ENERGY STAR® Program Requirements
Product Specification for Imaging Equipment

Test Method for Determining
Imaging Equipment Energy Use
Version 2.0 – Draft 2 (1)
Rev. Nov-2011

1 # 1 OVERVIEW

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

> **Note**: This document contains proposed changes to the ENERGY STAR test methods for both
> Operational Mode (OM) and Typical Energy Consumption (TEC) imaging equipment products. The
> proposed changes incorporate the feedback received during and after the imaging equipment webinars
> held on April 13, 2011 and August 4, 2011. The U.S. Department of Energy (DOE) and the U.S.
> Environmental Protection Agency (EPA) thank all stakeholders who participated and provided feedback
> and welcome additional comments on the changes outlined below.
>
> Please note that significant changes are proposed for the network connections used in the OM and TEC
> test methods; only one network connection is to be used for the test, and the network connection order of
> preference is specified in Table 6, below. These changes may invalidate at least 57% of OM product data
> used during the development of the revised Version 2.0 specification as the energy consumption will be
> different when measured according to the revised test method. On the other hand, the changes proposed
> to the TEC test method should affect few products as most were tested using a single Ethernet
> connection, the primary connection specified in Table 6.

4 # 2 APPLICABILITY

5 ENERGY STAR test requirements are dependent upon the feature set of the products under evaluation.
6 Table 1 shall be used to determine the applicability of each section of this document.

7 **Table 1: 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

Product Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
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

8 3 DEFINITIONS

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

> **Note**: DOE and EPA are seeking comments from stakeholders on an appropriate definition for Draft Mode that is based on quantifiable performance characteristics.

11 4 TEST SETUP

12 A) <u>Test Setup and Instrumentation</u>: Test setup and instrumentation for all portions of this procedure shall
13   be in accordance with the requirements of International Electrotechnical Commission (IEC) Standard
14   62301, Ed. 2.0, "Measurement of Household Appliance Standby Power", Section 4, "General
15   Conditions for Measurements." In the event of conflicting requirements, the ENERGY STAR test
16   method shall take precedence.

> **Note:** The reference procedure for test setup has been updated to the most recent version of IEC Standard 62301, Ed. 2.0. Standards that have been superseded shall no longer be referenced. In all cases, the most recent version of the standard shall be referenced.

17

18 B) <u>Ac Input Power</u>: Products intended to be powered from an ac mains power source shall be connected
19   to a voltage source appropriate for the intended market, as specified in Table 2 or Table 3.

20   1) Products shipped with External Power Supplies (EPSs) shall first be connected to the EPS and
21   then to the voltage source specified in Table 2 or Table 3.

22   2) If a product is designed to operate at a voltage/frequency combination in a specific market that is
23   different from the voltage/frequency combination for that market (e.g., 230 volts (V), 60 hertz (Hz)
24   in North America), the manufacturer should test the product at the regional combination that most
25   closely matches the product's design capabilities and note this on the test reporting sheet.

26 **Table 2: Input Power Requirements for Products with**
27 **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 %
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 %

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

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

31

32 C) <u>Low-voltage Dc Input Power</u>:

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

36   2) Products powered by low-voltage dc shall be configured with an ac source of the dc power for
37   testing (e.g., an ac-powered universal serial bus (USB) hub).

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

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

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

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

Note: Stakeholder comments suggest that certain dc-powered products may not enter low powered modes such as Sleep Mode depending on the power settings of the computer to which the unit is connected. As such, DOE and EPA are seeking additional feedback on how a computer's power settings may impact the operation of low-voltage dc source units.

43

44 D) <u>Ambient Temperature</u>: Ambient temperature shall be 23°C ± 5°C.

45 E) <u>Relative Humidity</u>: Relative humidity shall be between 10% and 80%.

46 F) <u>Power Meter</u>: Power meters shall possess the following attributes:

47   1) <u>Minimum Frequency Response</u>: 3.0 kHz

48   2) <u>Minimum Resolution</u>:

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

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

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

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

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

58 G) <u>Measurement Uncertainty</u>:

59   1) Measurements of greater than or equal to 0.5 W shall have an uncertainty of 2% or better at the
60   95% confidence level.

