



ENERGY STAR® Program Requirements for Computer Servers

Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR qualified products. The ENERGY STAR Partner must adhere to the following partner commitments:

Qualifying Products

1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for Computer Servers. A list of eligible products and their corresponding Eligibility Criteria can be found at www.energystar.gov/specifications.
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR qualification from a Certification Body recognized by EPA for Computer Servers. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform Computer Servers testing. A list of EPA-recognized laboratories and certification bodies can be found at www.energystar.gov/testingandverification.

Using the ENERGY STAR Name and Marks

3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at www.energystar.gov/logouse.
4. Use the ENERGY STAR name and marks only in association with qualified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is qualified and offered for sale in the U.S and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR qualified Computer Servers.

Partner shall adhere to the following product-specific commitments regarding use of the ENERGY STAR certification mark on qualified products:

5.1. Partner must use the ENERGY STAR mark in all of the following ways:

- 5.1.1. The ENERGY STAR mark shall be included on the product specification sheet on the Partner's Web site where product information is displayed. This mark shall serve as a hyperlink from the manufacturer's specification sheet to the ENERGY STAR product website for Computer Servers;
- 5.1.2. The ENERGY STAR mark shall be used to identify qualified computer servers and computer server families in electronic and printed marketing and collateral materials, including but not limited to user manuals, product guides, and marketing brochures.

5.2. If additional information about the ENERGY STAR program(s) or other products is provided by the Partner on its Web site, Partner must comply with the *ENERGY STAR Web Linking Policy*, which can be found at www.energystar.gov/partners.

Verifying Ongoing Product Qualification

6. Participate in third-party verification testing through a Certification Body recognized by EPA for Computer Servers, providing full cooperation and timely responses, EPA/DOE may also, at its

discretion, conduct tests on products that are referred to as ENERGY STAR qualified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

Providing Information to EPA

7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
 - 7.1. Partner must submit the total number of ENERGY STAR qualified Computer Servers shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner. Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).
 - 7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
 - 7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner;
8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR qualified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR qualified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR qualified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR qualified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR qualified products.

- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR qualified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR qualified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.
- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway.
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel-based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit www.epa.gov/greenpower.



ENERGY STAR® Program Requirements Product Specification for Computer Servers

Eligibility Criteria Version 3.0

Following is the Version 3.0 ENERGY STAR Product Specification for Computer Servers. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1 DEFINITIONS

A) Product Types:

- 1) Computer Server: A computer that provides services and manages networked resources for client devices (e.g., desktop computers, notebook computers, thin clients, wireless devices, PDAs, IP telephones, other computer servers, or other network devices). A computer server is sold through enterprise channels for use in data centers and office/corporate environments. A computer server is primarily accessed via network connections, versus directly-connected user input devices such as a keyboard or mouse. For purposes of this specification, a computer server must meet **all** of the following criteria:
 - A. is marketed and sold as a Computer Server;
 - B. is designed for and listed as supporting one or more computer server operating systems (OS) and/or hypervisors;
 - C. is targeted to run user-installed applications typically, but not exclusively, enterprise in nature;
 - D. provides support for error-correcting code (ECC) and/or buffered memory (including both buffered dual in-line memory modules (DIMMs) and buffered on board (BOB) configurations).
 - E. is packaged and sold with one or more ac-dc or dc-dc power supplies; and
 - F. is designed such that all processors have access to shared system memory and are visible to a single OS or hypervisor.
- 2) Blade System: A system comprised of a blade chassis and one or more removable blade servers and/or other units (e.g., blade storage, blade network equipment). Blade systems provide a scalable means for combining multiple blade server or storage units in a single enclosure, and are designed to allow service technicians to easily add or replace (hot-swap) blades in the field.
 - A. Blade Server: A computer server that is designed for use in a blade chassis. A blade server is a high-density device that functions as an independent computer server and includes at least one processor and system memory, but is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for operation. A processor or memory module that is intended to scale up a standalone server is not considered a Blade Server.
 - (1) *Multi-bay Blade Server*: A blade server requiring more than one bay for installation in a blade chassis.
 - (2) *Single-wide Blade Server*: A blade server requiring the width of a standard blade server bay.

- (3) *Double-wide Blade Server*: A blade server requiring twice the width of a standard blade server bay.
 - (4) *Half-height Blade Server*: A blade server requiring one half the height of a standard blade server bay.
 - (5) *Quarter-height Blade Server*: A blade server requiring one quarter the height of a standard server bay.
 - (6) *Multi-Node Blade Server*: A blade server which has multiple nodes. The blade server itself is hot swappable, but the individual nodes are not.
- B. Blade Chassis: An enclosure that contains shared resources for the operation of blade servers, blade storage, and other blade form-factor devices. Shared resources provided by a chassis may include power supplies, data storage, and hardware for dc power distribution, thermal management, system management, and network services.
 - C. Blade Storage: A storage device that is designed for use in a blade chassis. A blade storage device is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for operation.
- 3) Fully Fault Tolerant Server: A computer server that is designed with complete hardware redundancy, in which every computing component is replicated between two nodes running identical and concurrent workloads (i.e., if one node fails or needs repair, the second node can run the workload alone to avoid downtime). A fully fault tolerant server uses two systems to simultaneously and repetitively run a single workload for continuous availability in a mission critical application.
 - 4) Resilient Server: A computer server designed with extensive Reliability, Availability, Serviceability (RAS) and scalability features integrated in the micro architecture of the system, CPU and chipset. For purposes of ENERGY STAR certification under this specification, a Resilient Server shall have the following characteristics:
 - A. Processor RAS: The processor must have capabilities to detect, correct, and contain data errors, as described by all of the following:
 - (1) Error recovery by means of instruction retry for certain processor faults;
 - (2) Error detection on L1 caches, directories, and address translation buffers using parity protection; and
 - (3) Single bit error correction (or better) on caches that can contain modified data. Corrected data is delivered to the recipient as part of the request completion.
 - B. System Recovery & Resiliency: No fewer than six of the following characteristics shall be present in the server:
 - (1) Error recovery and containment by means of (a) data poison indication (tagging) and propagation which includes mechanism to notify the OS or hypervisor to contain the error, thereby reducing the need for system reboots and (b) containment of address/command errors by preventing possibly contaminated data from being committed to permanent storage;
 - (2) The processor technology is designed to provide additional capability and functionality without additional chipsets, enabling the design into systems with four or more processor sockets;
 - (3) Memory Mirroring: A portion of available memory can be proactively partitioned such that a duplicate set may be utilized upon non-correctable memory errors. This can be implemented at the granularity of DIMMs or logical memory blocks;
 - (4) Memory Sparing: A portion of available memory may be pre-allocated to a spare function such that data may be migrated to the spare upon a perceived impending failure;

