



ENERGY STAR® Program Requirements Product Specification for Displays

Test Method

1 OVERVIEW

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

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: Based on stakeholder feedback, proposed modifications to the test method, such as the implementation of IEC 62087, Ed 3.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, and the accommodation of displays that have data or networking capabilities, have been retained. Further modifications to the test method include new luminance requirements for testing displays with viewable diagonal screen sizes of less than 30 inches, and separate luminance requirements for displays with viewable diagonal screen sizes of 30 inches or more.

3 DEFINITIONS

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

4 TEST SETUP

- A. Test Setup and Instrumentation: Test setup and instrumentation for all portions of this method shall be in accordance with the requirements of IEC 62301, Ed. 2.0, "Measurement of Household Appliance 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. Ac Input Power: Products capable of being powered from ac mains shall be connected to an external power supply if one is shipped with the unit, and then connected to a voltage source appropriate for the intended market, as specified in Table 1 and Table 2.

25
26

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 %

27
28

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 %

29 C. Low-voltage Dc Input Power:

- 30 1) Products may be powered with a low-voltage dc source (e.g., via network or data connection)
31 only if the dc source is the only available source of power for the product (e.g., no ac plug or EPS
32 is available).
- 33 2) Products powered by low-voltage dc shall be configured with an ac source of the dc power for
34 testing (e.g., an ac-powered USB hub).
- 35 3) Power for the unit under test (UUT) shall include the following, as measured per Section 6 of this
36 method:
- 37 i) Ac power consumption of the low-voltage dc source with the UUT as the load (P_L).
- 38 ii) Ac power consumption of the low-voltage dc source with no load (P_S).

39 **Note:** The test method and qualification criteria have been clarified to delineate guidance for testing
40 products powered by a low-voltage dc source, and for determining the On Mode Power for these
41 products.

42 D. Ambient Temperature: Ambient temperature shall be from 18 °C to 28 °C.

43 E. Relative Humidity: Relative humidity shall be from 10% to 80%.

44

- 45 F. Power Meter: Power meters shall possess the following attributes¹:
- 46 1) Crest Factor:
- 47 i) An available current crest factor of 3 or more at its rated range value; and
- 48 ii) Lower bound on the current range of 10mA or less.
- 49 2) Minimum Frequency Response: 3.0 kHz
- 50 3) Minimum Resolution:
- 51 iii) 0.01 W for measurement values less than 10 W;
- 52 iv) 0.1 W for measurement values from 10 W to 100 W; and
- 53 v) 1.0 W for measurement values greater than 100 W.
- 54 G. Measurement Accuracy:
- 55 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an
- 56 uncertainty of less than or equal to 2% at the 95% confidence level.
- 57 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than
- 58 or equal to 0.01 W at the 95% confidence level.
- 59 3) Ambient light measurements (lux) shall be measured within a $\pm 10\%$ tolerance.

60 5 TEST CONDUCT

61 5.1 Guidance for Implementation of IEC 62087 Ed. 3.0

- 62 A. Testing at Factory Default Settings: Power measurements shall be performed with the product in its
- 63 as-shipped condition for the duration of Sleep Mode and On Mode testing, with all user-configurable
- 64 options set to factory defaults, except as otherwise specified by this test method.
- 65 1) Picture level adjustments shall be performed per the instructions in IEC 62087, Ed. 3.0, Section
- 66 11.4.8.
- 67 2) Products that include a “forced menu” upon initial start-up shall be tested in “standard” or “home”
- 68 picture mode. Products that do not include a forced menu shall be tested in the default picture
- 69 mode. In the case that no “standard” mode or equivalent exists, the first mode listed in the on-
- 70 screen menus shall be used for testing, and recorded in the test report.

71 **Note:** Based on data submitted by stakeholders on the power consumption of displays using the

72 Dynamic Broadcast Content video signal and the Internet Content video signal, the difference in power

73 measurements was found to be less than 1 W across displays of various diagonal screen sizes. Since the

74 results from both video signals are comparable, EPA proposes to test all displays using the Dynamic

75 Broadcast Content video signal in an effort to model real-world usage while harmonizing the test method

76 with the ENERGY STAR Televisions test method.

¹ Characteristics of approved meters taken from *IEC 62301 Ed 2.0: Household Electrical Appliances – Measurement of Standby Power*.

- 77 B. Point of Deployment (POD) Modules: Optional POD modules shall not be installed.
- 78 C. Multiple Sleep Modes: If the product offers multiple Sleep Modes, the power during all Sleep Modes
79 shall be measured and recorded.

