AccuSine
Harmonic filtering and reactive power compensation

Make the most of your energy

Schneider Electric
Harmonic filtering and reactive power compensation
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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.

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 causes voltage distortion in the distribution system.

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 the 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 is 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)
Correction of displacement power factor (DPF) is well known as a method of reducing penalty charges on utility electrical bills and reducing the rms current loading on the safety devices and conductors within the plant. However, correction of DPF is 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 connected to the electrical system.

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

When electrical systems contain nonlinear loads that exceed about 50 percent of the total load, DPF correction can not be achieved by applying capacitors alone. DPF correction must be achieved with an alternate means. One method is using active harmonic filters or other power electronic devices that inject 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. 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 power electronic device does not require time-consuming on-site 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

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 due to the existence of negative sequence current.

Negative sequence current, caused by unbalanced network voltage, or loads, behaves just like reactive current (leading or lagging) in the electrical distribution system by reducing the overall system capacity (i.e. transformers, cables, and buses). Premature relay device tripping may occur due to an unbalance of current.

As we can see, negative sequence current will cause voltage unbalance (due to the existence of negative sequence component). Likewise, an unbalanced three-phase voltage will cause unbalanced current in other loads.

Direct on line (DOL) AC motors and asynchronous generators will experience major heating effects with very little unbalanced voltage. A voltage unbalance of 2 percent can reduce AC motor life about 10-15 percent.

Negative sequence current produces negative torque in DOL AC motors. In some applications, this negative torque can cause mechanical breakdown of shafts or couplings. Motor shafts can break and shaft couplings can fly apart, stopping production for extended time periods. Additionally, employee injuries may occur due to flying debris.

AC voltage imbalance also causes nonlinear loads to draw unbalanced AC line currents. This can cause premature aging of the rectifying device, premature tripping of the relay device, or cause peak currents in excess of the operational limits for the DC bus capacitors. The result is reduced life and for the nonlinear loads, intermittent shutdown of devices.
Reactive energy fluctuations

Equipment such as welders, induction furnaces, crushers, shredders, steels mills, and 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, often to levels that can adversely affect sensitive loads or cause 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. 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 deliver “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.

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) 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

Reduce capital expenditures

Savings 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, and 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 utilization of capacity
- Harmonic mitigation and reactive current correction reduce utility demand thus reducing utility penalty 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
# Offer introduction

## Applications

<table>
<thead>
<tr>
<th>General duty</th>
<th>Performance</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| Water and wastewater treatment plants, textile mills, paper mills, pharmaceutical plants, package sorting facilities, bulk material handling, printing presses | > THDv \(^{(1)}\) < 5%  
> TDD \(^{(2)}\) ≤ 5%  
> DPF correction to 0.95 or better  
> Generators operate efficiently  
> Eliminate resonance potential of PF capacitors | > Meet industry standards for THDv or THD\(^{(2)}\)/TDD  
> 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 TDD to < 5%  
> Corrects DPF to set point  
> Load balances current  
> Prevents resonance conditions | > Compliance to off-shore standards  
> Reduces 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).
AccuSine family of products

Schneider Electric™ is specialized in electronic power quality solutions. A broad range of products is available for different applications. 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 identifies the model that best performs the solutions defined.

<table>
<thead>
<tr>
<th>AccuSine model</th>
<th>Neutral harmonics</th>
<th>Harmonic mitigation</th>
<th>DPF correction</th>
<th>Load balancing</th>
<th>VAR support</th>
</tr>
</thead>
<tbody>
<tr>
<td>AccuSine PCS</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>AccuSine PFV</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**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 devices are designed to measure the load current; calculate the variance from objectives set by the user; and inject the right 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 microprocessors 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 three cycles to begin injecting corrective current.

Another type of logic employs discrete spectrum logic (DSL) that uses one cycle of current to calculate the harmonic spectrum, thus providing less than two-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 nonlinear equipment to transmission systems and distribution networks in the United Kingdom
Harmonic compensation offer

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

AccuSine PCS

Key features and main benefits
- Correction capacity per unit:
  - 208 - 480 V: 50, 100, 300 A
  - 600 V: 39, 78, 235 A
  - 690 V: 33, 67, 200 A
- Voltage: 208 - 480 VAC, 600 VAC, 690 VAC three-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: three-wire or four-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: four 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 LCD display with touchscreen 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-, 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)
- Automatic adaption for unbalanced harmonic phase loading. Optional fundamental current load balancing

