FUSECO

AHF BROCHURE

Modular Active Harmonic Filters

- SiC-MOSFET Technology
- 99% Efficiency
- Unprecidented Performance
- 3 & 4 Wire Options in Each Unit
- Wall Mounting Solutions
- Load Balancing & PFC

Sinexcel®

Cabinet Solutions up to 1200A

Rack Mount Solutions

Wall Mount Solutions

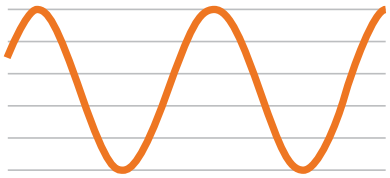
Unrivalled in its class

The Need for Harmonic Mitigation

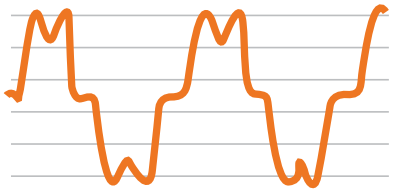
Harmonics are additional frequencies beyond the fundamental frequency (50Hz) and their presence in an electrical system distorts the clean shape of a sine wave.

A harmonic of a wave is a component frequency of the signal that is an integer multiple of the fundamental frequency. In Australia, the frequencies of the harmonics are 100Hz, 150Hz, 200Hz, 250Hz and so on. 100Hz is called the '2nd harmonic' (2 x 50Hz), 250Hz is called the '5th harmonic' (5 x 50Hz), etc.

The impact of harmonic pollution is an increasing problem given the growth of sophisticated power electronics and the proliferation of non-linear loads in power systems. Such loads are increasingly used in all industrial, commercial and residential installations.



Sinusoidal AC Waveform



Waveform influenced by harmonics

What are non-linear loads?

Non-linear loads change their impedance by conducting current only near the peak of the wave. Switching loads on and off during the waveform results in non-sinusoidal current pulses. These pulses introduce reflective currents (harmonics) back into the power distribution system. The resulting non-sinusoidal waveforms have the fundamental wave plus integral multiples of that fundamental wave.

Typical non-linear loads include:

- Variable speed drives for asynchronous and DC motors.
- Industrial equipment (induction furnaces, static converters, welding machines).
- Uninterruptible power supplies (UPS) and saturated magnetic devices.
- Office equipment (computers, servers, printers, photocopy machines).
- Switch-mode power supplies, fluorescent lighting, TV, light dimmers, microwave ovens, etc.

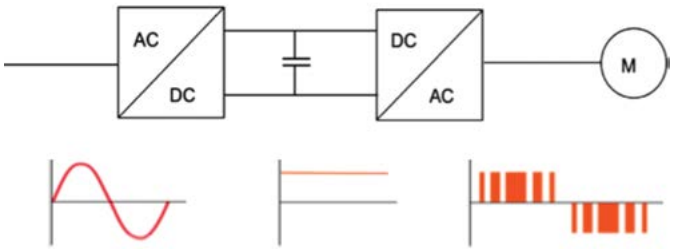
What are the effects of harmonics?

The presence of harmonic currents increases the RMS current in power networks and creates voltage harmonics resulting in voltage distortions. Such adverse effects are often manifested in the following forms:

- Overheating (thermal losses) & unstable network conditions.
- Costly downtime leading to higher operation and replacement costs.
- Reduction in the lifespan of equipment, including motors and drives.
- Premature degradation of a motor's bearings & insulation.
- Overloading of neutral conductors / nuisance tripping.
- Load imbalance / poor power factor.

VSDs and Harmonics

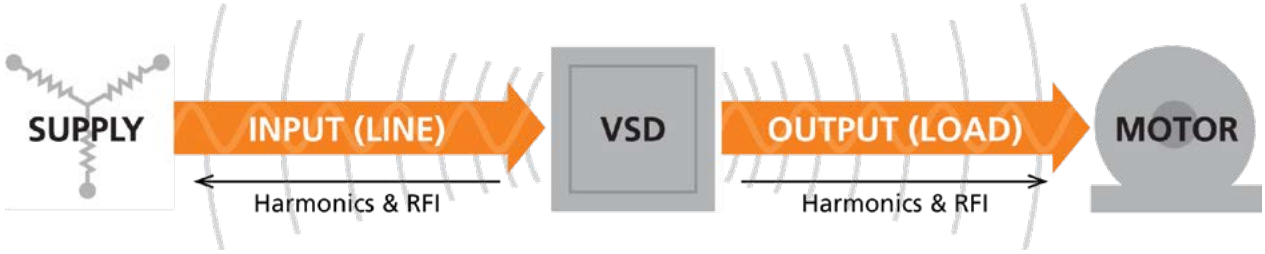
For motors to be used in a practical and useful way, we need to be able to control their speed of operation. A Variable Speed Drive (VSD), also known as a Variable Frequency Drive (VFD) is a programmable device that controls motor speed.



A VSD works by having a rectifier section at the input and this creates DC voltage on the DC bus (needed for switching). The inverter section at the output side provides the Pulse Width Modulation (PWM) waveform. A drive changes the speed of the motor by changing the frequency to the motor. As an aside, the impedance of the motor is determined by the inductive reactance in the windings, and it changes as the frequency changes.

PWM is employed to control the voltage and frequency to the motor drive. DC voltage is applied to the motor by controlled pulses at high frequency, which results in voltage that approximates a sine wave of the chosen frequency.

This PWM method creates harmonics in the system. The switching also creates radio frequency interference (RFI) and voltage spikes that can be up to 1200V at the motor terminals. The high switching frequency can also lead to 'capacitive bearing currents' that flow through the motor bearings and can damage the bearing surfaces. A portion of the harmonics are reflected back to the VSD by the motor, creating further issues in the electrical environment.



The presence of harmonics in an electrical system can result in:

- Degradation of motors, especially the bearings and insulation = higher costs.
- Significant reduction of the lifespan of equipment due to excessive heat = higher costs.
- Although you will get billed for the power that you are supplied, a large percentage of that power may be unusable = higher costs.
- Unusual events such as flickering lights, alarms going off, or MCB's, MCCB's, RCD's and Earth Leakage devices tripping for no apparent reason = more down time = higher costs.

