

# $\Phi$ *Cos Phi*

Power Factor & Power Quality Specialists



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# Power Factor and Power Quality Correction Sales & Services!

## Who is Cos Phi?

Cos Phi is a premier Canadian owned Power Factor and Power Quality correction equipment manufacturer and service provider located in Hensall, Ontario.

## Products & Services offered:

- Power Monitoring
- Power Quality Studies
- Harmonic Mitigation
- Complimentary Hydro Billing Analysis
- Power Factor Correction Capacitors
- Static Power Factor Correction Banks (local correction)
- Auto Switching Power Factor Correction Banks (centralized correction)
- Detuning Reactors
- Line/Load Reactors
- Parts & Accessories
- Annual Preventative Maintenance Programs
- Refurbishing & Retro-fitting existing Power Factor Correction Banks



**We service all manufacturers brands of Power Factor Correction Banks!**

For more information visit [www.cosphi.com](http://www.cosphi.com)

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## Some Recent Projects

### Refurbishing & Retro-fit



480kVAR detuned auto-switching Power Factor Correction bank & some static capacitor banks for a polymer/plastics facility



A 20+ year old Cos Phi power factor correction bank was sent in for refurbishing.

The unit was also retrofit with an air conditioning unit to help it deal with an increase in the high ambient temperatures that are being experienced in the location it is installed.

### Custom Design



One of eight custom designed fast auto-switching power factor correction banks built and installed at Queens Park. (Ontario Government House)



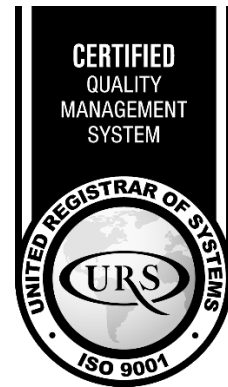
Some of our customers: *Thompsons Limited, Hensall District Co-op, Parrish & Heimbecker, Pepsico, Magna, Great Lakes Copper, Erie Flooring & Wood Products, Sybron Dental, Five Star Tool & Die, Hammond Power Solutions, Green Seafood Limited, Hershey Centre, Toronto Metro Convention Centre*



TECHNICAL SPECIFICATION  
FOR 600V, 480V & 208V  
DETUNED AUTOMATIC  
POWER FACTOR  
CORRECTION BANKS

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## 1.0 Equipment Size / Ratings

### 1.1 600V

1.1.1 System operating voltage (line-to-line): 600V, 3-phase, 60Hz.  
Capacitors shall be rated minimum 690V to protect against current and voltage overload due to harmonic distortion.

1.1.2 kVAR range: 60 to 1080 kVAR

1.1.3 Steps size configuration:

60 kVAR, 40kVAR, 20kVAR (e.g. 180 kVAR = 3\*60 kVAR, OR ((1\*20 kVAR) + (1\*40 kVAR) + (2\*60 kVAR))), for sensitive or seasonal loads.

### 1.2 480V

1.2.1 System operating voltage (line--line): 480V, 3-phase, 60Hz.  
Capacitors shall be rated minimum 600V to protect against current and voltage overload due to harmonic distortion.

1.2.2 kVAR range: 50 to 950 kVAR

1.2.3 Steps size configuration:

50 kVAR (e.g. 150 kVAR = 3\*50 kVAR).

### 1.3 208V

1.3.1 System operating voltage (line-to-line): 208V, 3-phase, 60Hz.  
Capacitors shall be rated minimum 230V to protect against current and voltage overload due to harmonic distortion.

1.3.2 kVAR range: 20 to 420 kVAR

1.3.3 Steps size configuration:

20 kVAR (e.g. 200 kVAR = 10\*20 kVAR).

## 2.0 Capacitors

- 2.1 Individual capacitors shall be, 3-phase, delta connected, gas filled under vacuum, and of a self-healing design utilizing a low loss metallized polypropylene film dielectric system with an over-pressure internal disconnect. Metallized paper is not acceptable.
- 2.2 Capacitor casing shall be of a seamless aluminum design. Electrical losses shall be less than 0.25w/kVAr.
- 2.3 Dielectric fluid shall be high flash point, biodegradable, non-toxic and contain no PCB's. Capacitors shall include a grounding/mounting stud at the bottom of the capacitor cell for easy replacement.
- 2.4 Capacitors shall be rated for a minimum of 135% continuous current overload and 110% continuous voltage overload based on the 690 Volt rating of the capacitors.
- 2.5 Individual capacitor cells shall not exceed 25 kVAr at the system voltage to keep replacement costs at a minimum.
- 2.6 Capacitors shall be suitable for -50°C to +65°C ambient temperature.
- 2.7 Dry type capacitors and / or capacitors without a pressure sensitive circuit interrupter are not acceptable.

## 3.0 Discharge Resistors

- 3.1 Adequate discharge resistors shall be provided for each capacitor cell to reduce the voltage to 50 Volts or less in one minute after disconnection of supply voltage.

## 4.0 Detuning Reactors (Filters/Chokes)

- 4.1 Filter tuning frequency shall be 3.78 x 60 Hz (227 Hz). Filtering factor shall be 7% by default, or 14% upon request (e.g. for systems with high harmonic distortion).
- 4.2 Harmonic filtering reactors shall be three phase iron core. Reactor maximum continuous RMS amperage shall be sized to match the maximum continuous RMS amperage of the capacitors.
- 4.3 In no case shall the harmonic filtering reactor size exceed 60 kVAr at the system voltage to allow for ease of replacement.
- 4.4 Core material : Grain oriented electric steel.

- 4.5 Winding material: Al foil. Insulation : Nomex , Temp class H 180 dec C .
- 4.6 Temperature switch 145 dec C +-5% . NTC type

## 5.0 Contactors

- 5.1 Contactors shall be 3 phase, IEC rated, and rated for capacitor switching duty. Contactors must be capable of switching 135% of the nominal amperage of the capacitors being switched. The contactors shall be capable of switching the maximum continuous rms amperage rating of the capacitors. Contactor coils shall be 120 Volt, 60 Hz. Contactors must include a current limiting resistor kit.

## 6.0 HRC Fusing

- 6.1 3 HRC fuses shall be included for each contactor. A4J fuses shall have a minimum interrupting rating of 100 kA. Fast acting fuses shall be sized for at least 135% of the nominal amperage of the capacitors to prevent clearing on inrush.

## 7.0 Digital Microprocessor Controller

- 7.1 The digital microprocessor controller shall be a minimum 8 steps .
- 7.2 Adjustable target power factor from 0.5 IND to 0.5 CAP.
- 7.3 Automatic free selection or LIFO logic of step insertion.
- 7.4 Automatic or manual switching of steps.
- 7.5 Option of selecting switched steps as fixed steps.
- 7.6 Selectable step reconnection time of 1-30.000 seconds.
- 7.7 Selectable sensitivity delay of 1-1000 seconds.
- 7.8 Manual selection of CT ratio, primary 1-30,000A, secondary 5A.
- 7.9 Automatic detection of CT polarity.



- 7.10 Option for 3 CTs to measure 3 phase current.
- 7.11 Measuring voltage range of 100 - 600 Volts on 3 phases without potential transformer.
- 7.12 Aux. power supply of 120V .
- 7.13 Multimeter capability including waveform, system power (kW, kVA, kVA<sub>r</sub>), Voltage (L-L & L-N) Amperage (L1, L2, L3), energy meter (kWh, kVA<sub>r</sub>h, kVAh) and harmonic measurement to 31<sup>st</sup> order.
- 7.14 Time and date settings.
- 7.15 Temperature sensor adjustable from 0 to 212°C and output relay for fan control.
- 7.16 Alarm relay for temperature above set point, individual harmonic current distortion above set point, total harmonic current distortion above set point, power factor below target set point.
- 7.17 Selection of activation or deactivation of individual alarms.
- 7.18 Display shows error code for alarms when in alarm status and dry alarm contact closes in alarm condition.
- 7.19 No voltage release switches out all capacitors in case of interruption of supply voltage.
- 7.20 Monitors and displays quantity of individual step operations for determining contactor wear.
- 7.21 Monitors and displays quantity of individual step operating hours for determining capacitor wear.
- 7.22 Displays a fault when any step current is reduced to zero indicating faulty step components.
- 7.23 Communications via optical programming interface standard (USB/Wifi programming dongle available as adder).
- 7.24 Key board locking feature to prevent unauthorized tampering.

## 8.0 Split Core Current Transformer

- 8.1 A split core current transformer of adequate size, ratio, and burden shall be supplied.

## 9.0 Termination

- 9.1 A suitably sized three pole distribution block shall be provided for feeder termination. Ground terminals shall be provided for ground wire termination.
- 9.2 Standard feeder cable entry location is on top. Other locations can be specified during the quoting phase.

## 10.0 Enclosure

- 10.1 Enclosures shall be of at least the minimum gauge steel as required by code. Enclosures shall be made suitable for the installation location. NEMA 12 style enclosures will be used by default. NEMA 3R style can be specified where appropriate.
- 10.2 Thermostatically controlled ventilation shall be sized to maintain a maximum temperature of 45°C inside the enclosure at the extreme high ambient temperature.
- 10.3 Drip shields, air filters for dust, moisture, and vermin shall also be included for NEMA 3R enclosures. Air filters for dust shall be included for NEMA 12 style enclosures. The controller shall be semi-flush mounted on the door for NEMA 1 applications. The controller shall be mounted behind a hinged safety glass cover and the display visible for NEMA 3R.
- 10.4 Adequately sized control transformer and control fuses shall be provided for all controls including heating and cooling.
- 10.5 All components must be suitably mounted to provide ease of replacement with front access only. All enclosure mounting hardware and framework shall be either galvanized steel or zinc plated steel for grounding continuity. Painted mounting hardware and framework with paint removed for grounding is not acceptable. All enclosure parts other than mounting hardware and framework shall be powder coated RAL 7035 (standard) or ASA 61 Grey (Custom).



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- 10.6 The enclosure door shall have a lockable handle. One double-bit key will be supplied with every enclosure.
- 10.7 Minimum ambient temperature: -20°C Maximum ambient temperature: 35°C
- 10.8 To maintain warranty in a >35°C ambient environment, an air conditioner unit must be installed.

## 11.0 Labelling

- 11.1 A "Wait one minute after disconnection from supply" label shall be located on the enclosure door. A "Wait five minutes after disconnection from supply" label shall be provided loose for the disconnecting device. Both labels shall be worded as per code requirements.

## 12.0 Testing

- 12.1 Testing shall be performed as per CSA and ESA standards. All assemblies must bear a certification label. For filtered units, a confirmation of the filter tuning frequencies must be performed prior to shipment.

## Applications

- Branch panels
- Main Service Entrance

## Standard Ratings

- 100kVAR-1200kVAR (custom sizes available)
- 208, 480, 600V
- 3-phase
- 60 Hz
- De-rated or detuned (choked) configurations

## Capacitor Cells

- 200,000 – hour rated life
- 3-phase delta connected
- MKP, dry inert gas N<sub>2</sub>
- Low loss - 0.2 W per kVAR
- Internal overpressure disconnect
- Touch safe terminals

## Enclosure

- NEMA 12 style for indoor use
- Wall-mounted or free-standing with hinged door and lockable door handle

## Field Wiring Termination

- Mechanical connections provided for all field wiring termination points

## Microprocessor base “intelligent” controller

- Backlight graphic 128 x 80 pixel LCD with text in 10 languages
- Automatic sensing of CT current flow
- Connection to single and three phase lines, three phase lines with neutral and co-generation systems with 4 quadrant operation
- Capability to correctly operate in systems having high harmonic content
- Extreme reduction of the number of switching operations
- Balanced use of steps with the same power rating
- Reactive power measurement per installed step
- Recording of the number of connections per step
- Capacitor over-current protection on all three phases
- Over-temperature protection by internal sensor
- Accurate no-voltage release protection function
- Current and voltage harmonic analysis
- Harmonic analysis of current and voltage waveforms recorded for overload events
- Quick CT programming function

## Additional Controller functionality options:

- USP and Wi-Fi communication interface for personal computer, smartphone and table connection
- Modbus-RTU, TCP and ASCII communications protocols
- Set-up and remote control software
- SMS sending for alarm conditions with EXP10 15 expansion module



## Inrush limiting magnetic contactor

- Reduced I<sup>2</sup>R losses
- Eliminate current inrush or ring waves when switching

## Options

- Circuit breaker or disconnect switch
- Other enclosure ratings
- Surge Protection device
- Installation and Commissioning
- Equipment financing
- Preventive Maintenance Services

3 yr Warranty (extendable)



## 600V Auto-Switching Power Factor Correction Bank

Part #	kVAR	Step Configuration (kVAR)	Rated Current (A)	Breaker Size Required (A)	Base Shipping Weight lb / kg	Dimensions Standard W x D x H (mm)	Standard Wire Lug Size
CPA120/600/X/D/N1	120	2 x 60	115.4	250	600lbs/272kg	600 x 600 x 2000	350mcm (or 2x 2/0)
CPA120/600/X/D/N1+		1 x 20, 1 x 40, 1 x 60	115.4	250	600lbs/272kg	600 x 600 x 2000	350mcm (or 2x 2/0)
CPA180/600/X/D/N1	180	3 x 60	173.2	250	700lbs/318kg	600 x 600 x 2000	350mcm (or 2x 2/0)
CPA180/600/X/D/N1+		1 x 20, 1 x 40, 2 x 60	173.2	250	700lbs/318kg	600 x 600 x 2000	350mcm (or 2x 2/0)
CPA240/600/X/D/N1	240	4 x 60	230.9	350	800lbs/363kg	600 x 600 x 2000	2x 3/0
CPA300/600/X/D/N1	300	5 x 60	288.7	400	1000lbs/454kg	800 x 600 x 2000	2x4/0
CPA360/600/X/D/N1	360	6 x 60	346.4	500	1200lbs/545kg	1000 x 600 x 2000	2x350mcm
CPA420/600/X/D/N1	420	7 x 60	404.2	600	1400lbs/635kg	1200 x 600 x 2000	3x4/0
CPA480/600/X/D/N1	480	8 x 60	461.9	700	1500lbs/680kg	1200 x 600 x 2000	3x250mcm
CPA540/600/X/D/N1	540	9 x 60	519.6	800	1800lbs/817kg	1600 x 600 x 2000	3x350mcm
CPA600/600/X/D/N1	600	10 x 60	577.4	800	2000lbs/908kg	1600 x 600 x 2000	3x350mcm

## 600V Auto-Switching Power Factor Correction Bank - with Installed Breaker

	kVAR	Step Configuration (kVAR)	Rated Current (A)	Breaker Size (A)	Breaker Interrupting Rating (KA)	Base Shipping Weight w/Breaker lb / kg	Dimensions w/Breaker W x D x H (mm)	Standard Wire Lug Size
CPA120/600/1/D/N1	120	2 x 60	115.4	250	50	650lbs/295kg	600 x 600 x 2200	350mcm (or 2x 2/0)
CPA120/600/1/D/N1+		1 x 20, 1 x 40, 1 x 60	115.4	250	50	750lbs/430kg	800 x 600 x 2200	350mcm (or 2x 2/0)
CPA180/600/1/D/N1	180	3 x 60	173.2	250	50	850lbs/386kg	800 x 600 x 2200	350mcm (or 2x 2/0)
CPA180/600/1/D/N1+		1 x 20, 1 x 40, 2 x 60	173.2	250	50	850lbs/386kg	800 x 600 x 2200	350mcm (or 2x 2/0)
CPA240/600/1/D/N1	240	4 x 60	230.9	350	50	950lbs/431kg	800 x 600 x 2200	2x 3/0
CPA300/600/1/D/N1	300	5 x 60	288.7	400	50	1200lbs/545kg	1200 x 600 x 2200	2x4/0
CPA360/600/1/D/N1	360	6 x 60	346.4	500	50	1400lbs/635kg	1200 x 600 x 2200	2x350mcm
CPA420/600/1/D/N1	420	7 x 60	404.2	600	50	1600lbs/726kg	1600 x 600 x 2200	3x4/0
CPA480/600/1/D/N1	480	8 x 60	461.9	700	50	1800lbs/817kg	1600 x 600 x 2200	3x250mcm
CPA540/600/1/D/N1	540	9 x 60	519.6	800	50	2000lbs/908kg	1600 x 600 x 2200	3x350mcm
CPA600/600/1/D/N1	600	10 x 60	577.4	800	50	2200lbs/998lbs	1600 x 600 x 2200	3x350mcm

Available in other sizes and step configurations

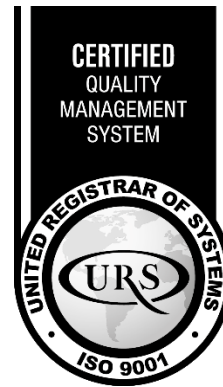
Thyristor switching available



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# TECHNICAL SPECIFICATION FOR STATIC POWER FACTOR CORRECTION BANKS

V2.0 18/01/2019





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## 1.0 Enclosures

- 1.1 NEMA 1 style, RAL 7040.
- 1.2 Connection terminal block included when required.
- 1.3 Utilizing capacitor cells as defined below (see 2.0).
- 1.4 All banks shall have grounding lug provided.
- 1.5 All enclosures to include specifications label.

## 2.0 Capacitors

- 2.1 Individual capacitors shall be delta connected N<sub>2</sub> gas-filled, 3 phase cells, manufactured with metalized polypropylene film. Wye connected capacitors are not acceptable.
- 2.2 Each three-phase capacitor shall contain internal over pressure disconnect protection.
- 2.3 Electrical losses including contribution of discharge resistors shall be <0.25W/kVAR.
- 2.4 Terminal bushing shall withstand 10kV AC to ground and be rated to 35BIL or greater and shall be totally enclosed, including touch safe housing discharge resistors.
- 2.5 Nominal design life of individual capacitor cells shall be 150,000-200,000 hours depending on conditions.
- 2.6 Individual capacitors shall be covered by a 3-year warranty.
- 2.7 All capacitor cells shall have a terminal block, lug type terminal, four-wire connection.
- 2.8 No individual capacitor in a static capacitor bank shall exceed 50kVAR @ 600V, 50kVAR @ 480V or 12.5kVAR @208V.





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- 2.9 Capacitor cells shall be designed to handle the increase in voltage from a de-tuning reactor when cell contains one.
- 2.10 Over-current rating according to standards, 1.5 or more ( $I_N$ ).
- 2.11 Maximum permissible rate of change in switching operation  $(DV/DT)_{\max}$  shall be a minimum of 30V/ $\mu$ s or greater.
- 2.12 The capacitor shall be rated for continuous duty at 45-degree C ambient.
- 2.13 A +/- 10% variation in the line voltage shall not affect the life of the capacitor.

### 3.0 Testing and Installation

- 3.1 All capacitor cells shall be traceable through construction and testing.

### 4.0 General

- 4.1 Acceptable manufacturer: Cos Phi
- 4.2 All capacitor banks shall be calculated for natural series resonant point in order to avoid resonance.
- 4.3 All capacitor banks for non-lineal loads up to 20% of the total load shall be standard.
- 4.4 All capacitor banks for non-lineal loads of 20-50% of the total load shall be de-rated and/or detuned (i.e. have filter reactors).
- 4.5 All banks for non-lineal loads of more than 50% of the total load shall be of a harmonic filter design (i.e. sharply tuned).
- 4.6 The following standard type tests shall be performed and passed:
  - 4.6.1 Resistance check.
  - 4.6.2 Capacitance check.
  - 4.6.3 Hi-pot test.
- 4.7 All capacitor banks shall be sized and designed to cope with non-lineal loads.
- 4.8 All fuses for the capacitor banks or steps shall be no less than 100kA interrupting capacity.



