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
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

<table>
<thead>
<tr>
<th>Market</th>
<th>Voltage</th>
<th>Voltage Tolerance</th>
<th>Maximum Total Harmonic Distortion</th>
<th>Frequency</th>
<th>Frequency Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America, Taiwan</td>
<td>115 Vac</td>
<td>+/- 1.0 %</td>
<td>2.0 %</td>
<td>60 Hz</td>
<td>+/- 1.0 %</td>
</tr>
<tr>
<td>Europe, Australia, New Zealand</td>
<td>230 Vac</td>
<td>+/- 1.0 %</td>
<td>2.0 %</td>
<td>50 Hz</td>
<td>+/- 1.0 %</td>
</tr>
<tr>
<td>Japan</td>
<td>100 Vac</td>
<td>+/- 1.0 %</td>
<td>2.0 %</td>
<td>50 Hz/60 Hz</td>
<td>+/- 1.0 %</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Market</th>
<th>Voltage</th>
<th>Voltage Tolerance</th>
<th>Maximum Total Harmonic Distortion</th>
<th>Frequency</th>
<th>Frequency Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America, Taiwan</td>
<td>115 Vac</td>
<td>+/- 4.0 %</td>
<td>5.0 %</td>
<td>60 Hz</td>
<td>+/- 1.0 %</td>
</tr>
<tr>
<td>Europe, Australia, New Zealand</td>
<td>230 Vac</td>
<td>+/- 4.0 %</td>
<td>5.0 %</td>
<td>50 Hz</td>
<td>+/- 1.0 %</td>
</tr>
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<td>+/- 4.0 %</td>
<td>5.0 %</td>
<td>50 Hz/60 Hz</td>
<td>+/- 1.0 %</td>
</tr>
</tbody>
</table>

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

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

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 10 mA 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 unit 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.

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

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

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

3) Acceptance Angle: 3 degrees or less.
The overall tolerance of LMDs is found by taking the absolute sum of 2 percent of the targeted screen luminance and a 2 digit tolerance of the displayed value's least significant digit. For example, if the screen luminance value is 90 nits and the LMD's least significant digit is a tenth of a nit, 2% of 90 nits would be 1.8 nits and a 2 digit tolerance of the least significant digit would be 0.2 nits. Thus, the displayed value would need to be 90 ± 2 nits (1.8 nits + 0.2 nits).

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

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

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 (Short and Long), Sleep, and Off with Full Network Connectivity (“Proxying”) features enabled or disabled as shipped.

5.2 Preparing Display Luminance of Notebooks and Integrated Desktops

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

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

A) Before performing any tests, disable display dimming, display sleep mode, computer sleep mode, and automatic brightness control (ABC) in the computer settings. Document all settings that were changed from the default configuration.
1) If ABC cannot be disabled, position a light source so that at least 300 lux directly enters the ABC sensor.

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


C) Allow 30 minutes for display warm-up.

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

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

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

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

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

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**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 ± 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 UUT 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.

\[
\sqrt{\frac{m \times 1000}{8}}
\]

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.