61   2) Measurements of less than 0.5 W shall have an uncertainty of 0.01 W or better at the 95%
62   confidence level.

63 H) <u>Time Measurement</u>: Time measurements may be performed with a standard stopwatch with
64   resolution of at least 1 second.

65 I) <u>Paper Specifications</u>:

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

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

68   **Table 4: 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

69   5   LOW-VOLTAGE DC SOURCE MEASUREMENT FOR ALL
70   PRODUCTS

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72   1) Connect the dc source to the power meter and relevant ac supply as specified in Table 2.

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74   2) Verify that the dc source is unloaded.

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76   3) Allow the dc source to stabilize for a minimum of 30 minutes.

77

78   4) Measure and record the unloaded dc source power (P_S) according to section 9.1.A.1 of this test
79   method.

6 PRE-TEST UUT CONFIGURATION FOR ALL PRODUCTS

6.1 General Configuration

A) <u>Product Speed for Calculations and Reporting</u>: The product speed for all calculations and qualification 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.

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

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

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

    c) The manufacturer-claimed scan speed.

3) For non-Continuous Form products, with the exception of mailing machines, the product speed shall be calculated per Table 5. If the maximum claimed speeds differ when producing images on different sizes of paper (e.g., A4 versus 8.5" × 11"), 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 pages 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"	$0.25 \times s_P$
	A6	$0.25 \times s_P$
	Smaller than A6 or 4" × 6"	$16 \times w \times \ell \times s_P$
Large	A2	$4 \times s_P$
	A0	$16 \times s_P$

4) 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),*

| 106 | | | • s_L is the maximum claimed monochrome speed, in meters per |
| 107 | | | minute. |

| 108 | | 5) | For Mailing Machines, product speed shall be reported in units of mail pieces per minute (mppm). |

| 109 | | 6) | Note that the product speed used for all calculations and qualification, as calculated above, may |
| 110 | | | not be the same as the print speed used for test. |

Note: DOE and EPA received written comments following the release of Draft 1 test method that Partners should report the default ("as-shipped") speed, rather than the "highest" speed. During the August 4 webinar, there was further discussion about the mode in which the unit should be tested. Since this ambiguity could create an uneven playing field for qualification and lead to testing failures during verification, DOE and EPA need to clarify this issue.

For purposes of calculations and qualification, the maximum claimed print speed shall be recorded and will also be posted on the Qualified Product List along with the model's other data. For testing purposes, the unit under test shall be in the as-shipped mode, to emulate the end user's expected performance (see Section 7.A)3)a)). These two requirements are consistent with the Version 1.2 test method; however, DOE and EPA, also propose reporting the as-shipped product speed. The claimed default as-shipped product speed should be recorded and will be posted on the Qualified Product List along with the model's other data.

As there is no referenced test method to measure product speed, all values are as-claimed. This clarification should not require additional testing but will require additional data (the default as-shipped speed) on the UUT. DOE and EPA seek stakeholder feedback on this approach.

111

| 112 | B) | Color: Color-capable products shall be tested making monochrome images unless incapable of doing |
| 113 | | so. |

Note: DOE and EPA have decided not to include color testing in the Test Method due to the limited impact on energy consumption and limited apparent prevalence of color printing in typical usages. Additionally, by testing only in monochrome, testing will remain consistent across all products.

114

| 115 | C) | Network Connections: Products that are capable of being network-connected as-shipped shall be |
| 116 | | connected to a network. |

| 117 | | 1) | Products shall be connected to only one network or data connection for the duration of the test. |

| 118 | | 2) | The type of network connection depends on the characteristics of the UUT and shall be the |
| 119 | | | topmost available connection in the appropriate column of Table 6. |

| 120 | | 3) | Products shall be connected only to a local area network (LAN), not to a wide area network |
| 121 | | | (WAN) or the Internet. |

122   **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 Mb/s
3	USB 3.x
4	USB 2.x
5	USB 1.x
6	RS232
7	IEEE 1284[1]
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)

123

Note: The above table is intended to balance the requirements of the test method to be reflective of typical use while maintaining testing uniformity. Specifically, it was assumed that individual consumers are more likely to use Wi-Fi than commercial users, and though this may not always be the case, testing in a standard fashion will make the tests more repeatable.

