1	7.8
15	480	B32455L8015A 11	18.0	6 x 34.5	400 x 225 x 155	1	1	7.8
16.6	480	B32455L8016A661	20	6 x 38.2	400 x 225 x 155	1	1	7.9
18	480	B32455L8018A 11	21.6	6 x 41.5	400 x 225 x 155	1	1	7.9
20	480	B32455L8020A 11	24.0	6 x 46	400 x 225 x 155	1	1	8.1
22.1	480	B32455L8022A161	26.6	6 x 51.1	400 x 225 x 155	1	1	8.3
25	480	B32455L8025A 11	30.0	6 x 58	400 x 225 x 155	1	1	8.5
27.7	480	B32455L8027A761	33.3	6 x 63.5	400 x 225 x 155	1	1	9.0
29	480	B32455L8029A 11	34.8	12 x 33.5	450 x 325 x 225	1	1	14.0
50	480	B32455L8050A 11	60.1	12 x 58	450 x 325 x 225	1	1	17.5
SquareCap ESHDC - 525 V(AC) 3PH, 50Hz (Series B32455)								
6.6	525	B32455L6006A611	7.3	3 x 25.4	405 x 225 x 80	1	1	3.2
10	525	B32455L6010A 11	11	3 x 38.5	405 x 225 x 80	1	1	4.4
12.5	525	B32455L6012A511	13.7	3 x 48	405 x 225 x 80	1	1	4.6
13.2	525	B32455L6013A211	14.5	3 x 50.8	405 x 225 x 80	1	1	4.6
15	525	B32455L6015A 11	16.5	6 x 28.9	400 x 225 x 155	1	1	7.7
16.6	525	B32455L6016A611	18.3	6 x 32	400 x 225 x 155	1	1	7.8
20	525	B32455L6020A 11	21.9	6 x 38.5	400 x 225 x 155	1	1	8.1
25	525	B32455L6025A 11	27.4	6 x 48	400 x 225 x 155	1	1	8.3
26.5	525	B32455L6026A511	29.1	6 x 50.8	400 x 225 x 155	1	1	8.5
33.1	525	B32455L6033A111	36.4	12 x 32	450 x 325 x 225	1	1	14.5
35	525	B32455L6035A 11	38.4	12 x 34	450 x 325 x 225	1	1	14.5
50	525	B32455L6050A 11	54.9	12 x 48	450 x 325 x 225	1	1	17.5

SquareCap PFC Capacitors

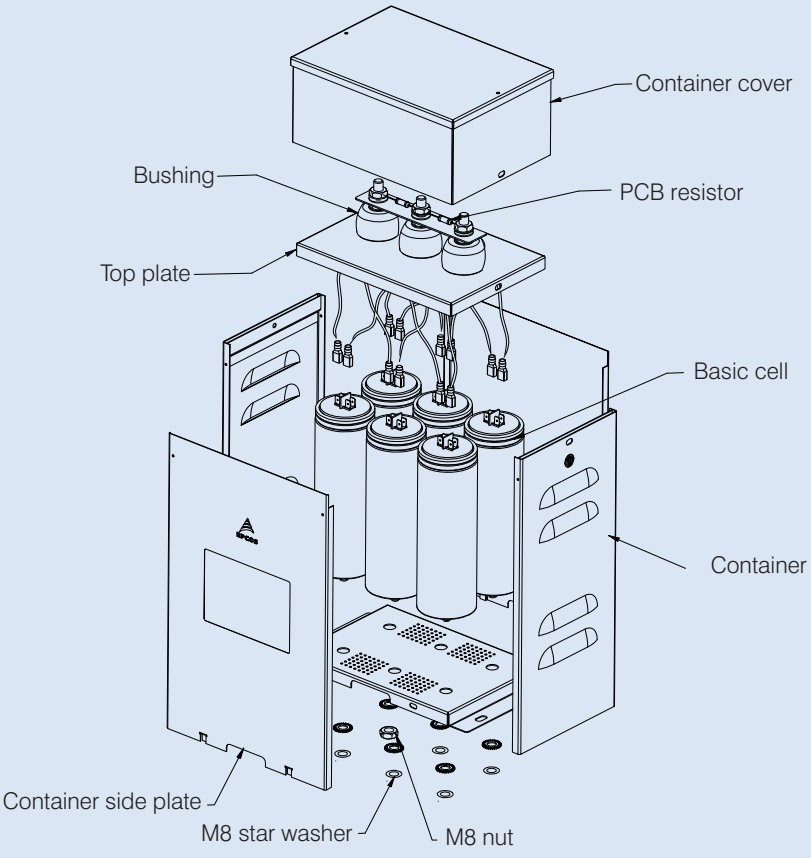
Semi-dry biodegradable resin • Modular construction • Triple safety system

SquareCap : Overall dimensions and information table



KVAr rating	Mounting brackets fixed/ separate/ sliding	Louvers/ holes	Basic cell	Mounting
ENDC/EHDLL				
1 to 2	fixed bracket	no	3	- - - -
3 to 5	fixed bracket	no	3	2 holes
6 to 15	seperate bracket	holes	3	2 slot
16 to 30	sliding bracket	2 louvers	6	4 slot
31 to 60	sliding bracket	8 louvers	6	12 slot
ESHDC				
1 to 2	fixed bracket	no	3	- - - -
3 to 5	fixed bracket	holes	3	2 slot
6 to 13	seperate bracket	holes	3	2 slot
14 to 25	sliding bracket	4 louvers	6	4 slot
26 to 50	sliding bracket	8 louvers	12	4 slot

SquareCap : Exploded view



LT-APP Capacitors

Biodegradable NPCB Oil impregnated • PP + Foil technology • Internal fuse protection

EPCOS

General

APP Capacitor is proven technology from more than 30 years. The combination of polypropylene film and aluminum foil makes the capacitor, more robust in varying conditions of the load.

The power range varies from 5 KVAr to 100 KVAr and voltage range varies from 240V to 1000V in three phase units. Single phase units are also available on demand.

The LT-APP capacitors are utilized in industry for sustaining large load variations, THD and hazardous conditions. With high qualitative manufacturing process, LT-APP capacitors offer higher life expectancy.

Applications

- Automated PFC Capacitor banks.
- Fixed PFC (e.g. – Motors, Transformers lighting etc.)
- Group compensation for larger load variation
- Tuned and detuned Capacitor
- Dynamic PFC and RTPFC
- Filter applications
- Product suitable for outdoor application, available on request.

Features

- Extended foil design Low Energy consumption
- Natural air cooled.
- Voltage range, 230, 415, 440…1000V
- Output range 5 KVAr to 100 KVAr.

Electrical

- Single phase and three phase
- Life expectancy 150,000 hrs. at STP
- Pulse current withstand capability – 300 x I_R
- Type tested according to IS –13585
- Low temperature rise.

Maintenance

- Maintenance free

Safety

- Internal fuse provided
- Hermetically Sealed construction. (CRCA or SS)

LT-APP Capacitors

Biodegradable NPCB Oil impregnated • PP + Foil technology • Internal fuse protection

EPCOS

Technical data : LT-APP Capacitors	
Series type	B25160
Power-KVAr	5 to 100 KVAr
Rated voltage-V (AC)	415…525 V*
Frequency	50 Hz /60Hz
Transient peak current maximum permissible	(400 to 500) • I_R
Maximum permissible temperature category	-5/D
Losses (without discharge resistors)	≤0.5 W/KVAr
Maximum permissible voltage	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)**
Maximum permissible Current	(2.2 to 3.0) • I_R***
Safety	Internal fuse provided
Impregnation	Non PCB, biodegradable oil
Life expectancy	300 000 hours
Cooling	ONAN (Oil Natural Air Natural)
Case shape/Finish	Rectangular box spray painted
Terminal	M- 6, M- 8, M-10 thread brass terminal
Mounting and grounding	Self standing with rigid mounting bracket and a bracket for grounding
Enclosure	IP 32 with terminal cover
Discharge resistor	Provided with external discharge resistor
Connection	Delta 3 Phase
Casing of capacitor cell	CRCA or SS container
Dielectric	Polypropylene film
No. of switching per annum	Max. 20 000 switching
Reference standard	IS: 13585 (part - 1/2012) ISI mark applicable for 415 and 440 V up to 25 KVAr. IEC 60931 - 1

* other voltages available on request
** V_R rated voltage
*** I_R : RMS line current that occurs at rated sinusoidal voltage and rated frequency, excluding transients.
Note : for capacitors with different features/parameters than above, please check with our nearest sales office

LT-APP Capacitors

Biodegradable NPCB Oil impregnated • PP + Foil technology • Internal fuse protection

EPCOS

LT-APP Capacitors - 3Phase								
Rating KVAr	**Voltage V (AC)**	**Material code**	**I_R A**	**C_N F**	**H x W x D mm**	**Packing units**	**MOQ**	**Approx. weight Kg**
LT - APP - 415 V(AC) 3PH, 50Hz (Series B25160)								
5	415	B25160A4005T015	7	3 x 30.8	230 x 300 x 120	1	1	5.5
7.5	415	B25160A4007T515	10.4	3 x 46.2	265 x 300 x 120	1	1	7.5
10	415	B25160A4010T015	13.9	3 x 61.6	290 x 300 x 120	1	1	10
12.5	415	B25160A4012T515	17.4	3 x 77	340 x 300 x 120	1	1	12
15	415	B25160A4015T015	20.9	3 x 92.4	340 x 300 x 120	1	1	12
20	415	B25160A4020T015	27.8	3 x 123.2	415 x 300 x 120	1	1	15
25	415	B25160A4025T015	34.8	3 x 154	465 x 300 x 120	1	1	17
30	415	B25160A4030T015	41.7	3 x 184.8	515 x 300 x 120	1	1	19
50	415	B25160A4050T015	69.6	3 x 308	750 x 300 x 120	1	1	31
LT - APP - 440 V(AC) 3PH, 50Hz (Series B25160)								
5	440	B25160A4005T040	6.6	3 x 27.4	230 x 300 x 120	1	1	5.5
7.5	440	B25160A4007T540	9.8	3 x 41.1	265 x 300 x 120	1	1	7.5
10	440	B25160A4010T040	13.1	3 x 54.8	290 x 300 x 120	1	1	10
12.5	440	B25160A4012T540	16.4	3 x 68.5	315 x 300 x 120	1	1	11
15	440	B25160A4015T040	19.7	3 x 82.2	340 x 300 x 120	1	1	12
20	440	B25160A4020T040	26.2	3 x 109.6	390 x 300 x 120	1	1	14
25	440	B25160A4025T040	32.8	3 x 137	440 x 300 x 120	1	1	16
30	440	B25160A4030T040	39.4	3 x 164.4	490 x 300 x 120	1	1	18
50	440	B25160A4050T040	65.6	3 x 274	690 x 300 x 120	1	1	28
LT - APP - 480 V(AC) 3PH, 50Hz (Series B25160)								
5	480	B25160A4005T080	6	3 x 23	215 x 300 x 120	1	1	5
7.5	480	B25160A4007T580	9	3 x 34.5	265 x 300 x 120	1	1	7.5
10	480	B25160A4010T080	12	3 x 46.1	265 x 300 x 120	1	1	8
12.5	480	B25160A4012T580	15	3 x 57.6	290 x 300 x 120	1	1	10
15	480	B25160A4015T080	18	3 x 69.1	315 x 300 x 120	1	1	11
20	480	B25160A4020T080	24.1	3 x 92.1	365 x 300 x 120	1	1	13
27.67	480	B25160A4027T080	33.3	3 x 127.4	415 x 300 x 120	1	1	16
30	480	B25160A4030T080	36.1	3 x 138.2	440 x 300 x 120	1	1	16
50	480	B25160A4050T080	60.1	3 x 230.3	615 x 300 x 120	1	1	23
LT - APP - 525 V(AC) 3PH, 50Hz (Series B25160)								
5	525	B25160A5005T025	5.5	3 x 19.2	215 x 400 x 120	1	1	7
7.5	525	B25160A5007T025	8.2	3 x 28.9	230 x 400 x 120	1	1	8
10	525	B25160A5010T025	11	3 x 38.5	240 x 400 x 120	1	1	9
12.5	525	B25160A5012T525	13.7	3 x 48.1	265 x 400 x 120	1	1	10
15	525	B25160A5015T025	16.5	3 x 57.7	290 x 400 x 120	1	1	11
20	525	B25160A5020T025	22	3 x 77	315 x 400 x 120	1	1	13
25	525	B25160A5025T025	27.5	3 x 96.2	120 x 365 x 400	1	1	16
30	525	B25160A5030T025	33	3 x 15.5	390 x 400 x 120	1	1	18
50	525	B25160A5050T025	55	3 x 192.5	540 x 400 x 120	1	1	28

PF Controllers BR6000 Series

Intelligent • User-friendly • Cost-effective • Version 5.0

General

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

The PF controller series and BR6000 (six and twelve stages) offer highly intelligent control behavior and are very user-friendly thanks to menu-driven handling (plain language). Their multifunctional display greatly simplifies installation, handling and maintenance.

Different versions of the BR6000 series provide solutions to various applications:

- BR6000-R6 and BR6000-R12 for conventional applications with slowly changing loads (optionally with RS485 interface)
- BR6000-T6 and BR6000-T12 for dynamic PFC in applications with fast-changing loads

Features

- Display
  - Large and multifunctional LCD (2 x 16 characters)
  - 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
  - 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
  - Target cos
  - KVAr value to target cos
- Alarm output
  - Insufficient compensation
  - Overcompensation
  - Undercurrent
  - Overcurrent
  - Overtemperature
  - Harmonics exceeded
  - Threshold value programmable
  - Internal error storage
  - Programming of 2nd signal relay random
  - Undervoltage and overvoltage
- Recall recorded values
  - Number of contactor switching operations
  - Maximum voltage V (Vmax)
  - 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
  - Complete 2nd parameter set available
  - Automatic initialization
  - Dynamic PFC (transistor output)
  - Thyristor switching
- Dual target power factor setting (EB and DG) is available in selected models

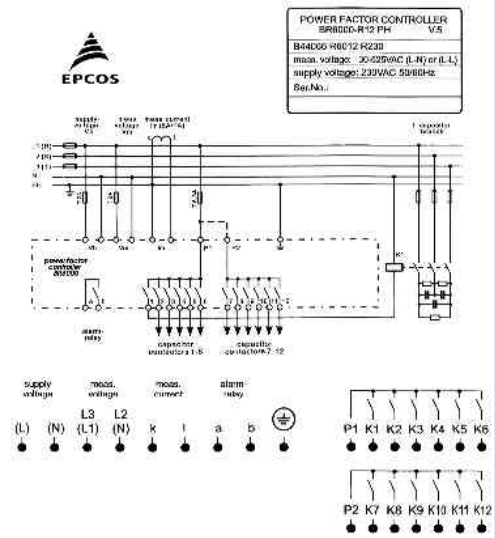
⚠ Cautions:

1. Discharge time: Make sure that the discharge time set in controller matches the capacitor discharge time. See page 84
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.