Easy to Control
- One LED indicator for power on
- 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 harmonic 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 (Web server)

Typical applications

- Oil & gas platforms
- Port cranes
- Steel
- Water/Wastewater
- HVAC
- Automotive
- Process plants
- Pulp and paper
- Wind and solar farms
- Lifts (ski or building)
- Marine vessels

The Schneider Electric solution for active harmonic filtering in industrial installations.
### Harmonic compensation offer

#### Technical specification

<table>
<thead>
<tr>
<th>AccuSine Specifications</th>
<th>PCS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Technical Specifications</strong></td>
<td></td>
</tr>
<tr>
<td>Compensation capacity per phase (A rms)</td>
<td>50 A, 100 A, 300 A - 208-480 VAC; 39 A, 78 A, 235 A - 600 VAC; 33 A, 67 A, 200 A - 690 VAC</td>
</tr>
<tr>
<td>Neutral compensation capacity</td>
<td>-</td>
</tr>
<tr>
<td><strong>System Input</strong></td>
<td></td>
</tr>
<tr>
<td>Nominal voltage</td>
<td>208-480 VAC; 400 VAC, 400-480 VAC; 600 VAC; 690 VAC; ±10% auto sensing; other voltages available with transformers</td>
</tr>
<tr>
<td>Nominal frequency</td>
<td>50/60 Hz, ±3%, auto sensing</td>
</tr>
<tr>
<td>Number of phases</td>
<td>Three-phase/three-wire; three-phase/four-wire</td>
</tr>
<tr>
<td>Power switching devices</td>
<td>IGBT</td>
</tr>
<tr>
<td>Control topology</td>
<td>Digital</td>
</tr>
<tr>
<td>Operation with single-phase loads</td>
<td>Yes</td>
</tr>
<tr>
<td>Current transformers (CT)</td>
<td>400 Hz and Class 1 accuracy; Any ratio from 250 to 10,000 A primary with 5 A secondary; 2.5 VA burden per unit</td>
</tr>
<tr>
<td>Quantity of Cts required</td>
<td>Two or three (three required when single phase loads present)</td>
</tr>
<tr>
<td><strong>Technical Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Harmonic cancellation spectrum</td>
<td>2nd to 50th, discrete</td>
</tr>
<tr>
<td>RMS current attenuation</td>
<td>&gt; 10:1</td>
</tr>
<tr>
<td>Parallel configuration</td>
<td>Up to 99 units operate independently in load share mode; any combination of models; automatic adjustment of capacity</td>
</tr>
<tr>
<td>Modes of operation</td>
<td>Harmonic, power factor correction, load balancing: independent or combined</td>
</tr>
<tr>
<td>Power factor correction</td>
<td>Leading (capacitive) or lagging (inductive) to target power factor</td>
</tr>
<tr>
<td>Priority assignment of modes</td>
<td>Manually adjustable capacity splits between harmonic and fundamental (PF/Load Balancing) modes</td>
</tr>
<tr>
<td>Response to overload conditions</td>
<td>&lt; 2 cycles</td>
</tr>
<tr>
<td>Resonance avoidance</td>
<td>Detects and discontinues resonant frequency within 2 cycles</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Built in step-by-step procedure with phase sequence detection, automatic CT configuration, and more</td>
</tr>
<tr>
<td>Voltages above base units design</td>
<td>Harmonic mode to 15 kV, PF/load balancing mode to 33 kV</td>
</tr>
<tr>
<td>Internal overtemperature protection</td>
<td>Field programmable; phase shift permitted</td>
</tr>
<tr>
<td>Display</td>
<td>High quality 96 mm color touchscreen</td>
</tr>
<tr>
<td>Display languages</td>
<td>English</td>
</tr>
<tr>
<td>Operators</td>
<td>Magelis™ HMI graphic touchscreen terminal</td>
</tr>
<tr>
<td>HMI display parameters and graphics</td>
<td>Mains AC voltage, bus DC voltage, load current - real, harmonic, and reactive, mains current - real, harmonic, and reactive, plus more; % THDi, event log with time and date stamp, on/off status of each harmonic order</td>
</tr>
<tr>
<td>Communications capability</td>
<td>Oscilloscope feature displays; harmonic spectrum to 50th order - bar graph, trend curves for many essential parameters, plus many more</td>
</tr>
<tr>
<td>Acoustic noise (ISO3746)</td>
<td>Modbus TCP/IP, Transparent Ready™, Ethernet IP via Web server</td>
</tr>
<tr>
<td>Color</td>
<td>≤ 80 db at one meter from unit surface</td>
</tr>
<tr>
<td>Environmental Conditions</td>
<td>NEMA 1 wall mounted units - quartz gray, all others light gray</td>
</tr>
</tbody>
</table>

| Operating temperature | 0 °C to 40 °C continuous (derate 2%/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 certification
- **Protection (enclosure)**: NEMA 1, NEMA 12, IP30, IP54

