



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:

- 1) Test procedures in Section 8 shall be performed on all products with viewable diagonal screen size less than 60 inches.

Note: The test method has been modified to clarify issues with the test procedure, accommodate testing using the IEC 62087, Ed 3.0¹: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, delineate the procedure for testing displays that have networking capabilities, introduce new lighting conditions for testing displays that are shipped with ABC enabled by default and define the luminance requirement for testing displays of all diagonal screen sizes.

EPA is in the process of conducting additional research to determine answers to the following questions:

1. What is the power consumption of displays less than 30" in diagonal screen size when tested with the dynamic broadcast content video signal and Internet-content video signal described the IEC 62087 test method?
2. What is the power consumption of displays 30"-60" in diagonal screen size that are not currently ENERGY STAR qualified?
3. What is the prevalence and applicability of displays greater than 60" in diagonal size in the market? Would these products benefit from an ENERGY STAR label? What is the typical power consumption of these products?
4. For products that are shipped with ABC enabled by default, are the lighting conditions specified in section 8.3 of the Test Method representative of how end users utilize their display products? What additional conditions, relevant to the test set up, should EPA specify in the test method?
5. What is the prevalence of networking capability and what is its typical power consumption?
6. How common are multiple sleep modes for displays and what is the power usage within each of those modes?
7. How do the testing room conditions affect power consumption results? What parameters within test room laboratories should be modified to ensure repeatability of testing results?

¹ Edition 3.0 of the IEC 62087 standard was published in April 2011; however, the provisions that relate to displays and televisions were unchanged. As such, Partners may continue to utilize Ed 2.0 for testing and qualifying displays for ENERGY STAR.

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Stakeholders who can assist EPA in the efforts to answer the questions illustrated above are encouraged to share test data by July 18, 2011. The information and data shared will be used to set performance levels for Draft 2 of Version 6.0 ENERGY STAR Displays Specification.

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3 DEFINITIONS

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

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4 TEST SETUP

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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. 3.0, "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.

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B. AC Input Power: Products capable of being powered from AC mains shall be connected to an external power supply shipped with the unit (if applicable) and then connected 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 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 %

50 C. Low-voltage Dc Input Power:

- 51 1) Products may only be powered with a low-voltage dc source (e.g., via network or data
52 connection) if the dc source is the only available source of power for the product (e.g., no ac plug
53 or EPS is available).
- 54 2) Products powered by low-voltage dc shall be configured with an ac source of the dc power for
55 testing (e.g., an ac-powered USB hub).
- 56 3) Reported UUT power shall be equal to the ac power consumption of the low-voltage dc source
57 with the UUT as the load, minus the ac power consumption of the low-voltage dc source with no
58 load (P_s), as measured per Section 6 of this procedure.

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

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

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- 62 F. Power Meter: Power meters shall possess the following attributes²:
- 63 1) Crest Factor:
- 64 i) An available current crest factor of 3 or more at its rated range value; and
- 65 ii) Lower bound on the current range of 10mA or less.
- 66 2) Minimum Frequency Response: 3.0 kHz
- 67 3) Minimum Resolution:
- 68 iii) 0.01 W for measurement values less than 10 W;
- 69 iv) 0.1 W for measurement values from 10 W to 100 W; and
- 70 v) 1.0 W for measurement values greater than 100 W.
- 71 G. Measurement Accuracy:
- 72 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an
- 73 uncertainty of less than or equal to 2% at the 95% confidence level.
- 74 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than
- 75 or equal to 0.01 W at the 95% confidence level
- 76 3) Ambient light measurements (Lux) shall be measured within a +/- 10% tolerance.

77 **Note:** Due a potential drift in the light source when measuring the various lighting conditions proposed for
78 testing displays with ABC enabled, EPA has specified a +/- 10% tolerance when measuring ambient light
79 conditions.

