Power factor correction

AccuSine

Harmonic filtering and reactive power compensation

Catalogue
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Schneider Electric

Contents

Offer Positioning

Harmonic Basics and their effects in the electrical system

Harmonics are a growing concern in the management of electrical systems today. Designers are requested to pay more and more attention to energy savings and improved availability of electricity. In this context, the topic of harmonics is often discussed.

But there is still a need for more explanation, in order to dissipate confusion and misinterpretation.

Power electronic devices have become abundant today due to their capabilities for precise process control and energy savings benefits. However, they also bring drawbacks to electrical distribution systems: harmonics.

The presence of harmonics in electrical systems means that current and voltage are distorted and deviate from sinusoidal waveforms.

Harmonics: origin, effects and consequences

Harmonic currents are caused by nonlinear loads connected to the distribution system. A load is said to be nonlinear when the current it draws does not have the same wave shape as the supply voltage. The flow of harmonic currents through the system impedances in turn creates voltage distortion which distorts the supply voltage.

Equipment consisting of power electronic circuits are typical nonlinear loads. Such loads are increasingly more abundant in all industrial, commercial, and residential installations and their percentage of the total load is growing steadily.

Examples include:

- Industrial equipment (welders, induction furnaces, battery chargers, DC power supplies)
- Variable Speed Drives for AC and DC motors
- Uninterruptible Power Supplies (UPS)
- Office equipment (PCs, printers, servers, displays, etc.)
- Household appliances (TVs, microwave ovens, fluorescent lighting, washing machines and dryers, light dimmers)

Harmonic currents increase the rms current in electrical systems and deteriorate the supply voltage quality. They stress the electrical network and potentially damage equipment. They may disrupt normal operation of devices and increase operating costs.

Symptoms of problematic harmonic levels include overheating of transformers, motors and cables, thermal tripping of protective devices, and logic faults of digital devices. In addition, the life span of many devices are reduced by elevated operating temperatures.

Instantaneous effects

> Harmonics can disrupt controllers used in electrical systems and can adversely affect thyristor switching due to displacement of the zero-crossing of the voltage wave.

> Harmonics can cause vibrations and audible noise in electrical machines (AC motors, transformers, reactors).

> Harmonics can reduce the available system capacity.

> Harmonics can induce heating or instabilities in generators.

Long-term effects

> Power factor (PF) Capacitor heating and degradation (capacitance reductions).

> Heating due to additional losses in transformers.

> Heating of busbars, cables, and equipment.

> Thermal damage to induction motors and generators.

> Thermal tripping of safety devices (thermal sensors in breakers, fuses).

Poor Displacement Power Factor

Correction of displacement power factor (DPF) is well known as a method of reducing penalty charges on utility electrical bills and reducing the r.m.s. current loading on the safety devices and conductors within the plant. However, correction of DPF is fast becoming very difficult due to abundant use of nonlinear loads. Using power factor capacitors alone in electrical systems where nonlinear loads are present can be hazardous to the capacitors and all other equipment affixed to the electrical system.

PF capacitors can be destroyed due to overheating or resonance may occur. Resonance can cause very high peak AC voltages detrimental to all loads. This may mean premature tripping of circuit breakers; nuisance faulting of equipment; or destruction of equipment. In all cases, plant interruptions occur.

When electrical systems contain nonlinear loads that exceed about 50 % of the total load, the solution for poor DPF is no longer viable with PF capacitors. DPF correction must be achieved with an alternate means. One method is using active harmonic filters or other power electronic devices that injects reactive current for correction of poor DPF.

Other suitable circumstances for use of power electronic devices for DPF correction are where the loads fluctuate quickly or where the flexible plant exists. Since power electronic devices measure and inject the exact amount of current to meet a PF set point on a per cycle basis, continuously changing load levels are corrected very easily. Instantaneous load demands are met without difficulty. The flexible plant does not require time consuming site harmonic studies to determine suitability of power factor correction equipment.

Effects of poor DPF

- Increased utility charges for poor DPF
- Increased utility demand charges
- Reduced network capacity
- Increased expense for new/ increased network capability
- Reduced PF capacitor life
- Reduced plant flexibility
- Increased expenses for power/ harmonic studies
- Increased downtime – lost productivity

Offer Positioning



Load Balancing

In many plants and buildings, loads are installed using single phase or two phase power. This creates unbalanced loading per phase on the three phase supply no matter how judiciously the loads have been arranged to create balanced distribution of the total load. The result is the creation of a reactive current identified as negative sequence current.

Negative sequence current does no work much like phase displaced current (displacement power factor), but is conducted within the electrical system. This reduces the overall system capacity – transformers, cables, and bus capacity is lost. Premature safety device tripping may occur due to one phase drawing high current.

Negative sequence current will cause voltage unbalance (known as negative sequence voltage). Likewise, an unbalanced 3-phase voltage will cause unbalanced current in other loads. One exasperates the other.

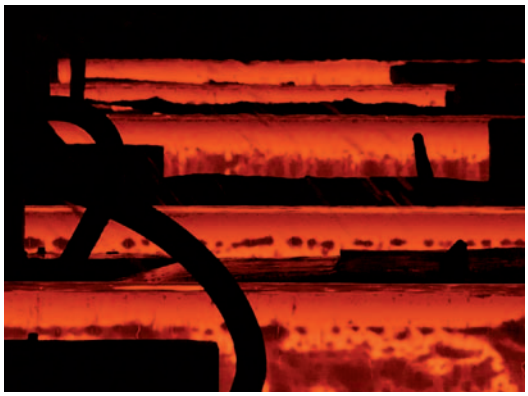
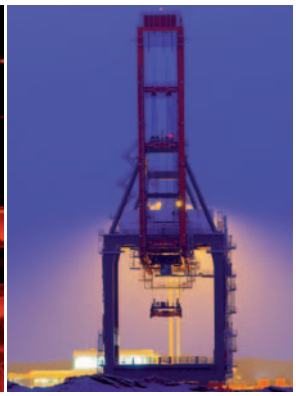
Direct on line (DOL) AC motors and asynchronous generators will experience major heating effects with very little unbalanced voltage. A voltage unbalance of 3 % can create a 20 % temperature rise in a motor due to unbalanced current per phase. A 10 % temperature rise may reduce AC motor life by 50 %.

Negative sequence current produces negative torque in DOL AC motors. In some applications, this negative torque can cause mechanical breakdown of shafts or couplings, stopping production for extended time periods for repairs. Additionally, employee injuries can occur due to flying debris when mechanical failures occur.

AC voltage imbalance also causes nonlinear loads to draw unbalanced AC line currents. This can cause premature failure of the rectifying device, premature tripping of the safety device, or cause peak currents in excess of safe limits for the DC bus capacitors. The result is reduced life for the nonlinear loads and intermittent faulting of safety devices.

Effects of Load Unbalance

- > Increased voltage unbalance
- > Increased heating in DOL AC motors
- > Increased heating in generators
- > Premature tripping of safety devices
- > Reduced system capacity
- > Increased nonlinear load faulting
- > Increased production downtime


Reactive Energy Fluctuations

Equipment such as welders, arc furnaces, crushers, shredders, steel mills, ball mills…. operate with rapid and frequent load variations. This results in rapid changes of real and reactive power requirements. Real current must be supplied by the power grid and is usually the basis of the network design. Reactive power surges can cause the network voltage to drop significantly and often to levels that cause sensitive loads to fault or lighting to flicker.

In the welder case, the voltage dips will cause poor quality welds. As such the quality of the end product (automobiles, pipes, etc) is severely affected and scrap may occur. Production must take remedial actions thus increasing the costs of production. Production quality and capacity are reduced.

Flicker is a physiological issue that causes varying degrees of stress on the employees. Some may suffer vision problems; others may have severe headaches; and some may even become nauseous. In all cases, employee well being suffers and lost production occurs.

Flicker can also be seen by neighbors on the utility grid. This may manifest itself as flickering lights, or electronic equipment interference, or clocks resetting to their initial time point. Any of these are cause for utility concern. The utility, by contract, is required to delivery "clean" power for the users on the grid.

Also, many of these loads employ independent phase to phase control. The result is unbalanced current on the electrical network that also causes unbalanced voltages.

