Commission Decision of 20 March 2014 determining the European Union position for a decision of the Management entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on adding specifications for computer servers and uninterruptible power supplies to Annex C to the Agreement and on the revision of specifications for displays and imaging equipment included in Annex C to the Agreement (Text with EEA relevance) (2014/202/EU)

COMMISSION DECISION

of 20 March 2014

determining the European Union position for a decision of the Management entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on adding specifications for computer servers and uninterruptible power supplies to Annex C to the Agreement and on the revision of specifications for displays and imaging equipment included in Annex C to the Agreement

(Text with EEA relevance)

(2014/202/EU)

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Council Decision 2013/107/EU of 13 November 2012 on the signing and conclusion of the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment[(1)], and in particular Article 4 thereof,

Whereas:

(1) The Agreement provides for the European Commission, together with the United States Environmental Protection Agency (EPA), to develop and periodically revise common specifications for office equipment specification, thereby amending Annex C to the Agreement.

(2) The position of the European Union with regard to amendment of the specifications is to be determined by the Commission.

(3) The measures provided for in this Decision take account of the opinion given by the European Union Energy Star Board referred to in Article 8 of Regulation (EC) No 106/2008 of the European Parliament and of the Council of 15 January 2008 on a Community energy-efficiency labelling programme for office equipment[(2)] as amended by Regulation (EU) No 174/2013[(3)].

(4) The display specification in Annex C, Part II, and imaging equipment specification in Annex C, Part III, should be repealed and replaced by the specifications annexed to this Decision,

HAS ADOPTED THIS DECISION:

Sole Article

The position to be adopted by the European Union for a decision by the Management Entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on revising the display and imaging equipment specifications in Annex C, Parts II and III, and adding new specifications for computer servers and uninterruptible power supplies, to the Agreement shall be based on the attached draft decision.

This Decision shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

Done at Brussels, 20 March 2014.

For the Commission

The President

José Manuel BARROSO

ANNEX I

DRAFT DECISIONof …of the Management entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on adding specifications for computer servers and uninterruptible power supplies to Annex C to the Agreement and on the revision of specifications for displays and imaging equipment included in Annex C of the Agreement

THE MANAGEMENT ENTITIES,

Having regard to the Agreement between the Government of the United States and the European Union on the coordination of energy-efficiency labelling programmes for office equipment, and in particular Article XII thereof,

Whereas specifications for new products ‘computer servers’ and ‘uninterruptible power supplies’ should be added to the Agreement and existing specifications for product type ‘imaging equipment’ and ‘displays’ should be revised,

HAVE DECIDED AS FOLLOWS:

Part I ‘Displays’, Part II ‘Uninterruptible Power Supplies’, Part III ‘Computer Servers’ and Part IV ‘Imaging Equipment’ shall be added to Annex C of the Agreement between the Government of the United States and the European Union on the coordination of energy-efficiency labelling programmes for office equipment as laid down hereafter.

Part II ‘Displays’ and Part III ‘Imaging Equipment’ currently included in Annex C of the Agreement between the Government of the United States and the European Union on the coordination of energy-efficiency labelling programmes for office equipment shall be repealed.

The Decision shall enter into force on the twentieth day following its publication. The Decision, done in duplicate, shall be signed by the Co-chairs.

Signed in Washington DC on the […]

[…]

on behalf of the United States Environmental Protection Agency

Signed in Brussels on the […]

[…]

on behalf of the European Union

ANNEX II

ANNEX C

PART II TO THE AGREEMENT

'I. DISPLAY SPECIFICATIONS

1. **Definitions**

1.1. Product Types

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, Display Port, IEEE 1394, USB), (2) external storage (e.g., USB flash drive, memorycard), 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.

Enhanced-Performance Display: A computer monitor that has all of the following features and functionalities:

(i) 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;

(ii) A native resolution greater than or equal to 2,3 megapixels (MP); and,

(iii) A colour gamut size of at least sRGB as defined by IEC 619662-1. Shifts in colour space are allowable as long as 99 % or more of defined sRGB colours 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.

1.2. 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.

1.3. Operational Modes:

(a) 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.

(b) 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.

Notes:

1. Examples of internal stimuli are a timer or occupancy sensor.

2. A power control is not an example of user input.

(c) 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.

1.4. 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). Luminance refers to the brightness settings of a display.

(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 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. 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.

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

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

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

1.8. 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.

1.9. Network capability: An ability to obtain an IP address when connected to a network.

1.10. 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.

1.11. 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.

1.12. Representative Model: The product configuration that is tested for ENERGY STAR qualification and is intended to be marketed and labelled 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 data or network connection, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2.

2.1.2. Typical products that would be eligible for qualification under this specification include:

(a) Computer Monitors

(b) Digital Picture Frames

(c) Signage Displays, and,

(d) 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.eu-energystar.org.

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

(a) Products with a viewable diagonal screen size greater than 61 inches;

(b) Products with an integrated television tuner;

(c) 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;

(d) 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;

(e) Dual-function televisions/computer monitors that are marketed and sold as such;

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

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

(h) 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:

(a) 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 Signalling (DPMS), enabled by default).

(b) 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.

(c) 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.

(d) 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 shall be less than or equal to the Maximum On Mode Power Requirement (P_{ON_MAX}), as calculated and rounded per Table 1, below.

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 (r) 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 the Product's Pixel Density (D_P) Exceeds 20 000 pixels/in^2

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

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 andDiagonal Screen Size, *d*(in inches)	**$P_{ON_MAX}$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***	**$P_{ON_MAX}$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***
$d < 12{,}0$	$(6{,}0 \times r)+(0{,}05 \times A)+3{,}0$	$((6{,}0 \times r_1)+(3{,}0 \times r_2)+(0{,}05 \times A)+3{,}0)$
$12{,}0 \leq d < 17{,}0$	$(6{,}0 \times r)+(0{,}01 \times A)+5{,}5$	$((6{,}0 \times r_1)+(3{,}0 \times r_2)+(0{,}01 \times A)+5{,}5)$
$17{,}0 \leq d < 23{,}0$	$(6{,}0 \times r)+(0{,}25 \times A)+3{,}7$	$((6{,}0 \times r_1)+(3{,}0 \times r_2)+(0{,}025 \times A)+3{,}7)$
$23{,}0 \leq d < 25{,}0$	$(6{,}0 \times r)+(0{,}06 \times A)-4{,}0$	$((6{,}0 \times r_1)+(3{,}0 \times r_2)+(0{,}06 \times A)-4{,}0)$
$25{,}0 \leq d \leq 61{,}0$	$(6{,}0 \times r)+(0{,}01 \times A)-14{,}5$	$((6{,}0 \times r_1)+(3{,}0 \times r_2)+(0{,}1 \times A)-14{,}5)$
$30{,}0 \leq d \leq 61{,}0$ *(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 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

$$P_{EP<27''} = 0{,}30 \times P_{ON\_MAX}$$

$$P_{EP\geq27''} = 0{,}75 \times P_{ON\_MAX}$$

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 %.

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

(b) P_{ON}, as measured with ABC disabled per the ENERGY STAR test method 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 data 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 data or network capabilities included in Table 3 or 4 shall be less than or equal to the Maximum Data/Networking Sleep Mode Power Requirement (P_{SLEEP_AP}), as calculated per Equation 7.

Equation 7: Calculation of Maximum Data/Networking Sleep Mode Power requirement

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

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 power allowance, in watts, as specified in Table 3 for data or networking capability connected during Sleep Mode testing, and

— P_{ADD} is the power allowance, in watts, as specified in Table 4 for additional capabilities enabled by default that are active during Sleep Mode testing.

Table 3

Power Allowances in Sleep Mode for Data or Network Capabilities

Capability	Included Types	P_{DN}(watts)
	USB 1.x	0,1
	USB 2.x	0,5
	USB 3.x, DisplayPort (non-video connection), Thunderbolt	0,7
Network	Fast Ethernet	0,2
	Gigabit Ethernet	1,0
	Wi-Fi	2,0

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 data or networking connection capabilities, or P_{SLEEP_AP}, in the case of products tested with additional power-consuming capabilities, such as data bridge connections or networking 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

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. 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.

4. **Test requirements**

4.1. Test Methods

For products placed on the market of the European Union manufacturers are required to perform tests and self-certify those models that meet Energy Star guidelines. Test methods identified below shall be used to determine qualification for ENERGY STAR.

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

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**

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. In the event that the manufacturer does not adopt *IEEE P1621*, the manufacturer shall provide EPA or the European Commission, as appropriate with its rationale for not doing so.

6. **Effective date**

6.1. The date that manufacturers may begin to qualify products as Energy Star under this Version 6.0, will be defined as the effective date of the Agreement. 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.

6.2. Future Specification Revisions: EPA and the European Commission reserve 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

It is understood 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. There is interest in better understanding the power consumption associated with these products when tested according to the Displays Test Method and EPA and the European Commission will

work with stakeholders prior to, and during, the next specification revision development process to access the information. EPA and the European Commission are in principle 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

EPA and the European Commission are committed to continuing to develop performance levels for displays that account for new features and functionality, and anticipate 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, DOE and the European Commission 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.

II. UNINTERRUPTIBLE POWER SUPPLIES SPECIFICATIONS

1. **Definitions**

Unless otherwise specified, all terms used in this document are consistent with the definitions in the International Electrical Commission (IEC) standard IEC 62040-3[(4)].

For the purpose of this specification the following definitions apply:

Uninterruptible Power Supply (UPS): Combination of convertors, switches, and energy storage devices (such as batteries) constituting a power system for maintaining continuity of load power in case of input power failure[(5)].

1.1. Power conversion mechanism:

(a) Static UPS: UPS where solid-state power electronic components provide the output voltage.

(b) Rotary UPS: UPS where one or more electrical rotating machines provide the output voltage.

(1) Rotary UPS (RUPS) without Diesel: A rotary UPS that does not contain an integral diesel engine to supply power to the load during an input power failure.

(2) Diesel-coupled rotary UPS (DRUPS): A rotary UPS that contains an integral diesel engine that may be used to supply power to the load during an input power failure.

(c) Power Output:

(1) Alternating Current (Ac)-output UPS: UPS that supplies power with a continuous flow of electric charge that periodically reverses direction.

(2) Direct Current (Dc)-output UPS/Rectifier: UPS that supplies power with a continuous flow of electric charge that is unidirectional. Includes both individual rectifier units for dc applications and entire dc-output UPS frames or systems, consisting of rectifier modules, controllers, and any other supporting components.

Note: Dc-output UPSs are also known as rectifiers. For the purposes of this document, the term 'Dc-output UPS/Rectifier' is used because a 'rectifier' may also refer to an Ac-output UPS subsystem.

1.2. Modular UPS: A UPS comprised of two or more single UPS units, sharing one or more common frames and a common energy storage system, whose outputs, in Normal Mode of operation, are connected to a common output bus contained entirely within the frame(s). The total quantity of single UPS units in a modular UPS equals 'n + r' where n is the quantity of single UPS units required to support the load; r is the quantity of redundant UPS units. Modular UPSs may be used to provide redundancy, to scale capacity or both.

1.3. Redundancy: Addition of UPS units in a parallel UPS to enhance the continuity of load power, and classified as follows.

(a) N + 0: UPS that cannot tolerate any failures while maintaining Normal Mode operation. No redundancy.

(b) N + 1: Parallel UPS that can tolerate the failure of one UPS unit or one group of UPS units while maintaining Normal Mode operation.

(c) 2N: Parallel UPS that can tolerate the failure of one half of its UPS units while maintaining Normal Mode operation.

1.4. UPS Operational Modes:

(a) Normal Mode: Stable mode of operation that the UPS attains under the following conditions:

(1) Ac input supply is within required tolerances and supplies the UPS.

(2) The energy storage system remains charged or is under recharge.

(3) The load is within the specified rating of the UPS.

(4) The Bypass is available and within specified tolerances (if applicable).

(b) Stored Energy Mode: Stable mode of operation that the UPS attains under the following conditions:

(1) Ac input power is disconnected or is out of required tolerance.

(2) All power is derived from the energy storage system or, in the case of a DRUPS, from the integrated Diesel engine or a combination of both.

(3) The load is within the specified rating of the UPS.

(c) Bypass Mode: Mode of operation that the UPS attains when operating the load supplied via the Bypass only.

1.5. UPS Input Dependency Characteristics:

(a) Voltage and Frequency Dependent (VFD): Capable of protecting the load from power outage[6].

(b) Voltage Independent (VI): Capable of protecting the load as required for VFD, above, and in addition from:

(1) Under-voltage applied continuously to the input

(2) Over-voltage applied continuously to the input[7]

(c) Voltage and Frequency Independent (VFI): Independent of voltage and frequency variations and capable of protecting the load against adverse effects from such variations without depleting the stored energy source.

1.6. Single-normal-mode UPS: A UPS that functions in Normal Mode within the parameters of only one set of input dependency characteristics. For example, a UPS that functions only as VFI.

1.7. Multiple-normal-mode UPS: A UPS that functions in Normal Mode within the parameters of more than one set of input dependency characteristics. For example, a UPS that can function as either VFI or VFD.

1.8. Bypass: Power path alternative to the ac converter.

(a) Maintenance Bypass (path): Alternative power path provided to maintain continuity of load power during maintenance activities.

(b) Automatic Bypass: Power path (primary or stand-by) alternative to the indirect ac converter.

(1) Mechanical Bypass: control is via a switch with mechanically separable contacts

(2) Static Bypass (electronic bypass): control is via an electronic power switch, for example transistors, thyristors, triacs or other semiconductor device or devices.

(3) Hybrid Bypass: control is via switch with mechanically separable contacts in combination with at least one controlled electronic valve device.

1.9. Reference Test Load: Load or condition in which the output of the UPS delivers the active power (W) for which the UPS is rated[8].

1.10. Unit Under Test (UUT): The UPS undergoing the test, configured as though for shipment to the customer, and including any accessories (e.g., filters or transformers) necessary to meet the test setup as specified in Section 3 of the ENERGY STAR Test Method.

1.11. Power Factor: Ratio of the absolute value of active power P to the apparent power S.

1.12. Product Family: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR qualification criteria, and (3) of a common basic design. For UPSs, acceptable variations within a product family include:

(a) Number of installed modules;

(b) Redundancy;

(c) Type and quantity of input and output filters;

(d) Number of rectifier pulses[9]; and

(e) Energy storage system capacity.

1.13. Abbreviations:

(a) A : Ampere
(b) ac : Alternating Current

(c) dc	:	Direct Current
(d) DRUPS	:	Diesel coupled rotary UPS
(e) RUPS	:	Rotary UPS
(f) THD	:	Total Harmonic Distortion
(g) UPS	:	Uninterruptible Power Supply
(h) UUT	:	Unit Under Test
(i) V	:	Volt
(j) VFD	:	Voltage and Frequency Dependent
(k) VFI	:	Voltage and Frequency Independent
(l) VI	:	Voltage Independent
(m) W	:	Watt
(n) Wh	:	Watt-hour

2. **Scope**

2.1. Products that meet the definition of an Uninterruptible Power Supply (UPS) as specified herein including Static and Rotary UPSs and Ac-output UPSs and Dc-output UPSs/Rectifiers are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.3.

2.2. Products eligible for qualification under this specification include:

(a) Consumer UPSs intended to protect desktop computers and related peripherals, and/or home entertainment devices such as TVs, set top boxes, DVRs, Blu-ray and DVD players;

(b) Commercial UPSs intended to protect small business and branch office information and communication technology equipment such as servers, network switches and routers, and small storage arrays;

(c) Data Center UPSs intended to protect large installations of information and communication technology equipment such as enterprise servers, networking equipment, and large storage arrays; and,

(d) Telecommunications Dc-output UPSs/Rectifiers intended to protect telecommunication network systems located within a central office or at a remote wireless/cellular site.

2.3. Excluded Products

2.3.1. 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.eu-energystar.org.

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

(a) Products that are internal to a computer or another end-use load (e.g., battery supplemented internal power supplies or battery backup for modems, security systems, etc.);

(b) Industrial UPSs specifically designed to protect critical control, manufacturing, or production processes or operations;

(c) Utility UPSs designed for use as part of electrical transmission and distribution systems (e.g. electrical substation or neighbourhood-level UPSs);

(d) Cable TV (CATV) UPSs designed to power the cable signal distribution system outside plant equipment and connected directly or indirectly to the cable itself. The 'cable' may be coaxial cable (metallic wire), fibre-optic, or wireless (e.g., 'Wi-Fi');

(e) UPSs designed to comply with specific UL safety standards for safety-related applications, such as emergency lighting, operations or egress, or medical diagnostic equipment; and,

(f) UPSs designed for mobile, shipboard, marine or airborne applications.

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 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. Energy Efficiency Requirements for Ac output UPSs

3.2.1. Single-normal-mode UPSs: Average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 1, shall be greater than or equal to the Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 2, for the specified rated output power and input dependency characteristic, except as specified below.

For products with rated output power greater than 10 000 W and communication and measurement capability, as specified in Section 3.6, average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 1, shall be greater than or equal to the Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 3, for the specified input dependency characteristic.

Equation 1: Calculation of Average Efficiency for Ac-output UPSs

$$\mathrm{Eff_{AVG}} = t_{25\,\%} \times \mathrm{Eff}|_{25\,\%} + t_{50\,\%} \times \mathrm{Eff}|_{50\,\%} + t_{75\,\%} \times \mathrm{Eff}|_{75\,\%} + t_{100\,\%} \times \mathrm{Eff}|_{100\,\%}$$

Where:

— Eff_{AVG} is the average loading-adjusted efficiency,

— tn % is the proportion of time spent at the particular n % of the Reference Test Load, as specified in the loading assumptions in Table 1, and

— Eff|n % is the efficiency at the particular n % of the Reference Test Load, as measured according to the ENERGY STAR Test Method.

TABLE 1

Ac-output UPS Loading Assumptions for Calculating Average Efficiency

Rated Output Power, P,in watts (W)	**InputDependencyCharacteristic**	**Proportion of Time Spent at Specified Reference Test Load,tn %**			
		25 %	**50 %**	**75 %**	**100 %**
P ≤ 1 500 W	VFD	0,2	0,2	0,3	0,3
	VFD	0	0,3	0,4	0,3

1 500 W < P ≤ 10 000 W	VFD, VI, or VFI	0	0,3	0,4	0,3
P > 10 000 W	VFD, VI, or VFI	0,25	0,5	0,25	0

TABLE 2

Ac-output UPS Minimum Average Efficiency Requirement

Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), where:P is the Rated Output Power in watts (W), andln is the natural logarithm.			
Rated Output Power	**Input Dependency Characteristic**		
	VFD	**VI**	**VFI**
P ≤ 1 500 W	0,967		0,0099 × ln(P) + 0,815
1 500 W < P ≤ 10 000 W	0,97	0,967	
P > 10 000 W	0,97	0,95	0,0099 × ln(P) + 0,805

TABLE 3

Ac-output UPS Minimum Average Efficiency Requirement for Products with Metering and Communications Capability

Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), where:P is the Rated Output Power in watts (W), andln is the natural logarithm.			
Rated Output Power	**Input Dependency Characteristic**		
	VFD	**VI**	**VFI**
P > 10 000 W	0,96	0,94	0,0099 × ln(P) + 0,795

3.2.2. Multiple-normal-mode UPSs that Do Not Ship with the Highest Input Dependency Mode Enabled by Default: If the Multiple-normal-mode UPS does not ship with its highest input dependency mode enabled by default, its average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 1, shall be greater than or equal to:

(a) The Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 2, for the rated output power and lowest input dependency mode provided by the UPS, for models with output power less than or equal to 10 000 W or no communication and measurement capability as specified in Section 3.6; or

(b) The Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 3, for the rated output power and lowest input dependency mode provided by the UPS, for models with output power greater than 10 000 W and communication and measurement capability as specified in Section 3.6.

