



ENERGY STAR® Program Requirements Product Specification for Computers

Draft 2 Test Method Rev. July-2019

1 OVERVIEW

2 The following test method shall be used for determining product compliance with requirements in the
3 ENERGY STAR Specification for Computers.

2 APPLICABILITY

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

- 7 ▪ The procedure in Section 6 shall be conducted on all eligible products that are covered under the
8 scope as defined in Section 2 of the ENERGY STAR Eligibility Criteria for Computers.
- 9 ▪ The procedure in Section 7 shall be conducted only on eligible Workstation Computer products.

10 3 DEFINITIONS

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

13 4 TEST SETUP

14 4.1 Test Setup and Instrumentation

15 Test setup and instrumentation for all portions of this procedure shall be in accordance with the
16 requirements of International Electrotechnical Commission (IEC) standard, IEC 62301, "Household
17 Electrical Appliances – Measurement of Standby Power" Edition 2.0, 2011-01, Section 4, "General
18 Conditions for Measurements", unless otherwise noted in this document. In the event of conflicting
19 requirements, the ENERGY STAR test method shall take precedence.

- 20 A) Input Power: Products intended to be powered from alternating current (ac) mains shall be connected
21 to a voltage source appropriate for the intended market, as specified in Table 1 and Table 2.

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

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 volts (V) ac	+/- 1.0 %	2.0 %	60 hertz (Hz)	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz or 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 V ac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz or 60 Hz	+/- 1.0 %

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

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

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

31 1) Accuracy: ± 2% (± 2 digits) of the digitally displayed value; and

32 2) Acceptance Angle: 3 degrees or less.

33 The overall tolerance of LMDs is found by taking the absolute sum of 2% of the targeted screen
34 luminance and a 2 digit tolerance of the displayed value's least significant digit. For example, if the
35 screen luminance value is 90 candela per meter squared (cd/m²) and the LMD's least significant digit
36 is a tenth of one cd/m², 2% of 90 cd/m² would be 1.8 cd/m² and a 2 digit tolerance of the least
37 significant digit would be 0.2 cd/m². Thus, the displayed value would need to be 90 ± 2 cd/m² (1.8
38 cd/m² + 0.2 cd/m²).

39 *Note: The term "nit" is sometimes used instead of the official SI unit cd/m². One nit is equivalent to*
40 *one cd/m².*

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

42 1) Crest Factor:

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

44 b) A bound on the current range of 10 milliamperes (mA) or less.

45 2) Minimum Frequency Response: 3.0 kilo-hertz (kHz)

46 3) Minimum Resolution:

47 a) 0.01 W for measurement values less than 10 W;

- 48 b) 0.1 W for measurement values from 10 W to 100 W; and
49 c) 1.0 W for measurement values greater than 100 W.
- 50 4) Measurement Accuracy: Measurement uncertainty as introduced by the instrument that measures
51 the input power to the unit under test (UUT), including any external shunts.
- 52 a) Power measurements with a value greater than or equal to 0.5 W shall be made with an
53 uncertainty of less than or equal to 2% at the 95% confidence level.
- 54 b) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less
55 than or equal to 0.01 W at the 95% confidence level.

56 **5 TEST CONDUCT**

57 **5.1 Guidance for Implementation of IEC 62623**

58 The Test Conduct shall be carried out according to the requirements in IEC 62623, “Desktop and
59 Notebook Computers – Measurement of Energy Consumption” Edition 1.0, 2012-10 (IEC 62623 Ed. 1.0,
60 2012-10) reference with the following guidance.

61

62 A) Thin Clients and Workstations shall be configured in a manner identical to Desktops (non-integrated)
63 unless otherwise specified. Slates/Tablets shall be configured in a manner identical to Notebooks
64 unless otherwise specified. Portable All-In-One Computers shall be configured in a manner identical
65 to Integrated Desktops unless otherwise specified.

66 1) Thin Clients shall run intended terminal/remote connection software during all tests.

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

68 C) For models that do not offer a Sleep Mode enabled by default, Section 6.2 shall measure power in the
69 lowest-latency user-activated mode or state that preserves machine state and is enabled by default.

