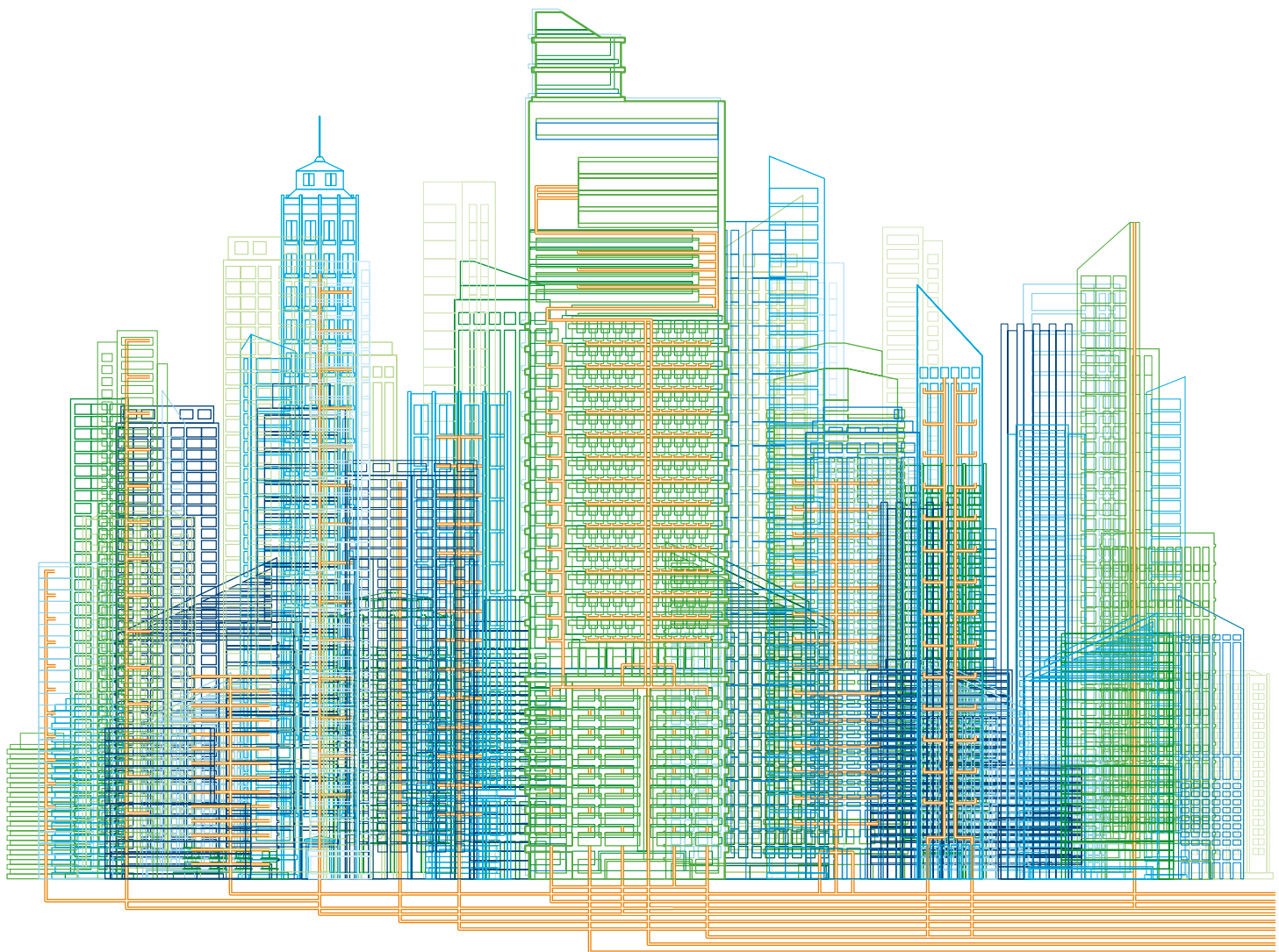


Power Quality Filters
PQFI – PQFM – PQFK – PQFS
Improving Power Quality for Efficiency
and Reliability

ABB Power Quality Filters: The most efficient solution for active filtering of harmonics, smooth reactive power compensation and load balancing. Enabling trouble-free and efficient operation of your system.