3.2.3. Multiple-normal-mode UPSs that Ship with the Highest Input Dependency Mode Enabled by Default: If the Multiple-normal-mode UPS does ship with its highest input dependency mode enabled by default, its average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 2, shall be greater than or equal to:

(a) The Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 2, for the rated output power and lowest input dependency mode provided by the UPS, for models with output power less than or equal to 10 000 W or no communication and measurement capability as specified in Section 3.6; or

(b) The Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 3, for the rated output power and lowest input dependency mode provided by the UPS, for models with output power greater than 10 000 W and communication and measurement capability as specified in Section 3.6.

Equation 2: Calculation of Average Efficiency for Multiple-normal-mode Ac-output UPSs

$$\mathbf{Eff_{AVG} = 0{,}75 \times Eff_1 + 0{,}25 \times Eff_2}$$

Where:

— Eff_{AVG} is the average loading adjusted efficiency,

— Eff_1 is the average loading adjusted efficiency in the lowest input dependency mode (i.e., VFI or VI), as calculated per Equation 1, and

— Eff_2 is the average loading adjusted efficiency in the highest input dependency mode (i.e., VFD), as calculated per Equation 1.

3.3. Energy Efficiency Requirements for Dc-output UPSs/Rectifiers

Average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 3, shall be greater than or equal to the Minimum Average Efficiency Requirement (Eff_{AVG_MIN}), as determined per Table 4. This requirement shall apply to complete systems and/or individual modules. Manufacturers can qualify either, subject to the following requirements:

(a) Complete systems that are also modular shall be qualified as Modular UPS Product Families with a particular model of module installed,

(b) Qualification of individual modules will have no bearing on the qualification of modular systems unless the entire systems are also qualified as specified above.

(c) For products with rated output power greater than 10 000 W and communication and measurement capability, as specified in Section 3.6, average loading-adjusted efficiency (Eff_{AVG}), as calculated per Equation 3, shall be greater than or equal to the Minimum Average Efficiency Requirement ($Eff_{AVG\_MIN)}$, as determined per Table 5.

Equation 3: Calculation of Average Efficiency for All Dc-output UPSs

$$\mathbf{Eff_{AVG} = \frac{Eff_{30\ \%} + Eff_{40\ \%} + Eff_{50\ \%} + Eff_{60\ \%} + Eff_{70\ \%} + Eff_{80\ \%}}{6}}$$

Table 4 **Dc-output UPS/Rectifier Minimum Average Efficiency Requirement**

Minimum Average Efficiency Requirement (Eff_{AVG_MIN})
0,955

TABLE 5

Dc-output UPS/Rectifier Minimum Average Efficiency Requirement for Products with Metering and Communications Capability

Rated OutputPower	**Minimum Average EfficiencyRequirement (Eff_{AVG_MIN})**

P > 10 000 W	0,945

3.4. Power Factor Requirements

The measured input power factor of all Ac-output UPSs at 100 percent of the Reference Test Load shall be greater than or equal to the Minimum Power Factor Requirement specified in Table 6 for all VFI and VI Normal Modes required for qualification.

Table 6 **UPS Minimum Input Power Factor Requirement for Ac-output UPSs**

Minimum Power Factor

Requirement

0,90

3.5. Standard Information Reporting Requirements

3.5.1. Data for a standardized Power and Performance Data Sheet (PPDS) shall be submitted to EPA and/or the European Commission for each model or Product Family.

3.5.2. Further details on the PPDS can be found on the ENERGY STAR web page for UPS at www.energystar.gov/products.

The PPDS contains the following information:

(a) General characteristics (manufacturer, model name and number);

(b) Electrical characteristics (power conversion mechanism, topology, input and output voltage and frequency);

(c) Average efficiency used for qualification;

(d) Efficiency at each loading point and power factor test results, in each applicable Normal Mode, and for both the tested maximum and minimum configurations for Modular UPS Product Families;

(e) Metering and communications ability (data displayed on the meter, data provided via the network, and available protocols);

(f) Web link to an available public document containing model specific test procedure guidelines, if applicable;

(g) Battery/stored energy device characteristics;

(h) Physical dimensions

3.5.3. EPA and the European Commission may periodically revise this PPDS, as necessary, and will notify Partners of the revision process.

3.6. Communication and Measurement Requirements

3.6.1. Ac-output UPSs and Dc-output UPSs/Rectifiers with rated output power greater than 10 000 W may qualify for a 1 percentage point efficiency incentive, as reflected in Tables 3 and 5, if sold with an energy meter possessing the following characteristics:

(a) The meter is either shipped as an independent, external component bundled with the UPS at the point of sale or is integral to the UPS.

(b) The meter measures UPS output energy in kWh in each Normal Mode.

(c) The meter can communicate the measurement results over a network using one of the following protocols: Modbus RTU, Modbus TCP, or SNMP (v1, 2, or 3)

(d) If the meter is external to the UPS, it meets the requirements in Section 3.6.2.

(e) If the meter is integral to the UPS, it meets the requirements in Section 3.6.3.

3.6.2. Requirements for External Meters: External meters bundled with the UPS shall meet one of the following requirements for the UPS to obtain the metering efficiency incentive:

(a) Meet Accuracy Class 2 or better (i.e., Class 1, Class 0,5 S, or Class 0,2 S), as specified in IEC 62053-21[(10)], IEC 62053-22[(11)], or ANSI C12.2[(12)];

(b) Exhibit a relative error in energy measurement less than or equal to 2 percent compared to a standard under the conditions specified in Section 3.6.4, with the exception of current, which shall be tested at 25 percent and 100 percent of the meter's maximum current; or

(c) Exhibit a relative error in energy measurement less than or equal to 5 percent compared to a standard when part of a complete measurement system (including current transformers that could be integrated with the meter and UPS) under the conditions specified in Section 3.6.4.

3.6.3. Requirements for Integral Meters: Integral meters shall meet the following requirements under the conditions specified in Section 3.6.4 for the UPS to obtain the metering efficiency incentive:

Exhibit a relative error in energy measurement less than or equal to 5 percent compared to a standard when part of a complete measurement system (including current transformers integrated with the meter and UPS).

3.6.4. Environmental and Electrical Conditions for Meter Accuracy: The meter shall meet the requirements specified in Section 3.6.2 or 3.6.3 under the following conditions:

(a) Environmental conditions: Consistent with the ENERGY STAR Test Method and the standards referenced therein; and

(b) Electrical conditions: Consistent with each of the loading points in the ENERGY STAR Test Method and the standards referenced therein.

4. **Testing**

4.1. Test Methods

For products placed on the market of the European Union manufacturers are required to perform tests and self-certify those models that meet Energy Star guidelines. When testing UPSs, the test methods identified in Table 7 shall be used to determine ENERGY STAR qualification.

TABLE 7

Test Methods for ENERGY STAR Qualification

Product Type	Test Method

All UPSs	ENERGY STAR Test Method for Uninterruptible Power Supplies, Rev. May-2012

4.2. Number of Units Required for Testing

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

(a) For qualification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labelled as ENERGY STAR is considered the Representative Model;

(b) For qualification of a Modular UPS Product Family where models vary by number of installed modules, the manufacturer shall select the maximum and minimum configurations to serve as Representative Models—i.e., a modular system shall meet the eligibility criteria in both its maximum and minimum non-redundant configurations. If the maximum and minimum configuration Representative Models meet the ENERGY STAR qualification criteria at their respective output power levels, all intermediate configuration models within a Modular UPS Product Family may be qualified for ENERGY STAR.

(c) For qualification of a UPS Product Family where the models are related by a characteristic other than the number of installed modules, the highest energy using configuration within the Product Family shall be considered the Representative Model with the exception of energy storage system variations—the manufacturer may select any energy storage system for the test, within the requirements of the ENERGY STAR Test Method. Other products within a Product Family do not have to be tested for qualification, but they are expected to meet relevant ENERGY STAR qualification criteria and may be subject to verification testing sometime after initial qualification.

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

4.2.3. All tested units shall meet ENERGY STAR qualification criteria.

5. **Effective Date**

5.1. The date that manufacturers may begin to qualify products as Energy Star under this Version 1.0, will be defined as the effective date of the Agreement. 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.

5.2. Future Specification Revisions: EPA and the European Commission reserve 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.

III. COMPUTER SERVERS SPECIFICATION (VERSION 2.0)

1. **Definitions**

1.1. Product Types

1.1.1. Computer Server: A computer that provides services and manages networked resources for client devices (e.g., desktop computers, notebook computers, thin clients, wireless devices, PDAs, IP telephones, other computer servers, or other network devices). A computer server is sold through enterprise channels for use in data centres and office/corporate environments. A computer server is primarily accessed via network connections, versus directly-connected user input devices such as a keyboard or mouse. For purposes of this specification, a computer server must meet all of the following criteria:

(a) is marketed and sold as a Computer Server;

(b) is designed for and listed as supporting one or more computer server operating systems (OS) and/or hypervisors;

(c) is targeted to run user-installed applications typically, but not exclusively, enterprise in nature;

(d) provides support for error-correcting code (ECC) and/or buffered memory (including both buffered dual in-line memory modules (DIMMs) and buffered on board (BOB) configurations).

(e) is packaged and sold with one or more ac-dc or dc-dc power supplies; and

(f) is designed such that all processors have access to shared system memory and are visible to a single OS or hypervisor.

1.1.2. Managed Server: A computer server that is designed for a high level of availability in a highly managed environment. For purposes of this specification, a managed server must meet all of the following criteria:

(a) is designed to be configured with redundant power supplies; and

(b) contains an installed dedicated management controller (e.g., service processor).

1.1.3. Blade System: A system comprised of a blade chassis and one or more removable blade servers and/or other units (e.g., blade storage, blade network equipment). Blade systems provide a scalable means for combining multiple blade server or storage units in a single enclosure, and are designed to allow service technicians to easily add or replace (hot-swap) blades in the field.

(a) Blade Server: A computer server that is designed for use in a blade chassis. A blade server is a high-density device that functions as an independent computer server and includes at least one processor and system memory, but is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for operation. A processor or memory module that is intended to scale up a standalone server is not considered a Blade Server.

(1) *Multi-bay Blade Server*: A blade server requiring more than one bay for installation in a blade chassis.

(2) *Single-wide Blade Server*: A blade server requiring the width of a standard blade server bay.

(3) *Double-wide Blade Server*: A blade server requiring twice the width of a standard blade server bay.

(4) *Half-height Blade Server*: A blade server requiring one half the height of a standard blade server bay.

(5) *Quarter-height Blade Server*: A blade server requiring one quarter the height of a standard server bay.

(6) *Multi-Node Blade Server*: A blade server which has multiple nodes. The blade server itself is hot swappable, but the individual nodes are not.

(b) Blade Chassis: An enclosure that contains shared resources for the operation of blade servers, blade storage, and other blade form-factor devices. Shared resources provided by a chassis may include power supplies, data storage, and hardware for dc power distribution, thermal management, system management, and network services.

(c) Blade Storage: A storage device that is designed for use in a blade chassis. A blade storage device is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for operation.

1.1.4. Fully Fault Tolerant Server: A computer server that is designed with complete hardware redundancy, in which every computing component is replicated between two nodes running identical and concurrent workloads (i.e., if one node fails or needs repair, the second node can run the workload alone to avoid downtime). A fully fault tolerant server uses two systems to simultaneously and repetitively run a single workload for continuous availability in a mission critical application.

1.1.5. Resilient Server: A computer server designed with extensive Reliability, Availability, Serviceability (RAS) and scalability features integrated in the micro architecture of the system, CPU and chipset. For purposes of ENERGY STAR qualification under this specification, a Resilient Server shall have the characteristics as described in Appendix B of this specification.

1.1.6. Multi-node Server: A computer server that is designed with two or more independent server nodes that share a single enclosure and one or more power supplies. In a multi-node server, power is distributed to all nodes through shared power supplies. Server nodes in a multi-node server are not designed to be hot-swappable.

Dual-node Server: A common multi-node server configuration consisting of two server nodes.

1.1.7. Server Appliance: A computer server that is bundled with a pre-installed OS and application software that is used to perform a dedicated function or set of tightly coupled functions. Server appliances deliver services through one or more networks (e.g., IP or SAN), and are typically managed through a web or command line interface. Server appliance hardware and software configurations are customized by the vendor to perform a specific task (e.g., name services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP) services), and are not intended to execute user-supplied software.

1.1.8. High Performance Computing (HPC) System: A computing system which is designed and optimized to execute highly parallel applications. HPC systems feature a large number of clustered homogeneous nodes often featuring high speed inter-processing interconnects as well as large memory capability and bandwidth. HPC systems may be purposely built, or assembled from more commonly available computer servers. HPC systems must meet ALL the following criteria:

(a) Marketed and sold as a Computer Server optimized for higher performance computing applications;

(b) Designed (or assembled) and optimized to execute highly parallel applications;

(c) Consist of a number of typically homogeneous computing nodes, clustered primarily to increase computational capability;

(d) Includes high speed inter-processing interconnections between nodes.

1.1.9. Direct Current (dc) Server: A computer server that is designed solely to operate on a dc power source.

1.1.10. Large Server: A resilient/scalable server which ships as a pre-integrated/pre-tested system housed in one or more full frames or racks and that includes a high connectivity I/O subsystem with a minimum of 32 dedicated I/O slots.

1.2. 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.

1.3. Computer Server Form Factors

1.3.1. Rack-mounted Server: A computer server that is designed for deployment in a standard 19-inch data centre rack as defined by EIA-310, IEC 60297, or DIN 41494. For the purposes of this specification, a blade server is considered under a separate category and excluded from the rack-mounted category.

1.3.2. Pedestal Server: A self-contained computer server that is designed with PSUs, cooling, I/O devices, and other resources necessary for stand-alone operation. The frame of a pedestal server is similar to that of a tower client computer.

1.4. Computer Server Components

1.4.1. Power Supply Unit (PSU): A device that converts ac or dc input power to one or more dc power outputs for the purpose of powering a computer server. A computer server PSU must be self-contained and physically separable from the motherboard and must connect to the system via a removable or hard-wired electrical connection.

(a) Ac-Dc Power Supply: A PSU that converts line-voltage ac input power into one or more dc power outputs for the purpose of powering a computer server.

(b) Dc-Dc Power Supply: A PSU that converts line-voltage dc input power to one or more dc outputs for the purpose of powering a computer server. For purposes of this specification, a dc-dc converter (also known as a voltage regulator) that is internal to a computer server and is used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by computer server components is not considered a dc-dc power supply.

(c) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to one primary dc output for the purpose of powering a computer server. Single-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from any additional PSU outputs that are not primary and standby outputs shall be no greater than 20 watts. PSUs that offer multiple outputs at the same voltage as the primary output are considered single-output PSUs unless those outputs (1) are generated from separate converters or have separate output rectification stages, or (2) have independent current limits.

(d) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to more than one primary dc output for the purpose of powering a computer server. Multi-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from any additional PSU outputs that are not primary and standby outputs is greater than or equal to 20 watts.

1.4.2. I/O Device: A device which provides data input and output capability between a computer server and other devices. An I/O device may be integral to the computer server motherboard or may be connected to the motherboard via expansion slots (e.g., PCI, PCIe). Examples of I/O devices include discrete Ethernet devices, InfiniBand devices, RAID/SAS controllers, and Fibre Channel devices.

I/O Port: Physical circuitry within an I/O device where an independent I/O session can be established. A port is not the same as a connector receptacle; it is possible that a single connector receptacle can service multiple ports of the same interface.

1.4.3. Motherboard: The main circuit board of the server. For purposes of this specification, the motherboard includes connectors for attaching additional boards and typically includes the following components: processor, memory, BIOS, and expansion slots.

1.4.4. Processor: The logic circuitry that responds to and processes the basic instructions that drive a server. For purposes of this specification, the processor is the central processing unit (CPU) of the computer server. A typical CPU is a physical package to be installed on the server motherboard via a socket or direct solder attachment. The CPU package may include one or more processor cores.

1.4.5. Memory: For purposes of this specification, memory is a part of a server external to the processor in which information is stored for immediate use by the processor.

1.4.6. Hard Drive (HDD): The primary computer storage device which reads and writes to one or more rotating magnetic disk platters.

1.4.7. Solid State Drive (SSD): A storage device that uses memory chips instead of rotating magnetic platters for data storage.

1.5. Other Datacenter Equipment:

1.5.1. Network Equipment: A device whose primary function is to pass data among various network interfaces, providing data connectivity among connected devices (e.g., routers and switches). Data connectivity is achieved via the routing of data packets encapsulated according to internet Protocol, Fibre Channel, InfiniBand or similar protocol.

1.5.2. Storage Product: A fully-functional storage system that supplies data storage services to clients and devices attached directly or through a network. Components and subsystems that are an integral part of the storage product architecture (e.g., to provide internal communications between controllers and disks) are considered to be part of the storage product. In contrast, components that are normally associated with a storage environment at the data centre level (e.g., devices required for operation of an external SAN) are not considered to be part of the storage product. A storage product may be composed of integrated storage controllers, storage devices, embedded network elements, software, and other devices. While storage products may contain one or more embedded processors, these processors do not execute user-supplied software applications but may execute data-specific applications (e.g., data replication, backup utilities, data compression, install agents).

1.5.3. Uninterruptible Power Supply (UPS): Combination of convertors, switches, and energy storage devices (such as batteries) constituting a power system for maintaining continuity of load power in case of input power failure.

1.6. Operational Modes and Power States

1.6.1. Idle State: The operational state in which the OS and other software have completed loading, the computer server is capable of completing workload transactions, but no active workload transactions are requested or pending by the system (i.e., the computer server is operational, but not performing any useful work). For systems where ACPI standards are applicable, Idle State correlates only to ACPI System Level S0.

1.6.2. Active State: The operational state in which the computer server is carrying out work in response to prior or concurrent external requests (e.g., instruction over the network). Active state includes both (1) active processing and (2) data seeking/retrieval from memory, cache, or internal/external storage while awaiting further input over the network.

1.7. Other Key Terms

1.7.1. Controller System: A computer or computer server that manages a benchmark evaluation process. The controller system performs the following functions:

(a) start and stop each segment (phase) of the performance benchmark;

(b) control the workload demands of the performance benchmark;

(c) start and stop data collection from the power analyser so that power and performance data from each phase can be correlated;

(d) store log files containing benchmark power and performance information;

(e) convert raw data into a suitable format for benchmark reporting, submission and validation; and

(f) collect and store environmental data, if automated for the benchmark.

1.7.2. Network Client (Testing): A computer or computer server that generates workload traffic for transmission to a unit under test (UUT) connected via a network switch.

1.7.3. RAS Features: An acronym for reliability, availability, and serviceability features. RAS is sometimes expanded to RASM, which adds ‘Manageability’ criteria. The three primary components of RAS as related to a computer server are defined as follows:

(a) Reliability Features: Features that support a server’s ability to perform its intended function without interruption due to component failures (e.g., component selection, temperature and/or voltage de-rating, error detection and correction).