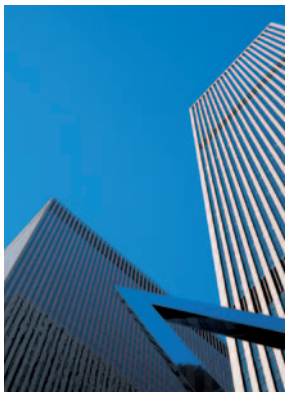
This type of reactive current injection is defined as VAR support.

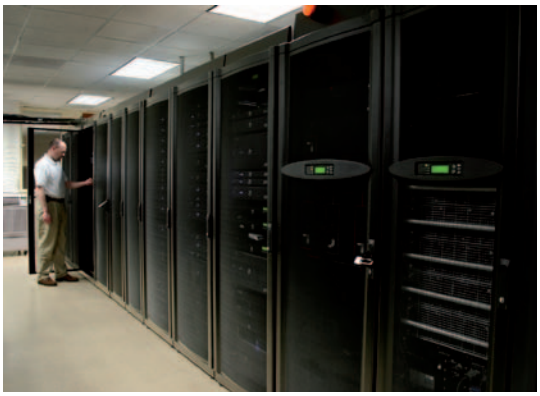
Effects of Reactive Energy Fluctuations

- > Flicker in plant causing medical problems for employees.
- > Flicker on utility network interfering with neighbors well being.
- > Poor quality of goods.
- > Increased scrap.
- > Lost productivity.

Typically include unbalance load effects as well.

Offer Positioning





Benefits of harmonic mitigation and reactive current correction

The benefits of providing harmonic and reactive current correction result in financial opportunities for the user or investor.
Improved competitiveness of companies is achieved in several ways:

- Savings of Capex (capital expenditures) and Opex (operating expenditures) of more than 25 % are achievable by designing the electrical system for the true need – kW – and by not requiring electrical network expansions.

- Improved business performance is achieved by significantly reducing downtime and obtaining increased equipment life – 32 % or more for single phase machines; 18 % or more for three phase machines; and 5 % or more for transformers.

Reduce capital expenditures

Saving on Capex is a constant concern for the investor.

- Harmonic mitigation, DPF correction, load balancing, and VAR support provide opportunities for significant savings; especially on the cost of the electrical distribution network.
- Solutions for harmonic mitigation, DPF correction, load balancing, and VAR support decrease the rms current value such that the size for busbars, cables, transformers can be reduced. Additionally, the ratings of circuit breakers and contactors are reduced.
- Harmonic mitigation, DPF correction, load balancing, and VAR support permit expansion without requiring additional distribution equipment. The total rms current is reduced by these types of correction.

Reduced operating expenses

Opex will be impacted in many different ways:

- Harmonic mitigation, DPF correction, load balancing, and VAR support contribute to reduced losses in switchgear, cables, transformers – providing longer life and more effective utilisation of capacity.
- Harmonic mitigation and reactive current correction reduce utility demand thus reducing utility charges.

Improve electricity availability and business performance.

- Increased reliability and service life
- Reduced risk of outages
- Increased productivity by eliminating downtime
- Increased quality due to better process performance
- Extended equipment life
- Increased generator performance and life

Electrical system support

- Continuous support where loads cause flicker.
- Maintain reactive current balance for renewable energy farms.



Applications	Performance	Benefits
Light duty + Neutral correction		
Data centers, server farms, hospitals, microelectronic manufacturers, X-ray & MRI equipment	> Increase critical uptime when generators and UPS employed > Inject fast reactive current support for surges > Stop neutral connection melt down and transformer neutral over load	> Reduced harmonics: Offload generators and UPS for longer life and more dependable service > Real time reactive current support for blade servers > Eliminate reactive current surges > Longer life for power distribution transformer
General duty		
Water and wastewater treatment plants, textile mills, paper mills, pharmaceutical plants, package sorting facilities, bulk material handling, printing presses	> THDv (1) < 5 % > THDi (2)/TDD ⩽ 5 % > DPF correction to 0.95 or better > Generators operate efficiently > Eliminate resonance potential of PF capacitors	> Meet industry standards for THDv or THDi/TDD (3) > Improved DPF - can attain unity > Increased system capacity > Extend equipment life due to reduced heating > Generator life extended - reduced total rms current
Marine duty applications: Ships, oil & gas platforms	> Reduces THDv and THDi/TDD to < 5 % > Corrects DPF to set point > Load balances current > Prevents resonance conditions	> Compliance to off-shore standards > Stops generator instabilities > Reduces generator heating for longer life > Reduces stress on busbars and cables > Increases generator capacity
Heavy duty		
Port cranes, DC drives and power supplies, steel mills	> Dynamic and continuous support for harmonics - ⩽ 5 % TDD > Dynamic and continuous support for DPF correction - ⩾ 0.95 > Reduce voltage sags due to current reversals (regenerative loads) > No interaction with utility substation PF capacitors	> Comply with standards for harmonics and DPF > Longer distribution equipment life - reduced total rms current > Productivity increased
Very heavy duty		
Arc welders (automotive and pipe industries), arc furnaces (steel and recycle smelting), linear induction motors (amusement parks), shredders (recycling), ball mills (rock crushers)	> Ultra fast VAR compensation - by cycle injection > Greatly reduce flicker > Reduce voltage sags due to current surge	> Meet industry standards for flicker, harmonics, and DPF > Eliminate equipment stresses - longer life; more dependable operation > Better quality of products > Enhanced production capability

(1) THDv - Total Harmonic Voltage Distortion.
(2) THDi - Total Harmonic Current Distortion.
(3) TDD - Total Demand Distortion (current).

Offer Positioning

AccuSine Family of Products

Schneider Electric is specialized in Electronic Power Quality solutions. A broad range of products is available for every need. We propose solutions that maximize the savings when balanced with the cost of the solution to obtain a reasonable Return On Investment (ROI). The table below indentifies the model that best performs the solutions defined.

Solutions by AccuSine Model

AccuSine Model	Neutral Harmonics	Harmonic Mitigation	DPF Correction	Load Balancing	VAR Support
AccuSine SWP	✓	✓	✓		
AccuSine PCS		✓	✓	✓	✓
AccuSine PFV			✓	✓	✓

AccuSine SWP

- Three or four wire connections (3 phase or 3-phase + Neutral).
- 400 V supply; other possible with transformers.
- Units from 20 A to 120 A, parallel to 480 A.
- Cancellation to the 50th order.
- Neutral harmonic correction at 3 times unit rating.
- Displacement PF correction to set point.
- Modbus & J-bus communications.

AccuSine PCS

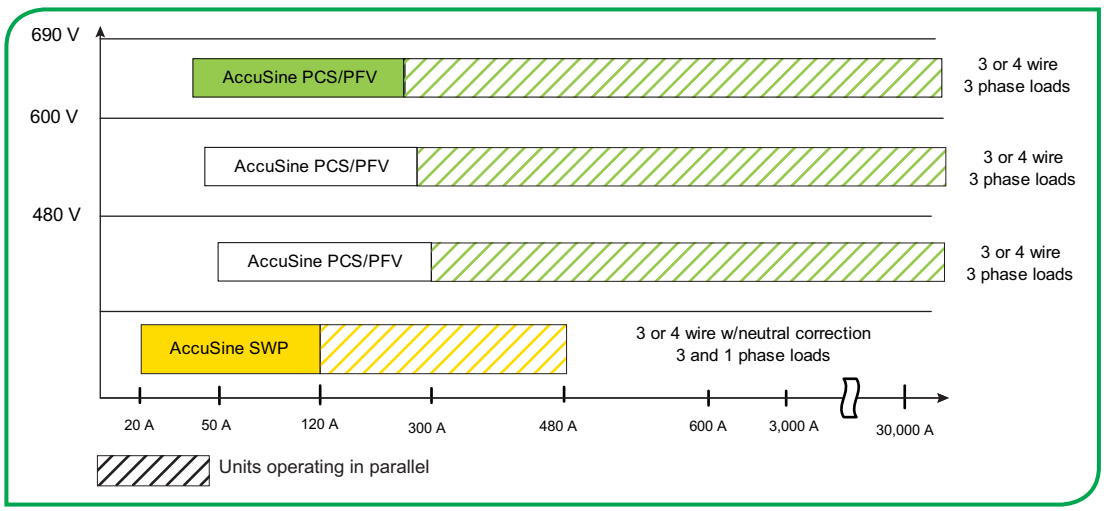
- Three wire connection.
- From 208 V to 690 V supply (higher voltages with transformers).
- Units from 33 A to 300 A, parallel up to 99 units.
- Cancellation to 50th harmonic.
- Displacement PF correction to set point.
- Load balancing of input current.
- Rapid VAR injection in < 1 cycle.
- Modbus TCP/IP and Ethernet IP communications.

