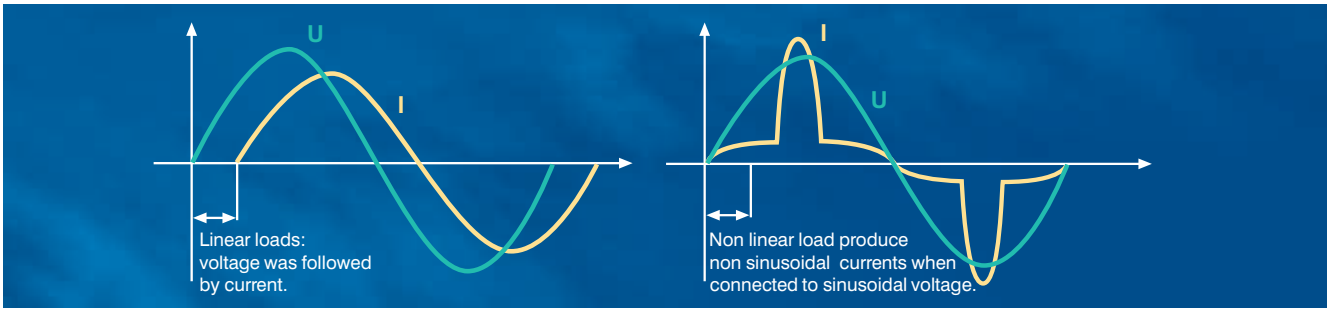
EPCOS Product Profile (India) 2013

Power Factor Correction

Power Quality Solutions

www.epcos.com

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.

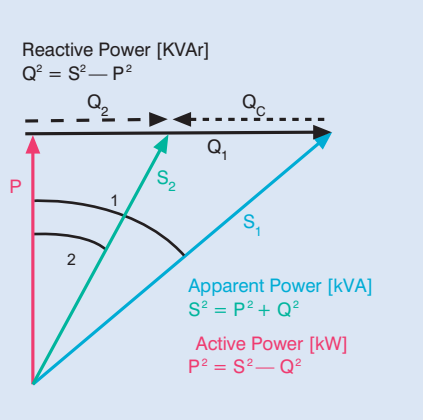
How reactive power is generated

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.

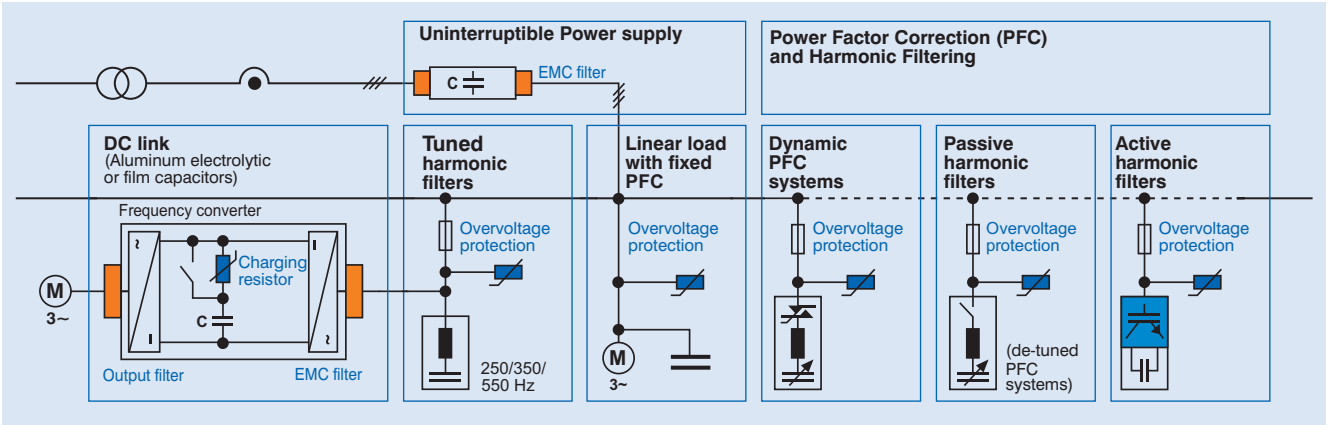
Preview

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.



