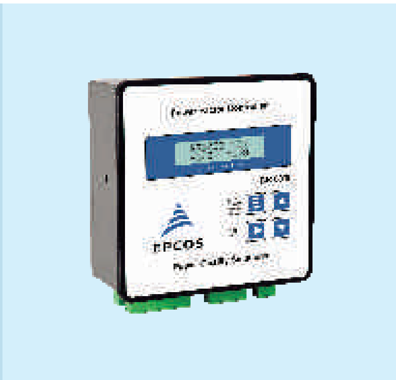
EPCOS Product Profile (India) 2013

# Power Factor Correction

Power Quality Solutions

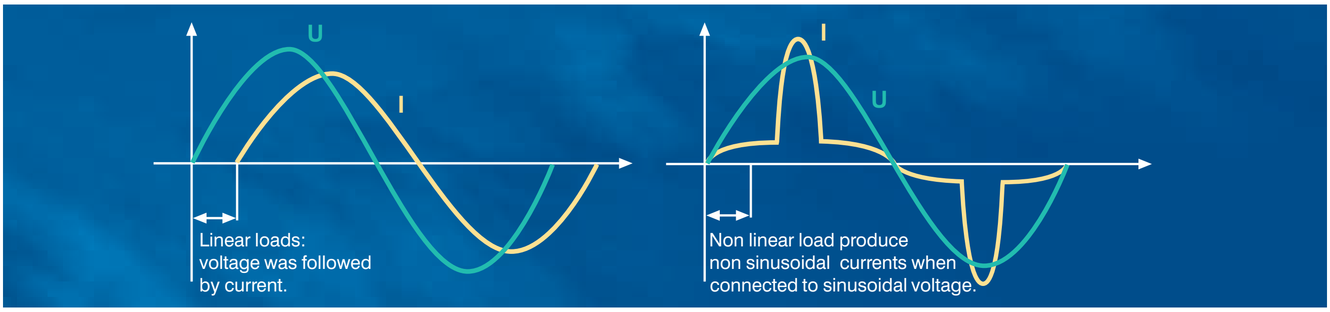






www.epcos.com

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

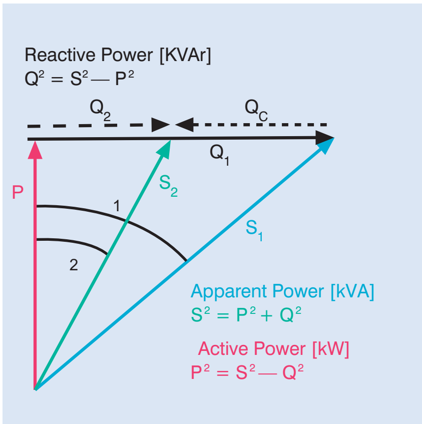
**How reactive power is generated**

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.

