

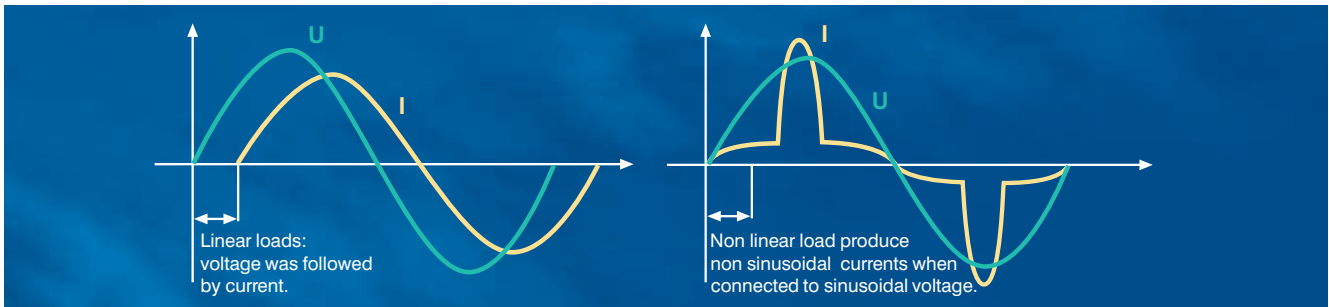
EPCOS Product Profile (India) 2013

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

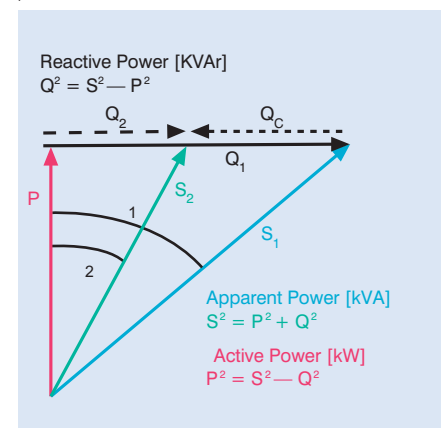
Every electric load that works with magnetic fields (motors, chokes, transformers, inductive heating, arc welding, generators) produces a varying degree of electrical lag, which is called inductance. This lag of inductive loads maintains the current sense (e.g. positive) for a time even though the negative-going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



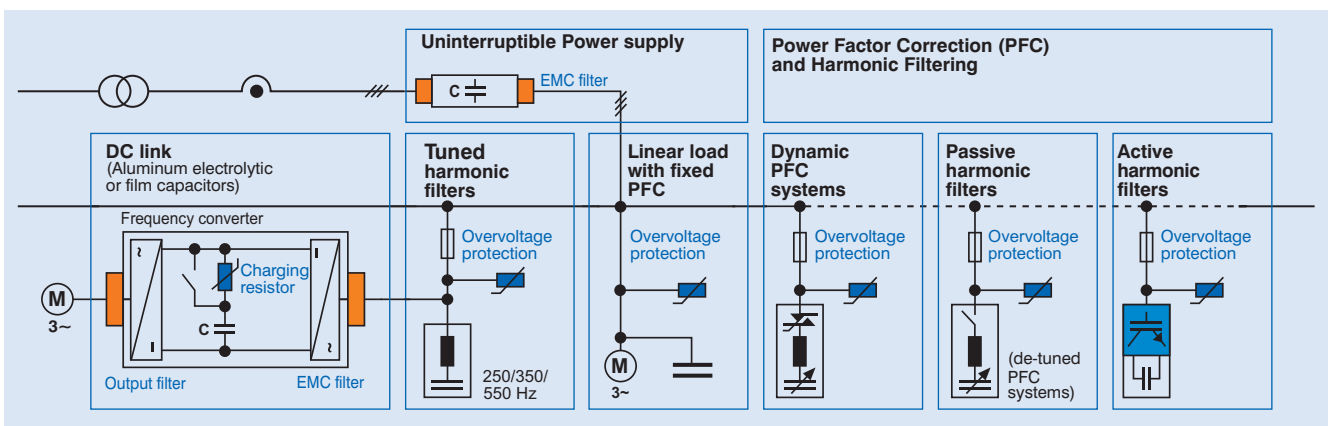
Power Quality Solution strategy

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					
BR6000					
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	
BR5000					
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		
BR4000					
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		
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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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.
- Auxiliary 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 and 16 relay outputs
- Supply frequency - 45 Hz to 62 Hz