VSDs are prolific creators of harmonics in electrical systems and as a result, most of the harmonic mitigation effort focuses on the input side and output side of a VSD. For the mitigation of harmonics on the input side (line side) of a VSD we recommend Line Reactors, Passive Harmonic Filters and Active Harmonic Filters. For the mitigation of harmonics on the output side (load side) of a VSD we recommend Load Reactors, dV/dT Filters and Sine Wave Filters.

Sellers of VSDs please note:

- Customers are becoming more aware of the damage caused by VSD related harmonics. Harmonic mitigation products are now being offered to customers as a 'value-add', in essence as an 'insurance policy' against the detrimental effects of harmonically rich environments, enhancing the longevity of both the motors and the drives.
- These products are also used on the input side of a drive in situations where harmonics are causing issues and in cases where a site needs to comply to supply authority requirements for harmonic content coming back onto the grid.
- Harmonic mitigation products MUST be considered for applications with long cable runs and/or multiple VSDs in the one environment.

The AHF Range

Wall Mount Solutions

25A, 35A, 50A, 60A & 75A
500W x 88D x 470H (mm)
Weight: 24kg

100A
500W x 88D x 520H (mm)
Weight: 27kg

150A
500W x 100D x 520H (mm)
Weight: 32kg

200A
500W x 220D x 646H (mm)
Weight: 63kg

300A
500W x 220D x 646H (mm)
Weight: 63kg

Rack-Mount Solutions

25A, 35A, 50A, 60A & 75A
500W x 470D x 88H (mm)
Weight: 24kg

100A
500W x 520D x 88H (mm)
Weight: 27kg

150A
500W x 520D x 100H (mm)
Weight: 32kg

200A
500W x 646D x 220H (mm)
Weight: 63kg

300A
500W x 646D x 220H (mm)
Weight: 63kg

P: 1300 387 326 **E:** sales@fuseco.com.au

The AHF Range

Flexi-Cabinet Series

Capacity: Up to 1200A (8x 150A)
800W x 800D x 2200H (mm)

Features

- Large Capacity
- Top or Bottom Cable Entry
- IP21 or IP31

Top Vent Series

Capacity: Up to 600A (4x 150A)
800W x 600D x 2200H (mm)

Capacity: Up to 750A (5x 150A)
1000W x 600D x 2200H (mm)

Capacity: Up to 900A (6x 150A)
1200W x 600D x 2200H (mm)

Features

- Only 600mm deep
- Flush Against the Wall
- Top Ventilated
- Top or Bottom Cable Entry
- IP21 or IP31

IP54 Series

Capacity: Up to 600A (4x 150A)
800W x 600D x 2000H (mm)
Note: Flush Against the Wall, Top Vent, 2 x 300mm Doors

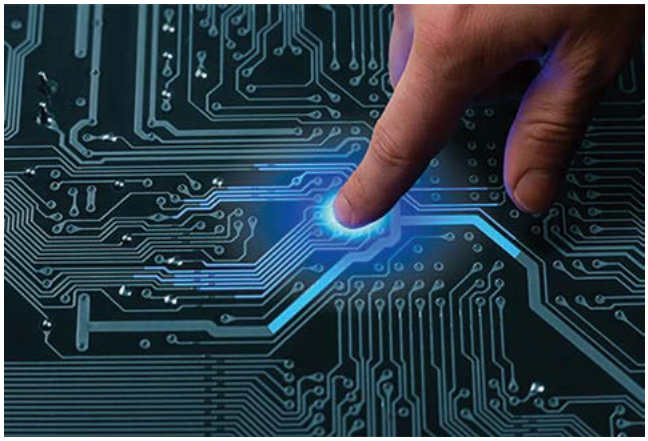
Also available in this size:
700W x 900D x 1800H (mm)

Features

- Bottom Cable Entry
- IP54

SiC-MOSFET Technology

Sinexcel are the first AHF manufacturer to implement Silicon Carbide Mosfet (SiC) technology. Sinexcel Active Harmonic Filters (P5 series) operate at 40kHz and have the ability to operate up to 90kHz when required (current standard is 20kHz). Much less heat is produced which has a dramatic impact on ventilation requirements and the sizing of supporting components. This in turn has resulted in extremely compact and light weight physical unit sizing which is unprecedented. 150A wall-mounted units weigh only 32kg and up to 1200A capacity is possible from a single cabinet! This is the latest in a long history of innovation which places Sinexcel as the undisputed global leader in AHF power electronics.