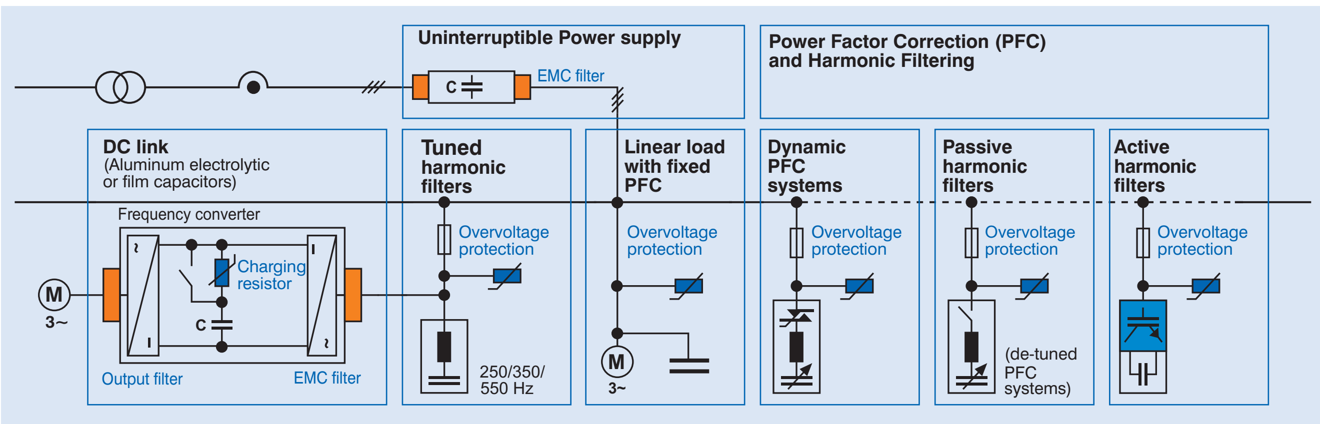
# Preview

## Power Quality Solution strategy

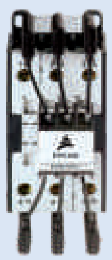
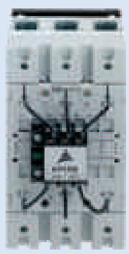
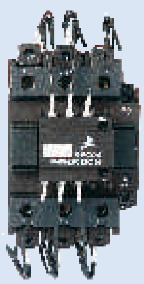
Along with the emerging demand for power quality and a growing awareness of the need for environmental protection, the complexity in the ener-energy market is increasing: users and decision-makers are consequently finding it increasingly difficult to locate the best product on the market and to make 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

| 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<br>TSM-HV: 3 x 690 V | 230...1000 V |
| **Output range** | 12.5...100 KVAr for B...J230<br>7...60 KVAr for B...C240 | TSM-LC: 10...50 KVAr<br>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<br>for all PFC systems<br>B44066S...C240<br>for all PFC systems | TSM-LC: B44066T...R440<br>TSM-HV: B44066T...R690 | B44066D... |
| |     |  |   |

# Switching Devices - Capacitor Duty Contactors

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

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## General

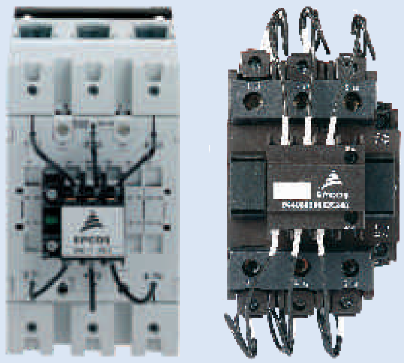
When a capacitor is switched to an AC voltage, the result is a resonant circuit damped to a greater or lesser degree. The switching of capacitors can cause high inrush currents, particularly when they are switched in parallel to others already activated in the power line, and if high short-circuit powers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

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## 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 slow, gL (gG) | $I_{coth}$ [A] | 25 | 20 | 20 | 20 | 20 | 20 | 20 | 20 |
| 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.

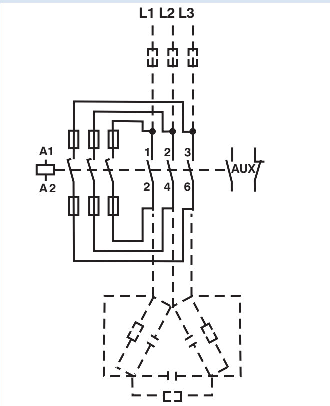
## Main technical parameters 230V coil:

| 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

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## 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 - | [mm²] | 2.5 | 2.5 | 4 | 4 | 6 | 16 | 16 | 50 |
| 1 conductor Flexible with cable end sleeve - 2 conductors | [mm²] | 1.5 | 1.5 | 2.5 | 4 | 4 | 6 | 6 | 25 |
| Solid without cable end sleeve - | [mm²] | 4 | 4 | 6 | 10 | 16 | 25 | 25 | 50 |
| 1 conductor Solid without cable end sleeve - 2 conductors | [mm²] | 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 |

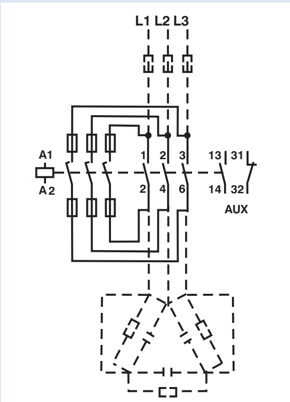
IEC 947-4-1, IEC 947-5-1, EN 60947-4-1, EN 60947-5-1, VDE 0660 Dimensional drawing: see datasheet
1) Applies to networks with grounded star point, overvoltage category I to IV, pollution severity 3 (industrial standard), Vimp = 8 kV. Values for other conditions on request.

## 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** | **55 °C** | **55 °C** | **55 °C** | | |
| **KVAr** | **KVAr** | **KVAr** | **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