ENERGY STAR® Program Requirements for Computers

Partner Commitments

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

Certified Products

1. **Comply with current ENERGY STAR Eligibility Criteria**, which define performance requirements and test procedures for Computers. A list of eligible products and their corresponding Eligibility Criteria can be found at 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 Computers. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Computer testing. A list of EPA-recognized laboratories and certification bodies can be found at www.energystar.gov/testingandverification.
3. **Ensure that any model associated with the ENERGY STAR name or mark** meets the following standards:

    3.1. Product material requirements as defined in restriction of hazardous substances (RoHS) regulations, as generally accepted. This includes exemptions in force at the date of product manufacture, where the maximum concentration values tolerated by weight in homogeneous materials are: lead (0.1%), mercury (0.1%), cadmium (0.01%), hexavalent chromium (0.1%), polybrominated biphenyls (PBB) (0.1%), or polybrominated diphenyl ethers (PBDE) (0.1%). Batteries are exempt.

    3.2. The generally accepted attributes of a recyclable product at the date of product manufacture: where products shall be designed for ease of disassembly and recyclability where external enclosures, sub-enclosures, chassis and electronic subassemblies are easily removable with commonly available tools, by hand, or by a recycler's automated processes.

    Notes:

    - The explicit intention is to harmonize with EU RoHS.
    - For purposes of ENERGY STAR third-party certification, these requirements shall not be reviewed when products are initially certified nor during subsequent verification testing. Rather, EPA reserves the right to request supporting documentation at any time.

Using the ENERGY STAR Name and Marks

4. 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.
5. Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S. and/or ENERGY STAR partner countries.
6. Provide clear and consistent labeling of ENERGY STAR certified Computers.

6.1. Partner shall adhere to the following product-specific commitments regarding use of the ENERGY STAR certification mark on certified products:

6.1.1. Partner must use the ENERGY STAR mark in one of the following ways:

1) Via permanent or temporary label,. All temporary labeling must be affixed to the product with an adhesive or cling-type application:

a. The label shall be on the top or front of the product if the top or front of the product has a contiguous, coplanar surface area not used for touch input or display that is greater than or equal to 0.625 in square;

b. Otherwise, the label shall be on the reverse side of the screen; or

2) Via electronic labeling displayed on the screen such that the ENERGY STAR mark must be at least 4% of the screen by area; must be greater than or equal to 76 pixels x 78 pixels; must be legible; must be in cyan, black, or white; and either

a. Must appear at system start-up, and must display for a minimum of 5 seconds; or

b. Must appear within the system power settings dialog window. EPA will consider alternative proposals for electronic labeling on a case-by-case basis.

6.2. Partner must use the ENERGY STAR mark in product literature (i.e., user manuals, spec sheets, etc.).

6.3. Partner must use the ENERGY STAR mark on product packaging for products sold at retail.

6.4. Partner must use the ENERGY STAR mark on the manufacturer's Internet site where information about ENERGY STAR certified models is displayed.

6.4.1. If additional information about the ENERGY STAR program or other products is provided by the Partner on its website, Partner must comply with the ENERGY STAR Web Linking Policy, which can be found at www.energystar.gov/partners;

Verifying Ongoing Product Qualification

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

Providing Information to EPA

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

8.1. Partner must submit the total number of ENERGY STAR certified Computers 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).

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

8.3. 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;

9. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
10. 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.

Training and Consumer Education

11. Partner shall agree to complete steps to educate users of their products about the benefits of power management by including the following information with each Computer (i.e., in the user manual or on a box insert):
    11.1. Energy saving potential;
    11.2. Financial saving potential;
    11.3. Environmental benefits;
    11.4. Information on ENERGY STAR and a link to www.energystar.gov; and
    11.5. ENERGY STAR logo (used in accordance with "The ENERGY STAR Identity Guidelines" available at www.energystar.gov/logos).
12. In addition, a link should be made available to www.energystar.gov/powermanagement from Computer product pages, product specifications, and related content pages.
13. At the manufacturer's request, EPA will supply suggested facts and figures related to the above criteria, template elements, or a complete template suitable for use in user guides or box inserts.

Performance for Special Distinction

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 certified 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 certified 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 certified 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 certified 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 certified 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 certified 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 certified 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.
- 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.

ENERGY STAR® Program Requirements Product Specification for Computers

Eligibility Criteria Version 6.1 Rev. March-2016

Following is the Version 6.1 ENERGY STAR Product Specification for Computers. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS

A) Product Types:

1) Computer: A device which performs logical operations and processes data. For the purposes of this specification, computers include both stationary and portable units, including Desktop Computers, Integrated Desktop Computers, Notebook Computers, Small-Scale Servers, Thin Clients, and Workstations. Although computers are capable of using input devices and displays, such devices are not required to be included with the computer upon shipment. Computers are composed of, at a minimum:

   a) A central processing unit (CPU) to perform operations. If no CPU is present, then the device must function as a client gateway to a server which acts as a computational CPU;

   b) User input devices such as a keyboard, mouse, or touchpad; and

   c) An Integrated Display screen and/or the ability to support an external display screen to output information.

2) Desktop Computer: A computer whose main unit is designed to be located in a permanent location, often on a desk or on the floor. Desktop computers are not designed for portability and are designed for use with an external display, keyboard, and mouse. Desktop computers are intended for a broad range of home and office applications, including point of sale applications.

   a) Integrated Desktop Computer: A Desktop Computer in which the computing hardware and display are integrated into a single housing, and which is connected to ac mains power through a single cable. Integrated Desktop Computers come in one of two possible forms: (1) a system where the display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the display is separate but is connected to the main chassis by a dc power cord and both the computer and display are powered from a single power supply. As a subset of Desktop Computers, Integrated Desktop Computers are typically designed to provide similar functionality as Desktop systems.

3) Notebook Computer: A computer designed specifically for portability and to be operated for extended periods of time both with and without a direct connection to an ac mains power source. Notebook Computers include an Integrated Display, a non-detachable, mechanical keyboard (using physical, moveable keys), and pointing device.

   Note: Notebook computers are typically designed to provide similar functionality to Desktops, including operation of software similar in functionality as that used in Desktops. For purposes of this specification, Notebook Computers include models with touch-sensitive screens.

   a) Mobile Thin Client: A computer meeting the definition of a Thin Client, designed specifically for portability, and also meeting the definition of a Notebook Computer. These products are considered to be Notebook Computers for the purposes of this specification.

b) Two-In-One Notebook: A computer which resembles a traditional Notebook Computer with a clam shell form factor, but has a detachable display which can act as an independent Slate/Tablet when disconnected. The keyboard and display portions of the product must be shipped as an integrated unit. Two-In-One Notebooks are considered Notebooks in the remainder of this specification and are therefore not referenced explicitly.

4) Slate/Tablet: A computing device designed for portability that meets all of the following criteria:

   a) Includes an integrated display with a diagonal size greater than 6.5 inches and less than 17.4 inches;

   b) Lacking an integrated, physical attached keyboard in its as-shipped configuration;

   c) Includes and primarily relies on touchscreen input; (with optional keyboard);

   d) Includes and primarily relies on a wireless network connection (e.g., Wi-Fi, 3G, etc.); and

   e) Includes and is primarily powered by an internal battery (with connection to the mains for battery charging, not primary powering of the device).

5) Portable All-In-One Computer: A computing device designed for limited portability that meets all of the following criteria:

   a) Includes an integrated display with a diagonal size greater than or equal to 17.4 inches;

   b) Lacking keyboard integrated into the physical housing of the product in its as-shipped configuration;

   c) Includes and primarily relies on touchscreen input; (with optional keyboard);

   d) Includes wireless network connection (e.g. Wi-Fi, 3G, etc.); and

   e) Includes an internal battery, but is primarily powered by connection to the ac mains.

6) E-Reader: A device designed for display and consumption of static images. The display is characterized by a low refresh rate and a display made of bistable materials where no energy is needed to maintain a visible image, only to alter the image.

7) Small-scale Server: A computer that typically uses desktop components in a desktop form factor, but is designed primarily to be a storage host for other computers. Small-scale Servers are designed to perform functions such as providing network infrastructure services (e.g., archiving) and hosting data/media. These products are not designed to process information for other systems or run web servers as a primary function. A Small-scale Server has the following characteristics:

   a) Designed in a pedestal, tower, or other form factor similar to those of desktop computers such that all data processing, storage, and network interfacing is contained within one box/product;

   b) Designed to operate 24 hours/day, 7 days/week, with minimal unscheduled downtime (on the order of hours/year);

   c) Capable of operating in a simultaneous multi-user environment serving several users through networked client units; and

   d) Designed for an industry accepted operating system for home or low-end server applications (e.g., Windows Home Server, Mac OS X Server, Linux, UNIX, Solaris).

8) Thin Client: An independently-powered computer that relies on a connection to remote computing resources (e.g., computer server, remote workstation) to obtain primary functionality. Main computing functions (e.g., program execution, data storage, interaction with other Internet resources) are provided by the remote computing resources. Thin Clients covered by this specification are (1) limited to devices with no rotational storage media integral to the computer and (2) designed for use in a permanent location (e.g. on a desk) and not for portability.

a) Integrated Thin Client: A Thin Client in which computing hardware and display are connected to ac mains power through a single cable. Integrated Thin Client computers come in one of two possible forms: (1) a system where the display and computer are physically combined into a single unit; or (2) a system packaged as a single system where the display is separate but is connected to the main chassis by a dc power cord and both the computer and display are powered from a single power supply. As a subset of Thin Clients, Integrated Thin Clients are typically designed to provide similar functionality as Thin Client systems.

b) Ultra-thin Client: A computer with lesser local resources than a standard Thin Client that sends raw mouse and keyboard input to a remote computing resource and receives back raw video from the remote computing resource. Ultra-thin clients cannot interface with multiple devices simultaneously nor run windowed remote applications due to the lack of a user-discernible client operating system on the device (i.e., beneath firmware, user inaccessible).

9) Workstation: A high-performance, single-user computer typically used for graphics, CAD, software development, financial and scientific applications among other compute intensive tasks. Workstations covered by this specification (a) are marketed as a workstation; (b) provide mean time between failures (MTBF) of at least 15,000 hours (based on either Bellcore TR-NWT-000332, issue 6, 12/97 or field collected data); and (c) support error-correcting code (ECC) and/or buffered memory. In addition, a workstation meets three or more of the following criteria:

a) Provide supplemental power support for high-end graphics (e.g., PCI-E 6-pin 12V supplemental power feed);

b) Wired for greater than x4 PCI-E on the motherboard in addition to the graphics slot(s) and/or PCI-X support;

c) Do not provide support for Uniform Memory Access (UMA) graphics;

d) Provide 5 or more PCI, PCI-E, or PCI-X slots;

e) Provide multi-processor support for 2 or more processors (shall support physically separate processor packages/sockets, i.e., requirement cannot be met with support for a single multi-core processor); and/or

f) Qualification by 2 or more Independent Software Vendor (ISV) product certifications; these certifications can be in process, but shall be completed within 3 months of qualification.

B) Product Category: A second-order classification or sub-type within a product type that is based on product features and installed components. Product categories are used in this specification to determine qualification and test requirements.

C) Computer Components:

1) Graphics Processing Unit (GPU): An integrated circuit, separate from the CPU, designed to accelerate the rendering of either 2D and/or 3D content to displays. A GPU may be mated with a CPU, on the system board of the computer or elsewhere to offload display capabilities from the CPU.

2) Discrete Graphics (dGfx): A graphics processor (GPU) with a local memory controller interface and local graphics-specific memory.

3) Integrated Graphics (iGfx): A graphics solution that does not contain Discrete Graphics.

4) 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, DisplayPort, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memory card), or (3) a network connection.

a) Enhanced-performance Integrated Display: An integrated Computer Display that has all of the following features and functionalities:

(1) A contrast ratio of at least 60:1 at a horizontal viewing angle of at least 85°, with or without a screen cover glass;

(2) A native resolution greater than or equal to 2.3 megapixels (MP); and

(3) A color gamut of at least sRGB as defined by IEC 61966-2-1. Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.

5) External Power Supply (EPS): Also referred to as External Power Adapter. An external power supply circuit that is used to convert household electric current into dc current or lower-voltage ac current to operate a consumer product.

6) Internal Power Supply (IPS): A component internal to the computer casing and designed to convert ac voltage from the mains to dc voltage(s) for the purpose of powering the computer components. For the purposes of this specification, an internal power supply shall be contained within the computer casing but be separate from the main computer board. The power supply shall connect to the mains through a single cable with no intermediate circuitry between the power supply and the mains power. In addition, all power connections from the power supply to the computer components, with the exception of a DC connection to a display in an Integrated Desktop Computer, shall be internal to the computer casing (i.e., no external cables running from the power supply to the computer or individual components). Internal dc-to-dc converters used to convert a single dc voltage from an external power supply into multiple voltages for use by the computer are not considered internal power supplies.

D) Operational Modes:

1) Active State: The power state in which the computer is carrying out useful work in response to a) prior or concurrent user input or b) prior or concurrent instruction over the network. Active State includes active processing, seeking data from storage, memory, or cache, including Idle State time while awaiting further user input and before entering low power modes.

2) Idle State: The power state in which the operating system and other software have completed loading, a user profile has been created, activity is limited to those basic applications that the system starts by default, and the computer is not in Sleep Mode. Idle State is composed of two sub-states: Short Idle and Long Idle.

a) Long Idle: The mode where the Computer has reached an Idle condition (i.e., 15 minutes after OS boot or after completing an active workload or after resuming from Sleep Mode) and the main Computer Display has entered a low-power state where screen contents cannot be observed (i.e., backlight has been turned off) but remains in the working mode (ACPI G0/S0). If power management features are enabled as-shipped in the scenario described in this definition, such features shall engage prior to evaluation of Long Idle (e.g., display is in a low power state, HDD may have spun-down), but the Computer is prevented from entering Sleep Mode. P_{LONG_IDLE} represents the average power measured when in the Long Idle Mode.

b) Short Idle: The mode where the Computer has reached an Idle condition (i.e., 5 minutes after OS boot or after completing an active workload or after resuming from Sleep Mode), the screen is on, and Long Idle power management features have not engaged (e.g. HDD is spinning and the Computer is prevented from entering sleep mode). P_{SHORT_IDLE} represents the average power measured when in the Short Idle mode.

3) Off Mode: The lowest power mode which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the appliance is connected to the main electricity supply and used in accordance with the manufacturer's instructions. For systems where ACPI standards are applicable, Off Mode correlates to ACPI System Level S5 state.

4) Sleep Mode: A low power mode that the computer enters automatically after a period of inactivity or by manual selection. A computer with Sleep capability can quickly "wake" in response to network connections or user interface devices with a latency of less than or equal to 5 seconds from initiation of wake event to system becoming fully usable including rendering of display. For systems where ACPI standards are applicable, Sleep Mode most commonly correlates to ACPI System Level S3 (suspend to RAM) state.

E) Networking and Additional Capabilities:

1) Additional Internal Storage: Any and all internal hard disk drives (HDD) or solid state drives (SSD) shipping with a computer beyond the first. This definition does not include external drives.

2) Energy Efficient Ethernet (EEE): A technology which enables reduced power consumption of Ethernet interfaces during times of low data throughput. Specified by IEEE 802.3az.

3) Full Network Connectivity: The ability of the computer to maintain network presence while in Sleep Mode or an alternative low power mode (LPM) with power less than or equal to 10 watts and intelligently wake when further processing is required (including occasional processing required to maintain network presence). Presence of the computer, its network services and applications, is maintained even though the computer is in a LPM. From the vantage point of the network, a computer with full network connectivity that is in LPM is functionally equivalent to an idle computer with respect to common applications and usage models. Full network connectivity in LPM is not limited to a specific set of protocols but can cover applications installed after initial installation. Also referred to as "network proxy" functionality and as described in the *Ecma-393* standard.

   a) Network Proxy - Base Capability: To maintain addresses and presence on the network while in LPM, the system handles IPv4 ARP and IPv6 NS/ND.

   b) Network Proxy - Full Capability: While in LPM, the system supports Base Capability, Remote Wake, and Service Discovery/Name Services.

   c) Network Proxy - Remote Wake: While in LPM, the system is capable of remotely waking upon request from outside the local network. Includes Base Capability.

   d) Network Proxy - Service Discovery/Name Services: While in LPM, the system allows for advertising host services and network name. Includes Base Capability.

4) Network Interface: The components (hardware and software) whose primary function is to make the computer capable of communicating over one or more network technologies. Examples of Network Interfaces are IEEE 802.3 (Ethernet) and IEEE 802.11 (Wi-Fi).

5) Wake Event: A user, scheduled, or external event or stimulus that causes the computer to transition from Sleep Mode or Off Mode to an active state of operation. Examples of wake events include, but are not limited to: movement of the mouse, keyboard activity, controller input, real-time clock event, or a button press on the chassis, and in the case of external events, stimulus conveyed via a remote control, network, modem, etc.

6) Wake On LAN (WOL): Functionality which allows a computer to transition from Sleep Mode or Off Mode to an Active State of operation when directed by a network Wake Event via Ethernet.

7) Switchable Graphics: Functionality that allows Discrete Graphics to be disabled when not required in favor of Integrated Graphics.

   Note: This functionality allows lower power and lower capability integrated GPUs to render the display while on battery or when the output graphics are not overly complex while then allowing the more power consumptive but more capable discrete GPU to provide rendering capability when the user requires it.

F) Marketing and Shipment Channels:

1) Enterprise Channels: Sales channels typically used by large and medium-sized business, government, educational, or other organizations to purchase computers for use in managed client/server environments.

2) Model Name: A marketing name that includes reference to the computer model number, product description, or other branding references.

3) Model Number: A unique marketing name or identification reference that applies to a specific hardware and software configuration (e.g., operating system, processor type, memory, GPU), and is either pre-defined or selected by a customer.

G) Product Family: A high-level description referring to a group of computers sharing one chassis/motherboard combination that often contains hundreds of possible hardware and software configurations. 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 Computers, acceptable variations within a product family include:

1) Color;

2) Housing; and

3) Electronic components other than the chassis/motherboard, such as the processor, memory, GPU, etc.

2 SCOPE

2.1 Included Products

2.1.1 Products that meet the definition of a Computer and one of the following Product Type definitions, as specified herein, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2:

i. Desktop Computers and Integrated Desktop Computers;

ii. Notebook Computers;

iii. Slates/Tablets;

iv. Portable All-In-One Computers;

v. Workstations;

vi. Small-scale Servers that are marketed and sold for non-data center use; and

vii. Thin Clients.

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.

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

i. Docking Stations;

ii. Game Consoles;

iii. E-Readers;

iv. Handheld gaming devices, typically battery powered and intended for use with an integral display as the primary display;

v. Mobile Thin Clients not meeting the definition of Notebook Computer;

vi. Personal Digital Assistant devices (PDAs);

vii. Point of Sale (POS) products that do not use internal components common to Notebook, Desktop, or Integrated Desktop Computers, including a processor, motherboard, and memory;

viii. Small-scale Servers that are marketed and sold for use in data centers;

ix. Handheld Computers which contain cellular voice capability;

x. Ultra-thin Clients.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

3.1.2 Unless otherwise specified in this specification, compliance with specification limits shall be evaluated using directly measured or calculated values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 General Requirements

3.2.1 Power supply test data and test reports from testing entities recognized by EPA to perform power supply testing shall be accepted for the purpose of certifying the ENERGY STAR product.

3.2.2 Internal Power Supply (IPS) Requirements: IPSs used in Computers eligible under this specification must meet the following requirements when tested using the *Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.6* (available at http://www.plugloadsolutions.com/docs/collatrl/print/Generalized_Internal_Power_Supply_Efficiency_Test_Protocol_R6.6.pdf).

i. IPS with maximum rated output power less than 75 watts shall meet minimum efficiency requirements as specified in Table 1.

ii. IPS with maximum rated output power greater than or equal to 75 watts shall meet both minimum efficiency requirements and minimum power factor requirements, as specified in Table 1.

