



# ENERGY STAR® Program Requirements

## Product Specification for Uninterruptible Power Supplies

### Test Method- DRAFT 3.0 (1)

## 1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Uninterruptible Power Supplies (UPSs).

## 2 APPLICABILITY

The following test method is applicable to all products eligible for qualification under ENERGY STAR Eligibility Criteria for UPSs, including:

- Single-phase and three-phase UPSs, for home, small and medium business, and datacenter use;
- Static and rotary UPSs; and
- Ac-output and dc-output UPSs/Rectifiers.

## 3 TEST SETUP

A) Test Setup and Instrumentation: Unless otherwise specified within this Test Method, the test setup and instrumentation for all portions of this method shall be in accordance with the following:

- 1) For ac-output UPSs, International Electrotechnical Commission (IEC) standard:
  - a. IEC 62040-3:2011, Ed. 2.0, *Uninterruptible power systems (UPS) - Part 3: Method of specifying the performance and test requirements*, Section J.2.
- 2) For dc-output UPSs/Rectifiers, Alliance for Telecommunications Industry Solutions (ATIS) standards:
  - a. ATIS-0600015.2009, *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting – General Requirements*; and
  - b. ATIS-0600015.04.2010, *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting DC Power Plant – Rectifier Requirements*.

**Note:** DOE has validated the test setup and approach specified in Section J.2 of IEC standard 62040-3, Ed. 2.0. The ENERGY STAR program became aware of the ATIS test methods through recent comments; therefore, the ATIS test methods have not been validated. DOE expects to review and validate the ATIS test procedures for dc-output UPSs/Rectifiers over the next 12 months, which may result in technical modifications to the test method and/or specification.

B) Ac Input Power: The Unit Under Test (UUT) shall be connected to the first (highest) compatible voltage and frequency combination specified in Table 1.

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**Table 1: Input Power Requirements**

Voltage	Frequency
600Δ V ac	60 Hz
600Y/346 V ac	60 Hz
480Δ V ac	60 Hz
480Y/277 V ac	60 Hz
415Δ V ac	60 Hz
415Y/240 V ac	60 Hz
400Δ V ac	50 Hz
400Y/230 V ac	50 Hz
230 V ac	50 or 60 Hz
208Δ V ac	60 Hz
208Y/120 V ac	60 Hz
200 V ac	50 Hz
115 V ac	50 or 60 Hz
100 V ac	50 or 60 Hz

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**Note:** Based on stakeholder comment, ENERGY STAR has restored the frequency column to Table 1: Input Power Requirements, to match Table 1 as published in the Draft 1 Test Method. ENERGY STAR welcomes comment on this change.

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1) UUTs that are not compatible with any of the combinations listed in Table 1 shall be connected to the highest nominal voltage and frequency combination. The test voltage and frequency used for the test shall be reported.

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C) Ac-output Power: For ac-output UPSs, the output voltage waveform of the UUT shall have the same characteristics as the input voltage, specified in Table 1 and Section J.2 of IEC standard 62040-3, Ed. 2.0.

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1) UUTs that have an output voltage different from the input voltage shall be tested at the highest compatible output voltage. The test voltage and frequency used for the test shall be reported.

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D) Dc-output Power: For dc-output UPSs/Rectifiers, the output voltage waveform of the UUT shall be the first applicable voltage specified in Table 2, from top to bottom.

**Table 2: Dc-output Power Requirements and Precedence**

Nominal Voltage	Voltage for Test <sup>1</sup>	Voltage Tolerance
380 V dc	418 V dc	+/- 1 %
48 V dc	53 V dc	+/- 1 %
60 V dc	66 V dc	+/- 1 %
24 V dc	26 V dc	+/- 1 %
575 V dc	595 V dc	+/- 1 %

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**Note:** Based on stakeholder comment, ENERGY STAR has added a 595 V dc voltage test condition to Table 2: Dc-output Power Requirements and Precedence. ENERGY STAR welcomes comment on this addition.

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<sup>1</sup> Expected voltage for a fully charged battery

51 **4 TEST CONDUCT**

52 **4.1 UPS Operating Mode Conditions**

53 If the UUT can operate in two or more distinct normal modes, conduct all parts of the test and report all  
54 parameters listed in Appendix A in:

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- 56 ▪ The highest input dependency, and/or
  - 57 ▪ The lowest input dependency, as specified in the ENERGY STAR Eligibility Criteria for UPSs.
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59 **4.2 ENERGY STAR Guidance for Implementation of IEC 62040-3, Ed. 2.0<sup>2</sup>**

**Note:** In the August 1 Stakeholder Meeting, stakeholders commented that the UPS setup figure and power meter specification originally in Section 4.2.A) are unnecessary and may be specific to the testing of consumer UPSs. As a result, ENERGY STAR has removed this section.