80 5.2 Conditions for Power Measurements

81 A. Power measurements:

- 82 1) Power measurements shall be taken from a point between the power source and the UUT.
- 83 2) Power measurements shall be recorded in watts as directly measured (unrounded) values.

84 **Note:** To ensure accurate power measurements and consistency with the eligibility criteria, EPA
85 proposes unrounded power measurements be recorded.

- 86 3) Power measurements shall be recorded after instrument readings are stable to within 1% over a
87 five minute period.

88 B. Dark Room Conditions:

- 89 1) Unless otherwise specified, the display screen illuminance measured with the UUT in Off Mode
90 shall be less than or equal to 1.0 lux.

91 C. UUT Configuration and Control:

92 1) Peripherals and Network Connections:

- 93 i) External peripheral devices shall not be connected to the Universal Serial Bus (USB) ports or
94 other data ports on the UUT.

95 ii) UUT connections shall be set up as follows:

- 96 (1) In the case of a UUT that has data and network capabilities (e.g., Wi-Fi, Ethernet), the
97 UUT shall be configured and connected to an active data or network.

- 98 (2) In the case of a peripheral device data connection (e.g., USB, Firewire), another device
99 shall be capable of bridging the data connection, while active and powered with a live
100 bridge; i.e., the two devices shall act as bridged USB hub controllers.

- 101 (3) In the case of a UUT that has network capabilities, the capabilities shall be activated and
102 connected to a live physical network, including wireless RF, which supports the highest
103 and lowest data speeds of the UUT's network function. An active connection is defined as
104 a live physical connection over the physical layer of the networking protocol. The tester
105 shall configure the address layer of the protocol, taking note of the following:

- 106 (a) IPv4 and IPv6 have neighbor discovery and will generally configure a limited, non-
107 routable connection automatically.

- 108 (b) IP can be configured manually or using DHCP with an address in the 192.168.1.x
109 NAT address space if the UUT does not behave normally when autoIP is used. The
110 network shall be configured to support the NAT address space and/or autoIP.

- 111 iii) The UUT shall maintain this live connection to the network for the duration of testing,
112 disregarding any brief lapses, e.g., when transitioning between link speeds. If the UUT is
113 equipped with multiple network capabilities, only one connection shall be made in the
114 following order of preference.

- 115 (1) Wi-Fi (IEEE 802.11).

- 116 (2) Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet, IEEE 802.3az, then
117 it shall be connected to a device that also supports IEEE 802.3az.

- 118 (3) Thunderbolt.

- 119 (4) USB.

- 120 (5) Firewire (IEEE 1394).
121 (6) Other.
- 122 iv) A bridge connection should be made between the UUT and the host machine. The
123 connection should be made in the following order of preference, and only one connection
124 should be made.
- 125 (1) Thunderbolt.
126 (2) USB.
127 (3) Firewire (IEEE 1394).
128 (4) Other.
- 129 v) In the case of a UUT that has no data/network capabilities, the UUT should be tested as-is.
130 vi) Built-in speakers and other product features and functions not specifically addressed by the
131 ENERGY STAR eligibility criteria or test method must be configured in the as-shipped power
132 configuration.

133 **Note:** EPA proposes that manufacturers engage the USB/Firewire/Thunderbolt hub controller (or similar)
134 in the display when testing for ENERGY STAR qualification to reflect a more accurate depiction of the
135 state of hardware when operated by the end user. The requirements for data and network connections
136 during testing have been revised to provide more guidance across various types of connections. EPA
137 seeks additional data and feedback pertaining to the power consumption associated with peripherals'
138 (e.g., data or network hubs, speakers, mice) connection to displays during Sleep Mode testing.

- 139 2) Signal Interface: Displays that offer both an analog and a digital interface shall be tested with the
140 digital interface.
- 141 i. Connect the UUT to a PC, network or other input source signal via the following precedence
142 rules.
- 143 ii. If the UUT has multiple digital interfaces, the UUT shall be tested with the first available
144 interface from the list below:
- 145 (1) Thunderbolt.
146 (2) DisplayPort.
147 (3) HDMI.
148 (4) DVI.
- 149 iii. If the UUT has only analog interfaces, analog component should take precedence over
150 analog composite.

151 **Note:** Stakeholders commented that analog component more accurately represents real-world use and
152 should take precedence over analog composite. EPA therefore proposes the use of analog component
153 over analog composite for products with only analog interfaces.

- 154 3) Resolution and Refresh Rate:
- 155 i. Fixed-pixel displays:
- 156 (1) Pixel format shall be set to the native level.
157 (2) Refresh rate shall be set to 60 Hz, unless the product manual specifies a different default
158 refresh rate, in which case the specified default refresh rate shall be used.