Table 1: Requirements for Internal Power Supplies

Loading Condition (Percentage of Nameplate Output Current)	Minimum Efficiency	Minimum Power Factor
20%	0.82	-
50%	0.85	-
100%	0.82	0.90

3.2.3 External Power Supply (EPS) Requirements: Single- and Multiple-voltage EPSs shall meet the Level V or higher performance requirements under the International Efficiency Marking Protocol when tested according to the Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to 10 CFR Part 430.

i. Single-voltage EPSs shall include the Level V or higher marking.

ii. Multiple-voltage EPSs meeting Level VI or higher shall include the Level VI or higher marking.

iii. Additional information on the Marking Protocol is available at http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218

3.3 Power Management Requirements

3.3.1 Products shall include power management features in their "as-shipped" condition as specified in Table 2, subject to the following conditions:

i. For Thin Clients, the Wake-on-LAN (WOL) requirement shall apply for products designed to receive software updates from a centrally managed network while in Sleep Mode or in Off Mode. Thin Clients whose standard software upgrade framework does not require off-hours scheduling are exempt from the WOL requirement.

ii. For Notebooks, WOL may be automatically disabled when the product is disconnected from ac mains power.

iii. For all products with WOL, directed packet filters shall be enabled and set to an industry standard default configuration.

iv. Products that do not support Sleep Mode by default are only subject to the Display Sleep Mode requirement.

Table 2: Power Management Requirements

Mode or Mode Transition	Requirement	Desktops	Integrated Desktops	Portable All-In-Ones	Notebooks	Small-scale Servers	Slates/Tablets	Thin Clients	Workstations
System Sleep Mode[i]	(1) Sleep Mode shall be set to activate after no more than 30 minutes of user inactivity. (2) The speed of any active 1 Gb/s Ethernet network links shall be reduced when transitioning to Sleep Mode or Off Mode.	Yes	Yes	Yes	Yes	No	N/A	Yes	Yes
Display Sleep Mode	(1) Display Sleep Mode shall be set to activate after no more than 15 minutes of user inactivity.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wake on LAN (WOL)[i]	(1) Computers with Ethernet capability shall provide users with an option to enable and disable WOL for Sleep Mode. (2) Computers with Ethernet capability that are shipped through enterprise channels shall either: (a) be shipped with WOL enabled by default for Sleep Mode, when the computer is operating on ac mains power; or (b) provide users with the ability to enable WOL that is accessible from both the client operating system user interface and over the network.	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes
Wake Manage-ment[i]	(1) Computers with Ethernet capability that are shipped through enterprise channels shall: (a) be capable of both remote (via network) and scheduled (via real-time clock) wake events from Sleep Mode, and (b) provide clients with the ability to centrally manage (via vendor tools) any wake management settings that are configured through hardware settings if the manufacturer has control over such features.	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes

i Where Sleep Mode is supported by the UUT by default and Sleep Mode power is used as part of the TEC equation for qualification.

3.4 User Information Requirements

3.4.1 Products shall be shipped with informational materials to notify customers of the following:

i. A description of power management settings that have been enabled by default,

ii. A description of the timing settings for various power management features, and

iii. Instructions for properly waking the product from Sleep Mode.

3.4.2 Products shall be shipped with one or more of the following:

i. A list of default power management settings.

ii. A note stating that default power management settings have been selected for compliance with ENERGY STAR (within 15 min of user inactivity for the display, within 30 min for the computer, if applicable per Table 2), and are recommended by the ENERGY STAR program for optimal energy savings.

iii. Information about ENERGY STAR and the benefits of power management, to be located at or near the beginning of the hard copy or electronic user manual, or in a package or box insert.

3.4.3 Provisions 3.4.1 and 3.4.2 may be met through use of either electronic or printed product documentation, provided it adheres to all of the following:

i. Documentation is shipped with the product (e.g., in a printed manual or insert, on included optical media, in a file installed with the software load shipped to the customer) or available electronically on the manufacturer's website. In the latter case, instructions for accessing the information on the website shall be provided in the product package or on the Desktop or home screen; and

ii. Documentation is included either (a) only with ENERGY STAR certified Computers; or (b) as part of the standard documentation if and only if accompanied by EPA-approved customer guidance on how to identify if their computer configuration is ENERGY STAR certified.

3.5 Requirements for Desktop, Integrated Desktop, and Notebook Computers

3.5.1 Calculated Typical Energy Consumption (E_{TEC}) for Desktop, Integrated Desktop, and Notebook Computers per Equation 1 shall be less than or equal to the maximum TEC requirement (E_{TEC_MAX}) per Equation 2, subject to the following requirements:

i. The Additional Internal Storage adder allowance ($TEC_{STORAGE}$) shall be applied if there are more than one internal storage devices present in the product, in which case it shall only be applied once.

ii. The Integrated Display adder allowance ($TEC_{INT\_DISPLAY}$) applies only for Integrated Desktops and Notebooks and may be applied for each display. For Enhanced-performance Integrated Displays, the adder is calculated as presented in Table 7 and Equation 3.

iii. For a product to qualify for the Full Network Connectivity mode weightings, the following criteria shall be satisfied:

- Products shall meet a non-proprietary Full Network Connectivity standard such as ECMA 393 or another standard that has been approved by EPA as meeting the goals of ENERGY STAR. Such approval must be in place prior to submittal of product data for qualification.
- Products shall have the applied level of functionality enabled and configured by default upon shipment. If Full Network Connectivity features are not enabled by default, the system shall be tested and reported with Conventional TEC weightings.
- Products shall be capable of Sleep Mode or alternative low power modes with power less than or equal to 10 watts.

Note: Full Network Connectivity is a manufacturer-reported parameter. On Mac computers, "Wake for network access" enabled within the Energy Saver/Power Adapter Preferences signifies Base Capability or better. On Windows computers, "ARP Offload" or "NS Offload" or similar enabled within the Advanced Properties of the Network Interface Card (accessed through the Device Manager) signifies Base Capability or better. For systems with a dual Network Interface Card (NIC) configuration, only one NIC configuration needs to comply. The manufacturer can provide further guidance on how to confirm Proxy Support.

iv. For Notebooks, Desktops, and Integrated Desktops that use an alternative low power mode in place of System Sleep Mode, power in Long Idle (P_{LONG_IDLE}) may be used in place of power in Sleep (P_{SLEEP}) in Equation 1 if the alternative low power mode is less than or equal to 10 watts. In such instances, ($P_{SLEEP} \times T_{SLEEP}$), is replaced by ($P_{LONG\_IDLE} \times T_{SLEEP}$); Equation 1 remains otherwise unchanged.

v. Notebooks, Desktops, and Integrated Desktops with switchable graphics may not apply the Discrete Graphics allowance, $TEC_{GRAPHICS}$, from Table 7 in Equation 2. However, for Desktop and Integrated Desktop systems providing Switchable Graphics and enabling it by default, an allowance equal to 50% of the G1 graphics allowance for the platform type (Desktop or Integrated Desktop) may be applied. The switchable graphics incentive only applies to automated switching that is enabled by default. This capability is manufacturer-declared.

Equation 1: TEC Calculation (E_{TEC}) for Desktop, Integrated Desktop, Thin Client and Notebook Computers

$$E_{TEC} = \frac{8760}{1000} \times (P_{OFF} \times T_{OFF} + P_{SLEEP} \times T_{SLEEP} + P_{LONG\_IDLE} \times T_{LONG\_IDLE} + P_{SHORT\_IDLE} \times T_{SHORT\_IDLE})$$

Where:

- P_{OFF} *= Measured power consumption in Off Mode (W);*
- P_{SLEEP} *= Measured power consumption in Sleep Mode (W);*
- P_{LONG_IDLE} *= Measured power consumption in Long Idle Mode (W);*
- P_{SHORT_IDLE} *= Measured power consumption in Short Idle Mode (W); and*
- T_{OFF}, T_{SLEEP}, T_{LONG_IDLE}, *and* T_{SHORT_IDLE} *are mode weightings as specified in Table 3 (for Desktops, Integrated Desktops, and Thin Clients) or Table 4 (for Notebooks).*

Table 3: Mode Weightings for Desktop, Thin Clients, and Integrated Desktop Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery/ Name Services	Full Capability
T_{OFF}	45%	40%	30%	25%	20%
T_{SLEEP}	5%	15%	28%	36%	45%
T_{LONG_IDLE}	15%	12%	10%	8%	5%
T_{SHORT_IDLE}	35%	33%	32%	31%	30%

Table 4: Mode Weightings for Notebook Computers

Mode Weighting	Conventional	Full Network Connectivity			
		Base Capability	Remote Wake	Service Discovery / Name Services	Full Capability
T_{OFF}	25%	25%	25%	25%	25%
T_{SLEEP}	35%	39%	41%	43%	45%
T_{LONG_IDLE}	10%	8%	7%	6%	5%
T_{SHORT_IDLE}	30%	28%	27%	26%	25%

Equation 2: E_{TEC_MAX} Calculation for Desktop, Integrated Desktop, and Notebook Computers

$$E_{TEC\_MAX} = (1+ALLOWANCE_{PSU}) \times (TEC_{BASE} + TEC_{MEMORY} + TEC_{GRAPHICS} + TEC_{STORAGE} + TEC_{INT\_DISPLAY} + TEC_{SWITCHABLE} + TEC_{EEE})$$

Where:

- $ALLOWANCE_{PSU}$ *is an allowance provided to power supplies that meet the optional more stringent efficiency levels specified in Table 5; power supplies that do not meet the requirements receive an allowance of 0;*
- TEC_{BASE} *is the Base allowance specified in Table 6; and,*
- $TEC_{GRAPHICS}$ *is the discrete graphics allowance as specified in Table 7, with the exception of systems with integrated graphics, which do not receive an allowance, or Desktops and Integrated Desktops with switchable graphics enabled by default, which receive an allowance through* $TEC_{SWITCHABLE}$*; and*
- TEC_{MEMORY} *,* $TEC_{STORAGE}$*,* $TEC_{INT\_DISPLAY}$*,* $TEC_{SWITCHABLE}$*, and* TEC_{EEE} *are adder allowances as specified in Table 7.*

Table 5: Power Supply Efficiency Allowance

Power Supply Type	Computer Type	Minimum Efficiency at Specified Proportion of Rated Output Current[ii]				Minimum Average Efficiency[iii]	$Allowance_{PSU}$
		10%	20%	50%	100%		
IPS	Desktop	0.81	0.85	0.88	0.85	-	0.015
		0.84	0.87	0.90	0.87	-	0.03
	Integrated Desktop	0.81	0.85	0.88	0.85	-	0.015
		0.84	0.87	0.90	0.87	-	0.04
EPS	Notebook or Desktop	0.83	-	-	-	0.88	0.015
		0.84	-	-	-	0.89	0.03
	Integrated Desktop	0.83	-	-	-	0.88	0.015
		0.84	-	-	-	0.89	0.04

Table 6: Base TEC (TEC_{BASE}) Allowances

Category Name	Graphics Capability[iv]	Desktop or Integrated Desktop		Notebook	
		Performance Score, *P*[v]	Base Allowance	Performance Score, *P*[v]	Base Allowance
0	Any Graphics dGfx ≤ G7	***P* ≤ 3**	69.0	***P* ≤ 2**	14.0
I1	Integrated or Switchable Graphics	**3 < *P* ≤ 6**	112.0	**2 < *P* ≤ 5.2**	22.0
I2		**6 < P ≤ 7**	120.0	**5.2 < P ≤ 8**	24.0
I3		***P* > 7**	135.0	***P* > 8**	28.0
D1	Discrete Graphics dGfx ≤ G7	**3 < *P* ≤ 9**	115.0	**2 < *P* ≤ 9**	16.0
D2		***P* > 9**	135.0	***P* > 9**	18.0

ii EPSs shall meet the specified requirements when tested using the *Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to 10 CFR Part 430.* IPSs shall meet the specified requirements when tested using the *EPRI 306 Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.6*.

iii Average efficiency is the arithmetic mean of efficiencies tested at 25%, 50%, 75%, and 100% of rated output current. EPSs shall meet the specified requirements when tested using the *Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to 10 CFR Part 430.*

iv Discrete Graphics capability is categorized based on frame buffer bandwidth, as shown in Table 7.

v P = [# of CPU cores] × [CPU clock speed (GHz)] , where # of cores represents the number of physical CPU cores and CPU clock speed represents the Max TDP core frequency, not the turbo boost frequency.

Table 7: Functional Adder Allowances for Desktop, Integrated Desktop, Thin Client, and Notebook Computers

Function			Desktop	Integrated Desktop	Notebook
TEC_{MEMORY} (kWh) *vi*			0.8		
$TEC_{GRAPHICS}$ (kWh) *vii*	**Graphics Category** *viii*	**G1** *(FB_BW ≤ 16)*	36		14
		G2 *(16< FB_BW ≤ 32)*	51		20
		G3 *(32 < FB_BW ≤ 64)*	64		26
		G4 *(64 < FB_BW ≤ 96)*	83		32
		G5 *(96 < FB_BW ≤ 128)*	105		42
		G6 *(FB_BW > 128; Frame Buffer Data Width < 192 bits)*	115		48
		G7 *(FB_BW > 128; Frame Buffer Data Width ≥ 192 bits*	130		60
$TEC_{SWITCHABLE}$ (kWh) *ix*			0.5 × G1		N/A
TEC_{EEE} (kWh) *x*			8.76 × 0.2 × (0.15 + 0.35)		8.76 × 0.2 × (0.10 + 0.30)
$TEC_{STORAGE}$ (kWh) *xi*			26		2.6
$TEC_{INT\_DISPLAY}$ (kWh) *xii*			N/A	8.76 × *0.35* × *(1+EP)* × (4×*r* + 0.05×*A*)	8.76 × *0.30* × (1+*EP)* × (2×*r* + 0.02×*A*)

Equation 3: Calculation of Allowance for Enhanced-performance Integrated Displays

$$EP = \begin{cases} 0, & No\ Enhanced\ Performance\ Display \\ 0.3, & Enhanced\ Performance\ Display, d < 27 \\ 0.75, & Enhanced\ Performance\ Display, d \geq 27 \end{cases}$$

Where:

- *d is the diagonal of the screen, in inches;*

vi TEC_{MEMORY} Adder: Applies per GB installed in the system.
vii $TEC_{GRAPHICS}$ Adder: Applies to only the first dGfx installed in the system, but not Switchable Graphics.
viii FB_BW: Is the display frame buffer bandwidth in gigabytes per second (GB/s). This is a manufacturer declared parameter and should be calculated as follows: (Data Rate [Mhz] × Frame Buffer Data Width [bits]) / (8 × 1000)
ix $TEC_{SWITCHABLE}$ Incentive: Applies to automated switching that is enabled by default in Desktops and Integrated Desktops.
x TEC_{EEE}: Applies per IEEE 802.3az-compliant (Energy Efficient Ethernet) Gigabit Ethernet port.
xi $TEC_{STORAGE}$ Adder: Applies once if system has more than one Additional Internal Storage element.
xii $TEC_{INT\_DISPLAY}$ Adder: EP is the Enhanced Performance Display allowance calculated per Equation 3; r is the Screen resolution in megapixels; and A is viewable screen area in square inches.

3.6 Requirements for Slates/Tablets and Portable All-In-One Computers

3.6.1 Slates/Tablets shall follow **all** of the requirements for Notebook Computers in Section 3.5 above, including calculations of the following:

i. Calculated Typical Energy Consumption (E_{TEC}), using Equation 1 with the Notebook Computer Mode Weightings from Table 4.

ii. Calculated Maximum Allowed Typical Energy Consumption (E_{TEC_MAX}), using Equation 2 with the appropriate base Notebook Computer allowance from Table 6, and applicable Notebook Computer functional adder allowances from Table 7.

3.6.2 Portable All-In-One Computers shall follow **all** of the requirements for Integrated Desktop Computers in Section 3.5 above, including calculation of the following:

i. Calculated Typical Energy Consumption (E_{TEC}), using Equation 1 with the Integrated Desktop Computer Mode Weightings from Table 3.

ii. Calculated Maximum Allowed Typical Energy Consumption (E_{TEC_MAX}), using Equation 2 with the appropriate base Integrated Desktop Computer allowance from Table 6, and applicable Integrated Desktop Computer functional adder allowances from Table 7.

Note: EPA intends to further evaluate Slate/Tablet and Portable All-In-One Computer product data to inform the development of future energy consumption requirements in Version 7.0.

3.7 Requirements for Workstations

3.7.1 Weighted power consumption (P_{TEC}) as calculated per Equation 4 shall be less than or equal to the maximum weighted power consumption requirement (P_{TEC_MAX}) as calculated per Equation 5.

Equation 4: P_{TEC} Calculation for Workstations

$$P_{TEC} = P_{OFF} \times T_{OFF} + P_{SLEEP} \times T_{SLEEP} + P_{LONG\_IDLE} \times T_{LONG\_IDLE} + P_{SHORT\_IDLE} \times T_{SHORT\_IDLE}$$

Where:

- P_{OFF} *= Measured power consumption in Off Mode (W);*
- P_{SLEEP} *= Measured power consumption in Sleep Mode (W);*
- P_{LONG_IDLE} *= Measured power consumption in Long Idle Mode (W);*
- P_{SHORT_IDLE} *= Measured power consumption in Short Idle Mode (W); and*
- T_{OFF}, T_{SLEEP}, T_{LONG_IDLE}, *and* T_{SHORT_IDLE} *are mode weightings as specified in Table 8*

Table 8: Mode Weightings for Workstations

T_{OFF}	T_{SLEEP}	T_{LONG_IDLE}	T_{SHORT_IDLE}
35%	10%	15%	40%

Equation 5: P_{TEC_MAX} Calculation for Workstations

$$P_{TEC\_MAX} = 0.28 \times (P_{MAX} + N_{HDD} \times 5) + 8.76 \times P_{EEE} \times (T_{SLEEP} + T_{LONG\_IDLE} + T_{SHORT\_IDLE})$$

Where:

- P_{MAX} *= Measured maximum power consumption (W)*
- N_{HDD} *= Number of installed hard disk drives (HDD) or solid state drives (SSD)*

- *P_{EEE} is an EEE allowance of 0.2 W per IEEE 802.3az-compliant (Energy Efficient Ethernet) Gigabit Ethernet port.*

3.7.2 Active State Benchmark: To be ENERGY STAR certified, a Workstation must be submitted for qualification with the following information disclosed in full:

i. Linpack benchmark test results, compiler optimizations, and total energy consumed over the duration of the test; and

ii. SPECviewperf benchmark test results, configuration options, total duration of the test, and total energy consumed over the duration of the test.

3.7.3 Desktop Workstations: Products marketed as workstations may be ENERGY STAR certified under the Desktop requirements in Section 3.5 instead of the Workstation requirements in Section 3.6, at the Partner's option. EPA will identify Workstations certified as Desktops as "Desktops" in all ENERGY STAR marketing materials, on certified product lists, etc.

3.8 Requirements for Small-scale Servers

3.8.1 Measured Off Mode power (P_{OFF}) shall be less than or equal to the Maximum Off Mode Power Requirement(P_{OFF_MAX}), as calculated per Equation 6, subject to the following requirements:

i. The Off Mode Wake-on-LAN (WOL) adder allowance (P_{OFF_WOL}) shall only be applied to products that offer WOL enabled by default upon shipment.

Equation 6: Calculation of P_{OFF_MAX} for Small-scale Servers

$$P_{OFF\_MAX} = P_{OFF\_BASE} + P_{OFF\_WOL}$$

Where:

- *P_{OFF_BASE} is the base allowance as specified in Table 9; and*
- *P_{OFF_WOL} is the Wake-on-LAN allowance as specified in Table 9.*

Table 9: Off Mode Power Allowances for Small-scale Servers

P_{OFF_BASE} (watts)	P_{OFF_WOL} (watts)
1.0	0.4

3.8.2 Measured Long Idle State power (P_{LONG_IDLE}) shall be less than or equal to the Maximum Idle State Power Requirement (P_{IDLE_MAX}), as calculated per Equation 7.

