

SECTION 16732

UNINTERRUPTIBLE POWER SUPPLY (UPS)
SYSTEM FOR TRAFFIC SIGNAL CABINETS

PART 1 GENERAL

1.01 SECTION INCLUDES

Furnish, install, and make fully operational an Uninterruptable Power Supply (UPS) system at designated locations as shown on the plans and as detailed in accordance with these specifications. Use the same manufacturer and model for each Uninterruptable Power Supply (UPS). The Uninterruptable Power Supply provides reliable power to a traffic signal intersection (vehicle and pedestrian) in the event of utility failure or interruption. The UPS system shall also act as a power conditioner and/or voltage regulation device.

1.02 MEASUREMENT AND PAYMENT

A. Measurement

This item will be measured as each unit furnished, installed, made fully functional and tested in accordance with these special specifications or as directed by the Engineer. The UPS system will include, but is not limited to an automatic bypass switch, power transfer relay, an inverter/charger, batteries, battery charge management device, wiring, external cabinet, all mounting hardware, manufacturer's operation manual, required testing results, manufacturers technical specification, and the cost of all materials, training, warranty, equipment, and all accessories necessary to the complete installation of the unit.

B. Payment

Payment for the work performed and materials furnished in accordance with this item will be paid for at the unit price bid for "Uninterruptable Power Supply". This price will include all equipment described under this item with automatic bypass switch, power transfer relay, an inverter/charger, batteries, battery charge management device, wiring, external cabinet, mounting hardware; all documentation and testing and will also include the cost of furnishing all labor, materials, software, warranty, training, equipment, and incidentals.

PART 2 PRODUCTS

2.01 MATERIALS

Provide an Uninterruptable Power Supply (UPS) unit that meets the following requirements.

A. GENERAL REQUIREMENTS

The UPS system shall be capable of operating a signalized intersection (700 watt load) for 4 hours of full runtime when utility power is disabled and under ambient temperature of 25°C. The UPS system shall switch the intersection to flash mode when approximately 40% of the battery charge is remaining, via relay contact connection points on the front panel of the unit. The UPS system shall operate the intersection in the flash mode of the operation (350 watt load) for an additional 2 hours. The UPS system shall be rated for a minimum 2,000 watt load capacity.

B. DISPLAYS, CONTROLS, DIAGNOSTICS AND MAINTENANCE

1. The UPS system shall include a front panel display. All applicable programmable functions of the operational methods described in this specification shall be viewable through the front panel display.
2. All events described in Operations Section shall be viewable from the front panel display.
3. The UPS system software shall be programmable from the front panel of the inverter/charger by means of a keyboard or momentary buttons allowing the user to step through menu driven software.
4. A 10/100 Ethernet port shall be provided on the front panel of the inverter/charger.
5. UPS system software shall be provided for the operational needs of the UPS system. The user/operator shall be able to access all system software via the Ethernet port and RS232 port on the front panel of the inverter/charger. The user shall be able to read logged events and/or change programmable parameters from the keyboard, laptop, or local area network via Ethernet port.
6. System software shall be upgradable via the RS232 and Ethernet ports on the front panel of the inverter/charger.
7. All upgrades for software shall be provided for hardware components for the duration of the warranty period at a minimum.

C. INVERTER/CHARGER

Provide an inverter/charger that has the following features:

1. When utility line voltage is out of normal operating range (typical 100V AC to 135V AC), the inverter/charger shall provide voltage regulation and/or power conditioning to the inverter line voltage using one or more of the methods described in Section 3.0 of this specification. When utility line voltage is present, it shall act as a charging device for the batteries.

2. Operating temperature range for both the inverter/charger unit and power transfer relay shall be -34°C to 74°C.)
3. When battery power is used, the UPS system output voltage shall be between 110V AC and 125V AC, pure sine wave output, $\leq 3\%$ THD, 60Hz \pm 3Hz.
4. As a minimum the inverter/charger shall be rated for 2,000 watts of continuous power from the unit.

