Testing Guidelines (Protocol) for ENERGY STAR® for Consumer Electronics
Current as of April 2001

To ensure consistency in measuring the power requirements for electronics products under ENERGY STAR for Consumer Electronics (televisions, VCRs, TV/VCR combination units, home audio products, and DVDs), this protocol should be followed. Outlined in Section I are the ambient test conditions that should be respected when performing power measurements. These conditions ensure that outside factors do not affect the test results and that the test results can be reproduced. Sections II and III describe the specifications for testing equipment and the test method, respectively. Section IV reviews responsibilities, while Section V covers continuing verification.

I. TEST CONDITIONS

General Criteria:

Total Harmonic Distortion (Voltage):	< 3 percent THD
Ambient Temperature:	22ºC ± 4 ºC

Terminations: External speaker terminals terminated per 3.6.2.2 (IEC 107-1)

Market-Specific Criteria:

Market:	**United States**	**Europe**	**Japan**
Voltage:	115 V RMS ±3 V RMS	230 V RMS ± 10 V RMS	100 V RMS ± 5 V RMS & 200 V RMS ± 10 V RMS
Frequency:	60 Hz ± 3 Hz	50 Hz ± 3 Hz	50 Hz ± 3 Hz & 60 Hz ± 3 Hz

Note: Testing needs to be done only at a voltage and frequency in the above range. It is not necessary to test all combinations of high voltage/low frequency, high voltage/high frequency, etc.

II. TEST EQUIPMENT

Manufacturers should measure and report the true standby power[1] requirements of the product. Doing so

[1] 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; therefore, true power is always less than apparent power.

necessitates the use of a true power watt meter. Because there are many watt meters from which to choose, manufacturers need to exercise care in selecting an appropriate model. The following items should be considered when procuring equipment and performing the test:

1. AC Power Source (with sufficient output current for the test unit that meets the requirement for AC line voltage, frequency stability, and THD).
2. True Power Meter (with sufficient accuracy, resolution, crest factor rating, and bandwidth).
3. Oscilloscope with Current Probe (to monitor AC line current waveform, amplitude, and frequency. Optional but recommended).
4. True RMS Volt Meter (to verify voltage at the input of test unit. Optional if AC source output is sufficiently accurate).
5. Frequency Counter (to verify frequency at the input of test unit. Optional if AC source output is sufficiently accurate).

Crest Factor

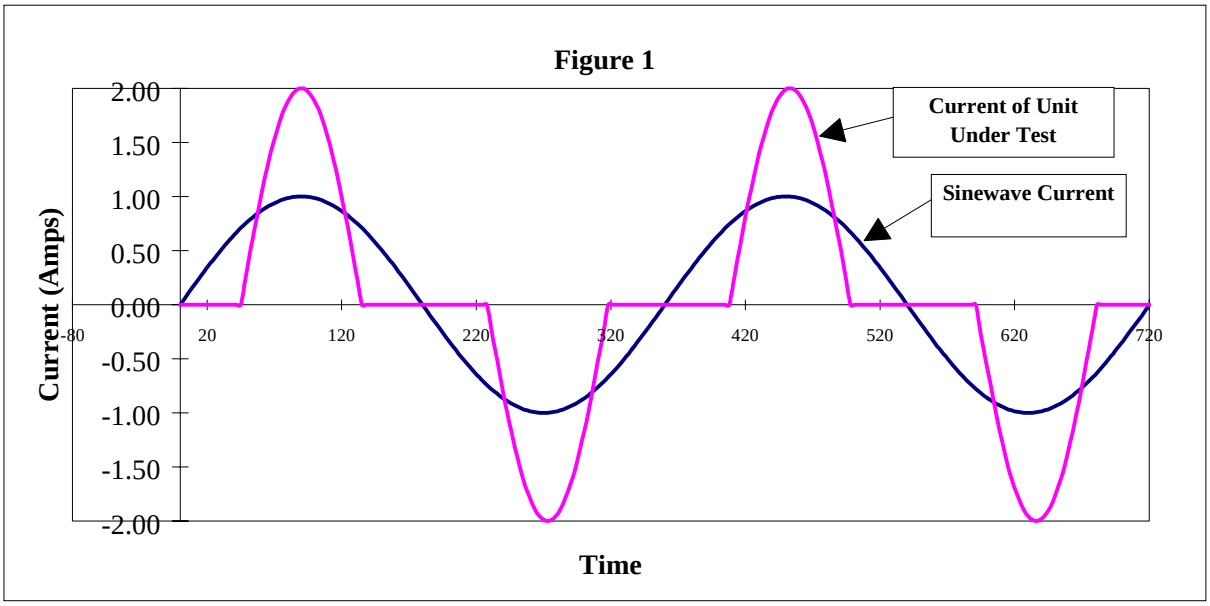
Electronics equipment may draw current that is not sinusoidal.[2] While virtually any watt meter can measure a standard current waveform, it is more difficult to select a watt meter when irregular current waveforms are involved.

