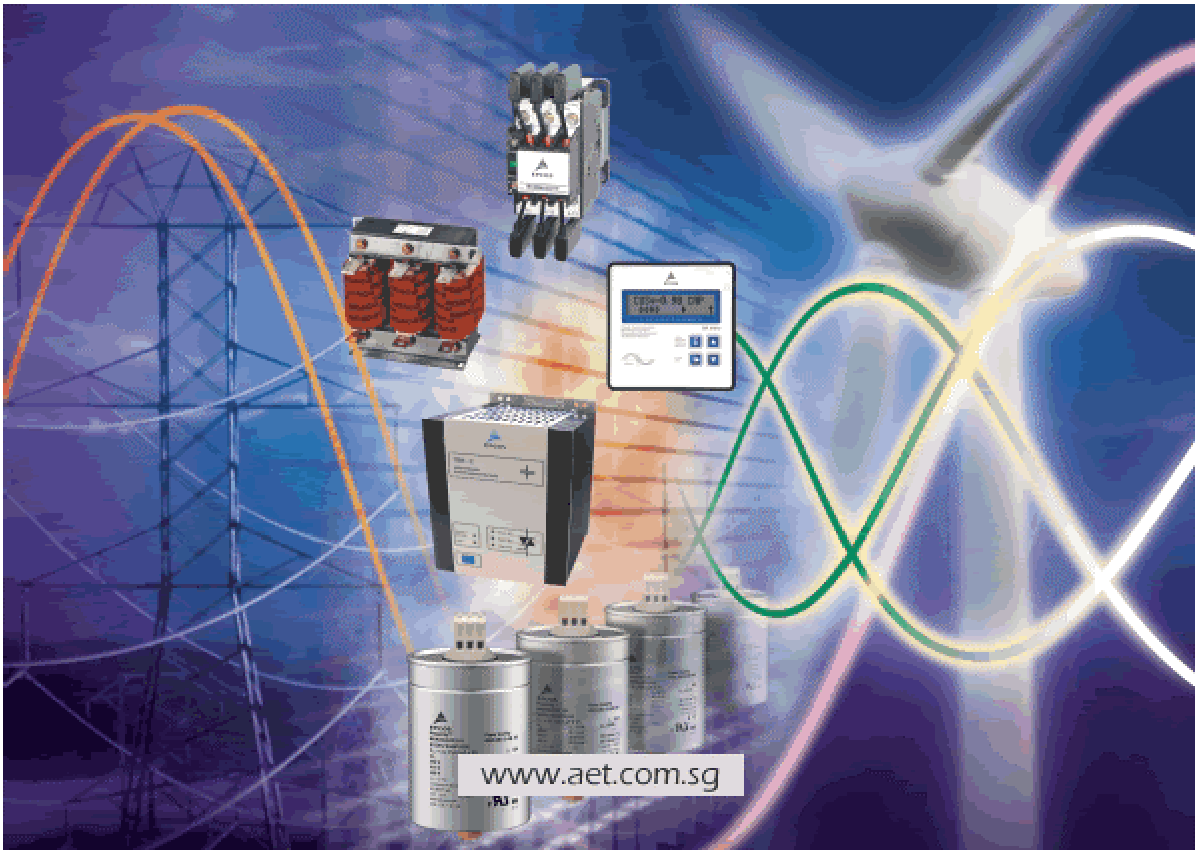
AsiaElectricTechnologies

CPFC / CDPFC series

Automatic Power Factor Correction Equipment



Catalogue no. AET-CPFC-2004-01

Preview

General

Awareness of the necessity of power quality is increasing, and power factor correction (PFC) will be implemented on a growing scale in future. 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 φ) 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, what 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 alternating voltage networks (50/60 Hz) such a process repeats 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 factory plants. 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.

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.

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

Fundamentals of Power Factor Correction

General Information

The rational use of electrical energy calls for economical generation, transmission and distribution with little loss. That means restricting all factors in electrical networks that cause losses. One of these factors is lagging reactive power. Consumers in industrial and public electrical networks 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. In this way impermissibly high voltage drops and additional ohmic losses are also avoided. The necessary leading power is produced by capacitors parallel to the supply network, as close as possible to the inductive consumer. Static capacitive compensation devices reduce the lagging reactive power component transmitted over the network. If network conditions alter, the required leading reactive power can be matched in steps by adding and taking out single power capacitors (regulated PFC) to compensate the lagging reactive power.