The cost of poor power quality

Electrical networks with poor power quality result in financial loss, environmental impacts and/or safety concerns.

There are three significant sources of poor power quality caused by a variety of loads in customer installations:

- Harmonic pollution
- Load imbalance resulting in voltage imbalance and phase to neutral voltage
- Reactive power

Poor power quality when excessive costs money. It leads amongst others to:

- Frequent failures of equipment
- Reduced lifetime of equipment
- Production losses
- Reduced safety levels of installations
- Increased carbon footprint
- Non-compliance with utility regulations



In addition, there are costs incurred due to extra kWh losses in typical network components such as transformers, cables and motors. These losses are cascaded back to the utility power plants and result in increased CO₂ emissions. The emissions can be significant or marginal depending on the process and the fuel type from which the electrical power is generated.



ABB PQF active filters are the ultimate answer to tough power quality problems caused by harmonics, load unbalance and reactive power demand.

ABB PQF active filters can be applied to small, medium or large applications and are suitable for both industrial and commercial installations. They provide harmonic mitigation, load balancing and step-less reactive power control for inductive and capacitive loads. Selection from the large choice of ratings from several tens of Amps to several thousands of Amps enables the optimal solution for each system to be easily defined. The desired filter rating can be obtained by combining different master and slave units. Under normal conditions, the load of the filter will be distributed evenly over all the filter units operating in parallel.

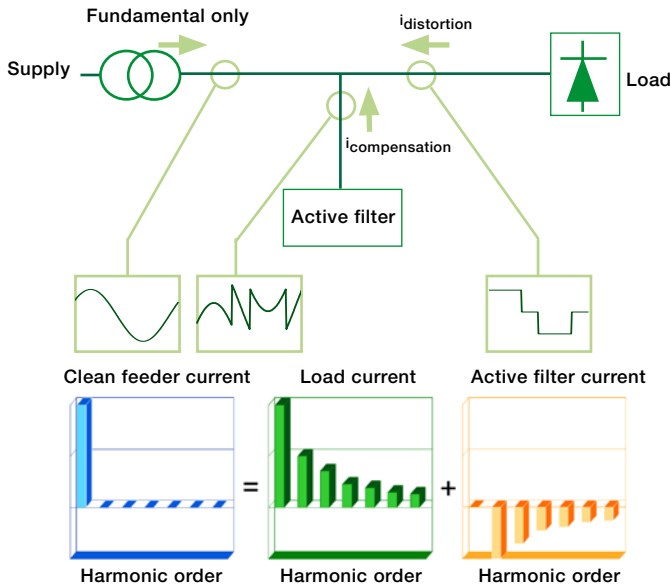
ABB PQF active filters can be installed in LV networks. They can also be employed in MV networks through the use of a suitable coupling transformer.

ABB PQF active filters offer the following system benefits:

- Reduced production downtime and/or commercial installation downtime.
- Increased system efficiency and reduction of CO₂ emissions.
- Compliance with the strictest power quality regulations thanks to their unique control concept, thereby avoiding penalties and/or refusal by utilities to connect installations to the electrical grid.
- No detailed network analysis required, rapid and easy implementation of the solution.
- Not overloadable, thanks to their active concept, hence well adapted to LV installations where loads are upgraded frequently.

A Unique Operating Principle

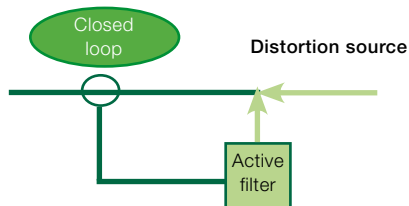
ABB PQF active filters excel thanks to the quality of the compact and user-friendly control system, built according to the highest ABB manufacturing and quality standards.



