Hammond Power Solutions Inc.

HPS TruWave™

Active Harmonic Filter
Typical Specification

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HPS TruWave – Hammond Power Solutions.
Low Voltage Active Harmonic Filters

Active Harmonic Filters (Low Voltage)

Part 1 General

1.1 Summary

A. **Scope:** Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for low voltage active harmonic filters (AHF) as required for the complete performance of the work, as herein specified.

B. **Section Includes**: The work specified in this Section includes, the characteristics for a continuous duty Active Harmonic Filter (AHF) designed to reduce total demand distortion (TDD and total harmonic distortion (THD (V)) to levels less than 5%. The AHF will also be able to correct for linear displacement and to balance the incoming three-phase current.

1.2 References, Codes, and Standards

A. **General:** The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. **Institute of Electrical and Electronics Engineers, Inc. (IEEE):**
1. ANSI/IEEE 519-2014, "Guide for Harmonic Control in Electrical Power Systems."
2. ANSI/IEEE C62.41-1991, “Guide for Surge Voltages in Low AC Power Circuits”

C. **Canadian Standards Association (CSA):**
1. CSA C.22.2 No. 14, “Industrial Control Equipment.”

D. **Underwriters Laboratories, Inc. (UL):**
1. UL 508, "Standard for Industrial Control Equipment."

1.3 System Description

A. **Performance Requirements:**

1. General: The AHF shall incorporate a state of the art IGBT based inverter to draw energy from the line at some portion(s) of the 50/60 Hz cycle, store the energy at the capacitor bank of the system DC buss, and then deliver the stored energy at some other portion(s) of the cycle. The AHF will utilize digital signal processor technology to continuously monitor the incoming line current and instantaneously direct energy/current flow in and out of the inverter to effectively correct; harmonic distortion, linear phase displacement and to balance the incoming three-phase lines.
    a. Limit the 2nd through the 51st order harmonic current to less than 5% TDD at each AHF installation point.
    b. Limit the voltage distortion THD (V) added to the facility electrical system to less than or equal to 5% immediately to the line side of each AHF installation point
    c. Power Factor: Near unity at each AHF installation point.
    d. Three-Phase line current balancing: ± 3% each AHF installation point.
    e. Crest Factor Capability: 3.0
2. **Note:** The AHF shall not correct for distortion caused by equipment installed upstream of the system installation point or for incoming utility voltage distortion. The AHF installation point shall be defined as the installation point for the system input wiring and current sensors.

B. **Environmental Service Conditions**

1. Ambient Operation Temperature: 0º C to 40º C
2. Humidity: 0 to 95%, non-condensing
3. Altitude: Operate up to 1000 M (de-rated at higher altitudes)

1.4 Submittals

A. **Action Submittals**

1. Technical Brochure detailing the features of the AHF
2. Dimensional drawings with the size, installed weight, and heat dissipation for each size AHF provided
3. Installation wiring diagram for each AHF provided

1.5 Quality Assurance

A. **Third Party Certification:** The AHF shall have the third party certification by Underwriters Laboratories (UL listing, USL, and CNL)

B. **Manufacturer Qualifications:** The manufacturer shall have been engaged in the production of low voltage active harmonic filters of the types and sizes required for a minimum of 10 years.

1.6 Delivery, Storage, and Handling

A. The AHF is to be delivered to the project site in the supplier's or manufacturer's original containers, labeled with the supplier's or manufacturer's name or product brand name

B. Store AHF and accompanying materials in their original, undamaged packages and containers, inside a well-ventilated area, which is protected from weather, moisture, extreme temperatures, and humidity.

C. Storage Temperature: -20º C to 60º C

1.7 Project Conditions

A. **Environmental Requirements:** Prior to the installation of AHF ensure that workplace is weatherproof, environmental conditions are within specifications for the AHF, and all significant in the area of the AHF is completed.

1.8 Warranty

A. **General:** Standard Factory Warranty shall be at least 18 months from the date of shipment, or one year from the verified date of startup, whichever comes first. This warranty covers defects in material and workmanship.

Part 2 Products

2.1 Manufacturers

A. **Basis of Design:** The AHF specified shall be manufactured by Hammond Power Solutions Inc. This specification is to establish a standard of quality for the design, function, materials, and appearance of the systems. Equivalents products by other manufacturers are acceptable.

B. **Acceptable Manufacturers**
1. Hammond Power Solutions Inc.
2. "Approved" Equal

2.2 Equipment Size & Ratings

A. Active harmonic filter (AHF) shall be designed to operate from an input voltage of 480, 240, or 208 VAC, +12%, -15%, 3phase, 3 wire plus ground.

