



# ENERGY STAR® Program Requirements Product Specification for Uninterruptible Power Supplies

## Test Method- DRAFT

### 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) Section J.2 of IEC standard 62040-3 for AC output UPSs.
- 2) ATIS-0600015.2009 and ATIS-0600015.04.2010 for DC-output UPSs/Rectifiers.

**Note:** DOE has validated the test setup and approach specified in Section J.2 of IEC standard 62040-3. 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.

21

22 B) AC Input Power: The UUT shall be connected to the first (highest) compatible voltage and frequency  
 23 combination specified in Table 1.  
 24

25 **Table 1: Input Power Requirements**

| Voltage       |
|---------------|
| 600Δ V ac     |
| 600Y/346 V ac |
| 480Δ V ac     |
| 480Y/277 V ac |
| 415Δ V ac     |
| 415Y/240 V ac |
| 400Δ V ac     |
| 400Y/230 V ac |
| 230 V ac      |
| 208Δ V ac     |
| 208Y/120 V ac |
| 200 V ac      |
| 115 V ac      |
| 100 V ac      |

26  
 27 1) UUTs that are not compatible with any of the combinations listed in Table 1 shall be connected to  
 28 the highest nominal voltage and frequency combination. The test voltage and frequency used for  
 29 the test shall be reported.  
 30

31 C) AC Output Power: For AC-output UPSs, the output voltage waveform of the UUT shall have the same  
 32 characteristics as the input voltage, specified in Table 1 and section J.2 of IEC standard 62040-3.  
 33

34 1) UUTs that have an output voltage different from the input voltage shall be tested at the highest  
 35 compatible output voltage. The test voltage and frequency used for the test shall be reported.  
 36

37 D) DC Output Power: For DC-output UPSs/Rectifiers, the output voltage waveform of the UUT shall be  
 38 the first applicable voltage specified in Table 2, from top to bottom.  
 39  
 40

**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 %           |

41 **Note:** ENERGY STAR has added voltage specifications for common DC UPSs.  
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<sup>1</sup> Expected voltage for a fully charged battery

43 **4 TEST CONDUCT**

44 **4.1 UPS Operating Mode Conditions**

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

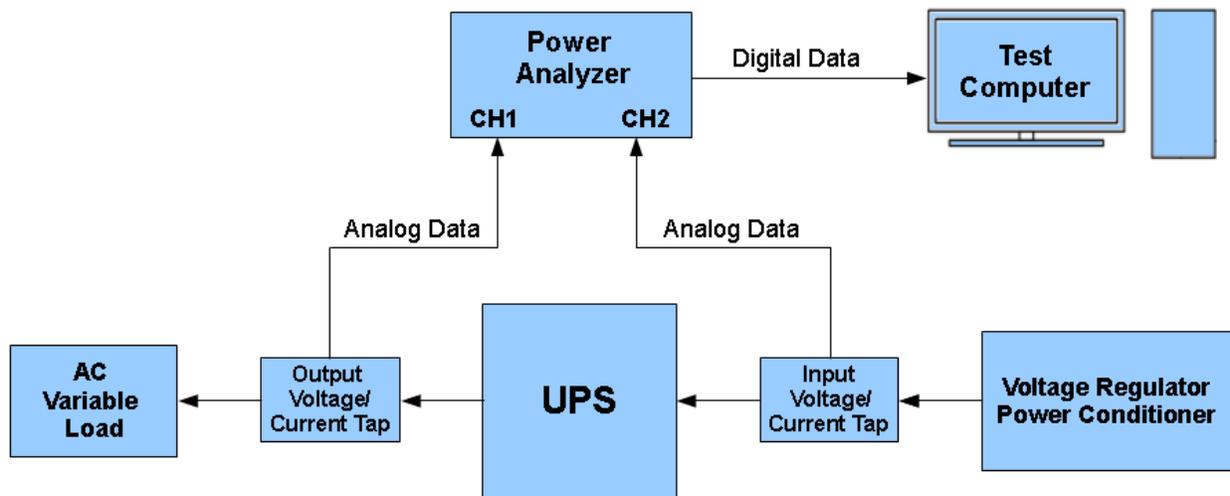
- 47
- 48     ▪ The highest input dependency, and/or
  - 49     ▪ The lowest input dependency, as specified in the ENERGY STAR Eligibility Criteria for UPSs.
- 50

