ENERGY STAR® Program Requirements for Single Voltage External Ac-Dc and Ac-Ac Power Supplies

Eligibility Criteria (Version 2.0)

Final

Table of Contents

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Below is the product specification (Version 2.0) for ENERGY STAR qualified single voltage external ac-ac and ac-dc power supplies. A product must meet all of the identified criteria if it is to be qualified as ENERGY STAR by its manufacturer.

The goal of this ENERGY STAR external power supply specification is to recognize those models with an efficient ac-ac or ac-dc conversion process. This specification along with its complement, the specification for products with battery charging systems (BCSs), intends to comprehensively cover the full range of energy conversion products. Manufacturers shall carefully examine their product designs and compare them to the detailed definitions (Section 1) and qualifying product descriptions (Section 2) for an external power supply and battery charging system (visit http://www.energystar.gov/products) to determine the appropriate specification for ENERGY STAR qualification. Manufacturers may only qualify individual models under the one specification (i.e., external power supply OR battery charging system) that best reflects the power supply and product design.

1) **Definitions**: EPA has prepared detailed definitions of single voltage external ac-ac and ac-dc power supplies and other related terms as relevant to ENERGY STAR.

   A. External Power Supply (EPS): For the purposes of this specification, an external power supply:
      a) is designed to convert line voltage ac input into lower voltage ac or dc output;
      b) is able to convert to only one output voltage at a time;
      c) is sold with, or intended to be used with, a separate end-use product that constitutes the primary load;
      d) is contained in a separate physical enclosure[1] from the end-use product;
      e) is connected to the end-use product via a removable or hard-wired male/female electrical connection, cable, cord or other wiring;
      f) does not have batteries or battery packs that physically attach directly (including those that are removable) to the power supply unit;
      g) does not have a battery chemistry or type selector switch **AND** an indicator light or state of charge meter (e.g., a product with a type selector switch AND a state of charge meter is excluded from this specification; a product with only an indicator light is still covered by this specification); and
      h) has nameplate output power less than or equal to 250 watts.

   B. Ac-Ac External Power Supply: An external ac-ac power supply is an EPS designed to convert line voltage ac input into lower voltage ac output.

   C. Ac-Dc External Power Supply: An external ac-dc power supply is an EPS designed to convert line voltage ac input into lower voltage dc output.

   D. Low Voltage External Power Supply: For the purposes of this specification, a low voltage model is an EPS with a nameplate output voltage of less than 6 volts and a nameplate output current greater than or equal to 550 milliamps.

   E. Model: An EPS that is sold or marketed under a unique model number or marketing name. Any variation in the nameplate information (e.g., the rated input or output voltage, amperage, or wattage), circuitry, or output cord size is considered a unique model.

[1] "Physical enclosure" refers to the housing of the products themselves, not their retail packaging.

F. Active Mode: The condition in which the input of a power supply is connected to line voltage ac and the output is connected to an ac or a dc load drawing a fraction of the power supply's nameplate power output greater than zero.

G. No-Load Mode: The condition in which the input of a power supply is connected to an ac source consistent with the power supply's nameplate ac voltage, but the output is not connected to a product or any other load.

H. Power Factor (True): The true power factor is the ratio of the active, or real, power (P) consumed in watts to the apparent power (S), drawn in volt-amperes (VA).

$$PF = \frac{P}{S}$$

This definition of power factor includes the effect of both distortion and displacement.

2) **Qualifying Products**: In order to qualify as ENERGY STAR, an external power supply model must meet the definition in Section 1.A, as well as either the definition in 1.B or 1.C, and the specification requirements provided in Section 3, below.

3) **Energy-Efficiency Specifications for Qualifying Products**: Only those products in Section 2 that meet all of the following criteria for Active Mode, No-Load Mode, and power factor (if applicable) may qualify as ENERGY STAR.

A. Active Mode

To be eligible for ENERGY STAR qualification, an external power supply model must meet or exceed a minimum average efficiency for Active Mode, which varies based on the model's nameplate output power. Tables 1 and 2, below, outline the equations for determining minimum average efficiency, where P_{no} stands for nameplate output power and Ln refers to the natural logarithm. Table 1 addresses all standard EPSs, while Table 2 gives separate equations for a subset of low voltage EPSs that meet the appropriate definition in Section 1.D. All efficiency values shall be expressed in decimal form and rounded to the hundredths place.