Can be used with PF capacitors as Hybrid VAR Compensation (HVC) system.

AccuSine PFV

- Three wire connection.
- From 208 V to 690 V supply (higher voltages with transformers).
- Units from 33 A to 300 A, parallel up to 99 units.
- Displacement PF correction to set point.
- Load balancing of input current.
- Rapid VAR injection in <1 cycle.
- Modbus TCP/IP and Ethernet IP communications.

Can be used with PF capacitors as Hybrid VAR Compensation (HVC) system.



Electronic Power Quality Operating Principle

Electronic power quality devices are designed to measure the load current; calculate the errors from objectives set by the user; and inject the precise amount of current to make the supply current meet the objective levels for harmonics, displacement PF, or load balancing.

When harmonic mitigation is required, the logic measures the load current and calculates the harmonic current spectrum – that is the amplitude and phase angle for every harmonic to the 50th order. The logic then determines the amplitude to be injected at the opposite phase angle for each harmonic order selected for mitigation. Then a control signal is generated and the semiconductors (IGBT) are directed to duplicate the control signal as injected current into the supply. In this manner, the supply side harmonic current is greatly reduced.

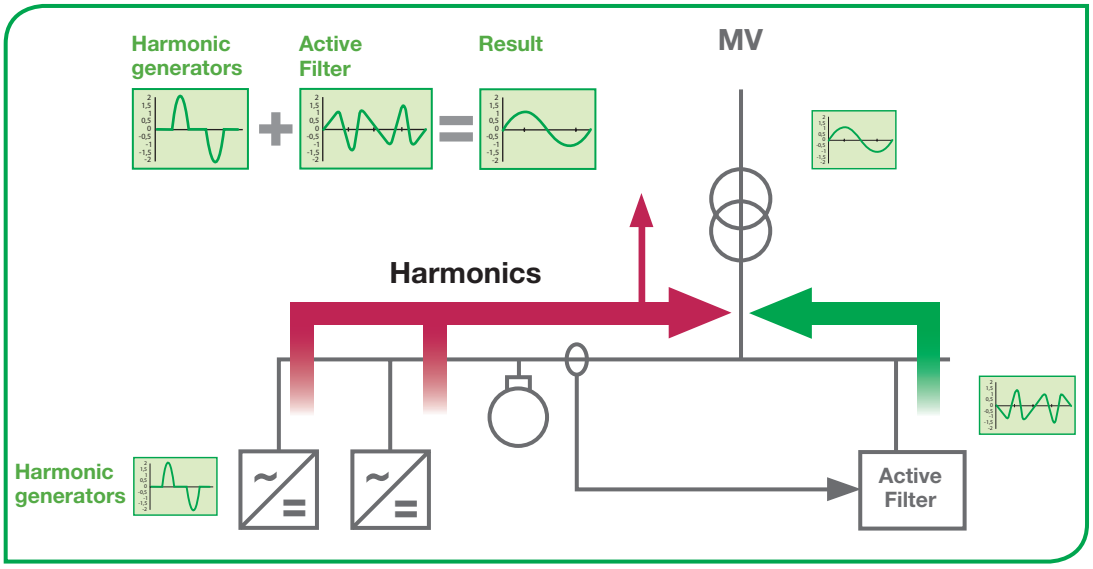
The speed of response is controlled by:
1) the logic calculation method,
2) the switching rate of the IGBT (also identified as carrier frequency), and
3) the speed of the microprocessor in the control logic. The carrier frequencies and micorprocessors are generally fast enough to provide per cycle response.

One type of logic employs fast Fourier transforms (FFT) that require three cycles of current to calculate the harmonic spectrum, thus requiring more than 3 cycles to begin injecting corrective current. AccuSine SWP employs FFT.

Another type of logic employs discrete spectrum logic (DSL) that uses one cycle of current to calculate the harmonic spectrum, thus providing less than 2 cycle response time for corrective action. AccuSine PCS employs DSL.

Correction for displacement PF calculates the phase shift of the fundamental current from the voltage of the supply on a per cycle basis. The control logic then calculates the amplitude and phase shift required to meet the user selected objective for displacement power factor. The IGBT are then directed to inject fundamental current at the proper phase shift to meet the objective. The actual displacement PF and objective may be leading (capacitive) or lagging (inductive). Near unity objectives can be met with no complications to the network. All AccuSine models perform displacement PF correction.

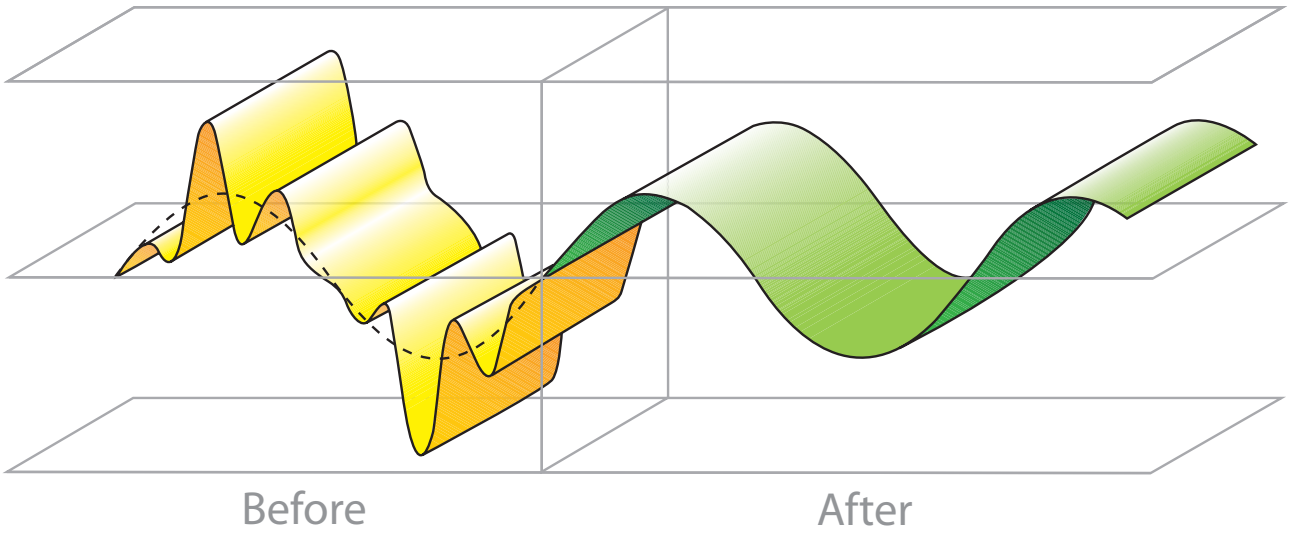
In a similar manner, the current required to correct for measured load unbalance (negative sequence current) is calculated and injected to balance the load for the supply. AccuSine PCS and AccuSine PFV are capable of providing Load Balancing.



Standard compliances

By using Schneider Electric active filters, it is possible to put any installation in compliance with the most relevant standards and regulations:

- IEEE 519: recommended practices and requirements for harmonic control in Electrical Power Systems.
- IEC 61000.3.6: assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems.
- ER G5/4: planning levels for harmonic voltage distortion and the connection of non-linear equipment to transmission systems and distribution networks in the United Kingdom.



AccuSine SWP

The Schneider Electric solution for harmonic filtering in buildings.

