ENERGY STAR®
Product Specification for Imaging Equipment

Eligibility Criteria
Version 3.2

Following is the Version 3.2 ENERGY STAR Product Specification for Imaging Equipment. A product shall meet all of the identified criteria if it is to earn ENERGY STAR certification.

1 DEFINITIONS

A) Product Types:

1) Printer: A product whose primary function is to generate paper output from electronic input. A printer is capable of receiving information from single-user or networked computers, or other input devices (e.g., digital cameras). This definition is intended to cover products that are marketed as printers and printers that can be field-upgraded to meet the definition of an MFD.

2) Scanner: A product whose primary function is to convert paper originals into electronic images that can be stored, edited, converted, or transmitted, primarily in a personal computing environment. This definition is intended to cover products that are marketed as scanners.

3) Copier: A product whose sole function is to produce paper duplicates from paper originals. This definition is intended to cover products that are marketed as copiers, and upgradeable digital copiers (UDCs).

4) Facsimile (Fax) Machine: A product whose primary functions are (1) to scan paper originals for electronic transmission to remote units, and (2) to receive electronic transmissions for conversion to paper output. A fax machine may also be capable of producing paper duplicates. Electronic transmission is primarily over a public telephone system, but may also be via a computer network or the Internet. This definition is intended to cover products that are marketed as fax machines.

5) Multifunction Device (MFD): A product that performs the core functions of a Printer and Scanner. An MFD may have a physically integrated form factor, or it may consist of a combination of functionally integrated components. MFD copy functionality is considered to be distinct from single-sheet convenience copying functionality sometimes offered by fax machines. This definition includes products marketed as MFDs and “multi-function products” (MFPs).

6) Digital Duplicator: A product sold as a fully-automated duplicator system through the method of stencil duplicating with digital reproduction functionality. This definition is intended to cover products that are marketed as digital duplicators.

7) Mailing Machine: A product whose primary function is to print postage onto mail pieces. This definition is intended to cover products that are marketed as mailing machines.

8) Professional Imaging Product: A printer or MFD marketed as intended for producing deliverables for sale, with the following features:

a) Supports paper with basis weight greater than or equal to 141 g/m$^{2;}$

b) A3-capable;

c) If product is monochrome, monochrome product speed equal to or greater than 86 ipm;

d) If product is color, color product speed equal to or greater than 50 ipm;

e) Print resolution of 600 × 600 dots per inch or greater for each color;

f) Weight of the base model greater than 180 kg; and

Five of the following additional features for color products or **four** for monochrome products, included standard with the Imaging Equipment product or as an accessory:

g) Paper capacity equal to or greater than 8,000 sheets;

h) Digital front-end (DFE);

i) Hole punch;

j) Perfect binding or ring binding (or similar, such as tape or wire binding, but not staple saddle stitching);

k) Dynamic random access memory (DRAM) storage equal to or greater than 1,024 MB.

l) Third-party color certification (e.g., IDEAlliance Digital Press Certification, FOGRA Validation Printing System Certification, or Japan Color Digital Printing Certification, if product is color capable); and

m) Coated paper compatibility.

9) Remanufactured Imaging Equipment: Product that meets one of the product types defined in Section 1.A)1-8)), which has been returned to a "like new" state of the base model, including energy performance, by the manufacturer, utilizing new and/or reused components from the original equipment manufacturer.

B) Marking Technologies:

1) Direct Thermal (DT): A marking technology characterized by the burning of dots onto coated print media that is passed over a heated print head. DT products do not use ribbons.

2) Dye Sublimation (DS): A marking technology characterized by the deposition (sublimation) of dye onto print media as energy is supplied to heating elements.

3) Electro-photographic (EP): A marking technology characterized by the illumination of a photoconductor in a pattern representing the desired output image via a light source, development of the image with particles of toner using the latent image on the photoconductor to define the presence or absence of toner at a given location, transfer of the toner to the final print media, and fusing to cause the output to become durable. For purposes of this specification, Color EP products simultaneously offer three or more unique toner colors, while Monochrome EP products simultaneously offer one or two unique toner colors. This definition includes Laser, Light Emitting Diode (LED), and Liquid Crystal Display (LCD) illumination technologies.

4) Impact: A marking technology characterized by the formation of the desired output image by transferring colorant from a "ribbon" to the print media via an impact process. This definition includes Dot Formed Impact and Fully Formed Impact.

5) Ink Jet (IJ): A marking technology characterized by the deposition of colorant in small drops directly to the print media in a matrix manner. For purposes of this specification, Color IJ products offer two or more unique colorants at one time, while Monochrome IJ products offer one colorant at a time. This definition includes Piezo-electric (PE) IJ, IJ Sublimation, and Thermal IJ. This definition does not include High Performance IJ.

6) High Performance IJ: An IJ marking technology that includes nozzle arrays that span the width of a page and/or the ability to dry ink on the print media via supplemental media heating mechanisms. High-performance IJ products are used in business applications usually served by electro-photographic marking products.

7) Solid Ink (SI): A marking technology characterized by ink that is solid at room temperature and liquid when heated to the jetting temperature. This definition includes both direct transfer and offset transfer via an intermediate drum or belt.

8) Stencil: A marking technology characterized by the transfer of images onto print media from a stencil that is fitted around an inked drum.

9) Thermal Transfer (TT): A marking technology characterized by the deposition of small drops of solid colorant (usually colored waxes) in a melted/fluid state directly to print media in a matrix manner. TT is distinguished from IJ in that the ink is solid at room temperature and is made fluid by heat.

C) Operational Modes:

1) On Mode:

a) Active State: The power state in which a product is connected to a power source and is actively producing output, as well as performing any of its other primary functions.

b) Ready State: The power state in which a product is not producing output, has reached operating conditions, has not yet entered into any lower-power modes, and can enter Active State with minimal delay. All product features can be enabled in this state, and the product is able to return to Active State by responding to any potential inputs, including external electrical stimulus (e.g., network stimulus, fax call, or remote control) and direct physical intervention (e.g., activating a physical switch or button).