- (5) Support for making additional resources available without the need for a system restart. This may be achieved either by processor (cores, memory, I/O) on-lining support, or by dynamic allocation/deallocation of processor cores, memory, and I/O to a partition;
 - (6) Support of redundant I/O devices (storage controllers, networking controllers);
 - (7) Has I/O adapters or storage devices that are hot-swappable;
 - (8) Can identify failing processor-to-processor lane(s) and dynamically reduce the width of the link in order to use only non-failing lanes or provide a spare lane for failover without disruption;
 - (9) Capability to partition the system such that it enables running instances of the OS or hypervisor in separate partitions. Partition isolation is enforced by the platform and/or hypervisor and each partition is capable of independently booting; or
 - (10) Uses memory buffers for connection of higher speed processor-memory links to DIMMs attached to lower speed DDR channels. Memory buffer can be a separate, standalone buffer chip which is integrated on the system board or integrated on custom-built memory cards.
- C. Power Supply RAS: All power supplies installed or shipped with the server shall be redundant and concurrently maintainable. The redundant and repairable components may also be housed within a single physical power supply, but must be repairable without requiring the system to be powered down. Support must be present to operate the system in a degraded mode.
- D. Thermal and Cooling RAS: All active cooling components shall be redundant and concurrently maintainable. The processor complex must have mechanisms to allow it to be throttled under thermal emergencies. Support must be present to operate the system in a degraded mode when thermal emergencies are detected in the system components.
- 5) Multi-node Server: A computer server that is designed with two or more independent server nodes that share a single enclosure and one or more power supplies. In a multi-node server, power is distributed to all nodes through shared power supplies. Server nodes in a multi-node server are not designed to be hot-swappable.
- A. Dual-node Server: A common multi-node server configuration consisting of two server nodes.
- 6) Server Appliance: A computer server that is bundled with a pre-installed OS and application software that is used to perform a dedicated function or set of tightly coupled functions. Server appliances deliver services through one or more networks (e.g., IP or SAN), and are typically managed through a web or command line interface. Server appliance hardware and software configurations are customized by the vendor to perform a specific task (e.g., name services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP) services), and are not intended to execute user-supplied software.
- 7) High Performance Computing (HPC) System: A computing system which is designed and optimized to execute highly parallel applications for high performance, deep learning, or artificial intelligence applications. HPC systems feature clustered nodes often featuring high speed inter-processing interconnects as well as high memory capability and bandwidth. HPC systems may be purposely built, or assembled from more commonly available computer servers. HPC systems must meet ALL the following criteria:
- A. Marketed and sold as a Computer Server optimized for higher performance computing, augmented or artificial intelligence, or deep learning applications;
 - B. Designed (or assembled) and optimized to execute highly parallel applications;
 - C. Consist of multiple computing nodes, clustered primarily to increase computational capability;

D. Includes high speed inter-processing interconnections between nodes.

- 8) Direct Current (dc) Server: A computer server that is designed solely to operate on a dc power source.
- 9) Large Server: A resilient/scalable server which ships as a pre-integrated/pre-tested system housed in one or more full frames or racks and that includes a high connectivity I/O subsystem with a minimum of 32 dedicated I/O slots.

B) Computer Server Form Factors:

- 1) Rack-mounted Server: A computer server that is designed for deployment in a standard 19-inch data center rack as defined by EIA-310, IEC 60297, or DIN 41494. For the purposes of this specification, a blade server is considered under a separate category and excluded from the rack-mounted category.
- 2) Pedestal/Tower Server: A self-contained computer server that is designed with PSUs, cooling, I/O devices, and other resources necessary for stand-alone operation. The frame of a pedestal server is similar to that of a tower client computer.

C) Computer Server Components:

- 1) Power Supply Unit (PSU): A device that converts ac or dc input power to one or more dc power outputs for the purpose of powering a computer server. A computer server PSU must be self-contained and physically separable from the motherboard and must connect to the system via a removable or hard-wired electrical connection.
 - A. Ac-Dc Power Supply: A PSU that converts line-voltage ac input power into one or more dc power outputs for the purpose of powering a computer server.
 - B. Dc-Dc Power Supply: A PSU that converts line-voltage dc input power to one or more dc outputs for the purpose of powering a computer server. For purposes of this specification, a dc-dc converter (also known as a voltage regulator) that is internal to a computer server and is used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by computer server components is not considered a dc-dc power supply.
 - C. Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to one primary dc output for the purpose of powering a computer server. Single-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from any additional PSU outputs that are not primary and standby outputs shall be no greater than 20 watts. PSUs that offer multiple outputs at the same voltage as the primary output are considered single-output PSUs unless those outputs (1) are generated from separate converters or have separate output rectification stages, or (2) have independent current limits.
 - D. Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output power to more than one primary dc output for the purpose of powering a computer server. Multi-output PSUs may offer one or more standby outputs that remain active whenever connected to an input power source. For purposes of this specification, the total rated power output from any additional PSU outputs that are not primary and standby outputs shall be no greater than or equal to 20 watts.
- 2) I/O Device: A device which provides data input and output capability between a computer server and other devices. An I/O device may be integral to the computer server motherboard or may be connected to the motherboard via expansion slots (e.g., PCI, PCIe). Examples of I/O devices include discrete Ethernet devices, InfiniBand devices, RAID/SAS controllers, and Fibre Channel devices.
 - A. I/O Port: Physical circuitry within an I/O device where an independent I/O session can be established. A port is not the same as a connector receptacle; it is possible that a single connector receptacle can service multiple ports of the same interface.

