ENERGY STAR® Program Requirements
Product Specification for Imaging Equipment

Test Method for Determining
Professional Imaging Product Energy Use
Final Draft, Rev. August-2019

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1 OVERVIEW

The following test method shall be used for determining Professional Imaging 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 1 shall be used to determine the applicability of this ENERGY STAR Test Method.

Table 1. Test Procedure Applicability

Product Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Professional Imaging Products	All	All	Professional Imaging Product

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 Organization for Standardization (ISO) Standard 21632, "Graphic technology -- Determination of the energy consumption of digital printing devices including transitional and related modes", Section 4, "General Conditions"; and

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

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

E) 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.

F) 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.

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

H) 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 uncoated paper in any compatible paper size.

Table 4: Paper Size and Weight Requirements

Market	Paper Size	Basis Weight (g/m^2)
North America	8.5” × 11”	120.0
Taiwan	A4 or 8.5” × 11”	120.0
Switzerland	A4	120.0
Japan	A4	127.9

Note: EPA has clarified that to reduce testing burden, all testing shall be conducted using uncoated paper. Stakeholder feedback indicated that uncoated paper and coated paper are sold in roughly equal quantities in the market, however, uncoated paper reduces testing burden slightly. Additionally, one stakeholder commented that the as-shipped condition instructions be moved to the General Initialization section and any redundancies be removed. EPA has moved the as-shipped condition.

I) 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:

J) 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).

1) 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).

2) 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.

d) When a manufacturer intends to qualify 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.

[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.

Note: In the related Non-professional Imaging Equipment test method, one stakeholder noted that the requirement in Section 5.1.B.2)d) to use "test results that certified the product in another market using other size of paper" appears to be in conflict with Section 4.3.1 of the specification, which states "Products shall be tested for certification at the relevant input voltage/frequency combination for each market . . . " EPA and DOE have removed the phrase "by making use of test results that qualified the product in another market using other size of paper (e.g., A4 versus 8.5" x 11")". The rest of the requirement retains its meaning without conflicting with the tables of paper sizes or Section 4.3.1 of the specification.

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

K) Color: Color-capable products shall be tested under the default (as-shipped) setting.

L) 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 5 available on the unit as-shipped.

Table 5: 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.

5) Products connected to Ethernet, per paragraph 0.L)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:

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

b) 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.

c) 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).

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

[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.

M) Service/Maintenance Modes: Service/maintenance modes, including color calibration, shall be in their default state during testing.

1) Energy consumption of any automatic adjustments shall be measured if captured by other portions of the test method (e.g., Production Print).

2) Any manual interventions, as specified in Section 4.5.3.1.4 of ISO 21632, shall be excluded to ensure repeatability of the test method.

5 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

5.1 General Initialization

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

1) Set up the UUT per 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.

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

3) As-shipped condition: Professional Imaging Products shall be tested in their "as-shipped" configuration unless otherwise specified by this test method

a) If the product has Auto-off capability (whether based on a delay time or time-of-day) and it is enabled as-shipped, it shall be disabled prior to testing.

Note: One stakeholder noted that there are two conflicting instructions for disabling Auto-Off, and recommended keeping the broader instruction to disable all auto-off to prevent it from interfering with the test. EPA has kept the broader auto-off instructions (to include both delay time and time-of-day).

b) If the product has a Default Delay Time to Sleep, it shall be disabled prior to testing.

Note: Two stakeholders requested that initialization instructions require disabling of default delay time to sleep functionality if it would interfere with testing, similar to how auto-off is disabled. As professional imaging equipment are expected to rarely be in sleep mode, EPA has allowed the disabling of the default delay time to sleep to obtain more representative measurements in non-sleep modes.

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

d) Professional Imaging Products shall be tested under the default as-shipped combination of productivity and quality.

Note: One stakeholder asked for a clarification of the requirement to test under one Best Quality and Best Productivity (BQ/BP) combination, as these are typically two different configurations requiring two tests. The stakeholder noted that products are typically set to Best Productivity by default. While the setting is called BQ/BP in ISO 21632, it is the default as-shipped setting, which is supposed to be representative of a range of operation, not necessarily both the BQ and BP. EPA has therefore renamed this setting to "default as-shipped" in the test method.