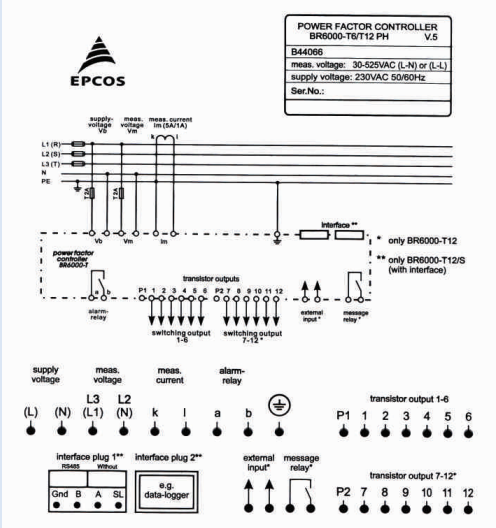
PF Controllers BR6000 Series

Intelligent ● User-friendly ● Cost-effective ● Version 5.0

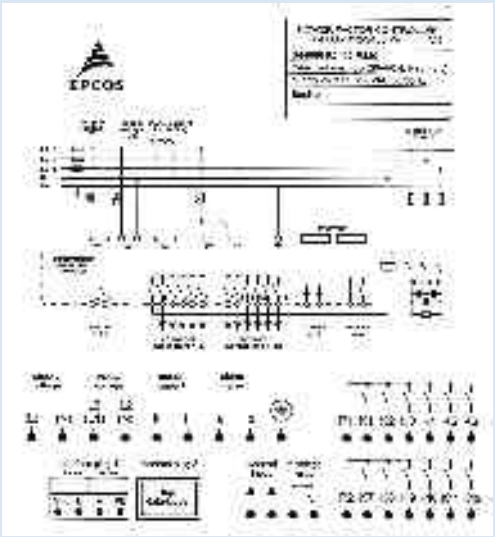
PF controller BR6000 R-12 : Relay output



PF Controller BR6000 T- 6/12 : Transistor output



PF Controller BR6000 R-12 (RS 485) : Relay output



PF Controllers BR6000 Series

Intelligent • User-friendly • Cost-effective

Selection table for controllers

	BR6000 relay output		BR6000 transistor output	
Steps	6 STEP	12 STEP	6 STEP	12 STEP
Switching	Contactor	Contactor	Thyristor	Thyristor
Ordering code	B44066R6006R230N1	B44066R6012R230N1	B44066R6106R230N1	B44066R6112R230N1
Auxiliary supply	1-Phase, 2-Wire, 245 Vac (-20% to+20%)	1-Phase, 2-Wire, 245 Vac (-20% to+20%)	1-Phase, 2-Wire, 245 Vac (-20% to+20%)	1-Phase, 2-Wire, 245 Vac (-20% to+20%)
Measurement voltage	30-525 V AC (L-N) or (L-L)	30-525 V AC (L-N) or (L-L)	1Ph 30-300 V AC (L-N)	1Ph 30-300 V AC (L-N)
Load CT Input current	1 / 5 A	1 / 5 A	1 / 5 A	1 / 5 A
No. of outputs	6	12	6	12
Alarm outputs	1 No.	1 No.	1 No.	1 No.
- Insufficient Compensation	Yes	Yes	Yes	Yes
- Overcompensation	Yes	Yes	Yes	Yes
- Over / under voltage	Yes	Yes	Yes	Yes
- Overcurrent	Yes	Yes	Yes	Yes
Automatic Initialisation		Yes	Yes	YesYes
Communication RSXXX interface	No	No*	No	No
Parameters displayed				
System voltage	Yes	Yes	Yes	Yes
Load current	Yes	Yes	Yes	Yes
Capacitor current	No	No	No	No
Active power	Yes	Yes	Yes	Yes
Reactive power	Yes	Yes	Yes	Yes
Apparent power	Yes	Yes	Yes	Yes
Frequency	Yes	Yes	Yes	Yes
Individual harmonics measurement upto	19	19	19	19
THD - V	Yes	Yes	Yes	Yes
THD - I	Yes	Yes	Yes	Yes
Monitoring of individual capacitor current	Yes - Health check	Yes - Health check	No	No
Apparent current	Yes	Yes	Yes	Yes
Overtemperature	Yes	Yes	Yes	Yes
Real time cos	Yes	Yes	Yes	Yes
Target cos	Yes	Yes	Yes	Yes
KVAr value to target cos	Yes	Yes	Yes	Yes
Switching and discharge time range				
- Correction time	1 sec - 20 min	1 sec - 20 min	20-1000 m sec	20-1000 m sec
- Discharge time	1 sec - 20 min	1 sec - 20 min	20-1000 m sec	20-1000 m sec
Number of control series	20 + E series	20 + E series	20 + E series	20 + E series
Weight (in kG)	1kG	1kG	1kG	1kG
Dimensions (L x D x H in mm)	144 x 55 x 144 mm	144 x 55 x 144 mm	144 x 53 x 144 mm	144 x 53 x 144 mm

*RS 232-B44066R6312R230N1

*RS 485-B44066R6412R230N1

PF Controllers BR5000 Series

Intelligent • User-friendly • Cost-effective

General

The BR5000 controller series is intended to be used with unbalanced three phase loading conditions and to correct the power factor. The controller needs 3 Load CT inputs and corresponding voltages. The overall compensation is done on averaging basis. The controller is having ultra intelligent processor in built. It covers almost all the electrical parameters to be displayed and monitored .

The three versions of BR5000 Controller are

- BR5000 – 16 for contactor switching logic for slow varying loads
- BR5000 – 16TX for rapidly changing loading conditions (Option for GSM communication available)
- BR5000 – HT for High tension upto 33kV sensing of power factors and correction. Version available in 8/16 steps.

Features

- Microcontroller logic for measurements
- Control mode: Binary, unequal, Preset and user defined
- Multifunctional LCD display
- Three CT sensing for unbalanced loads
- Dual target Power Factor setting- useful for utility and DG mode operation
- Automatic synchronization possible
- Separate 3 CT monitoring of healthiness of capacitor within panel
- Data logging
- RS 232 in front and RS 232/485 switchable connection at rear
- Step operation indication on LCD display plus LED which facilitates viewing from a distance
- Unique facility of including 'Fixed Capacitor Bank' for purpose of Transformer compensation. This can be set such that the controller doesn't 'see' this capacitor
- Unique external temperature sensing by PT 100
- Settable alarm facility - undervoltage, overvoltage and so on
- Settable auxiliary outputs - 2 Nos for Alarm, etc.
- Auxilary input -1 No
- EMI/EMC type tested
- Individual Harmonic measurement Upto 15th

Protection Warning

- Over / under voltage
- Capacitor over / under current
- Over / under frequency
- Load unbalance
- Over temperature
- Out of steps (Indication)
- NV-Ram battery down

Important display parameters

- Voltage
- Current
- Active power
- Reactive power
- Apparent power
- Capacitor current
- Per phase values of V, I and neutral current
- Power factor
- Frequency
- V_{THD}
- I_{THD}

Technical Data

- Auxiliary supply voltage -1Ph, 415V (-40% to + 20%)
- Measurement voltage: 3PH 3 wire 415 VAC (-40% to + 20%)
- Current Input - 1A or 5A
- Steps - 8 and16 relay outputs
- Supply frequency - 45 Hz to 62 Hz

Mechanical and Maintenance

- Operating temperature - 0° to $70^{\circ}C$
- Storage temperature - $-10^{\circ}C$ to $+75^{\circ}C$
- Humidity -0 to 98%

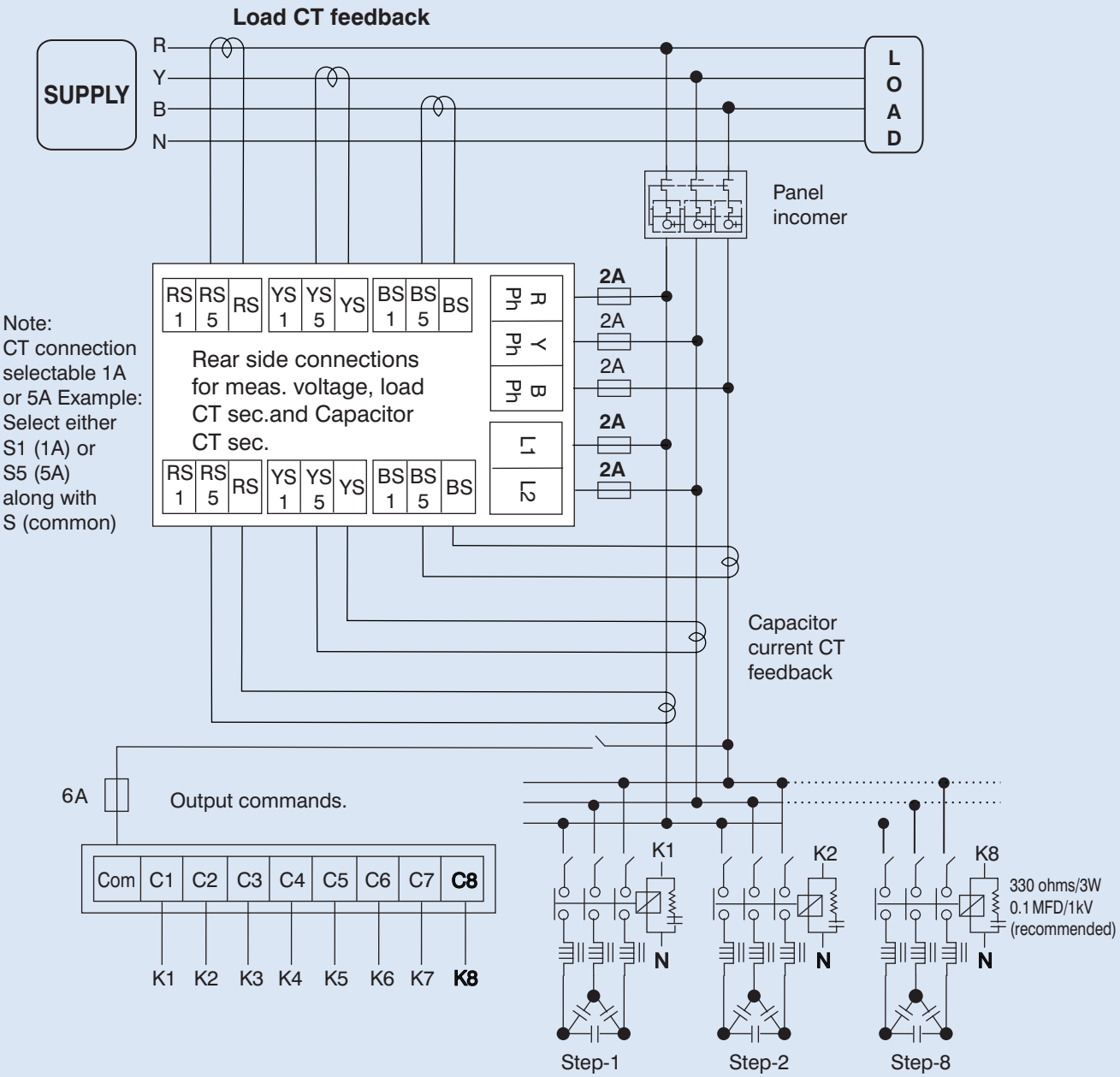
Dynamic Power Factor Controller (Transistorised) available in 16 steps

Special 8/16 step Controller for Medium Voltage application available

PF Controller BR5000 Relay Output

Intelligent • User-friendly • Cost-effective

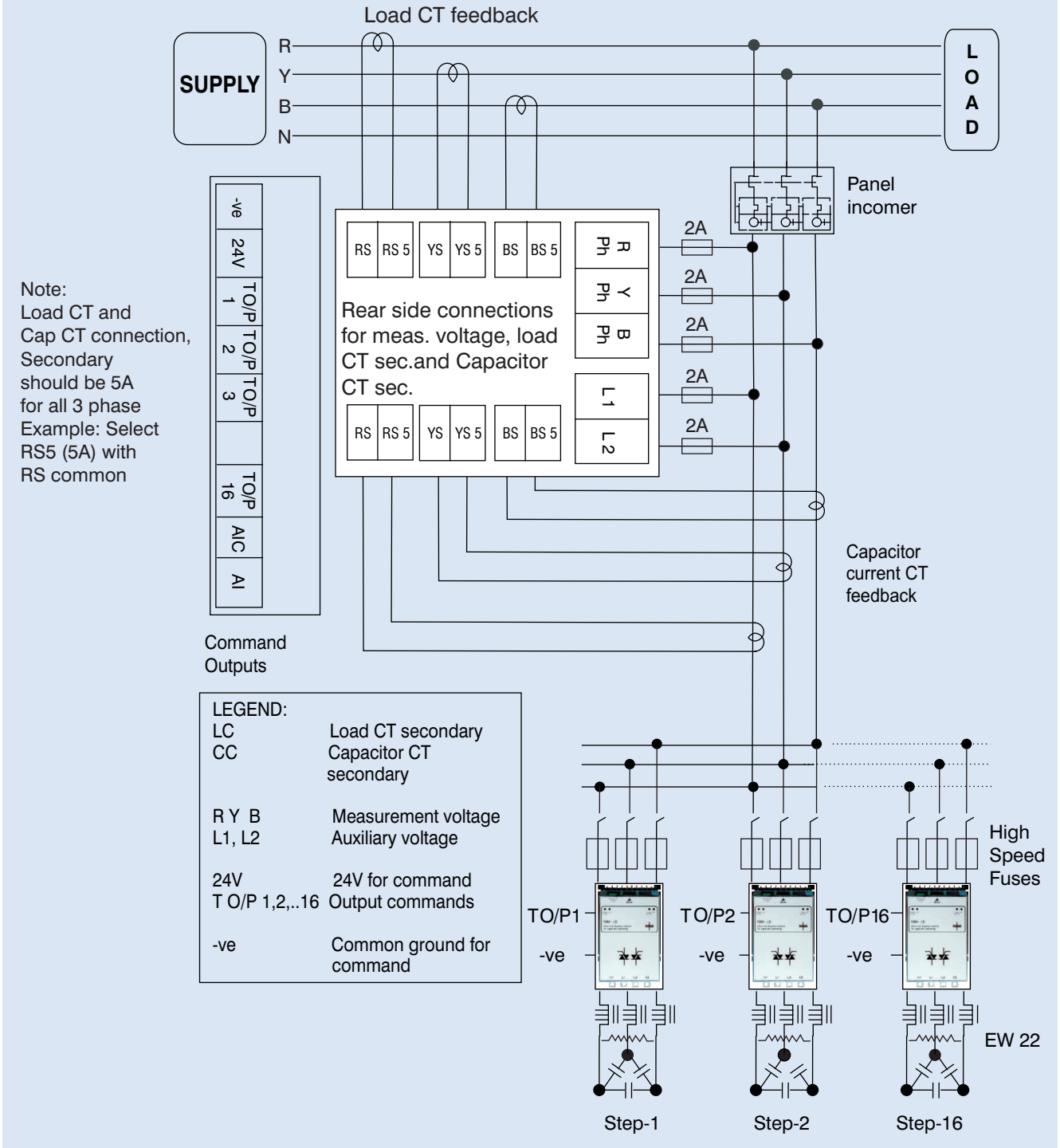
Typical wiring diagram for PF correction : Contactor switching