80 5 TEST CONDUCT

81 5.1 Guidance for Implementation of IEC 62301 Ed. 2.0

- 82 A. Testing at Factory Default Settings: Power measurements shall be performed with the product in its
- 83 as-shipped condition for the duration of Sleep Mode and On Mode testing, with all user-configurable
- 84 options set to factory defaults, except as otherwise specified by the test procedure.
- 85 1) Picture level adjustments shall be performed per the instructions in IEC 62087, Ed. 3.0, Section
- 86 11.4.8.
- 87 2) Products that include a “forced menu” upon initial start-up shall be tested in “standard” or “home”
- 88 picture mode. Products that do not include a forced menu shall be tested in the default picture
- 89 mode. In the case that no “standard” mode or equivalent exists, the first mode listed in the on-
- 90 screen menus shall be used for testing and noted in the test report.
- 91 B. Point of Deployment (POD) Modules: Optional POD modules shall not be installed.
- 92 C. Multiple Sleep Modes: If the product offers multiple Sleep Modes, the power during all Sleep Modes
- 93 shall be measured and recorded.

94 5.2 Conditions for Power Measurements

- 95 A. Power measurements: shall be taken from a point between the power source and the unit under test
- 96 (UUT).
- 97 1) Power measurements shall be recorded in watts and rounded to the nearest tenth of a watt.

² Characteristics of approved meters taken from IEC 62301 Ed 2.0: Household Electrical Appliances – Measurement of Standby Power.

- 98 2) Power measurements shall be recorded after instrument readings are stable to within 1% over a
99 five minute period.

Note: The stabilization period has increased from three minutes to five minutes. During the current data assembly process, EPA welcomes stakeholder test data with either three or five minute stabilization period, as EPA understands that some stakeholder might have already administered the power consumption tests using the previous three minute requirement.

104 B. Dark Room Conditions:

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

107 C. UUT Configuration and Control:

108 1) Peripherals and Network Connections:

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

- 111 ii) In the case of a UUT that has Data and Network capabilities (e.g. Wi-Fi, Ethernet), the
112 product shall be configured with networking features activated and connected to a live
113 physical network which supports the highest and lowest data speeds of the UUT's network
114 function. The UUT shall maintain this live connection to the network for the duration of
115 testing, disregarding any brief lapses like when transitioning between link speeds. If the UUT
116 is equipped with multiple networking functions, only one connection. If the UUT is equipped
117 with multiple network functions, only one connection shall be made in the following order of
118 preference.

119 (1) Wi-Fi (IEEE 802.11)

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

122 (3) Thunderbolt

123 (4) USB

124 (5) Firewire (IEEE 1394)

125 (6) Other

- 126 iii) A bridge connection should be made between the UUT and the host machine connected to
127 the UUT for testing. The connections should be made in the following order of preference and
128 only one connection should be made.

129 (1) Wi-Fi (IEEE 802.11)

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

132 (3) Thunderbolt

133 (4) USB

134 (5) Firewire (IEEE 1394)

135 (6) Other

- 136 iv) In the case of a UUT that has Data capabilities only and no Network capabilities, a bridge
137 connection should be made between the UUT and the host machine connected to the UUT
138 for testing. The connections should be made in the following order of preference and only one
139 connection should be made.

140 (1) Thunderbolt

- 141 (2) USB
142 (3) Firewire (IEEE 1394)
143 (4) Other
144 v) In the case of a UUT that has no Data/Network capabilities, the unit should be tested as is.
145 vi) Built-in speakers, and other product features and functions not specifically addressed by the
146 ENERGY STAR eligibility criteria or test method must be configured in the as shipped power
147 configuration.

148 **Note:** EPA has an interest in ensuring that testing for ENERGY STAR qualification resembles intended
149 product usage. In doing so, EPA is best able to ensure real consumer savings when ENERGY STAR
150 products are used.

151 EPA proposes that manufacturers engage the USB/Firewire/Thunderbolt hub controller (or similar) in the
152 display when testing for ENERGY STAR qualification, which will reflect a more accurate depiction of the
153 state of hardware when in use by the end user.