2) Off Mode: The power state that the product enters when it has been manually or automatically switched off but is still plugged in and connected to the mains. This mode is exited when stimulated by an input, such as a manual power switch or clock timer to bring the unit into Ready State. When this state is resultant from a manual intervention by a user, it is often referred to as Manual Off, and when it is resultant from an automatic or predetermined stimulus (e.g., a delay time or clock), it is often referred to as Auto-off.[1]

3) Sleep Mode: A reduced power state that a product enters either automatically after a period of inactivity (i.e., Default Delay Time), in response to user manual action (e.g., at a user-set time of day, in response to a user activation of a physical switch or button), or in response to external electrical stimulus (e.g., network stimulus, fax call, remote control). For products evaluated under the TEC test method, Sleep Mode permits operation of all product features (including maintenance of network connectivity), albeit with a possible delay to transition into Active State. For products evaluated under the OM test method, Sleep Mode permits operation of a single active network interface, as well as a fax connection if applicable, albeit with a possible delay to transition into Active State.

D) Media Format:

1) Large Format: Products designed for A2 media and larger, including those designed to accommodate continuous form media greater than or equal to 406 mm wide. Large-format products may also be capable of printing on standard-size or small-format media.

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1 For the purposes of this specification “mains” or the “main electricity supply” refers to the input power source, including a dc power supply for products that operate solely off dc power.

2) Standard Format: Products designed for standard-sized media (e.g., Letter, Legal, Ledger, A3, A4, B4), including those designed to accommodate continuous form media between 210 mm and 406 mm wide. Standard-size products may also be capable of printing on small-format media.

   a) A3-capable: Standard Format products with a paper path width equal to or greater than 275 mm.

3) Small Format: Products designed for media sizes smaller than those defined as Standard (e.g., A6, 4"x6", microfilm), including those designed to accommodate continuous form media less than 210 mm wide.

4) Continuous Form: Products that do not use a cut-sheet media format and that are designed for applications such as printing of bar codes, labels, receipts, banners, and engineering drawings. Continuous Form products can be Small, Standard, or Large Format.

E) Additional Terms:

1) Automatic Duplexing: The capability of an MFD or printer to produce images on both sides of an output sheet, without manual manipulation of output as an intermediate step. A product is considered to have automatic duplexing capability only if all accessories needed to produce a duplex output are included with the product upon shipment.

2) Data Connection: A connection that permits the exchange of information between the Imaging Equipment and one external powered device or storage medium.

3) Default Delay Time: The time set by the manufacturer prior to shipping that determines when the product will enter a lower-power mode (e.g., Sleep, Auto-off) following completion of its primary function.

4) Recovery Time: The time it takes for a device to return from a Sleep or Off Mode to a Ready State.

5) Digital Front-end (DFE): A functionally-integrated server that hosts other computers and applications and acts as an interface to Imaging Equipment. A DFE provides greater functionality to the Imaging Equipment.

   a) A DFE offers three or more of the following advanced features:

      i. Network connectivity in various environments;
      ii. Mailbox functionality;
      iii. Job queue management;
      iv. Machine management (e.g., waking the Imaging Equipment from a reduced power state);
      v. Advanced graphic user-interface (UI);
      vi. Ability to initiate communication with other host servers and client computers (e.g., scanning to email, polling remote mailboxes for jobs); or
      vii. Ability to post-process pages (e.g., reformatting pages prior to printing).

   b) Type 1 DFE: A DFE that draws its dc power from its own ac power supply (internal or external), which is separate from the power supply that powers the Imaging Equipment. This DFE may draw its ac power directly from a wall outlet, or it may draw it from the ac power associated with the Imaging Equipment's internal power supply. A Type 1 DFE may be sold standard with the Imaging Equipment product or as an accessory.

c) Type 2 DFE: A DFE that draws its dc power from the same power supply as the Imaging Equipment with which it operates. Type 2 DFEs must have a board or assembly with a separate processing unit that is capable of initiating activity over the network and can be physically removed, isolated, or disabled using common engineering practices to allow power measurements to be made.

d) Professional Digital Front-end (DFE): A DFE which meets **all** of the following criteria:

i. Is sold with a product defined above as a Professional Imaging Product;
ii. has processor performance per socket[2] equal to or greater than 20;
iii. provides support for buffered memory (including both buffered dual in-line memory modules (DIMMs) and buffered on board (BOB) configurations).
iv. is packaged and sold with one or more ac-dc or dc-dc power supplies; and
v. is designed such that all processors have access to shared system memory.

e) Auxiliary Processing Accelerator (APA): A computing expansion add-in card installed in a general-purpose add-in expansion slot of the DFE (e.g., GPGPU installed in a PCI slot).

6) Network Connection: A connection that permits the exchange of information between the Imaging Equipment and one or more external powered devices.

7) Functional Adder: A data or network interface or other component that adds functionality to the marking engine of an Imaging Equipment product and provides a power allowance when certifying products according to the OM method.

8) Operational Mode (OM): For the purposes of this specification, a method of comparing product energy performance via an evaluation of power (measured in watts) in various operating states, as specified in Section 9 of the ENERGY STAR Imaging Equipment Test Method.

9) Typical Electricity Consumption (TEC): For the purposes of this specification, a method of comparing product energy performance via an evaluation of typical electricity consumption (measured in kilowatt-hours) during normal operation over a specified period of time, as specified in Section 8 of the ENERGY STAR Imaging Equipment Test Method.

10) Marking Engine: The fundamental engine of an Imaging Equipment product that drives image production. A marking engine relies upon functional adders for communication ability and image processing. Without functional adders and other components, a marking engine cannot acquire image data for processing and is non-functional.

11) Base Product: The most fundamental configuration of a particular Product Model, which possesses the minimum number of functional adders available. Optional components and accessories are not considered part of a base product.

