**Eaton Guide Specification**

**Notes and instructions to specwriter**

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**26 33 00 BATTERY EQUIPMENT**

26.33.53 STATIC UNINTERRUPTIBLE POWER SUPPLY

**GUIDE SPECIFICATION**

**Eaton Power Xpert™ 9395P high performance UPS**

**675–1100 kW, 380/400/415 VAC**

PART 1 - GENERAL

# 1.01 SUMMARY

* 1. This specification describes a three-phase continuous duty, on-line, double conversion, three-level converter topology, 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 power conditioning, back‑up and distribution for critical electrical loads. The UPS system shall consist of, as required by the project, the UPS module, battery cabinet(s), maintenance bypass and other features as described in this specification.

# 1.02 UPS SYSTEM DESCRIPTION

* 1. UPS system components: the UPS system shall consist of the following main components:
		1. One integrated system bypass module (ISBM) and two or more internal uninterruptible power modules (UPMs). The ISBM includes a static bypass and associated control and monitor panel, and each UPM includes a rectifier, inverter and battery charger.
		2. Battery string(s) in matching battery cabinets, or cabinets provided by 3rd party manufacturers.
		3. Non-matching, wall-mounted or floor standing maintenance bypass cabinets.
	2. UPM modes of operation: each UPM shall operate as an on-line, fully automatic system in the following modes:
		1. Standard: Utilizing commercial AC power, the critical load shall be continuously supplied by the inverter. The inverter shall power the load while regulating both voltage and frequency. The rectifier shall derive power from the commercial AC source and shall supply DC power to the inverter with the UPS operating at an efficiency up to 97 percent.
		2. Battery or flywheel: 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 UPM must be taken out of the standard 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 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 System (ESS) feature: 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 99 percent or greater, over the range of 10 to 100 percent load. The Energy Saver System (ESS) 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 ESS is utilized, the UPS must attenuate ANSI C62.41-type line transients to within IEC and ITIC limits. ESS shall be able to distinguish between upstream (utility) faults and downstream (load) faults and react appropriately to protect and support the critical load, without interruption.
		6. Variable Module Management System (VMMS) feature: The modular UPS shall offer the ability to scale its capacity and/or redundancy by automatically shifting load to fewer 275/ kW power modules (UPMs). The UPS shall provide an optional Variable Module Management System (VMMS), which will control the UPS to selectively place unnecessary UPMs in the “ready-state” based on the sensed output load level. This is in order to drive the load higher on the remaining UPMs. Therefore, with multiple UPMs, a UPS shall achieve 1-2 percent higher efficiencies than conventional operation when loaded less than 30 percent of system rating.

# 1.03 REFERENCES

1. UL 1778 (Underwriters Laboratories) – Standard for Uninterruptible Power Supply Equipment. Product safety requirements for the United States.
2. CSA C22.2 No 107.1(Canadian Standards Association) – Commercial and Industrial Power Supplies. Product safety requirements for Canada.
3. NEMA PE-1 – (National Electrical Manufacturers Association) – Uninterruptible Power Systems standard.
4. EC 62040-1 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 1: Uninterruptible power systems (UPS) – Part 1: General and safety requirements for UPS.
5. IEC 62040-2 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 2: Electromagnetic Compatibility (EMC) requirements
6. IEC 62040-3 (International Electrotechnical Commission) – Uninterruptible power systems (UPS) – Part 3: Method of specifying the performance and test requirements.
7. IEEE 587 (ANSI C62.41) Category A & B (International Electrical and Electronics Engineers) – Recommended practices on surge voltages in low voltage power circuits.

# 1.04 SUBMITTALS

* 1. The UPS shall be supplied with sufficient documentation, including the following manuals:
		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:
			1. UPS description
			2. UPS site planning and unpacking
			3. UPS installation
			4. Optional accessory installation
			5. UPS theory of operation
			6. Operating procedures
			7. System events
			8. UPS maintenance
			9. Performance and technical specifications
			10. Wiring requirements and recommendations
			11. Physical features and requirements
			12. Cabinet dimensions

# 1.05 QUALIFICATIONS

* 1. The UPS manufacturer shall have a minimum of fifty years of experience in the design, manufacture and testing of three-phase solid-state UPS systems.
	2. The UPS manufacturer shall have ISO 9001 certification for engineering/R&D, manufacturing facilities and service organization.
	3. The UPS manufacturer shall maintain a staffed 7x24x365 call center for technical and emergency support.
	4. Field engineering support: The UPS manufacturer shall directly employ a nationwide 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 key 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 must be submitted with the proposal. Third-party maintenance will not be accepted.
	5. Spare parts support: Parts supplies shall be located in the field to provide 80 percent of all emergency needs. Parts are stocked in regional logistics centers, ensuring a 95% First Time Fix rate and maximizing system availability.
	6. 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.
	7. 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

