



# ENERGY STAR® Program Requirements Product Specification for Imaging Equipment

## Test Method for Determining Imaging Equipment Energy Use Draft 2, Rev. March-2018

### 1 OVERVIEW

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

### 2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the products under evaluation. Table 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	Professional Imaging Product

**Note:** EPA proposes to remove copiers and fax from the scope and to remove them from Table 1. Due to a low number of both ENERGY STAR certified and conventional models available on the market. ENERGY STAR shipment numbers have decreased about 100 fold since 2010 for both standalone copiers and fax machines and this trends continues.

12 **Note:** EPA proposes to add Professional Imaging Products to the scope of the test method, with a new  
13 test that references International Organization for Standardization (ISO) Standard 21632 “Graphic  
14 technology -- Determination of the energy consumption of digital printing devices including transitional  
15 and related modes”. Professional Imaging Products are Imaging Equipment products intended to  
16 produce outputs for sale. Because their use differs from that of Imaging Equipment intended for office and  
17 home use, some stakeholders have commented that the current ENERGY STAR TEC test method is not  
18 representative and that EPA should reference ISO 21632. A Draft International Standard (DIS) was  
19 released for vote in December 2017. EPA does not expect significant changes to the standard at this  
20 stage, and so is proposing language referencing the standard in key places with the intention of seeking  
21 feedback regarding its use and will verify and update all references once the final standard is published  
22 later in 2018.

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24 The draft version of ISO 21632 provides flexibility to test a variety of Printers and MFDs with print  
25 capability, specifying the setup and test of each mode. The results obtained through ISO 21632 can then  
26 be combined with a job structure specific to Professional Imaging Products to ensure that the result is  
27 representative of the application. While this is also the general structure employed by ENERGY STAR  
28 (the modal results of the TEC test method are multiplied by a usage assumption in the specification to  
29 arrive at an annual energy consumption), there are several differences with ISO 21632. Harmonizing with  
30 the current draft of ISO 21632 would require changes in the following areas:

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32 Test Setup:

- 33 1. Including three-phase test voltages;
- 34 2. Allowable temperature and humidity ranges (but ISO 21632 is more stringent than ENERGY STAR  
35 test method);
- 36 3. Estimation of required air conditioning energy consumption at 10 and 20 °C due to the heat generated  
37 by the Professional Imaging Equipment;
- 38 4. Power measurement meter minimum sampling frequency (ISO 21632 specifies 5 kHz versus  
39 ENERGY STAR’s 6 kHz for a 3 kHz resolution);
- 40 5. Measurement accuracy/uncertainty (ISO 21632 specifies  $\pm 3\%$  accuracy versus ENERGY STAR’s  
41  $2\%/0.02\text{ W}$  uncertainty at the 95% confidence level);
- 42 6. Paper size can be A3 or larger; an A3, letter, or A4 image size can be imposed (tiled multiple times)  
43 to permit testing of larger-format products;
- 44 7. The paper weight is not specified; instead, the substrate (either paper or plastic) is selected to provide  
45 first best quality and then best productivity;

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47 Pre-test UUT Configuration:

- 48 1. The reported product speed is used to set up the print job, but then the actual product speed is also  
49 calculated;
- 50 2. Two configurations for test: best quality and best productivity combination;
- 51 3. The best quality combination requires “all colorants of the system” be used; the best productivity  
52 combination requires a print mode that is still saleable;
- 53 4. Network connection details are unspecified;
- 54 5. Energy consumption in maintenance mode shall be measured if manufacturer recommends daily  
55 maintenance;

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57 Pre-test UUT Initialization:

- 58 1. Pre-conditioning/acclimation time in ambient conditions of 1 hour before the start of testing;

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60 Test:

- 61 1. Recommended image for test: ISO/IEC 24734:2014 Annex B B.2 Advertising and graphics test suite  
62 “Adobe Reader file” page 2;
- 63 2. Active test shall be performed for 5 minutes, so for a 100 ipm product, this would require 500 page  
64 jobs;
- 65 3. The energy consumption of two jobs is measured and the results are checked for consistency; if not  
66 within 5%, a third job is performed;

67 4. Test results shall be rounded to 4 significant figures, in the more conservative direction (down for  
68 energy efficiency, and up for energy consumption)  
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70 EPA has provided detailed proposals and questions for comment related to the above items throughout  
71 the test method and welcomes stakeholder feedback on how best to accommodate Professional Imaging  
72 Products. Finally, the aforementioned Professional Imaging Product job structure is not part of ISO  
73 21632. EPA has received a job structure proposal from stakeholders and has included questions related  
74 to it in the Draft 1 specification for review and comment.  
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### 76 3 DEFINITIONS

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

### 79 4 TEST SETUP

#### 80 4.1 General Test Setup

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

83 1) The requirements of International Organization for Standardization (ISO) Standard 21632,  
84 "Graphic technology -- Determination of the energy consumption of digital printing devices  
85 including transitional and related modes", Section 4, "General Conditions" for Professional  
86 Imaging Products; and