- 3) Motherboard: The main circuit board of the server. For purposes of this specification, the motherboard includes connectors for attaching additional boards and typically includes the following components: processor, memory, BIOS, and expansion slots.
- 4) Processor: The logic circuitry that responds to and processes the basic instructions that drive a server. For purposes of this specification, the processor is the central processing unit (CPU) of the computer server. A typical CPU is a physical package to be installed on the server motherboard via a socket or direct solder attachment. The CPU package may include one or more processor cores.
- 5) Memory: For purposes of this specification, memory is a part of a server external to the processor in which information is stored for immediate use by the processor.
- 6) Storage Device: A collective term for disk drives (HDDs), solid state drives (SSDs), tapes cartridges, and any other mechanisms providing non-volatile data storage. This definition is specifically intended to exclude aggregating storage elements such as RAID array subsystems, robotic tape libraries, filers, and file servers. Also excluded are storage devices which are not directly accessible by end-user application programs, and are instead employed as a form of internal cache.

D) Other Datacenter Equipment:

- 1) Large Network Equipment: A device whose primary function is to pass data among various network interfaces/ports, is mountable in a Standard Equipment Rack, supports network management protocols (e.g. SNMP) and contains at least one of the following features:
 - A. Contains more than eleven (11) physical network ports.
 - B. Total aggregate port throughput of the product is greater than 12 Gb/s.
- 2) Storage Product: A fully-functional storage system that supplies data storage services to clients and devices attached directly or through a network. Components and subsystems that are an integral part of the storage product architecture (e.g., to provide internal communications between controllers and disks) are considered to be part of the storage product. In contrast, components that are normally associated with a storage environment at the data center level (e.g., devices required for operation of an external SAN) are not considered to be part of the storage product. A storage product may be composed of integrated storage controllers, storage devices, embedded network elements, software, and other devices. While storage products may contain one or more embedded processors, these processors do not execute user-supplied software applications but may execute data-specific applications (e.g., data replication, backup utilities, data compression, install agents).
- 3) Uninterruptible Power Supply (UPS)¹: Combination of convertors, switches, and energy storage devices (such as batteries) constituting a power system for maintaining continuity of load power in case of input power failure.

E) Operational Modes and Power States:

- 1) Idle State: The operational state in which the OS and other software have completed loading, the computer server is capable of completing workload transactions, but no active workload transactions are requested or pending by the system (i.e., the computer server is operational, but not performing any useful work). For systems where ACPI standards are applicable, Idle State correlates only to ACPI System Level S0.
- 2) Active State: The operational state in which the computer server is carrying out work in response to prior or concurrent external requests (e.g., instruction over the network). Active state includes **both** (1) active processing and (2) data seeking/retrieval from memory, cache,

¹ Input power failure occurs when voltage and frequency are outside rated steady-state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the UPS.

or internal/external storage while awaiting further input over the network.

F) Other Key Terms:

- 1) Controller System: A computer or computer server that manages a benchmark evaluation process. The controller system performs the following functions:
 - A. start and stop each segment (phase) of the performance benchmark;
 - B. control the workload demands of the performance benchmark;
 - C. start and stop data collection from the power analyzer so that power and performance data from each phase can be correlated;
 - D. store log files containing benchmark power and performance information;
 - E. convert raw data into a suitable format for benchmark reporting, submission and validation; and
 - F. collect and store environmental data, if automated for the benchmark.
- 2) Network Client (Testing): A computer or computer server that generates workload traffic for transmission to a unit under test (UUT) connected via a network switch.
- 3) RAS Features: An acronym for reliability, availability, and serviceability features. The three primary components of RAS as related to a computer server are defined as follows:
 - A. *Reliability Features*: Features that support a server's ability to perform its intended function without interruption due to component failures (e.g., component selection, temperature and/or voltage de-rating, error detection and correction).
 - B. *Availability Features*: Features that support a server's ability to maximize operation at normal capacity for a given duration of downtime (e.g., redundancy [both at micro- and macro-level]).
 - C. *Serviceability Features*: Features that support a server's ability to be serviced without interrupting operation of the server (e.g., hot plugging).
- 4) Server Processor Utilization: The ratio of processor computing activity to full-load processor computing activity at a specified voltage and frequency, measured instantaneously or with a short term average of use over a set of active and/or idle cycles.
- 5) Hypervisor: A type of hardware virtualization technique that enables multiple guest operating systems to run on a single host system at the same time.
- 6) Auxiliary Processing Accelerators (APAs): An additional compute device installed in the computer server that handles parallelized workloads in place of the CPU. This includes, but is not limited to, General Purpose Graphics Processing Units (GPGPUs) and Field Programmable Gate Array (FPGA) chips. There are two specific types of APAs used in servers:
 - A. Expansion APA: An APA that is an add-in card installed in an add-in expansion slot (e.g., GPGPUs installed in a PCI slot). An expansion APA add-in card may include one or more APAs and/or separate, dedicated removeable switches.
 - B. Integrated APA: An APA that is integrated into the motherboard or CPU package.
- 7) Buffered DDR Channel: Channel or Memory Port connecting a Memory Controller to a defined number of memory devices (e.g., DIMMs) in a computer server. A typical computer server may contain multiple Memory Controllers, which may in turn support one or more Buffered DDR Channels. As such, each Buffered DDR Channel serves only a fraction of the total addressable memory space in a computer server.

- G) **Product Family:** A high-level description referring to a group of computers sharing one chassis/motherboard combination that often contains hundreds of possible hardware and software configurations. Products within a product family may differ in color.
- 1) **Common Product Family Attributes:** A set of features common to all models/configurations within a product family that constitute a common basic design. All models/configurations within a product family must share the following:
 - A. Be from the same model line or machine type;
 - B. Either share the same form factor (i.e., rack-mounted, blade, pedestal) or share the same mechanical and electrical designs with only superficial mechanical differences to enable a design to support multiple form factors;
 - C. Either share processors from a single defined processor series or share processors that plug into a common socket type. All configurations shipped as ENERGY STAR within the product family shall contain the same number of populated sockets used during testing. A product family can be defined for a server with only partially populated sockets (e.g. one processor populated in a two socket processor system) as long as the configuration(s) are tested as a separately certified product family, as required, and meet the active efficiency limit for the number of populated sockets within that separate family.
 - D. Share PSUs that perform with efficiencies greater than or equal to the efficiencies at all required load points specified in Section 3.2 (i.e., 10%, 20%, 50%, and 100% of maximum rated load for single-output; 20%, 50%, and 100% of maximum rated load for multi-output).
 - 2) **Product Family Tested Configurations²:**
 - A. **Low-end Performance Configuration:** The combination of Processor Socket Power, PSUs, Memory, Storage Devices, and I/O devices that represents the lowest-performance computing platform within the Product Family. This configuration shall include the lowest processor performance per socket, as represented by the lowest numerical value resulting from the multiplication of the core count by the frequency in GHz, offered for sale and capable of meeting ENERGY STAR requirements.³ It shall also include a memory capacity at least equal to the number of memory channels in the server multiplied by the smallest DIMM size offered in the family.
 - B. **High-end Performance Configuration:** The combination of Processor Socket Power, PSUs, Memory, Storage Devices, and I/O devices that represents the highest-performance computing platform within the Product Family. This configuration shall include the highest processor performance per socket, as represented by the highest numerical value resulting from the multiplication of the core count by the frequency in GHz, offered for sale and capable of meeting ENERGY STAR requirements.² It shall also include a memory capacity equal to the value found in Equation 1 below:

Equation 1: Minimum Memory Capacity of High-end Performance Configuration

$$Mem_Capacity_High \geq 3 \times (\# \text{ of Sockets} \times \# \text{ of Physical Cores} \times \# \text{ Threads per Core})$$

² A single product configuration may be certified alone without a family.

³ Processor performance per socket = [# of processor cores] x [processor clock speed (GHz)], where # of cores represents the number of physical cores and processor clock speed represents the Max TDP core frequency as reported by SERT for a given processor.

- C. Typical Configuration: A product configuration that lies between the Low-end Performance and High-end Performance configurations and is representative of a deployed product with high volume sales. It shall also include a memory capacity equal to the value found in Equation 2 below:

Equation 2: Minimum Memory Capacity of Typical Configuration

$$Mem_Capacity_Typ \geq 2 \times (\# \text{ of Sockets} \times \# \text{ of Physical Cores} \times \# \text{ Threads per Core})$$

2 SCOPE

2.1 Included Products

- 2.1.1 A product must meet the definition of a Computer Server provided in *Section 1* of this document to be eligible for ENERGY STAR certification under this specification. Eligibility under Version 3.0 is limited to Blade-, Multi-node, Rack-mounted, or Pedestal form factor computer servers with no more than four processor sockets in the computer server (or per blade or node in the case of blade or multi-node servers). Products explicitly excluded from Version 3.0 are identified in *Section 2.2*.

2.2 Excluded Products

- 2.2.1 Products that are covered under other ENERGY STAR product specifications are not eligible for certification under this specification. The list of specifications currently in effect can be found at www.energystar.gov/products.
- 2.2.2 The following products are not eligible for certification under this specification:
- i. Computer Servers shipped with Integrated APAs;
 - ii. Fully Fault Tolerant Servers;
 - iii. Server Appliances;
 - iv. High Performance Computing Systems;
 - v. Large Servers;
 - vi. Storage Products including Blade Storage; and
 - vii. Large Network Equipment.

3 CERTIFICATION CRITERIA

3.1 Significant Digits and Rounding

- 3.1.1 All calculations shall be carried out with directly measured (unrounded) values.
- 3.1.2 Unless otherwise specified, compliance with specification limits shall be evaluated using directly measured or calculated values without any benefit from rounding.
- 3.1.3 Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

3.2 Power Supply Requirements

- 3.2.1 Power supply test data and test reports from testing entities recognized by EPA to perform power supply testing shall be accepted for the purpose of certifying the ENERGY STAR product.

3.2.2 Power Supply Efficiency Criteria: Power Supplies used in products eligible under this specification must meet the following requirements when tested using the *Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.7* (available at www.efficientpowersupplies.org). Power Supply data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, 6.5, or 6.6 are acceptable provided the test was conducted prior to the effective date of Version 3.0 of this specification.

- i. Pedestal and Rack-mounted Servers: To certify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with **only** PSUs that meet or exceed the applicable efficiency requirements specified in Table 1 **prior to shipment**.
- ii. Blade and Multi-node Servers: To certify for ENERGY STAR, a Blade or Multi-node computer server shipped with a chassis must be configured such that **all** PSUs supplying power to the chassis meet or exceed the applicable efficiency requirements specified in Table 1 **prior to shipment**.

Table 1: Efficiency Requirements for PSUs

Power Supply Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Multi-output (Ac-Dc)	All Output Levels	N/A	90%	92%	89%
Single-output (Ac-Dc)	All Output Levels	83%	90%	94%	91%

3.2.3 Power Supply Power Factor Criteria: Power Supplies used in Computers Servers eligible under this specification must meet the following requirements when tested using the *Generalized Internal Power Supply Efficiency Test Protocol, Rev. 6.7* (available at www.efficientpowersupplies.org). Power Supply data generated using Rev. 6.4.2 (as required in Version 1.1), 6.4.3, 6.5 or 6.6 are acceptable provided the test was conducted prior to the effective date of Version 3.0.

- i. Pedestal and Rack-mounted Servers: To certify for ENERGY STAR, a pedestal or rack-mounted computer server must be configured with **only** PSUs that meet or exceed the applicable power factor requirements specified in Table 2 **prior to shipment**, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.
- ii. Blade or Multi-node Servers: To certify for ENERGY STAR, a Blade or Multi-node computer server shipped with a chassis must be configured such that **all** PSUs supplying power to the chassis meet or exceed the applicable power factor requirements specified in Table 2 **prior to shipment**, under all loading conditions for which output power is greater than or equal to 75 watts. Partners are required to measure and report PSU power factor under loading conditions of less than 75 watts, though no minimum power factor requirements apply.

Table 2: Power Factor Requirements for PSUs

Power Supply Type	Rated Output Power	10% Load	20% Load	50% Load	100% Load
Ac-Dc Multi-output	All Output Ratings	N/A	0.80	0.90	0.95
Ac-Dc Single-output	Output Rating ≤ 500 W	N/A	0.80	0.95	0.95
	Output Rating > 500 W and Output Rating ≤ 1,000 W	0.65	0.80	0.95	0.95
	Output Rating > 1,000 watts	0.80	0.90	0.95	0.95

3.3 Power Management Requirements

- 3.3.1 Server Processor Power Management: To certify for ENERGY STAR, a Computer Server must offer processor power management that is enabled by default in the BIOS and/or through a management controller, service processor, and/or the operating system shipped with the computer server. **All** processors must be able to reduce power consumption in times of low utilization by:
- i. reducing voltage and/or frequency through Dynamic Voltage and Frequency Scaling (DVFS), or
 - ii. enabling processor or core reduced power states when a core or socket is not in use.
- 3.3.2 Supervisor Power Management: To certify for ENERGY STAR, a product which offers a pre-installed supervisor system (e.g., operating system, hypervisor) must offer supervisor system power management that is enabled by default.
- 3.3.3 Power Management Reporting: To certify for ENERGY STAR, all power management techniques that are enabled by default must be detailed in the certification submission. This requirement applies to power management features in the BIOS, operating system, or any other origin that can be configured by the end-user.