70 1) If no such state separate from Long Idle State or Off Mode exists, the measurement in
71 Section 6.2 shall be skipped.

72 D) For Long Idle Mode Testing (Section 6.3), the UUT shall be allowed no more than 20 minutes from
73 the point of ceased user input before measurements must be started. If any default settings cause the
74 UUT to enter Long Idle after 20 minutes, begin taking measurements when the UUT has reached the
75 20 minute mark. Display sleep settings shall be set to default for Long Idle Mode Testing.

76 E) For Alternative Low Power Mode Testing (Section 6.3), the UUT shall be allowed no more than 20
77 minutes from the point of ceased user input before measurements must be started. If any default
78 settings cause the UUT to enter the Alternative Low Mode after 20 minutes, begin taking
79 measurements when the UUT has reached the 20 minute mark. Display sleep settings shall be set to
80 default for Alternative Low Power Mode Testing. When conducting the test in section 6.3, replace all
81 instances of “Long Idle Mode” with “Alternative Low Power Mode.”, and apply the definition of
82 Alternative Low Power Mode from the ENERGY STAR Specification for Computers.

83 F) For Short Idle Mode Testing (Section 6.4), the UUT shall be allowed no more than five minutes from
84 the point of ceased user input before measurements must be taken. Display sleep settings shall be
85 disabled for Short Idle Mode Testing. If any other default settings cause the UUT to exit Short Idle
86 during the measurement time, extend the settings so that the UUT remains in short idle for the
87 duration of the measurement.

88 extend the short idle test long enough to capture the energy consumption over one or more complete
89 cycles. The extended test shall be conducted by keeping the unit in short idle through minimal user
90 input such as moving the mouse or pressing a key that does not perform any action (e.g. shift, ctrl,
91 tab, etc). The UUT must remain in short idle during the entire time of the extended test.

92 **Note:** DOE continued to seek feedback on this topic from stakeholders present at the June 18, 2019
93 stakeholder meeting. Stakeholders recommended an extended short idle test be performed without user
94 input. However, a lack of periodic user input makes it difficult to ensure that the system remains in short
95 idle mode throughout the duration of the test. Accordingly, DOE intends to retain the approach of
96 extending the short idle test with minimal user feedback as proposed in Draft 1.

97 In Version 7.1, DOE also allowed a temporary solution of disabling the battery via software when the
98 existing short idle test would not adequately capture a systems cyclical charging behavior, provided that
99 the software disconnect solution could be verified by comparing the results to an extended short idle test
100 measured over one or more complete cyclical patterns. With the implementation of the extended short
101 idle test as the test measurement, the interim solution of disabling the battery is no longer required and
102 has been removed.

103 G) Desktops, Integrated Desktops, Notebook Computers, Portable All-In-One Computers, and
104 Slates/Tablets shall be tested for Idle, Sleep, and Off Mode with Full Network Connectivity
105 (“Proxying”) features using the as shipped setting.

106 H) Cellular network connections shall be disabled for testing. Additionally, Bluetooth should be left as-
107 shipped.

108 I) If the UUT exhibits any cycling behavior and the normal measurement time would not capture one or
109 more complete cycles, measure the long idle, alternative low power mode, sleep mode, and off mode
110 measurement using an extended measurement capturing one or more full cycles per IEC 62301,
111 section B.2.3.

112 **Note:** DOE did not receive any comments on its proposal to extend testing in long idle, alternative low
113 power mode, sleep mode and off mode as part of Draft 1. DOE is therefore retaining these provisions for
114 Version 8.0.

115 J) Any secondary storage drive may have the power management features enabled during short idle as
116 long as those power management features are enabled by default. A secondary storage drive refers
117 to any drive that does not contain the operating system software.

118 **5.2 Preparing Display Luminance of Notebooks, Integrated Desktops,** 119 **Slates/Tablets and Portable All-In-One Computers**

120 A) Before performing any tests, disable display dimming, display Sleep Mode, Computer Sleep Mode,
121 and automatic brightness control (ABC) in the Computer settings. Document all settings that were
122 changed from the default configuration.

123 1) If ABC cannot be disabled, position a light source such that at least 300 lux directly enters the
124 ABC sensor.

