AMETEK®
POWERVAR

3300 Series

Three Phase UPS Specification

15/20kVA

AMETEK POWERVAR

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1. SCOPE

This specification describes an on-line, double conversion three-phase, solid state, dual input uninterruptible power system, hereafter known as the UPS. The UPS shall operate utilizing the existing power distribution system to provide a high quality, reserve source of power to electronic equipment loads. The system shall consist of a converter, system battery, solid-state inverter, automatic static bypass transfer circuit and integral maintenance bypass circuit. UPS design shall be for an 18-year life.

2. SYSTEM DESCRIPTION

2.1 COMPONENTS

The UPS shall be comprised of the major components listed below:

2.1.1 Insulated Gate Bipolar Transistor (IGBT) Converter Section
2.1.2 Insulated Gate Bipolar transistor (IGBT) Inverter Section
2.1.3 Digital Signal Processor (DSP) using Pulse Width Modulation (PWM) control for Direct Digital Control (DDC) of all UPS control and monitoring functions.
2.1.4 Static Bypass switch sized to provide fault clearing (>130% for 1 seconds)
2.1.5 Standard features:

a) Transistorized PWM IGBT Converter
b) Transistorized PWM IGBT Inverter
c) DSP based fault memory and diagnostics
d) DSP based menu controlled operation
e) Active mitigation of reflected input current harmonics
f) Active control of output distortion
g) Automatic input current walk-in
h) Automatic UPS restart and load pick-up (after system battery depleted, AC restored).
i) Remote Emergency Power Off (EPO)
j) Input AC Disconnect and Fuse Protection
k) Internal Maintenance Bypass Switch (3 breaker MBS)
l) Battery Self Test (programmable times)
m) 4.3” color LCD touch screen display provides full system control and monitoring
n) Communication Network Interfaces for UPS Management (SNMP/WEB/Modbus)

2.1.6 Optional features:

a) Input Isolation Transformer (Standard on all 480-208/120. 480-480/277, 600-208/120 and 600-600/347 units). (Available in separate enclosure)
b) Matching and non-matching battery cabinets
c) Wall-mounted and external maintenance bypass cabinets
d) Matching maintenance bypass cabinets (floor units)
e) Software for Central Monitoring of Facilities-wide UPS
f) Software for Automated Shutdown of Server & Workstation Computers

2.2 MODES OF OPERATION

The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic system in the following modes:

2.2.1 Normal Mode- The inverter continuously supplies AC power to the critical load. The converter converts commercial AC power to regulated DC power which then serves as the inverter input and, simultaneously, as a float charge input to the battery system.

2.2.2 Backup Mode – In the event of a commercial AC power failure, the inverter shall derive it's input from the battery system, thus providing uninterrupted power to the critical load. This transition shall be accomplished without any switching or coupling, and with no interruption of power to the critical load from either a failure or restoration of the commercial AC power.

2.2.3 Bypass Mode – In the event that the UPS must be taken off-line due to an overload condition or UPS failure, the critical load shall be transferred to the bypass source via the static switch without interruption of power to the critical load. The static switch shall only be utilized for automatic emergency transfers. A re-transfer from bypass to inverter shall be performed automatically in overload conditions. A re-transfer shall be inhibited if satisfactory synchronization of the inverter and the bypass is not accomplished.

2.2.4 Internal Maintenance Bypass – The UPS system shall be equipped with an internal maintenance bypass to allow safe and reliable maintenance of the UPS. The MBS shall be of the 3 breaker "Make-before-Break", "Zero Energy" type to ensure maximum load reliability and personnel safety.

2.2.5 Frequency Conversion Mode – The UPS can convert the input frequency (either 50 or 60 Hz.) to a selectable (50 or 60Hz) output frequency.