12) Accessory: A piece of peripheral equipment that is not necessary for the operation of the Base Product, but that may be added before or after shipment in order to add functionality. An accessory may be sold separately under its own model number or sold with a base product as part of a package or configuration.

13) Product Model: An Imaging Equipment product that is sold or marketed under a unique model number or marketing name. A product model may be comprised of a base product or a base product plus accessories.

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2 Processor performance per socket = [# of processor cores] x [processor clock speed (GHz)], where # of cores represents the number of physical cores and processor clock speed represents the Max TDP core base frequency for a given processor.

14) Product Family[3]: A group of product models that are (1) made by the same manufacturer, (2) subject to the same ENERGY STAR certification criteria, and (3) of a common basic design. Product models within a family differ from each other according to one or more characteristics or features that either (1) have no impact on product performance with regard to ENERGY STAR certification criteria, or (2) are specified herein as acceptable variations within a product family. For Imaging Equipment, acceptable variations within a product family include:

a) Color,

b) Housing,

c) Input or output paper-handling accessories,

d) Electronic components not associated with the marking engine of the Imaging Equipment product, including Type 1 and Type 2 DFEs.

2 SCOPE

2.1 Included Products

2.1.1 Commercially-available products that meet one of the Imaging Equipment definitions in Section 1.A) and are capable of being powered from (1) a wall outlet, (2) a data or network connection, or (3) both a wall outlet and a data or network connection, are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.2.

2.1.2 An Imaging Equipment (except Professional Equipment) product must further be classified as either "TEC" or "OM" in Table 1, below, depending on the method of ENERGY STAR evaluation.

Table 1: Evaluation Methods for Imaging Equipment (New or Remanufactured)

Equipment 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

[3] Product families may include remanufactured imaging equipment products, so long as they meet the requirements for a product family.

Equipment Type	Media Format	Marking Technology	ENERGY STAR Evaluation Method
Professional Imaging Products	All	All	Production Energy (Section 3.4.3) and Ready Mode Power (Section 3.4.4)

2.2 Excluded Products

2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/products.

2.2.2 Products that satisfy one or more of the following conditions are not eligible for ENERGY STAR certification under this specification:

i. Products that are designed to operate directly on three-phase power;
ii. Standalone Copiers;
iii. Standalone Fax Machines; and
iv. Products with two serially connected printing engines.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

3.1.1 All calculations shall be carried out with directly measured (unrounded) values.

3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using directly measured or calculated values without any benefit from rounding.

3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 General Requirements

3.2.1 External Power Supply (EPS): Single- and Multiple-voltage EPSs shall meet the Level VI or higher performance requirements under the International Efficiency Marking Protocol when tested according to the Uniform Test Method for Measuring the Energy Consumption of External Power Supplies, Appendix Z to 10 CFR Part 430.

i. Single-voltage EPSs shall include the Level VI or higher marking.
ii. Multiple-voltage EPSs meeting Level VI or higher shall include the Level VI or higher marking.
iii. Additional information on the Marking Protocol is available at http://www.regulations.gov/#!documentDetail;D=EERE-2008-BT-STD-0005-0218.
iv. The above requirements shall not apply to any EPSs shipped with a Digital Front End (DFE).

3.2.2 Additional Cordless Handset: Fax machines and MFDs with fax capability that are sold with additional cordless handsets shall use an ENERGY STAR certified handset, or one that meets the ENERGY STAR Telephony specification when tested to the ENERGY STAR test method on the date the Imaging Equipment product is certified as ENERGY STAR. The ENERGY STAR specification and test method for telephony products may be found at www.energystar.gov/products.

3.2.3 Functionally Integrated MFD: If a MFD consists of a set of functionally integrated components (i.e., the MFD is not a single physical device), the sum of the measured energy or power consumption for all components shall be less than or equal to the relevant MFD energy or power consumption requirements for ENERGY STAR certification.

3.2.4 DFE Requirements for Non-Professional Imaging Products: The Typical Electricity Consumption (TEC_{DFE}) of a Type 1 or Type 2 DFE sold with an Imaging Equipment product at the time of sale shall be calculated using Equation 1 for a DFE without Sleep Mode or Equation 2 for a DFE with Sleep Mode. The resulting TEC_{DFE} value shall be less than or equal to the maximum TEC_{DFE} requirement specified in Table 2 for the given DFE type.

i. For Type 1 DFEs that meet the relevant TEC_{DFE} requirement, the DFE should be excluded from the TEC energy or OM power measurements.
ii. For Type 2 DFEs that meet the relevant TEC_{DFE} requirement, the TEC value or Ready State power of the DFE should be subtracted or excluded from the TEC energy or OM power measurements of the Imaging Equipment product.
iii. Section 3.3.2 provides further detail on subtracting TEC_{DFE} values from TEC products with Type 2 DFEs;
iv. Section 3.5.2 provides further detail for excluding Type 2 DFE power from OM Sleep and Off Mode levels.
v. Imaging Equipment products with DFEs that fail to meet these requirements may be certified without subtracting or excluding the DFE power from that of the Imaging Equipment product as a whole. The combined energy consumption of the DFE and the Imaging Equipment must be below the appropriate requirement.

