

**STATIC UNINTERRUPTIBLE POWER SUPPLY  
GUIDE SPECIFICATION  
Eaton 93PM 20-200 kW UPS  
Models 50, 50+1, 100, 100+1, 150, 150+1, and 200**

**PART 1 - GENERAL**

**1.01 SUMMARY**

- A. This specification describes a three-phase continuous duty, on-line, double conversion solid-state uninterruptible power system, hereafter referred to as the UPS. The UPS shall operate in conjunction with the existing building electrical system to provide voltage conditioning, back-up and distribution for critical electrical loads. The UPS shall consist of, as required by the project, the UPS module, batteries, or other DC storage system and accessory cabinet(s) for transformers, maintenance bypass, and distribution applications, and other features as described in this specification.

**1.02 UPS SYSTEM DESCRIPTION**

- A. UPS System Components: The UPS system shall consist of the following main components:
1. UPS module containing Rectifier(s), Inverter(s), Battery Charger(s), Static Bypass, and associated Control and Monitor Panel.
  2. Battery string(s) in Line-and-Match Battery Cabinets.
  3. Line-and-Match and/or sidecar-type accessory cabinets for transformer, maintenance bypass, parallel tie and distribution applications.
  4. Non-matching wall mounted or floor standing maintenance bypass cabinet multi-module parallel tie cabinets.
- B. UPS Module Modes of Operation: The UPS Module shall operate as an on-line, fully automatic system in the following modes:
1. Normal: Utilizing commercial AC power, the critical load shall be continuously supplied by the Inverter. The Inverter shall power the load while regulating voltage and frequency. The Rectifier shall derive power from the commercial source and shall supply DC power to the Inverter. Simultaneously, the Battery Charger shall charge the battery.
  2. Battery: Upon failure of the commercial AC power, the critical load shall continue to be supplied by the Inverter, which shall obtain power from the batteries without any operator intervention. There shall be no interruption to the critical load upon failure or restoration of the commercial AC source.
  3. Recharge: Upon restoration of the AC source, the Charger shall recharge the batteries and simultaneously the Rectifier shall provide power to the Inverter. This shall be an automatic function and shall cause no interruption to the critical load.
  4. Bypass: If the UPS module must be taken out of the Normal mode for overload, load fault, or internal failures, the static bypass switch shall automatically transfer the critical load to the commercial AC power. Return from Bypass mode shall be automatic.

the critical load to the commercial AC power. Return from Bypass mode to Normal mode of operation shall be automatic. No-break transfer to and from Bypass mode shall be capable of being initiated manually from the front panel.

5. Energy Saver: The UPS shall continuously monitor the voltage and frequency of the bypass source. When the source parameters are within acceptable limits, the UPS will utilize a minimal/optimal combination of its internal subsystems to ensure acceptable power is always delivered to the critical load, at a system efficiency of up to 99.1%. The Energy Saver System shall be enabled by the user, and shall be adjustable. It shall incorporate a "High Alert Mode" to automatically (without user intervention) provide maximum power conditioning any time bypass source variation levels exceed preset, adjustable limits. When the Energy Saver System is utilized, the UPS shall attenuate ANSI C62.41-type transients to within IEC and ITIC limits. The Energy Saver System shall be able to distinguish between upstream (utility) faults and downstream (load) faults and react appropriately to protect and support the critical load, without interrupting the critical load.

### 1.03 REFERENCES

- A. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States, 4<sup>th</sup> Edition.
- B. CSA/cUL C22.2 No 107.1 (Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
- C. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
- D. IEC 62040-2 C3
- E. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power system (UPS) – Part 3: Method of specifying the performance and test requirements.
- F. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.
- G. CISPR 22 and 24, FCC Rules and Regulations 47, Part 15, Class A (Federal Communications Commission) – Radio Frequency Devices.
- H. MIL-HDBK-217E (Military Handbook) – Reliability prediction of electronics equipment

### 1.04 SUBMITTALS

- A. The UPS shall be supplied with sufficient documentation, including the following:
  1. Installation and Operation Manual: One copy of the installation and operation manual shall be furnished. It shall possess sufficient detail and clarity to enable the owner's technicians or representatives to install and operate the UPS equipment and accessories. The manual shall include the following major items:
    - a) UPS description
    - b) UPS site planning and unpacking
    - c) UPS installation
    - d) Optional accessory installation

- d) Optional accessory installation
- e) UPS theory of operation
- f) Operating procedures
- g) System events
- h) UPS maintenance
- i) Performance and technical specifications
- j) Wiring requirements and recommendations
- k) Physical features and requirements
- l) Cabinet dimensions