PE90044-r.eps

Key features and main benefits

- Correction capacity per unit: 20, 30, 45, 60, 90, 120 Amperes.
- Voltage: base design 400 V AC 3-phase supply, other voltages with transformer.
- Harmonic compensation: H2 to H50, global or selective.
- Reactive compensation: power factor correction, cos φ to near unity, selectable set point.
- Electrical systems: 3-wire or 4-wire.
- Neutral current correction: 3 times unit rating.
- Product standards: CE Certified.
- Parallel capability: up to 4 like units.
- Enclosure type: IP20, wall mounted.
- Communication: 3 dry (voltage free) contacts to monitor status from remote location; Standard RS422/485 link for J-Bus and Modbus.
- Functionality: harmonic mitigation or power factor correction, separately or combined.
- Human Machine Interface: graphic display, seven languages.

Performance capability

- Stepless automatic adaption to load changes.
- Suitable for all types and mixes of nonlinear loads.
- Fast response at < 2 cycles.
- Assist in compliance to any worldwide harmonic standards: IEEE 519, G5/4-1, GBT 14549, IEC-61000-3.
- THDi reduction to approximately 1/10 of network THDi.
- Corrects power factor, cos φ, for IT servers to insure proper operation of UPS.
- Compatible with any type of neutral system.
- Harmonic current balancing on mains.

Easy to Control

- Three LED indicators for run, stop, and current limit.
- Very user friendly graphic terminal.
- Choice of seven languages.
- Parameters and notifications clearly displayed.
- Graphic display of THDu, THDi.
- Remote run/stop via RS 422/485 link via Modbus or J-Bus.
- Remote monitoring of parameters and notifications via RS 422/485 link via Modbus or J-Bus.

Typical applications

Data Centres and Networks

- Data center & IT room.
- Offices and buildings.
- UPS systems.
- HVAC.

Building

HVAC

- Computer centers.
- Casinos.
- Power supplies for silicon production.

Lift

The Schneider Electric solution for active harmonic filtering in industrial installations.

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Key features and main benefits

■ Correction capacity per unit:
□ 208 - 480V: 50, 100, 300 A
□ 600 V: 39, 78, 235 A
□ 690 V: 33, 67, 200 A.
■ Voltage: 208 - 480 V AC, 600 V AC, 690 V AC 3-phase supply, other voltages with transformer.
■ Harmonic compensation: H2 to H50, discrete spectrum cancellation; global or selectable.
■ Reactive compensation: power factor correction, cos φ to near unity, selectable set point.
■ Load Balancing of source current.
■ Electrical systems: 3-wire or 4-wire.
■ Neutral current correction: None.
■ Product standards: CE Certified, UL, cUL, CSA, ABS, C-Tick.
■ Parallel capability: up to 99 units of any capacity.
■ Enclosure type: NEMA 1, NEMA 12, IP30, IP54.
■ Communication: 4 dry (voltage free) contacts to monitor status from remote location; Modbus TCP/IP or Ethernet IP.
■ Functionality: harmonic mitigation, power factor correction, or load balancing, separately or combined.
■ Human Machine Interface: graphic display with touch screen control.

Performance capability

■ Stepless automatic adaption to load changes.
■ Suitable for all types and mixes of nonlinear loads.
■ Ultra fast response at < 2 cycle.
■ Provides compliance to any worldwide harmonic standard: IEEE 519, G5/4-1, GBT 14549, IEC-61000-3.
■ THDi reduction to approximately 1/10 of network THDi.
■ Rapid injection of reactive current (also known as VAR compensation or flicker control).
■ Harmonic current balancing on mains. Optional fundamental current load balancing.

Easy to Control

■ One LED indicator for power on.
■ Very user friendly graphic terminal.
■ Easy to read 96 mm QVGA screen.
■ Parameters and notifications clearly displayed.
■ Graphic display of all current trends, bar graphs of source and load harmonics by order.
■ Remote monitoring and run/stop control via Modbus TCP/IP over ethernet.
■ Total remote control, including parameter setup, and monitoring via Ethernet IP (webserver).

Typical applications

Oil and gas

- Oil and gas platforms.
- Port cranes.
- Steel
- Water/Wastewater.
- HVAC

Water

Cement

HVAC

Building

Wind mills

- Automotive.
- Process plants. Pulp and paper.
- Wind and solar farms.
- Lifts (ski or building)
- Marine vessels…

Technical specification

AccuSine Specifications	SWP	PCS
Technical Specifications		
Compensation capacity per phase (A rms)	20 A, 30 A, 45 A, 60 A, 90 A, 120 A - 400 V AC	50 A, 100 A, 300 A - 208-480 V AC; 39 A, 78 A, 235 A - 600 V AC 33 A, 67 A, 200 A - 690 V AC
Neutral compensation capacity	3 times rating	-
System Input		
Nominal voltage	400 V AC; ±10 % auto sensing; other voltages available with transformers	208-480 V AC; 400-480 V AC; 600 V AC; 690 V AC; ±10 % auto sensing; other voltages available with transformers
Nominal frequency	50/60 Hz, ±3 %, auto sensing	50/60 Hz, ±3 %, auto sensing
Number of phases	3-Phase/3-Wire; 3-Phase/4-Wire	3-Phase/3-Wire; 3-Phase/4-Wire
Power Switching devices	IGBT	IGBT
Control topology	Digital	Digital
Operation with single phase loads	Yes	Yes
Current transformers (CT)	400 Hz & Class 1 accuracy	400 Hz & Class 1 accuracy
	300, 500, 600, 1000, 1500, 2000, 3000, 4000, 5000 & 6000 A primary with 1 A secondary; 3.5 VA burden per unit	Any ratio from 250 to 10,000 A primary with 5 A secondary; 2.5 VA burden per unit
Quantity of Cts required	3	2 or 3 (3 required when single phase loads present)
Technical Characteristics		
Harmonic cancellation spectrum	2nd to 50th, Discrete	2nd to 50th, Discrete
RMS current attenuation	> 10:1	> 10:1
Parallel configuration	4 units of same rating (master/slave)	Up to 99 units operate independently in load share mode; any combination of models
Modes of Operation	Harmonic and Power Factor Correction: independent or combined	Harmonic, Power Factor Correction, Load Balancing: Independent or combined
Power factor correction	Leading (capacitive) or Lagging (inductive) to target power factor	Leading (capacitive) or Lagging (inductive) to target power factor
Priority assignment of modes	Harmonic cancellation	Manually adjustable capacity splits between harmonic and fundamental (PF/Load Balancing) modes
Response Time	< 2 cycles	< 2 cycles
Resonance avoidance	Detects and discontinues resonant frequency within 2 cycles	Detects and discontinues resonant frequency within 2 cycles
Commissioning	-	Built in step by step procedure with phase sequence detection, automatic CT configuration, and more
Voltages above base units design	To 15 kV	Harmonic mode to 15 kV PF/load balancing mode to 33 kV
		Field programmable; Phase shift permitted
Internal overtemperature protection	Automatic roll back of output current	Automatic roll back of output current
Display	Graphic display with keypad	High quality 96 mm touch screen
Display languages	English (British & American), French, German, Italian, Spanish, & Dutch	English
Operators	Keypad	Magelis HMI graphic touch screen terminal
HMI display parameters & graphics	LED for run, stop, current limit graphic display, mains voltage and current, load voltage and current, THDi - mains, THDi - load, event log, harmonic spectrum -mains & load.	Mains AC voltage, bus DC voltage, load current - real, harmonic & reactive, mains current - real, harmonic and reactive, + more; % THDi, event log with time and date stamp, on/off status of each harmonic order.
	-	Oscilloscope feature displays; harmonic spectrum to 50th order - bar graph, trend curves for many essential parameters, plus many more
Communications Capability	J-Bus & Modbus	Modbus TCP/IP, Transparent Ready, Ethernet IP via webserver
Acoustic Noise (ISO3746)	≤ 67 db at one meter from unit surface	≤ 80 db at one meter from unit surface
Color	RAL 9002	NEMA 1 wall mounted units - Quartz Gray, all others RAL7035
Environmental Conditions		
Operating Temperature	0 °C to 40 °C continuous (derate 2 %/1 °C to 50 °C)	0 °C to 40 °C continuous (derate 2 %/1 °C to 50 °C)
Relative humidity	0-95 %, noncondensing	0-95 %, noncondensing
Seismic qualification	IBC and ASCE7	IBC and ASCE7
Operating Altitude	1000 m, (derate 1 %/100 m above)	1000 m, (derate 1 %/100 m above)
Contamination levels (IEC 60721-3-3)	Chemical Class 3C3 (1) Mechanical Class 3S3 (2)	Chemical Class 3C3 (1) Mechanical Class 3S3 (2)
Reference technical standards		
Design	CE Certified per CE EMC Certification IEC/EN 60439-1, EN 61000-6-4 Class A, EN 61000-6-2	Optional CE Certification
Protection (enclosure)	IP20	NEMA 1, NEMA 12, IP30, IP54

(1) Locations with normal levels of contaminants, experienced in urban areas with industrial activities scattered over the whole area, or with heavy traffic. Also applies to locations with immediate neighborhood of industrial sources with chemical emissions.
(2) Locations without special precautions to minimize the presence of sand or dust. Also applies to locations in close proximity to sand or dust sources.

