ENERGY STAR® Program Requirements
Product Specification for Imaging Equipment

Test Method for Determining
Imaging Equipment Energy Use
Rev. Dec-2018

1 OVERVIEW

The following test method shall be used for determining 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 1 shall be used to determine the applicability of each section of this document.

Table 1: Test Procedure Applicability

Product Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Digital Duplicator	Standard	Stencil	TEC
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	High Performance IJ, 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
	Large	High Performance IJ	OM
	Small	High Performance IJ	TEC
Scanner	All	N/A	OM
Professional Imaging Products	All	All	TEC

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

4.1 General Test Setup

A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure shall be in accordance with:

1) The requirements of International Electrotechnical Commission (IEC) Standard 62301, Ed. 2.0, "Measurement of Household Appliance Standby Power", Section 4, "General Conditions for Measurements" for all products.

2) In the event of conflicting requirements, the ENERGY STAR test method shall take precedence.

B) 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 2 or Table 3.

1) Products shipped with external power supplies (EPSs) shall first be connected to the EPS and then to the voltage source specified in Table 2 or Table 3.

2) 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 2: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Switzerland	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz or 60 Hz	+/- 1.0 %

Table 3: Input Power Requirements for Products with Nameplate Rated Power Greater than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Switzerland	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz or 60 Hz	+/- 1.0 %

C) Low-voltage Dc Input Power:

1) Products may be powered with a low-voltage dc source (e.g., via network or data connection) only if the dc source is the only acceptable source of power for the product (i.e., no ac plug or EPS is available).

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

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

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

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

1) The spliced cable shall be used in addition to the shipped cable described in Section 4.1.C)3).

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

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

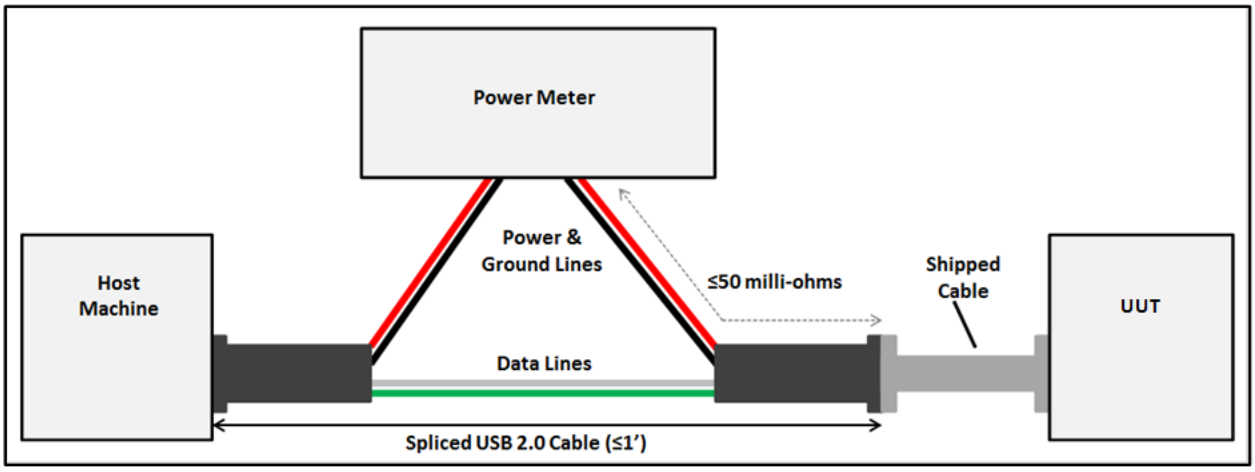
4) For measuring voltage, the total amount of wiring used between the voltage measurement and the shipped cable shall be less than 50 milliohms of resistance. This only applies to the wiring that is carrying load current.

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

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

Note**:** Figure 1 depicts an example spliced cable setup using a USB 2.0-powered UUT connected to the Host Machine.

Figure 1: Example Spliced USB 2.0 Cable Arrangement



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

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

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

1) Minimum Frequency Response: 3.0 kHz

2) Minimum Resolution:

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

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

c) 1 W for measurement values from 100 W to 1.5 kW; and

d) 10 W for measurement values greater than 1.5 kW.

e) 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.