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

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

91 **Note:** EPA has included a new section outlining the general test setup for Professional Imaging Products.  
92 By proposing to set up Professional Imaging Products in accordance with ISO 21632, EPA is excluding  
93 Professional Imaging Products from the IEC 62301 conditions. Nonetheless, ENERGY STAR continues  
94 to specify a number of conditions based on IEC 62301 in the sections below. The only conditions which  
95 are not specified by the ENERGY STAR test method are test room air speed ( $\leq 0.5$  m/s) and ambient  
96 illuminance ( $> 300$  lux and  $< 10$  lux). These should therefore be set up per IEC 62301 for Non-  
97 Professional Imaging Products and left to the tester's discretion for Professional Imaging Products.

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

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

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

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**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 %
Europe, Australia, New Zealand	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz or 60 Hz	+/- 1.0 %

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**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 %
Europe, Australia, New Zealand	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz or 60 Hz	+/- 1.0 %

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**Note:** ISO 21632 for Professional Imaging Products permits testing at any voltage, 1- or 3-phase, 50–60 Hz, and 100–650 V. EPA proposes to continue specifying common test voltages across regions, which will provide comparable results for models that can be tested at these typical voltages and frequencies, while still allowing models that cannot operate at these frequency and voltage conditions to be “at the manufacturer rated voltage/frequency combination” per Section 4.1.B)2), above.

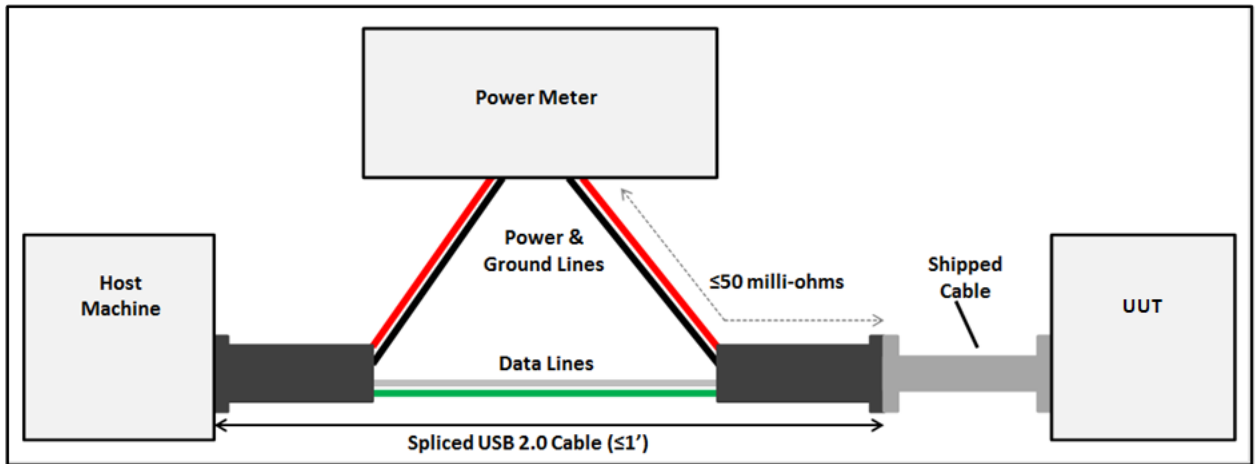
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117 C) Low-voltage Dc Input Power:

- 118 1) Products may be powered with a low-voltage dc source (e.g., via network or data connection)
- 119 only if the dc source is the only acceptable source of power for the product (i.e., no ac plug or
- 120 EPS is available).
- 121 2) Dc-powered products shall be installed and powered as directed by the manufacturer, using a
- 122 port with the full specifications recommended for the UUT (e.g., Universal Serial Bus (USB) 3.1 if
- 123 applicable, even if backwards-compatible with USB 2.0).
- 124 3) The power measurement shall be made between the dc source (e.g., Host Machine) and the
- 125 cable shipped with the product, including the losses introduced by the shipped cable. If no cable
- 126 is shipped with the product, any cable between 2 and 6 feet long may be used in its place. The
- 127 resistance of the cable used to connect the UUT to the point of measurement shall be measured
- 128 and reported.
- 129 Note: The measured resistance of dc power cables includes the sum of resistances of both the dc
- 130 supply voltage wire and the ground wire.
- 131 4) A spliced cable may be used between the shipped cable and dc source in order to connect the
- 132 power meter. If this method is used, the following requirements must be met:

- 133 1) The spliced cable shall be used in addition to the shipped cable described in Section  
 134 4.1.C)3).
- 135 2) The spliced cable shall be connected between the dc source and the shipped cable.
- 136 3) The spliced cable shall be no longer than 1 foot.
- 137 4) For measuring voltage, the total amount of wiring used between the voltage measurement  
 138 and the shipped cable shall be less than 50 milliohms of resistance. This only applies to the  
 139 wiring that is carrying load current.
- 140 Note: Voltage and current need not necessarily be measured at the same location, so long as  
 141 the voltage is measured within 50 milliohms of the shipped cable.
- 142 5) The current measurement can be made either on the ground wire or the dc supply voltage  
 143 wire.
- 144 Note: Figure 1 depicts an example spliced cable setup using a USB 2.0-powered UUT  
 145 connected to the Host Machine.