(b) Availability Features: Features that support a server’s ability to maximize operation at normal capacity for a given duration of downtime (e.g., redundancy [both at micro- and macro-level]).

(c) Serviceability Features: Features that support a server’s ability to be serviced without interrupting operation of the server (e.g., hot plugging).

1.7.4. Server Processor Utilization: The ratio of processor computing activity to full-load processor computing activity at a specified voltage and frequency, measured

instantaneously or with a short term average of use over a set of active and/or idle cycles.

1.7.5. Hypervisor: A type of hardware virtualization technique that enables multiple guest operating systems to run on a single host system at the same time.

1.7.6. Auxiliary Processing Accelerators (APAs): Computing expansion add-in cards installed in general-purpose add-in expansion slots (e.g., GPGPUs installed in a PCI slot).

1.7.7. Buffered DDR Channel: Channel or Memory Port connecting a Memory Controller to a defined number of memory devices (e.g. DIMMs) in a computer server. A typical computer server may contain multiple Memory Controllers, which may in turn support one or more Buffered DDR Channels. As such, each Buffered DDR Channel serves only a fraction of the total addressable memory space in a computer server.

1.8. 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.

1.8.1. Common Product Family Attributes: A set of features common to all models/configurations within a product family that constitute a common basic design. All models/configurations within a product family must share the following:

(a) Be from the same model line or machine type;

(b) Either share the same form factor (i.e., rack-mounted, blade, pedestal) or share the same mechanical and electrical designs with only superficial mechanical differences to enable a design to support multiple form factors;

(c) Either share processors from a single defined processor series or share processors that plug into a common socket type.

(d) Share PSUs that perform with efficiencies greater than or equal to the efficiencies at all required load points specified in Section 3.2 (i.e., 10 %, 20 %, 50 %, and 100 % of maximum rated load for single-output; 20 %, 50 %, and 100 % of maximum rated load for multi-output).

1.8.2. Product Family Tested Product Configurations

(a) Purchase Consideration Variations:

(1) Low-end Performance Configuration: The combination of Processor Socket Power, PSUs, Memory, Storage (HDD/SDD), and I/O devices that represents the lower-price or lower-performance computing platform within the Product Family.

(2) High-end Performance Configuration: The combination of Processor Socket Power, PSUs, Memory, Storage (HDD/SDD), and I/O devices that represents either the higher-price or higher-performance computing platform within the Product Family.

(b) Typical Configuration:

Typical Configuration: A product configuration that lies between the Minimum and Maximum Power configurations and is representative of a deployed product with high volume sales.

(c) Power Utilization Variations:

(1) Minimum Power Configuration: The minimum configuration that is able to boot and execute supported OSs. The Minimum Configuration contains the lowest Processor Socket Power, least number of installed PSUs, Memory, Storage (HDD/SDD), and I/O devices, that is both offered for sale and capable of meeting ENERGY STAR requirements.

(2) Maximum Power Configuration: The vendor-selected combination of components that maximize power usage within the Product Family once assembled and operated. The Maximum Configuration contains the highest Processor Socket Power, greatest number of installed PSUs, Memory, Storage (HDD/SDD), and I/O devices that is both offered for sale and capable of meeting ENERGY STAR requirements.

2. **Scope**

2.1. Included Products

A product must meet the definition of a Computer Server provided in Section 1 of this document to be eligible for ENERGY STAR qualification under this specification. Eligibility under Version 2.0 is limited to Blade-, Multi-node, Rack-mounted, or Pedestal form factor computer servers with no more than four processor sockets in the computer server (or per blade or node in the case of blade or multi-node servers) Products explicitly excluded from Version 2.0 are identified in Section 2.2.

2.2. Excluded Products

2.2.1. Products that are covered under other ENERGY STAR product specifications are not eligible for qualification under this specification. The list of specifications currently in effect can be found at www.eu-energystar.org/.

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

(a) Fully Fault Tolerant Servers;

(b) Server Appliances;

(c) High Performance Computing Systems;

(d) Large Servers;

(e) Storage Products including Blade Storage; and

(f) Network Equipment.

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 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. Power Supply 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 qualifying the ENERGY STAR product.

3.2.2. Power Supply Efficiency Criteria: Power Supplies used in products 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 www.efficientpowersupplies.org). Power Supply data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, or 6.5 are acceptable provided the test was conducted prior to the effective date of Version 2.0 of this specification.

(a) Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with only PSUs that meet or exceed the applicable efficiency requirements specified in Table 1 prior to shipment.

(b) Blade and Multi-node Servers: To qualify for ENERGY STAR, a Blade or Multi-node computer server shipped with a chassis must be configured such that all PSUs supplying power to the chassis meet or exceed the applicable efficiency requirements specified in Table 1 prior to shipment.

Table 1

Efficiency Requirements for PSUs

Power Supply Type	Rated Output Power	10 % Load	20 % Load	50 % Load	100 % Load
Multi-output (Ac-Dc)	All Output Levels	N/A	85 %	88 %	85 %
Single-output (Ac-Dc)	All Output Levels	80 %	88 %	92 %	88 %

3.2.3. Power Supply Power Factor Criteria: Power Supplies 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 www.efficientpowersupplies.org). Power Supply data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, or 6.5 are acceptable provided the test was conducted prior to the effective date of Version 2.0.

(a) Pedestal and Rack-mounted Servers: To qualify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with only PSUs that meet or exceed the applicable power factor requirements specified in Table 2 prior to shipment, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.

(b) Blade or Multi-node Servers: To qualify for ENERGY STAR, a Blade or Multi-node computer server shipped with a chassis must be configured such that all PSUs supplying power to the chassis meet or exceed the applicable power factor requirements specified in Table 2 prior to shipment, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to

measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.

Table 2

Power Factor Requirements for PSUs

Power Supply Type	Rated Output Power	10 % Load	20 % Load	50 % Load	100 % Load
Ac-Dc Multi-output	All Output Ratings	N/A	0,8	0,9	0,95
Ac-Dc Single-output	Output Rating ≤ 500 W	N/A	0,8	0,9	0,95
	Output Rating > 500 W and Output Rating ≤ 1 000 W	0,65	0,8	0,9	0,95
	Output Rating > 1 000 watts	0,8	0,9	0,9	0,95

3.3. Power Management Requirements

3.3.1. Server Processor Power Management: To qualify for ENERGY STAR, a Computer Server must offer processor power management that is enabled by default in the BIOS and/or through a management controller, service processor, and/or the operating system shipped with the computer server. All processors must be able to reduce power consumption in times of low utilization by:

(a) reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS), or

(b) enabling processor or core reduced power states when a core or socket is not in use.

3.3.2. Supervisor Power Management: To qualify for ENERGY STAR, a product which offers a pre-installed supervisor system (e.g., operating system, hypervisor) must offer supervisor system power management that is enabled by default.

3.3.3. Power Management Reporting: To qualify for ENERGY STAR, all power management techniques that are enabled by default must be itemized on the Power and Performance Data Sheet. This requirement applies to power management features in the BIOS, operating system, or any other origin that can be configured by the end-user.

3.4. Blade and Multi-Node System Criteria

3.4.1. Blade and Multi-Node Thermal Management and Monitoring: To qualify for ENERGY STAR, a blade or multi-node server must provide real-time chassis or blade/node inlet temperature monitoring and fan speed management capability that is enabled by default.

3.4.2. Blade and Multi-Node Server Shipping Documentation: To qualify for ENERGY STAR, a blade or multi-node server that is shipped to a customer independent of the

chassis must be accompanied with documentation to inform the customer that the blade or multi-node server is ENERGY STAR qualified only if it is installed in a chassis meeting requirements in Section 3.4.1 of this document. A list of qualifying chassis and ordering information must also be provided as part of product collateral provided with the blade or multi-node server. These requirements may be met via either printed materials, electronic documentation provided with the blade or multi-node server, or information publically available on the Partner's website where information about the blade or multi-node server is found.

3.5. Active State Efficiency Criteria

3.5.1. Active State Efficiency Reporting: To qualify for ENERGY STAR, a Computer Server or Computer Server Product Family must be submitted for qualification with the following information disclosed in full and in the context of the complete Active State efficiency rating test report:

(a) Final SERT rating tool results, which include the results files (both html and text format) and all results-chart png files; and

(b) Intermediate SERT rating tool results over the entire test run, which include the results-details files (both html and text format) and all results-details-chart png files.

Data reporting and formatting requirements are discussed in Section 4.1 of this specification.

3.5.2. Incomplete Reporting: Partners shall not selectively report individual workload module results, or otherwise present efficiency rating tool results in any form other than a complete test report, in customer documentation or marketing materials.

3.6. Idle State Efficiency Criteria – One-Socket (1S) and Two-Socket (2S) Servers (neither Blade nor Multi-Node)

3.6.1. Idle State Data Reporting: Maximum Idle State power (P_{IDLE_MAX}) shall be measured and reported, both in qualification materials and as required in Section 4.

3.6.2. Idle State Efficiency: Measured Idle State power (P_{IDLE}) shall be less than or equal to the Maximum Idle State Power Requirement (P_{IDLE_MAX}), as calculated per Equation 1.

Equation 1: Calculation of Maximum Idle State Power

$$P_{IDLE\_MAX} = P_{BASE} + \sum_{i=1}^{n} P_{ADDL\_i}$$

Where:

— P_{IDLE_MAX} is the Maximum Idle State Power Requirement,

— P_{BASE} is the base idle power allowance, as determined per Table 3,

— P_{ADDL_i} is the Idle State power allowance for additional components, as determined per Table 4.

(a) These Idle power limits are applicable to one and two socket systems only.

(b) Use Section 6.1 of the ENERGY STAR Computer Servers Test Method to determine the Idle State power for qualification.

(c) The Resilient category in Table 3 applies only to two socket systems that meet the definition of Resilient Server as set forth in Appendix B.

(d) All quantities (with the exception of installed processors) in Tables 3 and 4 refer to the number of components installed in the system, not the maximum

number of components the system can support (e.g., installed memory, not supported memory; etc.)

(e) The Additional Power Supply allowance may be applied for each redundant power supply used in the configuration.

(f) For the purposes of determining Idle power allowances, all memory capacities shall be rounded to the nearest GB[13].

(g) The Additional I/O Device allowance may be applied for all I/O Devices over the Base Configuration (i.e., Ethernet devices additional to two ports greater than or equal to 1 Gigabit per second (Gbit/s), onboard Ethernet, plus any non-Ethernet I/O devices), including on-board I/O devices and add-in I/O devices installed through expansion slots. This allowance may be applied for each of the following types of I/O functionality: Ethernet, SAS, SATA, Fibre Channel and Infiniband.

(h) The Additional I/O Device allowance shall be calculated based upon the rated link speed of a single connection, rounded to the nearest Gbit. I/O devices with less than 1 Gbit speed do not qualify for the Additional I/O Device allowance.

(i) The Additional I/O Device allowance shall only be applied for I/O devices that are active/enabled upon shipment, and are capable of functioning when connected to an active switch.

Table 3

Base Idle State Power Allowances for 1S and 2S Servers

Category	Maximum Possible Number of Installed Processors(# P)	Managed Server	Base Idle State Power Allowance, P_{BASE}(watts)
A	1	No	47,0
B	1	Yes	57,0
C	2	No	92,0
D	2	Yes	142,0
Resilient	2	Yes	205,0

Table 4

Additional Idle Power Allowances for Extra Components

System Characteristic	Applies To:	Additional Idle Power Allowance
Additional Power Supplies	Power supplies installed explicitly for power redundancy	20 watts per Power Supply
Hard Drives (including solid state drives)	Per installed hard drive	8,0 watts per Hard Drive
Additional Memory	Installed memory greater than 4 GB	0,75 watts per GB

Table 4

Additional Idle Power Allowances for Extra Components		
Additional Buffered DDR Channel	Installed buffered DDR Channels greater than 8 channels (Resilient Servers only)	4,0 watts per Buffered DDR Channel
Additional I/O Devices	Installed Devices greater than two ports of ≥ 1 Gbit, onboard Ethernet	< 1 Gbit: No Allowance = 1 Gbit: 2,0 watts/Active Port > 1 Gbit and < 10 Gbit: 4,0 watts/Active Port ≥ 10 Gbit: 8,0 watts/Active Port

3.7. Idle State Efficiency Criteria – Three-Socket (3S) and Four-Socket (4S) Servers (neither Blade nor Multi-Node)

Idle State Data Reporting: Idle State power (P_{IDLE}) shall be measured and reported, both in qualification materials and as required in Section 4.

3.8. Idle State Efficiency Criteria – Blade Servers

3.8.1. Idle State Data Reporting: Idle State power ($P_{TOT\_BLADE\_SYS}$) and (P_{BLADE}) shall be measured and reported, both in qualification materials and as required in Section 4.

3.8.2. The testing of Blade Servers for compliance with Section 3.8.1 shall be carried out under all of the following conditions:

(a) Power values shall be measured and reported using a half-populated Blade Chassis. Blade Servers with multiple power domains, choose the number of power domains that is closest to filling half of the Blade Chassis. In a case where there are two choices that are equally close to half, test with the domain or combination of domains which utilize a higher number of Blade Servers. The number of blades tested during the half-populated Blade Chassis test shall be reported.

(b) Power for a fully-populated blade chassis may be optionally measured and reported, provided that half-populated chassis data is also provided.

(c) All Blade Servers installed in the Blade Chassis shall share the same configuration (homogeneous).

(d) Per-blade power values shall be calculated using Equation 2.

Equation 2: Calculation of Single Blade Power

$$P_{BLADE} = \frac{P_{TOT\_BLADE\_SYS}}{N_{INST\_BLADE\_SRV}}$$

Where:

— P_{BLADE} is the per-Blade Server Power

— $P_{TOT\_BLADE\_SYS}$ is total measured power of the Blade System,

— $N_{INST\_BLADE\_SRV}$ is the number of installed Blade Servers in the tested Blade Chassis.

3.9. Idle State Efficiency Criteria – Multi-Node Servers

3.9.1. Idle State Data Reporting: Idle State power ($P_{TOT\_NODE\_SYS}$) and (P_{NODE}) shall be measured and reported, both in qualification materials and as required in Section 4, below.

3.9.2. The testing of Multi-Node Servers for compliance with Section 3.9.1 shall be carried out under all of the following conditions:

(a) Power values shall be measured and reported using a fully-populated Multi-Node Chassis.

(b) All Multi-Node Servers in the Multi-Node Chassis shall share the same configuration (homogeneous).

(c) Per-node power values shall be calculated using Equation 3.

Equation 3: Calculation of Single Node Power

$$P_{NODE} = \frac{P_{TOT\_NODE\_SYS}}{N_{INST\_NODE\_SRV}}$$

Where:

— P_{NODE} is the per Node Server Power

— $P_{TOT\_NODE\_SYS}$ is total measured power of the Multi Node Server,

— $N_{INST\_NODE\_SRV}$ is the number of installed Multi Node Servers in the tested Multi-Node Chassis.

3.10. Other Testing Criteria

APA Requirements: For all computer servers sold with APAs, the following criteria and provisions apply:

(a) For single configurations: All Idle State testing shall be conducted both with and without the APAs installed. Idle Power measurements taken both with the APAs installed and removed shall be submitted to EPA or the European Commission, as appropriate as part of ENERGY STAR qualification materials.

(b) For Product Families: Idle State testing shall be conducted both with and without the APAs installed in the Maximum Power/High-end Performance Configuration found in 1.8.2. Testing with and without the APAs installed may optionally be conducted and disclosed at the other test points.

(c) Idle State power measurements taken both with the APAs installed and removed shall be submitted to EPA or the European Commission, as appropriate as part of ENERGY STAR qualification materials. These measurements shall be submitted for each individual APA product that is intended for sale with the qualified configuration.

(d) Measurements of P_{IDLE} in Sections 3.6 and 3.7, P_{BLADE} in Section 3.8 and P_{NODE} in Section 3.9 shall be performed with APAs removed, even if they are installed as-shipped. These measurements shall then be repeated with each APA installed, one at a time, to evaluate Idle State power consumption of each installed APA.

(e) The Idle State power consumption of each installed APA in qualified configurations shall not exceed 46 watts.

(f) The Idle State power consumption of each individual APA product sold with a qualified configuration shall be reported.

4. **Standard Information Reporting Requirements**

Data Reporting Requirements

4.1. All required data fields in the ENERGY STAR Version 2.0 Computer Servers Qualified Product Exchange form shall be submitted to the European Commission for each ENERGY STAR qualified Computer Server or Computer Server Product Family.

(a) Partners are encouraged to provide one set of data for each ENERGY STAR qualified product configuration, though the European Commission will also accept a data set for each qualified product family.

(b) A product family qualification must include data for all defined test points in 1.8.2, as applicable.

(c) Whenever possible, Partners must also provide a hyperlink to a detailed power calculator on their Web site that purchasers can use to understand power and performance data for specific configurations within the product family.

4.2. The following data will be displayed on the EU ENERGY STAR Web site through the product finder tool:

(a) model name and number, identifying SKU and/or configuration ID;

(b) system characteristics (form factor, available sockets/slots, power specifications, etc.);

(c) system type (unmanaged, managed, scalable, etc.);

(d) system configuration(s) (including Low-end Performance Configuration, High-end Performance Configuration, Minimum Power Configuration, Maximum Power Configuration, and Typical Configuration for Product Family qualification);

(e) power consumption and performance data from required Active and Idle State Efficiency Criteria testing including results.xml, results.html, results.txt, all results-chart png files, results-details.html, results-details.txt, all results-details-chart png files;

(f) available and enabled power saving features (e.g., power management);

(g) a list of selected data from the ASHRAE Thermal Report;

(h) inlet air temperature measurements made prior to the start of testing, at the conclusion of Idle State testing, and at the conclusion of Active State testing;

(i) for product family qualifications, a list of qualified configurations with qualified SKUs or configuration IDs; and

(j) for a blade server, a list of compatible blade chassis that meet ENERGY STAR qualification criteria.

4.3. EPA and the European Commission may periodically revise this list, as necessary, and will notify and invite stakeholder engagement in such a revision process.

5. **Standard Performance Data Measurement and Output Requirements**

5.1. Measurement and Output

5.1.1. A computer server must provide data on input power consumption (W), inlet air temperature (°C), and average utilization of all logical CPUs. Data must be made available in a published or user-accessible format that is readable by third-party, non-

proprietary management software over a standard network. For blade and multi-node servers and systems, data may be aggregated at the chassis level.

5.1.2. Computer servers classified as Class B equipment as set out in EN 55022:2006 are exempt from the requirements to provide data on input power consumption and inlet air temperature in 5.1.1. Class B refers to household and home office equipment (intended for use in the domestic environment). All computer servers in the program must meet the requirement and conditions to report utilization of all logical CPUs.

5.2. Reporting Implementation

5.2.1. Products may use either embedded components or add-in devices that are packaged with the computer server to make data available to end users (e.g., a service processor, embedded power or thermal meter (or other out-of-band technology), or pre-installed OS);

5.2.2. Products that include a pre-installed OS must include all necessary drivers and software for end users to access standardized data as specified in this document. Products that do not include a pre-installed OS must be packaged with printed documentation of how to access registers that contain relevant sensor information. This requirement may be met via either printed materials, electronic documentation provided with the computer server, or information publically available on the Partner's website where information about the computer server is found.