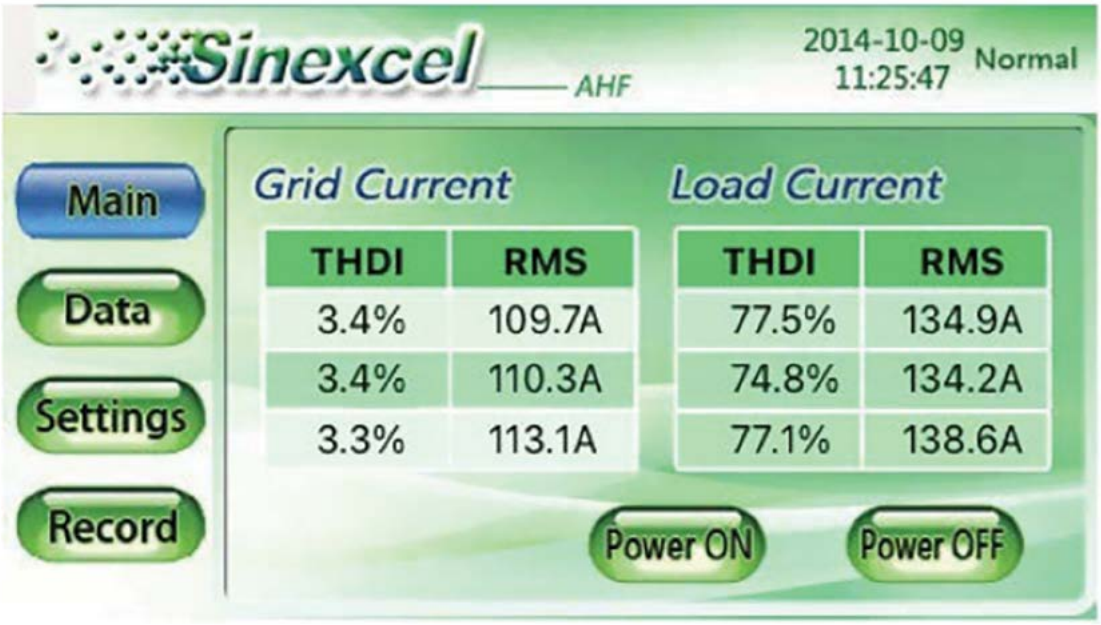


99% Efficiency

Considered to be the greatest ever breakthrough in AHF design, Sinexcel have launched the new P5 series which delivers an unprecedented peak efficiency of 99%. If achieving your Net Carbon goals is important to your project, the Sinexcel AHF is the most efficient AHF technology available. This has been achieved by the first-ever implementation of Silicon Carbide Mosfet (SiC) technology, which allows the switching frequency to be increased up to 4.5 times the present standard of 20kHz. This has a dramatic impact on efficiency – a genuine game-changer for AHF applications.

- Ultra-low Heat Loss
- High Switching Frequency
- High Withstand Voltage
- High Power Density
- High Heat Conduction Rate

AHF in Action



This screen shot is from a Sinexcel AHF unit operating at one of our customer locations.

Please Note:

- The Load Current THDI (Total Harmonic Distortion Current across the 3 phases at the site) is between 74.8% and 77.5% which is very high.
- The Grid Current THDI (Total Harmonic Distortion Current across the 3 phases after the Sinexcel Active Harmonic Filter has compensated the current) is between 3.3% and 3.4% which is a significant reduction in harmonics. This is an exceptional result and indicative of the advanced performance of the 3-level topology and the algorithms employed by Sinexcel engineering.
- Another benefit is the reduction in the RMS current as shown by the indicated Load and Grid RMS figures. This is achieved by the injection of the compensating current from the Sinexcel Active Harmonic Filter to reduce the damaging effects of the load harmonics. The natural by-product of this process is the correcting of the distortion power factor.

Unprecented Performance

- Up to 300A capability from a single wall-mounted module – can be parallel connected for unlimited capacity.
- Up to 300A capability from a single rack-mounted module.
- Up to 1200A capability from a single cabinet solution.

Features

SiC Technology

- Sinexcel are the first AHF manufacturer to implement Silicon Carbide Mosfet (SiC) technology.
- Operates at 40kHz & up to 90kHz when required (standard is 20kHz).

99% Efficiency

- Achieve Net Carbon goals.

Advanced Performance

- Harmonics filtering performance THDi < 5%.
- Select every harmonic to the 50th order & filter up to 50 harmonics simultaneously.
- Harmonic filtering levels [%] can be pre-configured.
- Resonance protection by means of pre-configuring harmonic filtering levels for the potential resonance zones.
- Unique 3-level topology based on a zero voltage transformation design.
- Capable of suppressing ripple currents effectively and promote a high compensation precision for the output waveform with respect to the sinusoidal waveform.

Compact Size and Light Weight

- Can be wall mounted and installed in small spaces.
- Wall mounted units can be parallel connected for unlimited capacity.

Load Balancing and Reactive Power

- Capable of measuring each phase and then redirecting the existing load current to balance the phases.
- Capable of using their remaining capacity to dynamically inject reactive power to correct the power factor.
- It is possible for the user to program the unit to prioritise load balancing or reactive power, depending on the application.

Available in Various Configurations

- 3-Wire and 4-Wire versions available in each unit.
- Also available in 690V and in IP20, IP31 and IP54.

Benefits

Compliance to the Standards

- Comply with AS/NZS 61000.3.6 (relevant standard for harmonic voltage distortion in Australia) & the IEEE 519 recommendations.

User-friendly Graphical Interface

- Very easy to operate.
- Backlit HMI Graphical User Interface.
- High readability, easy menu navigation.
- Password protected for critical settings.

Monitoring

- Offers direct control, complete configuration, monitoring and harmonic analysis of the AHF without the need for a PC.
- Online monitoring and programming available.
- Presents information in terms of numerical data, waveform analysis, etc.
- Provides comprehensive data for analysis, like network RMS voltages/currents, network voltage/current distortions (THDu and THDi) in data and graphical representations.
- Provides data such as system frequency, load factor, compensated RMS currents, comparison of PF (before and after).
- Provides graphical representation of the harmonic spectrum for network and load currents from the 2nd to the 50th harmonic order.

Flexibility and Ease of Commissioning

- Designed to be a 'Plug and Play' experience for the user.
- Unlimited parallel operation of modular AHF units in combination as per system requirements.
- Installation & commissioning process is the industry benchmark for simplicity and ease of use.

On-going costs are negligible

- The AHF does not require a maintenance contract because of innovative design and no capacitor banks to maintain.

Reduced burden on infrastructure

- The AHF reduces heat on the electrical system, resulting in greater longevity and lower maintenance costs.