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#### 1.05 QUALIFICATIONS

- A. The UPS manufacturer shall have a minimum of forty years' experience in the design, manufacture and testing of solid-state UPS systems. A list of installed UPS systems of the same type as the manufacturer proposes to furnish for this application shall be supplied upon request.
- B. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.
- C. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical emergency support.
- D. Field Engineering Support: The UPS manufacturer shall directly employ a national field service department staffed by factory-trained field service engineers dedicated to startup, maintenance, and repair of UPS equipment. The organization shall consist of local offices managed from a central location. Field engineers shall be deployed in high population areas to provide on-site emergency response within 24 hours. A map of the United States showing the location of all field service offices shall be submitted with the proposal. Third-party service or maintenance will not be accepted.
- E. Spare Parts Support: Parts supplies shall be located in the field to provide 80% of emergency needs. The factory shall serve as the central stocking facility where a dedicated supply of all parts shall be available within 24 hours.
- F. Product Enhancement Program: The UPS manufacturer shall make available feature upgrade service offerings to all users as they are developed. These upgrades shall be available as optional field-installable kits.
- G. Maintenance Contracts: A complete range of preventative and corrective maintenance contracts shall be provided and offered with the proposal. Under these contracts, the manufacturer shall maintain the user's equipment to the latest factory revisions.

#### 1.06 ENVIRONMENTAL REQUIREMENTS

- A. The UPS shall withstand any combination of the following external environmental conditions without operational degradation.
1. Operating Temperature: 5 degrees C to + 40 degrees C (41 degrees F to 104 degrees F) without de-rating (excluding batteries).
  2. Storage Temperature: - 25 degrees C to + 55 degrees C (-13 degrees F to 131 degrees F). Prolonged storage above + 40 degrees C (104 degrees F) will result in rapid self-discharge and permanent damage to the battery.
  3. Relative Humidity (operating and storage): 5-95% non-condensing.
  4. Elevation:
    - (1) Operational: 5000 ft. (1500 m) maximum without de-rating.
    - (2) Transportation: Capable of air transport, up to 15,000m.

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## 1.07 SAFETY

- A. The UPS shall be certified by Underwriters Laboratories in accordance with UL 1741 Edition.
- B. The UPS shall be certified by the Canadian Standards Association in accordance with cUL/CSA C22.2 NO.107.1-M91.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Approved Manufacturers: Eaton Corporation

### 2.02 UPS MODULE STANDARD FEATURES

The UPS module shall consist of the following standard components, housed in a 50 kW, 150kW or a 200kW frame:

- A. Quantity 1, 2, 3, or 4, identical 50kW UPM Universal Power Modules, each containing
  1. Rectifier/Charger: The rectifier/charger shall convert incoming AC power to a regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high frequency PWM design using Insulated Gate Bipolar Transistors (IGBTs).

rectifier/charger shall be a high-frequency PWM design, using insulated bipolar Transistors (IGBTs). The modular design of the UPS shall permit safe removal and replacement of the rectifier/charger module. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return the UPS to normal mode. The rectifier/charger module shall also provide the following:

2. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
3. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
4. Inverter: The inverter shall feature an IGBT pulse-width-modulation (PWM) design with high speed switching. The inverter shall also have the following features:
  5. The inverter shall be capable of providing the specified quality output power operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
  6. The modular design of the UPS shall permit safe and fast removal and replacement of the power module, while in maintenance bypass. Mean time to repair (MTTR) for the module shall be no more than 30 minutes in order to return the UPS to normal mode.
  7. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.

- B. Static Bypass: The bypass shall serve as an alternative source of power for the critical load when an abnormal condition prevents operation in normal mode. The bypass shall consist of a fully rated, continuous duty, naturally commutated static switch for high speed transfers. The bypass shall feature the following transfer and operational characteristics.

1. Transfers to bypass (for stand alone, and parallel capacity systems) shall be automatically initiated for the following conditions:
  - a) Output overload period expired.
  - b) Critical bus voltage out of limits.
  - c) Internal over temperature period expired.
  - d) Total battery discharge.
  - e) UPS failure.
2. Parallel Redundant UPS systems shall transfer to bypass on conditions (a) and (d) above. Conditions (c) and (e) will result in the affected UPS isolating from the parallel bus, allowing the remaining UPS(s) to support the critical load.
3. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
4. Uninterrupted automatic re-transfers shall be inhibited for the following

conditions:

- a) When transfer to bypass is activated manually or remotely.
  - b) In the event of multiple transfers/re-transfer operations the control circuitry shall limit "cycling" to three (3) operations in any ten-minute period. The third transfer shall lock the critical load on the bypass source, for 60 minutes.
  - c) UPS failure.
5. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible through the inverter logic. During manual transfers to bypass mode, the inverter shall verify proper bypass operations before transferring the critical load to the bypass source.
  6. All transfers to bypass shall be inhibited for the following conditions:
    - a) Bypass voltage out of limits (+10%, to -10% of nominal)
    - b) Bypass frequency out of limits (+/- 4 Hz, adjustable, factory set)
    - c) Bypass out of synchronization
    - d) Bypass phase rotation / installation error
  7. Static transfer time: No break, complete in less than 4ms.
  8. The bypass shall be manually energized using the control panel or remotely through a building alarm input.
- C. Monitoring and control components: The following components shall provide monitoring and control capability:
1. Control panel: color LCD, touch sensitive, with LED status indicators.
  2. Alarm and metering display.
  3. Building alarm monitoring.
  4. Communication ports: RS-232 and USB.
- D. Battery management system: The UPS shall contain a battery management system which has the following features:
1. The battery management system shall provide battery time remaining while operating in normal mode and battery mode. Battery time available information

shall be displayed real-time, even under changing load conditions. Upon commissioning, battery runtime information shall be available.

2. The battery management system shall automatically test the battery system to ensure that the battery is capable of providing greater than 80% of its rated capacity. Testing the batteries shall not jeopardize the operation of the critical load. Upon detection of the battery string(s) not capable of providing 80% of rated capacity, the UPS system will alarm that the battery needs attention/replacement. The

test shall be able to detect the following:

- Open battery string
- Shorted battery string (current limit)
- Battery capacity (runtime) less than 80% of "new" battery capacity

- E. Wiring Terminals: The UPS 50 kW, 100kW, and 150kW frame modules shall contain mechanical compression terminals (adequately sized to accommodate 75 degree wiring). The 200kW frame shall utilize threaded busbar terminals for attachment of lug cabling, for securing user wiring to the following locations:
1. Rectifier/charger input connections (3-wire plus ground)
  2. Bypass input connections, (for dual source configurations): 3-wire plus ground for 3-wire plus ground output configuration (480Vac)
  3. DC link connections for battery cabinets (positive and negative plus ground)
  4. AC output connections (3 wires plus ground), 4 wire plus ground if distribution accessory cabinet with transformer is utilized.

### 2.03 UPS MODULE OPTIONS AND ACCESSORIES

The UPS system may include the following options and accessories as required:

- A. Integrated Maintenance Bypass, Distribution, Parallel Tie and Accessory Cabinet( Integrated Line-and-Match cabinet(s) shall be provided that include(s):
1. All hardware and interconnecting cable for connection to UPS module. Example is the IAC-D distribution cabinet.
  2. IAC-B (Bypass) Sidecar: Two, three, or four-breaker manual maintenance bypass switch in a sidecar configuration, to isolate UPS module from common AC input and critical load. The sidecar may be mounted on either side of the module. Switch shall provide complete isolation of UPS for servicing. Switch shall be make-before-break, interlocked between UPS and bypass to prevent improper operation.
  3. IAC-D (Distribution) cabinet : This may be positioned on either side of the module, and may include a K-1, or K-13 rated output isolation and step down transformer. Optionally, the transformer shall meet TP-1 specifications. An optional input step up transformer may be included as well.
    - a) The 50kW, 100kW, 150kW, and 200kW versions house up to a quantity of 42 pole distribution panels with main disconnects for a total of 84 poles of distribution. Up to five (5) distribution circuit breakers may be substituted in lieu of distribution panels. The 200kW version may have one of its 42-pole panels provided with a 400A main breaker. Additionally, a separate 225A sub feed breaker may be provisioned, regardless of the configuration of distribution panels.
  4. Parallel Tie Sidecar: This will include 2x Module Output Breakers (MOB) intended to allow a maximum of 2 UPS modules to be paralleled for capacity.

redundancy. Optionally, a maintenance bypass circuit, including a Maintenance Isolation Switch (MIS) and a Maintenance Bypass Switch (MBS) can be in this sidecar. The Parallel Tie sidecar may be provisioned with a single tie breaker with the intention of adding the second UPS at a later time.

5. IAC-T (Tie) cabinet: This can include up to 4x Module Output Breakers (MOCBs) intended to allow a maximum of 4 UPS modules to be paralleled for capacity and redundancy. Optionally, a maintenance bypass circuit, including a Maintenance Isolation Switch (MIS) and a Maintenance Bypass Switch (MBS) can be in this cabinet.
- B. Network Adapter and UPS Power Monitoring Software: Optional PX Gateway card adapter shall provide a communications interface between the UPS module and the following network management systems.
1. SNMP v.1, v.3
  2. Modbus TCP
  3. BACnet/WS or /IP
  4. IPv6

This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.