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(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.
## Harmonic Compensation Offer

### PCS Selection Table

#### Harmonic and PF Correction — 208-480 V models

<table>
<thead>
<tr>
<th>Rated Current (A (rms))</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame</th>
<th>Weight kg (Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>1875 2250</td>
<td>PCS05D5N12</td>
<td>NEMA 1 Wall Mount</td>
<td>4</td>
<td>300 (661)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS05D5CE30</td>
<td>IP30 (CE Certified)</td>
<td></td>
<td>300 (661)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS05D5CE54</td>
<td>IP54 (CE Certified)</td>
<td></td>
<td>300 (661)</td>
</tr>
<tr>
<td>100</td>
<td>3125 3750</td>
<td>PCS10D5N1</td>
<td>NEMA 1 Wall Mount</td>
<td>2</td>
<td>159 (350)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS10D5CE30</td>
<td>IP30 (CE Certified)</td>
<td>4</td>
<td>386 (849)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS10D5CE54</td>
<td>IP54 (CE Certified)</td>
<td></td>
<td>350 (771)</td>
</tr>
<tr>
<td>300</td>
<td>4500 7500 9000</td>
<td>PCS30D5N1</td>
<td>NEMA 1 Floor Mount</td>
<td>3</td>
<td>352 (775)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS30D5CE30</td>
<td>IP30 (CE Certified)</td>
<td></td>
<td>652 (1400)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS30D5CE54</td>
<td>IP54 (CE Certified)</td>
<td></td>
<td>550 (1212)</td>
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</tbody>
</table>

#### Harmonic and PF Correction — 600 V models

<table>
<thead>
<tr>
<th>Rated Current (A (rms))</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame</th>
<th>Weight kg (Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>2850</td>
<td>PCS03D6N1</td>
<td>NEMA 1 Floor Mount</td>
<td>6</td>
<td>600 (1322)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS03D6N12</td>
<td>NEMA12</td>
<td></td>
<td>621 (1366)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS03D6CE30</td>
<td>IP30 (CE Certified)</td>
<td></td>
<td>600 (1322)</td>
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<tr>
<td></td>
<td></td>
<td>PCS03D6CE54</td>
<td>IP54 (CE Certified)</td>
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<td>600 (1322)</td>
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<tr>
<td>78</td>
<td>4610</td>
<td>PCS07D6N1</td>
<td>NEMA 1 Floor Mount</td>
<td>6</td>
<td>700 (1542)</td>
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<td>PCS07D6N12</td>
<td>NEMA12</td>
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<td>736 (1620)</td>
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<td>700 (1542)</td>
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<td></td>
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<td>IP54 (CE Certified)</td>
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<td>700 (1542)</td>
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<td>235</td>
<td>12750</td>
<td>PCS23D6N1</td>
<td>NEMA 1 Floor Mount</td>
<td>7</td>
<td>1102 (2424)</td>
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<td></td>
<td></td>
<td>PCS23D6N12</td>
<td>NEMA12</td>
<td></td>
<td>1183 (2602)</td>
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<td></td>
<td></td>
<td>PCS23D6CE30</td>
<td>IP30 (CE Certified)</td>
<td></td>
<td>1102 (2424)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PCS23D6CE54</td>
<td>IP54 (CE Certified)</td>
<td></td>
<td>1102 (2424)</td>
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</table>