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- 4.9 In filtered units, capacitors shall be de-rated at 600V from 690V, at 480V from 600V, at 208V from 230V.
- 4.10 De-tuning Reactors when used shall have a gap between the iron core and the winding of no less than 5mm all the way around the iron core.
- 4.11 All detuning reactors shall be built as such that the thermal currents can escape easily and located in the bank in such manner that the heat will not affect the capacitors (reactors away from or above capacitors).

Inductive loads can demand large amounts of reactive power which reduces the overall facility power factor. The full load power factor of individual motors can range from 0.60 to 0.93 and drops as the load is reduced. Since many motors operate well below full load conditions, typical power factors may be much lower than stated on the motor nameplate. When capacitors are added to motors, the capacitor supplies the reactive power needs of the motor, thus improving power factor at this point and all points upstream from it. Both the facility and the electric utility benefit when fixed capacitors are applied right at the motor or other inductive load.



208V		Capacitance μF	Dimensions mm			Encl. Fig #	Weight* (kg)	Single Phase
kVAR	Part #		W	D	H			Current (A)
0.5	CPS0.5/208C1	3 x	260	170	406	1	5	1.39
0.8	CPS0.8/208C1	3 x	260	170	406	1	5	2.22
1.5	CPS1.5/208C1	3 x	260	170	406	1	5	4.16
2	CPS2/208C1	3 x	260	170	406	1	5	5.55
2.5	CPS2.5/208C1	3 x	260	170	406	1	5	6.94
3	CPS3/208C1	3 x	260	170	406	1	5	8.33
4	CPS4/208C1	3 x	260	170	406	1	5	11.1
5.5	CPS5.5/208C1	3 x	260	170	406	1	5	15.3
6	CPS6/208C1	3 x	260	170	406	1	5	16.7
8	CPS8/208C1	3 x	430	170	525	1	5	22.2
10.5	CPS10.5/208C1	3 x	430	170	525	1	5	29.2

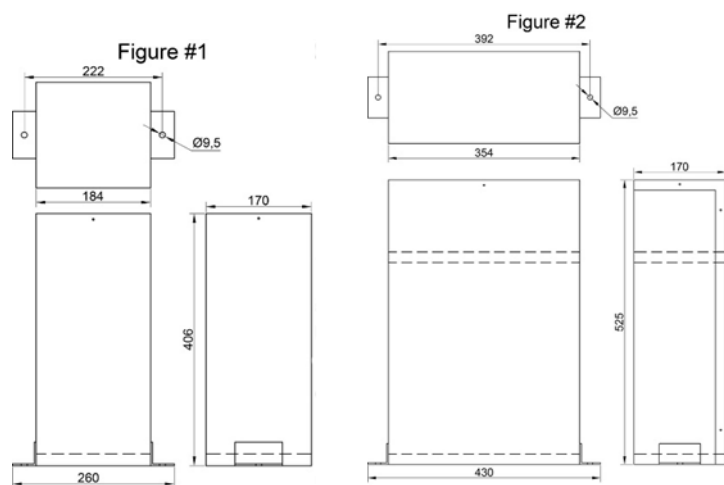
\* weight is approximate  
(Other sizes available)

### Features

- 3-year warranty
- NEMA 1 Enclosure RAL 7040 Gray
- Small footprint, saving floor space
- De-rated from 230V to 208V
- Delta-connected
- Internal over-pressure disconnect
- Internal discharge resistors
- 20 year expected lifespan
- All capacitor banks ESA inspected

### Options

- Fused
- LED status indicators
- De-tuning reactors



Measurements in mm

Inductive loads can demand large amounts of reactive power which reduces the overall facility power factor. The full load power factor of individual motors can range from 0.60 to 0.93 and drops as the load is reduced. Since many motors operate well below full load conditions, typical power factors may be much lower than stated on the motor nameplate. When capacitors are added to motors, the capacitor supplies the reactive power needs of the motor, thus improving power factor at this point and all points upstream from it. Both the facility and the electric utility benefit when fixed capacitors are applied right at the motor or other inductive load.



480V kVAR	Part #	Capacitance μF	Dimensions mm			Encl. Fig #	Weight (kg)	Single Phase Current (A)
			W	D	H			
2	CPS2/480C1	3 x 7.4	260	170	406	1	5	2.4
3	CPS3/480C1	3 x 12.3	260	170	406	1	5	3.6
5	CPS5/480C1	3 x 18.4	260	170	406	1	5	6.0
6	CPS6/480C1	3 x 24.6	260	170	406	1	5	7.2
10	CPS10/480C1	3 x 36.9	260	170	406	1	5	12.0
11	CPS11/480C1	3 x 43.0	260	170	406	1	5	13.2
13	CPS13/480C1	3 x 50.7	260	170	406	1	5	15.7
15	CPS15/480C1	3 x 58.0	260	170	406	1	5	18.1
16	CPS16/480C1	3 x 61.4	260	170	406	1	5	19.3
19	CPS19/480C1	3 x 73.7	430	170	525	2	5	22.8
22	CPS22/480C1	3 x 86.0	430	170	525	2	11	26.5
26	CPS26/480C1	3 x 98.3	430	170	525	2	11.5	31.3

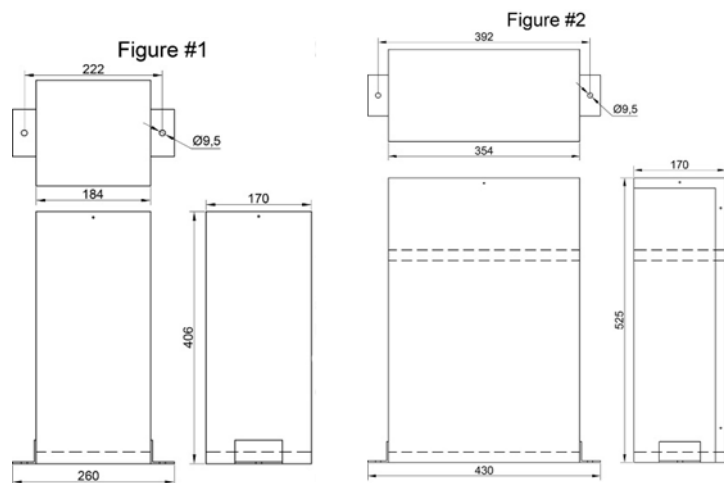
\* weight is approximate  
(Other sizes available)

### Features

- 3-year warranty
- NEMA 1 Enclosure RAL 7040 Gray
- Small footprint, saving floor space
- De-rated from 600V or 525V to 480V
- Delta-connected
- Internal over-pressure disconnect
- Internal discharge resistors
- 20 year expected lifespan
- All capacitor banks ESA inspected

### Options

- Fused
- LED status indicators
- De-tuning reactors



Measurements in mm



Inductive loads can demand large amounts of reactive power which reduces the overall facility power factor. The full load power factor of individual motors can range from 0.60 to 0.93 and drops as the load is reduced. Since many motors operate well below full load conditions, typical power factors may be much lower than stated on the motor nameplate. When capacitors are added to motors, the capacitor supplies the reactive power needs of the motor, thus improving power factor at this point and all points upstream from it. Both the facility and the electric utility benefit when fixed capacitors are applied right at the motor or other inductive load.



600V kVAR	Part #	Capacitance μF	Dimensions mm			Encl. Fig #	Weight (kg)	Single Phase Current (A)
			W	D	H			
4	CPS4/600C1	3 x 9.3	260	170	406	1	5	3.6
6	CPS6/600C1	3 x 14.0	260	170	406	1	5	5.5
8	CPS8/600C1	3 x 18.6	260	170	406	1	5	7.3
10	CPS10/600C1	3 x 23.2	260	170	406	1	5	9.1
11	CPS11/600C1	3 x 27.9	260	170	406	1	6	10.9
13	CPS13/600C1	3 x 32.5	260	170	406	1	6	12.7
15	CPS15/600C1	3 x 37.1	260	170	406	1	6	14.6
19	CPS19/600C1	3 x 46.4	260	170	406	1	6	18.2
23	CPS23/600C1	3 x 55.7	260	170	406	1	7	21.8
27	CPS27/600C2	3 x 65.0	430	170	525	2	11	25.5
30	CPS30/600C2	3 x 74.3	430	170	525	2	11.5	29.1
34	CPS34/600C2	3 x 83.6	430	170	525	2	11.5	32.7

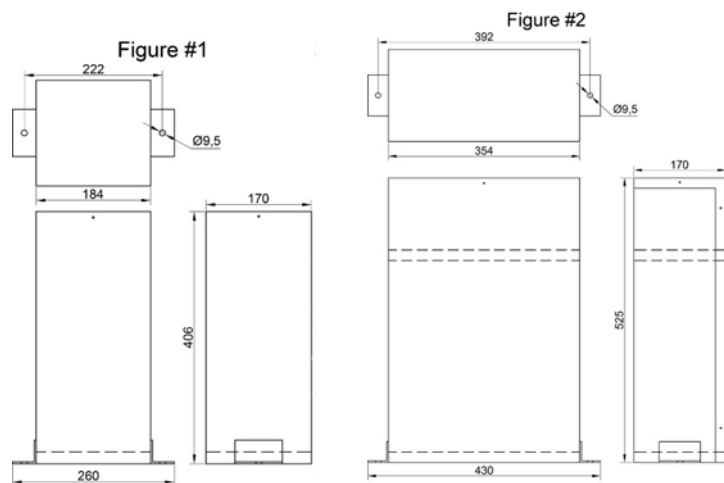
\* weight is approximate  
(Other sizes available)

### Features

- 3-year warranty
- NEMA 1 Enclosure RAL 7040 Gray
- Small footprint, saving floor space
- De-rated from 690V to 600V
- Delta-connected
- Internal over-pressure disconnect
- Internal discharge resistors
- 20 year expected lifespan
- All capacitor banks ESA inspected

### Options

- Fused
- LED status indicators
- De-tuning reactors



Measurements in mm

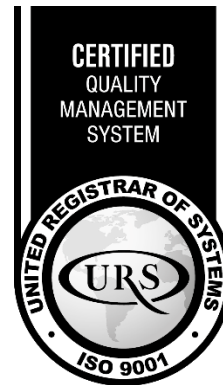


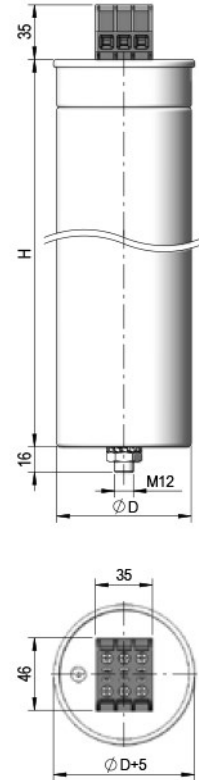
TECHNICAL  
SPECIFICATION FOR  
230V, 480V, 600V, 690V  
POWER FACTOR  
CAPACITORS

V1.0 24/01/2019

$\Phi$  *Cos Phi*

Power Factor & Power Quality Specialists

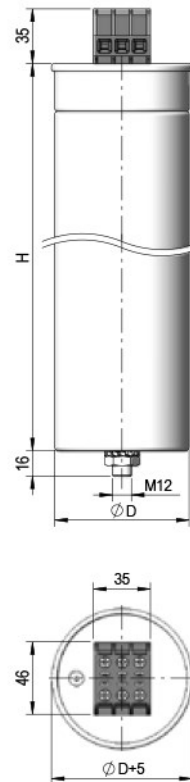




Part #	Power kVAR	Capacitance $\mu\text{F}$	Current $I_n$ (A)	Weight (kg)	Dimensions D x H (mm)
CVADG 2.0,23,0.6,60	0.6	30.1	2.6	0.5	85 x 100
CVADG 2.0,23,1,60	1	50.2	4.3	0.6	85 x 100
CVADG 2.0,23,1.5,60	1.5	75.2	6.5	0.6	85 x 100
CVADG 2.0,23,1.67,60	1.67	83.7	7.3	0.6	85 x 100
CVADG 2.0,23,2,60	2	100	8.7	0.7	85 x 100
CVADG 2.0,23,2.5,60	2.5	125	10.9	0.7	85 x 100
CVADG 2.0,23,3,60	3	151	13	0.7	85 x 100
CVADG 2.0,23,3.3,60	3.3	166	14.3	0.7	85 x 100
CVADG 2.0,23,4,60	4	201	17.4	0.9	85 x 100
CVADG 2.0,23,5,60	5	251	21.7	0.9	85 x 100
CVADG 2.0,23,7.5,60	7.5	376	32.6	1.2	85 x 175
CVADG 2.0,23,10,60	10	502	43.5	2.9	85 x 175
CVADG 2.0,23,12.5,60	12.5	627	54.3	2.9	85 x 245

### General Specifications

<b>Frequency:</b> 50 / 60 Hz	<b>Inrush current:</b> Max $400 \times I_N$
<b>Max Over Voltage:</b> $U_n + 10\%$ (up to 8 hrs daily) $U_N + 15\%$ (up to 30 minutes daily) $U_N + 20\%$ (up to 5 minutes) $U_N + 30\%$ (up to 1 minute)	<b>Life:</b> 150,000-200,000 (depending on voltage & temperature)
<b>Overcurrent:</b> $1.5 - 2.0 \times I_N$	<b>Mounting:</b> M12 Stud on bottom, Any position
<b>Capacitance tolerance:</b> -5 / +10%	<b>Degree of Protection:</b> IP20
<b>Test Voltage, terminal/terminal:</b> $2.15 \times U_N$ , AC, 2 s	<b>Max above sea level:</b> 4000 m
<b>Test Voltage, terminal/case:</b> $U_N < 500\text{V}$ : 3000V AC, 10s $U_N > 500\text{V}$ : $2 \times U_N + 2000\text{V}$ AC, 10s	<b>Case:</b> Aluminum
	<b>Dielectric:</b> MKP—metalized PP fim
	<b>Impregnant:</b> Dry, inert gas $N_2$
	<b>Discharge Resistors:</b> Included - 50V, 1minute or 75V, 3 minutes.
	<b>Standards:</b> IEC 60831-1+2, EN 60831-1+2, GOST



Part #	Power kVAR	Capacitance µF 3x	Current I <sub>n</sub> (A) 3x	Weight (kg)	Dimensions D x H (mm)
CSADG 1.0,23,0.6,60	0.6	10	1.5	0.5	85 x 175
CSADG 1.0,23,1,60	1	16.7	2.5	0.6	85 x 175
CSADG 1.0,23,1.5,60	1.5	25.1	3.8	0.7	85 x 175
CSADG 1.0,23,1.67,60	1.67	27.9	4.2	0.7	85 x 175
CSADG 1.0,23,2,60	2	33.4	5	0.7	85 x 175
CSADG 1.0,23,2.5,60	2.5	41.8	6.3	0.7	85 x 245
CSADG 1.0,23,3,60	3	50.2	7.5	0.9	85 x 245
CSADG 1.0,23,3.3,60	3.3	55.2	8.3	0.9	85 x 245
CSADG 1.0,23,4,60	4	66.9	10	1.0	85 x 245
CSADG 1.0,23,5,60	5	83.6	12.6	1.1	85 x 245
CSADG 1.0,23,7.5,60	7.5	125	18.8	1.3	85 x 245
CSADG 1.0,23,10,60	10	167	25.1	1.7	110 x 245
CSADG 1.0,23,12.5,60	12.5	209	31.4	2.0	110 x 245

### General Specifications

**Frequency:** 50 / 60 Hz

**Inrush current:** Max 400 x I<sub>N</sub>

**Max Over Voltage:**

- U<sub>n</sub> + 10% (up to 8 hrs daily)
- U<sub>N</sub> + 15% (up to 30 minutes daily)
- U<sub>N</sub> + 20% (up to 5 minutes)
- U<sub>N</sub> + 30% (up to 1 minute)

**Life:** 150,000-200,000 (depending on voltage & temperature)

**Mounting:** M12 Stud on bottom, Any position

**Degree of Protection:** IP20

**Overcurrent:** 1.5 – 2.0 \* I<sub>N</sub>

**Max above sea level:** 4000 m

**Capacitance tolerance:** -5 / +10%

**Case:** Aluminum

**Test Voltage, terminal/terminal:**  
2.15 \* U<sub>N</sub>, AC, 2 s

**Dielectric:** MKP—metalized PP fim

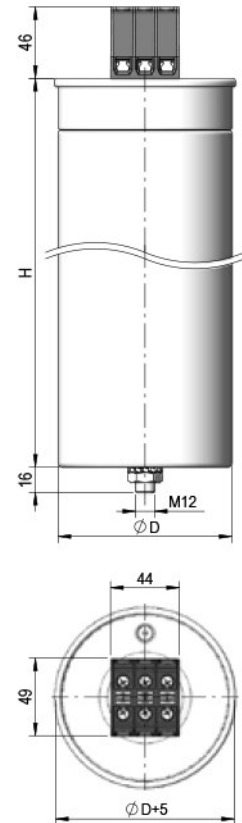
**Impregnant:** Dry, inert gas N<sub>2</sub>

**Test Voltage, terminal/case:**

- U<sub>N</sub> < 500V: 3000V AC, 10s
- U<sub>N</sub> > 500V: 2 x U<sub>N</sub> + 2000V AC, 10s

**Discharge Resistors:** Included - 50V, 1minute or 75V, 3 minutes.

**Standards:** IEC 60831-1+2, EN 60831-1+2, GOST



Part #	Power kVAR	Capacitance $\mu\text{F}$ 3x	Current $I_n$ (A) 3x	Weight (kg)	Dimensions D x H (mm)
CSADG 1.0,48,3,60	3	11.5	3.6	0.8	85 x 175
CSADG 1.0,48,5,60	5	19.2	6.0	0.9	85 x 175
CSADG 1.0,48,7.5,60	7.5	28.8	9.0	1.0	85 x 245
CSADG 1.0,48,10,60	10	38.4	12.0	1.0	85 x 245
CSADG 1.0,48,12.5,60	12.5	48.0	15.0	1.1	85 x 245
CSADG 1.0,48,15,60	15	57.6	18.1	1.2	85 x 245
CSADG 1.0,48,17.5,60	17.5	67.2	21.0	1.6	110 x 245
CSADG 1.0,48,20,60	20	76.8	24.0	1.9	110 x 245
CSADG 1.0,48,25,60	25	95.9	30.1	2.1	110 x 245
CSADG 1.0,48,30,60	30	115.0	36.1	2.6	136 x 220

## General Specifications

**Frequency:** 50 / 60 Hz

**Inrush current:** Max  $400 \times I_N$

**Max Over Voltage:**

- Un + 10% (up to 8 hrs daily)
- UN + 15% (up to 30 minutes daily)
- UN + 20% (up to 5 minutes)
- UN + 30% (up to 1 minute)

**Life:** 150,000-200,000 (depending on voltage & temperature)

**Mounting:** M12 Stud on bottom, Any position

**Degree of Protection:** IP20

**Overcurrent:**  $1.5 - 2.0 \times I_N$

**Max above sea level:** 4000 m

**Capacitance tolerance:** -5 / +10%

**Case:** Aluminum

**Test Voltage, terminal/terminal:**  
 $2.15 \times U_N$ , AC, 2 s

**Dielectric:** MKP—metalized PP fim

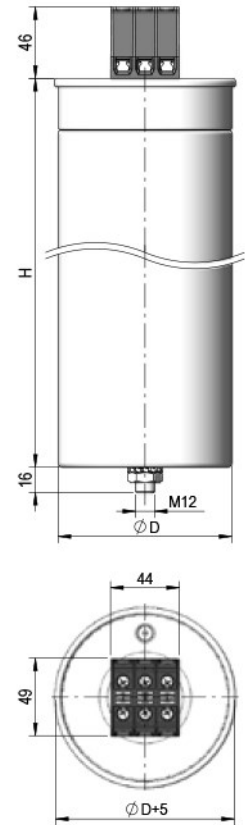
**Impregnant:** Dry, inert gas  $N_2$

**Test Voltage, terminal/case:**  
 $U_N < 500\text{V}$ : 3000V AC, 10s  
 $U_N > 500\text{V}$ :  $2 \times U_N + 2000\text{V}$  AC, 10s

