

## 1.0 General

### 1.1 Summary

This specification describes the 5K Modular UPS, a modular uninterruptible power supply system for workstation, server, network, telecom and other sensitive electronic equipment applications. It defines the electrical and mechanical characteristics and requirements for a continuous-duty single-phase, solid-state, uninterruptible power supply system. The uninterruptible power supply system, hereafter referred to as the UPS, provides high-quality AC power.

### 1.2 Standards

The UPS was designed in accordance with the applicable sections of the current revision of the following documents. Where a conflict arises between these documents and statements made herein, the statements in this specification shall govern.

IEEE C62.41, Category A & B  
ASME  
CSA 22.2, No. 107.1  
FCC Part 15, Sub Part B, Class A  
National Electrical Code (NFPA 70)  
NEMA PE-I  
OSHA  
UL Standard 1778

### 1.3 System Description

#### 1.3.1. General

The 5K Modular UPS system consists of the appropriate number of modules for capacity and/or redundancy. All modules are to be operating simultaneously and sharing the load. In a nonredundant system, all the modules making up the UPS are required to supply the full rated load. If a power or control module should malfunction, the load is to be transferred automatically to the bypass line. If a battery module should malfunction, it is to be isolated from the system resulting in reduced back up time. For redundant operation, the UPS will have one or more modules than what is required to supply the full rated load. The malfunction of one of the modules shall cause that module to be isolated from the system and the remaining module(s) shall continue to carry the load. Replacement of a module shall be capable without disturbance to the connected load.

#### 1.3.2. Modes of Operation

The UPS shall be designed to operate as a true on-line system in the following modes:

- A. **Normal** - The critical AC load is continuously supplied by the UPS inverter. The input converter derives power from a utility AC source and supplies DC power to the inverter. The battery charger shall maintain a float-charge on the battery.
- B. **Back-up** - Upon failure of utility AC power the critical AC load is supplied by the inverter, which obtains power from the battery. There shall be no interruption in power to the critical load upon failure or restoration of the utility AC source.

- C. **Recharge** - Upon restoration of utility AC power, after a utility AC power outage, the input converter shall automatically restart and resume supplying power to the inverter. Also the battery charger shall recharge the battery.
  
- D. **Automatic Restart** - Upon restoration of utility AC power, after a utility AC power outage and complete battery discharge, the UPS shall automatically restart and resume supplying power to the critical load. Also the battery charger shall automatically recharge the battery. This feature shall be enabled from the factory and shall be capable of being disabled by the user. The user shall also be able to program two auto restart delay settings
  - 1. Battery capacity % level
  - 2. Countdown timer
  
- E. **Bypass** - The bypass shall provide an alternate path for power to the critical load that shall be capable of operating in the following manner:
  - 1. **Automatic** - In the event of an internal failure or should the inverter overload capacity be exceeded, the UPS shall perform an automatic transfer of the critical AC load from the inverter to the bypass source.
  - 2. **Manual** - Should the UPS need to be taken out of service for limited maintenance or repair, manual activation of the bypass shall cause an immediate transfer of the critical AC load from the inverter to the bypass source. The input converter, inverter, and battery charging operations shall continue to operate, provided the control enable switch is in the “ On “ position.

### 1.3.3. Performance Requirements

#### 1.3.3.1. System

- A. **Configuration:** Select UPS systems shall be configured or upgradeable to power ratings as follows:

##### 8 Bay Frame Systems

- 4.0 KVA single system to 8, 12 or 16 KVA single systems, 4, 8 or 12 KVA redundant systems.
- 8.0 KVA single systems to 12, or 16 KVA single systems, 8 or 12KVA redundant systems.
- 12.0 KVA single systems to 16KVA single systems or 12KVA redundant systems.

##### 12 Bay Frame Systems

- 4.0 KVA single system to 8, 12 or 16 KVA redundant systems.
- 8.0 KVA single systems to 12, or 16 KVA redundant systems.
- 12.0 KVA single systems to 16KVA redundant systems.