#### Harmonic and PF Correction — 690 V models

<table>
<thead>
<tr>
<th>Rated Current (A (rms))</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame</th>
<th>Weight kg (Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.3</td>
<td>3050</td>
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<td>NEMA 1 Floor Mount</td>
<td>6</td>
<td>624 (1372)</td>
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<tr>
<td></td>
<td></td>
<td>PCS03D7N12</td>
<td>NEMA12</td>
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<td></td>
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<td>PCS03D7CE30</td>
<td>IP30 (CE Certified)</td>
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<tr>
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<td>PCS03D7CE54</td>
<td>IP54 (CE Certified)</td>
<td></td>
<td>624 (1372)</td>
</tr>
<tr>
<td>66.7</td>
<td>5400</td>
<td>PCS06D7N1</td>
<td>NEMA 1 Floor Mount</td>
<td>6</td>
<td>724 (1592)</td>
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<td>NEMA12</td>
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<td>835 (1870)</td>
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<td>IP30 (CE Certified)</td>
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<td>724 (1592)</td>
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<td>IP54 (CE Certified)</td>
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<td>724 (1592)</td>
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<tr>
<td>200</td>
<td>13565</td>
<td>PCS20D7N1</td>
<td>NEMA 1 Floor Mount</td>
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<td>1170 (2574)</td>
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<td>PCS20D7CE54</td>
<td>IP54 (CE Certified)</td>
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<td>1170 (2574)</td>
</tr>
</tbody>
</table>

---

(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.
### CT Selection table

#### Round solid-core selection table

<table>
<thead>
<tr>
<th>Ampacity</th>
<th>Cat. Number</th>
<th>Dimensions mm (in)</th>
<th>Weight kg (Lbs)</th>
<th>Accuracy Class</th>
<th>Burden Capacity (VA)</th>
<th>Secondary Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ID     OD  Thickness</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>600</td>
<td>CT7RL6011</td>
<td>63 (2.5) 116 (4.58) 28 (1.1)</td>
<td>1.5 (3.8)</td>
<td>1</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>1000</td>
<td>CT7RL1021</td>
<td>63 (2.5) 116 (4.58) 28 (1.1)</td>
<td>1.5 (3.8)</td>
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<td>35</td>
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#### Round split-core selection table

<table>
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<th>Ampacity</th>
<th>Cat. Number</th>
<th>Dimensions mm (in)</th>
<th>Weight kg (Lbs)</th>
<th>Accuracy Class</th>
<th>Burden Capacity (VA)</th>
<th>Secondary Current</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>A     B  C    D</td>
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<td></td>
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<td></td>
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<tr>
<td>1000</td>
<td>CT1000SC</td>
<td>101 (4) 32 (1.25) 38 (1.5) 165 (6.5)</td>
<td>1.75 (3.5)</td>
<td>1</td>
<td>10</td>
<td>5</td>
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<tr>
<td>3000</td>
<td>CT3000SC</td>
<td>152 (6) 32 (1.25) 38 (1.5) 216 (8.5)</td>
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<td>5000</td>
<td>CTFCL500058</td>
<td>203 (8) 32 (1.25) 38 (1.5) 267 (10.5)</td>
<td>2.5 (5.5)</td>
<td>1</td>
<td>45</td>
<td>5</td>
</tr>
</tbody>
</table>

**Note:**

1. AccuSine PCS requires CT with a secondary current rating of 5 amperes. Two mains (2) CT are required for three (3) phase loads; three (3) mains CT are required when single (1) phase loads are present.

2. AccuSine PFV requires CT with a secondary current rating of 5 amperes. Two mains (2) CT are required for three (3) phase loads; three (3) mains CT are required when single (1) phase loads are present. See page 13.
Reactive compensation offer

The Schneider Electric solution for ultra fast reactive current compensation requirement.

AccuSine PFV

Key features and main benefits

- Correction capacity per unit:
  - ≤ 480 V: 50, 100, 300 A
  - 600 V: 39, 78, 235 A
  - 690 V: 35, 70, 209 A
- Voltage: 208 - 480 VAC, 600 VAC, 690 VAC three-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: three-wire or four-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: four 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 color display with touchscreen control

Performance capability

- Stepless automatic adaption to load changes
- Suitable for 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
- 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 (Web server)

Typical applications

- Oil & gas platforms
- Port cranes
- Steel
- Water/Wastewater
- HVAC
- Automotive
- Process plants
- Pulp and paper
- Wind and solar farms
- Lifts (ski or building)

Oil & gas Water Cement HVAC Buildings Wind mills

The Schneider Electric solution for ultra fast reactive current compensation requirement.
## AccuSine Specifications