UPS Power Monitoring Software: This system shall continuously monitor power elements associated with the UPS, using the communications port on each module and a customer furnished PC. The system shall automatically detect if any problems arise and notify local or remote personnel of the alarm condition via email, page, or text message.

- C. Relay Card: Serial dry contact card providing 4 isolated dry output contacts, 1 isolated input. The relays are programmable.
- D. External Battery Cabinet: The battery cabinet shall feature valve regulated, high-rate discharge, lead-acid batteries which provide energy to support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements. The battery cabinet shall have the following features:
1. The battery cabinet shall be the same depth and height as the UPS module. A "Slim" (20" width) battery cabinet is optional, and may contain 1, 2 or 3 string of batteries.
  2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters for easy installation. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide bottom cable entry standard and top entry cable capability via sidecar.
  3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature up to 9 battery trays which can be individually disconnected from the battery cabinet power wiring with quick disconnect devices. Each battery tray shall be firmly secured to the battery cabinet frame with fasteners. Each battery tray shall be removable from the front of the cabinet.
  4. Up to 4 battery cabinets may be connected to a single UPS, containing 2 50 kW UPMs, Up to 2 battery cabinets may be connected to a single UPS containing only one UPM.
  5. For parallel systems, each UPS frame shall have a discrete battery system. A single battery system may not be shared across multiple UPS frames.



6. Each battery cabinet shall feature a DC rated circuit breaker. The circuit breaker within the battery cabinet shall only provide protection to the battery string within that battery cabinet. For battery configurations involving multiple battery cabinets, the batteries in one battery cabinet may be isolated from the DC bus by its circuit breaker without disconnecting other battery cabinets from the DC bus and the UPS module.
  7. The circuit breaker in each battery cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
  8. The circuit breaker in each battery cabinet shall feature a 48VDC shunt trip device. The shunt trip shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
  9. Power and Control wiring between the co-located battery cabinet and the UPS shall be factory provided.
  10. The batteries shall be optionally configured with a ¼" spade type connector attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
  11. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.
- E. Internal Batteries: The 50kW UPS frame shall feature internal, valve regulated, high discharge, lead-acid batteries which provide energy to the support the critical load during a momentary loss of input power to the rectifier. The batteries shall be flame retardant in accordance with UL 94V2 requirements.
1. The 50kW frame with internal batteries shall be configurable with either 3, 6, or 12 strings of batteries (12, 16, or 20 battery trays, respectively). Each battery tray shall be removable from the front of the UPS cabinet.
  2. The circuit breaker in the 50kW UPS cabinet shall feature an A/B auxiliary switch. The UPS module shall be capable of monitoring and alarming an open battery cabinet circuit breaker condition.
  3. The circuit breaker in the 50kW UPS cabinet shall feature a 48VDC shunt trip device. The shunt trip shall operate to trip the battery breaker(s) for an emergency power off command or battery disable command.
  4. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.
- F. Parallel Systems: Up to 8 UPS modules (UPS "frames") may be paralleled for N+1 redundancy, and/or for increased capacity. Maximum capacity in a parallel-for-capacity system is 1600kW. Maximum capacity for a parallel redundant system is 1550kW
1. UPS frames are not required to be identical in terms of quantity of internal batteries. For example, a 50kW UPS may be paralleled with a 100kW UPS.
  2. Additional 50kW UPSs may be field-added to any UPS frame in a parallel system.

3. Each UPS frame must have a dedicated battery system, or DC storage system.
4. Each UPS will contain a built-in circuit (Control Area Network, or CAN) for communication of metering and status information between UPS frames. This circuit will not require the use of a separate communication card. Interruption of the bus will not cause the parallel system to fail to support the critical load.
5. Load share balance will be within +/-5% of full load rating.
6. For 2-UPS parallel systems ONLY, an optional sidecar cabinet shall be available to provide 2x module output breakers. A further option provides maintenance bypass (MBS) and maintenance isolation (MIS) switches. This cabinet will be

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wired and tested with one UPS at the factory, and shall ship attached to the first UPS.

## 2.05 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

### A. UPS Continuous Ratings. The UPS shall be rated:

UPS Rating (max)	Opt. Rating (1)	Opt. Rating (2)	Opt. Rating (3)	Opt. Rating (4)	Opt. Rating (5)	Opt. Rating (6)	Opt. Rating (7)
50 kW	40kW	30kW	20kW	--	--	--	--
50 kW+1	40kW	30kW	20kW	--	--	--	--
100 kW	90kW	80kW	70kW	60kW	50kW	40kW	30kW
100 kW+1	90kW	80kW	70kW	60kW	50kW	40kW	30kW
150 kW	140kW	130kW	120kW	110kW	100kW	90kW	80kW
	60kW	50kW	40kW	30kW	20kW		
150 kW+1	140kW	130kW	120kW	110kW	100kW	90kW	80kW
	60kW	50kW	40kW	30kW	20kW		
200k W	190kW	180kW	170kW	160kW	150kW	140kW	130kW
	100kW	90kW	80kW	70kW	60kW	50kW	40kW
	20kW						

Units may be upgraded to their maximum UPS frame rating when sufficient UPS modules are installed and appropriate firmware settings are implemented.