4) 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.

6 PROFESSIONAL IMAGING PRODUCT TEST PROCEDURE

6.1 Test Flow

A) Test Image: ISO/IEC 24734:2014 AdGraphics Adobe Reader file page 2 test image shall be used for test.

B) Images per Copy: Each copy of the job shall consist of 16 copies of the image.

C) Copies per Job: The number of copies that correspond to at least 5 minutes continuous printing excluding 1st page, shall be computed according to Equation 2.

Equation 2: Calculation of Number of Images per Job

$$N_{COPIES} = \text{ceil}\left[\frac{(M \times s) + 1}{16}\right]$$

Where:

- N_{COPIES} is the number of images per job;
- ceil is the function that rounds up to the next integer;
- *s* is the product speed in images per minute (ipm); and
- *M* is the printing time, which is an integer value of 5 minutes or more.

Note: Two stakeholders commented that typical jobs for professional products consist of multiple copies of small booklets. Therefore, the stakeholder recommended sending "a file of 10-20 images multiple times to meet the 5 minutes run time." EPA has modified the job structure, dividing the necessary number of pages to operate the unit under test for 5 minutes into an integer multiple of 16-page jobs.

6.2 Measurement Procedures

A) Measurement of Professional Imaging Product TEC shall be conducted according to Figure 1 and Table 6, subject to the following provisions:

1) Paper: There shall be sufficient paper in the UUT to perform the specified print.
2) Simplex mode Testing: Products shall be tested in simplex mode.
3) Energy Measurement Method: All measurements shall be recorded as accumulated energy over time, in Wh; all time shall be recorded in minutes or seconds.
4) "Zero meter" references may be accomplished by recording the accumulated energy consumption at that time rather than physically zeroing the meter.