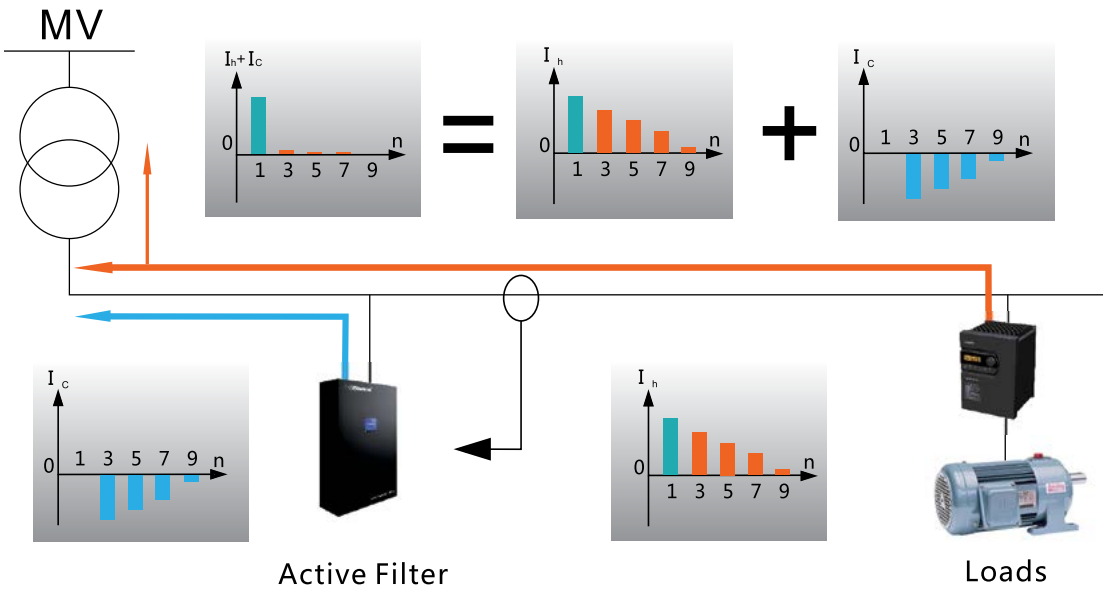
Advanced Performance

The 3-Level Topology Design Approach

Sinexcel have introduced their latest generation range of Active Harmonic Filters that incorporate many unique and innovative design features. Active Harmonic Filters are designed for mitigating harmonics that are injected into power networks by non-linear loads.

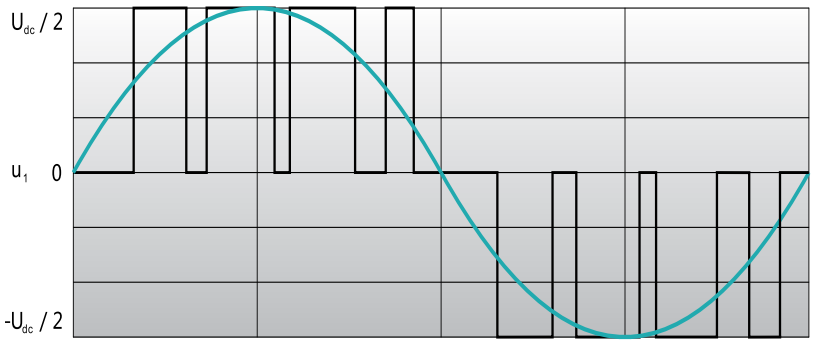
Generally installed in parallel to the polluting loads, the active filters analyse the line current harmonics drawn by the loads and generate a compensation current at the opposite phase angle, thereby "neutralising" the harmonic currents.

The unique technology incorporated within Sinexcel Active Harmonic Filters consists of the control current operating circuit and the compensated current generating circuit.



When harmonic mitigation is required, the operating circuit measures the load current and calculates the harmonic current spectrum via the advanced control algorithm programmed in the DSP. Sinexcel AHF series employs a Fast Fourier Transform (FFT) logic calculation method for the harmonic current spectrum from the 2nd to the 50th order. The logic then determines the amplitude of the compensated current control signal, to be injected at the opposite phase angle for each harmonic order selected for mitigation.

The compensated current generating circuit will then provide a control signal to the SiC-MOSFET (semiconductor switch) via Pulse Width Modulation (PWM) and consequently a compensation current with perfect opposite phase for each harmonic is injected into the system. As a result, the harmonic currents at the supply side are significantly reduced.



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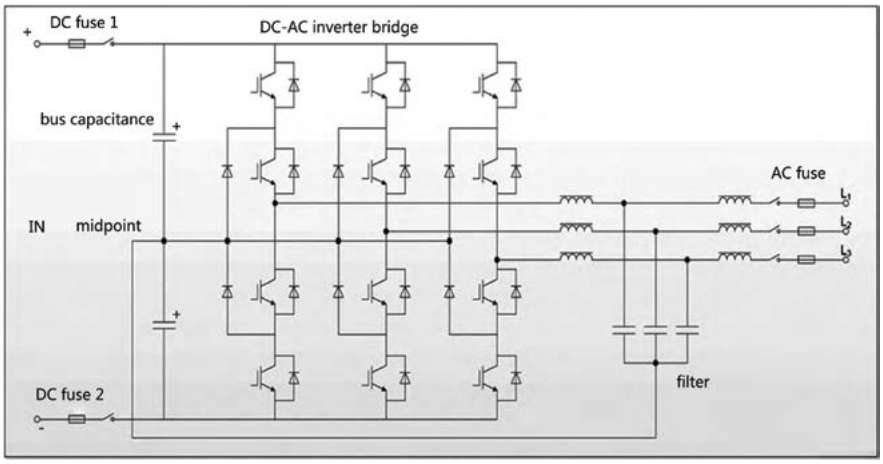


3-level Topology Circuit Diagram

Due to their 3-level topology design based on a zero level voltage transformation (comprising of SiC-MOSFET's of lower voltage corresponding higher switching frequency), Sinexcel AHF's are capable of suppressing the undesirably generated ripple currents effectively and promote a high compensation precision for the output waveform with respect to the sinusoidal waveform.

Harmonics Compensation Capability

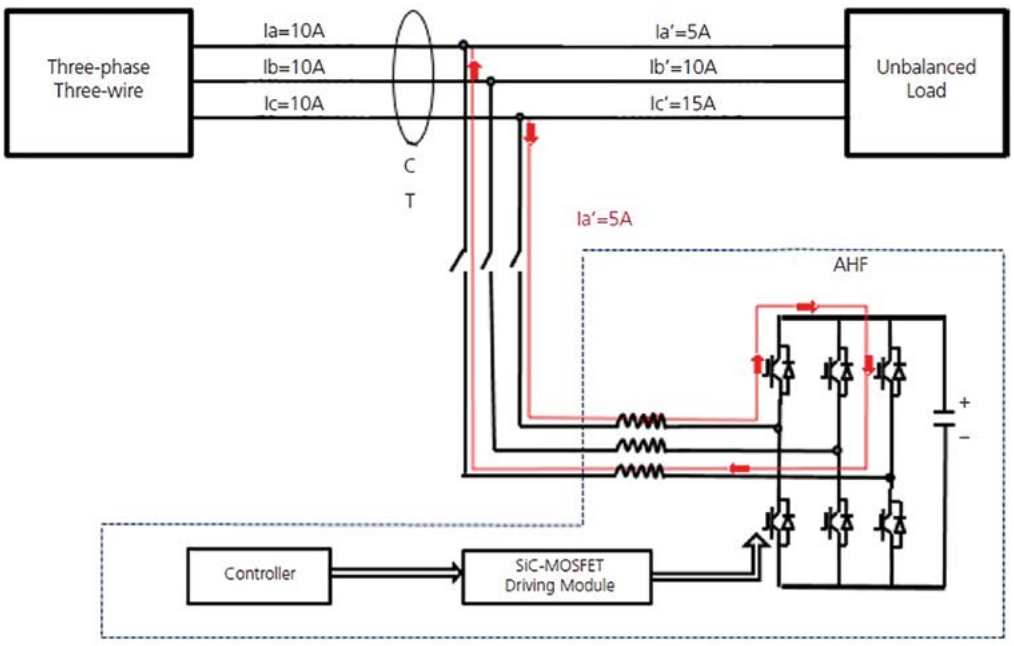
Compensates 2nd to 50th harmonic order or simultaneous compensation of all 50 harmonic orders.

