

Static Uninterruptible Power Supply Systems
Guide Specifications for a 700 to 3000 VA Rack Tower
Single - Phase Uninterruptible Power Supply System

1.0 GENERAL

1.1 SUMMARY

This specification defines the electrical and mechanical characteristics and requirements for a continuous-duty single-phase, solid-state, uninterruptible power system. The uninterruptible power system, hereafter referred to as the UPS, shall provide high-quality AC power for sensitive electronic equipment loads.

1.2 STANDARDS

The UPS is 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.

120V Units

UL Standard 1778 (Suitable for Computer-Room Applications)
c-UL
FCC Part 15, Subpart B, Class A
IEEE 587, Category A & B
ISTA Procedure 1A

230 Volt Units

EN50091-1-1
EN50091-2, Class B
EN50082-1
EN61000-4-2, Level 4, criteria A
EN61000-4-3, Level 3, criteria A
EN61000-4-4, Level 4, criteria A
EN61000-4-5, Level 3, criteria A
EN61000-3-2
EN61000-3-3
CE compliance mark, For both Low Voltage and EMC Directives
ISTA Procedure 1A

The 120VAC UPS units will be UL and c-UL listed. The 230 VAC UPS units will be TUV / GS listed and will bear the CE compliance mark and Australia C-tick (C_v) mark.

1.3. SYSTEM DESCRIPTION

1.3.1 Modes of Operation

The UPS is designed to operate as a true on-line double conversion system in the following modes:

A. Normal - In normal operation incoming AC power is fed to the input power factor corrected (PFC) rectifier that converts the AC power to DC power for the inverter. In this mode, power is also derived from utility power for the battery charger. The inverter derives DC power from either the PFC rectifier or the battery and regenerates filtered and regulated AC sinewave power for the connected load. The battery will be charged once the unit is connected to utility power, regardless of whether the UPS is ON or OFF. In the event of a utility outage or severe abnormality (sag or swell), the inverter will support the connected load from battery power, until the battery is discharged or the utility returns; whichever occurs first.

B. Battery - Upon failure of utility / mains AC power, the critical AC load is supplied by the inverter, which obtains power from the battery. There is no interruption in power to the critical load upon failure or restoration of the utility / mains AC source.

C. Recharge - Upon restoration of utility / mains AC power, after a utility / mains AC power outage, the input converter automatically restarts and assumes supplying power to the inverter and the battery charger to recharge the battery.

D. Automatic Restart - Upon restoration of utility / mains AC power, after a utility mains AC power outage and complete battery discharge, the UPS automatically restarts and assumes supplying power to the critical load and the battery charger automatically recharges the battery. This feature shall be capable of being disabled by the user.

E. Bypass - The integral bypass performs an automatic transfer of the critical AC load from the inverter to the bypass source, in the event of an overload, PFC failure, over temperature, DC Bus over voltage, or inverter failure conditions.

1.3.2 Design Requirements

A. Voltage: Input/output voltage specifications of the UPS are:

Input:

120V Units: 0 - 140 VAC, 60/50 Hz, single-phase, 2-wire-plus-ground.

230V Units: 0 - 280 VAC, 50/60 Hz, single-phase, 2-wire-plus-earth.

Output:

120 V Units: 120 VAC (user configurable: 100V, 110V, 115V, 120V, 127V)
 $\pm 3\%$, 60/50 Hz, single-phase, 2-wire-plus-ground.

230 V Units: 230 VAC (user configurable: 200V, 208V, 220V, 230V, 240V)
 $\pm 3\%$, 50/60 Hz, single-phase, 2-wire-plus-earth.

B. Output Load Capacity: Specified output load capacity of the UPS is:

700 VA/490 Watts at 0.7 lagging power factor.
1000 VA/700 Watts at 0.7 lagging power factor.
1500 VA/1050 Watts at 0.7 lagging power factor.
2000 VA/1400 Watts at 0.7 lagging power factor.
2700 VA/1890 Watts at 0.7 lagging power factor.
3000 VA/2100 Watts at 0.7 lagging power factor.