Selection Table

Harmonic and PF Correction - 208-480 V models

Rated Current A (rms)	Neutral Cancellation A (rms)	Watt Losses (watt) 240 V	400 V	480 V	Model Number	Enclosure Information Rating	Style / Cable entry	Frame [4]	Weight kg (Lbs)
20	60		1000		PCS020Y4IP20 [3] [5]	IP20 (CE Certified)	Wall Mount [2] / bottom	1	65 (143)
30	90		1200		PCS030Y4IP20 [3] [5]	IP20 (CE Certified)	Wall Mount [2] / bottom	1	65 (143)
45	135		1900		PCS045Y4IP20 [3] [5]	IP20 (CE Certified)	Wall Mount [2] / bottom	2	110 (242)
50	N/A	900	1500	1800	PCS050D5N1	NEMA 1	Wall Mount [1][2] / bottom	4	250 (114)
			1875	2250	PCS050D5N12	NEMA12	Floor Standing / top or bottom	7	300 (661)
					PCS050D5CE30 [3]	IP30 (CE Certified)			320 (705)
					PCS050D5CE54 [3]	IP54 (CE Certified)			
					PCS050D5IP30	IP30			300 (661)
					PCS050D5IP54	IP54			
60	180		2400		PCS060Y4IP20 [3]	IP20 (CE Certified)	Wall Mount [2] / bottom	2	110 (242)
90	270		3800		PCS090Y4IP20 [3]	IP20 (CE Certified)	Wall Mount [2] / bottom	3	220 (484)
100	N/A	1500		3000	PCS100D5N1	NEMA 1	Wall Mount [1][2] / bottom	5	159 (350)
			3125	3750	PCS100D5N12	NEMA12	Floor Standing / top or bottom	7	350 (771)
					PCS100D5CE30 [3]	IP30 (CE Certified)			386 (849)
					PCS100D5CE54 [3]	IP54 (CE Certified)			
					PCS100D5IP30	IP30			350 (771)
					PCS100D5IP54	IP54			
120	360		4800		PCS120Y4IP20 [3]	IP20 (CE Certified)	Wall Mount [2] / bottom	3	220 (484)
300	N/A	4500	7500	9000	PCS300D5N1	NEMA 1	Floor Standing / top	6	352 (775)
			8333	10000	PCS300D5N12	NEMA12	Floor Standing / top or bottom	8	550 (1212)
					PCS300D5CE30 [3]	IP30 (CE Certified)			632 (1390)
					PCS300D5CE54 [3]	IP54 (CE Certified)			
					PCS300D5IP30	IP30			550 (1212)
					PCS300D5IP54	IP54			

Harmonic and PF Correction - 600 V models

Rated Current A (rms)	Watt Losses (watt) 600 V	Model Number	Enclosure Information Rating	Style / Cable entry	Frame [4]	Weight kg (Lbs)
39	2850	PCS039D6N1	NEMA 1	Floor Standing / top or bottom	9	600 (1322)
		PCS039D6N12	NEMA12			
		PCS039D6CE30 [3]	IP30 (CE Certified)			621 (1366)
		PCS039D6CE54 [3]	IP54 (CE Certified)			
		PCS039D6IP30	IP30			600 (1322)
		PCS039D6IP54	IP54			
78	4610	PCS078D6N1	NEMA 1	Floor Standing / top or bottom	9	700 (1542)
		PCS078D6N12	NEMA12			
		PCS078D6CE30 [3]	IP30 (CE Certified)			736 (1620)
		PCS078D6CE54 [3]	IP54 (CE Certified)			
		PCS078D6IP30	IP30			700 (1542)
		PCS078D6IP54	IP54			
235	12750	PCS235D6N1	NEMA 1	Floor Standing / top or bottom	10	1102 (2424)
		PCS235D6N12	NEMA12			
		PCS235D6CE30 [3]	IP30 (CE Certified)			1183 (2602)
		PCS235D6CE54 [3]	IP54 (CE Certified)			
		PCS235D6IP30	IP30			1102 (2424)
		PCS235D6IP54	IP54			

(1) Floor stand available. Order Catalog Number - FSPCS100D5N1.
(2) Wall mounted units do not include a power disconnect.
(3) CE Certified units meet EMC Directive 89/336 EEC.
(4) See page 19 and 20.
(5) AccuSine SWP may be ordered as stand alone "unitary" unit or "parallel" ready. For unitary, add "U" to the end of the Model Number, i.e. SWPxxxY4IP20U. For parallel ready, add 'P' to the end of the Model Number, i.e. SWPxxxY4IP20P.

Selection Table

Harmonic and PF Correction - 690 V models

Rated Current A (rms)	Watt Losses (watt) 690 V	Model Number	Enclosure Information Rating	Enclosure Information Style / Cable entry	Frame (2)	Weight kg (Lbs)
33.3	3050	PCS033D7N1	NEMA 1	Floor Standing / top or bottom	9	624 (1372)
		PCS033D7N12	NEMA12			
		PCS033D7CE30 (1)	IP30 (CE Certified)			644 (1416)
		PCS033D7CE54 (1)	IP54 (CE Certified)			
		PCS033D7IP30	IP30			624 (1372)
		PCS033D7IP54	IP54			
66.7	5400	PCS067D7N1	NEMA 1	Floor Standing / top or bottom	9	724 (1592)
		PCS067D7N12	NEMA12			
		PCS067D7CE30 (1)	IP30 (CE Certified)			835 (1670)
		PCS067D7CE54 (1)	IP54 (CE Certified)			
		PCS067D7IP30	IP30			724 (1592)
		PCS067D7IP54	IP54			
200	13565	PCS200D7N1	NEMA 1	Floor Standing / top or bottom	10	1170 (2574)
		PCS200D7N12	NEMA12			
		PCS200D7CE30 (1)	IP30 (CE Certified)			2752 (1251)
		PCS200D7CE54 (1)	IP54 (CE Certified)			
		PCS200D7IP30	IP30			1170 (2574)
		PCS200D7IP54	IP54			

(1) CE Certified units meet EMC Directive 89/336 EEC.
(2) See page 19 and 20.

***Note:** AccuSine PCS requires CT with a secondary current rating of 5 amperes.*
AccuSine PCS requires two mains CT for three phase loads. When single phase loads are present three mains CT are required.
AccuSine SWP requires CT with a secondary current rating of 1 ampere. Three (3) mains CT are required.