Equation 1: TEC_{DFE} Calculation for Digital Front Ends without Sleep Mode

$$TEC_{DFE} = \frac{168 \times P_{DFE\_READY}}{1000}$$

Where:

- *TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh for reporting;*
- *P_{DFE_READY} is Ready State power measured in the test procedure in watts.*

Equation 2: TEC_{DFE} Calculation for Digital Front Ends with Sleep Mode

$$TEC_{DFE} = \frac{\left(45 \times P_{DFE\_READY}\right) + \left(123 \times P_{DFE\_SLEEP}\right)}{1000}$$

Where:

- *TEC_{DFE} is the typical weekly energy consumption for DFEs, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.1 kWh for reporting;*
- *P_{DFE_READY} is the DFE Ready State power measured in the test procedure in watts.*

- P_{DFE_SLEEP} *is the DFE Sleep Mode power measured in the test procedure in watts.*

Table 2: Maximum TEC_{DFE} Requirements for Type 1 and Type 2 DFEs

DFE Category	Category Description	Maximum TEC_{DFE} (kWh/week)	
		Type 1 DFE	Type 2 DFE
A	All DFEs that do not meet the definition of Category B will be considered under Category A for ENERGY STAR certification.	7	3
B	To be certified under Category B DFEs must have: 2 or more physical CPUs or 1 CPU and ≥ 1 discrete Auxiliary Processing Accelerators (APAs)	12	3

3.2.5 Default Delay Time Requirements for Non-Professional Imaging Products: Measured Default Delay Time to Sleep ($t_{DEFAULT}$) shall be less than or equal to the Required Default Delay Time to Sleep ($t_{DEFAULT\_REQ}$) requirement specified in Table 3, subject to the following conditions:

i. When reporting data and certifying products that can enter Sleep Mode in multiple ways, partners should reference a Sleep level that can be reached automatically. If the product is capable of automatically entering multiple, successive Sleep levels, it is at the manufacturer's discretion which of these levels is used for certification purposes; however, the default-delay time provided must correspond with whichever level is used.
ii. Default Delay Time does not apply to OM products that can meet Sleep Mode requirements in Ready State.
iii. The Default Delay Time to Sleep may not be adjusted by the user to be greater than the Maximum Delay Times to Sleep Adjustable by the User, as specified in Table 4.

Table 3: Required Default Delay Time to Sleep for OM and TEC Products

Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm or mppm)	Required Default Delay Time to Sleep, $t_{DEFAULT\_REQ}$ for MFDs, Scanners, Mailing Machines, and Digital Duplicators with Copying Capability (minutes)	Required Default Delay Time to Sleep, $t_{DEFAULT\_REQ}$, for Printers and Digital Duplicators without Copying Capability (minutes)
$s \leq 10$	15	5
$10 < s \leq 20$	30	15
$20 < s \leq 30$	45	30
$30 < s \leq 50$	45	45
$s > 50$	45	45

Table 4: Maximum Delay Times to Sleep Adjustable by the User

All Devices with a Monochrome Product Speed, *s*	Maximum Delay Times for Sleep Mode Adjustable by the User (min)
$s \leq 30$	60
$s > 30$	120

3.3 Requirements for Typical Electricity Consumption (TEC) Products, Excluding Professional Imaging Products

3.3.1 Automatic Duplexing Capability: For all MFDs and printers subject to the TEC test method, automatic duplexing capability shall be integral to the base product and duplex printing must be set as default for products with speed greater than those specified in Table 5. Printers whose intended function is to print on special single-sided media for the purpose of single sided printing (e.g., release coated paper for labels, direct thermal media, etc.) are exempt from this requirement.

Table 5: Automatic Duplexing Requirements for all TEC MFDs and Printers

Product Type	Product Speed (ipm)
Color	$s > 19$
Monochrome	$s > 24$

3.3.2 Typical Electricity Consumption: Calculated Typical Electricity Consumption (TEC_{2018}) per Equation 3 or Equation 4 shall be less than or equal to the Maximum TEC Requirement (TEC_{MAX}) specified in Equation 6.

i. For Imaging Equipment with a Type 2 DFE that meets the Type 2 DFE maximum TEC_{DFE} requirement in Table 2, the measured energy consumption of the DFE shall be divided by 0.80 to account for internal power supply losses and then excluded when comparing the product's measured TEC value to TEC_{MAX} and for reporting.
ii. For Imaging Equipment with a DFE that does not meet the DFE maximum TEC_{DFE} requirement, the measured TEC value must meet the TEC_{MAX} without any subtractions or exclusions for the DFE.
iii. The DFE shall not interfere with the ability of the Imaging Equipment to enter or exit its lower-power modes.

Example: A printer's total TEC result is 24.50 kWh/wk and its Type 2 TEC_{DFE} value calculated in Section 3.2.4 is 9.0 kWh/wk. The TEC_{DFE} value is then divided by 0.80 to account for internal power supply losses with the Imaging Equipment in Ready State, resulting in 11.25 kWh/wk. The power supply adjusted value is subtracted from the tested TEC value: 24.50 kWh/wk – 11.25 kWh/wk = 13.25 kWh/wk. This 13.25 kWh/wk result is then compared to the relevant TEC_{MAX} to determine certification.

iv. For printers, digital duplicators with print capability, and MFDs with print capability, TEC shall be calculated per Equation 3.

Equation 3: TEC Calculation for Printers, Fax Machines, Digital Duplicators with Print Capability, and MFDs with Print Capability

$$TEC_{2018} = \left[5 \times \left(E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - \frac{N_{JOBS}}{16} - (2 \times t_{FINAL}) \right] \times \frac{E_{SLEEP}}{t_{SLEEP}} \right) + 48 \times \frac{E_{SLEEP}}{t_{SLEEP}} \right],$$

Where:

- TEC_{2018} *is the typical weekly energy consumption for printers, digital duplicators with print capability, and MFDs with print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.01 kWh for reporting;*
- E_{JOB_DAILY} *is the daily job energy, as calculated per Equation 5, in kWh;*
- E_{FINAL} *is the final energy, as measured in the test procedure, converted to kWh;*

- N_{JOBS} *is the number of jobs per day, as calculated in the test procedure,*
- t_{FINAL} *is the final time to Sleep, as measured in the test procedure, converted to hours;*
- E_{SLEEP} *is the Sleep energy, as measured in the test procedure, converted to kWh; and*
- t_{SLEEP} *is the Sleep time, as measured in the test procedure, converted to hours.*

v. For digital duplicators without print capability and MFDs without print capability, TEC shall be calculated per Equation 4.