* 1. The UPS shall withstand any combination of the following external environmental conditions without operational degradation:
		1. Operating temperature: +5°C to + 40°C (41°F to 104°F); no derating is required within this range (excluding batteries).
		0°C to + 35°C (32°F to 95°F) for 900 kW and 1200 kW units; no derating is required within this range (excluding batteries).
		2. Storage temperature: -25°C to + 60°C (-13°F to 140°F). Prolonged storage above + 40°C (104°F) will cause rapid battery self-discharge.
		3. Relative humidity (operating and storage): 5 to 95 percent maximum non-condensing.
		4. There shall be at least a 1.8°F (1.0°C) difference between the dry bulb temperature and the wet bulb temperature, at all times, to maintain a non-condensing environment
		5. The maximum rate of temperature change shall be limited to 3°F over 5 minutes (36°F/hour), based on the ASHRAE standard 90.1-2013
		6. Elevation:
			+ 1. Operational: 1,000 meters above sea level at 40°C maximum above this level, altitude de-rating as per IEC 62040-3.
				2. Transportation: Capable of air transport.

# 1.07 SAFETY

1. The UPS shall be certified by a U.S.-recognized NRTL (National Recognized Test Laboratory) in accordance with UL 1778.
2. The UPS shall be certified by a Canadian-recognized test laboratory in accordance with CSA C22.2 No.107.3-05.
3. The UPS shall be compliant with IEC 62040-1.
4. The cabinets shall be NEMA 1 and IP20 rated.

PART 2 - PRODUCTS

## 2.01 MANUFACTURERS

* 1. Approved Manufacturers: Eaton

## 2.02 UPS STANDARD FEATURES

The UPS shall consist of the following standard components and features:

* 1. Two or more UPMs, each consisting of:
		1. Rectifier/charger: Each rectifier/charger shall convert incoming AC power to regulated DC output for supplying the inverter and for charging the battery. The rectifier/charger shall be a high-frequency, three-level converter design, using insulated gate bi-polar transistors (IGBTs). The modular design of the UPS shall permit safe and fast 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:
			1. The rectifier shall be capable of drawing power from the utility with a power factor of 0.99 under nominal conditions.
			2. The rectifier shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
		2. Inverter: Each inverter shall feature an IGBT three-level pulse width modulation (PWM) design with high-speed switching. The inverter shall also have the following features:
			1. The inverter shall be capable of providing the specified quality output power while operating from any DC source voltage (rectifier or battery) within the specified DC operating range.
			2. The modular design of the UPS shall permit safe and fast removal and replacement of the inverter 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.
			3. The inverter shall feature protection circuitry that prevents the IGBTs from sourcing current in excess of their published ratings.
	2. ISBM section with 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 shall be automatically initiated for the following conditions:
			1. Output overload time period expired
			2. Critical bus voltage out of limits
			3. Internal over temperature exceeded
			4. Total battery discharge
			5. UPS failure
		2. Uninterrupted automatic re-transfer shall take place whenever the inverter is capable of assuming the critical load.
		3. Uninterrupted automatic re-transfers shall be inhibited for the following conditions:
			1. When transfer to bypass is activated manually or remotely.
			2. In the event of multiple transfers/re-transfer operations the control circuitry shall limit “cycling” to three operations in any ten-minute period. The fourth transfer shall lock the critical load on the bypass source.
			3. UPS failure.
		4. Uninterrupted manual transfers shall be initiated from the control panel. Uninterrupted manual transfers to bypass and from bypass shall be possible with the inverter logic. During manual transfers to bypass mode, the inverter must verify proper bypass operations before transferring the critical load to the bypass.
		5. All transfers to bypass shall be inhibited for the following conditions:
			1. Bypass voltage out of limits (+/- 10 percent of nominal)
			2. Bypass frequency out of limits (+/- 3 Hz of nominal)
			3. Bypass out of synchronization
			4. Bypass phase rotation/installation error
		6. Static transfer time: No break, complete in less than 4 ms.
		7. The bypass shall be manually engaged using the operator control panel or remotely through a building alarm input.
	3. Monitoring and control components: The following components shall provide monitor and control capability:
		1. Control panel with status indicators
		2. Alarm and metering display
		3. Building alarm monitoring
		4. Communication ports
	4. Battery management system: The UPS shall contain a battery management system which has the following features when used with lead acid batteries:
		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 string(s) to ensure the battery is capable of providing greater than 80 percent 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 percent, the UPS system will alarm that the battery needs attention/replacement. The battery test shall be able to detect the following:

 Open battery string

 Shorted battery string

 Battery capacity (runtime) less than 80 percent of “new” battery capacity

* + 1. The UPS shall communicate battery test and monitoring data to the UPS manufacturer’s remote monitoring site. Battery life remaining, capacity and number of on-battery events shall be provided in a monthly report.
	1. Wiring terminals: The UPS module shall contain mechanical compression terminals (adequately sized to accommodate 90°C wiring) for securing user wiring to the following locations:
		1. Rectifier/charger input connections (3-wire plus ground)
		2. Bypass input connections (4-wire plus ground)
		3. DC link connections for battery cabinets (positive and negative). Separate batteries per UPM, or common batteries across all UPMs can be connected.
		4. AC output connections (4-wire plus ground)
	2. UPS system configuration features:
		1. UPS configurations for capacity and redundancy: UPS shall be constructed such that multiple internal UPMs can be combined for redundancy or capacity. Internal UPMs shall be capable of being paralleled to increase system power levels or to provide redundant power. Up to four internal UPMs shall be capable of parallel operation, either for capacity or redundancy. The UPS shall have intelligence to automatically recognize the need for capacity and/or redundancy. The UPS shall utilize autonomous internal UPMs that do not rely on any control interconnections for synchronized operation. The internal UPMs shall operate in a peer-to-peer manner to provide automatic load sharing, synchronization and selective tripping capabilities. “primary-secondary” configurations are not acceptable.
		2. The UPS shall utilize a communications network to provide system information and status, such as operating mode and meter data. This network shall provide individual internal UPM information as well as total UPS information and shall be available from the UPS front panel display. The loss of this system information network shall not cause the UPS to transfer to bypass or drop the critical load.
		3. The UPS shall have the option to be inherently redundant when the load is less than 66 percent (825 kW rating), or 75 percent (1100 kW rating) of the UPS-rated capacity. Under load conditions less than 66 percent (825 kW rating) or 75 percent (1100 kW rating) of rated UPS capacity, at least one internal UPM shall be redundant.
		4. Variable Module Management System (VMMS) option:
			1. VMMS user configurable modes: The 9395 VMMS feature shall have three configurable modes of operation: double-conversion, double-conversion with VMMS and high alert mode. All modes will be selectable from the front panel.
				1. **Double-conversion mode**: the unit shall operate by supplying power through each of the power converters (providing equal load-share between all available UPMs).
				2. **Variable Module Management Mode (VMMS)**: The unit shall operate as a traditional double-conversion UPS. However, the unit will place identified UPM(s) in “ready-state” based on the following number of UPMs required equations:

Total number of UPMs required equations (the highest result of the equations below):

 UPM required = (UPSKW ) + VMMS redundancy

 (UPMKWRating \* VMMSLimit))

Or

UPM required = (SystemKVA) + VMMS redundancy

 (UPMVARating \* VMMSLimit))

Or

UPM required = (PhaseCurrent(L1, L2, L3, or N) + VMMS redundancy

 (UPMPhaseCurrentRating \* VMMSLimit))

* + - * 1. **High alert mode:** All ready-state UPMs are active for one hour (user adjustable). At the completion of the hour, the UPS defaults back to VMMS mode. If the high alert command is received again during the hour, the one-hour timer will be restarted.
			1. VMMS in parallel systems: Variable Module Management mode shall support both distributed bypass and centralized bypass (SBM) parallel configurations. SBM configurations shall support up to eight parallel units (four UPMs per UPS lineup). VMMS operation allows instantaneous UPM transfers from VMMS “ready” mode to double-conversion. Any of the following shall result in all ready-state UPMs transferring from VMMS to double-conversion mode:
				1. A utility outage that results in the unit going to battery
				2. Greater than a +/- 3 percent (adjustable) voltage variation on the output
				3. Any UPM exceeds current limit
				4. A UPS or UPM load >80 percent (user adjustable)
				5. Battery test initiated
				6. Battery charging required
				7. Any UPM being serviced

## 2.03 UPS SYSTEM OPTIONS AND ACCESSORIES

The UPS system shall consist of the following options and accessories as required:

* 1. Field upgrades: Manufacturer shall offer the ability to upgrade the capacity or redundancy of the UPS system in the field. Manufacturer shall offer integrated UPMs that can be added in the field, to increase the capacity or redundancy of the UPS. UPS design shall allow for at least one integrated UPM to be added in the field. The 1100 kW units require this integrated UPM, and cannot be further expanded.
	2. SNMP network adapter and UPS power monitoring software: SNMP adapters shall provide a communications interface between the UPS module and SNMP-compatible network management systems. This capability shall allow the unit to be monitored remotely over an Ethernet network using a standard web browser.
		1. UPS power monitoring software: This system shall continuously monitor critical power elements associated with the UPS, using the communications port on each module and a customer-furnished PC. The system shall automatically alarm if any problems arise and notify local or remote personnel of the alarm condition via email, page or text message.
	3. Battery cabinet: The battery cabinet shall feature valve-regulated, high-rate 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 94V-2 requirements as a minimum. The battery cabinet shall have the following features:
		1. The battery cabinet shall be the same depth and height as the UPS module.
		2. The battery cabinet shall feature a mechanical enclosure of like appearance to the UPS module and shall feature casters. Each battery cabinet shall require front access only for installation, service and maintenance. The battery cabinet shall provide top and bottom cable entry.
		3. Power wiring internal to each battery cabinet shall be factory provided. Each battery cabinet shall feature up to 10 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 battery cabinet.
		4. 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, a battery string in one battery cabinet may be isolated from the DC link via its circuit breaker without removing other battery strings from the DC link and the UPS module.
		5. 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.
		6. The circuit breaker in each battery cabinet shall feature a 48V DC shunt trip device. The ST device shall operate to trip the battery breaker(s) for a load off, command (optional), an emergency power off command or battery disable command.
		7. The batteries shall be configured with a ¼” spade type connector for attaching sense leads to each jar to facilitate the future addition of a battery monitoring system.
		8. Expected battery life: 200 complete full load discharge cycles when operated and maintained within specifications.
		9. Lithium ion external battery cabinets: these cabinets will be manufactured by a 3rd party battery vendor, and as such will differ from the Eaton-built cabinets described above. They will have the following general features:
			1. Lithium ion battery systems/cabinets will be equipped with a standard battery management system (BMS) that monitors temperature, voltage and cabinet status, and acts independently of the UPS to protect itself.
			2. Each cabinet will contain a circuit breaker that can be opened automatically by the BMS if conditions require.
			3. Lithium ion battery systems will have been approved by Eaton for use with the 9395P UPS product, and the UPS will be programmed for use with the specific lithium ion battery.

D. Module tie cabinet: An external cabinet shall be available which shall allow connection of up to four UPS modules to be connected for distributed bypass parallel operation. Module tie cabinet rating shall be in accordance with UPS module output ratings. This cabinet shall be utilized where individual UPS module output disconnect and isolation is desired via module output breakers (MOB), or when future expansion of a parallel system is planned. Each MOB shall be equipped with dual form C auxiliary contacts for communication back to the UPS. The tie cabinet shall also have the ability to house a(n) (optional) main output breaker and a(n) (optional) bypass breaker. Cabinet shall be designed for remote installation using customer-supplied wiring and conduit and shall be capable of either free-standing or wall-mounted installation.

## 2.05 UNINTERRUPTIBLE POWER SUPPLY RATINGS AND OPERATING CHARACTERISTICS

* 1. UPS continuous ratings. The UPS shall be rated as follows:

|  |
| --- |
| UPS rating (max) |
| 675 kVA/675 kW |
| 750 kVA/750 kW |
| 825 kVA/825 kW |
|  |
| 1000 kVA/1000 kW |
| 1100 kVA/1100 kW |
|  |

UPS rating (max) is the maximum output possible from the UPS (for a load power factor range of 0.7 lagging to 0.9 leading). The UPS shall not require de-rating when supporting a leading power factor load of 0.9 or greater. The UPS may be ordered with the optional rating (where available) and later upgraded to its corresponding full UPS rating (max).