B. AHF shall be designed to operate with a voltage frequency of 50 or 60 Hz, ±5 Hz.

C. AHF efficiency shall be no less than 98% at full load with heat losses not exceeding more than 2% of the unit KVAR rating.

Select desired amperes below

D. AHF amperage output shall be [_____] amperes. Additional units can be paralleled if the amount of harmonic correction needed for an installation exceeds the maximum current rating of the largest single AHF.
   1. Refer to section 2.3 B for additional details

E. AHF shall include a door interlocked disconnect switch. The disconnect switch shall be lockable in the off position.

F. AHF output shall be electronically current limited to 100% rms of system current rating.

G. Fuses will provide redundant overload protection. Fuses shall be Class T rated at 200,000 AIC.

2.3 Active Harmonic Filter System

A. **Enclosure:**
   1. AHF shall be provided in a NEMA Type 1 gasketed enclosure with air intake filters
   2. Enclosed AHF systems rated for 50 amps through 200 amps shall be supplied in wall mountable enclosures with top or bottom cable entry. Each enclosed wall mountable system shall include a door interlocked disconnect switch, which is lockable in the off position, and lifting lugs to aid in installation
   3. Enclosed AHF systems rated for 300 amps shall be supplied in a floor mount (freestanding) enclosure with top or bottom cable entry. Each enclosed floor mount system shall include a door interlocked disconnect switch, which is lockable in the off position, lifting lugs to aid in the installation, and shall be mounted on rails to facilitate lifting by pallet truck or forklift.

B. **Function of AHF**

1. In order to monitor the incoming line current, the AHF will utilize two current sensors mounted on phases A and B of the incoming line. A third current sensor shall be utilized on phase C if there are line to neutral single phase loads present on the load side of the system installation point. Scaling for different size current sensors will be programmable via the HMI remote interface and LCD touch screen.
    a. The AHF shall inject the corrective current required to limit the 2nd through the 51st order harmonic current to less than 5% TDD at each AHF installation point as defined by ANSI/IEEE Standard 519-2014.
    b. The AHF shall limit the voltage distortion THD (V) added to the facility electrical system to less than or equal to 5% immediately to the line side of each AHF installation point as defined in ANSI/IEEE Standard 519-2014.
    c. Non-linear loads installed downstream of the AHF shall be equipped with line reactors rated for a minimum of 3% **or** have DC link chokes rated for a minimum of 4%. Both are **not** required.
    d. The AHF will also have the capability to provide reactive current correction, and load balancing of the three phase lines. These functions will be field selectable via the HMI.
2. If the amount of harmonic correction needed for an installation exceeds the maximum current rating of the largest single AHF available from the manufacturer, then multiple systems may be installed in parallel with each other to achieve the required amount of harmonic correction.
    a. AHF that are installed in parallel with each other will utilize the one set of current sensors to monitor the load current.
    b. Up to six systems may be installed in parallel with each other.
3. The AHF shall use electronic current limiting technology for protection of the system in the case of an overload condition.
    a. In the case of an overload condition the AHF will electronically current limit its output to 100% rms of the system maximum current capacity.
    b. The AHF will be designed to operate continuously while current limited at 100% rms of maximum capacity.
4. The AHF shall be equipped with a Standby/Power Saving function which will automatically disable the AHF inverter when the monitored load power drops below a user selected, pre-programmed level.
    a. This function can be used for power savings, or to automatically disable the AHF when an alternate input (emergency) source is being utilized which does not require harmonic correction.
    b. During the Standby/Power Saving mode the AHF inverter bridge will remained energized in order to prevent any time delay when the AHF is automatically re-enabled.
5. The AHF shall enable the user to select the desired harmonic current TDD% to be achieved.
    a. This function can be accessed via the LCD front screen

