



ENERGY STAR[®] Program Requirements Product Specification for Computer Servers

Final Draft Test Method Rev. Jan-2013

1 OVERVIEW

The following test method shall be used for determining compliance with requirements in the ENERGY STAR Product Specification for Computer Servers and when acquiring test data for reporting of Full Load power on the ENERGY STAR Power and Performance Data Sheet.

2 APPLICABILITY

The following test method is applicable to all products eligible for qualification under the ENERGY STAR Product Specification for Computer Servers.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the ENERGY STAR Product Specification for Computer Servers.

4 TEST SETUP

A) Input Power: Input power shall be as specified in Table 1 and Table 2. The frequency for input power shall be as specified in Table 3.

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with ac-dc Single-Output Power Supply Units (PSUs)	230 V ac	+/- 1.0 %	2.0 %
Servers with ac-dc Multi-Output PSUs	230 V ac and/or 115 V ac		
Optional Testing Conditions For ac-dc Japanese Market	100 V ac		
Three-phase Servers	208 V ac		

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Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than 1500 W

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with ac-dc Single-Output PSUs	230 V ac	+/- 4.0 %	5.0 %
Servers with ac-dc Multi-Output PSUs	230 V ac and/or 115 V ac		
Optional Testing Conditions For ac-dc Japanese Market	100 V ac		
Three-phase Servers	208 V ac		

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Table 3: Input Frequency Requirements for All Products

Supply Voltage	Frequency	Frequency Tolerance
100 V ac	50 Hz	±1.0%
115 V ac	60 Hz	
230 V ac	50 Hz or 60 Hz	
Three-phase	60 Hz	

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Note: DOE received recommendations to include three-phase powered Servers in the input voltage requirements. DOE has modified Table 1, Table 2, and Table 3 to include three-phase voltage and frequency requirements. The values specified are consistent with the Server Efficiency Rating Tool (SERT) Run and Reporting Rules.

DOE welcomes feedback on the specified voltage and frequency levels.

- 20 B) Ambient Temperature: Ambient temperature shall be within 25 ± 5 °C.
- 21 C) Relative Humidity: Relative humidity shall be within 15% and 80%.
- 22 D) Power Analyzer: The power analyzer shall report true Root Mean Square (RMS) power and at least
- 23 two of the following measurement units: voltage, current and power factor. Power analyzers shall
- 24 possess the following attributes:

- 25 1) Compliance: The power analyzer shall be chosen from the list of power measuring devices
26 specified in the Server Efficiency Rating Tool (SERT)^{TM1} Power Measurement and Set up Guide.
- 27 2) Calibration: The analyzer shall have been calibrated within a year of the test date, by a standard
28 traceable to the National Institute of Science and Technology (USA) or a counterpart national
29 metrology institute in other countries.
- 30 3) Crest Factor: An available current crest factor of 3 or more at its rated range value. For analyzers
31 that do not specify the current crest factor, the analyzer must be capable of measuring an
32 amperage spike of at least 3 times the maximum amperage measured during any 1 second
33 sample.
- 34 4) Minimum Frequency Response: 3.0 kHz.
- 35 5) Minimum Resolution:
- 36 a) 0.01 W for measurement values less than 10 W;
- 37 b) 0.1 W for measurement values from 10 W to 100 W; and
- 38 c) 1.0 W for measurement values greater than 100 W.
- 39 6) Logging: The reading rate supported by the analyzer shall be at least 1 set of measurements per
40 second, where set is defined as a power measurement, in watts. The data averaging interval of
41 the analyzer shall equal the reading interval. Data averaging interval is defined as the time period
42 over which all samples captured by the high-speed sampling electronics of the analyzer are
43 averaged to provide the measurement set.
- 44 7) Measurement Accuracy: Power measurements shall be reported by the analyzer with an overall
45 accuracy of 1% or better for all measured power values.
- 46 E) Temperature Sensor: The temperature sensor shall possess the following attributes:
- 47 1) Compliance: The temperature sensor shall be chosen from the list of temperature measuring
48 devices specified in the SERT Power Measurement and Set up Guide.
- 49 2) Logging: The sensor shall have a minimum reading rate of 4 samples per minute.
- 50 3) Measurement Accuracy: Temperature must be measured no more than 50mm in front of (upwind
51 of) the main airflow inlet of the UUT and reported by the sensor with an overall accuracy of
52 ± 0.5 °C or better.
- 53 F) Active State Test Tool: SERT, provided by Standard Performance Evaluation Corporation (SPEC)²
- 54 G) Controller: The controller system may be a server, a desktop computer, or a laptop and shall be used
55 to record power and temperature data.
- 56 1) The power analyzer and the temperature sensor shall be connected to the controller.
- 57 2) The controller and the UUT shall be connected to each other via an Ethernet network switch.
- 58 H) General SERT Requirements: Any additional requirements specified in any SPEC or SERT
59 supporting documents shall be followed, unless otherwise specified in this test method. Supporting
60 documents from SPEC include:
- 61 1) Power and Performance Benchmark Methodology
- 62 2) Power and Temperature Measurement Setup Guide
- 63 3) PTDaemon Design Document
- 64 4) SERT Design Document
- 65 5) SERT Run and Reporting Rules
- 66 6) SERT User Guide

¹ <http://www.spec.org/sert/>

² <http://www.spec.org/>

Note: DOE has included the SERT, developed by SPEC, to test the power and performance of computer servers.