3.4 Blade and Multi-Node System Criteria

- 3.4.1 Blade and Multi-Node Thermal Management and Monitoring: To certify for ENERGY STAR, a blade or multi-node server must provide real-time chassis or blade/node inlet temperature monitoring and fan speed management capability that is enabled by default.
- 3.4.2 Blade and Multi-Node Server Shipping Documentation: To certify for ENERGY STAR, a blade or multi-node server that is shipped to a customer independent of the chassis must be accompanied with documentation to inform the customer that the blade or multi-node server is ENERGY STAR qualified only if it is installed in a chassis meeting requirements in *Section 3.4.1* of this document. A list of certified chassis and ordering information must also be provided as part of product collateral provided with the blade or multi-node server. These requirements may be met via either printed materials, electronic documentation provided with the blade or multi-node server, or information publicly available on the Partner's website where information about the blade or multi-node server is found.

3.5 Active State Efficiency Criteria

- 3.5.1 Active State Efficiency Reporting: To certify for ENERGY STAR, a Computer Server or Computer Server Product Family must be submitted for certification with the following information disclosed in full and in the context of the complete Active State efficiency rating test report:

- i. Final SERT rating tool results, which include the results files (in xml, html, and text format) and all results-chart png files; and
- ii. Intermediate SERT rating tool results over the entire test run, which include the results-details files (in xml, html, and text format) and all results-details-chart png files.

Data reporting and formatting requirements are discussed in Section 4.1 of this specification.

3.5.2 **Incomplete Reporting:** Partners shall not selectively report individual workload module results, or otherwise present efficiency rating tool results in any form other than a complete test report, in customer documentation or marketing materials.

3.5.3 **Active State Efficiency Requirements:** Calculated Active State efficiency score (Eff_{ACTIVE}) shall be greater than or equal to the minimum Active State efficiency thresholds listed in Table 3 for **all** configurations submitted for certification within a product family, as well as any additional configurations within the product family shipped as ENERGY STAR.

Equation 3: Calculation Eff_{ACTIVE}

$$Eff_{ACTIVE} = EXP(0.65 * \ln(Eff_{CPU}) + 0.30 * \ln(Eff_{MEMORY}) + 0.05 * \ln(Eff_{STORAGE}))$$

Where:

- Eff_{ACTIVE} is comprised of Eff_{CPU} , Eff_{MEMORY} and $Eff_{STORAGE}$ which are defined in equations 4 through 6 below:

Equation 4: Calculation Eff_{CPU}

$$Eff_{CPU} = Geomean(Eff_{COMPRESS}, Eff_{LU}, Eff_{SOR}, Eff_{CRYPTO}, Eff_{SORT}, Eff_{SHA256}, Eff_{HYBRIDSSJ})$$

Where:

- $Eff_{COMPRESS}$ is the calculated Compression worklet score
- Eff_{LU} is the calculated LU worklet score
- Eff_{SOR} is the calculated SOR worklet score
- Eff_{CRYPTO} is the calculated Crypto worklet score
- Eff_{SORT} is the calculated Sort worklet score
- Eff_{SHA256} is the calculated SHA256 worklet score
- $Eff_{HYBRIDSSJ}$ is the calculated Hybrid SSJ worklet score

Equation 5: Calculation Eff_{MEMORY}

$$Eff_{MEMORY} = Geomean(Eff_{FLOOD2}, Eff_{CAPACITY2})$$

Where:

- Eff_{FLOOD3} is the calculated Flood3 worklet score
- $Eff_{CAPACITY3}$ is the calculated Capacity3 worklet score

Equation 6: Calculation $Eff_{STORAGE}$

$$Eff_{STORAGE} = Geomean(Eff_{SEQUENTIAL}, Eff_{RANDOM})$$

Where:

- $Eff_{SEQUENTIAL}$ is the calculated Sequential worklet score
- Eff_{RANDOM} is the calculated Random worklet score

Equation 7: Calculation Eff_i

$$Eff_i = 1000 \frac{Perf_i}{Pwr_i}$$

Where:

- i = Represents each workload referenced in Equations 4 through 6

- $Perf_i$ = Geometric mean of the normalized interval performance measurements.
- Pwr_i = Geometric mean of the calculated interval power values.

Table 3: Active State Efficiency Thresholds for all Computer Servers

Product Type	Minimum Eff_{ACTIVE}
One Installed Processor	
Rack	11.0
Tower	9.4
Blade or Multi-Node	9.0
Resilient	4.8
Two Installed Processors	
Rack	13.0
Tower	12.0
Blade or Multi-Node	14.0
Resilient	5.2
Greater Than Two Installed Processors	
Rack	16.0
Blade or Multi-Node	9.6
Resilient	4.2

3.6 Idle State Efficiency Criteria

3.6.1 **Idle State Data Reporting:** Idle State power (P_{IDLE} , P_{BLADE} , or P_{NODE}) shall be measured and reported, both in certification materials and as required in Section 4 for all computer server types. In addition, for blade and multi-node products, $P_{TOT_BLADE_SYS}$ and $P_{TOT_NODE_SYS}$ shall also be reported respectively. Please see Section 3.7 for details on how to calculate P_{BLADE} and $P_{TOT_BLADE_SYS}$, and Section 3.8 for details on how to calculate P_{NODE} and $P_{TOT_NODE_SYS}$.