Mechanical and Maintenance

- Operating temperature - 0° to 70°C
- Storage temperature - -10°C to +75°C
- Humidity -0 to 98%

Dynamic Power Factor Controller (Transistorised) available in 16 steps

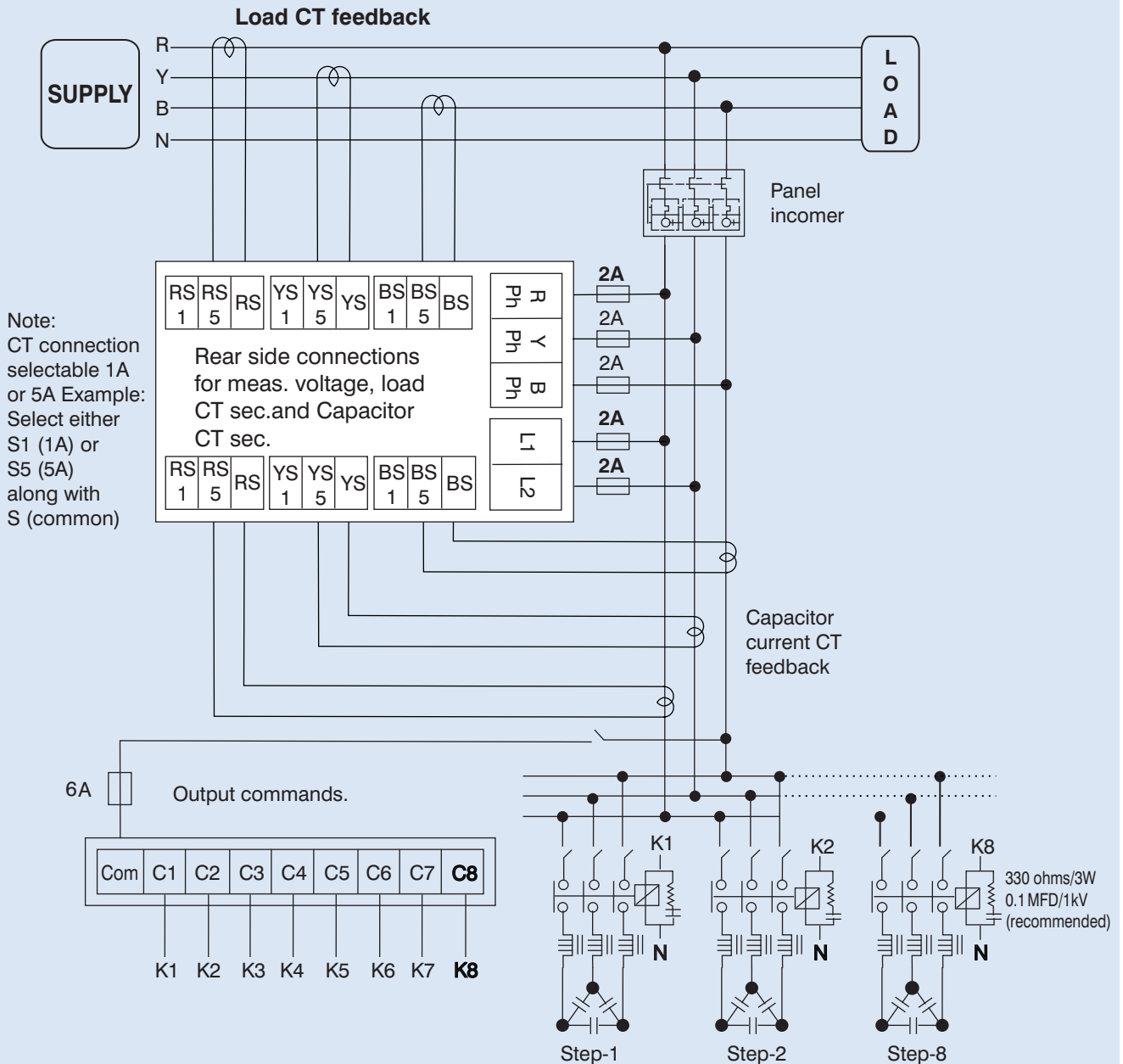
Special 8/16 step Controller for Medium Voltage application available