Equation 4: TEC Calculation for Digital Duplicators without Print Capability and MFDs without Print Capability

$$TEC_{2018} = \left[5 \times \left(E_{JOB\_DAILY} + (2 \times E_{FINAL}) + \left[24 - \frac{N_{JOBS}}{16} - (2 \times t_{FINAL})\right] \times \frac{E_{AUTO}}{t_{AUTO}}\right) + 48 \times \frac{E_{AUTO}}{t_{AUTO}}\right],$$

Where:

- TEC_{2018} *is the typical weekly energy consumption for digital duplicators without print capability and MFDs without print capability, expressed in kilowatt-hours (kWh) and rounded to the nearest 0.01 kWh for reporting;*
- E_{JOB_DAILY} *is the daily job energy, as calculated per Equation 5, in kWh;*
- E_{FINAL} *is the final energy, as measured in the test procedure, converted to kWh;*
- N_{JOBS} *is the number of jobs per day, as calculated in the test procedure;*
- t_{FINAL} *is the final time to Sleep, as measured in the test procedure, converted to hours;*
- E_{AUTO} *is the Auto-off energy, as measured in the test procedure, converted to kWh; and*
- t_{AUTO} *is the Auto-off time, as measured in the test procedure, converted to hours.*

vi. Daily Job Energy shall be calculated per Equation 5.

Equation 5: Daily Job Energy Calculation for TEC Products

$$E_{JOB\_DAILY} = \frac{1}{4}\left[2 \times E_{JOB1} + (N_{JOBS} - 2) \times \frac{E_{JOB2} + E_{JOB3} + E_{JOB4}}{3}\right],$$

Where:

- E_{JOB_DAILY} *is the daily job energy, expressed in kilowatt-hours (kWh);*
- E_{JOBi} *is the energy of the* i^{th} *job, as measured in the test procedure, converted to kWh; and*
- N_{JOBS} *is the number of jobs per day, as calculated in the test procedure.*

Equation 6: Maximum TEC Requirement Calculation

$$TEC_{MAX} = TEC_{REQ} + Adder_{A3} + Adder_{Wi-Fi},$$

Where:

- TEC_{MAX} *is the maximum TEC requirement in kilowatt-hours per week (kWh/wk), rounded to the nearest 0.01 kWh/wk for reporting;*
- TEC_{REQ} *is the TEC requirement specified in Table 6, in kWh;*
- $Adder_{A3}$ *is a 0.05 kWh/wk allowance provided for A3-capable products; and*
- $Adder_{Wi-Fi}$ *is a 0.1 kWh/wk allowance provided for products with Wi-Fi enabled as shipped during the test..*

Table 6: TEC Requirement

Color Capability	Monochrome Product Speed, *s*, as Calculated in the Test Method (ipm)	TEC_{REQ} (kWh/wk, rounded to the nearest 0.01 kWh/wk for reporting)
Monochrome Non-MFD	s ≤ 20	0.226
	20 < s ≤ 40	0.018 × s – 0.152
	40 < s ≤ 60	0.025 × s – 0.439
	60 < s ≤ 135	0.049 × s – 1.903
	s > 135	0.183 × s – 20.127
Monochrome MFD	s ≤ 20	0.263
	20 < s ≤ 40	0.018 × s – 0.115
	40 < s ≤ 60	0.016 × s – 0.033
	60 < s ≤ 80	0.037 × s – 1.314
	s > 80	0.086 × s – 5.283
Color Non-MFD	s ≤ 20	0.275
	20 < s ≤ 40	0.032 × s – 0.397
	40 < s ≤ 60	0.002 × s + 0.833
	s > 60	0.100 × s – 5.145
Color MFD	s ≤ 20	0.254
	20 < s ≤ 40	0.024 × s – 0.250
	40 < s ≤ 60	0.011 × s + 0.283
	60 < s ≤ 80	0.055 × s – 2.401
	s > 80	0.118 × s – 7.504

3.3.3 Additional Test Results Reporting Requirements:

i. DFE model name/number, Ready State power, Sleep Mode power, and TEC_{DFE} shall be reported for any Type 1 DFE sold with an Imaging Equipment product, including those not tested with the Imaging Equipment product as part of the highest energy using configuration per Section 4.2.1.iii.

3.3.4 Recovery Time: Recovery Time, t_{R_TEC} as calculated per Equation 7, shall be less than or equal to the Maximum Recovery Time, t_{R_MAX}, subject to the following requirements:

i. For models with a shorter Default Delay Time to Sleep as found in Table 7, t_{R_MAX} shall be calculated per Equation 8.
ii. For models with a longer Default Delay Time to Sleep as found in Table 7, t_{R_MAX} shall be calculated per Equation 9.
iii. Models with a Default Delay Time to Sleep greater than any found in Table 7 shall not be subject to a Recovery Time requirement.

Example: A 25 ipm MFD with a default sleep delay of 40 minutes (acceptable per Table 3) but falling outside Table 7 is not subject to a recovery time requirement.

iv. Recovery times from various modes (Active 0, Active 1, Active 2 times) shall be reported for all products tested using the TEC test method.

Equation 7: TEC Recovery Time

$$t_{R\_TEC} = t_{Active1} - t_{Active0},$$

Where:

- t_{R_TEC} *is TEC Recovery Time;*
- $t_{Active1}$ *is the time from Sleep Mode to the first sheet exiting the unit, in seconds, as measured per the test method; and*
- $t_{Active0}$ *is the time from Ready State to the first sheet exiting the unit, in seconds, as measured per the test method.*

Table 7: Determination of Maximum Recovery Time

Print Speed, *s* (ipm)	Maximum Default Delay Time to Sleep Values to Permit Applicability of Shorter Recovery Time in Equation 8. (minutes)	Maximum Default Delay Time to Sleep Values to Permit Applicability of Longer Recovery Time in Equation 9 (minutes)
$0 < s \leq 5$	$0 < t_{DEFAULT} \leq 5$	$t_{DEFAULT} > 5$
$5 < s \leq 10$	$0 < t_{DEFAULT} \leq 10$	$10 < t_{DEFAULT} \leq 15$
$10 < s \leq 20$	$0 < t_{DEFAULT} \leq 10$	$10 < t_{DEFAULT} \leq 20$
$20 < s \leq 30$	$0 < t_{DEFAULT} \leq 10$	$10 < t_{DEFAULT} \leq 30$
$30 < s \leq 40$	$0 < t_{DEFAULT} \leq 10$	$10 < t_{DEFAULT} \leq 45$
$s > 40$	$0 < t_{DEFAULT} \leq 15$	$15 < t_{DEFAULT} \leq 45$