- B. **Isolation**

Input to output isolation shall be provided, via the output transformer, regardless of operating mode. (UPS or bypass)

- C. **Remote Stop**

The UPS shall provide provisions for remote stop capability.

**1.3.3.2. AC Input to UPS**

A. **Voltage Configuration:** 208 VAC nominal, single-phase, 2-wire-plus-ground. The operating voltage range shall be variable based upon output loading percentages as follows:

<b>% UPS Load</b>	<b>Input Voltage</b>
80 – 100%	170 VAC
60 – 90%	144 VAC
20 – 70%	127 VAC
0 – 30%	100 VAC

B. **Frequency:** 40 to 70 Hz.

C. **Input Current Distortion:** 5% THD maximum at full load.

D. **Input Power Factor:** 0.98 lagging at 100% rated load.

E. **Inrush Current:** 150% of full load input current maximum for 3 cycles.

F. **Surge Protection:** Sustains input surges without damage per criteria listed in IEEE C62.41, Category B.

**1.3.3.3. AC Output**

A. **Voltage Configuration:** 208/120 VAC, single-phase, 3-wire-plus-ground. Field configurable to 240/120 VAC.

B. **Voltage Regulation:** +/- 3% steady state.

C. **Frequency Regulation:** 60 Hz, +/- 0.01%.

D. **Frequency Slew Rate:** 5.0 Hertz per second maximum.

E. **Bypass Frequency Synchronization Range:** +/- 5.0 Hertz.

F. **Voltage Distortion:** 3% total harmonic distortion (THD) maximum into a 100% linear load, 7% THD maximum into a 100% non-linear load with crest factor ratio of 3:1.

G. **Load Power Factor Range:** 0.5 lagging to 1.

H. **Output Power Rating:** Rated KVA at: 0.7 lagging power factor.

I. **Inverter Overload Capability:** >100% - 110% for 10 minutes, 111% -150% for 8 seconds, 151% - 200% for 0.25 seconds, The load shall be transferred to bypass when any of the above conditions are exceeded.

J. **Voltage Transient Response:** +/- 7% maximum for any load step up to and including 100% of the UPS rating.

K. **Transient Recovery Time:** To within 1% of steady state output voltage within 96 milliseconds.

#### 1.3.3.4. Batteries

- A. **Internal Battery:** The battery shall consist of gas recombination, valve regulated, lead acid cells. Flame retardant batteries shall be provided, which renders the UPS suitable for installation inside a computer room per requirements of UL Standard 1778.
- B. **Reserve Time:** (with ambient temperature between 20 and 25 deg C) The UPS shall contain an internal battery system to provide a reserve time of 7 minutes at 100% load with an equal number of power and battery modules fitted. The UPS shall contain provisions to fit additional battery modules internally if space permits. The UPS shall also interface with an external battery cabinet to extend reserve time capabilities.
- C. **Battery Recharge:** To prolong battery life, the UPS shall contain temperature-compensated battery charging. When equal number of power modules and battery modules are fitted the battery charger shall be able to recharge the internal batteries to 90% charge in three to five hours at nominal input voltage and nominal ambient temperature.

#### 1.4 Environmental Conditions

##### A. Ambient Temperature

Operating UPS 0°C to +40°C; battery 20°C to 25°C for optimum performance.  
Storage: UPS -20°C to +60°C; battery -20°C to 25°C for maximum 6 months.

##### B. Relative Humidity

Operating: 5 to 95% non-condensing.  
Storage: 5 to 95% non-condensing.

##### C. Altitude

Operating: To 10,000 feet. Derating or reduced operating temperature range required for higher altitudes.  
Storage: To 30,000 feet.

##### D. Audible Noise

Noise generated by the UPS during normal operation shall not exceed 62 dBA measured at 1 meter from the surface of the UPS.

##### E. Electrostatic Discharge

The UPS shall be able to withstand a minimum 15 kV without damage and shall not affect the critical load.

