

EPCOS Product Brief 2015

Power Quality Solutions

PQSine Series of Active Harmonic Filters and Power Optimizers

EPCOS has been offering a comprehensive range of key components for power factor correction (PFC) and power quality solutions (PQS) for many years.

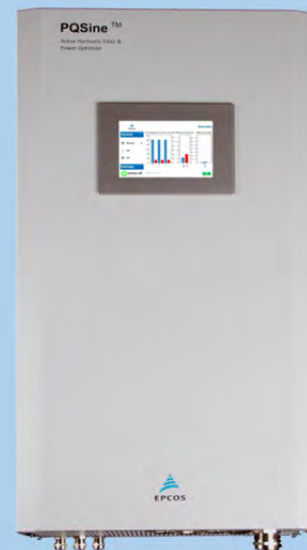
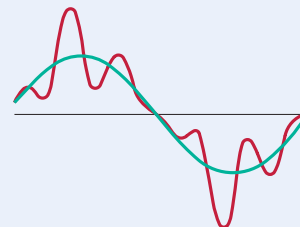
In the past, most consumer loads were linear, i.e. when they were connected to a sinusoidal voltage, the current was also sinusoidal. In the meantime, the use of power electronics has significantly increased. These devices are usually non-linear, i.e. when connected to a sinusoidal voltage they produce non-sinusoidal currents which may create problems for other devices.

Besides passive filters, more and more active harmonic filters are now used, especially where the PF is close to 1 and harmonic disturbances change frequently.

The PQSine series of active filters and power optimizers from EPCOS

- Eliminate harmonics up to the 50th order
- Offer dynamic VAR compensation
- Balance the load actively to all phases
- Offer high performance
- Have a three-level topology
- Improve power quality and enhance system reliability
- Ensure integrated overload, overvoltage and undervoltage protection
- Ensure low life-cycle costs thanks to a modular concept and low losses.

PQS



Active Harmonic Filters and Power Optimizers PQSine Series

The cleaner the grid, the greater the benefit

EPCOS active harmonic filters and power optimizers help to eliminate harmonic pollution from the grid, reduce power quality problems and use energy more efficiently and reliably.

Harmonic pollution is a growing problem with the increasing use of power electronics and non-linear loads (such as variable speed drives, UPS, computers, servers, TV sets, etc.).

The presence of harmonics increases the RMS current in power networks. The circulation of harmonic currents through the system impedance creates voltage harmonics which produce voltage distortions and thus deteriorate the quality of the supply voltage. This leads to higher operating and energy costs, production/process downtimes, overheating and malfunction of equipment.

The active harmonic filters and power optimizers of the PQSine series from EPCOS are based on the latest state of the art in power electronics technology. They are installed in parallel to the polluting loads. The active filter analyzes the line current and its associated harmonics and generates a compensation current which neutralizes the harmonic currents and creates an almost sinusoidal waveform (see Figure 1).

Figure 2 shows the total current harmonic distortion without PQSine. Figure 3 shows the result with activated PQSine, namely a cleaner grid.

In addition to eliminating the harmonics, the PQSine active filter and power optimizer also actively balances the loads to all three phases, performs dynamic VAR compensation and even some transient compensation. These features avoid line resonance and ensure high performance and reliability.