125 B) Display the three vertical bar video signal as defined in section 3.2.1.3 of IEC 60107-1, “Methods of
126 measurement on receivers for television broadcast transmissions – Part 1: General conditions –
127 Measurements at radio and video frequencies” Edition 3.0, 1997 (IEC 60107-1 Ed. 3.0, 1997). The
128 three bar image shall be configured using the default image display application.

129 C) Devices with a cold cathode fluorescent lamp (CCFL) backlight shall warm-up for at least 30 minutes.
130 All other displays shall warm-up for at least 5 minutes.

131 D) With the LMD, measure the luminance in the center of the display.

132 E) Calibrate the UUT display brightness to the closest brightness setting that is at least 90 cd/m² for
133 Notebook Computers, at least 150 cd/m² for Integrated Desktop Computers, Portable All-In-One
134 Computers and Slates/Tablets. If the UUT’s brightest setting cannot achieve the specified brightness,
135 then set the UUT display to the brightest setting.

- 136 F) The display shall be configured with the ENERGY STAR test image, which can be found [here](#)¹. For
 137 Desktops, Integrated Desktops, Notebook Computers and Portable All-In-One Computers it may be
 138 set as the “desktop background” (wallpaper) or shown via an image display application. The image
 139 shall be scaled to completely fill the display area. For Slates/Tablets, the display shall be configured
 140 with the default image display application.
- 141 G) Optional setting for units with multiple integrated displays. Configure all displays in the same way
 142 using the previous steps. The displays do not have to be configured sequentially (i.e. warmup times
 143 can be done simultaneously for all displays). For notebook computers, all displays must be set to the
 144 closest brightness setting that is at least 90 cd/m² for every display. For Integrated Desktop
 145 Computers, Portable All-In-One Computers and Slates/Tablets, all displays must be set to the closest
 146 brightness setting that is at least 150 cd/m² for every display.
- 147 H) For all testing specified in Section 6, the UUT shall not be rebooted or restarted until after the power
 148 measurements for Long Idle Mode and Short Idle Mode tests are taken.
- 149 I) Slate/Tablet and Portable All-In-One Computers shall be tested with a docking station only if it is
 150 shipped with the product and is the only way to power the device mains.

151 **5.3 Preparing External Displays for Desktops**

152 A) Display Connection Priority

153
 154 If the UUT and external monitor support multiple signal interfaces, the UUT shall be tested with the
 155 first available interface from the list below:

External Display Connection Priority
i. Thunderbolt
ii. DisplayPort
iii. USB-C
iv. HDMI
v. DVI
vi. VGA

156 **Note:** DOE has added a display connection priority to improve testing repeatability and uniformity. The
 157 proposed priority aligns with the requirements in the ENERGY STAR Displays Specification, which is
 158 used to test computer monitors. DOE requests feedback on the priority order and whether there are other
 159 factors that should be considered in selecting a display connection when multiple interfaces exist.

160 B) Display Resolution:

¹ <https://www.energystar.gov/ia/partners/images/ComputerTestingImage.bmp>

161 **Note:** There currently does not exist a display resolution requirement for systems that require an external
162 display and one is not shipped with the unit. Similarly, there is no test parameter that requires systems to
163 be tested at a particular resolution.

164 At the June 18, 2019, stakeholder meeting, DOE presented the idea of testing systems with an external
165 display that supports 4K resolution. Stakeholders present at the meeting communicated that the
166 ENERGY STAR specification is based strictly on systems that did not utilize a 4K display. As such,
167 updating the test method to test with such a display would be inconsistent with the specification.

168 DOE continues to request feedback on whether such a resolution parameter would improve the
169 repeatability of the test method and, if so, what that resolution should be. EPA and DOE may consider
170 updating a future specification and test method to reflect a 4K resolution display.

171 **6 TEST PROCEDURES FOR ALL PRODUCTS**

172 **6.1 UUT Preparation**

173 UUT preparation shall be performed according to IEC 62623, Ed.1.0, 2012-10, Section 5.2: Test Setup;
174 with the additional guidance in Section 5 of this document.

