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PRODUCT BROCHURE

# Active Filters - PQFI-PQFM-PQFS

## Improving power quality for efficiency and reliability

# **Enhancing power quality**
## In industrial and commercial applications

ABB is a pioneering technology leader in electrification products, robotics and motion, industrial automation and power grids, serving customers in utilities, industry and transport & infrastructure globally. Continuing a history of innovation spanning more than 130 years, ABB today is writing the future of industrial digitalization and driving the Energy and Fourth Industrial Revolutions. As title partner of Formula E, the fully electric international FIA motorsport class, ABB is pushing the boundaries of e-mobility to contribute to a sustainable future. ABB operates in more than 100 countries with about 136,000 employees.

ABB offers a wide range of products from 208 V up to 1200 kV that help enhance the reliability, efficiency and quality of power in transmission and distribution grids, power plants and industries while minimizing environmental impact. The wide product range is complemented by a comprehensive service offering.

Power quality is a major concern for transmission and distribution utilities, industries, transport and infrastructure sectors. Poor power quality affects grid reliability, productivity, leads to higher operating costs and penalties for non-compliance with grid codes. ABB is a technology leader with a wide range of products, systems and services that improve power quality including capacitors and filters, power electronics-based compensators and software solutions, across the power value chain for low, medium and high-voltage applications, helping to shape a stronger, smarter and greener grid.

Active filters PQFI, PQFM and PQFS from ABB are the result of more than a decade of intensive research and development efforts combined with more than 20 years of field experience all over the world. Active filters from ABB protect critical industrial, residential and commercial applications, as well as make installations compliant with any prevailing power quality regulations.

Active filters from ABB are the ultimate answer to tough power quality problems caused by harmonics, load unbalance and reactive power demand for all applications by all types of customers. They can be installed in LV networks and in MV networks through the use of a suitable coupling transformer.

Active filter PQF is a power electronics based equipment that is installed in parallel to the polluting loads. It monitors the line current harmonics and for each harmonic frequency generates a compensation current in perfect phase opposition to the polluting current. It can also perform load balancing and reactive power compensation of loads in a stepless manner. It is an ideal solution for commercial, residential, light, medium and heavy industrial applications, for installations with or without neutral. The filter is available in free standing cubicle format and in a compact wall-mounted design that allows installation even in limited space. An IP00 plate version can be integrated by panel builders and systems integrators as part of a complete low voltage switchgear.

**Typical applications include applications in following segments:**

- Industrial: oil and gas (onshore and offshore), steel, water, process plants, chilling stations, cement, automotive, pulp and paper, printing, solar panel and solar panel inverter manufacturing lines, light industrial loads such as remote pumping stations etc.
- Infrastructure: ski lifts, office loads, computer/ data centers, UPS-systems, air conditioning systems, lifts and advanced lighting systems (LED)
- Transport: light railway and metro applications

# **Active filters PQFI, PQFM and PQFS**
# Features and benefits

**There are several benefits of installing active filters from ABB:**

- Operational efficiency
  - Fewer events of equipment failure due to poor power quality of the network, thereby creating trouble-free and efficient operations
  - Improved performance of loads thanks to a cleaner supply network
- Cost efficiency
  - Increased lifetime of the equipment enabling lower plant running costs
  - Compliance with the strictest regulations (such as individual harmonic limits) thanks to the unique control concept, thereby avoiding penalties and/or refusal by utilities to connect installations to the electrical grid
- Energy efficiency: lower energy losses in cables and transformers and hence a higher efficiency of the system but also a reduction of $CO_2$ emissions
- Better safety of the installations and better operation of sensitive loads as the voltage drop between neutral and earth is reduced

**Harmonic filtering efficiency**

The active filters PQF have high filtering efficiency due to the following features:

- Capability of filtering up to 20 harmonics simultaneously
- Selection of harmonics up to the 50$^{th}$ harmonic
- Harmonic attenuation factor better than 97%
- Desired harmonic levels can be preset for each selected harmonic

**Reactive power compensation**

PQF can perform precise stepless reactive power compensation of both inductive and capacitive loads. The target cos ϕ is programmable from 0.6 (inductive) to 0.6 (capacitive) which makes PQF an alternative to a conventional capacitor bank. Moreover this allows compensation of loads fed by generators without the risk of overcompensation. In addition, capacitive loads can also be compensated.

