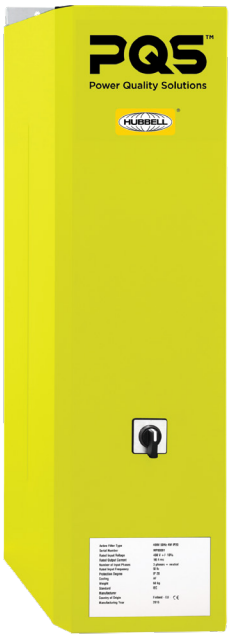
POWEROHM RESISTORS

PQS™
Power Quality Solutions



1. Active harmonic filter specification

1.1 Summary

1.1.1 This specification defines the requirements for active harmonic filter systems in order to fulfill the requirements of IEEE-519-1992 or IEEE-519-2014 for the harmonic current limits.

1.1.2 By reducing harmonic current in the network, the active harmonic filter will increase the lifetime of the electrical equipment and increase the customer's electrical energy efficiency.

1.2 General

1.2.1 The active harmonic filter shall be provided by reputable supplier who can demonstrate adequate experience in the power quality and active harmonic filtering sector. The supplier's manufacturing process shall be audited in accordance with ISO 9001 quality standard. The supplier shall have their own R&D capabilities for the design, development and technical support of active harmonic filter hardware and control algorithms.

1.2.2 The active harmonic filter shall be connected in parallel with the load to be compensated.

1.3 Active harmonic filter characteristics

1.3.1 The active harmonic filter unit shall be compatible with any supply voltage from 200 V up to 480 V.

1.3.2 The active harmonic filter unit shall be compatible with both 50Hz and 60Hz networks.

1.3.3 The nominal output current of the active harmonic filter modules shall be 50A, 100A, 150A and 200A. The total current capacity shall be any combination of these module currents.

1.3.4 The configuration of the active harmonic filter shall be selectable to either 3- wire or 4-wire connection in order to filter harmonics from phase conductors and optionally the neutral conductor.

1.3.5 The active harmonic filter shall not need any external power supplies or controller other than those built into the unit.

1.3.6 The active harmonic filter shall measure all three phases of line current in real time and generate the measured harmonics currents in opposite phase by means of a Digital Signal Processor (DSP) based system.

1.3.7 The active harmonic filter power inverter module shall be neutral point clamped 3-level topology based IGBT technology to provide good and accurate output current. The PWM modulation technology using fixed switching frequency shall be used. The switching frequency shall not be less than 20kHz to minimize audible noise.

1.3.8 The active harmonic filter shall be capable of measuring the network currents from either the supply side or the load side allowing closed loop or open loop current control. The current signal provided by standard current transformers of Class 0.5 accuracy shall be sufficient for proper filter operation and performance.

1.3.9 There shall be galvanic isolation between the current measuring transformer signals and active harmonic filter control electronics input.

1.3.10 The active harmonic filter main circuit shall have galvanic isolation from the power network when active harmonic filter is switched off.

1.3.11 The active harmonic filter shall be capable of filtering simultaneously from the 2nd to the 50th harmonic including even harmonics and interharmonics.

1.3.12 The active harmonic filter shall have an operation mode enabling the user to set a target percentage of wanted mitigation of harmonic components from 2nd to the 25th harmonics.

1.3.13 The active harmonic filter shall be capable of providing fundamental frequency reactive power compensation up to full nominal output. This reactive power can be either capacitive or inductive.

1.3.14 The active harmonic filter shall be capable of load balancing up to full nominal output current.

1.3.15 The active harmonic filter shall have an automatic re-start feature enabling recovery of normal operation after a black out of the supply system or after being subjected to a non-severe condition.

1.3.16 The active filter shall recognize the main voltage rotation and give indication if this is not correct.

1.3.17 The active filter shall have the capability to change CT-polarity from the user interface without changing the actual CT-wires.

1.3.18 The active harmonic filter shall have speed-controlled fans which are controlled via temperature in order to increase component lifetime and decrease heat losses.

1.3.19 The active filter shall be constructed in a way that component changes are possible for service activity.

1.3.20 The active filter shall operate correctly when operated at up to the full rated current without any trips in correct environment.

1.3.21 The active filter shall be constructed in a way that module protects itself from overheating by derating the output in case of high temperatures.

1.4 Output performance

1.4.1 Filtering efficiency shall be not less than 95% provided that filter capacity is sufficient and load rate of the module is between 30 and 90%. The active harmonic filter shall not correct for utility supplied voltage distortion levels. Network nonlinear sources shall have >3% inductive impedance.

1.4.2 The active harmonic filter shall have heat losses less than 2.3% of nominal power.

1.4.3 The installation network shall not include capacitors without detuning reactors.

1.4.4 The active filter shall automatically sense the network angles and operate without any manual tuning parameters.

1.4.5 The parallel operation of multiple active harmonic filters shall be possible in both open-loop and closed-loop configuration. The possible amount of parallel connected active harmonic filters shall be more than 8 modules.

