



# ENERGY STAR® Program Requirements for Displays

## Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR qualified products. The ENERGY STAR Partner must adhere to the following partner commitments:

### Qualifying Products

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1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for Displays. A list of eligible products and their corresponding Eligibility Criteria can be found at [www.energystar.gov/specifications](http://www.energystar.gov/specifications).
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR qualification from a Certification Body recognized by EPA for Displays. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Displays testing. A list of EPA-recognized laboratories and certification bodies can be found at [www.energystar.gov/testingandverification](http://www.energystar.gov/testingandverification).

### Using the ENERGY STAR Name and Marks

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3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at [www.energystar.gov/logouse](http://www.energystar.gov/logouse).
4. Use the ENERGY STAR name and marks only in association with qualified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is qualified and offered for sale in the U.S and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR qualified Displays.
  - 5.1. The ENERGY STAR mark must be clearly displayed:
    - 5.1.1. On the top or front of the product. Labeling on the top or front of the product may be permanent or temporary. All temporary labeling must be affixed to the top or front of the product with an adhesive or cling-type application;  
Electronic Labeling Option: Partners have the option of using an alternative electronic labeling approach in place of this product labeling requirement, as long it meets the following requirements:
      - The ENERGY STAR mark in cyan, black, or white (as described in "The ENERGY STAR Identity Guidelines" available at [www.energystar.gov/logos](http://www.energystar.gov/logos)) appears at system start-up. The electronic mark must display for a minimum of 5 seconds;
      - The ENERGY STAR mark must be at least 10% of the screen by area, may not be smaller than 76 pixels x 78 pixels, and must be legible.  
EPA will consider alternative proposals regarding approach, duration, or size for electronic labeling on a case-by-case basis.

5.1.2. In product literature (i.e. user manuals, spec sheets, etc.);

5.1.3. On product packaging for products sold at retail; and

5.1.4. On the Partner's Internet site where information about ENERGY STAR qualified models is displayed:

5.1.4.1. If information concerning ENERGY STAR is provided on the Partner Web site, as specified by the ENERGY STAR Web Linking Policy (this document can be found in the Partner Resources section on the ENERGY STAR Web site at [www.energystar.gov](http://www.energystar.gov)), EPA may provide links where appropriate to the Partner Web site

### **Verifying Ongoing Product Qualification**

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6. Participate in third-party verification testing through a Certification Body recognized by EPA for Displays, providing full cooperation and timely responses, EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

### **Providing Information to EPA**

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7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:

7.1. Partner must submit the total number of ENERGY STAR qualified Displays shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).

7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.

7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;

8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.

9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at [www.energystar.gov/mesa](http://www.energystar.gov/mesa).

### **Performance for Special Distinction**

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In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the

ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.

- Ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified products.
- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.
- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit [www.epa.gov/smartway](http://www.epa.gov/smartway).
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit [www.epa.gov/greenpower](http://www.epa.gov/greenpower).



# ENERGY STAR® Program Requirements Product Specification for Displays

## Eligibility Criteria Version 5.1

Following is the Version 5.1 ENERGY STAR Product Specification for Displays. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

### 1 DEFINITIONS

#### A) Product Types:

- 1) Electronic Display (Display): A commercially-available product with a display screen and associated electronics, often encased in a single housing, that as its primary function displays visual information from (1) a computer, workstation or server via one or more inputs (e.g., VGA, DVI, HDMI, IEEE 1394), (2) a USB flash drive, (3) a memory card, or (4) a wireless Internet connection.

- #### B) External Power Supply (EPS): Also referred to as External Power Adapter. A component contained in a separate physical enclosure external to a display, designed to convert line voltage AC input from the mains to lesser DC voltage(s) in order to provide power to the display. An EPS connects to the display via a removable or hard-wired male/female electrical connection, cable, cord or other wiring.

#### C) Operational Modes:

- 1) On Mode: The operational mode of a display that (1) is connected to a power source, (2) has all mechanical (hard) power switches turned on, and (3) is producing an image.
- 2) Sleep Mode: The operational mode of a display that (1) is connected to a power source, (2) has all mechanical (hard) power switches turned on, and (3) is in a reduced-power state after receiving a signal from a connected device (e.g., computer, game console, set-top box) or by cause of an internal function (e.g., sleep timer, occupancy sensor). Sleep Mode is considered a "soft" low-power condition, in that the product may exit Sleep Mode upon receiving a signal from a connected device or by cause of an internal function.
- 3) Off Mode: The operational mode of a display that (1) is connected to a power source, (2) has one or more manual power switches turned off, and (3) is not providing any function. The product may only exit Off Mode by cause of direct user actuation of a manual power switch.