D. AUTOMATIC BYPASS SWITCH

Provide an automatic bypass switch that has the following features:

1. The automatic bypass switch shall be provided as a separate unit external to the inverter/charger unit. The automatic bypass switch shall be 2 position and rated at a minimum of 240V AC/30 amp. A UPS supply breaker rated at 240V AC/30 amps shall be provided for the 120V AC input to the inverter/charger.
2. When the automatic bypass switch is in the “on” position and the supply breaker is “on”, the UPS system is connected to utility line voltage and its output is connected to the cabinet service panel. If the utility line voltage is deactivated, the UPS system will automatically switch over to battery power.
3. When the automatic bypass switch is in the “off” position, and the supply is “on”, utility line power is provided to the cabinet service panel and the inverter/charger allowing equipment to be tested without interrupting power to the traffic signal load.
4. When the automatic bypass switch is “off” and the supply breaker is “off”, the utility line voltage will feed power directly to the traffic signal cabinet service panel and power to the inverter/charger will be deactivated allowing the user to service UPS equipment.

E. BATTERIES

Provide batteries for the Uninterruptable Power Supply System that have the following features:

1. Individual batteries shall be 12V type rated for at least 165 minutes of runtime, and shall be easily replaced and commercially available for purchase as common off the shelf equal.
2. Batteries shall be sized and rated to operate at 700 watt load for 4 hours (normal operation) followed by a 350 watt load (flash operation) for 2 hours.

3. Battery configurations shall consist of 12V batteries arranged in one of the following arrangements: 48V, 60V, 72V, 84V, 96V.
4. Batteries shall be deep discharge sealed prismatic valve regulated acid (VRLA) AGM or Gel cell batteries.
5. Batteries shall operate over a temperature range of -34°C to 74°C.
6. Batteries shall not be charged when battery temperature exceeds 50°C ± 3°C.
7. Batteries shall indicate maximum recharge data, recharging cycles, and manufacture defaults on the inverter. Batteries shall not allow the recharging process to exceed the batteries maximum values.
8. Battery interconnect wiring shall connect to the inverter unit via modular harness with red and black cables. Harness shall have battery ring lug at the battery end of the cables that are .40" in diameter and connect to batteries using a ¼" – 20 UNC bolt that is ¾" in length.
9. Batteries shall have maintenance free threaded inserts sized to fit a ¼" – 20 UNC bolt that ¾" in length.
10. Insulated covers shall be provided at the connection points of the batteries to prevent accidental shorting.
11. Battery harness and cabling shall be a minimum of 6ft in length
12. Batteries weighing more than 50 pounds shall be provided with a handle or hand strap allowing the user to carry or move the battery without the use of other equipment.

F. BATTERY MONITORING SYSTEMS

Provide a temperature compensated battery charging system and a temperature sensor that have the following features:

1. The UPS system shall use a temperature compensated battery charging system. The charging system shall compensate over a range of 2.5 to 4mV/°C per cell.
2. The temperature sensor shall be used to monitor the temperature and regulate the charge rate of the batteries. Unless required otherwise by the plans the temperature sensor wire shall be as follows:
 - a. Temperature sensor wire shall be a minimum of 8 feet in length.

- b. Should the temperature sensor fail, the inverter/charger shall not allow the UPS system to overcharge the batteries. The UPS system shall provide an alarm should the temperature sensor fail.
- c. Recharge time for the batteries to 80% or more of full battery charge capacity shall not exceed 20 hours at 70°F.
- d. Batteries shall not be charged when the battery temperature exceeds $50^{\circ}\text{C} \pm 3^{\circ}\text{C}$.
- e. The UPS system shall monitor battery strings within a system and set a fault indicator if the battery voltage falls below normal operating voltages.

G. EXTERNAL UPS SYSTEM CABINET

Provide an external cabinet to house all of the UPS system components that has the following features:

1. The external cabinet shall be NEMA Type 3R all aluminum with stainless steel hardware, or equal, approved by the City of Houston Traffic Signal Maintenance Shop. The external cabinet shall be sized to house all of the UPS system components including batteries and designed to mount to the side of the traffic signal cabinet. Dimensions of the external cabinet shall not exceed 56" height x 26" width x 18" depth. The cabinet shall be mounted in a manner that does not obstruct pedestrian travel on adjacent sidewalk.
2. The cabinet shall be provided with one door in front that will provide access to the cabinet. The door shall be provided with three hinges with non-removable stainless steel pins, or a full-length piano hinge with stainless steel pins spot welded at the top of the hinge. The hinges shall be mounted so that it is not possible to remove them from the door or cabinet without first opening the door.
3. The cabinet door shall be fitted with a Number 2 Corbin lock and a cast aluminum or chrome plated steel handle with a 16mm (minimum) diameter shaft (or equivalent cross-sectional area for a square shaft) and a three point latch. The lock and latch design shall be such that the handle cannot be released until the lock is released. One key shall be provided for each cabinet. A gasket shall be provided to act as a permanent dust and weather resistant seal at the cabinet door facing. The gasket material shall be of a nonabsorbent material and shall maintain its resiliency after long term exposure to the outdoor environment. The gasket shall have a minimum thickness of 6.25mm. The gasket shall be located in a channel provided on the cabinet

or on the door(s). An “L” bracket is acceptable in lieu of this channel if the gasket is fitted snugly against the bracket to insure a uniform dust and weather resistant seal around the entire door facing. Any other method is subject to written purchaser approval during inspection of an order.