**Load balancing**

This feature is available in both 3 and 4-wire systems between phases and between phase and neutral. It helps to improve voltage unbalance on the phases and reduction of neutral current which increases the safety of the installation and allows sensitive loads to operate.

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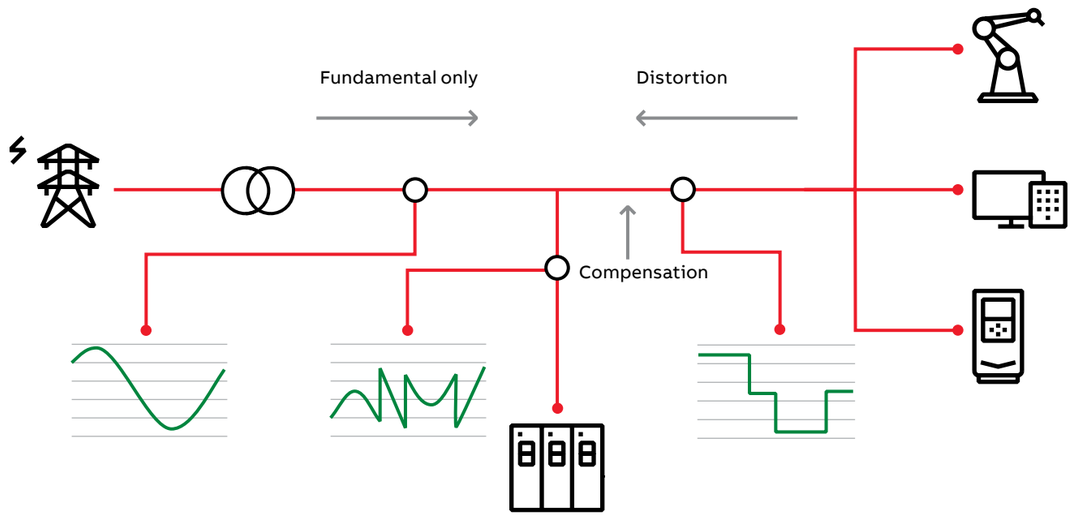
**Harmonic filtering efficiency**






**User interface**

The user-friendly PQF-Manager interface is provided as a standard accessory with all types of active filters. It offers direct access to filter control, programming, and monitoring functions without a PC. Communication facilities and detailed fault and event logging with real time stamp are also available.

The large dimensions (320x240 pixels) display offers a high level of readability thanks to the clear positioning of information, prompts and icons.

**The main features are:**

- Supports six languages
- Touch sensitive multicolored screen
- Enhanced connectivity for communication purposes (Modbus RTU, Modbus TCP, PQ-Link)
- Possibility to connect temperature probes (up to 8 probes)
- Access to parameters of various units from the “master” unit
- Enhanced on screen (contextual) help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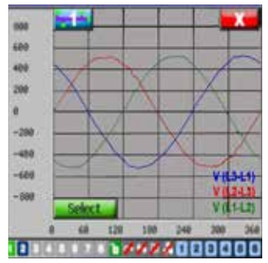


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The PQF-Manager’s graphical user interface helps in quick commissioning and allows the user to supervise the network quality in real time.

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01 PQF-Manager welcome screen
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02 Select languages from six different options
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03 Select harmonics option
—
04 V harm chart
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05 Voltage waveform

# **Active filters PQFI, PQFM and PQFS**
# Features and benefits

ABB's PQF active filters can be applied to small, medium or large applications and are suitable for both industrial and commercial installations in low and medium-voltage networks.

**Communication**
The PQF-Manager is provided with Modbus RTU and Modbus TCP communication features. Through a Modbus RS-485 converter (optional) or Ethernet, the PQF can be linked to the supervision system of the customer. All parameters, settings and measurements are accessible remotely.

Apart from the Modbus communication features, the PQF is also provided with two additional communication ports, a mini-USB and an RJ45 (Ethernet) port. Using ABB proprietary Windows® based software called PQ-Link and a computer, one can communicate with the filter locally or from a remote location. An IP address is required to use connectivity over Ethernet communication channel.