**Discharge Resistors:** Included - 50V, 1minute or 75V, 3 minutes.

**Standards:** IEC 60831-1+2, EN 60831-1+2, GOST





Part #	Power kVAR	Capacitance $\mu\text{F}$ 3x	Current $I_n$ (A) 3x	Weight (kg)	Dimensions D x H (mm)
CSADG 1.0,6,3,60	3	7.4	2.9	0.7	85 x 220
CSADG 1.0,6,5,60	5	12.3	4.8	0.9	85 x 220
CSADG 1.0,6,7.5,60	7.5	18.4	7.2	0.9	85 x 220
CSADG 1.0,6,10,60	10	24.6	9.6	1.1	85 x 245
CSADG 1.0,6,12.5,60	12.5	30.7	12.0	1.3	85 x 245
CSADG 1.0,6,15,60	15	36.9	14.4	1.7	110 x 245
CSADG 1.0,6,17.5,60	17.5	43.0	16.8	1.8	110 x 245
CSADG 1.0,6,20,60	20	49.1	19.2	1.9	110 x 245
CSADG 1.0,6,25,60	25	61.4	24.1	2.0	110 x 245
CSADG 1.0,6,30,60	30	73.7	28.9	2.9	136 x 220

## General Specifications

**Frequency:** 50 / 60 Hz

**Inrush current:** Max  $400 \times I_N$

**Max Over Voltage:**

- Un + 10% (up to 8 hrs daily)
- UN + 15% (up to 30 minutes daily)
- UN + 20% (up to 5 minutes)
- UN + 30% (up to 1 minute)

**Life:** 150,000-200,000 (depending on voltage & temperature)

**Mounting:** M12 Stud on bottom, Any position

**Degree of Protection:** IP20

**Overcurrent:**  $1.5 - 2.0 \times I_N$

**Max above sea level:** 4000 m

**Capacitance tolerance:** -5 / +10%

**Case:** Aluminum

**Test Voltage, terminal/terminal:**  
 $2.15 \times U_N$ , AC, 2 s

**Dielectric:** MKP—metalized PP fim

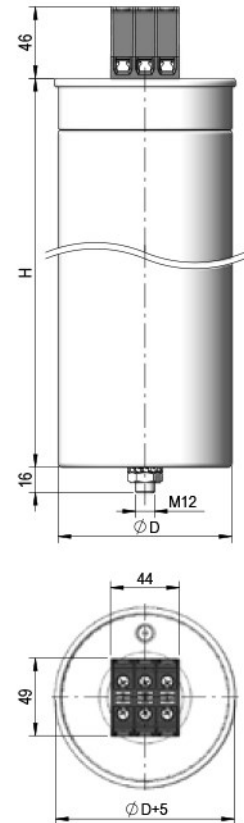
**Impregnant:** Dry, inert gas  $N_2$

**Test Voltage, terminal/case:**  
 $U_N < 500\text{V}$ : 3000V AC, 10s  
 $U_N > 500\text{V}$ :  $2 \times U_N + 2000\text{V}$  AC, 10s

**Discharge Resistors:** Included - 50V, 1minute or 75V, 3 minutes.

**Standards:** IEC 60831-1+2, EN 60831-1+2, GOST





Part #	Power kVAR	Capacitance $\mu\text{F}$ 3x	Current $I_n$ (A) 3x	Weight (kg)	Dimensions D x H (mm)
CSADG 1.0,69,3,60	3	5.6	2.5	0.7	85 x 220
CSADG 1.0,69,5,60	5	9.3	4.2	0.8	85 x 220
CSADG 1.0,69,7.5,60	7.5	13.9	6.3	0.9	85 x 245
CSADG 1.0,69,10,60	10	18.6	8.4	1.0	85 x 245
CSADG 1.0,69,12.5,60	12.5	23.2	10.5	1.1	85 x 245
CSADG 1.0,69,15,60	15	27.9	12.6	1.2	85 x 245
CSADG 1.0,69,17.5,60	17.5	32.5	14.6	1.3	85x 245
CSADG 1.0,69,20,60	20	37.2	16.7	1.8	110 x 245
CSADG 1.0,69,25,60	25	46.5	20.9	1.9	110 x 245
CSADG 1.0,69,30,60	30	55.7	25.1	2.9	136 x 220

## General Specifications

**Frequency:** 50 / 60 Hz

**Inrush current:** Max  $400 \times I_N$

**Max Over Voltage:**

- Un + 10% (up to 8 hrs daily)
- UN + 15% (up to 30 minutes daily)
- UN + 20% (up to 5 minutes)
- UN + 30% (up to 1 minute)

**Life:** 150,000-200,000 (depending on voltage & temperature)

**Mounting:** M12 Stud on bottom, Any position

**Degree of Protection:** IP20

**Overcurrent:**  $1.5 - 2.0 \times I_N$

**Max above sea level:** 4000 m

**Capacitance tolerance:** -5 / +10%

**Case:** Aluminum

**Test Voltage, terminal/terminal:**  
 $2.15 \times U_N$ , AC, 2 s

**Dielectric:** MKP—metalized PP fim

**Impregnant:** Dry, inert gas N<sub>2</sub>

**Test Voltage, terminal/case:**  
 $U_N < 500\text{V}$ : 3000V AC, 10s  
 $U_N > 500\text{V}$ :  $2 \times U_N + 2000\text{V}$  AC, 10s

**Discharge Resistors:** Included - 50V, 1minute or 75V, 3 minutes.

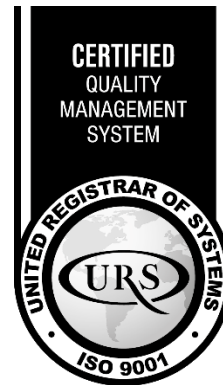
**Standards:** IEC 60831-1+2, EN 60831-1+2, GOST



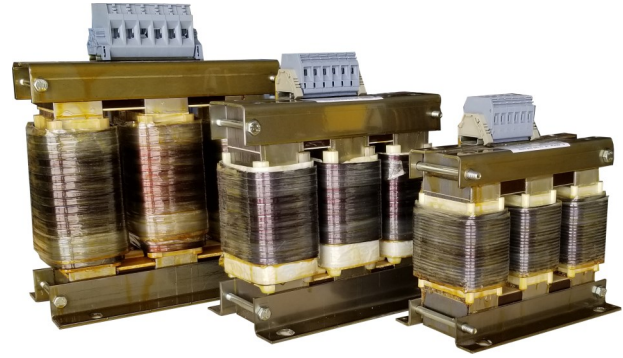
## Parts & Accessories

V1.0 24/01/2019

**$\Phi$  Cos Phi**  
**Power Factor & Power Quality Specialists**



The primary purpose of de-tuning reactors in a capacitor bank, is to prevent a phenomenon in the electrical system known as harmonic resonance. Resonance can have a devastating effect on electrical equipment, and is the main reason why older capacitor banks without de-tuning reactors fail and cause problems in the facility's power distribution system.



## Reactors for Harmonic Filtering

### Features

- ◆ High quality materials
- ◆ Design optimized to reduce total losses
- ◆ Small mechanical size
- ◆ Low noise level due to the glued air gaps
- ◆ 7% impedance (Z), 14%Z available on request

### Benefits

- ◆ Eliminates harmonic amplification
- ◆ Enhances life of capacitors by reducing voltage and thermal stress due to harmonics
- ◆ Reduces over heating of the transformer, busbars, cables, switchgear etc caused due to harmonic amplification
- ◆ Improves Power Factor in harmonic rich environment

## Technical specifications

<b>Standards</b>	IEC60289, IEC60076, VDE 0532 UL/Ur file E202612, RoHs, CE
<b>Design</b>	Iron core multiple airgap, low loss grain oriented steel
<b>Tolerance, Inductance</b>	-3 +3%
<b>Linearity/%</b>	1.75 x In 95% inductance
<b>Insulation level</b>	4 kVac
<b>Temperature Class</b>	F155 °C 6.25-12.5 kVAR / H 180 °C 25-75 kVAR
<b>Cooling</b>	Natural cooling
<b>Ambient Temperature</b>	-20 ... + 60 °C T60
<b>Protection Class</b>	IP00
<b>Installation</b>	Screw Fastening
<b>Noise level</b>	Max 50 dB with rated harmonic Currents at 1 m distance

### 480V De-tuning Reactors

(Dimensions and weight may vary slightly.)

Part #	kVAR	Voltage	Length (mm)	Width (mm)	Height (mm)	Weight kg
3INP15.3/3.06CU	15	480V	230	96	243	14
3INP33.1/1.84CU	25	480V	230	140	200	19
3INP39.8/1.54CU	30	480V	225	124	260	24
3INP66.2/0.919CU	50	480V	300	150	260	37
3INP132.4/0.46CU	100	480V	360	190	320	65

### 600V De-tuning Reactors

(Dimensions and weight may vary slightly.)

Part #	kVAR	Voltage	Length (mm)	Width (mm)	Height (mm)	Weight kg
3INP21.2/3.6CU	20	600V	225	124	215	20
3INP42.4/1.76CU	40	600V	283	148	285	32
3INP53/1.436CU	50	600V	283	148	295	34
3INP63.6/1.2CU	60	600V	283	148	321	37
3INP105.9/0.869CU	100	600V	309	166	410	65

Other sizes available by special request

## General Characteristics

The DM...TA type current transformers (CTs) are installed in an electrical system to reduce the line current to a secondary value of 5A compatible with the ammeter inputs of digital multimeters or protection relays. DM...TA are instrument transformers in class 0.5/1 without a primary winding and are normally used for high primary current values starting from 250A.

## Operational characteristics

- Operating frequency: 50-60Hz
- Secondary output current: 5A
- Overload withstand 120% I<sub>pn</sub>
- Screw terminals
- Sealable terminal covers
- Screw fixing (fixing elements supplied with the product)



DM1TA ...



DM2TA ...



DM3TA ...



DM4TA ...

Order Code	Primary Current I <sub>pn</sub> /5 (A)	Burden		Qty per pkg No.	Weight (kg)
		Cl. 0.5 (VA)	Cl. 1 (VA)		

### 50 x 80 mm hole

DM1TA 0250	250	1	2	1	0.9
DM1TA 0300	300	1.5	3	1	0.9
DM1TA 0400	400	1.5	3	1	0.9
DM1TA 0500	500	2.5	5	1	0.9
DM1TA 0600	600	2.5	5	1	0.9
DM1TA 0800	800	3	7.5	1	0.9
DM1TA 1000	1000	5	10	1	0.9

### 80 x 80 mm hole

DM2TA 0250	250	1	2	1	1.05
DM2TA 0300	300	1.5	3	1	1.05
DM2TA 0400	400	1.5	3	1	1.05
DM2TA 0500	500	2.5	5	1	1.05
DM2TA 0600	600	2.5	5	1	1.05
DM2TA 0800	800	3	7.5	1	1.05
DM2TA 1000	1000	5	10	1	1.05

### 80 x 120 mm hole

DM3TA 0500	500	-	4	1	1.25
DM3TA 0600	600	-	5	1	1.25
DM3TA 0800	800	3	7.5	1	1.25
DM3TA 1000	1000	5	10	1	1.25
DM3TA 1250	1250	7.5	15	1	1.25
DM3TA 1500	1000	8	17	1	1.25

### 80 x 160 mm hole

DM4TA 2000	2000	15	20	1	3.16
DM4TA 2500	2500	15	20	1	3.34
DM4TA 3000	3000	20	25	1	3.5
DM4TA 4000	4000	20	25	1	3.76

## Operational Characteristics

Ambient operating temperature:  $\leq 50^{\circ}\text{C}$ . For ambient temperatures higher than  $50^{\circ}\text{C}$  and up to  $70^{\circ}\text{C}$ , the maximum operating power values indicated in the table must be reduced by a percentage equal to the difference between the operating ambient temperature and  $50^{\circ}\text{C}$ .

## Certification and compliance

Certification obtained: CCC, EAC, UL Listed for USA and Canada (cULus - file E93602), as Motor Controllers—Magnetic Capacitive Switches.

Type	UL/CSA protection fuse gG-SC
	(A)
BFK09	16
BFK12	25
BFK18	40
BFK26	40
BFK32	63

**BFK contactors**



**Kit to assemble BFK contactors**



Order Code	Maximum operational power at $\leq 50^{\circ}\text{C}$				No. Aux. Con-tacts	Qty per pkg	Weight (kg)
	240V	400V	440V	690V			

### AC Coil

BFK09 00A	4,5	7.5	9	10	1	10	0.413
BFK12 00A	7	12.5	14	16	1	10	0.413
BFK18 00A	9	15	17	20	1	10	0.413
BFK26 00A	11	20	22	25	-	10	0.472
BFK32 00A*	14	5	27.5	30	-	10	0.472
BFK38 00A	17	30	33	36	-	10	0.472
BFK50 00A	22	40	41	46	-	5	1.080
BFK65 00A	26	45	50	56	-	5	1.080
BFK80 00A	30	50	56	65	-	5	1.080
11BF80K 00A*	34	60	65	70	-	5	1.470
11BF110K 00A	45	75	80	100	-	5	1.470

Order Code	For contactor	Qty per	Weight (kg)
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### Current Limiting Resistor Kit

11G460	BF09 10A, BF12 10A, BF18 10A, BF26 00A, BF32 00A, BF38 00A	10	0.072
BFX10K3	BF50 00A, BF65 00A, BF80 00A	10	0.078
11 G464	BF80 00, BF110 00	10	0.080

\* Normal in-stock item





# Automatic Power Factor Controllers DCRG series

**$\varphi$  Cos Phi**

**Power Factor & Power Quality Specialists**

151 Richmond St. S.W., PO Box 519  
Hensall, Ontario, N0M 1X0  
Ph: 519-262-2822 Fax: 519-262-2310

# The Solution for All Applications!

• **Backlight**

**Graphic Display**

128 x 80 Pixels with excellent legibility, with adjustable brightness and contrast



• **Optical Communication Port**

The Optical port on the front using a standard USB, Wi-Fi point or dongle allows to communicate with a PC, smartphone and tablet, to carry out programming diagnostics and data download without removing power to the electric pane.

**General characteristics**

The DCRG8 controller has been designed to satisfy technical characteristics of modern electrical installations in industry and new users' needs.

The main power factor controller characteristics include: reliability, capability of working in all conditions and the ability to detect critical operating conditions and all this to protect the power factor correction system.

DCRG8 is created to satisfy these requirements and with the option to extend its own functionality by using specific expansion modules. A standard-supplied USB frontal optic is also available for controller programming , diagnostics and data downloads.

User interface is easy to view thanks to the backlit graphical LCD that contributes to excellent data reading even with bad lighting condition and to view information clearly and comprehensively.

**Main features are:**

- Backlight graphic 128 x 80 pixel LCD with 10 language options.
- Automatic sensing of CT current flow
- Connection to single and three-phase lines, three-phase lines with neutral and co-generation systems with 4-quadrant operation
- Use with medium-voltage lines
- Capability to operate correctly in systems having high harmonic content
- Reduction of the number of switching operations
- Balanced use of steps with same power rating
- Reactive power measurement per installed step
- Recording of the number of connections per step
- Capacitor over-current protection on all three phases
- Over-temperature protection by internal sensor
- Accurate no-voltage release protection function
- Current and voltage harmonic analysis
- Harmonic analysis of current and voltage waveforms recorded for overload events
- USB and Wi-Fi communications interface for personal computer, smartphone and tablet connection.
- Modbus-RTU, TCP and ASCII communication protocols
- Set-up and remote control software
- SMS sending for Alarm conditions with EXP10 15 expansion module.

Order Code	Steps No.	Rush-mount Housing Size (mm)	Qty Per Pkg No.	Wt kg
DCRG 8	8	144 x 144	1	0.98

DCRG 8 Controller	EXP10 06 2 relay-output module	EXP10 01 4 static-output module	Total Steps	
			Relay	Static
No. of steps	No. of modules	No. of modules		
8	1 (2 step)	-	10	-
8	1 (2 step)	1 (4 steps)	10	4
8	2 (4 step)	-	12	-
8	2 (4 step)	1 (4 steps)	12	-
8	3 (6 step)	-	14	-
8	4 (8 step)	-	16	-
8	-	-	16	-
8	-	1 (4 steps)	8	4
8	-	1 (8 steps)	8	-

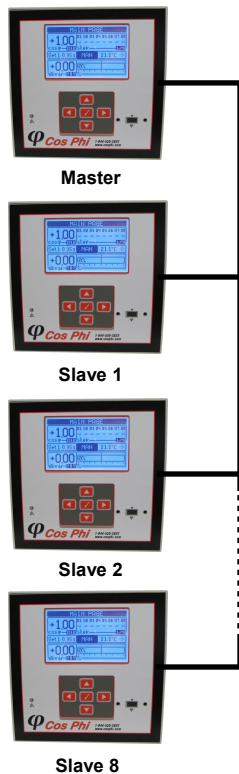
**Operational characteristics**

- Voltage Circuit
- Auxiliary power supply: 100-415VAC
- Rated frequency: 50/60Hz ± 10%
- Current circuit
- Single and three-phase input
- Rated current Ie: 5A (1A programmable)
- Measurement and control
- Power factor adjustment: 0.5 ind to 0.5 cap
- Voltage measurement range: 85-720VAC
- Current measurement range: 0.025-6A
- TRMS voltage and current measurements
- Reconnection delay time of the same step: 1-3000s
- Tripping sensitivity: 1-1000s/step



## Master-Slave Function

The DCRG controller can control the outputs of other analog controllers in addition to its own steps. In this way it offers a master-slave architecture. Up to 8 slaves can be controlled to obtain a system with a maximum 32 steps.



## Web Services Function

By installing the Ethernet expansion module EXP0 13, the main measured values of the controller can be viewed by most common Web-client compatibles on the market, using Java platform and with no need to install any additional PC software.

## Capacitor Protection

By adding the EXP10 16 expansion module, the DCRG controller can be equipped with additional capacitor protection functions. The module can measure the harmonic current values and the capacitor temperature on-site, in addition to detecting a failure on any phase.

## Three Current Inputs

- Independent power factor correction of each step can be done.
- Analysis of all electrical parameters of the system by a multimeter

## Wide Range of Rated Voltage Measurements

The wide measurement range between 100 to 600VAC allows to use the controller in most types of applications.

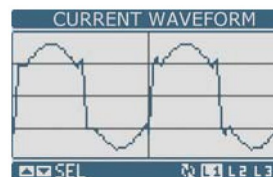
## GSM/GPRS Modem

By fitting the EXP10 15 expansion module the controller is automatically equipped and configures a GSM/GPRS modem, This simplifies installation and wiring. Once a data-enabled SIM card is inserted, alarm or even SMS and email can be transmitted by the controller to FTP servers.

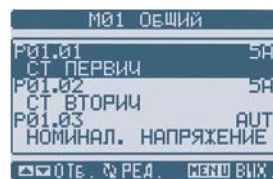
## 5A and 1A Both on the Same Controller

By configuring an apposite parameter, the controller can be enabled for use with either a 5A or 1A secondary current transformer

## Graphs and Text in Multi Languages



Viewing of waveforms, text, trend and bar graphs in 10 languages: Italian, English, Spanish, French, German, Czech, Polish, Russian, Portuguese and customisable.