UPS Rating (max) is the maximum output possible from the UPS (for a load power factor range of 0.8 lagging to 0.8 leading). The UPS shall not require derating when supporting a leading power factor load of 0.8 or greater.

The UPS may be ordered with any of the optional ratings, and later upgraded to its corresponding maximum frame rating (50kW, 100kW, 150kW or 200kW). It is recommended that premises wiring should be sized for the maximum possible

rating of the UPS (i.e. to match the UPS frame rating).

- B. Acceptable UPS input sources: UPS shall support 3-wire grounded Wye sources. neutral conductor is not used from the source, and is not supplied to the load
1. Single source, single or dual feed: 3-wire grounded neutral wye (TN, TT\*)
  2. Dual source, dual feed: 3-wire grounded neutral wye (TN, TT\*)
- \*TT sources for the UPS must all share the same ground plane.
- C. Rectifier/charger input:
1. Nominal three phase input voltage: 480 Vac:  
3-wire plus ground for 3-wire plus ground output configuration
  2. Operating input voltage range: +10%, -15% of average nominal input voltage without battery discharge. Note the UPS shall "power share" with the battery 30% of nominal voltage, at full rated load.
  3. Operating input frequency range shall be 40 to 72Hz.
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4. Input power factor 0.99 lagging at rated load.
  5. Normal input current limit: The UPS shall have the following programmable current limit settings while operating in normal mode:
    - a) Rectifier/charger input current limit shall be adjustable from 100 to 115% of UPS kW rating.
    - b) Battery input current limit shall be adjustable from 5% to 7% of the full load kW rating regardless of the actual load on the UPS.
  6. On generator input current limit: The UPS shall have the following programmable input current limit settings while operating in normal mode generator:
    - a) Rectifier/charger input current limit shall be adjustable from 100% to 115% of UPS full load kW rating.
    - b) Battery recharge input current limit shall be adjustable from 16.5A to 29.3A per UPS power module..
  7. Input current total harmonic distortion (THD) shall be less than 3% at nominal voltage and 5% nominal source impedance.
  8. Power walk-in: Ramp-up to full utility load adjustable from 10 amps per second to 1 amp per second.
- D. Bypass input:
1. Synchronizing bypass voltage range shall be +10, -15% of average nominal voltage.
  2. Synchronizing bypass frequency range is +/- 0.5 Hz to +/-4 Hz, user adjustable and is centered on the nominal frequency. Default setting is +/- 4 Hz.

and is centered on the nominal frequency. Default setting is  $\pm 4$  Hz.

3. Slew rate: 0.8 Hz per second, maximum.
4. Bypass and rectifier inputs can be supplied from out of phase sources if required.
5. Input surge withstand capability: The UPS shall be in compliance with IEC (ANSI C62.41), category A & B (6kV).

E. Rectifier/charger output:

1. Nominal DC voltage shall be 432 VDC (open circuit battery voltage).
2. Capacity: The rectifier/charger shall support a fully loaded inverter and recharge the battery to 90% of its full capacity within 10 times the discharge when in current limit is set at maximum.
3. Low line operation: The rectifier/charger shall be capable of sharing the load with the battery when the input voltage falls below the specified operation voltage range, the "on battery" indicator shall annunciate operation in this mode.
4. DC sensing: DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
5. Battery charger characteristics: The UPS battery charging system shall have the following characteristics:
  - a) The charger shall be capable of being configured for several charging modes including:
    - (1) A charging mode that increases battery life by allowing the battery to rest, reducing positive plate corrosion
    - (2) A charging mode floating the battery at a set level, which is adjustable via software.
  - b) UPS module will automatically adjust battery shutdown based upon load and battery capacity.
    - (1) The UPS module shall automatically adjust the final discharge voltage between 1.67 and 1.75 Volts per cell based on the existing load and the rate and length of discharge.
    - (2) The absolute minimum operational voltage is 1.67 V per cell (adjustable upward).

F. UPS output in normal mode

1. Nominal output voltage 480V, 3-phase, 3-wire plus ground at the UPS output terminals, or 4 wire plus ground at the output of the IAC-D cabinet with 20 kVA output transformer. Output wiring configuration is based upon input wiring configuration for systems without transformers.