C. Internal Battery: Valve regulated, non-spillable, flame retardant, lead acid cells.

D. Reserve Time: 700 VA minimum 17 minutes, 1000 VA minimum 11 minutes, 1500 VA minimum 7 minutes, 2000 VA minimum 6 minutes, 2700 VA minimum 5 minutes, 3000 VA minimum 5 minutes, these times are at full load with ambient temperature of 25°C (77°F).

E. Battery Recharge: The UPS contains a battery recharge rate designed to prolong battery life. Recharge time for UPS internal batteries is five (5) hours maximum to 95% capacity after a complete discharge into full load.

1.3.3 Performance Requirements

1.3.3.1 AC Input to UPS

A. Voltage Configuration: The UPS operates at these values without drawing power from the batteries.

120 VAC; single phase, 2 wire plus ground nominal; variable based upon output loading:

700/1000 VA MODELS

| LOAD | TRANSFER VOLTAGE | COMEBACK VOLTAGE |
|-----------|------------------|------------------|
| 100 - 70% | 80 VAC | 87 VAC |
| 70 - 30% | 70 VAC | 77 VAC |
| 30 - 0% | 60 VAC | 67 VAC |

1500/2000/3000 VA MODEL

| LOAD | TRANSFER VOLTAGE | COMEBACK VOLTAGE |
|-----------|------------------|------------------|
| 100 – 90% | 90 VAC | 97 VAC |
| 90 – 70% | 80 VAC | 87 VAC |
| 70 – 30% | 70 VAC | 77 VAC |
| 30 - 0% | 60 VAC | 67 VAC |

230 VAC; single phase, 2 wire plus earth nominal; variable based upon output loading:

1000 VA MODELS

| LOAD | TRANSFER VOLTAGE | COMEBACK VOLTAGE |
|-----------|------------------|------------------|
| 100 - 70% | 159 VAC | 171 VAC |
| 70 - 30% | 139 VAC | 151 VAC |
| 30 - 0% | 119 VAC | 131 VAC |

2000/3000 VA MODELS

| LOAD | TRANSFER VOLTAGE | COMEBACK VOLTAGE |
|-----------|------------------|------------------|
| 100 – 90% | 176 VAC | 188 VAC |
| 90 – 70% | 159 VAC | 171 VAC |
| 70 – 30% | 139 VAC | 151 VAC |
| 30 - 0% | 119 VAC | 131 VAC |

B. Frequency: UPS auto senses input frequency when first powered up and will operate within the following frequency specifications. UPS is capable of Cold Start with default frequency of 60 Hz/ 120 VAC units and 50 Hz/ 230 VAC. Once started frequency operating window is 40-70 Hz. There are 3 different frequency settings available in the optional S4K Configuration program: Auto frequency sensing (factory default setting), 50 Hz. frequency conversion, and 60 Hz. Frequency conversion.

C. Input Power Factor: >0.97 lagging at rated load.

D. Input Current reflected distortion: 25% THD maximum.

E. Input Current Ratings: 700 VA = 5.8A (230 volt units are N/A)
1000 VA = 8.3A (230 volt units are 3.9A) 1500 VA = 12.5A (230
volt units are N/A) 2000 VA = 16.0A (230 volt units are 7.8A)
2700 VA = 20.3A (230 volt units are N/A)
3000 VA = 24.0A (230 volt units are 11.7A)

F. Inrush Current (initial start up, no load): The UPS has a maximum inrush current of 6 times the full load peak input current.

G. Input Line Transient Immunity: UPS conforms to an input line transient conforming to IEEE 587, Category A & B tests for 120 VAC models. The 230 VAC models meet EN61000-4-5, Level 3, Criteria A.

J. Surge Protection:

120 VAC units: MOV ratings will be 175 Volt, 90 Joules minimum connected L-N. The MOVs will be rated 300 Volt, 150 Joules minimum connected L-G and N-G. The L-G and N-G connected MOVs will have the capability of being disconnected and reconnected easily.