Equation 7: Calculation of P_{IDLE_MAX} for Small-scale Servers

$$P_{IDLE\_MAX} = P_{IDLE\_BASE} + (N - 1) \times P_{IDLE\_HDD} + P_{EEE}$$

Where:

- *N is equal to the number of installed storage devices in the Small Scale Server (either hard disk drives or solid state drives);*
- *P_{IDLE_BASE} is the base allowance as specified in Table 10;*
- *P_{IDLE_HDD} is the hard drive allowance as specified in Table 10; and*
- *P_{EEE} is an EEE allowance of 0.2 W per IEEE 802.3az-compliant (Energy Efficient Ethernet) Gigabit Ethernet port.*

Table 10: Idle Mode Power Allowances for Small-scale Servers

P_{IDLE_BASE} (watts)	P_{IDLE_HDD} (watts)
24.0	8.0

3.9 Requirements for Thin Clients

3.9.1 Calculated Typical Energy Consumption (E_{TEC}) per Equation 1 shall be less than or equal to the Maximum TEC Requirement (E_{TEC_MAX}), as calculated per Equation 8, subject to the following requirements.

i. Allowances can only be applied if the corresponding adders are enabled by default.

ii. Thin Clients can utilize the proxy weightings in Table 3 when calculating E_{TEC}.

iii. For Thin Clients that lack a discrete System Sleep Mode, Long Idle State power (P_{LONG_IDLE}) may be used in place of Sleep Mode Power (P_{SLEEP}) in Equation 1 so long as the system meets the Thin Client TEC allowance. In such instances, ($P_{SLEEP} \times T_{SLEEP}$), is replaced by ($P_{LONG\_IDLE} \times T_{SLEEP}$); Equation 1 remains otherwise unchanged.

Equation 8: Calculation of E_{TEC_MAX} for Thin Clients

$$E_{TEC\_MAX} = TEC_{BASE} + TEC_{GRAPHICS} + TEC_{WOL} + TEC_{INT\_DISPLAY} + TEC_{EEE}$$

Where:

- *TEC_{BASE} is the Base Allowance specified in Table 11;*
- *$TEC_{GRAPHICS}$ is the Discrete Graphics allowance specified in Table 11 if applicable;*
- *TEC_{WOL} is the Wake-on-LAN allowance specified in Table 11 if applicable;*
- *$TEC_{INT\_DISPLAY}$ is the Integrated Display allowance for Integrated Desktops specified in Table 7 if applicable; and*
- *TEC_{EEE} is the Energy Efficiency Ethernet incentive for Desktops specified in Table 7 if applicable, per IEEE 802.3az-compliant (Energy Efficient Ethernet) Gigabit Ethernet port.*

Table 11: Adder Allowances for Thin Clients

Adder	Allowance (kWh)
TEC_{BASE}	60
$TEC_{GRAPHICS}$	36
TEC_{WOL}	2

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR® Program Requirements for Computers: Partner Commitments for details.

4 TESTING

4.1 Test Methods

4.1.1 When testing Computer products, the test methods identified in Table 12 shall be used to determine ENERGY STAR qualification.

Table 12: Test Methods for ENERGY STAR Qualification

Product Type or Component	Test Method
All	ENERGY STAR Test Method for Computers, Rev. March-2016

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 configuration, the unique configuration that is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model.

ii. For qualification of a Product Family of all product types, with the exception of Workstations, product configurations that represent the worst-case power consumption for each product category within the family are considered Representative Models. When submitting Product Families, manufacturers continue to be held accountable for any efficiency claims made about their products, including those not tested or for which data were not reported.

iii. For systems that meet the definition for multiple categories (as defined in Section 1.B) depending on the specific configuration, manufacturers will have to submit the highest power configuration for each category under which they would like the system to be ENERGY STAR certified. For example, a system that could be configured as either a Category 0 or 1 Desktop, as defined in Table 6 would require submittal of the highest power configuration for both categories in order to be ENERGY STAR certified. If a product could be configured to meet all categories, it would then have to submit data for the highest power configuration in all categories.

iv. For qualification of a Product Family of Workstations under the Workstation or Desktop product type, the product configuration that represents the worst-case power consumption with a single GPU within the family is considered the Representative Model.

Note: Workstations that meet ENERGY STAR requirements with a single graphics device may also have a configuration with more than one graphics device be ENERGY STAR certified, provided the additional hardware configuration is identical with the exception of the additional graphics device(s). The use of multiple graphics includes, but is not limited to, driving multiple displays and ganging for high performance, multi-GPU configurations (e.g. ATI Crossfire, NVIDIA SLI). In such cases, and until such time as SPECviewperf® supports multiple graphics threads, manufacturers may submit the test data for the workstation with the single graphics device for both configurations without retesting the system.

4.2.2 A single unit of each Representative Model shall be selected for testing.

4.2.3 All units/configurations for which a Partner is seeking ENERGY STAR qualification, must meet the ENERGY STAR requirements. However, if a Partner wishes to certify configurations of a model for which non-ENERGY STAR certified alternative configurations exist, the Partner must assign the certified configurations an identifier in the model name/number that is unique to ENERGY STAR certified configurations. This identifier must be used consistently in association with the certified configurations in marketing/sales materials and on the ENERGY STAR list of certified products (e.g. model A1234 for baseline configurations and A1234-ES for ENERGY STAR certified configurations).

Note: There may be cases—as described in the paragraph above—where not all units/configurations will meet ENERGY STAR requirements. If so, the worst-case configuration for test will be the worst-case certified configuration, and not one of the presumably even higher-energy consuming non-certified configurations.

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.

4.4 Customer Software and Management Service Pre-Provisioning

4.4.1 If a manufacturing Partner is hired by a customer to load a custom image on an ENERGY STAR certified computer, the Partner shall take the following steps:

i. Inform the customer that their product may not meet ENERGY STAR with the custom image. A sample notification letter is available on the ENERGY STAR Web site.

ii. Encourage the customer to test the product for ENERGY STAR compliance.

iii. Encourage the customer, should the product no longer meet ENERGY STAR, to make use of EPA's free technical assistance that can assist with Power Management performance, which can be found at www.energystar.gov/fedofficeenergy.

5 USER INTERFACE

5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard IEEE 1621: 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 6 ENERGY STAR Computers specification shall take effect **June 2, 2014**. To be ENERGY STAR certified, 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 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.

7 CONSIDERATIONS FOR FUTURE REVISIONS

7.1.1 **Dc-powered Computers:** EPA remains interested in including Dc-powered Computers in a future specification revision.

7.1.2 **New Benchmark for Workstation Testing:** EPA expects to work with stakeholders to develop a workstation benchmark in time for the future ENERGY STAR Computers Version 7.0.

7.1.3 **TEC for Alternative Low Power Modes**: EPA anticipates that modal limits for the alternative low power modes will eventually be removed and those modes will be integrated into the TEC formula in a future revision of the spec.

7.1.4 **Battery Charging Efficiency in Slates/Tablets**: EPA is interested in investigating the inclusion of battery charging energy efficiency requirements for Slates/Tablets in the future ENERGY STAR Computers Version 7.0 if sufficient differentiation is identified from available data.

APPENDIX A:
Sample Calculations

I. **Desktop, Integrated Desktop, Notebook Computers:** Below is a sample TEC calculation intended to show how levels for compliance are determined based on functional adders and operational mode measurements.

Following is a sample E_{TEC} evaluation for a 2.0 GHz, dual core Notebook with Switchable Graphics, 8 GB Memory, Energy Efficient Ethernet (EEE), and 1 hard disk drive (HDD).

A) Measure values using the ENERGY STAR Computers Test Method:

1) Off Mode = 1.0 W
2) Sleep Mode = 1.7 W
3) Long Idle State = 8.0 W
4) Short Idle State = 10.0 W

B) Determine the proxy support provided by the operating system and network card. This is a manufacturer-reported parameter.

1) On Mac computers, "Wake for network access" enabled within the Energy Saver/Power Adapter Preferences signifies Base Capability or better.
2) On Windows computers, "ARP Offload" or "NS Offload" or similar enabled within the Advanced Properties of the Network Interface Card (accessed through the Device Manager) signifies Base Capability or better. OEM can provide further guidance on how to confirm Proxy Support

C) Calculate E_{TEC} from power measurements and mode weightings—this example assumes no Proxy Support/Conventional Weightings:

T_{OFF}	25%
T_{SLEEP}	35%
T_{LONG_IDLE}	10%
T_{SHORT_IDLE}	30%

1) $E_{TEC} = \frac{8760}{1000} \times (P_{OFF} \times T_{OFF} + P_{SLEEP} \times T_{SLEEP} + P_{LONG\_IDLE} \times T_{LONG\_IDLE} + P_{SHORT\_IDLE} \times T_{SHORT\_IDLE})$
2) $E_{TEC} = \frac{8760}{1000} \times (1.0\ \text{W} \times 25\% + 1.7\ \text{W} \times 35\% + 8.0\ \text{W} \times 10\% + 10.0\ \text{W} \times 30\%)$
3) E_{TEC} = 40.7 kWh / year

D) Determine which Base TEC allowance applies based on graphics capability and performance score: *P = [# of CPU cores] × [CPU clock speed (GHz)] = 2×2 GHz = 4.*

Table 6: Base TEC (TEC_{BASE}) Allowances

Category Name	Graphics Capability	Notebook	
		Performance Score, *P*	Base Allowance
I1	**Integrated or Switchable Graphics**	**2 < *P* ≤ 5.2**	**22.0**

E) Determine which Functional Adder Allowances apply:

1) Memory: *8 GB installed, so a TEC_{MEMORY} allowance of* $8\ \text{GB} \times 0.8\frac{\text{kWh}}{\text{GB}} = 6.4\ \text{kWh}$ *applies*

2) Discrete Graphics? *No, therefore $TEC_{GRAPHICS}$ allowance does not apply.*

3) Switchable Graphics? *Yes, but $TEC_{SWITCHABLE}$ allowance does not apply to Notebooks.*

4) Energy Efficient Ethernet (EEE)? *Yes, and assuming one EEE-compliant Ethernet port, a TEC_{EEE} allowance of* 8.76 × 0.2 × (0.10 + 0.30) = 0.7 kWh *applies*

5) Storage? *No, the notebook has only one hard disk drive, so no storage allowance applies.*

6) Integrated Display? *Yes, and assuming a non-enhanced performance, 14 inch display with an area of 83.4 square inches and a resolution of 1.05 megapixels, a $TEC_{INT\_DISPLAY}$ allowance of* 8.76 ×*0.30* × (1+*EP)* × (2×*r* + 0.02×*A*) = 8.76 ×*0.30* × (2×*1.05* MP+ 0.02×83.4 in^2) = 9.9 kWh *applies.*

F) Calculate E_{TEC_MAX}:

1) E_{TEC_MAX} = 22.0 kWh + 6.4 kWh + 0.7 kWh + 9.9 kWh

2) E_{TEC_MAX} = 39.0 kWh/yr

G) Compare E_{TEC} to the E_{TEC_MAX} to determine if the model qualifies:

40.7 kWh/yr > 39.0 kWh/yr

Therefore, the Notebook does not meet ENERGY STAR requirements.

II. **Workstations:** Below is a sample P_{TEC} calculation for a Workstation with 2 hard drives and no Energy Efficient Ethernet capability.

A) Measure values using the ENERGY STAR Computers Test Method:

1) Off Mode = 2 W

2) Sleep Mode = 4 W

3) Long Idle State = 50 W

4) Short Idle State = 80 W

5) Max Power = 180 W

A) Note number of Hard Drives installed: Two hard drives installed during test.

B) Calculate P_{TEC} from power measurements and mode weightings using Equation 4:

T_{OFF}	T_{SLEEP}	T_{LONG_IDLE}	T_{SHORT_IDLE}
35%	10%	15%	40%

1) P_{TEC} = (35% × P_{OFF} + 10% × P_{SLEEP} + 15% × P_{LONG_IDLE} + 40% × P_{SHORT_IDLE})

2) P_{TEC} = (35% × 2 W + 10% × 4 W + 15% × 50 W + 40% × 80 W)

3) P_{TEC} = 40.6 W

C) Calculate the P_{MAX} requirement using Equation 5:

1) $P_{TEC\_MAX} = 0.28\times(P_{MAX} + N_{HDD}\times 5) + 8.76\times P_{EEE}\times(T_{SLEEP} + T_{LONG\_IDLE} + T_{SHORT\_IDLE})$

2) $P_{TEC\_MAX} = 0.28\times(180+ 2\times 5) + 8.76\times 0\times(T_{SLEEP} + T_{LONG\_IDLE} + T_{SHORT\_IDLE})$

3) P_{TEC_MAX} = 53.2 + 0

D) Compare P_{TEC} to the ENERGY STAR levels to determine if the model qualifies:

40.6 W ≤ 53.2 W

Therefore, the Workstation meets ENERGY STAR requirements.

ENERGY STAR® Program Requirements Product Specification for Computers

Final Test Method Rev. March-2016

1 OVERVIEW

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

2 APPLICABILITY

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

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

3 DEFINITIONS

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

4 TEST SETUP

4.1 Test Setup and Instrumentation

Test setup and instrumentation for all portions of this procedure shall be in accordance with the requirements of International Electrotechnical Commission (IEC) standard, IEC 62301, "Household Electrical Appliances – Measurement of Standby Power" Edition 2.0, 2011-01, 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.

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

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 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 %

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 %

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

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

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

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

2) Acceptance Angle: 3 degrees or less.

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

Note: The term "nit" is sometimes used instead of the official SI unit cd/m^2. One nit is equivalent to one cd/m^2.

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

1) Crest Factor:

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

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

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

3) Minimum Resolution:

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

b) 0.1 W for measurement values from 10 W to 100 W; and

c) 1.0 W for measurement values greater than 100 W.

4) Measurement Accuracy: Measurement uncertainty as introduced by the instrument that measures the input power to the unit under test (UUT), including any external shunts.

a) 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.

b) 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

5.1 Guidance for Implementation of IEC 62623

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

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

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

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

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

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

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

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

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

G) Celluar network connections shall be disabled for testing. Additionally, Bluetooth should be left as-shipped.

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

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

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

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

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

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

E) Calibrate the UUT display brightness to the closest brightness setting that is at least 90 cd/m^2 for Notebook Computers, at least 150 cd/m^2 for Integrated Desktop Computers, Portable All-In-One Computers and Slates/Tablets. If the UUT's brightest setting cannot achieve the specified brightness, then set the UUT display to the brightest setting.

F) the display shall be configured with the ENERGY STAR test image, which can be found here[1]. For Desktops, Integrated Desktops, Notebook Computers and Portable All-In-One Computers it may be set as the "desktop background" (wallpaper) or shown via an image display application. The image shall be scaled to completely fill the display area. For Slates/Tablets, the display shall be configured with the default image display application.

G) For all testing specified in Section 6, the UUT shall not be rebooted or restarted until after the power measurements for Long Idle Mode and Short Idle Mode tests are taken.

H) Slate/Tablet and Portable All-In-One Computers shall be tested with a docking station only if it is shipped with the product and is the only way to power the device mains.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 UUT Preparation

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

6.2 Sleep Mode Testing

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

6.3 Long Idle Mode Testing

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

6.4 Short Idle Mode Testing

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

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.

6.6 Additional Testing For Reporting

[1] https://www.energystar.gov/ia/partners/images/ComputerTestingImage.bmp

For Notebook Computers, repeat the Short Idle test with the display brightness set to the closest setting that is at least 150 cd/m^2.

7 TEST PROCEDURES FOR WORKSTATIONS

7.1 Maximum Power Test

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

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

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

Table 3: Benchmark Information for Maximum Power Test

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

A) UUT Preparation:

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

B) Maximum Power Testing:

1) Set the meter to begin accumulating true power values at a rate greater than or equal to one reading per second, and begin taking measurements.

2) Run SPECviewperf and as many simultaneous instances of Linpack as needed to fully stress the system. Recommended setup information can be found in Section 9.1 C).

3) Accumulate power values until SPECviewperf and all Linpack instances have completed running. Record the maximum power value attained during the test.

4) The following data shall also be recorded:

   a) Value of "n" (the array size) used for Linpack;

   b) Number of simultaneous copies of Linpack run during the test;

   c) Version of SPECviewperf run for test;

   d) All compiler optimizations used in compiling Linpack and SPECviewperf; and

   e) A precompiled binary for end users to download and run both SPECviewperf and Linpack. These can be distributed either through a centralized standards body such as SPEC, by the original equipment manufacturer (OEM), or by a related third party.

7.2 Benchmark Test

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

Table 4: Information for Benchmark Testing

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

A) UUT Preparation:

1) The UUT shall be setup identical to Step 1) through Step 4) of Section 7.1 A)

2) If not already installed, install the benchmark as indicated on the websites listed in Table 4.

3) Configure the benchmark as specified in Section 7.2 B).

4) Time Measurement: Time measurements may be performed with a standard stopwatch or other time keeping device with a resolution of at least 1 second.

B) Benchmark Configurations:

1) Linpack

   a) Configure the Linpack settings identically to the maximum power workstation test (e.g. Follow Step 5) and Step 7) of Section 7.1 A)).

   b) Run as many simultaneous instances of Linpack as needed to fully stress the system. Recommended settings would be to set the number of simultaneous instances of Linpack equal to the number of logical and/or physical CPU cores of the system.

2) SPECviewperf

   a) Configure the settings identically to the maximum power workstation test (e.g. Follow Step 6) of Section 7.1 A)).

C) Benchmark Testing:

1) Set the meter to begin accumulating true power values at a rate of greater than or equal to one reading per second and begin power and time measurement.
2) Execute the benchmark.
3) Stop time measurement and accumulate power values for the entire duration of the benchmark run.
4) The following data shall be reported:
    a) Linpack
        i. Value of “n” (the array size) used for Linpack;
        ii. Number of instances of Linpack simultaneously run on the system;
        iii. All compiler options used in compiling Linpack;
        iv. Energy consumed over the duration of the test; and
        v. Linpack output file in text format which contains system performance in floating point operations per second (Flops) in addition to other Linpack parameters (e.g. number of tests, problem size, etc.).
    b) SPECviewperf
        i. Version of SPECviewperf used;
        ii. All compiler optimizations used in compiling SPECviewperf;
        iii. Duration of the test;
        iv. Energy consumed over the duration of the test; and
        v. All files and folders present in the Result folder of SPECviewperf suite shall be reported.

8 REFERENCES

A) IEC 62301 Edition 2.0 2011-01, Household electrical appliances – Measurement of standby power.

B) IEC 60107-1 Edition 3.0 1197-04, Methods of measurement on receivers for television broadcast transmissions – Part 1: General Considerations – Measurements at radio and video frequencies.

C) IEC 62623 Edition 1.0 2012-10, Desktop and notebook computers – Measurement of energy consumption

9 APPENDIX: BENCHMARK PARAMETERS

9.1 Typical Linpack Starting Parameters

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

A) Number of equations (problem size): See Equation.

B) Leading dimensions of array: See Equation.

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

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

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

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

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

Equation 1: Memory Size Calculation

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

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

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

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.
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.
3. **Ensure that any model associated with the ENERGY STAR name or mark** meets the following standards:

   3.1. Product material requirements as defined in restriction of hazardous substances (RoHS) regulations, as generally accepted. This includes exemptions in force at the date of product manufacture, where the maximum concentration values tolerated by weight in homogeneous materials are: lead (0.1%), mercury (0.1%), cadmium (0.01%), hexavalent chromium (0.1%), polybrominated biphenyls (PBB) (0.1%), or polybrominated diphenyl ethers (PBDE) (0.1%). Batteries are exempt.