147 Figure 1: Example Spliced USB 2.0 Cable Arrangement



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149 **Note:** EPA proposes to replace the current dc test, which consists of measuring the ac power of a dc  
 150 source with and without the UUT connected, with a direct dc measurement of the UUT. The above test  
 151 method is taken from the ENERGY STAR test method for Displays and should avoid complications from  
 152 interactions between the dc source and the UUT (e.g., a stakeholder noted that power management of  
 153 the source could reduce its power draw when the UUT is disconnected ( $P_S$  in the current test method),  
 154 which in turn would increase the power draw attributable to the UUT ( $P_S - P_L$ )).

- 155 D) Ambient Temperature: Ambient temperature shall be  $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ .
- 156 E) Relative Humidity: Relative humidity shall be between 10% and 80%.

157 **Note:** ISO 21632 for Professional Imaging Products specifies more stringent temperature and frequency  
 158 ranges (20–25 °C and 45–60%), therefore any tests conducted in accordance with ISO 21632 would still  
 159 be in compliance with ENERGY STAR.

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 161 In addition, ISO 21632 factors in the energy consumption of any air conditioning equipment required for  
 162 Professional Imaging Equipment operation; however, EPA proposes to leave this unspecified so as to  
 163 focus on the efficiency of the imaging equipment.

- 164 F) Power Meter: Power meters shall possess the following attributes:
- 165 1) Minimum Frequency Response: 3.0 kHz

166 **Note:** ISO 21632 for Professional Imaging Products specifies a meter sampling rate of 5 kHz, which is  
 167 less stringent than the 6 kHz sampling rate necessary to achieve a Nyquist frequency of 3 kHz, specified  
 168 above. However, EPA expects that most commercially available power meters will easily surpass either  
 169 requirement, such that the difference will not be significant. EPA welcomes feedback on this issue.

170 2) Minimum Resolution:

- 171 a) 0.01 W for measurement values less than 10 W;
- 172 b) 0.1 W for measurement values from 10 W to 100 W;
- 173 c) 1 W for measurement values from 100 W to 1.5 kW; and
- 174 d) 10 W for measurement values greater than 1.5 kW.
- 175 e) Measurements of accumulated energy should have resolutions which are generally  
 176 consistent with these values when converted to average power. For accumulated energy  
 177 measurements, the figure of merit for determining required accuracy is the maximum power  
 178 value during the measurement period, not the average, since it is the maximum that  
 179 determines the metering equipment and setup.

180 **Note:** ISO 21632 for Professional Imaging Products specifies reporting to four significant figures, which  
 181 would require minimum resolution of 0.001 W for measurement values from 1 W to 10 W, 0.01 for  
 182 measurement values from 10 W to 100 W and so on, i.e., an additional significant figure than specified  
 183 above. Since the ISO 21632 requirement is more stringent, tests conducted in accordance with ISO  
 184 21632 would still be in compliance with ENERGY STAR.

185 G) Measurement Uncertainty<sup>1</sup>:

- 186 1) Measurements of greater than or equal to 0.5 W shall have an uncertainty of 2% (3% for  
 187 Professional Imaging Products) or better at the 95% confidence level.
- 188 2) Measurements of less than 0.5 W shall have an uncertainty of 0.02 W or better (0.03 W or better  
 189 for Professional Imaging Products) at the 95% confidence level.

190 **Note:** ISO 21632 for Professional Imaging Products specifies measurement accuracy of  $\pm 3\%$ , which is  
 191 less stringent than the current ENERGY STAR test method. To harmonize with ISO 21632, EPA  
 192 proposes to relax the uncertainty requirement to 3% for Professional Imaging Products, while maintaining  
 193 the overall structure of the requirement (to reduce ambiguity) and the de minimis criterion (to avoid  
 194 unnecessary accuracy at low power levels).

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

197 I) Paper Specifications:

- 198 1) Non-Professional Imaging Standard Format Products shall be tested in accordance with Table 4.
- 199 2) Large, Small, and Continuous Form products shall be tested using any compatible paper size.

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**Table 4: Paper Size and Weight Requirements**

Market	Paper Size	Basis Weight (g/m <sup>2</sup> )
North America	8.5" × 11"	75
Taiwan	A4	70
Europe / Australia / New Zealand	A4	80
Japan	A4	64

<sup>1</sup> 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.