5.2.3. When an open and universally available data collection and reporting standard becomes available, manufacturers should incorporate the universal standard into their systems;

5.2.4. Evaluation of the accuracy (5.3) and sampling (5.4) requirements shall be completed through review of data from component product datasheets. If this data is absent, Partner declaration shall be used to evaluate accuracy and sampling.

5.3. Measurement Accuracy

5.3.1. Input power: Measurements must be reported with accuracy of at least ± 5 % of the actual value, with a maximum level of accuracy of ± 10 W for each installed PSU (i.e., power reporting accuracy for each power supply is never required to be better than ± 10 watts) through the operating range from Idle to full power;

5.3.2. Processor utilization: Average utilization must be estimated for each logical CPU that is visible to the OS and must be reported to the operator or user of the computer server through the operating environment (OS or hypervisor);

5.3.3. Inlet air temperature: Measurements must be reported with an accuracy of at least ± 2 °C.

5.4. Sampling Requirements

5.4.1. Input power and processor utilization: Input power and processor utilization measurements must be sampled internally to the computer server at a rate of greater than or equal to measurement per contiguous 10 second period. A rolling average, encompassing a period of no more than 30 seconds, must be sampled internally to the computer server at a frequency of greater than or equal to once per ten seconds.

5.4.2. Inlet air temperature: Inlet air temperature measurements must be sampled internally to the computer server at a rate of greater than or equal to 1 measurement every 10 seconds.

5.4.3. Time stamping: Systems that implement time stamping of environmental data shall sample internally to the computer server data at a rate of greater than or equal to 1 measurement every 30 seconds.

5.4.4. Management Software: All sampled measurements shall be made available to external management software either via an on-demand pull method, or via a coordinated push method. In either case the system's management software is responsible for establishing the data delivery time scale while the computer server is responsible to assuring data delivered meets the above sampling and accuracy requirements.

6. **Testing**

6.1. Test Methods

6.1.1. When testing Computer Server products, the test methods identified in Table 5 shall be used to determine ENERGY STAR qualification.

Table 5

Test Methods for ENERGY STAR Qualification

Product Type or Component	Test Method
All	ENERGY STAR Test Method for Computer Servers (Rev. March-2013)
All	Standard Performance Evaluation Corporation (SPEC) Server Efficiency Rating Tool (SERT), Version 1.0.0, Rev. Feb 26, 2013

6.1.2. When testing Computer Server products, UUTs must have all Processor Sockets populated during testing.

If a Computer Server cannot support populating all Processor Sockets during testing, then the system must be populated to its maximum functionality. These systems will be subject to the base idle state power allowance based on the number of sockets in the system.

6.2. Number of Units Required for Testing

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

(a) For qualification of an individual product configuration, the unique configuration that is intended to be marketed and labelled as ENERGY STAR is considered the Representative Model.

(b) For qualification of a product family of all product types, one product configuration for each of the five points identified in definitions 1.8.2 within the family are considered Representative Models. All such representative models shall have the same Common Product Family Attributes as defined in 1.8.1.

6.3. Qualifying Families of Products

6.3.1. Partners are encouraged to test and submit data on individual product configurations for qualification to ENERGY STAR. However, a Partner may qualify multiple product configurations under one Product Family designation if each configuration within the family meets one of the following requirements:

(a) Individual products are built on the same platform, are eligible under and meet the same specific requirements in this specification, and are identical in every respect to the tested, representative product configuration except for housing and colour; or

(b) Individual products meet the requirements of a product family, as defined in Section 1.8, above. In this case, partners must test and submit data as required in Section (b).

6.3.2. Partners are required to submit a Power and Performance Data Sheet for each product family that is submitted for qualification.

6.3.3. All product configurations within a product family that is submitted for qualification must meet ENERGY STAR requirements, including products for which data was not reported.

7. **Effective Date**

7.1. The effective date of this Version 2.0 ENERGY STAR Computer Servers specification will be defined as the effective date of the Agreement. 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.

7.2. Future Specification Revisions: EPA and the European Commission reserve 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.

8. **Considerations for Future Revisions**

8.1. Active State Efficiency Criteria: EPA and the European Commission intend to set active state efficiency criteria in Version 3.0 for all computer server categories in which it has enough SERT data to adequately differentiate products.

8.2. Right Sizing of Power Supplies: EPA and the European Commission will investigate opportunities for encouraging right-sizing of power supplies in Version 3.0.

8.3. Inclusion of Dc-Dc Computer Servers: EPA and the European Commission encourage manufacturers to work with SPEC to develop support for dc servers in the SERT, so that dc computer servers may be considered for qualification in Version 3.0.

8.4. Inclusion of Additional System Architectures: EPA and the European Commission encourage manufacturers to work with SPEC to develop support for architectures that are not currently supported by the SERT, but which represent a sizeable portion of the Computer Servers market. EPA and the European Commission will consider any architecture that is supported by the SERT prior to the development of Version 3.0.

8.5. Removal of Adder for Additional Redundant Power Supplies: EPA and the European Commission are aware of technology that allows redundant power supplies to be kept in standby mode and only activated when needed. EPA and the European Commission encourage the adoption of this technology in computer servers, and will investigate whether the current adder for additional redundant power supplies is still necessary in Version 3.0.

8.6. Auxiliary Processing Accelerator (APA) Requirements: EPA and the European Commission intends to revisit and potentially expand APA requirements in Version

3.0, based on APA data collected from Version 2.0 as well as the potential incorporation of APA evaluation in the SERT.

8.7. Thermal Reporting and Testing Requirements: EPA and the European Commission plans to re-evaluate current temperature reporting and testing requirements to maximize the value of the data collected for manufacturers as well as data centre operators.

Appendix A **Sample Calculations**

1. **Idle State Power Requirements**

To determine the Maximum Idle State Power Requirement for ENERGY STAR qualification, determine the base idle state level from Table 3, and then add power allowances from Table 4 (provided in Section 3.6 of this Eligibility Criteria). An example is provided below:

Example: A standard single processor Computer Server with 8 GB of memory, two hard drives, and two I/O devices (the first with two 1 Gbit ports and the second with six 1 Gbit ports).

1.1. Base allowance:

(a) Determine base idle allowance from Table 3, provided for reference below.

(b) The example server is evaluated under Category A and could consume no more than 47,0 watts in Idle to qualify for ENERGY STAR.

Category	Number of Installed Processors(# P)	Managed Server	Base Idle Power Allowance(W)
A	1	No	47,0
B	1	Yes	57,0
C	2	No	92,0
D	2	Yes	142,0
Resilient	2	Yes	205,0

1.2. Additional Idle Power Allowances: Calculate additional idle allowances for extra components from Table 4, provided for reference below.

System Characteristic	Applies To	Additional Idle Power Allowance
Additional Power Supplies	Power supplies installed explicitly for power redundancy	20,0 watts per Power Supply
Hard Drives (including solid state drives)	All installed hard drives	8,0 watts per Hard Drive
Additional Memory	Installed memory greater than 4 GB	0,75 watts per GB

Additional Buffered DDR Channel	Installed buffered DDR Channels greater than 8 channels (Resilient Servers only)	4,0 watts per Buffered DDR Channel
Additional I/O Devices (single connection speed rounded to nearest Gbit)	Installed Devices greater than two ports of 1 Gbit, onboard Ethernet	< 1 Gbit: No Allowance = 1 Gbit: 2,0 watts/Active Port > 1 Gbit and < 10 Gbit: 4,0 watts/Active Port ≥ 10 Gbit: 8,0 watts/ Active Port

(a) The example server has two hard drives. It therefore is provided with an additional 16,0 watt allowance for each hard drive (2 HDD × 8,0 watts).

(b) The example server has 4 GB in excess of the base configuration. It therefore is provided with an additional 3,0 watt allowance for memory (4 extra GB × 0,75 watts/GB).

(c) The example server has one I/O card that does not qualify for an adder: the first device has only two Ethernet ports and does not exceed the two-port threshold. Its second device does qualify for an adder: the server is provided with an additional 12,0 watt allowance for the device (six 1Gbit ports × 2,0 watts/active port).

1.3. Calculate the final idle allowance by adding the base allowance with the additional power allowances. The example system would be expected to consume no more than 78,0 watts at Idle to qualify (47,0 W + 16,0 W + 3,0 W + 12,0 W).

2. **Additional Idle Allowance — Power Supplies**

The following examples illustrate the idle power allowances for additional power supplies:

2.1. If a Computer Server requires two power supplies to operate, and the configuration includes three installed power supplies, the server would receive an additional 20,0 watt idle power allowance.

2.2. If the same server were instead shipped with four installed power supplies, it would receive an additional idle power allowance of 40,0 watts.

3. **Additional Idle Allowance — Additional Buffered DDR Channel**

The following examples illustrate the idle power allowances for additional buffered DDR channels:

3.1. If a resilient Computer Server is shipped with six installed buffered DDR channels, the server would not receive an additional idle power allowance.

3.2. If the same resilient server were instead shipped with 16 installed buffered DDR channels, it would receive an additional idle power allowance of 32,0 watts (first 8 channels = no additional allowance, second 8 channels = 4,0 watts × 8 buffered DDR channels).

Appendix B **Identifying resilient server class**

1. **Processor RAS and Scalability** — All of the following shall be supported:

1.1. Processor RAS: The processor must have capabilities to detect, correct, and contain data errors, as described by all of the following:

(a) Error detection on L1 caches, directories and address translation buffers using parity protection;

(b) Single bit error correction (or better) using ECC on caches that can contain modified data. Corrected data is delivered to the recipient (i.e., error correction is not used just for background scrubbing);

(c) Error recovery and containment by means of (1) processor checkpoint retry and recovery, (2) data poison indication (tagging) and propagation, or (3) both. The mechanisms notify the OS or hypervisor to contain the error within a process or partition, thereby reducing the need for system reboots; and

(d) (1) Capable of autonomous error mitigation actions within processor hardware, such as disabling of the failing portions of a cache, (2) support for predictive failure analysis by notifying the OS, hypervisor, or service processor of the location and/or root cause of errors, or (3) both.

1.2. The processor technology used in resilient and scalable servers is designed to provide additional capability and functionality without additional chipsets, enabling them to be designed into systems with 4 or more processor sockets. The processors have additional infrastructure to support extra, built-in processor busses to support the demand of larger systems.

1.3. The server provides high bandwidth I/O interfaces for connecting to external I/O expansion devices or remote I/O without reducing the number of processor sockets that can be connected together. These may be proprietary interfaces or standard interfaces such as PCIe. The high performance I/O controller to support these slots may be embedded within the main processor socket or on the system board.

2. **Memory RAS and Scalability** — All of the following capabilities and characteristics shall be present:

(a) Provides memory fault detection and recovery through Extended ECC;

(b) In x4 DIMMs, recovery from failure of two adjacent chips in the same rank;

(c) Memory migration: Failing memory can be proactively de-allocated and data migrated to available memory. This can be implemented at the granularity of DIMMs or logical memory blocks. Alternatively, memory can also be mirrored;

(d) Uses memory buffers for connection of higher speed processor -memory links to DIMMs attached to lower speed DDR channels. Memory buffer can be a separate, standalone buffer chip which is integrated on the system board, or integrated on custom-built memory cards. The use of the buffer chip is required for extended DIMM support; they allow larger memory capacity due to support for larger capacity DIMMs, more DIMM slots per memory channel, and higher memory bandwidth per memory channel than direct-attached DIMMs. The memory modules may also be custom-built, with the memory buffers and DRAM chips integrated on the same card;

(e) Uses resilient links between processors and memory buffers with mechanisms to recover from transient errors on the link; and

(f) Lane sparing in the processor-memory links. One or more spare lanes are available for lane failover in the event of permanent error.

3. **Power Supply RAS:** All PSUs installed or shipped with the server shall be redundant and concurrently maintainable. The redundant and repairable components may also be housed within a single physical power supply, but must be repairable without requiring the system to be powered down. Support must be present to operate the system in degraded mode when power delivery capability is degraded due to failures in the power supplies or input power loss.

4. **Thermal and Cooling RAS:** All active cooling components, such as fans or water-based cooling, shall be redundant and concurrently maintainable. The processor complex must have mechanisms to allow it to be throttled under thermal emergencies. Support must be present to operate the system in degraded mode when thermal emergencies are detected in system components.

5. **System Resiliency** — no fewer than six of the following characteristics shall be present in the server:

(a) Support of redundant storage controllers or redundant path to external storage;

(b) Redundant service processors;

(c) Redundant dc-dc regulator stages after the power supply outputs;

(d) The server hardware supports runtime processor de-allocation;

(e) I/O adapters or hard drives are hot-swappable;

(f) Provides end to end bus error retry on processor to memory or processor to processor interconnects;

(g) Supports on-line expansion/retraction of hardware resources without the need for operating system reboot (‘on-demand’ features);

(h) Processor Socket migration: With hypervisor and/or OS assistance, tasks executing on a processor socket can be migrated to another processor socket without the need for the system to be restarted;

(i) Memory patrol or background scrubbing is enabled for proactive detection and correction of errors to reduce the likelihood of uncorrectable errors; and

(j) Internal storage resiliency: Resilient systems have some form of RAID hardware in the base configuration, either through support on the system board or a dedicated slot for a RAID controller card for support of the server’s internal drives.

6. **System Scalability** — All of the following shall be present in the server:

(a) Higher memory capacity: >=8 DDR3 or DDR4 DIMM Ports per socket, with resilient links between the processor socket and memory buffers; and

(b) Greater I/O expandability: Larger base I/O infrastructure and support a higher number of I/O slots. Provide at least 32 dedicated PCIe Gen 2 lanes or equivalent I/O bandwidth, with at least one x16 slot or other dedicated interface to support external PCIe, proprietary I/O interface or other industry standard I/O interface.

Appendix C **Test Method**

1. Overview

The following test method shall be used for determining compliance with requirements in the ENERGY STAR Product Specification for Computer Servers and when acquiring test data for reporting of Idle State power and Active State power on the ENERGY STAR Power and Performance Data Sheet.

2. Applicability

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

3. Definitions

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

4. Test setup

4.1. Input Power: Input power shall be as specified in Tables 6 and 7. The frequency for input power shall be as specified in Table 8.

Table 6

Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1 500 watts (W)

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with alternating current (ac)-direct current (dc) Single-Output Power Supply Units (PSUs)	230 volts (V) ac or 115 V ac[0]	+/– 1,0 %	2,0 %
Servers with ac-dc Multi-Output PSUs	230 V ac or 115 V ac[0]		
Optional Testing Conditions For ac-dc (Japanese Market)	100 V ac		
Three-phase Servers (North American Market)	208 V ac		
Three-phase Servers (Europe Market)	400 V ac		

Table 7

Input Power Requirements for Products with Nameplate Rated Power Greater Than 1 500 W

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with ac-dc Single-Output PSUs	230 V ac or 115 V ac[a]	+/– 4,0 %	5,0 %
Servers with ac-dc Multi-Output PSUs	230 V ac or 115 V ac[a]		
Optional Testing Conditions For ac-dc (Japanese Market)	100 V ac		
Three-phase Servers (North American Market)	208 V ac		
Three-phase Servers (Europe Market)	400 V ac		

a *Note:* 230 V ac refers to the European market and 115 V ac refers to the North American market.

TABLE 8

Input Frequency Requirements for All Products

Supply Voltage	Frequency	Frequency Tolerance
100 V ac	50 hertz (Hz) or 60 Hz	± 1,0 %
115 V ac	60 Hz	
230 V ac	50 Hz or 60 Hz	
Three-phase (North American Market)	60 Hz	
Three-phase (Europe Market)	50 Hz	

4.2. Ambient Temperature: Ambient temperature shall be within 25 ± 5 °C.

4.3. Relative Humidity: Relative humidity shall be within 15 % and 80 %.

4.4. Power Analyser: The power analyser shall report true Root Mean Square (RMS) power and at least two of the following measurement units: voltage, current, and power factor. Power analysers shall possess the following attributes:

(a) Compliance: The power analyser shall be chosen from the list of power measuring devices specified in the Server Efficiency Rating Tool (SERT)^{TM}[(14)] Design Document 1.0.0[(15)].

(b) Calibration: The analyser shall have been calibrated within a year of the test date, by a standard traceable to the National Institute of Science and Technology (USA) or a counterpart national metrology institute in other countries.

(c) Crest Factor: An available current crest factor of 3 or more at its rated range value. For analysers that do not specify the current crest factor, the analyser must be capable of measuring an amperage spike of at least 3 times the maximum amperage measured during any 1 second sample.

(d) Minimum Frequency Response: 3,0 kHz.

(e) Minimum Resolution:

(1) 0,01 W for measurement values less than 10 W;

(2) 0,1 W for measurement values from 10 W to 100 W; and

(3) 1,0 W for measurement values greater than 100 W.

(f) Logging: The reading rate supported by the analyser shall be at least 1 set of measurements per second, where set is defined as a power measurement, in watts. The data averaging interval of the analyser shall equal the reading interval. Data averaging interval is defined as the time period over which all samples captured by the high-speed sampling electronics of the analyser are averaged to provide the measurement set.

(g) Measurement Accuracy: Power measurements shall be reported by the analyser with an overall accuracy of 1 % or better for all measured power values.

4.5. Temperature Sensor: The temperature sensor shall possess the following attributes:

(a) Compliance: The temperature sensor shall be chosen from the list of temperature measuring devices specified in the SERT Design Document 1.0.0.

(b) Logging: The sensor shall have a minimum reading rate of 4 samples per minute.

(c) Measurement Accuracy: Temperature must be measured no more than 50 mm in front of (upwind of) the main airflow inlet of the Unit Under Test (UUT) and reported by the sensor with an overall accuracy of ± 0,5 °C or better.

4.6. Active State Test Tool: SERT 1.0.0, provided by Standard Performance Evaluation Corporation (SPEC)[16].

4.7. Controller System: The Controller System may be a Server, a desktop computer, or a laptop and shall be used to record power and temperature data.

(a) The power analyser and the temperature sensor shall be connected to the Controller System.

(b) The Controller System and the UUT shall be connected to each other via an Ethernet network switch.

4.8. General SERT Requirements: Any additional requirements specified in any SPEC or SERT 1.0.0 supporting documents shall be followed, unless otherwise specified in this test method. Supporting documents from SPEC include:

(a) SPEC Power and Performance Methodology

(b) SPEC Power Measurement Setup Guide

(c) SPEC PTDaemon Design Document

(d) SERT Design Document

(e) SERT Run and Reporting Rules

(f) SERT User Guide

(g) SERT JVM Options

(h) SERT Result File Fields

5. **Test conduct**

5.1. Test Configuration

Power and efficiency shall be tested and reported for the Computer Servers being tested. Testing shall be conducted as follows:

5.1.1. As-shipped Condition: Products shall be tested in their 'as-shipped' configuration, which includes both hardware configuration and system settings, unless otherwise specified in this test method. Where relevant, all software options shall be set to their default condition.

5.1.2. Measurement Location: All power measurements shall be taken at a point between the ac 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 Idle and Active State power data are fully recorded. When testing a Blade System, power shall be measured at the input of the Blade Chassis (i.e., at the power supplies that convert data centre distribution power to Chassis distribution power).