### Technical Specifications


### System Input

| Nominal voltage | 208-480 VAC; 600 VAC; 690 VAC; ±10% auto sensing; other voltages with transformers |
| Nominal frequency | 50/60 Hz, ±3%, auto sensing |
| Number of phases | Three-phase/three-wire; three-phase/four-wire |
| Power switching 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
- Two or three (three 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 33 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 touchscreen terminal

### HMI display parameters and graphics

- Oscilloscope feature (built-in) to display the following: mains AC voltage, bus DC voltage, load current - real and reactive; mains current - real and reactive, plus 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 Web server

### Acoustic noise (ISO3746)

- < 80 db at one meter from unit surface

### Color

- NEMA 1 wall mounted units - quartz gray, all others light gray

## Environmental Conditions

### Operating temperature

- 0 °C to 40 °C continuous (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.
## Reactive Compensation Offer

### PFV Selection Table

### PF Correction + VAR Support — 208-480 V models

<table>
<thead>
<tr>
<th>Rated Current A (rms)</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame(4)</th>
<th>Weight kg (Lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>240 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td></td>
<td>PFV050D5N1</td>
<td>NEMA 1</td>
<td>Wall Mount(1)(2) / bottom</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1350</td>
<td>PFV050D5N12</td>
<td>NEMA12</td>
<td>Floor Standing / top or bottom</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PFV050D5CE30</td>
<td>IP30 (CE Certified)</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>PFV050D5CE54</td>
<td>IP54 (CE Certified)</td>
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</tr>
<tr>
<td></td>
<td>1925</td>
<td>PFV100D5N1</td>
<td>NEMA 1</td>
<td>Wall Mount(1)(2) / bottom</td>
<td>2</td>
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<tr>
<td></td>
<td>1925</td>
<td>PFV100D5N12</td>
<td>NEMA12</td>
<td>Floor Standing / top or bottom</td>
<td>4</td>
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<td>IP30 (CE Certified)</td>
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<td>5500</td>
<td>PFV300D5N12</td>
<td>NEMA12</td>
<td>Floor Standing / top or bottom</td>
<td>5</td>
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<td>NEMA 1</td>
<td>Floor Standing / top or bottom</td>
<td>6</td>
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<td>NEMA12</td>
<td>Floor Standing / top or bottom</td>
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### PF Correction + VAR Support — 600 V models

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<th>Rated Current A (rms)</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame(4)</th>
<th>Weight kg (Lbs)</th>
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<td>600 V</td>
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<td>39</td>
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<td>4475</td>
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<td></td>
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<td>Floor Standing / top or bottom</td>
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### PF Correction + VAR Support — 690 V models

<table>
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<th>Rated Current A (rms)</th>
<th>Watt Losses (watt)</th>
<th>Model Number</th>
<th>Enclosure Information</th>
<th>Frame(4)</th>
<th>Weight kg (Lbs)</th>
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<td>34.8</td>
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<td></td>
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<td>PFV209D7N1</td>
<td>NEMA 1</td>
<td>Floor Standing / top or bottom</td>
<td>7</td>
</tr>
</tbody>
</table>

---

(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.

---

NA Not Applicable
The family of AccuSine products offered by Schneider Electric provide a Human Machine Interface (HMI) including a Graphical User Interface. Direct control, programming, and monitoring are possible without using a PC or the Internet.

Human Machine Interface (HMI)

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:
- three or four-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 rms voltages
- total rms load currents (on three phases)
- active filter output rms currents (on three phases)
- harmonic rms load and line currents
- voltage and current distortions (THDu and THDI)
- reactive rms load current
- active filter reactive rms output current
- heatsink temperature (in deg. C)

Alarms and status display
Detailed alarms and status messages are displayed for easy troubleshooting:
- supply voltage or frequency outside of normal operating range
- current limitation
- overtemperature
- controller status
- communication status
Appendix

Unit dimensions and installation guidelines

<table>
<thead>
<tr>
<th>Frame size figure</th>
<th>Exterior dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Height in.</td>
</tr>
<tr>
<td>1</td>
<td>48.0</td>
</tr>
<tr>
<td>2</td>
<td>64.9</td>
</tr>
<tr>
<td>3</td>
<td>75.3</td>
</tr>
<tr>
<td>4</td>
<td>75.0</td>
</tr>
<tr>
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<td>6</td>
<td>75.0</td>
</tr>
<tr>
<td>7</td>
<td>75.0</td>
</tr>
</tbody>
</table>

Frame size 1

Frame size 2

Frame size 3

Frame size 4 and 5

Frame size 6 and 7