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**Note:** Per stakeholder request, EPA has added a separate test condition of A4 and 70 grams per square meter as the paper size and weight requirements, respectively, for testing standard format products sold in Taiwan.

ISO 21632 for Professional Imaging Products specifies testing with the substrates (media) that will result in, first, the best quality and second, the best productivity. EPA expects that this will require thicker, coated paper for the first test and thinner, uncoated paper for the second, and that the paper weight will vary by product, such that no standard weight should be specified. However, EPA has concerns that it may be difficult to determine which paper offers the best quality or productivity and would prefer an approach that clearly identifies the paper requirements for this test. EPA welcomes feedback on the approach outlined in ISO 21632 versus specifying a standard paper weight for Professional Imaging Products (e.g., according to Professional Imaging Product stakeholders, 127.9 g/m<sup>2</sup> is the typical weight in the Japanese offset printing industry, a market similar to that for Professional Imaging Products. This corresponds to 85 lb. text paper). Including recommendations for what a standard paper weight is for these products is strongly encouraged.

Finally, ISO 21632 permits testing with any compatible paper size, including A4, letter, A3, or even larger.

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## 5 PRE-TEST UUT CONFIGURATION FOR ALL PRODUCTS

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### 5.1 General Configuration

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#### A) As-shipped Condition:

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1) Professional Imaging Products shall be tested at the best quality and best productivity combinations, as specified in Section 4.1 of ISO 21632

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

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**Note:** EPA has modified the above requirement to permit changes to the as-shipped condition for Professional Imaging Products, in line with ISO 21632.

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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:

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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).

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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).

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

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

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

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c) The manufacturer-claimed scan speed.

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

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244 **Note:** One stakeholder requested that EPA require testing print speed in accordance with international  
 245 standards, similar to the Blue Angel Award requirements which refers to the ISO/IEC 24734:2014 print  
 246 standards. After conducting research, EPA decided not to harmonize the print speed requirements with  
 247 Blue Angel or ISO/IEC as these international standards do not apply to all of the different types of imaging  
 248 equipment ENERGY STAR certifies. However, EPA recognizes print speeds tested in accordance with  
 249 ISO/IEC 24734:2014 allow consumers to gauge the real world performance of printers and compare all  
 250 printers from different manufacturers. Therefore, manufacturers can report their claimed speed or report  
 251 ISO tested speeds.

252 d) When a manufacturer intends to qualify a product in a certain market by making use of test  
 253 results that qualified the product in another market using other sizes of paper (e.g., A4 versus  
 254 8.5" × 11"), and if its maximum claimed speeds differ when producing images on different  
 255 sizes of paper, the highest speed shall be used.

256 **Note:** ISO 21632 requires calculation and reporting of product speed during test, referred to as  
 257 productivity. EPA proposes to keep the above requirements pertaining to reported product speed for all  
 258 products distinct from any other requirements pertaining to productivity, applicable only to Professional  
 259 Imaging Products.

260 **Table 5: Calculation of Product Speed for Standard, Small, and Large Format Products with the**  
 261 **Exception of Mailing Machines**

Media Format	Media Size	Product Speed, <i>s</i> (ipm)
		Where: <ul style="list-style-type: none"> <li>• <i>s<sub>P</sub></i> is the maximum claimed monochrome speed in images per minute when processing the given media,</li> <li>• <i>w</i> is the width of the media, in meters (<i>m</i>),</li> <li>• <i>ℓ</i> is the length of the media, in meters (<i>m</i>).</li> </ul>
Standard	8.5" × 11"	<i>s<sub>P</sub></i>
	A4	<i>s<sub>P</sub></i>
Small	4" × 6"	0.25 × <i>s<sub>P</sub></i>
	A6	0.25 × <i>s<sub>P</sub></i>
	Smaller than A6 or 4" × 6"	16 × <i>w</i> × <i>ℓ</i> × <i>s<sub>P</sub></i>
Large	A2	4 × <i>s<sub>P</sub></i>
	A0	16 × <i>s<sub>P</sub></i>

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

263 **Equation 1: Calculation of Product Speed**

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

265 *Where:*

- 266 • *s* is the product speed, in ipm,
- 267 • *w* is the width of the media, in meters (*m*),
- 268 • *s<sub>L</sub>* is the maximum claimed monochrome speed, in meters per  
 269 minute.

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

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



273 C) Color: For Non-professional Imaging Products, color-capable products shall be tested making  
274 monochrome (black) images.

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

276 **Note:** EPA has clarified that the requirement to test in monochrome applies only to Non-professional  
277 Imaging Products. Per ISO 21632, Professional Imaging Products, shall be tested in their best quality and  
278 best productivity combinations. The best quality combination requires “all colorants of the system” be  
279 used; the best productivity combination requires a print mode that is still saleable (no visible pixilation or  
280 other artifacts and a minimum of 4 colors (if available). EPA welcomes feedback whether the use of color  
281 in the best quality and best productivity combinations should be further clarified here.