An ABB PQF active filter is a power electronics based electrical equipment that is installed parallel to the polluting loads. It monitors the line current harmonics, as well as the customer requirements programmed by the user. It can then generate for each harmonic frequency a compensation current in perfect phase opposition to the polluting current.

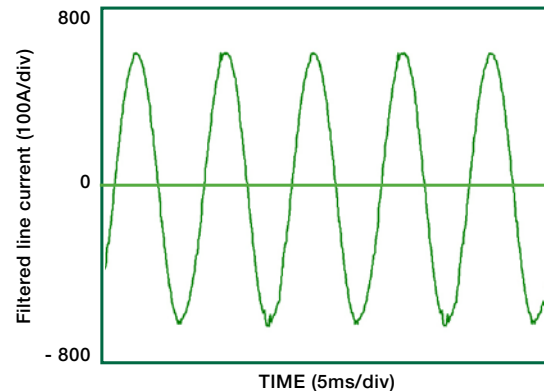
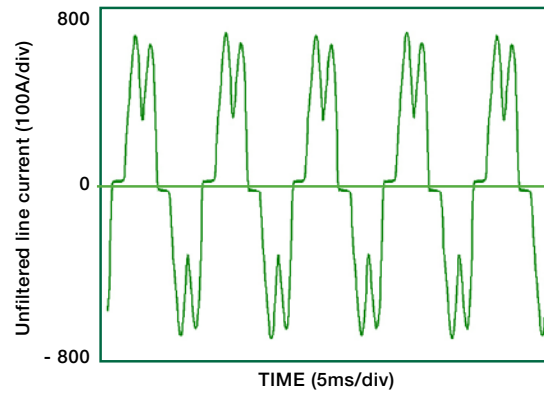
The use of a closed loop control system in combination with the selection capability of individual harmonic components makes the ABB PQF active filter the most precise active filter in the market:

- The closed loop control system measures the line current for each harmonic and reactive power component and compares this with the target set by the customer. Any deviation is automatically eliminated.



- The selection capability of individual harmonic components is the result of an advanced control algorithm. A compensation current with perfect opposite phase is injected for each harmonic selected. This ensures optimal cancellation of all harmonic components that are selected by the user.

This unique ABB technology enables installations to comply with even the most stringent of harmonic regulations and guidelines such as IEEE519, G5/4, etc. Unlike other active filter products on the market, the ABB PQF active filters allow setting individual harmonic target limits as imposed by the regulations.



The closed loop control concept also enables the filter to demonstrate excellent performance for achieving target power factor and load balancing.

Load balancing example

Without filter

Line current 1	49.1 Arms
Line current 2	5.3 Arms
Line current 3	5.1 Arms

Neutral current 44.1 Arms

With filter

Line current 1	19.6 Arms
Line current 2	19.4 Arms
Line current 3	19.5 Arms

Neutral current 3.5 Arms



Peace of Mind

ABB is a leading manufacturer of power quality solutions offering a rich product portfolio to address a variety of power quality problems throughout the complete voltage and application range.

Thanks to ABB's vast first hand experience with power quality issues in the field, the ABB R&D centers are able to bring optimal solutions to the market. As an important added benefit to the customer, the ABB products are supported by an unrivalled service network operating worldwide which can support customers to any level desired.

The ABB PQF active filters available today are the result of more than a decade of intensive R&D efforts combined with continuing field experience from a large installed base. This makes the ABB PQF products the preferred choice for demanding applications such as safeguarding critical industrial or commercial processes, or rendering installations compliant with any prevailing power quality regulations. ABB PQF active filters provide peace of mind to customers.

Key Product Features and Benefits

ABB PQF active filters:

Have unprecedented filtering efficiency thanks to the unique closed loop control system and individual harmonic selection capability.

- Filter up to 20 harmonics simultaneously (15 for PQFK and PQFS in 4-wire mode).
- Selection of harmonics up to the 50th harmonic.
- Harmonic attenuation factor better than 97%.
- Desired harmonic levels can be preset for each selected harmonic.
- Compliance with all aspects of harmonic regulations including compliance with individual harmonic limits.
- Resolving harmonic problems due to both low frequency and high frequency harmonics.
- Increase system reliability.

