SECTION 16280
LOW VOLTAGE ACTIVE HARMONIC FILTER SYSTEM
NEMA 1 ENCLOSED

PART 1 - GENERAL

1.1 SUMMARY

This specification defines the requirements for active harmonic filter systems in order to meet IEEE-519-2014 electrical system requirements for harmonic current limits. The active harmonic filter shall maintain power factor between 0.95 and 0.999 lagging when operated within limits.

1.2 STANDARDS

The active harmonic filter system shall be designed in accordance with the applicable sections of the following documents.

ANSI IEEE std 519-2014
UL 508
ARRA – American Recovery and Reinvestment Act
Manufactured in the USA

The products shall include third party approvals by cULus.

1.3 SYSTEM DESCRIPTION

1.3.1 System Description

A. **Voltage**: 208/240/480/600 Volts, 60 Hz, 3 phase, 3 wire plus ground.
B. **Current Rating**: Provide the rated current as indicated on the drawings
C. **Current Transformers:**
   1. Two current transformers are required and mounted on phases A & C.
   2. Current transformers are an integral part of the active harmonic filter. 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.
   3. Current ratings of the current transformers shall be according to full load current of the circuit on which installed. Primary rating of 500A, 1000A, 3000A, or 5000A with a secondary rating of 5A are acceptable.
   4. Current transformers rated for 400 hertz shall be used.
   5. The current transformers shall be placed as close as possible to the non-linear load to be conditioned, within manufacturer guidelines.

1.3.2 Philosophy of Operation

The active harmonic filter shall electronically supply the non-fundamental current demanded by the non-linear load that results in a near sinusoidal current being drawn from the supply.

1.3.3 Performance Requirements

A. **Response Time:**
1. In a steady state condition, the active harmonic filter shall have a response time of less than one (1) line cycle.
2. In the event of a load change or transient condition, the response time shall be within three (3) line cycles.

B. **Input Power**:
1. Voltage: 208/240/480/600 Volt, 3 phase, 3 wire plus ground
2. Voltage Tolerance: +/- 10% of nominal
3. Frequency: automatically adapted to 60Hz, +/- 3%
4. Input Circuit Breaker: 100k AIC Rated

C. **Output Performance**
1. Performance of the active harmonic filter shall be independent of the impedance of the power source. All performance levels shall be attained whether on the AC lines, backup generator, or output of UPS.
2. Harmonic Correction:
   a. Limit the 2nd through 50th order harmonic current to <5% TDD at each installed location indicated herein. Levels for individual harmonic orders shall comply with respective levels established in ANSI/IEEE std 519-2014.
   b. Limit the THD (V) added to the electrical system immediately upstream of the active line conditioner location(s) to less than or equal to 5%. The active harmonic filter shall not correct for utility supplied voltage distortion levels.
3. Reactive Current Compensation shall improve power factor to be to between 0.95 and 0.999 lagging.

1.4 ENVIRONMENTAL CONDITIONS

The active harmonic filter shall be able to withstand the following environmental conditions without damage or degradation of operating characteristics or life.
1. Operating Ambient Temperature: 0^0C to 40^0C.
2. Operating Ambient Temperature for selected open chassis units: -20^0C to 50^0C.
3. Storage Temperature: -40^0C to 65^0C.
4. Relative Humidity: 0 to 95%, non-condensing.
5. Altitude: Operating to 1000 meters (3300 ft).

PART 2 – PRODUCT

2.1 ENCLOSURE

A. Each filter shall be provided in a UL Type 1 rated enclosure.
B. All UL Type 1 enclosed units shall have means to prevent the door from being opened when the unit is energized. This can be achieved by either:
   1. A door-interlocked circuit breaker that provides power interruption when the door is opened. The circuit breaker shall be lockable in the power-off position. Units shall be disconnected from the power source by a disconnect device or circuit breaker contained in the power distribution center as defined by local and national codes for branch circuit protection. OR
   2. A mechanism that locks the door when the unit is energized. The unit may be fed using an external disconnect or breaker.
C. Freestanding units shall include lifting provisions by forklift truck and lifting lugs. Wall mount units weighing more than 80 pounds shall be equipped with a means of lifting, such as lifting lugs.
D. Door Mounted Digital HMI Operator Interface.
E. All units shall be provided with a grounding lug. Grounding by the contractor is to be performed according to local and national standards.

F. The paint shall be the manufacturer's standard type and color.
G. All enclosed units shall have a door-interlocked disconnect for power interruption when the door is opened.

2.2 OPERATOR CONTROLS and INTERFACE

A. The active harmonic filter shall require minimal field programming.
B. The active harmonic filter shall contain a color touch screen display with the following features:
   a) A minimum display size of 5.6 inches, 65k colors, and LED backlight.
   b) Easily navigable screens, including Home, Status, Fault and Setup screens.
   c) Display voltage and current waveform data along with RMS metering data.
   d) A gauge based indicator of active filter current usage, from 0 to 100% of capacity. Dual state indications of nominal operation and "at capacity" operation.
   e) An alarm history buffer saved in non-volatile. Buffer information shall persist between power outages, with a minimum of 128 event entries.
   f) Ability to set the end user Line/Load CT ratio of the active harmonic filter system.
   g) The Operator Interface shall show THD, Power Factor, RMS Current, RMS Voltage, and Fault History.
C. The active harmonic filter shall have the ability to operate in three (3) modes: i) harmonic correction only mode, ii) power factor correction only mode, or iii) combination harmonic and power factor mode. All three control modes shall be configurable from the local operator color touch screen display.
D. The active harmonic filter shall have a configurable relay based run/stop command input in addition to the manual and auto run/stop commands. The active filter shall have a configurable relay based fault output. Each contact shall be rated for 2.0 Amperes at 250 volts.
E. The filter shall have a configurable network based run/stop command input in addition to the manual and auto run/stop commands.
F. The filter shall have the ability to load and save operational parameters in non-volatile persistent memory and the ability to revert to factory default parameter settings.
G. The filter shall possess an integrated industry standard serial TIA/EIA-485 / RS-485 fieldbus slave network connection such as Modbus RTU for remote monitoring and operation of the active filter.
H. The filter shall have the ability to communicate over a standard industrial Ethernet communications network such as Ethernet/IP Modbus TCP/IP.
I. The filter shall have the ability to communicate over a standard industrial Fieldbus communications network such as DeviceNet.
J. The unit shall automatically begin to correct harmonic currents after power up without the need for operator intervention.
K. The unit shall have the ability to display trend history data for line voltage, line current, filter current, current THD, filter bus voltage, and filter heatsink temperature.