4. The intake for the vent system shall be on the lower section of the cabinet front door and filtered with a washable, metal air filter. The filter shall be securely mounted so that any air entering the cabinet must pass through the filter. The cabinet opening for intake of air shall be large enough to use the entire filter. The air intake and exhaust vent shall be screened to prevent entry of insects. The screen shall have opening no larger than 8.1mm². The total free air opening of the exhaust vent shall be large enough to prevent excessive back-pressure on the fan.
5. The external cabinet must contain a fan mounted in the top of the cabinet. The fan must be 48Vdc and thermostat controlled. It must turn on when the inside temperature of the cabinet reaches or exceeds 49°C (120°F) and turn back off once the inside temperature of the cabinet returns to 32°C (89°F).
6. The external UPS system cabinet shall include a red LED mounted on the top of the cabinet that is visible from the street. This indicator shall be connected to light the LED “on” to allow maintenance to know when the intersection is running off UPS power. When the intersection is operating on utility line voltage the LED will be “off” (not illuminated).

H. OPERATION

The UPS system shall operate in one or more of the following methods:

1. Line Interactive (Buck and Boost) Method
 - a. When the buck and boost functions are enabled they shall set the upper and lower control limit allowable for the utility line voltage. If the utility line voltage fails within the parameters set by buck and boost, then the UPS system shall continue to operate the intersection under utility line power. If the utility line voltage fluctuates above or below the buck and boost values, the UPS system shall raise or lower the voltage by approximately 10%-15% of the utility line voltage in an attempt to bring the voltage back into the upper and lower control limits set by buck and boost. Buck and boost shall have preset manufacturer defaults.
 - b. If the utility line voltage falls above or below the functional capabilities of buck and boost, then the UPS system shall transfer power from the utility line

voltage and the inverter/charger shall operate the intersection from battery power converting DC voltage to AC.

2. Continuous Operating Mode, Double Conversion Method
 - a. Using the continuous operating mode buck and boost functions are disabled and the UPS system operates continuously converting the utility line voltage, 120V AC, to DC voltage, then back to 120V AC, supplying the cabinet with inverter line power. Should the utility line voltage fail, the UPS system will continue to supply inverter line power to the cabinet via the UPS system.
3. General Operation Requirements
 - a. The UPS system shall be capable of providing 2,000 watts active output capacity, with a minimum of 80% inverter efficiency. The inverter/charger shall be capable of operating at a 2,000 watt continuous load.
 - b. When the batteries are fully charged, ensure the UPS system provides power to run an intersection and all peripherals for a minimum of 4 hours of semi-actuated runtime (700 watt load), then switch to flash mode for a minimum of 2 hours of flash runtime (350 watt load).
 - c. When the system is running on battery power, the UPS system shall allow the user to select a voltage (typically 48V) at which the transition from normal operating loads (700 watts) to flash mode (350 watts) will occur via a set of relay contacts or connection points on the front panel of the inverter/charger.
 - d. The transfer time allowed, from disruption of normal utility line voltage to stabilized inverter line voltage from the batteries, shall be less than 65 milliseconds. The same allowable transfer time shall also apply when switching from inverter line voltage to utility voltage.
 - e. The UPS system shall bypass utility line voltage, whenever the utility line voltage is outside the manufacturer's defaults or a user programmed voltage range $\pm 5V$ AC.
 - f. When the utility line power has been restored to a normal operating voltage for more than 30 seconds, the UPS system shall transfer from battery back to

utility line mode. The UPS shall be equipped to prevent a malfunction feedback to the cabinet or from feeding back to the utility service.