   3.2. The generally accepted attributes of a recyclable product at the date of product manufacture: where products shall be designed for ease of disassembly and recyclability where external enclosures, sub-enclosures, chassis and electronic subassemblies are easily removable with commonly available tools, by hand, or by a recycler's automated processes.

   Notes:

   - The explicit intention is to harmonize with EU RoHS.
   - For purposes of ENERGY STAR third-party certification, these requirements shall not be reviewed when products are initially qualified nor during subsequent verification testing. Rather, EPA reserves the right to request supporting documentation at any time.

Using the ENERGY STAR Name and Marks

4. 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.
5. 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 US and/or ENERGY STAR partner countries.
6. Provide clear and consistent labeling of ENERGY STAR qualified displays.

   6.1. The ENERGY STAR mark must be clearly displayed:

6.1.1. 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/logouse) 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.

6.1.2. In product literature (i.e., user manuals, specification sheets, etc.);

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

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

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

Verifying Ongoing Product Qualification

7. 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

8. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
   8.1. 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).
   8.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
   8.3. 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;

9. Report to EPA any attempts by recognized laboratories or certification bodies to influence testing or certification results or to engage in discriminatory practices.
10. 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.

Performance for Special Distinction

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.
- 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.

ENERGY STAR® Program Requirements
Product Specification for Displays

Eligibility Criteria
Version 6.0
Rev. Jan-2013

Following is the ENERGY STAR product specification ("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, DisplayPort, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memory card), or (3) a network connection.

a) Computer Monitor: An electronic device, typically with a diagonal screen size greater than 12 inches and a pixel density greater than 5,000 pixels per square inch (pixels/in^2), that displays a computer's user interface and open programs, allowing the user to interact with the computer, typically using a keyboard and mouse.

(1) Enhanced-Performance Display: A computer monitor that has all of the following features and functionalities:
(a) A contrast ratio of at least 60:1 measured at a horizontal viewing angle of at least 85°, with or without a screen cover glass;
(b) A native resolution greater than or equal to 2.3 megapixels (MP); and,
(c) A color gamut size of at least sRGB as defined by IEC 61966 2-1. Shifts in color space are allowable as long as 99% or more of defined sRGB colors are supported.

b) Digital Picture Frame: An electronic device, typically with a diagonal screen size less than 12 inches, whose primary function is to display digital images. It may also feature a programmable timer, occupancy sensor, audio, video, or bluetooth or wireless connectivity.

c) Signage Display: An electronic device typically with a diagonal screen size greater than 12 inches and a pixel density less than or equal to 5,000 pixels/in^2. It is typically marketed as commercial signage for use in areas where it is intended to be viewed by multiple people in non-desk based environments, such as retail or department stores, restaurants, museums, hotels, outdoor venues, airports, conference rooms or classrooms.

B) External Power Supply (EPS): Also referred to as an 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 power mode in which the product has been activated, and is providing one or more of its principal functions. The common terms, "active," "in-use," and "normal operation" also describe this mode. The power in this mode is typically greater than the power in Sleep Mode and Off Mode.

2) Sleep Mode: The power mode the product enters after receiving a signal from a connected device or an internal stimulus. The product may also enter this mode by virtue of a signal produced by user input. The product must wake on receiving a signal from a connected device, a network, a remote control, and/or an internal stimulus. While the product is in this mode, it is not producing a visible picture, with the possible exception of user-oriented or protective functions such as product information or status displays, or sensor-based functions.

Note: Examples of internal stimuli are a timer or occupancy sensor.

Note: A power control is not an example of user input.

3) Off Mode: The power mode in which the product is connected to a power source, and is not providing any On Mode or Sleep Mode functions. This mode may persist for an indefinite time. The product may only exit this mode by direct user actuation of a power switch or control. Some products may not have this mode.

D) Luminance: The photometric measure of the luminous intensity per unit area of light travelling in a given direction, expressed in candelas per square meter (cd/m^2). Luminance refers to the brightness settings of a display.

1) Maximum Reported Luminance: The maximum luminance the display may attain at an On Mode preset setting, and as specified by the manufacturer, for example, in the user manual.

2) Maximum Measured Luminance: The maximum luminance the display may attain by manually configuring its controls, such as brightness and contrast.

3) As-shipped Luminance: The luminance of the display at the factory default preset setting the manufacturer selects for normal home or applicable market use. The As-shipped Luminance of displays with Automatic Brightness Control (ABC) enabled by default may vary based on the Ambient Light Conditions of the location in which the display is installed.

E) Screen Area: The viewable screen width multiplied by the viewable screen height, expressed in square inches (in^2).

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

G) Ambient Light Conditions: The combination of light illuminances in the environment surrounding a display, such as a living room or an office.

H) Bridge Connection: A physical connection between two hub controllers, typically, but not limited to, USB or FireWire, which allows for expansion of ports typically for the purpose of relocating the ports to a more convenient location or increasing the number of available ports.

I) Network Capability: An ability to obtain an IP address when connected to the network.

J) Occupancy Sensor: A device used to detect human presence in front of or in the area surrounding a display. An occupancy sensor is typically used to switch a display between On Mode and Sleep or Off Mode.

K) Product Family: A group of displays, made under the same brand, sharing a screen of the same size and resolution, and encased in a single housing that may contain variations in hardware configurations.

Example: Two computer monitors from the same model line with a diagonal screen size of 21 inches and a resolution of 2.074 megapixels (MP), but with variations in features such as built-in speakers or camera, could be qualified as a product family.

L) Representative Model: The product configuration that is tested for ENERGY STAR qualification and is intended to be marketed and labeled as ENERGY STAR.

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 bridging or network connection, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2. Typical products that would be eligible for qualification under this specification include:

i. Computer Monitors;

ii. Digital Picture Frames;

iii. Signage Displays; and,

iv. Additional products including monitors with keyboard, video and mouse (KVM) switch functionality, and other industry-specific displays that meet the definitions and qualification criteria in this specification.

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.

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

i. Products with a viewable diagonal screen size greater than 61 inches;

ii. Products with an integrated television tuner;

iii. Products that are marketed and sold as televisions, including products with a computer input port (e.g., VGA) that are marketed and sold primarily as televisions;

iv. Products that are component televisions. A component television is a product that is composed of two or more separate components (e.g., display device and tuner) that are marketed and sold as a television under a single model or system designation. A component television may have more than one power cord;

v. Dual-function televisions / computer monitors that are marketed and sold as such;

vi. Mobile computing and communication devices (e.g., tablet computers, slates, electronic readers, smartphones);

vii. Products that must meet FDA specifications for medical devices that prohibit power management capabilities and/or do not have a power state meeting the definition of Sleep Mode; and,

viii. Thin clients, ultra-thin clients, or zero clients.

3 QUALIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

3.1.2 Unless otherwise specified, compliance with specification requirements shall be evaluated using directly measured or calculated values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification requirements.

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.

- 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:

i. 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 either by a connected host device or internally (e.g., support for VESA Display Power Management Signaling (DPMS), enabled by default).

ii. 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.

iii. For products that have an internal default delay time after which the product transitions from On Mode to Sleep Mode or Off Mode, the delay time shall be reported.

iv. Computer monitors shall automatically enter Sleep Mode or Off Mode within 15 minutes of being disconnected from a host computer.

3.3 On Mode Requirements

3.3.1 On Mode power (P_{ON}), as measured per the ENERGY STAR test method (referenced in Table 6), shall be less than or equal to the Maximum On Mode Power Requirement (P_{ON_MAX}), as calculated and rounded per Table 1, below.

i. If the product's pixel density (D_P), as calculated per Equation 1, is greater than 20,000 pixels/in^2, then the screen resolution used to calculate P_{ON_MAX} shall be determined per Equation 2.

Equation 1: Calculation of Pixel Density

$$D_P = \frac{r \times 10^6}{A}$$

Where:

- *D_P is the pixel density of the product rounded to the nearest integer, in pixels/in^2,*
- *r is the screen resolution, in megapixels, and*
- *A is the viewable screen area, in in^2.*

Equation 2: Calculation of Resolution if D_p > 20,000 pixels/in^2

$$r_1 = \frac{20{,}000 \times A}{10^6} \qquad r_2 = \frac{(D_P - 20{,}000) \times A}{10^6}$$

Where:

- *r_1 and r_2 are the screen resolutions, in megapixels, to be used when calculating P_{ON_MAX},*
- *D_P is the pixel density of the product rounded to the nearest integer, in pixels/in^2, and*

- *A is the viewable screen area, in in^2.*

Table 1: Calculation of Maximum On Mode Power Requirements (P_{ON_MAX})

Product Type and Diagonal Screen Size, *d* (in inches)	P_{ON_MAX} where $D_p \leq 20{,}000$ pixels/in^2 (in watts) *Where:* ▪ *r = Screen resolution in megapixels* ▪ *A = Viewable screen area in in^2* ▪ *The result shall be rounded to the nearest tenth of a watt*	P_{ON_MAX} where $D_P > 20{,}000$ pixels/in^2 (in watts) *Where:* ▪ *r = Screen resolution in megapixels* ▪ *A = Viewable screen area in in^2* ▪ *The result shall be rounded to the nearest tenth of a watt*
$d < 12.0$	$(6.0 \times r) + (0.05 \times A) + 3.0$	$\left((6.0 \times r_1) + (3.0 \times r_2) + (0.05 \times A) + 3.0\right)$
$12.0 \leq d < 17.0$	$(6.0 \times r) + (0.01 \times A) + 5.5$	$\left((6.0 \times r_1) + (3.0 \times r_2) + (0.01 \times A) + 5.5\right)$
$17.0 \leq d < 23.0$	$(6.0 \times r) + (0.025 \times A) + 3.7$	$\left((6.0 \times r_1) + (3.0 \times r_2) + (0.025 \times A) + 3.7\right)$
$23.0 \leq d < 25.0$	$(6.0 \times r) + (0.06 \times A) - 4.0$	$\left((6.0 \times r_1) + (3.0 \times r_2) + (0.06 \times A) - 4.0\right)$
$25.0 \leq d \leq 61.0$	$(6.0 \times r) + (0.1 \times A) - 14.5$	$\left((6.0 \times r_1) + (3.0 \times r_2) + (0.1 \times A) - 14.5\right)$
$30.0 \leq d \leq 61.0$ *(for products meeting the definition of a Signage Display only)*	$(0.27 \times A) + 8.0$	$(0.27 \times A) + 8.0$

3.3.2 For products meeting the definition of an Enhanced-Performance Display, a power allowance (P_{EP}), as calculated per Equation 3, shall be added to P_{ON_MAX}, as calculated per Table 1. In this case, P_{ON}, as measured per the ENERGY STAR test method (referenced in Table 6), shall be less than or equal to the sum of P_{ON_MAX} and P_{EP}.

Equation 3: Calculation of On Mode Power Allowance for Enhanced-Performance Displays

$$P_{EP<27"} = 0.30 \times P_{ON\_MAX}$$

$$P_{EP\geq 27"} = 0.75 \times P_{ON\_MAX}$$

Where:

- *$P_{EP<27"}$ is the On Mode power allowance, in watts, for an Enhanced-Performance Display with a diagonal screen size less than 27 inches,*
- *$P_{EP\geq 27"}$ is the On Mode power allowance, in watts, for an Enhanced-Performance Display with a diagonal screen size greater than or equal to 27 inches, and*
- *P_{ON_MAX} is the maximum On Mode power requirement, in watts.*

3.3.3 For products with Automatic Brightness Control (ABC) enabled by default, a power allowance (P_{ABC}), as calculated per **Equation 5**, shall be added to P_{ON_MAX}, as calculated per Table 1, if the On Mode power reduction (R_{ABC}), as calculated per **Equation 4**, is greater than or equal to 20%.

i. If R_{ABC} is less than 20%, P_{ABC} shall not be added to P_{ON_MAX}.

ii. P_{ON}, as measured with ABC disabled per the ENERGY STAR test method, referenced in Table 6 below, shall be less than or equal to P_{ON_MAX}.

Equation 4: Calculation of On Mode Power Reduction for Products with ABC Enabled by Default

$$R_{ABC} = 100 \times \left(\frac{P_{300} - P_{10}}{P_{300}}\right)$$

Where:

- *R_{ABC} is the On Mode percent power reduction due to ABC,*
- *P_{300} is the measured On Mode power, in watts, when tested with an ambient light level of 300 lux, and*
- *P_{10} is the measured On Mode power, in watts, when tested with an ambient light level of 10 lux.*

Equation 5: Calculation of On Mode Power Allowance for Products with ABC Enabled by Default

$$P_{ABC} = 0.10 \times P_{ON\_MAX}$$

Where:

- *P_{ABC} is the On Mode power allowance, in watts, and*
- *P_{ON_MAX} is the maximum On Mode power requirement, in watts.*

3.3.4 For products powered with a low-voltage dc source, P_{ON}, as calculated per Equation 6, shall be less than or equal to P_{ON_MAX}, as calculated per Table 1.

Equation 6: Calculation of On Mode Power for Products Powered by a Low-voltage Dc Source

$$P_{ON} = P_L - P_S$$

Where:

- *P_{ON} is the calculated On Mode power, in watts,*
- *P_L is the ac power consumption, in watts, of the low-voltage dc source with the unit under test (UUT) as the load, and*
- *P_S is the marginal loss of the ac power supply of the source, in watts.*

3.4 Sleep Mode Requirements

3.4.1 Measured Sleep Mode power (P_{SLEEP}) for products with none of the bridging or network capabilities included in Table 3 or 4 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 Requirement (P_{SLEEP_MAX})

P_{SLEEP_MAX} (watts)
0.5

3.4.2 Measured Sleep Mode power (P_{SLEEP}) for products with one or more of the bridging, network, or additional capabilities included in Table 3 or 4 shall be less than or equal to the Maximum Bridging/Network Sleep Mode Power Requirement (P_{SLEEP_AP}), as calculated per Equation 7.

Equation 7: Calculation of Maximum Bridging/Network Sleep Mode

$$P_{SLEEP\_AP} = P_{SLEEP\_MAX} + P_{DN} + P_{ADD}$$

Where:

- *P_{SLEEP_AP} is the Maximum Sleep Mode Power Requirement, in watts, for products that were tested with additional power-consuming capabilities,*
- *P_{SLEEP_MAX} is the Maximum Sleep Mode Power Requirement, in watts, as specified in Table 2,*
- *P_{DN} is the sum of power allowances, in watts, as specified in Table 3, for the bridging and/or network capabilities that are connected and enabled during Sleep Mode testing, and*
- *P_{ADD} is the sum of power allowances, in watts, as specified in Table 4, for the additional capabilities that are enabled during Sleep Mode testing.*

Table 3: Power Allowances in Sleep Mode for Bridging or Network Capabilities

Capability	Included Types	P_{DN} (watts)
Bridging	USB 1.x	0.1
	USB 2.x	0.5
	USB 3.x, DisplayPort (non-video connection), Thunderbolt	0.7
Network	Wi-Fi	2.0
	Fast Ethernet	0.2
	Gigabit Ethernet	1.0

Table 4: Power Allowances in Sleep Mode for Additional Capabilities

Capability	Included Types	P_{ADD} (watts)
Sensor	Occupancy Sensor	0.5
Memory	Flash memory-card/smart-card readers, camera interfaces, PictBridge	0.2

Example 1: A digital picture frame with only one bridging or network capability connected and enabled during Sleep Mode testing, **Wi-Fi**, and no additional capabilities enabled during Sleep Mode testing, would qualify for the 2.0 W Wi-Fi adder. Recalling that $P_{SLEEP\_AP} = P_{SLEEP\_MAX} + P_{DN} + P_{ADD}$, P_{SLEEP_AP} = 0.5 W + 2.0 W + 0 W = **2.5 W**.

Example 2: : A computer monitor with **USB 3.x** and **DisplayPort (non-video connection)** bridging capability shall be tested with only the USB 3.x connected and enabled. Assuming no additional capabilities are enabled during Sleep Mode testing, this display would qualify for the 0.7 W USB 3.x adder. Recalling that $P_{SLEEP\_AP} = P_{SLEEP\_MAX} + P_{DN} + P_{ADD}$, P_{SLEEP_AP} = 0.5 W + 0.7 W + 0 W = **1.2 W**.

Example 3: A computer monitor with one bridging and one network capability, **USB 3.x** and **Wi-Fi**, shall be tested with both capabilities connected and enabled during Sleep Mode testing. Assuming no additional capabilities are enabled during Sleep Mode testing, this display would qualify for the 0.7 W USB 3.x adder and the 2.0 W Wi-Fi adder. Recalling that $P_{SLEEP\_AP} = P_{SLEEP\_MAX} + P_{DN} + P_{ADD}$, P_{SLEEP_AP} = 0.5 W + (0.7 W + 2.0 W) + 0 W = **3.2 W**.

3.4.3 For products that offer more than one Sleep Mode (e.g., "Sleep" and "Deep Sleep"), measured Sleep Mode power (P_{SLEEP}) in any Sleep Mode shall not exceed P_{SLEEP_MAX} in the case of products without bridging or network connection capabilities, or P_{SLEEP_AP} in the case of products tested with additional power-consuming capabilities, such as bridging connections or network connections. If the product has a variety of Sleep Modes that may be manually selected, or if the product can enter Sleep Mode via different methods (e.g., remote control or putting the host PC to sleep), the measured Sleep Mode power (P_{SLEEP}) of the Sleep Mode with the highest P_{SLEEP}, as measured per Section 6.5 of the Test Method, shall be the P_{SLEEP} reported for qualification. If the product automatically transitions through its various Sleep Modes, the average P_{SLEEP} of all Sleep Modes as measured in Section 6.5 of the Test Method shall be the P_{SLEEP} reported for qualification

3.5 Off Mode Requirements

3.5.1 A product need not have an Off Mode to be eligible for qualification. For products that do offer Off Mode, measured Off Mode power (P_{OFF}) shall be less than or equal to the Maximum Off Mode Power Requirement (P_{OFF_MAX}) specified in Table 5.

Table 5: Maximum Off Mode Power Requirement (P_{OFF_MAX})

P_{OFF_MAX} (watts)
0.5

3.6 Luminance Reporting Requirements

3.6.1 Maximum reported and maximum measured luminance shall be reported for all products; as-shipped luminance shall be reported for all products except those with ABC enabled by default.

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR® Program Requirements for Displays: Partner Commitments for details.

4 TEST REQUIREMENTS

4.1 Test Methods

4.1.1 Test methods identified in Table 6 shall be used to determine qualification for ENERGY STAR.

Table 6: Test Methods for ENERGY STAR Qualification

Product Type	Test Method
All Product Types and Screen Sizes	ENERGY STAR Test Method for Determining Displays Energy Use Version 6.0 – Rev. Jan-2013

4.2 Number of Units Required for Testing

4.2.1 One unit of a Representative Model, as defined in Section 1, shall be selected for testing.

4.2.2 For qualification of a product family, the product configuration that represents the worst-case power consumption for each product category within the family shall be considered the Representative Model.

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 Manufacturers 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. Note, adoption of *IEEE P1621* is not a requirement for ENERGY STAR qualification, but in the event that the manufacturer does not adopt *IEEE P1621*, EPA requests that the manufacturer provide EPA with its reason for not doing so.

6 EFFECTIVE DATE

6.1.1 Effective Date: The Version 6.0 ENERGY STAR Display Products specification shall take effect on **June 1, 2013**. 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 ENERGY STAR qualification is not automatically granted for the life of a model

7 CONSIDERATIONS FOR FUTURE REVISIONS

7.1 Displays Larger Than 61” in Diagonal Screen Size

7.1.1 EPA understands that interactive displays greater than 60" in diagonal screen size are currently available in the market and are namely used for commercial and educational purposes. EPA is interested in better understanding the power consumption associated with these products when tested according to the Displays Test Method and will work with stakeholders prior to, and during, the next specification revision development process to access the information. DOE may also explore testing of these products. EPA is interested in exploring expanding the scope of products to those greater than 61" in diagonal screen size in the next specification revision.