Table 1: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: Standard Models

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.480 * P_{no} + 0.140
> 1 to ≤ 49 watts	≥ [0.0626 * Ln (P_{no})] + 0.622
> 49 watts	≥ 0.870

Table 2: Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode: Low Voltage Models

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal) [2]
0 to ≤ 1 watt	≥ 0.497 * P_{no} + 0.067
> 1 to ≤ 49 watts	≥ [0.0750 * Ln (P_{no})] + 0.561
> 49 watts	≥ 0.860

[2] (a) "Ln" refers to the natural logarithm. The algebraic order of operations requires that the natural logarithm calculation be performed first and then multiplied by 0.0626 (or 0.0750 for low voltage models), with the resulting output added to 0.622 (or 0.561 for low voltage models). (b) An efficiency of 0.87 or 0.86 in decimal form corresponds to the more familiar value of 87% or 86% when expressed as a percentage.

Examples to Illustrate the Active Mode Approach: Average Active Mode efficiency and ENERGY STAR qualification shall be determined as follows:

- Determine whether the product meets the definition for low voltage products by comparing the nameplate output voltage and nameplate output current to the definition found in Section 1.D.
- Calculate the model's single average Active Mode efficiency for each test voltage by testing at 100%, 75%, 50%, and 25% of rated current output and then computing the simple arithmetic average of these four values, as specified in the Test Method found in Section 4.
- Based on the model's nameplate output power, select the appropriate equation from Table 1 or 2 and calculate the minimum average efficiency required by ENERGY STAR.
- Compare the model's actual average efficiency to the minimum average efficiency required by ENERGY STAR. If the actual average efficiency is greater than or equal to the minimum average efficiency, the model has satisfied ENERGY STAR's Active Mode requirement.

To provide an example using the criteria in Table 1 and Table 2, the minimum average efficiencies required of six sample power supplies are provided in Table 3, below. Power supplies 1 through 6 would meet the ENERGY STAR Active Mode requirement if they had average efficiencies greater than or equal to the corresponding values shown in the far right column. Therefore, if Power Supply 3 in Table 3 had an actual average efficiency of 80%, it would satisfy the Active Mode requirement because it surpassed the ENERGY STAR minimum average efficiency of 79%.

Table 3: Examples of Minimum Average Efficiency in Active Mode

Sample	Nameplate Output Power (P_{no})	Nameplate Output Voltage	Nameplate Output Current	Average Efficiency in Active Mode (expressed as a decimal)
PS 1	0.75 watts	1V	750 mA	0.497 * 0.75 + 0.067 = 0.4398 or 0.44
PS 2	0.75 watts	10V	75 mA	0.480 * 0.75 + 0.140 = 0.5000 or 0.50
PS 3	20 watts	5V	4000 mA	[0.0750 * Ln (20)] + 0.561 = 0.7857 or 0.79
PS 4	20 watts	10V	2000 mA	[0.0626 * Ln (20)] + 0.622 = 0.8095 or 0.81
PS 5	75 watts	5V	15000 mA	0.86
PS 6	75 watts	10V	7500 mA	0.87

B. Power Factor Correction (PFC)

In addition to the Active Mode efficiency requirements found above, power supplies with greater than or equal to 100 watts *input* power must have a true power factor of 0.9 or greater at 100% of rated load when tested at 115 volts @ 60Hz.

Note: In the most recent round of comments, several stakeholders noted that power factor losses are less significant at 230 volts, because with half the current, the conduction losses are one-quarter of what they would be at 115 volts. Stakeholders also noted that EPS units meeting a 0.9 power factor at 115 volts will also generally have a high power factor at 230 volts (although slightly lower than 0.9 in some cases). Further, products sold in Europe must already meet the requirements for harmonic currents (EN 61000-3-2), and thus are effectively covered for power quality at 230 volts.

In addition, other manufacturers have noted that the 0.9 power factor requirement at 230 volts could eliminate the single stage PFC architecture, which is a cost effective approach to designing efficient EPSs with improved power quality. While a dual stage PFC architecture is capable of meeting a 0.9 power factor requirement at 230 volts, it is a more resource intensive design and may lead to decreases in Active Mode efficiency.

