

P2 Power Solutions Pvt. Ltd.

An ISO 9001:2008 Company



Active Current Conditioners



POWER

Power Your Power



P2 Power Solutions Pvt. Ltd.

P2 Power Solutions works to deliver Innovative Engineering solutions with specific focus on energy efficiency and power quality enhancement.

Today, in this highly competitive world, operating costs have become a major concern for all industries. Power is a huge component of the operating cost for any industry. Poor quality and inefficient usage of power can increase leakages and lead to significantly inflated energy bills. Moreover, poor power quality, high harmonic distortions and high neutral current conditions lead to increased failure resulting in unintended and expensive downtimes.

With our wide range of intelligent current conditioning solutions, we ensure that the industries draw (and pay for) only useful power from the grid and everything else is supplied by our Active Filters in real time. Our team of experts partners with industries to identify leakages and critical sections; this allows us to deliver relevant solutions to reduce operating costs, preempt and eliminate unknown failures or nuisance trips and make the overall electrical infrastructure more efficient and reliable.

Promoted by IITians; we are associated with IIT Kharagpur, one of the top technical institutes in the world, through TIETS (Technology Incubation and Entrepreneurship Training Society) for all technical support and R&D. We are also associated with the Department of Science and Technology, Government of India. Our advisory board consists of eminent members with over 50 years experience in the electrical industry.

We are an ISO 9001-2008 certified company offering CE certified products. Our flagship product technology (P2 Power - Active Filter) is a Universal Current Conditioner which has been rated as the topmost Techno Innovation at the India Innovation Initiative (i3) awards organized by the Department of Science & Technology (DST), Confederation of Indian Industry (CII) & Agilent Technologies.

P2 Power Active Current Conditioners



Active Current Conditioners are used for reactive power compensation, harmonic mitigation, load balancing and neutral correction. Active Current Conditioners can provide compensation on grid supply and are also fully compatible with DG operation. The ultra fast response and step-less current compensation of Active Current Conditioners makes them effective even with fast fluctuating loads, where traditional solutions fail to have any impact.

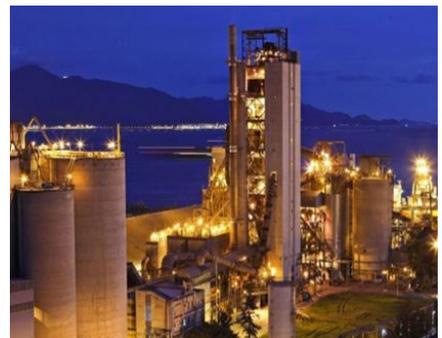
Features

The Active Current Conditioners can be programmed to simultaneously address all current related issues making their application universal:

- Inductive and capacitive reactive compensation
- Harmonic compensation
- Load Balancing - Negative Sequence compensation
- Neutral Correction - Zero Sequence compensation

The Active Advantage

- Ultra Fast reaction time of < 200 micro seconds
- Step-less compensation
- Programmable and customizable
- Compatible with DG operation
- Proven performance on welding loads
- No risk of resonance
- No voltage transients
- Easy to connect and disconnect (shunt connection)
- Auto fold-back feature, no risk of over loading
- Fully compatible with future load expansion
- Reduced energy bills by elimination of losses
- Reduced failures by elimination of distortions
- Elimination of DG heating and hunting



Typical Installations

- Print Industry
- Process Industry
- Auto and welding plants
- Steel plants, Rolling Mills & Furnaces
- Construction sites
- Railway Traction substations
- Oil and gas sector
- IT sector
- Medical Sector
- Heavy Industries like cement and steel
- Commercial/Residential Complexes
- Textile/Spinning Industry

Technology

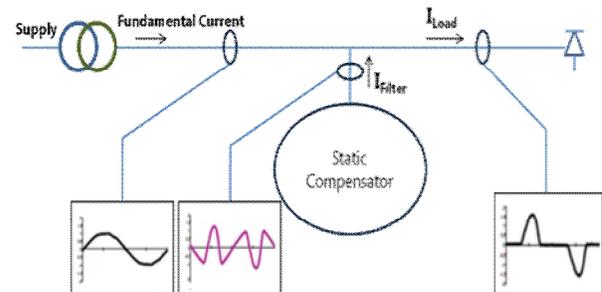
P2 Power Active Current Conditioners are based on Static Compensator (StatCom) technology which consists of an IGBT inverter capable of generating current waveform of any shape or size. The versatility of the technology makes this the only solution which can simultaneously correct all current related issues like reactive demand, harmonic distortions, high unbalance, and high neutral. Due to the advanced micro processor and fast switching of the IGBT inverter topology, we can achieve ultra fast reaction time of < 200 micro seconds.