154 EPA welcomes stakeholder input on the prevalence of network connectivity for display products and the
155 associated power consumption in On, Off and Sleep Mode when a network connection is activated. In the
156 longer term, EPA seeks to work with stakeholders to develop a testing approach that mirrors more closely
157 how home and business users configure and employ their Displays. As such, EPA recognizes that in
158 many cases peripherals, e.g., speakers, mice, cameras, smartphones, may be connected to a display in
159 home or office settings, and, therefore, seeks additional data and feedback pertaining to:

- 160 1. The connection of peripherals to displays. In particular, how widespread is the connection of
161 peripherals, in both home and office settings, and what is the typical duration of this connection?
162 2. The energy impact associated with peripherals' connection to displays during On, Off and Sleep mode
163 testing.

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165 2) Signal Interface: Displays that offer both an analog and a digital interface shall be tested with the
166 digital interface.

- 167 i. Connect the UUT to a PC, network or other input source signal via the following precedence
168 rules.
169 ii. If a product has multiple digital interfaces, the product shall be tested with the first available
170 interface from the list below:

- 171 (1) Thunderbolt
172 (2) DisplayPort
173 (3) HDMI
174 (4) DVI

175 ii. If they product only has analog interfaces, analog composite should take precedence over
176 analog component.

177 **Note:** Currently qualified ENERGY STAR display products exhibit the increasing adoption of digital
178 interfaces, as the majority of qualified products have digital interfaces. Therefore, in efforts to standardize
179 and enhance the repeatability of the test method, EPA has indicated the sequence for testing display
180 interfaces. EPA welcomes stakeholder feedback on this sequence.

181 3) Resolution and Refresh Rate:

182 i. Fixed-pixel Displays:

- 183 (1) Pixel format shall be set to the native level.

- 184 (2) Refresh rate shall be set to 60 Hz, unless a different default refresh rate is specified in
185 the product manual, in which case the specified default refresh rate shall be used.
- 186 (3) For CRT Displays, pixel format shall be set to the highest resolution that is designed to
187 be driven at a 75 Hz refresh rate, as specified in the product manual. Typical industry
188 standards for pixel format timing shall be used for testing.
- 189 (a) Refresh rate shall be set to 75 Hz.
- 190 D. Battery Operated Products: For products designed to operate using batteries when not connected to
191 the mains, the battery shall be fully charged before the start of testing and shall be left in place for the
192 test.
- 193 E. Accuracy of Input Signal Levels: Video inputs shall be within $\pm 2\%$ of reference white and black levels.
194 When using digital interfaces, the source video signal shall not be adjusted for color, or modified by
195 the tester for any purpose other than that required to compress/inflate and encode/decode for
196 transmission.
- 197 F. True Power Factor: Due to increased awareness of the importance of power quality on the part of
198 EPA and electric utilities, Partners shall indicate the true power factor of their displays during On
199 Mode measurement.
- 200 G. Test Materials:
- 201 1) "Dynamic Broadcast Content" shall be used for testing, as specified in IEC 62087 Ed. 3.0, Section
202 11.6, "On (average) mode testing using dynamic broadcast-content video signal."
- 203 2) "Internet Video Content" shall be used for testing, as specified in IEC 62087 Ed. 3.0, Section
204 11.7, "On (average) mode testing using Internet-content video signal."

205 **6 LOW-VOLTAGE DC SOURCE MEASUREMENT**

- 206 A. Connect the dc source to the power meter and relevant ac supply as specified in Table 1.
- 207 1) Verify that the dc source is unloaded.
- 208 2) Allow the dc source to warm up for a minimum of 30 minutes.
- 209 3) Measure and record the unloaded dc source power (PS) according to IEC 62301 Ed. 1.0³.

210 **7 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS**

- 211 A. Prior to the start of testing, the UUT shall be initialized as follows:
- 212 1) Set up the UUT per the instructions in the supplied operating manual.
- 213 2) Connect the power meter to the power source and connect the UUT to the power outlet on the
214 power meter.
- 215 3) With the UUT off, set the ambient light level such that the measured display screen illuminance is
216 less than 1 lux.
- 217 4) Power on the UUT and perform initial system configuration, as applicable.
- 218 5) Ensure that UUT settings are in their as-shipped configuration.
- 219 6) Warm up the UUT for at least 20 minutes and until the unit has completed initialization and is
220 ready for use.