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- 61 A) The reference test load defined in IEC 62040-3, Ed. 2.0 Section 3.3.5 shall be a resistive test load.
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  - 63 B) Modular UPSs tested at their minimum and maximum non-redundant configurations shall be tested  
64 with redundant components (e.g., fans, controllers, etc.) for the vacant module slots functioning  
65 according to the unit's as-shipped default behavior.
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**Note:** ENERGY STAR has added clarification that modular UPSs shall be tested with redundant components functioning according to the unit's as-shipped default behavior in order to ensure both minimum and maximum configurations are tested consistently. ENERGY STAR welcomes comment on this change.

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- 68 C) Back-feeding the UPS shall not be used in place of a test load during testing.
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**Note:** ENERGY STAR became aware that back-feeding the UPS is not a sufficient replacement for a test load from test procedure comments and manufacturer interviews. ENERGY STAR has added clarification that back-feeding shall not be used during testing. ENERGY STAR welcomes comment on this change.

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- 71 D) The UPS's firmware and software shall remain as-shipped for all testing (i.e., the test unit's firmware  
72 shall not be modified in order to disable battery charging features such as battery self-test and trickle  
73 charging).
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**Note:** Stakeholder comments on the ENERGY STAR Draft 2 Test Procedure indicated that when testing UPSs with the battery connected, some manufacturers adjust the UPS's firmware in order to disable battery charging functions such as trickle charges and the battery self-test. While ENERGY STAR understands that this is done to improve repeatability, allowing firmware customizations may lead to "gaming" of the test procedure, as a Certification Body (CB) may not know exactly what has been altered in the UPS. Allowing firmware customizations may also create an inconsistent test environment and an unfair market advantage if some manufacturers choose to not disable these features. For these reasons, ENERGY STAR is not allowing adjustments to the UPS's firmware. ENERGY STAR welcomes comment on this change.

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<sup>2</sup> This guidance also applies to dc-Output UPSs/Rectifiers.

- 77 E) Energy Storage System:  
78 1) If the energy storage system is able to be disconnected by physical means or by using default  
79 controls while maintaining normal operation, and the user manual does not advise against  
80 disconnecting it, the UPS shall be tested with the energy storage system disconnected<sup>3</sup>.  
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82 2) If unable to disconnect the energy storage system as instructed above, a fully charged battery is  
83 acceptable.  
84 a) To ensure the battery is fully charged, perform the following steps:  
85 i. For UPSs that have an indicator to show that the battery is fully charged, continue  
86 charging for an additional 5 hours after the charged indicator is present.  
87 ii. If there is no charge indicator, but the manufacturer's instructions provide a time estimate  
88 for when charging this battery or this capacity of battery should be complete, continue  
89 charging for an additional 5 hours after the manufacturer's estimate.  
90 iii. If there is no indicator and no time estimate in the instructions, but the charging current is  
91 stated on the UPS or in the instructions, terminate charging 1 hour after the calculated  
92 test duration or, if none of the above applies, the duration shall be 24 hours.  
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**Note:** ENERGY STAR has added further clarification that if the energy storage system can be disconnected, the unit shall be tested with this configuration, as specified in IEC 62040-3, Ed. 2.0. Through validation testing and manufacturer interviews, it was brought to our attention that many units are unable to have the battery removed and still operate normally without customizing the UPS. Many units, especially at the consumer size, have interlocks that trigger alarms or prevent the unit from operating if the battery is disconnected. Some units have workarounds to keep the UPS functioning with the battery removed, but these workarounds often go against the instructions in the user manual. For this reason, ENERGY STAR has added clarification that if the unit's user manual instructs the user to not disconnect the battery, the unit shall be tested with the battery connected, even if it is possible to modify the UPS to run without the battery.

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95 b) If the UPS is shipped with a battery, that battery shall be used for testing. Otherwise, the  
96 manufacturer may select which battery is used for the test. The battery used for testing shall  
97 be recorded in Appendix A: Test Reporting Template for Uninterruptible Power Supplies.  
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**Note:** ENERGY STAR understands that the use of different batteries may result in differences in a unit's efficiency. For this reason, ENERGY STAR has added clarification that if a UPS is shipped with a battery, that battery shall be used for testing, and the manufacturer may specify the battery if no battery is shipped with the unit. In addition, the manufacturer shall specify the battery used in Appendix A: Test Reporting Template for Uninterruptible Power Supplies. ENERGY STAR welcomes comment on this change.

**Note:** Based on stakeholder comment, ENERGY STAR has removed the thermal stabilization method proposed in the Draft 2 Test Procedure. Stabilization will be performed at 125% of the manufacturer-specified rise time, as specified in IEC 62040-3, Ed. 2.0.