PF Controller BR5000 Transistor Output

Intelligent • User-friendly • Cost-effective

Typical wiring diagram for PF correction : TSM switching



PF Controllers BR5000 Series

Intelligent • User-friendly • Cost-effective

Selection table for controllers

	BR5000 relay output		BR5000 transistor output
Steps	8 STEP	16 STEP	16 STEP
Switching	Contactor	Contactor	Thyristor
Ordering code	B44066R5908A415N1	B44066R5916A415N1	B44066R5716A415N1
Auxiliary supply	1Ph 415V (-40% to +20%)	1Ph 415V (-40% to +20%)	1Ph 415V (-40% to +20%)
Measurement voltage	3Ph 3wire 415V (-40% to +20%)	3Ph 3wire 415V (-40% to +20%)	3Ph 3wire 415V (-40% to +20%)
Load CT Input current	1/5 A-separate connectors for either of the CT connections	1 / 5 A-separate connectors for either of the CT connections	only 5Amp CT secondary
No. of outputs	8 Nos. relay o/p of burden 1000VA by contactor coils	16 Nos. relay o/p of burden 1000VA by contactor coils	16 digital outputs maximum 20 mA loading
Alarm outputs	2 Nos.	2 Nos.	1 No.
-Insufficient Compensation	Yes	Yes	Yes (only display)
-Overcompensation	Yes	Yes	Yes
-Over / under voltage	Yes	Yes	Yes
-Overcurrent	Yes	Yes	Yes
Automatic initialisation		No	NoNo
Communication interface **RSXXX**	RS232 and RS485	RS232 and RS485	RS232 and RS485
Parameters displayed			--
System voltage	Yes	Yes	Yes
Load current	Yes	Yes	Yes
Capacitor current	No	No	No
Active power	Yes	Yes	Yes
Reactive power	Yes	Yes	Yes
Apparent power	Yes	Yes	Yes
Frequency	Yes	Yes	Yes
Individual harmonics measurement upto	15	15	15
THD - V	Yes	Yes	Yes
THD - I	Yes	Yes	Yes
Monitoring of individual capacitor current	Yes - Health check	Yes - Health check	Yes - total panel capacitor current monitored
Apparent current	Yes	Yes	Yes
Overtemperature	Yes	Yes (only INT temp.)	
Real time cos	Yes	Yes	Yes
Target cos	Yes (upper and lower target PF- programmable)	Yes (upper and lower target PF- programmable)	Yes- (upper and lower target PF- programmable)
KVAr value to target cos	Yes - displayed as System reactive power	Yes - displayed as System reactive power	Yes - displayed as System reactive power
Switching and discharge time range			
-Correction time	1 - 240 sec	1 - 240 sec	20-5000 m sec
-Discharge time	1 - 240 sec	1 - 240 sec	NA
Number of control series	Unequal, C-series (1-15), E-series	Unequal, C-series (1-15), E-series	Binary, unequal C-series (1-15), E-series
Weight (in kG)	2.5 kG	2.5 kG	2.5 kG
Dimensions (L x D x H in mm)	144 x 155 x 144 mm	144 x 155 x 144 mm	144 x 155 x 144 mm

PF Controllers BR4000 Series

Intelligent • User-friendly • Cost-effective

General

The BR4000 controller series is the most economical series and intended to serve the basic purpose of power factor corrections... The simplest menu driven version controller with navigational keys. The microcontroller based logic, multifunctional display of electrical parameters, compact size 96 x 96 mm and protections makes this controller extremely user friendly.

BR4000 Controller series is available in 4 stages and 8 stages. Best suited with conventional APFC applications.

Features

- Microcontroller logic for measurements
- User friendly operation
- Control mode: binary, unequal, Preset and User defined
- Multifunctional LCD display
- Single CT sensing for unbalanced loads
- Compact 96X96 mm front fascia
- Suitable for auto / manual operation
- Individual harmonic measurement upto 15th

Protection Warning

- Over / under voltage
- Over / under load
- Over temperature
- User friendly operation

Important display parameters

- Voltage
- Current
- Active power
- Reactive power
- Apparent power
- Frequency
- V_{THD}
- I_{THD}

Technical Data

- Measurement voltage: 1PH 230 VAC (-25% to +20%)
- Current input selectable - 1A or 5A for load with class 2 accuracy
- Auxiliary supply - 1Ph, 230V (-25% to +20%)
- Steps - 4 and 8 relay outputs
  Supply frequency -47 Hz to 53 Hz

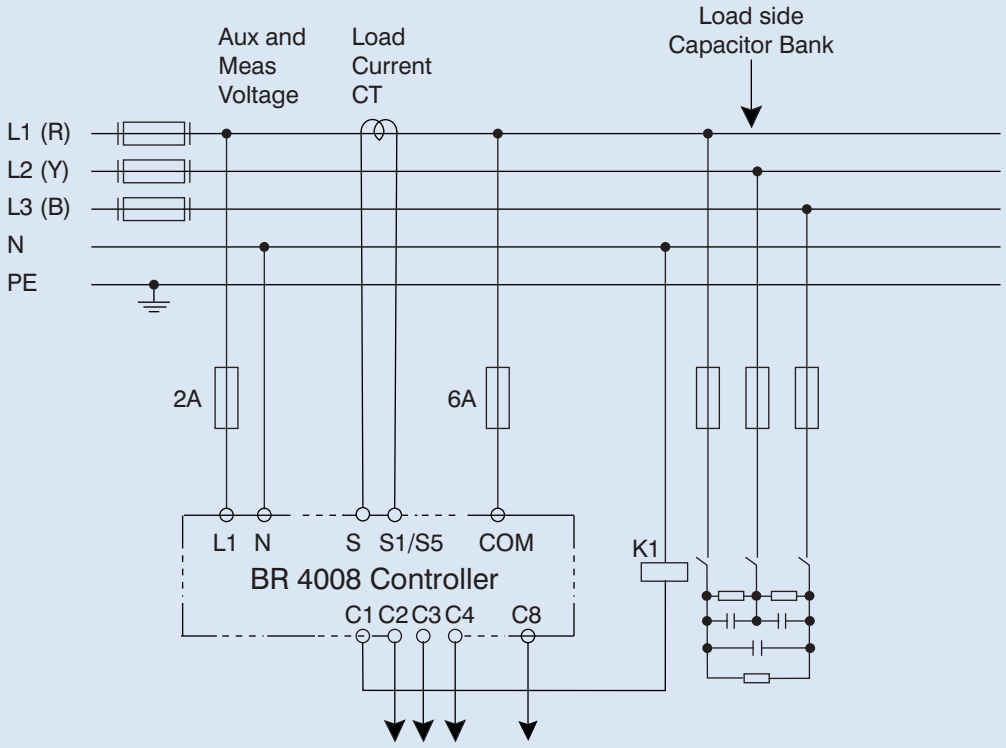
Mechanical and Maintenance

- Compact size
- Operating temperature - 0° to 50° C
- Storage temperature - -5°C to 65°C
- Humidity -0 to 98%

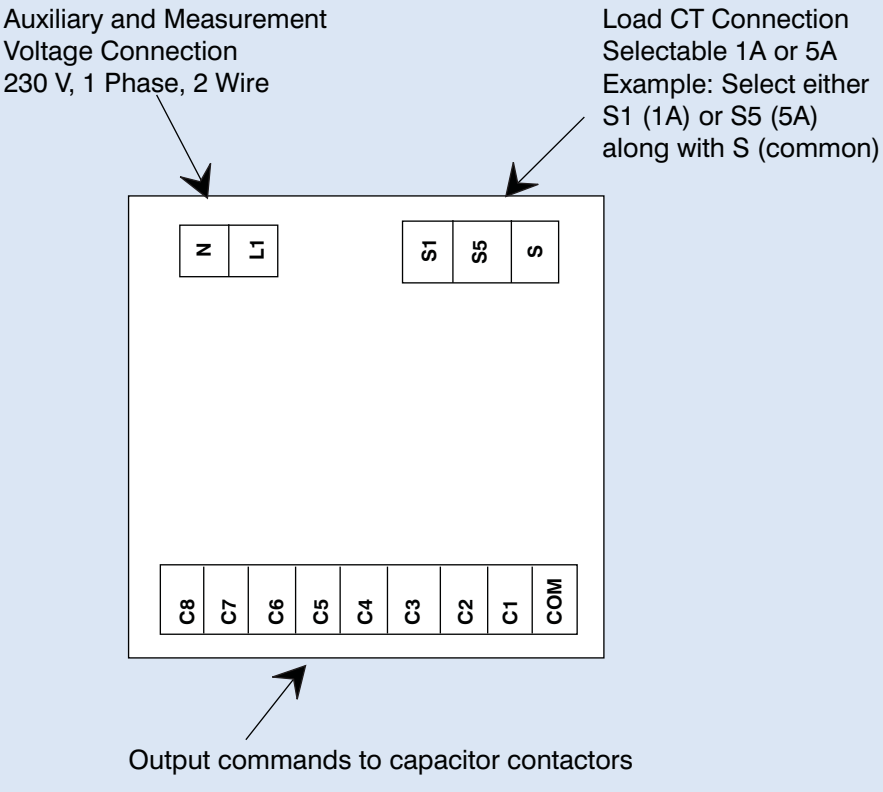
PF Controllers BR4000 Series

Intelligent • User-friendly • Cost-effective

Typical wiring diagram for PF correction



Rear side terminals - measurement voltage, measurement current and auxiliary supply



PF Controllers BR4000 Series

Intelligent • User-friendly • Cost-effective

EPCOS

Selection table for controllers

	BR4000 relay output	
Steps	4 STEP	8 STEP
Switching	Contactor	Contactor
Ordering code	B44066R4904A230N1	B44066R4808A230N1
Auxiliary supply / Measurement voltage	1-Phase, 2-Wire, 230 Vac (-25% to +20%) (common for both measurement and auxiliary)	1-Phase, 2-Wire, 230 Vac (-25% to +20%) (common for both measurement and auxiliary)
Load CT input current	1 / 5 A - separate connectors for either of the CT connections	1 / 5 A - separate connectors for either of the CT connections
No. of outputs	4 Nos. Relay o/ps of 5A @230V AC Resistive	8 Nos. Relay o/ps of 5A @230V AC Resistive
Alarm outputs	No	No
-Insufficient compensation	Yes (only display)	Yes (only display)
-Overcompensation	No	No
-Over / under voltage	Yes (not editable) (Factory set UV@170V (P-N) resume@178V, OV@276V (P-N) resume@264V)	Yes, programmable
-Overcurrent	No	Yes, programmable
Automatic initialisation	No	No
Communication interface RSXXX	No	No
Parameters displayed		
System voltage	Yes	Yes
Load current	Yes	Yes
Capacitor current	No	No
Active power	Yes	Yes
Reactive power	Yes	Yes
Apparent power	Yes	Yes
Frequency	Yes	Yes
Individual harmonics measurement upto	15	15
THD - V	Yes	Yes
THD - I	Yes	Yes
Monitoring of individual Capacitor current	No	No
Apparent current	Yes	Yes
Overtemperature	Yes (only INT temp.)	Yes (only INT temp.)
Real time cos	Yes	Yes
Target cos	Yes (single target PF - programmable)	Yes (upper and lower target PF programmable)
KVAr value to target cos	Yes (as system reactive power)	Yes (as system reactive power)
Switching and discharge time range		
- Correction time	1 - 1200 sec	1 - 65530 sec
- Discharge time	1 - 1200 sec	1 - 65530 sec
Number of control series	Only unequal	Binary, unequal, C-series, E-series
Weight (in kG)	1 kG	1 kG
Dimensions (L x D x H in mm)	96 x 90 x 96 mm	96 x 90 x 96 mm

PF Controller BR7000

15 relay outputs • Three-phase measuring and controlling

General

The PF controller BR7000* is a folllow-up development of the PF controller BR6000-series, featuring two devices in one: it can be used as a controller as well as a grid measuring tool.

The BR7000 offers 15 relay outputs for the steps and three message/ alarm relays. Due to the possibility of programming, the 15 outputs can be used for a broad range of applications, for example:

- 15 conventional steps, each for one three-phase capacitor
- 15 steps for single-phase capacitors, where each output will switch a single-phase capacitor to N (usually 5 per phase, balancing of grid is possible)
- Mixed operation: 6 single-phase capacitors (2 per phase) for balancing plus 9 steps for conventional compensation (three-phase capacitors)

The controller can be connected to a PC via an RS485 interface. The Windows-based software BR7000-SOFT allows the readout of acquired data. The possibility of graphical display of all values offers a comfortable visualization.

