

## **1 General**

### **1.1 Description**

This Specification defines the requirements for active harmonic filtering (AHF) systems.

Filter voltage rating: 208 – 415V<sub>ac</sub>, –15% / +10%, 50/60 Hz, transformer less, 3-phase 4-wire plus ground.

RMS current rating: Provide the rated current as indicated on the drawings or as required.

### **1.2 Reference standards**

The AHF shall be CE certified and designed as per the following standards.

Design reference	IEC 62477-1, IEC 61439-1, EN 61000-6-2, EN 61000-6-4 Class A, ISO 9001, IEEE 519-2014
EMC compliance	EN 61000-6-4 Class A (Emissions), EN 61000-6-2 (Immunity)
Product Certification	CE certified, RCM, EAC, RoHS

The contractor shall be responsible for the installation compliance to local regulations and as per manufacturer's installation guidelines.

### **1.3 Performance requirements**

The AHF shall be rated for the following network conditions.

- Rated voltage: 208 – 415V<sub>ac</sub>, –15% / +10%
- Rated frequency: 50 or 60Hz, ± 3Hz auto sensing
- Connection type: 3ph/3-wire or 3ph/4-wire within the same unit
- Compensation type: 3-phase only or 3-phase + neutral within the same unit
- Earthing system: TT, TN-C, TN-S, TN-C-S, IT and HRG

The AHF shall be able to operate in multiple modes to provide harmonic compensation, reactive power correction and load balancing, whether simultaneously or independently selectable.

Harmonic correction:

- Limit the 2nd through 51st order harmonic current to THDi ≤ 5% at each installed location indicated herein.
- Levels for individual harmonic orders shall comply with respective levels established in IEEE 519-2014, Table 2. A THDi setpoint may be set to optimise THD performance.
- Limit the THDv contribution to the electrical system immediately upstream of the active line conditioner location(s) to less than or equal to 5%. The user shall be able to set and vary the target THDv. The active harmonic filter shall not correct for utility supplied voltage distortion levels.
- Spectrum cancellation and selection: 2nd to 51st order, fully selectable and adjustable per harmonic order in amplitude (%) or ON/OFF.
- Neutral harmonic current limit correction shall be user-adjustable up to 3 times unit rating.

Reactive power compensation shall improve displacement power factor through VAR injection (leading or lagging) using a 3-level IGBT based technology.

- PF range can be from 0 to 1.0.
- AHF shall include an option to achieve optimized PF correction. Optimized PF correction is designed to prevent correction when the system PF is better (closer to unity) than the programmed PF set point.
- Any AHF that reduces the system PF to attain the set point is not acceptable.
- Response time shall be within ½ cycle (10ms).

Load balancing shall be provided as a capability to improve the mains current seen by the utility supply. The AHF shall correct for line-line or line-neutral connected loads, selectable individually or simultaneously.

#### **1.4 Service Conditions**

The active harmonic filter shall be suitable to operate in the following conditions:

- Operating ambient temperature:
  - continuous operation at full performance without derating: 0°C to +45°C.
  - with derating (2% per °C): up to +50°C
- Relative Humidity: 0 - 95%, non-condensing.
- Operating altitude:
  - without derating up to 1000m,
  - with derating, above 3000m requires solid grounding up to 4800m.
- Airflow: 560m<sup>3</sup>/h (329 cfm)
- Heat loss: ≤ 23W per amp at 400Vac, full load
- Contaminant levels: Chemical Class 3C2, Mechanical Class 3S2

#### **1.5 Storage Conditions**

The active harmonic filter shall be suitable to store in its original shipping packaging in the following conditions:

- Storage temperature: -20°C to +60°C
- Relative humidity: up to 95%, non-condensing
- Contaminant levels: Chemical Class 3C3, Mechanical Class 3S3

## 2 Product Requirements

### 2.1 Construction and Enclosure

- AHF shall be provided in an IP20 wall mount enclosure with bottom cable entry or IP20 rack mount module with front cable access.
- An incoming circuit breaker, mounted remotely shall be provided by others. Provisions shall be made for locking the circuit breaker in the off position. Provisions for additional padlocking shall be made by the Owner using an approved lockout/tag-out device.
- When noted in the electrical one-line drawings, the AHF shall be incorporated into MCC or switchboard assemblies using an IP00 chassis mount solution.