Active harmonic filter

Figure 1: Principle of an active filter

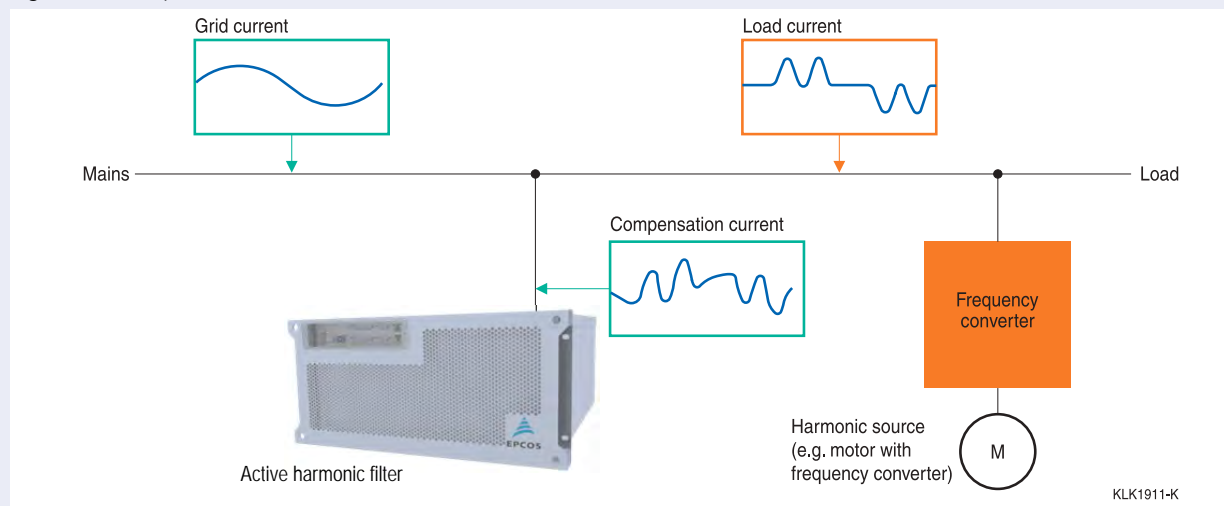


Figure 2: Total harmonic current distortion without active filter

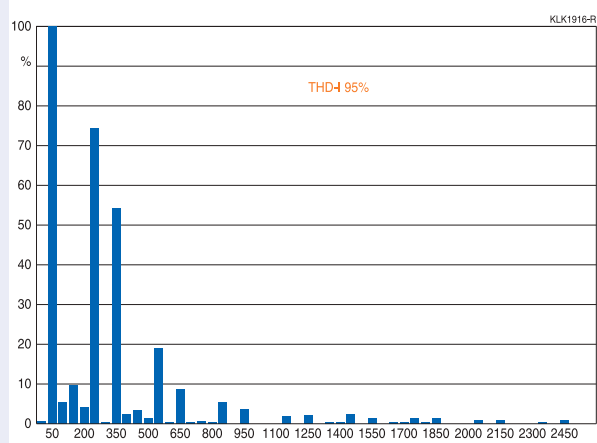
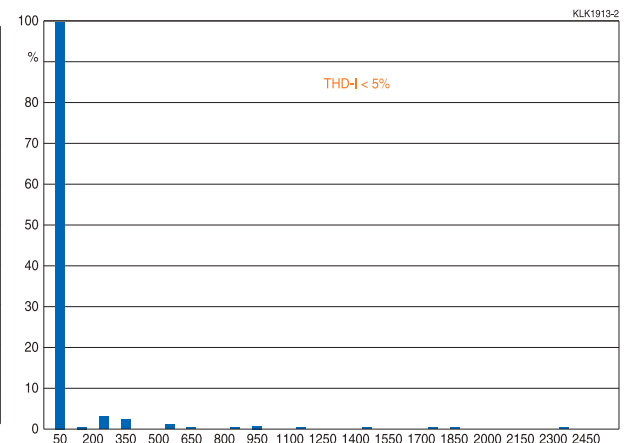


Figure 3: Total harmonic current distortion with activated active

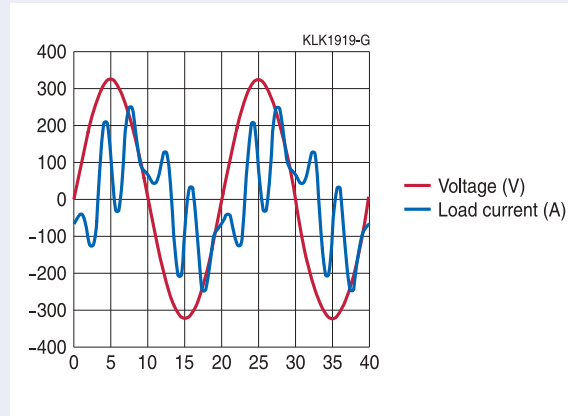


Active Harmonic Filters and Power Optimizers PQSine Series

Active harmonic filter

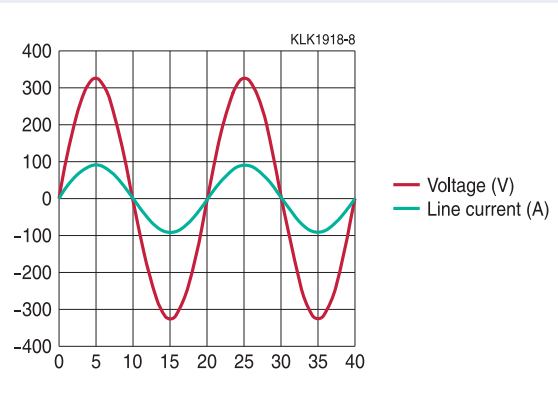
Without PQSine

Harmonic disturbances caused by e.g. non-linear loads



With PQSine

Reactive power harmonic oscillations are actively compensated



General information

The PQSine series is an active harmonic filter system designed to eliminate harmonic oscillations and consequently reduce costs. PQSine monitors the current signal and compensates the unwanted elements of the measured current. Thus, the filter ensures harmonic suppression independently of the number of loads. It also corrects the power factor, improving the system efficiency while reducing harmonic pollution.