2. Steady-state voltage regulation (in inverter) shall be within +/- <1% average nominal output voltage.
3. Transient voltage response shall be per EN62040-3, Class 1, VFI-SS-111
4. Transient voltage recovery shall be compliant to EN62040-3, Class 1, VFI 111.
5. Linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% linear load.
6. Non-linear load harmonic distortion capability: Output voltage THD of less than 5% for 100% non-linear load when tested using the non-linear load description IEC 62040-3.
7. Line synchronization range shall be +/- 4Hz, adjustable to +/-0.5 Hz.
8. Frequency regulation shall be +/- 0.1Hz free running.
9. Frequency slew rate shall be 0.8 Hz/second maximum (adjustable).
10. Phase angle control:
  - a) Balanced linear load shall be <1 degree from nominal 120 degree
11. Phase voltage control:
  - a) Balanced linear loads shall be +/- 1% from average phase voltage
  - b) Unbalanced linear loads shall be less than <2% from average phase voltage for 100% load unbalanced
12. Overload current capability (with nominal line and fully charged battery, not paralleled systems):
  - a) Double Conversion mode: The unit shall maintain voltage regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and 126% to 150% for 10 seconds, >151% for 300ms.
  - b) Stored energy mode (typically on battery): The unit shall maintain regulation for 102% to <110% of resistive/inductive load for 10 minutes, 111% to <125% for 60 seconds, and >126% for 300ms
  - c) Energy Saver System operation: Continuous = 110%. Transient = 1000% peak current for 10ms.
  - d) On bypass (single UPS systems): Continuous = 125%. Transient = 1000% peak current for 10ms.

13. Fault clearing current capability: See section 12 above.
14. Static transfer time, inverter to bypass: No break, completed in less than 4ms.
15. Static transfer time, Energy Saver to inverter: No break, completed in less than 4ms maximum, typically <2ms.
16. Common mode noise attenuation:
  - a) -65dB up to 20kHz, -40db up to 100kHz
  - b) > 100dB with isolation transformer

17. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load, per ISO 7779 standard.
18. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part Class A devices, CISPR22, and IEC62040-2 C2 and C3.
19. Electrostatic discharge (ESD): The UPS shall meet IEC61000-4-2 level 3 contact/8kV air discharge.
20. Efficiency: The UPS incorporate 3-level power converter design for highest possible efficiency. Full load efficiency for non-derated hardware shall be 97%, 50% load efficiency shall be 96.5%, and the UPS shall achieve >95% efficiency at 25% load. These numbers are for N+0 configurations only.

G. UPS Output with Energy Saver System option

1. The Energy Saver System acts to optimize the internal components of the power train to maximize system efficiency when the bypass source is with following (adjustable) limits: Voltage: +/-10%, and Frequency: +/-3Hz.
2. Nominal output voltage 480V, 3-phase, 3-wire plus ground at UPS output terminals (or 4 wire plus ground at the output of the IAC-D cabinet with transformer). Output wiring configuration is based upon input wiring config for systems without internal transformers.
3. Steady-state voltage regulation shall be within +/- 10% from nominal output voltage.
4. Line synchronization range shall be +/- 4 Hz, adjustable.
5. Frequency regulation shall be +/-4 Hz when bypass source is within the limits (1) above, and +/- 0.1Hz free running,
6. Overload current capability (with bypass source within the limits of (1) above): Continuous: 110%, Transient: 1000% for 10msec.
7. Static transfer time: No break, typically completed in less than 2ms, including detection time.
8. Acoustical noise: Noise generated by the UPS under normal operation shall not exceed 65dbA at one meter from any operator surface, measured at 25 degrees C (77 degrees F) and full load.
9. EMI Suppression: The UPS shall meet FCC rules and regulation 47, part Class A devices, CISPR22, and IEC62040-2 C2 and C3.
10. Electrostatic discharge (ESD): The UPS shall meet IEC61000-4-2 level 3 contact/8kV air discharge.
11. Efficiency: The UPS efficiency shall be greater than 99%, over the range of 100kW load; for N+0 configurations only.

\*Unless otherwise specified, performance data in Sec 2.05 above is measured under conditions of 100% resistive load for fully rated UPS sizes, 25 degrees C ambient temperature, nominal rectifier and bypass voltages, and battery system floating.