7.2 Touch Screen Functionality

7.2.1 EPA is committed to continuing to develop performance levels for displays that account for new features and functionality, and anticipates that displays with touch screen functionality, which are included in the scope of this specification, will become more prevalent in the market, especially among signage displays. Going forward, EPA and DOE will explore with stakeholders whether touch screen functionality impacts On Mode power consumption to determine to what extent the next specification development process should address touch screen functionality.

ENERGY STAR® Program Requirements Product Specification for Displays

Test Method for Determining Displays Energy Use Version 6.0 Rev. Jan-2013

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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

The following test method is applicable to all products eligible for qualification under the ENERGY STAR Product Specification for Displays.

Note: DOE has published the Test Procedure for Television Sets Notice of Proposed Rulemaking (77 FR 2830). Any product that is included in DOE's scope of coverage for TVs shall ultimately be tested according to the Test Procedure for Television Sets Final Rulemaking published by DOE.

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.

Table 1: Input Power Requirements for Products

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

C) Low-voltage Dc Input Power:

1) Products may be powered with a low-voltage dc source (e.g., via network or data connection) only if the dc source is the only available source of power for the product (i.e., no ac plug or External Power Supply (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 Universal Serial Bus (USB) hub).

3) The USB hub power adapter must have the following attributes:

a) Voltage Rating: 5 V

b) Current Range: 2 A to 3 A

4) Power for the unit under test (UUT) shall include the following, as measured per Section 5.3 of this method:

a) Ac power consumption of the low-voltage dc source with the UUT as the load (P_L).

b) Ac power consumption of the low-voltage dc source with no load (P_S).

D) Ambient Temperature: Ambient temperature shall be 23^{o} C ± 5^{o} C.

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

F) UUT Alignment:

1) All four corners of the face of the Unit Under Test (UUT) shall be equidistant from a vertical reference plane (e.g., wall)

2) The bottom two corners of the face of the UUT shall be equidistant from a horizontal reference plane (e.g., floor).

G) Light Source:

1) Lamp Type:

a) Standard spectrum halogen flood reflector lamp. The lamp shall not meet the definition of "Modified spectrum" as defined in 10 CFR 430.2 - Definitions[1].

b) Rated Brightness: 980 ± 5% lumens.

2) Light Source Alignment For Testing Products With ABC Enabled By Default:

a) There shall be no obstructions between the lamp and the UUT's Automatic Brightness Control (ABC) sensor (e.g., diffusing media, frosted lamp covers, etc.).

b) The center of the lamp shall be placed at a distance of 5 feet from the center of the ABC sensor.

[1] http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol3/pdf/CFR-2011-title10-vol3-sec430-2.pdf

c) The center of the lamp shall be aligned at a horizontal angle of 0° with respect to the center of the UUT's ABC sensor.

d) The center of the lamp shall be aligned at a height equal to the center of the UUT's ABC sensor with respect to the floor (i.e. the light source shall be placed at a vertical angle of 0° with respect to the center of the UUT's ABC sensor).

e) No test room surface (i.e., floor, ceiling, and wall) shall be within 2 feet of the center of the UUT's ABC Sensor.

f) Illuminance values shall be obtained by varying the input voltage of the lamp.

g) Figure 1 and Figure 2 and provide more information on UUT and light source alignment.

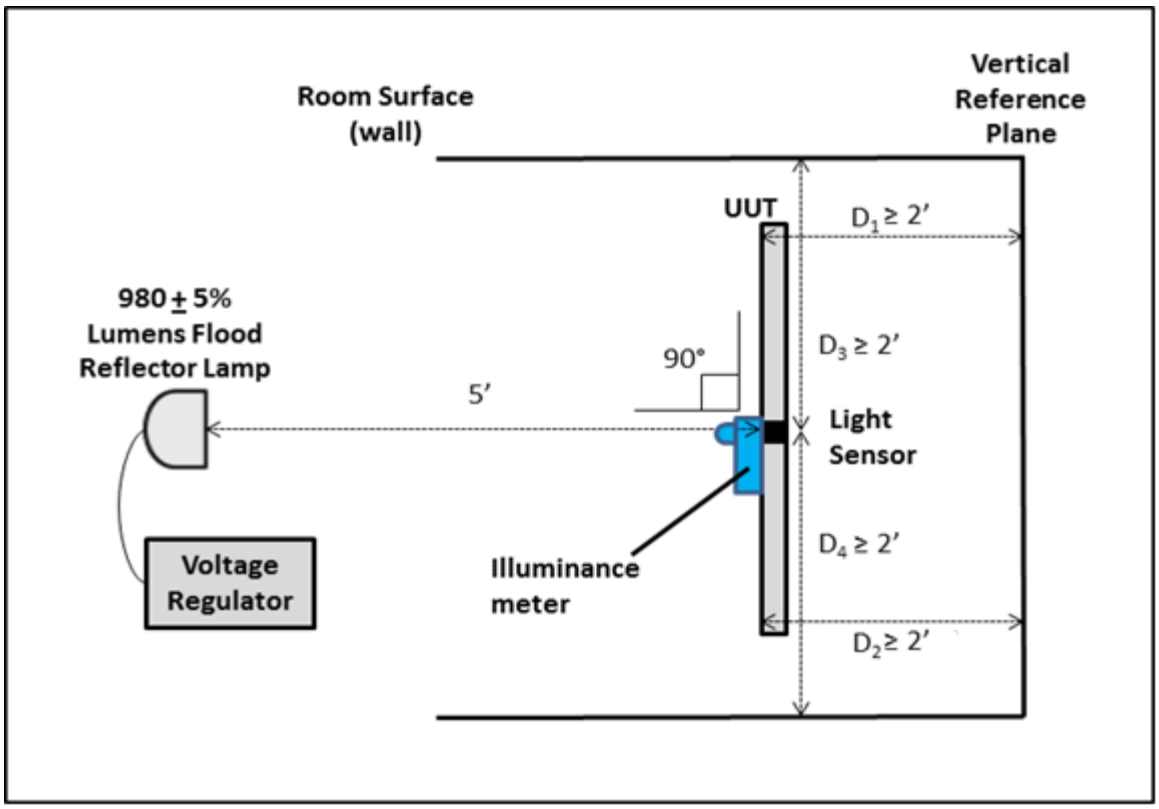

Figure 1: Test Setup - Top View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- D_3 and D_4 indicate that the center of the light sensor shall be at least 2 feet from the room walls

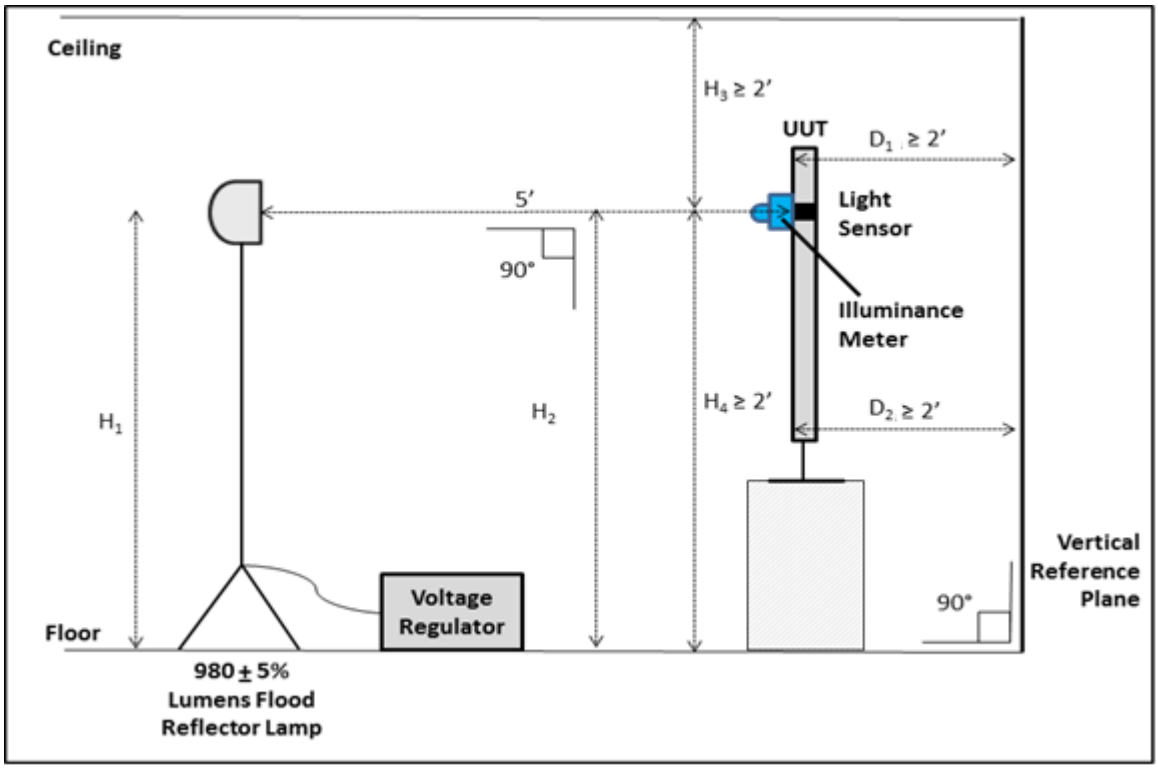

Figure 2: Test Setup - Side View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- Illuminance meter shall be removed for power measurements, after target illuminance achieved
- $H_1 = H_2$ with respect to horizontal reference plane (e.g. floor)
- H_3 and H_4 indicate that the center of the light sensor must be at least 2 feet from the floor and 2 feet from the ceiling
- Illuminance meter removed for power measurements, after target illuminance achieved

H) Power Meter: Power meters shall possess the following attributes

1) Crest Factor:

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

   b) Lower bound on the current range of 10 mA or less

2) Minimum Frequency Response: 3.0 kHz

3) Minimum Resolution:

   a) 0.01 W for measurement values less than or equal to 10 W;

b) 0.1 W for measurement values from greater than 10 W to 100 W; and

c) 1.0 W for measurement values greater than 100 W.

l) Light Measuring Device (LMD):

1) Luminance measurement shall be performed using either

a) A contact meter; or

b) A distance meter

2) All LMDs shall meet the following specifications:

a) Accuracy: ± 2% (± 2 digits) of the digitally displayed value

b) Acceptance Angle: 3 degrees or less

The overall accuracy of LMDs is found by taking (±) the absolute sum of 2% of the targeted illuminance and a 2 digit tolerance of the displayed value least significant digit. For example, if the LMD displays “200.0” when measuring a screen brightness of 200 nits, 2% of 200 nits is 4.0 nits. The least significant digit is 0.1 nits. “Two digits” implies 0.2 nits. Thus, the displayed value would be 200 ± 4.2 nits (4 nits + 0.2 nits).The accuracy is specific to the LMD and shall not be considered as tolerance during actual light measurements. Light measurement accuracy shall be within the tolerance specified in 4.J)4).

J) 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.

3) All ambient light values (measured lux) shall be measured at the location of the ABC sensor on the UUT with light entering directly into the sensor and with the IEC 62087 Ed. 3.0 test signal main menu displayed on the product. For products not compatible with the IEC 62087 test signal format, ambient light values shall be measured with the VESA FPDM2 FK test signal being displayed on the product.

4) Ambient light values shall be measured within the following tolerances:

a) At 10 lux, ambient lighting shall be within ± 1.0 lux; and

b) At 300 lux, ambient lighting shall be within ± 9.0 lux.

5 TEST CONDUCT

5.1 Guidance for Implementation of IEC 62087 Ed. 3.0

A) Testing at Factory Default Settings: Power measurements shall be performed with the product in its as-shipped condition for the duration of Sleep Mode and On Mode testing, with all user-configurable options set to factory defaults, except as otherwise specified by this test method.

1) Picture level adjustments shall be performed per the instructions in this test method.

2) Products that include a “forced menu” upon initial start-up shall be tested in “standard” or “home” picture setting. In the case that no “standard” setting or equivalent exists, the default setting recommended by the manufacturer shall be used for testing and recorded in the test report. Products that do not include a “forced menu” shall be tested in the default picture setting.

B) Point of Deployment (POD) Modules: Optional POD modules shall not be installed.

C) Multiple Sleep Modes: If the product offers multiple Sleep Modes, the power during all Sleep Modes shall be measured and recorded. All Sleep Mode Testing shall be carried out as per Section 6.5.

5.2 Conditions for Power Measurements

A) Power measurements:

1) Power measurements shall be taken from a point between the power source and the UUT. No Uninterruptible Power Supply (UPS) units may be connected between the power meter and the UUT. The power meter shall remain in place until all On Mode, Sleep Mode and Off Mode power data are fully recorded.

2) Power measurements shall be recorded in watts as directly measured (unrounded) values at a rate of greater than or equal to 1 reading per second.

3) Power measurements shall be recorded after voltage measurements are stable to within 1%.

B) Dark Room Conditions:

1) Unless otherwise specified, the illuminance measured at the UUT screen with the UUT in Off Mode shall be less than or equal to 1.0 lux. If the UUT does not have an Off Mode, the illuminance shall be measured at the UUT screen with the UUT’s power cord disconnected.

C) UUT Configuration and Control:

1) Peripherals and Network Connections:

a) External peripheral devices (e.g. mouse, keyboard, external hard disk drive (HDD) etc.) shall not be connected to USB ports or other data ports on the UUT.

b) Bridging: If the UUT supports bridging per the definition in section 1 of the ENERGY STAR Eligibility Criteria Version 6.0, a bridge connection shall be made between the UUT and the host machine. The connection shall be made in the following order of preference. Only one connection shall be made and the connection shall be maintained for the duration of the test.

i. Thunderbolt

ii. USB

iii. Firewire (IEEE 1394)

iv. Other

Note: Examples of bridging for displays may include:

1. *A case where the display converts data between two different port types (e.g. Thunderbolt and Ethernet). This can allow a device to use Thunderbolt as an Ethernet connection or vice versa.*
2. *Allowing a USB keyboard/mouse to be connected to another system (e.g. host system) through the display by a USB hub controller.*

c) Networking: If the UUT has networking capability (i.e., it has the ability to obtain an IP address when configured and connected to a network) the networking capability shall be activated, and the UUT shall be connected to a live physical network (e.g., WiFi, Ethernet, etc.). The physical network shall support the highest and lowest data speeds of the UUT's network function. An active connection is defined as a live physical connection over the physical layer of the networking protocol. In the case of Ethernet, the connection shall be via a standard Cat 5e or better Ethernet cable to an Ethernet switch or router. In the case of WiFi the device shall be connected and tested in proximity to a wireless access point (AP). The tester shall configure the address layer of the protocol, taking note of the following:

   i. Internet Protocol (IP) v4 and IPv6 have neighbor discovery and will generally configure a limited, non-routable connection automatically.

   ii. IP can be configured manually or by using Dynamic Host Configuration Protocol (DHCP) with an address in the 192.168.1.x Network Address Translation (NAT) address space if the UUT does not behave normally when autoIP is used. The network shall be configured to support the NAT address space and/or autoIP.

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

   i. WiFi (Institution of Electrical and Electronics Engineers - IEEE 802.11- 2007[2])

   ii. Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet (IEEE 802.3az-2010[3]), then it shall be connected to a device that also supports IEEE 802.3az

   iii. Thunderbolt

   iv. USB

   v. Firewire (IEEE 1394)

   vi. Other

e) In the case of a UUT that has a single connection capable of performing both bridging and networking functionality, a single connector can be used to meet these functionalities provided it is the highest preferred connection the UUT supports for each functionality.

f) In the case of a UUT that has no data/network capabilities, the UUT shall be tested as-shipped.

g) Built-in speakers and other product features and functions not specifically addressed by the ENERGY STAR eligibility criteria or test method must be configured in the as-shipped power configuration.

h) Availability of other capabilities such as occupancy sensors, flash memory-card/smart-card readers, camera interfaces, PictBridge shall be recorded.

2) Signal Interface:

a) If the UUT has multiple signal interfaces, the UUT shall be tested with the first available interface from the list below:

   i. Thunderbolt

   ii. DisplayPort

[2] IEEE 802 – Telecommunications and information exchange between systems—Local and metropolitan area networks – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[3] Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Amendment 5: Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet

iii. HDMI

iv. DVI

v. VGA

vi. Other Digital Interface

vii. Other Analog Interface

3) Occupancy Sensor: If the UUT has an occupancy sensor, the UUT shall be tested with the occupancy sensor settings in the as-shipped condition. For UUT's with an occupancy sensor enabled as-shipped:

a) A person shall be within close proximity of the occupancy sensor for the entire warm up, stabilization, luminance testing and On Mode to prevent the UUT from entering a lower power state (e.g. Sleep Mode or Off Mode). The UUT shall remain in On Mode for the duration of the warm up period, stabilization period, luminance test and On Mode test.

b) No person shall be within close proximity of the occupancy sensor for the duration of the Sleep Mode and Off Mode tests to prevent the UUT from entering a higher power state (e.g. On Mode). The UUT shall remain in Sleep Mode or Off Mode for the duration of the Sleep Mode or Off Mode tests, respectively.

D) Resolution and Refresh Rate:

1) Fixed-pixel Displays:

a) Pixel format shall be set to the native level as specified in the product manual.

b) For non-Cathode Ray Tube (CRT) Displays, 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.

c) For CRT Displays, 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. Typical industry standards for pixel format timing shall be used for testing. Refresh rate shall be set to 75 Hz.

E) Battery Operated Products:

1) For products designed to operate using batteries when not connected to the mains, the battery shall be removed for all tests. For UUTs where operation without a battery pack is not a supported configuration, the batteries shall be fully charged before the start of testing and shall be left in place for the test. To ensure the battery is fully charged, perform the following steps:

a) For products that have an indicator to show that the battery is fully charged, continue charging for an additional 5 hours after the charged indicator is present.

b) If there is no charge indicator, but the manufacturer's instructions provide a time estimate for when charging this battery or this capacity of battery should be complete, continue charging for an additional 5 hours after the manufacturer's estimate.

c) If there is no indicator and no time estimate in the instructions, but the charging current is stated on the UUT or in the instructions, terminate charging 1 hour after the calculated test duration or, if none of the above applies, the duration shall be 24 hours.

F) Accuracy of Input Signal Levels: When using analog interfaces, video inputs shall be within ± 2% of referenced white and black levels. When using digital interfaces, the source video signal shall not be adjusted for color, or modified by the tester for any purpose other than to compress/inflate and encode/decode for transmission, as required.

G) True Power Factor: Partners shall report the true power factor (PF) of the UUT during On Mode measurement. The power factor values shall be recorded at the same rate at which the power values are recorded. The reported power factor shall be averaged over the entire duration of the On Mode testing.

H) Test Materials:

1) "IEC 62087-2011 Dynamic Broadcast-Content Signal" shall be used for testing, as specified in IEC 62087, Ed. 3.0, Section 11.6, "On (average) mode testing using dynamic broadcast-content video signal."

2) "Video Electronics Standard Association (VESA) Flat Panel Display Measurements (FPDM) Standard version 2.0 test patterns" shall be used only for products that cannot be tested using the IEC 62087-2011 Dynamic Broadcast-Content Signal.

5.3 Low-Voltage Dc Source Measurement

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

1) Verify that the dc source is unloaded.

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

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

4) Record the brand name, model number, voltage and current rating of the dc source.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 Pre-Test UUT Initialization

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 product manual.

2) Connect an acceptable watt meter to the power source and connect the UUT to the power outlet on the watt meter.

3) With the UUT off, set the ambient light level such that the measured screen illuminance is less than 1.0 lux (see Section 5.2B)).

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

5) Ensure UUT settings are in their as-shipped configuration, unless otherwise specified in this Test Method.