Based on stakeholder feedback, two tables listing the order of preference based on product usage have been combined into one universal table applicable to all products.

Because only one interface shall be active during testing, DOE and EPA are considering eliminating allowances for functional adders, such as data and network connections, as well as hard disk drives and memory. DOE and EPA welcome comments on this proposed approach. DOE and EPA are also interested in stakeholder comments on updated allowance levels, should the adders be retained.

124
125   4) Products connected to Ethernet, per paragraph 6.1.C)2) above, and capable of supporting
126   Energy Efficient Ethernet (IEEE Standard 802.3az)[2], shall be connected to a network switch or
127   router that also supports Energy Efficient Ethernet for the duration of the test.

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

> **Note**: Since IEEE 802.3az was finalized in September 2010, DOE and EPA do not expect any currently qualified products to be affected by this test procedure and does not expect this change to require any retesting.

128

129   5) In all cases the type of connection used during the test shall be reported.

130   D) <u>Service/Maintenance Modes</u>: UUTs shall never be in service/maintenance modes, including color
131   calibration, during testing.

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

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

136   c) If service/maintenance modes cannot be disabled and a service/maintenance mode occurs
137   during a job other than the first job, the results from the job with the service/maintenance
138   mode may be replaced with results from a substitute job. In this case, the substitute job shall
139   be inserted into the test procedure immediately following Job 4. Each job period shall be 15
140   minutes.

141   **6.2   Configuration for Fax Machines**

142   A) All fax machines and products incorporating fax machines that connect to a telephone line shall be
143   connected to a telephone line during the test.

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

> **Note:** DOE and EPA assume that products purchased with fax capability will be operated with a connection to a telephone line, and should therefore be tested as such; however, DOE and EPA do not expect this test method change to require retesting prior to Version 2 dataset assembly, as during the April 13 webinar partners stated that fax connection should not have an impact on energy consumption. Further data provided by stakeholders have also indicated that the impact will be limited (up to 0.15 W increase in Sleep Mode)
>
> A working phone line may not be available at some test laboratories. Therefore, DOE and EPA have included a conditional provision to allow the use of a line simulator. Research has shown that line simulators operate in the same manner as a working phone line and will not affect the products energy consumption.

146

147   B) Unless sending jobs via phone line (i.e., for fax machine testing), originals may be placed in the
148   document feeder before the test begins.

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

151   2) Fax machines shall be tested with one image per job.

152   **6.3   Configuration for Digital Duplicators**

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

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

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

159   7   PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS

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

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

162   a) Accessories such as paper source and finishing hardware that are intended to be installed or
163   attached by the end-user shall be installed.

164   b) If the product is connected to a computer during the test, the computer shall be running the
165   newest version of the manufacturer's default driver available at the time of testing using
166   settings corresponding to the default settings upon shipment. The version of the print driver
167   used shall be recorded, along with the settings used during testing.

168   c) For products designed to operate on battery power when not connected to the mains power
169   source, the battery shall be removed for all tests. For UUTs where operation without a battery
170   pack is not a supported configuration, the test shall be performed with fully charged battery
171   pack(s) installed, making sure to report this configuration in the test results. To ensure the
172   battery is fully charged, perform the following steps:
173

174   i) For UUTs that have an indicator to show that the battery is fully charged, continue
175   charging for an additional 5 hours after the indication is present.
176   ii) If there is no charge indicator, but the manufacturer's instructions provide a time estimate
177   for when charging this battery or this capacity of battery should be complete, continue
178   charging for an additional 5 hours after the manufacturer's indication.
179   iii) If there is no indicator and no time estimate in the instructions, but the charging current is
180   stated on the UUT or in the instructions, terminate charging 1 hour after the calculated
181   test duration or, if none of the above applies, the duration shall be 24 hours.
182

Note: To clarify the test method and promote repeatability in qualification and verification, DOE and EPA have clarified that key driver settings used during testing must correspond to the defaults upon shipment, regardless of the implementation details of those settings. Based on stakeholder input, DOE and EPA do not intend to require testing with the same driver as that installed upon shipment. Specifically, DOE and EPA would like to ensure that any image sent to the UUT via a computer has been processed by the Original Equipment Manufacturer (OEM) driver using default settings.