2.2.6 Please note: When in frequency conversion mode, the static bypass is automatically disabled.

2.3 APPLICABLE STANDARDS

The UPS has been designed in accordance with, and complies to, the following standards:

a) UL 1778 (4th edition) and CSA 22.2 (cUL equivalent)
b) IEC, 62040 UPS Standard
c) ISO 9001 Quality Assurance Program.
d) EMI compatibility: FCC Title 47, Part 15, Subpart B.
e) IEEE C62. 41-1991
f) Seismic Rated (Pending— expected completion 4th qtr. 2019)
g) OSHPD Rated, File#OSP-0336—10 (Pending— expected completion 4th qtr. 2019)

3. PERFORMANCE CHARACTERISTICS

3.1 POWER RATINGS

The UPS output capacity shall be:

- 15kVA/15kW @ 1.0 PF lagging or leading
- 20kVA/20kW @ 1.0 PF lagging or leading

3.2 INPUT (CONVERTER)

3.1.1 Nominal input voltage: 208VAC, 3 phase, 4 wire
3.1.2 Input voltage range: -18% to +22% of nominal voltage @ 100% load (+/-3%)
3.1.3 Input frequency range: 50/60Hz +/- 4Hz in each range
3.1.4 Input power factor: 0.99 at 100% load, 0.98 minimum at 50% load
3.1.5 Converter walk-in time: 20 seconds

3.3 INPUT (BYPASS)

3.3.1 Nominal input voltage: 208VAC, 3 phase, 4 wire
3.3.2 Input synchronization voltage range: +/- 10% of nominal
3.3.3 Input frequency tracking range: +/- 4 Hz

3.4 OUTPUT

3.4.1 Nominal output voltage: 208VAC and 220VAC, 3 phase, 4 wire
3.4.2 Static voltage regulation: +/- 2%

3.4.3 Voltage transient response: Voltage transient response shall not exceed the following, and shall recover to within nominal voltage regulation limits within 10 milliseconds:
a) +/- 1% (loss or return of AC input)

3.4.4 Output frequency (inverter synchronous): 60Hz (tracks frequency of static bypass source) +/- 0.2, 0.5, 1.0, 2.0 Hz (user settable).

3.4.5 Output frequency slew rate (inverter synchronized to static bypass)

3.4.6 Free running output frequency (on battery or asynchronous): 60Hz +/- 0.01%

3.4.7 Output voltage harmonic distortion:
a) Less than 1% (Linear load), less than 4% (non-linear load)

3.4.8 Output overload capability
a) > 300%, 140 milliseconds
b) > 130%, 1 second
c) 110% - 130%, 1 minute
d) 100% - 110%, 60 minutes

3.5 ENVIRONMENT

The UPS shall be capable of withstanding any combination of the following external environmental conditions without mechanical damage, electrical failure or degradation of operating characteristics.

3.5.1 Efficiency:
- DC to AC (emergency mode, 100% load): up to 92.5%
- AC to AC (normal mode, 100% load): 94%
- ECO Mode: 97%

3.5.2 Ambient operating temperature range: 0 to +40 degrees C (no de-rating required)

3.5.3 Storage temperature (non-operating): -20 to +60 degrees C. (without batteries)

3.5.4 Relative humidity
a) Maximum operating range: 5% to 95% (non-condensing).
b) Recommended operating range: 30% to 90%.

3.5.5 Heat dissipation (at 100% load).
a) 10kVA = 2.57kBTU/Hr at 208 VAC input

3.5.6 Acoustical noise level: <60dba @ 1 meter.

3.6 RELIABILITY

The UPS equipment reliability shall be represented in terms of "Theoretical" Mean-Time-Between-Failures (MTBF). The UPS manufacturer shall, at a minimum, provide the following capabilities:

3.6.1 Total single module UPS system output (reliability of critical bypass circuit components only):

159432 MTBF hours

3.6.2 Single module UPS operation (represents UPS module operation only – with prescribed maintenance program):

87600 MTBF hours

3.7 MAINTAINABILITY

Mean-Time-To-Repair (MTTR) shall not exceed two (2) hours (time to replace components).

3.8 SYSTEM BATTERY

The system battery (included in the UPS) is sized to provide the specified back-up time to the inverter when the UPS is supplying 100% rated load. The external battery (if required) shall be of the VRLA type. Additional battery back-up can be added. Standard external battery packs are available which may be used with or without the internal battery pack.