- #### D) Luminance: The photometric measure of the luminous intensity per unit area of light travelling in a given direction, expressed in units of candelas per square meter (cd/m<sup>2</sup>).

- #### E) Screen Area: The viewable screen area of a product, calculated by multiplying the viewable image width by the viewable image height.

- #### F) Automatic Brightness Control (ABC): The self-acting mechanism that controls the brightness of a display as a function of ambient light.

G) Product Family: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR qualification criteria, and (3) of a common basic design. Product models within a family differ from each other according to one or more characteristics or features that either (1) have no impact on product performance with regard to ENERGY STAR qualification criteria, or (2) are specified herein as acceptable variations within a product family. For Displays, acceptable variations within a product family include:

- 1) Color, and
- 2) Housing.

## **2 SCOPE**

### **2.1 Included Products**

2.1.1 Products that meet the definition of a Display as specified herein and are powered directly from ac mains, via an external power supply, or via a data or network connection, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2.

### **2.2 Excluded Products**

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for qualification under this specification. The list of specifications currently in effect can be found at [www.energystar.gov/products](http://www.energystar.gov/products).

2.2.2 The following products are not eligible for qualification under this specification:

- i. Products with a viewable diagonal screen size greater than 60 inches,
- ii. Under Tier 1 eligibility criteria, products with an integrated television tuner that are marketed and sold exclusively as televisions,
- iii. Under Tier 2 eligibility criteria, all products with an integrated television tuner.

## **3 QUALIFICATION CRITERIA**

### **3.1 Significant Digits and Rounding**

3.1.1 All calculations shall be performed with actual measured or observed values. Only the final result of a calculation shall be rounded. Calculated results shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

### **3.2 General Requirements**

3.2.1 External Power Supply: If the product is shipped with an EPS, the EPS shall meet the level V performance requirements under the International Efficiency Marking Protocol and include the level V marking. Additional information on the Marking Protocol is available at [www.energystar.gov/powersupplies](http://www.energystar.gov/powersupplies).

- External Power Supplies shall meet level V requirements when tested using the *Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies, Aug. 11, 2004*.

### 3.2.2 Power Management:

- Products shall offer at least one power management feature that is enabled by default, and that can be used to automatically transition from On Mode to Sleep Mode or Off Mode (e.g., support for VESA Display Power Management Signaling [DPMS], enabled by default).
- Products that generate content for display from one or more internal sources shall have a sensor or timer enabled by default to automatically engage Sleep or Off Mode.

## 3.3 On Mode Requirements

- 3.3.1 For products with Automatic Brightness Control (ABC) enabled by default, On Mode power ( $P_{ON}$ ), as calculated per Equation 1, shall be less than or equal to the Maximum On Mode Power Requirement ( $P_{ON\_MAX}$ ), as calculated per Table 1.

### Equation 1: Calculation of On Mode Power for Products with ABC Enabled by Default

$$P_{ON} = (0.8 \times P_H) + (0.2 \times P_L)$$

Where:

- $P_{ON}$  is the calculated On Mode power
- $P_H$  is the measured On Mode power in high ambient lighting conditions (300 lux),
- $P_L$  is the measured On Mode power in low ambient lighting conditions (0 lux).

- 3.3.2 For products that do not offer ABC, or for which ABC is not enabled by default, On Mode power ( $P_{ON}$ ), as calculated per the ENERGY STAR test method, shall be less than or equal to the Maximum On Mode Power Requirement ( $P_{ON\_MAX}$ ), as calculated per Table 1.