DOE and EPA have also clarified guidelines for products designed to operate on battery power, requiring batteries to be removed for all testing, or, if not possible, testing with a fully charged battery. This clarification harmonizes with the specification requirements for other ENERGY STAR products.

Version 1.2 of this test procedure does not provide sufficient requirements to ensure a fully charged battery, so DOE and EPA have adapted a method from DOE's 10 CFR 430: "Energy Conservation Program for Certain Consumer Appliances: Test Procedures for Battery Chargers and External Power Supplies", Section 5.2: Charge Test Duration. DOE and EPA welcome comment on this approach for ensuring a fully charged battery.

183

184   2) Connect the UUT to its power source.

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

188   a) <u>Product Speed for Testing</u>: The product shall be tested with speed settings in their default as-
189   shipped configuration.

190   a) <u>Auto-off for TEC Products</u>: If a printer, digital duplicator, fax machine, or MFD with print-
191   capability has Auto-off capability and it is enabled as-shipped, it shall be <u>disabled</u> prior to
192   testing.

193   b) <u>Auto-off for OM Products</u>: If a product has an Auto-off Mode enabled as-shipped, it shall
194   remain <u>enabled</u> for the duration of testing.

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

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

197   a) For EP products, let the UUT sit in Off Mode for an additional 105 minutes, for a total of 120
198   minutes (2 hours).

Note: DOE and EPA have extended the initial pre-conditioning time to 2 hours prior to any testing of EP, products to ensure that they begin testing with their internal temperature equal to that of the ambient air. The product may be left unattended during pre-conditioning. DOE and EPA welcome stakeholder feedback on the necessity of such a requirement and whether additional pre-conditioning should be required for any other marking technologies.

199

8 TYPICAL ENERGY CONSUMPTION (TEC) TEST PROCEDURE

8.1 Job Structure

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

203 **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

204

205 B) <u>Images per Job</u>: Except for fax machines, the number of images shall be computed according to
206   Equation 2, below. For convenience, Table 11 at the end of this document provides the resultant
207   images per job computation for each integer product speed up through 100 ipm.

208 **Equation 2: Calculation of Number of Images per Job**

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

209
210
211 *Where:*
212 • N_{IMAGES} *is the number of images per job, rounded down*
213 *(truncated) to the nearest integer,*
214 • *s is the (monochrome) maximum reported speed in images per*
215 *minute (ipm), calculated in section 6.1.A), of this test*
216 *procedure, and*
217 • N_{JOBS} *is the number of jobs per day, as calculated per Table 7.*

Note: DOE and EPA have decided not to modify the usage assumptions integrated into the TEC test procedure (i.e., the number of images per job, and the number of jobs per day) due to a lack of data indicating a more representative usage pattern.

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218 C) <u>Test Image</u>: Test Pattern A from International Organization for Standardization (ISO)/IEC Standard
219 10561:1999 shall be used as the original image for all testing.

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

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

Note: DOE and EPA have decided not to include color testing in the Test Method due to the limited prevalence of color printing in typical use.

224

225 D) <u>Print Jobs</u>: Print jobs for the test shall be sent over the network connection designated in Table 6.

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

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

231 E) <u>Copy Jobs</u>:

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

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

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

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

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

243 **8.2 Measurement Procedures**

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

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

249   2) <u>Duplexing</u>: Products shall be tested in simplex mode, unless the speed of duplex mode output is
250   greater than the speed of simplex mode output, in which case they will be tested in duplex mode.
251   In all cases, the mode in which the unit was tested and the print speed used must be
252   documented. Originals for copying shall be simplex images.