5.1.3. Air Flow: Purposefully directing air in the vicinity of the measured equipment in a way that would be inconsistent with normal data centre practices is prohibited.

5.1.4. Power Supplies: All PSUs shall be connected and operational.

UUTs with Multiple PSUs: All power supplies shall be connected to the ac power source and operational during the test. If necessary, a Power Distribution Unit (PDU) may be used to connect multiple power supplies to a single source. If a PDU is used, any overhead electrical use from the PDU shall be included in the power measurement of the UUT. When testing Blade Servers with half-populated Chassis configurations, the power supplies for the unpopulated power domains can be disconnected (see section 5.2.4(b) for more information).

5.1.5. Power Management and Operating System: The as-shipped operating system or a representative operating system shall be installed. Products that are shipped without operating systems shall be tested with any compatible operating system installed. For all tests, the power management techniques and/or power saving features shall be left as-shipped. Any power management features which require the presence of an operating system (i.e. those that are not explicitly controlled by the Basic Input Output System (BIOS) or management controller) shall be tested using only those power management features enabled by the operating system by default.

5.1.6. Storage: Products shall be tested for qualification with at least one Hard Disk Drive (HDD) or one Solid State Drive (SSD) installed. Products that do not include pre-installed hard drives (HDD or SSD) shall be tested using a storage configuration used in an identical model for sale that does include pre-installed hard drives. Products that

do not support installation of hard drives (HDD or SSD) and, instead, rely exclusively on external storage solutions (e.g. storage area network) shall be tested using external storage solutions.

5.1.7. Blade System and Dual/Multi-Node Servers: A Blade System or Dual/Multi-Node Server shall have identical configurations for each node or Blade Server including all hardware components and software/power management settings. These systems shall also be measured in a way that ensures all power from all tested nodes/Blade Servers is captured by the power meter during the entire test.

5.1.8. Blade Chassis: The Blade Chassis, at a minimum, shall have power, cooling, and networking capabilities for all the Blade Servers. The Chassis shall be populated as specified in section 5.2.4. All power measurements for Blade Systems shall be made at the input of the Chassis.

5.1.9. BIOS and UUT System Settings: All BIOS settings shall remain as-shipped unless otherwise specified in the test method.

5.1.10. Input/Output (I/O) and Network Connection: The UUT shall have at least one port connected to an Ethernet network switch. The switch shall be capable of supporting the UUT's highest and lowest rated network speeds. The network connection shall be live during all tests, and, although the link shall be ready and able to transmit packets, no specific traffic is required over the connection during testing. For the purpose of testing ensure the UUT offers at least one Ethernet port (using a single add-in card only if no onboard Ethernet support is offered).

5.1.11. Ethernet Connections: Products shipped with support for Energy Efficient Ethernet (compliant with IEEE 802.3az) shall be connected only to Energy Efficient Ethernet compliant network equipment during testing. Appropriate measures shall be taken to enable EEE features on both ends of the network link during all tests.

5.2. UUT Preparation

5.2.1. The UUT shall be tested with the processor sockets populated as specified in Section 6.1.2 of ENERGY STAR Eligibility Criteria Version 2.0.

5.2.2. Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is complete.

5.2.3. If the UUT is a Multi-node system, the UUT shall be tested for per node power consumption in the fully-populated Chassis configuration. All Multi-node Servers installed in the Chassis shall be identical, sharing the same configuration.

5.2.4. If the UUT is a Blade System, the UUT shall be tested for Blade Server power consumption in the half-populated Chassis configuration with an additional option of testing the UUT in the fully-populated Chassis configuration. For Blade Systems, populate the Chassis as follows:

(a) Individual Blade Server Configuration

All Blade Servers installed in the Chassis shall be identical, sharing the same configuration (homogeneous).

(b) Half Chassis Population (Required)

(1) Calculate the number of Blade Servers required to populate half the number of Single-wide Blade Server slots available in the Blade Chassis.

(2) For Blade Chassis having multiple power domains, choose the number of power domains that is closest to filling half of the Chassis. In a case where there are two choices that are equally close to filling half of the Chassis, test with the domain or combination of domains which utilize a higher number of Blade Servers.

Example 1:*A certain Blade Chassis supports up to 7 Single-wide Blade Servers on two power domains. One power domain supports 3 Blade Servers and the other supports 4 Blade Servers. In this example, the power domain which supports 4 Blade Servers would be fully populated during testing, while the other power domain would remain unpopulated.*

Example 2:*A certain Blade Chassis supports up to 16 Single-wide Blade Servers on four power domains. Each of the four power domains supports 4 Blade Servers. In this example, two of the power domains would be fully populated during testing, while the other two power domains would remain unpopulated.*

(3) Follow all user manual or manufacturer recommendations for partially populating the Chassis, which may include disconnecting some of the power supplies and cooling fans for the unpopulated power domains.

(4) If user manual recommendations are not available or are incomplete, then use the following guidance:

(i) Completely populate the power domains.

(ii) If possible, disconnect the power supplies and cooling fans for unpopulated power domains.

(iii) Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of testing.

(c) Full Chassis Population (Optional)

Populate all available Chassis bays. All power supplies and cooling fans shall be connected. Proceed with all required tests in the test procedure as specified in Section 6.

5.2.5. Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection shall be maintained for the duration of testing, except for brief lapses necessary for transitioning between link speeds.

5.2.6. The Controller System required to provide SERT workload harness control, data acquisition, or other UUT testing support shall be connected to the same network switch as the UUT and satisfy all other UUT network requirements. Both the UUT and Controller System shall be configured to communicate via the network.

5.2.7. Connect the power meter to an ac voltage source set to the appropriate voltage and frequency for the test, as specified in Section 4.

5.2.8. Plug the UUT into the measurement power outlet on the power meter following the guidelines in 5.1.2.

5.2.9. Connect the data output interface of the power meter and the temperature sensor to the appropriate input of the Controller System.

5.2.10. Verify that the UUT is configured in its as–shipped configuration.

5.2.11. Verify that the Controller System and UUT are connected on the same internal network via an Ethernet network switch.

5.2.12. Use a normal ping command to verify that the Controller System and UUT can communicate with each other.

5.2.13. Install SERT 1.0.0 on the UUT and the Controller System as specified in the SERT User Guide 1.0.0[17].

6. **Test procedures for all products**

6.1. Idle State Testing

6.1.1. Power on the UUT, either by switching it on or connecting it to mains power.

6.1.2. Power on the Controller System.

6.1.3. Begin recording elapsed time.

6.1.4. Between 5 and 15 minutes after the completion of initial boot or log in, set the power meter to begin accumulating idle power values at an interval of greater than or equal to 1 reading per second.

6.1.5. Accumulate idle power values for 30 minutes. The UUT shall maintain in Idle State throughout this period and shall not enter lower power states with limited functionality (e.g., sleep or hibernate).

6.1.6. Record the average idle power (arithmetic mean) during the 30 minute test period.

6.1.7. When testing a Multi-node or Blade System, proceed as follows to derive single node or single Blade Server power:

(a) Divide the measured total idle power in Section 6.1.6 by the number of nodes/Blade Servers installed for the test;

(b) Record the measured total and per-node/per-Blade Server power values as calculated in 6.1.7(a) for each measurement.

6.2. Active State Testing Using SERT

6.2.1. Reboot the UUT.

6.2.2. Between 5 and 15 minutes after the completion of initial boot or log in, follow the SERT User Guide 1.0.0 to engage SERT.

6.2.3. Follow all steps outlined in the SERT User Guide 1.0.0 to successfully run SERT.

6.2.4. Manual intervention or optimization to the Controller System, UUT, or its internal and external environment is prohibited during the execution of SERT.

6.2.5. Once SERT is completed, include the following output files with all testing results:

(a) Results.xml

(b) Results.html

(c) Results.txt

(d) All results-chart.png files (e.g. results-chart0.png, results-chart1.png, etc.)

(e) Results-details.html

(f) Results-details.txt

(g) All results-details-chart png files (e.g. results-details-chart0.png, results-details-chart1.png, etc.)

IV. IMAGING EQUIPMENT SPECIFICATION (VERSION 2.0)

1. **Definitions**

1.1. Product Types:

1.1.1. Printer: A product whose primary function is to generate paper output from electronic input. A printer is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). This definition is intended to cover products that are marketed as printers, and printers that can be field-upgraded to meet the definition of an MFD.

1.1.2. Scanner: A product whose primary function is to convert paper originals into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. This definition is intended to cover products that are marketed as scanners.

1.1.3. Copier: A product whose sole function is to produce paper duplicates from paper originals. This definition is intended to cover products that are marketed as copiers, and upgradeable digital copiers (UDCs).

1.1.4. Facsimile (Fax) Machine: A product whose primary functions are (1) to scan paper originals for electronic transmission to remote units, and (2) to receive electronic transmissions for conversion to paper output. A fax machine may also be capable of producing paper duplicates. Electronic transmission is primarily over a public telephone system, but may also be via a computer network or the internet. This definition is intended to cover products that are marketed as fax machines.

1.1.5. Multifunction Device (MFD): A product that performs two or more of the core functions of a Printer, Scanner, Copier, or Fax Machine. An MFD may have a physically integrated form factor, or it may consist of a combination of functionally integrated components. MFD copy functionality is considered to be distinct from single-sheet convenience copying functionality sometimes offered by fax machines. This definition includes products marketed as MFDs, and ‘multi-function products’ (MFPs).

1.1.6. Digital Duplicator: A product sold as a fully-automated duplicator system through the method of stencil duplicating with digital reproduction functionality. This definition is intended to cover products that are marketed as digital duplicators.

1.1.7. Mailing Machine: A product whose primary function is to print postage onto mail pieces. This definition is intended to cover products that are marketed as mailing machines.

1.2. Marking Technologies:

1.2.1. Direct Thermal (DT): A marking technology characterized by the burning of dots onto coated print media that is passed over a heated print head. DT products do not use ribbons.

1.2.2. Dye Sublimation (DS): A marking technology characterized by the deposition (sublimation) of dye onto print media as energy is supplied to heating elements.

1.2.3. Electro-photographic (EP): A marking technology characterized by the illumination of a photoconductor in a pattern representing the desired output image via a light source, development of the image with particles of toner using the latent image on the photoconductor to define the presence or absence of toner at a given location, transfer of the toner to the final print media, and fusing to cause the output to become durable. For purposes of this specification, Colour EP products simultaneously offer three or more unique toner colours, while Monochrome EP products simultaneously offer one or two unique toner colours. This definition includes Laser, Light Emitting Diode (LED), and Liquid Crystal Display (LCD) illumination technologies.

1.2.4. Impact: A marking technology characterized by the formation of the desired output image by transferring colorant from a 'ribbon' to the print media via an impact process. This definition includes Dot Formed Impact and Fully Formed Impact.

1.2.5. Ink Jet (IJ): A marking technology characterized by the deposition of colorant in small drops directly to the print media in a matrix manner. For purposes of this specification, Color IJ products offer two or more unique colorants at one time, while Monochrome IJ products offer one colorant at a time. This definition includes Piezo-electric (PE) IJ, IJ Sublimation, and Thermal IJ. This definition does not include High Performance IJ.

1.2.6. High Performance IJ: An IJ marking technology that includes nozzle arrays that span the width of a page and/or the ability to dry ink on the print media via supplemental media heating mechanisms. High-performance IJ products are used in business applications usually served by electro-photographic marking products.

1.2.7. Solid Ink (SI): A marking technology characterized by ink that is solid at room temperature and liquid when heated to the jetting temperature. This definition includes both direct transfer and offset transfer via an intermediate drum or belt.

1.2.8. Stencil: A marking technology characterized by the transfer of images onto print media from a stencil that is fitted around an inked drum.

1.2.9. Thermal Transfer (TT): A marking technology characterized by the deposition of small drops of solid colorant (usually coloured waxes) in a melted/fluid state directly to print media in a matrix manner. TT is distinguished from IJ in that the ink is solid at room temperature and is made fluid by heat.

1.3. Operational Modes:

1.3.1. On Mode:

(a) Active State: The power state in which a product is connected to a power source and is actively producing output, as well as performing any of its other primary functions

(b) Ready State: The power state in which a product is not producing output, has reached operating conditions, has not yet entered into any lower-power modes, and can enter Active State with minimal delay. All product features can be enabled in this state, and the product is able to return to Active State by responding to any potential inputs, including external electrical stimulus (e.g., network stimulus, fax call, or remote control) and direct physical intervention (e.g., activating a physical switch or button).

1.3.2. Off Mode: The power state that the product enters when it has been manually or automatically switched off but is still plugged in and connected to the mains. This mode is exited when stimulated by an input, such as a manual power switch or clock timer to bring the unit into Ready State. When this state is resultant from a manual intervention by a user, it is often referred to as Manual Off, and when it is resultant from an automatic or predetermined stimuli (e.g., a delay time or clock), it is often referred to as Auto-off[18].

1.3.3. Sleep Mode: A reduced power state that a product enters either automatically after a period of inactivity (i.e., Default Delay Time), in response to user manual action (e.g., at a user-set time of day, in response to a user activation of a physical switch or button), or in response to external electrical stimulus (e.g., network stimulus, fax call, remote control). For products evaluated under the TEC test method, Sleep Mode permits operation of all product features (including maintenance of network connectivity), albeit with a possible delay to transition into Active State. For products evaluated under the OM test method, Sleep Mode permits operation of a single active network interface, as well as a fax connection if applicable, albeit with a possible delay to transition into Active State.

1.3.4. Standby: The lowest power consumption state which cannot be switched off (influenced) by the user and that may persist for an indefinite time when the product is connected to the main electricity supply and used in accordance with the manufacturer's instructions[19]. Standby is the product's minimum power state. For Imaging Equipment products addressed by this specification, the 'Standby' Mode usually corresponds to Off Mode, but may correspond to Ready State or Sleep Mode. A product cannot exit Standby and reach a lower power state unless it is physically disconnected from the main electricity supply as a result of manual manipulation.

1.4. Media Format:

1.4.1. Large Format: Products designed for A2 media and larger, including those designed to accommodate continuous-form media greater than or equal to 406 mm wide. Large-format products may also be capable of printing on standard-size or small-format media.

1.4.2. Standard Format: Products designed for standard-sized media (e.g., Letter, Legal, Ledger, A3, A4, B4), including those designed to accommodate continuous-form media between 210 mm and 406 mm wide. Standard-size products may also be capable of printing on small-format media.

A3-capable: Standard Format products with a paper path width equal to or greater than 275 mm.

1.4.3. Small Format: Products designed for media sizes smaller than those defined as Standard (e.g., A6, 4″ × 6″, microfilm), including those designed to accommodate continuous-form media less than 210 mm wide.

1.4.4. Continuous Form: Products that do not use a cut-sheet media format and that are designed for applications such as printing of bar codes, labels, receipts, banners, and engineering drawings. Continuous Form products can be Small, Standard, or Large Format.

1.5. Additional Terms:

1.5.1. Automatic Duplexing: The capability of a copier, fax machine, MFD, or printer to produce images on both sides of an output sheet, without manual manipulation of

output as an intermediate step. A product is considered to have automatic duplexing capability only if all accessories needed to produce duplex output are included with the product upon shipment.

1.5.2. Data Connection: A connection that permits the exchange of information between the Imaging Equipment and one external powered device or storage medium.

1.5.3. Default Delay Time: The time set by the manufacturer prior to shipping that determines when the product will enter a lower-power mode (e.g., Sleep, Auto-off) following completion of its primary function.

1.5.4. Digital Front-end (DFE): A functionally-integrated server that hosts other computers and applications and acts as an interface to Imaging Equipment. A DFE provides greater functionality to the Imaging Equipment.

(a) A DFE offers three or more of the following advanced features:

(1) Network connectivity in various environments;

(2) Mailbox functionality;

(3) Job queue management;

(4) Machine management (e.g., waking the Imaging Equipment from a reduced power state);

(5) Advanced graphic user-interface (UI);

(6) Ability to initiate communication with other host servers and client computers (e.g., scanning to e-mail, polling remote mailboxes for jobs); or

(7) Ability to post-process pages (e.g., reformatting pages prior to printing).

(b) Type 1 DFE: A DFE that draws its dc power from its own ac power supply (internal or external), which is separate from the power supply that powers the Imaging Equipment. This DFE may draw its ac power directly from a wall outlet, or it may draw it from the ac power associated with the Imaging Equipment's internal power supply. A Type 1 DFE may be sold standard with the Imaging Equipment product or as an accessory.

(c) Type 2 DFE: A DFE that draws its dc power from the same power supply as the Imaging Equipment with which it operates. Type 2 DFEs must have a board or assembly with a separate processing unit that is capable of initiating activity over the network and can be physically removed, isolated, or disabled using common engineering practices to allow power measurements to be made.

(d) Auxiliary Processing Accelerator (APA): A computing expansion add-in card installed in a general-purpose add-in expansion slot of the DFE (e.g., GPGPU installed in a PCI slot).

1.5.5. Network Connection: A connection that permits the exchange of information between the Imaging Equipment and one or more external powered devices.

1.5.6. Functional Adder: A data or network interface or other component that adds functionality to the marking engine of an Imaging Equipment product and provides a power allowance when qualifying products according to the OM method.

1.5.7. Operational Mode (OM): For the purposes of this specification, a method of comparing product energy performance via an evaluation of power (measured in watts) in various operating states, as specified in Section 9 of the ENERGY STAR Imaging Equipment Test Method.

1.5.8. Typical Electricity Consumption (TEC): For the purposes of this specification, a method of comparing product energy performance via an evaluation of typical electricity consumption (measured in kilowatt-hours) during normal operation over a specified period of time, as specified in Section 8 of the ENERGY STAR Imaging Equipment Test Method.

1.5.9. Marking Engine: The fundamental engine of an Imaging Equipment product that drives image production. A marking engine relies upon functional adders for communication ability and image processing. Without functional adders and other components, a marking engine cannot acquire image data for processing and is non-functional.

1.5.10. Base Product: The most fundamental configuration of a particular Product Model, which possesses the minimum number of functional adders available. Optional components and accessories are not considered part of a base product.

1.5.11. Accessory: A piece of peripheral equipment that is not necessary for the operation of the Base Product, but that may be added before or after shipment in order to add functionality. An accessory may be sold separately under its own model number, or sold with a base product as part of a package or configuration.

1.5.12. Product Model: An Imaging Equipment product that is sold or marketed under a unique model number or marketing name. A product model may be comprised of a base product or a base product plus accessories.

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

(a) Colour,

(b) Housing,

(c) Input or output paper-handling accessories,

(d) Electronic components not associated with the marking engine of the Imaging Equipment product, including Type 1 and Type 2 DFEs.

2. **Scope**

2.1. Included Products

2.1.1. Commercially-available products that meet one of the Imaging Equipment definitions in Section 1.1 and are capable of being powered from (1) a wall outlet, (2) a data or

network connection, or (3) both a wall outlet and a data or network connection, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.2.

2.1.2. An Imaging Equipment product must further be classified as either 'TEC' or 'OM' in Table 1, below, depending on the method of ENERGY STAR evaluation.

Table 1

Evaluation Methods for Imaging Equipment

Equipment Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Copier	Standard	DT, DS, EP, SI, TT	TEC
	Large	DT, DS, EP, SI, TT	OM
Digital Duplicator	Standard	Stencil	TEC
Fax Machine	Standard	DT, DS, EP, SI, TT	TEC
		IJ	OM
Mailing Machine	All	DT, EP, IJ, TT	OM
Multifunction Device (MFD)	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large	DT, DS, EP, IJ, SI, TT	OM
Printer	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large or Small	DT, DS, EP, Impact, IJ, SI, TT	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM

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.eu-energystar.org.