7RL_photo_R.eps

Round solid-core selection table

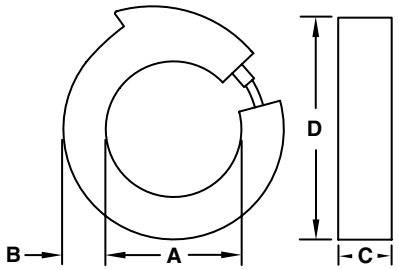
Ampacity	Cat. number	Dimensions mm (in) ID	OD	Thickness	Weight kg (Lbs)	Accuracy Class	Burden Capacity (VA)	Secondary Current
600	PCSCT7RL6011	63 (2.5)	116 (4.58)	28 (1.1)	1.5 (3.8)	1	30	1
1000	PCSCT7RL1021	63 (2.5)	116 (4.58)	28 (1.1)	1.5 (3.8)	1	35	1

FC-round-open-photo_R.eps

Round split-core selection table

Ampacity	Cat. number	Dimensions mm (in) A	B	C	D	Weight kg (Lbs)	Accuracy Class	Burden Capacity VA	Secondary Current
1000	PCSCT1000SC	101 (4)	32 (1.25)	38 (1.5)	165 (6.5)	1.75 (3.5)	1	10	5
3000	PCSCT3000SC	152 (6)	32 (1.25)	38 (1.5)	216 (8.5)	1.9 (4.25)	1	45	5
5000	PCSCTFCL500058	203 (8)	32 (1.25)	38 (1.5)	267 (10.5)	2.5 (5.5)	1	45	5

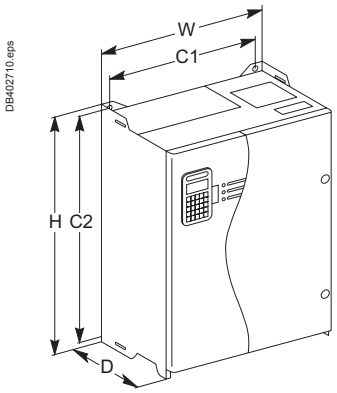
Flexcore-round-dim.eps



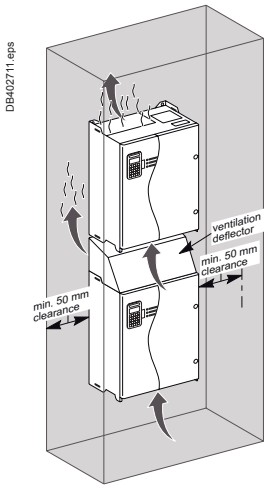
Unit dimensions and installation guidelines

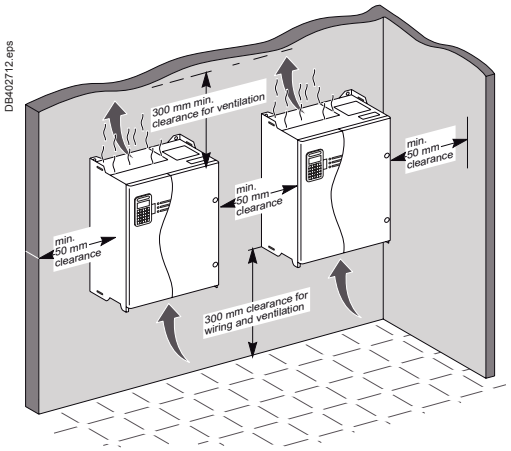
Frame size figure	Exterior dimensions						Fixing centre distance (mm)	
	Height		Width		Depth		Width	Height
	in.	mm	in.	mm	in.	mm	C1	C2
1	26.8	680	21.3	540	11.0	280	475	660
2	30.7	780	23.2	590	12.8	325	525	760
3	Consists of two Frame 2 units - Installation Options							
4	48.0	1219	20.7	525	18.5	469		
5	64.9	1648	20.7	525	18.5	469		
6	75.3	1913	31.5	801	19.6	497		
7	75.0	1905	31.5	801	23.8	605		
8	75.0	1905	39.4	1000	31.5	801		
9	77.7	1972	55.1	1400	23.8	605		
10	75.0	1905	70.9	1800	31.5	801		

Frame size 1 and 2

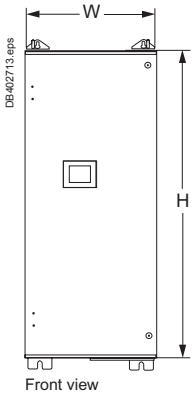


Frame size 3

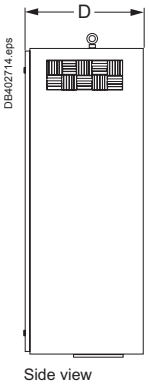




Frame size 4

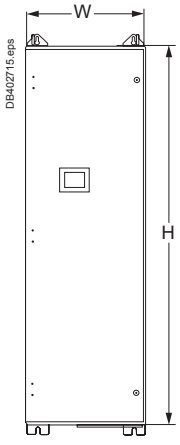


Front view

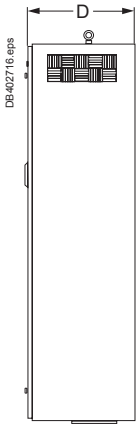


Side view

Frame size 5



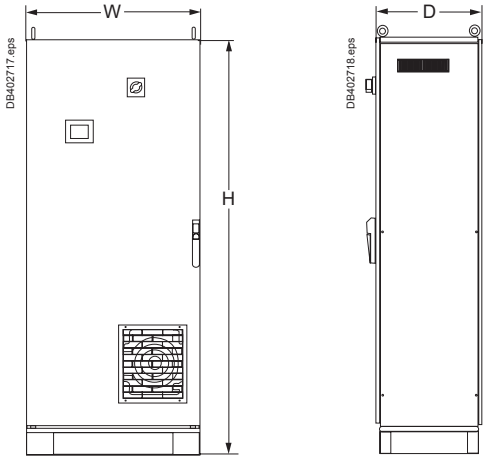
Front view



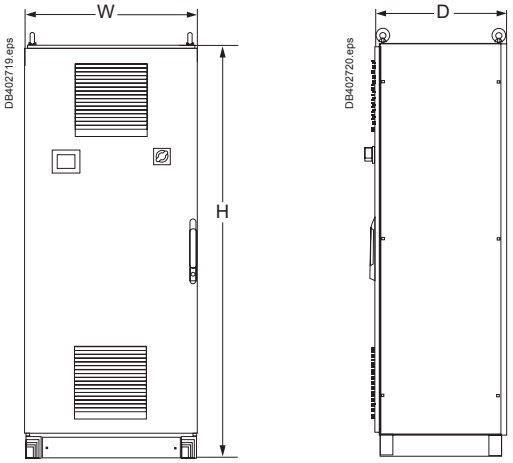
Side view

Unit dimensions and installation guidelines

Frame size 6



Frame size 7 and 8



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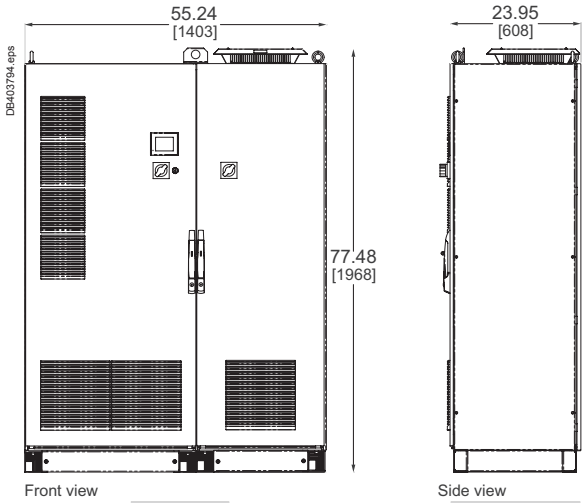

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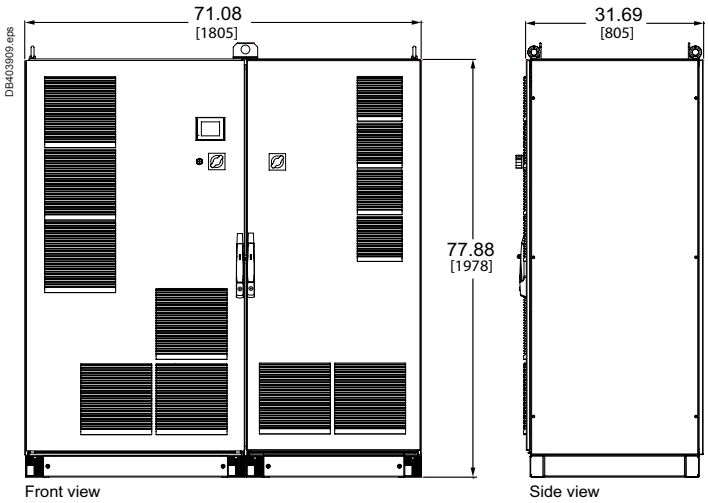


AccuSine PFV

The Schneider Electric solution for active reactive current compensation for specific and high performance solutions.