1.4.6 Each of the active harmonic filter modules shall have their own control system and the operation of the system shall continue if one of the parallel active harmonic filter modules is not operational.

1.4.7 Each of active harmonic filter modules shall have balanced outputs with respect to each other when operated in parallel active harmonic filter connections.

1.4.8 The active harmonic filter performance on reactive power mitigation shall increase the power factor to at least 0.99

1.4.9 The active filter shall provide up to the full nominal current at frequencies up to the 17th harmonic without derating.

1.5 Active harmonic filter operation modes

1.5.1 The active harmonic filter shall have several operation modes allowing the user to program device to solve specific power quality problems in the most economic manner. Every operation mode shall include possibility to set fundamental cycle load current balancing from 0 to 100%.

1.5.2 The active harmonic filter shall have 'all harmonics' operation mode. This operation mode shall offer real time compensation of all harmonics and fundamental reactive power. The response time of the active harmonic filter in this mode shall be less than 100µs.

1.5.3 The active harmonic filter shall have 'all harmonics but not fundamental frequency' operation mode. This operation mode shall offer real time compensation of all harmonics. Fundamental frequency reactive power compensation shall be excluded in this mode. The response time of Active harmonic filter in this mode shall be less than 100µs.

1.5.4 The active harmonic filter shall have 'selectable' operation mode. This operation mode shall offer the possibility to select which harmonic order is to be compensated. It shall be possible to set the percentage of compensation degree for harmonic orders 1 to 25. Odd and even harmonics shall be possible to select. The response time of the active harmonic filter in this mode shall be equal to fundamental frequency cycle time.

1.5.5 The active harmonic filter shall have an 'automatic standby' mode which is activated when the active harmonic filter output current falls below a predefined set point. The active harmonic filter shall automatically return to normal operation when the required output next exceeds the predefined set point. In the standby mode the power electronics controls and cooling fans shall be switched off to minimize energy consumption.

1.6 Human Machine Interface (HMI)

1.6.1 The active harmonic filter shall be provided with a graphical Human Machine Interface (HMI) suitable for programming and monitoring the performance of the filter. A 7" touchscreen panel PC shall be used as the graphical HMI.

1.6.2 The user interface shall be of the touchscreen type and the user interface shall have color display with LED backlight with screensaver functionality

1.6.3 It shall be possible to connect up to seven active harmonic filters to one user interface.

1.6.4 The user interface shall have a lock-feature possibility in order to avoid parameter changes by unqualified persons.

1.6.5 The active harmonic filter user interface shall have a commissioning wizard to make the time required for commissioning as short as possible.

1.6.6 The user interface shall allow the user to control the logical operations of Active harmonic filter, such as:

1.6.6.1. Program active harmonic filter parameters.

1.6.6.2. Program system parameters.

1.6.6.3. Select operation mode of the active harmonic filter.

1.6.6.4. Initializing start or stop sequences.

1.6.6.5. Update firmware's for the active harmonic filter and for the user interface.

1.6.6.6. Download log, trend charts and fault signals to a USB-drive.

1.6.7 The graphical touchscreen user interface shall allow the user to monitor the operation status of the active harmonic filter. The monitored statuses of the active harmonic filter shall be as a minimum ready to run, pre-charging, running, alarm and trip. The status of the active harmonic filter shall be shown in color indications and written format.

1.6.8 The user main screen shall have visual indication of the active harmonic filter states, the load rate of the active harmonic filter units and network parameters such as powers and THDI, as a minimum.

1.6.9 An event log shall be provided for normal events, alarms and trips. The event list shall be recorded into internal flash memory and up to 5000 latest events shall be available for retrieval. Every event shall have clear written information about the events, and shall be divided into a minimum of five categories:

1.6.9.1. Normal events which give information when operations such as start and stop sequence have taken place.

1.6.9.2. Informative alarms which give information when operations such as ac voltage high have been noticed but ac voltage has returned to normal operation level.

1.6.9.3. Action alarms, such as IGBT temperature high, shall limit output current in order to get IGBT temperature back to normal operation range.

1.6.9.4. Trips, such as IGBT temperature max, shall cause system trip. In this case the operator needs to clear out the reason for the trip and acknowledge error before restarting.

1.6.9.5. Parameter changes.

1.6.10 The active harmonic filter shall be capable of analyzing and calculating power quality parameters from the measured voltage and current signals. As a minimum, the following power quality parameters from both the load and the system feeder shall be monitored in graphical user interface.

1.6.10.1. Total harmonic current distortion thd(I) on each phase.

1.6.10.2. Each individual harmonic current 1..25th on each phase.

1.6.10.3. Total harmonic voltage distortion thd(U) on each phase.

1.6.10.4. Each individual harmonic voltage 1..25th on each phase.

1.6.10.5. Line to line ac voltages.

1.6.10.6. Line to neutral ac voltages.

1.6.10.7. Active power on each phase.

1.6.10.8. Reactive power on each phase.

1.6.10.9. Apparent power on each phase.

1.6.10.10. Power factor on each phase.

1.6.10.11. 1.6.10.11 Load currents.