2.2.2. Products that satisfy one or more of the following conditions are not eligible for ENERGY STAR qualification under this specification:

Products that are designed to operate directly on three-phase power.

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 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. External Power Supply (EPS):

If the product is shipped with a single-voltage 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.

— Single-output EPS 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.

— Multi-output EPS shall meet the level V requirements when tested using the EPRI 306 Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.6. Power Supply data generated using Rev. 6.4.2 (as required in Version 1.2) is acceptable provided the test was conducted prior to the effective date of Version 2.0.

3.2.2. Additional Cordless Handset: Fax machines and MFDs with fax capability that are sold with additional cordless handsets shall use an ENERGY STAR qualified handset, or one that meets the ENERGY STAR Telephony specification when tested to the ENERGY STAR test method on the date the Imaging Equipment product is qualified as ENERGY STAR. The ENERGY STAR specification and test method for telephony products may be found at www.energystar.gov/products.

3.2.3. Functionally Integrated MFD: If an MFD consists of a set of functionally integrated components (i.e., the MFD is not a single physical device), the sum of the measured energy or power consumption for all components shall be less than the relevant MFD energy or power consumption requirements for ENERGY STAR qualification.

3.2.4. DFE Requirements: The Typical Electricity Consumption (TEC_{DFE}) of a Type 1 or Type 2 DFE sold with an Imaging Equipment product at the time of sale shall be calculated using Equation 1 for a DFE without Sleep Mode or Equation 2 for a DFE with Sleep Mode. The resulting TEC_{DFE} value shall be less than or equal to the maximum TEC_{DFE} requirement specified in Table 2 for the given DFE type.

(a) The TEC value or Ready State power of a DFE that meets the maximum TEC_{DFE} requirements should be excluded or subtracted from the TEC energy and OM power measurements of the Imaging Equipment product as appropriate.

(b) Section 3.3.2 provides further detail on subtracting TEC_{DFE} values from TEC products;

(c) Section 3.4.2 provides further detail for excluding DFEs from OM Sleep and Standby levels.

Equation 1: TEC_{DFE} Calculation for Digital Front Ends without Sleep Mode

$$\mathrm{TEC_{DFE}} = \frac{168 \times P_{\mathrm{DFE\_READY}}}{1000}$$

Where:

— TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0,1 kWh;

— P_{DFE_READY} is Ready State power measured in the test procedure in watts.

Equation 2: TEC_{DFE} Calculation for Digital Front Ends with Sleep Mode

$$TEC_{DFE} = \frac{(45 \times P_{DFE\_READY}) + (123 \times P_{DFE\_SLEEP})}{1000}$$

Where:

— TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0,1 kWh;

— P_{DFE_READY} is the DFE Ready State power measured in the test procedure in watts.

— P_{DFE_SLEEP} is the DFE Sleep Mode power measured in the test procedure in watts.

Table 2

Maximum TEC_{DFE} Requirements for Type 1 and Type 2 DFEs

DFE Category	Category Description	Maximum TEC_{DFE}(kWh/week, rounded to the nearest 0,1 kWh/week for reporting)	
		Type 1 DFE	Type 2 DFE
A	All DFEs that do not meet the definition of Category B will be considered under Category A for ENERGY STAR qualification.	10,9	8,7
B	To qualify under Category B DFEs must have: 2 or more physical CPUs or 1 CPU and ≥ 1 discrete Auxiliary Processing Accelerators (APAs)	22,7	18,2

3.3. Requirements for Typical Electricity Consumption (TEC) Products

3.3.1. Automatic Duplexing Capability:

(a) For all copiers, MFDs, and printers subject to the TEC test method, automatic duplexing capability shall be present at the time of purchase as specified in Tables 3 and 4. Printers whose intended function is to print on special single-sided media for the purpose of single sided printing (e.g., release coated paper for labels, direct thermal media, etc.) are exempt from this requirement.

Table 3

Automatic Duplexing Requirements for all Color TEC Copiers, MFDs, and Printers

Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	**Automatic Duplexing Requirement**
$s \leq 19$	None
$19 < s < 35$	Integral to the base product or optional accessory
$s \geq 35$	Integral to the base product

Table 4

Automatic Duplexing Requirements for all Monochrome TEC Copiers, MFDs, and Printers

Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	**Automatic Duplexing Requirement**
$s \leq 24$	None
$24 < s < 37$	Integral to the base product or optional accessory
$s \geq 37$	Integral to the base product

(b) If a product is not certain to be bundled with an automatic duplex tray, the partner must make clear in their product literature, on their Web site, and in institutional sales literature that although the product meets the ENERGY STAR energy efficiency requirements, the product only fully qualifies for ENERGY STAR when bundled with or used with a duplexer tray. EPA and the European Commission ask that partners use the following language to convey this message to customers: 'Achieves ENERGY STAR energy savings; product fully qualifies when packaged with (or used with) a duplex tray.'

3.3.2. Typical Electricity Consumption: Calculated Typical Energy Consumption (TEC) per Equation 3 or Equation 4 shall be less than or equal to the Maximum TEC Requirement (TEC_{MAX}) specified in Equation 6.

(a) For Imaging Equipment with a Type 2 DFE that meet the Type 2 DFE maximum TEC_{DFE} requirement in Table 2, the measured energy consumption of the DFE shall be divided by 0,80 to account for internal power supply losses and then excluded when comparing the product's measured TEC value to TEC_{MAX}. The DFE shall not interfere with the ability of the Imaging Equipment to enter or exit its lower-power modes. The energy use of a DFE can only be excluded if it meets the DFE definition in Section 1 and is a separate processing unit that is capable of initiating activity over the network.

Example: A printer's total TEC result is 24,50 kWh/wk and its Type 2 TEC_{DFE} value calculated in Section 3.2.4 is 9,0 kWh/wk. The TEC_{DFE} value is then divided by 0,80 to account for internal power supply losses with the Imaging Equipment in Ready State, resulting in 11,25 kWh/wk. The power supply adjusted value is subtracted from the tested TEC value: 24,50 kWh/wk – 11,25 kWh/wk = 13,25 kWh/wk. This 13,25 kWh/wk result is then compared to the relevant TEC_{MAX} to determine qualification.

(b) For printers, fax machines, digital duplicators with print capability, and MFDs with print capability, TEC shall be calculated per Equation 3.

Equation 3: TEC Calculation for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + [24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})] \times \frac{E_{SLEEP}}{t_{SLEEP}}\right] + 48 \times \frac{E_{SLEEP}}{t_{SLEEP}}$$

,

Where:

— TEC is the typical weekly energy consumption for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0,1 kWh;

— E_{JOB_DAILY} is the daily job energy, as calculated per Equation 5, in kWh;

— E_{FINAL} is the final energy, as measured in the test procedure, converted to kWh;

— N_{JOBS} is the number of jobs per day, as calculated in the test procedure,

— t_{FINAL} is the final time to Sleep, as measured in the test procedure, converted to hours;

— E_{SLEEP} is the Sleep energy, as measured in the test procedure, converted to kWh; and

— t_{SLEEP} is the Sleep time, as measured in the test procedure, converted to hours.

(c) For copiers, digital duplicators without print capability, and MFDs without print capability, TEC shall be calculated per Equation 4.

Equation 4: TEC Calculation for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

$$TEC = 5 \times \left[E_{JOB\_DAILY} + (2 \times E_{FINAL}) + [24 - (N_{JOBS} \times 0.25) - (2 \times t_{FINAL})] \times \frac{E_{AUTO}}{t_{AUTO}}\right] + 48 \times \frac{E_{AUTO}}{t_{AUTO}}$$

,

Where:

— TEC is the typical weekly energy consumption for copiers, digital duplicators without print capability, and MFDs without print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0,1 kWh;

— E_{JOB_DAILY} is the daily job energy, as calculated per Equation 5, in kWh;

— E_{FINAL} is the final energy, as measured in the test procedure, converted to kWh;

— N_{JOBS} is the number of jobs per day, as calculated in the test procedure;

— t_{FINAL} is the final time to Sleep, as measured in the test procedure, converted to hours;

— E_{AUTO} is the Auto-off energy, as measured in the test procedure, converted to kWh; and

— t_{AUTO} is the Auto-off time, as measured in the test procedure, converted to hours.

(d) Daily Job Energy shall be calculated per Equation 5.

Equation 5: Daily Job Energy Calculation for TEC Products

$$E_{\text{JOB\_DAILY}} = (2 \times E_{\text{JOB1}}) + \left((N_{\text{JOBS}} - 2) \times \frac{E_{\text{JOB2}} + E_{\text{JOB3}} + E_{\text{JOB4}}}{3}\right)$$

,

Where:

— $E_{\text{JOB\_DAILY}}$ is the daily job energy, expressed in kilowatt-hours (kWh);

— E_{JOBi} is the energy of the ith job, as measured in the test procedure, converted to kWh; and

— N_{JOBS} is the number of jobs per day, as calculated in the test procedure.

Equation 6: Maximum TEC Requirement Calculation

$$\text{TEC}_{\text{MAX}} = \text{TEC}_{\text{REQ}} + \text{Adder}_{\text{A3}}$$

,

Where:

— TEC_{MAX} is the maximum TEC requirement in kilowatt-hours per week (kWh/wk), rounded to the nearest 0,1 kWh/wk for reporting;

— TEC_{REQ} is the TEC requirement specified in Table 5, in kWh; and

— Adder_{A3} is a 0,3 kWh/wk allowance provided for A3-capable products.

Table 5

TEC Requirement Before A3 Allowance (If Applicable)

Color Capability	**Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)**	**TEC_{REQ}(kWh/week, to the nearest 0,1 kWh/ week for reporting)**
Monochrome Non-MFD	$s \leq 5$	0,3
	$5 < s \leq 20$	$(s \times 0{,}04) + 0{,}1$
	$20 < s \leq 30$	$(s \times 0{,}06) - 0{,}3$
	$30 < s \leq 40$	$(s \times 0{,}11) - 1{,}8$
	$40 < s \leq 65$	$(s \times 0{,}16) - 3{,}8$
	$65 < s \leq 90$	$(s \times 0{,}2) - 6{,}4$
	$s > 90$	$(s \times 0{,}55) - 37{,}9$
Monochrome MFD	$s \leq 5$	0,4
	$5 < s \leq 30$	

Table 5

TEC Requirement Before A3 Allowance (If Applicable)		
		$(s \times 0{,}07)+0{,}05$
	$30 < s \leq 50$	$(s \times 0{,}11)-1{,}15$
	$50 < s \leq 80$	$(s \times 0{,}25)-8{,}15$
	$s > 80$	$(s \times 0{,}6)-36{,}15$
Color Non-MFD	$s \leq 10$	1,3
	$10 < s \leq 15$	$(s \times 0{,}06)+0{,}7$
	$15 < s \leq 30$	$(s \times 0{,}15)-0{,}65$
	$30 < s \leq 75$	$(s \times 0{,}2)-2{,}15$
	$s > 75$	$(s \times 0{,}7)-39{,}65$
Color MFD	$s \leq 10$	1,5
	$10 < s \leq 15$	$(s \times 0{,}1)+0{,}5$
	$15 < s \leq 30$	$(s \times 0{,}13)-0{,}05$
	$30 < s \leq 70$	$(s \times 0{,}2)-2{,}05$
	$70 < s \leq 80$	$(s \times 0{,}7)-37{,}05$
	$s > 80$	$(s \times 0{,}75)-41{,}05$

3.3.3. Additional Test Results Reporting Requirements:

(a) Recovery times from various modes (Active 0, Active 1, Active 2 times) and Default Delay Time shall be reported for all products tested using the TEC test method.

(b) DFE model name/number, Ready State power, Sleep Mode power, and TEC_{DFE} shall be reported for any Type 1 DFE sold with an Imaging Equipment product, including those not tested with the Imaging Equipment product as part of the highest energy using configuration per Section 4.2.1(c).

3.4. Requirements for Operational Mode (OM) Products

3.4.1. Multiple Sleep Modes: If a product is capable of automatically entering multiple successive Sleep Modes, the same Sleep Mode shall be used to determine qualification

under the Default Delay Time to Sleep requirements specified in Section 3.4.3 and the Sleep Mode power consumption requirements specified in Section 3.4.4.

3.4.2. DFE Requirements: For Imaging Equipment with a functionally-integrated DFE that relies on the Imaging Equipment for its power, and that meets the appropriate maximum TEC_{DFE} requirement found in Table 2, the DFE power shall be excluded subject to the following conditions:

(a) Ready State power of the DFE, as measured in the test method, shall be divided by 0,60 to account for internal power supply losses.

(1) Sleep Mode Requirements: If the resultant power in Paragraph (a), above, is less than or equal to the Ready State or Sleep Mode power of the Imaging Equipment, then the power shall be excluded from the Imaging Equipment's measured Ready State or Sleep Mode power when comparing to the Sleep Mode requirements in Section 3.4.4, below. Otherwise, the Sleep Mode power of the DFE, as measured in the test method, shall be divided by 0,60 and excluded from the Ready or Sleep Mode power of the Imaging Equipment for comparing to the requirements.

(2) Standby Requirements: If the resultant power in Paragraph (a), above, is less than or equal to the Ready State, Sleep Mode, or Off Mode power of the Imaging Equipment, then the power shall be excluded from the Imaging Equipment's Ready State, Sleep Mode, or Off Mode power when comparing to the Standby requirements in Section 3.4.5, below. Otherwise, the Sleep Mode power of the DFE, as measured in the test method, shall be divided by 0,60 and excluded from the Ready State, Sleep Mode, or Off Mode power of the Imaging Equipment for comparing to the requirements.

(b) The DFE must not interfere with the ability of the Imaging Equipment to enter or exit its lower-power modes.

(c) In order to take advantage of this exclusion, the DFE must meet the definition in Section 1 and be a separate processing unit that is capable of initiating activity over the network.

Examples: Product 1 is an Imaging Equipment product whose Type 2 DFE has no distinct sleep mode. The Type 2 DFE has measured Ready State and Sleep Mode power both equal to 30 watts. The measured Sleep Mode power of the product is 53 watts. When subtracting 50 watts (30 watts/0,60) from the measured Sleep Mode power of the product, 53 watts, the resulting 3 watts is the Sleep Mode power of the product for use in the criteria limits below.

Product 2 is an Imaging Equipment product whose Type 2 DFE goes to sleep when the Imaging Equipment goes to sleep during testing. The Type 2 DFE has measured DFE Ready State and Sleep Mode power equal to 30 watts and 5 watts, respectively. The measured Sleep Mode power of the product is 12 watts. When subtracting 50 watts (30 watts/0,60) from the measured Sleep Mode power of the product, 12 watts, the result is -38 watts. In this case, instead subtract 8,33 watts (5 watts/0,60) from the measured Sleep Mode power of the product, 12 watts, resulting in 3,67 watts which is used in the criteria limits below.

3.4.3. Default Delay Time: Measured Default Delay Time to Sleep (t_{SLEEP}) shall be less than or equal to the Required Default Delay Time to Sleep (t_{SLEEP_REQ}) requirement specified in Table 6, subject to the following conditions:

(a) The Default Delay Time to Sleep may not be adjusted by the user to be greater than the Maximum Machine Delay Time. This Maximum Machine Delay Time shall be set by the manufacturer at less than or equal to 4 hours.

(b) When reporting data and qualifying products that can enter Sleep Mode in multiple ways, partners should reference a Sleep level that can be reached automatically. If the product is capable of automatically entering multiple, successive Sleep levels, it is at the manufacturer's discretion which of these levels is used for qualification purposes; however, the default-delay time provided must correspond with whichever level is used.

(c) Default Delay Time does not apply to OM products that can meet Sleep Mode requirements in Ready State.

Table 6

Required Default Delay Time to Sleep for OM Products

Product Type	**Media Format**	**Monochrome Product Speed, *s*, as Calculated in the Test Method(ipm or mppm)**	**Required Default Delay Time to Sleep, t_{SLEEP_REQ}(minutes)**
Copier	Large	$s \leq 30$	30
		$s > 30$	60
Fax Machine	Small or Standard	All	5
MFD	Small or Standard	$s \leq 10$	15
		$10 < s \leq 20$	30
		$s > 20$	60
	Large	$s \leq 30$	30
		$s > 30$	60
Printer	Small or Standard	$s \leq 10$	5
		$10 < s \leq 20$	15
		$20 < s \leq 30$	30
		$s > 30$	60
	Large	$s \leq 30$	30
		$s > 30$	60
Scanner	All	All	15
Mailing Machine	All	$s \leq 50$	20
		$50 < s \leq 100$	30
		$100 < s \leq 150$	40
		$s > 150$	60

3.4.4. Sleep Mode Power Consumption: Measured Sleep Mode power consumption (P_{SLEEP}) shall be less than or equal to the maximum Sleep Mode power consumption requirement (P_{SLEEP_MAX}) determined per Equation 7, subject to the following conditions:

(a) Only those interfaces that are present and used during the test, including any fax interface, may be considered functional adders.

(b) Product functionality offered through a DFE shall not be considered a functional adder.

(c) A single interface that performs multiple functions may be counted only once.

(d) Any interface that meets more than one interface type definition shall be classified according to the functionality used during the test.

(e) For products that meet the Sleep Mode power requirement in Ready State, no further automatic power reductions are required to meet Sleep Mode requirements.

Equation 7: Calculation of Maximum Sleep Mode Power Consumption Requirement for OM products

$$P_{SLEEP\_MAX} = P_{MAX\_BASE} + \sum_{1}^{n} Adder_{INTERFACE} + \sum_{1}^{m} Adder_{OTHER}$$

Where:

— P_{SLEEP_MAX} is the maximum Sleep Mode power consumption requirement, expressed in watts (W), and rounded to the nearest 0,1 watt;

— P_{MAX_BASE} is the maximum Sleep Mode power allowance for the base marking engine, as determined per Table 7, in watts;

— $Adder_{INTERFACE}$ is the power allowance for the interface functional adders used during the test, including any fax capability, and as selected by the manufacturer from Table 8, in watts;

— n is the number of allowances claimed for interface functional adders used during the test, including any fax capability, and is less than or equal to 2;

— $Adder_{OTHER}$ is the power allowance for any non-interface functional adders in use during the test, as selected by the manufacturer from Table 8, in watts; and

— m is the number of allowances claimed for any non-interface functional adders in use during the test, and is unlimited.