PF Controller BR5000 Relay Output

Intelligent • User-friendly • Cost-effective



Typical wiring diagram for PF correction : Contactor switching



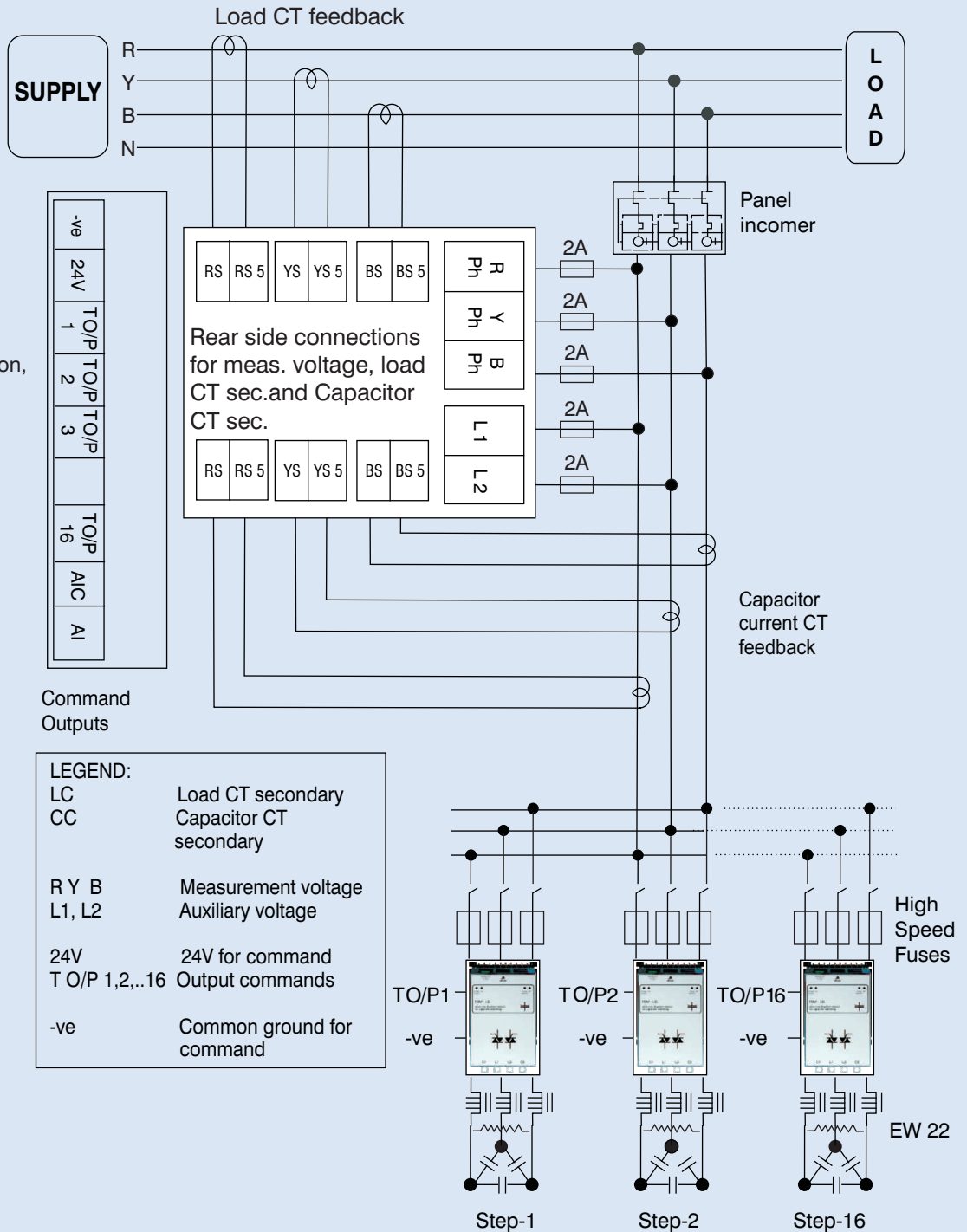
PF Controller BR5000 Transistor Output

Intelligent • User-friendly • Cost-effective



Typical wiring diagram for PF correction : TSM switching

Note:
Load CT and
Cap CT connection,
Secondary
should be 5A
for all 3 phase
Example: Select
RS5 (5A) with
RS common



PF Controllers BR5000 Series

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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