175 **6.2 Sleep Mode Testing**

176 Sleep Mode power shall be measured according to IEC 62623, Ed.1.0, 2012-10, Section 5.3.3:
177 Measuring Sleep Mode; with the additional guidance in Section 5 of this document.

178 **6.3 Long Idle Mode Testing**

179 Long Idle Mode power shall be measured according to IEC 62623, Ed.1.0, 2012-10, Section 5.3.4:
180 Measuring Long Idle Mode; with the additional guidance in Section 5 of this document.

181 **6.4 Short Idle Mode Testing**

182 Short Idle Mode power shall be measured according to IEC 62623, Ed.1.0, 2012-10, Section 5.3.5:
183 Measuring Short Idle Mode; with the additional guidance in Section 5 of this document.

184 **6.5 Off Mode Testing**

Off Mode power shall be measured according to IEC 62623, Ed.1.0, 2012-10, Section 5.3.2: Measuring
Off Mode; with the additional guidance in Section 5 of this document.

185 **6.6 Additional Testing For Reporting**

186 For Notebook Computers, repeat the Short Idle test with the display brightness set to the closest setting
187 that is at least 150 cd/m² for all displays.

188 **6.7 Sleep to Wake Latency Test**

189 **Note:** With this Draft, EPA has proposed that compliance with the Sleep to Wake Latency requirement be
190 self-certified. The value will not be confirmed through the ENERGY STAR certification process. As such,
191 DOE is removing the Sleep to Wake Latency test.

192 **7 TEST PROCEDURES FOR WORKSTATIONS**

193 **7.1 Maximum Power Test**

194 The maximum power for Workstations is found by the simultaneous operation of two industry standard
195 benchmarks: Linpack to stress the core system (e.g., processor, memory, etc.) and SPECviewperf®
196 (latest available version for the UUT) to stress the system's Graphics Processing Unit (GPU). This test
197 shall be repeated three times on the same UUT, and all three measurements shall fall within a ± 2%
198 tolerance relative to the average of the three measured maximum power values. The average power
199 should be used for qualification and/or TEC calculations.

200

201 Note: Workstations may certify configurations using Microsoft Windows® OS as a proxy for Linux for the
202 maximum power test, as SPEC does not currently support a version of SPECviewperf® capable of
203 running on the Linux OS.

204

205 Additional information on these benchmarks, including free downloads, can be found at the following
206 locations as specified in Table 3.

207

Table 3: Benchmark Information for Maximum Power Test

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

208 A) UUT Preparation:

- 209 1) Connect a power meter capable of measuring true power to an ac line voltage source set to the
210 appropriate voltage/frequency combination for the test. The meter shall have all the attributes
211 listed in Section 4.1 E). The meter shall also store and output the maximum power measurement
212 reached during the test or be capable of another method of determining maximum power.
- 213 2) Plug the UUT into the measurement power outlet on the meter. No power strips or uninterruptible
214 power supply (UPS) units shall be connected between the meter and the UUT.
- 215 3) Record the ac voltage.
- 216 4) Boot the UUT and, if not already installed, install Linpack and SPECviewperf as indicated on the
217 above Websites.
- 218 5) Set Linpack with all the defaults for the given architecture of the UUT and set the appropriate
219 array size "n" for maximizing power draw during the test.
- 220 6) Ensure all technical guidelines relevant to running the benchmark set by the Standard
221 Performance Evaluation Corporation (SPEC) organization for running SPECviewperf have been
222 met.
- 223 7) For additional information regarding Linpack setup, see Section 9.1 Typical Linpack Starting
224 Parameters.

225 B) Maximum Power Testing:

- 226 1) Set the meter to begin accumulating true power values at a rate greater than or equal to one
227 reading per second, and begin taking measurements.
- 228 2) Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the
229 system. Recommended setup information can be found in Section 9.1 C).
- 230 3) Accumulate power values until SPECviewperf and all Linpack instances have completed running.
231 Record the maximum power value attained during the test.
- 232 4) The following data shall also be recorded:
 - 233 a) Value of "n" (the array size) used for Linpack;

- 234 b) Number of simultaneous copies of Linpack run during the test;
- 235 c) Version of SPECviewperf run for test;
- 236 d) All compiler optimizations used in compiling Linpack and SPECviewperf; and
- 237 e) A precompiled binary for end users to download and run both SPECviewperf and Linpack.
- 238 These can be distributed either through a centralized standards body such as SPEC, by the
- 239 original equipment manufacturer (OEM), or by a related third party.