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

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

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

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

288 **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 <sup>2</sup>
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)

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

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

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

<sup>2</sup> Also referred to as a Parallel or Centronics interface.

- 295 5) Products connected to Ethernet, per paragraph 5.1.D)2) above, and capable of supporting  
296 Energy Efficient Ethernet (IEEE Standard 802.3az)<sup>3</sup>, shall be connected to a network switch or  
297 router that also supports Energy Efficient Ethernet for the duration of the test.
- 298 6) The tester shall configure the address layer of the protocol, taking note of the following:
- 299 1) Internet Protocol (IP) v4 and IPv6 have neighbor discovery and will generally configure a  
300 limited, non-routable connection automatically.
- 301 2) IP can be configured manually or by using Dynamic Host Configuration Protocol (DHCP) with  
302 an address in the 192.168.1.x Network Address Translation (NAT) address space if the UUT  
303 does not behave normally when autoIP is used. The network shall be configured to support  
304 the NAT address space and/or autoIP.
- 305 3) The UUT shall maintain this live connection to the network for the duration of testing unless  
306 otherwise specified in this Test Method, disregarding any brief lapses (e.g., when  
307 transitioning between link speeds).

308 **Note:** Per stakeholder request, EPA has added further clarification to the Network Connections section of  
309 the Pre-test Configuration for All products to ensure repeatability of products tested with network and data  
310 connections. The above language is based on that in the ENERGY STAR test method for Displays.  
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312 Also, EPA notes that ISO 21632 does not provide any requirements relating to network configuration. Due  
313 to frequent questions from stakeholders on the network connections of Imaging Equipment and other  
314 ENERGY STAR electronic products, EPA considers these requirements valuable in clarifying product  
315 configuration and proposes to maintain them for all products, including Professional Imaging Products.  
316 Under this proposal, ISO 21632 would have to be supplemented with the above networking requirements  
317 to be used for ENERGY STAR certification. EPA welcomes feedback on this proposal.

- 318 E) Service/Maintenance Modes: Non-Professional Imaging Products shall never be in  
319 service/maintenance modes, including color calibration, during testing.
- 320 1) Service/Maintenance modes shall be disabled prior to testing.
- 321 2) Manufacturers shall provide instructions detailing how to disable service/maintenance modes if  
322 this information is not included in the product documentation packaged with the UUT or is not  
323 readily available online.
- 324 3) If service/maintenance modes cannot be disabled and a service/maintenance mode occurs  
325 during a job other than the first job, the results from the job with the service/maintenance mode  
326 shall be replaced with results from a substitute job. In this case, the substitute job shall be  
327 inserted into the test procedure immediately following Job 4 and the inclusion of the substitute job  
328 shall be reported. Each job period shall be 15 minutes.

329 **Note:** ISO 21632 includes a test for energy consumption during maintenance and requires it for models  
330 with daily maintenance needs. EPA is proposing to exclude Professional Imaging Products from the  
331 above requirement that products shall not be tested in service/maintenance modes.

## 332 **5.2 Configuration for MFDs with Fax Capability**

- 333 A) All MFDs with fax capability that connect to a telephone line shall be connected to a telephone line  
334 during the test, in addition to the network connection specified by Table 6 if the UUT is network  
335 capable.

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<sup>3</sup> 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.

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

338 **Note:** Since EPA proposes to remove fax machines from the scope, the Agency has revised the  
339 configuration for fax capability to apply only to MFDs.

### 340 **5.3 Configuration for Digital Duplicators**

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

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

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

## 347 **6 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS**

### 348 **6.1 General Initialization**

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

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

351 a) Accessories, such as paper source, that are shipped with the base product and are intended  
352 to be installed or attached by the end-user shall be installed as intended for the product  
353 model. Paper shall be placed in all paper sources designated to hold the paper specified for  
354 testing, and the UUT shall pull from the default paper source, using the as-shipped paper  
355 source settings.

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

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

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

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

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

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

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

377 2) Connect the UUT to its power source.

- 378 3) Power on the UUT and perform initial system configuration, as applicable. Verify that default  
 379 delay times are configured according to product specifications and/or manufacturer  
 380 recommendations.
- 381 a) Product Speed for Testing for Professional Imaging Products: The product shall be tested at  
 382 two speeds, corresponding to the best quality and best productivity configurations, unless  
 383 there is no meaningful difference between them, in which case the product shall be tested at  
 384 the speed corresponding to the best quality / best productivity configuration.
- 385 b) Product Speed for Testing All Other Products: The product shall be tested with speed  
 386 settings in their default as-shipped configuration.

387 **Note:** ISO 21632 for Professional Imaging Products requires testing in two configurations.

