



# Equipment Specifications

**Low Voltage  
Automatic  
Power Factor Correction  
Harmonic Mitigation Systems**

***StacoVAR***®

## 1.0 General Description

This section contains the design standards, general equipment type and configuration, components, product description, warranty and installation requirements for power factor correction (PFC) and harmonic mitigation systems, or harmonic filter correction (HFC). Such equipment shall be utilized for the improvement of power factor and/or mitigation of harmonics in AC electrical power systems.

The manufacturer shall have been engaged in the engineering and production of electrical equipment for a minimum of ten years. The finished product shall be designed, assembled, tested, and shipped by the PFC/HFC manufacturer. Equipment finished in any other manner is not acceptable.

## 2.0 System and Environment

PFC/HFC systems shall be suitable for environments of either indoor or outdoor, intended as either stand-alone or integrated with other equipment, such as motor control centers, switchboards, switchgear, static switches, voltage regulation, or UPS. Equipment is intended for use with voltage classifications from 240VAC to 600VAC and shall be provided in either a fixed or automatically switched configuration. PFC/HFC equipment shall be used on three phase, 3 wire, three phase 4 wire, grounded wye, ungrounded wye, or delta wire systems at 50 or 60 Hz. Equipment is designed for reliable, continuous operation in ambient temperatures of -5° C to + 40° C, up to 6000 feet (1800 meters) above sea level, with relative humidity of 70% at 20° C or higher, when controlled by thermostats, conditioned air, heaters and/or fans, where applicable. The finished StacoVAR equipment shall be UL listed to 508A, C-UL.

## 3.0 Basic Equipment Type

Equipment shall provide incoming/entry, capacitor, harmonic tuning reactor and auxiliary sections, where applicable. Compartments shall be segregated as required. Dependent upon the application, the finished assembly may include one of the following design arrangements:

**Power Factor Correction Capacitors** - use of externally fused capacitor configuration as either fixed or switched, along with electro-mechanical contactors, and bussing, mounted on a separate chassis/module. A multiple chassis/module system shall be vertically arranged to complete each enclosure section.

**Harmonic Suppression** - use of an externally fused capacitor and iron-core reactor configuration, as either fixed or switched, along with electro-mechanical contactors and bussing, mounted on a separate chassis/module system. Multiple modules shall be vertically arranged to complete each enclosure section.

## 4.0 Equipment Specifications and References

- A. Low voltage at load capacitors, transient free switched capacitors, real time switched capacitors, active harmonic filters
- B. Low voltage power distribution equipment, motor control centers, motors/drives, switchboards, switchgear
- C. Medium voltage switchgear, switches and static transfer switches
- D. Medium voltage metal enclosed capacitors and harmonic filters
- E. Engine-generator control, distributed generation systems, paralleling switchgear
- F. Energy management, SCADA systems
- G. UPS, voltage regulation, surge protection, and other power quality components
- H. American National Standards Institute (ANSI)
- I. Institute of Electrical and Electronic Engineers (IEEE)
- J. National Electrical Manufacturers Association (NEMA)

- K. Underwriters Laboratories, Inc. (UL)
- L. Canadian Standards Association (CSA)
- M. International Electrotechnical Commission (IEC)
- N. European Standards, EN

## 5.0 Submittals

Documentation for approval or reference shall be submitted in a CAD format. Common information, where applicable, shall include equipment plan view and outline dimensions, capacitor sections, incoming locations, cable entry, main bus ratings, capacitor, fuse, switching device, reactor rating data, mounting locations, and component technical descriptions.

## 6.0 Construction Guidelines

Equipment design shall follow the most recent applicable IEEE standards and guidelines and shall serve to meet the intended power factor and/or harmonic mitigation requirements. Installation and operation of equipment is for general business, commercial, industrial, government and energy or utility service provider.

The enclosure assembly shall be minimum 16 gauge formed sheet steel, with a rigid frame structure, manufactured in accordance to Staco Energy Products design criteria. Standard construction shall be bolted design and allow for ease of expansion and will be designed, where required, to include shipping splits. The complete assembly shall be painted using electrostatically applied powder coated paint, providing for enhanced durability and extended protection. Standard color shall be light grey, or other color as specified. Top or bottom entry shall be provided.

The finished enclosure shall provide front, rear and side access via hinged doors or bolted, removable panels. Doors shall be equipped with a latch-close system and include a lockable feature, where applicable. Hardware shall be environmentally sound; either zinc plated or stainless steel, for optimum corrosion resistance. The entire assembly shall provide adequate personnel safety and component security. Lifting lugs shall be provided for transport and to facilitate ease of installation of the finished equipment. Such removable lugs shall be located at the top of the equipment.