240 **7.2 Benchmark Test**

241 The benchmark test shall be performed by running both benchmarks listed below separately. The UUT
 242 shall be rebooted before testing with each benchmark. Additional information on these benchmarks,
 243 including downloads, can be found at the following locations specified in Table 4. All testing shall be
 244 performed with the latest available version of the benchmarks.

245 **Table 4: Information for Benchmark Testing**

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

246 A) UUT Preparation:

- 247 1) The UUT shall be setup identical to Step 1) through Step 4) of Section 7.1 A)
- 248 2) If not already installed, install the benchmark as indicated on the websites listed in Table 4.
- 249 3) Configure the benchmark as specified in Section 7.2 B).
- 250 4) Time Measurement: Time measurements may be performed with a standard stopwatch or other
- 251 time keeping device with a resolution of at least 1 second.

252 B) Benchmark Configurations:

- 253 1) Linpack
 - 254 a) Configure the Linpack settings identically to the maximum power workstation test (e.g. Follow
 - 255 Step 5) and Step 7) of Section 7.1 A)).
 - 256 b) Run as many simultaneous instances of Linpack as needed to fully stress the system.
 - 257 Recommended settings would be to set the number of simultaneous instances of Linpack
 - 258 equal to the number of logical and/or physical CPU cores of the system.
- 259 2) SPECviewperf
 - 260 a) Configure the settings identically to the maximum power workstation test (e.g. Follow Step 6)
 - 261 of Section 7.1 A)).

262 C) Benchmark Testing:

- 263 1) Set the meter to begin accumulating true power values at a rate of greater than or equal to one
- 264 reading per second and begin power and time measurement.
- 265 2) Execute the benchmark.
- 266 3) Stop time measurement and accumulate power values for the entire duration of the benchmark
- 267 run.
- 268 4) The following data shall be reported:
 - 269 a) Linpack

- 270 i. Value of “n” (the array size) used for Linpack;
- 271 ii. Number of instances of Linpack simultaneously run on the system;
- 272 iii. All compiler options used in compiling Linpack;
- 273 iv. Energy consumed over the duration of the test; and
- 274 v. Linpack output file in text format which contains system performance in floating point
- 275 operations per second (Flops) in addition to other Linpack parameters (e.g. number of
- 276 tests, problem size, etc.).
- 277 b) SPECviewperf
 - 278 i. Version of SPECviewperf used;
 - 279 ii. All compiler optimizations used in compiling SPECviewperf;
 - 280 iii. Duration of the test;
 - 281 iv. Energy consumed over the duration of the test; and
 - 282 v. All files and folders present in the Result folder of SPECviewperf suite shall be reported.

283 8 REFERENCES

- 284 A) IEC 62301 Edition 2.0 2011-01, Household electrical appliances – Measurement of standby power.
- 285 B) IEC 60107-1 Edition 3.0 1197-04, Methods of measurement on receivers for television broadcast
- 286 transmissions – Part 1: General Considerations – Measurements at radio and video frequencies.
- 287 C) IEC 62623 Edition 1.0 2012-10, Desktop and notebook computers – Measurement of energy
- 288 consumption

289 9 APPENDIX: BENCHMARK PARAMETERS

290 9.1 Typical Linpack Starting Parameters

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

- 295 A) Number of equations (problem size): See Equation.
- 296 B) Leading dimensions of array: See Equation.

297 The matrix size (the combination of number of equations and leading dimensions of array) should be
 298 the maximum size that will fit in the Random Access Memory (RAM) on the machine.
 299 This AWK script will calculate matrix size on a Linux machine:

```
300     awk '
301         BEGIN {
302             printf "Maximum matrix dimension that will fit in RAM on this machine: "
303         }
304         /^MemTotal:/ {
305             print int(sqrt(($2*1000)/8)/1000) "K"
306         }
307     ' /proc/meminfo
```

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

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

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

313

314

Equation 1: Memory Size Calculation

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

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