6. The AHF shall enable the user to select the desired Power Factor to be achieved.
    a. This function can be accessed via the LCD front screen
7. In the case of a shutdown to due to AC line conditions, which are outside the specifications of the AHF, the system will be programmed to restart in a controlled manner once the AC conditions are within system specifications.
    a. The AHF shall be able to record the last 1,856 reset events that include line occurrences and/or fault conditions. The AHF will have a battery backup memory feature that will enable the unit to store the reset event information in the event of a power failure, or if the unit is manually turned off.
        (i) Reset event information shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped
8. In the case of shutdown due to a fault condition, the AHF will be programmed to attempt an auto restart and resume normal operation.
    a. If the AHF completes the preprogrammed number of restarts and the fault condition still exists then the system will not attempt to restart until the system is attended to manually.
    b. The AHF shall be able to record the last 480 shutdown events that include AC line occurrences and/or fault conditions. The AHF will have a battery backup memory feature that will enable the unit to store shutdown event information in the event of a power failure, or if the unit is manually turned off.
        (i) Shutdown event information shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as RMS, and instantaneous, values for:
            1. AC line voltages
            2. AC line currents
            3. Load currents
            4. AHF currents
            5. AHF inverter currents
            6. DC buss voltage
            7. Heat sink temperatures
            8. PC board temperatures
    c. The AHF shall be able to record FDR (oscilloscope) data for the last 100 shutdown events, which allows for the customer or manufacturer to plot data from the last 4 cycles. The AHF will have a battery backup memory feature that will enable the unit to store shutdown event information in the event of a power failure, or if the unit is manually turned off.
        (i) FDR Data information shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as values for:
            1. AC line voltages
            2. AC line currents
            3. Load currents
            4. AHF currents
            5. AHF inverter currents

C. **Customer Interface**

1. Front Panel Interface
   a. AHF shall incorporate 6” x 3.5” dust tight graphic color LCD touch screen display
   b. The AHF LCD touch screen display shall enable the user to view detailed power quality information, before and after the system installation point, so that the end user can evaluate the effectiveness of the system. This detailed information shall include, but not be limited to, the following:
      (i) Line Voltage
      (ii) Line Frequency
      (iii) Line current (amps) before and after AHF installation point
      (iv) Line THD % before and after AHF installation point
      (v) Harmonic current (amps) before and after AHF installation point
      (vi) Line Kilowatts (KW), Kilovolt amperes (KVA), and Power Factor (PF) before and after AHF installation point.
   c. The operating status of the AHF (“ON” or “OFF) shall be indicated towards the bottom of the LCD touch screen display on every operational display page.
   d. Additional status information such as: normal operation, max. Load, reduced power factor mode, low AC line, and warning or diagnostic messages shall be displayed directly below the “ON” or “OFF” status information.
   e. Miscellaneous AHF operating parameters shall also be viewable on the LCD touch screen display. These parameters shall include: system heat sink temperature, system PC board temperature, AHF currents, AHF % loading, AHF inverter currents, Internal DC buss voltage, and system internal supply voltages.
   f. The LCD touch screen display shall enable the user to perform the following system functions by touching the appropriate icons.
      (i) Run
      (ii) Stop
      (iii) Menu (select)
      (iv) Set Parameters
   g. The LCD touchscreen shall allow the operator to view a single AC line period of multiple voltage and waveform parameters. This is an oscilloscope function to view trends of real time data with a line graph.
      (i) At least twenty-one separate parameters must be available for viewing including the following:
         1. ILINE- A, B, C: The line current is the current measured coming from the utility. When the AHF is operating, this current represents the corrected current.
         2. ILOAD- A, B, C: The load current is the current measured going to the loads (motor drives, etc.).
         3. VAB, VBC, VCA: These are the line-to-line voltages for all 3 phases.
         4. VAN, VBN, VCN: These are the equivalent line-to-neutral voltages for all 3 phases. Displaying a line-to-neutral voltage and corresponding line or load current will show the linear phase displacement.
         5. IAHF- A, B, C: This is the current drawn by the AHF (both harmonics and out-of-phase linear current). They represent those drawn by the load that are

being “cancelled”, so that the current does not have to come from the line (or utility).

6. IINV- A, B, C: The inverter are currents related to the inverter switching frequency that are internally filtered so do not appear in the AHF currents.
7. VCAP- AB, BC, CA: These are internal line-to-line voltages which are primarily used for diagnostic purposes.

(ii) Up to three parameters must be available to view at a time

(iii) Both single capture and continuous capture over time are available for viewing

h. The LCD touchscreen shall enable the user to view detailed historical data. This detailed information shall include, but not be limited to, the following:

(i) Most recent 480 shutdown records that include AC line occurrences and/or fault conditions

(ii) Most recent 1856 reset records that include AC line occurrences and/or fault conditions

(iii) FDR information shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as values for:

1. AC line voltages
2. AC line currents
3. Load currents
4. AHF currents
5. AHF inverter currents

i. The AHF shall enable the user to save status history and FDR data to a flash drive from the front panel interface for data acquisition and troubleshooting.