A StatCom produces three-phase AC Voltage from a DC Bus using Pulse Width Modulation (PWM) technique. The StatCom generated voltage is coupled to the source voltage (Grid/Generator) through a coupling reactor. By varying the magnitude of AC terminal voltage of the StatCom, power exchange takes place between filter and the AC Source (Grid/Generator). If the magnitude of StatCom output voltage is more than the AC Source Voltage, current flows from the filter to the Supply. If the magnitude of StatCom output voltage is less than the AC Source Voltage, current flows from supply voltage into the filter. If amplitude of StatCom output voltage is equal to the AC Source voltage, no current flow takes place between Supply and StatCom and the filter is said to be in a floating state of operation. Thus, just by manipulating the voltage at the output terminal of the StatCom, the device can be programmed to generate current waveform of any shape, size or phase. A StatCom cannot generate/provide Active Power to the load.

P2 Power Active Filters use an advanced DSP micro processor which analyzes various network parameters every 100 micro seconds and adjusts the output voltage of the StatCom every 200 micro seconds. The ultra fast sensing and advanced control algorithm ensures step-less correction and instantaneous compensation.

The hardware topology of the Static Compensator remains constant regardless of the application and the output can simply be controlled just by customizing the control algorithm in the DSP micro processor. This flexibility makes the system infinitely configurable and customizable which ensures the optimum utilization of

available capacity. e.g: We can implement algorithms like priority settings based on the type of load wherein we can program the filter to perform Harmonic correction on first priority, Reactive correction on second priority, and Unbalance correction on third priority for a non linear drive based load, this will ensure full harmonic compensation, near unity power factor and fully



balanced load distribution.

Comparison: Power Factor Compensation

Power Factor is the ratio of True Power to the Apparent Power drawn by any load. Low power factor leads to increased transmission and distribution losses, increased electricity bills without increase in productivity, heating & hunting of DGs with increased fuel consumption.

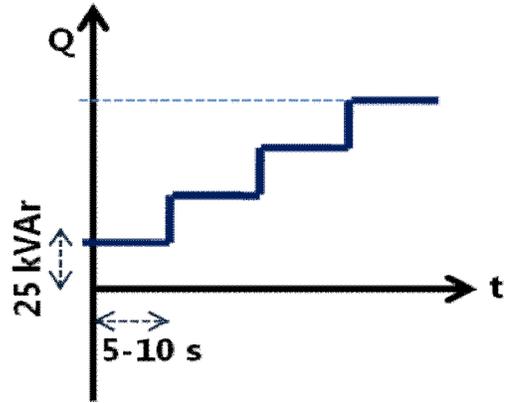
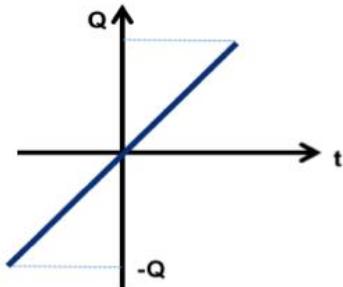
Active Current Conditioners

P2 Power Active Current Conditioning solutions perform step-less reactive power compensation with an ultrafast reaction time of <200 micro seconds. This feature makes them effective even with fast fluctuating loads.

Moreover, Active Current Conditioners are capable of correcting both leading and lagging power factor situations. The ultra fast response time of Active Conditioners makes them effective even with fast fluctuating loads where traditional solutions are ineffective. The reactive compensation by Active Conditioners is accurate and smooth without any risk of voltage transients or resonance.

Also, Active Current Conditioners provide safe reactive compensation on DG sets. This helps the client utilize the full capacity of the generators without any issues like heating of alternator or hunting of the engine. The client can use fewer generators for a given load and realize significant savings in fuel consumption.