3.8.1 The battery is made up of two and three strings (10 x 10 each). Each shall be capable of operating in an average ambient temperature of 25 degree C, with excursions of 16 ° C to 32 ° C. The voltage for each 1/2 string is:

- Float voltage: 135 VDC (2.25 /cell)
- Final voltage: 105 VDC (1.75 V/cell) = Shutdown voltage

3.8.2 Internal battery AH rating and runtimes

- a) 15 kVA 9 AH 4.5 minutes @ 100% load
- b) 20kVA 9 AH 6 minutes @ 100% load

4. FUNCTIONAL DESCRIPTION

4.1 CONVERTER

4.1.1 General

The converter shall convert the incoming AC power into regulated DC power to supply the inverter input and system battery. The Converter shall utilize the following technologies:

a) Solid state PWM controlled IGBT (Insulated Gate BiPolar Transistors) power transistors switching at 19.2kHz. Switching shall be defined as the IGBT turn on and turn off rate.
b) Input Power: Rated kVA at 1:1 ratio.
c) DSP based control logic.

4.1.2 Input Current Limit

The Converter logic shall provide input current limiting by limiting the AC input current. Three (3) line-side current transformers shall be employed as a means of sensing the current amplitude. The Converter shall be capable of supplying one-minute overload current equal to 130% of its full load rating. It shall also provide sufficient capacity to provide power to a fully loaded inverter while simultaneously recharging the system battery to 90% of full capacity within 9 hrs. recharge time.

4.1.3 Battery Charge Current Limit

The Converter logic shall provide DC battery current limiting for the controlled battery charging. The battery current sensing shall be independent of the Converter DC output current sensing to provide precise battery re-charging.

4.1.4 Voltage regulation

The Converter output voltage shall not deviate by more than +/-6% RMS due to the following conditions:

a) From 0 to 100% loading (w/25ms recovery time)
b) Converter input variations of voltage and frequency within the limitations set in section 3.2.
c) Environmental conditions variations within the limitations set in section 3.5.

4.1.5 Reflected Harmonic Content

The converter shall not produce more than a maximum of 2% reflected current distortion into the Converter input utility source when nominal voltage and rated load is applied.

4.1.6 Automatic Input Walk-in

The Converter logic shall employ circuitry to allow a delayed and timed ramping of the input current. Subsequent to energizing the Converter input, the ramping of current shall be delayed by a maximum of three (3) seconds. Upon starting the walk-in process, the ramping of current shall be timed to assume the load gradually within 20 seconds. This function shall be supplied as standard equipment.

4.1.7 Input Overload protection

An input AC fuse/contactor arrangement shall provide Converter input overload isolation protection. The input AC fuse/contactor shall be standard.

4.1.8 Step-Load (0-100%) changes

100% step load changes shall use only the converter to supply power to the inverter. The batteries SHALL NOT be cycled at any time during these steps load changes.

4.1.9 Battery Test

For a short duration of time, (30 seconds) the output power is delivered from the battery. From the discharge, the UPS evaluates the degradation of the battery. The following advantages are therefore achieved:

a) Battery Self-Test function can be performed even when the load is on inverter.
b) Due to short duration small power discharge there is little to no effect to the battery life expectancy.
c) Negligible effect on overall battery back-up time. The small power discharged, is quickly replenished.

4.2 INVERTER

4.2.1 General

The Inverter shall generate AC power that is derived from DC power supplied from the Converter or the battery system. The Inverter shall be capable of providing rated output as stated in section 3.4 while operating from any DC voltage within the battery operating range. The Inverter shall utilize the following technologies:

a) Solid state PWM controlled IGBT power transistors switching at 19.2kHz Switching shall be defined as IGBT turn on and turn off rate.
b) Digital Signal processing (DSP) based control logic.

4.2.2 Voltage regulation

The Inverter output voltage shall not deviate by more than +/-6% RMS due to the following steady state conditions:

a) 0 to 100% loading (w/25ms recovery time)
b) Inverter DC input varies from maximum to minimum.
c) Environmental condition variations within the limitations set in section 3.5.

4.2.3 Frequency Control

The Inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g.; the bypass source) or operating asynchronously. The oscillator shall maintain synchronization with the external reference within the limitations set in section 3.3.3. A front panel display alarm alerts the loss of synchronization. Synchronization shall be maintained at 60Hz +/- 0.01 continuously. The inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

a) 0 to 100% loading.
b) Inverter DC input varies from maximum to minimum.
c) Environmental condition variations within the limitations set in section 3.5.

4.2.4 Output Harmonic Distortion

The Inverter output shall limit the amount of harmonic content to the values stated in section 3.4.7.