Table 7

Sleep Mode Power Allowance for Base Marking Engine

Product Type	**Media Format**	**Marking Technology**				**P_{MAX_BASE}(watts)**
		Impact	**Ink Jet**	**All Other**	**Not Applicable**	
Copier	Large			x		8,2
Fax Machine	Standard		x			0,6
Mailing Machine	N/A		x	x		5,0
MFD	Standard	x	x			0,6
	Large		x			4,9

Table 7

Sleep Mode Power Allowance for Base Marking Engine

				x		8,2
Printer	Small	x	x	x		4,0
	Standard	x	x			0,6
	Large	x		x		2,5
			x			4,9
Scanner	Any				x	2,5

Table 8

Sleep Mode Power Allowances for Functional Adders

Adder Type	Connection Type	Max. Data Rate, *r*(Mbit/second)	Details	Functional Adder Allowance(watts)
Interface	Wired	r < 20	Includes: USB 1.x, IEEE 488, IEEE 1284/Parallel/ Centronics, RS232	0,2
		20 ≤ r < 500	Includes: USB 2.x, IEEE 1394/FireWire/ i.LINK, 100 Mb Ethernet	0,4
		r ≥ 500	Includes: USB 3.x, 1 G Ethernet	0,5
		Any	Includes: Flash memory-card/ smart-card readers, camera interfaces, PictBridge	0,2
	Fax Modem	Any	Applies to Fax Machines and MFDs only.	0,2
	Wireless, Radio-frequency (RF)	Any	Includes: Bluetooth, 802.11	2,0
	Wireless, Infrared (IR)	Any	Includes: IrDA.	0,1
Cordless Handset	N/A	N/A	Capability of the Imaging Equipment to	0,8

Table 8

Sleep Mode Power Allowances for Functional Adders

			communicate with a cordless handset. Applied only once, regardless of the number of cordless handsets the product is designed to handle. Does not address the power requirements of the cordless handset itself.	
Memory	N/A	N/A	Applies to the internal capacity available in the Imaging Equipment for storing data. Applies to all volumes of internal memory and should be scaled accordingly for RAM. This adder does not apply to hard disk or flash memory.	0,5/GB
Scanner	N/A	N/A	Applies to MFDs and Copiers only. Includes: Cold Cathode Fluorescent Lamp (CCFL) or a technology other than CCFL, such as Light-Emitting Diode (LED), Halogen, Hot-Cathode Fluorescent Tube (HCFT), Xenon,	0,5

Table 8

Sleep Mode Power Allowances for Functional Adders

			or Tubular Fluorescent (TL) technologies. (Applied only once, regardless of the lamp size or the number of lamps/bulbs employed.)	
Power Supply	N/A	N/A	Applies to both internal and external power supplies of Mailing Machines and Standard Format products using Inkjet and Impact marking technologies with nameplate output power (POUT) greater than 10 watts.	0,02 x (POUT – 10,0)
Touch Panel Display	N/A	N/A	Applies to both monochrome and colour touch panel displays.	0,2
Internal Disk Drives	N/A	N/A	Includes any high-capacity storage product, including hard-disk and solid-state drives. Does not cover interfaces to external drives.	0,15

3.4.5. Standby Power Consumption: Standby Mode power, which is the lesser of the Ready State Power, Sleep Mode Power, and Off Mode Power, as measured in the test procedure, shall be less than or equal to the Maximum Standby Power specified in Table 9, subject to the following condition.

The Imaging Equipment shall meet the Standby Power requirement independent of the state of any other devices (e.g., a host PC) connected to it.

Table 9

Maximum Standby Power Requirement

Product Type	Maximum Standby Power(watts)
All OM Products	0,5

4. **Testing**

4.1. Test Methods

When testing Imaging Equipment products, the test methods identified in Table 10 shall be used to determine qualification for ENERGY STAR.

TABLE 10

Test Methods for ENERGY STAR Qualification

Product Type	Test Method
All Products	ENERGY STAR Imaging Equipment Test Method, Rev. May-2012

4.2. Number of Units Required for Testing

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

(a) For qualification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labelled as ENERGY STAR is considered the Representative Model;

(b) For qualification of a product family that does not include a Type 1 DFE, the highest energy using configuration within the family shall be considered the Representative Model. Any subsequent testing failures (e.g., as part of verification testing) of any model in the family will have implications for all models in the family.

(c) For qualification of a product family that includes Type 1 DFE, the highest energy using configuration of the Imaging Equipment and highest energy using DFE within the family shall be tested for qualification purposes. Any subsequent testing failures (e.g., as part of verification testing) of any model in the family and all Type 1 DFEs sold with the Imaging Equipment, including those not tested with the Imaging Equipment product, will have implications for all models in the family. Imaging Equipment products that do not incorporate a Type 1 DFE may not be added to this product family for qualification and must be qualified as a separate family without a Type 1 DFE.

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

4.3. International Market Qualification

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**

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

Effective Date: The Version 2.0 ENERGY STAR Imaging Equipment specification shall take effect on January 1, 2014. 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. Future Specification Revisions: EPA and the European Commission reserve 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.

6.2. Items for Consideration in a Future Revision:

(a) Test Method Changes: EPA, DOE and the European Commission will continue to monitor the implementation of proxying capability in Imaging Equipment hardware and consider the development of a test method to determine the presence of a network proxy (e.g., one compliant with ECMA-393 ProxZzzy for Sleeping Hosts). EPA, DOE and the European Commission will also evaluate the possibility of measuring and reporting as-shipped product speed, recovery time from Sleep or Off Modes for OM products, and wakeup from Sleep Mode caused by common network events.

(b) TEC Requirements in Kilowatt-hours per Year: EPA and the European Commission have added columns to the TEC Tables expressing the requirements in kilowatt-hours per year in addition to the currently-used kilowatt-hours per week. Although this is purely informative, EPA and the European Commission will consider making this unit the only way to express TEC in a future specification revision as a way to address issues with reporting accuracy and comparisons between other ENERGY STAR products (which typically report in kilowatt-hours/year).

(c) Equipment for Printing and Scanning Media Other than Paper: EPA and the European Commission often receive questions about qualifying products that print or scan media other than paper (e.g., cloth, microfilm, etc.) and welcomes data on their energy consumption. Such data would support development of requirements for these products in a future version of the specification.

(d) Professional Products (High-speed TEC Products for Printing on Heavier, Larger Paper): EPA and the European Commission have learned that some high-speed TEC products have additional requirements for handling larger and heavier paper. EPA and the European Commission will consider separating these into a separate category in a future version of the specification.

(e) Decoupled Requirements for TEC Categories: In Version 1 and 2 Imaging Equipment specifications, EPA and the European Commission assumed that colour products would have higher TEC than monochrome products due to their additional complexity, and multi-function would have higher TEC than single-function. The TEC requirements were structured to reflect this relationship. However, EPA and the European Commission have recently learned that colour MFDs—a premium product —can incorporate energy saving features that decrease their energy consumption below that for monochrome non-MFDs. EPA and the European commission will therefore consider decoupling the TEC requirements in the future to recognize the highest performers among all TEC categories.

(f) Scope Re-evaluation: EPA and the European Commission may re-assess the current market for Imaging Equipment to determine whether the current scope of included products is still relevant and whether ENERGY STAR label continues to provide a market differentiation for all product classes included in scope.

(g) Expanding Duplexing Requirements: EPA and the European Commission may re-assess the requirements for the presence of duplexing as integral to the base product and consider how the optional requirements could be made more stringent. Changing the requirements to result in greater coverage of products with duplexing integral to the base marking engine could reduce paper usage.

Appendix D **Test Method for Determining Imaging Equipment Energy Use**

1. **Overview**

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

2. **Applicability**

ENERGY STAR test requirements are dependent upon the feature set of the products under evaluation. Table 11 shall be used to determine the applicability of each section of this document.

TABLE 11

Test Procedure Applicability

Product Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Copier	Standard	Direct Thermal (DT), Dye Sublimation (DS), Electro-photographic (EP), Solid Ink (SI), Thermal Transfer (TT)	Typical Energy Consumption (TEC)
	Large	DT, DS, EP, SI, TT	Operational Mode (OM)
Digital Duplicator	Standard	Stencil	TEC
Fax Machine	Standard	DT, DS, EP, SI, TT	TEC
		Ink Jet (IJ)	OM
Mailing Machine	All	DT, EP, IJ, TT	OM
Multifunction Device (MFD)	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC
		IJ, Impact	OM
	Large	DT, DS, EP, IJ, SI, TT	OM
Printer	Standard	High Performance IJ, DT, DS, EP, SI, TT	TEC

		IJ, Impact	OM
	Large or Small	DT, DS, EP, Impact, IJ, SI, TT	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM

3. **Definitions**

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

4. **Test Setup**

General 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 62301, Ed. 2.0, 'Measurement of Household Appliance Standby Power', Section 4, 'General Conditions for Measurements.' In the event of conflicting requirements, the ENERGY STAR test method shall take precedence.

4.2. Ac Input Power: Products intended to be powered from an ac mains power source shall be connected to a voltage source appropriate for the intended market, as specified in Table 12 or 13.

(a) Products shipped with external power supplies (EPSs) shall first be connected to the EPS and then to the voltage source specified in Table 12 or 13.

(b) If a product is rated to operate at a voltage/frequency combination in a specific market that is different from the voltage/frequency combination for that market (e.g., 230 volts (V), 60 hertz (Hz) in North America), the unit shall be tested at the manufacturer rated voltage/frequency combination for that unit. The voltage/frequency used shall be reported.

Table 12

Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1 500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/– 1,0 %	2,0 %	60 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/60 Hz	+/– 1,0 %

Table 13

Input Power Requirements for Products with Nameplate Rated Power Greater than 1 500 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/60 Hz	+/– 1,0 %

4.3. Low-voltage Dc Input Power:

(a) 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 acceptable source of power for the product (i.e., no ac plug or EPS is available).

(b) 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).

The ac source of the dc power used for testing shall be recorded and reported for all tests.

(c) Power for the unit under test (UUT) shall include the following, as measured per Section 5 of this method:

(1) Ac power consumption of the low-voltage dc source with the UUT as the load (P_L); and

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

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

4.5. Relative Humidity: Relative humidity shall be between 10 % and 80 %.

4.6. Power Meter: Power meters shall possess the following attributes:

(a) Minimum Frequency Response: 3,0 kHz

(b) Minimum Resolution:

(1) 0,01 W for measurement values less than 10 W;

(2) 0,1 W for measurement values from 10 W to 100 W;

(3) 1 W for measurement values from 100 W to 1,5 kW; and

(4) 10 W for measurement values greater than 1,5 kW.

(5) Measurements of accumulated energy should have resolutions which are generally consistent with these values when converted to average power. For accumulated energy measurements, the figure of merit for determining required accuracy is the maximum power value during the measurement period, not the average, since it is the maximum that determines the metering equipment and setup.

4.7. Measurement Uncertainty[20]:

(a) Measurements of greater than or equal to 0,5 W shall have an uncertainty of 2 % or better at the 95 % confidence level.

(b) Measurements of less than 0,5 W shall have an uncertainty of 0,02 W or better at the 95 % confidence level.

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

4.9. Paper Specifications:

(a) Standard Format Products shall be tested in accordance with Table 14.

(b) Large, Small, and Continuous Format products shall be tested using any compatible paper size.

Table 14

Paper Size and Weight Requirements

Market	Paper Size	Basis Weight(g/m^2)
North America/Taiwan	8,5″ × 11″	75
Europe/Australia/New Zealand	A4	80
Japan	A4	64

5. **Low-voltage dc source measurement for all products**

5.1. Connect the dc source to the power meter and relevant ac supply as specified in Table 12.

5.2. Verify that the dc source is unloaded.

5.3. Allow the dc source to stabilize for a minimum of 30 minutes.

5.4. Measure and record the unloaded dc source power (PS) according to IEC 62301 Ed. 1.0.

6. **Pre-Test UUT Configuration for all products**

6.1. General Configuration

6.1.1. Product Speed for Calculations and Reporting: The product speed for all calculations and reporting shall be the highest speed as claimed by the manufacturer per the following criteria, expressed in images per minute (ipm) and rounded to the nearest integer:

(a) In general, for Standard-size products, a single A4 or 8,5″ × 11″ sheet printed/copied/scanned on one side in one minute is equal to 1 (ipm).

When operating in duplex mode a single A4 or 8,5″ × 11″ sheet printed/copied/scanned on both sides in one minute is equal to 2 (ipm).

(b) For all products, the product speed shall be based on:

(1) The manufacturer-claimed print speed, unless the product cannot print, in which case,

(2) The manufacturer-claimed copy speed, unless the product cannot print or copy, in which case,

(3) The manufacturer-claimed scan speed.

(4) When a manufacturer intends to qualify a product in a certain market by making use of test results that qualified the product in another market using other sizes of paper (e.g., A4 versus 8,5″ × 11″), and if its maximum claimed speeds, as determined per Table 15, differ when producing images on different sizes of paper, the highest speed shall be used.

Table 15

Calculation of Product Speed for Standard, Small, and Large Format Products with the Exception of Mailing Machines

Media Format	**Media Size**	**Product Speed, s(ipm)*Where: s_P is the maximum claimed monochrome speed in images per minute when processing the given media, w is the width of the media, in meters (m),ℓ is the length of the media, in meters (m).***
Standard	8,5″ × 11″	s_P
	A4	s_P
Small	4″ × 6″	0,25 × s_P
	A6	0,25 × s_P
	Smaller than A6 or 4″ × 6″	16 × w × ℓ × s_P
Large	A2	4 × s_P
	A0	16 × s_P

(c) For Continuous Form products, product speed shall be calculated per Equation 8

Equation 8: Calculation of Product Speed

$$s = 16 \times w \times s_L$$

Where:

— s is the product speed, in ipm,

— w is the width of the media, in meters (m),

— s_L is the maximum claimed monochrome speed, in meters per minute.

(d) For Mailing Machines, product speed shall be reported in units of mail pieces per minute (mppm).

(e) The product speed used for all calculations and qualification, as calculated above, may not be the same as the product speed used for testing.

6.1.2. Color: Color-capable products shall be tested making monochrome (black) images.

(a) For those products without black ink, a composite black shall be used.

Network Connections: Products that are capable of being network-connected as-shipped shall be connected to a network.

(b) Products shall be connected to only one network or data connection for the duration of the test.

Only one computer may be connected to the UUT, either directly or via a network.

(c) The type of network connection depends on the characteristics of the UUT and shall be the topmost connection listed in Table 16 available on the unit as-shipped.

Table 16

Network or Data Connections for Use in Test

Order of Preference for Use in Test (if Provided by UUT)	**Connections for all Products**
1	Ethernet – 1 Gb/s
2	Ethernet – 100/10 Mb/s
3	USB 3.x
4	USB 2.x
5	USB 1.x
6	RS232
7	IEEE 1284[a]
8	Wi-Fi
9	Other Wired – in order of preference from highest to lowest speed
10	Other Wireless – in order of preference from highest to lowest speed
11	If none of the above, test with whatever connection is provided by the device (or none)

a Also referred to as a Parallel or Centronics interface.

(d) Products connected to Ethernet, per paragraph 6.1.2(c) above, and capable of supporting Energy Efficient Ethernet (IEEE Standard 802.3az)[21], shall be connected to a network switch or router that also supports Energy Efficient Ethernet for the duration of the test.

(e) In all cases the type of connection used during the test shall be reported.

Service/Maintenance Modes: UUTs shall never be in service/maintenance modes, including colour calibration, during testing.

(f) Service/Maintenance modes shall be disabled prior to testing.

(g) Manufacturers shall provide instructions detailing how to disable service/maintenance modes if this information is not included in the product documentation packaged with the UUT or is not readily available online.

(h) If service/maintenance modes cannot be disabled and a service/maintenance mode occurs during a job other than the first job, the results from the job with the service/ maintenance mode may be replaced with results from a substitute job. In this case, the substitute job shall be inserted into the test procedure immediately following Job 4, and the inclusion of the substitute job shall be reported. Each job period shall be 15 minutes.

6.2. Configuration for Fax Machines

All fax machines and MFDs with fax capability that connect to a telephone line shall be connected to a telephone line during the test, in addition to the network connection specified by Table 16 if the UUT is network capable.

(a) In the case that a working phone line is not available, a line simulator may be used as a replacement.

(b) Only fax machines shall be tested using the fax capability.

Fax machines shall be tested with one image per job.

6.3. Configuration for Digital Duplicators

Except as noted below, digital duplicators shall be configured and tested as printers, copiers, or MFDs, depending on their capabilities as-shipped.

(a) Digital duplicators shall be tested at maximum claimed speed, which is also the speed that should be used to determine the job size for performing the test, not at the default as-shipped speed, if different.

(b) For digital duplicators, there shall be only one original image.

7. Pre-test UUT Initialization for all products

General Initialization

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

(a) Set up the UUT per the instructions in the Manufacturer’s Instructions or documentation.

(1) Accessories, such as paper source, that are shipped with the base product and are intended to be installed or attached by the end-user shall be installed as intended for the product model. Paper shall be placed in all paper sources

designated to hold the paper specified for testing, and the UUT shall pull from the default paper source, using the as-shipped paper source settings.

(2) If the product is connected to a computer, either directly or via a network, during the test, the computer shall be running the newest version of the manufacturer's default driver available at the time of testing using settings corresponding to the default settings upon shipment, unless otherwise specified in this test method. The print driver version used for testing shall be recorded.

(i) In the event that a setting does not have a default and is not defined in this test method, the setting shall be set according to the tester's discretion and shall be recorded.

(ii) When connecting via a network and multiple computers are connected to the network, print driver settings apply only to the computer sending the print jobs to the UUT.

(3) For products designed to operate on battery power when not connected to the mains power source, the battery shall be removed for all tests. For UUTs where operation without a battery pack is not a supported configuration, the test shall be performed with fully charged battery pack(s) installed, making sure to report this configuration in the test results. To ensure the battery is fully charged, perform the following steps:

(i) For UUTs that have an indicator to show that the battery is fully charged, continue charging for an additional 5 hours after the indication is present.

(ii) 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 indication.

(iii) If there is no indicator and no time estimate in the instructions, the duration shall be 24 hours.

(b) Connect the UUT to its power source.

(c) Power on the UUT and perform initial system configuration, as applicable. Verify that default delay times are configured according to product specifications and/or manufacturer recommendations.

(1) Product Speed for Testing: The product shall be tested with speed settings in their default as-shipped configuration.

(2) Auto-off for TEC Products: If a printer, digital duplicator, fax machine, or MFD with print-capability has Auto-off capability and it is enabled as-shipped, it shall be disabled prior to testing.

(3) Auto-off for OM Products: If a product has an Auto-off Mode enabled as-shipped, it shall remain enabled for the duration of testing.

(d) User-controllable anti-humidity features shall be turned off or disabled for the duration of testing.

(e) Pre-conditioning: Place the UUT in Off Mode, then let the UUT sit idle for 15 minutes.

(1) For EP-TEC products, let the UUT sit in Off Mode for an additional 105 minutes, for a total of at least 120 minutes (2 hours).

(2) Pre-conditioning is only required prior to beginning the first test on each UUT.

8. **Typical Energy Consumption (TEC) Test Procedure**

8.1. Job Structure

8.1.1. Jobs per Day: The number of jobs per day (N_{JOBS}) is specified in Table 17.

Table 17

Number of Jobs per Day (N_{JOBS})

Monochrome Product Speed, s(ipm)	**Jobs per Day(N_{JOBS})**
$s \leq 8$	8
$8 < s < 32$	s
$s \geq 32$	32

8.1.2. Images per Job: Except for fax machines, the number of images shall be computed according to Equation 9, below. For convenience, Table 21 at the end of this document provides the resultant images per job computation for each integer product speed up through 100 ipm.

Equation 9: Calculation of Number of Images per Job

$N_{IMAGES} =$	1	$s < 4$
	$\text{int}\left[\frac{(0,5\times s^2)}{N_{JOBS}}\right]$	$s \geq 4$

Where:

— N_{IMAGES} is the number of images per job, rounded down (truncated) to the nearest integer,

— s is the (monochrome) maximum reported speed in images per minute (ipm), calculated in section 6.1.1, of this test procedure, and

— N_{JOBS} is the number of jobs per day, as calculated per Table 17.

