



ENERGY STAR® Program Requirements Product Specification for Imaging Equipment

Test Method for Determining Professional Imaging Product Energy Use Draft 2, Rev. Nov-2018

1 OVERVIEW

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

2 APPLICABILITY

ENERGY STAR test requirements are dependent upon the feature set of the products under evaluation. Table 1 shall be used to determine the applicability of this ENERGY STAR Test Method.

Table 1. Test Procedure Applicability

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

3 DEFINITIONS

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

4 TEST SETUP

4.1 General Test Setup

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

- 1) The requirements of International Organization for Standardization (ISO) Standard 21632, "Graphic technology -- Determination of the energy consumption of digital printing devices including transitional and related modes", Section 4, "General Conditions"; and
- 2) In the event of conflicting requirements, the ENERGY STAR test method shall take precedence.

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

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

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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 %
Switzerland	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz or 60 Hz	+/- 1.0 %

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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 %
Switzerland	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz or 60 Hz	+/- 1.0 %

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31 **Note:** As there are no longer formal partnerships with the European Union, Australia, or New Zealand,
32 EPA has removed references for those markets.

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

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

35 E) Power Meter: Power meters shall possess the following attributes:

36 1) Minimum Frequency Response: 3.0 kHz

37 2) Minimum Resolution:

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

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

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

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

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

47 F) Measurement Uncertainty¹:

48 1) Measurements of greater than or equal to 1 W shall have an uncertainty of 2% or better at the
49 95% confidence level.

¹ Measurement uncertainty calculations should be performed according IEC 62301 Ed. 2.0 Appendix D. Only the uncertainty due to the measurement instrument shall be calculated.

- 50 2) Measurements of less than 1 W shall have an uncertainty of 0.02 W or better at the 95%
 51 confidence level.
- 52 G) Time Measurement: Time measurements may be performed with a standard stopwatch or other time
 53 keeping device with a resolution of at least 1 second.
- 54 H) Paper Specifications:
- 55 1) Standard Format Products shall be tested in accordance with Table 4.
- 56 2) Large, Small, and Continuous Form products shall be tested using any compatible paper size.

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

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

58 **Note:** EPA has revised Table 4 to specify 120 g/m² as the standard paper weight in regions outside of
 59 Japan, while maintaining 127.9 g/m² in Japan.

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 61 As there are no longer formal partnerships with the European Union, Australia, or New Zealand, EPA has
 62 also removed references for those markets.

- 63 I) As-shipped Condition:
- 64 1) Professional Imaging Products shall be tested under one best quality and best productivity
 65 (BQ/BP) combination.
- 66 2) If the UUT has an Auto-off feature set for a specific time of day that would interfere with the
 67 testing, this feature shall be disabled.

68 **Note:** One stakeholder commented that "If the product has Auto-off capability and it is enabled as-
 69 shipped, it shall be disabled prior to testing." It is not clear why an 'auto-off' functionality would interfere
 70 with the test results, assuming 'auto-off' is a feature that automatically puts the UUT in a low power mode
 71 after a period of inactivity. This is already the case in the current TEC test method. However, if auto-off is
 72 set for a specific time of day, this could interfere with the testing. Therefore, EPA and DOE have clarified
 73 that Auto-off be disabled if it interferes with testing.

- 74 J) Product Speed for Calculations and Reporting: The product speed for all calculations and reporting
 75 shall be the highest speed as claimed by the manufacturer per the following criteria, expressed in
 76 images per minute (ipm) and rounded to the nearest integer:
- 77 1) In general, for Standard-size products, a single A4 or 8.5" x 11" sheet printed/copied/scanned on
 78 one side in one minute is equal to 1 (ipm).
- 79 a) When operating in duplex mode a single A4 or 8.5" x 11" sheet printed/copied/scanned on
 80 both sides in one minute is equal to 2 (ipm).
- 81 2) The product speed shall be based on:
- 82 a) The highest manufacturer-claimed monochrome print speed, unless the product cannot print,
 83 in which case,
- 84 b) The highest manufacturer-claimed monochrome copy speed, unless the product cannot print
 85 or copy, in which case,
- 86 c) The manufacturer-claimed scan speed.

87 d) When a manufacturer intends to qualify a product in a certain market by making use of test
88 results that qualified the product in another market using other sizes of paper (e.g., A4 versus
89 8.5" × 11"), and if its maximum claimed speeds differ when producing images on different
90 sizes of paper, the highest speed shall be used.

