ENERGY STAR® Qualified Imaging Equipment

Test Procedure

Operational Mode Measurement

June 28, 2004

This document provides an example of an ENERGY STAR operational mode test procedure. For simplicity, printers and fax machines are used as an example.

Outlined below are the ambient test conditions that should be established when performing the power measurement. These are necessary in order to ensure that outside factors do not affect the test results, and that test results can be reproduced later. A description of the specifications for testing equipment, as well as a discussion of testing issues, follow on the succeeding pages.

Test Conditions

Line Impedance:	< 0.25 ohm
Total Harmonic Distortion: (Voltage)	< 5%
Input AC Voltage:[1]	115 VAC RMS +/- 5V RMS
Input AC Frequency:[4]	60 Hz +/- 3 Hz
Ambient Temperature:	25 deg. C +/- 3 deg. C

Test Method

Printer and fax machine manufacturers should measure and report the **average** power consumption of their printer and fax machine products when in the Sleep Mode. This should be done by evaluating the printer or fax machine over a time period sufficiently long to include typical variations or surges in power (e.g., any cycling of the fuser). The recommended approach is to utilize a watt-hour meter, and measure the energy consumption in the Sleep Mode of the printer or fax machine over 1 hour. This will allow manufacturers to capture any variations in power usage that occur during the Sleep Mode. Dividing the measured energy consumption by the time period over which it is measured will produce average Watts. While this approach will provide the most accurate results, it is not essential to follow this for printers and fax machines whose idle-mode power consumption does not vary (e.g., dot matrix printers, inkjet type printers and fax machines, and laser printers and fax machines where the fuser is turned off during idle mode). For printers and fax machines with constant idle-mode power consumption, manufacturers may choose to utilize a high quality watt meter and take several measurements of instantaneous power.

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[1] If products will be sold in Europe or Asia, testing should also be performed at the appropriate machine-rated voltage and frequency. For example, products destined for European markets might be tested at 230 V and 50 Hz. The logo should not be displayed on products shipped to Europe or Asia if the equipment does not meet the power requirements of the Program at the local voltage and current conditions.

Testing Equipment

The goal is to accurately measure the TRUE power consumption[2] of the printer or fax machine. This necessitates the use of a **True RMS** Watt Meter or Watt-Hour Meter. There are many watt meters and watt-hour meters to choose from, but manufacturers will need to exercise care in selecting an appropriate model. The following factors should be considered when purchasing a meter and setting up the actual test.

Crest Factor

A previous version of EPA's testing procedure included a requirement that manufacturers utilize a meter with a crest factor greater than eight. As many Partners pointed out, this is not a useful or relevant requirement. The following paragraphs are meant to discuss the issues relating to crest factor and to clarify the intent of the initial statement. Unfortunately, EPA cannot provide a specific equipment requirement because testing is as much art as it is science. Manufacturers and testers will have to exercise judgment, and draw on people well versed in testing issues, to select an appropriate meter.

It is important to understand that electronic equipment such as printers and fax machines typically draw current in a waveform different from typical sinusoidal current.[3] While virtually any meter can measure a standard current waveform, it is more difficult to select a meter when irregular current waveforms are involved.

It is critical that the meter selected be capable of reading the current drawn by the printer or fax machine without causing internal peak distortion (i.e., clipping off the top of the current wave). This requires a review of the meter's crest factor,[4] and of the current ranges available on the meter. Better meters will have higher crest factors, and more choices of current ranges. When preparing the test, the first step should be to determine the peak current (amps) associated with the printer or fax machine being measured. This can be accomplished using an oscilloscope. A current range must be selected that will enable the meter to register the peak current. Specifically, the full scale value of the current range selected multiplied by the crest factor of the meter (for current) must be greater than the peak current reading from the oscilloscope. For example, if a meter has a crest factor of 4, and the current range is set on 3 amps, the meter can register current spikes of up to 12 amps. If the measured peak current is only 6 amps, the meter would be satisfactory. However, if the current range is set too high in order to register peak current, then it may lose accuracy in measuring the non-peak current. Therefore, some delicate balancing is necessary. Again, with more current range choices and higher crest factors you will get better results.

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[2] True power is defined as (volts)x(amps)x(power factor), and is typically reported as Watts. Apparent Power is defined as (volts)x(amps) and is usually expressed in terms of VA or volt-amps. The power factor for equipment with switching power supplies is always less than 1.0, so true power is always less than apparent power.

[3] The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with equipment containing a switching power supply will always be greater than 1.4 (though typically no higher than eight). The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps).

[4] The crest factor of a watt meter is often provided for both current and voltage. For current it is the ratio of the peak current to the RMS current in a specific current range. When only one crest factor is given, it is usually for current. An average True RMS Watt meter has a crest factor in the range of 2:1 to 6:1.

Frequency Response

Another issue to consider when selecting a watt meter is the frequency response rating of the meter. Electronic equipment that contains switching power supplies causes harmonics (odd harmonics typically up to the 21st). These harmonics must be accounted for in power measurement, or the Wattage consumption will be inaccurate. Accordingly, EPA recommends that manufacturers purchase meters that have a frequency response of at least 3 kHz. This will account for harmonics up to the 50th, and is recommended by IEC 555.

Resolution

When testing printers and fax machines whose power consumption is close to the ENERGY STAR requirements, manufacturers will probably want a meter than can provide resolution of 0.1 W.

Accuracy

Another feature to consider is the resulting accuracy you will be able to achieve. Catalogues and specification sheets for watt meters typically provide information on the accuracy of power readings that can be achieved at different range settings. If you are measuring a product that is very close to the various watt ceilings noted in Tables 1 through 8, you will need to set up a test that will provide greater accuracy. For example, if the resulting accuracy for your watt-meter at the test settings is $\pm$ 0.5 W, then with a measured power consumption of $\leq$ 29.5 W you can be fairly sure that your printer or fax machine is compliant.

Calibration

Meters should be calibrated every year to maintain their accuracy.