For these reasons, EPA has revised the final power factor requirement to only apply to testing at 115 volts, with no power factor requirement at 230 volts. Products designed to operate at *both* 115 volts and 230 volts must meet the power factor requirement when tested at 115 volts, but not when tested at 230 volts.

C. No-Load Mode

The third element of the ENERGY STAR specification is the No-Load power requirement, which specifies the maximum ac power that may be used by a qualifying ac-ac external power supply or ac-dc external power supply in the No-Load condition. Maximum power consumption levels for No-Load Mode are provided in Table 4, below.

Table 4: Energy Consumption Criteria for No-Load

Nameplate Output Power (P_{no})	Maximum Power in No-Load	
	Ac-Ac EPS	Ac-Dc EPS
0 to < 50 watts	≤ 0.5 watts	≤ 0.3 watts
≥ 50 to ≤ 250 watts	≤ 0.5 watts	≤ 0.5 watts

4) **Test Methodology**

The specifics for testing the energy efficiency of an external power supply model are outlined in a separate document titled "Test Method for Calculating the Energy Efficiency of Single-Voltage External Ac-Dc and Ac-Ac Power Supplies (August 11, 2004)," which is available on the ENERGY STAR Web site. The test results produced by this procedure shall be used to determine if a model qualifies as ENERGY STAR. In addition, below are five ENERGY STAR-specific testing requirements.

A. Safety Standards: ENERGY STAR qualified external power supplies shall comply with applicable safety standards from UL, CSA, and other global standards organizations. Relevant standards include, but are not limited to:

- *UL 1012, Standard for Power Units Other Than Class 2, Edition 7, April 29, 2005*
- *UL 1310, Standard for Class 2 Power Units, Edition 5, May 3, 2005*

It is the Partner's responsibility to ensure that its products meet applicable local safety standards based on where the product will be sold.

B. Number of Units Required for Test: Testing shall be conducted by the manufacturer or its authorized representative on three randomly chosen units of the same model. Manufacturers shall measure and maintain the Active Mode, No-Load Mode, and power factor values (if applicable) for all three units as well as the average values. To qualify as ENERGY STAR, all three units must meet the ENERGY STAR specification; only the average values will be displayed on ENERGY STAR's qualifying product list (see Section 4.E below).

C. Models Capable of Operating at Multiple Voltage/Frequency Combinations: For switchmode power supplies capable of operating at multiple voltages and frequencies, testing shall be conducted at both 115 volts @ 60 Hz and 230 volts @ 50 Hz, with the least efficient set of test values used to determine if products qualify for the Active Mode, No-Load Mode, and power factor (only applicable at 115 volts @ 60 Hz) specifications.

D. Multiple Tap or Switch Selectable Models: Manufacturers shall test a multiple tap or switch selectable model at the highest and the lowest voltage outputs of the power supply. If the model meets or exceeds the ENERGY STAR requirements at both the highest and the lowest voltage outputs, then it qualifies as ENERGY STAR.

E. Submittal of Qualified Product Data to EPA: Partners are required to self-certify those product models that meet the ENERGY STAR guidelines and report information to EPA. ENERGY STAR qualifying product lists, including information about new models as well as notification of discontinued models, must be provided on a quarterly basis, or more frequently if desired by the manufacturer. If no new models are introduced during a particular quarter, manufacturer should notify EPA to ensure its partnership status is maintained.

All unique EPS models, as defined in Section 1.E, must be separately tested and reported for ENERGY STAR qualification. However, in some cases, a partner may have a base model number

with several extensions to reflect various input pin and output connector configurations. If the only variation between the models is the physical connector configuration (provided that the nameplate information, circuit design, and output cord length and gauge are the same), partners may test one representative model and qualify it using a generic "XX" designation for the extension in the model number.

When qualifying EPSs as ENERGY STAR, partners also have the option of qualifying a family of EPSs that **all** meet the ENERGY STAR requirements, rather than individually submitting each model. For ENERGY STAR's purposes, an EPS model family is defined as **a group of switching-mode external power supplies that feature the same design (e.g., circuitry and components), transformer, and output wattage, but differ in rated output voltage.** To qualify a model family, partners must provide the efficiency data (average of three test units) for the highest and lowest output voltage members of the EPS model family that meet the ENERGY STAR specification. When submitting model families, manufacturers continue to be held accountable for any efficiency claims made about their external power supply products. In other words, even though data may not be submitted to ENERGY STAR on each model, manufacturers are still responsible for ensuring (and if challenged by another party, defending) each model's compliance with ENERGY STAR within the model family.