159 (3) For CRT displays, pixel format shall be set to the highest resolution that is designed to be
160 driven at a 75 Hz refresh rate, as specified in the product manual. Typical industry
161 standards for pixel format timing shall be used for testing. Refresh rate shall be set to 75
162 Hz.

163 D. Battery Operated Products: For products designed to operate using batteries when not connected to
164 the mains, the battery shall be fully charged before the start of testing and shall be left in place for the
165 test.

166 E. Accuracy of Input Signal Levels: When using analog interfaces, video inputs shall be within $\pm 2\%$ of
167 reference white and black levels. When using digital interfaces, the source video signal shall not be
168 adjusted for color, or modified by the tester for any purpose other than that required to
169 compress/inflate and encode/decode for transmission.

170 F. True Power Factor: Partners shall indicate the true power factor of their displays during On Mode
171 measurement.

172 **Note:** Stakeholders did not express concern over measuring true power factor during On Mode testing.
173 EPA therefore proposes to retain this measurement requirement to expand its dataset.

174 G. Test Materials:

175 1) "Dynamic Broadcast Content" shall be used for testing, as specified in IEC 62087, Ed. 3.0,
176 Section 11.6, "On (average) mode testing using dynamic broadcast-content video signal."

177 **Note:** EPA intends for displays of all sizes to be tested using the IEC 62087 Dynamic Broadcast Content
178 video signal. For displays that are not able to play the Dynamic Broadcast Content, EPA proposes testing
179 them with the IEC 62087 three-bar static signal. EPA welcomes stakeholder feedback on any displays,
180 such as digital picture frames, which may not be tested using either the IEC 62087 Dynamic Broadcast
181 Content video signal or the IEC 62087 three-bar static signal.

182 6 LOW-VOLTAGE DC SOURCE MEASUREMENT

183 A. Connect the dc source to the power meter and relevant ac supply as specified in Table 1.

184 1) Verify that the dc source is unloaded.

185 2) Allow the dc source to warm up for a minimum of 30 minutes.

186 3) Measure and record the unloaded dc source power (P_S) according to IEC 62301 Ed. 2.0.

187 7 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

188 A. Prior to the start of testing, the UUT shall be initialized as follows:

189 1) Set up the UUT per the instructions in the supplied operating manual.

190 2) Connect the power meter to the power source and connect the UUT to the power outlet on the
191 power meter.

192 3) With the UUT off, set the ambient light level such that the measured display screen illuminance is
193 less than 1 lux (see section 5.2 B, Dark Room Conditions).

194 4) Power on the UUT and perform initial system configuration, as applicable.

195 5) Ensure UUT settings are in their as-shipped configuration.

196 6) Warm up the UUT for the longer of 20 minutes or the time it takes the UUT to complete
197 initialization and become ready for use.

198 7) Measure and record the ac input voltage and frequency.

199 8) Measure and record the test room ambient temperature and relative humidity.

200 8 TEST METHOD FOR ALL PRODUCTS

201 8.1 Luminance Testing

202 A. Luminance testing shall be performed in dark room conditions. Display screen illuminance as
203 measured with the UUT in Off Mode shall be less than or equal to 1.0 lux.

204 B. Luminance shall be measured perpendicular to the center of the display screen using a Light
205 Measuring Device (LMD). Following the LMD's manufacturer's instructions, it is recommended that
206 the LMD either be used as close to the screen as possible, or measure an area of at least 500 pixels.

207 **Note:** Stakeholders pointed out redundancy and inconsistency in recommending the LMD to be placed at
208 a certain distance from the screen or covering a set pixel area. EPA has therefore clarified the
209 recommendation to measure an area of at least 500 pixels.

210 C. The position of the LMD relative to the display screen shall remain fixed throughout the duration of
211 testing.

212 D. For products with Automatic Brightness Control, luminance measurements shall be performed with
213 ABC disabled. If ABC cannot be disabled, luminance measurements shall be performed with the
214 display positioned at a 90 degree angle relative to the horizontal in a test room with ambient lighting
215 greater than or equal to 300 lux.

216 E. Luminance measurements shall be performed as follows:

217 1) Verify that the UUT is in the default as-shipped luminance value or 'Home' picture mode.

218 2) Begin to display the three-bar video signal specified in IEC 62087, Ed. 3.0, Section 11.5.5 (three
219 bars of white (100%) over a black (0%) background).

220 3) Display the three-bar video signal for not less than 10 minutes to allow the UTT luminance to
221 stabilize. This 10-minute stabilization period may be reduced if luminance measurements are
222 stable to within 2% over a period of not less than 60 seconds.