Features

- LCD full graphic display 128 x 64 dots, 8 lines
- Self explanatory menu navigation in five languages
- Three-phase measuring and controlling; display of following grid parameters:
  - Voltage
  - Current
  - Frequency
  - Real power
  - Reactive power
  - Apparent power
  - Power factor
  - Missing reactive power
  - Harmonic of voltage and current (up to 31st)
  - THD-V
  - THD-I
  - Temperature
- HELP-button for interactive help text
- 15 switching outputs 3 additional alarm/message relays
- 2 isolated interfaces
- Detailed error messages with time stamp
- Automatic initialization/test run
- Automatic and manual operation, service operation, expert mode Three-phase and single-phase controlling; mixed mode possible
- Display and storage of maximum values, switching operations and operating time
- Display of date and time Time-controlled functions possible by internal timer
- Oscilloscope mode for graphical display
- Quick programming

*BR7000 is imported and sold in India.

PF Controller BR7000

15 relay outputs ● Three-phase measuring and controlling

Technical data : BR7000 controller	
BR7000	
Supply voltage	110 … 230 V AC 50/60 Hz
Measurement voltage range	3 · 30 … 440 V AC (L-N); 50 … 760 V AC (L-L)
Power consumption	< 3 VA
Operating ambient temperature	–20 … 60 °C
Display	illuminated graphic display, 128 x 64 dots, 8 lines
Large display of 3 grid parameters	selection in display editor
Plain language	E / ES / GER / RU / TR
In- and outputs	
Number of relay outputs	15 switching outputs, freely programmable for switching of 1- or 3-phase capacitors
Number of transistor outputs	–
Alarm/message relay	1/1
Additional separate fan relay	yes
Interface	2 independent isolated RS485-interfaces
Input 2nd parameter-set switchover target PF	yes
Special functions	
Measuring	three-phase
Controlling	single-phase, three-phase, mixed mode
Automatic initialization	yes
Test-run of complete PFC-system	yes
Quick-program	yes
Internal timers	yes
Oscilloscope (graphical display) mode	yes
Display editor	yes
Backwards navigation ESCAPE button	yes
HELP button for interactive help text	yes
Number of control series	20 series pre-set
Control series editor for free programming	yes

PF Controller BR7000

15 relay outputs • Three-phase measuring and controlling

Technical data : BR7000 controller	
Parameters displayed (three-phase display)	
Apparent current (A)	real value / large display / in %
Reactive power (KVAr)	real value / large display / in %
Active power (kW)	real value / large display / in %
Apparent power (kVA)	real value / large display / in %
KVAr value to target cos	real value / large display / in %
Energy	real value / large display
Frequency	real value / large display
Temperature	real value / large display
Real-time cos	real value / large display
Target cos	real value / large display
Individual harmonics up to	up to 31st, real value / in % / bar graph
THD-V, THD-I	real value / in % / bar graph
Time/date	yes
Recall recorded values	
Min. and maximum voltage	yes, with time stamp
Maximum current	yes, with time stamp
Maximum active power	yes, with time stamp
Maximum reactive power	yes, with time stamp
Maximum apparent power	yes, with time stamp
Maximum value THD-V, THD-I	yes, with time stamp
Maximum temperature (°C)	yes, with time stamp
Operation time of all capacitors	yes
Number of contactor switching operations	yes
Others	
Weight	1 kg
Dimensions (h x w x d)	144 x 144 x 60 mm
PC-software included	yes
Suitable for dynamic PFC	no
Ordering code	B44066R7415E230

PF Controller BR7000

15 relay outputs • Three-phase measuring and controlling

BR7000-SOFT Windows-based software

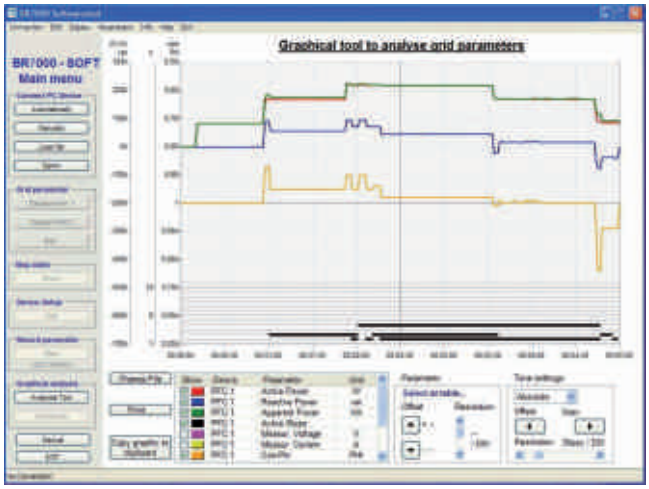
This program offers the possibility for a comfortable parameterization, recording, analysis and visualization of grid parameters in online operation via a PC. It is compatible with PF controllers BR6000-R12/S485 (V5.0 onwards) and series BR7000.

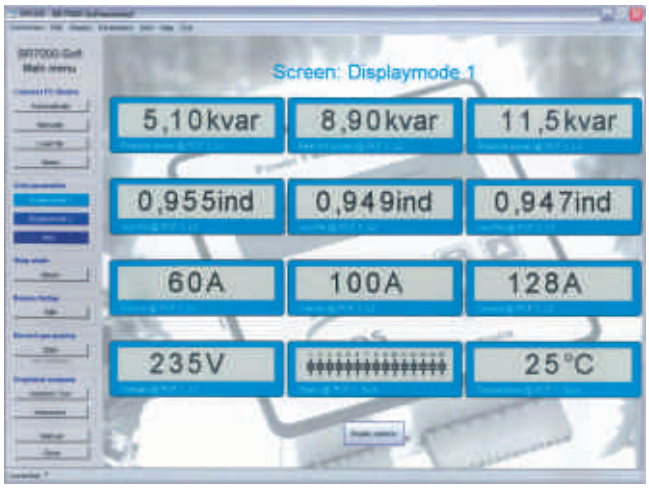
The software allows the recording and a graphical evaluation of all values including export- and print function. The spectrum of harmonics can be displayed as bar chart.

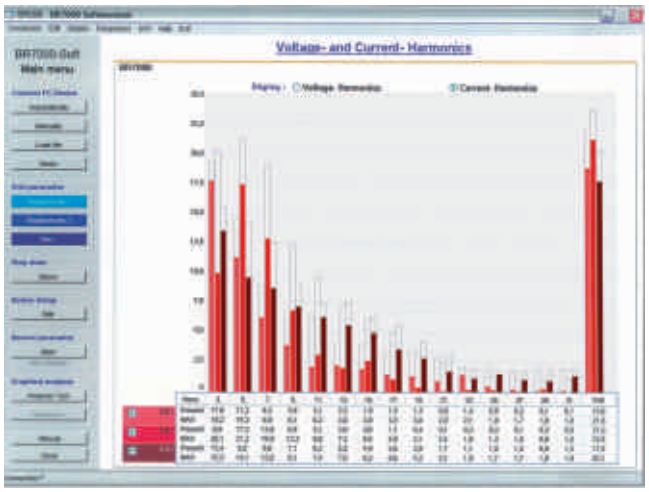
The configuration manager is used for a complete read out, editing, storing and writing of all parameters of the PF controller via PC. All data can be stored in a configuration file.

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







Grid Analysis Tool MC7000-3

Three-phase measuring • Easy evaluation of data • 1GB memory card included

EPCOS

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 (1 GB) 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- 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

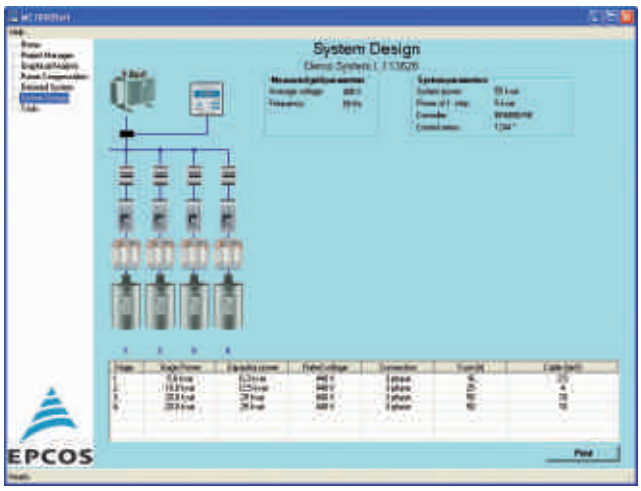
*MC7000-3 is imported and sold in India

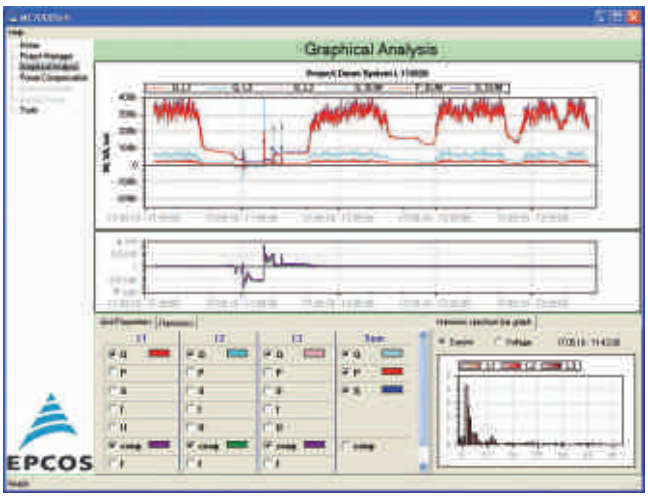
Grid Analysis Tool MC7000-3

Three-phase measuring • Easy evaluation of data • 1GB memory card included

Technical data : Grid analysis tool MC7000-3	
Grid analysis tool MC 7000-3	
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 (auxillary 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
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 Ordering code: B44066M7777E230
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 Duty Contactors

Soft Switching of Capacitor • Excellent Damping of Inrush • Improved Power Quality • UL Certified

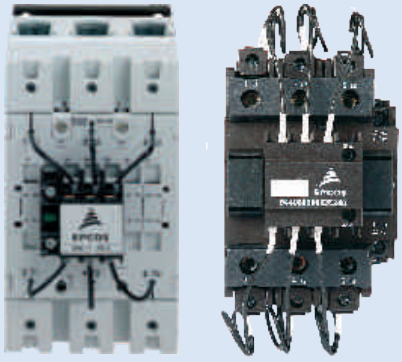
General

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).

The capacitor duty contactors are offered in two versions, viz
- Standard series
- Premium series (imported)



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
- Series J230 / C240 for all PFC systems
- AC6b utilization category

Approvals
- UL file E224924 NLDX and NLDX 7 for J series
- UL file E334934 NLDX and NLDX 7 for C series

Switching Devices - Capacitor Duty Contactors

Soft Switching of Capacitor • Excellent Damping of Inrush • Improved Power Quality • UL Certified

EPCOS

Technical data : Capacitor duty contactors premium series

Type		B44066*****J230							
Main contacts		**S1811**	**S2411**	**S3211**	**S5011**	**S6211**	**S7411**	**S9011**	**S9911**
Rated insulation voltage V_i V_{is}	[V AC]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]	690[1)]	1,000[1)]	1,000[1)]
Admissible frequency of operation	1/h	120	120	120	120	120	80	80	80
Contact life	million operations	0.25	0.15	0.15	0.15	0.15	0.12	0.12	0.12
Cable cross section									
Solid or standard	[mm^2]	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	[mm^2]	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	[mm^2]	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 V_s magnet coils in multiples of control voltage		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	I_{coth} [A]	25	20	20	20	20	20	20	20
slow, gL (gG)									
Auxiliary contacts	NO/NC	1/1	1/1	1/1	1/1	1/1	1/1	1/1	1/1

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), Vimp = 8 kV. Values for other conditions on request.

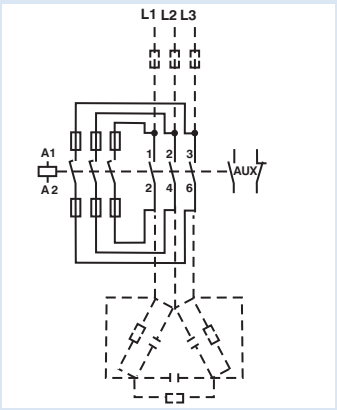
Main technical parameters 230V coil:

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**	
0–12.5	0–12.5	0–13	0–13	0–20	0–20	18	18	0.34	B44066S1811J230
10–20	10–20	10.5–22	10.5–22	17–33	17–33	28	28	0.60	B44066S2411J230
10–25	10–25	10.5–27	10.5–27	17–41	17–41	36	36	0.60	B44066S3211J230
20–33.3	20–33.3	23–36	23–36	36–55	36–55	48	48	1.10	B44066S5011J230
20–50	20–50	23–53	23–53	36–82	36–82	72	72	1.10	B44066S6211J230
20–75	20–60	23–75	23–64	36–120	36–100	108	87	1.10	B44066S7411J230
33–80	33–75	36–82	36–77	57–120	57–120	115	108	2.30	B44066S9011J230*
33–100	33–90	36–103	36–93	57–148	57–148	144	130	2.30	B44066S9911J230*

* without CCC

Connection diagram

All types B44066S****J230 (with preload resistors),
B44066S1811J230 with wires on the bottom,
B44066S9911J230 with resistors inside housing.



Switching Devices - Capacitor Duty Contactors

Soft Switching of Capacitor • Excellent Damping of Inrush • Improved Power Quality • UL Certified

Technical data : Capacitor duty contactors standard series

Type	B44066*****C240							
Main contacts		**C1011**	**C1211**	**C1611**	**C2011**	**C2511**	**C3312**	**C4012**	**C6012**
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)]
Admissible frequency of operation	1/h	240	240	240	240	240	240	240	100
Contact life	million operations	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1
Cable cross section									
Flexible with cable end sleeve -	[mm^2]	2.5	2.5	4	4	6	16	16	50
1 conductor Flexible with cable end sleeve - 2 conductors	[mm^2]	1.5	1.5	2.5	4	4	6	6	25
Solid without cable end sleeve -	[mm^2]	4	4	6	10	16	25	25	50
1 conductor Solid without cable end sleeve - 2 conductors	[mm^2]	4	4	6	6	10	16	16	35
Operating range of magnet coils in multiples of control voltage V_s		0.78-1.1	0.78-1.1	0.78-1.1	0.78-1.1	0.78-1.1	0.78-1.1	0.78-1.1	0.78-1.1
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: 40° C	I_{coth}[A]	10	10	10	10	10	10	10	10
60° C	I_{coth}[A]	8	8	8	8	8	8	8	8
Utilization category AC15									
220 ... 240 V	I_{coth}[A]	3	3	3	3	3	3	3	3
380 ... 440 V	I_{coth}[A]	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Short circuit protection Highest fuse size, slow, gL (gG)	I_{coth}[A]	10	10	10	10	10	10	10	10
Auxiliary contacts	NO	1	1	1	1	1	1	1	1
	NC	1	1	1	1	1	2	2	2

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

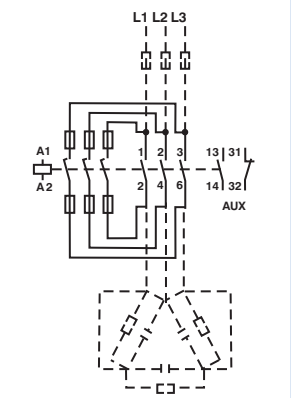
1) Applies to networks with grounded star point, overvoltage category I to IV, pollution severity 3 (industrial standard), Vimp = 8 kV. Values for other conditions on request.