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

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.**
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   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.

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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%

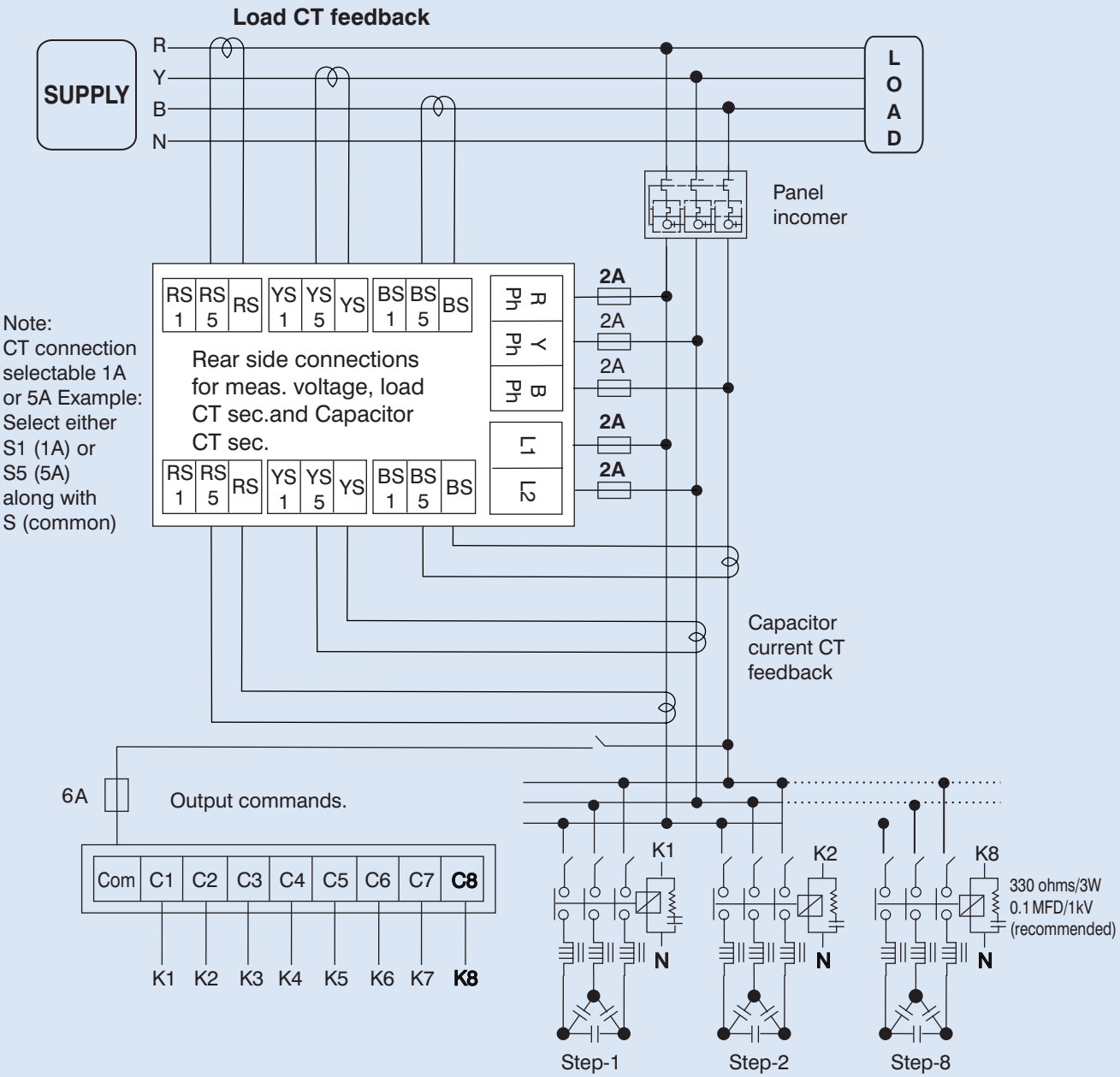
Dynamic Power Factor Controller (Transistorised) available in 16 steps