Features

- Harmonic compensation up to 50th harmonic (individually selectable)
- Flicker compensation
- Ultra-fast reactive power compensation (inductive and capacitive)
- Load balancing between phases and unloaded neutral wire
- Compact design
- Modular system extendable from 60 A to 600 A
- Grid resonance detection
- Advanced digital control with SDC (Selective Direct Control) algorithm
- Ethernet and Ethercat system for interconnection
- User-friendly menu operation
- High performance and reliability
- Insensitive to network conditions
- Simple installation

Typical applications

Fast current harmonics and reactive power suppression e.g. for:

- Data centers
- UPS systems
- Green power generation (e.g. photovoltaics and wind turbines)
- Sensitive equipment manufacturing (e.g. silicon wafer production, semiconductor production)
- Industrial production machines
- Electrical welding systems
- Plastic industry machinery (extruders, injection molders)
- Office buildings and shopping centers (3rd and triple harmonic cancellation and neutral conductor unloading)

Safety features

- Highest safety and reliability
- Overload protection
- Internal short-circuit protection
- Overheating protection
- Overvoltage and undervoltage protection
- Inverter bridge protection
- Resonance protection
- Fan fault alarm

Active Harmonic Filters and Power Optimizers PQSine Series

Depending on the requirements, EPCOS offers either complete panels, wall-mounted cabinets or modules.

Floor-mounted panel (60 A – 600 A)^{*)}



Wall-mounted panel (for 60 A or 120 A)



60 A active filter module



^{*)} For 600 A, two 300 A cabinets are needed

Active Harmonic Filters and Power Optimizers PQSine Series

Modular system – up to 300 A in one cabinet

The state-of-the-art modular design of the PQSine series offers the advantage of being prepared for future filter power requirements: the slots in each cabinet are ready to receive up to 5 PQSine modules.



PQSine – 60 A

Consisting of:

- 1 60 A PQSine module
- 1 SU current transformer sensor unit
- 1 LCD touch screen 7" control / display unit

PQSine – 120 A

Consisting of:

- 2 60 A PQSine modules
- 1 SU current transformer sensor unit
- 1 LCD touch screen 7" control / display unit

PQSine – 180 A

Consisting of:

- 3 60 A PQSine modules
- 1 SU current transformer sensor unit
- 1 LCD touch screen 7" control / display unit

PQSine – 240 A

Consisting of:

- 4 60 A PQSine modules
- 1 SU current transformer sensor unit
- 1 LCD touch screen 7" control / display unit

PQSine – 300 A

Consisting of:

- 5 60 A PQSine modules
- 1 SU current transformer sensor unit
- 1 LCD touch screen 7" control / display unit

Active Harmonic Filters and Power Optimizers PQSine Series

Active filter module (60 A)



60 A PQSine module front side

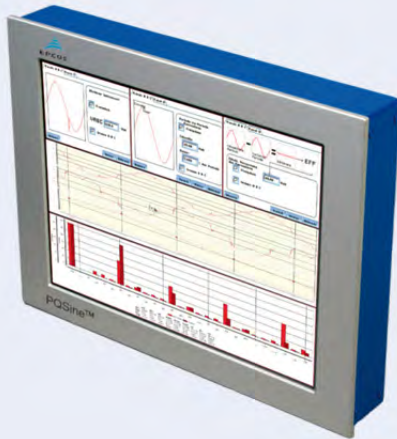


60 A PQSine module rear side: fork-plug spring connectors for fast, reliable and easy connection to the busbars of the cabinet

- Standardized 60 A active filter modules
- Three-phase 4-wire (3P4W) version for neutral current correction or three-phase 3-wire (3P3W) version for correction of phase currents only
- Floating-point 32 bit DSP, FPGA (integrated)
- Switching / control frequency 24/48 kHz
- Reaction time: 21 μ s
- Selective direct control algorithm^{*)} (no internal FFT algorithm needed)
- Compensation up to 50th harmonic (individually selectable)
- Individually selectable degree of harmonic reduction
- Simple electrical connection of power and control wiring

^{*)} Patent pending

TFT color control / display touch screen unit (7" / 12.1")



- For mounting in the panel front
- Protection class: IP65
- LED backlight
- Intensity: 450 cd/m²
- Input: touch screen 4-wire resistive
- For parameter setting, status indication, alarm setting, monitoring, event logging
- Operating system: embedded Linux
- Communication: Ethercat Master, Ethernet TCP/IP
- Interface: USB, 3x opto-insulated input, 2-relay output display bus
- Operating temperature: -20 ... + 55 °C
- Firmware update via SD card possible
- Dimensions (W x H x D): 230 x 168 x 56 mm (7"); 340 x 270 x 53 mm (12.1")
- Weight: 1 kg (7"); 2 kg (12.1")

SU active sensor unit



- Interface for active sensor bus
- Connection box for external current sensors
- Module requirement (max. 5 modules per unit)
- Source or load-side selectable, primary current range 100 A to 2500 A, secondary current 1 A

TFT color control / display touch screen unit in rugged equipment case (7" / 12.1")



- Needed for parameterization of PQSine modules ordered without the 7" / 12.1" TFT color control / display touch screen unit, for instance.