* 1. Rectifier/charger input:
		1. Nominal three-phase input voltage: 380/400/415 VAC:

3-wire plus ground input (grounded wye source or high resistance ground (HRG) source required)

Separate inputs for each UPM are optional

* + 1. Operating input voltage range: 380V nominal, -10 percent, +15 percent, 400V nominal, -15 percent, +15 percent, 415V nominal, -15 percent, +10 percent, of average nominal input voltage without battery discharge; Voltage tolerance, partial load: -30 percent of 400V without discharging the battery at loads less than 85 percent.
		2. Operating input frequency range shall be 45 to 65Hz.
		3. Input power factor 0.99 typical load.
		4. Normal input current limit: the UPS shall have the following programmable input current limit settings while operating in normal mode:
			1. Rectifier/ input current limit shall be adjustable from 100 to 115 percent of full load input current.
			2. Battery charger current limit shall be adjustable from 0 to 120 amps DC per UPM. With decreased load, maximum charge current per UPM is 120A. Charge capability drops to zero with input line at minus 15% of nominal voltage at full load

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* + 1. On-generator input current limit: the UPS shall have the following programmable input current limit settings while operating in normal mode on generator:
			1. Rectifier input current limit shall be adjustable from 100 to 115 percent of full load input current.
			2. Battery charger current limit shall be adjustable from 0 to 120 amps DC per UPM. With decreased load, maximum charge current per UPM is 120A. Charge capability drops to zero with input line at minus 15% of nominal voltage at full load

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* + 1. Input current total harmonic distortion (THD) shall be less than 3 percent.
		2. Power walk-in: ramp-up to full utility load adjustable from three seconds to 60 seconds.
		3. Optional 100 kAIC rating shall be available.
	1. Bypass input:
		1. Synchronizing bypass voltage range shall be +/- 10 percent of average nominal input voltage.
		2. Synchronizing bypass frequency range is centered on the nominal frequency.
		3. Bypass and rectifier inputs must have a common ground; can be supplied from out of phase sources if required.
		4. Input surge withstand capability: The UPS shall be in compliance with IEEE 587 (ANSI C62.41), category A & B (6kV).
	2. Rectifier/charger output:
		1. Nominal DC voltage shall be 480VDC.
		2. Steady state voltage regulation shall be +/- 1 percent.
		3. Voltage ripple shall be less that 0.5 percent (peak-to-peak).
		4. Capacity: the rectifier/charger shall support a fully loaded inverter and recharge the battery to 90 percent of its full capacity within 10 times the discharge when input current limit is set at maximum.
		5. Low line operation: the rectifier/charger shall be capable of sharing the DC load with the battery when the input voltage falls below the specified operation input voltage range, the on-battery indicator shall annunciate operation in this mode.
		6. DC sensing: redundant DC voltage sensing methods shall be incorporated for providing battery over-voltage protection.
		7. Battery charger characteristics: the UPS battery charging system shall have the following characteristics:
			1. The charger shall be capable of being configured for several charge 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 can be adjusted via software, used for flooded cell applications

Nominal float voltage: 2.27 V per cell

Equalizing voltage: 2.31 V maximum per cell (adjustable)

Automatic (time-based) or manual (user-initiated) equalization available

* + - 1. UPM will automatically adjust battery shutdown based upon loading and battery capacity.
				1. The UPM 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 1.56 V per cell.
		1. The UPM will automatically disconnect the battery system via contactor in case of full battery discharge followed by prolonged utility AC voltage failure. The time window before battery disconnection occurs shall be programmable for both time and voltage.
	1. UPS output in standard double-conversion mode:
		1. 380/400/415V, three-phase, four-wire plus ground.
		2. Steady-state voltage regulation (in inverter) shall be within +/- 1 percent average from nominal output voltage.
		3. Transient voltage response shall be compliant to IEC 62040-3 Class 1.