**PQ-Link software**
The PQ-Link software offers direct control and monitoring of the filter from a local or a remote computer. The connection is through a USB port or Ethernet (RJ45) port provided through the PQF-Manager. This Windows based software allows the user to access the filter, monitor all parameters and change “user specific” parameters of the filter. Multicolored displays for voltage, current and various other parameters- which are available directly on the PQF-Manager- makes the PQ-Link a customer friendly and useful tool. Connection to the filter from a remote location is possible by assigning a specific IP address to the filter.

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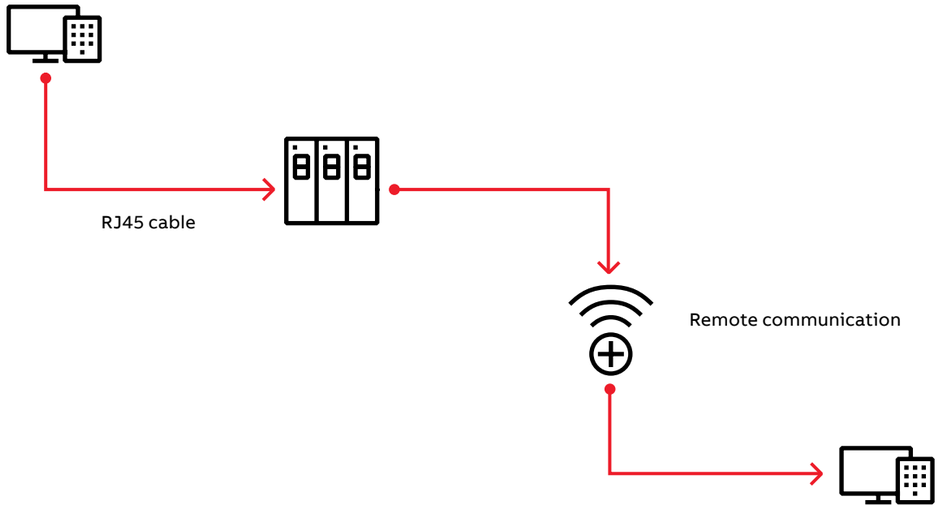
**A customer friendly and useful tool**




# **Application example**
# Hospital

Active harmonic filters from ABB installed in parallel to the power feed cancelled the harmonic currents allowing 'clean' ECG recordings.

An Australian hospital, located in Melbourne, Victoria, is one of the country's leading public hospitals established in 1848.  It is a major teaching hospital for tertiary health care with a reputation in clinical research. It has one of the largest Emergency Departments in Victoria and is one of the city’s two major trauma referral centers.

**Customer problem statement**
The electrocardiogram or the ECG is an indicator of the healthy functioning of the heart and therefore one of the most critical diagnostic tools. The ECG is a low voltage signal (1mV) recorded from the body surface and measures the electrical activity of the heart. To allow for good diagnostics, it must be free from any external electrical interferences.

The Emergency Department of this Australian hospital was built close to the main power distribution for the hospital. Non-linear loads connected to the electrical network introduced electromagnetic field (EMF) interference in the facility of such severity that they disrupted the ECG recordings and the ECG reports were deemed unacceptable by the local cardiologist. This interference was present even though standard EMF shielding had been installed over the main hospital power feed.

Traditionally, the load connected to the supply in infrastructure applications had a predominant linear characteristic, e.g.  incandescent lights, resistive heating, induction motors. This equipment draws a sinusoidal current with the same frequency as the wave shape of the supply voltage. The increasing need to decrease consumption of electrical power, and the need for more sophisticated control- and measurement equipment, has meant that almost all electrical loads have non-linear power supplies nowadays, enabling more efficient operation but creating harmonic pollution in the process. Examples include computers, measurement- and control- equipment, HVAC installations, CFL’s, LED lighting etc. These loads all present a non-linear characteristic, i.e. drawing pulses of current that contain odd harmonics, e.g. 3$^{rd}$ harmonic, 5$^{th}$ harmonic, 7$^{th}$ harmonic and so on. The issue in the hospital was that the resultant harmonics from the non-linear-loads created an excessive EMF that interfered with the ECG measurements.

**ABB solution**
ABB conducted a site analysis to measure the magnitude and frequencies of the currents in the power cable. The data collected showed third harmonic current from 70 to 110 A during the entire measurement campaign. With the investigation indicating that the interference was emanating from the power feed, two PQF active filters were connected in parallel to it. The PQF is sampling the frequency and magnitude of the harmonic currents and introduce anti-phase current of appropriate magnitude into the power circuit cancelling thereby the harmonics flowing into the upstream feeder, and allowing ‘clean’ ECGs to be recorded.