Active Harmonic Filters and Power Optimizers PQSine Series

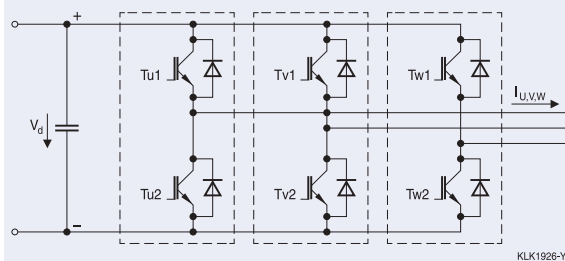
Advantages of PQSine three-level NPC topology

The PQSine range operates on the basis of a three-level Neutral-Point-Clamped (NPC) topology circuit. As can be seen from the diagrams below, the conventional two-level circuit configuration consists of 6 IGBTs (two IGBT power devices in each phase leg and current path). In case of a three-level topology, the circuit configuration consists of 12 IGBTs (four IGBT power devices in each phase leg and current path).

The three-level NPC circuit can produce three voltage levels at the output: the DC bus plus voltage, zero voltage and DC bus negative voltage. The two-level topology can only connect the output to either the plus bus or the negative bus.

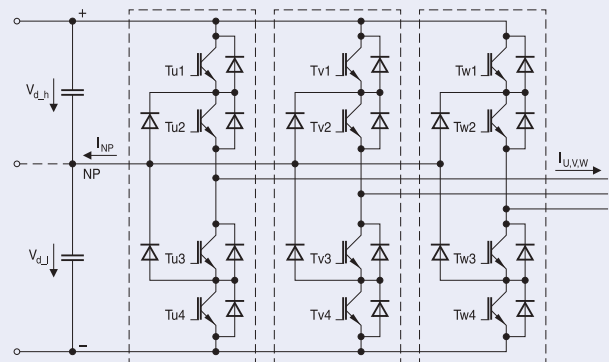
It also ensures higher quality and better harmonics of the line-to-line output voltage, thus reducing the output filter requirement and the associated costs.

Two-level topology circuit:



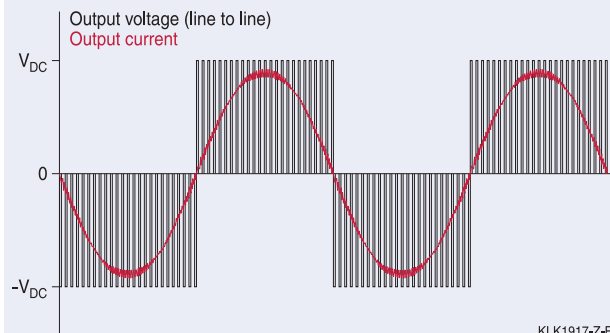
KLK1926-Y

Three-level NPC topology circuit:



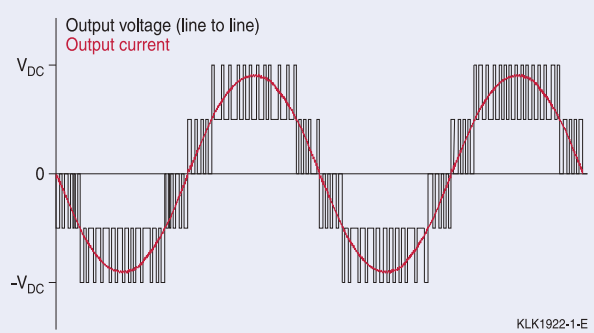
KLK1921-S

Current and switched output voltage for a two-level topology:



KLK1917-Z-E

Current and switched output voltage for a three-level NPC topology:



KLK1922-1-E

Main advantages of the three-level NPC topology are:

- Lower losses: only half of the voltage has to be switched, thus reducing the switching losses in the transistor. Three-level solutions are characterized by reduced circuit losses and higher efficiency, thus supporting energy-saving concepts.
- Smaller output current ripple: the NPC three-level topology has a lower ripple in the output current and half of the output voltage transient thanks to a higher quality output voltage. This improves performance and reduces the internal filter requirement.