4.2.5 Output Overload Capability

The Inverter output shall be capable of providing an overload current while maintaining rated output voltage to the values stated in section 3.4.9. A front panel alarm shall indicate this condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current amplitude, the load power shall be transferred to the bypass source without interruption.

4.2.6 Inverter Current Limit

The inverter output shall also be limited to 300% of the rated current load. Two sensing locations shall operate separately and independently thus providing redundancy and, in the event of a failure, prevent unnecessary damage to power transistor component/fuses. Load current above 300% shall cause a transfer (within ½ cycle) of the load to the bypass source for fault clearing.

4.2.7 Inverter Overload Protection

The Inverter AC output shall utilize electronic current limiting for overload conditions. The Inverter shall utilize a static switch to isolate its output from the critical bus.

a) The Inverter DC fuses shall be fast acting semi-conductor type to clear faults on the DC bus.

4.3 BYPASS AND STATIC SWITCH

4.3.1 General

A bypass circuit shall be provided as an alternate source of power other than the inverter. A high-speed thyristor assisted relay circuit shall be used to assume the critical load during automatic transfers to the bypass circuit. The static switch module shall be 100% continuously rated thus, increasing system reliability. The static switch shall be capable of supplying the UPS rated load current and also provide fault clearing current. The UPS system logic shall employ sensing which shall cause the static switch to energize immediately thus providing an uninterrupted transfer to the bypass source when any of the following limitations are exceeded:

a) Inverter output under-voltage or over-voltage.
b) Overloads beyond the capability of the inverter.
c) DC circuit under-voltage or over-voltage.

d) Final voltage of system battery is reached (bypass source present and available).
e) System failure (e.g.: logic fail, fuse blown, etc.)

4.3.2 Automatic re-transfers

In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic shall monitor the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow re-transfer to occur three times within a one minute period. Re-transfers shall be inhibited on the fourth transfer due to the likely-hood of a recurring problem at the UPS load distribution. The re-transfer of the load to the inverter shall also be inhibited due to the limitations set in section 3.3. All re-transfers will be inhibited if the inverter and static bypass line are not synchronized.

4.3.3 Manual Transfers

The UPS shall be capable of transferring the critical load to/from the bypass source via the front control panel. Manual transfers will be inhibited if the inverter and the static bypass line are not synchronized.

4.3.4 Static Switch

The static switch shall be a high- speed transfer device comprised of a thyristor assisted relay circuit.

4.4 INTERNAL MAINTENANCE BYPASS

4.4.1 The UPS system shall incorporate a manual internal maintenance bypass (MBS) system to allow for safe and reliable maintenance of the UPS. The maintenance bypass system shall be a “Make before Break”, zero energy type to ensure maximum load reliability and personnel safety.

5. OPERATOR CONTROL PANEL

The AMETEK Powervar 3300 Series indication and controls are implemented with a 4.3” color LCD touch panel. The LCD display provides the following functions:

5.1 SYSTEM DIAGRAM

A system diagram identifying the internal UPS power circuits, contactors/circuit breakers, operating status and fault conditions is provided on the LCD Display. The following displays are included:

a) Normal Operation – AC Present
b) Battery operation – AC Not Present
c) Load on Static Bypass
d) Load on internal maintenance bypass

5.2 REMOTE OPERATION

An Emergency Power OFF (EPO) function is provided as a separate input on the I/O PCB. It requires a normally closed switch.

5.3 MICROPROCESSOR INTERFACE/DIAGNOSTICS

5.3.1 Microprocessor Controls

The microprocessor shall monitor each step, thus prompting itself to the next step of the instructions. The following instructions shall be available on the display interface

a) Inverter stop (transfer to bypass)
b) Inverter start
c) UPS shutdown (output OFF)
d) UPS start-up

5.3.2 Microprocessor Controlled Metering

All meters shall be digitally displayed having an accuracy of 1% or better. The following parameters shall be available for display on the touch screen:

a) Converter input voltage (all phases L-L and L-N)
b) Converter input current (RMS all phases)
c) Converter input frequency
d) Input Power (kW) and Apparent (kVA)
e) Battery voltage
f) Battery charging/discharging current
g) Estimated runtime remaining
h) Output L-N voltage (all phases)
i) Output current in RMS Amps (RMS each phases)
j) Load Effective and Apparent Power
k) Percentage of load
l) Output Frequency