2.06 MECHANICAL DESIGN

- A. Enclosures: The UPS shall be housed in free-standing double front enclosures (with shields behind doors) equipped with casters and leveling feet. The enclosures shall be designed for computer room applications. Front doors shall have locks to prevent unauthorized entry.
- B. Modular construction: The UPS shall be comprised of Universal Power Modules (each hardware-rated for 50kW, and each including the rectifier, inverter, and battery converter power and control circuitry. These UPMs shall be draw-out assemblies that can be quickly exchanged or replaced as necessary.
- C. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be at the front of the unit. Air outlet configuration for the UPS, and its accessory cabinet (for wall installations), shall be user selectable at time of order to exhaust warm air at the top of the cabinet (top exhaust), or exhaust at the rear of the cabinet for "hot aisle" configuration. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation (top exhaust), or working space (rear exhaust). An air filter shall be mounted in the front door of the UPS module.
- D. No back or side clearance or access shall be required for the system. The back of the enclosure covers shall be capable of being located directly adjacent to a wall.

- E. Cable entry: Standard cable entry for the 50/100/150kW frame UPS cabinet shall through the enclosure bottom. Top cable entry shall be facilitated by a sidecar which shall be mounted on either side of the 50/100/150kW frame UPS. Standard cable entry for 200kW frame UPS shall be through the enclosure top or bottom.
- F. Front access: All serviceable subassemblies shall be modular and capable of being replaced from the front of the UPS (front access only required). Side or rear access for installation, service, repair or maintenance of the UPS system shall not be required.
- G. Service area requirements: The system shall require no more than thirty six (36) inches of front service access room and shall not require side or rear access for service or installation.

## 2.07 CONTROLS AND INDICATORS

- A. Microprocessor controlled circuitry: The UPS controls shall have the following design and operating characteristics:
  1. Fully automatic operation of the UPS shall be provided through the use of microprocessor controlled Digital Signal Processing. Start-up and transfer shall be automatic functions, and will not require operator intervention.
- B. Digital Front Panel Display: The UPS control panel shall be a 7" touch sensitive, LCD front panel display that includes LED indicators for basic UPS status. Large, luminous, color coded LED pillars (vertical bars) shall show the UPS status (green, amber, red), and be visible up to 30m from the UPS. The LCD shall display:
  1. UPS status (home screen): the LCD screen shall have a color coded border (header) that turns red on alarm, and shows basic UPS status in the header of the display, visible at all times. The header shall alternately show UPS status, output voltage and battery time remaining, and be visible constantly in all screens. The home screen shall show load level, average efficiency, and consumption in kWh. The home screen shall show a system mimic diagram and a color-highlighted power path, operating mode, and active events.
  2. Controls tab: Shall provide touch sensitive button controls, with a confirmation for turning the UPS on and off, transfer to/from bypass, and enabling or disabling the battery charger, initiating a battery test, and enabling or disabling the Ene Saver System (ESS).
  3. Metering tab: The metering screen shall show voltages, currents, temperature, kW, kVA, and power factor (as applicable) for the UPS input, output, bypass source, and battery. Color coded (green, amber, red) bar graph indicators shall accompany power and temperature measurements.
  4. Logs tab: alarm/event queue, active alarms and alarm history, events, status changes and commands, all timed to the 1/1000<sup>th</sup> second for tracking and analysis.
  5. Statistics tab: Numerically and graphically displays the estimated savings afforded by ESS operation over time.
  6. Settings tab: shall provide button access to user adjustable settings such as, but not limited to: date/time, building alarm designations, communications parameters.



setup, UPS name, user passwords, and display language.

- C. Control Panel Lamp Indicators: The UPS control panel shall provide the following monitoring functions with indicator (icon) LED's:
1. NORMAL: This green LED shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load.
  2. BYPASS: This amber LED shall indicate that the UPS has transferred the load to the bypass circuit.
  3. BATTERY: This amber LED shall indicate that the commercial AC utility or generator source has failed and the battery is supplying power to the inverter which is supporting the load.
  4. ALARM: This red LED and the accompanying audible alarm horn, shall indicate that the UPS detects an alarm condition, outlined in detail in the Logs tab on the home screen and in the operator's manual.
- D. Interface panel: The UPS shall be equipped with an interface panel, located behind a protective cover, which provides the following signals and communication features in a Class 2 environment:
1. Alarm contact: A dry contact for annunciating a summary alarm shall be provided for customer use. This contact shall be Form "C" capable of supporting both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage that does not exceed 28VDC or 277VAC.
  2. RS232 (EIA / TIA-232) and USB communications interfaces: Circuitry shall be provided for one "host", and one "device" USB connector, and one RS232 (EIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple ("dumb") terminals to provide remote access to all unit operation information.
  3. Building alarms: Five inputs shall be provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the UPS front panel display or via the RS232 (EIA / TIA-232) port.
  4. External REPO contacts: Shall be provided to connect an external remote emergency power off switch to shut down the UPS and de-energize the critical load. Normally open or normally closed contacts shall be acceptable.
  5. Battery control contacts: Contacts shall be provided to connect the battery trip and auxiliary contact signals from a battery breaker or battery disconnect switch.

