1. Active Filter Generic Specifications

1.1. Active filter supplier

1.1.1. The active filter shall be provided by a well reputed supplier who can demonstrate adequate experience in the active filtering and power quality domain (> 6 years). The supplier's manufacturing process shall be in accordance with the relevant ISO quality standards. The manufacturer shall have in-house R&D facilities and competence for the design and development of the active filter control algorithms and hardware.

1.2. Active filter type and arrangement

1.2.1. The active filter shall be of the shunt configuration and of 3-wire type to filter harmonics in the phases.

1.2.2. The active filter shall be connected at the LV level in an installation allowing for the reduction of harmonic stress at load level and to reduce transformer losses and harmonic emissions to the feeding network.

1.2.3. The active filter shall have bottom cable entry. Top cable entry must be available as an option.

1.2.4. The active filter shall be able to work on utility fed networks as well as on local backup generators.

1.2.5. The active filter shall be able to do reactive power compensation. Target power factor must be settable up to unity. Both capacitive and inductive mode must be possible.

1.2.6. The active filter shall be able to do load balancing.

1.2.7. The active filter shall measure the network currents at the supply side of the unit allowing for closed loop control. Standard current transformers of class 1 accuracy shall be sufficient for proper filter operation.

1.2.8. The active filter power inverter shall be based on IGBT technology. It shall employ a PWM modulation technology using a fixed switching frequency.

1.2.9. The communication between the main controller board and the individual power modules must occur through an optical link to ensure maximal galvanic isolation.

1.3. Mode of operation

The active filter shall monitor all three phases of the low voltage line current in real time and process the measured harmonics by means of a Digital Signal Processor (DSP) based system.

The output of the DSP based system shall be a pulse width modulated (PWM) signal to control power modules based on IGBT (Insulated Gate Bipolar Transistor) technology that shall be controlled as a current source.

The control of the power modules and associated reactors shall be such that harmonic currents of exactly the opposite phase of those to be filtered are injected into the source of supply to the filter so that the harmonic currents flowing in the line are reduced to levels that can be individually programmed by the user.

The system shall be operated under closed loop control. The control system shall be such that the active filter cannot be overloaded.

The active filter shall be able to co-exist with tuned and detuned capacitor banks in some way.

1.4. Proven design

1.4.1. The active filter shall be of a fully proven design which is in production currently as a standard product or which is based on an active filter generation that has been in production for more than five years.

1.4.2. Each active filter shall undergo a functional filtering test before leaving the product's originator factory.

1.5. Extensible design

The design of the active filter shall be such that the current rating of the filter system can be increased by the addition of extra power modules, up to a total of no less than 1200 Arms in the phases.

2. Voltage rating

The active filter shall be 3 phase 3-wire units suitable for operation on a network with neutral characterized by system line voltages in the range of 208 Vrms – 690 Vrms +/- 10%.

3. Current rating

The RMS current rating of each active filter module shall not be less than 150 Arms per phase.

4. Enclosure

The active filter shall be mounted in self-ventilated enclosures rated not less than IP21 with the door closed and not less than IP20 with the door open. The product supplier shall be able to provide enclosures respecting IP41 classification on request.

5. Filtering characteristics

5.1. Harmonic orders that can be filtered.

The active filter shall be able to filter simultaneously at least 20 individual harmonic components individually programmable in a frequency range from the 2nd to the 50th harmonic.

5.2. Degree of filtering

The degree of filtering shall be programmable, for each harmonic, in Amps.

5.3. Filtering modes

The active filter shall allow for different filter modes to be set expressing the priority to be given to the filtering of harmonics and the generation of reactive power and load balancing.

5.4. Filtering efficiency

Filtering efficiency shall be typically not less than 95% related to the filter rating.

6. Reactive power compensation

The active filter shall be able to do reactive power compensation and aim to compensate for a target displacement power factor ensuring correct operation in the presence of harmonics. The user must be able to choose this target power factor in a range from 0.6 inductive to unity and in a range from 0.6 capacitive to unity.

In addition to power factor targeting the filter shall also be able to generate/absorb a fixed amount of reactive power within the filter's current capabilities on the user's request.