- 388 c) Auto-off for TEC Products: If a printer, digital duplicator, or MFD with print-capability has  
 389 Auto-off capability and it is enabled as-shipped, it shall be disabled prior to testing.
- 390 d) Auto-off for OM Products: If a product has an Auto-off Mode enabled as-shipped, it shall  
 391 remain enabled for the duration of testing.
- 392 4) User-controllable anti-humidity features shall be turned off or disabled for the duration of testing.
- 393 5) Pre-conditioning: Place the UUT in Off Mode, then let the UUT sit idle for 15 minutes.
- 394 a) For EP-TEC products, let the UUT sit in Off Mode for an additional 105 minutes, for a total of  
 395 at least 120 minutes (2 hours).
- 396 b) Pre-conditioning is only required prior to beginning the first test on each UUT.

397 **Note:** ISO 21632 for Professional Imaging Products requires a pre-conditioning/acclimation period of  
 398 1 hour or more, in contrast to the above ENERGY STAR requirement of 2 hours or more for  
 399 Electrophotographic (EP) products. EPA had originally included this requirement to eliminate any  
 400 advantage of drum pre-heating prior to the start of a test, and a 2 hour acclimation period was considered  
 401 sufficient. EPA welcome feedback whether a 1 hour acclimation period is sufficient for Professional  
 402 Imaging Products and whether it might also be sufficient for TEC products.

## 403 7 TYPICAL ENERGY CONSUMPTION (TEC) TEST PROCEDURE

### 404 7.1 Job Structure

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

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

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

407 B) Images per Job: The number of images shall be computed according to Equation 2, below. For  
 408 convenience, Table 11 at the end of this document provides the resultant images per job computation  
 409 for each integer product speed up through 100 ipm.  
 410

411

### Equation 2: Calculation of Number of Images per Job

412

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

413

414

Where:

415

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

416

- $s$  is the product speed in images per minute (ipm), calculated in section 5.1.B), of this test procedure, and

417

418

419

- $N_{JOBS}$  is the number of jobs per day, as calculated per Table 7.

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

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

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

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

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

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

433 E) Copy Jobs:

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

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

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

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

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

## 445 7.2 Measurement Procedures

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

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

- 450 2) Duplexing: Products shall be tested in simplex mode, unless the speed of duplex mode output is  
451 greater than the speed of simplex mode output, in which case they shall be tested in duplex  
452 mode. In all cases, the mode in which the unit was tested and the print speed used must be  
453 documented. Originals for copying shall be simplex images.
- 454 3) Energy Measurement Method: All measurements shall be recorded as accumulated energy over  
455 time, in Wh; all time shall be recorded in minutes.
- 456 a) "Zero meter" references may be accomplished by recording the accumulated energy  
457 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	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.	Default delay time to Sleep, $t_{DEFAULT}$	–	–
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, $t_{SLEEP}$ ( $\leq 1$ 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.	Final energy, $E_{FINAL}$	Watt-hours (Wh)	Ready, Sleep
			Final time, $t_{FINAL}$	Minutes (min)	

460 Notes:

- 461 • 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.
- 462

**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	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 and measure the default time to sleep	Default delay time to Sleep, $t_{DEFAULT}$	Minutes (min)	–
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, $E_{SLEEP}$	Watt-hours (Wh)	Sleep
			Sleep time, $t_{SLEEP}$ ( $\leq 1$ 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, $E_{JOB2}$	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 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)	

465 Notes:



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

468 **Note:** Certification bodies already measure a product's default delay time to sleep and submit the  
469 information via the ENERGY STAR Qualified Product Exchange (QPX) system. To clarify this  
470 measurement in the test method, EPA has introduced a new variable  $t_{DEFAULT}$ , in Step 4 of the TEC test  
471 procedure in Table 9.

472 Due to concerns raised by a stakeholder regarding power management being thwarted by network  
473 activity, EPA worked with stakeholders to draft a test method specific to network wake behavior. Next,  
474 EPA validated the network activity test method on imaging equipment in the field with the help of the  
475 California Plug Load Research Center (CalPlug). After testing 10 models, CalPlug was unable to replicate  
476 the network wakeup behavior that prompted the development of the test method: all models investigated  
477 increase their power only slightly and returned to sleep promptly when subjected to Simple Network  
478 Management Protocol (SNMP) and NetBIOS Network System (NBNS) packets, as well as several other  
479 protocols.

480 The only exception is specific user-initiated requests, such as print jobs or Hypertext Transfer Protocol  
481 (HTTP) access to the device scan folders or administrative console; however, these activities should not  
482 occur outside of working hours when the device is in sleep mode.

483 Therefore, EPA is withdrawing the network activity test method from the proposal, pending additional  
484 information on models or protocols that may be affected by unnecessary wakeup.

