

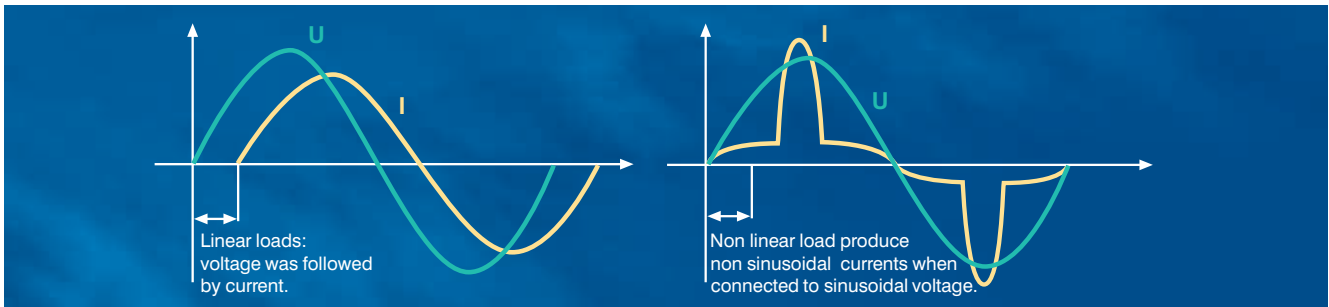
EPCOS Product Profile (India) 2013

# Power Factor Correction

Power Quality Solutions



# 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 ( $\cos \varphi$ ) and the optimization of voltage stability by generating reactive power – to improve voltage quality and reliability at distribution level.

## How reactive power is generated

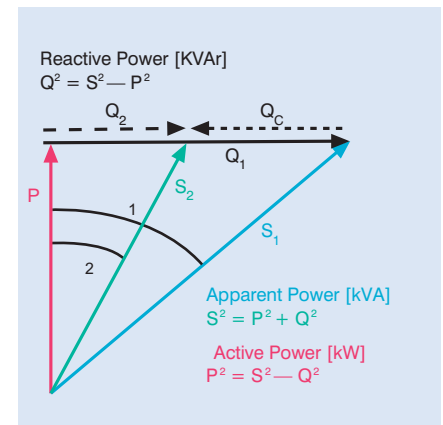
Every electric load that works with magnetic fields (motors, chokes, transformers, inductive heating, arc welding, generators) produces a varying degree of electrical lag, which is called inductance. This lag of inductive loads maintains the current sense (e.g. positive) for a time even though the negative-going 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.

$$\begin{aligned} \text{Apparent power } S &= \sqrt{P^2 + Q^2} \\ \text{Active power } P &= S \cdot \cos \varphi \\ \text{Reactive power } Q &= S \cdot \sin \varphi \end{aligned}$$

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



## Power factor

### Low power factor ( $\cos \varphi$ )

Low  $\cos \varphi$  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



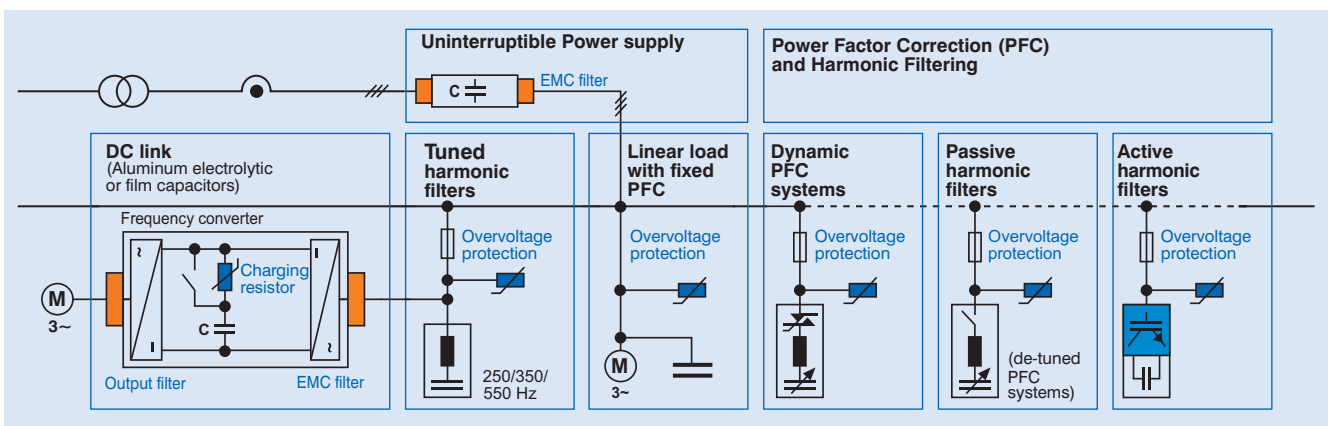
## Power Quality Solution strategy

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.



