



ENERGY STAR® Program Requirements Product Specification for Computers

Test Method
July 21, 2011

1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Computers.

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation. The following guidelines shall be used to determine the applicability of each section of this document:

Note: Provisions TBD.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Computers.

Note: For the purposes of initial dataset development, below are reference definitions for Long and Short Idle, along with a series of acronym references that may appear in this document.

- 1) Idle Mode: The mode in which the operating system and other software have completed loading, the product is not in Sleep Mode, and activity is limited to those basic applications that the product starts by default. There are two forms of idle that comprise Idle Mode.
 - a) Long Idle: The mode where the UUT has been inactive for a period of time (e.g., 15 minutes after OS boot or after completing an active workload or after resuming from sleep) and the screen has blanked but the UUT remains in the working mode. All default power management features should have engaged (e.g., display is off, hard drive may have spun-down) but the UUT has not entered Sleep Mode.
 - b) Short Idle: The mode where the UUT has been inactive for a brief period of time (e.g., 5 minutes or less after OS boot or after completing an active workload or after resuming from sleep), the screen is on and set to as shipped brightness, and Long Idle power management features have not engaged (e.g., the hard drive is still spinning and the UUT is not entering Sleep Mode, ACPI G0/S0).
- 2) Acronyms:
 - AC: Alternating Current
 - ACPI: Advanced Configuration and Power Interface
 - AWK: Named for its authors; a script-based, computer utility used for extracting data
 - C: Celsius

- CAD: Computer Aided Design
- CPU: Central Processing Unit
- DC: Direct Current
- ECC: Error Correcting Code
- EPS: External Power Supply
- GPU: Graphics Processing Unit
- Hz: Hertz
- IPS: Internal Power Supply
- ISV: Independent Software Vendor
- LAN: Local Area Network
- MTBF: Mean Time Between Failures
- OEM: Original Equipment Manufacturer
- OS: Operating System
- PCI: Peripheral Component Interconnect
- PCI-E: Peripheral Component Interconnect-Express
- PCI-X: Peripheral Component Interconnect-Extended
- RAM: Random Access Memory
- SPEC: Standard Performance Evaluation Corporation
- UMA: Uniform Memory Access
- USB: Universal Serial Bus
- UUT: Unit Under Test
- V: Volts
- W: Watts
- WoL: Wake on LAN

4 TEST SETUP

- A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure shall be in accordance with the requirements of IEC 62301, Ed. 2.0 , “Household Electrical Appliances – Measurement of Standby Power,” Section 4, “General Conditions for Measurements”, unless otherwise noted in this document. In the event of conflicting requirements, the ENERGY STAR test method shall take precedence.
- B) Input Power: Products intended to be powered from AC mains shall be connected to a voltage source appropriate for the intended market, as specified in Table 1 and Table 2.

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz/60 Hz	+/- 1.0 %

Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 4.0 %	5.0 %	50 Hz/60 Hz	+/- 1.0 %

C) Ambient Temperature: Ambient temperature shall remain between 18 °C to 28 °C, inclusive, for the duration of the test.

D) Relative Humidity: Relative humidity shall be from 10% to 80%.

E) Power Meter: Power meters shall possess the following attributes:

1) Crest Factor:

- i) An available current crest factor of 3 or more at its rated range value; and
- ii) Lower bound on the current range of 10mA or less.

2) Minimum Frequency Response: 3.0 kHz

3) Minimum Resolution:

- i) 0.01 W for measurement values less than 10 W;
- ii) 0.1 W for measurement values from 10 W to 100 W; and
- iii) 1.0 W for measurement values greater than 100 W.

4) Measurement Accuracy: Measurement uncertainty as introduced by the instrument that measures the input power to the product under test, including any external shunts.

- i) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.
- ii) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

5 TEST CONDUCT

5.1 Guidance for Implementation of ECMA-383

- A) Small-Scale Servers, Thin Clients, and Workstations shall be configured in a manner identical to Desktops (non-integrated).
 - i) Thin Clients shall run intended terminal/remote connection software during all tests.
- B) Screen dimming settings on Notebooks and Integrated Desktops should be disabled for testing Short Idle.
- C) Wake on LAN (WoL) settings shall be in as-shipped condition for testing Sleep Mode and Off Mode.
- D) For Thin Client computers that do not offer a Sleep Mode, Section 6.3 can be skipped.
- E) For Long Idle Mode Testing (Section 6.4), the Unit Under Test (UUT) shall be allowed no more than 20 minutes from the point of ceased user input before measurements must be recorded.
- F) For Short Idle Mode Testing (Section 6.5), the UUT shall be allowed no more than five minutes from the point of ceased user input before measurements must be recorded.
- G) Desktop, Integrated Desktop, and Notebook Computers shall be tested for Idle, Sleep, and Off with Full Network Connectivity ("Proxying") features enabled or disabled as shipped.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 UUT Preparation

UUT preparation shall be performed according to *ECMA-383, Ed.3: Measuring the Energy Consumption of Personal Computing Products; Section 6.1: Test Setup*; with the additional guidance in Section 5 of this document.