(i) Status history information includes shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as RMS, and instantaneous, values including:

1. AC line voltages
2. AC line currents
3. Load currents
4. AHF currents
5. AHF inverter currents
6. DC buss voltage
7. Heat sink temperatures
8. PC board temperatures
9. Parameter data
10. Most recent 480 shutdown records that include AC line occurrences and/or fault conditions
11. Most recent 1856 reset records that include AC line occurrences and/or fault conditions

(ii) FDR information shall include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as values for:

1. AC line voltages
2. AC line currents
3. Load currents
4. AHF currents
5. AHF inverter currents

j. The AHF shall enable the user to update firmware from the front panel interface with the use of a flash drive. (No computer or additional protocols required)

k. The AHF shall have LED indicators on the front panel that clearly show the customer the following status information in case of LCD screen issues
   (i) Power
   (ii) Control Status
   (iii) Power Status

2. **Ethernet Communications Interface**

a. The AHF shall have ethernet communications interface that can be accessed at the system front panel.

b. The AHF ethernet interface shall enable the user to configure the selectable system parameters, collect system diagnostic information, collect current system operational data, collect historical system operational data, and remotely enable or disable the system.

c. The AHF ethernet interface shall also enable the user to collect detailed power quality information, before and after the system installation point, so that the end user can evaluate the effectiveness of the system. This detailed information shall include, but not be limited to, the following:
   (i) Line Voltage
   (ii) Line Frequency
   (iii) Line current (amps) before and after system installation point
   (iv) Line TDD % before and after system installation point
   (v) Harmonic current (amps) before and after system installation point
   (vi) Line Kilowatts (KW), Kilovolt amperes (KVA), and Power Factor (PF) before and after system installation point.

d. The AHF ethernet interface shall also enable the user to collect and view detailed status history information, including:
   (i) Current parameter information
   (ii) Most recent 480 shutdown records that include AC line occurrences and/or fault conditions
   (iii) Most recent 1,856 reset records that include AC line occurrences and/or fault conditions
   (iv) Most recent 100 FDR records that include a message stating the reason for the shutdown and/or fault, which is date and time stamped, as well as values for:
      1. AC line voltages

2. AC line currents
3. Load currents
4. AHF currents
5. AHF inverter currents

e. An optional Ethernet/IP or Modbus TCP module shall also be available

3. **Status Contacts**

a. The AHF shall be equipped with three status relays for remote monitoring of the system. The relay contacts shall be rated for 1.0 amps @ 24 VDC or 0.5 amps @ 125 VAC. The first relay will be energized if the system is fully operational and correcting harmonics. The second relay will be energized if a diagnostic or warning condition is indicated. The third relay will be energized if the system is operating at maximum capacity.

4. **Remote Enable/Disable Dry Contact Input**

a. The AHF shall be equipped with a remote enable/disable input which can be controlled by a dry contact or a switch. This feature will permit the operator to remotely enable or disable the system without having to utilize the serial, or Ethernet communications interface.

2.4 External Current Transformers

A. AHF shall utilize two split core type current transformers mounted on the phases A and B to monitor the line current drawn by the load(s) A third CT shall be mounted on phase C if any line to neutral loads are present.
B. AHF shall be equipped with a CT setup function which can automatically determine if the external currents transformers are installed on the correct phase and in the correct direction and alert the user of improper CT placement. Automatic correction for improper CT placement will also be possible.
C. Current Transformers shall be rated at a minimum for the total rated rms current of the load at the system installation point and shall have an output of current of 5 amperes.
D. Current Transformers rated for 400 Hz shall be used

2.5 Source Quality Control

A. The manufacturer shall fully test the performance of the AHF at full current and voltage, while functioning as a harmonic correction system to assure compliance with equipment specifications herein. The AHF shall be factory tested under steady state and varying load conditions.

Part 3 Execution

3.1 Installation

A. Preparation and installation of the AHF shall be in accordance with reviewed product data, final shop drawings, and manufacturer's written recommendations.
   1. Install low voltage active harmonic filters in accordance with the NEC and applicable local codes.

3.2 Field Quality Control

Select who does the inspections and testing below

A. Field inspection startup and testing shall be performed by a qualified technician from (the owner) (the contractor) (the manufacturer).

B. Perform equipment startup and testing in accordance with the manufacturer's instruction manual.

C. Document equipment nameplate information and startup/testing data on the manufacturer's recommended startup/test report.