230 VAC units: MOV ratings will be 320 Volt, 80 Joules minimum. They will be connected L-N.

1.3.3.2 AC Output, UPS Inverter

A. Voltage Configuration:

120 V Units: 120 VAC, 60/50 Hz, single-phase, 2-wire-plus-ground, configuration program selectable (100V, 110V, 115V, 120V, 127V).

Note: Running the unit at 100 V derates the 700/1000 VA unit 90%, 1500/2000/3000 VA 80%.

230 V Units: 230 VAC, 50/60 Hz, single-phase, 2-wire-plus-earth, configuration program selectable (200V, 208V, 220V, 230V, 240V).

Note: Running the unit at 208 V derates all VA model units 90%.

Note: Running the unit at 200 V derates the 1000 unit 90%, 2000/3000 VA unit 80%.

B. Voltage Regulation: $\pm 3\%$ steady state.

C. Frequency Regulation: $\pm 5\%$ Synchronized to utility / mains. ± 0.1 Hz free running or on battery operation.

D. Frequency Slew Rate: 1.0 Hertz per second maximum

E. Voltage Distortion: $\leq 3\%$ total harmonic distortion (THD) typical into a 100% linear load, $\leq 5\%$ THD typical into a 100% non-linear load with crest factor ratio of 3:1.

F. Load Power Factor Range: 0.65 lagging to 1.0 (unity).

G. Output Power Rating: 700 VA/490 Watts, 1000 VA/700 Watts, 1500 VA/1050 Watts, 2000 VA/1400 Watts, 2700 VA/1890 Watts, and 3000 VA/2100 Watts at 0.7 lagging power factor.

H. Inverter Overload Capability: 112 - 130%, $\pm 10\%$ for 10 seconds then transfer to bypass, 131 - 200%, $\pm 10\%$ for 2 seconds then transfer to bypass, $> 201\%$, $\pm 10\%$ for 96 msec. minimum then transfer to bypass.

I. Voltage Transient Response: $\pm 7\%$ in line mode 0-100-0 % loading of the UPS, $\pm 7\%$ in battery mode for 0-100-0 % loading of the UPS rating.

J. Transient Recovery Time: To nominal voltage within 90 milliseconds.

K. Efficiency: $\geq 88\%$ AC-AC, minimum

1.4 ENVIRONMENTAL CONDITIONS

A. Ambient Temperature:

Operating: 0°C to $+40^{\circ}\text{C}$ ($+ 32^{\circ}\text{F}$ to $+ 104^{\circ}\text{F}$) for altitudes 0 to 1500 meters (0 to 5,000 ft.) above sea level

0°C to $+30^{\circ}\text{C}$ ($+ 32^{\circ}\text{F}$ to $+ 95^{\circ}\text{F}$) for altitudes 1500 to 3000 meters (5,000 to 10,000 ft.) above sea level

25°C ($+ 77^{\circ}\text{F}$) for optimum battery performance

Storage: -15°C to $+50^{\circ}\text{C}$ ($+ 5^{\circ}\text{F}$ to $+122^{\circ}\text{F}$) with batteries removed.

20°C ($+ 68^{\circ}\text{F}$) for optimum battery storage.

B. Relative Humidity:

Operating: 0 to 95% non-condensing.

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Storage: 0 to 95% non-condensing.

C. Altitude:

3,000 m / 10,000 ft. max., without power derating when operated within the temperature specified in section 1.4.A. Ambient temperature will be derated 5° C for each additional 500 meters.

D. Audible Noise:

Noise generated by the UPS under normal operation does not exceed 50dBA when measured at 1 meter from the surface of the UPS.

E. Electrostatic Discharge:

The UPS is able to withstand an electrostatic discharge compliant to ENC61000-4-2, level 4, for 120 VAC, and 230 VAC units (15 kV through air, 8 kV contact) without damage and will not affect the connected load.