DOE has modified the Final Draft Test Method to be consistent with the language and specifications in the Run and Reporting Rules, User Guide, Power and Temperature Measurement Setup Guide, and any other supporting documents provided for SERT.

67 **5 TEST CONDUCT**

68 **5.1 Active State Efficiency Test Configuration**

69 Power and efficiency shall be tested and reported for the computer servers being tested. Testing shall be
70 conducted as follows:

71 A) As-shipped Condition: Products shall be tested in their “as-shipped” configuration, which includes
72 both hardware configuration and system settings, unless otherwise specified in this test method.
73 Where relevant, all software options shall be set to their default condition.

74 B) Measurement Location: All power measurements shall be taken at a point between the ac power
75 source and the UUT. No Uninterruptible Power Supply (UPS) units may be connected between the
76 power meter and the UUT. The power meter shall remain in place until all Idle and Active Load power
77 data are fully recorded. When testing a Blade system, power shall be measured at the input of the
78 blade chassis (i.e., at the power supplies that convert data center distribution power to chassis
79 distribution power).

80 C) Air Flow: Purposefully directing air in the vicinity of the measured equipment in a way that would be
81 inconsistent with normal data center practices is prohibited.

82 D) Power Supplies: All power supply units (PSUs) shall be connected and operational.

83 1) UUTs with Multiple PSUs: All power supplies shall be connected to the ac power source and
84 operational during the test. If necessary, a Power Distribution Unit (PDU) may be used to connect
85 multiple power supplies to a single source. If a PDU is used, any overhead electrical use from the
86 PDU shall be included in the power measurement of the UUT. When testing blade servers with
87 half-populated chassis configurations, the power supplies for the unpopulated power domains can
88 be disconnected (see section 5.2.D)3) for more information).

89 E) Power Management and Operating System: The as-shipped operating system or a representative
90 operating system shall be installed. Products that are shipped without operating systems shall be
91 tested with any compatible operating system installed. For all tests, the power management
92 techniques and/or power saving features shall be left as-shipped. Any power management features
93 which require the presence of an operating system (i.e. those that are not explicitly controlled by the
94 Basic Input Output System (BIOS) or management controller) shall be tested using only those power
95 management features enabled by the operating system by default.

96 F) Storage: Products shall be tested for qualification with at least one Hard Disk Drive (HDD) or one
97 Solid State Drive (SSD) installed. Products that do not include pre-installed hard drives (HDD or SSD)
98 shall be tested using a storage configuration used in an identical model for sale that does include pre-
99 installed hard drives. Products that do not support installation of hard drives (HDD or SDD) and,
100 instead, rely exclusively on external storage solutions (e.g. storage area network) shall be tested
101 using external storage solutions.

102 G) Blade and Dual/Multi-Node Servers: A Blade or Dual/Multi-Node Server shall have identical
103 configurations for each node or blade including all hardware components and software/power

104 management settings. These systems shall also be measured in a way to ensure that all power from
105 all tested nodes/blades is being captured by the power meter during the entire test.

106 H) Blade Chassis: The blade chassis, at a minimum, shall have power, cooling and networking
107 capabilities for all the blade servers. The chassis shall be populated as specified in section 5.2.D). All
108 power measurements for blades shall be made at the input of the chassis.

109 I) BIOS and UUT System Settings: All BIOS settings shall remain as-shipped unless otherwise
110 specified in the test method.

111 J) I/O and Network Connection: The UUT shall have at least one port connected to an Ethernet network
112 switch. The switch shall be capable of supporting the UUT's highest and lowest rated network
113 speeds. The network connection shall be live during all tests, and, although the link shall be ready
114 and able to transmit packets, no specific traffic is required over the connection during testing. The
115 UUT shall be set up with minimal I/O add-in cards; for testing, ensure the server offers at least one
116 Ethernet port (using a single add-in card only if no onboard Ethernet support is offered).

117 1) Ethernet Connections: Products shipped with support for Energy Efficient Ethernet (compliant
118 with IEEE 802.3az) shall be connected only to Energy Efficient Ethernet compliant network
119 equipment during testing. Appropriate measures shall be taken to enable EEE features on both
120 ends of the network link during all tests.

121 5.2 UUT Preparation

122 A) The UUT shall be tested with all available processor sockets populated.

123 B) Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is
124 complete.

125 C) If the UUT is a multi-node system, the UUT shall be tested for per node power consumption in the full
126 chassis configuration. All multi-node servers installed in the chassis shall be identical, sharing the
127 same configuration.