Special 8/16 step Controller for Medium Voltage application available

PF Controller BR5000 Relay Output

Intelligent • User-friendly • Cost-effective

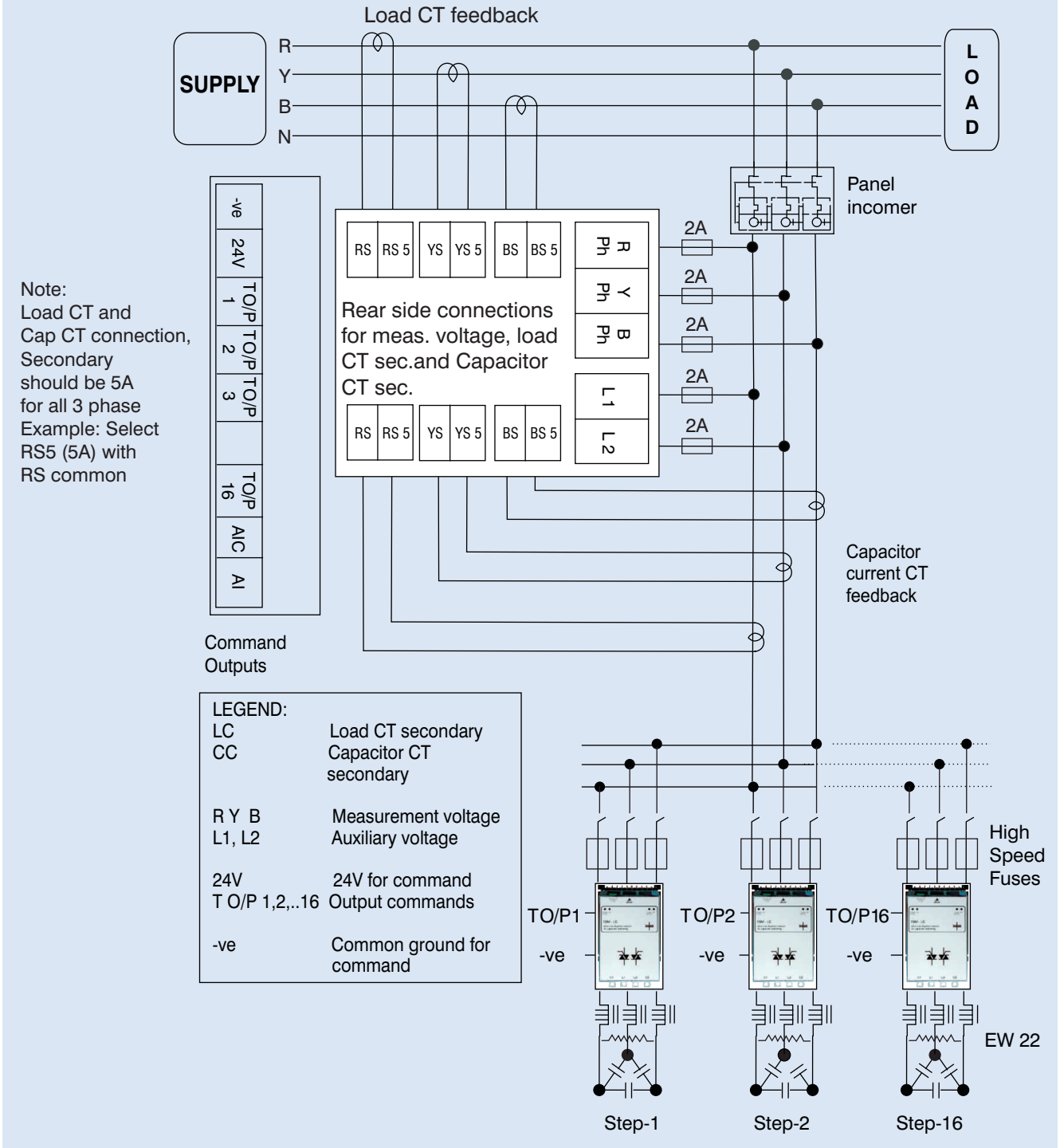
Typical wiring diagram for PF correction : Contactor switching