Algorithm Intelligence

Intelligent technology that integrates both FFT and Dynamic Compensation Modes, customised to the client's requirements.

Load Balancing and Reactive Power

During operation, Sinexcel Active Harmonic Filters are capable of measuring each phase and then redirecting the existing load current to balance the phases. They are also capable of using their remaining capacity to dynamically inject reactive power to correct the power factor. It is possible for the user to program the unit to prioritise load balancing or reactive power, depending on the application.



Case Study - Wallumbilla Gas Hub

Located in remote central Queensland, the Wallumbilla Gas Hub is a major part of the Australian natural gas infrastructure network. The function of this facility is to compress the natural gas that is extracted from the ground in that area and pipe it to Brisbane and Rockhampton. To comply with the requirements, Fuseco supplied a Sinexcel 200A Active Harmonic Filter in an IP54 cabinet due to its exceptional performance, small footprint and flexibility.

The Challenge

Part of the design specification was a defined electrical harmonic level for the site. The majority of the load comprises of VSD's and the Engineering team decided to use an Active Harmonic Filter to mitigate the harmonics at the main switchboard and comply with the requirements. The electricity supply to the site consists of the local grid and two generators. When running at full load all three of these supplies are required to power the site.

The Solution

Fuseco selected the Sinexcel 200A Active Harmonic Filter (AHF) due to its exceptional performance, small footprint and flexibility. In this case an IP54 version was installed to comply with the customer's requirements. One of the challenges of this site was that the incoming supply was soft and unpredictable which necessitated the use of two large generators on-site. It was deemed important for the AHF to be able to operate efficiently in such an environment that often had three independent synchronised power supplies.

The Outcome

The results were immediate and the performance of the AHF was above and beyond the requirements of the specification, the Supply Authority and the manufacturer of the two generators.

If we refer to the screen shot from the AHF's touch screen post installation, we can note the following points:

1. The harmonic content of the load is 32%, which is quite typical of VSD loads (top left).
2. The Sinexcel AHF mitigated the load harmonics down to approx. 3% (bottom right).
3. As a result of the compensation by the AHF the corresponding grid voltage harmonics is approx. 2% (bottom left).

The Sinexcel AHF - Benefits

Sinexcel have applied new generation thinking and innovative design principles to create a new range of Active Harmonic Filters that have redefined what is possible from a cost vs performance vs space perspective. Their performance and ease of use is unsurpassed and able to compensate the 2nd to the 50th harmonic order or the simultaneous compensation of all 50 harmonic orders in real time! Operating with 99% efficiency, the Sinexcel AHF offers instantaneous, dynamic harmonic compensation, ideal for the challenging demands of modern electrical environments. The Sinexcel AHF are a compact, light-weight and modular design, available in wall mounting and rack/cabinet configurations. The Sinexcel AHF has set the standards for all others to follow.

- Compact Size and Light Weight.
- Harmonics Compensation Capability - Compensates 2nd to 50th harmonic order or stimultaneous compensation of all 50 harmonic orders.
- Algorithm Intelligence.
- 3-Level Topology.
- Easy of Installation and Commisioning ('Plug and Play').
- User-friendly Interface and Monitoring.
- Also available in 690V.
- 1 year warranty.
- Complies with IEC61000 / IEC60146 / EN55011 / EN50091 / IEEE519.

Case Study - Somers Water Recycling Plant

The Somers Water Recycling Plant is one of eight such facilities operated by South East Water in Victoria, servicing the region covered by Hastings right across to the HMAS Cerberus Naval Training Base. The pump system VSD's were polluting the electrical environment with a very high harmonic content and this was creating a lot of problems within the electrical environment. A Sinexcel 200A AHF in an IP54 cabinet completely transformed the electrical system!

The Challenge

The Somers Water Treatment Plant produces Class A recycled water for re-use by a large industrial customer and Class C recycled water for re-use by local agricultural customers. The electrical team on site were encountering overheating of motors (pumps) and cables, overheating of switchboards, pumps requiring frequent reconditioning and intermittent issues with the electrical system. A site power audit revealed that there was an extraordinarily high level of harmonics in the system (80%). Further analysis also revealed very poor power factor. This site was one of the most affected by harmonic content that the Fuseco team had ever encountered.

The Solution

Fuseco supplied a Sinexcel AHF 200A 400V unit in an IP54 cabinet solution. With their unique modular design and 3-level topology performance, Sinexcel Active Harmonic Filters offer a highly flexible, reliable and customisable solution in active harmonic compensation systems. In this application, potential water ingress was a problem that had to be mitigated against so the IP54 cabinet was specified as mandatory.

The Outcome

Once the Sinexcel Active Filter was commissioned and turned on, its effect on the electrical system was immediate and very obvious. The existing Harmonic Distortion was at an unprecedented 80% (horrendous!) and the Active Harmonic Filter compensated it down to 7.5%. By redirecting the THDi and improving the distortion power factor, the Active Harmonic Filter was asked to correct the displacement power factor and this culminated in a grid power factor of 0.975 and a reduction in grid current. This was a significant improvement of the reduction of the stress & heat experienced by this local electrical network.