3.7 Calculating Idle State Values – Blade Servers

- 3.7.1 The testing of Blade Servers for compliance with Section 3.6.1 shall be carried out under all of the following conditions:
- Power values shall be measured and reported using a half-populated Blade Chassis. Blade Servers with multiple power domains, choose the number of power domains that is closest to filling half of the Blade Chassis. In a case where there are two choices that are equally close to half, test with the domain or combination of domains which utilize a higher number of Blade Servers. The number of blades tested during the half-populated Blade Chassis test shall be reported.
 - Power for a fully-populated blade chassis may be optionally measured and reported, provided that half-populated chassis data is also provided.
 - All Blade Servers installed in the Blade Chassis shall share the same configuration (homogeneous).
 - Per-blade power values shall be calculated using Equation 8.

Equation 8: Calculation of Single Blade Power

$$P_{BLADE} = \frac{P_{TOT_BLADE_SYS}}{N_{INST_BLADE_SRV}}$$

Where:

- P_{BLADE} is the per-Blade Server Power, $P_{TOT_BLADE_SYS}$ is total measured power of the Blade System,
- $N_{INST_BLADE_SRV}$ is the number of installed Blade Servers in the tested Blade Chassis.

3.8 Calculating Idle State Values – Multi-Node Servers

3.8.1 The testing of Multi-Node Servers for compliance with Section 3.6.1 shall be carried out under all of the following conditions:

- i. Power values shall be measured and reported using a fully-populated Multi-Node Chassis.
- ii. All Multi-Node Servers in the Multi-Node Chassis shall share the same configuration (homogeneous).
- iii. Per-node power values shall be calculated using Equation 9.

Equation 9: Calculation of Single Node Power

$$P_{NODE} = \frac{P_{TOT_NODE_SYS}}{N_{INST_NODE_SRV}}$$

Where:

- P_{NODE} is the per-Node Server Power, $P_{TOT_NODE_SYS}$ is total measured power of the Multi-Node Server,
- $N_{INST_NODE_SRV}$ is the number of installed Multi-Node Servers in the tested Multi-Node Chassis.

3.9 Other Testing Criteria

3.9.1 APA Requirements: For all computer servers sold with expansion APAs, the following criteria and provisions apply:

- i. For all configurations, Active State and Idle State testing shall be conducted without any APAs installed which may be offered with the product. Where an APA relies on a separate PCIE switch for communication between the APA and CPU, the separate PCIE card(s) or riser(s) shall be removed for Active State and Idle State testing of all configurations.
- ii. Manufacturers shall report the model name, model number, idle power consumption, and number of APA devices on each APA card for each APA offered as an accessory within an ENERGY STAR product family.
- iii. The idle power for the expansion APA card shall be calculated by installing the APA expansion card in the computer server and performing just the SERT idle test (skipping the worklet tests) and subtracting the SERT idle power measured without the APA present in the computer servers.
- iv. Where a removable switch is required to support the expansion APA, the switch should be installed with the APA and included in the APA card idle measurement and calculation above.

4 STANDARD INFORMATION REPORTING REQUIREMENTS

4.1 Data Reporting Requirements

- 4.1.1 All required data fields in the ENERGY STAR Version 3.0 Computer Servers Qualified Product Exchange form shall be submitted to EPA for each ENERGY STAR certified Computer Server or Computer Server Product Family.
- i. Partners are encouraged to provide one set of data for each ENERGY STAR certified product configuration, though EPA will also accept a data set for each certified product family.
 - ii. A product family certification must include data for all defined test points in 1.G)2), as applicable.
 - iii. Whenever possible, Partners must also provide a hyperlink to a detailed power calculator on their Web site that purchasers can use to understand power and performance data for specific configurations within the product family.
- 4.1.2 The following data will be displayed on the ENERGY STAR Web site through the product finder tool:
- i. model name and number, identifying SKU and/or configuration ID;
 - ii. system characteristics (form factor, available sockets/slots, power specifications, etc.);
 - iii. system type (e.g. resilient.);
 - iv. system configuration(s) (including Low-end Performance Configuration, High-end Performance Configuration, and Typical Configuration for Product Family certification);
 - v. power consumption and performance data from required Active and Idle State Efficiency Criteria testing including results.xml, results.html, results.txt, all results-chart png files, results-details.html, results-details.txt, results-details.xml, all results-details-chart png files;
 - vi. available and enabled power saving features (e.g., power management);
 - vii. for product family certifications, a list of qualified configurations with qualified SKUs or configuration IDs; and
 - viii. for a blade server, a list of compatible blade chassis that meet ENERGY STAR certification criteria.
- 4.1.3 EPA may periodically revise this list, as necessary, and will notify and invite stakeholder engagement in such a revision process.

5 STANDARD PERFORMANCE DATA MEASUREMENT AND OUTPUT REQUIREMENTS

5.1 Measurement and Output

- 5.1.1 A computer server must provide data on input power consumption (W), inlet air temperature (°C), and average utilization of all logical CPUs. Data must be made available in a published or user-accessible format that is readable by third-party, non-proprietary management software over a standard network. For blade and multi-node servers and systems, data may be aggregated at the chassis level.
- 5.1.2 Computer servers classified as Class B equipment as set out in EN 55022:2006 are exempt from the requirements to provide data on input power consumption and inlet air temperature in 5.1.1. Class B refers to household and home office equipment (intended for use in the domestic environment). All computer servers in the program must meet the requirement and conditions to report utilization of all logical CPUs.

5.2 Reporting Implementation

- 5.2.1 Products may use either embedded components or add-in devices that are packaged with the computer server to make data available to end users (e.g., a service processor, embedded power or thermal meter (or other out-of-band technology), or pre-installed OS);
- 5.2.2 Products that include a pre-installed OS must include all necessary drivers and software for end users to access standardized data as specified in this document. Products that do not include a pre-installed OS must be packaged with printed documentation of how to access registers that contain relevant sensor information. This requirement may be met via either printed materials, electronic documentation provided with the computer server, or information publicly available on the Partner's website where information about the computer server is found.
- 5.2.3 When an open and universally available data collection and reporting standard becomes available, manufacturers should incorporate the universal standard into their systems;
- 5.2.4 Evaluation of the accuracy (5.3) and sampling (5.4) requirements shall be completed through review of data from component product datasheets. If this data is absent, Partner declaration shall be used to evaluate accuracy and sampling.