The diagram shows the smooth response of an Active Current Conditioner. There are no steps; hence it can provide very accurate correction. Moreover, it can provide both leading and lagging reactive power support which is not possible with traditional, passive solutions.



Passive: APFCs/RTPFCs

APFCs/RTPFCs are the most commonly available Passive Solutions for the Power Factor Correction. These solutions employ capacitor banks which are switched to provide reactive power support. The compensation is stepped, creates voltage transients and is extremely slow (in seconds). These limitations make these solutions ineffective in modern industrial setups. These solutions are not only ineffective but at many places can put the electrical infrastructure at risk due to voltage transients and harmonic resonance. Moreover, traditional solutions are not compatible with DG sets as they put the alternator at risk of failure.

Also, these solutions cannot perform leading current correction.

Typical Loads

- Induction Motors
- Welding Loads
- DC Drives
- AC Drives

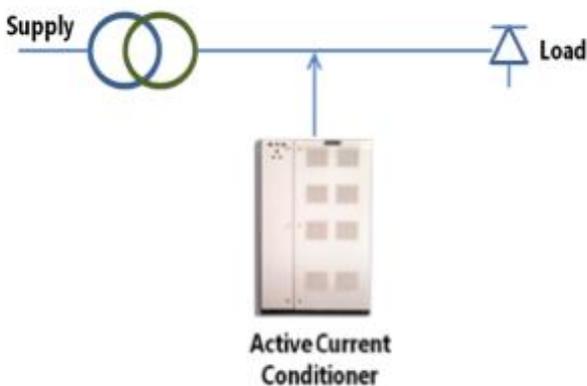
Comparison: Harmonic Mitigation

Harmonics are the currents or voltages with frequencies that are integral multiple of the fundamental (power) frequency. High harmonic distortions lead to overloading of switchgears, overheating of transformers, nuisance tripping of circuit breakers, electronic card failure, voltage distortions and DG Hunting.

Active Current Conditioners

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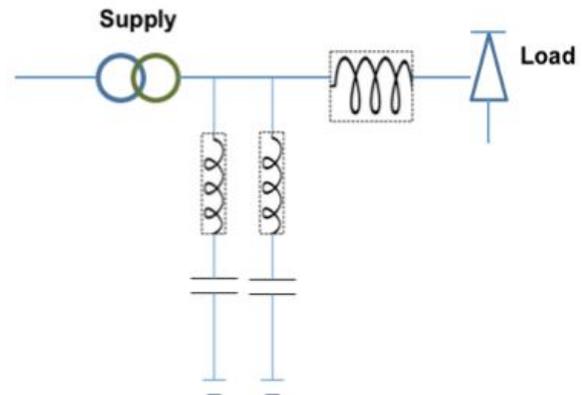
Active Current Conditioners can be programmed to correct a single harmonic order or a combination of harmonic orders without any change in the hardware at all. Moreover, the filter is connected in shunt therefore it is very easy to connect or disconnect from the load. Additionally, the filter is compatible with future load expansions unlike traditional filters which need to be replaced if the load increases in the future.



Passive: Tuned Filters

Tuned harmonic filters have a reactor coil connected in series with the load and also a shunt leg with L and C components. The shunt leg is tuned to a particular frequency by selection of specific L and C component values. For compensating multiple harmonic orders, parallel shunt legs are connected where each leg is tuned

to a different frequency. As can be understood from the topology, this design is extremely rigid and inflexible. If the load profile changes in the future, or the load increases then the components of the filter also need to be replaced with higher capacity components. Moreover, the use of a series reactor leads to significantly increased losses resulting in increased bills.



Typical Loads

- Variable Frequency Drives
- DC Drives
- UPS Systems
- Electronic Ballasts
- Arc Furnaces
- Battery Chargers
- CNC Machines

Load Balancing

Distribution networks often have issues of uneven load distribution among the three phases. This is a very common phenomenon in industries with two phase loads. This results in overloading of two phases of the source transformer and under utilization of the third phase. This leads to pre mature ageing of the transformers, uneven voltage profile, overloading of switchgears and stress on generators. Moreover, it's difficult to maintain good power factor on two phase loads.