5) **Effective Date for EPS Manufacturers**: The ENERGY STAR single voltage external ac-ac and ac-dc power supplies specification (Version 2.0) effective date is November 1, 2008. Any previously executed agreement on the subject of ENERGY STAR qualified EPSs shall be terminated effective October 31, 2008.

Note: The following sentence has been removed in the Final specification: "The date that manufacturers may begin to promote products as ENERGY STAR under Version 2.0 will be defined as the *effective date* of the agreement." Because products that meet Version 2.0 also meet the ENERGY STAR specification in effect (Version 1.1) prior to November 1, 2008, EPA agrees that manufacturers may begin qualifying and promoting their Version 2.0 products as ENERGY STAR prior to its effective date.

A. Product Qualification under Version 2.0: Prior to November 1, 2008, EPA will begin accepting product qualifications under Version 2.0 through the ENERGY STAR online product submittal system. All products, including models originally qualified under Version 1.1, with a date of manufacture on or after November 1, 2008 must meet the new Version 2.0 requirements in order to qualify as ENERGY STAR. The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.

6) **Effective Date for ENERGY STAR Product Specifications**

A. Computer and Imaging Equipment Specifications: To qualify as ENERGY STAR under the Computer Version 4.0 Tier 1 and Imaging Equipment Version 1.0 Tier 1 specifications, computers and imaging equipment with an EPS must meet the following requirements as provided in Tables 5 and 6. These requirements are identical to the EPS Version 1.1 specification, which was in effect upon completion and implementation of the Computer and Imaging Tier 1 specifications, and do not include a power factor requirement as specified in this Version 2.0 specification. **Computers qualified under the Version 5.0 specifications (effective July 2009) and Imaging Equipment qualified under the Version 1.1 Tier 2 specifications (effective April 2009) will need to meet the EPS Version 2.0 requirements, regardless of the EPS's date of manufacture. Refer to Section 3, Energy-Efficiency Specifications for Qualifying Products, of this document for the detailed Version 2.0 EPS requirements.**

Note: Two changes have been made to Section 6.A, above. The first change was to update the reference to the latest Computer specification from Version 4.0 Tier 2 to Version 5.0 and similarly to change the reference to the latest Imaging Equipment specifications from Version 1.0 Tier 2 to Version 1.1 Tier 2. The second change was to clarify that once the latest Computer (Version 5.0) and Imaging Equipment (Version 1.1 Tier 2) specifications take effect, qualifying models with an EPS must include an EPS that meets the EPS Version 2.0 requirements, even if the EPS manufacture date is prior to July 2009 or April 2009, respectively.

- Computers and Imaging Equipment products that make use of an EPS must ensure that their EPS meets or exceeds a minimum average efficiency for Active Mode, which varies based on the model's nameplate output power. The following table outlines the equations for determining minimum average efficiency where P_{no} stands for nameplate output power and Ln refers to the natural logarithm. Efficiency shall be expressed in decimal form and rounded to the hundredths place.

Table 5: Version 1.1 Energy-Efficiency Criteria for Ac-Ac and Ac-Dc External Power Supplies in Active Mode

Nameplate Output Power (P_{no})	Minimum Average Efficiency in Active Mode (expressed as a decimal)
0 to ≤ 1 watt	≥ 0.49 * P_{no}
> 1 to ≤ 49 watts	≥ [0.09 * Ln (P_{no})] + 0.49
> 49 watts	≥ 0.84

- External Power Supplies must meet a No-Load power requirement, which specifies the maximum ac power that may be used by a qualifying external power supply in the No-Load condition. Maximum power consumption levels for No-Load Mode are provided in the table below.

Table 6: Version 1.1 Energy Consumption Criteria for No-Load

Nameplate Output Power (P_{no})	Maximum Power in No-Load
0 to < 10 watts	≤ 0.5 watts
≥ 10 to ≤ 250 watts	≤ 0.75 watts

B. Primarily Portable Products with Qualified EPSs: To qualify as ENERGY STAR, the EPS associated with primarily portable products that are not otherwise covered by the ENERGY STAR program (e.g., mobile phones, MP3 speaker systems, water filtration systems) must meet the EPS Version 2.0 specification as of its November 1, 2008 effective date, as outlined in Section 5, above. Visit http://www.energystar.gov/index.cfm?c=ext_power_supplies_pd.CE_manufacturers for more information about this product category.

