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

Eligibility Criteria (Version 2.0)

Draft 1

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Below is the **Draft 1** 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.

Note: EPA has consolidated the characteristics shared by external power supplies into a single EPS definition to improve the readability of the Definitions section. Specific definitions for ac-ac and ac-dc power supply types are included below.

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. 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.

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

E. 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.

F. 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.

Note: EPA has included a power factor definition to support the power factor requirements included in the Draft 1 Version 2.0 specification.

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, Power Factor, and No-Load Mode 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. Table 1, below, 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 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) [2]
0 to ≤ 1 watt	≥ 0.44 * P_{no} + 0.145
> 1 to ≤ 36 watts	≥ [0.08 * Ln (P_{no})] + 0.585
> 36 watts	≥ 0.870

Note: EPA has developed proposed new Active Mode levels for the Version 2.0 specification from a dataset of 1,834 units measured in 2006 or 2007 including: currently qualified ENERGY STAR external power supplies; data shared with EPA from China's Standard Certification Center (CSC); and a small set of new models purchased at US retail stores and tested on behalf of EPA. The dataset includes both 230 volt data as well as 115 volt data and shows a compliance rate of 26% for units meeting the Active Mode, No-Load and Power Factor requirements. While the current dataset includes a preponderance of ENERGY STAR models, EPA does not feel that this biases the analysis because: 1) Regulations in California, Australia, and potentially elsewhere will exceed ENERGY STAR's Tier 1 levels (Version 1.1 specification) as early as July 2008, making ENERGY STAR models representative of the status quo and a good proxy for the US market in 2008; and 2) Beginning in June, EPA has invited interested manufacturers to submit data for non-ENERGY STAR models for incorporation into the dataset; EPA encourages manufacturers to provide test data for analysis along with their formal comments on this draft specification.

[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 0.08, with the resulting output added to 0.585. (b) An efficiency of 0.87 in decimal form corresponds to the more familiar value of 87% when expressed as a percentage.

Note (cont.): The suggested Version 2.0 requirements follow the same form as the Version 1.1 requirements, with a sloped line below 1 watt, a log function for mid-wattage units, and a flat line requirement above a certain wattage threshold. With these more stringent requirements, the increased flat line limit of 0.87 (87%) begins earlier than the cutoff used in the Version 1.1 specification (at 36 watts instead of 49 watts). These tighter limits require an average efficiency improvement of about 10 percentage points at the low end and 3 percentage points at the high end, which EPA believes will garner significant savings from modest improvements of power supply design.

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

- Calculate the model's single average Active Mode efficiency value 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.
- Based on the model's nameplate output power, select the appropriate equation from Table 1 and calculate the minimum average efficiency.
- Compare the model's actual average efficiency to the minimum average efficiency required by ENERGY STAR. If 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, the minimum average efficiencies required of three sample power supplies are provided in Table 2 below. As shown in the last column, power supplies 1, 2, and 3 would meet the ENERGY STAR Active Mode requirement if they had average efficiencies of at least 37%, 82%, and 87%, respectively. Therefore, if Power Supply 1 in Table 2 had an actual average efficiency of 40%, it would satisfy the Active Mode requirement because it surpassed the ENERGY STAR minimum average efficiency of 37%.

Table 2: Examples of Minimum Average Efficiency in Active Mode

Sample	Nameplate Output Power (P_{no})	Average Efficiency in Active Mode (expressed as a decimal)
Power Supply 1	0.5 watts	0.44 * 0.5 + 0.145 = 0.365 or 0.37
Power Supply 2	20 watts	[0.08 * Ln (20)] + 0.585 = 0.82466 or 0.82
Power Supply 3	75 watts	0.87

B. Power Factor Correction

In addition to the Active Mode efficiency requirements found above, all qualifying power supplies with a nameplate output power (P_{no}) of greater than or equal to 75 watts must have a true power factor of 0.9 or greater when measured at 100% of rated output.