223 4) Measure and record luminance in default as-shipped luminance value or 'Home' picture mode,
224 L_{HOME} .

225 **Note:** To provide consumers with the most accurate intended usage information, EPA proposes that
226 partners test their products in the as-shipped configuration. A number of stakeholders highlighted
227 difficulties with measuring the maximum luminance of a display, listing factors such as variation of
228 measurements from unit to unit which would result in inconsistent qualification and cause issues with
229 verification testing. Therefore, instead of being measured as part of the test method, the maximum
230 luminance shall be as claimed by the manufacturer.

231 8.2 On Mode Testing for Products without ABC Enabled by Default

232 A. Prior to the On Mode power measurement, the luminance of the UUT shall be set according to the
233 following:

234 1) For displays with viewable diagonal screen size **less than 30 inches**, adjust the brightness
235 control until the luminance of the screen is **200 Cd/m²**. If the UUT cannot achieve this luminance,
236 set the display luminance to the nearest achievable value.

237 2) For displays with viewable diagonal screen size of **30 inches or more**, the luminance shall be
238 tested at a value **greater than or equal to 65% of the maximum luminance**.

- 239 B. On Mode power (P_{ON}) shall be measured according to IEC 62087, Ed 3.0: Methods of Measurement
240 for the Power Consumption of Audio, Video and Related Equipment; Section 11: Measuring
241 Conditions for Television Sets in On (average) Mode; with the additional guidance in Section 5.

242 **Note:** Many stakeholders commented that a fixed luminance for displays with a viewable screen size less
243 than 30 inches is the optimal approach because it offers straightforward testing, provides consistent
244 measurements, and allows for fair comparability between products. Following analysis of currently
245 qualified products, EPA has determined the average as-shipped luminance to be 235 cd/m^2 . Furthermore,
246 most of these displays have a resolution of more than 1.1 MP and were therefore tested for qualification
247 at 200 cd/m^2 using the VESA test standard under the previous ENERGY STAR Version 5.1 Displays
248 specification. To ensure that testing for ENERGY STAR qualification resembles intended product usage,
249 EPA proposes to test displays with a viewable screen size less than 30 inches at 200 cd/m^2 .

250 For displays with a viewable screen size of 30 inches or more, the as-shipped luminance of currently
251 qualified displays was found to vary significantly from product to product across the entire range of sizes,
252 thus making it difficult to set a fixed luminance for all sizes. EPA proposes to test displays with a viewable
253 screen size of 30 inches or more at a luminance that is greater than or equal to 65% of the reported
254 maximum luminance. Since many of the displays already ship at a luminance that is greater than or equal
255 to 65% of the reported maximum luminance, EPA expects that requiring products to be tested at greater
256 than or equal to 65% of the maximum luminance also accurately reflects, at minimum, how most products
257 are shipped or installed. This testing approach is similar to the approach used in the Televisions
258 specification.

259 **8.3 On Mode Testing for Products with ABC Enabled by Default**

- 260 A. TBD

261 **Note:** EPA is currently investigating the approach to ABC and will include guidance in the subsequent
262 version of the draft test method.

263 **8.4 Sleep Mode Testing**

- 264 A. Sleep Mode power (P_{SLEEP}) shall be measured according to IEC 62301, Ed 2.0: Household Electrical
265 Appliances – Measurement of Standby Power, with the additional guidance in section 5.
- 266 B. If the product has a variety of Sleep Modes that can be manually selected, measurements shall be
267 performed in the most energy consumptive Sleep Mode. If the product automatically cycles through
268 its various Sleep Modes, measurement time shall be long enough to obtain a true average of all
269 Sleep Modes, which will be the Sleep Mode power used for qualification.

270 **8.5 Off Mode Testing**

- 271 A. At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power
272 switch.
- 273 B. Measure Off Mode power (P_{OFF}). Document the method of adjustment and sequence of events
274 required to reach Off Mode.
- 275 C. Any input sync signal check cycle may be ignored when measuring Off Mode power.

276 **8.6 Additional Testing**

- 277 A. For products with data/networking capabilities, in addition to tests performed with data/networking
278 capabilities activated and a bridge connection established, the test found in Section 8.4 Sleep Mode
279 Testing shall be performed with data/networking features deactivated and without any bridge
280 connection established, per section 5.2.C.1) Peripherals and Network Connections: ii and iii.

281
282
283
284

Note: Balancing the benefit of having an exhaustive dataset and testing load for manufacturers, EPA proposes gathering data on the power consumption increment due to data/networking capabilities in Sleep Mode only, which EPA expects to be similar to the power consumption increment for this capability in On Mode.