## Energy Monitoring Functionality

By installing EXP10 13 and EXP10 30 the DCRG controller can also offer energy monitoring functionality viewable on most common web-client compatibles on the market.

## Suitable for Medium-Voltage Systems

The controllers can be installed in medium-voltage systems thanks to its configuration for voltage transformer ratio, thereby obtaining measurements with regards to the transformer primary value both for the correction adjustment and the display readouts.

## Suitable for Dynamic (FAST) Power Factor Correction

With the EXP10 01 static output expansion module installed, the controller can be used in dynamic power factor correction systems where the reactive load quickly varies over time. Also taking advantage of the built in controller relay outputs, a mixed system of traditional relay and dynamic type of correction steps can be obtained.

## Technical Characteristics

### Auxiliary Supply Circuit

Rated Auxiliary voltage	100-415VAC
Operation Range	-10 to +10%
Rated Frequency	50Hz or 60Hz ± 10%
Maximum power consumption	12VA
Maximum power dissipation (output contacts excluded)	4.5W

### Voltage Slave

Control Voltage	100-600VAC
Operating Range	50-720VAC
Rated frequency	50Hz or 60Hz ± 10% - 360-440Hz
Immunity time for micro-breakings	35ms (110VAC) - 80ms (220-415VAC)

### Current Circuit

Rated current Ie	Programmable 5A/1A
Operating range	0.025-6A / 0.025-1.2A
Constant overload	1.2 Ie
Short time withstand current	50 Ie for 1s
Current consumption	0.6VA

### Measurement Data

Type of voltage-current measurement	TRMS
Power factor adjustment	0.5 inductive to 0.5 capacitive
Type of Temperature sensor	internal + PT100 with EXP10 04 + NTC with EXP10 16

### Relay Outputs

Number of outputs	8 (10,12, 14, 16 with EXP...)
Contact arrangement	7 NO (SPST + 1 changeover (SPSD) contacts
IEC rated capacity	5A 250V (AC1)
Maximum capacity of common terminal of contacts	10A
Maximum switching voltage	415 VAC
UL/CSA and IED/EN 60947-5-1 designation	B300
Electrical life (at rated load)	10 <sup>5</sup>
Mechanical life	30 x 10 <sup>6</sup> cycles

### Static Outputs

Number of outputs	4 or 8 w/EXP10 01
-------------------	-------------------

### Connections

Type fo terminal	Removable/plug-in
Conductor section min-max	0.2-2.5mm <sup>2</sup> (24- 12AWG)

### Ambient Conditions

Operating temperature	-30...+70°C
Storage temperature	-30...+80°C

### Housing

Version	Flush mount 144 x 144mm
Material	Polycarbonate
IEC degree of protection	IP54

## Expansion Modules

Order Code	Description	Qty No.	Wt kg
<b>Inputs and outputs</b>			
EXP10 06	2 relay outputs to increase number of steps	1	0.064
EXP10 01	4 static outputs, opto-isolated to increase number of steps	1	0.054
EXP10 16	Capacitor banks protection	1	0.080
EXP10 00	4 digital inputs, opto-isolated	1	0.060
EXP10 02	2 digital inputs and 2 static outputs, opto-isolated	1	0.058
EXP10 03	2 relay outputs, rated 5A250VAC	1	0.050
EXP10 04	2 analog inputs, opto-isolated, 0/4-20mA, PT100, 0-10V or 0 to ± 5V	1	0.056
EXP10 05	2 analog inputs, opto-isolated, 0/4-20mA, 0-10V or 0 to ± 5V	1	0.064
<b>Communication Ports</b>			
EXP10 11	Opto-isolated RS232 interface	1	0.050
EXP10 12	Opto-isolated RS485 interface	1	0.040
EXP10 13	Opto-isolated Ethernet interface with Web server function	1	0.060
EXP10 14	Opto-isolated Profibus-DP interface	1	0.080
<b>Various Functionality</b>			
EXP10 15	GPRS/GSM modem	1	0.080
EXP10 30	Data storage, clock-calendar with backup energy for data logging	1	0.050



### General characteristics

EXP series expansion modules can add extra functions to the DCRG series power factor controllers. Each controller can mount a maximum of four expansion modules. These models snap on to the rear of the controller and allow to:

- Increase the number of steps to connect
- Use in application with static real-time (fast) power factor correction
- Add analog type of inputs and outputs to have 0/4-20mA, 0-10V, -5 to +5 or PT100 function
- Add RS232 and RS485 communication ports
- Predispose the controller for connection to Ethernet TCP/IP, Profibus-DP, GPRS/GSM.

### Certifications and compliance

Certifications obtained: UL Listed, for USA and Canada (cULus—File E93601), as listed Accessory under Auxiliary Devices, for EXP... modules only except for EXP10 15 and EXP10 16 pending. Compliant with standards: IEC/EN 61010-1, IEC/EN 61000-6-2, IEC/EN 61000-4 for EXP10 13, IEC/EN 61000-6-3 for all the rest, UL508, CSA C22.2 no. 14.

## Communication Devices

Order Code	Description	Qty No.	Wt kg
CX 01	PC ↔ DCRG8 connecting cable, with USB connector for programming, data download, diagnostics and firmware upgrade	1	0.090
CX 02	PC ↔ DCRG8 Wi-Fi connecting device for programming, data download, diagnostics and firmware upgrade	1	0.090
CX 03	GSM quad-band antenna (800/900/1800/1900MHz) for EXP10 15 expansion module	1	0.090



### General characteristics

Communication and connection devices allow the DCRG8 controller to be linked to:

- Personal computers (PC)
- Smartphones
- Tablets

### CX 01

This USB option connector complete with cable, provides for connection on DCRG8 controller, with a PC without even disconnecting the power supply of the electric panel board and to be able to:

- Program parameters
- Download data and event logs
- Complete diagnostics.

The PC identifies the connection as a standard USB.

### CX 02

Using Wi-Fi connection, the DCRG8 power factor controllers can be viewed by a PC, smartphone and tablet without having to connect cables and allows to:

- Program parameters
- Download data and event logs
- Complete diagnostics.

### CX 03

Compatible with major worldwide mobile phone networks, thanks to the 800/900/1800/1900MHz frequencies.

## Software and accessories

Order Code	Description	Qty No.	Wt kg
<b>Software</b>			
DCRJ SW	Setup, automatic panel test and remote control software with 51 C2 connecting cable	1	0.246
<b>Accessories</b>			
51 C2	PC ↔ DCRG8 c/w EXP10 11 connecting cable, 1.8m long	1	0.090
51 C4	PC ↔ PX1 converter drive connecting cable 1.8m long	1	0.147
51 C6	4 PX1 converter drive ↔ DCRG8 c/w EXP10 11 connecting cable 1.8m long	1	0.102
51 C9	PC ↔ Analog modem connecting cable 1.8m long	1	0.137
4 PX1	RS232/RS485 converter drive, galvanically isolated, 220-240VAC (110-120VAC on request) <sup>1</sup>	1	0.090



<sup>1</sup>RS232/R485 opto-isolated analog modem, 38,400 Baud rate maximum, automatic or manual TRANSMIT line supervision, 220-240VAC ± 10% power supply (110-120VAC on request)

# SURGE-TRAP® STXT SERIES

## NEMA DEVICES FOR ANSI/UL 1449 TYPE 1 AND 2 APPLICATIONS



The most advanced of the STX series, the Surge-Trap® Type 1 STXT Series comes standard with EMI/RFI Filtering and surge capacities up to 200kA. The STXT features TPMOV® technology inside, making it the safest product available. With line or load side installation flexibility, this unit is a great fit from the service entrance all the way down to each distribution and/or branch panel.

### FEATURES AND BENEFITS:

- Premium 200kA surge capacity for longer life and higher single impulse withstand
- Includes EMI/RFI filter for cleaner attenuation
- Mounting hub and mounting feet for installation flexibility
- Optional audible alarm and remote dry contacts
- Up to 10 Modes of Protection (L-N, L-L, L-G, N-G)
- 10-year warranty

### RATINGS:

- **Volts ( $U_n$ ):** 120-600VAC
- **Nominal Discharge Current Rating ( $I_n$ ):** 20kA
- **Surge Capacity (per phase):** 100kA or 200kA
- **Short-Circuit Current Rating (SCCR):** 200kA
- **EMI/RFI Filter:** Up to -50dB from 10kHz to 100MHz

### APPROVALS:

- ANSI/UL 1449 4th Edition, Type 1 SPD, File E210793
- CSA C22.2, Type 1 SPD
- ANSI/IEEE C62.41.1, C62.41.2, C62.45
- UL96A Lightning Protection
- RoHS Compliant



## GENERAL PRODUCT SPECIFICATIONS

Mounting:	Female 3/4" – 14 threaded hub Mounting feet with 0.25" diameter holes	Operating & Storage Temperature:	-40°C to +85°C
Wiring:	Wire Lugs for 8 AWG copper	Relative Humidity Range:	0 to 95% non-condensing
Enclosure:	NEMA 4X Non-metallic	Visual End-of-Life Indicator:	GREEN = OK, OUT = REPLACE
Flammability:	UL94-5VA	Frequency:	50-60Hz

CATALOG NUMBER (INCLUDES SUFFIXES*)	SYSTEM VOLTAGE AND CONFIGURATION	I <sub>n</sub>	MAXIMUM CONTINUOUS OPERATING VOLTAGE (MCOV, U <sub>c</sub> )				VOLTAGE PROTECTION RATING (VPR) (UL 1449, 6kA, 3kV)			
			L-N	L-G	L-L	N-G*	L-N	L-G	L-L	N-G*
STXT120P20	120V Single Phase	20kA	150	150	-	150	700	700	-	700
STXT240P20	240V Single Phase	20kA	320	320	-	150	1200	1200	-	700
STXT240S20	240/120V Split Phase	20kA	150	150	300	150	700	700	1000	700
STXT480S20	480/240V Split Phase	20kA	320	320	640	150	1200	1200	2000	700
STXT208Y20	208/120V 3-Phase WYE	20kA	150	150	300	150	700	700	1000	700
STXT380Y20	380/220V 3-Phase WYE	20kA	320	320	640	150	1200	1200	2000	700
STXT480Y20	480/277V 3-Phase WYE	20kA	320	320	640	150	1200	1200	2000	700
STXT600Y20	600/347V 3-Phase WYE	20kA	420	420	840	275	1500	1500	2500	1200
STXT240D20	240V 3-Phase DELTA	20kA	-	320	640	-	-	1200	2000	-
STXT480D20	480V 3-Phase DELTA & HRG WYE	20kA	-	550	1100	-	-	1800	3000	-
STXT600D10	600V 3-Phase DELTA	20kA	-	695	840	-	-	2500	2500	-
STXT480B20	480V B Corner Ground DELTA	20kA	-	550	1100	-	-	1800	4000	-
			L-N/ HL-N	L-G/ HL-G	L-L/ HL-L	N-G*	L-N/ HL-N	L-G/ HL-G	L-L/ HL-L	N-G*
STXT240H20	240/120V Hi-Leg DELTA	20kA	150/275	150/275	300/425	150	700/1.2k	700/1.2k	1.0k/2000	700
STXT480H20	480/240V Hi-Leg DELTA	20kA	320/550	320/550	640/870	320	1.2k/1.8k	1.2k/1.8k	2.0k/2.5k	1200

\*Suffixes: Add Suffix "A" for Audible Alarm and Dry Contact. Example: STXP208Y10A  
For 100kA Surge Capacity models, substitute "10" for "20." Example: STXT208Y10

### Optional Form C Dry Contact and Audible Alarm (Suffix "A")

#### Form C Dry Contact

125VAC, 1A Resistive  
30VDC, 2A General Purpose

COM = Common  
NO = Normally Open  
NC = Normally Closed

#### Audible Alarm

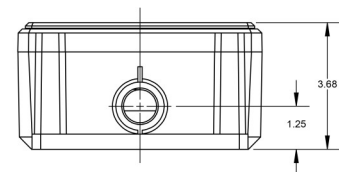
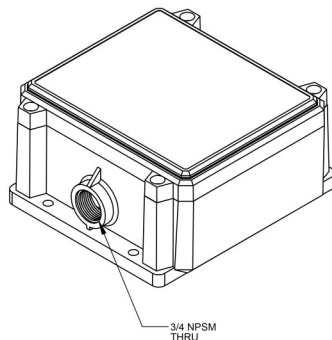
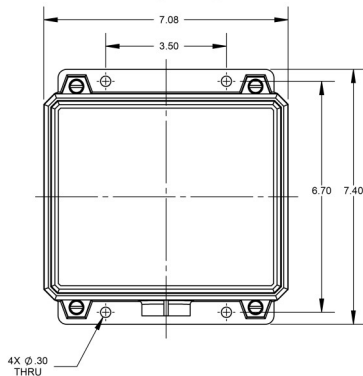
Alarm sounds when any protection is lost



### 3/4"-14 Female Mounting Hub



### Dimensions and Mounting Configurations





## Get best-in-class performance with our RL Line/Load Reactors.

Our RL Line/Load Reactors are a robust, best-in-class filtering solution for virtually any 4 or 6-pulse rectifier or power conversion unit. There is no need to derate these reactors. They are harmonic compensated and protected to assure optimum performance in the presence of harmonics, and can help you meet IEEE-519 requirements. There are units available for a full line of currents (1A to 1,500A) and a full line of impedance options (1.5%, 3% and 5%).

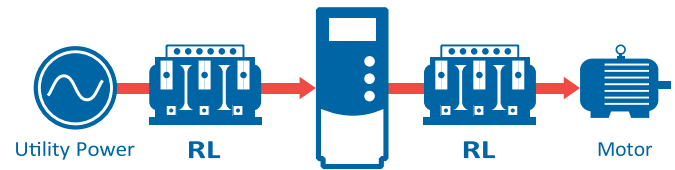


**Robust design and construction** for unequaled filtering of power line disturbances.

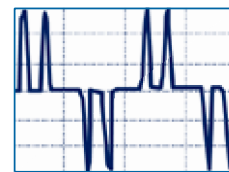
**Highest continuous service factor** virtually eliminates breakdowns in the field.

**Reduces audible noise.**

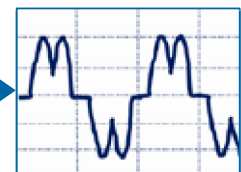
**Multiple cabinet designs** help meet NEMA 1/2 and 3R.



### Input Reactor

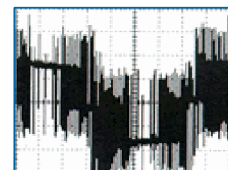


Waveform without reactor

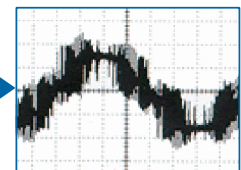


Waveform with reactor

### Output Reactor



Waveform without reactor



Waveform with reactor

Performance Specifications	
Impedance Levels	1.5%, 3% and 5%
Continuous Service Factor	Reactors rated 1 to 750 Amps - 150% of rating Reactors rated above 750 Amps - 125% of rating
Overload Rating	200% of rated for 30 minutes 300% of rated for 1 minute
Input Voltage Range	208V - 690V
Current Range	1A - 1,500A
Temperature Rise	135°C
Ambient Temperature	-40°C to 50°C
Altitude Maximum Without Derating	1,000 meters
Fundamental Frequency	50/60 Hz
Inductance Curve	100% at 100% Current 100% at 150% Current 50% at 350% Current

Note: Final product specifications subject to change at anytime.

### Altitude Derating Curve

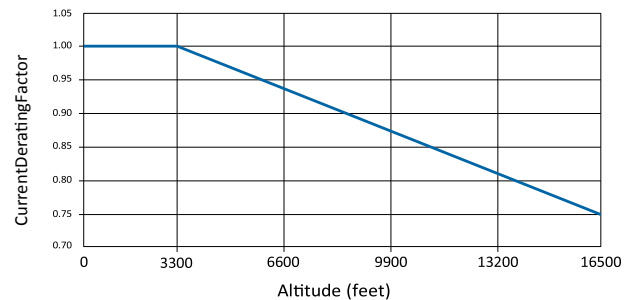


FIGURE 1

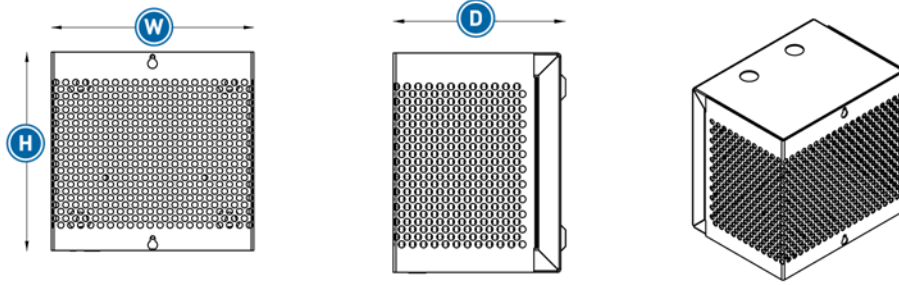
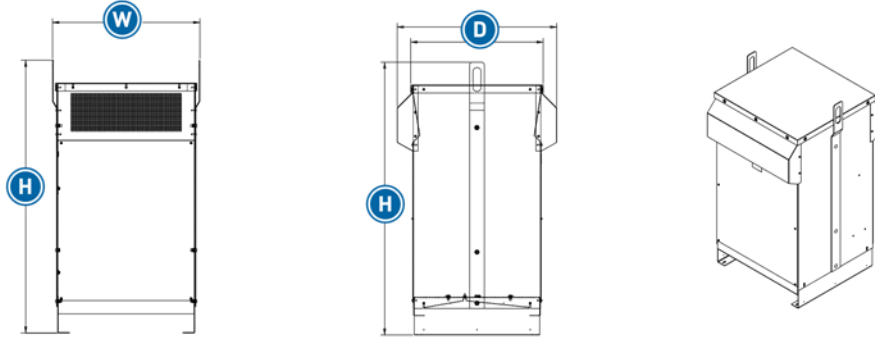
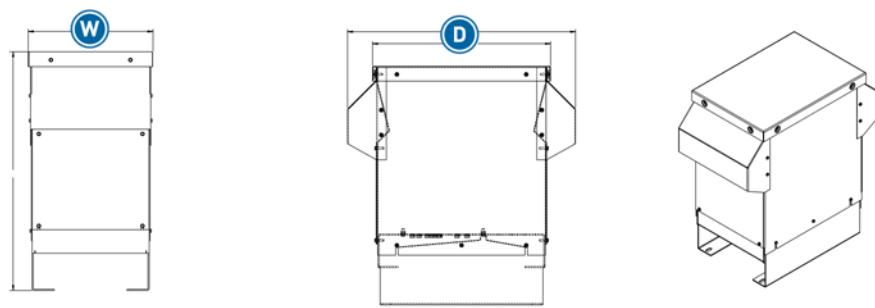


