



ENERGY STAR[®] Program Requirements

Product Specification for Uninterruptible Power Supplies

Test Method – FINAL DRAFT (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: The requirement in Section 6.2 of ATIS-0600015.04.2010 which states the Unit Under Test (UUT) shall be evaluated with “a power source with a rating of at least 2X the maximum input power rating of the rectifier” is optional for ENERGY STAR testing.

35 B) Ac-input Power: The UUT shall be connected to the first (highest) rated voltage and rated frequency
 36 combination specified in Table 1. If two frequencies are provided in a given row, the manufacturer
 37 may specify which frequency shall be used for testing.
 38

39 **Table 1: Input Supply 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	50 or 60 Hz
400Δ V ac	50 Hz
400Y/230 V ac	50 Hz
380Y/220 V Ac	50 or 60 Hz
230 V ac	50 or 60 Hz
208Δ V ac	60 Hz
208Y/120 V ac	60 Hz
200 V ac	50 or 60 Hz
120 V ac	60 Hz
115 V ac	50 or 60 Hz
100 V ac	50 or 60 Hz

40
 41 **Note:** Based on stakeholder comments, the following modifications have been made to Table 1:

- 42 - Added 380Y/220 V ac 50 Hz, as it is common in several countries around the world
- 43 - Added 200 V ac 60 Hz to accommodate the nominal voltage of Japan
- 44 - Added 120 V ac 60 Hz to accommodate the nominal voltage of North America

45
 46 To avoid issues that may result from the inclusion of both the 50 and 60 Hz frequencies for these two
 47 input supplies, language has been added to Section 3.B, above, to allow the manufacturer to specify the
 48 frequency used for testing.

49
 50 1) UUTs that are not compatible with any of the combinations listed in Table 1 shall be connected to
 51 the highest rated voltage and frequency combination. The test voltage and frequency used for the
 52 test shall be reported.

53
 54 C) Ac-output Power: For Ac-output UPSs, the output voltage and frequency of the UUT shall have the
 55 same characteristics as the input voltage, specified in Table 1, above, and Section J.2 of IEC
 56 standard 62040-3, Ed. 2.0.

57
 58 1) UUTs that have an output voltage different from the input voltage shall be tested at the highest
 59 compatible output voltage. The voltage and frequency used for the test shall be reported.

60
 61 D) Dc-output Power: For Dc-output UPSs/Rectifiers, the output voltage of the UUT shall be the first
 62 applicable voltage specified in Table 2, from top to bottom. The voltage used for the test shall be
 63 reported.
 64

65

Table 2: Dc-output Power Requirements and Precedence

Nominal Voltage	Voltage for Test ¹	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 %

66

67 4 TEST CONDUCT

68 **Note:** "Section 4: Test Conduct" and "Section 5: Test Procedures for All Products" apply to both Ac-output
 69 and Dc-output UPSs. The standards referenced in Section 3.A.2 shall be used only for setup and
 70 instrumentation guidance in the testing of Dc-output UPSs.

71

72 4.1 UPS Operating Mode Conditions

73 If the UUT can operate in two or more distinct normal modes, conduct all parts of the test and report all
 74 parameters listed in the test reporting template in:

75

- 76 ▪ The highest input dependency, and
- 77 ▪ The lowest input dependency, as specified in the ENERGY STAR Eligibility Criteria for UPSs.

78

79 *Note:* If applicable, the UUT shall be tested in the highest efficiency sub-mode of each tested
 80 normal mode.

81

82 **Note:** DOE has added clarification that, if applicable, the test unit shall be tested in the highest efficiency
 83 sub-mode of each tested normal mode.

84

85 4.2 ENERGY STAR Guidance for Implementation of IEC 62040-3, Ed. 2.0²

86 A) The reference test load defined in IEC 62040-3, Ed. 2.0 Section 3.3.5 shall be a resistive test load.

87

88 B) Modular UPSs with output power that varies depending on the number of modules installed shall be
 89 tested twice, at both their minimum and maximum non-redundant (i.e., N+0) configurations.

90

91 1) For Dc-output UPSs/Rectifiers, this test method shall take precedence over the requirements
 92 specified in Section 5.10 of the ATIS -0600015.2009 standard³.

93

¹ Expected voltage for a fully charged battery

² This guidance also applies to Dc-output UPSs/Rectifiers.

³ The ATIS-0600015.2009 specifies that modular Dc-Output UPSs/Rectifiers may be tested on a per-module basis.

- 94 C) Modular UPSs tested at their minimum and maximum non-redundant configurations shall be tested
95 with redundant components (e.g., fans, controllers, etc.) of the vacant module slots functioning
96 according to the unit's as-shipped default behavior.
97
- 98 D) Back-feeding the UPS may be used in place of a test load during testing of UPS systems larger than
99 100 kW output.
100
- 101 E) The UPS's firmware shall not be modified to disable energy storage charging features such as energy
102 storage self test and trickle charging.
103
- 104 F) Only publicly available documents referenced in the Power and Performance Data Sheet (PPDS)
105 may be used as guidelines for implementing IEC 62040-3, Ed. 2.0. Any special instructions used shall
106 be documented in the test reporting template.
107
- 108 G) Energy Storage System:
109
- 110 1) If the energy storage system is able to be disconnected by physical means or by using default
111 controls while maintaining normal operation, and the user manual does not advise against
112 disconnecting it, the UPS shall be tested with the energy storage system disconnected⁴.
113
- 114 2) The UPS may be adjusted to disable any alarms, indications, or default detection mechanisms
115 that may result from disconnecting the energy storage system, as long as the controls necessary
116 to do so are natively present on the UPS or are included in end user software.
117

118 **Note:** Based on stakeholder recommendations, DOE has modified this requirement to allow the use of
119 end user software to disable any resulting alarms. The intent is to allow for repeatable off-the-shelf testing
120 by any tester.