* + 1. Linear load harmonic distortion capability: output voltage THD of 1 percent for 100 percent linear load.
		2. Non-linear load harmonic distortion capability: output voltage THD of less than 5 percent for 100 percent non-linear load when tested using the non-linear load described in IEC 62040-3.
		3. Manual output voltage adjustment shall be +/- 3 percent from nominal.
		4. Line synchronization range shall be +/- 3Hz, adjustable to +/- 0.5Hz.
		5. Frequency regulation shall be +/- 0.1Hz free running.
		6. Frequency slew rate shall be adjustable up to 0.7 Hz/second maximum
		7. Phase angle control:
			1. Balanced linear load shall be +/- 1° from nominal 120°.
			2. Unbalanced linear loads shall less than +/- 3° from average phase voltage for 100 percent load unbalance.
		8. Phase voltage control:
			1. Balanced linear loads shall be +/- 1 percent from average phase voltage
			2. Unbalanced linear loads shall be less than +/- 5 percent for 100 percent load unbalanced
		9. Overload current capability (with nominal line and fully charged battery): the unit shall operate with up to 110 percent of resistive/inductive load for 10 minutes, up to 125 percent for two minutes and up to 150 percent for 15 seconds.
		10. Fault clearing current capability: 1000 percent RMS for 20 ms. and 600 percent for 50 ms. with bypass intervention. Inverter alone (no bypass), shall produce 660A RMS per UPM for 10 cycles.
		11. Static transfer time: no break, completed in less than 4 ms.
		12. Acoustical noise: noise generated by the UPS under normal operation shall not exceed 85 dbA (as low as 75 dbA for UPS with battery charging off) at one meter from any operator surface, measured at 25°C (77°F) and <60% load, per ISO7779 standard.
		13. EMC suppression: the UPS shall meet IEC 62040-2, category C3.
		14. Electrostatic discharge (ESD): The UPS shall meet EN 61000-4-2 level 3.
		15. Efficiency: the UPS incorporates a three-level power converter design for the highest possible efficiency. Efficiency shall be up to 97 percent, with 25 percent load efficiency no less than 95.6% and 50 percent load efficiency no less than 96.3%, and 75 percent load efficiency no less than 96.1%, and 100 percent load efficiency no less than 95.7% When in VMMS mode, the UPS shall operate at no less than 96 percent efficiency at loads down to 15 percent of UPS capacity.
	1. UPS output with Energy Saver System (ESS):
		1. ESS acts to optimize the internal components of the UPS power train to maximize system efficiency when the bypass source is within the following (adjustable) limits: Voltage: +/- 10 percent, and Frequency: +/- 3Hz.
		2. 380/400/415V, three-phase, four-wire plus ground.
		3. Steady-state voltage regulation (in inverter) shall be within +/- 10 percent from nominal output voltage.
		4. Line synchronization range shall be +/- 3Hz, adjustable to +/- 5Hz.
		5. Frequency regulation shall be +/- 3Hz when bypass source is within limits in (1) above.
		6. Overload current capability (with bypass source within the limits of (1) above) 1000 percent for 20 ms., 600 percent for 50 ms.
		7. Static transfer time for input outage: no break, completed in less than 2 ms.
		8. Acoustical noise: noise generated by the UPS under normal operation shall not exceed 75 dbA at one meter from any operator surface, measured at 25°C (77°F) and full load.
		9. EMC suppression: The UPS shall meet IEC 62040-2, category C3.
		10. Electrostatic discharge (ESD): The UPS shall meet EN61000-4-2 level 3.
		11. Efficiency: the UPS efficiency shall be up to 99 percent over the range of 10 to 100 percent load. If UPS requires input filters for controlling input THD, manufacturer shall state efficiency of UPS with input filters connected.
	2. UPS in distributed bypass parallel configurations:

UPS modules (825 and 1100- kW lineups) shall be capable of being paralleled to increase system power levels or to provide redundant power. A total of four (4) UPS modules shall be capable of parallel operation, either for capacity or redundant systems. It shall be possible to parallel up to four (4) UPS modules where each UPS lineup contains a discrete static switch, and without a central static switch/bypass cabinet. A simple “tie cabinet” with module output breakers (MOB) shall be required. Each MOB shall have dual sets of form C auxiliary contacts to provide breaker status to the UPS modules. The parallel system shall have intelligence to automatically recognize the need for capacity and/or redundancy. Parallel systems shall utilize autonomous UPS power modules that do not rely on any control interconnections for synchronized operation. The individual modules shall operate in a peer-to-peer manner to provide automatic load sharing, synchronization, and selective tripping capabilities. “primary-secondary” configurations are not acceptable.

* 1. The parallel system shall utilize a communications network to provide system information and status, such as operating mode and meter data. This network shall provide individual module information as well as total system information, and individual module information shall be available from any module’s front panel display. The loss of this system information network shall not cause the parallel units to transfer to bypass or drop the critical load.

## 2.06 MECHANICAL DESIGN

* 1. Ventilation: The UPS shall be designed for forced-air cooling. Air inlets shall be on the front of the unit. Air outlets shall be on the top. Eighteen inches of clearance over the UPS outlets shall be required for proper air circulation.
	2. No back or side clearance or access shall be required for the system. The back and side enclosure covers shall be capable of being located directly adjacent to a wall.
	3. Cable entry: Standard cable entry for the UPS cabinet shall be through either the enclosure bottom or top. A dedicated wireway shall be provided within the UPS cabinet for routing user input and output wiring.
	4. 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.
	5. Service area requirements: the system shall require no more than 36 inches of front service access room and shall not require side or rear access for service or installation.
	6. Shipping shock and vibration: per ASTM D4169.
	7. Seismic standards: UPS modules shall be designed to meet California Building Code 2010, International Building Code 2009 and OSHPD seismic requirements, when Eaton seismic bracing kits are installed.
	8. Dimensions: All modules that comprise the UPS will be 34.3 in., (871 mm.) depth and 73.3 in. (1872 mm.) height. Width will vary as necessary to fit the parts and options and to facilitate ease of installation. Width of 275/300 kW frame sections will be 21.3 in. (540 mm.) in width. Field-installable 275/300 kW UPM shall be 30 in. (762 mm.) in width.

