Note: This Test Method revision is reformatted for clarity and incorporates updates to support the active mode testing criteria in the specification. As this topic remains under development, the Test Method will be further revised prior to finalization of Version 2.0 to address updates from the draft development process.

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 ACRONYMS

A) Ac: Alternating Current
B) BIOS: Basic Input Output System
C) Dc: Direct Current
D) DOE: U.S Department of Energy
E) EEE: Energy Efficient Ethernet
F) EPA: Environmental Protection Agency
G) HDD: Hard Disk Drive
H) Hz: Hertz
5 TEST SETUP

A) Input Power: Input power shall be as specified in Ambient Temperature: Ambient temperature shall be no less than 18 °C and no greater than 28 °C over the duration of the test.

B) Relative Humidity: Relative humidity shall be within 15% and 80%.

C) Table 1 and Table 2. The frequency for input power shall be as specified in Table 3.

D) Ambient Temperature: Ambient temperature shall be no less than 18 °C and no greater than 28 °C over the duration of the test.

E) Relative Humidity: Relative humidity shall be within 15% and 80%.
Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Supply Voltage</th>
<th>Voltage Tolerance</th>
<th>Maximum Total Harmonic Distortion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers with Ac-Dc Single-Output PSUs</td>
<td>230 V ac</td>
<td>+/- 1.0 %</td>
<td>2.0 %</td>
</tr>
<tr>
<td>Servers with Ac-Dc Multi-Output PSUs</td>
<td>230 V ac and/or 115 V ac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional Testing Conditions For Ac-Dc Japanese Market</td>
<td>100 V ac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dc Servers</td>
<td>+/- 53 V dc</td>
<td>+/- 1.0 V</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Supply Voltage</th>
<th>Voltage Tolerance</th>
<th>Maximum Total Harmonic Distortion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servers with Ac-Dc Single-Output PSUs</td>
<td>230 V ac</td>
<td>+/- 4.0 %</td>
<td>5.0 %</td>
</tr>
<tr>
<td>Servers with Ac-Dc Multi-Output PSUs</td>
<td>230 V ac and/or 115 V ac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Optional Testing Conditions For Ac-Dc Japanese Market</td>
<td>100 V ac</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dc Servers</td>
<td>+/- 53 V dc</td>
<td>+/- 1.0 V</td>
<td></td>
</tr>
</tbody>
</table>

Note: For clarity purposes, voltage requirements are reorganized based on nameplate power ratings of the product. This is consistent with other ENERGY STAR Test Methods.
Table 3: Input Frequency Requirements for All Products

<table>
<thead>
<tr>
<th>Supply Voltage</th>
<th>Frequency</th>
<th>Frequency Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 V ac</td>
<td>50 Hz</td>
<td>±1.0%</td>
</tr>
<tr>
<td>115 V ac</td>
<td>50 Hz</td>
<td></td>
</tr>
<tr>
<td>230 V ac</td>
<td>50 Hz or 60 Hz</td>
<td></td>
</tr>
</tbody>
</table>

F) Power Meter: Power Meter(s) shall report true Root Mean Square (RMS) power and at least two of the following measurement units: voltage, current and power factor. Power Meter(s) shall possess the following attributes:

**Note:** The Power Meter language is revised to clarify required measurement outputs.

1) **Calibration:** The meter shall be calibrated within the past one year of the test date, by a standard traceable to National Institute of Science and Technology (USA) or a counterpart national metrology institute in other countries.

**Note:** The Calibration provisions are added per Stakeholder recommendations for active mode testing.

2) **Crest Factor:** An available current crest factor of 3 or more at its rated range value. For analyzers that do not specify the current crest factor, the analyzer must be capable of measuring an amperage spike of at least 3 times the maximum amperage measured during any 1 second sample.

3) **Minimum Frequency Response:** 3.0 kHz

4) **Minimum Resolution:**
   a) 0.01 W for measurement values less than 10 W;
   b) 0.1 W for measurement values from 10 W to 100 W; and
   c) 1.0 W for measurement values greater than 100 W.

5) **Logging:** The reading rate supported by the meter shall be at least 1 set of measurements per second, where set is defined as watts. The data averaging interval of the analyzer shall equal the reading interval. Data averaging interval is defined as the time period over which all samples captured by the high-speed sampling electronics of the analyzer are averaged to provide the measurement set.

**Note:** The Logging provisions for power measurements are added per Stakeholder recommendations for active mode testing.

6) **Measurement Accuracy:** Measurement uncertainty as introduced by the instrument that measures the input power to the product under test, including any external shunts.
   a) Power measurements with a value greater than or equal to 0.5 W shall be made with an uncertainty of less than or equal to 2% at the 95% confidence level.
   b) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than or equal to 0.01 W at the 95% confidence level.

G) **Temperature Sensor:** The temperature sensor shall possess the following attributes:

1) **Logging:** The sensor shall have a minimum reading rate of 4 samples per minute.
2) **Measurement Accuracy:** Temperature must be measured no more than 50 mm in front of (upwind of) the main airflow inlet of the UUT and reported by the sensor with an overall accuracy of ± 0.5 °C or better.

**Note:** The Temperature Sensor provisions are added per Stakeholder recommendations for active mode testing.

### 6 TEST CONDUCT

#### 6.1 Active Mode Efficiency Test Configuration

The Partner must test and report power and efficiency test results for the computer servers being tested. Testing shall be conducted as follows:

A) **As-shipped Condition:** 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 options and software shall be set to their default condition.