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

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

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

94 *Where:*

- 95 • *s is the product speed, in ipm,*
- 96 • *w is the width of the media, in meters (m),*
- 97 • *s_L is the maximum claimed monochrome speed, in meters per*
98 *minute.*

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

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

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

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

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

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

111 **Note:** EPA and DOE propose the above clarification to ensure that products are tested in a repeatable
112 fashion. The speed of the USB port has been found to impact power draw in Displays.

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114 2) The type of network connection depends on the characteristics of the UUT and shall be the
115 topmost connection listed in Table 5 available on the unit as-shipped.

Table 5: Network or Data Connections for Use in Test

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

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

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

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

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

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

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

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

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

² Also referred to as a Parallel or Centronics interface.

³ Institute of Electrical and Electronics Engineers (IEEE) Standard 802.3az-2010. “IEEE Standard for Information Technology—Telecommunications and Information Exchange Between Systems—Local and Metropolitan Area Networks—Specific Requirements—Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.” 2010.

- 136 M) Service/Maintenance Modes: Service/maintenance modes, including color calibration, shall be in
137 their default state during testing.
- 138 1) Energy consumption of any automatic adjustments shall be measured if captured by other
139 portions of the test method (e.g., Production Print).
- 140 2) Any manual interventions, as specified in Section 4.5.3.1.4 of ISO 21632, shall be excluded
141 to ensure repeatability of the test method.

142 **5 PRE-TEST UUT INITIALIZATION FOR ALL PRODUCTS**

143 **5.1 General Initialization**

- 144 A) Prior to the start of testing, the UUT shall be initialized as follows:
- 145 1) Set up the UUT per the instructions in the Manufacturer's Instructions or documentation.
- 146 a) Accessories, such as paper source, that are shipped with the base product and are intended
147 to be installed or attached by the end-user shall be installed as intended for the product
148 model. Paper shall be placed in all paper sources designated to hold the paper specified for
149 testing, and the UUT shall pull from the default paper source, using the as-shipped paper
150 source settings.
- 151 b) If the product is connected to a computer, either directly or via a network, during the test, the
152 computer shall be running the newest version of the manufacturer's default driver available at
153 the time of testing using settings corresponding to the default settings upon shipment, unless
154 otherwise specified in this test method. The print driver version used for testing shall be
155 recorded.
- 156 i) In the event that a setting does not have a default and is not defined in this test method,
157 the setting shall be set according to the tester's discretion and shall be recorded.
- 158 ii) When connecting via a network and multiple computers are connected to the network,
159 print driver settings apply only to the computer sending the print jobs to the UUT.
- 160 c) For products designed to operate on battery power when not connected to the mains power
161 source, the battery shall be removed for all tests. For UUTs where operation without a battery
162 pack is not a supported configuration, the test shall be performed with fully charged battery
163 pack(s) installed, making sure to report this configuration in the test results. To ensure the
164 battery is fully charged, perform the following steps:
- 165 i) For UUTs that have an indicator to show that the battery is fully charged, continue
166 charging for an additional 5 hours after the indication is present.
- 167 ii) If there is no charge indicator, but the manufacturer's instructions provide a time estimate
168 for when charging this battery or this capacity of battery should be complete, continue
169 charging for an additional 5 hours after the manufacturer's indication.
- 170 iii) If there is no indicator and no time estimate in the instructions, the duration shall be 24
171 hours.
- 172 2) If the product has Auto-off capability and it is enabled as-shipped, it shall be disabled prior to
173 testing.

174 **Note:** One stakeholder commented that "If the product has Auto-off capability and it is enabled as-
175 shipped, it shall be disabled prior to testing." It is not clear why an 'auto-off' functionality would interfere
176 with the test results, assuming 'auto-off' is a feature that automatically puts the UUT in a low power mode
177 after a period of inactivity. This is already the case in the current TEC test method.
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179 However, if auto-off is set for a specific time of day, this could interfere with the testing. Therefore, EPA
180 and DOE have clarified that Auto-off be disabled if it interferes with testing.