PB105007.eps

Key features and main benefits

■ Correction capacity per unit:
□ <480V: 50, 100, 300 A
□ 600V: 39, 78, 235 A
□ 690V: 35, 70, 209 A.
■ Voltage: 208 - 480 V AC, 600 V AC, 690 V AC 3-phase supply, other voltages with transformer.
■ Reactive compensation: power factor correction, cos φ to near unity, selectable set point.
■ Load Balancing of source current.
■ Electrical systems: 3-wire or 4-wire.
■ Product standards: CE Certified, UL, cUL, CSA, ABS, C-Tick.
■ Parallel capability: up to 99 units of any capacity.
■ Enclosure type: NEMA 1, NEMA 12, IP30, IP54.
■ Communication: 4 dry (voltage free) contacts to monitor status from remote location; Modbus TCP/IP or Ethernet IP.
■ Functionality: power factor correction (capacitive or inductive), or load balancing, VAR compensation separately or combined.
■ Human Machine Interface: graphic display with touch screen control.

Performance capability

■ Stepless automatic adaption to load changes.
■ Compatible with all types and mixes of nonlinear loads.
■ Ultra fast response at < 1 cycle.
■ Rapid injection of reactive current (also known as VAR compensation or flicker control).
■ Optional fundamental current load balancing.

Easy to Control

■ One LED indicator for power on.
■ Very user friendly graphic terminal.
■ Easy to read 96 mm QVGA screen.
■ Parameters and notifications clearly displayed.
■ Graphic display of all current trends, bar graphs of source and load
■ Remote monitoring and run/stop control via Modbus TCP/IP over ethernet.
■ Total remote control, including parameter setup, and monitoring via Ethernet IP (webserver).

Typical applications

Oil and gas

- Oil and gas platforms.
- Port cranes.
- Steel
- Water/Wastewater.
- HVAC

Water

Cement

HVAC

- Automotive.
- Process plants. Pulp and paper.
- Lifts (ski or building)
- Marine vessels…

Building

Wind mills

Technical specification

AccuSine Specifications	PFV
Technical Specifications	
Standard RMS output current rating	50 A, 100 A, 300 A - 208-480 V AC; 39 A, 78 A, 235 A - 600 V AC 35 A, 70 A, 209 A - 690 V AC
System Input	
Nominal voltage	208-480 V AC; 600 V AC; 690 V AC; ±10 % auto sensing; other voltages with transformers
Nominal frequency	50/60 Hz, ±3 %, auto sensing
Number of phases	3-phase/3-wire; 3-phase/4-wire
Power Switchning devices	IGBT
Control topology	Fully Digital
Operation with single phase loads	Yes
Current transformers (CT)	400 Hz rated, Class 1 accuracy Any ratio from 250 to 10,000 A with 5 A secondary,
Quantity of Cts required	2 or 3 (3 required when single phase loads present)
Technical Characteristics	
Parallel configuration	Up to 99 units operate independently in load share mode; limit due to VA rating of CT, any combination of models; automatic adjustment of capacity
Modes of Operation	Power factor correction, Load balancing, VAR compensation; independently or combined
Power factor correction	Leading (capacitive) or Lagging (inductive) to target power factor
Response time	< 1 cycle
Dynamic current injection	< 1 cycle
Commissioning	Built in step by step procedure with phase sequence detection and automatic CT configuration
Voltages above base units design	Any to 35 kV with field setup, including phase angle adjustment
Internal overtemperature protection	Automatic roll back of output
Display	High quality 96 mm color screen
Languages	English
Operators	Magelis HMI graphic touch screen terminal
HMI display parameters & graphics	Oscilloscope feature (built-in) to display the following: - mains AC voltage, bus DC voltage, load current - real, & reactive, mains current - real and reactive, + more; - event log with time and date stamp, on/off status of each trend curves for many essential parameters, plus many more
Communications Capability	Modbus IP, Transparent Ready, Ethernet via webserver
Acoustic Noise (ISO3746)	< 80 db at one meter from unit surface
Color	NEMA 1 wall mounted units - Quartz Gray, all others RAL7035
Environmental Conditions	
Operating Temperature	0 °C to 40 °C continuous (derate 1 %/1 °C to 50 °C)
Relative humidity	0-95 %, noncondensing
Seismic qualification	IBC and ASCE7
Operating Altitude	1000 m, (derate 1 %/100 m above)
Contamination levels (IEC 60721-3-3)	Chemical Class 3C3 (1) Mechanical Class 3S3 (2)
Reference technical standards	
Design	Optional: CE Certified per CE EMC Certification IEC/EN 60439-1, EN 61000-6-4 Class A, EN 61000-6-2
Protection (enclosure)	NEMA 1, NEMA 12, IP30, IP54

(1) Locations with normal levels of contaminants, experienced in urban areas with industrial activities scattered over the whole area, or with heavy traffic. Also applies to locations with immediate neighborhood of industrial sources with chemical emissions.
(2) Locations without special precautions to minimize the presence of sand or dust. Also applies to locations in close proximity to sand or dust sources.

Selection Table

PF Correction + VAR Support - 208-480 V models

Rated Current A (rms)	Watt Losses (watt) 240 V	400 V	480 V	Model Number	Enclosure Information Rating	Style / Cable entry	Frame [4] Figure #	Weight kg (Lbs)
50	1350	1875	2250	EVC 050D5N1	NEMA 1	Wall Mount [1][2] / bottom	4	250 (114)
	NA			EVC050D5N12	NEMA12	Floor Standing / top or bottom	7	300 (661)
				EVC050D5CE30 [3]	IP30 (CE Certified)			320 (705)
				EVC050D5CE54 [3]	IP54 (CE Certified)			
				EVC050D5IP30	IP30			300 (661)
				EVC050D5IP54	IP54			
100	1925	3125	3750	EVC100D5N1	NEMA 1	Wall Mount [1][2] / bottom	5	159 (350)
	NA			EVC100D5N12	NEMA12	Floor Standing / top or bottom	7	350 (771)
				EVC100D5CE30 [3]	IP30 (CE Certified)			386 (849)
				EVC100D5CE54 [3]	IP54 (CE Certified)			
				EVC100D5IP30	IP30			350 (771)
				EVC100D5IP54	IP54			
300	5500	8333	10000	EVC300D5N1	NEMA 1	Floor Standing / top	6	352 (775)
	NA			EVC300D5N12	NEMA12	Floor Standing / top or bottom	8	550 (1212)
				EVC300D5CE30 [3]	IP30 (CE Certified)			632 (1390)
				EVC300D5CE54 [3]	IP54 (CE Certified)			
				EVC300D5IP30	IP30			550 (1212)
				EVC300D5IP54	IP54			

NA: *not applicable.*

PF Correction + Volt-VAR Support - 600 V models

Rated Current A (rms)	Watt Losses (W) 600 V	Model Number	Enclosure Information Rating	Style / Cable entry	Frame [4] Figure #	Weight kg (Lbs)
39	2725	EVC039D6N1	NEMA 1	Floor Standing / top or bottom	9	600 (1322)
		EVC039D6N12	NEMA12			
		EVC039D6CE30 [3]	IP30 (CE Certified)			621 (1366)
		EVC039D6CE54 [3]	IP54 (CE Certified)			
		EVC039D6IP30	IP30			600 (1322)
		EVC039D6IP54	IP54			
78	4475	EVC078D6N1	NEMA 1	Floor Standing / top or bottom	9	700 (1542)
		EVC078D6N12	NEMA12			
		EVC078D6CE30 [3]	IP30 (CE Certified)			736 (1620)
		EVC078D6CE54 [3]	IP54 (CE Certified)			
		EVC078D6IP30	IP30			700 (1542)
		EVC078D6IP54	IP54			
235	11700	EVC235D6N1	NEMA 1	Floor Standing / top or bottom	10	1102 (2424)
		EVC235D6N12	NEMA12			
		EVC235D6CE30 [3]	IP30 (CE Certified)			1183 (2602)
		EVC235D6CE54 [3]	IP54 (CE Certified)			
		EVC235D6IP30	IP30			1102 (2424)
		EVC235D6IP54	IP54			