The final installation consisted of a 200 A PQF active filter allowing for future load increase.

01. ECG without the PQF

02. ECG with the PQF

# **Application example**
# Mining

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Active harmonic filters from ABB reduced the current total harmonic distortion (THDI) to acceptable levels, decreasing significantly the downtime of the electrical loads.

This case study refers to a gold mining company located in northern Greece. It operates an underground mine with silver and zinc metals.

The processing of precious metals involves several important steps. This includes crushing of mineral using high power motors (milling) and then processing it further for enhancing the concentration, before the actual metallurgical process can start. These high power motors are controlled by modern AC drives for efficient use of electrical energy.

**Customer problem statement**
The drives, which are using modern semiconductor switches, inject significant levels of harmonic currents in the supply network. If not properly filtered, these harmonic currents distort the voltage waveform and that affects the operation of other electrical loads connected to the same network. High harmonic distortion results in equipment malfunction, additional losses, communication interferences and increased downtime.

Operation of large drives for the mill motors from ‘transformer 3’ resulted in very high current distortion which in turn gives rise to a non-sinusoidal voltage waveform and poor system performance.

**ABB solution**
A PQFI active filter 450 A was installed on one of the plant transformers to filter the harmonics injected by the two mill drives.  Thanks to this solution the customer has noticed a reduction of the electrical pollution due to efficient harmonic filtering, and a decreased downtime of the electrical loads.

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**Electrical values without the filter in operation**

| Parameters | Values |
|---|---|
| THDV (Total Harmonic Distortion of Voltage) | L1-L2: 5.3 % |
| | L2-L3: 5.4 % |
| | L3-L1: 6.0 % |
| THDI (Total Harmonic Distortion of Current) | L1-L2: 34.1 % |
| | L2-L3: 31.6 % |
| | L3-L1: 34.0 % |
| Active power | 617 kW |
| Reactive power | 179 kvar |
| Apparent power | 657 kVA |
| PF | 0.94 |
| Cos ϕ | 0.96 |

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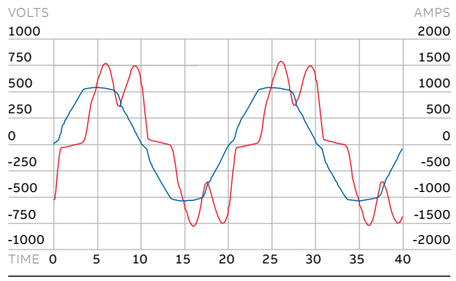
**Electrical values with the filter in operation**

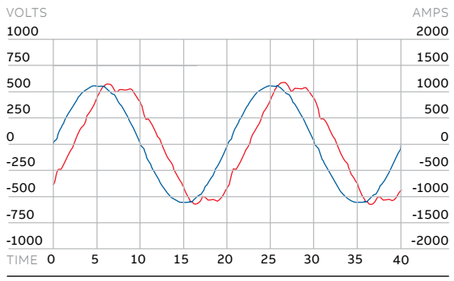
| Parameters | Values |
|---|---|
| THDV (Total Harmonic Distortion of Voltage) | L1-L2: 1.5 % |
| | L2-L3: 1.5 % |
| | L3-L1: 1.9 % |
| THDI (Total Harmonic Distortion of Current) | L1-L2: 7.1 % |
| | L2-L3: 7.1 % |
| | L3-L1: 7.3 % |
| Active power | 524 kW |
| Reactive power | 154 kvar |
| Apparent power | 564 kVA |
| PF | 0.96 |
| Cos ϕ | 0.96 |

Line current(A)
Line Voltage(V)