3 Considering that IEC62301 Ed. 2.0 does not include dc powered products in its scope, EPA is referencing IEC62301 Ed. 1.0.

- 221 7) Measure and record the ac input voltage and frequency.
222 8) Measure and record the test room ambient temperature and relative humidity.

223 8 TEST PROCEDURES FOR ALL PRODUCTS

224 8.1 Luminance Testing

- 225 A. Luminance testing shall be performed in dark room conditions. Display screen illuminance (E) as
226 measured with the UUT in Off Mode shall be less than or equal to 1.0 lux.
- 227 B. Luminance shall be measured perpendicular to the center of the display screen using a Light
228 Measuring Device (LMD). Following the LMD's manufacturer's instructions, it is recommended that
229 the LMD either be used as close to the screen as possible, not exceeding 500mm, or measure an
230 area of at least 500 pixels.
- 231 C. The position of the LMD relative to the display screen shall remain fixed throughout the duration of
232 testing.
- 233 D. For products with Automatic Brightness Control, luminance measurements shall be performed with
234 ABC disabled. If ABC cannot be disabled, luminance measurements shall be performed with the
235 display positioned at a 90 degree angle in a test room with ambient lighting greater than or equal to
236 300lux.
- 237 E. Luminance measurements shall be performed per the following procedure:
- 238 1) Verify that the product is in the default as-shipped luminance value or 'Home' picture mode.
- 239 2) Immediately following the conclusion of On Mode power testing, begin to display the three-bar
240 video signal specified in IEC 62087 Ed. 3.0, Section 11.5.5 (three bars of white (100%) over a
241 black (0%) background).
- 242 3) Display the three-bar video signal for not less than 10 minutes to allow the UTT luminance to
243 stabilize. This 10-minute stabilization period may be reduced if luminance measurements are
244 stable to within 2% over a period of not less than 60 seconds.
- 245 4) Measure and record luminance in default as-shipped luminance value or 'Home' picture mode,
246 L_{HOME} .
- 247 5) Within 1 minute of performing the measurement, set the controls of the UUT to the maximum
248 contrast and brightness settings, maximum luminance, L_{MAX} .
- 249 6) Display the three-bar video signal for not less than 10 minutes to allow the display luminance to
250 stabilize. This 10-minute stabilization period may be reduced if luminance measurements are
251 stable to within 2% over a period of not less than 60 seconds.
- 252 7) Measure and record the displays maximum luminance, L_{MAX} .

253 **Note:** In order to provide consumers with the most accurate intended usage information, EPA proposes
254 that Partners test their products in their as-shipped configuration. As such, Section 8 describes L_{HOME} as
255 the luminance of the display in the 'as-shipped' condition, which is at least 65% of the maximum
256 luminance, L_{MAX} .

257 8.2 On Mode Testing for Products without ABC Enabled by Default

- 258 A. Set the luminance to the as-shipped luminance or 'Home' picture mode L_{HOME}

259 B. On mode power (P_{ON}) shall be measured according to IEC 62087, Ed 3.0: Methods of Measurement
260 for the Power Consumption of Audio, Video and Related Equipment; Section 11: Measuring
261 Conditions for Television Sets in On (average) Mode; with the additional guidance in section 5. On
262 Mode power tests must be repeated using the Internet-content video signal as defined in IEC 62087
263 Ed 3.0 Section 11.7.

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265 8.3 On Mode Testing for Products with ABC Enabled by Default

266 A. On mode power in various lighting conditions, Pbroadcast_10lux, Pbroadcast_100lux,
267 Pbroadcast_150lux, and Pbroadcast_300lux, for displays with ABC enabled shall be measured
268 according to IEC 62087, Ed 3.0: Methods of Measurement for the Power Consumption of Audio,
269 Video and Related Equipment; Section 11: Measuring Conditions for Television Sets in On (average)
270 Mode; with the additional guidance in section 5. On Mode power tests must be repeated using the
271 Internet-content video signal as defined in IEC 62087 Ed 3.0 Section 11.7.

