

# Frequency Converter (FC)

## Harsh Environment Three Phase

### Technical Specifications

#### PART 1 GENERAL

##### 1.1 SUMMARY

- A. The system shall be a solid-state, three phase, Frequency Converter designed to provide regulated and conditioned sinusoidal power to both linear and non-linear type loads. The specified equipment shall be referred to as "FC".

##### 1.2 STANDARDS

- A. The unit shall be listed to UL1778 latest reversion standards (at the time this is written).

##### 1.3 SUBMITALS

- A. Submittals for engineering approval shall contain the following documentation:
  - 1. Installation Drawings: Indicate electrical characteristics and connection requirements. Provide cabinet dimensions; size, dimensions, weight and location of conduit entry and exit; single-line diagram, control, and external wiring requirements; heat rejection and air flow requirements.
  - 2. Product Data: Provide catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
- B. Upon delivery of the FC system the following submittals shall be included:
  - 1. The specified FC system shall be supplied with one user's manual. Manuals shall include installation drawings and instructions, a functional description of the equipment with block diagrams, safety precautions, illustrations, step-by-step operating procedures and routine maintenance guidelines.

##### 1.4 QUALIFICATIONS & QUALITY ASSURANCE

- A. Manufacturers Qualification: A minimum of 20 years experience in the design, manufacture and testing of solid-state power conditioning systems is required.

- B. Factory Testing: Before shipment, the manufacture shall fully and completely test the system to assure compliance with the specifications.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. All products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by all modes of ground transportation and air transportation where specified.
- B. Prior to shipping all products shall be inspected at the factory for damage.
- C. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.

## 1.6 ENVIRONMENTAL REQUIREMENTS

- A. The FC shall operate under the following environmental conditions:
  - 1. Temperature:
    - a. FC unit
      - (1). Operating: -20° to +60°C (-4°F to 140°F)
      - (2). Non-Operating: -20°C to +60°C (-4°F to 140°F)
  - 2. Relative humidity (operating and storage): 0 to 95% non-condensing
  - 3. Altitude up to 6,000 feet (1,829 meters)
  - 4. Efficiency 93% typical
  - 5. Surge withstand capability ANSI C62.41-1980 Categories A & B
  - 6. Audible Noise: 62 DBA measures in “response curve A”

## 1.7 WARRANTY

- A. The UPS manufacturer shall warrant the FC against defects in materials and workmanship for one (1) year. Start-up and maintenance contract packages shall be available.

## PART 2 PRODUCTS

### 2.1 PRODUCT SPECIFICATION

#### A. FC Specifications

1. Output Rating: The continuous output power rating of the FC shall be shall be \_\_\_\_\_ KVA (refer to product data sheet for power levels).
2. Input Voltage: \_\_\_\_\_ VAC – 15% / +10%, single phase, 4 wire plus ground.
3. Output voltage(s): \_\_\_\_\_ VAC, 4 wire plus ground.
4. Frequency: \_\_\_\_\_ Hz.

#### B. Input Specifications

1. Voltage range of +10% to -15%
2. Power connections hard wired (terminal blocks).
3. Four (4) wires plus ground.

#### C. Output Specifications

1. Voltage Regulation:  $\pm 2\%$  for no-load to full load, high line to low line.
2. Frequency: 50, 60 or 400 Hz.
3. Harmonic Distortion: <5% THD; <3% total harmonic at 100% linear load.
4. Sine wave.
5. Crest factor of 2 to 1.
6. Overload: 125% for ten (10) minutes; 150% surge for ten (10) seconds.
7. Protection: Fault current limited.
8. Power Connections: Hard wired (terminal blocks), optional output circuit breakers.
9. Four (4) wires plus ground.

## 2.2 MODES OF OPERATION

- A. Normal: During normal operation, utility (or generation) power is converted to DC, this converter supplies DC power to the Inverter section. The Inverter supplies power converters the DC to the desired AC voltage and frequency.