1.5 USER DOCUMENTATION

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

1.6 WARRANTY

The UPS manufacturer warrants the UPS against defects in materials and workmanship for two (2) years. An optional one (1) and three (3) year full coverage extension warranty are available.

1.7 QUALITY ASSURANCE

1.7.1 Manufacturer Qualifications

A minimum of twenty year's experience in the design, manufacture, and testing of solid-state UPS systems is required. The manufacturer is certified to ISO 9001.

1.7.2 Factory Testing

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

2.0 PRODUCT

2.1 FABRICATION

All materials and components making up the UPS are new, of current manufacture, and have not been in prior service except as required during factory testing. All relays are provided with dust covers.

2.1.2 Wiring

Wiring practices, materials, and coding are in accordance with the requirements the standards listed in section 1.2 and other applicable codes and standards. All wiring is copper.

2.1.3 Cabinet

The UPS unit is comprised of: input converter, battery charger, inverter, and battery consisting of the appropriate number of sealed battery cells; and is housed in a rack - tower NEMA type 1 enclosure and meet the requirements of IP20. The UPS cabinet is cleaned, primed, and painted IBM Black. Dimensions and weights are:

| MODEL | DIMENSIONS (W x D x H) | WEIGHT |
|---------|--------------------------------------------------|-------------------|
| 700 VA | 3.47" x 21.75" x 16.9" (87mm x 553mm x 430mm) | 49.4lbs. (22.4kg) |
| 1000 VA | 3.47" x 21.75" x 16.9" (87mm x 553mm x 430mm) | 49.4lbs. (22.4kg) |
| 1500 VA | 3.47" x 21.75" x 16.9" (87mm x 553mm x 430mm) | 51.4lbs. (23.3kg) |
| 2000 VA | 3.47" x 21.75" x 16.9" (87mm x 553mm x 430mm) | 51.4lbs. (25kg) |
| 3000 VA | 3.47" x 24.75" x 16.9" (87mm x 615mm x 430mm) | 75.2lbs. (34kg) |

2.1.4 Cooling

The UPS is forced air cooled by an internally mounted, continuous fan. Fan power is provided from the internal DC supply. Air intake is through the front of the unit and exhausted out the rear of the unit.

2.2 COMPONENTS

2.2.1 Input Converter

2.2.1.1 General

Incoming AC power is converted to a regulated DC output by the input converter for supplying DC power to the inverter. The input converter provides input power factor correction and input current distortion reduction.

2.2.1.2 AC Input Current Limit

The input converter is provided with AC input current limiting whereby the maximum input current is limited to 125% of the full load input current rating.

2.2.1.3 Input Protection

The UPS has built-in protection against undervoltage, overcurrent, and overvoltage conditions including low-energy lightning surges, introduced on the primary AC source. The 120 VAC models can sustain input surges without damage per criteria listed in IEEE 587 CAT. A & B. The 230 VAC UPS can sustain input surges without damage per criteria listed in EN61000-4-5, Level 3. The 120V model UPS have input fuses. The 230V models have circuit breakers.

2.2.1.4 Battery Recharge

The UPS contains a battery recharge rate designed to prolong battery life. The battery is constant current charged to restore capacity, then shall be constant voltage charged to maintain the battery in a fully charged state. Recharge time for the internal UPS batteries shall be five (5) hours maximum to 95% capacity (full load discharge rate). There is DC overvoltage protection so that if the DC voltage exceeds the pre-set limit, the UPS will shutdown automatically and the critical load is transferred to bypass.

2.2.2 Inverter

2.2.2.1 General

The UPS inverter is a pulse-width-modulated (PWM) design capable of providing the specified AC output. The inverter converts DC power from the input converter output, or the battery, into precise sine wave AC power for supporting the critical AC load.

2.2.2.2 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 indicates 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 devices.

2.2.2.3 Inverter DC Protection

The inverter is protected by the following DC shutdown levels:

DC Overvoltage Shutdown

DC Undervoltage Shutdown (End of Discharge)

DC Undervoltage Warning (Low Battery Reserve); factory default set at 2 minutes (user configurable 2 to 30 minutes).