Note: In recent years, there has been increased interest from the international efficiency community in decreasing the effect that high wattage products have on power quality. To this end, EPA has included power factor requirements for high power devices. Power factor correction helps to cut I-squared R losses in building distribution wiring significantly, yielding increased savings in large buildings. For the purpose of this specification, all EPSs with a power output of at least 75 watts will be required to have a power factor of at least 0.9 at 100% of rated load. This 75-watt cutoff coincides with the European regulation EN 61000-3-2, which went into effect in 2001 and requires limited total harmonic distortion for appliances above 75 watts input power. A power factor of at least 0.9 at 100% of rated load is consistent with the internal power supply requirement in the Version 4.0 ENERGY STAR Computer specification. At these levels, approximately 90% of current ENERGY STAR qualified power supplies can meet this requirement.

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 3, below.

Table 3: 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

Note: Based on feedback from stakeholders regarding ac-ac design differences and data submitted to ENERGY STAR, EPA is proposing separate No-Load requirements for ac-dc and ac-ac models under the Version 2.0 specification in order to reflect the market and recognize opportunities for increased savings. As ac-dc power supplies generally have lower No-Load losses, EPA suggests tightening the No-Load requirement for low wattage ac-dc EPSs to 0.3 watts, while simultaneously increasing the low-wattage cutoff to 50 watts (from 10 watts in the Version 1.1 specification). In addition, EPA proposes that ac-dc models above 50 watts meet the more stringent No-Load level of less than or equal to 0.5 watts. Because available test data for ac-ac power supplies indicates that they would have significant difficulty meeting the low-wattage No-Load level of 0.3 watts, EPA has suggested a No-Load level of 0.5 watts for all eligible ac-ac power supplies. All ac-ac power supplies in EPA's current dataset can meet this No-Load requirement. EPA has received feedback that ac-ac external power supplies above 30 watts should receive a less stringent No-Load requirement, but EPA has very little data on ac-ac supplies over even 15 watts to support this claim. Manufacturers with high wattage ac-ac external power supplies are encouraged to submit relevant data on these products for EPA's analysis.

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, Power Factor, and No-Load Mode values 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, Power Factor, and No-Load specifications.

Note: As background, it is important to note that 115 volts @ 60 Hz and 230 volts @ 50 Hz were specifically selected during test procedure development in order to balance the need to reflect the multiple combinations of voltage and frequency found in global markets with a desire to minimize the testing burden for participating manufacturers. The 115 volts @ 60 Hz combination was selected because the United States provides a nominal voltage of 120 volts and Japan provides 110 volts. The other test point is specified at 230 volts @ 50 Hz because 230 volts represents the average between the voltages used by Europe (240 volts) and the United Kingdom and China (both at 220 volts).

Recently, one stakeholder has suggested to EPA that manufacturers have the option of voluntarily providing additional measurement data at 100 volts @ 50/60 Hz if destined for the Japanese marketplace. ENERGY STAR qualification would still be determined based on the guidelines provided in Section 4.C above (i.e., models could not qualify based solely on test data at 100 volts @ 50/60 Hz). EPA is willing to consider input from industry on this proposal, but would need to see evidence that the benefits outweigh the additional administrative costs for both EPA and its partners.

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.

5) **Effective Date**: The date that manufacturers may begin to qualify and promote products as ENERGY STAR will be defined as the *effective date* of the agreement. The ENERGY STAR single voltage external ac-ac and ac-dc power supplies (Version 2.0) effective date is July 1, 2008.

Note: EPA is proposing that the EPS Version 2.0 specification take effect for EPS manufacturers on July 1, 2008. After this specification takes effect, all EPSs marketed as ENERGY STAR must meet the Version 2.0 levels.

Revisions to the EPS specification will have implications for ENERGY STAR specifications for several electronic product categories (i.e., computers, monitors, imaging, televisions, telephony, set-top boxes, and audio/DVD). EPA is committed to advancing power supply efficiency in all products as quickly as is reasonable. Please refer to EPA's letter dated October 11, 2007, which accompanies this draft specification, for details.

6) **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.

7) **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 is 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. (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 and No-Load 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 and No-Load requirements.

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.

Note: The international community has reserved level V of the international efficiency marking protocol for ENERGY STAR's Version 2.0 specification. Once the Version 2.0 specification is finalized, 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.