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

Step 1 : Press <Tripple Arrow Key> Select 1Edit Parameter will be displayed .
Step 2 : Press <Enter Key> Edit Parameters General and IO will be displayed
Step 3 : Press <Down Key> ,Edit Parameters System will be displayed.
Step 4 : Press < Enter Key> Measuring Voltage :415 will be displayed
Step 5 : Press <Down Key> EXT-PT Ratio 0001.0:1 Will be displayed
Step 6 : Press <Down Key> CUR CT Primary Mains :1000 (Bydefault) Will be displayed, to assing the primary load sensing CT Current, press <Enter Key> Last digit will be blink i.e1000 ,by pressing
< Up or Down key> you can increase or decrease the value.Similarly to come forward or reverse press <LHS or RHS Key> and repeat the same to increase or decrease the value.Afte enter the Current CT Primary Press <Enter Key>.
Step7: Press <Down Key> CUR CT Primary Gener (Generator) : 500 Will be displayed Keep it as it is (if feedback source current for Generator is not used i.e.summatiion CT).
Step 8 : Press <Down Key> CAP (Capacitor) CT Primary : 1000 Will be displayed If Capacitor CT is used to measure the capacitor current ,put actual CAP (Capacitor) CT Primary Current by follow Step no 6.
Step 9: Press <Down Key> PF Up Lim : Mains [IND :1] 0.980 bydefault factory setted will be displayed . If you want to change [IND:1] by [Cap : 0] press <Enter Key> in bracket 1 will be blink and by pressing <Down Key> [Cap: 0] will be displayed.To set either [Cap: 0] or [IND :1] Press <Enter Key> .
(IND- Inductive and Cap- Capacitive)
Step 10 : Press <Down Key> [0.980] bydefault factory setted Will be displayed, to Set desired
PF Up Lim press <Enter Key> Last digit will be blink i.e[0.980] ,by pressing< Up or Down key> you can increase or decrease the value.Similarly to come forward or reverse press <LHS or RHS Key> and repeat the same step to increase or decrease the value.Afte enter the PF Up Lim Press <Enter Key>
(Set PF Up limit Mains at 0.998 Inductive.)

Step 11 : Press <Down Key> PF Low Lim : Mains [IND :1] 0.970 bydefault factory setted will be displayed .To set either [Cap: 0] or [IND :1] Please refer step no 9

Step 12 : Repeat the step no 10 to set the desired PF Low Lim Mains. (Set PF lower limit Mains at 0.997 Inductive)

Step 13 : Press <Down Key> PF Up Lim : Gen [Cap :0] 0.820 bydefault factory setted will be displayed .Keep it as it is.Press

Step 14 : Press <Down Key> PF Up Lim : Gen Cap :0 [0.820] bydefault factory setted will be displayed .Keep it as it is.

Step 15 : Press <Down Key> PF Up Lim : Gen Cap :0 [0.820] bydefault factory setted will be displayed .Keep it as it is.

Step 16 : Press <Down Key> PF Low : Gen [Cap :0] 0.800 bydefault factory setted will be displayed .Keep it as it is.

Step 17 : Press <Down Key> PF Low : Gen Cap :0 [0.800] bydefault factory setted will be displayed .Keep it as it is.

Step 18 : Press <Down Key>Mains /Generator Mains : 0 will be displayed .

Step 19 :Press <Down Key> Phase Auto Sync No :0 Auto syncronisation featur is Disable :0, Enable :1 by pressing <Enter Key> followed by <Down Key >.To set this press <Enter Key>

Step 20 : Press <Down Key> Auto Sync Fault Tol (%) :15 will be displayed.