Main technical parameters 240 V coil:

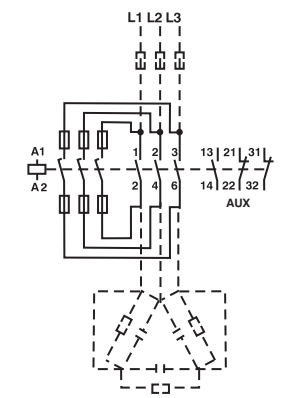
Capacitor power at ambient temperature, voltage, 50 / 60 Hz Rated current				Weight	Ordering code
380 - 400 V	**415 - 440 V 660 - 690 V**				
55 °C KVAr	**55 °C KVAr**	**55 °C KVAr**	**55 °C A**	**kg**	
0-10	0-10	0-12.5	14	0.43	B44066S1011C240
0-12.5	0-12.5	0-18	18	0.43	B44066S1211C240
0-16.7	0-16.7	0-24	24	0.43	B44066S1611C240
0-20	0-20	0-30	29	0.43	B44066S2011C240
0-25	0-25	0-36	36	0.43	B44066S2511C240
0-33.3	0-33.3	0-48	48	0.43	B44066S3312C240
0-40	0-40	0-58	58	0.43	B44066S4012C240
0-60	0-60	0-92	92	0.43	B44066S6012C240

Connection diagrams

Types B44066S...1C240



Types B44066S...2C240



Switching Devices - Thyristor Modules for Dynamic PFC TSM Series

Ultrafast Smooth Switching • Natural Cooled • Compact Design • Enhanced Life of System

EPCOS

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 and TSM-HV, 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 50 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

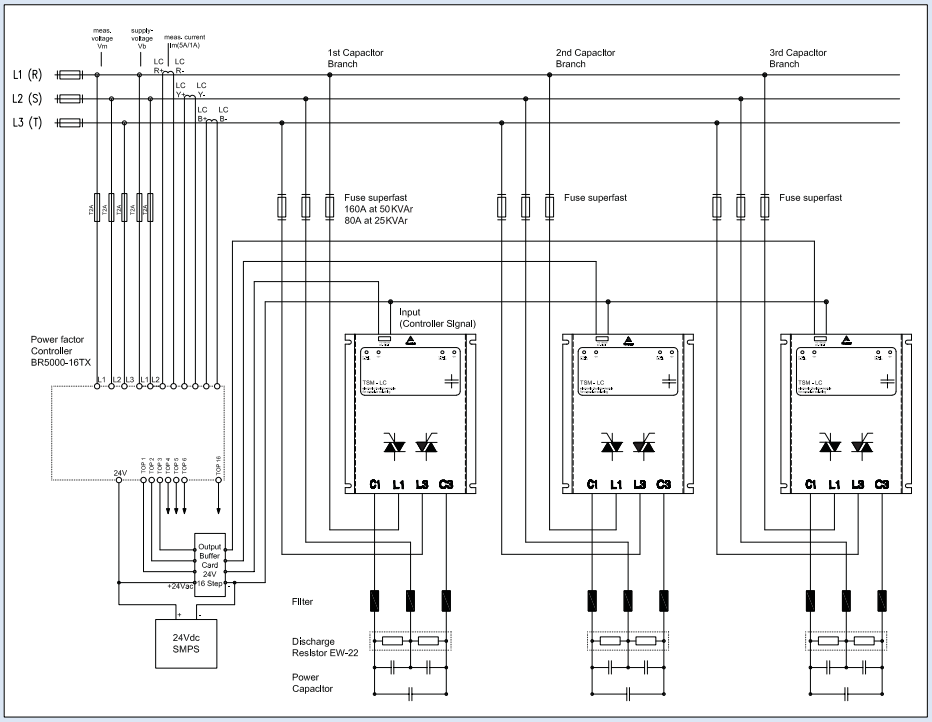
Features

- 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
- Voltage range: 440 V and 690 V
  Output range:
  440 V: 10, 25 and 50 KVAr
  690 V: 50 KVAr

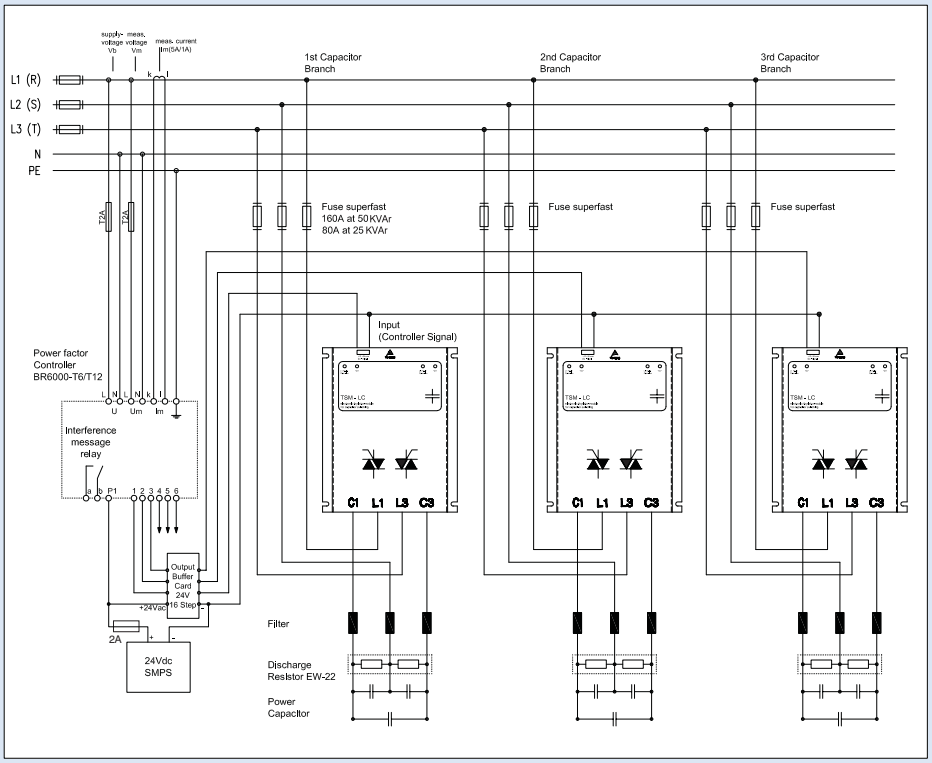
Switching Devices - Thyristor Modules for Dynamic PFC TSM Series

Ultrafast Smooth Switching • Natural Cooled • Compact Design • Enhanced Life of System

Dynamic PFC network BR5000-T multiple stages



Dynamic PFC network BR6000-T multiple stages



Switching Devices - Thyristor Modules for Dynamic PFC TSM Series

Ultrafast Smooth Switching • Natural Cooled • Compact Design • Enhanced Life of System

EPCOS

Selection table TSM series

	TSM-LC 10	TSM-LC 25	TSM-LC 50	TSM-HV 50
Ordering code	B44066T0010R440	B44066T0025R440	B44066T0050R440	B44066T0050R690
Rated voltage	380 … 440 V	380 … 440 V	380 … 440 V	690 V
Max. grid voltage: – in conventional PFC systems(without reactors)	440 V	440 V	440 V	690 V
– in detuned PFC system (7% detuning)	440 V (no upwards tolerance)	440 V (no upwards tolerance)	440 V (no upwards tolerance)	690 V
– in detuned PFC system (14% detuning)	400 V	400 V	400 V	690 V
Frequency	50/60 Hz	50/60 Hz	50/60 Hz	50/60 Hz
Maximum power / at nominal voltage	10 KVAr	25 KVAr	50 KVAr	50 KVAr
Power circuit	Direct connection 4 pole via terminal clamps (D = 6 mm^2 resp. 4 mm^2)	Direct connection 4 pole via busbar (cable lug 25mm^2 D =8 mm)	Direct connection 4 pole via busbar (cable lug 25mm^2 D =8 mm)	Direct connection 4 pole via busbar (cable lug 25mm^2 D =8 mm)
Neutral required	No*	No*	No*	Yes**
Aux. supply voltage required	No	No	No	230 V AC
Connection	from bottom	from bottom	from bottom	from bottom
Losses (PD in W)	2.0 x I (in A) typical; 35 W (thermal)	2.0 x I (in A) typical; 75 W (thermal)	2.0 x I (in A) typical; 150 W (thermal)	3.0 x I (in A) typical; at 690 V/ 50 KVAr approx. 125 W (thermal)
Recommended fuses "superfast"	3 x BS Type (AC 690 V) 40 A	3 x BS Type (AC 690 V) 80 A	3 x BS Type (AC 690 V) 160 A	3 x BS Type (AC 690 V)
Dimensions in mm (w x h x d)	163 x 150 x 75	157 x 200 x 180	157 x 200 x 180	157 x 200 x 195
Weight	1.75 kg	4.8 kg	4.8 kg	5 kg
LED display per phase	2	2	2	1
Cascading	yes	yes	yes	yes
Ambient temperature	–10 °C ... 55 °C	–10 °C ... 55 °C	–10 °C ... 55 °C	–10 °C ... 55 °C
Discharge resistors EW-22 needed	1	1	1	Standard resistor sufficient
Three phase current limitation reactor needed* **	1	1	1	1

*For operation with three-phase capacitor or three single-phase capacitors. **Only for and compulsorily for operation with single-phase capacitors. ***For PFC systems without detuning reactors mandatory.

Accessories for TSM-LC modules

Type/Description
Discharge resistors EW-22 at least 1 piece per step to be used for all types of TSM-LC if fast re-switching time is required. For higher rated steps please contact your local sales office.

Ordering Code
B44066T0022S400

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	: wago terminal, ready for three-phase connection to the capacitor

Note :
Three phase current limitation reactor for thyristor modules TSM-series in conventional dynamic PFC-systems without reactor is a must
Used for limitation of the pace of current increase di/dT in the thyristors to the maximum permissible value

Buffer Card

Current amplifier for TSM application • Short circuit protected

Output Buffer card

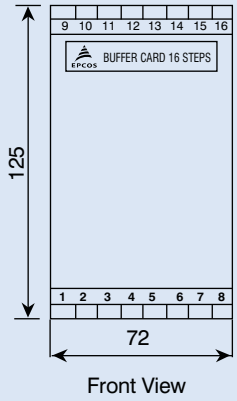
Features

- Transistorised output for fast switching
- Short circuit protection for outputs
- Standard DIN rail mount design provides for easy mounting

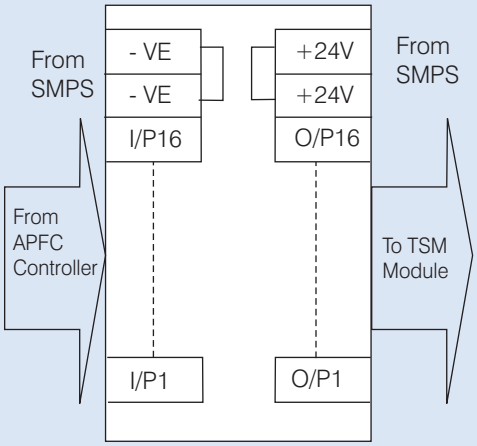
Technical Data

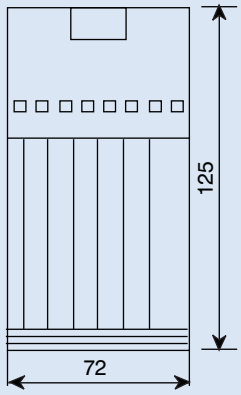
Input signal	24 VDC ± 3V, 15mA
Output voltage	Maximum 1V drop on input signal
Output current	100mA max.
Output type	Transistor output
Number of inputs	16
Number of outputs	16
Temperature range	0°C to 60°C
Mounting	Din Rail mounting
Dimensions (L x W x H)	72 x 125 x 125 mm
Total weight (kG)	0.4 kG (approx)

Dimensions and Connection

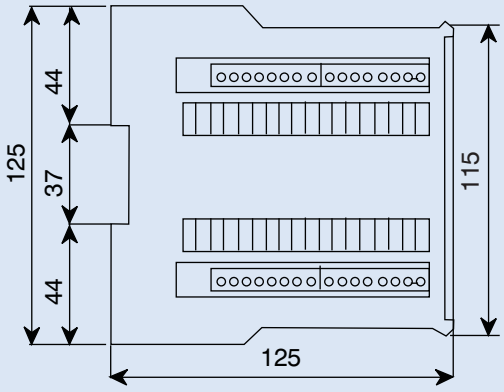


Front View





Top View



Side View

Reactors - Antiresonance Harmonic Filter

Type tested at CPRI • 'H' Class insulation • Thermal Micro Switch • Linearity ≥ 73%

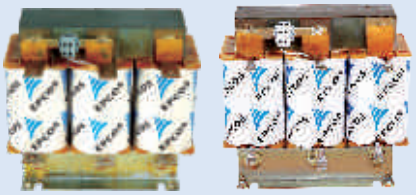
General

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	$Irms = \sqrt{(I_1^2 + I_3^2 \ldots I_{13}^2)}$
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 page 62 and 63
Three-phase filter reactors to EN 60289	
Frequency	50 Hz or 60 Hz
Voltage	230, 380, 400, 415, 440, 690, 750, 800, 1000
Output	5 … 100 KVAr
Detuning	5.67%, 7%, 14%
Cooling	natural
Ambient temperature	40 °C
Class of insulation	H
Enclosure	IP00

* According to DIN ENV VV61000-2-2

Reactors - Antiresonance Harmonic Filter

Type tested at CPRI ● 'H' Class insulation ● Thermal Micro Switch ● Linearity ≥ 73%