51 **4.2 ENERGY STAR Guidance for Implementation of IEC 62040-3<sup>2</sup>**

52 A) Power Meter Setup

- 53
- 54     1) The power meter and UPS setup should mirror the setup in Figure 1.
- 55

56 **Figure 1: Example UPS Setup**



- 57
- 58
  - 59     2) At each load condition for both input and output, set up the power meters to read:
- 60

- 61         i) Voltage (V)
  - 62         ii) Current (A)
  - 63         iii) Power (W)
  - 64         iv) Energy (Wh)
  - 65         v) Power Factor
  - 66         vi) Crest Factor of Current
  - 67         vii) Voltage Frequency
- 68

- 69     B) The reference test load defined in IEC 62040-3 section 3.3.5 shall be a resistive test load.
- 70

**Note:** ENERGY STAR has provided clarification for a resistive test load and welcomes comment on this specification.

71

<sup>2</sup>This guidance applies to DC-Output UPSs/Rectifiers as well.

- 72 C) Energy Storage System:  
73 1) The energy storage system within the UUT shall be disconnected throughout the duration of the  
74 test<sup>3</sup>.  
75  
76 2) If unable to disconnect the energy storage system as instructed in IEC 62040-3, a fully charged  
77 battery is acceptable. To ensure the battery is fully charged, perform the following steps:  
78 i) For UPSs that have an indicator to show that the battery is fully charged, continue  
79 charging for an additional 5 hours after the indication is present.  
80 ii) If there is no charge indicator, but the manufacturer's instructions provide a time estimate  
81 for when charging this battery or this capacity of battery should be complete, continue  
82 charging for an additional 5 hours after the manufacturer's indication.  
83 iii) If there is no indicator and no time estimate in the instructions, but the charging current is  
84 stated on the UPS or in the instructions, terminate charging 1 hour after the calculated  
85 test duration or, if none of the above applies, the duration shall be 24 hours.  
86

**Note:** IEC 62040-3 may not provide sufficient requirements to ensure a fully charged battery, so ENERGY STAR has adapted a method from DOE's 10 CFR 430: "Energy Conservation Program for Certain Consumer Appliances: Test Procedures for Battery Chargers and External Power Supplies", Section 5.2: Charge Test Duration. This method maintains the stabilization efforts seen throughout the ENERGY STAR test method. ENERGY STAR welcomes comment on this method for ensuring a fully charged battery.

- 87  
88 D) Thermal Stability: In order to ensure the UPS is thermally stable, perform the following steps:  
89 1) For UPSs with less than 3 kVA output power, if unable to disconnect the energy storage system,  
90 perform the battery charging method in Section 4.2)C) of this test method to ensure stability.  
91 2) For UPSs greater than 3 kVA and those less than 3 kVA with removable energy storage systems,  
92 the sufficient amount of time for the UPS to have reached stability shall be 125% of the required  
93 time provided by the manufacturer.  
94  
95

## 96 5 TEST PROCEDURES FOR ALL PRODUCTS

- 97 A) Steady State: In order to verify the UPS is steady-state, perform the following sampling method, per  
98 Section 5.3.2 of IEC 62301: Household electrical appliances – Measurement of standby power:  
99 1) The product shall be energized for not less than 15 minutes; this is the total period.  
100 2) Any data from the first one third of the total period is always discarded. Data recorded in the  
101 second two thirds of the total period is used to determine stability.  
102 3) Establishment of stability depends on the average power recorded in the second two thirds of the  
103 total period.  
104 4) For input powers less than or equal to 1 W, stability is established when a linear regression  
105 through all power readings for the second two thirds of the total period has a slope of less than 10  
106 mW/h.  
107 5) For input powers of more than 1 W, stability is established when a linear regression through all  
108 power readings for the second two thirds of the total period has a slope of less than 1% of the  
109 measured input power.  
110 6) Where a total period of 15 minutes does not result in the above stability criteria being satisfied,  
111 the total period is continuously extended until the relevant criteria above is achieved (in the  
112 second two thirds of the total period).