6) Warm up the UUT for 20 minutes, or the time it takes the UUT to complete initialization and become ready for use, whichever is longer. The IEC 62087 test signal format, as specified in section 5.2 H) 1), shall be displayed for the entire warm up period. Displays that are not compatible with the IEC 62087 test signal format shall have the VESA FPDM2 L80 test signal, as specified in section 5.2H)2), displayed on the screen.

7) Report the ac input voltage and frequency.

8) Report the test room ambient temperature and relative humidity.

6.2 Luminance Testing

A) Luminance testing shall be performed immediately following the warm up period and in dark room conditions. Product screen illuminance, as measured with the UUT in Off Mode, shall be less than or equal to 1.0 lux.

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

C) The position of the LMD relative to the product screen shall remain fixed throughout the duration of testing.

D) For products with ABC, luminance measurements shall be performed with ABC disabled. If ABC cannot be disabled, luminance measurements shall be measured perpendicular to the center of the product screen with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux.

E) Luminance measurements shall be performed as follows:

1) Verify that the UUT is in the default as-shipped luminance value or "Home" picture setting.

2) Display the test video signal for the specific product class, as described below:

a) All products: IEC 62087-2011 Three-bar video signal specified in IEC 62087, Ed. 3.0, Section 11.5.5 (three bars of white (100%) over a black (0%) background).

b) Products that cannot be tested with signals from IEC 62087: VESA FPDM2 L80 test signal for the maximum resolution supported by the product.

3) Display the test video signal for no less than 10 minutes to allow the UUT luminance to stabilize. This 10 minute stabilization period may be reduced if luminance measurements are stable to within 2% over a period of not less than 60 seconds.

4) Measure and record the luminance in default as-shipped setting $L_{As\text{-}shipped}$.

5) Set the brightness and contrast levels of the UUT to their maximum values.

6) Measure and record the luminance as $L_{Max\_Measured}$.

7) Record the manufacturer-reported maximum luminance $L_{Max\_Reported}$.

F) The contrast setting shall be left at the maximum level for the subsequent On Mode tests unless otherwise specified.

6.3 On Mode Testing for Products without ABC Enabled by Default

A) After the Luminance Testing and prior to On Mode power measurement, the luminance of the UUT shall be set according to the following:

1) For products with viewable diagonal screen size **less than 30 inches and any Computer Monitors 30 inches or more**, adjust appropriate luminance controls until the luminance of the screen is **200 candelas per square meter (cd/m^2)**. If the UUT cannot achieve this luminance, set the product luminance to the nearest achievable value. Luminance values shall be measured as per section 6.2. This luminance value L_{On} shall be reported. Appropriate luminance controls refer to any controls that adjust the brightness of the display, but do not include contrast settings.

2) For products with viewable diagonal screen size of **30 inches or more that are Signage Displays**, the product shall be tested with luminance set at a value greater than or equal to 65% of the manufacturer-reported maximum luminance ($L_{Max\_Reported}$). Luminance values shall be measured as per section 6.2. This luminance value L_{On} shall be recorded.

B) For a UUT capable of displaying the IEC signals, On Mode power (P_{ON}) shall be measured according to IEC 62087 Ed 3.0 Section 11: Measuring Conditions for Television Sets in On (average) Mode; with the additional guidance in Section 5.

1) Section 11.6 "On (average) Mode testing using dynamic broadcast-content video signal" for products capable of playing video.

C) For a UUT not capable of displaying the IEC signals, On Mode power (P_{ON}) shall be measured as follows:

1) Ensure that the UUT has been initialized per Section 6.1.

2) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).

3) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.

4) 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.

5) Display the VESA FPDM2, A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).

6) Ensure that the LMD measurement area falls entirely within the white portion of the test pattern.

7) Adjust appropriate luminance controls until the luminance of the white area of the screen is set as described in section 6.3A).

8) Record the screen luminance (L_{On}).

9) Record On Mode power (P_{ON}) and total pixel format (horizontal x vertical). The On Mode power shall be measured over a 10 minute period similar to the IEC 62087 Ed 3.0 dynamic broadcast-content test.

6.4 On Mode Testing for Products with ABC Enabled by Default

The average On Mode power consumption of the product shall be determined with the dynamic broadcast-content as defined in IEC 62087 Ed. 3.0. If the product does not support the IEC 62087 signal format, then the VESA FPDM2 L80 test pattern, as described in section 6.3C)5), shall be used for all of the following steps.

A) Stabilize the UUT for 30 minutes. This shall be done with three repetitions of the 10 minute IEC dynamic broadcast-content video signal.

B) Set the light output of the lamp used for testing to 10 lux as measured at the face of the ambient light sensor.

C) Display the 10 minute dynamic broadcast-content video signal. Measure and record the power consumption, P_{10}, during the 10 minute dynamic broadcast-content video signal.

D) Repeat steps 6.4B) and 6.4C) for an ambient light level of 300 lux, to measure P_{300}.

E) Disable ABC and measure On Mode power (P_{ON}) per Section 6.3. If ABC cannot be disabled, power measurements shall be conducted as follows:

1) If the brightness can be set to a fixed value as specified in Section 6.3, then On Mode power for these products shall be measured as per Section 6.3 with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux.

2) If the brightness cannot be set to a fixed value, then On Mode power for these products shall be measured as per Section 6.3 with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux and without modifying the screen brightness.

6.5 Sleep Mode Testing

A) Sleep Mode power (P_{SLEEP}) shall be measured according to IEC 62301-2011: Household Electrical Appliances – Measurement of Standby Power, with the additional guidance in Section 5.

B) The Sleep Mode test shall be conducted with the UUT connected to the host machine. The host machine shall be placed into Sleep Mode. For a computer host machine, Sleep Mode is defined in the Version 5.2 ENERGY STAR Computers specification.

C) If the product has a variety of Sleep Modes that may be manually selected, or if the product can enter Sleep Mode via different methods (e.g., remote control or putting the host PC to sleep), measurements shall be performed and recorded in all Sleep Modes.

If the product automatically transitions through its various Sleep Modes, the measurement time shall be long enough to obtain an average of all Sleep Modes. The measurement shall still meet requirements (e.g., stability, measurement period, etc.) outlined in Section 5.3 of IEC 62301-2011.

6.6 Off Mode Testing

A) For products having Off Mode capability, at the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.

B) Measure Off Mode power (P_{OFF}) according to Section 5.3.1 of the IEC 62301 off mode test. Document the method of adjustment and sequence of events required to reach Off Mode.

C) Any input synchronizing signal check cycle may be ignored when measuring Off Mode power.

D) Off Mode power for products without a physical power switch shall be measured with the UUT connected to the host machine, with the host machine in the power Off Mode.

6.7 Additional Testing

A) For products with data/networking capabilities, in addition to tests performed with data/networking capabilities activated and a bridge connection established (see Section 5.2C)1)), Sleep Mode Testing shall be performed with data/networking features deactivated and without any bridge connection established, per Section 5.2C) b), c) and d).

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

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.
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.
3. **Ensure that any model associated with the ENERGY STAR name or mark** meets the following standards:

   3.1. Product material requirements as defined in restriction of hazardous substances (RoHS) regulations, as generally accepted. This includes exemptions in force at the date of product manufacture, where the maximum concentration values tolerated by weight in homogeneous materials are: lead (0.1%), mercury (0.1%), cadmium (0.01%), hexavalent chromium (0.1%), polybrominated biphenyls (PBB) (0.1%), or polybrominated diphenyl ethers (PBDE) (0.1%). Batteries are exempt.

   3.2. The generally accepted attributes of a recyclable product at the date of product manufacture: where products shall be designed for ease of disassembly and recyclability where external enclosures, sub-enclosures, chassis and electronic subassemblies are easily removable with commonly available tools, by hand, or by a recycler's automated processes.

   Notes:

   - The explicit intention is to harmonize with EU RoHS.
   - For purposes of ENERGY STAR third-party certification, these requirements shall not be reviewed when products are initially qualified nor during subsequent verification testing. Rather, EPA reserves the right to request supporting documentation at any time.

Using the ENERGY STAR Name and Marks

4. 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.
5. 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 US and/or ENERGY STAR partner countries.
6. Provide clear and consistent labeling of ENERGY STAR qualified displays.

   6.1. The ENERGY STAR mark must be clearly displayed:

6.1.1. 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/logouse) 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.

6.1.2. In product literature (i.e., user manuals, specification sheets, etc.);

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

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

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

Verifying Ongoing Product Qualification

7. 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

8. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
   8.1. 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).
   8.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
   8.3. 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;

9. Report to EPA any attempts by recognized laboratories or certification bodies to influence testing or certification results or to engage in discriminatory practices.
10. 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.

Performance for Special Distinction

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.
- 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.

ENERGY STAR® Program Requirements Product Specification for Displays

Eligibility Criteria Version 7.0 Rev. May-2016

Following is the Version 7.0 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 product with a display screen and associated electronics, often encased in a single housing, that as its primary function produces visual information from (1) a computer, workstation, or server via one or more inputs (e.g., VGA, DVI, HDMI, DisplayPort, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memory card), or (3) a network connection.

a) Monitor: An Electronic Display intended for one person to view in a desk based environment.

b) Signage Display: An Electronic Display intended for multiple people to view in non-desk based environments, such as retail or department stores, restaurants, museums, hotels, outdoor venues, airports, conference rooms or classrooms. For the purposes of this specification, a Display shall be classified as a Signage Display if it meets two or more criteria listed below:

(1) Diagonal screen size is greater than 30 inches;

(2) Maximum Reported Luminance is greater than 400 candelas per square meter;

(3) Pixel density is less than or equal to 5,000 pixels per square inch; or

(4) Ships without a mounting stand.

B) Operational Modes:

1) On Mode: The mode in which the Display has been activated, and is providing the primary function.

2) Sleep Mode: A low-power mode in which the Display provides one or more non-primary protective functions or continuous functions.

Note: Sleep Mode may serve the following functions: facilitate the activation of On Mode via remote switch, Touch Technology, internal sensor, or timer; provide information or status displays including clocks; support sensor-based functions; or maintain a network presence.

3) Off Mode: The mode where the Display is connected to a power source, produces no visual information, and cannot be switched into any other mode with the remote control unit, an internal signal, or an external signal.

Note: The Display may only exit this mode by direct user actuation of an integrated power switch or control. Some products may not have an Off Mode.

C) Visual Characteristics:

1) Ambient Light Conditions: The combination of light illuminances in the environment surrounding a Display, such as a living room or an office.

2) Automatic Brightness Control (ABC): The self-acting mechanism that controls the brightness of a Display as a function of Ambient Light Conditions.

   Note: ABC functionality must be enabled to control the brightness of a Display.

3) Color Gamut: Color gamut area shall be reported as a percentage of the CIE LUV 1976 *u*' *v*' color space and calculated per Section 5.18 Gamut Area of the Information Display Measurements Standard Version 1.03.

   Note: Any gamut support in non-visible/invisible color areas is not to be counted. The gamut's size must be expressed as a percentage of area of the visible CIE LUV color space only.

4) Luminance: The photometric measure of the luminous intensity per unit area of light travelling in a given direction, expressed in candelas per square meter (cd/m^2).

   a) Maximum Reported Luminance: The maximum luminance the Display may attain at an On Mode preset setting, and as specified by the manufacturer, for example, in the user manual.

   b) Maximum Measured Luminance: The maximum measured luminance the Display may attain by manually configuring its controls, such as brightness and contrast.

   c) As-shipped Luminance: The luminance of the Display at the factory default preset setting the manufacturer selects for normal home or applicable market use.

5) Native Vertical Resolution**:** The number of physical lines along the vertical axis of the Display within the visible area of the Display.

   Note: A Display with a screen resolution of 1920 x 1080 (horizontal x vertical) would have a Native Vertical Resolution of 1080.

6) Screen Area: The visible area of the Display that produces images.

   Note: Screen Area is calculated by multiplying the viewable image width by the viewable image height. For curved screens, measure the width and height along the arc of the Display.

D) Additional Functions and Features:

1) Bridge Connection: A physical connection between two hub controllers (i.e., USB, FireWire).

   Note: Bridge Connections allow for expansion of ports typically for the purpose of relocating the ports to a more convenient location or increasing the number of available ports.

2) Full Network Connectivity: The ability of the Display to maintain network presence while in Sleep Mode. Presence of the Display, its network services, and its applications, is maintained even if some components of the Display are powered down. The Display can elect to change power states based on receipt of network data from remote network devices, but should otherwise stay in Sleep Mode absent a demand for services from a remote network device.

   Note: Full Network Connectivity is not limited to a specific set of protocols. Also referred to as "network proxy" functionality and described in the Ecma-393 standard.

3) Occupancy Sensor: A device used to detect human presence in front of or in the area surrounding a Display.

   Note: An Occupancy Sensor is typically used to switch a Display between On Mode and Sleep Mode.

4) Touch Technology: Enables the user to interact with a product by touching areas on the Display screen.

5) Plug-in Module: A modular plugin device that provides one or more of the following functions without the explicit purpose of providing general computing function:

   a) Display images, mirror remote content streamed to it, or otherwise render content on the screen from local or remote sources; or

   b) Process touch signals.

   Note: Modules providing any other additional input options are not considered Plug-in Modules for the purposes of this specification.

E) Product Family: A group of product models that (1) are made by the same manufacturer, (2) share the same Screen Area, Resolution, and Maximum Reported Luminance, and (3) are of a common basic screen design. Models within a Product Family may differ from each other according to one or more characteristics or features. For Displays, acceptable variations within a Product Family include:

   1) External housing;

   2) Number and types of interfaces;

   3) Number and types of data, network, or peripheral ports; and

   4) Processing and memory capability.

F) Representative Model: The product configuration that is tested for ENERGY STAR certification and is intended to be marketed and labeled as ENERGY STAR.

G) Power Source

   1) External Power Supply (EPS): An external power supply circuit that is used to convert household electric current into dc current or lower-voltage ac current to operate a consumer product.

   2) Standard dc: A method for transmitting dc power defined by a well-known technology standard, enabling plug-and-play interoperability.

      Note: Common examples are USB and Power-over-Ethernet. Usually Standard dc includes both power and communications over the same cable, but as with the 380 V dc standard, that is not required.

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, an External Power Supply, or Standard dc are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.2. Typical products that would be eligible for certification under this specification include:

i. Monitors;

ii. Monitors with keyboard, video, and mouse (KVM) switch functionality;

iii. Signage Displays; and

iv. Signage Displays and Monitors with Plug-in Modules.

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under this specification including Televisions and Computers (Thin Clients, Slates/Tablets, Portable All-in-one Computers, Integrated Desktops). The list of specifications currently in effect can be found at www.energystar.gov/products.

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

i. Products with an integrated television tuner;

ii. Displays with integrated or replaceable batteries designed to support primary operation without ac mains or external dc power, or device mobility (e.g., electronic readers, battery-powered digital picture frames); and

iii. Products that must meet Food and Drug Administration specifications for medical devices that prohibit power management capabilities and/or do not have a power state meeting the definition of Sleep Mode.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

3.1.2 Unless otherwise specified, compliance with specification requirements shall be evaluated using directly measured or calculated values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification requirements.

3.2 General Requirements for Monitors and Signage Displays

3.2.1 External Power Supplies (EPSs): Single- and Multiple-voltage EPSs shall meet the Level VI or higher performance requirements under the International Efficiency Marking Protocol when tested according to the Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to 10 CFR Part 430.

i. Single- and Multiple-voltage EPSs shall include the Level VI or higher marking.

ii. Additional information on the Marking Protocol is available at http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218.

3.2.2 Power Management:

i. 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 either by a connected host device or internally (e.g., support for VESA Display Power Management Signaling (DPMS), enabled by default).

ii. 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.

iii. For products that have an internal default delay time after which the product transitions from On Mode to Sleep Mode or Off Mode, the delay time shall be reported.

iv. Monitors shall automatically enter Sleep Mode or Off Mode within 5 minutes of being disconnected from a host computer.

3.2.3 Signage Displays shall have a true power factor in On Mode of 0.7 or greater per Section 5.2.F) in the ENERGY STAR Test Method.

3.3 Energy Requirements for Computer Monitors

3.3.1 The Total Energy Consumption (TEC) in kWh shall be calculated per Equation 1 based on measured values.

Equation 1: Total Energy Consumption Calculation

$$E_{TEC} = 8.76 \times (0.35 \times P_{ON} + 0.65 \times P_{SLEEP})$$

Where:

- *E_{TEC} is the Total Energy Consumption calculation in kWh;*
- *P_{ON} is Measured On Mode Power in watts*
- *P_{SLEEP} is Measured Sleep Mode Power in watts; and*
- *The result shall be rounded to the nearest tenth of a kWh for reporting.*

3.3.2 The Maximum TEC (E_{TEC_MAX}) in kWh for Monitors shall be calculated per Table 1.

Table 1: Calculation of Maximum TEC (E_{TEC_MAX}) for Monitors in kWh

Area (in^2)	**E_{TEC} Max (kWh)** Where: A = Viewable screen area in in^2 r = Screen resolution in megapixels The result shall be rounded to the nearest tenth of a kWh for reporting
A < 130	$(6.13 \times r) + (0.06 \times A) + 9$
130 ≤ A <150	$(6.13 \times r) + (0.69 \times A) - 72.38$
150 ≤ A <180	$(6.13 \times r) + (0.21 \times A) - 0.50$
180 ≤ A < 200	$(6.13 \times r) + (0.05 \times A) + 28$
200 ≤ A <230	$(6.13 \times r) + (0.03 \times A) + 31.33$
230 ≤ A <280	$(6.13 \times r) + (0.2 \times A) - 7$
280 ≤ A <300	$(6.13 \times r) + 49$
300 ≤ A <500	$(6.13 \times r) + (0.2 \times A) - 11$
A ≥ 500	$(6.13 \times r) + 89$

3.3.3 For all Monitors, Calculated TEC (E_{TEC}) in kWh shall be less than or equal the calculation of Maximum TEC (E_{TEC_MAX}) with the applicable allowances and adjustments (applied at most once) per Equation 2.

Equation 2: Total Energy Consumption Requirement for Monitors

$$E_{TEC} \leq (E_{TEC\_MAX} + E_{EP} + E_{ABC} + E_N + E_{OS} + E_T) \times eff_{AC\_DC}$$

Where:

- *E_{TEC} is TEC in kWh calculated per Equation 1;*
- *E_{TEC_MAX} is the Maximum TEC requirement in kWh calculated per Table 1;*
- *E_{EP} is the enhanced performance display allowance in kWh per Section 3.3.4;*
- *E_{ABC} is the Automatic Brightness Control allowance in kWh per Equation 4;*
- *E_N is the Full Network Connectivity allowance in kWh per Table 3;*
- *E_{OS} is the Occupancy Sensor allowance in kWh per Table 4;*
- *E_T is the Touch Technology allowance in kWh per Equation 5; and*
- *eff_{AC_DC} is the standard adjustment for ac-dc power conversion losses that occur at the device powering the Display, and is 1.0 for Ac-powered Displays and 0.85 for Displays with Standard dc.*

3.3.4 For Monitors meeting the enhanced performance display (EPD) requirements below, only one of the following Table 2 allowances shall be used in Equation 2:

i. Contrast ratio of at least 60:1 measured at a horizontal viewing angle of at least 85° from the perpendicular on a flat screen and at least 83° from the perpendicular on a curved screen, with or without a screen cover glass;

ii. A native resolution greater than or equal to 2.3 megapixels (MP); and

iii. Color Gamut greater than or equal to 32.9% of CIE LUV.

Table 2: Calculation of Energy Allowance for Enhanced Performance Displays

Color Gamut Criteria	**E_{EP} (kWh)** *Where:* ▪ *E_{TEC_MAX} is the Maximum TEC requirement in kWh; and* ▪ *r is screen resolution in megapixels*
Color Gamut support is 32.9% of CIE LUV or greater.	$0.15 \times (E_{TEC_{MAX}} - 6.13 \times r)$
Color Gamut support is 38.4% of CIE LUV or greater.	$0.65 \times (E_{TEC\_MAX} - 6.13 \times r)$

Note: A model supporting greater than 99% of the sRGB color space translates to 32.9% of CIE LUV and a model supporting greater than 99% of Adobe RGB translates to 38.4% of CIE LUV.