Active Harmonic Filters and Power Optimizers PQSine Series



Technical data					
System input / number of phases	3-phase / 3-wire; 3-phase / 4-wire				
Rate of harmonic reduction	> 98%				
Phase compensation current	60 A	120 A	180 A	240 A	300 A
Neutral lead compensation current ^{*)}	180 A	360 A	540 A	720 A	900 A
Input voltage (min. / max.)	3P3W device: 180 V ... 528 V 3P4W device: 180 V ... 460 V				
Inverter technology	Three-level NPC topology, IGBT				
Frequency	50/60 Hz ±3 Hz				
Reaction time	21 μs (immediate load change reaction)				
Steady state response time	< 300 μs (steady state response time to full steady state compensation)				
Switching frequency	24 kHz				
Control frequency	48 kHz				
Harmonic compensation	Up to 50 th harmonic, 50 active harmonic orders simultaneously selectable				
Power factor correction	Fully inductive and capacitive current compensation from 0 ... 100%				
Weight of a single unit	59 kg 3P3W, 60 kg 3P4W				
Dimensions of a single unit	482 x 678 x 222 mm (w x d x h)				
Current transformer	Source or load-side selectable, primary current range 100 A ... 2500 A, secondary current 1 A				
Overload current	150 A @cf2.5	300 A @cf2.5	450 A @cf2.5	600 A @cf2.5	750 A @cf2.5
Typical power losses	530 W	1100 W	1700 W	2000 W	2800 W
Cabinet mounting	Wall ^{**)}	Wall ^{**)}	Floor	Floor	Floor
Weight including cabinet	96 kg	160 kg	413 kg	474 kg	535 kg
Dimensions including cabinet	504 x 290 x 979	504 x 514 x 979	600 x 805 x 2095	600 x 805 x 2095	600 x 805 x 2095
Air flow rate	470 cfm	940 cfm	1410 cfm	1880 cfm	2350 cfm
Interface	Ethercat 100 Mbit/s, USB, active sensor bus, display bus				
Ambient temperature	-10 ... +40 °C full performance, up to +55 °C derating 2%/K				
Protection class	IP20 for module and panels, IP54 for floor-mounted panels is optionally available on request				
Panel color	RAL7035				
Humidity	95% non-condensing				
Self-protection	Yes				
Overheating protection	Yes				
Overvoltage and undervoltage protection	Yes				
Noise level	< 56 dB up to < 69 dB (depending on model and load conditions)				
Altitude	Max. 4000 m (1% power derating for each additional 100 m, between 1500 m and 4000 m)				
Standards / recommendations specifying limits for harmonics in networks or units	IEC 61000-2-2, IEC 61000-2-4, IEC 61000-3-2, IEC 61000-3-12, IEC 61000-3-3, EN 50160, TOR D2, IEEE 519-1992, G5/4 and D.A.CH.CZ				
Design standards	EN 50178, EN 61439-1, EN 61439-2, EN 61000-6-2, EN 61000-6-4, EN 55011				

^{*)} In the case of a 3P4W device

^{**)} Floor-mounting upon request

Active Harmonic Filters and Power Optimizers PQSine Series



400 V PQSine series – 3P4W systems¹⁾

Type	Rated filter current A	System min. / max. voltage		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
		V	V				
PQSW4060N344	60	180	460	Wall-mounted	96	504 x 290 x 979	B44066F4060N344
PQSW4120N344	120	180	460	Wall-mounted	160	504 x 514 x 979	B44066F4120N344
PQSF4180N315	180	180	460	Floor-mounted	413	600 x 805 x 2095	B44066F4180N315
PQSF4240N315	240	180	460	Floor-mounted	474	600 x 805 x 2095	B44066F4240N315
PQSF4300N315	300	180	460	Floor-mounted	535	600 x 805 x 2095	B44066F4300N315
PQSF4420N315	420	180	460	Floor-mounted	887	2x 600 x 805 x 2095	B44066F4420N315
PQSF4540N315	540	180	460	Floor-mounted	948	2x 600 x 805 x 2095	B44066F4540N315
PQSF4600N315	600	180	460	Floor-mounted	1070	2x 600 x 805 x 2095	B44066F4600N315

400 V PQSine series – 3P3W systems¹⁾

Type	Rated filter current A	System min. / max. voltage		Mounting variant	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
		V	V				
PQSW3060N344	60	180	528	Wall-mounted	95	504 x 290 x 979	B44066F3060N344
PQSW3120N344	120	180	528	Wall-mounted	158	504 x 514 x 979,5	B44066F3120N344
PQSF3180N315	180	180	528	Floor-mounted	410	600 x 805 x 2095	B44066F3180N315
PQSF3240N315	240	180	528	Floor-mounted	470	600 x 805 x 2095	B44066F3240N315
PQSF3300N315	300	180	528	Floor-mounted	530	600 x 805 x 2095	B44066F3300N315
PQSF3420N315	420	180	528	Floor-mounted	880	2x 600 x 805 x 2095	B44066F3420N315
PQSF3540N315	540	180	528	Floor-mounted	939	2x 600 x 805 x 2095	B44066F3540N315
PQSF3600N315	600	180	528	Floor-mounted	1060	2x 600 x 805 x 2095	B44066F3600N315

¹⁾ All systems include a 7" TFT color control / display unit (touch screen) and the SU sensor unit box. External current transformers are not included.