Note: For qualification, the ENERGY STAR Specification requires that the multi-node servers be tested in the full chassis configuration.

128 D) If the UUT is a blade system, the UUT shall be tested for per blade power consumption in the half
129 chassis configuration with an additional option of testing the UUT in the full chassis configuration. For
130 blade systems, populate the chassis as follows:

131 1) Individual Blade Configuration

132 a) All blade servers installed in the chassis shall be identical, sharing the same configuration
133 (homogeneous).

134 2) Full Chassis Population (Optional)

135 a) Populate all available chassis bays. All power supplies and cooling fans shall be connected.
136 Proceed with all required tests in the test procedure.

137 3) Half Chassis Population (Required)

138 a) Calculate the number of blades required to populate half the number of available chassis
139 bays. Round up to the nearest integer to fill any partially loaded power domains.

140 b) Follow all user manual or manufacturer recommendations for partially populating the chassis,
141 which may include disconnecting some of the power supplies and cooling fans for the
142 unpopulated power domains.

- 143 c) If user manual recommendations are not available or are incomplete, then use the following
144 guidance:
- 145 i. Starting with the top left corner while facing the chassis, completely populate the power
146 domains.
- 147 ii. If possible, disconnect the power supplies and cooling fans for the unpopulated power
148 domains.
- 149 iii. Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration
150 of testing.
- 151 E) Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection shall be
152 maintained for the duration of testing, except for brief lapses necessary for transitioning between link
153 speeds. If a controller system is required to provide workload harness control, data acquisition, or
154 other UUT testing support, the controller system shall be connected to the same network switch as
155 the UUT and satisfy all other UUT network requirements.
- 156 F) Connect the power meter to an ac voltage source set to the appropriate voltage and frequency for the
157 test, as specified in Section 4.
- 158 G) Plug the UUT into the measurement power outlet on the power meter following the guidelines in
159 5.1.B).
- 160 H) Connect the data output interface of the power meter and the temperature sensor to the appropriate
161 input of the controller system.
- 162 I) Verify that the UUT is configured in its as-shipped configuration.
- 163 J) Verify that the controller system and UUT are connected on the same internal network via an
164 Ethernet network switch.
- 165 K) Use a normal *ping* command to verify that the controller system and UUT can communicate with each
166 other.
- 167 L) Install SERT on the UUT and the controller system as specified in the SERT User Guide.

168 **6 TEST PROCEDURES FOR ALL PRODUCTS**

169 **6.1 Idle State Testing**

- 170 A) Power on the UUT, either by switching it on or connecting it to mains power.
- 171 B) Power on the controller system.
- 172 C) Begin recording elapsed time.
- 173 D) Between 5 and 15 minutes after the completion of initial boot or log in, set the power meter to begin
174 accumulating idle power values at an interval of greater than or equal to 1 reading per second.
- 175 E) Accumulate idle power values for 30 minutes. The UUT shall maintain in Idle State throughout this
176 period and shall not enter lower power states with limited functionality (e.g., sleep or hibernate).

Note: A stakeholder commented that intermittent maintenance activity automated by the server will affect power consumption in the Idle State and the 5 minute idle power measurement period will not capture this variation. Initiation of maintenance cycles, like memory scrubbing, during the Idle State operation will result in an increase in the server's Idle State power consumption.

DOE has increased the Idle State power measurement period from 5 to 30 minutes to capture the effect of such maintenance cycles. DOE believes that the longer measurement period will average out the effect

of these maintenance cycles and provide a more repeatable result.

- 177 F) Record the average idle power (arithmetic mean) during the 30 minute test period.
- 178 G) When testing a multi-node or blade system, proceed as follows to derive single node or single blade
179 power:
- 180 1) Divide the measured total idle power in Section 6.1.F) by the number of nodes/blades installed for
181 the test;
- 182 2) Record the measured total and per-node/per-blade power values as calculated in 6.1.G)1) for
183 each measurement.

184 **6.2 Active State Testing Using SERT**

- 185 A) Reboot the UUT.
- 186 B) Between 5 and 15 minutes after the completion of initial boot or log in, follow the SERT User Guide to
187 engage SERT.
- 188 C) Follow all steps outlined in the SERT user guide to successfully run SERT.
- 189 1) Manual intervention or optimization to the controller, UUT, or its internal and external environment
190 is prohibited during the execution of SERT.
- 191 D) Once SERT is completed, include the following output files with all testing results:
- 192 1) results.html
- 193 2) results.txt
- 194 3) all results-chart png files (e.g. results-chart0.png, results-chart1.png, etc.)
- 195 4) results-details.html
- 196 5) results-details.txt
- 197 6) all results-details-chart png files (e.g. results-details-chart0.png, results-details-chart1.png, etc.)

Note: DOE has added test configuration and reporting requirements using SERT. SERT replaces the previous Active State test, which was a benchmark used at the discretion of the manufacturer.