**Table 1: Calculation of Maximum On Mode Power Requirements ( $P_{ON\_MAX}$ )**

Product Type		$P_{ON\_MAX}$ Tier 1 (watts)	$P_{ON\_MAX}$ Tier 2 (watts)
Diagonal Screen Size, $d$ (inches)	Screen Resolution, $r$ (megapixels)		
$d < 30.0$	$r \leq 1.1$	$(6.0 \times r) + (0.05 \times A) + 3.0$	TBD
	$r > 1.1$	$(9.0 \times r) + (0.05 \times A) + 3.0$	TBD
$30.0 \leq d \leq 60.0$	Any	$(0.27 \times A) + 8.0$	TBD

## 3.4 Sleep Mode Requirements

- 3.4.1 Measured Sleep Mode power ( $P_{SLEEP}$ ) shall be less than or equal to the Maximum Sleep Mode Power Requirement ( $P_{SLEEP\_MAX}$ ), as specified in Table 2.

**Table 2: Maximum Sleep Mode Power Requirements ( $P_{\text{SLEEP\_MAX}}$ )**

$P_{\text{SLEEP\_MAX}}$ Tier 1 (watts)	$P_{\text{SLEEP\_MAX}}$ Tier 2 (watts)
2.0	1.0

3.4.2 For products that offer more than one Sleep Mode (e.g., “Sleep” and “Deep Sleep”), measured Sleep Mode power ( $P_{\text{SLEEP}}$ ) in any Sleep Mode shall not exceed the Maximum Sleep Mode Power Requirement ( $P_{\text{SLEEP\_MAX}}$ ).

### 3.5 Off Mode Requirements

3.5.1 Measured Off Mode power ( $P_{\text{OFF}}$ ) shall be less than or equal to the Maximum Off Mode Power Requirement ( $P_{\text{OFF\_MAX}}$ ) specified in Table 3.

**Table 3: Maximum Off Mode Power Requirements ( $P_{\text{OFF\_MAX}}$ )**

$P_{\text{OFF\_MAX}}$ Tier 1 (watts)	$P_{\text{OFF\_MAX}}$ Tier 2 (watts)
1.0	1.0

## 4 TEST REQUIREMENTS

### 4.1 Test Methods

4.1.1 When testing Display products, the test methods identified in Table 4 shall be used to determine ENERGY STAR qualification.

**Table 4: Test Methods for ENERGY STAR Qualification**

Diagonal Screen Size, $d$ (inches)	Test Method
$d < 30.0$	ENERGY STAR Test Method for Displays Rev. Aug 2010.  VESA Flat Panel Display Measurements (FPDM) Standard, Version 2.0
$30.0 \leq d \leq 60.0$	ENERGY STAR Test Method for Displays Rev. Aug 2010.  IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment
All Screen Sizes	IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power

### 4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing per the following requirements:

- i. For qualification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model;
  - ii. For qualification of a product family, any product configuration within the family may be considered the Representative Model.
- 4.2.2 If the steady-state power consumption of the UUT is greater than 85% of the ENERGY STAR qualification limit in *any* of the three operating modes, two additional units of the same model shall be tested.
- 4.2.3 Testing of additional units is not required if the steady-state power consumption of the first test unit is less than or equal to 85% of the ENERGY STAR qualification limit in *all* of the three operating modes.
- 4.2.4 All tested units shall meet ENERGY STAR qualification requirements.

### 4.3 International Market Qualification

- 4.3.1 Products shall be tested for qualification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

## 5 USER INTERFACE

- 5.1.1 Partners are encouraged to design products in accordance with the user interface standard IEEE P1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see <http://eetd.LBL.gov/Controls>.

## 6 EFFECTIVE DATE

- 6.1.1 Effective Date: The Version 5.1 ENERGY STAR Displays specification shall take effect on the dates specified in Table 5. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.
- 6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR qualification is not automatically granted for the life of a product model.

**Table 5: Specification Effective Dates**

Diagonal Screen Size, <i>d</i> (inches)	Tier 1 Effective Date	Tier 2 Effective Date
$d < 30.0$	October 30, 2009	October 30, 2011
$30.0 \leq d \leq 60.0$	January 30, 2010	October 30, 2011



## **7 CONSIDERATIONS FOR FUTURE REVISIONS**

### **7.1 Greenhouse Gas Emissions**

- 7.1.1 EPA is interested in working with LCD industry stakeholders through the ENERGY STAR program to reduce the emission of high global warming potential gases associated with LCD production, specifically  $\text{NF}_3$ ,  $\text{SF}_6$ , and  $\text{CF}_4$ . EPA recognizes the opportunity to significantly reduce emissions beyond product use-phase, and to engage partners in achieving significant, measurable greenhouse gas and energy reductions from other phases of the product lifecycle.