400 V PQSine series – modules

Type	Rated filter current A	System rated min. / max. voltage		Filter model	Approx. weight kg	Approx. dimensions (w x d x h) mm	Ordering code
		V	V				
PQSM4060N300	60	180	460	3P4W	60	482 x 678 x 222	B44066F4060N300
PQSM3060N300	60	180	528	3P3W	59	482 x 678 x 222	B44066F3060N300

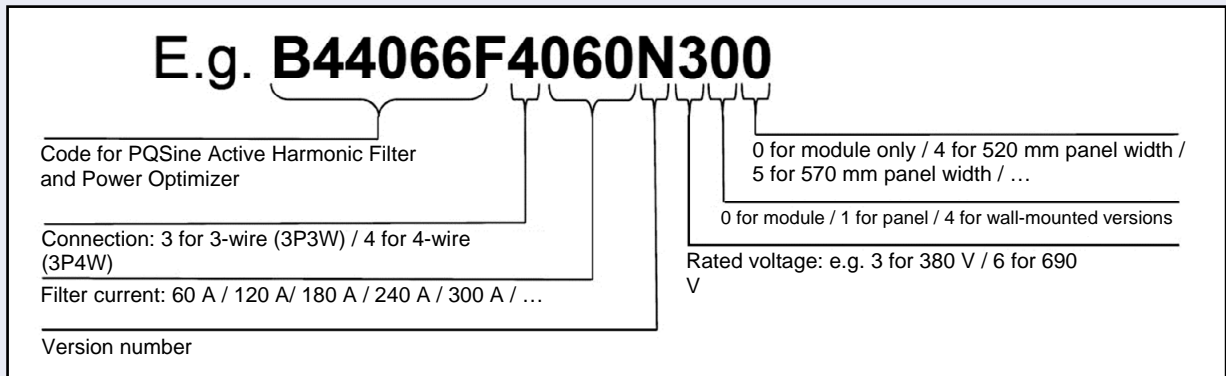
400 V PQSine series – accessories

Product description	Ordering code
SU sensor unit: connection box for external current sensors (needed for the modules, max. 5 modules per unit)	B44066F8888N230
7" TFT color control / display unit, touch screen	B44066F9007N230
12.1" TFT color control / display unit, touch screen	B44066F9012N230
7" TFT portable and rugged equipment case (for parameterization of the PQSine modules without display, including power supply)	B44066F9907N230
12.1" TFT portable and rugged equipment case (for parameterization of the PQSine modules without display, including power supply)	B44066F9912N230