2.2.2.4 Output Frequency

The inverter holds the output frequency to ± 0.1 Hz of nominal when not synchronized to the utility/mains source.

2.2.2.5 Output Protection

The UPS inverter employs electronic current limiting circuitry.

2.2.2.6 Battery Over Discharge Protection

To prevent battery damage from over discharging, the UPS control logic automatically raises the shutdown voltage set point; dependent upon output load at the onset of battery operation.

2.2.3 Display and Controls

2.2.3.1 General

The UPS is provided with a microprocessor based unit status display and controls section designed for convenient and reliable user operation. The monitoring functions such as status and alarm indicators are displayed on an LED display.

2.2.3.2 System Indicators

The UPS contains a row of LED's to indicate UPS load and battery capacity and five single LED's to indicate UPS status as described below:

The "Fault" LED indicator illuminates red to indicate a UPS fault condition.

The "Battery" LED indicator illuminates amber to indicate the UPS is operating from battery power.

The "Bypass" LED indicator illuminates amber to indicate the UPS is operating on Bypass power.

An audible alarm is provided and activated by any of the above alarm conditions.

The "UPS ON" LED indicator illuminates green to indicate the UPS inverter is operating and supplying power.

The "AC Input" LED indicator illuminates green to indicate the UPS is operating from utility / mains power.

2.2.3.3 Controls

UPS start-up and shutdown operations are accomplished by the "ON" and "OFF" push buttons located on the front panel of the UPS. The "ON" push button is a means to turn the UPS on and also serve as a means to manually test the battery and to reset active visual and audible alarms. The "OFF" push button allows manual transfers of the load from the inverter to bypass power. Pressing the "OFF" push button twice within a four second time period will completely shutdown the UPS and its connected load in normal and battery mode.

2.2.4 On-Line Battery Test

The UPS is provided with an automatic biweekly battery test feature (factory default). Via the set-up configuration program on a Windows based PC the automatic battery test can be disabled or configured to operate every 7, 14, 21, or 28 days.

The battery test will ensure the capability of the battery to supply power to the inverter while loaded. If the battery fails the test, the UPS will display a warning message to indicate the internal batteries need replaced. The battery test feature is user accessible by the push button located on the front of the unit and with Communications Software. The Automatic Battery test feature is capable of being disabled through the User Configuration Program shipped with the UPS.

2.2.5 Bypass

2.2.5.1 General

A bypass circuit is provided as an integral part of the UPS. The bypass control logic contains an automatic transfer control circuit that senses the status of the inverter logic signals, and operating and alarms conditions. This control circuit provides a transfer of the load to the bypass source if available, and if the inverter is capable of powering the load (i.e. overload condition, if your unit is in Manual Bypass Mode, or if the voltage and or frequency is out of tolerance).

2.2.5.2 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:

- UPS overload
- UPS over temperature
- PFC failure
- Inverter failure
- DC Bus Overvoltage

Once overload condition is reduced, the load is automatically transferred back to inverter power.

2.2.6 Internal Battery

Valve regulated, non-spillable, flame-retardant lead acid cells are used as a stored-energy source for the specified UPS system. The battery is housed internal to the UPS cabinet, and sized to support the inverter at rated load and power factor, with ambient temperature of 25 °C (77 °F) for a minimum of 7 minutes reserve time. The expected life of the battery shall be 3 - 5 years or a minimum 250 complete discharge cycles. The UPS units have the capability to allow the operator to replace the internal battery.