#### 1.5 User Documentation

The specified UPS system shall be supplied with one (1) user's manual. Manuals shall include installation drawings and instructions, a functional description of the equipment with block diagrams, safety precautions, illustrations, step by step operating procedures, and routine maintenance guidelines.

#### 1.6 Warranty

The UPS manufacturer warrants the UPS against defects in materials and workmanship for two (2) years. The warranty covers all parts for two (2) years and onsite labor for ninety (90) days. With start-up provided by LGS, the warranty covers all parts and onsite labor for two (2) years. Maintenance contract packages shall also be available.

## 1.7 Quality Assurance

### 1.7.1. Manufacturer Qualifications

A minimum of thirty year's experience in the design, manufacture, and testing of solid-state UPS systems is required.

### 1.7.2 Factory Testing

Before shipment, the manufacturer shall fully and completely test the system to assure compliance with the specification. These tests shall include operational discharge and recharge tests on the internal battery to guarantee rated performance.

## 2.0 Product

### 2.1 Fabrication

All materials and components making up the UPS shall be new, of current manufacture, and shall not have been in prior service except as required during factory testing. The UPS shall be constructed of replaceable subassemblies. All active electronic devices shall be solid-state.

#### 2.1.2. Wiring

Wiring practices, materials, and coding shall be in accordance with the requirements of the National Electrical Code (NFPA 70) and other applicable codes and standards.

#### 2.1.3. Cabinet

The UPS unit comprised of: power module, battery module, control module, system interconnect module and user interface module housed in a single free-standing enclosure and meets the requirements of IP20. The UPS system shall be designed such that the battery modules may be installed into any module bay in the cabinet and power modules into any module bay in the top half of the cabinet. The UPS cabinet shall be cleaned, primed, and painted with the manufacturer's standard color. Casters and leveling feet shall be provided. UPS cabinet dimensions shall not exceed 20 inches wide, 29 inches deep and 40 inches high ( 8 Bay Frame ) or 20 inches wide, 29 inches deep, and 53 inches high ( 12 Bay Frame ).

#### 2.1.4. Cooling

The UPS shall be forced air cooled by internally mounted fans.

## 2.2 Components

### 2.2.1 Input Converter

#### A. General

Incoming AC power shall be converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter shall provide input power factor and input current distortion correction.

#### B. AC Input Current Limit

The input converter shall be provided with AC input over current protection.

**C. Input Protection**

The UPS has built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy surges introduced on the primary AC source and the bypass source. The UPS shall sustain input surges without damage per criteria listed in IEEE C62.41, Category. The UPS cabinet contains an input breaker sized to supply full 16 KVA rated load and to recharge the battery at the same time.

**D. Battery Recharge**

To prolong battery life, the UPS contains temperature-compensated battery charging. When an equal number of power modules and battery modules are fitted, the battery charger can recharge the internal batteries to 90% charge in three to five hours at nominal input voltage and nominal ambient temperature.

**E. Charger Output Filter**

The battery charger has an output filter to minimize ripple current into the battery.

**2.2.2. Inverter****A. General**

The inverter converts DC power from the input converter output, or the battery, into precise regulated sine wave AC power for supporting the critical AC load.

**B. Overload**

The inverter is capable of supplying current and voltage for overloads exceeding 100% and up to 200% of full load current. A visual indicator and audible alarm will indicate overload operation. For greater currents or longer time duration, the inverter has electronic current-limiting protection to prevent damage to components. The inverter is self-protecting against any magnitude of connected output overload. Inverter control logic senses and disconnects the inverter from the critical AC load without the requirement to clear protective fuses. The load transfers to bypass when any of the above conditions are exceeded.

**C. Maximum Load Alarm**

The user can set the alarm point to a value less than 100% rating so that the UPS will alarm before an overload condition or loss of redundancy is reached.