### 2.2 Operation and Interface

#### a) Operational Capability

- Simultaneous filtering shall be provided for at least 30 individual harmonics that shall be individually programmed per harmonic order up to the 50th harmonic. The filtering efficiency shall be typically 97% or better.
- The AHF shall include a built-in EMC filter, certified to CE and carry the CE mark.
- AHF shall detect any resonance and take corrective actions to reduce current output at/near the resonant frequency.
- During commissioning steps, AHF shall automatically check for CT polarity and correct if required.
- AHF shall operate on positive or negative phase sequence. Sensitivity to phase rotation is not acceptable.
- Cooling of the AHF shall be part of the product's thermal design employing speed controlled fans with a high heat plenum or separate airflow methodology.
- AHF shall reduce its output automatically when ambient temperature is above limits for full performance. The unit shall self-protect once the operating temperature rises above acceptable tolerances.
- Diagnostics file, commissioning report and event log shall be available for download directly from the AHF HMI.
- Multiple AHF units configured in parallel to provide additional current compensation shall use a proprietary communication bus between each operating unit. Load CTs on parallel units is not an acceptable architecture.
- Multiple active harmonic filters may be installed in parallel. The units will function independently. If one unit is stopped or faulted, the remaining units will continue to operate normally and make up any spare capacity.
- Parallel AHF units shall offer full redundancy. Single master controller architecture is not acceptable. AHF units shall support multi-master, multi-slave arrangements.

#### b) Human Machine Interface (HMI)

- AHF shall have a panel mounted HMI with touch screen control rated IP65, dust tight and liquid resistant.
- HMI shall provide an oscilloscope feature to display specific parameters.

- Performance trend curves shall be displayed for load total RMS current, load RMS harmonic current per phase, AHF harmonic current output per phase, AC mains voltage per phase, THDi, TDD, load RMS reactive current and AHF RMS reactive current output.
  - Bar graphs shall be provided for display of the mains and load harmonic current amplitudes per harmonic order.
  - Selected internal curves shall be provided for diagnostic and performance checks
  - HMI shall display operating and setup parameters and event/fault messages in plain English, no cryptic codes or symbols are permitted on the display.
  - HMI shall provide a step-by-step commissioning process.
- c) Communications
- AHF shall have the ability to communicate over a standard industrial communications network such as Modbus RTU or Modbus TCP/IP.
  - AHF data and parameters shall be available in a remote monitoring platform, native (preferred) or through Modbus register mapping.
- d) Current transformers
- Minimum of 2 CTs are required for 3 phase loads only and can be mounted on any phases. 3 CTs required for compensation of neutral corrected loads.
  - Current transformers are an integral part of the active harmonic filtering solution. When current transformers are installed external to the active harmonic filter equipment, the contractor shall be responsible for the installation of manufacturer provided current transformers.
  - Current ratings of the current transformers shall be according to full load current of the circuit on which installed. Refer to drawings.
  - Current transformers shall be rated:
    - Class 1.0 accuracy
    - 50/60 Hz or 400 Hz
    - 1A or 5A secondary.
  - The current transformers shall be installed as source sensing, either at the main incoming switch gear or where the nonlinear loads are concentrated, ie: MCC.

### **2.3 Quality Assurance**

- **Manufacturer Qualifications:** Manufacturer shall be a firm engaged in the manufacture of low voltage active harmonic filters of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 10 years. Manufacturing facility shall be ISO 9001 certified.
- **Installer Qualifications:** Installer shall be a firm that shall have a minimum of five years of experience installing low voltage active harmonic filters similar in type and scope to that required for this Project.
- **Regulatory Requirements:** Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State and local authorities having jurisdiction.
- **Electrical Components, Devices, and Accessories** shall be listed, labeled and marked for intended use.