7. Load balancing

The active filter shall be able to do load balancing with the same priority level as doing reactive power compensation.

8. Main and auxiliary filter settings

The active filter shall have the possibility to set up two different types of compensation settings that are selectable by triggering an external contact.

9. Heat losses/power dissipation

The active filter shall have intelligent control technology that minimizes the filter switching losses for each operating point.

The heat loss from each active filter operating at full load shall not be more than 5% of the module rating per module.

10. Operator interface

10.1. Interface type

The active filter shall be provided with an operator interface suitable for programming and monitoring the performance of the unit. The operator interface must at least be a dedicated programming and monitoring unit mounted permanently on the front of each active filter.
In addition, the operator interface may take the form of an external Windows based software.

10.2. Access levels

The operator interface shall allow at least for:

a) Monitoring network and filter parameters;
b) Programming the filtering, reactive power and balancing requirements;
c) Setting up the hardware configuration parameters.

Adequate protection mechanisms should be provided to ensure that non-authorized people cannot alter system settings.

10.3. Displays

The operator interface shall give information on at least the following subjects:

a) numerical data on at least the following network parameters:
   - (i) Vrms of all phase to phase voltages,
   - (ii) Vfundamental of all phase to phase voltages
   - (iii) THDV of all phase to phase voltages,
   - (iv) Irms of all line currents,
   - (v) Ifundamental of all the line currents
   - (vi) THDI of all line currents
   - (vii) Active, reactive and apparent power
   - (viii) Power factor and displacement power factor
   - (ix) Voltage imbalance
   - (x) Network frequency
b) numerical data on at least the following filter parameters:
   - (i) Percentage of filter capacity used,
   - (ii) IGBT and control board temperatures
   - (iii) Voltage present on the DC bus
   - (iv) Operating hours of the filter fan
   - (v) Operating hours of the filter system
c) spectrum displays in bar graph and value table form of:
   - (i) All the line voltages,
   - (ii) All the line currents,
   - (iii) All the filter currents.
d) waveform displays of:
   - (i) All the line voltages,
   - (ii) All the line currents,
   - (iv) All the filter currents.
e) event and faults that have occurred, presented in an event log with real time stamp

10.4. Other function requirements of the operator interface

The operator interface shall allow for the logging of the time during which selected network parameters have been higher than a preset value and also for the storing of the maximum value recorded during a logging session.

The operator interface shall allow for the setting up of programmable warnings and alarms that may be associated with a selection of network parameters.

The operator interface shall allow for the setting up of the digital inputs and the digital outputs of the active filter.

The operator interface shall allow for the printing of the setup parameters and selected measurements on a serial printer.

11. Input/Output contacts

11.1. Remote control functionality

It shall be possible to switch the filter on and off by remote control.

11.2. Alarm contact functionality

The active filter shall provide at least two complementary potential free alarm contacts that allows to monitor the active filter alarm status (e.g. by remote control).

11.3. Digital input contacts

The active filter shall have at least two multi-purpose digital input contacts.

11.4. Digital output contacts

The active filter shall have at least six multi-purpose digital output contacts. It must at least be possible to use these contacts to monitor basic filter operation or to output specific alarm conditions selectable out of a predefined list.

12. Auto-restart functionality after power outage

The active filter shall have an automatic restart function which will ensure that the filter will restart automatically after a power outage when it was on at the moment that the power outage occurred.

13. Modbus RTU communication requirement

The active filter must be Modbus RTU compliant.

14. Environmental conditions

The active filter shall be suitable for indoor operation in an air-conditioned switchroom with the following environmental factors:

Maximum temperature: + 40°C (50°C with derating)
Minimum temperature: + 5°C
Maximum average temperature: + 35°C over 24 hours
Relative humidity: maximum 95% non-condensing
Altitude: maximum 1000m without derating

15. Protections

The active filter shall incorporate its own protection devices that ensure protection against at least overcurrent, short-circuit, thermal overload, IGBT bridge abnormal operation, network voltage phase loss, network synchronization loss and DC capacitor over- and undervoltage.

ABB Inc.
1206 Hatton Rd.
Wichita Falls, TX 76302

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