Can perform stepless reactive power compensation of both inductive and capacitive loads.

- Offload network components resulting in reduced system losses.
- Avoid penalties from utilities.
- Allow generator compensation without the risk of overcompensation.
- Compensate capacitive loads such as modern blade-server systems, allowing for UPS-systems to run at nominal rating.

Can perform load balancing in both 3- and 4-wire systems.

- Reduce the impact on the loads due to voltage unbalance.
- Offload supply cables and neutral cable current wise.
- Reduce the voltage drop between neutral and earth. This increases the safety of the installations and allows sensitive loads to operate.

Raise system reliability to unprecedented levels.

ABB PQF active filters incorporate full redundancy functionality. This feature allows different filter units to work together in a coordinated and efficient manner and permits compliance with even the most stringent requirements on redundancy imposed in critical applications, varying from data centers over telecommunication hubs to sensitive industrial processes.

Depending on the application requirements, the customers can select either a system offering full or limited redundancy.

- With a fully redundant system, the load of any unit in a filter system is taken over by the other units if a shut down of a unit occurs, provided that the appropriate filter capacity is available.
- With a limited redundant system, the load of any slave unit in a filter system is taken over by the other units if the shut down of a slave unit occurs, provided that the appropriate filter capacity is available.

In order to obtain full redundancy, it is necessary to select a filter system consisting of only master units. If limited redundancy is acceptable, a combination of master and slave units can be selected. The degree of redundancy can be varied by selecting more or less master units.



Are designed with the customer requirements in mind.

- Standard products with direct coupling in a wide voltage and current range allowing the optimal choice to be made for each installation.
- Works with standard class CT's.
- Modular non-overloadable technology which can be upgraded in the future.
- User friendly backlit GUI interface with network monitoring capabilities and extensive I/O possibilities.
- Automatic thermal derating function allowing to run automatically in derated mode when switchroom temperatures become too high. No risk of abrupt system tripping.
- Compact solution usable in both new and retrofit applications.

Product Portfolio and Application Area

In order to cater for different requirements and applications, ABB PQF active filters are available in different forms, dimensions and ratings.



The PQFI active filters are the ideal solution for heavy industrial applications using high power where three phase harmonic loads need to be filtered. The PQFI filters are available in free standing cubicle format.

Typical applications include:

- Oil and gas industry (on- and offshore)
- Steel industry
- Water industry
- Cement industry
- Automotive industry
- Process plants
- Pulp and paper industry
- Solar panel and solar panel inverter manufacturing lines
- Printing industry, ...

The PQFM active filters are the ideal solution for medium scale industrial three wire applications. They can be obtained both as a free standing cubicle with limited footprint and as an IP00 plate to be readily used by panel builders and system integrators.

Typical applications include:

- Oil and gas industry (on- and offshore)
- Water industry
- Process plants
- Chilling stations
- Cement industry
- Pulp and paper industry
- Ski lifts
- Printing industry, ...



Product Portfolio and Application Area

PQFK



The PQFK is the ABB free standing cubicle solution for commercial and residential applications with neutral and for industrial applications also containing a lot of single phase harmonic producing loads. In addition to a cubicle version with limited footprint, the PQFK can also be obtained in an IP00 plate version making it an interesting choice for panel builders and system integrators that wish to integrate it in their system.

Typical applications include:

- Offices and other commercial buildings
- Computer/data centers
- Residential buildings
- Advanced lighting systems, ...

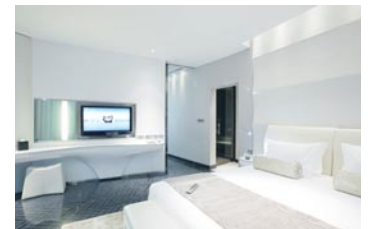
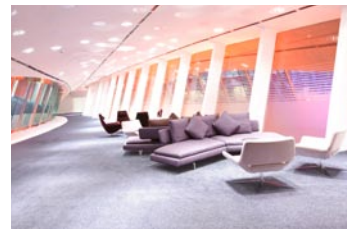
PQFS



The PQFS is the ABB compact solution for commercial, residential and light industrial applications for installations with or without neutral. Its wall-mount compact design allows it to be installed at any location where only limited space is available. It can also be integrated by panel builders as part of a complete system.