## 2.07 CONTROLS AND INDICATORS

* 1. 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. DSP shall eliminate variances from component tolerance or drift and provide consistent operational responses.
		2. All operating and protection parameters shall be firmware controlled, thus eliminating a need for manual adjustments. The logic shall include system test capability to facilitate maintenance and troubleshooting. Printed circuit board replacement shall be possible without requiring calibration.
		3. Start-up and transfers shall be automatic functions.
	2. Digital front panel display: The UPS control panel shall be a digital front panel display that features 7” color touchscreen LCD. The LCD shall display UPS status, metering, battery status, alarm/event queue and active alarms. The front panel display shall show a system mimic diagram with an outlined power path, current operating mode and event logs, as well as statistics and load profiling.
	3. Control panel information: the UPS control panel shall provide the following functions from front panel touchscreen LCD:
		1. HOME: Displays the power map of the UPS with colors indicating the power flow (online or bypass mode). Also displays data pertaining to system load and efficiency.
		2. METERS: Displays performance meters for the system or critical load. When selected, the front display shall show individual screens of input parameters, output parameters or bypass parameters, including; voltage, current and frequency in a graphical format. In addition, the battery display shall show runtime remaining. In a parallel system, meters for the local UPS and the other UPS in the system can be viewed.
		3. CONTROLS: Allows selection of operating mode, normal, bypass, charger on/off and power module on/off. Individual UPMs can also be controlled through this screen. The EAA controls screen can be used to enable and disable installed Energy Advantage Architecture options
		4. POWER MAPS: Shows the power flow for the system via the UPS power map and shows UPM detail through the UPS module map (for the local UPS). In a parallel system, the system overview displays the entire parallel system with the ability to access any UPS information in the system.
		5. LOGS: Displays the list of active system events and a historical log of system events. Historical logs shall include a detailed time stamped list of over 300 events. Events shall include detailed information including the description, source, type and solution.

Battery log shall include time on battery, load on battery, end voltage and source (UPM). The battery log shall also include the average time and total time on battery for each UPM.

* + 1. STATISTICS: This screen shall summarize the time on various modes for the current month, prior month and since the last reset. This includes online, online ESS, online VMMS, on bypass and on battery. A graphical comparison shall show the consumption in double-conversion mode and ESS, along with estimated savings.
		2. SETTINGS: Allows configuration of the unit including meters format, ESS and VMMS configuration, backlight adjustments, display contrast, date and time information, serial communication port configuration and display of firmware revision numbers.
		3. STATUS BAR: A status across the top of the screen displays unit name, date/time, active alarms, system voltage and frequency, and battery levels. Two interactive buttons on the status bar allow for language changes and passcode input.
	1. Control panel indicators: the UPS control panel shall provide the following monitoring functions with indicator LEDs:
		1. NORMAL: This shall indicate that the commercial AC utility or generator source is supplying power to the rectifier and the inverter is supporting the critical load. A text message shall indicate if the bypass line is not within tolerance.
		2. BYPASS: This shall indicate that the UPS has transferred the load to the bypass circuit.
		3. BATTERY: This shall indicate that the battery is supplying power to the inverter, which is supporting the load. A text message shall indicate if the battery charge is low or if the battery is installed but disconnected.
		4. ALARM: This shall indicate that the UPS detects an alarm condition, outlined in detail in the operator’s manual.
	2. 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 supplying both N/O and N/C contacts. Contact ratings shall be 5A max at a voltage not to exceed 28VDC or 277VAC.
		2. RS232 (EIA/TIA-232) communications interface: Circuitry shall be provided for one RS232 (EIA/TIA-232) communication port for connection to automated service department diagnostic tools. This port may be used with simple (“dumb”) terminals to gain remote access to all unit operation information.
		3. Building alarm inputs: The unit will have four configurable, galvanic isolated (SELV) "building alarm" inputs, provided for monitoring the status of external dry contacts. Building alarms shall be set up through the UPS configuration mode function on the RS232 (EIA / TIA-232) port.
		4. External EPO contacts: Shall be provided to connect an external remote emergency power off switch to shut down the UPS and de-energize the critical load. Alternatively, these contacts can be configured to transfer the UPS to bypass.
		5. Battery control contacts: contacts shall be provided to connect the battery shunt trip and auxiliary 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.
		7. The following display languages are supported: English, French, Spanish, Simplified Chinese, Traditional Chinese, German, Italian, Korean, Russian and Portuguese.
	3. COMMUNICATIONS
1. Communications bay: The UPS shall be equipped with field configurable communications bays that will accommodate four (4) communication devices.
2. 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. UPS manufacturer shall provide optional communications devices capable of communicating via various industry standard protocols such as RS232, BACnet, and ModBus. Monitoring of UPS status may also be performed through isolated dry contact form C relays.
		3. Remote monitoring of the UPS shall also be possible through status indicators elsewhere in the same facility through a device that replicates these indicators.