Equation 8: Maximum Recovery Time for Models with Shorter Default Delay Times to Sleep, as Indicated in Table 7

$$t_{R\_MAX} = \min(0.42 \times s + 5, 30),$$

Where:

- t_{R_MAX} *is Maximum Recovery Time, in seconds;*
- s *is the product speed; and*
- min *is the minimum function (i.e., the Maximum Recovery Time shall be the lesser of* $0.42 \times s + 5$ *or 30 seconds).*

Equation 9: Maximum Recovery Time for Models with Longer Default Delay Times to Sleep, as Indicated in Table 7

$$t_{R\_MAX} = \min(0.51 \times s + 15, 60),$$

Where:

- t_{R_MAX} *is Maximum Recovery Time, in seconds;*
- s *is the product speed; and*
- min *is the minimum function (i.e., the Maximum Recovery Time shall be the lesser of* $0.51 \times s + 15$ *or 60 seconds).*

3.4 Requirements for Professional Imaging Products

3.4.1 Automatic Duplexing Capability:

i. For all Professional Imaging Products, automatic duplexing capability shall be present at the time of purchase. Professional Imaging Products whose intended function is to print on special single-sided media for the purpose of single sided printing (e.g., release coated paper for labels, direct thermal media, etc.,) are exempt.
ii. If a product is not certain to be bundled with an automatic duplex tray, the partner must make clear in their product literature, on their Web site, and in institutional sales literature that although the product meets the ENERGY STAR energy efficiency requirements, the product only fully qualifies for ENERGY STAR when bundled with or used with a duplexer tray. EPA asks that partners use the following language to convey this message to customers: "Achieves ENERGY STAR energy savings; product fully qualifies when packaged with (or used with) a duplex tray."

3.4.2 Professional Imaging Products Equipped with DFEs: For products where a DFE is equipped during testing, the energy consumed by the DFE is to be added to the energy consumed by the main product for determining compliance:

i. For products equipped with a Type 1 DFE, the energy consumed by the DFE, being measured separately from the main product, shall be incorporated into the calculations for Production Energy and Ready Mode Power as outlined in Equation 12 and Equation 14, respectively; and

ii. For products equipped with a Type 2 DFE, the energy consumed by the DFE should already be evident in measurements taken for the main product as both devices share a single power cord. Although the Ready Mode energy and Sleep Mode energy of the DFE will be measured independently in Section 7.1 of the Professional Imaging Equipment test method, do not separate the DFE energy from the energy of main unit when determining compliance against the requirements in Section 3.4.3 and Section 3.4.4.

3.4.3 Production Energy Requirements: The Production Energy of Professional Imaging Products shall be calculated per Equation 10 to be no greater than the applicable Maximum Allowable Production Energy as indicated by Table 8.

Equation 10: Production Energy of Professional Imaging Products

$$E_P = {E_T}/{I_T}$$

Where:

- E_P *is the production energy of the product, in terms of Watt-hours per Image;*
- I_T *is the average number of images produced as calculated per Equation 11; and*
- E_T *is the average energy measured as calculated per Equation 12, in Watt-hours.*

Equation 11: Average Number of Images, I_T

$$I_T = \frac{I_3 + I_5 + I_6}{3}$$

Where:

- I_T *is the average number of images produced during Steps 3, 5, and 6 of the Professional Imaging Equipment test method; and*
- I_3, I_5, *and* I_6 *are the number of images produced during Steps 3,5, and 6 of the Professional Imaging Equipment test method, respectively.*

Equation 12: Average Energy, E_T

$$E_T = \frac{E_3 + E_5 + E_6}{3} + E_{P\_DFE}$$

Where:

- *E_T is the average energy measured during Steps 3, 5, and 6 of the Professional Imaging Equipment test method, in Watt-hours;*
- *E_3, E_5, and E_6 are the energies recorded for Production Print phase of Steps 3,5, and 6 of the Professional Imaging Equipment test method, in Watt-hours, respectively. Do not include FPPT from ready (transition) energy; and*
- *E_{P_DFE1} is the average energy of the Type 1 DFE equipped during testing as calculated per Equation 13, if applicable. If a Type 1 DFE was not equipped, E_{P_DFE1} equals 0 Wh.*

Equation 13: Average Type 1 DFE Energy, E_{P_DFE1}

$$E_{P\_DFE1} = \frac{E_{DFE3} + E_{DFE5} + E_{DFE6}}{3}$$

Where:

- *E_{P_DFE1} is the average energy of the Type 1 DFE equipped during testing as measured during Steps 3, 5, and 6 of the Professional Imaging Equipment test method, in Watt-hours, if applicable; and*
- *E_{DFE3}, E_{DFE5}, and E_{DFE6} are the energies recorded for the Type 1 DFE equipped during the Production Print phase of Steps 3,5, and 6 of the Professional Imaging Equipment test method, in Watt-hours, respectively. Do not include energy from the FPPT from ready (transition) step.*

Table 8: Production Efficiency Requirements for Professional Imaging Products

Applicable Professional Imaging Product Type	Maximum Allowable Production Energy (Watt-hour/Image)
Monochrome	0.42
Color	0.67

3.4.4 Ready Mode Power Requirement: The Ready Mode Power of Professional Imaging Products shall be calculated per Equation 14 to be less than or equal to 900 W.