G) Measurement Uncertainty[1]:

1) Measurements of greater than or equal to 1 W shall have an uncertainty of 2% or better at the 95% confidence level.

2) Measurements of less than 1 W shall have an uncertainty of 0.02 W or better at the 95% confidence level.

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

I) Paper Specifications:

1) Standard Format Products shall be tested in accordance with Table 4.

2) Large, Small, and Continuous Form products shall be tested using any compatible paper size.

Table 4: Paper Size and Weight Requirements

Market	Paper Size	Basis Weight (g/m^2)
North America	8.5” × 11”	75
Taiwan	A4	70
	8.5” × 11”	75
Switzerland	A4	80
Japan	A4	64

5 PRE-TEST UUT CONFIGURATION FOR ALL PRODUCTS

5.1 General Configuration

A) As-shipped Condition:

1) All products shall be tested in their “as-shipped” configuration unless otherwise specified by this test method.

B) 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:

1) 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).

a) 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).

[1] 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.

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

   a) The highest manufacturer-claimed monochrome print speed, unless the product cannot print, in which case,

   b) The highest manufacturer-claimed monochrome copy speed, unless the product cannot print or copy, in which case,

   c) The manufacturer-claimed scan speed.

      Note: EPA recommends that manufacturers report print speeds using the ISO/IEC 24734:2014 test image for consistency with other reporting.

   d) When a manufacturer intends to certify a product in a certain market and if its maximum claimed speeds differ when producing images on different sizes of paper, the highest speed shall be used.

Table 5: 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

3) For Continuous Form products, product speed shall be calculated per Equation 1.

Equation 1: 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.*

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

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

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

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

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

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

a) Only one computer may be connected to the UUT, either directly or via a network.
b) The UUT shall be connected using a port with the full specifications recommended for the UUT

Example: A Universal Serial Bus (USB) 3.1 port shall be used if present, even if backwards-compatible with USB 2.0.

2) The type of network connection depends on the characteristics of the UUT and shall be the topmost connection listed in Table 6 available on the unit as-shipped.

Table 6: 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	Wi-Fi
4	USB 3.x
5	USB 2.x
6	USB 1.x
7	RS232
8	IEEE 1284[2]
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)

3) All data and network cables and routers shall support the highest and lowest data speeds of the UUT's network interface.

Example: In the case of Ethernet, the connection shall be via a standard Category (Cat) 5e or better cable.

4) Products connected to a wireless protocol, such as Wi-Fi, shall be connected in close proximity to the appropriate router or computer.

[2] Also referred to as a Parallel or Centronics interface.

5) Products connected to Ethernet, per paragraph 5.1.D)2) above, and capable of supporting Energy Efficient Ethernet (IEEE Standard 802.3az)[3], shall be connected to a network switch or router that also supports Energy Efficient Ethernet for the duration of the test.

6) The tester shall configure the address layer of the protocol, taking note of the following:

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

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

3) The UUT shall maintain this live connection to the network for the duration of testing unless otherwise specified in this Test Method, disregarding any brief lapses (e.g., when transitioning between link speeds).

E) Service/Maintenance Modes: Imaging Products shall never be in service/maintenance modes, including color calibration, during testing.

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

2) 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.

3) 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 shall 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.

5.2 Configuration for MFDs with Fax Capability

A) All 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 6 if the UUT is network capable.

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

5.3 Configuration for Digital Duplicators

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

1) 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.

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

[3] 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.

6 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

6.1 General Initialization

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

1) Set up the UUT per the instructions in the Manufacturer's Instructions or documentation.

a) 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.

b) 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.

c) 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.

2) Connect the UUT to its power source.

3) 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.

a) Product Speed for Testing All Products: All products, except digital duplicators, shall be tested with speed settings in their default as-shipped configuration. Digital duplicators shall be tested at maximum claimed speed as required in Section 5.3.

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

c) 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.

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

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

a) 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).

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

7 TYPICAL ENERGY CONSUMPTION (TEC) TEST PROCEDURE

7.1 Job Structure

A) Jobs per Day: The number of jobs per day (N_{JOBS}) is specified in Table 7.