## 485 **8 OPERATIONAL MODE (OM) TEST PROCEDURE**

### 486 **8.1 Measurement Procedures**

- 487 A) Measurement of OM power and delay times shall be conducted according to Table 10, subject to the  
488 following provisions:
- 489 1) Power Measurements: All power measurements shall be made using either the average power or  
490 accumulated energy approaches as described below:
- 491 a) Average Power Method: The true average power shall be measured over the course of a  
492 user selected period, which shall be no less than 5 minutes.
- 493 i) For those modes that do not last 5 minutes, the true average power shall be measured  
494 over the mode's entire duration.
- 495 b) Accumulated Energy Approach: If the test instrument is incapable of measuring the true  
496 average power, the accumulated energy consumption over the course of a user selected  
497 period shall be measured. The test period shall be no less than 5 minutes. The average  
498 power shall be determined by dividing the accumulated energy consumption (in watt-hours)  
499 by the time of the test period (in hours).
- 500 i) For those modes that do not last 5 minutes, the accumulated energy consumption shall  
501 be measured over the mode's entire duration.
- 502 c) If the power consumption of the tested mode is periodic, then the test duration shall contain  
503 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)

505 **Note:** To avoid confusion with the Sleep Mode power measurement in the TEC test method (Table 8 and  
506 Table 9), which is derived from  $E_{SLEEP}$  and  $t_{SLEEP}$ , EPA renamed the Default Delay Time to Sleep variable  
507 in Table 10 above to  $t_{DEFAULT}$ .

508 **Notes:**

- 509 • *Step 1 – If the unit has no Ready indicator, use the time at which the power consumption level*  
510 *stabilizes to the Ready level, and note this detail when reporting the product test data.*
- 511 • *Step 4 – The Default Delay Time shall be measured starting from the completion of the job until*  
512 *the unit enters Sleep Mode.*
- 513 • *Steps 4 and 5 – For products with more than one Sleep level, repeat these steps as many times*  
514 *as necessary to capture all successive Sleep levels and report these data. Two Sleep levels are*  
515 *typically used in MFDs that use high-heat marking technologies. For products lacking this Mode,*  
516 *disregard Steps 4 and 5.*
- 517 • *Steps 4 and 5 – For products without a Sleep Mode, perform and record measurements from*  
518 *Ready Mode.*
- 519 • *Steps 4 and 6 – Default-delay time measurements are to be measured in parallel fashion,*  
520 *cumulative from the start of Step 4. For example, a product set to enter a Sleep level in 15*  
521 *minutes and enter a second Sleep level 30 minutes after entering the first Sleep level will have a*  
522 *15-minute default-delay time to the first level and a 45 minute default-delay time to the second*  
523 *level.*

## 524 9 PROFESSIONAL IMAGING PRODUCT TEST PROCEDURE

### 525 9.1 Testing in Accordance with ISO 21632

526 A) All testing shall be conducted in accordance with Sections 4.3.2, 4.3.3, 4.4 and 4.5 of ISO 21632.

527 **Note:** EPA proposes to reference ISO 21632 for all Professional Imaging Product testing and welcomes  
528 comment on the standards applicability as well as any additional guidance that would be helpful.

## 529 10 TEST PROCEDURES FOR PRODUCTS WITH A DIGITAL FRONT 530 END (DFE)

531 This step applies only to products that have a DFE as defined in Section 1 of the ENERGY STAR  
532 Program Requirements for Imaging Equipment.

### 533 10.1 Ready Mode DFE Test

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

536 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal  
537 or external to the imaging product, a 10 minute power measurement of the DFE alone shall be made,  
538 and the average power recorded while the main product is in Ready Mode.

539 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required  
540 for the DFE when the unit as a whole is in Ready Mode. This will most commonly be accomplished by  
541 taking an instantaneous power measurements of each dc input into the DFE and adding them  
542 together for the total dc power.

543 **Note:** EPA is proposing a simplification to the dc power measurement, removing the previous 10 minute  
544 power measurement requirement of each dc input to calculate an average power, and instead allowing  
545 testing of instantaneous dc power on each dc input into the DFE to be summed to report the total DFE dc  
546 ready mode power. Stakeholders have shared that this will reduce testing burden and test equipment  
547 necessary while yielding an accurate result. EPA welcomes feedback on this proposed change.

### 548 10.2 Sleep Mode DFE Test

549 This testing shall be performed to obtain the Sleep Mode power of a DFE device over a 1 hour period.  
550 The resulting value will be used to qualify Imaging Equipment products that incorporate DFEs with  
551 network-capable Sleep Modes.

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

554 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal  
555 or external to the imaging product, a 1 hour power measurement of the DFE alone shall be made,  
556 and the average power recorded while the main product is in Sleep Mode. At the end of the 1 hour  
557 power measurement, a print job shall be sent to the main product to ensure the DFE is responsive.

558 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required  
559 for the DFE when the unit as a whole is in Sleep Mode. A 1 hour power measurement of the dc input  
560 to the DFE shall be made, and the average power recorded while the main product is in Sleep Mode.  
561 At the end of the 1 hour power measurement, a print job shall be sent to the main product to ensure  
562 the DFE is responsive.