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273 **Note:** EPA and DOE are interested in improving the measurement associated with ABC enabled by
274 default. Both EPA and DOE believe that the test conditions for room illuminance should be representative
275 of consumer use. EPA is proposing testing conditions for ABC enabled by default that have been
276 recommended by DOE for televisions in order to further harmonize this draft specification for Displays with
277 the Version 6.0 draft specification for Televisions. EPA also welcomes feedback on testing ABC at three
278 room illuminance levels instead of four and whether the proposed room illuminance levels are appropriate
279 for displays 30"-60" in diagonal screen size intended for non-household applications, such as professional
280 signage. EPA intends to adopt the DOE test procedure once it is finalized.

281 EPA is examining how different test room conditions across different testing laboratories affect power
282 consumption results, specifically as they pertain to displays tested with ABC enabled. As such,
283 stakeholders are invited to share the typical test room conditions used when testing On Mode power and
284 the variability in test results when these conditions are changed. In addition, to ensure consistency in
285 testing conditions, EPA encourages stakeholders to follow the workstation environment conditions
286 disseminated by the United States Department of Labor's Occupational Safety and Health Administration,
287 when testing display products. For additional information, please visit:

288 http://www.osha.gov/SLTC/etools/computerworkstations/wkstation_enviro.html,

289 **Note:** IEC 62087 defines testing for On Mode power with either static content, dynamic broadcast-
290 content, or Internet-content video signals. EPA is proposing to test On Mode power using both, the
291 **dynamic broadcast content video signal and the Internet-content video signals for all product**
292 **sizes.** EPA believes that the Internet-content video signal is pertinent for testing displays, considering that
293 a significant percentage of ENERGY STAR qualified displays are computer monitors, where one of their
294 main functions is to use the Internet. In special cases where products may not be able to display moving
295 images, and therefore, may neither be able to use the dynamic nor Internet-content video signals, EPA
296 proposes testing using the static content video signal. EPA requests stakeholder input regarding what
297 type of display products would necessitate the use of static content and feedback on this proposed
298 approach. **Stakeholders are encouraged to test displays less than 30" in diagonal screen size**
299 **using the IEC 62087 test method and to share the test data for EPA consideration no later than**
300 **July 18, 2011.** In addition, EPA encourages feedback from stakeholders on the most appropriate method
301 for weighting or averaging the two video signals, dynamic broadcast and Internet, in order to best
302 represent how the product will be used by consumers.

303 8.4 Sleep Mode Testing

304 A. Sleep Mode power (P_{SLEEP}) shall be measured according to IEC 62301, Ed 3.0: Household Electrical
305 Appliances – Measurement of Standby Power, with the additional guidance in section 5.

306 B. If the product has a variety of Sleep Modes that can be manually selected, measurements shall be
307 performed in the most energy consumptive Sleep Mode. If the product automatically cycles through
308 its various Sleep Modes, measurement time shall be long enough to obtain a true average of all
309 Sleep Modes.

310 **8.5 Off Mode Testing**

- 311 A. At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power
312 switch.
- 313 B. Document the method of adjustment and sequence of events required to reach Off Mode.
- 314 C. Any input sync signal check cycle may be ignored when measuring Off Mode power.

315 **8.6 Additional Testing**

316 A. For data collection purposes, where applicable, EPA is requiring the following tests found in Section
317 8.1- 8.5 to be performed with networking features deactivated and without any bridge connection, in
318 addition to tests performed with networking capabilities activated and a bridge connection
319 established, per section 5.2.C.1. ii and iii, above:

- 320 1) On Mode
- 321 2) Sleep Mode

322 **Note:** EPA is in the process of analyzing the power consumption associated with displays that have
323 network connectivity and, for purposes of determining energy efficiency levels under Version 6.0 of the
324 ENERGY STAR specification for Display Products, welcomes stakeholders test data of displays with
325 network connectivity activated and deactivated in both On and Sleep mode. After the data assembly
326 period is over, EPA will assess opportunities to reduce the amount of testing required under the Version
327 6.0 specification.