> **Note**: The previously specified accuracy requirements have been removed as they were redundant with those in Section 4 (Test Setup), above.

253

254   3) <u>Energy Measurement Method</u>: All measurements shall be recorded as accumulated energy over
255   time, in Wh; all time shall be recorded in minutes.

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

**Table 8: 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 11. 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. 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
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; 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)	

Table 9: 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 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 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 until unit enters Auto-off Mode. Record the energy and time.	Sleep energy	Watt-hours (Wh)	Sleep
			Sleep time (≤ 1 hour)	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	Minutes (min)	
7	Ready (or other)	Repeat Step 6.	Job2 energy, E_{JOB2}	Minutes (min)	Same as above
			Active2 time	Watt-hours (Wh)	
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)	

262

> **Note:** Because there is a lack of specific product examples with a power buffer, DOE and EPA do not intend to modify the test method to require recording energy consumed during Step 2 of the TEC measurement.
>
> DOE and EPA have clarified the TEC test method in Table 8 and Table 9 above and will clarify the reporting requirements to indicate that the duration of time until the UUT has reached its final sleep or auto-off mode shall be specified by the manufacturer. This change will remove potential testing ambiguity by specifying how long testers must wait before concluding measurement in these modes.

263 # 9 OPERATIONAL MODE (OM) TEST PROCEDURE

264 ## 9.1 Measurement Procedures

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

267   1) <u>Power Measurements</u>: All power measurements shall be made using either the average power or
268   accumulated energy approaches as described below:

269   a) <u>Average Power Method</u>: The true average power shall be measured over the course of a
270   user selected period, which shall be no less than 5 minutes.

271   b) <u>Accumulated Energy Approach</u>: If the test instrument is incapable of measuring the true
272   average power, the accumulated energy consumption over the course of a user selected
273   period shall be measured. The test period shall be no less than 5 minutes. The average
274   power shall be determined by dividing the accumulated energy consumption by the time of
275   the test period.

276   c) If the power consumption of the tested mode varies over a cycle then the test period shall
277   contain one or more complete cycles.

> **Note**: The previously-specified accuracy requirements have been removed as they were redundant with those in section 4 (Test Setup), above.

278

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_{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)

280 *Notes:*
281 • *Step 1 – If the unit has no Ready indicator, use the time at which the power consumption level*
282 *stabilizes to the Ready level, and note this detail when reporting the product test data.*
283 • *Steps 4 and 5 – For products with more than one Sleep level, repeat these steps as many times*
284 *as necessary to capture all successive Sleep levels and report these data. Two Sleep levels are*
285 *typically used in large-format copiers and MFDs that use high-heat marking technologies. For*
286 *products lacking this Mode, disregard Steps 4 and 5.*
287 • *Steps 4 and 5 – For products without a Sleep Mode, perform and record   measurements from*
288 *Ready Mode.*
289 • *Steps 4 and 6 – Default-delay time measurements are to be measured in parallel fashion,*
290 *cumulative from the start of Step 4. For example, a product set to enter a Sleep level in 15*
291 *minutes and enter a second Sleep level 30 minutes after entering the first Sleep level will have a*
292 *15-minute default-delay time to the first level and a 45 minute default-delay time to the second*
293 *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.

> **Note**: DOE and EPA intend to incentivize energy efficiency of imaging products with DFEs by measuring the energy consumption of the DFE in the modes that are most prevalent: Ready and Sleep. This change will require retesting of all imaging equipment units with DFEs.

Following retesting, the energy savings potential of DFE energy consumption requirements will be analyzed and DFE energy consumption requirements may be proposed for discussion during the specification development process.

A) 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 five-minute energy measurement of the DFE alone shall be made while the main product is in Ready Mode. The unit must be connected to a network if applicable.

B) If the DFE does not have a separate main power cord, the manufacturer 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 measurement of the dc input to the DFE.