Table 7: Number of Jobs per Day (N_{JOBS})

Monochrome Product Speed, s (ipm)	Jobs per Day (N_{JOBS})
s ≤ 8	8
8 < s < 32	s
s ≥ 32	32

B) Images per Job: The number of images shall be computed according to Equation 2, below. For convenience, Table 11 at the end of this document provides the resultant images per job computation for each integer product speed up through 100 ipm.

Equation 2: Calculation of Number of Images per Job

$$N_{IMAGES} = \begin{Bmatrix} 1 & s < 4 \\ \boldsymbol{int}\left[\frac{(0.5 \times s^2)}{N_{JOBS}}\right] & s \geq 4 \end{Bmatrix}$$

Where:

- *N_{IMAGES} is the number of images per job, rounded down (truncated) to the nearest integer,*
- *s is the product speed in images per minute (ipm), calculated in section 5.1.B), of this test procedure, and*
- *N_{JOBS} is the number of jobs per day, as calculated per Table 7.*

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

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

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

D) Print Jobs: Print jobs for the test shall be sent over the network connection designated in Table 6 immediately before printing each job.

1) 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).

2) 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.

E) Copy Jobs:

1) For products with copying capability and with speed less than or equal to 20 ipm, there shall be one original per required image.

2) For products with copying capability and 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.

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

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

7.2 Measurement Procedures

A) Measurement of TEC shall be conducted according to Table 8 for printers, digital duplicators, and MFDs with print capability, and Table 9 for digital duplicators and MFDs without print capability, subject to the following provisions:

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

2) 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 shall 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.

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

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

Table 8: TEC Test Procedure for Printers, 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 11. Measure and record time to first sheet exiting unit.	Active0 time	Seconds (s)	–
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.	Default delay time to Sleep, $t_{DEFAULT}$	Minutes (min)	–
5	Sleep	Zero meter; measure energy and time for 1 hour. Record the energy and time.	Sleep energy, E_{SLEEP}	Watt-hours (Wh)	Sleep
			Sleep time, t_{SLEEP} (≤ 1 hr)	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	Seconds (s)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Watt-hours (Wh)	Same as above
			Active2 time	Seconds (s)	
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 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)	

Note: 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 9: TEC Test Procedure for 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 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 has entered Ready Mode.	–	–	–
3	Ready	Copy a job of at least one image but no more than a single job per Table 11. Measure and record time to first sheet exiting unit	Active0 time	Seconds (s)	–
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 and measure the default time to sleep	Default delay time to Sleep, $t_{DEFAULT}$	Minutes (min)	–
5	Sleep	Zero meter; measure energy and time for 1 hour or until unit enters Auto-off Mode. Record the energy and time.	Sleep energy, E_{SLEEP}	Watt-hours (Wh)	Sleep
			Sleep time, t_{SLEEP} (≤ 1 hr)	Minutes (min)	
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	Seconds (s)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Watt-hours (Wh)	Same as above
			Active2 time	Seconds (s)	
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 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 energy, E_{FINAL}	Watt-hours (Wh)	Ready, Sleep
			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)	Auto-off
			Auto-off time, t_{AUTO}	Minutes (min)	

Note: 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.

8 OPERATIONAL MODE (OM) TEST PROCEDURE

8.1 Measurement Procedures

A) Measurement of OM power and delay times shall be conducted according to Table 10, subject to the following provisions:

1) Power Measurements: All power measurements shall be made using either the average power or accumulated energy approaches as described below:

a) 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.

i) For those modes that do not last 5 minutes, the true average power shall be measured over the mode's entire duration.

b) 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 (in watt-hours) by the time of the test period (in hours).

i) For those modes that do not last 5 minutes, the accumulated energy consumption shall be measured over the mode's entire duration.

c) If the power consumption of the tested mode is periodic, then the test duration shall contain one or more complete periods.

Table 10: 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, $t_{DEFAULT}$	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 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.*

9 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.

9.1 Ready Mode DFE Test

A) Products that are network-capable as-shipped shall be connected during testing. The network connection used shall be determined using Table 6.

B) 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.

C) 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. This will most commonly be accomplished by taking an instantaneous power measurements of each dc input into the DFE and adding them together for the total dc power.