## 2.3 COMPONENT DESCRIPTION

- A. INVERTER: Incoming AC power shall be converted to a DC output by the input converter for supplying DC power to the inverter.
  1. The inverter shall convert the AC power supplied from the utility, when within specified limits, to output AC power. It shall be a pulse width modulated (PWM) type design. The unit shall have a three power PCB for maximum reliability (multiple PCB's decrease reliability).
  2. Overload: The inverter shall be capable of supplying current and voltage for overloads exceeding 100% and up to 125% of full load current. A visual indicator/alarm shall indicate overload operation. For greater currents or longer time duration, the inverter shall have electronic current-limiting protection to prevent damage to components. Inverter control logic shall sense and disconnect the inverter from the critical load without the requirements to clear protective fuses.
  3. Maximum Load Alarm: The user receives an alarm when the unit is overloaded (greater than 100%) such that the FC will alarm before an overload condition causes the unit to shut down.
  4. Power Connections: The FC shall be hard-wired input and output.
  5. AC Input Current Limit: The input converter shall be provided with AC input over current protection. The unit shall not allow an overload to sustain damage to the unit; the unit will alarm the end user when an overload is present.
  6. Input Protection: The FC shall have built-in protection against under voltage, over current, and over voltage conditions including low-energy surges introduced on the primary AC source. The FC shall sustain input surges without damage per criteria listed in IEEE C62.41, Category A & B. The FC cabinet shall contain an input breaker sized to supply the fully rated load.
  7. Output Frequency: A microprocessor-controlled oscillator shall maintain the output frequency of the inverter. The oscillator shall hold the inverter output frequency to  $\pm 0.5\%$  for the steady state and transient conditions.
  8. Output Protection: The inverter shall employ electronic current limiting. (Optional output circuit breakers are available)

- B. Fabrication: All materials and components making up the FC shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The FC shall be constructed of replaceable subassemblies. All active electronic devices shall be in solid-state
  - 1. Wiring: Wiring practices, materials and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70) and other applicable codes and standards.
  - 2. Cabinet: The FC unit shall be comprised of: power module, control module, system interconnect module and user interface module housed in a freestanding enclosure. The FC cabinet shall be cleaned, primed and painted with the manufacturers standard color.
  - 3. Cooling: The FC shall be forced are cooled by internally mounted fans. The fans shall be redundant in nature to ensure maximum reliability; The fans shall be easily replaceable without the use of special tools.

## 2.4 SYSTEM CONTROLS AND INDICATORS

- A. The system status panel on the FC shall have a liquid crystal display. The LCD display shall display FC operating information such as input voltage, output current, output voltage and output KVA, also alarm information.
  - 1. If there is a fault condition, the FC shall attempt to maintain conditioned power to the load.
  - 2. There shall also be indication on each module should the module fail and need to be replaced
  - 3. In addition to a visual fault signal, the FC shall also record fault occurrences in a rolling event log. The event log on the standard unit shall record up to 63 occurrences, with the oldest events discarded first, etc. Every alarm and/or event recorded in the event log will contain a time and date stamp.

## 2.5 COMMUNICATIONS

- A. The FC shall allow for flexibility in communications. The use of relay contacts shall not affect the operation of the two communication ports.

## PART 3 FIELD SERVICE

Factory trained field service personnel shall perform the following inspections and test procedures during the FC start-up as required.

### 3.1 VISUAL INSPECTION

- A. Inspect equipment for signs of shipping or installation damage.
- B. Verify installation per drawings.
- C. Inspect cabinets for foreign objects.
- D. Verify neutral and ground conductors are properly sized and configured.

### 3.2 MECHANICAL INSPECTION

- A. Check all power modules are correctly fitted.
- B. Check all terminal screws, nuts and/or spade lugs for tightness

### 3.3 ELECTRICAL INSPECTION

- A. Confirm input voltage and phase rotation is correct.

### 3.4 UNIT START UP AND SITE TESTING

- A. The manufacturers field service personnel shall provide site testing if requested. Site testing shall consist of a complete test of the FC system and the associated accessories supplied by the manufacturer. The test results shall be documented, signed and dated for future reference.

### 3.5 MANUFACTURERS FIELD SERVICE

- A. Service Personnel: The FC manufacturer shall directly employ a nationwide service organization, consisting of factory trained customer engineers or 3<sup>rd</sup> party dedicated to the start-up maintenance and repair of FC and power equipment. The organization shall consist of factory-trained customer engineers working out of District Offices in most major cities. An automated procedure shall be in place to insure that the manufacturer is dedicating the appropriate technical support resources to match escalating consumer needs.

The manufacturer shall provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number shall reach a qualified support person 24 hours/day, 7 days/week and 365 days/year. If emergency service is required call back response time for a local customer engineer shall be approximately 15 minutes.

- B. Replacement Parts Stocking: Parts shall be available through an extensive network to ensure around the clock parts availability around the country.

Customer support parts coordinators shall be on-call 24 hours a day, 7 days a week and 365 days a year for immediate parts availability.

- C. FC Maintenance Training: Maintenance training courses for customer employees shall be available by the FC manufacturer. This training is in addition to the basic operator training conducted as a part of the system start-up.

The training course shall cover FC theory, location of subassemblies, safety considerations and FC operational procedures. The course shall include AC to DC conversion and DC to AC inversion techniques as well as control and metering. Troubleshooting and fault isolation using alarm information and internal self-diagnostics shall be stressed.

### 3.6 MAINTENANCE CONTRACTS

- A. A complete offering of preventive and full service maintenance contracts for the FC system shall be available. An extended warranty and preventive maintenance package shall be available. Trained customer engineers shall perform warranty and preventative maintenance service.

END OF SECTION