# PQS Key Components Overview



PF controllers					
<b>BR6000</b>					
Supply voltage	BR6000-R06 245 V AC (±20%; L-N)	BR6000-R12 245 V AC (±20%; L-N)	BR6000-T06 245 V AC (±20%; L-N)	BR6000-T12 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	
<b>BR5000</b>					
Supply voltage	BR5000-R08 415V AC (-40% to +20%; L-L)	BR5000-R16 415V AC (-40% to +20%; L-L)	BR5000-T16 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		
<b>BR4000</b>					
Supply voltage	BR4904 230V AC (-25% to +20%; L-N)		BR4008 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		
<b>BR Series and Ordering Details</b>					
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	
<b>BR7000</b>	15 relay outputs PF controller for 3 phase measuring and controlling			B44066R7415E230	
<b>MC7000-3</b>	Grid analysis tool for 3 phase measuring, display and storage of electric parameters			B44066M1301E230	

# Important Notes

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# 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 15<sup>th</sup>

## 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<sub>THD</sub>
- I<sub>THD</sub>

## 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

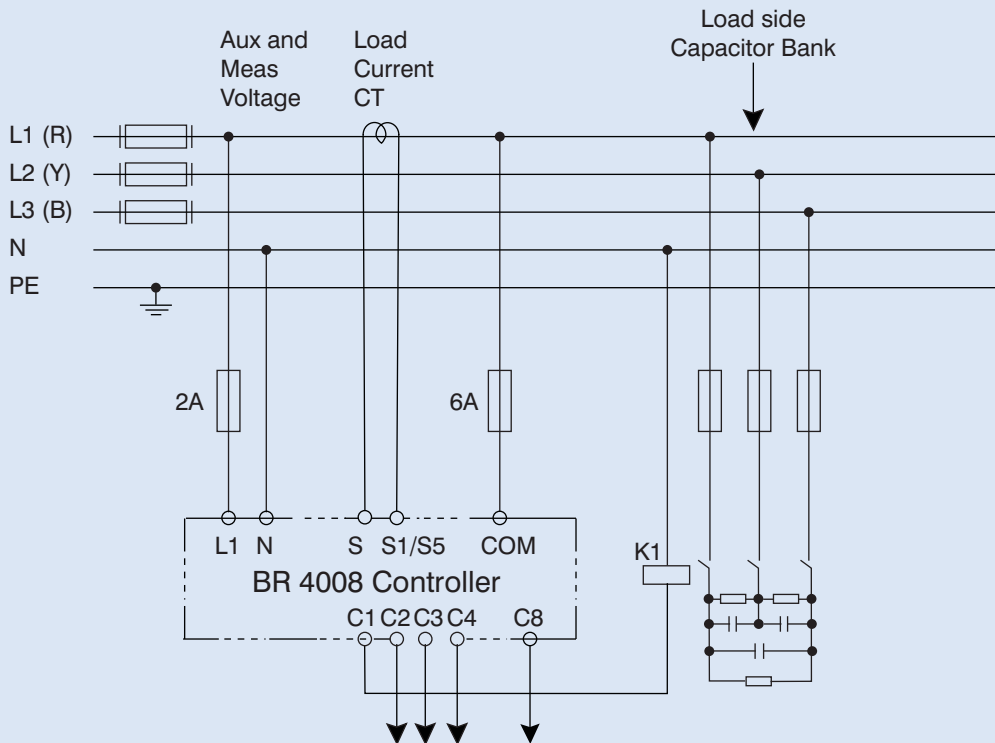
- Compact size
- Operating temperature - 0° to 50° C
- Storage temperature - -5°C to 65°C
- Humidity -0 to 98%

# PF Controllers BR4000 Series

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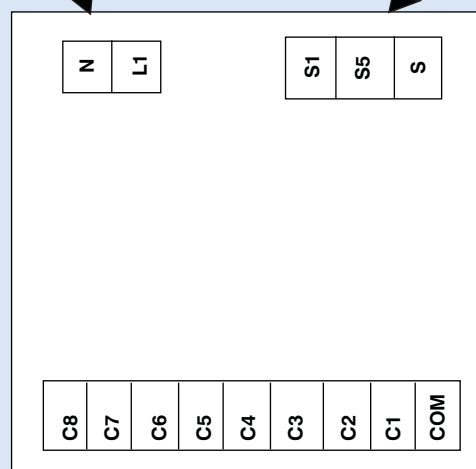
## Typical wiring diagram for PF correction



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

Auxiliary and Measurement Voltage Connection  
230 V, 1 Phase, 2 Wire

Load CT Connection  
Selectable 1A or 5A  
Example: Select either S1 (1A) or S5 (5A) along with S (common)