Benefits of power factor correction

☐ <u>Amortization in 8 to 24 months through lower power costs.</u>
Power factor correction reduces the reactive power in a system. Power consumption and thus power costs drop in proportion.

☐ <u>Effective installation use</u>
An improved power factor means that an electrical installation works more economically (higher effective power for the same apparent power).

☐ <u>Improved voltage quality</u>

☐ <u>Reduced voltage drop</u>

☐ <u>Optimum cable dimensioning</u>
Cable cross-section can be reduced with improvement of power factor (less current). In existing installations for instance, extra or higher power can be transmitted.

☐ <u>Reduced transmission losses</u>
The transmission and switching devices carry less current, i.e. only the effective power, meaning that the ohmic losses in the leads are reduced.

Design of Capacitor bank

AET CPFC/CDPFC series capacitor banks are constructed using modular design stand-alone cabinets for power ratings up to 1200 kVAr. Custom-made designs such as wall-mounted cabinets are also available upon request.

Key components

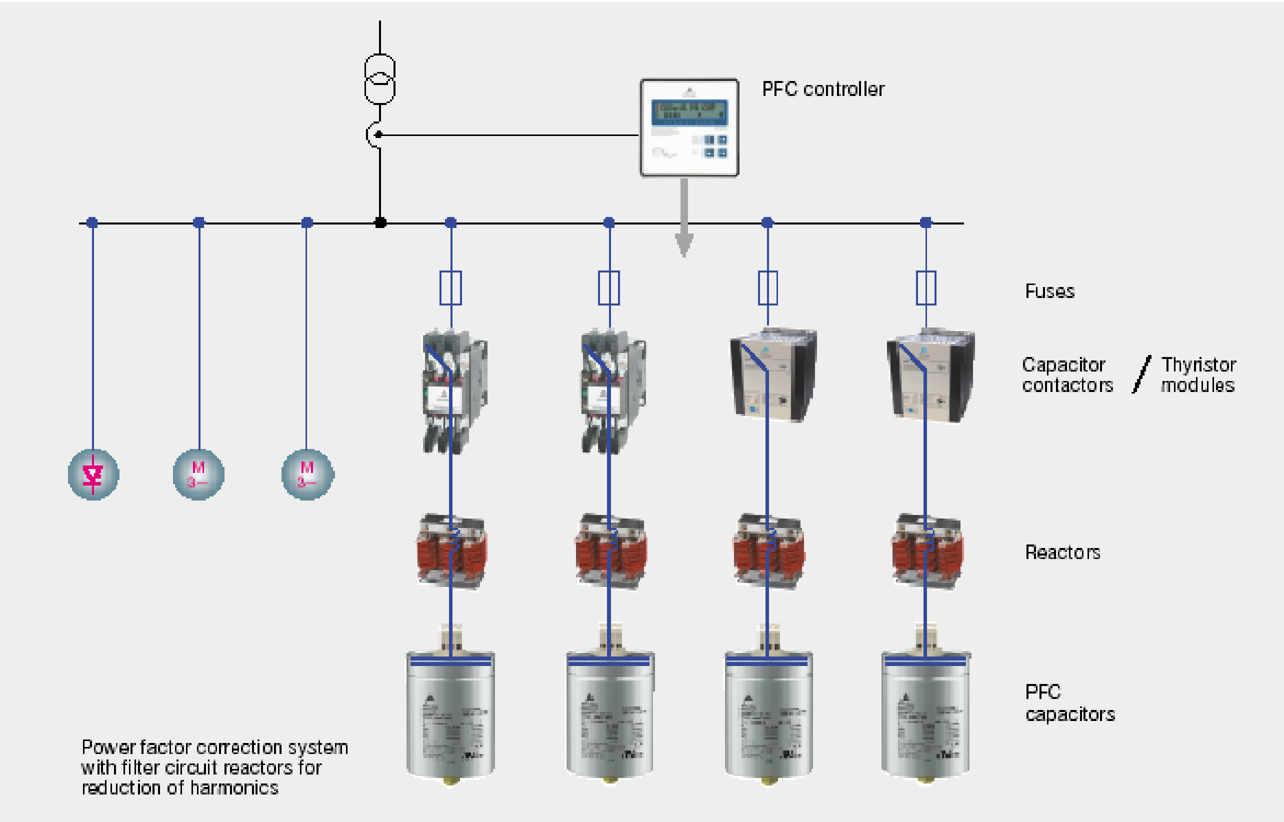
<u>Enclosure</u>

AET automatic capacitor banks are housed in enclosures, which are constructed and assembled in accordance to IEC 60439-1 standards. All panels are constructed from 2 mm thick electro-galvanized steel sheet and coated with epoxy powder polyester in order to maximize corrosion resistance.