> **Note**: DOE and EPA are proposing to require that manufacturers directly report the dc power to the DFE without adjusting for any power supply inefficiency as such adjustments are likely to be unreliable without knowing the efficiency curve of the power supply used for the test.

C) If the DFE has a Sleep Mode that is enabled as-shipped, wait until the DFE is in a Sleep Mode and repeat one of the above measurements, as appropriate for the DFE type, recording the DFE Sleep Mode power.

    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 no Sleep Mode is enabled as-shipped, the Ready Mode value measured in Section A) or B), above, shall be recorded as the DFE Sleep Mode power.

> **Note:** DOE and EPA are considering incentives to encourage implementation of ProxZzzy technology during sleep mode in DFE products. We welcome stakeholder input as to the best methods to incentivize this technology.

11 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.

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Table 11: 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	Speed (ipm)	Jobs/Day	Unrounded Images/ Job	Images/ Job	Images/ Day
1	8	0.06	1	8	51	32	40.64	40	1280
2	8	0.25	1	8	52	32	42.25	42	1344
3	8	0.56	1	8	53	32	43.89	43	1376
4	8	1.00	1	8	54	32	45.56	45	1440
5	8	1.56	1	8	55	32	47.27	47	1504
6	8	2.25	2	16	56	32	49.00	49	1568
7	8	3.06	3	24	57	32	50.77	50	1600
8	8	4.00	4	32	58	32	52.56	52	1664
9	9	4.50	4	36	59	32	54.39	54	1728
10	10	5.00	5	50	60	32	56.25	56	1792
11	11	5.50	5	55	61	32	58.14	58	1856
12	12	6.00	6	72	62	32	60.06	60	1920
13	13	6.50	6	78	63	32	62.02	62	1984
14	14	7.00	7	98	64	32	64.00	64	2048
15	15	7.50	7	105	65	32	66.02	66	2112
16	16	8.00	8	128	66	32	68.06	68	2176
17	17	8.50	8	136	67	32	70.14	70	2240
18	18	9.00	9	162	68	32	72.25	72	2304
19	19	9.50	9	171	69	32	74.39	74	2368
20	20	10.00	10	200	70	32	76.56	76	2432
21	21	10.50	10	210	71	32	78.77	78	2496
22	22	11.00	11	242	72	32	81.00	81	2592
23	23	11.50	11	253	73	32	83.27	83	2656
24	24	12.00	12	288	74	32	85.56	85	2720
25	25	12.50	12	300	75	32	87.89	87	2784
26	26	13.00	13	338	76	32	90.25	90	2880
27	27	13.50	13	351	77	32	92.64	92	2944
28	28	14.00	14	392	78	32	95.06	95	3040
29	29	14.50	14	406	79	32	97.52	97	3104
30	30	15.00	15	450	80	32	100.00	100	3200
31	31	15.50	15	465	81	32	102.52	102	3264
32	32	16.00	16	512	82	32	105.06	105	3360
33	32	17.02	17	544	83	32	107.64	107	3424
34	32	18.06	18	576	84	32	110.25	110	3520
35	32	19.14	19	608	85	32	112.89	112	3584
36	32	20.25	20	640	86	32	115.56	115	3680
37	32	21.39	21	672	87	32	118.27	118	3776
38	32	22.56	22	704	88	32	121.00	121	3872
39	32	23.77	23	736	89	32	123.77	123	3936
40	32	25.00	25	800	90	32	126.56	126	4032
41	32	26.27	26	832	91	32	129.39	129	4128
42	32	27.56	27	864	92	32	132.25	132	4224
43	32	28.89	28	896	93	32	135.14	135	4320
44	32	30.25	30	960	94	32	138.06	138	4416
45	32	31.64	31	992	95	32	141.02	141	4512
46	32	33.06	33	1056	96	32	144.00	144	4608
47	32	34.52	34	1088	97	32	147.02	147	4704
48	32	36.00	36	1152	98	32	150.06	150	4800
49	32	37.52	37	1184	99	32	153.14	153	4896
50	32	39.06	39	1248	100	32	156.25	156	4992

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