Rated voltage - 440 V 7% aluminum wound reactors

Electrical Parameters and Terminations

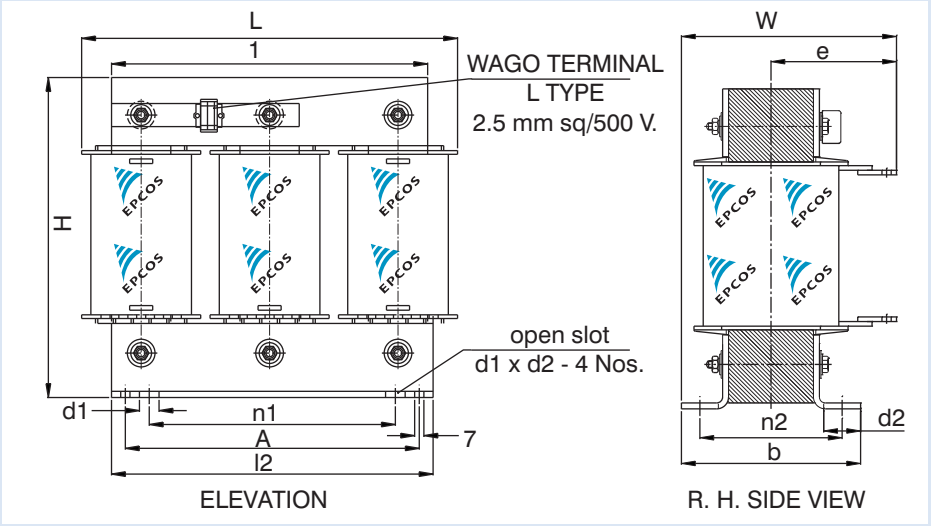
KVAr	Material Code	Rated Current (A)	I rms (A)	Inductance (mH)	Terminations
5	B44066D7005K440N1	6.6	7.45	9.28	CU. 6/6 Sq. mm
10	B44066D7010K440N1	13.2	14.9	4.65	CU. 6/6 Sq. mm
12.5	B44066D7012K440N1	16.5	18.7	3.71	CU. 6/6 Sq. mm
15	B44066D7015K440N1	19.65	22.35	3.1	AL. 8/35 Sq. mm
20	B44066D7020K440N1	26.24	29.78	2.32	AL. 8/35 Sq. mm
25	B44066D7025K440N1	32.8	37.2	1.86	AL. 8/35 Sq. mm
30	B44066D7030K440N1	39.36	44.7	1.55	AL. 8/50 Sq. mm
40	B44066D7040K440N1	52.49	59.6	1.16	AL. 8/50 Sq. mm
50	B44066D7050K440N1	65.61	74.5	0.93	AL. 8/50 Sq. mm
75	B44066D7075E440N1	98.41	111.68	0.62	20X3 CU BUSBAR
100	B44066D7100E440N1	131.22	148.91	0.46	25X3 CU BUSBAR

Rated voltage - 415 V 7% aluminum wound reactors

Electrical Parameters and Terminations

KVAr	Material Code	Rated Current (A)	I rms (A)	Inductance (mH)	Terminations
5	B44066D7005K415N1	6.96	7.89	8.257	CU. 6/6 Sq. mm
10	B44066D7010K415N1	13.91	15.79	4.128	CU. 6/6 Sq. mm
12.5	B44066D7012K415N1	17.39	19.73	3.303	CU. 6/6 Sq. mm
15	B44066D7015K415N1	20.87	23.68	2.752	AL. 8/35 Sq. mm
20	B44066D7020K415N1	27.82	31.58	2.064	AL. 8/35 Sq. mm
25	B44066D7025K415N1	34.78	39.47	1.651	AL. 8/35 Sq. mm
30	B44066D7030K415N1	41.74	47.36	1.376	AL. 8/50 Sq. mm
40	B44066D7040K415N1	55.65	63.15	1.032	AL. 8/50 Sq. mm
50	B44066D7050K415N1	69.56	78.94	0.826	AL. 8/50 Sq. mm
75	B44066D7075E415N1	104.34	118.41	0.55	20x3 CU BUSBAR
100	B44066D7100E415N1	139.12	157.88	0.413	25x3 CU BUSBAR

Reactor dimensional details



Reactors - Antiresonance Harmonic Filter

Type tested at CPRI • 'H' Class insulation • Thermal Micro Switch • Linearity ≥ 73%

EPCOS

Rated voltage - 440 V 7% aluminum wound reactors

Dimensions														
KVAr	**Material Code**	**L**	**W**	**H**	**l1**	**l2**	**n1**	**n2**	**b**	**e**	**d1**	**d2**	**A**	**B**
5	B44066D7005K440N1	175	95 ± 5	158	150	150	100	56 ± 3	73	60 ± 5	10.8	15.5	125	56
10	B44066D7010K440N1	175	124 ± 5	160	150	150	100	78 ± 3	95	75 ± 5	10.8	15.5	125	78
12.5	B44066D7012K440N1	175	124 ± 5	160	150	150	100	78 ± 3	95	75 ± 5	10.8	15.5	125	78
15	B44066D7015K440N1	225	150 ± 5	230	190	190	150	73 ± 3	93	105 ± 5	10.8	15.5	180	73
20	B44066D7020K440N1	225	165 ± 5	205	190	190	150	95 ± 3	114	115 ± 5	10.8	15.5	180	95
25	B44066D7025K440N1	225	165 ± 5	205	190	190	150	95 ± 3	114	115 ± 5	10.8	15.5	180	95
30	B44066D7030K440N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
40	B44066D7040K440N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
50	B44066D7050K440N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
75	B44066D7075E440N1	310	180 ± 5	270	265	265	150	132 ± 3	150	97 ± 5	10.8	15.5	175	132
100	B44066D7100E440N1	330	180 ± 5	270	285	285	150	132 ± 3	155	97 ± 5	10.8	15.5	175	132

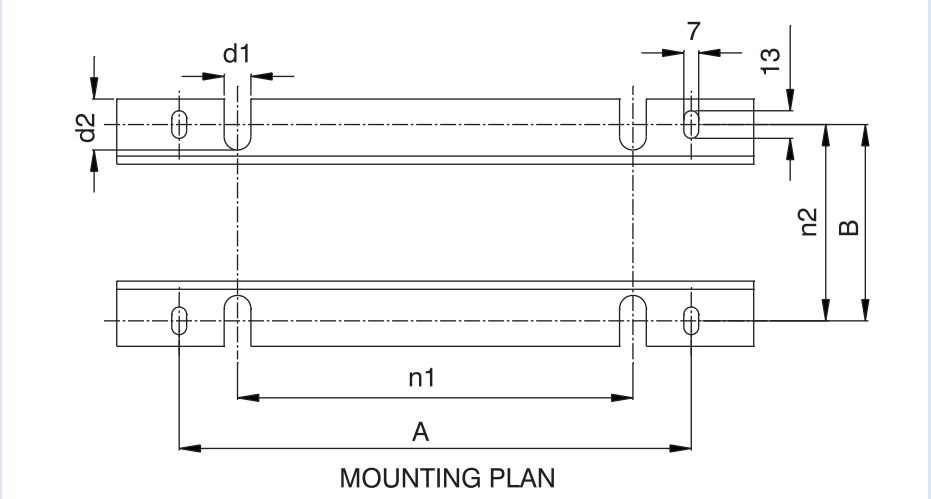
* All dimensions are in mm.

Rated voltage - 415V 7% aluminum wound reactors

Dimensions														
KVAr	**Material code**	**L**	**W**	**H**	**l1**	**l2**	**n1**	**n2**	**b**	**e**	**d1**	**d2**	**A**	**B**
5	B44066D7005K415N1	175	95 ± 5	158	150	150	100	56 ± 3	73	60 ± 5	10.8	15.5	125	56
10	B44066D7010K415N1	175	124 ± 5	160	150	150	100	78 ± 3	95	75 ± 5	10.8	15.5	125	78
12.5	B44066D7012K415N1	175	124 ± 5	160	150	150	100	78 ± 3	95	75 ± 5	10.8	15.5	125	78
15	B44066D7015K415N1	225	150 ± 5	230	190	190	150	73 ± 3	93	105 ± 5	10.8	15.5	180	73
20	B44066D7020K415N1	225	165 ± 5	205	190	190	150	95 ± 3	114	115 ± 5	10.8	15.5	180	95
25	B44066D7025K415N1	225	165 ± 5	205	190	190	150	95 ± 3	114	115 ± 5	10.8	15.5	180	95
30	B44066D7030K415N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
40	B44066D7040K415N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
50	B44066D7050K415N1	260	225 ± 5	240	220	220	150	165 ± 3	185	127 ± 5	10.8	15.5	175	165
75	B44066D7075E415N1	310	180 ± 5	270	265	265	150	132 ± 3	150	97 ± 5	10.8	15.5	175	132
100	44066BD7100E415N1	330	180 ± 5	270	285	285	150	132 ± 3	155	97 ± 5	10.8	15.5	175	132

* All dimensions are in mm.

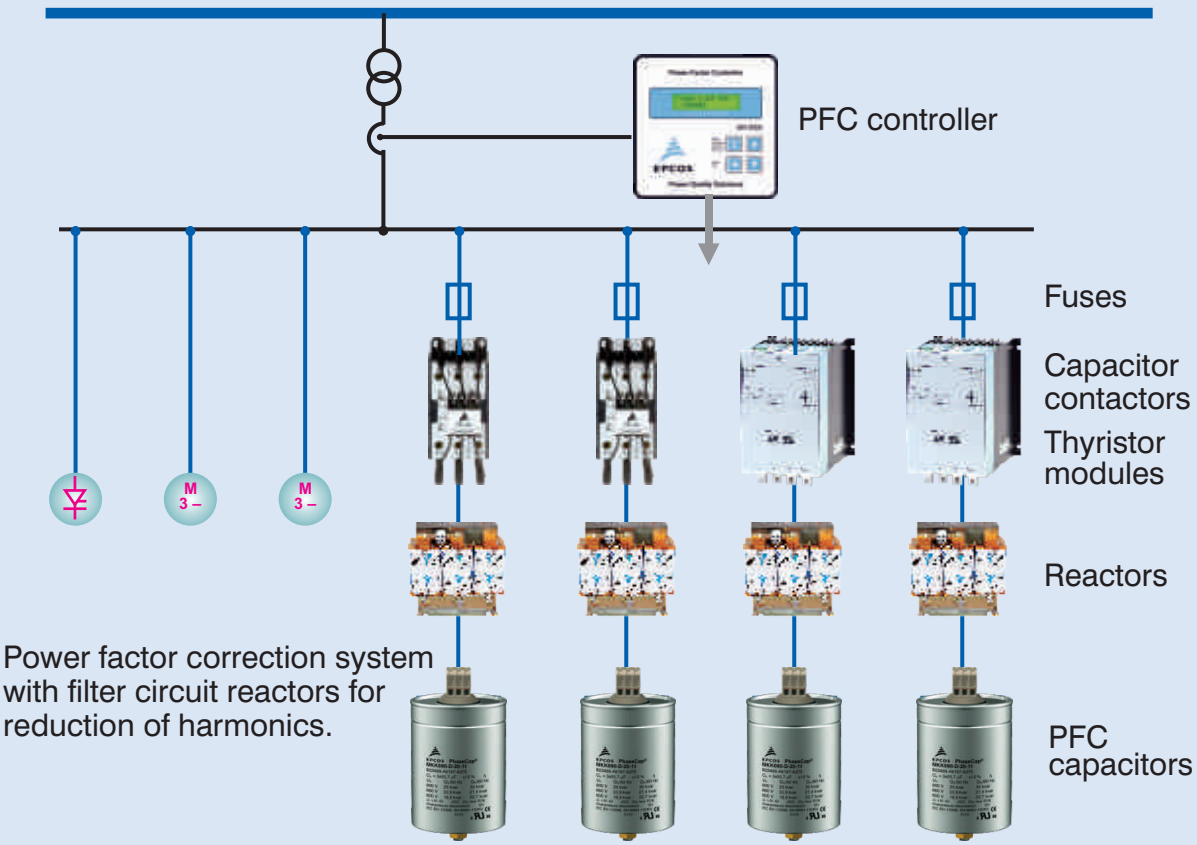
Reactor dimensional details



MOUNTING PLAN

Fundamentals of Power Factor Correction

Typical power factor correction circuit diagramm



Power factor correction system with filter circuit reactors for reduction of harmonics.

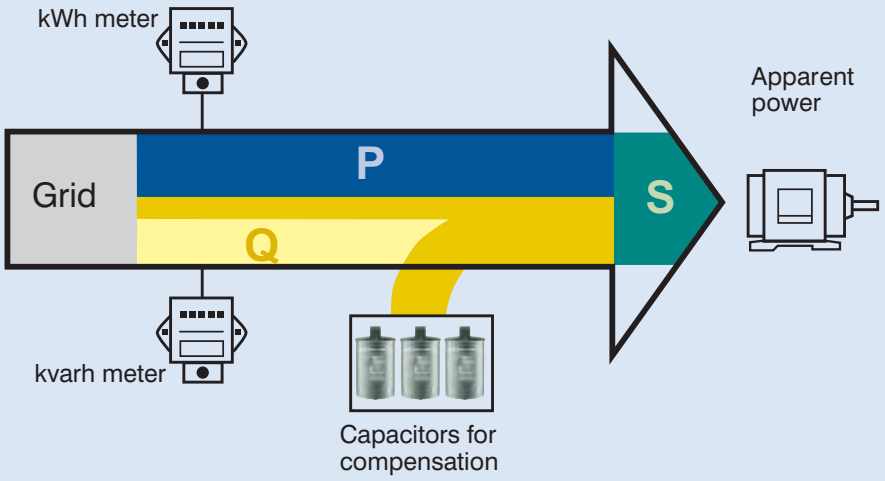
The rational use of electrical energy calls for economical generation, transmission and distribution with little losses. That means restricting all factors in electrical networks that cause losses. One of these factors is lagging reactive power. Loads in industrial and public power grids are primarily 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.

Components of 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 ($>100 \cdot I_R$). If they are connected in parallel, i.e. as banks, the inrush current will increase ($\geq 150 \cdot I_R$) because the charging current comes from the power line as well as from other capacitors connected in parallel.