Output commands to capacitor contactors

# PF Controllers BR4000 Series

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Selection table for controllers		
	BR4000 relay output	
<b>Steps</b>	4 STEP	8 STEP
<b>Switching</b>	Contactor	Contactor
<b>Ordering code</b>	B44066R4904A230N1	B44066R4808A230N1
<b>Auxiliary supply / Measurement voltage</b>	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)
<b>Load CT input current</b>	1 / 5 A - separate connectors for either of the CT connections	1 / 5 A - separate connectors for either of the CT connections
<b>No. of outputs</b>	4 Nos. Relay o/ps of 5A @230V AC Resistive	8 Nos. Relay o/ps of 5A @230V AC Resistive
<b>Alarm outputs</b>	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
<b>Automatic initialisation</b>	No	No
<b>Communication interface RSXXX</b>	No	No
<b>Parameters displayed</b>		
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
<b>Monitoring of individual Capacitor current</b>	No	No
<b>Apparent current</b>	Yes	Yes
<b>Overtemperature</b>	Yes (only INT temp.)	Yes (only INT temp.)
<b>Real time cos</b>	Yes	Yes
<b>Target cos</b>	Yes (single target PF - programmable)	Yes (upper and lower target PF programmable)
<b>KVAr value to target cos</b>	Yes (as system reactive power)	Yes (as system reactive power)
<b>Switching and discharge time range</b>		
- Correction time	1 - 1200 sec	1 - 65530 sec
- Discharge time	1 - 1200 sec	1 - 65530 sec
<b>Number of control series</b>	Only unequal	Binary, unequal, C-series, E-series
<b>Weight (in kG)</b>	1 kG	1 kG
<b>Dimensions (L x D x H in mm)</b>	96 x 90 x 96 mm	96 x 90 x 96 mm





## Programing of BR 4000 ER Power Factor Controller

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**Step 1 :** Press <Tripple Arrow Key> **BASIC SETTINGS will be displayed.**

**Step 2 :** Press <Enter Key> **ENTER PASSWORD : by default password is set to 0000.**

**Step 3 :** Press <UP Key> **CT PRIMARY will be displayed.** to assing the primary load sensing CT Current, **press <Enter Key>** Last digit will be blink i.e.1000 ,by pressing < Up or Down key> you can increase or decrease the value.Similarly to come forward or reverse press < Enter Key> and repeat the same to increase or decrease the value.Afte enter the Current CT Primary **Press <Enter Key>**.to exit.

**Step4:** Press <UP Key> **CT SECONDARY will be displayed.** to assing the Secondary load sensing CT Current, **press <Enter Key>** Last digit will be blink i.e.1 or 5amp. **press <Enter Key>**to exit.

**Step5:** Press <UP Key> **BANKS IN USE will be displayed.** **press <Enter Key>** to edit bank kVAr values.

**Pressing <up or down Key>** will increment or decrement digit value. Then **press <Enter Key>** will advance to next digit & confirm newly changed values. **Press <Tripple Arrow Key>** to Exist.

**Step 6 :** Press <UP Key> **ADVANCED SETTINGS will be displayed.**

**Step 7:** Press <Enter Key> **ENTER PASSWORD : by default password is set to 0001.**

**SYSTEM SETUP will be displayed.**

**Step 8:** Press <Enter Key> **TARGET PF.** Press <Enter Key> to Value is settable from 0.8 Inductive to 0.8 capacitive. **Pressing <up or down Key>** will increment or decrement digit value. **Press <Enter Key>**.to exit.

**Step 9 :** Press <UP Key> **SWITCH IN TIME will be displayed.**

**Step 10:** Press <Enter Key> Switch in time Value is settable from 10 to 1800 Sec. **Pressing <up or down Key>** will increment or decrement digit value.

**Step 11:** Press <UP Key> **SWITCH OFF TIME will be displayed.**

**Step 12:** Press <Enter Key> Switch in time Value is settable from 10 to 1800 Sec. **Pressing <up or down Key>** will increment or decrement digit value. **Press <Enter Key>**.to exit.

**Step 13:** Press <UP Key> **DISCHARGE TIME will be displayed.**

**Step 14:** Press <Enter Key> Switch in time Value is settable from 60 to 1800 Sec. **Pressing <up or down Key>** will increment or decrement digit value. **Press <Enter Key>**.to exit.

**Step 15:** Press <UP Key> **4 times Active power will be display.** If these values if any showing (- Minus) indication that means that CT Secondary Polarity / connection is reversed.

**To make the proper connection of CT Secondary ,It should be ensure that CT Secondary should not be opened while making the connection.It should be shorted If current flowing through primary.**

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