ENERGY STAR® Program Requirements
Product Specification for
Computer Servers

Final Draft Test Method
Rev. Jan-2013

1 # 1 OVERVIEW

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

5 # 2 APPLICABILITY

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

8 # 3 DEFINITIONS

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

11 # 4 TEST SETUP

12 **A)** <u>Input Power:</u> Input power shall be as specified in Table 1 and Table 2. The frequency for input power
13 shall be as specified in Table 3.

14 **Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or**
15 **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		

16 **Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater Than**
17 **1500 W**

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

18 **Table 3: Input Frequency Requirements for All Products**

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

19

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. |

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.

5 TEST CONDUCT

5.1 Active State Efficiency Test Configuration

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

A) <u>As-shipped Condition</u>: Products shall be tested in their "as-shipped" configuration, which includes both hardware configuration and system settings, unless otherwise specified in this test method. Where relevant, all software options shall be set to their default condition.

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

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

D) <u>Power Supplies</u>: All power supply units (PSUs) shall be connected and operational.

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

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

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

G) <u>Blade and Dual/Multi-Node Servers</u>: A Blade or Dual/Multi-Node Server shall have identical 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.

5.2 UUT Preparation

121

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.

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.