Note: Based on stakeholder feedback, EPA has extended the effective date for Primarily Portable Products with Qualified EPSs from July 1 to November 1, 2008. This change provides interested partners with additional time to begin including Version 2.0 EPSs in their end-use product designs and also simplifies the specification overall by aligning effective dates.

C. Other Electronic Product Specifications: EPA is committed to advancing power supply efficiency in all products as quickly as is reasonable. For Telephony, the EPSs are a central part of this specification and thus must meet Version 2.0 as of its effective date of November 1, 2008, as outlined in Section 5, above. For Monitors, Televisions, Set-top Boxes, and Audio/DVD, updated specifications will specifically require that any EPSs meet the Version 2.0 requirements. Manufacturers should refer to the latest electronic product category specification for relevant effective dates.

7) **Future Specification Revisions**: EPA reserves the right to change the 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 ENERGY STAR qualification is not automatically granted for the life of a product model. To qualify as ENERGY STAR, a product model must meet the ENERGY STAR specification in effect on the model's 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.

8) **International Efficiency Marking Protocol**: ENERGY STAR partners shall follow the international efficiency marking protocol to indicate the energy performance of their ENERGY STAR qualified

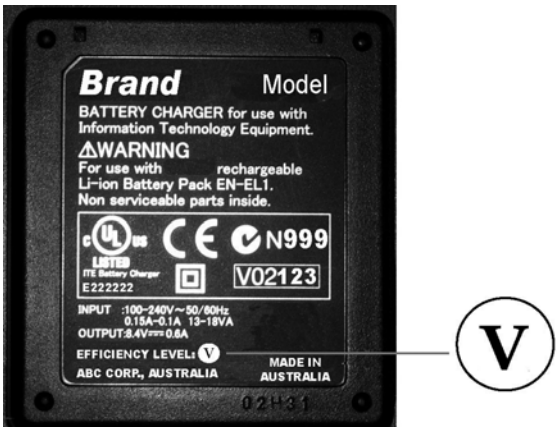
power supplies. (See Figure 1 for an illustration of the international efficiency mark.) In addition, the efficiency level, as denoted by a Roman numeral under the protocol, shall be reported to EPA as part of the qualified product data submission process. Further information about the endorsers of the marking protocol and its intent will be available at www.energystar.gov/powersupplies.

ENERGY STAR partners shall clearly and permanently mark (e.g., imprint, label, etc.) the nameplate of their qualifying external power supplies with the appropriate Roman numeral (I – VI) that corresponds to specific minimum Active and No-Load efficiency levels and power factor requirements (where applicable). (See www.energystar.gov/powersupplies and click on "International Efficiency Marking Protocol" for energy performance requirements at each Roman numeral.) Partners shall determine the appropriate Roman numeral by: 1) comparing the unit's Active, No-Load, and power factor test data (when tested in accordance with the ENERGY STAR Test Method and at each relevant test voltage and frequency value) with the performance requirements at each level of the Roman numeral scale; and 2) choosing the highest Roman numeral where the power supply meets the Active, No-Load, and power factor (where applicable) requirements.

Note: EPA updated the International Efficiency Marking Protocol text above to address power factor requirements, where applicable, given that power factor is one of the performance criteria covered under the ENERGY STAR Version 2.0 EPS specification.

The Protocol will be amended with the new requirements for level V and only EPSs with level V efficiency levels will qualify as ENERGY STAR. In addition, EPA plans to include updated information about the marking protocol on its ENERGY STAR Web site in the near future.

Figure 1: Illustration of International Efficiency Mark



When applied by a manufacturer, the mark shall conform to the following characteristics:

Format: Roman numeral: I, II, III, IV, V, or VI.
Font: Times Roman preferred (or other plain serif fonts).
Size: Legible and indelible.
Color: Text to contrast with the nameplate background.
Placement: On the power supply nameplate; however, the exact location is at the discretion of the manufacturer. The text "Efficiency Level" shown above is optional.

Example: Any external power supply meeting the performance requirements for level V and above would qualify as ENERGY STAR (Version 2.0). Power supplies with performance levels of I - IV would not qualify under the Version 2.0 specification.