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

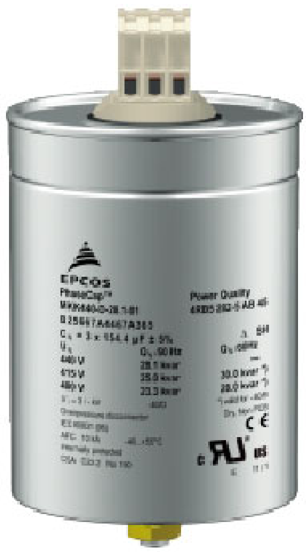
The front of the enclosure is equipped with a hinged door for easy access.

Capacitor supports and enclosure base consists of welded 75mm structural steel channel.



<u>Capacitor</u>

Power factor correction capacitors produce the necessary leading reactive power to compensate the lagging reactive power. Only premium quality PhaseCap capacitors are used in AET CPFC / CDPFC series equipments.



PhaseCap capaicitors offer the following features :

Electrical

- Long useful life
- High pulse current withstand capability (200 * I_R)
- Corona-free

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

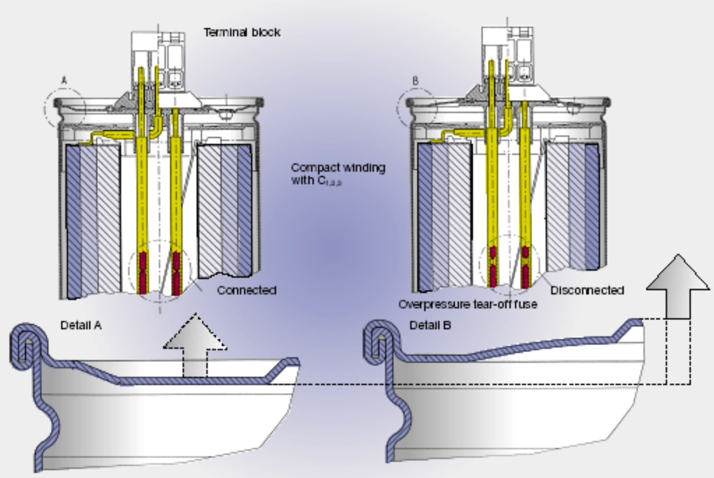
Mechanical and maintenance

- Reduced mounting costs
- Maintenance-free
- Dry design
- Self-healing
- Overpressure disconnector
- Non-flammable
- Touch-proof terminals
- Longterm approved

Environment

- Easy disposal
- Non-polluting
- PCB-free

Overpressure disconnector (tear-off fuse)



PhaseCap Technical Data

Standards	: IEC 60831-1+2, EN 60831-1+2, VDE 560-46+47
Overvoltage	: Umax- UR + 10% (up to 8 h daily) / UR + 15% (up to 30 min daily) / UR + 30% (up to 1 min)
Overcurrent	: Imax 1.3 * IR (in certain cases higher)
Inrush current	: IS 200 * IR
Losses:	
- Dielectric	: < 0.2 W/kvar
- Total	: < 0.45 W/kvar
Rated frequency	: 50/60 Hz
Capacitance tolerance	: –5% / +10%
Test voltage	
- terminal/terminal	: UTT- 2.15 * UR1, AC, 10 s
- terminal/case	: UTC- up to UR . 660 V: 3000 VAC, 10 s; above UR = 660 V: 6000 VAC, 10 s
Useful life	: 115 000 h
Ambient temperature	: –40/D, max. 55 °C, with forced cooling higher ambient temperature possible
Cooling	: natural or forced
Humidity	: max. 95%
Altitude	: 4 000 m above sea level
Mounting position	: random
Mounting	: threaded M12 stud on bottom of case
Safety	: dry technology, overpressure disconnector, self-healing
Discharge resistors	: discharge module included
Case	: extruded aluminum
Enclosure	: IP20, indoor mounting (optionally with cap for IP54)
Dielectric	: polypropylene film
Impregnation	: non-PCB, inert gas
Terminals	: dual, three-way SIGUT terminal strip with electric shock protection (VDE 0106 part 100), max. 16 mm2 cable cross-section
Certification	: cUL file # E96954
Number of switching operations	: 5 000 switchings per year according IEC831

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

Protection & Switching Equipment

A main circuit breaker will be provided as the main protection and at the same time provides as isolation mean during servicing.