**D. Output Frequency**

The output frequency of the inverter is controlled by an oscillator. The oscillator holds the inverter output frequency to +/- 0.05% for steady state and transient conditions. The inverter tracks the bypass continuously, provided that the bypass source maintains a frequency within the user selected synchronization range. If the bypass source fails to remain within the selected range, the inverter reverts to the internal oscillator.

**F. Output Protection**

The UPS inverter uses electronic current limiting.

**G. Battery over Discharge Protection**

To prevent battery damage from over discharging, the UPS control logic controls the shutdown voltage set point. This point is dependent on the rate of discharge.

### 2.2.3. Display and Controls

#### A. General

The front panel consists of multiple status LEDs, switches, and a four line by twenty character LCD display for additional alarm/configuration information. All mimic display LEDs are green in color and indicate the following:

- AC Input
- On Battery
- Load On/Off
- On Inverter
- On Bypass

The UPS fault indicator is used with additional indicators and audible alarms to notify the user that a UPS fault condition has occurred. The color of the fault indicator LED is amber.

- Replace Battery Module
- Replace Power Module
- Replace Control Module
- On Bypass
- Low Battery
- OverTemp Warning
- UPS Shutdown

If there is a fault condition, the UPS will attempt to maintain conditioned power to the load, or at minimum transfer to bypass. There is also an indication on each module if the module fails and needs to be replaced.

In addition to a visual fault signal, the UPS records fault occurrences in a rolling event log. The event log on the standard unit records up to 255 occurrences with the oldest events discarded first, etc. The user can access to the event log through the LCD display. Every alarm and/or event recorded in the event log contains a time and date stamp.

#### B. Audible Alarms

The volume of all audible alarms should be at least 65 dBA at a distance of one meter (three feet). An audible alarm is used in conjunction with the LED/LCD indication to indicate a change in UPS status.

The audible alarms sounds for utility line loss, low battery (while on battery), and all other alarm conditions. For all alarm conditions, the user must look at the display to determine the cause of error/alarm. All alarm will continue until the condition rectifies itself or the alarm is silenced. Once silenced, the audible alarm will not sound again until a new alarm condition is present.

#### C. Alarm Silence Button

In addition to the load on/off switch, the user interface ncludes an audible '**Alarm Silence**' switch. If the alarm silence switch is pressed for one second, all current audible alarms are disabled. If a new alarm occurs, or a cancelled alarm condition disappears and then re-appears, the audible alarm is re-enabled.

## D. LCD Display

The LCD display is used to provide information to the user and to program **all** information (voltage, frequency, etc.) into the UPS. Any display values that require time/date are 'Y2K' compliant.

### 2.2.4. Automatic Battery Test

The UPS initiates an automatic battery testing sequence periodically, at a programmed day and time of day, selectable by the end user. The user can select the interval of the battery test (1, 2, 3, 4, or 6 week intervals) or can disable the automatic battery test.

Should a failure of the battery occur, the UPS will immediately return to normal mode and fault signals (visual, audible, and remote via serial) are communicated. No audible or remote (via serial/contact closures) indication of the battery test is communicated during the duration of the automatic battery test. The automatic battery test factory default settings are enabled at a two week interval and to occur on Wednesdays at 0600hours (based on the twenty four hour clock).

### 2.2.5. Remote Emergency Power Off (REPO)

The Remote Emergency Power Off function (REPO) allows the user to disable all UPS outputs in an emergency situation. The REPO, in order to be flexible, can interface with either normally open (N.O.) or normally closed (N.C.) systems. The REPO is activated when a pair of 'SELV' contacts, external to the UPS, are activated. The REPO connection is through a simple terminal block type connector.

The REPO function shall not operate if no system control modules are present in the UPS or if the manual bypass switch is in the bypass position. The user must also supply a means of interfacing with the REPO circuit to allow disconnecting the UPS input feeder breaker to remove all sources of power to the UPS and the connected equipment to comply with local wiring codes/regulations.