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

564 1) Manufacturers shall provide information on:

- 565 a) Whether DFE Sleep Mode is enabled as-shipped; and  
 566 b) The expected time to sleep of the DFE.  
 567 2) If the DFE does not respond to the print request at the end of 1 hour, the Ready Mode power  
 568 level measured in the test method shall be reported as the Sleep Mode power.  
 569

570 *Note: All information specified or provided by manufacturers for product testing shall be publicly available.*

## 571 11 REFERENCES

- 572 A) ISO/IEC 10561:1999. Information technology — Office equipment — Printing devices — Method  
 573 for measuring throughput — Class 1 and Class 2 printers.  
 574 B) IEC 62301:2011. Household Electrical Appliances – Measurement of Standby Power. Ed. 2.0.

575 **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	<b>1</b>	51	32	40.64	<b>40</b>
2	8	0.25	<b>1</b>	52	32	42.25	<b>42</b>
3	8	0.56	<b>1</b>	53	32	43.89	<b>43</b>
4	8	1.00	<b>1</b>	54	32	45.56	<b>45</b>
5	8	1.56	<b>1</b>	55	32	47.27	<b>47</b>
6	8	2.25	<b>2</b>	56	32	49.00	<b>49</b>
7	8	3.06	<b>3</b>	57	32	50.77	<b>50</b>
8	8	4.00	<b>4</b>	58	32	52.56	<b>52</b>
9	9	4.50	<b>4</b>	59	32	54.39	<b>54</b>
10	10	5.00	<b>5</b>	60	32	56.25	<b>56</b>
11	11	5.50	<b>5</b>	61	32	58.14	<b>58</b>
12	12	6.00	<b>6</b>	62	32	60.06	<b>60</b>
13	13	6.50	<b>6</b>	63	32	62.02	<b>62</b>
14	14	7.00	<b>7</b>	64	32	64.00	<b>64</b>
15	15	7.50	<b>7</b>	65	32	66.02	<b>66</b>
16	16	8.00	<b>8</b>	66	32	68.06	<b>68</b>
17	17	8.50	<b>8</b>	67	32	70.14	<b>70</b>
18	18	9.00	<b>9</b>	68	32	72.25	<b>72</b>
19	19	9.50	<b>9</b>	69	32	74.39	<b>74</b>
20	20	10.00	<b>10</b>	70	32	76.56	<b>76</b>
21	21	10.50	<b>10</b>	71	32	78.77	<b>78</b>
22	22	11.00	<b>11</b>	72	32	81.00	<b>81</b>
23	23	11.50	<b>11</b>	73	32	83.27	<b>83</b>
24	24	12.00	<b>12</b>	74	32	85.56	<b>85</b>
25	25	12.50	<b>12</b>	75	32	87.89	<b>87</b>
26	26	13.00	<b>13</b>	76	32	90.25	<b>90</b>
27	27	13.50	<b>13</b>	77	32	92.64	<b>92</b>
28	28	14.00	<b>14</b>	78	32	95.06	<b>95</b>
29	29	14.50	<b>14</b>	79	32	97.52	<b>97</b>
30	30	15.00	<b>15</b>	80	32	100.00	<b>100</b>
31	31	15.50	<b>15</b>	81	32	102.52	<b>102</b>
32	32	16.00	<b>16</b>	82	32	105.06	<b>105</b>
33	32	17.02	<b>17</b>	83	32	107.64	<b>107</b>
34	32	18.06	<b>18</b>	84	32	110.25	<b>110</b>
35	32	19.14	<b>19</b>	85	32	112.89	<b>112</b>

36	32	20.25	<b>20</b>	86	32	115.56	<b>115</b>
37	32	21.39	<b>21</b>	87	32	118.27	<b>118</b>
38	32	22.56	<b>22</b>	88	32	121.00	<b>121</b>
39	32	23.77	<b>23</b>	89	32	123.77	<b>123</b>
40	32	25.00	<b>25</b>	90	32	126.56	<b>126</b>
41	32	26.27	<b>26</b>	91	32	129.39	<b>129</b>
42	32	27.56	<b>27</b>	92	32	132.25	<b>132</b>
43	32	28.89	<b>28</b>	93	32	135.14	<b>135</b>
44	32	30.25	<b>30</b>	94	32	138.06	<b>138</b>
45	32	31.64	<b>31</b>	95	32	141.02	<b>141</b>
46	32	33.06	<b>33</b>	96	32	144.00	<b>144</b>
47	32	34.52	<b>34</b>	97	32	147.02	<b>147</b>
48	32	36.00	<b>36</b>	98	32	150.06	<b>150</b>
49	32	37.52	<b>37</b>	99	32	153.14	<b>153</b>
50	32	39.06	<b>39</b>	100	32	156.25	<b>156</b>

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**Note:** EPA has removed Images/Day from Table 11. The test method remains unchanged, but changes to the TEC calculation have been made to the specification.