6.2 Off Mode Testing

Off Mode power shall be measured according to *ECMA-383, Ed.3: Measuring the Energy Consumption of Personal Computing Products; Section 6.2.1: Measuring Off Mode*; with the additional guidance in Section 5 of this document.

6.3 Sleep Mode Testing

Sleep Mode power shall be measured according to *ECMA-383, Ed. 3: Measuring the Energy Consumption of Personal Computing Products; Section 6.2.2: Measuring Sleep Mode*; with the additional guidance in Section 5 of this document.

6.4 Long Idle Mode Testing

Long Idle Mode power shall be measured according to *ECMA-383, Ed. 3: Measuring the Energy Consumption of Personal Computing Products; Section 6.2.3: Measuring Long Idle Mode*; with the additional guidance in Section 5 of this document.

6.5 Short Idle Mode Testing

Short Idle Mode power shall be measured according to *ECMA-383, Ed. 3: Measuring the Energy Consumption of Personal Computing Products; Section 6.2.4: Measuring Short Idle Mode*; with the additional guidance in Section 5 of this document.

7 MAXIMUM POWER TEST FOR WORKSTATIONS

The maximum power for workstations is found by the simultaneous operation of two industry standard benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf® (latest available version for the UUT) to stress the system's GPU. This test shall be repeated three times on the same UUT, and all three measurements shall fall within a $\pm 2\%$ tolerance relative to the average of the three measured maximum power values.

Additional information on these benchmarks, including free downloads, can be found at the following locations:

Linpack	http://www.netlib.org/linpack/
SPECviewperf®	http://www.spec.org/benchmarks.html#gpc

7.1 UUT Preparation

- 1) Connect an approved meter capable of measuring true power to an ac line voltage source set to the appropriate voltage/frequency combination for the test. The meter should be able to store and output the maximum power measurement reached during the test or be capable of another method of determining maximum power.
- 2) Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units should be connected between the meter and the UUT.

- 3) Record the ac voltage.
- 4) * Boot the computer and, if not already installed, install Linpack and SPECviewperf as indicated on the above Websites.
- 5) Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate array size "n" for maximizing power draw during the test.
- 6) Ensure all technical guidelines relevant to running the benchmark set by the Standard Performance Evaluation Corporation (SPEC) organization for running SPECviewperf have been met.

Note: Below are some typical starting values for the use of Linpack for testing workstations. These values are starting points and not meant to be binding. The tester is free to use the settings most advantageous to their UUT. Platform and Operating System (OS) will have a significant impact on the applicability of these starting values. The below assumes Linux as the testing OS.

A) Number of equations (problem size): See Equation.

B) Leading dimensions of array: See Equation.

The matrix size (the combination of number of equations and leading dimensions of array) should be the maximum size that will fit in the Random Access Memory (RAM) on the machine.

This AWK script will calculate matrix size on a Linux machine:

```
awk '
  BEGIN {
    printf "Maximum matrix dimension that will fit in RAM on this machine: "
  }
  /^MemTotal:/ {
    print int(sqrt(($2*1000)/8)/1000) "K"
  }
' /proc/meminfo
```

Use the output of this to determine what matrix size to input for both the "Number of equations" and "Leading dimensions of array" inputs. The "Number of equations" will be equal to the printed output. The "Leading dimensions of the array" will be the output rounded up to the nearest multiple of eight.

Note: This calculation can be most easily calculated by taking the memory size, in bytes, of the UUT (denoted as m) and substituting m in Equation 1.

$$\sqrt{\frac{m \times 1000}{8}} \div 1000$$

Equation 1 Memory Size Calculation

C) *Number of trials:* c - 1 where c equals the number of logical and/or physical CPU cores of the system. The tester needs to determine which is more advantageous for the unit. The -1 leaves one core open for use by SPECviewperf.

D) *Data alignment value:* Typically four with Linux systems. The best value to use is the page size boundary of the OS.

7.2 Maximum Power Testing

- 1) Set the meter to begin accumulating true power values at an interval of less than or equal to one reading per second, and begin taking measurements.
- 2) Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the system.

- 3) Accumulate power values until SPECviewperf and all instances have completed running. Record the maximum power value attained during the test.
- 4) The following data shall also be recorded:
 - i) Value of the n (the array size) used for Linpack,
 - ii) Number of simultaneous copies of Linpack run during the test,
 - iii) Version of SPECviewperf run for test,
 - iv) All compiler optimizations used in compiling Linpack and SPECviewperf, and
 - v) A precompiled binary for end users to download and run of both SPECviewperf and Linpack. These can be distributed either through a centralized standards body such as SPEC, by the OEM, or by a related third party.