Enclosures shall be rated as NEMA 1, NEMA 12, (indoor) or NEMA 3R (outdoor). Where applicable, louvers shall be included for proper ventilation. For specific indoor or outdoor applications, aluminum mesh filters, fan(s) and heaters(s)/thermostats(s) shall be incorporated in the assembly. The design and construction integrity of the finished assembly shall allow for the equipment to be lifted, or slid into place. The "ready to ship" equipment shall meet stringent, applicable engineering and design standards and be neatly constructed and finished, meeting all Staco Energy Products quality and production control standards, prior to shipment.

## 7.0 Major Components

PFC/HFC equipment shall include, as a minimum, the following typical components and devices:

- Power Capacitors
- Current Limiting Fuses
- Capacitor Switching Devices
- Harmonic Filter Reactors (where applicable)
- Circuit Breaker (where applicable)
- Main Bus
- Controls (where applicable)

**Power Capacitors**, three phase type, shall meet or comply with industry standards, in particular IEEE Std. 18, NEMA CP-1, CSA 22.2, IEC 831, and UL 810. Each capacitor is contained in an unpainted aluminum cylindrical housing, with an internal self healing, metalized polypropylene film and castor oil-impregnated technology, allowing for improved voltage and current characteristics and reduced dielectric losses. Power capacitors shall contain no PCB material, will be non-polluting, non-toxic and comply with environmentally friendly requirements. In addition, capacitors shall include a safety design, incorporating an overpressure device and discharge resistors, which reduce residual voltage to 50VAC or less, within one minute from de-energization. Each capacitor shall include wire connections that are "finger safe." Each capacitor shall provide for low watt loss, and long life, with adequate overcurrent and overvoltage capabilities, constant output with little minimal variation in capacitance. The mounting arrangement of capacitors shall allow visual inspection and maintenance access, while allowing an individual capacitor to be removed without disconnection or removal of adjacent capacitors. Power capacitors shall also be capable to be mounted in an upright or side position, maintaining full operation. Capacitors designed with multiple internally connected elements per phase and housed in one encasement and capacitors that are internally fused are not acceptable. Capacitors shall have a five year warranty.

**Current Limiting Fuses** rated at 200KAIC, shall be utilized for protection and coordinated with the PFC or HFC equipment. Fusing is intended to protect system from major faults on all three phases. Fuse mounting arrangement shall be in such a manner to provide convenience for inspection and servicing and shall include blown fuse indication. Fuses shall be UL listed.

**Capacitor switching devices** employed shall be 3-pole electric-mechanical type contactors with a120VAC coil, providing for high-speed operation, while switching the low inductive, low loss capacitors. Each contactor shall be capable to withstand the full inrush current capacitors. Contactors are to include protection from contact welding by employing an early make contact design, along with damping resistors, where applicable (for back to back switching). Contactors shall be UL listed. Contactors shall be used with StacoVAR products.

**Harmonic Filter Reactors** (where applicable) shall be provided to mitigate principally the 5<sup>th</sup> order harmonic content and reduce harmonic amplification (de-tuned). Reactors shall be provided to correct other specific harmonic orders, as required. The reactor shall be sized appropriately for the purpose of tuning or de-tuning the power system. At a minimum, site collection and data analysis shall be provided to properly determine the reactor characteristics. Reactors shall be iron core with a gap-core construction, copper conductors, and be suitable to neutralize the harmonic content. Reactors are to be three phase, with Class H insulation (180° C), impregnated and baked with an epoxy resin, assuring an extended, reliable life. A thermal overload sensor shall be included. Reactors shall be UL listed or recognized.

**A circuit breaker** shall be provided to disconnect and isolate the PFC/HFC equipment from the electrical power distribution system. An acceptable switching device - molded case type circuit breaker, manually operated, or electrically operated shall be used where required. Switching device shall be rated according to the application and be UL listed.

**Main bus** shall be part of the finished assembly, fully rated and integral to the equipment. Horizontal and vertical bus is to be electrical grade, copper material, Brite Nickel Plated® and properly sized for the required rating. Insulated cable materials may also be utilized for component connections. Main bus shall be rated 50ka, at a minimum, and shall be braced to withstand specified short circuit ratings and provide adequate clearance. A grounding connection point shall also be included. Bus (bolted) joints shall utilize high quality grade bolts and Belleville washers. Design of bus system shall allow for expansion of the PFC/HFC assembly and for the integration with other power distribution equipment where required.