The Sinexcel AHF - Benefits

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- IEC61000 / IEC60146 / EN55011 / EN50091 / IEEE519 Standards

Why Sinexcel?

Prior to Sinexcel entering the market in 2009, Active Harmonic Filters were physically large, very expensive and quite limited in their performance.

Sinexcel revolutionised this area of power quality and continue to this day to be streaks ahead of any brand in the market.

You can trust that with Sinexcel, you are working with the people that invented this technology.

This is what Sinexcel has achieved in the field of harmonic mitigation:

- 1st to use IGBT switched technology.
- 1st to introduce ultra-compact sizing and wall-mounted solutions.
- 1st to introduce 3-level topology technology.
- 1st to introduce affordable AHF solutions.
- 1st to introduce Sic-MOSFET technology.

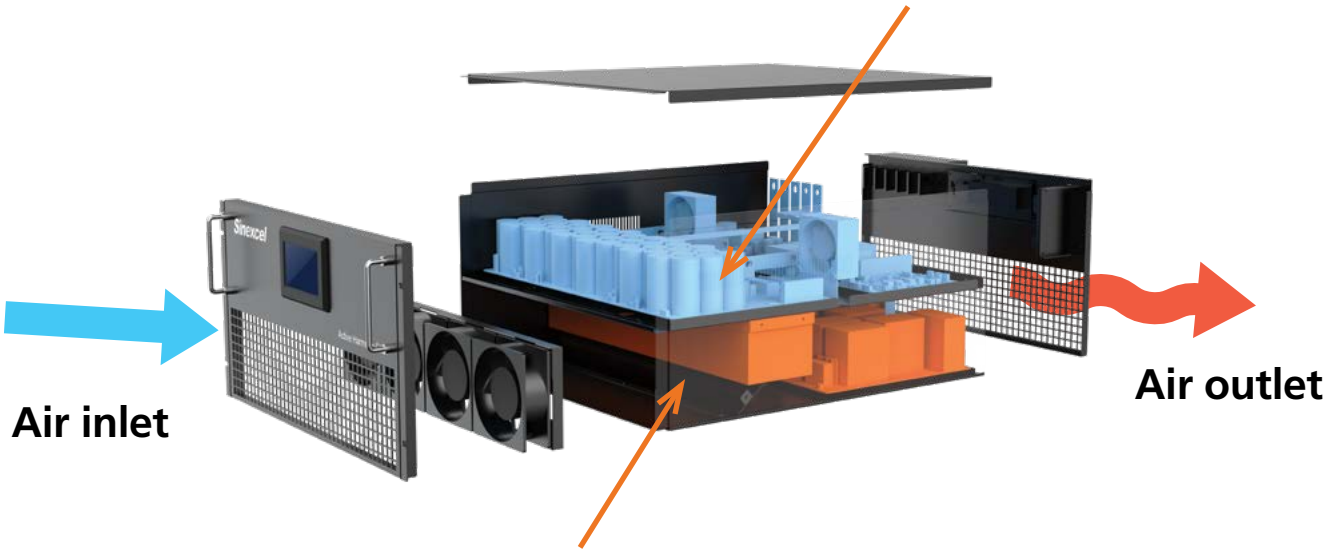
With literally hundreds of Sinexcel Active Harmonic Filters in service all over Australia, the brand has proven to be very reliable and has become the first choice for power engineers nationwide.

Intelligent Design

Designed for Efficiency & Minimal Maintenance

Minimising Dust Ingress

Electronic components separated from heat producing components and housed in their own sealed compartment, resulting in greater protection from the effects of heat and dust ingress.



Optimum Heat Dissipation

Heat sinks, SiC-MOSFET's, inductors and other heat producing components housed in a separate compartment optimised for efficient ventilation and cooling.

Protection Features

- Internal short circuit protection
- Temperature monitoring
- Over-voltage protection
- Under-voltage protection
- Abnormal frequency protection
- Output overload protection
- CT installation detection
- Inverter bridge abnormal operation protection
- Inverter over-current protection
- Over compensation capacity
- Component capacity redundancy
- Fan fault protection
- Fuse protection
- Busbar over-voltage protection

Power Quality Standards

Australian Standards

The relevant standard for harmonic voltage distortion in Australia is AS/NZS 61000.3.6 and it is compatible with the IEEE 519-2022 recommendations. If the supply authority is dissatisfied with the degree of voltage distortion at the point of common coupling (PCC), harmonic filtering may be specified to comply with the Australian Standards.

Odd harmonics, non-multiples of 3		Odd harmonics, multiples of 3 (triplens)		Even harmonics	
Order, h	% harmonic voltage	Order, h	% harmonic voltage	Order, h	% harmonic voltage
5	5	3	5	2	2
7	5	9	1.5	4	1
11	3.5	15	0.3	6	0.5
13	3	21	0.2	8	0.5
17	2	>21	0.2	10	0.5
19	1.5			12	0.2
23	1.5			>12	0.2
25	1.5				
>25	0.2 + 1.1(25/h)				

NOTE: total harmonic distortion (TDHV) 8% max

IEE 519-2022

The IEEE is the Institute of Electrical and Electronics Engineers. IEEE 519-2022 'Recommended Practices and Requirements for Harmonic Control in Electric Power Systems', was published in 1981. The document established the levels of voltage distortion that are acceptable to a distribution system and has been widely applied in establishing required harmonic correction throughout the electrical industry. The new IEEE 519, updated in 2022, sets forth limits for both harmonic voltages on the utility transmission and distribution systems and harmonic currents within the industrial distribution systems. Since harmonic voltages are generated by the passage of harmonic currents through distribution system impedances, by controlling the currents or system impedances within the industrial facility, one can control harmonic voltages on the utility distribution.

IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

Table 10-3 of IEEE Std 519-2022

ISC/IL	Individual harmonic limits. Harmonics values are in % of maximum demand load												TDD
	2 ≤h <6		6 ≤h <11		11 ≤h <17		17 < h <23		23 ≤ h < 35		35 ≤ h ≤ 50		
	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	Odd	Even	
<20*	4.0	2.0	4.0	4.0	2.0	2.0	1.5	1.5	0.6	0.6	0.3	0.3	5.0
20<50	7.0	3.5	7.0	7.0	3.5	3.5	2.5	2.5	1.0	1.0	0.5	0.5	8.0
50<100	10.0	5.0	10.0	10.0	4.5	4.5	4.0	4.0	1.5	1.5	0.7	0.7	12.0
100<1000	12.0	6.0	12.0	12.0	5.5	5.5	5.0	5.0	2.0	2.0	1.0	1.0	15.0
>1000	15.0	7.5	15.0	15.0	7.0	7.0	6.0	6.0	2.5	2.5	1.4	1.4	20.0

NOTE:
- Current Distortion Limits for General Distribution Systems (120V through 69,000V)
- Maximum Harmonic Current Distortion in Percent of IL • Individual Harmonic Order (Odd Harmonics)
- Even harmonics are limited to 25% of the odd harmonic limits above
- Current distortions that result in a DC offset, e.g. half-wave converters, are not allowed
- All power generation equipment is limited to these values of current distortion, regardless of actual ISC/IL
  (ISC = maximum short-circuit current at PCC; IL = maximum demand load current, fundamental frequency component, at PCC)

Site Appraisal

A Power Quality Site appraisal is a service offered by Fuseco to our customers. A Power Quality Consultant visits your site and conducts a power quality appraisal of your electrical system.

This involves setting up sophisticated measuring equipment on site that monitors and records all of the electrical activity that is occurring within the system over a period of time. The equipment is compact, easily transportable to most locations and can be set up indoors or outdoors.

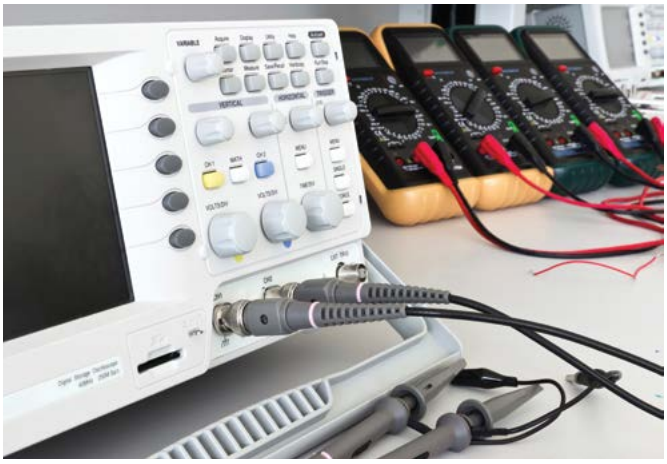
An analysis of the recorded data usually helps to reveal any harmful harmonics, voltage supply and power factor issues. Our power consultant will consider the data and present you with a power quality report, outlining the observed issues and suggesting solutions if required.

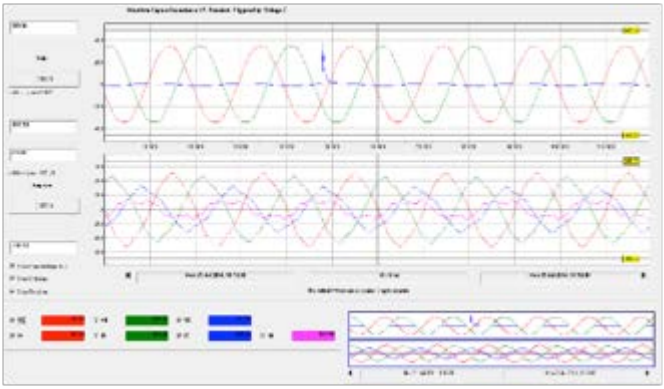
Appraisals are useful in determining electricity usage inefficiencies and identifying damaging harmonics which occur in electrical systems.

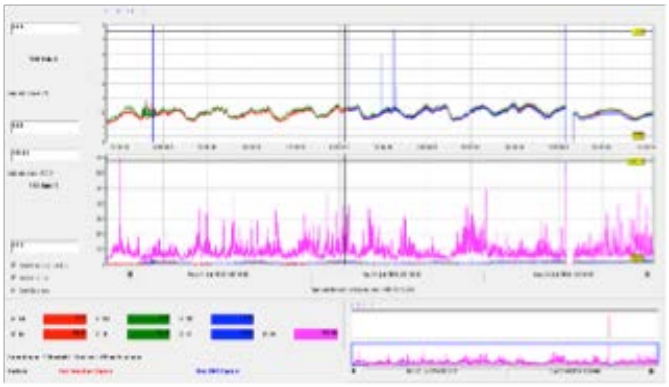
Even correctly functioning power systems require routine auditing to ensure early identification of any potential issues and proactive servicing requirements to keep power equipment operating to its full potential and the electrical environment complying to the Australian Standard AS/NZS 61000.3.6 and compatible with the IEEE519 recommendations.

A correctly functioning system could save you upwards of 30% off your power bills. In some industries and installations, that could translate to significant increases to your bottom line. By running an efficient system you also use less energy and therefore help the environment.

To discuss our site appraisal & analysis service in more detail, please contact a power quality consultant
at Fuseco.







Installation of Current Transformers (CT's)

The current transformer (CT) plays a key role in the normal operation of an AHF, so the correct selection and installation of CT's is vital. In a 3-phase 3-wire system, two CT's are required, each installed on phase A and phase C; while in 3-phase 4-wire system, three CT's are required, each installed on the circuits of phase A, phase B and phase C. In the AHF module, the allowable ratio of an external CT is 50:5 (min) – 30,000:5 (max). The ratio can be selected between the two levels in accordance with the actual load current. When selecting the CT ratio, the actual magnitude of load current should be taken into consideration so as to obtain a more accurate compensation. Generally, a selection of x1.5 of the maximum current during normal operation is preferred, and an appropriate level of margin is recommended to ensure more accurate harmonic suppression.

For example, suppose the maximum load current detected is 1,000A. The best selection of CT ratio is between 1,500:5 to 2,000:5. The accuracy of the external CT should be above level 0.2 (solid core) or above level 0.5 (split core). A lower degree of accuracy may affect the compensation accuracy.