FIGURE 2



NOTE: HOODS ONLY ON NEMA 3R ENCLOSURES

FIGURE 3



NOTE: HOODS ONLY ON NEMA 3R ENCLOSURES

FIGURE 4

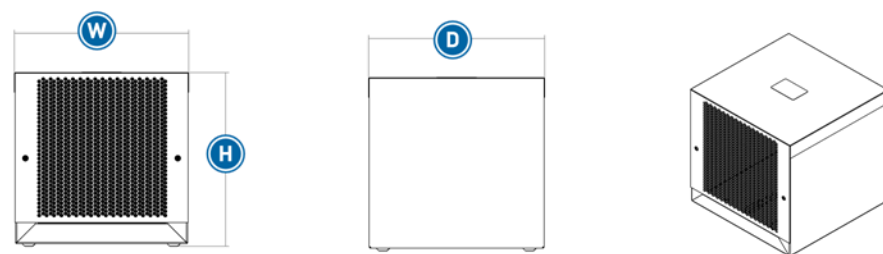
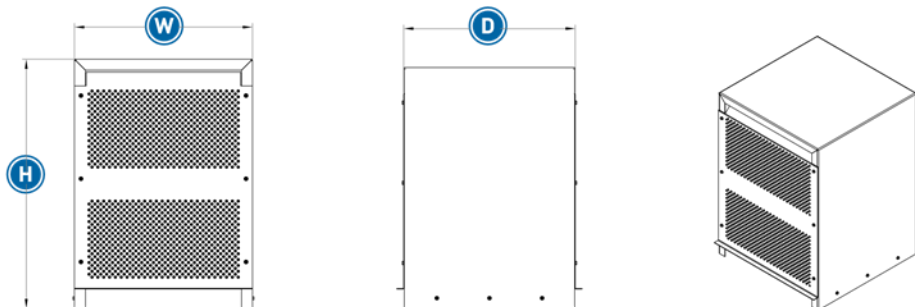


FIGURE 5



# Line/Load Reactor Selection Tables



Input Voltage & Hz	% Impedance	0.25 HP 0.18 kw	0.33 HP 0.25 kw	0.5 HP 0.37 kw	0.75 HP 0.55 kw	1.0 HP 0.75 kw	1.5 HP 1.1 kw	2.0 HP 1.5 kw	3.0 HP 2.2 kw	5.0 HP 3.7 kw	7.5 HP 5.5 kw	10.0 HP 7.5 kw	15.0 HP 11.0 kw	20.0 HP 15.0 kw	25.0 HP 18.5 kw	30.0 HP 22.0 kw
<b>Three Phase Input or Output Applications Selected by Motor</b>																
208V 60 Hz	3%	RL-00204	RL-00204	RL-00401	RL-00401	RL-00802	RL-00801	RL-00801	RL-01801	RL-03501	RL-03501	RL-05501	RL-05501	RL-08001	RL-10001	RL-13001
208V 60 Hz	5%	RL-00201	RL-00201	RL-00402	RL-00402	RL-00802	RL-00802	RL-00801	RL-01802	RL-03502	RL-03502	RL-03501	RL-05501	RL-08001	RL-08001	RL-10001
240V 60 Hz	3%	RL-00201	RL-00204	RL-00204	RL-00401	RL-00401	RL-00801	RL-00801	RL-01201	RL-01801	RL-02501	RL-03501	RL-04501	RL-05501	RL-08001	RL-10001
240V 60 Hz	5%	RL-00202	RL-00201	RL-00201	RL-00402	RL-00402	RL-00802	RL-00802	RL-01202	RL-01802	RL-03502	RL-03502	RL-05502	RL-08002	RL-08001	RL-10002
400V 50 Hz	3%	RL-00103	RL-00103	RL-00202	RL-00202	RL-00201	RL-00403	RL-00402	RL-00803	RL-00802	RL-01202	RL-01802	RL-02502	RL-03502	RL-04502	RL-04502
400V 50 Hz	5%	RL-00102	RL-00102	RL-00203	RL-00203	RL-00202	RL-00404	RL-00403	RL-00804	RL-00803	RL-01203	RL-01803	RL-02503	RL-03503	RL-04503	RL-04503
480V 60 Hz	3%	RL-00103	RL-00103	RL-00104	RL-00201	RL-00201	RL-00201	RL-00402	RL-00803	RL-00802	RL-01202	RL-01802	RL-02502	RL-03502	RL-03502	RL-04502
480V 60 Hz	5%	RL-00102	RL-00102	RL-00103	RL-00202	RL-00202	RL-00202	RL-00403	RL-00804	RL-00803	RL-01203	RL-01803	RL-02503	RL-03503	RL-03503	RL-04503
600V 60 Hz	3%	RL-00102	RL-00102	RL-00103	RL-00202	RL-00202	RL-00202	RL-00403	RL-00403	RL-00803	RL-01202	RL-01202	RL-01802	RL-02502	RL-02502	RL-03502
600V 60 Hz	5%	RL-00101	RL-00101	RL-00102	RL-00203	RL-00403	RL-00203	RL-00404	RL-00404	RL-00804	RL-01203	RL-01203	RL-01803	RL-02503	RL-02503	RL-03503
690V 50 Hz	2%	-	-	-	-	-	-	-	RL-00403	RL-00402	RL-00401	RL-00802	RL-01202	RL-01802	RL-01802	RL-02502
690V 50 Hz	3%	-	-	-	-	-	-	-	RL-00402	RL-00403	RL-00401	RL-00803	RL-01203	RL-01803	RL-01803	RL-02503
<b>Single Phase Input Applications</b>																
120V 60 Hz	5%	RL-00801	RL-01201	RL-01801	RL-02501	RL-02501	RL-03503	RL-03501	RL-05501	RL-10001	RL-13001	RL-13001	-	-	-	-
208V 60 Hz	5%	RL-00401	RL-00401	RL-00401	RL-01202	RL-00801	RL-01201	RL-02502	RL-03502	RL-03501	RL-04501	RL-05501	RL-08001	RL-13001	RL-13001	RL-16001
240V 60 Hz	5%	RL-00402	RL-00401	RL-00803	RL-00802	RL-01202	RL-01201	RL-01201	RL-01801	RL-04502	RL-08002	RL-08002	RL-08001	RL-10001	RL-16002	RL-20002B14
240V 50 Hz	5%	RL-00403	RL-00402	RL-00803	RL-00802	RL-01202	RL-01201	RL-01201	RL-01801	RL-04502	RL-08002	RL-08002	RL-08001	RL-10001	RL-16002	RL-20002B14
400V 50 Hz	5%	RL-00103	RL-00202	RL-00201	RL-00201	RL-00403	RL-00402	RL-00803	RL-01203	RL-01803	RL-02503	RL-03503	RL-04502	RL-05502	RL-08002	RL-08002
480V 60 Hz	5%	RL-00202	RL-00202	RL-00202	RL-00404	RL-00403	RL-00402	RL-00803	RL-01203	RL-01803	RL-02503	RL-02502	RL-05503	RL-08003	RL-08003	RL-08003
600V 60 Hz	5%	RL-00102	RL-00103	RL-00202	RL-00202	RL-00404	RL-00403	RL-00403	RL-00803	RL-01203	RL-01803	RL-02503	RL-03503	RL-04503	RL-05503	RL-08003

## Impedance Rating:

**3% impedance** reactors are typically sufficient to absorb power line spikes and motor current surges. They will prevent nuisance tripping of drives or circuit breakers in most applications.

**5% impedance** reactors are best for reducing harmonic currents and frequencies. Use them when you must reduce VFD drive generated harmonics, and to reduce motor operating temperature, or to reduce motor noise.

\*The effective impedance of the reactor changes with actual RMS current. A 5% impedance reactor becomes 3% if its current is reduced to 60%.



# Line/Load Reactor Selection Tables



40.0 HP 30.0 kw	50.0 HP 37.5 kw	60.0 HP 45.0 kw	75.0 HP 55.0 kw	100.0 HP 75.0 kw	125.0 HP 93.0 kw	150.0 HP 112.0 kw	200.0 HP 150.0 kw	250.0 HP 187.0 kw	300.0 HP 225.0 kw	350.0 HP 262.0 kw	400.0 HP 300.0 kw	500.0 HP 375.0 kw	600.0 HP 450.0 kw	700.0 HP 550.0 kw	800.0 HP 600.0 kw
Three Phase Input or Output Applications Selected by Motor															
RL-13001	RL-16001	RL-20001B14	RL-25001B14	RL-32001B14	RL-50001B14	RL-50001B14	RL-60001	RL-75001	RL-85001B14	RL-100001B14	RL-120001B14	RL-140001	-	-	-
RL-13001	RL-16001	RL-20002B14	RL-25002B14	RL-32001B14	RL-50002	RL-60002	RL-60001	RL-75002	RL-85001B14	RL-100002B14	RL-120002B14	RL-140001	-	-	-
RL-13001	RL-13001	RL-16001	RL-20001B14	RL-25001B14	RL-32001B14	RL-40001B14	RL-50001B14	RL-60001	RL-75001	RL-85001B14	RL-100001B14	RL-120001B14	-	-	-
RL-13002	RL-13001	RL-16002	RL-20002B14	RL-25002B14	RL-32002B14	RL-40002B14	RL-50002	RL-60002	RL-75002	RL-85002B14	RL-100002B14	RL-120002B14	-	-	-
RL-05502	RL-08002	RL-10002	RL-13002	RL-16002	RL-20002B14	RL-25002B14	RL-32002B14	RL-40002B14	RL-40002B14	RL-50002	RL-60002	RL-75002	RL-02B14	RL-100002B14	RL-120002B14
RL-05503	RL-08003	RL-10003	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-32003B14	RL-40003B14	RL-40003B14	RL-50003	RL-60003	RL-75003	RL-03B14	RL-100003B14	RL-120003B14
RL-05502	RL-08002	RL-08002	RL-10002	RL-13002	RL-16002	RL-20002B14	RL-25002B14	RL-32002B14	RL-40002B14	RL-50002	RL-50002	RL-60002	RL-75002	RL-85002B14	RL-100002B14
RL-05503	RL-08003	RL-08003	RL-10003	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-32003B14	RL-40003B14	RL-50003	RL-50003	RL-60003	RL-75003	RL-85003B14	RL-100003B14
RL-04502	RL-05502	RL-08002	RL-08002	RL-10002	RL-13002	RL-16002	RL-20002B14	RL-25002B14	RL-32002B14	RL-40002B14	RL-40002B14	RL-50002	RL-60002	RL-75002	RL-85002B14
RL-04503	RL-05503	RL-08003	RL-08003	RL-10003	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-32003B14	RL-40003B14	RL-40003B14	RL-50003	RL-60003	RL-75003	RL-85003B14
RL-02501	RL-03501	RL-04502	RL-05502	RL-08002	RL-08002	RL-10002	RL-13002	RL-13002	RL-16002	RL-20002B14	RL-25002B14	RL-32002B14	RL-40002B14	RL-40002B14	RL-50002
RL-02503	RL-03503	RL-04503	RL-05503	RL-08003	RL-08002	RL-10003	RL-13003	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-32003B14	RL-40003B14	RL-40003B14	RL-50003
Single Phase Input Applications															
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RL-20001B14	RL-25001B14	RL-32001B14	RL-40001B14	RL-50001B14	-	-	-	-	-	-	-	-	-	-	-
RL-25002B14	RL-32002B14	RL-40002B14	RL-50002	RL-60002	-	-	-	-	-	-	-	-	-	-	-
RL-25002B14	RL-32002B14	RL-40002B14	RL-50002	RL-60002	-	-	-	-	-	-	-	-	-	-	-
RL-10002	RL-13003	RL-16003	RL-20003B14	RL-25003B14	-	-	-	-	-	-	-	-	-	-	-
RL-10002	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-32003B14	RL-40003B14	RL-50003	-	-	-	-	-	-	-	-
RL-08002	RL-10003	RL-13003	RL-16003	RL-20003B14	RL-25003B14	RL-25003B14	RL-40003B14	-	-	-	-	-	-	-	-

## Impedance Rating:

**3% impedance** reactors are typically sufficient to absorb power line spikes and motor current surges. They will prevent nuisance tripping of drives or circuit breakers in most applications.

**5% impedance** reactors are best for reducing harmonic currents and frequencies. Use them when you must reduce VFD drive generated harmonics, and to reduce motor operating temperature, or to reduce motor noise.

\*The effective impedance of the reactor changes with actual RMS current. A 5% impedance reactor becomes 3% if its current is reduced to 60%.

# Line/Load Reactor Selection Tables



Open					
Open Part Number	Amps Rating	Inductance mh	Watts Loss	Open Weight (lbs)	Size (in) (H x W x D)
RL-00101	1	100	13.5	2.2	3.5 x 3.8 x 1.2
RL-00102	1	50	12.8	2.1	3.5 x 3.8 x 1.2
RL-00103	1	36	11.9	2.1	3.5 x 3.8 x 1.2
RL-00104	1	18	9.6	2	3.5 x 3.8 x 1.2
RL-00201	2	12	7.5	4	4.1 x 4.4 x 2.8
RL-00202	2	20	11.3	4	4.1 x 4.4 x 2.8
RL-00203	2	32	16	4	4.1 x 4.4 x 2.8
RL-00204	2	6	10.7	3	4.1 x 4.4 x 2.5
RL-00401	4	3	14.5	4	4.1 x 4.4 x 2.8
RL-00402	4	6.5	20	4	4.1 x 4.4 x 2.8
RL-00403	4	9	20	5	4.1 x 4.4 x 3.4
RL-00404	4	12	21	6	4.1 x 4.4 x 3.4
RL-00801	8	1.5	19.5	7	4.8 x 6 x 3
RL-00802	8	3	29	8	4.8 x 6 x 3
RL-00803	8	5	25.3	11	4.8 x 6 x 3.4
RL-00804	8	7.5	28	13	4.8 x 6 x 3.4
RL-01201	12	1.3	26	9	5 x 6 x 3.3
RL-01202	12	2.5	31	10	5 x 6 x 3.3
RL-01203	12	4.2	41	18	5 x 6 x 3.9
RL-01801	18	0.8	36	9	5.3 x 6 x 3.2
RL-01802	18	1.5	43	12	5.3 x 6 x 3.5
RL-01803	18	2.5	43	16	6.1 x 8.1 x 4
RL-02501	25	0.5	48	11	5.8 x 7.2 x 3.5
RL-02502	25	1.2	52	14	5.8 x 7.2 x 3.5
RL-02503	25	1.8	61	20	5.8 x 7.2 x 4.3
RL-03501	35	0.4	49	14	5.8 x 7.2 x 4
RL-03502	35	0.8	54	16	5.8 x 7.2 x 4
RL-03503	35	1.2	54	30	7.4 x 9 x 4.7
RL-04501	45	0.3	54	23	7.4 x 9 x 4.7
RL-04502	45	0.7	62	28	7.4 x 9 x 4.7
RL-04503	45	1.2	65	39	7.3 x 9 x 5.3
RL-05501	55	0.3	64	24	7.3 x 9 x 5.3
RL-05502	55	0.5	67	27	7 x 9 x 5.3
RL-05503	55	0.9	71	41	7 x 9 x 6
RL-08001	80	0.2	82	25	7.2 x 9 x 6.3
RL-08002	80	0.4	86	33	7.2 x 9 x 6.5
RL-08003	80	0.7	96	61	8.5 x 10.8 x 6.8
RL-10001	100	0.2	94	29	7.3 x 9 x 6.5
RL-10002	100	0.3	84	37	7.3 x 9 x 6.8
RL-10003	100	0.5	108	74	8.25 x 10.8 x 6.16
RL-13001	130	0.1	108	29	7 x 9 x 4.66
RL-13002	130	0.2	180	43	7.2 x 9 x 6.8
RL-13003	130	0.3	128	64	8.5 x 11 x 6.16

Open					
Open Part Number	Amps Rating	Inductance mh	Watts Loss	Open Weight (lbs)	Size (in) (H x W x D)
RL-16001	160	0.1	116	41	7.2 x 9 x 6.8
RL-16002	160	0.2	149	51	8.3 x 10.8 x 6
RL-16003	160	0.2	138	72	8.5 x 11.5 x 9
RL-20001B14	200	0.1	124	38	7.5 x 9 x 7.3
RL-20002B14	200	0.1	168	54	7.5 x 9 x 8.3
RL-20003B14	200	0.2	146	100	8.3 x 10.8 x 10
RL-25001B14	250	0	154	47	7.5 x 9 x 9
RL-25002B14	250	0.1	231	80	8.5 x 10.8 x 9
RL-25003B14	250	0.2	219	125	11.2 x 14.4 x 10.3
RL-32001B14	320	0	224	80	9 x 10.8 x 8.3
RL-32002B14	320	0.1	264	102	9 x 10.8 x 10
RL-32003B14	320	0.1	351	160	11.25 x 14.4 x 10.5
RL-40001B14	400	0	231	84	10 x 10.8 x 10
RL-40002B14	400	0.1	333	118	11.25 x 15 x 11.5
RL-40003B14	400	0.1	293	149	11.25 x 14.4 x 12.5
RL-50001B14	500	0	266	93	9 x 10.8 x 10.5
RL-50002	500	0.1	340	118	11.5 x 14.4 x 11.5
RL-50003	500	0.1	422	210	11.5 x 14.4 x 13.3
RL-60001	600	0	307	120	11.5 x 14.4 x 10
RL-60002	600	0	414	175	11.25 x 14.4 x 12
RL-60003	600	0.1	406	270	11.25 x 14.4 x 15
RL-75001	750	0	427	140	11.5 x 14.4 x 11
RL-75002	750	0	630	190	11.5 x 14.4 x 12.5
RL-75003	750	0	552	265	14.5 x 14.4 x 14
RL-85001B14	850	0	798	195	15.5 x 17.8 x 14.5
RL-85002B14	850	0	930	215	15.5 x 17.8 x 15.5
RL-85003B14	850	0	1133	315	15.5 x 17.8 x 17.5
RL-90001B14	900	0	860	200	16.8 x 17.8 x 13
RL-90002B14	900	0	1020	215	15.5 x 17.8 x 15.5
RL-90003B14	900	0	1365	315	15.8 x 17.8 x 17.1
RL-100001B14	1000	0	940	144	14.5 x 17.8 x 12.7
RL-100002B14	1000	0	1090	215	15.5 x 17.8 x 15.5
RL-100003B14	1000	0	1500	315	15.8 x 17.8 x 17.5
RL-120001B14	1200	0	980	195	15.5 x 17.8 x 14.5
RL-120002B14	1200	0	1130	275	15.5 x 17.8 x 17.8
RL-120003B14	1200	0	1550	390	15.4 x 17.4 x 18.3
RL-140001	1400	0		500	17 x 22 x 22
RL-140002	1400	0	1523	525	17 x 19 x 19
RL-140003	1400	0	1680	850	17 x 22 x 22
RL-150001	1500	0	1432	635	17 x 22 x 22
RL-150002	1500	0	1671	675	17 x 16.9 x 16
RL-150003	1500	0	1815	900	17 x 22 x 22

Note: Weights and dimensions are for reference only. Please visit [mtecorp.com](http://mtecorp.com) for detailed information.