Design of capacitors

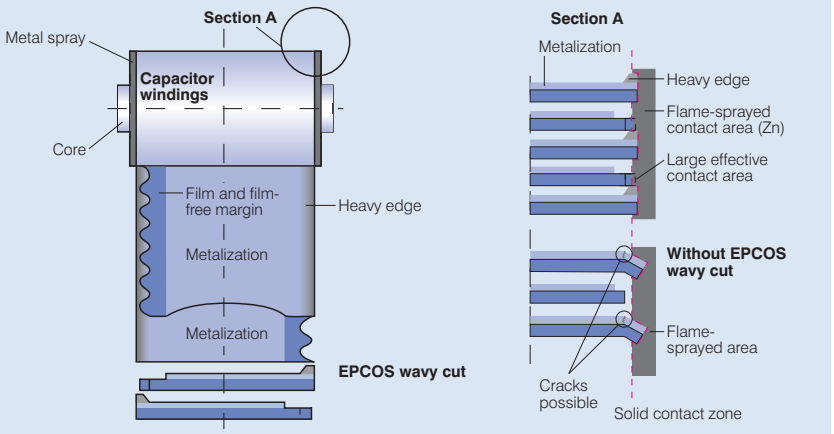
MKK/MKP technology
Metalized plastic compact capacitors with self-healing properties and a polypropylene dielectric. Film metallization with zinc/aluminum alloy results in high performance and a low film thickness allowing significantly more compact dimensions and a lower weight.
A heavy edge and special film-cutting technique (optimized combination of wavy and smooth cuts) produces a maximum effective surface for the metal spraying or contacting process

- Series PhaseCap and PhaseCap HD dry technology – impregnation with an inert gas (nitrogen N_2).
- Series PhaseCap Compact – semi-dry biodegradable resin.
- Series PhiCap – impregnation with semi dry biodegradable soft resin.

MKV technology
Based on oil impregnated polypropylene - paper capacitor winding. The winding element consists of double sided metalized paper as the electrode carrier and an unmetalized polypropylene film as the dielectric. This combination is especially well suited for high power dissipations. The film paper arrangement that forms the winding is wound in a slightly staggered alignment: one edge of each double sided metalized paper projects from the winding.

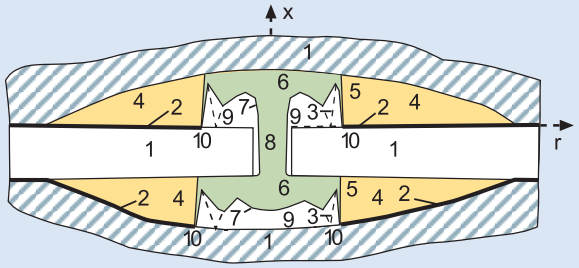
The edges are electrically contacted with vaporized zinc. The Schooping or metal spray process uses zinc of the highest purity.

Wavy cut design



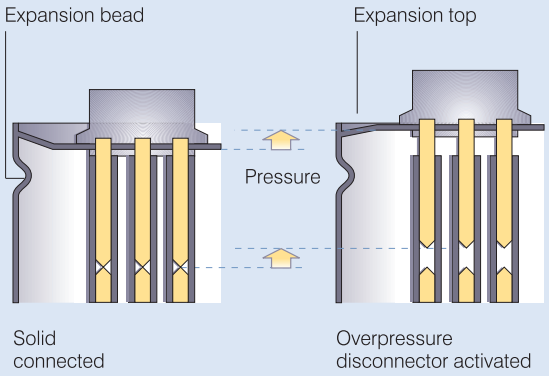
Components of Power Factor Correction

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)

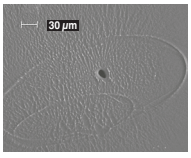
Overpressure disconnector

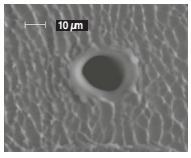


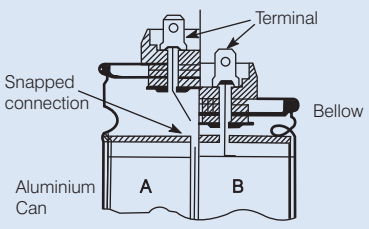
Safety

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.







A Safety device

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 (or bellow as shown in lower fig.) moves upwards 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 BR4904 is suited to small PFC systems with four steps .

Components of Power Factor Correction

The BR6000 series is available for conventional, dynamic and mixed compensation with six and twelve steps for medium and large systems respectively.

The PF controller BR7000 with its 15 relay 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 50).

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.

Thryristor 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 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.

⚠ **Caution:**
Appropriate ventilation/air circulation is must, when system is with detuned harmonic filter reactor and capacitor

7. 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 50 V or less within 60 seconds.
- 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, PhiCap B32344 series and MKV- capacitors.

⚠ **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.

8. 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!).

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

Selection table			
Power KVAr	**Current A**	**Cross section mm²**	**Fuse rating A**
Rated voltage 230 V, 50 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	75.8	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 x 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	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 x 95.0	350
175.0	252.6	2 x 95.0	400
200.0	288.0	2 x 120.0	500
Rated voltage 440 V, 50 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 x 95.0	350
175.0	231.0	2 x 95.0	400
200.0	264.0	2 x 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 harmonics 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.

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

Selection table			
Power KVAr	**Current A**	**Cross section mm²**	**Fuse rating A**
Rated voltage 480 V, 50 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 x 95.0	350
200.0	240.0	2 x 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 x 95.0	350
200.0	220.0	2 x 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 harmonics 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.

Capacitor (KVAr) selection chart

Current (ACTUAL) Tan φ	cos φ	achievable (TARGET) cos φ 0.80	0.82	0.85	0.88	0.90	0.92	0.94	Q_c	TARGET Cos φ = 0.96 Q Cos ≤1 $Q_c=P_{mot}$ x F(0.96)=...(KVAr) 100 x 1.01=101.0 KVAr 0.96	0.98	1.00
		Factor 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	0.26	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
00..33	95										0.13	0.33

Qc = PA x (tan φ1-tan φ2)
Qc (KVAr) = PA x F = active power (kW) x factor "F"
PA=S x cos φ = apparent power x cos φ
tan φ1 + φ2 according to cos φ values ref. Table

Example:

ACTUAL motor power	P = 100 kW	Capacitor reactive power Qc
Actual cos φ	0.61	Qc = 100 x 1.01 = 101.0 KVAr
TARGET cos φ	0.96	
Factor F from table	1.01	

Individual PFC for Motors

Approximate values (specified by the German Electricity Association VDEW) for fixed PFC of motors			
Motor nominal rating	**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…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.

Individual PFC for Transformers

Standard values for transformers power factor correction		
Rated apparent power of transformer KVAr	**Rated capacitor power for oil immersed transformer KVAr**	**Rated capacitor power for cast resin transformer 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:

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

Q_C = needed capacitor (KVAr)
I_0% = magnetising current of the transformer
AN = 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.

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 react tor 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 percentage.

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

f: fundamental frequency
f_{RES}: tuning frequency

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 74 to 77 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.

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 ampli tude for every harmonic that could exist.

Calculate the Total Harmonic Distortion of Current $THD\text{-}I = 100 \cdot \sqrt{[(I_3)^2 + (I_5)^2 + \ldots + (I_N)^2]}/I_1$
Calculate every existing value for $THD\text{-}I_N = 100 \cdot I_N / I_1$

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 $THD\text{-}V = 100 \cdot \sqrt{[(V_3)^2 + (V_5)^2 + \ldots + (V_N)^2]}/V_1$

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.

Capacitor Voltage Rating selection guideline for a Detuned Capacitor Bank

General

It is necessary to understand the importance of choosing the right voltage rating while using capacitors in a 'Detuned' system. In commonly accepted technical parlance, we say 'voltage drop across the reactor', however, notice that a capacitor and reactor are electrical components with opposite signs, i.e., $=jX_L$ and $-jX_c$

Hence, when you apply a basic voltage divider formula to these impedances, it's obvious that there exists a steady state voltage 'rise' across the capacitor in the circuit. Now the steady state voltage across the capacitor shall be as follows:

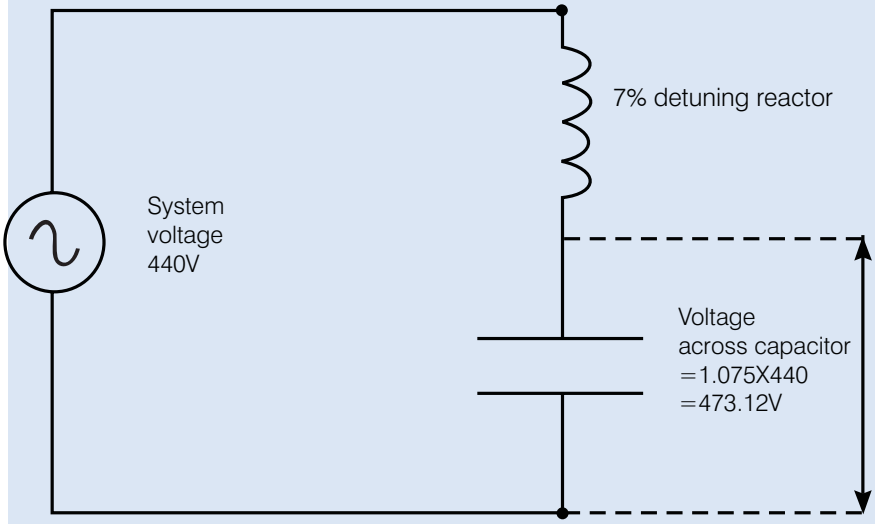
$$V_{cap} = \frac{-j X_C}{-j X_C + j X_L} \times 1pu$$

Where $X_L = p.\ X_C$

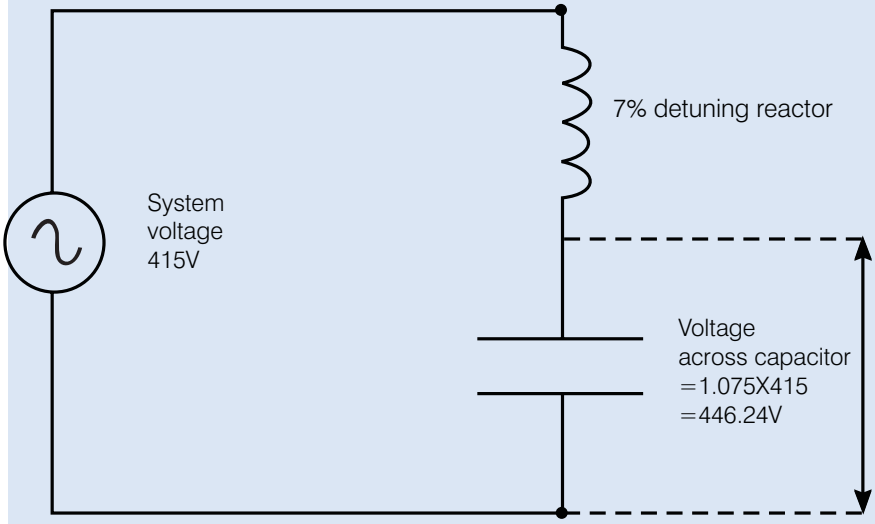
p = Detuning percentage

Example with p=7% detuning reactor, X_c=100Ω and X_L=7Ω

$$V_{cap} = \frac{-j\ 100}{-j\ 100\ +j\ 7} \times 1pu = 1.075\ pu$$



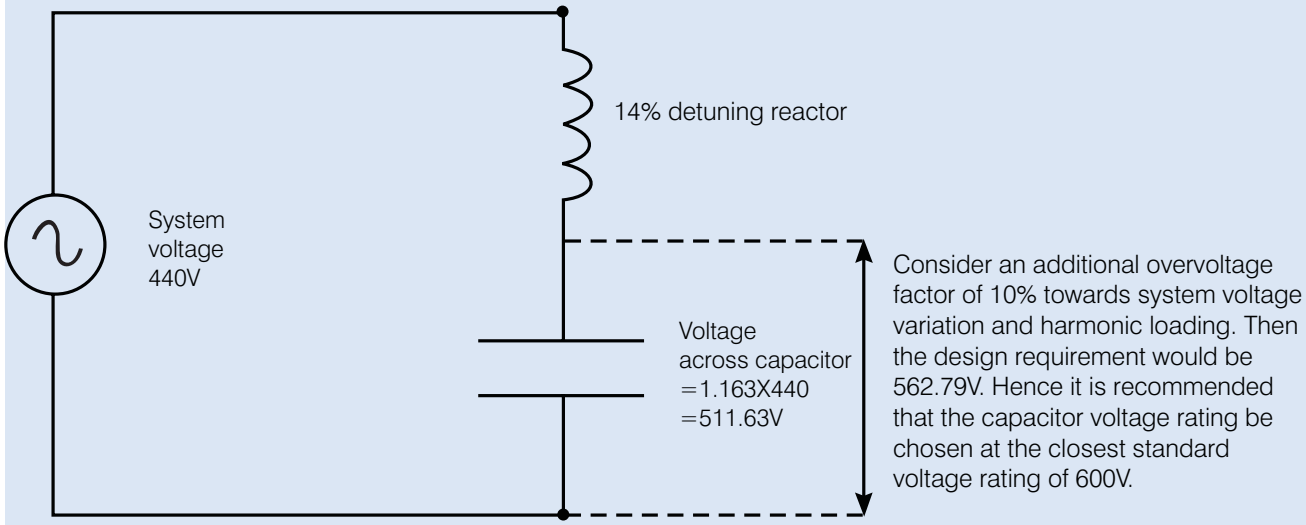
Consider an additional overvoltage factor of 10% towards system voltage variation and harmonic loading. Then the design requirement would be 520.43V. Hence it is recommended that the capacitor voltage rating be chosen at the closest standard voltage rating of 525V.