Other types/designs upon request

Active Harmonic Filters and Power Optimizers PQSine Series

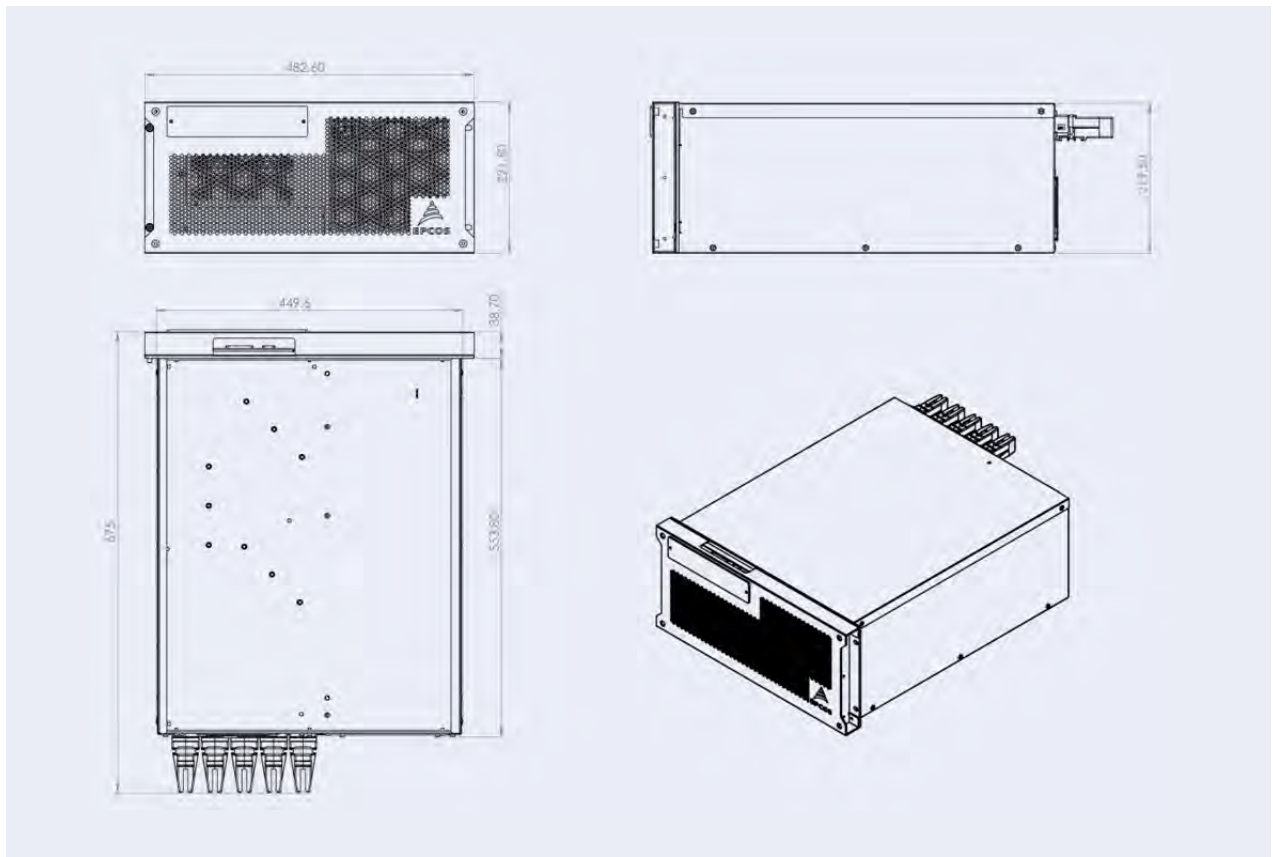
Ordering code nomenclature



Display of ordering codes for EPCOS products

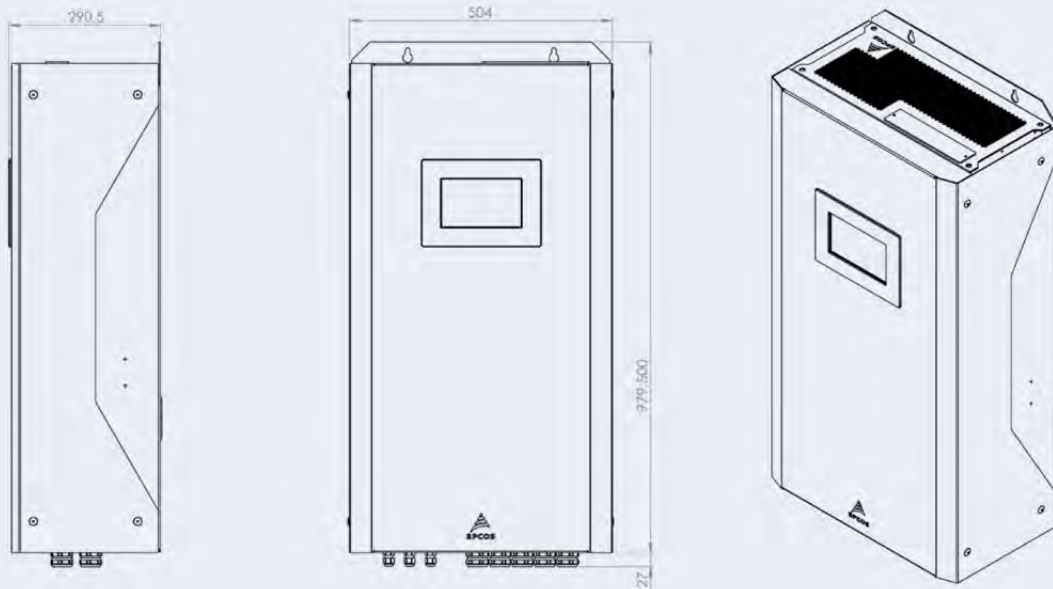
The ordering code for one and the same product can be represented differently in data sheets, data books, other publications and the website of EPCOS, or in order-related documents such as shipping notes, order confirmations and product labels. **The varying representations of the ordering codes are due to different processes employed and do not affect the specifications of the respective products.** Detailed information can be found on the Internet under www.epcos.com/orderingcodes