5.3.3 Microprocessor Controlled Diagnostics

The UPS shall provide microprocessor controlled diagnostics capable of retaining fault alarms along with metering parameters in the event of a UPS failure. The microprocessor memory data shall be viewed via a touch screen LCD display located on the front of the UPS. The following alarms/status information shall be provided:

- Rectifier Overload
- Inverter Overload
- Main Input Failure - Discharging
- Output DC Voltage
- Maintenance Bypass. Inverter Stop
- High Temperature. Reduce Applied Load
- Bypass Failure. Not Synchronized Inverter
- Unit on Bypass
- End of Battery Life
- Battery Temperature too High
- Battery Test Fail
- Batteries Disconnected
- Mains Phase Rotation Error
- Bypass Phase Rotation Error
- Input Voltage Wrong. Rectifier Stop
- Input Phase Rotation Error
- Shutdown command
- Over-temperature. Inverter Stop
- Low Battery. UPS Stop
- Emergency Power Off
- Output Short-circuit
- Inverter Failure - Overload
- Voltage Ramp Error – Inverter Stop
- DC BUS Voltage Wrong

6. CONTROL LOGIC POWER

The UPS control logic power supply shall employ a redundant design utilizing the UPS utility input and the battery as power sources.

7. UPS STATUS INTERFACE

7.1 UPS MANAGEMENT COMMUNICATIONS NETWORK INTERFACES

The UPS manufacturer shall offer communications network interface options for remote monitoring via SNMP, WEB, E-Mail and MODBUS communication protocols with the following functionality:

7.1.1 Physical Interfaces to Communications Networks

7.1.1.1 Ethernet Interface: 10/100 Base-T for SNMP/WEB, MODBUS TCPIP, Email & Server/computer shutdown

- Class 1 (DIX) packet format 802.3u Compliant
- Compatible w/FastEthernet full/half duplex

7.1.1.2 Serial Communications Interface for MODBUS RTU

- RS232, RS422, RAS485 – 2-wire, RS485 4-wire

7.1.1.3 Accessories Communications Interface for Environment Sensors

- CAN (Control Area Network)

7.1.2 Hardware Regulatory Compliance

- Complies with FCC Class A emissions
- Complies with CE emission and susceptibility requirements

7.1.3 Optional Environment Sensor

- Up to 16 Environment Sensors can be attached to the CAN network
- Each Sensor will read Temperature (0-75 degrees C, +/-1 degree C @10-50 degree C), Humidity (1-99%, +/-2%@10-90RH) and 3 digital inputs (“dry” relay contacts)

7.1.4 Embedded Software Application will provide the following services

TCPIP Network Configuration:

- Static, or Dynamic via DHCP client (RFC2131 & 2136-DDNS)
- IPv4

- Network Update of Firmware and Configuration files
- Event and Data Logging to local Flash memory with NTP client for date/time coordination.
- Event and Data logs downloadable as field delimited plain text files.

- WEB Servers
- Telnet Server
- E-mail alarm/alert messaging integrates with SMTP Servers for email forwarding via three selectable Email message formats: Long, Short, Short-No-Subject for compatibility with SMS message forwarding.
- Network Shutdown Controller
  - Calls Server Shutdown on UPS On Battery, Low Battery or Environment Sensor alarms via Ethernet communications network.
  - Routed (not broadcast) connections to specified remote host addresses via TCP sockets with authenticated login to call OS shutdown (OS shutdown enabled via Software – see 8.4)
  - Able to address 5,080 hosts 4 group delay intervals
- SNMP Agent Implements MIB-II (RFC1213) and IETF Standard UPS MIB (RFC1628)
- MODBUS Services to Include:
  - MODBUS TCPIP
  - MODBUS RTU (RS485 2-wire /4-wire, RS232. RS422)
  - MODBUS Diagnostics via WEB interface for RTU communications troubleshooting
- Optional Environment Sensor Integration via WEB interface, SNMP Agent, E-Mail and Network Shutdown Controller.