Test Image: Test Pattern A from International Organization for Standardization (ISO)/ IEC Standard 10561:1999 shall be used as the original image for all testing.

(a) Test images shall be rendered in 10 point size in a fixed-width Courier font (or nearest equivalent).

(b) German-specific characters need not be reproduced if the product is incapable of German character reproduction.

Print Jobs: Print jobs for the test shall be sent over the network connection designated in Table 16 immediately before printing each job.

(c) Each image in a print job shall be sent separately, (i.e., all images may be part of the same document), but shall not be specified in the document as multiple copies of a single original image (unless the product is a digital duplicator).

(d) For printers and MFDs that can interpret a page description language (PDL) (e.g., Printer Command Language PCL, Postscript), images shall be sent to the product in a PDL.

Copy Jobs:

(e) For copiers with speed less than or equal to 20 ipm, there shall be one original per required image.

(f) For copiers with speed greater than 20 ipm, it may not be possible to match the number of required original images (i.e., due to limits on document feeder capacity). In this case, it is permissible to make multiple copies of each original, and the number of originals shall be greater than or equal to ten.

Example: For a 50 ipm unit that requires 39 images per job, the test may be performed with four copies of 10 originals or three copies of 13 originals.

(g) Originals may be placed in the document feeder before the test begins.

Products without a document feeder may make all images from a single original placed on the platen.

Fax Jobs: Fax jobs shall be sent via the connected phone line or line simulator immediately before performing each job.

8.2. Measurement Procedures

Measurement of TEC shall be conducted according to Table 18 for printers, fax machines, digital duplicators with print capability, and MFDs with print capability, and Table 19 for copiers, digital duplicators without print capability, and MFDs without print capability, subject to the following provisions:

(a) Paper: There shall be sufficient paper in the UUT to perform the specified print or copy jobs.

(b) Duplexing: Products shall be tested in simplex mode, unless the speed of duplex mode output is greater than the speed of simplex mode output, in which case they will be tested in duplex mode. In all cases, the mode in which the unit was tested and the print speed used must be documented. Originals for copying shall be simplex images.

(c) Energy Measurement Method: All measurements shall be recorded as accumulated energy over time, in Wh; all time shall be recorded in minutes.

'Zero meter' references may be accomplished by recording the accumulated energy consumption at that time rather than physically zeroing the meter.

Table 18

TEC Test Procedure for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

Step	Initial State	Action	Record (at end of step)	Unit of Measure	Possible States Measured
1	Off	Connect the UUT to the meter. Ensure the unit is powered and in Off Mode. Zero the meter; measure energy over 5 minutes or more. Record both energy and time.	Off energy	Watt-hours (Wh)	Off
			Testing Interval time	Minutes (min)	
2	Off	Turn on unit. Wait until unit indicates it is in Ready Mode.	—	—	—
3	Ready	Print a job of at least one output image but no more than a single job per Table 21. Measure and record time to first sheet exiting unit.	Active0 time	Minutes (min)	—
4	Ready (or other)	Wait until the meter shows that the unit has entered its final Sleep	—	—	—

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 18

TEC Test Procedure for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

		Mode or the time specified by the manufacturer.			
5	Sleep	Zero meter; measure energy and time over 1 hour. Record the energy and time.	Sleep energy, E_{SLEEP}	Watt-hours (Wh)	Sleep
			Sleep time, t_{SLEEP} (≤ 1 hour)	Minutes (min)	
6	Sleep	Zero meter and timer. Print one job (calculated above). Measure energy and time. Record time to first sheet exiting unit. Measure energy over 15 minutes from job initiation. The job must finish within the 15 minutes.	Job1 energy, E_{JOB1}	Watt-hours (Wh)	Recovery, Active, Ready, Sleep
			Active1 time	Minutes (min)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Watt-hours (Wh)	Same as above
			Active2 time	Minutes (min)	
8	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job3 energy, E_{JOB3}	Watt-hours (Wh)	Same as above

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 18

TEC Test Procedure for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

9	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job4 energy, E_{JOB4}	Watt-hours (Wh)	Same as above
10	Ready (or other)	Zero meter and timer. Measure energy and time until meter and/or unit shows that unit has entered Sleep Mode or the final Sleep Mode for units with multiple Sleep modes, or the time specified by the manufacturer, if provided. Record energy and time.	Final energy, E_{FINAL}	Watt-hours (Wh)	Ready, Sleep
			Final time, t_{FINAL}	Minutes (min)	

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 19

TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

Step	Initial State	Action	Record	Unit of Measure	Possible States Measured
1	Off	Connect the UUT to the meter. Ensure the unit is powered	Off energy	Watt-hours (Wh)	Off
			Testing Interval time	Minutes (min)	

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 19

TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

		and in Off Mode. Zero the meter; measure energy over 5 minutes or more. Record both energy and time.			
2	Off	Turn on unit. Wait until unit has entered Ready Mode.	—	—	—
3	Ready	Copy a job of at least one image but no more than a single job per Job Table. Measure and record time to first sheet exiting unit	Active0 time	Minutes (min)	—
4	Ready (or other)	Wait until the meter shows that the unit has entered its final Sleep Mode or the time specified by the manufacturer.	—	—	—
5	Sleep	Zero meter; measure energy and time over 1 hour or	Sleep energy	Watt-hours (Wh)	Sleep
			Sleep time (≤ 1 hour)	Minutes (min)	

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 19

TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

		until unit enters Auto-off Mode. Record the energy and time.			
6	Sleep	Zero meter and timer. Copy one job (calculated above). Measure and record energy and time to first sheet exiting unit. Measure energy over 15 minutes from job initiation. The job must finish within the 15 minutes.	Job1 energy, E_{JOB1}	Watt-hours (Wh)	Recovery, Active, Ready, Sleep, Auto-off
			Active1 time	Minutes (min)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Watt-hours (Wh)	Same as above
			Active2 time	Minutes (min)	
8	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job3 energy, E_{JOB3}	Watt-hours (Wh)	Same as above
9	Ready (or other)	Repeat Step 6 (without Active time measurement).	Job4 energy, E_{JOB4}	Watt-hours (Wh)	Same as above
10	Ready (or other)	Zero meter and timer. Measure energy	Final energy, E_{FINAL}	Watt-hours (Wh)	Ready, Sleep

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

Table 19

TEC Test Procedure for Copiers, Digital Duplicators without Print Capability, and MFDs without Print Capability

		and time until meter and/or unit shows that unit has entered its Auto-off Mode or the time specified by the manufacturer. Record energy and time; if unit began this step while in Auto-off Mode, report both energy and time values as zero.	Final time, t_{FINAL}	Minutes (min)	
11	Auto-off	Zero the meter; measure energy and time over 5 minutes or more. Record both energy and time.	Auto-off energy, E_{AUTO}	Watt-hours (Wh)	Sleep, Auto-off
			Auto-off time, t_{AUTO}	Minutes (min)	

Notes: Steps 4 and 10: For those units that do not indicate when they have entered the Final Sleep Mode, manufacturers shall specify the time to Final Sleep Mode for testing purposes.

9. **Operational Mode (OM) Test Procedure**

Measurement Procedures

Measurement of OM power and delay times shall be conducted according to Table 20, subject to the following provisions:

Power Measurements: All power measurements shall be made using either the average power or accumulated energy approaches as described below:

(1) Average Power Method: The true average power shall be measured over the course of a user selected period, which shall be no less than 5 minutes.

For those modes that do not last 5 minutes, the true average power shall be measured over the mode's entire duration.

(2) Accumulated Energy Approach: If the test instrument is incapable of measuring the true average power, the accumulated energy consumption over the course of a user selected period shall be measured. The test period shall be no less than 5 minutes. The average power shall be determined by dividing the accumulated energy consumption by the time of the test period.

(3) If the power consumption of the tested mode is periodic, then the test duration shall contain one or more complete periods.

Table 20

OPERATIONAL MODE (OM) TEST PROCEDURE

Step	Initial State	Action(s)	Record	Unit of Measure
1	Off	Plug the UUT into meter. Turn on unit. Wait until unit indicates it is in Ready Mode.	—	
2	Ready	Print, copy, or scan a single image.	—	
3	Ready	Measure Ready power.	Ready power, P_{READY}	Watts (W)
4	Ready	Wait and measure default delay-time to Sleep.	Sleep default-delay time, t_{SLEEP}	Minutes (min)
5	Sleep	Measure Sleep power.	Sleep power, P_{SLEEP}	Watts (W)
6	Sleep	Wait and measure default delay time to Auto-off. (Disregard if no Auto-off Mode).	Auto-off default- delay time	Minutes (min)
7	Auto-off	Measure Auto-off power. (Disregard if no Auto-off Mode).	Auto-off power $P_{AUTO-OFF}$	Watts (W)

8	Auto-off	Manually turn device off and wait until unit is off. (If no manual on-off switch, note and wait for lowest-power Sleep state).	—	—
9	Off	Measure Off power. (If no manual on-off switch, note and measure Sleep Mode power).	Off power P_{OFF}	Watts (W)

Notes:

— *Step 1* – If the unit has no Ready indicator, use the time at which the power consumption level stabilizes to the Ready level, and note this detail when reporting the product test data.

— *Step 4* – The Default Delay Time shall be measured starting from the completion of the job until the unit enters Sleep Mode.

— *Steps 4 and 5* – For products with more than one Sleep level, repeat these steps as many times as necessary to capture all successive Sleep levels and report these data. Two Sleep levels are typically used in large-format copiers and MFDs that use high-heat marking technologies. For products lacking this Mode, disregard Steps 4 and 5.

— *Steps 4 and 5* – For products without a Sleep Mode, perform and record measurements from Ready Mode.

— *Steps 4 and 6* – Default-delay time measurements are to be measured in parallel fashion, cumulative from the start of Step 4. For example, a product set to enter a Sleep level in 15 minutes and enter a second Sleep level 30 minutes after entering the first Sleep level will have a 15-minute default-delay time to the first level and a 45 minute default-delay time to the second level.

10. Test Procedures for Products with a Digital Front End (DFE)

This step applies only to products that have a DFE as defined in Section 1 of the ENERGY STAR Program Requirements for Imaging Equipment.

10.1. Ready Mode DFE Test

10.1.1. Products that are network-capable as-shipped shall be connected during testing. The network connection used shall be determined using Table 16.

10.1.2. If the DFE has a separate main power cord, regardless of whether the cord and controller are internal or external to the imaging product, a 10 minute power measurement of the DFE alone shall be made, and the average power recorded while the main product is in Ready Mode.

10.1.3. If the DFE does not have a separate main power cord, the tester shall measure the dc power required for the DFE when the unit as a whole is in Ready Mode. A 10 minute power measurement of the dc input to the DFE shall be made, and the average power recorded while the main product is in Ready Mode. This will most commonly be accomplished by taking an instantaneous power measurement of the dc input to the DFE.

10.2. Sleep Mode DFE Test

This testing shall be performed to obtain the Sleep Mode power of a DFE device over a 1 hour period. The resulting value will be used to qualify Imaging Equipment products that incorporate DFEs with network-capable Sleep Modes.

10.2.1. Products that are network-capable as-shipped shall be connected during testing. The network connection used shall be determined using Table 16.

10.2.2. If the DFE has a separate main power cord, regardless of whether the cord and controller are internal or external to the imaging product, a 1 hour power measurement of the DFE alone shall be made, and the average power recorded while the main product is in Sleep Mode. At the end of the 1 hour power measurement, a print job shall be sent to the main product to ensure the DFE is responsive.

10.2.3. If the DFE does not have a separate main power cord, the tester shall measure the dc power required for the DFE when the unit as a whole is in Sleep Mode. A 1 hour power measurement of the dc input to the DFE shall be made, and the average power recorded while the main product is in Sleep Mode. At the end of the 1 hour power measurement, a print job shall be sent to the main product to ensure the DFE is responsive.

10.2.4. In cases 10.2.2 and 10.2.3, the following requirements apply:

(a) Manufacturers shall provide information on:

(1) Whether DFE Sleep Mode is enabled as-shipped; and

(2) The expected time to sleep of the DFE.

(b) If the DFE does not respond to the print request at the end of 1 hour, the Ready Mode power level measured in the test method shall be reported as the Sleep Mode power.

Note: All information specified or provided by manufacturers for product testing shall be publicly available.

11. **References**

11.1. ISO/IEC 10561:1999. Information technology — Office equipment — Printing devices — Method for measuring throughput — Class 1 and Class 2 printers.

11.2. IEC 62301:2011. Household Electrical Appliances – Measurement of Standby Power. Ed. 2.0.

Table 21

Number of Images per Day Calculated for Product Speeds from 1 to 100 ipm

Speed (ipm)	Jobs/Day	Unrounded Images/Job	Images/Job	Images/Day
1	8	0,06	1	8
2	8	0,25	1	8
3	8	0,56	1	8
4	8	1,0	1	8
5	8	1,56	1	8
6	8	2,25	2	16
7	8	3,06	3	24

Table 21

Number of Images per Day Calculated for Product Speeds from 1 to 100 ipm				
8	8	4,0	4	32
9	9	4,5	4	36
10	10	5,0	5	50
11	11	5,5	5	55
12	12	6,0	6	72
13	13	6,5	6	78
14	14	7,0	7	98
15	15	7,5	7	105
16	16	8,0	8	128
17	17	8,5	8	136
18	18	9,0	9	162
19	19	9,5	9	171
20	20	10,0	10	200
21	21	10,5	10	210
22	22	11,0	11	242
23	23	11,5	11	253
24	24	12,0	12	288
25	25	12,5	12	300
26	26	13,0	13	338
27	27	13,5	13	351
28	28	14,0	14	392
29	29	14,5	14	406
30	30	15,0	15	450
31	31	15,5	15	465
32	32	16,0	16	512
33	32	17,02	17	544
34	32	18,06	18	576
35	32	19,14	19	608
36	32	20,25	20	640
37	32	21,39	21	672
38	32	22,56	22	704
39	32	23,77	23	736

Table 21

Number of Images per Day Calculated for Product Speeds from 1 to 100 ipm				
40	32	25,0	25	800
41	32	26,27	26	832
42	32	27,56	27	864
43	32	28,89	28	896
44	32	30,25	30	960
45	32	31,64	31	992
46	32	33,06	33	1 056
47	32	34,52	34	1 088
48	32	36,0	36	1 152
49	32	37,52	37	1 184
50	32	39,06	39	1 248
51	32	40,64	40	1 280
52	32	42,25	42	1 344
53	32	43,89	43	1 376
54	32	45,56	45	1 440
55	32	47,27	47	1 504
56	32	49,0	49	1 568
57	32	50,77	50	1 600
58	32	52,56	52	1 664
59	32	54,39	54	1 728
60	32	56,25	56	1 792
61	32	58,14	58	1 856
62	32	60,06	60	1 920
63	32	62,02	62	1 984
64	32	64,0	64	2 048
65	32	66,02	66	2 112
66	32	68,06	68	2 176
67	32	70,14	70	2 240
68	32	72,25	72	2 304
69	32	74,39	74	2 368
70	32	76,56	76	2 432
71	32	78,77	78	2 496

Table 21

Number of Images per Day Calculated for Product Speeds from 1 to 100 ipm				
72	32	81,0	81	2 592
73	32	83,27	83	2 656
74	32	85,56	85	2 720
75	32	87,89	87	2 784
76	32	90,25	90	2 880
77	32	92,64	92	2 944
78	32	95,06	95	3 040
79	32	97,52	97	3 104
80	32	100,0	100	3 200
81	32	102,52	102	3 264
82	32	105,06	105	3 360
83	32	107,64	107	3 424
84	32	110,25	110	3 520
85	32	112,89	112	3 584
86	32	115,56	115	3 680
87	32	118,27	118	3 776
88	32	121,0	121	3 872
89	32	123,77	123	3 936
90	32	126,56	126	4 032
91	32	129,39	129	4 128
92	32	132,25	132	4 224
93	32	135,14	135	4 320
94	32	138,06	138	4 416
95	32	141,02	141	4 512
96	32	144,0	144	4 608
97	32	147,02	147	4 704
98	32	150,06	150	4 800
99	32	153,14	153	4 896
100	32	156,25	156	4 992'

(**1**) OJ L 63, 6.3.2013, p. 5.

(**2**) OJ L 39, 13.2.2008, p. 1.

(**3**) OJ L 63, 6.3.2013, p. 1.

(**4**) International Electrotechnical Commission (IEC). IEC standard 62040-3:2011. 'Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements.' Ed. 2.0.

(**5**) 2 Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the UPS.

(**6**) The output of the VFD UPS is dependent on changes in ac input voltage and frequency and is not intended to provide additional corrective functions, such as those arising from the use of tapped transformers.

(**7**) An output voltage tolerance band narrower than input voltage window shall be defined by the manufacturer. The output of the VI UPS is dependent on ac input frequency and the output voltage shall remain within prescribed voltage limits (provided by additional corrective voltage functions, such as those arising from the use of active and/or passive circuits).

(**8**) This definition permits the UPS output greater than 100 000 W to be backfed into the input ac supply when in test-mode and subject to local regulations.

(**9**) Pulses are the waveform peaks produced by a rectifier per cycle and depend on its design and the number of input phases.

(**10**) International Electrotechnical Commission (IEC). IEC standard 62053-21. 'Electricity metering equipment (a.c.) - Particular requirements — Part 21: Static meters for active energy (classes 1 and 2).' Ed. 1.0.

(**11**) International Electrotechnical Commission (IEC). IEC standard 62053-22. 'Electricity metering equipment (a.c.) - Particular requirements — Part 22: Static meters for active energy (classes 0,2 S and 0,5 S).' Ed. 1.0.

(**12**) American National Standards Institute. ANSI standard C12.1. 'American National Standard for Electric Meters: Code for Electricity Metering.' 2008.

(**13**) GB defined as $1\ 024^3$ or 2^{30} bytes.

(**14**) http://www.spec.org/sert/

(**15**) http://www.spec.org/sert/docs/SERT-Design_Document.pdf

(**16**) http://www.spec.org/

(**17**) http://www.spec.org/sert/docs/SERT-User_Guide.pdf

(**18**) For the purposes of this specification 'mains' or the 'main electricity supply' refers to the input power source, including a dc power supply for products that operate solely off dc power.

(**19**) IEC 62301 Ed. 1.0 – Household electrical appliances – Measurement of standby power.

(**20**) Measurement uncertainty calculations should be performed according IEC 62301 Ed. 2.0 Appendix D.
Only the uncertainty due to the measurement instrument shall be calculated.

(**21**) Institute of Electrical and Electronics Engineers (IEEE) Standard 802.3az-2010. 'IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems —Local and Metropolitan Area Networks—Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.' 2010.

Status:
Point in time view as at 20/03/2014.

Changes to legislation:
There are currently no known outstanding effects for the Commission Decision of 20 March 2014 determining the European Union position for a decision of the Management entities under the Agreement between the Government of the United States of America and the European Union on the coordination of energy-efficiency labelling programmes for office equipment on adding specifications for computer servers and uninterruptible power supplies to Annex C to the Agreement and on the revision of specifications for displays and imaging equipment included in Annex C to the Agreement (Text with EEA relevance) (2014/202/EU).