- 181 2) Connect the UUT to its power source.
- 182 3) Power on the UUT and perform initial system configuration, as applicable. Verify that default
183 delay times are configured according to product specifications and/or manufacturer
184 recommendations.
- 185 a) Product Speed for Testing for Professional Imaging Products: The product shall be tested in
186 its default as-shipped configuration.
- 187 4) User-controllable anti-humidity features shall be turned off or disabled for the duration of testing.
- 188 5) Pre-conditioning: Place the UUT in Off Mode, then let the UUT sit idle for 15 minutes.
- 189 a) For EP-TEC products, let the UUT sit in Off Mode for an additional 105 minutes, for a total of
190 at least 120 minutes (2 hours).
- 191 b) Pre-conditioning is only required prior to beginning the first test on each UUT.
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193 6 PROFESSIONAL IMAGING PRODUCT TEST PROCEDURE

194 6.1 Test Flow

- 195 A) Images per Job: The number of images which corresponds to at least 5 minutes continuous
196 printing excluding 1st page, shall be computed according to Equation 2.

197 Equation 2: Calculation of Number of Images per Job

$$198 N_{IMAGES} = (M \times s) + 1$$

199 Where:

- 200 • N_{IMAGES} is the number of images per job;
201 • s is the product speed in images per minute (ipm); and
202 • M is the printing time, which is an integer value of 5 minutes or more.
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205 **Note:** One stakeholder recommended that EPA specify the job size to ensure that printing will continue
206 for 5 minutes. EPA has proposed to add this requirement to the Professional Imaging Product test
207 method.
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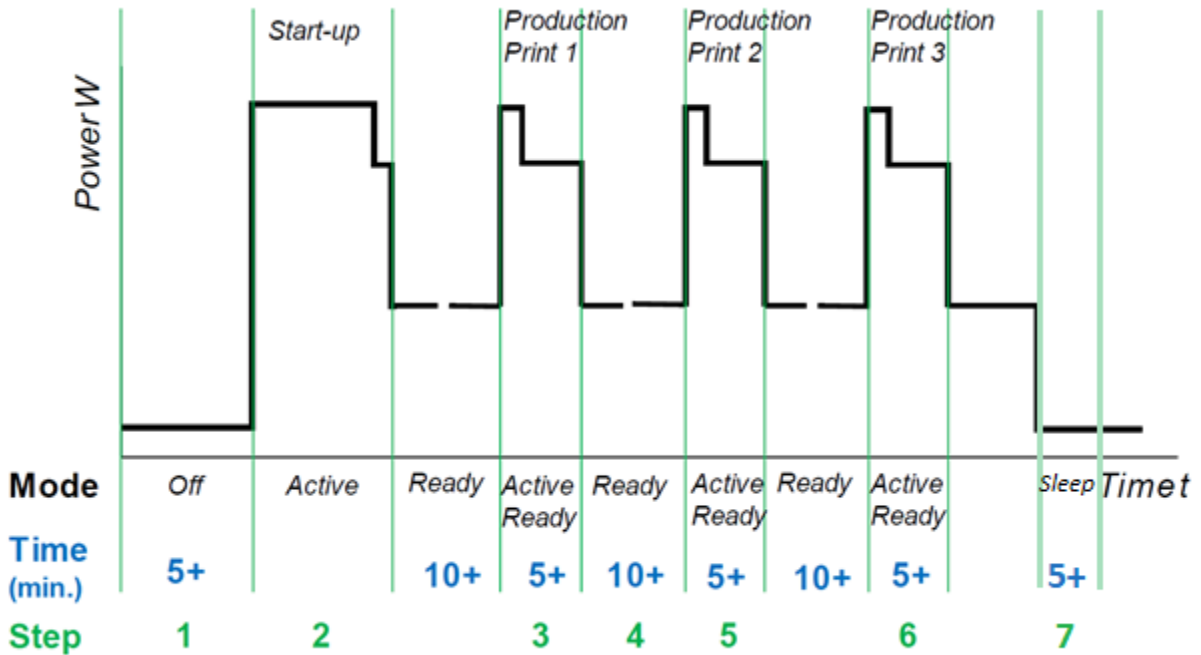
209 The stakeholder also recommended that print jobs for the Professional Imaging Products Test shall have
210 each image sent separately, but shall not be specified in the document as multiple copies of a single
211 original image. This appears to be representative of a single large print job with differing pages (like an
212 illustrated book) rather than multiple copies of a shorter document (like pamphlets or flyers). EPA
213 welcomes feedback on this proposal.

