



Commodity UPS Systems: An Application Guide, 2002

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Overview

For this project, we tested the performance of 18 small uninterruptible power supply (UPS) systems with load ratings of less than 1 kilovolt-ampere (kVa). These systems are often applied as a cure-all for all kinds of power quality problems, but there are many issues associated with the use of these devices, and they may not be the best solution for every PQ problem. The testing was designed to (1) evaluate the performance of the different systems over a range of operating conditions and (2) evaluate the features of the systems, such as software interfaces to the computer systems being protected. The literature on these units and our test results were combined to develop an Application Guide to these UPS products.

We explain the scope of testing and the tests we conducted below. If you'd like more information on this application guide, contact our business development team at tel 303-444-7788 or e-mail us at esource@esource.com.

Scope of the Testing Project

Most of the small UPS products we tested fall into one of three categories:

- **Line-interactive designs.** These systems typically have a ferroresonant type of transformer to provide steady-state voltage regulation, plus a standby battery system that can carry the load whenever there is a significant loss of voltage.
- **Standby designs.** These units do not include a ferroresonant transformer and therefore do not provide any steady-state voltage control.
- **On-line designs.** In these systems, the AC power is always charging the UPS's battery while the UPS continuously serves the load. That means the power always goes through a rectifier and an inverter.

Larger UPS units are often designed for full on-line operation. Very few UPSs in the 1-kVa size range are on-line units.

Specific Tests

The tests that were conducted for each UPS unit include:

- **Unpacking.** To evaluate the packaging, check actual contents against contents list, note any difficulties or surprises in unpacking, and note any software and connection system included.
- **Initial installation.** To install the unit installation, observe whether there is any possible confusion about connections and charge the UPS from 120 volt (V), 60 hertz (Hz) for 24 hours, or longer if the manufacturer recommends.
- **Initial safety inspection.** To check basic safety prior to testing, verify that the output jacks are connected to the earth terminal of the input power cord and verify that phase and neutral have not been reversed between the input and the output of the UPS.
- **Functional test.** To determine if the UPS is functional prior to any other testing and to verify that output voltage remains for at least 1 minute.

- **Room-temperature duration test.** To determine the length of time that elapses before the output voltage drops below 85% of nominal and record the ending transition: abrupt cut-off, gradual decline, overshoot, etc.
- **Low-temperature duration test.** To determine the length of time until the output voltage drops below 85% of nominal after soaking the UPS at 0 degrees C for at least 6 hours. (The remainder of this test was carried out at 0 degrees C.)
- **Input frequency tests.** To observe changes in output voltage after stepping the frequency from 60.0 Hz to 59.0 Hz and then from 59.0 Hz to 61.0 Hz.
- **Output frequency tests.** To emulate an additional device being turned on by adding another 40% rated VA load, linear, observe the output frequency of the UPS and observe the phase angle between the input voltage and the output voltage for 60 seconds (for on-line UPS's only).
- **Output load tests, short duration.** To determine the UPS performance under various loads, without stressing the battery, based on a consumer plugging in more loads than normal.
- **Output load tests, transitions.** To determine the UPS performance under abruptly changing loads, such as printing on a laser printer or turning off a monitor, during an outage.
- **Input voltage tests, steady-state.** To set the input voltage to 110%, 95%, 90%, 85%, and 80% of nominal, observe the output voltage at each setting and determine if the UPS able to charge its batteries at each of the voltages.
- **Input voltage tests, long-term low voltage.** To reduce input voltage in 5% increments and determine max voltage at which the UPS battery takes over.
- **Input voltage tests, voltage sags.** To apply 6 standard voltage sags (SEMI F47) to the UPS input and observe the output voltage.
- **Input voltage tests, voltage distortion.** To apply 2.9% THD, 7.2% THD and 10.0% THD to the input and observe the UPS behavior.
- **Input voltage tests, PF capacitor switching transient.** To apply capacitor switching transients (90 degrees and 270 degrees) and observe the output voltage and continuing function of the UPS.
- **Input voltage tests, lightning transient.** To test output voltage, including transients, and continuing function of the UPS during standard lightning impulses.
- **Hi-pot insulation testing.** To verify that the power lead insulation meets common standards (verify that the leakage current phase-to-ground, at 750 Vrms/60 Hz, slowed up in 5 seconds and held for 10 seconds, is less than 5 mA).
- **Disassembly inspection.** To disassemble the UPS and note connection forms and execution, spacing, grounding, etc. compared with applicable UL standards.
- **Plastic flame test.** To determine if plastic enclosure is flammable.
- **Home-office load characteristics.** To determine the peak VA load when operating the following systems vigorously: Dell Laptop computer, Dell desktop computer with minimal accessories, Dell desktop computer, fully loaded, a range of Sony and Dell VDT's, a range of HP DeskJet printers, HP LaserJet printer.