A three phase power system is called balanced or symmetrical if the three phase voltages and currents have the same amplitude and are phase shifted by 120° with respect to each other. If either or both of these conditions are not met, the system is called unbalanced or asymmetrical.

Any unbalanced three phase load (with negligible neutral) can be viewed as a combination of a Positive Sequence (50Hz) current and a Negative Sequence (-50Hz) current. Both Positive and Negative Sequence current components are independently balanced but when combined, result in unbalanced current distribution

among the three phases.

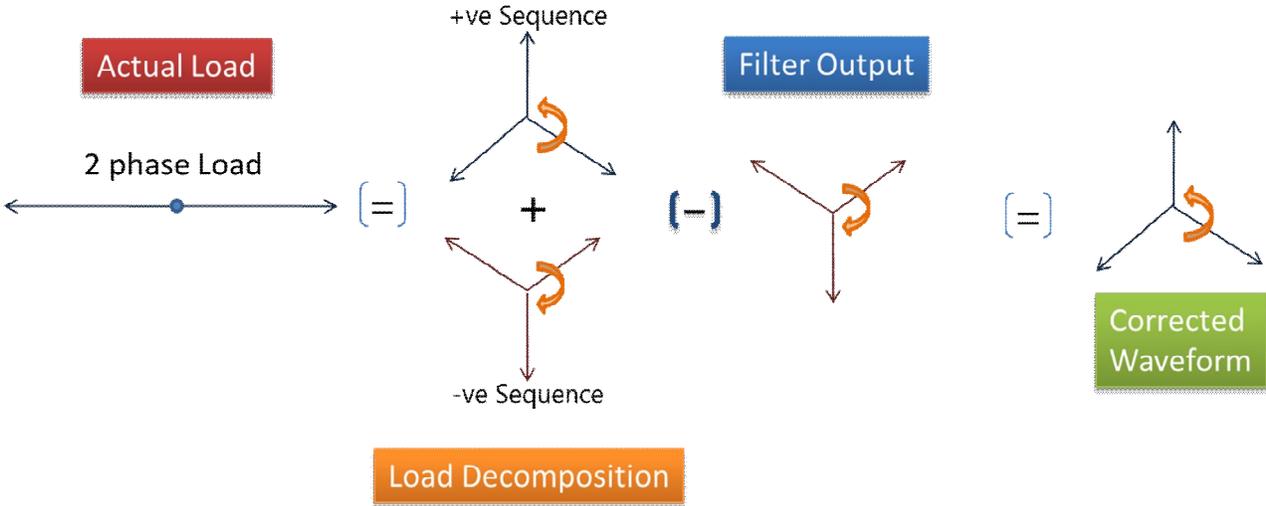
There are no passive solutions which can perform negative sequence compensation for load balancing. On the other hand, this can easily be achieved using Active Current Conditioners. Active Current Conditioners can not only eliminate Negative Sequence current components to < 3% but also perform reactive power correction to reduce the Positive Sequence current as well as maintain near unity power factor.

The end result is better utilization of existing electrical infrastructure, significantly reduced energy bills and better voltage profile.

Typical Loads

- Two Phase welding loads
- Poorly distributed single phase loads

In the diagram below shows a two phase load, this is the most severe case of unbalance in an industry. The current unbalance is ~100%. The two phase current is decomposed into the Positive Sequence and the Negative Sequence current by the DSP micro controller; it then supplies the negative sequence current component so that the corrected waveform only has the Positive Sequence current left. The positive sequence current is perfectly balanced in the three phases. Thus, regardless of the type of load, the source only sees a balanced load leading to optimum capacity utilization.