Equation 14: Ready Mode Power of Professional Imaging Products

$$P_{RM} = \frac{E_4 \times 60}{T_4} + P_{RM\_DFE1}$$

Where:

- *P_{RM} is the Ready Mode Power of the product, in Watts;*
- *E_4 is the Energy measured during Step 4 of the Professional Imaging Equipment test method, in Watt-hours;*
- *T_4 is the time recorded for Step 4 of the Professional Imaging Equipment test method, in minutes; and*
- *P_{RM_DFE1} is the Ready Mode Energy of the Type I DFE equipped during testing, as measured per Section 7.1 of the Professional Imaging Equipment test method, if applicable. If a Type 1 DFE was not equipped during testing, P_{RM_DFE1} equals 0 W.*

3.5 Requirements for Operational Mode (OM) Products

3.5.1 Multiple Sleep Modes: If a product is capable of automatically entering multiple successive Sleep Modes, the same Sleep Mode shall be used to determine certification under the Default Delay Time to Sleep requirements specified in Section 3.2.5 and the Sleep Mode power consumption requirements specified in Section 3.5.3.

3.5.2 DFE Requirements: For Imaging Equipment with a Type 2 DFE that relies on the Imaging Equipment for its power, and that meets the appropriate maximum TEC_{DFE} requirement found in Table 2, the DFE power shall be excluded subject to the following conditions:

i. Ready State power of the DFE, as measured in the test method, shall be divided by 0.60 to account for internal power supply losses.

- Sleep Mode Requirements: If the resultant power in Paragraph i, above, is less than or equal to the Ready State or Sleep Mode power of the Imaging Equipment product as a whole, then the power shall be excluded from the measured Ready State or Sleep Mode power of the Imaging Equipment product as a whole when comparing to the Sleep Mode requirements in Section 3.5.3, below, and for reporting.

  Otherwise, the Sleep Mode power of the DFE, as measured in the test method, shall be divided by 0.60 and excluded from the Ready or Sleep Mode power of the Imaging Equipment for comparing to the requirements, and for reporting.

- Off Mode Requirements: If the resultant power in Paragraph i, above, is less than or equal to the Ready State, Sleep Mode, or Off Mode power of the Imaging Equipment as a whole, then the power shall be excluded from the Ready State, Sleep Mode, or Off Mode power of the Imaging Equipment product as a whole when comparing to the Off Mode requirements in Section 3.5.4, below, and for reporting.

  Otherwise, the Sleep Mode power of the DFE, as measured in the test method, shall be divided by 0.60 and excluded from the Ready State, Sleep Mode, or Off Mode power of the Imaging Equipment for comparing to the requirements, and for reporting.

ii. The DFE must not interfere with the ability of the Imaging Equipment to enter or exit its lower-power modes.

iii. Imaging Equipment products with Type 2 DFEs that fail to meet these requirements may be certified without subtracting the DFE power from that of the Imaging Equipment product as a whole. The combined energy consumption of the DFE and the Imaging Equipment must be below the appropriate requirement.

Examples: Product 1 is an Imaging Equipment product whose Type 2 DFE has no distinct sleep mode. The Type 2 DFE has measured Ready State and Sleep Mode power both equal to 30 watts. The measured Sleep Mode power of the product is 53 watts. When subtracting 50 watts (30 watts / 0.60) from the measured Sleep Mode power of the product, 53 watts, the resulting 3 watts is the Sleep Mode power of the product for use in the criteria limits below.

Product 2 is an Imaging Equipment product whose Type 2 DFE goes to sleep when the Imaging Equipment goes to sleep during testing. The Type 2 DFE has measured DFE Ready State and Sleep Mode power equal to 30 watts and 5 watts, respectively. The measured Sleep Mode power of the product is 12 watts. When subtracting 50 watts (30 watts / 0.60) from the measured Sleep Mode power of the product, 12 watts, the result is -38 watts. In this case, instead subtract 8.33 watts (5 watts / 0.60) from the measured Sleep Mode power of the product, 12 watts, resulting in 3.67 watts which is used in the criteria limits below.

3.5.3 Sleep Mode Power Consumption: Measured Sleep Mode power consumption (P_{SLEEP}) shall be less than or equal to the maximum Sleep Mode power consumption requirement (P_{SLEEP_MAX}) determined per Equation 15, subject to the following conditions:

i. Only those interfaces that are present and used during the test, including any fax interface, may be considered functional adders.
ii. Product functionality offered through a DFE shall not be considered a functional adder.
iii. A single interface that performs multiple functions may be counted only once.
iv. Any interface that meets more than one interface type definition shall be classified according to the functionality used during the test.
v. For products that meet the Sleep Mode power requirement in Ready State, no further automatic power reductions are required to meet Sleep Mode requirements.

Equation 15: Calculation of Maximum Sleep Mode Power Consumption Requirement for OM products

$$P_{SLEEP\_MAX} = P_{MAX\_BASE} + \sum_{1}^{n} Adder_{INTERFACE} + \sum_{1}^{m} Adder_{OTHER}$$

Where:

- P_{SLEEP_MAX} *is the maximum Sleep Mode power consumption requirement, expressed in watts (W), and rounded to the nearest 0.1 watt for reporting;*
- P_{MAX_BASE} *is the maximum Sleep Mode power allowance for the base marking engine, as determined per Table 9, in watts;*
- $Adder_{INTERFACE}$ *is the power allowance for the interface functional adders used during the test, including any fax capability, and as selected by the manufacturer from Table 10, in watts;*
- *n is the number of allowances claimed for interface functional adders used during the test, including any fax capability, and is less than or equal to 2;*
- $Adder_{OTHER}$ *is the power allowance for any non-interface functional adders in use during the test, as selected by the manufacturer from Table 10, in watts; and*
- *m is the number of allowances claimed for any non-interface functional adders in use during the test and is unlimited.*

Table 9: Sleep Mode Power Allowance for Base Marking Engine

Product Type	Media Format	Marking Technology				P_{MAX_BASE} (watts)
		Impact	Ink Jet	All Other*	Not Applicable	
Mailing Machine	N/A		x	x		5.0
MFD	Standard	x	x			1.1
	Large		x			5.4
				x		8.7
Printer	Small	x	x	x		4.0
	Standard	x	x			0.6
	Large	x		x		2.5
			x			4.9
Scanner	Any				x	2.5

* "All Other" category includes High Performance Ink Jet.