Regardless of the UPS mode of operation when the REPO is activated, the UPS output shall not be re-enabled until the following occurs:

- REPO contacts are reset (closed if N.C. contacts are used and open if N.O. contacts are used)
- Input circuit breaker is closed
- Control enable switch is turned on
- User interface on/off switch is depressed

### 2.2.6. Bypass

#### A. General

A bypass circuit is provided as an integral part of the UPS. The bypass has an overload rating of 300% rated full load for 10 cycles and 1000% for sub-cycle fault clearing. The bypass control logic contains an automatic transfer control circuit that senses the status of the inverter logic signals and operating and alarm conditions. This control circuit provides a transfer of the load to the bypass source, without exceeding the transient limits specified herein, when an overload or malfunction occurs within the UPS.

**B. Automatic Transfers**

The transfer control logic automatically activates the bypass, transferring the critical AC load to the bypass source, after the transfer logic senses one of the following conditions:

- Inverter overload capacity exceeded
- Inverter over temperature
- UPS fault condition

For inverter overload conditions, the transfer control logic inhibits an automatic transfer of the critical load to the bypass source if one of the following conditions exists:

- Inverter/Bypass voltage difference exceeding preset limits ( $\pm 15\%$  of nominal)
- Bypass frequency out of preset limits ( $\pm 5\%$  of nominal frequency).

**C. Automatic Retransfer**

Retransfer of the critical AC load from the bypass source to the inverter output is automatically initiated unless inhibited by manual control. The transfer control logic inhibits an automatic retransfer of the critical load to the inverter if one of the following conditions exists:

- Bypass out-of-synchronization range with inverter output
- Overload condition exists in excess of inverter full load rating
- UPS fault condition present

**D. Manual Transfer**

In addition to the internal bypass function, the UPS has a manual bypass function. The manual bypass function is provided via a switch mounted on the bottom-front of the UPS. Removal of the lower front bezel is required. The actual AC break time between inverter and bypass is less than four milliseconds.

The manual bypass can also be a partial 'wrap-around' bypass and is configured to wrap around the rectifier, battery charger, inverter, and battery in the same manner as the automatic bypass. The manual bypass does not wrap around the EMI filtering, overcurrent protection or isolation transformer.

The UPS initiates an audible alarm upon transfer to manual bypass. The audible alarm can be silenced by the user. The alarm will continue to sound (unless silenced) while in bypass mode. This reminds the user that the load continues to be powered from utility supply alone.

**2.2.7. Internal Battery**

Flame retardant, valve regulated, gas recombination, lead acid batteries are used as a stored-energy source for the specified UPS system. The battery is housed in separate replaceable modules that slide into any open bay of the UPS cabinet and are sized to support the inverter at rated load and power factor, in an ambient temperature between 20° and 25°C, for a 7 minutes reserve time. The expected life of the battery is 3 to 5 years or a minimum 250 complete discharge cycles. For extended battery reserve time, additional battery modules may be added, if the frame size allows, external battery cabinets shall be also be available as an option.

## 2.3 Communications

The UPS allows for flexibility in communications because the UPS can communicate through two communications ports simultaneously; the media of either communications port may change without affecting the operation of the UPS. The use of relay contacts do not affect the operation of the two communications ports.

### 2.3.1. Relay Contacts

The relay contacts are available through at least one DB-9F communication connector and are compatible with the SiteNet MultiLink system. The UPS communicates the following information via relay contact closure:

- Low Battery
- On Battery

One connector to provide relay contacts is fitted on all UPS models as standard (designated comm port 1). Relay contacts are rated 48 VDC, 1 A. Additional signals (such as on bypass and summary alarm) are provided by an AS/400 Intellislot card option. The following pins for comm port 1 shall be used:

Pin 1	Low Battery (normally open)
Pin 4	Shutdown in battery mode ( 5 – 12 VDC for 1.5 sec)
Pin 5	Common
Pin 7	Low Battery common
Pin 8	On Battery (normally open)
Pin 9	On Battery common

As an option, an Intellislot option card may be used for additional contact outputs, as well as to accept contact inputs such as water/smoke detection.