7.2 SOFTWARE FOR CENTRAL MONITORING OF UPS & ENVIRONMENT SENSORS

The UPS manufacturer shall offer software for central monitoring and management of UPS and Environment Sensors distributed across a building, campus or enterprise WAN environment. Monitoring software shall have the following functionality:

7.2.1 Monitor any brand/manufacturer UPS fitted with that manufacturer's RFC1628 compliant SNMP agent, attached to a TCPIP Ethernet communications network.

7.2.2 Offer Install packages for Windows Server or Linux Server OS, real or virtual.

7.2.3 Provide thin-client UI component that can be installed on multiple workstations to allow access to monitoring server

7.2.4 Allow monitoring of up to 1,500 UPS/Sensor devices from each monitoring server

7.2.5 Provide a multi-level pin map for locating UPS assets by geography or within a facility floor plan diagram.

7.2.6 Provide a view of all devices with active alarm conditions

7.2.7 Allow organizing of UPS asset list by Folders and Groups

7.2.8 Provide a Rules-Based “Smart Group” mechanism to automatically and dynamically group devices based on specific alarms or other properties of interest. “SmartGroup” mechanism must be capable of sending email alerts whenever Group contents change.

7.2.9 Print preformatted Reports and/or export lists of any Group or SmartGroup for archive or further analysis

7.2.10 Provides for forwarding of summary alarms to higher level Facility Monitoring systems via BACnet TCPIP protocol

7.3 SOFTWARE FOR AUTOMATED SERVER SHUTDOWN

The UPS manufacturer shall offer software for safe, automated shutdown of multiple server computers on a shared UPS. The software will have the following features/functions:

7.3.1 Install packages offered for MS Windows, Linux, Solaris (UNIX) operating systems and VMWare ESX environments.

7.3.2 Authenticated login – software will only accept/execute host OS shutdown commands if the shutdown requestor presents a known password (MD5 encrypted) as part of the connection request.

7.3.3 Software can execute a script/batch file on the local host prior calling shutdown of the host OS.

8. MECHANICAL DESIGN

8.1 ENCLOSURE

The UPS shall be equipped with casters to allow for ease of movement and installation.

8.2 VENTILIATION

Forced air cooling shall be provided to allow all components to operate within their rated temperature window.

8.3 BUSBAR

All busbar used for conductivity within the UPS shall be designed with COPPER, or copper with silver plating for best conductivity.

9. FACTORY TEST REPORT

All UPS units shall come equipped (as standard) with one (1) factory test report included in the UPS. The factory test report shall include the following:

a) Series/kVA/kW
b) Serial Number
c) Date of test
d) Approved by/Inspected by/Tested by
e) Inspection of construction
f) Continuity of Grounding
g) Insulation strength test
h) Measurement of steady state characteristics
i) Transient characteristics (0-100% step load test)
j) Overload testing (150% for one (1) minute)
k) Transfer switch operation
   - Manual transfer - Inverter to Bypass
   - Manual transfer - Bypass to Inverter
   - Automatic transfer - AC Fail
   - Manual transfer - Inverter to Maintenance Bypass

10. FIELD PREPARATION

10.1 FIELD PREPARATION

The owner shall prepare the site for installation of the equipment.

10.2 INSTALLATION OF EQUIPMENT

a) UPS shall be placed in planned area, wired and connected in accordance with the approved drawings and technical manual delivered with equipment.
b) The installation shall be in accordance with local and manufacturer's recommendations.

10.3 FIELD QUALITY CONTROL

a) The equipment shall be checked and started by a customer support representative from the equipment manufacturer. Visual and mechanical inspection of electrical installation, initial UPS startup and operational training shall be performed. A signed report shall be submitted after equipment is operational.

b) The following inspection and test procedures shall be performed by field service personnel during the UPS startup.

Visual Inspection

- Ensure interior of UPS is free of foreign objects, tools and dirt.
- Check for damage (scratches, dents, frame misalignment, etc…)
- Check doors for proper alignment and operation.

Electrical Inspection

- Check input and bypass for proper voltage and phase rotation.
- Check batteries for proper voltage and polarity.

Mechanical Inspection

- Check all power wiring connections and tightness.
- Check all control wiring connections for tightness.

Start-up

- Start UPS.
- Check DC output voltage and inverter output voltage.
- Check the inverter output voltage on battery operation.
- Check for proper synchronization.
- Perform manual transfers and returns.