6. External bypass indicator connection: A connection point shall be provided to acknowledge that an external maintenance bypass has been closed around the UPS, placing the critical load on utility power.

## 2.08 COMMUNICATIONS

- A. Communications Bay: The UPS shall be equipped with field configurable communications bays that will accommodate four (4) plug-in communication devices.
- B. Remote Monitoring:
  1. Optional WEB/SNMP communication capabilities will be available for all systems.
  2. The UPS shall be able to be monitored remotely via communications devices. The UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232, S

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BACnet and ModBus. Monitoring of UPS status may also be performed through isolated dry contact Form C relays.

The UPS communication capability should be able to integrate into any industry standard Building Management System (BMS) and/or Network Management System (NMS). The UPS must also be able to be monitored via any standard Internet browser.

All optional hardware interfaces shall be "Hot-swappable" (UPS maintains power to critical applications while changing interfaces).

- C. Shutdown:
  1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. The shutdown shall be performed via in-network or out-of-network means. The order of shutdown shall be user-defined, allowing the maximization of runtime of the battery for more critical systems.
  2. The UPS shall also be capable of interfacing with an operating system's shutdown routine. This shall be done through a cable connection to the communication interface card.
- D. Notification:
  1. There shall be a mechanism to send alerts to key personnel via email or SNMP traps. An alarm notification may also be sent by a network message.

## 2.08 UPS MODULE PROTECTION

- A. Rectifier/Charger and Bypass protection shall be provided through individual fuses on each phase.
- B. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers on each battery cabinet (if standard battery pack is provided) or external protective devices for an external battery.

- C. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide overcurrent protection.
- D. To comply with agency safety requirements, the UPS module shall not rely upon external disconnect devices outside of the UPS module to isolate the battery cabinet from the UPS module.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

#### 3.02 COMMISSIONING

- A. Factory start-up shall be provided on a 5x8 basis (7 x 24 optional). Start-up service shall be provided at no extra charge and shall include one visit to perform all procedure tests specified within UPS Installation and Operation manual. UPS manufacturer also offer the following optional services:
  1. Pre-energize visit to inspect installation and provide guidance to installers required.

2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.
- B. The following procedures and tests shall be performed by Field Service personnel during the UPS startup:
    1. Visual Inspection:
      - a) Visually inspect all equipment for signs of damage or foreign material.
      - b) Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety related factors.
    2. Mechanical Inspection:
      - a) Check all the power connections for tightness.
      - b) Check all the control wiring terminations and plugs for tightness and proper seating.
    3. Electrical Pre-check:
      - a) Check the DC bus for a possible short circuit.
      - b) Check input and Bypass power for proper voltages and phase rotation.
      - c) Check all lamp test functions.

4. Initial UPS Startup:
  - a) Verify that all the alarms are in a "go" condition.
  - b) Energize the UPS module and verify the proper DC, walkup, and phase on.
  - c) Check the DC link holding voltage, AC output voltages, and output waveforms.
  - d) Check the final DC link voltage and Inverter AC output. Adjust if required.
  - e) Check for the proper synchronization.
  - f) Check for the voltage difference between the Inverter output and Bypass source.
  - g) Optional on site full-load, step-load, and battery discharge tests u supplier furnished load bank, shall also be offered.
5. Operational Training: Before leaving the site, the field service engineer shall familiarize responsible personnel with the operation of the UPS. The UPS equipment shall be available for demonstration of the modes of operation

### 3.03 WARRANTY

All components of the UPS system shall be covered by a standard one-year limited factory warranty and service protection package.

One-year limited factory warranty shall include replacement coverage for the UPS parts for a period of 18 months from shipment or 12 months from start-up, whichever occurs sooner. Coverage is for 90 days after product startup.

One-year service protection package shall include 7x24 on-site repair/replacement labor for parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (monthly reports for UPS and battery performance). Standard response time shall be 8 hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with

guaranteed response times of 4, or 2 hours in certain major metropolitan areas. Additional preventive maintenance visits shall be available as an option for both UPS and battery components.

Manufacturer shall also include Start-up services consisting of: 7x 24 Start-up service of UPS and batteries. On-site user training, Site Audit, installation and commissioning of monitoring service, and validation of one-year limited factory warranty will be performed during the start-up.

Manufacturer shall also offer an optional service plan to provide 7x24 on-site coverage (preventive and corrective) for UPS and batteries, guaranteed response time, remote monitoring, Web access to service site history, annual Site Audit, UPS and battery preventive maintenance visit, and discounts on upgrade and modification kits. Manufacturer shall also provide an optional battery service plan to provide parts-and-labor coverage for partial and full battery strings, with preventive maintenance or replacement coverage.

END