# Line/Load Reactor Selection Tables - w/Enclosure NEMA 1/2



Part #	Weight (lbs)	Cabinet	Size (In) H x W x D	Ref Fig.
RL-00111	9	CAB-8	8 x 8 x 6	1
RL-00112	9	CAB-8	8 x 8 x 6	1
RL-00113	9	CAB-8	8 x 8 x 6	1
RL-00114	9	CAB-8	8 x 8 x 6	1
RL-00211	11	CAB-8	8 x 8 x 6	1
RL-00212	11	CAB-8	8 x 8 x 6	1
RL-00213	11	CAB-8	8 x 8 x 6	1
RL-00214	10	CAB-8	8 x 8 x 6	1
RL-00411	11	CAB-8	8 x 8 x 6	1
RL-00412	11	CAB-8	8 x 8 x 6	1
RL-00413	12	CAB-8	8 x 8 x 6	1
RL-00414	13	CAB-8	8 x 8 x 6	1
RL-00811	14	CAB-8	8 x 8 x 6	1
RL-00812	15	CAB-8	8 x 8 x 6	1
RL-00813	18	CAB-8	8 x 8 x 6	1
RL-00814	20	CAB-8	8 x 8 x 6	1
RL-01211	16	CAB-8	8 x 8 x 6	1
RL-01212	17	CAB-8	8 x 8 x 6	1
RL-01213	25	CAB-8	8 x 8 x 6	1
RL-01811	16	CAB-8	8 x 8 x 6	1
RL-01812	19	CAB-8	8 x 8 x 6	1
RL-01813	34	CAB-13V	13 x 13 x 13	4
RL-02511	29	CAB-13V	13 x 13 x 13	4
RL-02512	32	CAB-13V	13 x 13 x 13	4
RL-02513	38	CAB-13V	13 x 13 x 13	4
RL-03511	32	CAB-13V	13 x 13 x 13	4
RL-03512	34	CAB-13V	13 x 13 x 13	4
RL-03513	48	CAB-13V	13 x 13 x 13	4
RL-04511	41	CAB-13V	13 x 13 x 13	4
RL-04512	46	CAB-13V	13 x 13 x 13	4
RL-04513	57	CAB-13V	13 x 13 x 13	4
RL-05511	42	CAB-13V	13 x 13 x 13	4
RL-05512	45	CAB-13V	13 x 13 x 13	4
RL-05513	5	CAB-13V	13 x 13 x 13	4
RL-08011	43	CAB-13V	13 x 13 x 13	4
RL-08012	51	CAB-13V	13 x 13 x 13	4
RL-08013	79	CAB-13V	13 x 13 x 13	4
RL-10011	47	CAB-13V	13 x 13 x 13	4
RL-10012	55	CAB-13V	13 x 13 x 13	4
RL-10013	92	CAB-13V	13 x 13 x 13	4
RL-13011	47	CAB-13V	13 x 13 x 13	4
RL-13012	61	CAB-13V	13 x 13 x 13	4
RL-13011	82	CAB-13V	13 x 13 x 13	4
RL-16011	59	CAB-13V	13 x 13 x 13	4

Part #	Weight (lbs)	Cabinet	Size (In) H x W x D	Ref Fig.
RL-16012	69	CAB-13V	13 x 13 x 13	4
RL-16013	90	CAB-13V	13 x 13 x 13	4
RL-16011	59	CAB-13V	13 x 13 x 13	4
RL-16012	69	CAB-13V	13 x 13 x 13	4
RL-16013	90	CAB-13V	13 x 13 x 13	4
RL-20011B14	56	CAB-13V	13 x 13 x 13	4
RL-20012B14	72	CAB-13V	13 x 13 x 13	4
RL-20013B14	118	CAB-13V	13 x 13 x 13	4
RL-25011B14	65	CAB-13V	13 x 13 x 13	4
RL-25012B14	104	CAB-17V	24 x 17 x 18.4	5
RL-25013B14	149	CAB-17V	24 x 17 x 18.4	5
RL-32011B14	104	CAB-17V	24 x 17 x 18.4	5
RL-32012B14	126	CAB-17V	24 x 17 x 18.4	5
RL-32013B14	184	CAB-17V	24 x 17 x 18.4	5
RL-40011B14	108	CAB-17V	24 x 17 x 18.4	5
RL-40012B14	142	CAB-17V	24 x 17 x 18.4	5
RL-40013B14	173	CAB-17V	24 x 17 x 18.4	5
RL-50011B14	117	CAB-17V	24 x 17 x 18.4	5
RL-50012	262	CAB-26C	47 x 27 x 25	3
RL-50013	354	CAB-26C	47 x 27 x 25	3
RL-60011	264	CAB-26C	47 x 27 x 25	3
RL-60012	319	CAB-26C	47 x 27 x 25	3
RL-60013	414	CAB-26C	47 x 27 x 25	3
RL-75011	284	CAB-26C	47 x 27 x 25	3
RL-75012	334	CAB-26C	47 x 27 x 25	3
RL-75013	409	CAB-26C	47 x 27 x 25	3
RL-85011B14	339	CAB-26C	47 x 27 x 25	3
RL-85012B14	359	CAB-26C	47 x 27 x 25	3
RL-85013B14	535	CAB-26D	72 x 26.5 x 25	3
RL-90011B14	420	CAB-26D	72 x 26.5 x 25	3
RL-90012B14	435	CAB-26D	72 x 26.5 x 25	3
RL-90013B14	535	CAB-26D	72 x 26.5 x 25	3
RL-100011B14	364	CAB-26D	72 x 26.5 x 25	3
RL-100012B14	435	CAB-26D	72 x 26.5 x 25	3
RL-100013B14	535	CAB-26D	72 x 26.5 x 25	3
RL-120011B14	415	CAB-26D	72 x 26.5 x 25	3
RL-120012B14	495	CAB-26D	72 x 26.5 x 25	3
RL-120013B14	610	CAB-26D	72 x 26.5 x 25	3
RL-140011B14	803	CAB-42C	60 x 42.6 x 31	3
RL-140012B14	828	CAB-42C	60 x 42.6 x 31	3
RL-140013B14	1153	CAB-42C	60 x 42.6 x 31	3
RL-150011B14	938	CAB-42C	60 x 42.6 x 31	3
RL-150012B14	978	CAB-42C	60 x 42.6 x 31	3
RL-150013B14	1203	CAB-42C	60 x 42.6 x 31	3

# Line/Load Reactor Selection Tables - w/Enclosure NEMA 3R



Part #	Weight (lbs)	Cabinet	Size (In) H x W x D	Ref Fig.
RL-00131	9	CAB-8	8 x 8 x 6	1
RL-00132	9	CAB-8	8 x 8 x 6	1
RL-00133	9	CAB-8	8 x 8 x 6	1
RL-00134	9	CAB-8	8 x 8 x 6	1
RL-00231	11	CAB-8	8 x 8 x 6	1
RL-00232	11	CAB-8	8 x 8 x 6	1
RL-00233	11	CAB-8	8 x 8 x 6	1
RL-00234	10	CAB-8	8 x 8 x 6	1
RL-00431	11	CAB-8	8 x 8 x 6	1
RL-00432	11	CAB-8	8 x 8 x 6	1
RL-00433	12	CAB-8	8 x 8 x 6	1
RL-00434	13	CAB-8	8 x 8 x 6	1
RL-00831	14	CAB-8	8 x 8 x 6	1
RL-00832	15	CAB-8	8 x 8 x 6	1
RL-00833	18	CAB-8	8 x 8 x 6	1
RL-00834	20	CAB-8	8 x 8 x 6	1
RL-01231	16	CAB-8	8 x 8 x 6	1
RL-01232	17	CAB-8	8 x 8 x 6	1
RL-01233	25	CAB-8	8 x 8 x 6	1
RL-01831	16	CAB-8	8 x 8 x 6	1
RL-01832	19	CAB-8	8 x 8 x 6	1
RL-01833	34	CAB-13V	13 x 13 x 13	4
RL-02531	29	CAB-13V	13 x 13 x 13	4
RL-02532	32	CAB-13V	13 x 13 x 13	4
RL-02533	38	CAB-13V	13 x 13 x 13	4
RL-03531	32	CAB-13V	13 x 13 x 13	4
RL-03532	34	CAB-13V	13 x 13 x 13	4
RL-03533	48	CAB-13V	13 x 13 x 13	4
RL-04531	41	CAB-13V	13 x 13 x 13	4
RL-04532	46	CAB-13V	13 x 13 x 13	4
RL-04533	57	CAB-13V	13 x 13 x 13	4
RL-05531	42	CAB-13V	13 x 13 x 13	4
RL-05532	45	CAB-13V	13 x 13 x 13	4
RL-05533	5	CAB-13V	13 x 13 x 13	4
RL-08031	43	CAB-13V	13 x 13 x 13	4
RL-08032	51	CAB-13V	13 x 13 x 13	4
RL-08033	79	CAB-13V	13 x 13 x 13	4
RL-10031	47	CAB-13V	13 x 13 x 13	4
RL-10032	55	CAB-13V	13 x 13 x 13	4
RL-10033	92	CAB-13V	13 x 13 x 13	4
RL-13031	47	CAB-13V	13 x 13 x 13	4
RL-13032	61	CAB-13V	13 x 13 x 13	4
RL-13031	82	CAB-13V	13 x 13 x 13	4
RL-16031	59	CAB-13V	13 x 13 x 13	4

Part #	Weight (lbs)	Cabinet	Size (In) H x W x D	Ref Fig.
RL-16032	69	CAB-13V	13 x 13 x 13	4
RL-16033	90	CAB-13V	13 x 13 x 13	4
RL-16031	59	CAB-13V	13 x 13 x 13	4
RL-16032	69	CAB-13V	13 x 13 x 13	4
RL-16033	90	CAB-13V	13 x 13 x 13	4
RL-20011B34	56	CAB-13V	13 x 13 x 13	4
RL-20012B34	72	CAB-13V	13 x 13 x 13	4
RL-20013B34	118	CAB-13V	13 x 13 x 13	4
RL-25011B34	65	CAB-13V	13 x 13 x 13	4
RL-25012B34	104	CAB-17V	24 x 17 x 18.4	5
RL-25013B34	149	CAB-17V	24 x 17 x 18.4	5
RL-32011B34	104	CAB-17V	24 x 17 x 18.4	5
RL-32012B34	126	CAB-17V	24 x 17 x 18.4	5
RL-32013B34	184	CAB-17V	24 x 17 x 18.4	5
RL-40011B34	108	CAB-17V	24 x 17 x 18.4	5
RL-40012B34	142	CAB-17V	24 x 17 x 18.4	5
RL-40013B34	173	CAB-17V	24 x 17 x 18.4	5
RL-50011B34	117	CAB-17V	24 x 17 x 18.4	5
RL-50032	262	CAB-26C	47 x 27 x 25	3
RL-50033	354	CAB-26C	47 x 27 x 25	3
RL-60031	264	CAB-26C	47 x 27 x 25	3
RL-60032	319	CAB-26C	47 x 27 x 25	3
RL-60033	414	CAB-26C	47 x 27 x 25	3
RL-75031	284	CAB-26C	47 x 27 x 25	3
RL-75032	334	CAB-26C	47 x 27 x 25	3
RL-75033	409	CAB-26C	47 x 27 x 25	3
RL-85011B34	339	CAB-26C	47 x 27 x 25	3
RL-85012B34	359	CAB-26C	47 x 27 x 25	3
RL-85013B34	535	CAB-26D	72 x 26.5 x 25	3
RL-90011B34	420	CAB-26D	72 x 26.5 x 25	3
RL-90012B34	435	CAB-26D	72 x 26.5 x 25	3
RL-90013B34	535	CAB-26D	72 x 26.5 x 25	3
RL-100011B34	364	CAB-26D	72 x 26.5 x 25	3
RL-100012B34	435	CAB-26D	72 x 26.5 x 25	3
RL-100013B34	535	CAB-26D	72 x 26.5 x 25	3
RL-120011B34	415	CAB-26D	72 x 26.5 x 25	3
RL-120012B34	495	CAB-26D	72 x 26.5 x 25	3
RL-120013B34	610	CAB-26D	72 x 26.5 x 25	3
RL-140011B34	803	CAB-42C	60 x 42.6 x 31	3
RL-140012B34	828	CAB-42C	60 x 42.6 x 31	3
RL-140013B34	1153	CAB-42C	60 x 42.6 x 31	3
RL-150011B34	938	CAB-42C	60 x 42.6 x 31	3
RL-150012B34	978	CAB-42C	60 x 42.6 x 31	3
RL-150013B34	1203	CAB-42C	60 x 42.6 x 31	3

## Why Preventive Maintenance Service?

Just like an automobile, your power factor correction bank requires regular maintenance to ensure that it is operating optimally. This maintenance should be conducted on a regular annual basis (twice in the first year of a newly installed bank occurring at six month intervals).

Some factors that may have adverse effects on the operation of your bank that occur naturally include:

- Loose connections – Can lead to arcing and catastrophic damage to the APFC
- Failed Fuses – indicate a problem with a step in the bank or with the bank as a whole
- Failing Capacitors due to their natural or unnatural life span – reduce amount of kVAR being injected into the system.
- Dust and Dirt (depending on the location of installation) – known to cause arcing and catastrophic damage to the APFC.



## Benefits

- Optimal operation of the APFC or PFC bank
- Ensures avoidance of penalties due to poor power factor
- Helps to lengthen life of electrical equipment on the system
- Help to reduce your carbon footprint

## PM Service of Auto Switching Power Factor Correction Banks Includes:

- Panel performance test report (Volt, Amp., Power Factor)
- Check wiring, connection points etc.
- Check condition of components, replace if necessary.
- Check power factor setting, calibrate set values
- Check power and control fuses
- General cleaning.
- Completed Service Report for your records

## Other Services offered by Cos Phi:

Free Hydro Billing analysis - determine if you are paying avoidable penalties being levied by your utility due to poor power factor.

Power Quality Measurements

Power Quality Studies

Power Factor Correction Capacitors

Power Factor Correction Banks (Static and Auto-switching)

Surge Protection Devices

Replacement parts for Cos Phi power factor correction banks

**Contact us today to schedule your PM service!**

We service all manufacturers brands of power factor correction

## Power Quality Monitoring



Power Quality is a measure of how well an electrical supply system supports the reliable operation of its loads. A power disturbance or event can involve voltage, current, or frequency. These disturbances can be caused by improper power systems design, faulty consumer loads, or the utility provider.

Cos Phi can monitor any of the various power quality conditions to establish the corrective action needed for your facility. Not using proper monitoring equipment, system problems are often diagnosed incorrectly which could lead to expensive solutions that

don't effectively correct the underlying problem. We know what to use, where/when to use it and have the expertise to analyze the data.

### ***The Costs of Poor Power Quality Can be Significant!***

- Poor quality of power causes not only physical damage to equipment, but also results in downtime, which, in turn, lowers productivity and a substantial increase in energy costs.
- Lost production: Each time production is interrupted, your business loses profit on product that is not manufactured and sold.
- Damaged equipment: Interruptions can damage a partially complete product, causing the material to be re-run or scrapped or worse yet, simply become product waste.
- Energy cost: Electric utilities may charge penalties on poor power factor or high peak demands.
- False utility issues: The inherent design of the Emergency Power System is to protect against utility power interruptions. Power quality issues can cause voltage fluctuations, creating wasted fuel costs and unnecessary run time on the Emergency Power System.
- Increased Carbon footprint. Poor power quality also means higher power demand requirements which in turn increases your carbon footprint.

### **Monitoring Packages**

Our monitoring packages come with a detailed report which includes our observations, measurement printouts, conclusions and recommendations for corrective measures. Because we also manufacture our own corrective equipment, we can also include a quotation for corrective equipment if needed, on request

#### **What we can monitor:**

- Power (kW, kVA, kVAR – min., avg., max.)
- Current (each phase - min., avg., max.)
- Voltage (each phase - min., avg., max.)
- Harmonic Spectrum (ITHD, VTHD, odd harmonics)
- Voltage and Current Disturbances (e.g. sags, surges, swells, dips, transients, etc.)
- Power Factor

We also conduct complimentary Hydro Billing Analysis for those concerned about power factor penalties that are being levied by their utility due to poor system power factor.

***To arrange your power quality monitoring contact us today!***



## Power Metering Solutions



Rationalizing an investment in a facility's infrastructure can be a difficult prospect for any plant engineer or technician, often requiring extensive justification. Investments that are deemed "low-risk" by upper management and have a fast return on investment (ROI) are typically the easiest to substantiate. One such investment that will pay considerable dividends over the course of its operating life is a comprehensive power monitoring system.

What are the benefits of monitoring?

- **Environmental** — A better knowledge of how energy is used within a facility allows you to identify areas to improve efficiency, minimize waste, reduce energy consumption and lower your carbon footprint.
- **Reliability** — System/Equipment monitoring can reveal existing or imminent issues that can adversely affect the operation and production within a facility.
- **Maintenance** — Data trends can forecast and notify the appropriate people when discrete equipment parameters may be exceeded, allowing you to plan ahead instead of facing an unscheduled shutdown.
- **Safety** — Monitoring systems can limit the exposure of personnel to potentially hazardous electrical environments by providing remote status and operational parameters of equipment within hazardous areas.
- **Financial** — Each benefit discussed above either directly or indirectly influences a business's bottom line. In most cases, the monetary impact from even one or two benefits can quickly justify the purchase and installation of a power monitoring system.

Cos Phi provides integrated metering solutions for commercial and industrial buildings.

The first step required to make the most of your energy is to choose the right meters for the right job. Cos Phi offers a variety of metering hardware to measure your energy consumption, power usage and power quality.

Meters offer the ability to view the data locally via an LCD display, downloaded on any web enabled device for later analysis, or transferred via local intranet for analysis through any web browser enabled device.

In multiple meter applications or for convenience, data can be collected and sent over the local network or internet and in remote locations by GPRS/GSM modem. Data can then be analyzed locally using our energy metering software, or via a secure internet connection via regular web browser software.



***To discuss your power metering needs contact us today!***





## Cos Phi expertise helps printing company improve electrical systems efficiency and achieve utility savings to pay for it.

**Location:**  
S.W. Ontario

**Segment:**  
Printing Industry

**Challenge:**  
Enhance electrical use to help eliminate power factor penalties and generate utility savings.

**Solution:**  
Expert electrical system analysis leading to the application of a customized power factor correction system.

**Results:**  
Increase electrical system efficiency and annual utility penalties reduce by more than \$12,500.00, enabling full return on investment in 14.2 months

### Background

Poor power usage results in low power factor. Certain industries such as the printing industry are known to have poor power factor utilization and low power factor.

Power factor is the ratio of working power (kW) to apparent power (kVA). It measures how effectively electrical power is being used. A high power factor signals efficient use, while a low power factor indicates poor use. Utilities constantly track this metric and often penalize companies with low power factor as an incentive to implement solutions that lead to more effective energy use - which results in lessened demand on the utility.

In this case, the local utility charged a penalty to a commercial printer when power factor dropped below 0.9. As a result, the customer was subjected to a monthly penalty due to poor power factor.

### Challenge

Operational load at the commercial printing facility varied significantly throughout the day leading to vast fluctuation in the demand placed on the electrical equipment.

The change in loading caused the power factor levels to drop as low as 0.66 which was well below the 0.9 utility threshold at which point the utility penalizes its demand customers for poor power factor.

The resulting poor power usage led to the plant suffering demand penalties excess of \$12,500.00 due to poor power factor. The penalties represented 20% of the cost of their demand charges.

Management contacted experts in the field to help them improve their power utilization and eliminate the penalties.



### Solution

To assist in developing a solution, the facility sought out the expertise of Cos Phi, a power factor and power quality correction company based in Hensall Ontario. They were able to facilitate in the development of an effective customized solution.

The team reviewed the facility's loads, historical data, and monthly utility bills. After the review the team developed a power factor correction capacitor bank solution that would raise the power factor to acceptable utility levels. Additional calculations were performed to specifically avoid harmonic resonance which could interfere with the reliable operation of the facilities equipment.

This led to Cos Phi recommending a custom de-tuned (harmonically filtered), automatically switched, low voltage power factor correction bank. The capacitor bank was installed at the main electrical panel.

The automatic PFC capacitor bank system was designed so that it will automatically switch capacitors in and out of the electrical system in order to maintain a pre-determined level of power factor correction. Additionally this PFC bank has an intelligent controller which monitors system kVAR, Voltage, Amps and harmonics.

### Results

After applying the Cos Phi solution, which was also manufactured by Cos Phi, the plant increased its average power factor level to a point avoiding utility penalties. The new system increase the average power factor from .7 to .91+ which exceeds the utility .9 threshold for penalties.