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

216 **Note:** One stakeholder commented that a different test image should be used for reporting product speed
 217 versus the TEC test. In particular the TEC test should use the test image of ISO/IEC 24734 AdGraphics
 218 Adobe Reader file page 2, which has "higher coverage than that for TEC test of Office Equipment. EPA
 219 has proposed to require a graphical test image for testing professional imaging products.

220 **6.2 Measurement Procedures**

- 221 A) Measurement of Professional Imaging Product TEC shall be conducted according to Figure 1 and
 222 Table 6, subject to the following provisions:
- 223 1) Paper: There shall be sufficient paper in the UUT to perform the specified print.
 - 224 2) Simplex mode Testing: Products shall be tested in simplex mode.
 - 225 3) Energy Measurement Method: All measurements shall be recorded as accumulated energy
 226 over time, in Wh; all time shall be recorded in minutes or seconds.
 - 227 4) "Zero meter" references may be accomplished by recording the accumulated energy
 228 consumption at that time rather than physically zeroing the meter.



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 230 **Figure 1: Illustration of TEC Test Procedure for Professional Imaging Products**
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Table 6: TEC Test Procedure for Professional Imaging Products

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

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Note: One stakeholder commented that the Professional Imaging Equipment energy measurements should not simply reference ISO 21632 Section 4.5.4, but a custom workload similar to the one set forth for TEC products, with some changes more representative of smaller Professional Imaging Products. In particular, and in contrast with ISO 21632, the proposed test does not include a maintenance mode, sleep mode, or measurement of power transition states, and requires three print jobs, versus 2—5 print jobs, depending on consistency. According to the stakeholder, this workload will simplify the test and reduce burden.

EPA welcomes feedback on this proposal, test results according to it, and recommendations on how to combine the results of the tests in future Professional Imaging Equipment eligibility criteria in Version 4.0.

245 **6.3 Testing in Accordance with ISO 21632**

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

247 **7 TEST PROCEDURES FOR PRODUCTS WITH A DIGITAL FRONT**
248 **END (DFE)**

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

251 **7.1 Ready Mode DFE Test**

- 252 A) Products that are network-capable as-shipped shall be connected during testing. The network
253 connection used shall be determined using Table 5.
- 254 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal
255 or external to the imaging product, a 10 minute power measurement of the DFE alone shall be made,
256 and the average power recorded while the main product is in Ready Mode.
- 257 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required
258 for the DFE when the unit as a whole is in Ready Mode. This will most commonly be accomplished by
259 taking an instantaneous power measurements of each dc input into the DFE and adding them
260 together for the total dc power.

261 **7.2 Sleep Mode DFE Test**

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

- 265 A) Products that are network-capable as-shipped shall be connected during testing. The network
266 connection used shall be determined using Table 5.
- 267 B) If the DFE has a separate main power cord, regardless of whether the cord and controller are internal
268 or external to the imaging product, a 1 hour power measurement of the DFE alone shall be made,
269 and the average power recorded while the main product is in Sleep Mode. At the end of the 1 hour
270 power measurement, a print job shall be sent to the main product to ensure the DFE is responsive.
- 271 C) If the DFE does not have a separate main power cord, the tester shall measure the dc power required
272 for the DFE when the unit as a whole is in Sleep Mode. A 1 hour power measurement of the dc input
273 to the DFE shall be made, and the average power recorded while the main product is in Sleep Mode.
274 At the end of the 1 hour power measurement, a print job shall be sent to the main product to ensure
275 the DFE is responsive.
- 276 D) In cases B) and C), the following requirements apply:

- 277 1) Manufacturers shall provide information on:
278 a) Whether DFE Sleep Mode is enabled as-shipped; and
279 b) The expected time to sleep of the DFE.
280 2) If the DFE does not respond to the print request at the end of 1 hour, the Ready Mode power
281 level measured in the test method shall be reported as the Sleep Mode power.
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283 *Note: All information specified or provided by manufacturers for product testing shall be publicly available.*

284 **8 REFERENCES**

- 285 A) ISO 21632 "Graphic technology -- Determination of the energy consumption of digital printing
286 devices including transitional and related modes"
287 B) IEC 62301:2011. Household Electrical Appliances – Measurement of Standby Power. Ed. 2.0.