It is critical that the watt meter selected be capable of reading the current drawn by the product 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 rating and the current ranges available on the meter. Better meters will have higher crest factor specifications and more choices of current ranges.

To determine the crest factor rating requirement of the meter and the proper current range settings, the peak current (amps) draw of the product under test in standby mode must first be measured. This can be accomplished using an oscilloscope with a current probe.

A current range on the meter must be selected that is sufficient 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 by at least 15 percent to compensate for any measurement error. (Note: It is difficult to measure within 5 percent using an analog oscilloscope.) For example, if a watt 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 measured peak current is only 6 amps, the meter would be satisfactory. If, however, the current range is set too high, the meter may lose accuracy in measuring non-peak current. Therefore, some delicate balancing is necessary. Make sure that the crest factor is given for the current level that you desire for the meter that you are considering.

[2] The crest factor of a current waveform is defined as the ratio of the peak current (amps) to the RMS current (amps). The crest factor for a sinusoidal 60 Hz current waveform is always 1.4. The crest factor for a current waveform associated with a product containing a switching power supply will always be greater than 1.4 (though typically no higher than 8).



Frequency Response

Another issue to consider when selecting a watt meter is the frequency response rating of the meter. Electronic equipment may cause harmonic waveforms that can lead to inaccuracies in the power measurements. For example, electronics equipment powered by switching power supplies typically produces odd harmonics up to the 21st. To ensure that the harmonics are properly addressed, EPA recommends the use of a watt meter with frequency response of at least 3 kHz. This will account for harmonics up to the 50th, which is recommended by IEC 555.

Resolution

Manufacturers should choose a watt meter that can provide resolution of 0.1 W.

Accuracy

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 the power measurement is very close to the energy-efficiency guideline specified in the MOU, a test procedure with greater accuracy will be necessary. For example, if the ENERGY STAR specification is 1.0 watt or less *and* the resulting accuracy of the watt meter at the test settings is ± 0.1 watts, then a power measurement of less than 0.9 watts will ensure that the product meets the specifications.

Calibration

To maintain their accuracy, watt meters should be calibrated every year with a standard that is traceable to the U.S. National Bureau of Standards (NBS).

III. TEST METHOD

Following are the test steps for measuring the true power requirements of the test unit in standby mode:

1. Power on all test equipment and properly adjust operation range.

2. Connect the test equipment and unit under test.

3. Check for normal operation of the test unit and leave all customer adjustment to factory default settings.

4. Bring the test unit into standby mode (not off mode) either by using the remote control device or by using the ON/OFF switch on the test unit cabinet.

5. Either verify that the wall outlet power is within specifications or adjust the AC power source output as described in Section I (e.g., 115Vrms ± 3Vrms, 60Hz ± 3Hz).

6. Set the power meter current range. The full scale value selected multiplied by the crest factor rating (Ipeak/Irms) of the meter must be greater than the peak current reading from the oscilloscope.

7. After the unit under test reaches operating temperature and the readings on the power meter stabilize (approximately 90 minutes), take the true power reading in watts from the power meter.

8. Record the test conditions and test data. The measurement time shall be sufficiently long to measure the correct average value to within a +10 percent - 0 percent error. If the device has different standby modes that can be manually selected, the measurement should be taken with the device in the most energy consumptive mode. If the modes are cycled through automatically, the measurement time should be long enough to obtain a true average that includes all modes.

IV. RESPONSIBILITIES

ENERGY STAR's testing guidelines are not mandatory, but they will be distributed to outside parties such as buyers and the press. Following these guidelines and producing accurate test results will assist manufacturers in qualifying products as ENERGY STAR. Companies may determine the appropriate level of stringency and accuracy for their own testing based on their specific products.

V. CONTINUING VERIFICATION

This testing procedure (protocol) describes the method by which a single unit may qualify as ENERGY STAR. An ongoing testing process is highly recommended to ensure that products from different production runs all meet the ENERGY STAR TV/VCR specifications. A model may qualify as ENERGY STAR if testing indicates that 95 percent of the units sold under this model name/number will meet the specifications contained within the MOU.