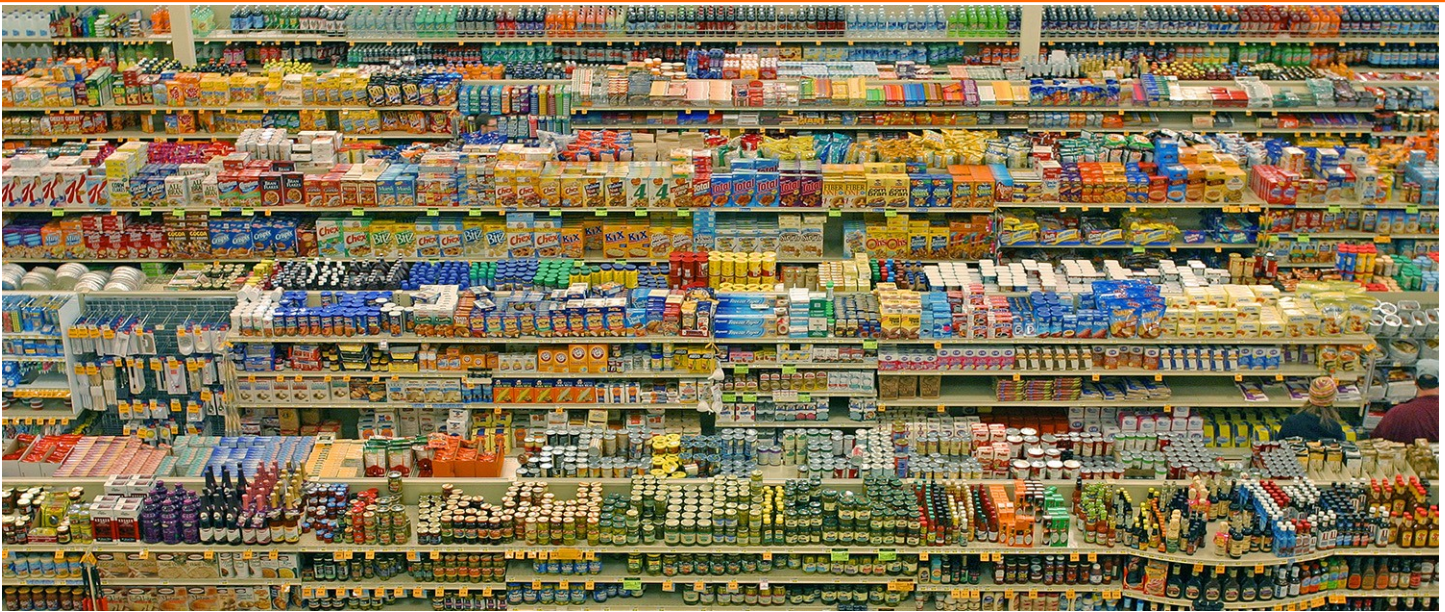
Since the PFC bank has been installed the facility has recorded savings of slightly over \$1,000.00 per month on demand charges alone. The estimated return on investment is 14.2 months.

An additional benefit to the installation of the power factor correction bank is that it will free up approximately 25-30% of the current kVA load on the transformer thus allowing for additional equipment to be added without upgrading the system. This reduced load will also increase the life expectancy of the transformer.

To learn more, visit

[www.cosphi.com](http://www.cosphi.com)





## Cos Phi expertise helps small dairy food processing plant improve electrical systems efficiency and achieve utility savings to pay for it.

**Location:**  
Central Ontario

**Segment:**  
Dairy Processing

**Challenge:**  
Enhance electrical use to help eliminate power factor penalties and generate utility savings.

**Solution:**  
Expert electrical system analysis leading to the application of a customized power factor correction system.

**Results:**  
Increase electrical system efficiency and annual utility penalties reduce by more than \$8,990.00\*, enabling full return on investment in 13.1 months

\*due to demand and rate increases after correction was installed double the forecasted potential savings were realized.

### Background

Poor power usage results in low power factor. Certain industries such as the dairy industry are typically known to have low power factor.

Power factor is the ratio of working power (kW) to apparent power (kVA). It measures how effectively electrical power is being used. A high power factor signals efficient use, while a low power factor indicates poor use. Utilities constantly track this metric and often penalize companies with low power factor as an incentive to implement solutions that lead to more effective energy use - which results in lessened demand on the utility.

In this case, the local utility charged a penalty to a dairy processing plant when power factor dropped below 0.9. As a result, the customer was subjected to a monthly penalty due to poor power factor.

### Challenge

Operational load at the commercial printing facility varied significantly throughout the day leading to vast fluctuation in the demand placed on the electrical equipment.

The power factor of the electrical system averaged 0.75 which was well below the 0.9 utility threshold at which point the utility penalizes its demand customers for poor power factor.

The resulting poor power usage led to the plant suffering demand penalties excess of 4,100.00 due to poor power factor. The penalties represented 16% of the cost of their demand charges.

Management contacted experts in the field to help them improve their power utilization and eliminate the penalties.



### Solution

To assist in developing a solution, the facility sought out the expertise of Cos Phi, a power factor and power quality correction company based in Hensall Ontario. They were able to facilitate in the development of an effective customized solution.

The team reviewed the facility's loads, historical data, and monthly utility bills. After the review the team developed a power factor correction capacitor bank solution that would raise the power factor to acceptable utility levels. Additional calculations were performed to specifically avoid harmonic resonance which could interfere with the reliable operation of the facilities equipment.

This led to Cos Phi recommending a custom de-tuned (harmonically filtered), automatically switched, low voltage power factor correction bank. This bank would switch on correction when needed.

The automatic PFC capacitor bank system was designed so that it will automatically switch capacitors in and out of the electrical system as needed in order to maintain a pre-determined level of power factor correction. Additionally this PFC bank has an intelligent controller which monitors system kVAR, Voltage, Amps and harmonics.

### Results

After applying the Cos Phi solution, which was also manufactured by Cos Phi, the plant increased its average power factor level to a point avoiding utility penalties. The new system increased the average power factor from an average 0.75 to .91+ which exceeds the utility .9 threshold for penalties.

Since the PFC bank has been installed the facility has recorded savings on the average of \$640.00 per month on demand charges alone. The return on investment was only 13.1 months. Due to demand and rate increases shortly after the correction was installed actual realized savings were more than double what was forecasted resulting in a quicker ROI than originally forecasted.

An additional benefit to the installation of the power factor correction bank is that it will free up approximately 20-25% of the current kVA load on the transformer thus allowing for additional equipment to be added without upgrading the system. This reduced load will also increase the life expectancy of the transformer. It will also help to reduce CO2 emissions.

To learn more, visit

[www.cosphi.com](http://www.cosphi.com)



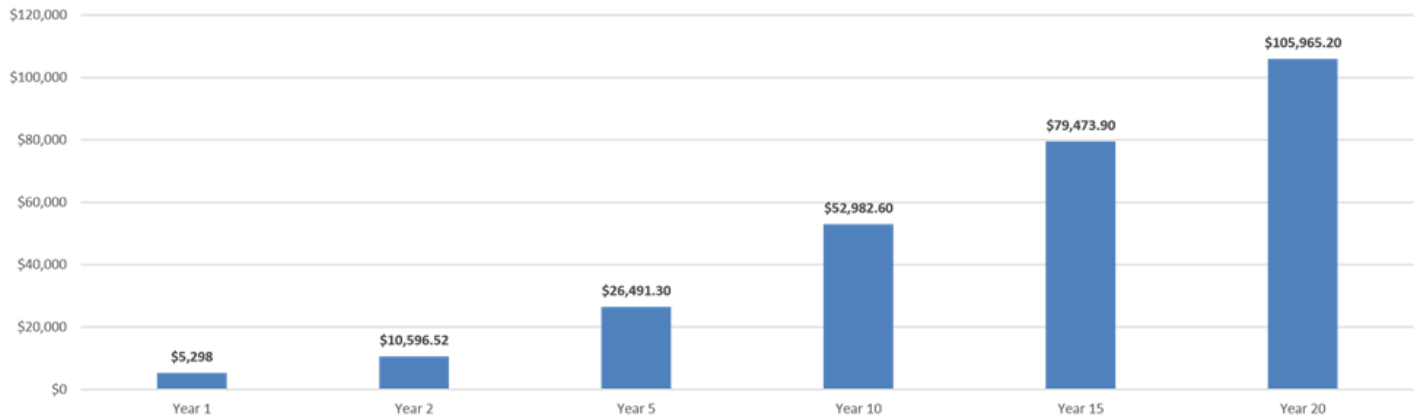
# Complimentary Hydro Billing Analysis

Client: <b>Sample</b>		Desired PF 95.0%		Demand Penalty \$ 4,945.17											
Location: <b>Sample</b>		Minimum KVAR Required 211		FR Loss Cost \$ 658.98											
Account # <b>Sample</b>		Min PF 80.0%		Total Potential Savings \$ 5,604.15											
Date Conducted <b>Sample</b>		Max PF 82.1%		Average Savings per Month \$ 467.81											
Demand Rates		Avg PF 80.6%		Annualized Savings \$ 5,604.15											
Delivery \$ 2,7093		Min KW 465		(Average savings x 12)											
Transmission \$ 2,5668		Max KW 512													
Network Charge \$ 1,5634		Avg KW 489													
Connection Charge															
Energy															
FR Heat Loss Multiplier 4%															
Total Months Analyzed 12															
Demand Readings & Adjustments		Demand Charges and Penalties				Estimated Cost of Line Losses									
Billing Reference Date	Demand Reading	System KVAR	Required KVAR	Power Factor	Rate Adjustment: KW @ 100% KVA @ 90%	Delivery \$	Transmission Network \$	Transmission Connection \$	Total KW Demand \$	Total KVA Demand \$	Actual Demand \$ Billed	Demand Penalty \$ Billed	Total Energy \$ Billed	Heat Loss Multiplier	Heat Loss \$ Billed
January 1, 2018	480.00	360	202	80.0%	480.00	\$ 1,300.45	\$ 1,341.66	\$ 942.43	\$ 3,484.56	\$ 3,920.13	\$ 3,920.13	\$ 435.57	\$ 3,650.00	0.01163435	\$ 42.47
February 1, 2018	475.00	350	194	80.5%	475.00	\$ 1,463.02	\$ 1,395.87	\$ 1,060.24	\$ 3,446.26	\$ 3,854.80	\$ 3,854.80	\$ 406.53	\$ 4,200.00	0.01127262	\$ 47.35
March 1, 2018	505.00	388	202	80.8%	505.00	\$ 1,286.92	\$ 1,226.73	\$ 932.62	\$ 3,666.05	\$ 4,083.47	\$ 4,083.47	\$ 417.42	\$ 4,125.00	0.01106420	\$ 45.64
April 1, 2018	512.00	357	188	82.1%	512.00	\$ 1,523.98	\$ 1,455.08	\$ 1,104.41	\$ 3,716.86	\$ 4,076.94	\$ 4,076.94	\$ 360.07	\$ 6,250.00	0.01016105	\$ 63.51
May 1, 2018	465.00	338	185	80.9%	465.00	\$ 1,521.54	\$ 1,452.75	\$ 1,102.65	\$ 3,375.67	\$ 4,076.94	\$ 3,756.79	\$ 381.12	\$ 4,800.00	0.01101435	\$ 52.87
June 1, 2018	476.00	352	196	80.4%	476.00	\$ 1,289.63	\$ 1,231.32	\$ 934.59	\$ 3,455.52	\$ 3,867.86	\$ 3,867.86	\$ 412.34	\$ 4,765.00	0.01134613	\$ 54.06
July 1, 2018	495.00	365	202	80.5%	495.00	\$ 1,341.10	\$ 1,280.47	\$ 971.89	\$ 3,593.45	\$ 4,018.13	\$ 4,018.13	\$ 424.68	\$ 4,690.00	0.01128737	\$ 52.94
August 1, 2018	503.00	376	211	80.1%	503.00	\$ 1,362.78	\$ 1,301.16	\$ 987.59	\$ 3,651.53	\$ 4,103.07	\$ 4,103.07	\$ 451.54	\$ 5,100.00	0.01156656	\$ 58.99
September 1, 2018	475.00	357	201	80.0%	475.00	\$ 1,531.30	\$ 1,455.06	\$ 1,097.71	\$ 3,446.26	\$ 3,880.53	\$ 3,880.53	\$ 432.67	\$ 5,250.00	0.01165822	\$ 61.21
October 1, 2018	490.00	367	206	80.1%	490.00	\$ 1,287.96	\$ 1,267.53	\$ 962.07	\$ 3,557.16	\$ 3,998.53	\$ 3,998.53	\$ 441.38	\$ 5,190.00	0.01158798	\$ 60.14
November 1, 2018	508.00	355	188	81.9%	508.00	\$ 1,492.28	\$ 1,424.81	\$ 1,081.44	\$ 3,687.83	\$ 4,050.80	\$ 4,050.80	\$ 362.98	\$ 5,630.00	0.01024521	\$ 57.68
December 1, 2018	485.00	358	199	80.4%	485.00	\$ 1,511.79	\$ 1,443.43	\$ 1,095.58	\$ 3,520.86	\$ 4,050.80	\$ 3,939.73	\$ 418.87	\$ 5,485.00	0.01132776	\$ 62.13
	603.00				542.70	\$ 1,470.34	\$ 1,403.86	\$ 1,065.54		<b>Total</b>	<b>\$ 47,551.18</b>	<b>\$ 4,945.17</b>	<b>\$ 59,135.00</b>		<b>\$ 658.98</b>

Note: This spreadsheet is designed as a forecast tool. It uses the previous historical 12 month of actual hydro billings to determine potential savings if power factor correction is implemented at the facility. It also estimates the total correction size needed to realize the forecast.

Note: This Sample billing analysis based on the rates and rate structure of a utility in Ontario. Each utility has its own rates and rate structure.

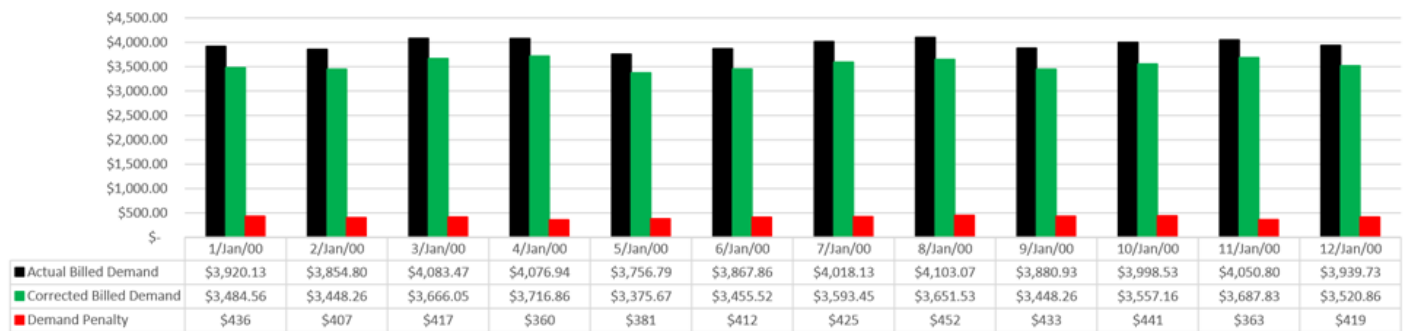
### Forecasted Savings Over Expected Life of Power Factor Correction Equipment



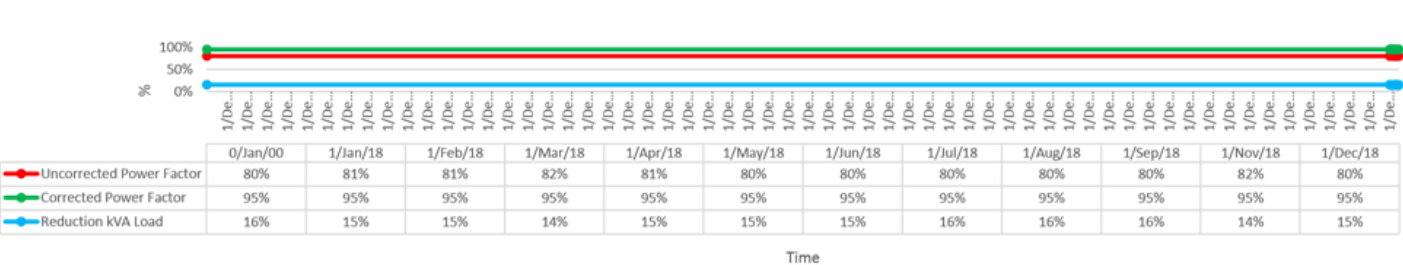
### Historical kW and kVA Demand



### Demand Charges and Penalties



### Actual PF, Corrected PF & kVA reduction with installed PFC in %

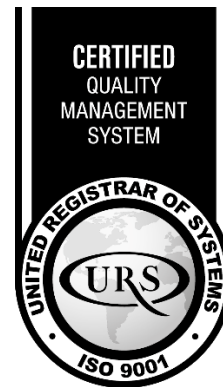




Product Part Numbers

$\Phi$  *Cos Phi*

*Power Factor & Power Quality Specialists*







## Contents

Automatic & Dynamic (APFC & DPFC) Part Numbers .....	2
Static Capacitor Bank Part Numbers .....	3
Power Quality Meters .....	4
Surge Protection Device (SPD) Assemblies Part Numbers .....	5

## Automatic & Dynamic (APFC & DPFC) Part Numbers

Note: All 600V banks are constructed using 690V capacitors.  
All 480V banks are constructed using 600V capacitors.

Sample: **CPA540/600/X/X/N1+**

<b>CPA</b>	<b>540</b>	<b>600</b>	<b>X</b>	<b>X</b>	<b>N1</b>	<b>+</b>
Type	kVAR	Voltage	Current Protection	Detuning	NEMA Rating	Adder

Type:

- **CPA** – Cos Phi Automatic (using contactors)
- **CPD** – Cos Phi Dynamic (using thyristors)

kVAR: Correction size in kVAR

Voltage (indicates capacitor bank nominal Voltage):

- **208**
- **480**
- **600**

Current Protection:

- **1** - indicates installed circuit breaker
- **X** – no circuit breaker

Detuning:

- **D** – indicates the bank has detuning reactors
- **X** – Not detuned

NEMA Rating:

- **N1** – NEMA 1 (NEMA 12 style)
- **3R** – NEMA 3R outdoor

Adder:

- **+** - Indicates an unspecified adder option and/or step configuration

## Static Capacitor Bank Part Numbers

Note: All 600V banks are constructed using 690V capacitors.  
All 480V banks are constructed using 600V capacitors.