### **7.2 Harmonization of Displays**

- 7.2.1 EPA is committed to continuing to develop performance levels for displays and televisions in a similar and convergent manner, as reflected in industry and market trends. Under Tier 2, EPA will explore testing all displays for On Mode power using the IEC 62087 test procedure. Issues such as luminance boundary levels, mode requirements, test conditions, power saving features, and other energy related attributes will be explored with stakeholders during the Tier 2 specification development process.

## APPENDIX A: Example Calculations

Diagonal Screen Size (inches)	Resolution (pixel count)	Resolution (MP)	Screen Dimensions (inches)	Screen Area (sq. inches)	P <sub>ON MAX</sub> (watts)
7	800 x 480	0.384	5.9 x 3.5	20.7	6.4
19	1440 x 900	1.296	16.1 x 10.1	162.6	22.8
26	1920 x 1200	2.304	21.7 x 13.5	293.0	38.4
42	1360 x 768	1.044	36.0 x 20.0	720.0	202.4
50	1920 x 1080	2.074	44.0 x 24.0	1056.0	293.1



# ENERGY STAR<sup>®</sup> Program Requirements Product Specification for Displays

## Test Method

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### 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 30 inches.
- 2) Test procedures in Section 9 shall be performed on all products with viewable diagonal screen size from 30 to 60 inches, inclusive.

### 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) Input Power:

- 1) AC Input Power: Products intended to be 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.

**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 %

**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 %

B) Low-voltage DC Input Power:

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

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

D) Relative Humidity: Relative humidity shall be from 10% to 80%.

E) Power Meter: Power meters shall possess the following attributes<sup>1</sup>:

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 10mA 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.

F) Measurement Accuracy:

- 1) 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.
- 2) 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.

## 5 TEST CONDUCT

A) Power Measurements:

- 1) Power measurements shall be taken from a point between the power source and the unit under test (UUT).
- 2) Power measurements shall be recorded in watts and rounded to the nearest tenth of a watt.
- 3) Power measurements shall be recorded after instrument readings are stable to within 1% over a three-minute period.

B) Dark Room Conditions:

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

C) Light Measurements:<sup>2</sup>

- 1) Light measurements shall be performed with the Light Measurement Device (LMD) located at the center of, and perpendicular to, the display screen.<sup>3</sup>

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<sup>1</sup> Characteristics of approved meters taken from IEC 62301 Ed 1.0: Household Electrical Appliances – Measurement of Standby Power.

<sup>2</sup> VESA FPDM Standard 2.0, Section 301-2H

<sup>3</sup> VESA FPDM Standard 2.0, Appendix A115

- 2) The LMD shall measure a rectangular area that is the greater of (1) an area each side of which is 10% as long as the corresponding side of the viewable screen area, or (2) 500 pixels.
- 3) The LMD measurement area shall be no larger than the illuminated screen area.

D) UUT Configuration and Control:

- 1) As-shipped Condition: The UUT shall be tested in its “as-shipped” configuration. For products that offer a choice of user-configurable options, all options, including color controls, shall be set to their default conditions.
- 2) Peripherals:
  - i) External devices shall not be connected to Universal Serial Bus (USB) ports.
  - ii) Built-in speakers, TV tuners, and other product features and functions not specifically addressed by the ENERGY STAR eligibility criteria or test method may be configured in a minimum power configuration, as adjustable by the user.
- 3) Signal Interface: Displays that offer both an analog and a digital interface shall be tested with the analog interface.

E) Resolution and Refresh Rate:

- 1) Fixed-pixel Displays:
  - i) Pixel format shall be set to the native level.
  - ii) Refresh rate shall be set to 60 Hz, unless a different default refresh rate is specified in the product manual, in which case the specified default refresh rate shall be used.
- 2) CRT Displays:
  - i) Pixel format shall be set to the highest resolution that is designed to be driven at a 75 Hz refresh rate, as specified in the product manual. VESA Discrete Monitor Timing (DMT) or other industry standard pixel format timing shall be used for testing.
  - ii) Refresh rate shall be set to 75 Hz.