3.3.5 For monitors with Automatic Brightness Control (ABC) enabled by default, an energy allowance (E_{ABC}), as calculated per Equation 4, shall be added to E_{TEC_MAX} in Equation 2, if the On Mode power reduction (R_{ABC}), as calculated per Equation 3, is greater than or equal to 20%.

Equation 3: Calculation of On Mode Reduction with ABC Enabled by Default

$$R_{ABC} = 100\% \times \left(\frac{P_{300} - P_{12}}{P_{300}}\right)$$

Where:

- *R_{ABC} is the On Mode percent power reduction due to ABC;*
- *P_{300} is the On Mode power in watts, as measured at an ambient light level of 300 lux in Section 6.4 of the Test Method; and*
- *P_{12} is the On Mode power in watts, as measured at an ambient light level of 12 lux in Section 6.4 of the Test Method.*

Equation 4: Monitors ABC Energy Allowance (E_{ABC}) for Monitors

$$E_{ABC} = 0.05 \times E_{TEC\_MAX}$$

Where:

- *E_{ABC} is the energy allowance for Automatic Brightness Control in kWh; and*
- *E_{TEC_MAX} is the Maximum TEC in kWh, per Table 1.*

3.3.6 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test Method shall apply the allowance specified in Table 3.

Table 3: Full Network Connectivity Energy Allowance (E_N) for Monitors

E_N (kWh)
2.9

3.3.7 Products tested with an Occupancy Sensor active shall apply the allowance specified in Table 4.

Table 4: Additional Functions Energy Allowance (E_{OS}) for Monitors

Type	Allowance (kWh)
Occupancy Sensor E_{OS}	1.7

3.3.8 Products tested with Touch Technology active in On Mode shall apply the allowance specified in Equation 5.

Equation 5: Energy Allowance for Touch Technology (E_T) for Monitors

$$E_T = 0.15 \times E_{TEC\_MAX}$$

Where:

- *E_T is the energy allowance for Touch Technology in kWh; and*
- *E_{TEC_MAX} is the Maximum TEC in kWh, per Table 1.*

3.4 On Mode Requirements for Signage Displays

3.4.1 The Maximum On Mode Power (P_{ON_MAX}) in watts shall be calculated per Equation 6.

Equation 6: Calculation of Maximum On Mode Power (P_{ON_MAX}) in Watts for Signage Displays

$$P_{ON\_MAX} = (4.0 \times 10^{-5} \times \ell \times A) + 119 \times tanh(0.0008 \times (A - 200.0) + 0.11) + 6$$

Where:

- *P_{ON_MAX} is the Maximum on Mode Power, in watts;*
- *A is the Screen Area in square inches;*
- *ℓ is the Maximum Measured Luminance of the Display in candelas per square meter, as measured in Section 6.2 of the test method;*
- *tanh is the hyperbolic tangent function; and*
- *The result shall be rounded to the nearest tenth of a watt for reporting.*

Equation 7: On Mode Power Requirement for Signage Displays

$$P_{ON} \leq P_{ON\_MAX} + P_{ABC}$$

Where:

- *P_{ON} is On Mode Power in watts, as measured in Section 6.3 or 6.4 of the Test Method;*
- *P_{ON_MAX} is the Maximum On Mode Power in watts, per Equation 6; and*
- *P_{ABC} is the On Mode power allowance for ABC in watts, per Equation 8.*

3.4.2 For Signage Displays with ABC enabled by default, a power allowance (P_{ABC}), as calculated per Equation 8, shall be added to P_{ON_MAX}, as calculated per Equation 6, if the On Mode power reduction (R_{ABC}), as calculated per Equation 3, is greater than or equal to 20 percent.

Equation 8: Calculation of On Mode Power Allowance for Signage Displays with ABC Enabled by Default

$$P_{ABC} = 0.05 \times P_{ON\_MAX}$$

Where:

- *P_{ABC} is the Measured On Mode Power allowance for ABC in watts; and*
- *P_{ON_MAX} is the Maximum On Mode Power requirement in watts.*

3.5 Sleep Mode Requirements for Signage Displays

3.5.1 Measured Sleep Mode Power (P_{SLEEP}) in watts shall be less than or equal the sum of the Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) and any allowances (applied at most once) per Equation 9.

Equation 9: Sleep Mode Power Requirement for Signage Displays

$$P_{SLEEP} \leq P_{SLEEP_{MAX}} + P_N + P_{OS} + P_T$$

Where:

- *P_{SLEEP} is Measured Sleep Mode Power in watts;*
- *P_{SLEEP_MAX} is the Maximum Sleep Mode Power requirement in watts per Table 5;*
- *P_N is the Full Network Connectivity allowance in watts per Table 6;*
- *P_{OS} is the Occupancy Sensor allowance in watts per Table 7; and*
- *P_T is the Touch allowance in watts per Table 7.*

Table 5: Maximum Sleep Mode Power Requirement (P_{SLEEP_MAX}) for Signage Displays

P_{SLEEP_MAX} (watts)
0.5

3.5.2 Products with Full Network Connectivity confirmed in Section 6.7 of the ENERGY STAR Test Method shall apply the allowance specified in Table 6.

Table 6: Full Network Connectivity Allowance for Signage Displays

P_N (watts)
3.0

3.5.3 Products tested with an Occupancy Sensor or Touch Technology active in Sleep Mode shall apply the allowances specified in Table 7.

Table 7: Additional Functions Sleep Mode Power Allowance for Signage Displays

Type	Screen Size (in)	Allowance (watts)
Occupancy Sensor P_{OS}	All	0.3
Touch Functionality P_T ***(applicable only to Signage Displays where screen size is greater than 30 inches)***	≤ 30	0.0
	> 30	1.5

3.6 Off Mode Requirements for all Displays

3.6.1 A product need not have an Off Mode to be eligible for certification. For products that do offer Off Mode, measured Off Mode power (P_{OFF}) shall be less than or equal to the Maximum Off Mode Power Requirement (P_{OFF_MAX}) in Table 8.

Table 8: Maximum Off Mode Power Requirement (P_{OFF_MAX})

P_{OFF_MAX} (watts)
0.5

3.7 Luminance Reporting Requirements

3.7.1 Maximum Reported and Maximum Measured Luminance shall be reported for all products; As-Shipped Luminance shall be reported for all products except those with ABC enabled by default.

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR® Program Requirements for Displays: Partner Commitments for details.

4 TEST REQUIREMENTS

4.1 Test Methods

4.1.1 Test methods identified in Table 9 shall be used to determine certification for ENERGY STAR.

Table 9: Test Methods for ENERGY STAR Certification

Product Type	Test Method
All Product Types and Screen Sizes	ENERGY STAR Test Method for Determining Display Energy – Rev. Sep-2015
Enhanced Performance Displays	International Committee for Display Metrology (ICDM) Information Display Measurements Standard – Version 1.03
Displays Claiming Full Network Connectivity	CEA-2037-A, Determination of Television Set Power Consumption

4.2 Number of Units Required for Testing

4.2.1 One unit of a Representative Model, as defined in Section 1, shall be selected for testing.

4.2.2 For certification of a Product Family, the product configuration that represents the worst-case power demand for each product category within the Product Family shall be considered the Representative Model.

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 Manufacturers 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://energy.lbl.gov/controls/.

6 EFFECTIVE DATE

6.1.1 Effective Date: The Version 7.0 ENERGY STAR Display specification shall take effect on **July 1, 2016**. 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 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 ENERGY STAR certification is not automatically granted for the life of a model

7 CONSIDERATIONS FOR FUTURE REVISIONS

7.1.1 On Mode DC Power Limit: EPA is interested in considering a separate On Mode Power Maximum requirement for Standard dc products that does not necessitate an ac-dc conversion calculation. EPA anticipates these products will become more popular on the market with the latest USB standard and looks forward to receiving additional direct dc-tested data for these products.

ENERGY STAR® Program Requirements Product Specification for Displays

Final Test Method Rev. Sep-2015

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

The following test method is applicable to all products eligible for qualification under the ENERGY STAR Product Specification for Displays.

Note: The U.S. Department of Energy (DOE) has published the Test Procedure for Television Sets Final Rule (78 FR 63823). Any product that is included in DOE's scope of coverage for TVs shall ultimately be tested according to the Test Procedure for Television Sets Rulemaking published by DOE in Appendix H to subpart B of 10 CFR 430.

3 DEFINITIONS

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

A) Host Machine: The machine or device used as the source of video/audio signal for testing Displays. It may be a computer or any other device capable of providing a video signal.

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 International Electrotechnical Commission (IEC) 62301:2011, "Household electrical appliances - Measurement of standby power," Section 4, "General Conditions for Measurements," unless otherwise noted in this document. In the event of conflicting requirements, the ENERGY STAR Test Method shall take precedence.

B) Ac Input Power: Products capable of being powered from ac mains shall be connected to a voltage source appropriate for the intended market, as specified in Table 1. If an external power supply is shipped with the product, it shall be used to connect the product to the specified voltage source.

Table 1: Input Power Requirements for Products

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

C) Dc Input Power:

1) Products may be tested with a dc source (e.g., via network or data connection) only if dc is the only available source of power for the product (i.e., no ac plug or External Power Supply (EPS) is shipped with the product).

2) Dc-powered products shall be installed and powered as directed by the manufacturer, using a port with the full specifications recommended for the Display (e.g., Universal Serial Bus (USB) 3.1 if applicable, even if backwards-compatible with USB 2.0).

3) The power measurement shall be made between the dc source (e.g., Host Machine) and the cable shipped with the product, including the losses introduced by the shipped cable. If no cable is shipped with the product, any cable between 2 and 6 feet long may be used in its place. The resistance of the cable used to connect the Display to the point of measurement shall be measured and reported.

   Note: The measured resistance of dc power cables includes the sum of resistances of both the dc supply voltage wire and the ground wire.

4) A spliced cable may be used between the shipped cable and dc source in order to connect the power meter. If this method is used, the following requirements must be met:

   a) The spliced cable shall be used in addition to the shipped cable described in Section 4.C)3.

   b) The spliced cable shall be connected between the dc source and the shipped cable.

   c) The spliced cable shall be no longer than 1 foot.

   d) For measuring voltage, the total amount of wiring used between the voltage measurement and the shipped cable shall be less than 50 milli-ohms of resistance. This only applies to the wiring that is carrying load current.

      Note: Voltage and current need not necessarily be measured at the same location, so long as the voltage is measured within 50 milli-ohms of the shipped cable.

   e) The current measurement can be made either on the ground wire or the dc supply voltage wire.

   f) Figure 1 depicts an example spliced cable setup using a USB 2.0-powered Display connected to the Host Machine.

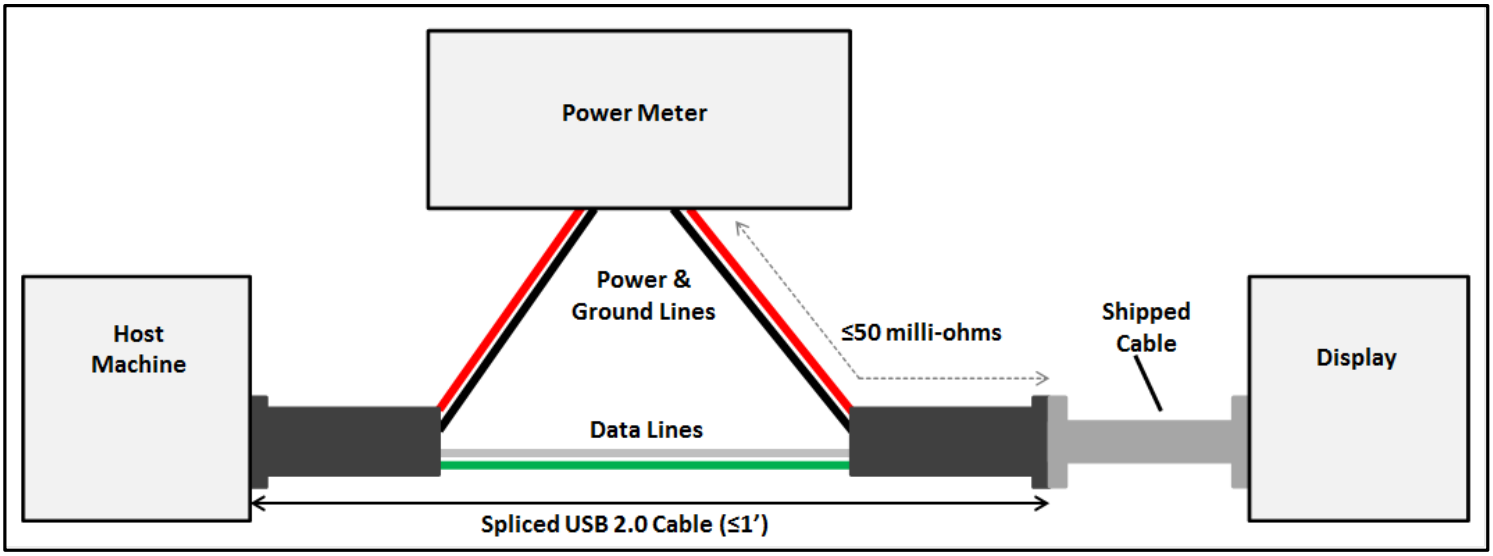

Figure 1: Example Spliced USB 2.0 Cable Arrangement

D) Ambient Temperature: Ambient temperature shall be 23° C ± 5° C.

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

F) UUT Alignment:

1) All four corners of the face of the Unit Under Test (UUT) shall be equidistant from a vertical reference plane (e.g., wall).

2) The bottom two corners of the face of the UUT shall be equidistant from a horizontal reference plane (e.g., floor).

G) Light Source for On Mode Testing:

1) Lamp Type:

a) Standard spectrum halogen flood reflector lamp. The lamp shall not meet the definition of "Modified spectrum" as defined in 10 CFR 430.2 - Definitions[1].

b) Rated Brightness: 980 ± 5% lumens.

2) Light Source Alignment For Testing Products With ABC Enabled By Default:

a) There shall be no obstructions between the lamp and the UUT's Automatic Brightness Control (ABC) sensor (e.g., diffusing media, frosted lamp covers, etc.).

b) The center of the lamp shall be placed at a distance of 5 feet from the center of the ABC sensor.

c) The center of the lamp shall be aligned at a horizontal angle of 0° with respect to the center of the UUT's ABC sensor.

d) The center of the lamp shall be aligned at a height equal to the center of the UUT's ABC sensor with respect to the floor (i.e. the light source shall be placed at a vertical angle of 0° with respect to the center of the UUT's ABC sensor).

e) No test room surface (i.e., floor, ceiling, and wall) shall be within 2 feet of the center of the UUT's ABC Sensor.

f) Illuminance values shall be obtained by varying the input voltage of the lamp.

[1] http://www.gpo.gov/fdsys/pkg/CFR-2011-title10-vol3/pdf/CFR-2011-title10-vol3-sec430-2.pdf

g) Figure 2 and Figure 3 and provide more information on UUT and light source alignment.

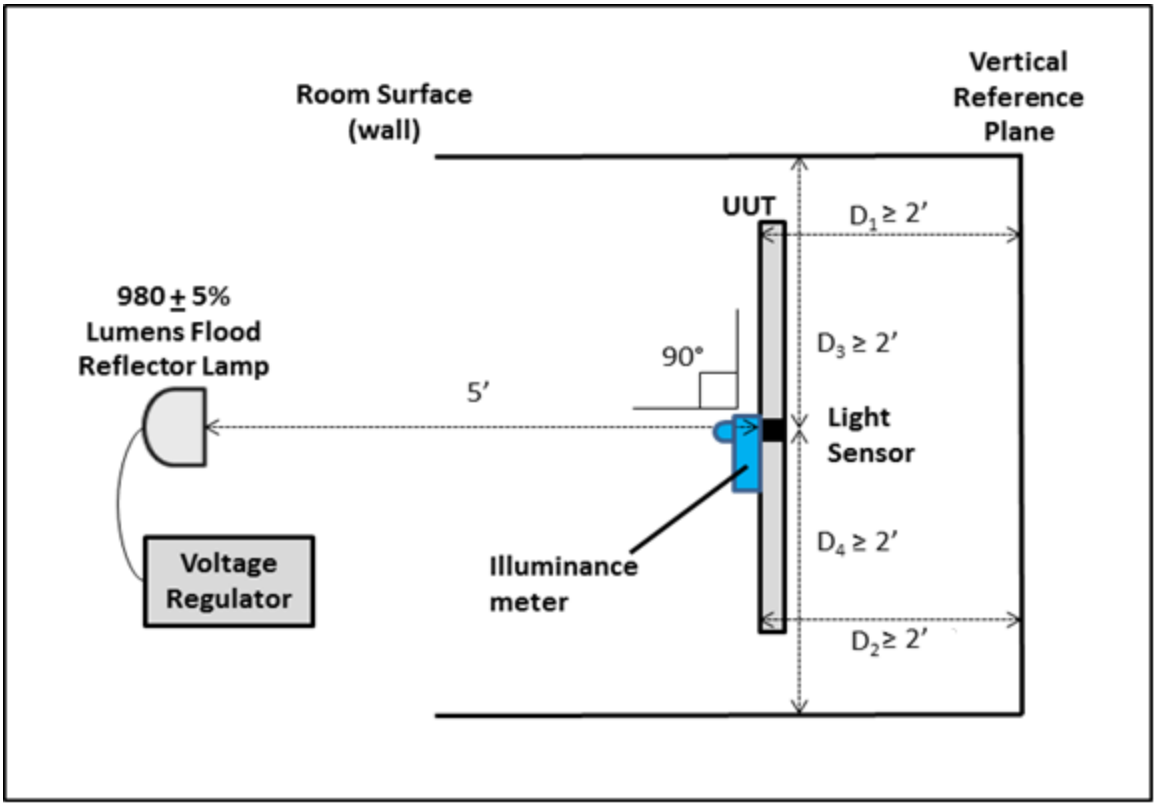

Figure 2: Test Setup - Top View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- D_3 and D_4 indicate that the center of the light sensor shall be at least 2 feet from the room walls

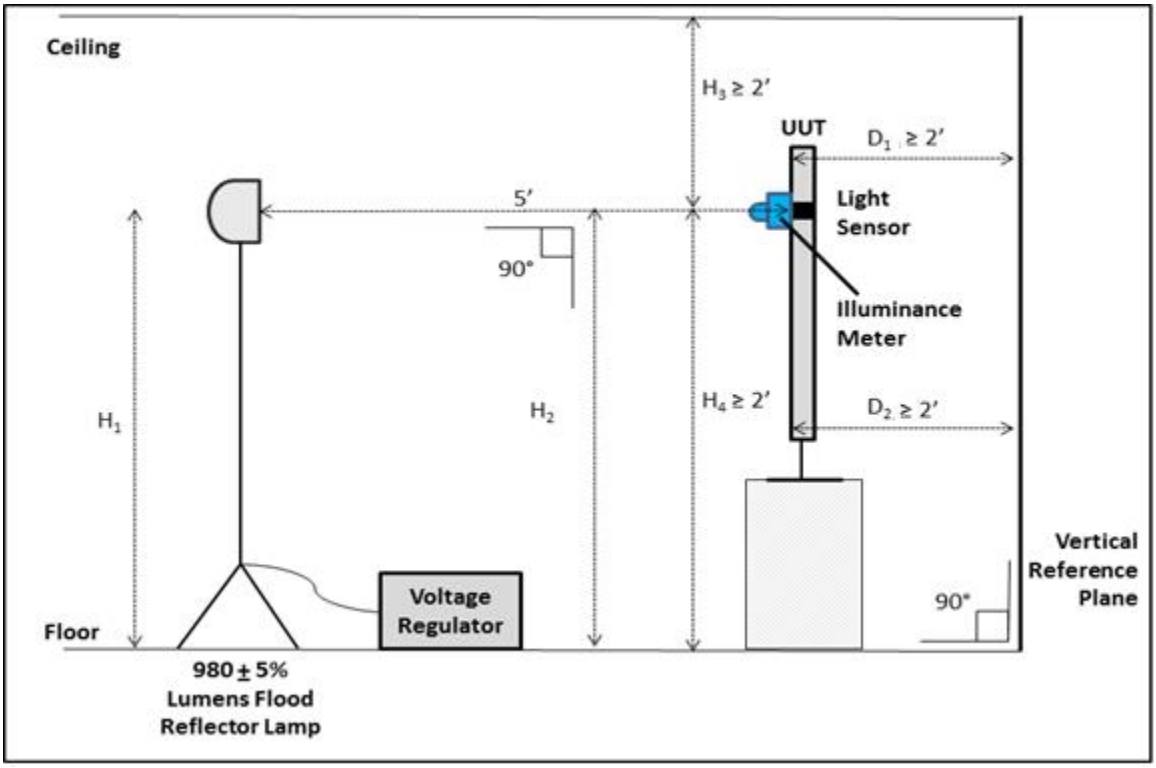

Figure 3: Test Setup - Side View

Notes:

- $D_1 = D_2$ with respect to vertical reference plane
- D_1 and D_2 indicate that the corners of the face of the UUT shall be at least 2 feet from the vertical reference plane
- Illuminance meter shall be removed for power measurements, after target illuminance achieved
- $H_1 = H_2$ with respect to horizontal reference plane (e.g. floor)
- H_3 and H_4 indicate that the center of the light sensor must be at least 2 feet from the floor and 2 feet from the ceiling
- Illuminance meter removed for power measurements, after target illuminance achieved

H) Power Meter: Power meters shall possess the following attributes

1) Crest Factor:

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

b) Lower bound on the current range of 10 mA or less.