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## 100 5 TEST PROCEDURES FOR ALL PRODUCTS

- 101 A) Steady-state: In order to verify the UPS is in steady-state, perform the following stabilization check at  
102 each load point:  
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104 1) Wait 125% of the manufacturer specified temperature rise time, as stated in IEC 62040-3, Ed 2.0.  
105 2) Measure the average power in W for at least 5 minutes using a power analyzer.

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<sup>3</sup> The ATIS standard does not specify the disconnection of the energy storage system. Therefore, all UPSs, including dc-output UPSs/Rectifiers shall follow this provision.

- 106 3) Wait a minimum of 10 minutes.
- 107 4) Repeat the average power measurement for another 5 minute measurement.
- 108 5) Compare the two readings.
- 109 6) The test unit may be considered to be in steady-state if the difference between the two
- 110 measurements is less than 1% of the average of the two measurements.
- 111 7) If the difference between the test measurements is greater than or equal to 1% of the average of
- 112 the two measurements, repeat steps 3 through 5 until the unit is considered to be in steady-state.
- 113 The most recent two readings shall be used for comparison.
- 114 8) Record the appropriate values in Appendix A.
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**Note:** In order to ensure that the stability time is adequate, ENERGY STAR has added a check to be performed before each load point. Two 5-minute average power measurements shall be taken 10 minutes apart. The UPS shall be considered in steady-state if the difference between the two measurements is less than 1%. This method has been implemented in validation testing and has proven to be an effective and repeatable method for checking UPS stability. ENERGY STAR welcomes comments on this approach.

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- 117 B) Efficiency Measurements: Input and output power measurements for efficiency calculations shall be
- 118 performed on the UUT according to Section J.3 of IEC standard 62040-3, Ed. 2.0, with the following
- 119 exceptions.
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- 121 1) Test the UUT at the following reference test load conditions:
- 122 a) Ac-output UPS: 100%, 75%, 50%, 25%, and 0% of the reference test load.
- 123 b) Dc-output UPS: 80%, 70%, 60%, 50%, 40%, 30%, 0% of the reference test load.
- 124 *Note:* For the 0% loading condition (i.e., the test load disconnected, but output inverter
- 125 operational for ac-output UPS), measure only at the input to the UUT.
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- 127 2) The test shall be performed by accumulating the total energy in watt-hours (Wh) over the 15-
- 128 minute test period, then determining the average power for the period by dividing total energy by
- 129 the measurement period time.
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**Note:** ENERGY STAR understands that increasing the sampling rate to one reading per second, as proposed in Draft 2, may force some manufacturers to develop an automated test which records the data. At the suggestion of some stakeholders, we have adjusted the sampling method to a calculation of the average power obtained from a 15-minute accumulated energy measurement. This method should ease manufacturer burden while providing an accurate and repeatable measurement that will average out some, if not all, of the battery charging functions' effects. ENERGY STAR welcomes comment on the proposed sampling method.

**Note:** The steady-state check proposed in ENERGY STAR Test Procedure Draft 2 evaluated the slope of 1 Hz power measurements over a 15-minute period to determine UPS stability. With the addition of the accumulated energy sampling method in Section 5.B.2) and stability checks in Section 5.A), the Draft 2 steady-state check is irrelevant and has been removed.

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- 132 3) Modular UPSs with output power that varies depending on the number of converters installed
- 133 shall be tested twice, at both their minimum and maximum non-redundant (i.e., N+0)
- 134 configurations.
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- 136 a) For dc-output UPSs/Rectifiers, this test method shall take precedence over the  
137 requirements specified in Section 5.10 of the ATIS -0600015.2009 standard.<sup>4</sup>  
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- 139 4) Measure and record all the applicable parameters listed in Appendix A for each ac-output/dc-  
140 output UPS test performed, including the ac-output UPS performance characteristics in the tested  
141 modes, as specified in Section 5.3.4 of IEC standard 62040-3, Ed. 2.0.  
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- 143 a) If all three parts of the output performance characteristics (AAA-BB-CCC) are not  
144 available or applicable, report only the characteristics applicable to the UUT.  
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- 146 C) Power Factor Measurements: Measure the power factor of the UUT per Section 6.4.1.5 of IEC  
147 standard 62040-3, Ed. 2.0, for each mode.<sup>5</sup>  
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## 149 **6 TEST RECORDS**

### 150 **6.1 Appendix A: Test Reporting Template for Uninterruptible Power Supplies**

151 *Appendix A: Test Reporting Template for Uninterruptible Power Supplies* shall be completed for each  
152 UPS tested.

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<sup>4</sup> The ATIS-0600015.2009 specifies that modular dc-Output UPSs/Rectifiers may be tested on a per-module basis.

<sup>5</sup> Neither the ATIS-0600015.2009 nor the ATIS-0600015.04.2010 standard specifies requirements for testing power factor; therefore, the provisions contained in section 6.4.1.5 of IEC standard 62040-3 will be used for testing the power factor of dc-output UPSs/Rectifiers.