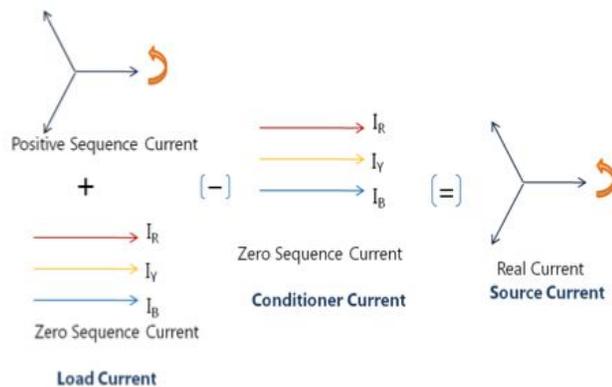
Comparison: Neutral Compensation

High neutral currents in any system are a result of the presence of homo-polar components or zero sequence currents. Homo-polar components have identical phase angles and only oscillate. Triple-N Harmonics add up in the neutral leg resulting in the overheating of the neutral conductor in 3-phase, 4-wire systems. High amount of neutral current can pose a serious fire risk.

Active Current Conditioners

The Active Current Conditioners (4 wire topology) is capable of correcting high neutral current scenarios by completely eliminating the zero sequence currents. Additionally, the filter can be programmed to perform unbalance, reactive, and harmonic compensation to reduce the load on the transformer resulting in reduced risk of HT winding failure. Moreover, the filter by removing harmonic distortions, ensures that the voltage profile is improved resulting in elimination of equipment failures in the facility.

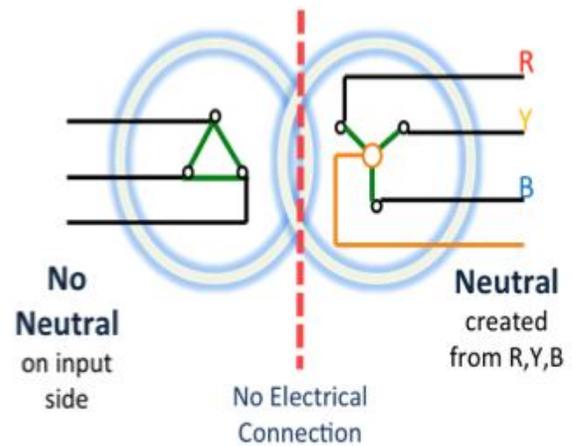
The Active Current Conditioner is connected in shunt; therefore it is compatible with future load expansions unlike traditional solutions which have to be replaced if the load increases in the future.



Passive: Isolation Transformers

Isolation Transformer, having delta-star configuration is used as a neutral suppressor by creating a new neutral connection at the transformer secondary. Isolation Transformers lead to increased losses, are cumbersome to handle, and not compatible with future load

expansions. Also, isolation transformers cannot perform harmonic, unbalance or reactive correction which is common in places with high neutral currents.



Moreover, the use of isolation transformers do not help remove voltage harmonic distortions which is a common cause for failure of sensitive equipment in any facility.

Typical Loads

- Computer/IT loads
- Modern lighting loads like CFLs, LEDs etc
- Single phase loads
- Computer Control Equipments

P2 Power Active Current Conditioners

Available Ratings

3-Phase, 4-Wire Range (415V)

- Harmonic Mitigation
- Unbalance (Negative Sequence) Correction
- Reactive (Leading/Lagging) Correction

| | Model Code | Nominal Voltage (V) | Connection | Nominal Current (Arms) | Peak Current (A) |
|---|-------------------|----------------------------|-------------------|-------------------------------|-------------------------|
| 1 | P2P-415-AF3 30A | 380-440 | 3Ph/4Wire | 30 | 40 |
| 2 | P2P-415-AF3 45A | 380-440 | 3Ph/4Wire | 45 | 60 |
| 3 | P2P-415-AF3 70A | 380-440 | 3Ph/4Wire | 70 | 100 |
| 4 | P2P-415-AF3 100A | 380-440 | 3Ph/4Wire | 100 | 140 |
| 5 | P2P-415-AF3 120A | 380-440 | 3Ph/4Wire | 120 | 170 |
| 6 | P2P-415-AF3 150A | 380-440 | 3Ph/4Wire | 150 | 210 |
| 7 | P2P-415-AF3 200A | 380-440 | 3Ph/4Wire | 200 | 280 |
| 8 | P2P-415-AF3 250A | 380-440 | 3Ph/4Wire | 250 | 350 |
| 9 | P2P-415-AF3 300A | 380-440 | 3Ph/4Wire | 300 | 420 |