Typical applications include:

- Offices and other commercial buildings
- Computer/data centers
- Residential buildings
- UPS-systems, lifts and advanced lighting systems
- Light industrial loads such as remote pumping stations
- Light railway and metro applications, ...



An Excellent User Interface

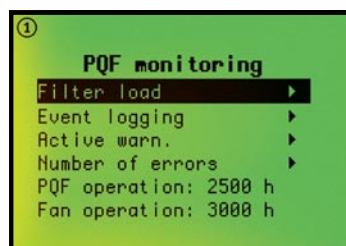
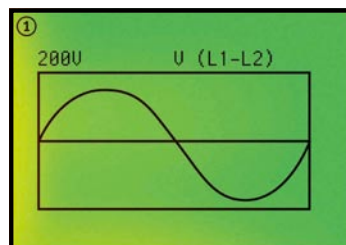
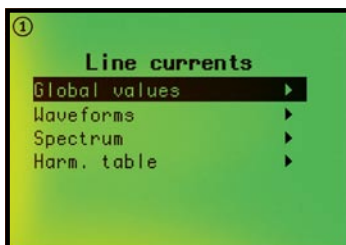
A short commissioning time is critical in demanding applications and the customer needs to supervise the network quality at all times. The user-friendly PQF-Manager interface has been designed with these requirements in mind.

The PQF-Manager is the Graphical User Interface provided with all the PQF types as a standard accessory. 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.



Customer benefits

- Protection available with minimal downtime
- Direct access to key parameters of the installation
- Usable in a variety of supervision systems



Fully graphics backlit display

With its large dimensions (64 x 132 pixel) and the clear positioning of information, prompts and icons, the backlit PQF-Manager offers a high level of readability and an unprecedented level of viewing comfort. It provides the following main functions :

- Starting, stopping and resetting the filter
- Measurement, analysis and logging of characteristic parameters
- Setting up the filter
- Monitoring the filter load and fault logging

Menu navigation

A simple and user friendly organization of menus and items makes the navigation easy and intuitive.

Communication

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

Help button

The Help button gives instant access to a comprehensive description of most of the features and functionality of the PQF.

Easy commissioning

With automatic detection and correction of incorrect CT connections commissioning is made easy.

Filter Specifications

Model	PQFI	PQFM	PQFK	PQFS
Electrical characteristics				
Connection method	3-wire	3-wire	4-wire	3-wire/4-wire
Network voltage ⁽¹⁾	V1: 208-480V V2: 480-690V	V1: 208-480V	208-415V	208-240V 380-415V
Network frequency	50 Hz/60 Hz - +/- 5%			
Line current rating per base unit (A _{rms})	V1: 250 A, 450 A V2: 180 A, 320 A ⁽²⁾	70 A, 100 A, 130 A, 150 A	70 A, 100 A	30 A, 45 A, 60 A, 70 A, 80 A, 90 A, 100 A
Neutral current rating per base unit (A _{rms})	-	-	3 times the line current rating ⁽³⁾	
Modularity ⁽⁴⁾	Maximum 8 units can be combined		Maximum 4 units can be combined	
Redundancy ⁽⁵⁾	Master/master or master/slave arrangement			
Equipment losses	3% of the equipment power typically			
Internal power circuit protection	Main breaker	Fuse box disconnecter (optional)		-
Filter characteristics				
Harmonic range	2 nd to 50 th order			
Harmonics selectable	20 orders		15 orders	3-wire: 20 orders 4-wire: 15 orders
Filtering degree	Programmable per harmonic in absolute Ampere value			
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) ⁽⁶⁾			
Load balancing characteristics				
Modes	Between phases: ON/OFF		Between phases: ON/OFF Between phase and neutral: ON/OFF	
Programming/Communication				
Digital I/O	2 digital inputs/6 digital outputs (potential free)			
Alarm contact	1 NO/NC alarm contact (potential free)			
Programming/Monitoring	Using PQF-Manager GUI Using Modbus RTU interface (optional) Using PQF-Link software (optional)			

(1) Acceptable network voltage tolerance is +/- 10%.