Table 10: Sleep Mode Power Allowances for Functional Adders

Adder Type	Connection Type	Max. Data Rate, *r* (Mbit/ second)	Details	Functional Adder Allowance (watts)
Interface	Wired	r < 20	Includes: USB 1.x, IEEE 488, IEEE 1284/Parallel/ Centronics, RS232	0.2
		20 ≤ r < 500	Includes: USB 2.x, IEEE 1394/ FireWire/i.LINK, 100Mb Ethernet	0.4
		r ≥ 500	Includes: USB 3.x,1G Ethernet	0.5
		Any	Includes: Flash memory-card/smart-card readers, camera interfaces, PictBridge	0.2
	Fax Modem	Any	**Applies to MFDs only.**	0.2
	Wireless, Radio-frequency (RF)	Any	Includes: Bluetooth, 802.11	2.0
	Wireless, Infrared (IR)	Any	Includes: IrDA.	0.1
Cordless Handset	N/A	N/A	Capability of the imaging product to communicate with a cordless handset. Applied only once, regardless of the number of cordless handsets the product is designed to handle. Does not address the power requirements of the cordless handset itself.	0.8
Memory	N/A	N/A	Applies to the internal capacity available in the Imaging Equipment for storing data. Applies to all volumes of internal memory and should be scaled accordingly for RAM. This adder does not apply to hard disk or flash memory.	0.5/GB
Power Supply	N/A	N/A	Applies to both internal and external power supplies of Mailing Machines and Standard Format products using Inkjet and Impact marking technologies with nameplate output power (P_{OUT}) greater than 10 watts.	0.02 x (P_{OUT} – 10.0)
Touch Panel Display	N/A	N/A	Applies to both monochrome and color touch panel displays.	0.2

3.5.4 Off Mode Power Consumption Off Mode power, as measured in the test procedure, shall be less than or equal to the Maximum Off Mode power specified in Table 11, subject to the following conditions.

i. For products that do not have an Off Mode, Sleep Mode power, as measured in the test procedure, shall be less than or equal to the Maximum Off Mode power.
ii. For products that do not have an Off Mode or Sleep Mode, Ready State power, as measured in the test procedure, shall be less than or equal to the Maximum Off Mode power.
iii. The Imaging Equipment shall meet the Off Mode Power requirement independent of the state of any other devices (e.g., a host PC) connected to it.

Table 11: Maximum Off Mode Power Requirement

Product Type	Maximum Off Mode Power (watts)
All OM Products	0.3

Note: Products intended for sale in the US market are subject to minimum toxicity and recyclability requirements. Please see ENERGY STAR Program Requirements for Imaging Equipment: Partner Commitments for details.

4 TESTING

4.1 Test Methods

4.1.1 When testing Imaging Equipment products, the test methods identified in Table 12 shall be used to determine certification for ENERGY STAR.

Table 12: Test Methods for ENERGY STAR Certification

Product Type	Test Method
All Imaging Products, excluding Professional Products	ENERGY STAR Test Method for Determining Imaging Equipment Energy Use, Rev. Dec-2018
Professional Imaging Products	ENERGY STAR Test Method for Determining Professional Imaging Product Energy Use, Rev. Feb-2020

i. For Professional Imaging Equipment with a Type 1 DFE equipped during testing, separately measure the energy consumed by the DFE, as prescribed in Section 7.1.B of Professional Imaging Products Test Method, during each step or sub-step of the procedure noted in Table 6 therein.

4.2 Number of Units Required for Testing

4.2.1 Representative Models shall be selected for testing per the following requirements for products both sold as new and remanufactured.

i. For certification of an individual product model, a product configuration equivalent to that which is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model;
ii. For certification of a product family that does not include a Type 1 DFE, the highest energy using configuration within the family shall be considered the Representative Model. Any subsequent testing failures (e.g., as part of verification testing) of any model in the family will have implications for all models in the family.
iii. For certification of a product family that includes Type 1 DFE, the highest energy using configuration of the Imaging Equipment and highest energy using DFE within the family shall be tested for certification purposes. Any subsequent testing failures (e.g., as part of verification testing) of any model in the family and all Type 1 DFEs sold with the Imaging Equipment, including those not tested with the Imaging Equipment product, will have implications for all models in the family. Imaging Equipment products that do not incorporate a Type 1 DFE may not be added to this product family for certification and must be certified as a separate family without a Type 1 DFE.

4.2.2 A single unit of each Representative Model shall be selected for testing.

4.2.3 All units/configurations for which a Partner is seeking ENERGY STAR certification, must meet the ENERGY STAR requirements. For remanufactured products, the Partner must assign the certified configurations an identifier in the model name/number that is unique to ENERGY STAR certified configurations. This identifier must be used consistently in association with the certified configurations in marketing/sales materials and on the ENERGY STAR list of certified products (e.g. model A1234 for baseline configurations and A1234-R for remanufactured ENERGY STAR certified configurations).

4.3 International Market Certification

4.3.1 Products shall be tested for certification at the relevant input voltage/frequency combination for each market in which they will be sold and promoted as ENERGY STAR.

5 USER INTERFACE

5.1.1 Manufacturers are encouraged to design products in accordance with the user interface standard IEEE 1621: Standard for User Interface Elements in Power Control of Electronic Devices Employed in Office/Consumer Environments. For details, see http://eta.LBL.gov/Controls.

6 EFFECTIVE DATE

6.1.1 Effective Date: The Version 3.2 ENERGY STAR Imaging Equipment specification shall take effect on the date of publication. To be certified as ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

6.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.

6.1.3 Items for Consideration in a Future Revision:

i. **Three-phase Products:** These products are currently excluded from scope. EPA will review this exclusion in a future revision.