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 (i.e. Internet Explorer).

All optional hardware interfaces shall be “hot-swappable” (UPS maintains power to critical applications while changing interfaces).

1. Shutdown:
	* + 1. There shall be a mechanism that provides graceful, orderly, unattended, sequential shutdown of one or multiple computers powered by one UPS. This 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 on battery for more critical systems.
			2. The UPS shall also be capable of interfacing with an operating system’s built-in shutdown routine. This shall be done through a cable connection to the optional network port on the UPS.
2. Notification:
3. 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.
4. Network access to a computer for alarm notification may be performed. The user may respond by connecting via the network to retrieve alarm history and a summary of current meter status.
5. Management: A remote battery test may be performed via an Ethernet network. The UPS shall be tested through invoking a single command.

## 2.08 UPS PROTECTION

* 1. Rectifier/charger and bypass protection shall be provided through fusing.
	2. Battery protection shall be provided by thermal-magnetic molded-case circuit breakers in each battery cabinet (if standard battery pack is provided) or external protective device for an external battery.
	3. Electronic current limiting circuitry and fuses in the Inverter circuit shall provide output protection.
	4. To comply with agency safety requirements, the UPS shall not rely upon any disconnect devices outside of the UPS to isolate the battery cabinet from the UPS.

PART 3 - EXECUTION

### 3.01 INSTALLATION

* 1. Install in accordance with manufacturer’s instructions.

### 3.02 COMMISSIONING

* 1. Factory start-up shall be available on a **7 x 24** basis. Start-up service shall be provided at no extra charge and shall include one visit to perform all procedures and tests specified within UPS installation and operation manual. UPS manufacturer shall also offer the following optional services:
		1. Pre-energize visit to inspect installation and provide guidance to installers as required.
		2. Post-start-up visit for alarm notification configuration, operator training, generator testing, etc.
	2. The following procedures and tests shall be performed by field service personnel during the UPS startup:
		1. Visual inspection:
			1. Visually inspect all equipment for signs of damage or foreign materials.
			2. Observe the type of ventilation, the cleanliness of the room, the use of proper signs, and any other safety-related factors.
		2. Mechanical inspection:
			1. Check all the power connections for tightness.
			2. Check all the control wiring terminations and plugs for tightness or proper seating.
		3. Electrical pre-check:
			1. Check the DC bus for a possible short circuit.
			2. Check input and bypass power for proper voltages and phase rotation.
			3. Check all lamp test functions.
		4. Initial UPS startup:
			1. Verify that all the alarms are in a “go” condition.
			2. Energize the UPS module and verify the proper DC, walkup and AC phase on.
			3. Check the DC link holding voltage, AC output voltages and output waveforms.
			4. Check the final DC link voltage and inverter AC output. Adjust if required.
			5. Check for the proper synchronization.
			6. Check for the voltage difference between the inverter output and the bypass source.

Optional ->

* + - 1. Optional internal load testing: The UPS system will be capable of utilizing the Easy Capacity Test (ECT) function, including internally adjustable load testing at the customer site, without the need for a load bank. Testing shall only be initiated using the Eaton Engineer’s Software Service Tool. This testing is not intended to be performed while the UPS is servicing the critical load
		1. 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.

### 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.

One-year service protection package shall include 5x8 or 7x24 hour on-site repair/replacement labor for UPS parts and batteries; 7x24 technical support coverage; and 7x24 remote monitoring service (with monthly reports for UPS and battery performance). Standard response time shall be eight (8) hours from receipt of call. Manufacturer shall also offer, as an option, 7x24 on-site service support with guaranteed response times of four (4), or two (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: 5x8 or **7x24** 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, either with preventive maintenance or replacement coverage.

END