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

## 6 LOW-VOLTAGE DC SOURCE MEASUREMENT

- 1) Connect the DC source to the power meter and relevant AC supply as specified in Table 1.
- 2) Verify that the DC source is unloaded.
- 3) Allow the DC source to warm up for a minimum of 30 minutes.
- 4) Measure and record the unloaded DC source power ( $P_S$ ) according to IEC 62301 Ed. 1.0.

## 7 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

- A) Prior to the start of testing, the UUT shall be initialized as follows:
- 1) Set up the UUT per the instructions in the supplied operating manual.
  - 2) Connect the power meter to the power source and connect the UUT to the power outlet on the power meter.
  - 3) Set the ambient light level such that the measured display screen illuminance is less than 1 lux.
  - 4) Power on the UUT and perform initial system configuration, as applicable.
  - 5) Ensure that UUT settings are in their as-shipped configuration.
  - 6) Warm up the UUT for at least 20 minutes and until the unit has completed initialization and is ready for use.<sup>4</sup>
  - 7) Measure and record the ac input voltage and frequency.
  - 8) Measure and record the test room ambient temperature.

## 8 TEST PROCEDURES FOR PRODUCTS WITH VIEWABLE DIAGONAL SCREEN SIZE LESS THAN 30 INCHES

### 8.1 On Mode Test for CRT Displays

- 1) Ensure that the UUT has been initialized per Section 7.
- 2) Display the VESA FPDM Standard 2.0, A112-2F, AT01P test pattern.
- 3) Set the UUT image size to the manufacturer's recommended image size (typically slightly smaller than maximum viewable screen size).
- 4) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).<sup>5</sup>
- 5) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.
- 6) If possible, adjust display brightness control until the lowest black-bar luminance level is just slightly visible, per VESA FPDM Section 301-3K.
- 7) Display the VESA FPDM A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).

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<sup>4</sup> VESA FPDM Standard 2.0, Section 301-2D or 305-3 for warm-up test.

<sup>5</sup> For digital-interface displays, image brightness shall correspond to voltage as follows:

- 0.0 V (black) = a setting of 0
- 0.1 V (darkest shade of gray analog) = 36 digital gray
- 0.7 V (full white analog) = 255 digital gray

- 8) Ensure that the LMD measurement area falls entirely within the illuminated portion of the test pattern.
- 9) Adjust the contrast control until the measured luminance of the white area of the screen is 100  $\text{cd/m}^2$  or nearest achievable value.
- 10) Measure and record display luminance. Note: Following this point in the test procedure, dark room conditions are no longer required.
- 11) Measure and record On Mode power ( $P_{ON}$ ) and total pixel format (horizontal x vertical).

## 8.2 On Mode Test for Fixed-pixel Displays

- 1) If the UUT does not have ABC Enabled by Default:
  - i) Ensure that the UUT has been initialized per Section 7.
  - ii) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).
  - iii) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.
  - iv) With the brightness and contrast controls at maximum, verify that the white and near-white-grey levels can be distinguished. If necessary, adjust contrast controls until the white and near-white-grey levels can be distinguished.
  - v) Display the VESA FPDM2, A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).
  - vi) Ensure that the LMD measurement area falls entirely within the white portion of the test pattern.
  - vii) Adjust the brightness control until the luminance of the white area of the screen is as specified in Table 3. If the UUT cannot achieve the specified luminance, set display luminance to the nearest achievable value.

**Table 3: Luminance Settings for On Mode Testing of Fixed-Pixel Displays**

Screen Resolution	Luminance ( $\text{Cd/m}^2$ )
Less than or equal to 1.1 MP resolution	175
Greater than 1.1 MP resolution	200

- viii) Measure and record display luminance. Note: Following this point in the test procedure, dark room conditions are no longer required.
- ix) Measure and record On Mode power ( $P_{ON}$ ) and total pixel format (horizontal x vertical).
- 2) If the UUT has ABC Enabled by Default:
  - i) Ensure that the UUT has been initialized per Section 7.



- ii) Set the ambient light level to 300 lux, as measured at the face of the product's ambient light sensor.
- iii) Measure and record On Mode power in high ambient lighting conditions ( $P_H$ ) and total pixel format (horizontal x vertical).
- iv) Set the ambient light level to 0 lux, as measured at the face of the product's ambient light sensor.
- v) Measure and record On Mode power in low ambient lighting conditions ( $P_L$ ).