2.3 DESIGN

A. All active harmonic filters shall be defined as power electronic devices which consist of power semiconductors and a DC bus that acts to inject current into the AC line that will cancel undesirable harmonic currents drawn by the load. A DC bus shall store power for power semiconductor switching. A digital microcontroller shall control the operation of the power converter.
B. The active harmonic filter shall feature fully digital synchronous frame controls for selected harmonics to enhance drive load compatibility.
C. The active harmonic filter shall feature a fully digital, broadband current regulator with progressive gains to eliminate system resonance tuning issues and simplify startup and commissioning.
D. The active harmonic filter shall feature single processor control of all power electronic devices per a single active filter to reduce fault response latency and harmonic correction loop times
E. Each unit shall be designed with over-current and current limiting self protection. Operation shall continue indefinitely at manufacturer defined safe operating levels without trip off or destruction of the active harmonic filter.
F. All inductive elements in the power circuit of active harmonic filter shall be coreless, in order to maintain constant inductance and avoid saturation at high current levels
G. Units shall detect heatsink temperature and have the ability to fold back the current limit based on the temperature measurement.

H. Two distinct levels of faults shall be employed: Critical and Non-critical levels Non-critical level faults will provide automatic restart and a return to normal operation upon automatic fault clearance. Critical level faults stop the function of the unit and await operator action to restart.
   1. Faults such as AC line power loss shall be automatically restarted upon power restoration. Upon removal of these fault conditions, the active line conditioner shall restart without user action.
   2. All other faults shall be considered critical faults and stop the active harmonic filter. The run relay shall be disabled and the fault relay enabled. User shall be required to initiate a power reset (cycle power off and on) to restart the active harmonic filter.

I. The logic of the active harmonic filter shall monitor the load current by utilizing two (2) current transformers (CTs) mounted on phases A and C to direct the function of the power electronic converter.

J. Multiple active harmonic filters may be installed in parallel to inject current. The units will function independently. If one unit is stopped or faulted, the remaining units will continue to operate normally.

K. Individual unit characteristics, including sample drawings, weight, and watts loss, can be found in the Installation, Operation, and Maintenance Manual.

L. Approved Manufacturers: TCI

2.4 Factory Test

A. Each active filter shall undergo a functional test and a full load current burn-in test at its original manufacturing plant. Equipment including a harmonic producing load, current sense CTs, and an active filter under test shall be used for the following tests:
   a. A harmonic correction performance test to ensure harmonic correction and attenuation specifications are met. The unit shall be tested at greater than 80% of rated current at rated voltage and frequency.
   b. A full load current burn-in test to reach thermal steady state within the unit. The test duration shall be from 1 hour to 4 hours depending on the active filter amp rating. The filter shall operate at greater than 95% of rated current with at least 80% of the current comprising of harmonics.

B. A factory test report shall be available when ordered with the active filter.

PART 3 – Execution

3.1 EXAMINATION

A. The supplier shall verify that jobsite is ready to receive the active harmonic filter.

B. The supplier shall verify that the jobsite environment can be maintained during and after installation within the service conditions required by the manufacturer**.**

3.2 INSTALLATION

A. Installation shall be in compliance with all manufacturer requirements, instructions, and contract drawings, including:
   1. Space surrounding the active harmonic filter to maintain adequate cooling.
   2. Conditioning of space surrounding the active harmonic filter enclosure to maintain the manufacturer's ambient temperature and humidity ranges.
   3. Accessibility of the active harmonic filter diagnostic lights and communication ports – these components shall be free from obstructions at all times.

B. Interface
   1. The supplier shall provide all required cables and connectors to interface with other equipment.
   2. The supplier shall ensure that communication connections and wiring are properly protected in accordance with manufacturer recommendations.

3.3 START-UP SERVICE

A. At a minimum, the start-up service shall include:
   1. Pre-power check:

a) Verify proper active filter installation and clearances
b) Inspection of the filter for damage and debris
c) Verify critical electrical and mechanical connections are tight
d) Tug test internal connections and verify wiring
e) Update hardware if appropriate
f) Verification of proper power connection at filter input terminals
g) Verification of proper CT installations and electrical connections

2. Active harmonic filter power-up and commissioning:
   a) Power the active harmonic filter and perform operational checks
   b) Update software if appropriate
   c) If applicable run the filter with VFD load and tune filter to system attributes

B. Performance measurements shall be recorded
C. Active harmonic filter parameter listing shall be provided
D. Training on active filter operation shall be provided by manufacturer

END OF SECTION

Note: For best system performance, the Variable Speed Drives specification must include a total of 5% impedance source on the front of each VFD. A 5% line reactor, or DC link choke and 3% line reactor, are acceptable. The 5% impedance enables an optimal (lower) active filter rating.