



ENERGY STAR[®] Program Requirements Product Specification for Computers

Test Method
February 2012

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:

- Section F) shall be conducted on all eligible Computer products.
- Section 7 shall be conducted on all eligible Workstation Computer products.

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: Acronyms referenced in this ENERGY STAR Test Method draft:

- ABC: Automatic Brightness Control
- 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
- IEC: International Electrotechnical Commission
- IPS: Internal Power Supply
- ISV: Independent Software Vendor
- LAN: Local Area Network
- LMD: Light Measuring Device

- 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
- UPS: Uninterruptible Power Supply
- USB: Universal Serial Bus
- UUT: Unit Under Test
- V: Volts
- W: Watts
- WoL: Wake on LAN

12 **4 TEST SETUP**

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

20 **Table 1: Input Power Requirements for Products with**
 21 **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 %

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**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 %

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

27 D) Relative Humidity: Relative humidity shall remain between be from 10% and 80%, inclusive, for the
28 duration of the test.

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

30 1) Crest Factor:

31 i) An available current crest factor of 3 or more at its rated range value; and

32 ii) Lower bound on the current range of 10 mA or less.

33 2) Minimum Frequency Response: 3.0 kHz

34 3) Minimum Resolution:

35 i) 0.01 W for measurement values less than 10 W;

36 ii) 0.1 W for measurement values from 10 W to 100 W; and

37 iii) 1.0 W for measurement values greater than 100 W.

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

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

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

44 F) Light Measuring Device (LMD): All LMDs shall meet the following specifications:

45 1) Accuracy: ± 2 percent (± 2 digits) of the digitally displayed value;

46 2) Repeatability: Within 0.4 percent (± 2 digits) of displayed value; and

47 3) Acceptance Angle: 3 degrees or less.

48 The overall tolerance of LMDs is found by taking the absolute sum of 2 percent of the targeted screen
49 luminance and a 2 digit tolerance of the displayed value's least significant digit. For example, if the
50 screen luminance value is 90 nits and the LMD's least significant digit is a tenth of a nit, 2% of 90 nits
51 would be 1.8 nits and a 2 digit tolerance of the least significant digit would be 0.2 nits. Thus, the
52 displayed value would need to be 90 ± 2 nits (1.8 nits + 0.2 nits).

53 G) Dark Room Conditions: The display illuminance measured with the UUT in Off Mode shall be less
54 than or equal to 1.0 lux.

55 **Note:** Items F) and G) are included to address display testing conditions. This section reflects the
56 incorporation of Short Idle testing with an active display into this test method.

57 **5 TEST CONDUCT**

58 **5.1 Guidance for Implementation of ECMA-383**

59 A) Small-Scale Servers, Thin Clients, and Workstations shall be configured in a manner identical to
60 Desktops (non-integrated).

61 i) Thin Clients shall run intended terminal/remote connection software during all tests.

62 B) Screen dimming settings on Notebooks and Integrated Desktops should be disabled for testing Short
63 Idle.

64 C) Wake on LAN (WoL) settings shall be in as-shipped condition for testing Sleep Mode and Off Mode.

65 D) For Thin Client computers that do not offer a Sleep Mode, Section 6.3 can be skipped.

66 E) For Long Idle Mode Testing (Section 6.4), the Unit Under Test (UUT) shall be allowed no more than
67 20 minutes from the point of ceased user input before measurements must be recorded.

68 F) For Short Idle Mode Testing (Section 6.5), the UUT shall be allowed no more than five minutes from
69 the point of ceased user input before measurements must be recorded.

70 G) Desktop, Integrated Desktop, and Notebook Computers shall be tested for Idle (Short and Long),
71 Sleep, and Off with Full Network Connectivity ("Proxying") features enabled or disabled as shipped.

72 **5.2 Preparing Display Luminance of Notebooks and Integrated Desktops**

73 **Note:** This section provides guidance for setting integrated computer displays to the appropriate
74 luminance values for testing and is consistent with the ENERGY STAR Displays v6.0 Test Method Draft 3
75 (not yet published).