5.3 Measurement Accuracy

- 5.3.1 *Input power:* Measurements must be reported with accuracy of at least $\pm 5\%$ of the actual value, with a maximum level of accuracy of $\pm 10W$ for each installed PSU (i.e., power reporting accuracy for each power supply is never required to be better than ± 10 watts) through the operating range from Idle to full power;
- 5.3.2 *Processor utilization:* Average utilization must be estimated for each logical CPU that is visible to the OS and must be reported to the operator or user of the computer server through the operating environment (OS or hypervisor);
- 5.3.3 *Inlet air temperature:* Measurements must be reported with an accuracy of at least $\pm 2^{\circ}C$.

5.4 Sampling Requirements

- 5.4.1 *Input power and processor utilization:* Input power and processor utilization measurements must be sampled internally to the computer server at a rate of greater than or equal to measurement per contiguous 10 second period. A rolling average, encompassing a period of no more than 30 seconds, must be sampled internally to the computer server at a frequency of greater than or equal to once per ten seconds.
- 5.4.2 *Inlet air temperature:* Inlet air temperature measurements must be sampled internally to the computer server at a rate of greater than or equal to 1 measurement every 10 seconds.
- 5.4.3 *Time stamping:* Systems that implement time stamping of environmental data shall sample internally to the computer server data at a rate of greater than or equal to 1 measurement every 30 seconds.
- 5.4.4 *Management Software:* All sampled measurements shall be made available to external management software either via an on-demand pull method, or via a coordinated push method. In either case the system's management software is responsible for establishing the data delivery time scale while the computer server is responsible to assuring data delivered meets the above sampling and currency requirements.

6 TESTING

6.1 Test Methods

- 6.1.1 When testing Computer Server products, the test methods identified in 6 shall be used to determine ENERGY STAR certification.

Table 6: Test Methods for ENERGY STAR Certification

Product Type or Component	Test Method
All	ENERGY STAR Test Method for Computer Servers (Rev. Sept-2018)
All	Standard Performance Evaluation Corporation (SPEC) most current ⁴ Server Efficiency Rating Tool (SERT)

6.1.2 When testing Computer Server products, UUTs must have the maximum number of Processor Sockets populated to represent that product family during testing. All systems will be subject to active efficiency threshold requirements based on the number of sockets populated in the system during testing.

6.2 Number of Units Required for Testing

6.2.1 Representative Models shall be selected for testing per the following requirements:

- i. For certification of an individual product configuration, the unique configuration that is intended to be marketed and labeled as ENERGY STAR is considered the Representative Model.
- ii. For certification of a product family of all product types, one product configuration for each of the three points identified in definitions 1.G)2) within the family are considered Representative Models. All such representative models shall have the same Common Product Family Attributes as defined in 1.G)1).

6.2.2 All product configurations within a product family that is submitted for certification must meet ENERGY STAR requirements, including products for which data is not reported.

7 EFFECTIVE DATE

7.1.1 Effective Date: This ENERGY STAR Computer Servers specification shall take effect on **June 17, 2019**. To certify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on its date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

7.1.2 Future Specification Revisions: EPA reserves the right to change this specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through stakeholder discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.

8 CONSIDERATIONS FOR FUTURE REVISIONS

8.1 Inclusion of Dc-Dc Computer Servers: EPA encourages manufacturers to work with SPEC to develop support for dc servers in SERT, so that dc computer servers may be considered for certification in Version 3.0.

⁴ For the purposes of this document, the most current SERT version will be listed in the most recently published Servers 3.0 Clarification Memo, located on the Enterprise Servers Specification Version 3.0 website (https://www.energystar.gov/products/spec/enterprise_servers_specification_version_3_0_pd)

8.2 Internal Power Supply Load Points: EPA will work with stakeholders to determine if additional investigation is needed to address the load points used in IPS requirements, to ensure they continue to reflect real-world operating conditions.



ENERGY STAR® Program Requirements Product Specification for Computer Servers

Final Test Method Rev. Sept-2018

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 Idle State power and Active State power for certification purposes.

2 APPLICABILITY

The following test method is applicable to all products eligible for certification 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 watts (W)

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Servers with alternating current (ac)-direct current (dc) Single-Output Power Supply Units (PSUs)	230 volts (V) ac or 115 V ac*	+/- 1.0 %	2.0 %
Servers with ac-dc Multi-Output PSUs	230 V ac or 115 V ac*		
Optional Testing Conditions For ac-dc (Japanese Market)	100 V ac		
Three-phase Servers (North American Market)	208 V ac		
Three-phase Servers (Europe Market)	400 V ac		

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 or 115 V ac*	+/- 4.0 %	5.0 %
Servers with ac-dc Multi-Output PSUs	230 V ac or 115 V ac*		
Optional Testing Conditions For ac-dc (Japanese Market)	100 V ac		
Three-phase Servers (North American Market)	208 V ac		
Three-phase Servers (Europe Market)	400 V ac		

Table 3: Input Frequency Requirements for All Products

Supply Voltage	Frequency	Frequency Tolerance
100 V ac	50 hertz (Hz) or 60 Hz	±1.0%
115 V ac	60 Hz	
230 V ac	50 Hz or 60 Hz	
Three-phase (North American Market)	60 Hz	
Three-phase (Europe Market)	50 Hz	

* Note: 230 V ac refers to the European market and 115 V ac refers to the North American market

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

- 1) Compliance: The power analyzer shall be chosen from the list of power measuring devices specified in the most current¹ Server Efficiency Rating Tool (SERT)^{TM 2} Design Document³.
 - 2) Calibration: The analyzer shall have been calibrated within a year of the test date, by a standard traceable to the National Institute of Science and Technology (USA) or a counterpart national metrology institute in other countries.
 - 3) 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.
 - 4) Minimum Frequency Response: 3.0 kHz.
 - 5) 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.
 - 6) Logging: The reading rate supported by the analyzer shall be at least 1 set of measurements per second, where set is defined as a power measurement, in 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.
 - 7) Measurement Accuracy: Power measurements shall be reported by the analyzer with an overall accuracy of 1% or better for all measured power values.
- E) Temperature Sensor: The temperature sensor shall possess the following attributes:
- 1) Compliance: The temperature sensor shall be chosen from the list of temperature measuring devices specified in the most current¹ SERT Design Document³.
 - 2) Logging: The sensor shall have a minimum reading rate of 4 samples per minute.
 - 3) Measurement Accuracy: Temperature must be measured no more than 50mm in front of (upwind of) the main airflow inlet of the Unit Under Test (UUT) and reported by the sensor with an overall accuracy of ± 0.5 °C or better.
- F) Active State Test Tool: The most current¹ version of SERT, provided by Standard Performance Evaluation Corporation (SPEC)⁴.
- G) Controller System: The Controller System may be a Server, a desktop computer, or a laptop and shall be used to record power and temperature data.
- 1) The power analyzer and the temperature sensor shall be connected to the Controller System.
 - 2) The Controller System and the UUT shall be connected to each other via an Ethernet network switch.
- H) General SERT Requirements: Any additional requirements specified in any SPEC, or the most current¹ SERT supporting documents shall be followed, unless otherwise specified in this test method. Supporting documents from SPEC include:
- 1) SPEC Power and Performance Methodology