**Power Factor Controller** for automatic regulation of the PFC/HFC shall be accomplished with the use of a door mounted StacoVAR Intelligent Controller, allowing for fast, accurate and reliable measurements. Microprocessor based controller shall manage and perform a variety of functions to include: regulating a multi-step capacitor system for up to 12-steps provide automatic C/k setting and CT circulation direction, circular and linear logic, for sequential operation of capacitors and contactors, allowing for more even distribution, for improved performance and reduced maintenance, provide operating time ranges which can be set from 0.5 to 300sec (discharge time settings 5 to 255sec). System protection alarms shall include: overvoltage, overtemperature, harmonic overload, no voltage. LED visual display and/or lights shall include: power factor, line voltage, line current, active power, reactive power, C.T. current crest factor, number of operations (output relays), number of alarm conditions, internal enclosure temperature (area around the PF controller), number of steps operating. An RS485 communications port shall also be included. The Power Factor controller shall be UL listed or recognized.

Where required, surge protection, current transformers, programmable logic controllers (PLC) and other control, protection, energy management and communication technologies shall be designed as part of the equipment. Specific user controls and devices shall be part of the PFC/HFC system, where applicable.

For 120VAC power requirements, a control voltage/power transformer (CPT) shall be provided rated accordingly with sufficient load capacity. The CPT shall have both primary and secondary fusing, and be split-core, multi-ratio type. Wiring within the PFC/HFC equipment shall have insulation, rated for minimum 90° C at 600VAC, and include required terminal blocks and lugs located conveniently inside the assembly.

## 8.0 Systems Integration

The PFC/HFC shall be compatible to allow other power quality related components and devices to be incorporated, allowing for maximum equipment provisions. Where applicable, the equipment shall be designed in such a manner for system and physical integration with new or existing power distribution equipment.

## 9.0 Testing and Safety

The equipment shall be production tested, prior to shipment. This will include, at a minimum, mechanical functional operation, electrical functional operation, control wiring and circuit continuity, and polarity verification. Major electrical and mechanical components and devices integral to the equipment shall include testing reports and technical information and other such data, where applicable.

A manual for the purpose of operation and maintenance instruction shall be included with the finished equipment.

The finished equipment shall include nameplates, labels, and other decals, providing applicable safety and general operation instruction. Such markings shall be visually accessible and conveniently located, both internally and externally, providing information for:

- A. Danger - High Voltage; or:
- B. Danger - Keep Out, High Voltage will shock, burn or cause death
- C. Caution - Allow minimum 1 minute for capacitor discharge prior to equipment entry
- D. Caution - Verify switch(es) / breaker(s) open, prior to equipment entry

## 10.0 Equipment Documentation

The finished equipment shall be provided with design and construction documentation, such as:

- Physical dimension data, outline/plan elevation drawings, general component layout, and technical information, weight, and installation detail.
- Single line and three line drawings (where applicable)
- Control schematic and control program (where applicable)
- Component Bill of Material
- Operations and Maintenance Instructions

## 11.0 Equipment Installation

Correct installation is required for proper performance and function of the PFC/HFC equipment. Physical inspection of equipment for damage is recommended, prior to any installation. Indoor storage for indoor and outdoor rated equipment should be in a clean, dry environment. Outdoor storage of outdoor equipment shall require installation of

any materials shipped for site assembly, such as fans and bus ducts and the mating of equipment at shipping splits. Where recommended, packaging materials may be required to be removed.

Equipment includes removable lifting lugs, for transport and site installation handling. As a cautionary note, placement of PFC/HFC shall be at a level and solid location, for correct operation.

National Electrical Code (NEC), electric utility company or service provider codes shall be adhered to during the installation. Electrical connections shall also be in compliance with required codes

Installer/Contractor shall inspect and verify proper alignment, anchorage and grounding, proper connections and tightness of connections, prior to any start-up functions.

Appropriate personnel shall start-up and operate equipment upon installation approval.

## 12.0 Equipment Warranty

The manufacturer shall provide its standard warranty for equipment of this type. The warranty shall provide for repair or replacement of the equipment, should it be found to be defective within twelve months from the date of being first energized, or eighteen months from date of shipment, or whichever occurs first.

### Approved Manufacturer

The manufacturer of approval for the design, engineering, construction and testing of Power Factor Correction and Harmonic Mitigation Systems shall be:

Staco Energy Products Co.  
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