3-Phase, 3-Wire Range (575/690V)

- Harmonic Mitigation
- Unbalance (Negative Sequence) Correction
- Reactive (Leading/Lagging) Correction

| | Model Code | Voltage (Urms) | Connection | Nominal Current (Arms) | Peak Current (A) |
|---|-------------------|-----------------------|-------------------|-------------------------------|-------------------------|
| 1 | P2P-U-AF3 70A | U +/- 5% | 3Ph/3Wire | 70 | 100 |
| 2 | P2P-U-AF3 100A | U +/- 5% | 3Ph/3Wire | 100 | 140 |
| 3 | P2P-U-AF3 150A | U +/- 5% | 3Ph/3Wire | 150 | 210 |
| 4 | P2P-U-AF3 200A | U +/- 5% | 3Ph/3Wire | 200 | 280 |

*U is 575 or 690

4-Phase, 4-Wire Range (415V)

- Neutral Compensation
- Harmonic Mitigation
- Unbalance (Negative & Zero Sequence) Correction
- Reactive (Leading/Lagging) Correction

| | Model Code | Voltage (Urms) | Connection | Peak Current (A) | Peak Current (A)* | Peak Neutral (A) |
|---|-------------------|-----------------------|-------------------|-------------------------|--------------------------|-------------------------|
| 1 | P2P-415-AF4 30A | 380-440 | 4Ph/4Wire | 30 | 40 | 40 |
| 2 | P2P-415-AF4 70A | 380-440 | 4Ph/4Wire | 70 | 100 | 100 |
| 3 | P2P-415-AF4 100A | 380-440 | 4Ph/4Wire | 100 | 140 | 140 |
| 4 | P2P-415-AF4 150A | 380-440 | 4Ph/4Wire | 145 | 210 | 210 |
| 5 | P2P-415-AF4 200A | 380-440 | 4Ph/4Wire | 195 | 280 | 280 |
| 6 | P2P-415-AF4 250A | 380-440 | 4Ph/4Wire | 245 | 350 | 350 |
| 7 | P2P-415-AF4 300A | 380-440 | 4Ph/4Wire | 295 | 420 | 420 |

* Neutral Correction not Selected

P2 Power Hybrid Current Conditioners

As has been explained so far, Active Current Conditioner is the only universal solution capable of addressing all current related issues. This flexibility is due to the advanced Static Compensator technology and the advanced control algorithms implemented through the DSP micro controller. Unfortunately, the flexibility also comes at a price which sometimes can be prohibitively high especially when the client's primary intention is to perform ultra fast, and step less reactive power compensation along with partial (lower priority) harmonic, unbalance or neutral compensation.

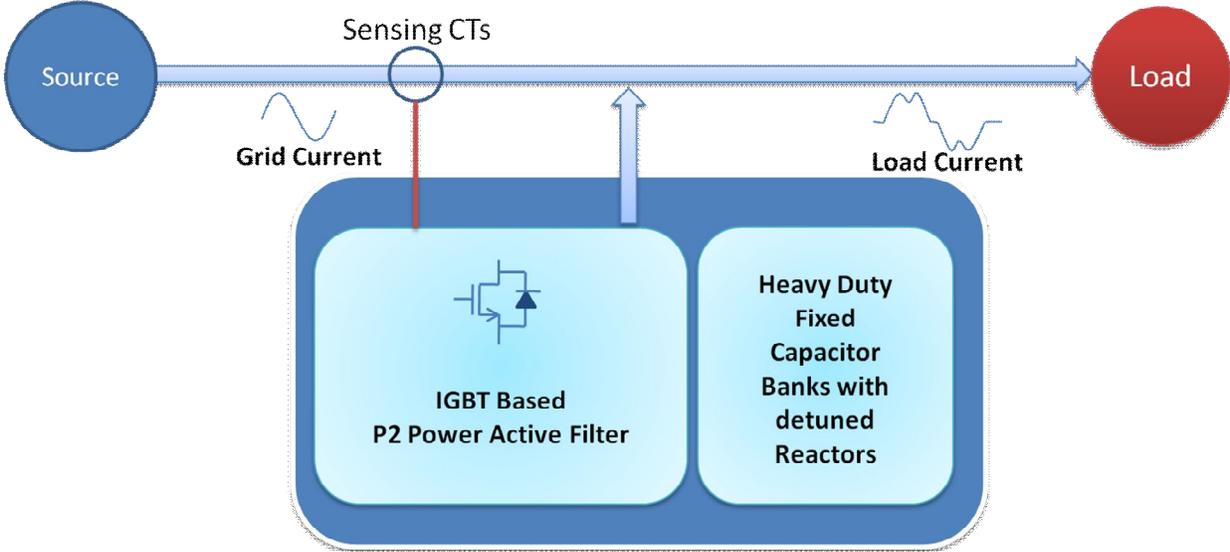
At P2 Power Solutions, we always put our clients first. To make our products more cost effective and increase technology penetration to even the smallest of industries, we have introduced Hybrid Current Conditioners.