76 Settings such as display dimming, display sleep mode, and computer sleep mode are disabled for
77 luminance setting as they might interfere with the warm-up period (display sleep mode shall be reset to its
78 as shipped setting for Long Idle testing).

79 A) Before performing any tests, disable display dimming, display sleep mode, computer sleep mode, and
80 automatic brightness control (ABC) in the computer settings. Document all settings that were changed
81 from the default configuration.

82 1) If ABC cannot be disabled, position a light source so that at least 300 lux directly enters the ABC
83 sensor.

84 **Note:** The nature of the light source is inconsequential as its sole purpose is to saturate the ABC sensor.
85 Saturation of the sensor ensures repeatability and is consistent with the ENERGY STAR Displays v6.0
86 Test Method under development.

87 B) Display the IEC 60107:1-1997, *Methods of measurement on receivers for television broadcast*
88 *transmissions – Part 1: General conditions – Measurements at radio and video frequencies*, three
89 vertical bar signal.

90 C) Allow 30 minutes for display warm-up.

91 D) With the LMD, measure the luminance in the center of the display in accordance with IEC 60107-1:
92 1997.

93 Calibrate display brightness to at least 90 nits for notebooks and at least 150 nits for integrated
94 desktop computers.

95 E) The display shall be configured with the ENERGY STAR test image. It may be set as the “desktop
96 background” (wallpaper) or shown via an image display application. The image shall be scaled to
97 completely fill the display area. The ENERGY STAR test image may be acquired from the IEC 62087-
98 BD ed3.0 publication from IEC.

99 F) Reset the display sleep setting to its as shipped value.

100 **Note:** DOE evaluated the power consumption using as shipped backgrounds, the gray ECMA
101 background, and the EPA dataset collection background (which was harmonized with IEC 62087). No
102 significant differences in power consumption were observed between the various backgrounds.

103 However, DOE recognizes that as computer displays advance (growing larger and utilizing different
104 display technologies), backgrounds have the potential to impact testing results, as they do for displays and
105 TVs, so it is prudent to specify a background setting. As shipped backgrounds vary by computer and could
106 unfairly affect power consumption. The EPA dataset collection background is a screenshot of internet
107 content and represents typical computer usage. For this reason, DOE is recommending that the display
108 background shall be the EPA test image.

109 **6 TEST PROCEDURES FOR ALL PRODUCTS**

110 **6.1 UUT Preparation**

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

114 **6.2 Off Mode Testing**

115 Off Mode power shall be measured according to *ECMA-383, Ed.3: Measuring the Energy Consumption of*
116 *Personal Computing Products; Section 6.2.1: Measuring Off Mode*; with the additional guidance in Section
117 5 of this document.

118 **6.3 Sleep Mode Testing**

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

122 **6.4 Long Idle Mode Testing**

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

126 **6.5 Short Idle Mode Testing**

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

130 **7 MAXIMUM POWER TEST FOR WORKSTATIONS**

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

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

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

138 **7.1 UUT Preparation**

- 139 1) Connect an approved meter capable of measuring true power to an ac line voltage source set to
140 the appropriate voltage/frequency combination for the test. The meter should be able to store and
141 output the maximum power measurement reached during the test or be capable of another
142 method of determining maximum power.
- 143 2) Plug the UUT into the measurement power outlet on the meter. No power strips or UPS units
144 should be connected between the meter and the UUT.
- 145 3) Record the ac voltage.
- 146 4) * Boot the UUT and, if not already installed, install Linpack and SPECviewperf as indicated on the
147 above Websites.
- 148 5) Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate
149 array size "n" for maximizing power draw during the test.
- 150 6) Ensure all technical guidelines relevant to running the benchmark set by the Standard
151 Performance Evaluation Corporation (SPEC) organization for running SPECviewperf have been
152 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.

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

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.

155 7.2 Maximum Power Testing

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

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