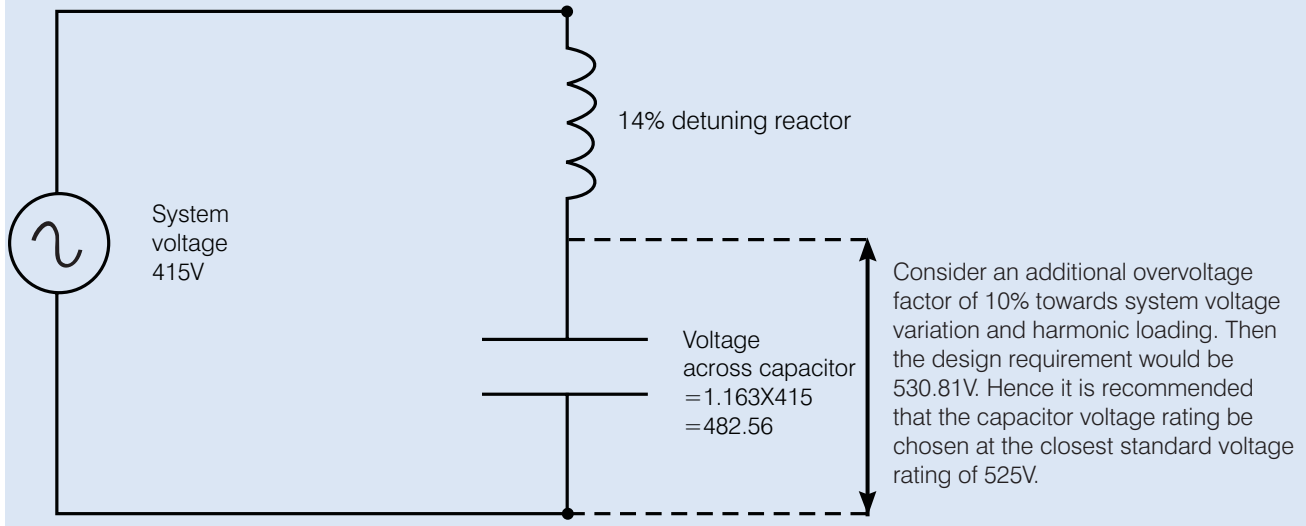


Consider an additional overvoltage factor of 10% towards system voltage variation and harmonic loading. Then the design requirement would be 490.86V. Hence it is recommended that the capacitor voltage rating be chosen at the closest standard voltage rating of 500V, or atleast 480V.

Capacitor Voltage Rating selection guideline for a Detuned Capacitor Bank

Example with p=14% detuning reactor, X_C=100Ω and X_L=14Ω

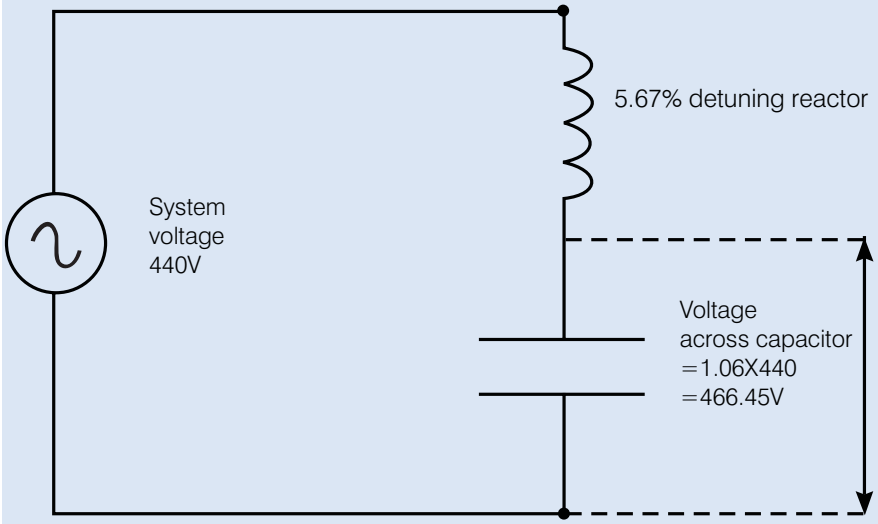




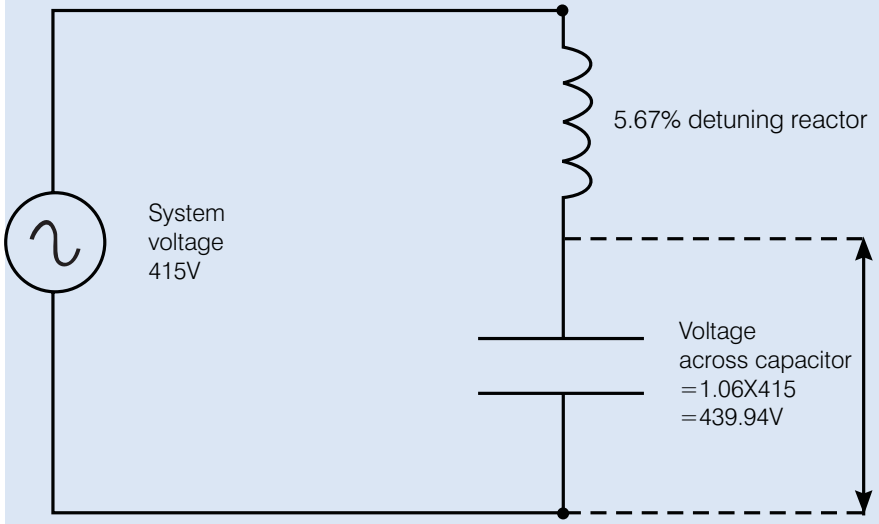
Capacitor Voltage Rating selection guideline for a Detuned Capacitor Bank

Example with p= 5.67% detuning reactor, X_c=100Ω and X_L=5.67Ω

$$V_{cap} = \frac{-j\,100}{-j\,100 + 5.67} \times 1\text{pu} = 1.06\ \text{pu}$$



Consider an additional overvoltage factor of 20% towards system voltage variation and harmonic loading. Notice the difference between the previous considerations of detuning. This is due to the fact that the detuning frequency has shifted upwards, more closer towards the 5th Harmonic frequency. This behaves like a partially tuned filter for the 5th Harmonic frequency. Then the design requirement would be 559.74V. Hence it is recommended that the capacitor voltage rating be chosen at the closest standard voltage rating of 600V. It is also preferred that the type of capacitor chosen is one which has a reasonably larger overcurrent capability as well.



Consider an additional overvoltage factor of 20% towards system voltage variation and harmonic loading. Notice the difference between the previous considerations of detuning. This is due to the fact that the detuning frequency has shifted upwards, more closer towards the 5th Harmonic frequency. This behaves like a partially tuned filter for the 5th Harmonic frequency. Then the design requirement would be 527.93V. Hence it is recommended that the capacitor voltage rating be chosen at the closest standard voltage rating of 525V. It is also preferred that the type of capacitor chosen is one which has a reasonably larger overcurrent capability as well.

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 200000 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 5 000 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 50 sec as necessary for conventional PFC is 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 57), the required fast transistor output controllers (BR6000-T, page 38), and the EPCOS standard reactor (page 60) and of course capacitor series (page 12).

PFC Basic Formulae

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.

$$S = \sqrt{3} \cdot V \cdot I \cdot (VA)$$

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
$\varphi 1$: actual angle of cos actual
$\varphi 2$: target angle of cos actual

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

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

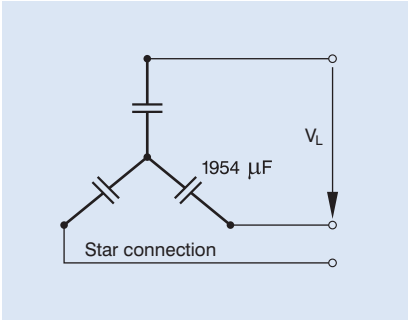
Formula 9

PFC Basic Formulae

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

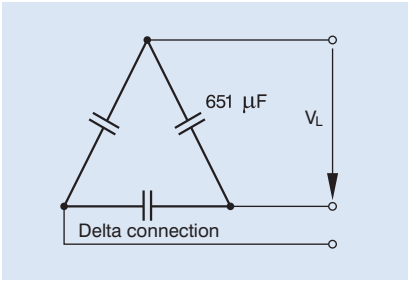
From formulae (9), (10) and (11)

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

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

Formula 12

- DELTA connection



$$V_C = V_L$$

Formula 13

From formulae (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.

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

Formula 16

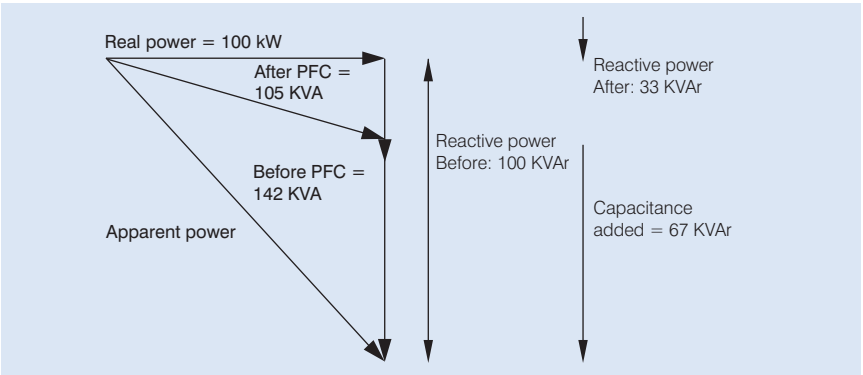
These values are operating conditions:
Q_{new} : new reactive power
V_{new} : new voltage
f_{new} : new frequency

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

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 Formulae

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:

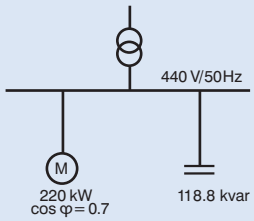
$\cos\varphi 1 = 0.7 \qquad \tan\varphi 1 = 1.02$

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

$Q_C = P\,(\tan\varphi 1 - \tan\varphi 2)$

$= 220 \cdot 1\,000\,(1.02 - 0.48)$

$= 118.8$ KVAr



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

STAR connection:

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

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

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

$C_{TOT} = 5\,862\ \mu F$

DELTA connection:

$$V_C = V_L = 440\ V$$

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

$$C_{DELTA} = \frac{118.8 \cdot 1\,000}{3 \cdot (440)^2 \cdot 2\pi \cdot 50} = 651\ \mu F \text{ / Line (phase)}$$

$C_{TOT} = 1954\ \mu F$

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):

$$I_1 = \frac{220 \cdot 1\,000}{\sqrt{3} \cdot 440 \cdot (0.7)} = 412\ A$$

I_2 compensated load (0.9):

$$I_2 = \frac{220 \cdot 1\,000}{\sqrt{3} \cdot 440 \cdot (0.9)} = 320\ A$$

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

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 ≥ 1mm diameter	Deep-water protection
Ip54	protection against tool touch and solid foreign bodies ≥ 1mm diameter, protection against dust deposit	Splash-water protection

Maximum admissible overvoltage			
Frequency (50 /60 Hz)	**Max. voltage (V_{rms})**	**Max. duration**	**Remarks**
Line frequency	$1.00 \cdot V_R$	Continuous duty	Highest mean during entire operating time of capacitor; exceptions (see below) are admissible for times of < 24 h
Line frequency	$1.10 \cdot V_R$	8 h daily	Line voltage fluctuations
Line frequency	$1.15 \cdot V_R$	30 min daily	Line voltage fluctuations
Line frequency	$1.20 \cdot V_R$	5 min daily	Line voltage fluctuations
Line frequency	$1.30 \cdot V_R$	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 · 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, over voltage 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 · 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 · 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.**

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 5 000 switching operations per year is acceptable. Before considering a higher number of switching operations, please contact EPCOS.

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 50 V or less within 1 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 5th and 7th 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. 3–4% 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.

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 2–6.

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 IEC60831 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.

Keep at least 20 mm space above the capacitor and do not attach any component on the top. This gap will allow a longitudinal extension of can in order to ensure that over-pressure disconnector can fully extend.

Useful life of capacitors strongly depends on the operating temperature (refer to page 44, temperature classes of capacitors).

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

Please read the Installation and Maintenance Instructionson 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.

Other PFC products in the basket

Capacitor Rack Module

M V Capacitors

M V Contactors

M V Capacitor Switch

AC (mfd) Capacitors

Contacts:

Nashik Plant

Bawal Plant

Factory:

EPCOS India Private Limited
Plot No. E22 – 25 MIDC Area,
Satpur, Nashik 422007, India
T: +91 253 2205 100
F: +91 253 2353 761

EPCOS India Private Limited
Plot No -32 Sec. -5
Phase –II, HSIIDC
Growth Centre Bawal
(Haryana) -123501, India
T: +91 1284 263 500/600
F: +91 1284 263 601

Sales Offices:

North :
EPCOS India Private Limited
2nd Floor, Tower - A,C-28, 29,
Logix Cyber Park Sector - 62,
Noida - 201301, India
T: +91 120 450 5801
F: +91 120 450 5818

East :
EPCOS India Private Limited
49/2, Purnadas Road, 4th floor,
Oxford Medical Centre Building
Kolkata 700 029, India
T: +91 33 2419 8870
F: +91 33 2419 8815

West :
EPCOS India Private Limited
Asha House (3rd floor),
28, Suren Road
(off Mathuradas Vasanji Road)
Andheri (East), Mumbai - 400 093, India.
T: +91 22 4256 0600
F: +91 22 4256 0628

South :
EPCOS India Private Limited
14/2, Rajesh Chambers,
Brunton Road,
Bengaluru 560001, India
T: +91 80 4039 0600
F: +91 80 4039 0603

sales.in@epcos.com

Service Contacts:

Nashik:
Plot No. E22 – 25 MIDC Area Satpur,
Nashik 422007, India
T: +91 253 2205 100/286
F: +91 253 2353 761
css.NA@epcos.com
http://www.service.epcos.in

North:
EPCOS India Private Limited
2nd Floor, Tower - A,
C-28, 29, Logix Cyber Park,
Sector - 62, Noida - 201301, India
T: +91 120 4505 815
F: +91 120 4505 818
customercare.ND@epcos.com

West:
EPCOS India Private Limited
Asha House (3rd floor),
28, Suren Road
(off Mathuradas Vasanji Road),
Andheri (East), Mumbai - 400 093, India.
T: +91 22 4256 0627
F: +91 22 4256 628
customercare.MB@epcos.com

South:
EPCOS India Private Limited
14/2, Rajesh Chambers,
Brunton Road, Bengaluru 560001, India
T: +91 80 4039 0645
F: +91 80 4039 0603
customercare.BG@epcos.com

EPCOS India Pvt. Ltd.
A Member of TDK-EPC Corporation
Sales Head Office:
14/2, Rajesh Chambers, Brunton Road, Bengaluru 560001.
Tel: +91-80-4039 0640. Fax :+91-80-4039 0603.
Email: sales.in@epcos.com.

EIPL- PFC Product Profile 2013 Prudent 012013 01