All switching devices and protection devices, busbars, cables are designed to carry continuously current of 1.5 times the rated current.

Contactors used are specially selected to withstand maximum inrush current possible to prevent contact welding during operation. Optional electronic switcher for dynamic power factor correction can be provided upon request.

Only NH-type fuses of slow-blow characteristic, i.e. type gL, are used except for dynamic electronic switchers. NH-type fuses serve the purpose of protection against short-circuiting. Rated at minimum 1.5 times the capacitor current in accordance to IEC 60831-1+2 standard.

Controller

BR6000 series (144x144 mm)

All standard models are equipped with BR6000 series PFC controller which offers very intelligent control behavior and is extremely user-friendly due to menu-driven handling (plain language). The multifunctional display makes installation, handling and maintenance as easy as possible.

BR6000 features:

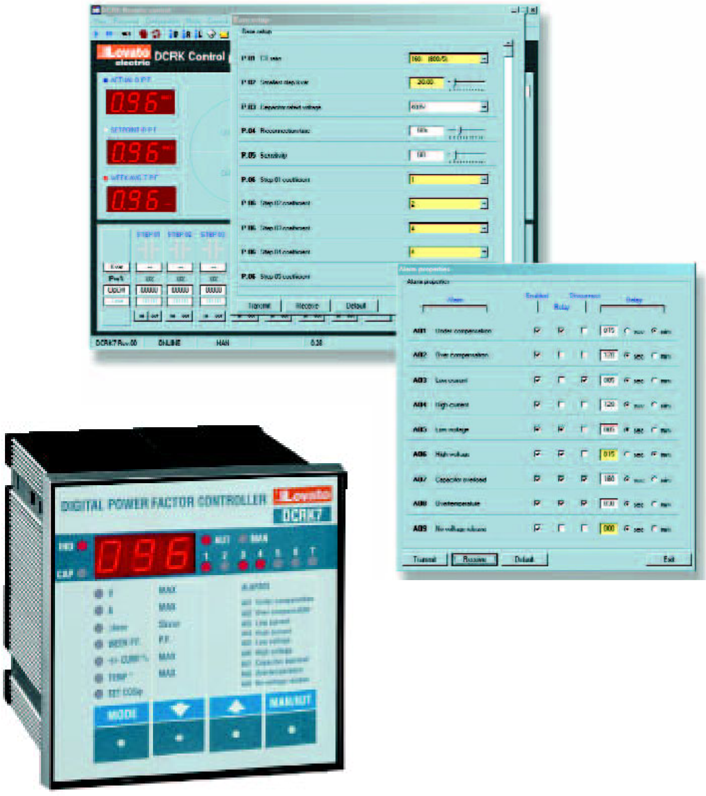
- Display
  Large and multifunctional LCD (2 x 16 characters)
  Graphic and alphanumeric LCD illumination
- Intelligent control
- Menu-driven handling (plain language)
- Self-optimizing control capability

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

- 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 (VAC)
  - Reactive power (kvar)
  - Active power (kW)
  - Frequency
  - THD-V, THD-I
  - Individual harmonics up to 19th order
  - Monitoring of individual capacitor currents
  - Apparent power (kVA)
  - Apparent current (A)
  - Temperature (°C)
  - Real time cos φ
  - Target cos φ
  - kvar value to target cos φ
- Alarm output:
  - Insufficient compensation
  - Overcompensation
  - Undercurrent
  - Overcurrent
  - Overtemperature
  - Harmonics exceeded
  - Treshold value programmable
  - Internal error storage
  - Programming of 2nd signal relay random
- Recall recorded values
  - Number of contactor
  - switching operations
  - Maximum voltage, U (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
- Dynamic PFC (transistor output)
  Thyristor switching

DCRK series (96 x 96 mm for DCRK5/7)

- 5, 7, 8 and 12 step versions, the last two of which are programmable as alarm and/or fan control
- Digital microprocessor regulator for automatic power factor correction systems with output relays for the connection and disconnection of capacitor banks
- RMS voltage and current measurements
- Average weekly power factor measurement (last 7 days)
- Adjustable tripping sensitivity, integral switching time
- Adjustable reconnection time delay
- No-voltage release protection
- Protection against capacitor overload and panel overheating
- Automatic set-up function
- TTL-RS-232 interface with personal computer for: fast set-up, function and alarm customising and automatic electric panel testing
- Installation ease with the use of one external current transformer only.



Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

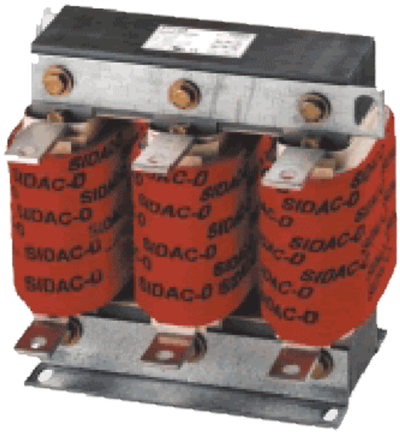
Harmonic Detuned Filters (optional)

The increasing use of modern power electronic apparatus (drives, uninterruptible power supplies, etc) that produce nonlinear current 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 lies typically between 250 and 500 Hz, i.e. in the region of the 5th and 7th harmonics.

Resonance 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. Detuned systems are scaled so 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 50 Hz line frequency, the detuned system acts purely capacitively, thus correcting the reactive power.



Features

- High harmonic overloading capability
- Very low losses
- High linearity to avoid choke tilt
- Low noise
- Simple mounting
- Long useful life
- Temperature protection (NC contact)

Filter Reactors Technical Data

Harmonics	: U_3	= 0.5% UR (ED = 100%)
	U_5	= 6.0% UR (ED = 100%)
	U_7	= 5.0% UR (ED = 100%)
	U_{11}	= 3.5% UR (ED = 100%)
	U_{13}	= 3.0% UR (ED = 100%)
Effective current	: $I_{rms} = \sqrt{(I_1^2+I_3^2 \ldots I_{13}^2)}$	
Fundamental current	: $I_1 = 1.06 * I_R$ (50 Hz current of capacitor)	
Temperature protection	: microswitch (NC)	
Frequency	: 50 / 60 Hz	
Voltage	: 400, 440, 480 V	
Output	: 5 ... 100 kvar	
Detuning	: 5.67%, 7%, 14%	
Cooling natural		
Ambient temperature	: 40 °C	
Standard	: EN 61558/VDE 0532	

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

Ordering Specifications

AET CPFC/CDPFC series low voltage power factor compensation equipment, in accordance with IEC 60831-1+2, EN 60831-1+2, VDE 560-46+47 for improving of cos φ in networks, for indoor application in ventilated rooms with a room temperature of -15°C / +35°C.

Multi-unit cubicle, modular construction, with a power factor control regulator installed in its door, and molded Case Circuit Breaker as mean of isolation, equipped with:

Standard components

- HRC-type drop/insert fuses for protection against short- circuit .
- Capacitor contactors (Optional: with inrush-current damping; Electronic Switchers for dynamic application).
- Low-loss, self-healing MKK-type power capacitors in cylindrical aluminum casings with overpressure tear-off fuses, losses < 0.35 Watt/kvar (total).
- Discharge resistors to IEC/VDE standard, discharge time 1 minute and residual voltage < 50 V.
- Power factor controller BR6000 series , 144 x 144 mm or DCRK series, 96 x 96mm.
- Control fuses and series terminals for connection to the current transformer .
- Thermostat-controlled ventilators (for 200kVAR and above), and air inlet filter in the door .