1.6.10.12. Active harmonic filter currents.

1.6.10.13. Network currents.

1.6.11 The harmonic currents and voltages shall be shown in graphical user interface as a bar-graph spectrum.

1.6.12 Three phase current and voltage waveforms shall be shown in graphical user interface.

1.6.13 At least five power quality parameters shall be possible to select for trend recoding purposes. The trend recordings shall be shown in the graphical user interface for one month cycling period. The measuring interwall shall be less or equal to one second.

1.7 Remote communications

1.7.1 The active harmonic filter shall have the option to be connected to external devices via TCP/IP.

1.7.2 The active harmonic filter shall have the default communication method of modbus TCP/IP.

1.7.3 The active harmonic filter shall have as minimum 3 no. programmable hardwired inputs that can be minimum configured to start/stop and disable operation modes from the user interface. The input signal can be either AC- or DC voltage.

1.7.4 The active harmonic filter shall have a minimum of 4 programmable hardwired outputs that can be configured to running, trip and alarm options via the user interface. The outputs shall be potential free relays with the possibility to connect up to 277 VAC signals.

1.7.5 The basic states and power quality parameters shall be readable from a remote terminal unit using modbus TCP/IP protocol.

1.8 Protections

1.8.1 The active harmonic filter shall have its own protection features which ensure safe and reliable operation in all abnormal system conditions. As a minimum, the following protection features shall be incorporate into Active harmonic filter:

1.8.1.1. Internal short circuit protection by fuses or circuit breaker.

1.8.1.2. RMS over current.

1.8.1.3. Peak value over current.

1.8.1.4. AC-system over- and undervoltage.

1.8.1.5. Ripple circuit overloading and ripple circuit failure.

1.8.1.6. IGBT over temperature.

1.8.1.7. Enclosure over temperature.

1.8.1.8. DC-capacitor over and under voltage.

1.9 Applied standards and environment

1.9.1 The active harmonic filter shall have following design standard and third-party approvals:

1.9.2 The active harmonic filter shall include third-party approval for by cULus: Ul 508

1.9.3 The active filter shall comply with EMC standards IEC/EN 61000-6-2 and IEC/EN 61000-6-4.

1.9.4 The active filter shall comply with safety standard EN 50178.

1.9.5 The active harmonic filter shall follow the additional European Union directives:

1.9.5.1. Low Voltage Directive (LVD) 2014/35/EU

1.9.5.2. Electromagnetic Compability Directive (EMC) 2014/30/EU

1.9.5.3. Restriction of Hazardous Substances (ROHS 2) Directive 2011/65/EU

1.9.5.4. Ecodesign Directive 2009/125/EU

1.9.5.5. Waste Electrical and Electronics Equipment (WEEE) 2012/19/EU

1.9.6 The active harmonic filter shall be compatible with the following environmental conditions:

Climatic cond. (EN50178)	Ambient temperature	Relative humidity	Air pressure
Operation	5...40°C (Class 3K3)	5..85% (Class 3K3)	86..106kPa (Class 3K3)
Storage	-25...55°C (Class 1K4)	5..95% (Class 1K3)	86..106kPa (Class 1K4)
Transportation	-25...70°C (Class 2K3)	95% (Class 2K3)	70..106kPa (Class 2K3)

Pollution degree (EN 50178)	2
Altitude	Up to 1000m

1.10 Testing

1.10.1 The active harmonic filter shall be tested according to relevant part of IEC/EN50178. At least following test shall be done for each active harmonic filter unit:

1.10.1.1. Visual inspection, main circuit test

1.10.1.2. Insulation resistance test

1.10.1.3. Insulation voltage withstanding test

1.10.1.4. Functional test at nominal voltage and current

1.10.1.5. Temperature rise test

1.10.1.6. Step response test

1.11 Enclosure and installation

1.11.1 The active harmonic filter module enclosure shall be rated for NEMA1 which can be installed in the switchgear enclosed having protection index up to NEMA 4X.

1.11.2 The air ventilation of the switchgear shall be equipped with adequate air filtering system.

1.11.3 The active harmonic filter shall be meant for cubicle mounting by default. Floor or wall mounting shall be possible through optional accessories. The enclosure shall be designed so that installation to commercially available standard cubicles is possible with the standard mounting brackets available from the cubicle manufacturer. Mounting to other cubicle types shall be easy by simply designing a suitable mounting bracket.

1.11.4 The active harmonic filter shall have bottom cable entry, top cable entry shall be available as an option.

1.11.5 The physical dimensions shall enable the user to install up to two 200A devices into a standard cubicle with dimensions (WxDxH) of 24 in. x 24 in. x 79 in. and up to four 200A devices in a standard cubicle with dimensions (WxDxH) of 48 in. x 24 in. x 79 in.

1.11.6 All units shall be provided with a grounding point.

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