Step 21 : Press <Down Key> Reset Auto Sync No :0 will be displayed.

Step 22 : Press <Down Key>EXT. Temp Meas(Measurement) Enable :1 will be displayed.

To configure programing in Edit Parameters System press <M Key> then Saving In EEprom will displayed and after 2/3 seconds delay noramal (PF) display will come on screen.

Programing of Edit Parameters Step

Step 23 : Repeat the step no 1st 2nd 3rd . After completion of step no 3 Edit Parameters System will be displayed.

Step 24 : Press two times <Down Key> then Edit Parameters Step will be displayed on screen.

Step 25 : Press<Enter Key> Step Cnnnected :16 (Bydefaults) will be displayed. To select the desired

Connected steps press <Enter Key> Step Cnnnected :16 will be blink on the screen. To increase or decrease the connected steps press <Up or Down Key> and <LHS or RHS Key> after selection of desired connected step press <Enter Key>

Step 26: Press <Down Key> Default Mode Auto :0 will be displayed Keep it as it is (It indicates controller in Auto Mode).

Step 27 : Press <Down Key > Compensation KVAR Mean :1 will be displayed Keep it as it is .

Step 28 : Press <Down Key> Cap Bank Voltage (L-L): 00415V (Bydfault) will be displayed ,Keep it as it is.

Step 29: Press <Down Key> Correction TimeSeconds: 00020 will be displayed ,Keep it as it is.

Step 30: Press <Down Key> Discharge Time Seconds : 0000 (Bydfault) will be displayed .Set it 60 Seconds by pressing <EnterKey> Followed By <Up/Down> and <LHS/RHS> Key.To set this Value press <Enter Key>.

Step 31 : Press <Down Key> Step Response Cycles : 00020 (Bydfault) will be displayed

Step 32: Press <Down Key> Fix –Bank Setting will be displayed .If you want to operate all the Connected steps in Auto mode then keep it as it is.

Step 33 : Press <Down Key> Correction Type C-Series :2 bydefault will be displayed. To make the correction type series Un-Equal Press <Enter Key> and by pressing <UP or Down Key> Correction type Un –Equal :1 will be on display.To set it press <Ente Key> .

Step 34 : Press <Down Key> C- Series :00 Will be displayed.

Step 35 : Press <Down Key> E- Series Will be displayed.

Step 36 : Press <Down Key > Bin/C/E Series Bank KVAR:020 bydefault factory setted will be displayed , (minimum Kvar bank to be set as step 1.If correction type E or C Series Selected).

Step 37 : Press <Down Key> Ext - Fix Bank KVAR :000 will be display on the screen.If no External Fixed Capacitor is used then keep it as it is.

Step 38:Press <Down Key> Unequal Bank[1] KVAr: 001 bydefault factory setted will be displayed on screen ,to set the first capacitor bank KVAr Rating press <Enter Key> last digit will be blink.By pressing <Up or Down Key>you can incerease or decrease the value. Similarly to come forward or reverse press <LHS or RHS Key> and repeat the step to increase or decrease the value.After setting of first capacitor bank KVAr rating(APFC Panel First Capacitor bank KVAr Rating) press <Enter Key> to set the value.

Step 39 : Press <Down Key > Unequal Bank [2,3,4,5,6,7,8 …16] KVAr : 00 bydefault factory setted will be displayed on screen. To set 2, 3,4,5,6,7,8…16 Capacitor bank KVAr rating refer Step no 38.

After Setting of all Capacitor Bank KVAr rating and to save the data in step mode press<Save Key>.Saving In EEprom will be display.

To operate/work the Controller in AUTO Mode for Power Factor correction ,It should be ensure that Load Sensing CTs to be connected to Controller.

To maintain the desired PF Load sensing CT s Polarity should be positive/Forward.

To check the CTs polarity Press <Down Key > till Display Power come on display. Then press <Enter Key> R Ph PF will display after Press <Down Key > untill Rph KW ,Y Ph KW,B Ph KW.

If out of these values if any shwoing (- Minus) indication that means that particular phase 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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