2) Minimum Frequency Response: 3.0 kHz

3) Minimum Resolution:

a) 0.01 W for measurement values less than or equal to 10 W;

b) 0.1 W for measurement values from greater than 10 W to 100 W; and

c) 1.0 W for measurement values greater than 100 W.

l) Luminance and Illuminance Meters:

1) Luminance measurement shall be performed using either

a) A contact meter; or

b) A non-contact meter.

2) All luminance and illuminance meters shall have be accurate to ± 2% (± 2 digits) of the digitally displayed value.

3) Non-contact luminance meters shall have an acceptance angle of 3 degrees or less.

The overall accuracy of a meter is found by taking (±) the absolute sum of 2% of the measurement and a 2 digit tolerance of the displayed value least significant digit. For example, if an illuminance meter displays “200.0” when measuring a screen brightness of 200 nits, 2% of 200 nits is 4.0 nits. The least significant digit is 0.1 nits. “Two digits” implies 0.2 nits. Thus, the displayed value would be 200 ± 4.2 nits (4 nits + 0.2 nits).The accuracy is specific to the illuminance meter and shall not be considered as tolerance during actual light measurements.

J) 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.

3) All ambient light values (measured lux) shall be measured at the location of the ABC sensor on the UUT with light entering directly into the sensor and with the main menu from the test signal from IEC 62087:2011, “Methods of measurement for the power consumption of audio, video and related equipment” displayed on the product. For products not compatible with the IEC test signal format, ambient light values shall be measured with the Video Electronics Standard Association (VESA) Flat Panel Display Measurements Standard version 2.0 (FPDM2) FK test signal being displayed on the product.

4) Ambient light values shall be measured within the following tolerances:

a) At 12 lux, ambient lighting shall be within ± 1.0 lux; and

b) At 300 lux, ambient lighting shall be within ± 9.0 lux.

5 TEST CONDUCT

5.1 Guidance for Power Measurements

A) Testing at Factory Default Settings: Power measurements shall be performed with the product in its as-shipped condition for the duration of Sleep Mode and On Mode testing, with all user-configurable options set to factory defaults, except as otherwise specified by this test method.

1) Picture level adjustments shall be performed per the instructions in this test method.

2) Products that include a “forced menu” that requires picture setting selection upon initial start-up shall be tested in the “standard” or “home” picture setting. In the case that no standard setting or equivalent exists, the default setting recommended by the manufacturer shall be used for testing and recorded in the test report. Products that do not include a forced menu shall be tested in the default picture setting.

B) Point of Deployment (POD) Modules: Optional POD modules shall not be installed.

C) Plug-in Modules: Optional Plug-in Modules shall be removed from the Display if the Display can be tested according to the test method without the module installed.

D) Sleep Mode with Multiple Functionalities: If the product offers multiple options for device behavior in Sleep Mode (e.g., quick start) or multiple methods by which Sleep Mode may be entered, the power during all Sleep Modes shall be measured and recorded. All Sleep Mode testing shall be carried out as per Section 6.5.

5.2 Conditions for Power Measurements

A) Power measurements:

1) Power measurements shall be taken from a point between the power source and the UUT. No Uninterruptible Power Supply (UPS) units may be connected between the power meter and the UUT. The power meter shall remain in place until all On Mode, Sleep Mode and Off Mode power data are fully recorded.

2) Power measurements shall be recorded in watts as directly measured (unrounded) values at a rate of greater than or equal to 1 reading per second.

3) Power measurements shall be recorded after voltage measurements are stable to within 1%.

B) Dark Room Conditions:

1) Unless otherwise specified, the illuminance measured at the UUT screen with the UUT in Off Mode shall be less than or equal to 1.0 lux. If the UUT does not have an Off Mode, the illuminance shall be measured at the UUT screen with the UUT’s power cord disconnected.

C) UUT Configuration and Control:

1) Peripherals and Network Connections:

a) External peripheral devices (e.g. mouse, keyboard, external hard disk drive (HDD) etc.) shall not be connected to USB ports or other data ports on the UUT.

b) Bridging: If the UUT supports bridging per the definition in Section 1 of the ENERGY STAR Eligibility Criteria for Displays Version 7.0, a bridge connection shall be made between the UUT and the Host Machine. The connection shall be made in the following order of preference. Only one connection shall be made and the connection shall be maintained for the duration of the test.

i. Thunderbolt

ii. USB

iii. Firewire (IEEE 1394)

iv. Other

Note: Examples of bridging for Displays may include:

1. *A case where the Display converts data between two different port types (e.g. Thunderbolt and Ethernet). This can allow a device to use Thunderbolt as an Ethernet connection or vice versa.*

2. *Allowing a USB keyboard/mouse to be connected to another system (e.g. Host*

Machine) through the Display by a USB hub controller.

c) Networking: If the UUT has networking capability (i.e., it has the ability to obtain an IP address when configured and connected to a network) the networking capability shall be activated, and the UUT shall be connected to a live physical network (e.g., WiFi, Ethernet, etc.). The physical network shall support the highest and lowest data speeds of the UUT's network function. An active connection is defined as a live physical connection over the physical layer of the networking protocol. In the case of Ethernet, the connection shall be via a standard Cat 5e or better Ethernet cable to an Ethernet switch or router. In the case of WiFi the device shall be connected and tested in proximity to a wireless access point (AP). The tester shall configure the address layer of the protocol, taking note of the following:

   i. Internet Protocol (IP) v4 and IPv6 have neighbor discovery and will generally configure a limited, non-routable connection automatically.

   ii. IP can be configured manually or by using Dynamic Host Configuration Protocol (DHCP) with an address in the 192.168.1.x Network Address Translation (NAT) address space if the UUT does not behave normally when autoIP is used. The network shall be configured to support the NAT address space and/or autoIP.

   iii. The UUT shall maintain this live connection to the network for the duration of testing unless otherwise specified in this Test Method, disregarding any brief lapses (e.g., when transitioning between link speeds). If the UUT is equipped with multiple network capabilities, only one connection shall be made in the following order of preference:

      a. WiFi (Institution of Electrical and Electronics Engineers - IEEE 802.11- 2007[2])

      b. Ethernet (IEEE 802.3). If the UUT supports Energy Efficient Ethernet (IEEE 802.3az-2010[3]), then it shall be connected to a device that also supports IEEE 802.3az

      c. Thunderbolt

      d. USB

      e. Firewire (IEEE 1394)

      f. Other

d) Touchscreen Functionality: If the UUT features a touchscreen that requires a separate data connection, this function shall be set up as directed by the manufacturer's instructions, including connections to the Host Machine and installation of software drivers.

e) In the case of a UUT that has a single connection capable of performing multiple functions (e.g. bridging, networking, and/or touchscreen functionality), a single connector can be used to meet these functionalities provided it is the highest preferred connection the UUT supports for each functionality.

f) In the case of a UUT that has no data/network capabilities, the UUT shall be tested as-shipped.

g) Built-in speakers and other product features and functions not specifically addressed by the ENERGY STAR eligibility criteria or test method must be configured in the as-shipped power configuration.

h) Availability of other capabilities such as occupancy sensors, flash memory-card/smart-card readers, camera interfaces, PictBridge shall be recorded.

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[2] IEEE 802 – Telecommunications and information exchange between systems—Local and metropolitan area networks – Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications

[3] Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Amendment 5: Media Access Control Parameters, Physical Layers, and Management Parameters for Energy-Efficient Ethernet

2) Signal Interface:

a) If the UUT has multiple signal interfaces, the UUT shall be tested with the first available interface from the list below:

i. Thunderbolt

ii. DisplayPort

iii. HDMI

iv. DVI

v. VGA

vi. Other Digital Interface

vii. Other Analog Interface

3) Occupancy Sensor: If the UUT has an occupancy sensor, the UUT shall be tested with the occupancy sensor settings in the as-shipped condition. For UUT's with an occupancy sensor enabled as-shipped:

a) A person shall be within close proximity of the occupancy sensor for the entire warm up, stabilization, luminance testing and On Mode to prevent the UUT from entering a lower power state (e.g. Sleep Mode or Off Mode). The UUT shall remain in On Mode for the duration of the warm up period, stabilization period, luminance test and On Mode test.

b) No person shall be within close proximity of the occupancy sensor for the duration of the Sleep Mode and Off Mode tests to prevent the UUT from entering a higher power state (e.g. On Mode). The UUT shall remain in Sleep Mode or Off Mode for the duration of the Sleep Mode or Off Mode tests, respectively.

4) Orientation: If the UUT can be rotated into vertical and horizontal orientations, it shall be tested in the horizontal orientation, with the longest dimension being parallel to the table surface.

D) Resolution and Refresh Rate:

1) Fixed-pixel Displays:

a) Pixel format shall be set to the native level as specified in the product manual.

b) For non-Cathode Ray Tube (CRT) Displays, 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.

c) For CRT Displays, 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. Typical industry standards for pixel format timing shall be used for testing. Refresh rate shall be set to 75 Hz.

E) Accuracy of Input Signal Levels: When using analog interfaces, video inputs shall be within ± 2% of referenced white and black levels. When using digital interfaces, the source video signal shall not be adjusted for color, or modified by the tester for any purpose other than to compress/inflate and encode/decode for transmission, as required.

F) True Power Factor: Partners shall report the true power factor (PF) of the UUT during On Mode measurement. The power factor values shall be recorded at the same rate at which the power value (P_{ON}) are recorded. The reported power factor shall be averaged over the entire duration of the On Mode testing.

G) Test Materials:

1) "IEC 62087:2011 Dynamic Broadcast-Content Signal" shall be used for testing, as specified in IEC 62087:2011, Section 11.6, "On (average) mode testing using dynamic broadcast-content video signal."

2) "VESA FPDM2" shall be used only for products that cannot display the IEC 62087:2011 Dynamic

Broadcast-Content Signal.

H) Video Input Signal:

1) The Host Machine shall generate the video input signal in the native resolution of the Display such that the active area of the video fills the entire screen. This may require the playback software to adjust the aspect ratio of the video.

2) The frame rate of the video input signal should match the frame rate most commonly used in the region in which the product is sold (e.g., For the US and Japan a 60 Hz frame rate is used; for Europe and Australia a 50 Hz frame rate is used).

3) The audio settings on the Host Machine shall be disabled so that no sound is produced alongside the video input signal.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 Pre-Test UUT Initialization

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 product manual.

2) Connect an acceptable watt meter to the power source and connect the UUT to the power outlet on the watt meter.

3) With the UUT off, set the ambient light level such that the measured screen illuminance is less than 1.0 lux (see Section 5.2B)).

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

5) Ensure UUT settings are in their as-shipped configuration, unless otherwise specified in this test method.

6) Warm up the UUT for 20 minutes, or the time it takes the UUT to complete initialization and become ready for use, whichever is longer. The IEC 62087:2011 test signal format, as specified in Section 5.2G)1), shall be displayed for the entire warm up period. Displays that cannot display the IEC 62087:2011 test signal format shall have the VESA FPDM2 L80 test signal, as specified in Section 5.2G)2), displayed on the screen.

7) Report the ac input voltage and frequency or dc input voltage.

8) Report the test room ambient temperature and relative humidity.

6.2 Luminance Testing

A) Luminance testing shall be performed immediately following the warm up period and in dark room conditions. Product screen illuminance, as measured with the UUT in Off Mode, shall be less than or equal to 1.0 lux.

B) Luminance shall be measured perpendicular to the center of the product screen using a luminance meter in accordance with the meter's user manual.

C) The position of the luminance meter relative to the product screen shall remain fixed throughout the duration of testing.

D) For products with ABC, luminance measurements shall be performed with ABC disabled. If ABC cannot be disabled, luminance measurements shall be measured perpendicular to the center of the product screen with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux.

E) Luminance measurements shall be performed as follows:

1) Verify that the UUT is in the default as-shipped luminance value or “Home” picture setting.

2) Display the test video signal for the specific product class, as described below:

   a) **All products, except as specified in b)**: Three-bar video signal specified in IEC 62087:2011, Section 11.5.5 (three bars of white (100%) over a black (0%) background).

   b) **Products that cannot display signals from IEC 62087:2011**: VESA FPDM2 L80 test signal for the maximum resolution supported by the product.

3) Display the test video signal for no less than 10 minutes to allow the UUT luminance to stabilize. This 10 minute stabilization period may be reduced if luminance measurements are stable to within 2% over a period of not less than 60 seconds.

4) Measure and record the luminance in default as-shipped setting $L_{As\text{-}shipped}$.

5) Set the brightness and contrast levels of the UUT to their maximum values.

6) Measure and record the luminance as $L_{Max\_Measured}$.

7) Record the manufacturer-reported maximum luminance $L_{Max\_Reported}$.

F) The contrast setting shall be left at the maximum level for the subsequent On Mode tests unless otherwise specified.

6.3 On Mode Testing for Products without ABC Enabled by Default

A) After the Luminance Testing and prior to On Mode power measurement, the luminance of the UUT shall be set according to the following:

1) **For Signage Displays**, the product shall be tested with luminance set at a value greater than or equal to 65% of the manufacturer-reported maximum luminance ($L_{Max\_Reported}$). Luminance values shall be measured as per Section 6.2. This luminance value L_{On} shall be recorded.

2) **For all other products**, adjust appropriate luminance controls until the luminance of the screen is **200 candelas per square meter (cd/m^2)**. If the UUT cannot achieve this luminance, set the product luminance to the nearest achievable value. Luminance values shall be measured as per Section 6.2. This luminance value L_{On} shall be reported. Appropriate luminance controls refer to any controls that adjust the brightness of the Display, but do not include contrast settings.

B) For a UUT capable of displaying the IEC signals, On Mode power (P_{ON}) shall be measured according to IEC 62087:2011 Section 11.6.1 “Measurements using dynamic broadcast-content video signal.” For a UUT not capable of displaying the IEC signals, On Mode power (P_{ON}) shall be measured as follows:

1) Ensure that the UUT has been initialized per Section 6.1.

2) Display the VESA FPDM2, A112-2F, SET01K test pattern (8 shades of gray from full black (0 volts) to full white (0.7 volts)).

3) Verify that input signal levels conform to VESA Video Signal Standard (VSIS), Version 1.0, Rev. 2.0, December 2002.

4) 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.

5) Display the VESA FPDM2, A112-2H, L80 test pattern (full white (0.7 volts) box that occupies 80% of the image).

6) Ensure that the luminance measurement area falls entirely within the white portion of the test pattern.

7) Adjust appropriate luminance controls until the luminance of the white area of the screen is set as described in Section 6.3A).

8) Record the screen luminance (L_{On}).

9) Record On Mode power (P_{ON}) and total pixel format (horizontal x vertical). The On Mode power shall be measured over a 10 minute period similar to the IEC 62087:2011 dynamic broadcast-content test.

6.4 On Mode Testing for Products with ABC Enabled by Default

The average On Mode power consumption of the product shall be determined with the dynamic broadcast-content as defined in IEC 62087:2011. If the product cannot display the IEC signal, then the VESA FPDM2 L80 test pattern, as described in Section 6.3B)5), shall be used for all of the following steps.

A) Stabilize the UUT for 30 minutes. This shall be done with three repetitions of the 10 minute IEC dynamic broadcast-content video signal.

B) Set the light output of the lamp used for testing to 12 lux as measured at the face of the ambient light sensor.

C) Display the 10 minute dynamic broadcast-content video signal. Measure and record the power consumption, P_{12}, during the 10 minute dynamic broadcast-content video signal.

D) Repeat steps 6.4B) and 6.4C) for an ambient light level of 300 lux, to measure P_{300}.

E) Disable ABC and measure On Mode power (P_{ON}) per Section 6.3. If ABC cannot be disabled, power measurements shall be conducted as follows:

1) If the brightness can be set to a fixed value as specified in Section 6.3, then On Mode power for these products shall be measured as per Section 6.3 with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux.

2) If the brightness cannot be set to a fixed value, then On Mode power for these products shall be measured as per Section 6.3 with light entering directly into the UUT's ambient light sensor at greater than or equal to 300 lux and without modifying the screen brightness.

6.5 Sleep Mode Testing

A) Sleep Mode power (P_{SLEEP}) shall be measured according to IEC 62301:2011, with the additional guidance in Section 5.

B) The Sleep Mode test shall be conducted with the UUT connected to the Host Machine in the same manner as in the On Mode test. If possible, Sleep Mode shall be enacted by putting the Host Machine to sleep. For a computer Host Machine, Sleep Mode is defined in the Version 6.1 ENERGY STAR Computers specification.

C) If the product has a variety of Sleep Modes that may be manually selected, or if the product can enter Sleep Mode via different methods (e.g., remote control or putting the Host Machine to sleep), measurements shall be performed and recorded in all Sleep Modes.

If the product automatically transitions through its various Sleep Modes, the measurement time shall be long enough to obtain an average of all Sleep Modes. The measurement shall still meet requirements (e.g., stability, measurement period, etc.) outlined in Section 5.3 of IEC 62301:2011.

6.6 Off Mode Testing

A) For products having Off Mode capability, at the conclusion of the Sleep Mode test, initiate Off Mode via the most easily accessible power switch.

B) Measure Off Mode power (P_{OFF}) according to Section 5.3.1 of the IEC 62301:2011. Document the method of adjustment and sequence of events required to reach Off Mode.

C) Any input synchronizing signal check cycle may be ignored when measuring Off Mode power.

6.7 Additional Testing

A) For products with data/networking capabilities or a bridge connection, in addition to tests performed with data/networking capabilities activated and a bridge connection established (see Section 5.2C)1)), Sleep Mode Testing shall be performed with data/networking features deactivated and without any bridge connection established, per Section 5.2C)1)b) and c).

B) The presence of Full Network Connectivity shall be determined by testing the Display for network activity in Sleep Mode according to section 6.7.5.2 of CEA-2037-A, Determination of Television Set Power Consumption, with the following guidance:

   1) The Display shall be connected to a network per Section 5.2C)1)c) prior to the test.

   2) The Display shall be placed into Sleep Mode in place of standby-active, low.