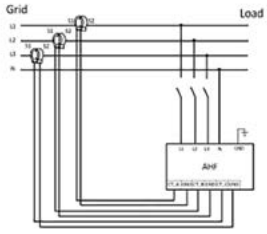
Solid Core CT's

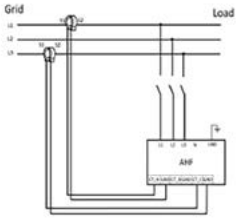
Series	Description	Ratio Range (5A Secondary)	Busbar (mm)	Cable Diameter (mm)
TUC30 Series	Solid Core	200-600	30 x 10	0.6
TUC40 Series	Solid Core	50-1000	40 x 10	1.0
TUC50 Series	Solid Core	400-2000	50 x 10	1.5
TUC60 Series	Solid Core	400-2000	60 x 10	2.0
TUC80 Series	Solid Core	400-2500	80 x 30	2.5
TU100PSH Series	Solid Core	400-5000	100 x 30 80 x 50	6

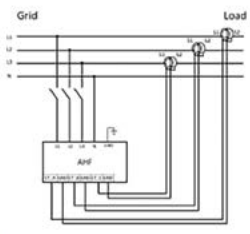
Split Core CT's

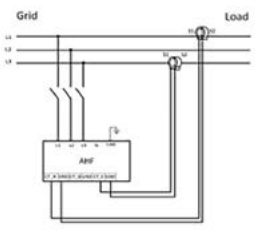
Series	Description	Ratio Range (5A Secondary)	Busbar (mm)	Cable Diameter (mm)
TA30P Series	Split Core	100-400	30 x 20	0.6
TA60P Series	Split Core	250-1000	60 x 30	1.0
TA80P Series	Split Core	250-1000	80 x 50	1.5
TA100P Series	Split Core	250-2000	100 x 80	2.0
TA125P Series	Split Core	500-3000	125 x 80	2.5
TA160P Series	Split Core	500-5000	160 x 80	80

As shown in the diagrams below, the signal is sent to the AHF by a CT installed at the load side or supply side. In a 3-phase 4-wire system, one set of 3 CT's is required to detect the current of the harmonic source. In a 3-phase 3-wire system, one set of 2 CT's is required. The polarity of the CT's must be correct and the phase rotation must also be correct.









Please note that the above diagrams are indicative of some common installations. For other configurations, please contact Fuseco.

Technical Specifications

Rated Compensation Current	25A-300A in wall-mount configuration 100A-1200A in rack/cabinet configuration
Rated Voltage (V)	380VAC -40% to 20% (690V also available)
Rated Frequency (Hz)	50Hz Auto Sensing (45-63Hz)
Functions	(1) Harmonic Compensation (2) Load Balancing (3) Reactive Power
Network Configuration	3P3W, 3P4W
Parallel Operation	Unlimited (up to 1200A per cabinet)
Harmonic Compensation Efficiency	99% (P5)
Harmonics Compensation Capability	THDi<5%
Harmonics Compensation Range	2nd to the 50th Harmonic Order
Reaction Time	<50µs
Full Response Time	<5ms
IGBT Frequency	Average 40kHz up to 95kHz (P5)
Self Protection	Yes
Communication Interface	RS485, Ethernet port (RJ45)
Filtering Degree	Programmable per harmonic from 10% to 110%
Communications Protocol	Modbus (TCP/IP, RTU)
Ingress Protection	IP20

Altitude Operating Limit	≤ 1500m, 1% power reduction for each additional 100m, between 1500m & 4000m
Operating Temperature Range (Ambient)	-10°C to 40°C (May derate capacity if ambient temperature exceeds 45°C)
Relative Humidity	Max <95% without condensation
Neutral Filtering Capability	Yes
Noise Level	<60dB (25A to 100A) <65dB (150A) <68dB (200A & 300A)
CT Rating Settings	50/5-30,000/5
Topology Design	3 Level
Neutral Compensation Capacity	3 times rating (4 wire)
Monitoring	Via centralised monitoring LCD Screen (4.3 or 7-inch touch screen)
Resonance Protection	Yes
Power Loss	1% (P5)
Harmonics Spectrum	2nd - 50th Harmonic Order
I/O	2 digital inputs, 2 dry contact outputs
Design / Approvals	IEC 61000-4-2, 4-3, 4-4, 4-5, 4-6, 4-8, 4-11, IEC 60146, EN 55011 Class A, EN 50091-1, EN 50178
Complies with Standards	IEC61439-2 (cabinet), IEEE519, AS/NZS61000.3.6:2001, IEC61000-3-6, ER G4/5

Model	25A	35A	50A	60A	75A	100A	150A	200A	300A
Wall-Mount Dimensions (mm)	500W x 88D x 470H					500W x 88D x 520H	500W x 100D x 520H	500W x 220D x 646H	500W x 220D x 646H
Rack-Mount Dimensions (mm)	500W x 470D x 88H					500W x 520D x 88H	500W x 520D x 100H	500W x 646D x 220H	500W x 646D x 220H
Net Weight (kg)	24					27	32	63	63
Smart Air Cooling (CFM)	180					165	240	480	480
Heat Loss (@ Full Output) (watts)	180	252	360	432	540	719	1079	2157	3235

Floor Standing Cabinet	Flexi-Cabinet Series	Top Vent Series			IP54 Series	
Rated Compensation Current	Up to 1200A	Up to 600A	Up to 750A	Up to 900A	Up to 600A	
Cabinet Dimensions (mm)	800W x 800D x 2200H	800W x 600D x 2200H	1000W x 600D x 2200H	1200W x 800D x 2200H	800W x 600D x 2000H	700W x 900D x 1800H
Net Weight (kg)	Up to 466	Up to 328	Up to 360	Up to 392	Up to 378	
Ingress Protection	IP21 / IP31 (other IP ratings available upon request)				IP54	

*Other current ratings available

Selection guidelines

- Suitable for use in 3-Wire and 4-Wire systems
- For 3-Wire configuration, 2 CT's are required (at L1 & L3)
- For 4-Wire configuration, 3 CT's are required (at L1, L2 & L3)
- The harmonic currents for compensation can be obtained from system measurement results or derived from calculations based on the transformer and load data.
- Modules with LED indicator are used in standalone cabinets that have a 7-inch touch screen on the front door.
- LCD versions are used where there is no external touch screen required (eg. when 2-4 units are connected in parallel with each other).

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