(2) If the system voltage is higher than 600 V, the current rating of this unit may be derated automatically depending on the load conditions for ambient temperatures higher than 30°C/86°F.

(3) Neutral current rating of PQFS 100 A units is limited to 270 Arms.

(4) A PQF filter system consists of a combination of base units selected within a type and voltage category. The base units can be of master or of slave type.

- For PQFI and PQFM filters, units of a different rating may be combined. For PQFM filters, maximum one unit rating difference between the largest and the smallest unit in a system is allowed. E.g. PQFM 150 A + PQFM 130 A.

- For PQFK and PQFS filters, the units of a filter system must all have the same rating.

(5) For full redundancy combine only master units. If limited redundancy is acceptable, master and slave units can be combined. The desired redundancy level can be obtained by selecting more or less master units.

(6) If cos φ of the installation is higher than the target cos φ, the filter will not downgrade the existing cos φ.

Model	PQFI	PQFM	PQFK	PQFS
Physical aspects (per base unit)				
Mounting	Free standing cubicle (PQFK-I-M) or IP00 plate (PQFK-M)			Wall-mount enclosure
Approximate dimensions	800 x 600 x 2150 mm	600 x 600 x 2150 mm (cubicle)		585 x 310 x 700 mm
W x D x H)	498 x 432 x 1697 mm (plate)	498 x 400 x 1697 mm (plate)		
Approximate weight (unpacked)	180 A/250 A units: 525 kg 320 A/450 A units: 620 kg	270 kg (cubicle) 150 kg (plate)		120 kg
Color	RAL 7035 (light gray)			
Installation aspects				
Altitude	Indoor installation in clean environment up to 1000 m altitude ⁽¹⁾			
Ambient temperature	-10°C to 40°C ⁽¹⁾			
Humidity	Maximum: 95% relative humidity, non-condensing ⁽²⁾			
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) • Filter burden: 5VA for upto 8 units • Secondary rating: 5 A CT's must be installed in closed loop configuration			
IP protection	IP21 Optional: IP41 ⁽³⁾	Plate version: IP00 Cubicle version: IP21 Optional: IP41 ⁽³⁾		IP30

(1) Higher altitudes (up to 2000 m/ 6600 ft max.) and temperatures (up to 50°C/122°F max.) with suitable derating.

(2) The maximum relative humidity for operational purposes is 95%. When the units are stored for a longer time, do not exceed a relative humidity of 85%.

(3) For IP41 models, 10% derating applies.

The data here presented is an extract of the complete product specification. Please refer to the document “PQFI-PQFM-PQFK-PQFS detailed technical specifications” for more technical information.

Examples of unit combinations

PQFI

Filter line current	Unit combinations for PQFI - V1
250 A	PQFI-V1-M25
450 A	PQFI-V1-M45
700 A	PQFI-V1-M45 + S25
900 A	PQFI-V1-M45 + S45

PQFM

Filter line current	Unit combinations for PQFM - V1
100 A	PQFM-V1-M10
130 A	PQFM-V1-M13
150 A	PQFM-V1-M15
300 A	PQFM-V1-M15 + S15
450 A	PQFM-V1-M15 + S15 + S15

PQFS

Filter line current	Unit combinations for PQFS
60 A	PQFS-M06
100 A	PQFS-M10
120 A	PQFS-M06 + S06
180 A	PQFS-M09 + S09
200 A	PQFS-M10 + S10

Notes:

- Any desired level of redundancy can be obtained by selecting more or less master units. In order to obtain full redundancy replace all slave units by master units.
- Other ratings can be obtained by combining the appropriate base units.
- Through the use of more specific options, a wide range of requirements can be catered for. Contact your ABB service provider for specific queries.

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1SXP981003D0201/April 2011