- 121
- 122 3) If unable to disconnect the energy storage system as instructed in Sections 4.2.G.1 and 4.2.G.2,
123 the energy storage system shall store maximum energy and the transfer of energy to and from
124 the energy storage system shall be minimized during the test.
125
- 126 a) For battery operated UPSs, to ensure the battery is fully charged, perform the following steps:
127 i. For UPSs that have an indicator to show that the battery is fully charged, continue
128 charging for an additional 5 hours after the charge indicator is present.
129 ii. If there is no charge indicator, but the manufacturer's instructions provide a time estimate
130 for when charging this battery or this capacity of battery should be complete, continue
131 charging for an additional 5 hours after the manufacturer's estimate.
132 iii. If there is no indicator and no time estimate in the instructions, but the charging current is
133 stated on the UPS or in the instructions, terminate charging 1 hour after the calculated
134 test duration or, if none of the above applies, the duration shall be 24 hours.
135
- 136 b) For battery operated UPSs, if the UPS is shipped with a battery, that battery shall be used for
137 testing. Otherwise, the manufacturer may select which battery is used for the test, which shall
138 be referenced in the PPDS and documented in the test reporting template. These units will
139 not be required to ship with the battery chosen for testing.
140
141

⁴ 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.

142 **5 TEST PROCEDURES FOR ALL PRODUCTS**

143 A) Required Calculations: Equations 1 and 2 shall be used when calculating the UUT’s average power
144 and efficiency:
145

146 **Equation 1: Calculation of Average Power**
147

$$P_{AVG} = \frac{E_{TOT}}{t}$$

148 *Where:*

- 149 ▪ P_{AVG} is the average power in watts.
- 150 ▪ E_{TOT} is the total energy in watt-hours.
- 151 ▪ t is the length of the measurement in hours.

152 **Equation 2: Calculation of Efficiency**
153
154

$$Eff = \frac{P_{AVG_OUT}}{P_{AVG_IN}}$$

155 *Where:*

- 156 ▪ Eff is the UPS efficiency.
- 157 ▪ P_{AVG_OUT} is the average output power in watts.
- 158 ▪ P_{AVG_IN} is the average input power in watts.

159
160 B) Steady-state: Allow the UUT to stabilize for 125% of the manufacturer-specified rise time, as
161 instructed in IEC 62040-3, Ed. 2.0. During the final 20 minutes of the stabilization period, at each
162 loading point, perform the following steady-state check:
163

- 164 1) Simultaneously measure the unit’s accumulated input and output energy in watt-hours (Wh) for at
165 least 5 minutes using a power meter.
- 166 2) Calculate the unit’s average power in watts (W) over the 5 minute period using Equation 1.
- 167 3) Calculate the unit’s efficiency over the 5 minute period using Equation 2.
- 168 4) Wait a minimum of 10 minutes.
- 169 5) Repeat steps 1 to 3 for another 5 minute measurement.
- 170 6) Compare the two efficiency calculations attained in step 3 and step 5.
- 171 7) The test unit is at steady-state if the absolute value of the difference between the two efficiency
172 calculations is less than one percent of the average of the two readings.
- 173 8) If the absolute value of the difference between the efficiency calculations is greater than or equal
174 to one percent of their average, repeat steps 4 to 6 until the unit is considered to be at steady-
175 state. Record the appropriate values in the test reporting template.

176
177 C) Efficiency Measurements: Input and output power measurements for efficiency calculations shall be
178 performed on the UUT according to Section J.3 of IEC standard 62040-3, Ed. 2.0, with the following
179 exceptions.
180

- 181 1) Test the UUT at the following reference test load conditions:
182
 - 183 a) Ac-output UPS: 100%, 75%, 50%, 25%, and 0% of the rated output power.
 - 184 b) Dc-output UPS: 80%, 70%, 60%, 50%, 40%, 30%, 0% of the rated output power.

185
186 *Note:* For the 0% loading condition (i.e., the test load disconnected, but output inverter
187 operational for Ac-output UPS), measure only at the input to the UUT.
188

189 2) The test shall be performed at each of the reference test loads by simultaneously accumulating
190 the total input and output energy in Wh over a 15 minute test period, then determining the
191 average power for the period using Equation 1.

192
193 *Note:* Total energy accumulation rate shall be at least 1 Hz.

194
195 3) Measure and record all the applicable parameters listed in the test reporting template for each
196 Ac-output/Dc-output UPS test performed, including the Ac-output UPS input dependency
197 characteristic (AAA) in the tested modes, as specified in Section 5.3.4 of IEC standard 62040-3,
198 Ed. 2.0.

199
200 D) Input Power Factor Measurements: Measure and report the input power factor of the UUT per Section
201 6.4.1.5 of IEC standard 62040-3, Ed. 2.0, for each mode at 100% of the reference test load.⁵

202

203 **6 REFERENCES**

204 A) ATIS-0600015.04.2010, *Energy Efficiency for Telecommunication Equipment: Methodology for*
205 *Measurement and Reporting DC Power Plant – Rectifier Requirements*. January 1, 2010.

206
207 B) ATIS-0600015.2009, *Energy Efficiency for Telecommunication Equipment: Methodology for*
208 *Measurement and Reporting – General Requirements*. February 1, 2009.

209
210 C) IEC 62040-3:2011, Ed. 2.0, *Uninterruptible power systems (UPS) - Part 3: Method of specifying the*
211 *performance and test requirements*, Section J.2. March 14, 2011.

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