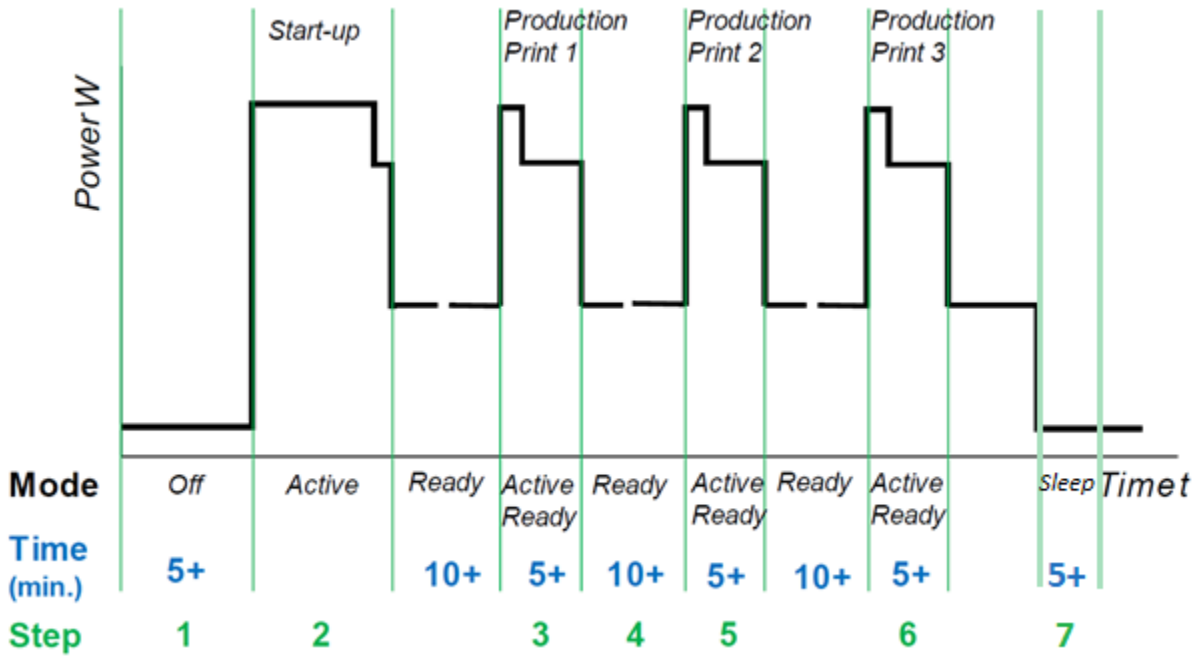

Figure 1: Illustration of TEC Test Procedure for Professional Imaging Products

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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 and print a job of at least one output image simultaneously. Zero the meter, measure energy and record time to trailing edge of first page reaches exit point. Record both energy and time.	Start-up energy	Watt-hours (Wh)	Start-up
			Testing interval time	Seconds (s)	
3	Ready	Production print 1 starts from at least 10 minutes ready duration after start-up. Zero meter and timer. Print one job (Print order includes number of pages, which corresponds to at least 5 minutes continuous printing excluding 1st page.). Measure energy and record time to trailing edge of first page reaches exit point.	FPPT from ready (transition) energy	Watt-hours (Wh)	FPPT from ready
			Trusting interval time	Seconds (s)	
		Continuously, after printing 1st page, print the number of pages, which corresponds to at least 5 minutes continuous printing. Measure energy, number of pages and record time to trailing edge of last page reaches exit point.	Production print 1 energy	Watt-hours (Wh)	Production print 1
			Number of images	Images	
			Testing interval time	Minutes (min)	
4	Ready	Zero meter and timer. Arbitrary time point after reaching stable print-ready mode. Measure energy over 5 minutes or more after arbitrary time point after reaching stable print-ready mode. Record both energy and time.	Ready energy	Watt-hours (Wh)	Ready
			Testing interval time	Minutes (min)	
5	Ready	Production print 2 starts at least 10 minutes ready duration after production print 1. Zero meter and timer. Print one job (Print order includes number of pages, which corresponds to at least 5 minutes continuous printing excluding 1st page.). Measure energy and record time to trailing edge of first page reaches exit point.	FPPT from ready (transition) energy	Watt-hours (Wh)	FPPT from ready (transition) energy
			Trusting interval time	Seconds (s)	
		Continuously, after printing 1st page, print the number of pages, which corresponds to at least 5 minutes continuous printing. Measure energy, number of pages and record time to trailing edge of last page reaches exit point.	Production print 2 energy	Watt-hours (Wh)	Production print 2
			Number of images	Images	
			Testing interval time	Minutes (min)	
6	Ready	Production print 3 starts at least 10 minutes ready duration after production print 1. Zero meter and timer. Print one job (Print order includes number of pages, which corresponds to at least 5 minutes continuous printing excluding 1st page.). Measure energy and record time to trailing edge of first page reaches exit point.	FPPT from ready (transition) energy	Watt-hours (Wh)	FPPT from ready (transition) energy
			Trusting interval time	Seconds (s)	
		Continuously, after printing 1st page, print the number of pages, which corresponds to at least 5 minutes continuous printing. Measure energy, number of pages and record time to trailing edge of last page reaches exit point.	Production print 3 energy	Watt-hours (Wh)	Production print 2
			Number of images	Images	
			Testing interval time	Minutes (min)	
7	Sleep	Begin measurement after the UUT enters sleep mode. This mode is skipped for UUT without sleep mode. Zero meter and timer. Measure energy over 5 minutes or more. Record both energy and time.	Sleep Mode energy	Watt-hours (Wh)	Sleep
			Testing Interval Time	Minutes (min)	

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Note: Two stakeholders commented that the measurement action shall be added to the test procedure in Step 2, Off Mode measurement. EPA has added the measurement action to Step 2, Off Mode measurement.

6.3 Testing in Accordance with ISO 21632

B) All other aspects of testing shall be conducted in accordance with Section 4.5.4 of ISO 21632.

7 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.

7.1 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 5.

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.

7.2 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.

A) Products that are network-capable as-shipped shall be connected during testing. The network connection used shall be determined using Table 5.

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.

8 REFERENCES

A) ISO 21632 “Graphic technology -- Determination of the energy consumption of digital printing devices including transitional and related modes”

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