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

113 7) Once stability is achieved, the result is taken to be the average power consumed during the  
114 second two thirds of the total period.  
115  
116

**Note:** During testing, ENERGY STAR discovered cases where the battery was charged but the UPS was not stable. This is a potential issue for obtaining repeatable results. To address this observed instability, ENERGY STAR proposes using a stabilization technique from *Section 5.3.2 of IEC standard 62301 (Ed. 2.0): Household electrical appliances – Measurement of standby power*. This section analyzes a linear regression through all power readings of the second two-thirds of the total measurement period (from 15 minutes up to 3 hours), and the UPS shall be considered stable if the regression has a slope of less than 1% of the average measured input power per hour. ENERGY STAR welcomes comment on this proposed method for ensuring UPS stability, the length of the total measurement period, as well as suggestions for other potential stability methods.

117  
118 B) Efficiency Measurements: Input and output power measurements for efficiency calculations shall be  
119 performed on the UUT according to Section J.3 of IEC standard 62040-3, with the following  
120 exceptions.

- 121  
122 1) Test the UUT at the following reference test load conditions:  
123 i) AC-output UPS: 100%, 75%, 50%, 25%, and 0% of the reference test load.  
124 ii) DC-output UPS: 80%, 70%, 60%, 50%, 40%, 30%, 0% of the reference test load.  
125 *Note:* For the 0% loading condition (i.e., the test load disconnected, but output inverter  
126 operational for AC-output UPS), measure only at the input to the UUT.  
127  
128 2) At each reference test load condition, the active input and output power (W) shall be measured  
129 simultaneously. Readings should be taken at a minimum sampling rate of 1 sample per second  
130 for 15 minutes.  
131

**Note:** During testing, some UPSs had wide input power variation ( $\pm 10\%$ ) even though the UPSs appeared stable. The requirement in IEC 62040-3, “three successive readings taken no more than 15 minutes apart,” may not provide enough resolution to guarantee the calculated efficiency is consistent and repeatable. Reported efficiencies could be inconsistent depending on which three measurements were taken during the test period. ENERGY STAR proposes a sampling rate of at least one (1) power reading per second over the test period, followed by calculation of the average of the samples. ENERGY STAR welcomes comment on this proposed method, as well as suggestions for alternative approaches.

- 132  
133 3) Modular UPSs with output power that varies depending on the number of converters installed,  
134 shall be tested twice, at both their minimum and maximum non-redundant (i.e., N+0)  
135 configurations.  
136  
137 i) For DC-Output UPSs/Rectifiers, this test method shall take precedence over the  
138 requirements specified in section 5.10 of the ATIS -0600015.2009 standard<sup>4</sup>.  
139  
140 4) Measure and record all the applicable parameters listed in Appendix A for AC-output UPS and  
141 Appendix B for DC-output UPS of this test method for each test performed, including the AC-  
142 output UPS performance characteristics in the tested modes, as specified in section 5.3.4 of IEC  
143 standard 62040-3.  
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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.

- 145 a. If all three parts of the output performance characteristics (AAA-BB-CCC) are not  
146 available or applicable, report only the characteristics applicable to the UUT.  
147
- 148 C) Power Factor Measurements: Measure the power factor of the UUT per section 6.4.1.5 of IEC  
149 standard 62040-3, for each mode.<sup>5</sup>  
150  
151

## 152 **6 TEST RECORDS**

### 153 **6.1 Appendix A: Test Reporting Template (TBD)**

154 *Appendix A: Test Reporting Template* shall be completed for each UPS tested.

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<sup>5</sup> Neither the ATIS-0600015.2009 nor the ATIS-0600015.04.2010 standard specifies requirements for testing power factor, as such 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.