9.2 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 certify Imaging Equipment products that incorporate DFEs with network-capable Sleep Modes.

A) Products that are network-capable as-shipped shall be connected during testing. The network connection used shall be determined using Table 6.

B) 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.

C) 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.

D) In cases B) and C), the following requirements apply:

   1) Manufacturers shall provide information on:

      a) Whether DFE Sleep Mode is enabled as-shipped; and

      b) The expected time to sleep of the DFE.

   2) 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.

10 REFERENCES

A) ISO/IEC 10561:1999. Information technology — Office equipment — Printing devices — Method for measuring throughput — Class 1 and Class 2 printers.

B) IEC 62301:2011. Household Electrical Appliances – Measurement of Standby Power. Ed. 2.0.

Table 11: Number of Images per Day Calculated for Product Speeds, s, from 1 to 100 ipm

Speed (ipm)	Jobs/Day (from Table 7, used only to calculate Images/Job)	Unrounded Images/ Job	Images/ Job	Speed (ipm)	Jobs/Day (from Table 7, used only to calculate Images/Job	Unrounded Images/ Job	Images / Job
1	8	0.06	**1**	51	32	40.64	**40**
2	8	0.25	**1**	52	32	42.25	**42**
3	8	0.56	**1**	53	32	43.89	**43**
4	8	1.00	**1**	54	32	45.56	**45**
5	8	1.56	**1**	55	32	47.27	**47**
6	8	2.25	**2**	56	32	49.00	**49**
7	8	3.06	**3**	57	32	50.77	**50**
8	8	4.00	**4**	58	32	52.56	**52**
9	9	4.50	**4**	59	32	54.39	**54**
10	10	5.00	**5**	60	32	56.25	**56**
11	11	5.50	**5**	61	32	58.14	**58**
12	12	6.00	**6**	62	32	60.06	**60**
13	13	6.50	**6**	63	32	62.02	**62**
14	14	7.00	**7**	64	32	64.00	**64**
15	15	7.50	**7**	65	32	66.02	**66**
16	16	8.00	**8**	66	32	68.06	**68**
17	17	8.50	**8**	67	32	70.14	**70**
18	18	9.00	**9**	68	32	72.25	**72**
19	19	9.50	**9**	69	32	74.39	**74**
20	20	10.00	**10**	70	32	76.56	**76**
21	21	10.50	**10**	71	32	78.77	**78**
22	22	11.00	**11**	72	32	81.00	**81**
23	23	11.50	**11**	73	32	83.27	**83**
24	24	12.00	**12**	74	32	85.56	**85**
25	25	12.50	**12**	75	32	87.89	**87**
26	26	13.00	**13**	76	32	90.25	**90**
27	27	13.50	**13**	77	32	92.64	**92**
28	28	14.00	**14**	78	32	95.06	**95**
29	29	14.50	**14**	79	32	97.52	**97**
30	30	15.00	**15**	80	32	100.00	**100**
31	31	15.50	**15**	81	32	102.52	**102**
32	32	16.00	**16**	82	32	105.06	**105**
33	32	17.02	**17**	83	32	107.64	**107**
34	32	18.06	**18**	84	32	110.25	**110**
35	32	19.14	**19**	85	32	112.89	**112**
36	32	20.25	**20**	86	32	115.56	**115**
37	32	21.39	**21**	87	32	118.27	**118**
38	32	22.56	**22**	88	32	121.00	**121**
39	32	23.77	**23**	89	32	123.77	**123**
40	32	25.00	**25**	90	32	126.56	**126**
41	32	26.27	**26**	91	32	129.39	**129**
42	32	27.56	**27**	92	32	132.25	**132**
43	32	28.89	**28**	93	32	135.14	**135**
44	32	30.25	**30**	94	32	138.06	**138**
45	32	31.64	**31**	95	32	141.02	**141**
46	32	33.06	**33**	96	32	144.00	**144**
47	32	34.52	**34**	97	32	147.02	**147**
48	32	36.00	**36**	98	32	150.06	**150**
49	32	37.52	**37**	99	32	153.14	**153**
50	32	39.06	**39**	100	32	156.25	**156**