A Hybrid Current conditioner has an Active Current Conditioner coupled with heavy duty, de tuned capacitor banks. The switching of the capacitors is

controlled by the Active Current Conditioner micro controller. The advantage is that the base load is catered to by the fixed banks whereas fine correction is achieved by utilizing the ultra fast and step-less response of the Active Current Conditioner block. Together, the solution is able to become extremely cost effective along with retaining all the performance advantages of a purely Active Current Conditioner.

In addition to achieving smooth, step-less and instantaneous power factor correction, our Hybrid solutions can be programmed to correct Harmonic distortions and Current Unbalance scenarios (on lower priority). Our 4 wire Hybrid filters can be used to perform neutral correction also.

Also, P2 Power Hybrid Conditioners have a compact footprint, a modular design and are virtually maintenance free.



P2 Power Hybrid Current Conditioners Available Ratings

3-Phase, 4-Wire Range (415V)

- Reactive Correction (1st Priority)
- Harmonic, Unbalance (Lower Priority)

| | Type No. | Voltage (Urms) | Connection | kVAr | Peak Current (A) |
|---|------------------|----------------|------------|------|------------------|
| 1 | P2P-415-HF3 250A | 380-440 | 3Ph/4Wire | 180 | 350 |
| 2 | P2P-415-HF3 300A | 380-440 | 3Ph/4Wire | 215 | 420 |
| 3 | P2P-415-HF3 350A | 380-440 | 3Ph/4Wire | 250 | 500 |
| 4 | P2P-415-HF3 400A | 380-440 | 3Ph/4Wire | 290 | 570 |
| 5 | P2P-415-HF3 450A | 380-440 | 3Ph/4Wire | 325 | 640 |
| 6 | P2P-415-HF3 500A | 380-440 | 3Ph/4Wire | 360 | 710 |
| 7 | P2P-415-HF3 550A | 380-440 | 3Ph/4Wire | 395 | 780 |

3-Phase, 3-Wire Range (575/690V)

- Reactive Correction (1st Priority)
- Harmonic, Unbalance (Lower Priority)

| | Type No. | Voltage (Urms) | Connection | Reactive Capacity (kVAr) | Peak Current (A) |
|---|----------------|----------------|------------|--------------------------|------------------|
| 1 | P2P-U-HF3 250A | U +/- 5% | 3Ph/3Wire | 300 | 350 |
| 2 | P2P-U-HF3 300A | U +/- 5% | 3Ph/3Wire | 360 | 420 |
| 3 | P2P-U-HF3 350A | U +/- 5% | 3Ph/3Wire | 420 | 500 |

*U is 575 or 690

4-Phase, 4-Wire Range (415V)

- Reactive Correction & Neutral Correction (1st Priority)
- Harmonic, Unbalance (Lower Priority)

| | Type No. | Voltage (Urms) | Connection | Reactive Capacity (kVAr) | Reactive Capacity (kVAr)* | Peak Neutral (A) |
|---|------------------|----------------|------------|--------------------------|---------------------------|------------------|
| 1 | P2P-415-HF4 300A | 380-440 | 4Ph/4Wire | 215 | 285 | 420 |
| 2 | P2P-415-HF4 350A | 380-440 | 4Ph/4Wire | 250 | 325 | 420 |

* Neutral Correction not Selected



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