2.2.7. Output Distribution

Output distribution is integral to the UPS, and located on the rear of the unit.

| MODEL | 120 VAC Units | 230 VAC Units |
|---------|------------------------------------|------------------|
| 700 VA | (4) NEMA 5-15R | N/A |
| 1000 VA | (4) NEMA 5-15R | (4) EN 60320/C13 |
| 1500 VA | (4) NEMA 5-15R | N/A |
| 2000 VA | (4) NEMA 5-20R T-slot | (4) EN 60320/C13 |
| 3000 VA | (4) NEMA 5-15R, (1) NEMA L5-30R | (4) EN 60320/C13 |

2.2.8 Communications

The UPS contains a DB9F (9 pin female) connector on the rear panel to allow UPS status communications to a computer system. The DB9F contains photo couplers to signal on battery and low battery operational status. The UPS is also capable of receiving a signal from the connected host system to initiate a UPS shutdown. This signal shall be a + 5 VDC to +12 VDC (RS232 level) that must remain for > 1.6 second duration. Additionally, it shall also communicate via serial communications using serial communications protocol.

The pin out configuration of the DB9F connector is:

| Pin | Assignment Description |
|-----|---------------------------------------------------------------------|
| 1 | Low Battery (Open Collector: +V) |
| 2 | UPS TxD |
| 3 | UPS RxD |
| 4 | Remote Shutdown (5-12V DC, 10.0-24.0 mA max.); on battery operation |
| 5 | Common |
| 6 | Remote shutdown (Short to Pin 5); any mode operation |
| 7 | Low Battery (Open Emitter: -V) |
| 8 | Utility /Mains Fail (Open Emitter: -V) |
| 9 | Utility/Mains Fail (Open Collector: +V) |

NOTE: Maximum voltage and current on pins 1,7,8,9 shall be 80 VDC, 10.0 mA maximum.

Pin 4 - Remote shutdown on Battery

1. This pin is only functional if the UPS is in battery mode. If the UPS is being powered by the utility (PFC on), ignore any signal on this pin.
2. Our Pin 4 requires a 5-12 volt signal to shutdown. This normally comes from the serial port using our contact closure cable. It cannot be used with just a contact closure unless the relay is used to switch a voltage source. A 5-12Vdc signal for 1.5 seconds or greater is required to signal a shutdown. Signals for less than 1.5 seconds must be ignored. After Pin 4 receives a shutdown signal for 1.5 seconds, the **command cannot be cancelled**.
3. A battery shutdown signal on pin 4 will NOT cause an immediate shutdown. A shutdown signal will start a 2-minute shutdown timer. The timer cannot be stopped. After 2 minutes, the UPS must shutdown.
4. If the utility returns during the 2-minute timer countdown, the shutdown timer will continue until the end of 2-minutes and the UPS will turn off. The UPS must remain off for at least 10 seconds even if AC input power returns before the UPS turns off. This serves to reset and restart the server.
5. Whether the UPS turns back on when power is restored depends on the auto-restart setting: enabled or disabled. If the auto-restart is disabled, the UPS will not restart after the 2-minute shutdown delay.

2.2.9 Optional Communications

The UPS contains one Intellislot communication port to allow the operator to field install optional communication cards. These optional cards shall allow the UPS to communicate via Ethernet SNMP, connected directly to the LAN. Once the SNMP card is installed, the serial communications is disabled in the DB9F connector; however the photo-coupler signals (on battery, and low battery) will remain active. The communication port is designed to provide simple installation where electrical connections are made via a 26-pin edge card connector.

2.3.0 S4K Configuration Program

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This is an optional program that ships with every UPS. There are several options that are programmable via this program:

- Select one of five input/output voltages to match voltages found around the world.
- Disable Auto-Restart.
- Disable the Line-Neutral-Reversal/Missing-Ground receptacle wiring alarm.
- Select frequency converter operation with a fixed output frequency of 50 or 60 Hz.
- Set the Low Battery Warning alarm time from 2 to 30 minutes.
- Disable the Auto-Battery test.
- Set the Auto-Battery test to 7, 14, 21, 28 days.
- Select the number of external battery cabinets connected to the UPS to adjust the remaining runtime calculations reported by the UPS.
- Modify the shutdown setting of DB-9 pin 6.

NOTE: A Windows 95®, 98®, or NT® computer/laptop is also required to run the configuration program.