B) **Measurement Location:** All power measurements shall be taken at a point between the ac or dc power source and the unit under test (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 full load power data are fully recorded.

C) **Airflow:** Overtly directing air flow in the vicinity of the measured equipment in a way that would be inconsistent with normal data center practices is not allowed.

**Note:** The Airflow provision is added per Stakeholder recommendations for active mode testing.

D) **Power Supplies:** All PSUs must be connected and operational.

1) **UUTs with Multiple PSUs:** All power supplies must be connected to the ac or dc 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.

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

F) **Storage (HDD, SSD):** Products shall be tested for qualification with at least one hard drive (HDD or SSD) installed. Products that do not include pre-installed hard drives (HDD or SSD) must be tested using a configuration that is identical in all respects with the exception of installation of at least one installed hard drive available for sale with the product. 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.
**Note:** Language is clarified regarding testing of Computer Servers shipping without an installed storage device. EPA welcomes feedback on appropriate conditions for Servers designed to rely exclusively on external storage.

**G) Blade and Dual/Multi-Node Servers:** A Blade or Dual/Multi-Node Server must have identical configurations for each node or blade including all hardware components and software/power management settings. These systems must also be measured in a way to ensure that all power from all tested nodes/blades is being captured by the power meter during the entire test.

**H) Blade Chassis:** The blade chassis, at a minimum, shall have power, cooling and networking capabilities for all the blade servers. The chassis shall be populated as specified in section 6.2 B). All power measurements for blades shall be made at the input of the chassis.

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

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

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

### 6.2 UUT Preparation

Computer Server power and efficiency must be determined and reported under the following conditions:

**A) Record the UUT manufacturer, model name, and configuration details, including:** operating system name and version, processor type and speed, installed power supplies, physical memory, hard drive configuration, installed I/O devices, power management features enabled, etc. Record nameplate power ratings.

1) When testing a blade server, also record the blade chassis model.

**B) Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is complete. If the UUT is a blade system, populate the chassis as follows:**

1) All blade servers installed in the chassis must be identical, sharing the same configuration (homogeneous).

2) **Chassis Population (Full)**

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

3) **Chassis Population (Half)**

   a) Populate half of the available chassis bays.
Follow all user manual recommendations for partially populating the chassis, which may include disconnecting some of the power supplies and cooling fans for the unpopulated power domains.

If user manual recommendations are not available or are incomplete, then use the following guidance:

i. When loading blades, completely populate one power domain of the chassis at a time.

ii. For partially-populated power domains, place the blades from the center outward.

iii. Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of testing.

Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection must be maintained for the duration of testing, except for brief lapses necessary for transitioning between link speeds. If a controller system is required to provide workload harness control, data acquisition, or other UUT testing support, the controller system shall be connected to the same network switch as the UUT and satisfy all other UUT network requirements.

Connect the power analyzers to an ac or dc voltage source set to the appropriate voltage and frequency for the test as specified in Section 4 of this test method.

Plug the UUT into the measurement power outlet on the power analyzer, using the following guidelines:

1) No UPS units shall be connected between the power analyzer and the UUT;

2) The power analyzer shall remain connected until all testing is complete;

3) 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);

4) If a controller system is being used, connect the data output interface of the power analyzer(s) to the appropriate input of the controller system.

Verify that the UUT is configured in its as–shipped configuration.

Install manufacturer specified workload software on the UUT. Record the installed workload and configuration, including any custom parameters or settings.

Record the input voltage and frequency.

7 TEST PROCEDURE

7.1 Power and Efficiency Testing

Power on the UUT, either by switching it on or connecting it to mains power.

If necessary, power on the controller system.

Begin recording elapsed time.
D) Between 5 and 15 minutes after the initial boot or log in, set the analyzer to begin accumulating power values at an interval of greater than or equal to 1 reading per second.

1) When testing using a controller system, the controller system may automate data accumulation and benchmark workload operation provided the measurement interval requirements are met.

E) Idle power measurement can be performed one of two ways:

1) Automatic idle measurement: The workload automates the measurement of Idle power.

2) Manual idle measurement: Accumulate Idle power values for 5 minutes before engaging the workload. The UUT must maintain an Idle state throughout this period and must not enter lower power states with limited availability (e.g., server sleep or hibernate states).

Note: DOE and EPA propose that for cases where the workload does not automate measurement of Idle power, manual Idle power measurements must be recorded before engaging any workload in order to avoid the aforementioned scenario. Such an approach is intended to avoid the system not fully entering an idle state due to remnants from active testing remaining present in the background. DOE and EPA welcome comments on this proposal.

F) Engage workload operation.

G) Record the following data at the end of workload operation:

1) Average Idle power (arithmetic mean) during the automated Idle state period; or

2) Average Idle power (arithmetic mean) during the 5 minute test period.

H) Record On Mode power averaged over the workload duration. If the workload is composed of different worklets stressing different functionalities, then the average power for each worklet shall be reported.

I) When testing a Blade System, proceed as follows to derive single blade power:

1) Divide the measured total power by the number of blades installed during the test;

2) Record the per-blade power values for each measurement and the measured total power.

8 REPORTING

Test Reporting Template for Computer Servers shall be completed with the recorded data for each Server tested.