### 8.3 Sleep Mode

- 1) At the conclusion of the On Mode test, initiate Sleep Mode.
- 2) Document the method of adjustment and sequence of events required to reach Sleep Mode.
- 3) If the product has a variety of Sleep Modes that can be manually selected, measurements shall be performed in the most energy consumptive Sleep Mode. If the product automatically cycles through its various Sleep Modes, measurement time shall be long enough to obtain a true average of all Sleep Modes.
- 4) Measure and record Sleep Mode power ( $P_{SLEEP}$ ).

### 8.4 Off Mode

- 1) At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.
- 2) Document the method of adjustment and sequence of events required to reach Off Mode.
- 3) Any input sync signal check cycle may be ignored when measuring Off Mode power.
- 4) Measure and record Off Mode power ( $P_{OFF}$ ).

## 9 TEST PROCEDURES FOR PRODUCTS WITH VIEWABLE DIAGONAL SCREEN SIZE FROM 30 TO 60 INCHES, INCLUSIVE

Table 4: Test Procedures

Requirement	Test Protocol
On Mode Power	IEC 62087, Ed 2.0: Methods of Measurement for the Power Consumption of Audio, Video and Related Equipment, Section 11, "Measuring conditions of television sets for On (average) mode."

### 9.1 On Mode

- A) Products shall be tested in On Mode according to the method specified in Table 4, subject to the following guidance:

- 1) Accuracy of Input Signal Levels: Video inputs shall be within  $\pm 2\%$  of reference white and black levels.
- 2) Signal Input: HDMI inputs should be used for testing wherever possible.
- 3) True Power Factor: Due to increased awareness of the importance of power quality on the part of EPA and electric utilities, Partners shall indicate the true power factor of their displays during On Mode measurement.
- 4) Test Materials: "Dynamic Broadcast Content" shall be used for testing, as specified in IEC-62087 Ed. 2.0, Section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."
- 5) As-shipped Conditions: The UUT shall be tested in its as-shipped factory-default condition. All picture adjustments required for On Mode testing shall be performed per IEC-62087, Ed. 2.0, 11.4.8, "Picture level adjustments."
- 6) Forced Menu: If the product includes a "forced menu" upon initial start-up for user selection of a picture mode, "standard" or "home" picture mode shall be selected.

B) If the UUT has ABC Enabled by Default:

- 1) Ensure that the UUT has been initialized per Section 7.
- 2) Set the ambient light level to 300 lux as measured at the face of an ambient light sensor.
- 3) Measure the high ambient lighting On Mode power consumption,  $P_h$ , as described in section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."
- 4) Set the ambient light level to 0 lux as measured at the face of an ambient light sensor.
- 5) Measure the low ambient lighting On Mode power consumption,  $P_l$ , as described in section 11.6.1, "On mode (average) testing with dynamic broadcast-content video signal."
- 6) Calculate average On Mode power consumption using the equation in section 3.A.3., Displays with Automatic Brightness Control.

## 9.2 Luminance

- 7) At the conclusion of the On Mode test, display a three bar ( $L_t$ ) static video signal per section 11.5 of IEC 62087.
- 8) Measure and record the center point, axial luminance of the display (per VESA FPDM Version 2.0, section 301-2H).

## 9.3 Sleep Mode

- 1) At the conclusion of the Luminance test, initiate Sleep Mode.
- 2) Document the method of adjustment and sequence of events required to reach Sleep Mode.
- 3) If the product has a variety of Sleep Modes that can be manually selected, measurements shall be performed in the most energy consumptive Sleep Mode. If the product automatically cycles through its various Sleep Modes, measurement time shall be long enough to obtain a true average of all Sleep Modes.

- 4) Measure and record Sleep Mode power ( $P_{\text{SLEEP}}$ ).

#### **9.4 Off Mode**

- 1) At the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.
- 2) Document the method of adjustment and sequence of events required to reach Off Mode.
- 3) Any input sync signal check cycle may be ignored when measuring Off Mode power.
- 4) Measure and record Off Mode power ( $P_{\text{OFF}}$ ).