### 2.3.2. Serial Communications

The 5K Modular UPS can communicate via proprietary protocol through the following communication ports:

- Comm port 2 (standard on UPS)
- Intellislot option card slot 1 only

At a minimum, the UPS is supported by SiteNet MultiLink software.

The pin-out configuration for comm port 2 is as follows:

- Pin 2      Transmit Data
- Pin 3      Receive Data
- Pin 5      Common

### 2.3.3. Network Communications

The user has the option of installing an optional Intellislot card to provide SNMP communication over a local area network. 10/100Mbit Ethernet support is included. At a minimum, the UPS is supported by SiteNet MultiLink software.

### 2.3.4. Intellislot Specification

All models of the 5K Modular UPS product line have four Intellislot ports standard. Existing Intellislot cards such as the MultiPort 4 card, and AS/400 card are compatible.

### 2.3.5. UPS Status Information

The software can retrieve all status information present in the UPS (and available on the display). Retrieval of data is through either serial communications or a network connection.

## 2.5 Accessories (Optional Components)

### 2.5.1. External Battery Cabinets

External battery cabinets can be added to the base UPS product. These external battery cabinets with chargers and front access battery terminals will be installed in parallel to provide backup times as required. The connections between the UPS and the extended battery cabinets contain DC power only. All of these can be connected or disconnected safely by the user without interrupting power to the load.

## 3.0 Field Services (Optional)

### 3.1 Field Quality Control

The following inspections and test procedures will be performed by factory trained field service personnel during the UPS start-up:

#### 3.1.1. Visual Inspection

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

#### 3.1.2. Mechanical Inspection

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

#### 3.1.3. Electrical Inspection

- A. Confirm input voltage and phase rotation is correct.
- B. Verify bypass voltage jumper is correct for voltages being used.

### 3.2 Unit Start-up and Site Testing

The manufacturer's field service personnel will provide site testing if requested. Site testing consists of a complete test of the UPS system and the associated accessories supplied by the manufacturer. A partial battery discharge test is provided as part of the standard start-up procedure. The test results will be documented, signed, and dated for future reference.

### **3.3 Manufacturer's Field Service**

#### **3.3.1. Service Personnel**

The UPS manufacturer will directly employ a nationwide service organization, consisting of factory trained Customer Engineers dedicated to the start-up, maintenance, and repair of UPS and power equipment. The organization consists of factory-trained Customer Engineers working out of District Offices in most major cities. An automated procedure is in place to ensure that the manufacturer is dedicating the appropriate technical support resources to match escalating customer needs.

The manufacturer will provide a fully automated national dispatch center to coordinate field service personnel schedules. One toll-free number reaches a qualified support person 24 hours/day, 7 days/week, and 365 days/year. If emergency service is required, call back response time from a local Customer Engineer will be 20 minutes or less.

#### **3.3.2. Replacement Parts Stocking**

Parts are available through an extensive network to ensure around-the-clock parts availability throughout the country. Local Customer Engineers stock replacement spare parts with back up available from District Service offices and the manufacturing location.

Customer Support Parts Coordinators are on-call 24 hours a day, 7 days a week, 365 days a year for immediate parts availability.

#### **3.3.3. UPS Maintenance Training**

Maintenance training courses for customer employees are available by the UPS manufacturer. This training is in addition to the basic operator training conducted as part of the system start-up.

The training course covers UPS theory, location of subassemblies, safety, battery considerations and UPS operational procedures. The course includes AC to DC conversion and DC to AC inversion techniques as well as control and metering, troubleshooting and fault isolation using alarm information and internal self-diagnostics.

#### **3.3.4. Maintenance Contracts**

A complete offering of preventive and full service maintenance contracts for both the UPS system and battery system is available. An extended warranty and preventive maintenance package is also available. Warranty and preventive maintenance service is performed by factory trained Customer Engineers.

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