Sample: **CPS100/600/C1/F/D/L/N1**

<b>CPS</b>	<b>540</b>	<b>600</b>	<b>C1</b>	<b>F</b>	<b>X</b>	<b>L</b>	<b>N1</b>
Type	kVAR	Voltage	Enclosure Size	Fusing	Detuning	Indication	NEMA Rating

Type:

- **CPS** – Static power factor correction bank

kVAR:

- **100** –Capacitor nominal kVAR size

Voltage (capacitor bank nominal Voltage):

- **208V**
- **480V**
- **600V**

Enclosure Size:

- **C1** – C001 enclosure
- **C2** – C002 enclosure
- **C3** – C003 enclosure

Fusing:

- **F** – Fused
- **X** – Not fused

Detuning:

- **D** – Detuning reactors
- **X** - No detuning reactors

Indication:

- **L** – Phase loss indicating lights
- **X** - No indicating Lights

NEMA Rating:

- **N1** – NEMA 12 style
- **N3R** – NEMA 3R

## Power Quality Meters

Sample: **PQM-800-EEEX-33-150-1-N1**

<b>PQM</b>	<b>800</b>	<b>K</b>	<b>K</b>	<b>K</b>	<b>X</b>	<b>3</b>	<b>3</b>	<b>150</b>	<b>1</b>	<b>N1</b>
Type	Meter	Mod 1	Mod 2	Mod 3	Mod 4	V Ph.	I Ph.	CT Size	Aux. Supply	NEMA Rating

Type:

- **PQM** – Power Quality Meter

Meter:

- **900**
- **800**
- **700**
- **610**
- **600**
- **300**
- **210**
- **200**

Mods 1-4:

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>• <b>A</b> Opto-isolated USB interface</li> <li>• <b>B</b> Opto-isolated RS232 interface</li> <li>• <b>C</b> Opto-isolated RS485 interface</li> <li>• <b>D</b> Opto-isolated Ethernet interface with Web server function</li> <li>• <b>E</b> Opto-isolated Profibus-DP interface</li> <li>• <b>F</b> 4 digital inputs, opto-isolated</li> <li>• <b>G</b> 4 static outputs, opto-isolated</li> <li>• <b>H</b> 2 digital inputs and 2 static outputs, opto-isolated</li> <li>• <b>I</b> 2 relay outputs, rated 5A 250VAC</li> <li>• <b>J</b> analog inputs, opto-isolated 0/4...20mA, PT100, 0-10V or 0...±5V</li> </ul> | <ul style="list-style-type: none"> <li>• <b>K</b> 2 analog outputs, opto-isolated 0/4...20mA, 0-10V or 0...±5V</li> <li>• <b>L</b> Data storage, clock-calendar</li> <li>• <b>X</b> No module</li> </ul> |
|---|--|

V Phases (Voltage):

- **1** – Single phase
- **2** – 2-phase
- **3** – 3-phase

I Phases (current):

- **1** – Single phase
- **2** – 2-phase
- **3** – 3-phase

CT Size: Current transformer size in Amps

Aux Supply:

- **1** – 120V corded
- **2** – Control Transformer 600:120V
- **3** – Control Transformer 480:120V

NEMA Rating:

- **N1** – NEMA 1
- **N3R** – NEMA 3R

## Surge Protection Device (SPD) Assemblies Part Numbers

Sample: **SPD/600/D/130/N1**

<b>SPD</b>	<b>600</b>	<b>D</b>	<b>130</b>	<b>N1</b>
Type	Voltage	Configuration	kA Rating	NEMA Rating

Type:

- **SPD** – Surge Protection Device

Voltage (operating Voltage):

- **120**
- **208**
- **480**
- **600**

Configuration:

- **Y**- WYE
- **D** - Delta
- **S** - Single

kA Rating: Surge capacity in kilo-Amps



NEMA Rating:

- **N1** – NEMA 1 (NEMA 12 style)
- **3R** – NEMA 3R outdoor

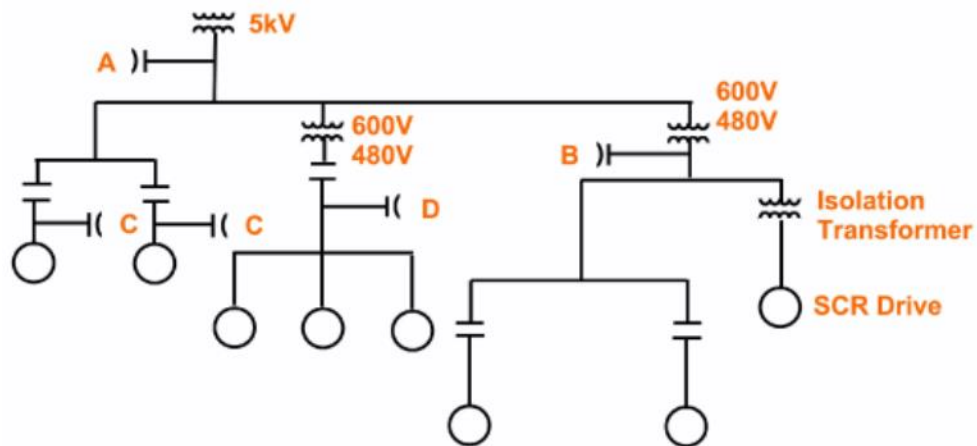
## Typical Locations for Power Capacitors

Before power capacitors can be installed in the customer facility system, the following factors must be addressed:

Meter Location: The physical location of the utility meter should be determined since all Power Capacitors must be installed “downstream” of the meter

There are four basic locations for Power Capacitors

- A. Load side of the utility transformer on the distribution bus
- B. Bank installation at Feeders, Sub-stations, or Transformers
- C. Load side of the AC motor, commonly referred to as “at the load” or “motor switched”
- D. Small motors operating from a common starter

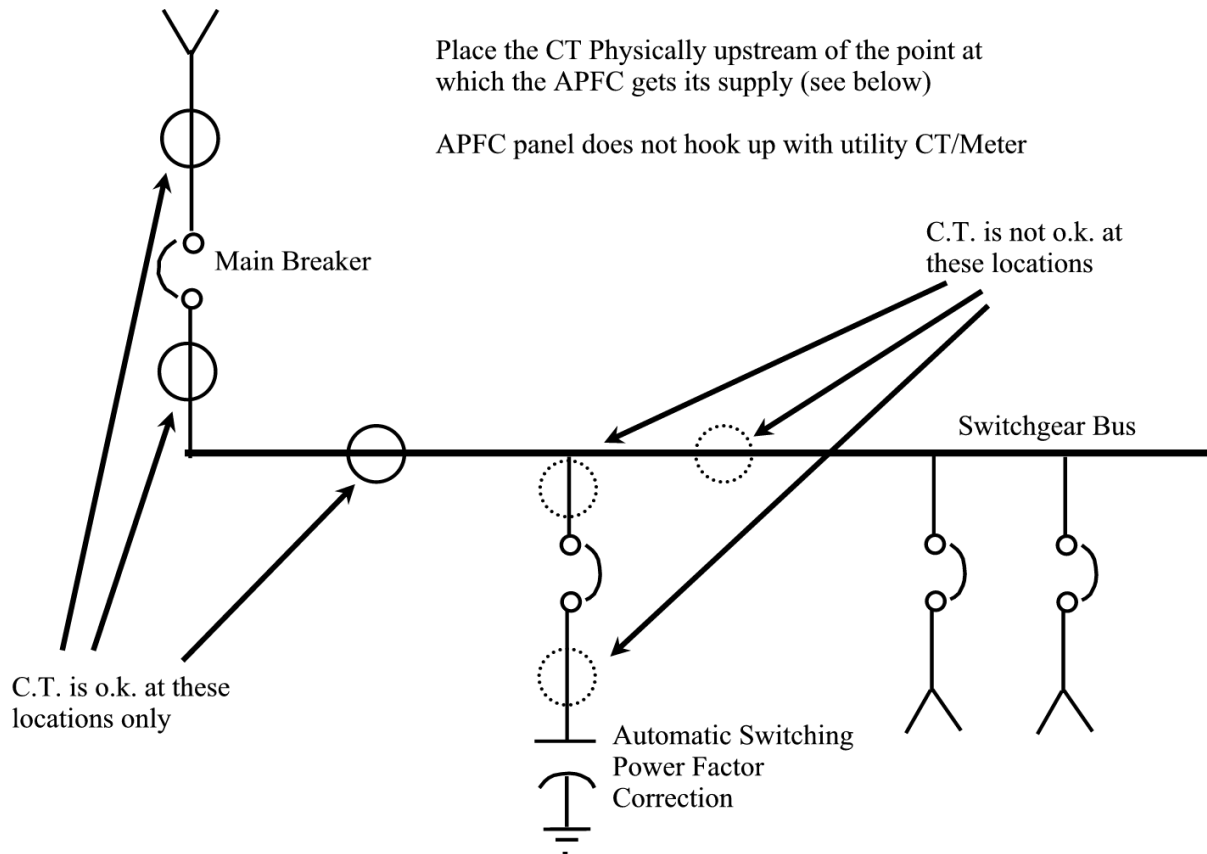


A Typical Facility System Line Diagram



## Guidelines for Locating CT

### Location Guidelines For The CT/APFC





## Formulas & Calculation Examples Related to Power Factor Correction

### 1. Determining Reactive Power (kVAR)

480V and 1200A are measured at the load side of the transformer and the facility load is 800kW.

- A. What is the Power Factor?
- B. How much Reactive Power (kVAR) is in the system?

A. To calculate the Power Factor we first need to calculate the kVA in the system

Next we substitute the kVA into the Power Factor formula

B. To calculate the Reactive Power (kVAR) in the system, requires re-arranging the formula  $kVA^2 = kW^2 + kVAR^2$  and solving for kVAR.

To further illustrate the impact of Reactive Power (kVAR) in a circuit, determine the ampere component of the Productive Power (kW). It is the **measured amperes** x the Power Factor =  $1200A \times .8PF = 960 A$ . Therefore the generating source **must supply 1200A to supply 960A** of productive power.

### 2. How to Determine Potential Demand Savings on Hydro Bills

Known information taken from Hydro Billing about electrical system:

$$kVA = 1000, kW = 800, kVAR = 600, PF = .8 \text{ or } 80\%$$

Typical Billing Structure Examples

A. 90% Billing Structure— Where demand billed is based on 90% of the kVA or 100% of the KW - Whichever is greater. Because the facility has a power factor of .80 they will pay demand rates on 90% of the kVA  $1000 \times .90 = 900$  kVA because it is the larger number ( $900 \text{ kVA} > 800 \text{ KW}$ ). Thus the facility is paying a penalty on 100 kVA of unproductive power. Correcting the facility's Power Factor to 90% +will eliminate this penalty cost.

B. 100% kVA Billing Structure—Where one rate is applied to 100% to the KVA. If we correct the power factor to unity ( $kVA = KW$  or  $800 \text{ kVA} = 800 \text{ KW}$ ) we can recover costs paid on 200 kVA.

### 3. Increase System Capacity

Known values for electrical system:

$$kVA = 1000, KW = 800, kVAR = 600, P.F. = .80$$

The uncorrected system can only support 800 KW of Productive Power at a P.F. of .80.



Increasing the system P.F. to 1.0 (unity), kVA = KW. The corrected system is now capable of supporting 1000 KW of productive power.

The system capacity has been increased by 200 KW.

#### **4. Lower Losses**

Assumed System wide Losses: 5%  
Increase Power Factor from 0.8 to 1.0 (unity)

% reduction in  $I^2R$  Losses =  $100 - 100(\text{Orig. P.F.} / \text{Corr. P.F.})^2 = 100 - 100(0.64) = 36\%$

The original system wide facility losses are reduced by  $.36 \times 5\% = 1.8\%$

As a result, the monthly kWh billing is reduced by 1.8%, an additional savings.

#### **5. How Much kVAR is Required for System Correction?**

1000 kVA and 800 KW are measured in the system.

How much Power Capacitor kVAR is required to operate the system at a P.F. of .95 while providing the same productive power of 800 KW.

- A. Determine System kVAR and Power Factor before correction:
- B. Determine system kVAR after Power Factor correction:

C. Determine Power Capacitor kVAR Rating Required

**Power Capacitor kVAR Required** = kVAR (uncorrected) - kVAR (corrected)

$$\text{kVAR} = \sqrt{\text{kVA}^2 - \text{KW}^2} = \sqrt{1000^2 - 800^2} = 600 \text{ kVAR}$$

$$\text{PF} = \frac{\text{kW}}{\text{kVA}} = \frac{800}{1000} = 0.8 \text{ or } 80\%$$

$$\text{kVA} = \frac{\text{kW}}{\text{PF}} = \frac{800}{.95} = 843$$

$$\text{kVAR} = \sqrt{\text{kVA}^2 - \text{KW}^2} = \sqrt{843^2 - 800^2} = 265 \text{ kVAR}$$

## **6. Calculating Breaker/Switch Size for capacitor banks**

*Example*

300kVAR, 600V auto-switching power factor correction bank

$$\begin{aligned} \text{Current} &= (\text{VAR} / \text{Nominal Voltage}) / 1.732 \\ &= (300,000 / 600\text{V}) / 1.732 \\ &= 288.7\text{A} \end{aligned}$$

$$\begin{aligned} \text{Circuit Protection} &= \text{Current} \times 1.35^* \\ &= 288.7\text{A} \times 1.35 \\ &= 389.7\text{A} \end{aligned}$$

Circuit breaker/switch must exceed 389.7A.

\*Canadian Electrical Code, Part 1, Section 26, Rule 26-214

## **7. Calculating Short Circuit Capacity of 3-Phase Transformer**

*Example*

Transformer kVA: 4000

Transformer % Impedance (Z): 5.7

L-L Voltage: 600

$$\begin{aligned} \text{Short Circuit Capacity} &= (\text{VA} / \text{Z}) / ((\text{V} \times 1.732) / 1000) \\ &= (4000 / .057) / ((600 \times 1.732) / 1000) \\ &= 67.53\text{kA} \end{aligned}$$

Breaker must be able to interrupt this much.





## Suggested Capacitor Ratings for High Efficiency Motors and older design (pre "T-Frame") Motors

Induction Motor HP Rating	2-3600 RPM		4-1800 RPM		6-1200 RPM		8-900 RPM		10-720 RPM		12-600 RPM	
	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %
3	1.5	14	1.5	15	1.5	20	2	27	2.5	35	3	41
5	2	12	2	13	2	17	3	25	4	32	4	37
7.5	2.5	11	2.5	12	3	15	4	22	5	30	6	34
10	4	10	3	11	4	14	5	21	6	27	7.5	31
15	5	9	4	10	5	13	6	18	8	23	9	27
20	6	9	5	10	6	12	7.5	16	9	21	12.5	25
25	7	9	6	10	7.5	11	9	15	10	20	15	23
30	9	8	7	9	9	11	10	14	12.5	18	17.5	22
40	12.5	8	9	9	10	10	12.5	13	15	16	20	20
50	15	8	10	9	12.5	10	13	12	20	15	25	19
60	17.5	8	15	8	15	10	17.5	11	22.5	15	27.5	19
75	22.5	8	17.5	8	17.5	10	20	10	25	14	35	18
100	27.5	8	20	8	20	9	27.5	10	35	13	40	17
120	30	8	25	8	30	9	30	10	40	13	50	16
150	35	8	30	8	35	9	37.5	10	50	12	50	15
200	40	8	37.5	8	40	8	50	10	60	12	60	14
250	50	8	45	7	50	8	60	9	70	11	75	13
300	60	8	50	7	60	8	60	9	80	11	90	12
350	60	8	60	7	75	8	75	9	90	10	95	11
400	75	8	60	6	75	8	85	9	95	10	100	11
450	75	8	75	6	80	8	90	9	100	9	110	11
500	75	8	75	6	85	8	100	9	100	9	120	10



## Suggested Capacitor Ratings for “T-Frame” NEMA® “Design B” Motors

Induction Motor HP Rating	2-3600 RPM		4-1800 RPM		6-1200 RPM		8-900 RPM		10-720 RPM		12-600 RPM	
	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %	kVAR	Current Reduction %
2	1	14	1	24	1.5	30	2	42	2	40	3	50
3	1.5	14	1.5	23	2	28	3	38	3	40	4	49
5	2	14	2.5	22	3	26	4	31	4	40	5	49
7.5	2.5	14	3	20	4	21	5	28	5	38	6	45
10	4	14	4	18	5	21	6	27	7.5	36	8	38
15	5	12	5	18	6	20	7.5	24	8	32	10	34
20	6	12	6	17	7.5	19	9	23	10	29	12.5	30
25	7.5	12	7.5	17	8	19	10	23	12.5	25	17.5	30
30	8	11	8	16	10	19	15	22	15	24	20	30
40	12.5	12	15	16	15	19	17.5	21	20	24	25	30
50	15	12	17.5	15	20	19	22.5	21	22.5	24	30	30
60	17.5	12	20	15	22.5	17	25	20	30	22	35	28
75	20	12	25	14	25	15	30	17	35	21	40	19
100	22.5	11	30	14	30	12	35	16	40	15	45	17
125	25	10	35	12	35	12	40	14	45	15	50	17
150	30	10	40	12	40	12	50	14	50	13	60	17
200	35	10	50	11	50	11	70	14	70	13	90	17
250	40	11	60	10	60	10	80	13	90	13	100	17
300	45	11	70	10	75	12	100	14	100	13	120	17
350	50	12	75	8	90	12	120	13	120	13	135	15
400	75	10	80	8	100	12	130	13	140	13	150	15
450	80	8	90	8	120	10	140	12	160	14	160	15
500	100	8	120	9	150	12	160	12	180	13	180	15

## NEMA Ratings and IP Equivalency Chart

NEMA Rating	IP Equivalent	NEMA Definition	IP Definition	
1	IP10	Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment and to provide a degree of protection against falling dirt	1 = Protected against solid foreign objects of 50mm in diameter and greater	0 = Not Protected
2	IP11	Enclosures constructed for indoor used to provide a degree of protection to personnel against incidental contact with the enclosed equipment, to provide a degree of protection against falling dirt, and to provide a degree of protection against dripping and light splashing of liquids	1 = Protected against solid foreign objects of 50mm in diameter and greater	1 = Protected against vertically falling water drops
3	IP54	Enclosures constructed for either indoor or outdoor used to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, and windblown dust; and that will undamaged by external formation of ice on the enclosure	5 = Protected against dust - Limited to ingress (no harmful deposit)	4 = Protected against water sprayed from all directions - Limited to ingress permitted.
3R	IP14	Enclosures constructed for either indoor or outdoor used to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, and snow; and that will be undamaged by external formation of ice on the enclosure	1 = Protected against vertically falling water drops	4 = Protected against water sprayed from all directions - Limited to ingress permitted.
3S	IP54	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, and windblown dust; and in which the external mechanism(s) remain operable when ice laden.	5 = Protected against dust - Limited to ingress (no harmful deposit)	4 = Protected against water sprayed from all directions - Limited to ingress permitted.

4	IP66	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, and hose-directed water; and that will be undamaged by the external formation of ice on the enclosure	6 = Totally protected against dust	6 = Protected against strong jets of water from all directions - Limited to ingress permitted.
4X	IP66	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt, rain, sleet, snow, windblown dust, splashing water, hose-directed water, and corrosion; and that will be undamaged by the external formation of ice on the enclosure	6 = Totally protected against dust	6 = Protected against strong jets of water from all directions - Limited to ingress permitted.
5	IP52	Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against settling airborne dust, lint, fibers, and flyings; and to provide a degree of protection against dripping and light splashing of liquids.	5 = Protected against dust - Limited to ingress (no harmful deposit)	2 = Protected against direct sprays of water up to 15° from the vertical.
6	IP67	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and the entry of water during occasional temporary submersion at a limited depth; and that will be undamaged by the external formation of ice on the enclosure.	6 = Totally protected against dust	7 = Protected against the effects of temporary immersion between 15cm and 1m. Duration of test 30 minutes.

6P	IP67	Enclosures constructed for either indoor or outdoor use to provide a degree of protection to the personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against hose-directed water and the entry of water during prolonged submersion at a limited depth; and that will be undamaged by the external formation of ice on the enclosure	6 = Totally protected against dust	7 = Protected against the effects of temporary immersion between 15cm and 1m. Duration of test 30 minutes.
12 and 12K	IP52	Enclosures constructed (without knockouts) for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against circulating dust, lint, fibers, and flying; and against dripping and light splashing of liquids	5 = Protected against dust - Limited to ingress (no harmful deposit)	2 = Protected against direct sprays of water up to 15° from the vertical.
13	IP54	Enclosures constructed for indoor use to provide a degree of protection to personnel against incidental contact with the enclosed equipment; to provide a degree of protection against falling dirt; against circulating dust, lint, fibers, and flyings; and against the spraying, splashing, and seepage of water, oil, and noncorrosive coolants.	5 = Protected against dust - Limited to ingress (no harmful deposit)	4 = Protected against water sprayed from all directions - Limited to ingress permitted.