Optional components:

- Earth fault relay for protection against direct earth fault and settable earth leakage isolation
- Analogue Meters
- Manual by-pass with switching pushbutton for each step
- Space heaters

Ordering code: CPFC/CDPFC □-□-□W / □-□ / □R / □

- CPFC: standard
- CDPFC: with detuned reactors
- 1st □: system voltage, example 400 - 400Volt
- 2nd □: 5 - 50Hz frequency system; 6 - 60Hz frequency system
- 3rd □ (W): 3 - 3Wire system without neutral; 4 - 4 Wire system
- 4th □: bank capacity in kVAR
- 5th □: number of steps
- 6th □ (R): 7 - 7% detuned series reactor; 6 - 6% detuned series reactor; 0 - no reactor
- 7th □: BR - BR6000 series controller; DK - DCRK series controller

Example, CPFC 380-5-4W/300-6/0R/BR denote;

300kVAR capacitor bank consists of 6 steps by 50kVAR rated at 380 Volt, 50Hz.
No series reactor required.
Controller model: BR6000

For dynamic application using electronic switcher,
CPFC and CDPFC shall be replaced with DynaVAR and DynaVARd respectively.

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069

Dimensions and weights

CPFC series – for 415V, 50Hz system.

Ordering Code	Rated output (kVAR)	Step ratio	Main Breaker (A)	Dimensions (WxDxH)mm	App. Weight (kg)
CPFC415-5-4W/015-03/0R/BR	15	05 x 1:1:1	40 (MCB)	400 x 300 x 600	45
CPFC415-5-4W/025-03/0R/BR	25	05 x 1:2:2	63	600 x 400 x 800	50
CPFC415-5-4W/050-06/0R/BR	50	05 x 1:1:2:2...	100	600 x 400 x 1200	65
CPFC415-5-4W/100-06/0R/BR	100	10 x 1:1:2:2...	200	600 x 500 x 1575	80
CPFC415-5-4W/120-06/0R/BR	120	20 x 1:1:1:1...	225	600 x 500 x 2075	100
CPFC415-5-4W/125-05/0R/BR	125	25 x 1:1:1:1...	225	600 x 500 x 2075	110
CPFC415-5-4W/150-06/0R/BR	150	25 x 1:1:1:1...	300	600 x 500 x 2075	120
CPFC415-5-4W/200-04/0R/BR	200	50 x 1:1:1:1	400	600 x 500 x 2075	150
CPFC415-5-4W/200-05/0R/BR	200	25 x 1:1:2:2...	400	600 x 500 x 2075	150
CPFC415-5-4W/250-05/0R/BR	250	50 x 1:1:1:1...	500	600 x 600 x 2075	180
CPFC415-5-4W/300-06/0R/BR	300	50 x 1:1:1:1	600	600 x 600 x 2075	220
CPFC415-5-4W/400-08/0R/BR	400	50 x 1:1:1:1...	800	1200 x 700 x 2075	300
CPFC415-5-4W/500-10/0R/BR	500	50 x 1:1:1:1...	1000	1300 x 800 x 2075	350
CPFC415-5-4W/600-12/0R/BR	600	50 x 1:1:1:1...	1200	1300 x 800 x 2075	400

CDPFC series – for 415V, 50Hz system with 7% detuned reactors

Ordering Code	Rated output (kVAR)	Step ratio	Main Breaker (A)	Dimensions (WxDxH)mm	App. Weight (kg)
CPFC415-5-4W/100-04/7R/BR	100	25 x 1:1:1:1	200	600 x 800 x 2075	200
CPFC415-5-4W/125-05/7R/BR	125	25 x 1:1:1:1...	225	600 x 800 x 2075	220
CPFC415-5-4W/150-03/7R/BR	150	25 x 1:1:1	300	600 x 500 x 2075	250
CPFC415-5-4W/200-04/7R/BR	200	50 x 1:1:1:1...	400	600 x 800 x 2075	300
CPFC415-5-4W/250-05/7R/BR	250	50 x 1:1:1:1...	500	600 x 1000 x 2075	400
CPFC415-5-4W/300-06/7R/BR	300	50 x 1:1:1:1	600	600 x 1000 x 2075	450
CPFC415-5-4W/400-08/7R/BR	400	50 x 1:1:1:1...	800	1200 x 1000 x 2075	500
CPFC415-5-4W/500-10/7R/BR	500	50 x 1:1:1:1...	1000	1300 x 1000 x 2075	600
CPFC415-5-4W/600-12/7R/BR	600	50 x 1:1:1:1...	1200	1300 x 1000 x 2075	800

Customised configuration avaliable upon request.

Asia Electric Technologies, Entrepreneur Business Centre, 18 Kaki Bukit Road 3 #01-05 Singapore 415978 ☎+ 65 62988550, FAX: + 65 62996069