Module 60 A

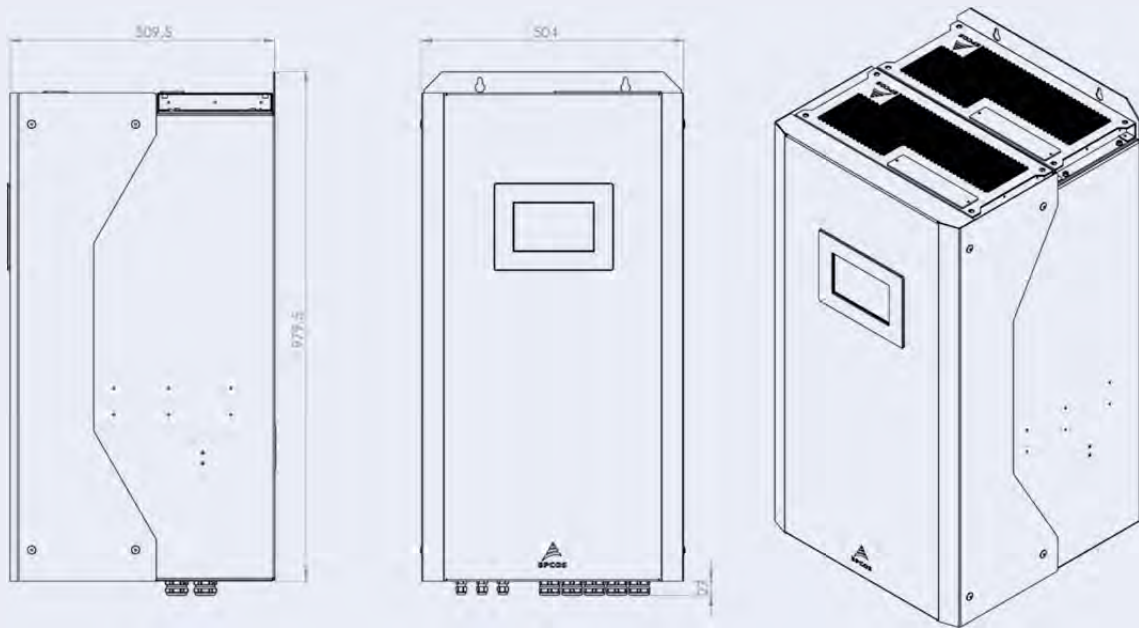


Active Harmonic Filters and Power Optimizers PQSine Series

Wall-mounted panel 60 A

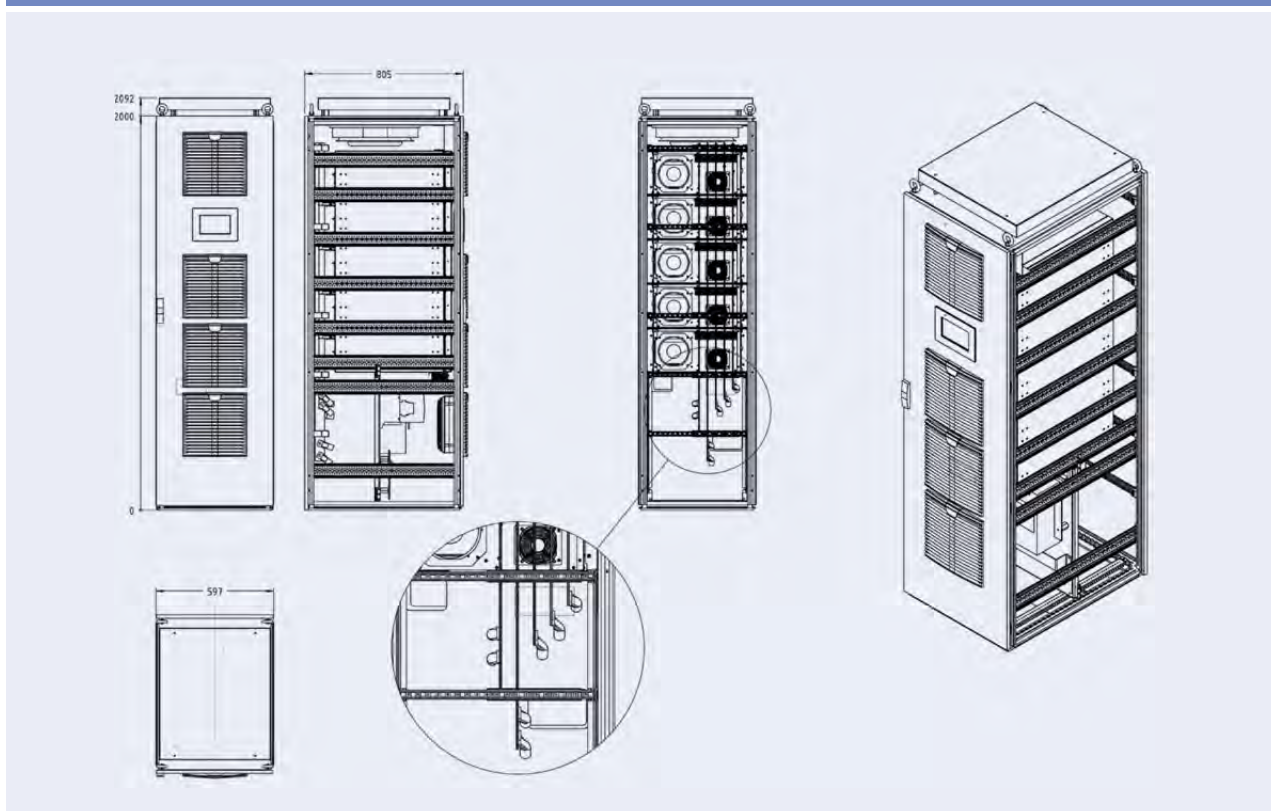


Wall-mounted panel 120 A



Active Harmonic Filters and Power Optimizers PQSine Series

Floor-mounted panel 300 A



Power Quality Solutions



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