PF Correction + VAR Support - 690 V models

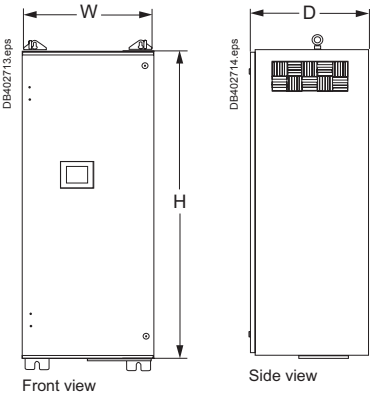
A (rms)	690 V		Rating	Style / Cable entry	Figure #	kg (Lbs)
34.8	3060	EVC035D7N1	NEMA 1	Floor Standing / top or bottom	9	624 (1372)
		EVC035D7N12	NEMA12			
		EVC035D7CE30 [1]	IP30 (CE Certified)			644 (1416)
		EVC035D7CE54 [1]	IP54 (CE Certified)			
		EVC035D7IP30	IP30			624 (1372)
		EVC035D7IP54	IP54			
69.6	4990	EVC070D7N1	NEMA 1	Floor Standing / top or bottom	9	724 (1592)
		EVC070D7N12	NEMA12			
		EVC070D7CE30 [1]	IP30 (CE Certified)			835 (1670)
		EVC070D7CE54 [1]	IP54 (CE Certified)			
		EVC06D7IP370	IP30			724 (1592)
		EVC070D7IP54	IP54			
208.7	12650	EVC209D7N1	NEMA 1	Floor Standing / top or bottom	10	1170 (2574)
		EVC209D7N12	NEMA12			
		EVC209D7CE30 [1]	IP30 (CE Certified)			2752 (1251)
		EVC209D7CE54 [1]	IP54 (CE Certified)			
		EVC209D7IP30	IP30			1170 (2574)
		EVC209D7IP54	IP54			

(1) Floor stand available. Order Catalog Number - FSPCS100D5N1.
(2) Wall mounted units do not include a power disconnect.
(3) CE Certified units meet EMC Directive 89/336 EEC.
(4) See page page 22.

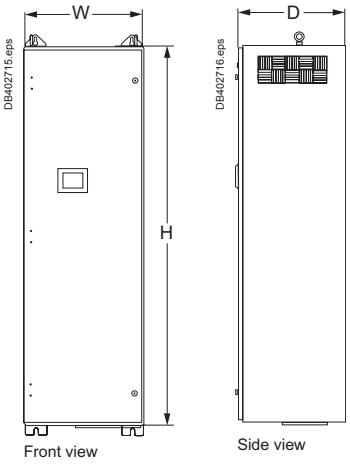
Unit dimensions and installation guidelines

Frame size figure	Exterior dimensions					
	Height		Width		Depth	
	in.	mm	in.	mm	in.	mm
4	48.0	1219	20.7	525	18.5	469
5	64.9	1648	20.7	525	18.5	469
6	75.3	1913	31.5	801	19.6	497
7	75.0	1905	31.5	801	23.8	605
8	75.0	1905	39.4	1000	31.5	801
9	77.7	1972	55.1	1400	23.8	605
10	75.0	1905	70.9	1800	31.5	801

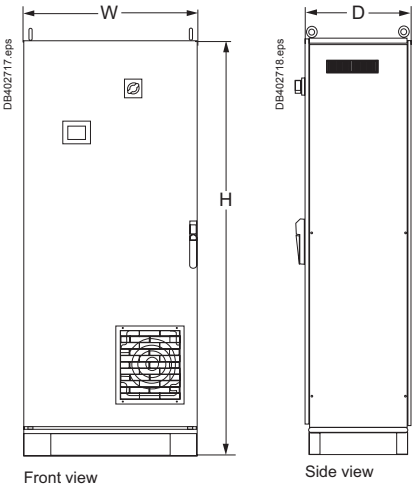
Frame size 4



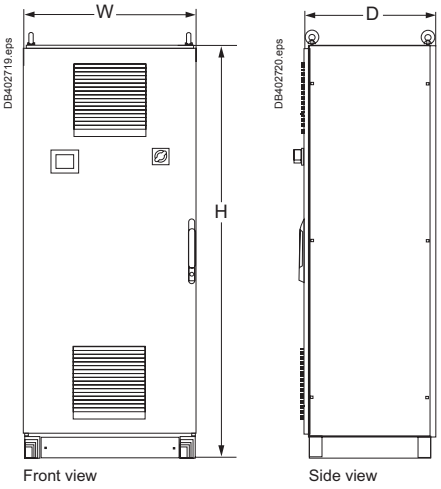
Frame size 5



Frame size 6



Frame size 7 and 8



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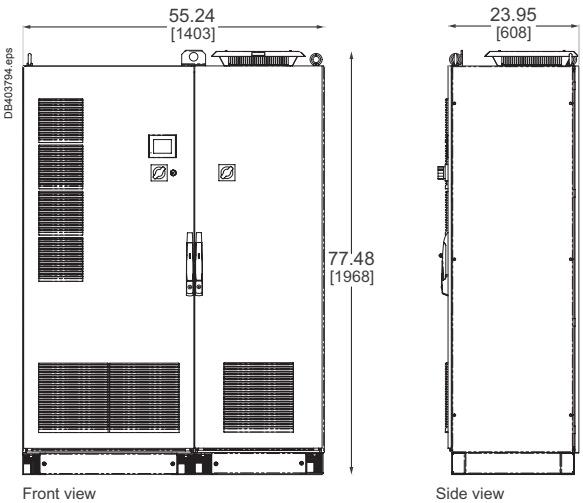
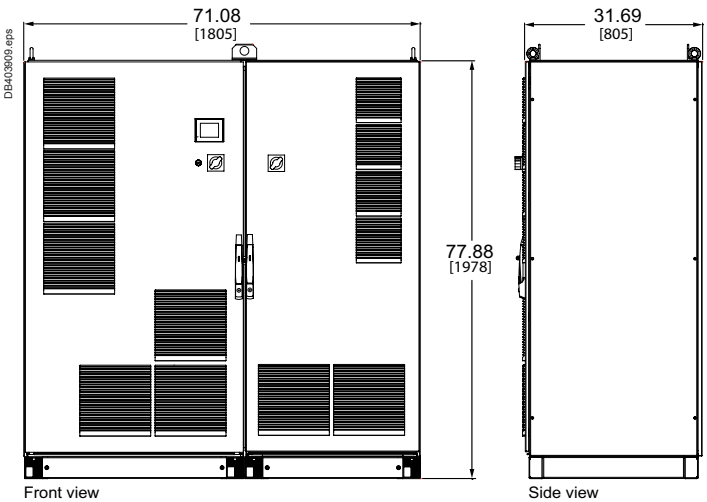


Frame size 10



Human Machine Interface (HMI)

The AccuSine products provide a HMI including a Graphical User Interface. Direct control, programming and monitoring are possible without a PC or the internet

PE90058.eps

Keypad

Direct control of the active filters is possible by using the RUN/STOP commands on a keypad.

Display

A graphical display is used for different functions:
- access and set up of operating parameters
- measurement data
- operation status (warnings, fault messages).

Menus are accessible for easy navigation.

Configuration parameters

List of selectable parameters:
- user language
- 3- or 4-wire configuration
- harmonics or reactive energy compensation (separately or in combination)
- current transformer ratio
- power factor target
- number of units in parallel
- communication parameters.

Measurements

A complete set of measurement data is accessible:
- line-to-line r.m.s. voltages
- total r.m.s load currents (on three phases)
- active filter output r.m.s currents (on three phases)
- harmonic r.m.s load and line currents
- voltage and current distortions (THDu and THDi)
- reactive r.m.s load current
- active filter reactive r.m.s output current
- heatsink temperature (in deg. C).

Alarms and Fault display

Detailed alarms and fault messages are displayed for easy trouble shooting:
- supply voltage or frequency outside of normal operating range
- current limitation
- overtemperature
- controller fault
- communication fault.

Appendix

Relevant websites

www.schneider-electric.com/solutions/energyefficiency
www.solution-toolbox.schneider-electric.com/segment
www.reactivar.com
www.APC.com

Technical reference guides

Harmonic mitigation - Solution Handbook	SLTED109014EN
Harmonic disturbances in networks and their treatment	Technical guide n° 152
The singularities of the third harmonic	Technical guide n° 202
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