**Voltage and current waveforms without the filter**




**Voltage and current waveforms with the filter**



# PQF active filters
## Technical specifications

| Power Quality Filters | PQFI | PQFM | PQFS |
|---|---|---|---|
| **Electrical characteristics** | | | |
| Connection method | 3-wire | 3-wire | 3-wire/4-wire |
| Network voltage (+/- 10%) | V1: 208-480 V | V1: 208-480 V | 208-240 V |
| | V2: 480-690 V | V2: 480-690 V (cUL versions limited to 600V) | 380-415 V |
| Network frequency | 50 Hz/60 Hz - +/- 5% | 50 Hz/60 Hz - +/- 5% | 50 Hz/60 Hz - +/- 5% |
| Line current rating per base unit ($A_{rms}$) | V1: 300 A, 450 A | V1: 70 A, 100 A, 130 A, 150 A | 30 A, 45 A, 60 A, 70 A, |
| | V2: 180 A, 320 A(1) | V2: 100 A | 80 A, 90 A, 100 A, 120 A |
| Neutral current rating per base unit ($A_{rms}$) | - | - | 3 times the line current rating (limited to 300 $A_{rms}$ for PQFS 120 A) |
| Modularity(2) | Maximum 8 units can be combined | | |
| Redundancy | Master/master or master/slave arrangement | | |
| Equipment losses | 3% of the equipment power typically | | |
| **Filter characteristics** | | | |
| Harmonic range | 2nd to 50th order | 2nd to 50th order | 2nd to 50th order |
| Harmonics selectable (programmable per harmonic in Amps) | 20 orders | 20 orders | 3-wire: 20 orders |
| | | | 4-wire: 15 orders |
| Harmonic attenuation factor ($I_H$ (source)/$I_H$ (load)) | Better than 97% at rated load | | |
| Reaction time | < 0.5 ms instantaneous response | | |
| Response time | 2 networks cycles typically (10-90% filtering) | | |
| **Reactive power characteristics** | | | |
| Target cos ϕ | Programmable from 0.6 (inductive) to 0.6 (capacitive) | | |
| **Programming/communication** | | | |
| Digital I/O | 2 digital inputs/6 digital outputs (potential free) | | |
| Alarm and fan contact | 1 NO/NC alarm contact and 1 NO fan contact (potential free) | | |
| Programming/monitoring | Using PQF-Manager GUI - Modbus RTU interface (optional) or Modbus TCP (Ethernet)<br>Using PQ-Link software (optional) | | |
| **Certification** | CE, cUL & CTick | CE, cUL & CTick | CE & CTick |
| **Physical aspects (per base unit)** | | | |
| Mounting | Free standing cubicle (PQFI-M) or IP00 plate (PQFM) | | Wall-mounted enclosure |
| Approximate dimensions (W x D x H) | 800 x 600 x 2150 mm | 600 x 600 x 2150 mm (cubicle) | 588 x 326 x 795 mm |
| | | 498 x 432 x 1697 mm (plate) | |
| Color | RAL 7035 (light gray) | | |
| **Installation aspects** | | | |
| Altitude | Indoor installation in clean environment up to 1000 m altitude(3) | | |
| Ambient temperature | -10°C to 40°C(3) | | |
| Humidity | Maximum 95% relative humidity, non-condensing | | |
| Fixation | Floor fixation/lifting lugs provided | | Wall-mounted |
| Cable entry | Bottom | Top or bottom (to be specified at time of ordering) | Bottom |
| CT requirements | 3 CT's are required (class 1.0 or better) | | |
| IP protection | IP21 | Plate version: IP00 | IP30 |
| | Optional: IP41 | Cubicle version: IP21 | Optional: IP54 |
| | | Optional: IP41 and IP54 | |

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(1) Please refer to the instruction manual for detailed derating tables.
(2) Please check with your ABB representative before selecting parallel units.
(3) Higher altitudes (up to 2000 m/ 6600 ft max.) and temperatures (up to 50°C/122°F max.) with suitable derating.

# ABB's commitment

**Quality assurance**
At ABB, we are committed to providing the best products and services. Our products comply with or exceed the latest international standards. In addition to type tests in independent laboratories, our certified design and manufacturing processes guarantee the highest quality. We are certified according to the latest relevant ISO quality standards.

**Sustainability**
For ABB, sustainability is about balancing economic success, environmental stewardship and social progress to benefit all our stakeholders. Sustainability considerations cover how we design and manufacture products, what we offer customers, how we engage suppliers, how we assess risks and opportunities, and how we behave in communities where we operate and towards one another, while striving to ensure the health, security and safety of our employees, contractors and others affected by our activities. We are certified according to the latest relevant ISO quality standards.

**For more information please refer to:**

Product webpage:

Active filters video:

Power Quality Challenge application:

SOLUTION TO GRID REGULATIONS

PQF active filters are suitable for wind and solar park operators to comply with international standards related to harmonic mitigation.