- g. The UPS system shall be compatible with ITS models, NEMA, and Model 170/2070, controller and cabinet components for full runtime operation.
- h. The UPS system shall be shelf mounted within its own side mounted external cabinet. The bypass switch can be mounted inside the traffic signal cabinet or in the side mounted external cabinet along with the batteries. The interconnection cables shall be no less than 10 feet in length. Relay contact wiring for relay contact closures shall be no less than 6 feet long of #10 AWG wire. Wire size shall be sized accordingly to manufacturer recommendations for any cable lengths greater than 10 feet.
- i. The UPS system shall have lightning surge protection compliant with IEEE/ANSI C.62.41, latest revision and meeting all current UL 1449 standards.
- j. The UPS system and batteries shall be easily replaced and provided with all needed hardware and software. The UPS system shall not require any special tools for installation.
- k. The UPS system shall operate with an automatic “fail safe” mode. Should a breaker trip on the inverter/charger and/or the power transfer relay, the unit will automatically default to utility line power and bypass the UPS system.
- l. The UPS system shall be capable of logging up to 100 events. Events shall date and time stamp faults with the AC line voltage and UPS battery voltage. At a minimum, the following conditions shall be recorded as an event:
 - i. The UPS system shall record utility line voltage occurrences whenever the line voltage falls above or below the upper and lower control limits or manufacturer preset defaults. When this condition occurs, it shall be record as an event.
 - ii. Whenever the UPS system automatically switches to battery power this shall be recorded as an event.

- iii. Whenever the UPS system returns to utility line power from battery power, this shall be recorded as an event.
- iv. The UPS system shall be capable of self-monitoring and record failure of any UPS system components as an event.

2.02 CONSTRUCTION

A. GENERAL

Provide equipment that utilizes the latest available techniques for design and construction with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality.

Design the equipment for ease of maintenance. Provide component parts that are readily accessible for inspection and maintenance. Provide test points that are for checking essential voltages and waveforms.

B. ELECTRONIC COMPONENTS

Provide this item in accordance with Special Specifications "Electronic Components".

C. MECHANICAL COMPONENTS

Provide external screws, nuts and locking washers that are stainless steel; no self-tapping screws will be used. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum or brass. Protect materials from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

D. DOCUMENTATION REQUIREMENTS

1. Operation and maintenance manuals shall be provided. The operation manual shall include a block diagram schematic of all systems hardware components. The manual shall include instructions for programming and viewing software features. The manual shall include all uploading/downloading (communications protocol) requirements via R232 port and Ethernet port.
2. Board level schematics shall be provided when requested.
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E. TESTING

City of Houston reserves the right to do testing on UPS systems to ensure quality assurance before installations and random sampling of units being provided to the City. UPS systems that fail will be removed from the Prequalified Products List (QPL).

City of Houston QPL testing procedures will include the following:

1. UPS system shall comply with all the criteria of this specification.
2. Event logging for fault/alarm conditions.
3. System will demonstrate one or more of the operation methods described in Section 3.0.
4. UPS system will operate at 700 watt load (minimum 4 hours), system will transfer to flash mode and operate at 350 watt load (minimum 2 hours) under battery power and at ambient temperature +25°C, total length of test 6 hours.
5. All component of the system shall be tested in environmental chamber (temperature ranges from -30°C to 74°C).

F. EXPERIENCE REQUIREMENTS

Meet the following requirements, as a minimum, for Contractor or designated subcontractors involved in the installation and testing of the UPS system:

Three years' experience in the installation of UPS equipment. Two installed systems where UPS systems are installed and the systems have been in continuously satisfactory operation for at least two (2) years. Submit as proof, photographs or other supporting documents, and the names, addresses and telephone numbers of the operating personnel who can be contacted regarding the system.

Provide necessary documentation of subcontractor qualifications pursuant to contract award.

G. TECHNICAL ASSISTANCE

Ensure that a manufacturer's technical representative is available on site to assist the technical personnel at each installation site and with UPS equipment installation and communication system configuration.

Do not execute the initial powering up of the UPS equipment without the permission of the manufacturer's representative.

H. WARRANTY

1. All components of the UPS system will be warranted by the manufacturer for five years following the acceptance of the system by City of Houston. The warranty will include the specific installation characteristics for the geographic region and project limits.
2. Batteries shall be warranted for full replacement for 5 years. Batteries shall be defined as bad, if they are not able to deliver 80% of battery rating.

PART 3 EXECUTION

A. SUBMITTALS

Manufacturers' cut sheets / specifications and software for all equipment proposed under these specifications shall be submitted to the City of Houston's Traffic Signal and Operations branch at Houston TranStar (713-881-3172) prior to construction.

END OF SECTION