¹ For the purposes of this document, the most current SERT version is listed in the most recently published Servers 3.0 Clarification Memo, located on the Enterprise Servers Specification Version 3.0 website (https://www.energystar.gov/products/spec/enterprise_servers_specification_version_3_0_pd)

² <http://www.spec.org/sert/>

³ http://www.spec.org/sert/docs/SERT-Design_Document.pdf

⁴ <http://www.spec.org/>

- 2) SPEC Power Measurement Setup Guide
- 3) SPEC PTDaemon Design Document
- 4) SERT Design Document
- 5) SERT Run and Reporting Rules
- 6) SERT User Guide
- 7) SERT JVM Options
- 8) SERT Result File Fields

5 TEST CONDUCT

5.1 Test Configuration

Power and efficiency shall be tested and reported 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 software options shall be set to their default condition.
- B) Measurement Location: 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 State 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) Air Flow: 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) Power Supplies: All PSUs shall be connected and operational.
 - 1) UUTs with Multiple PSUs: 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)2) for more information).
- E) Power Management and Operating System: 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) Storage: 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 SSD) and,

instead, rely exclusively on external storage solutions (e.g. storage area network) shall be tested using external storage solutions.

- G) Blade System and Dual/Multi-Node Servers: A Blade System or Dual/Multi-Node Server shall have identical configurations for each node or Blade Server including all hardware components and software/power management settings. These systems shall also be measured in a way that ensures all power from all tested nodes/Blade Servers is 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 5.2.D). All power measurements for Blade Systems 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) Input/Output (I/O) and Network Connection: The UUT shall 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 shall be live during all tests, and, although the link shall be ready and able to transmit packets, no specific traffic is required over the connection during testing. For the purpose of testing ensure the UUT 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.

5.2 UUT Preparation

- A) The UUT shall be tested with the processor sockets populated as specified in Section 6.1.2 of ENERGY STAR Eligibility Criteria Version 3.0.
- B) Install the UUT in a test rack or location. The UUT shall not be physically moved until testing is complete.
- C) If the UUT is a Multi-node system, the UUT shall be tested for per node power consumption in the fully-populated Chassis configuration. All Multi-node Servers installed in the Chassis shall be identical, sharing the same configuration.
- D) If the UUT is a Blade System, the UUT shall be tested for Blade Server power consumption in the half-populated Chassis configuration with an additional option of testing the UUT in the fully-populated Chassis configuration. For Blade Systems, populate the Chassis as follows:
 - 1) Individual Blade Server Configuration
 - a) All Blade Servers installed in the Chassis shall be identical, sharing the same configuration (homogeneous).
 - 2) Half Chassis Population (Required)
 - a) Calculate the number of Blade Servers required to populate half the number of Single-wide Blade Server slots available in the Blade Chassis.
 - b) For Blade Chassis having multiple power domains, choose the number of power domains that is closest to filling half of the Chassis. In a case where there are two choices that are equally close to filling half of the Chassis, test with the domain or combination of domains which utilize a higher number of Blade Servers.

Example 1: A certain Blade Chassis supports up to 7 Single-wide Blade Servers on two power domains. One power domain supports 3 Blade Servers and the other supports 4 Blade Servers. In this example, the power domain which supports 4 Blade Servers would be fully populated during testing, while the other power domain would remain unpopulated.

Example 2: A certain Blade Chassis supports up to 16 Single-wide Blade Servers on four power domains. Each of the four power domains supports 4 Blade Servers. In this example, two of the power domains would be fully populated during testing, while the other two power domains would remain unpopulated.

- c) Follow all user manual or manufacturer recommendations for partially populating the Chassis, which may include disconnecting some of the power supplies and cooling fans for the unpopulated power domains.
 - d) If user manual recommendations are not available or are incomplete, then use the following guidance:
 - i. Completely populate the power domains.
 - ii. If possible, disconnect the power supplies and cooling fans for unpopulated power domains.
 - iii. Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of testing.
- 3) Full Chassis Population (Optional)
- a) Populate all available Chassis bays. All power supplies and cooling fans shall be connected. Proceed with all required tests in the test procedure as specified in Section 6.
- E) Connect the UUT to a live Ethernet (IEEE 802.3) network switch. The live connection shall be maintained for the duration of testing, except for brief lapses necessary for transitioning between link speeds.
 - F) The Controller System required to provide SERT workload harness control, data acquisition, or other UUT testing support shall be connected to the same network switch as the UUT and satisfy all other UUT network requirements. Both the UUT and Controller System shall be configured to communicate via the network.
 - G) Connect the power meter to an ac voltage source set to the appropriate voltage and frequency for the test, as specified in Section 4.
 - H) Plug the UUT into the measurement power outlet on the power meter following the guidelines in 5.1.B).
 - I) Connect the data output interface of the power meter and the temperature sensor to the appropriate input of the Controller System.
 - J) Verify that the UUT is configured in its as-shipped configuration.
 - K) Verify that the Controller System and UUT are connected on the same internal network via an Ethernet network switch.
 - L) Use a normal *ping* command to verify that the Controller System and UUT can communicate with each other.

- M) Install the most current¹ SERT on the UUT and the Controller System as specified in the most current¹ SERT User Guide⁵.

6 TEST PROCEDURES FOR ALL PRODUCTS

6.1 Idle and Active State Testing Using SERT

- A) Power on the UUT, either by switching it on or connecting it to mains power.
- B) Between 5 and 15 minutes after the completion of initial boot or log in, follow the most current SERT User Guide⁵ to engage SERT.
- C) Follow all steps outlined in the most current¹ SERT User Guide to successfully run SERT.
- 1) Manual intervention or optimization to the Controller System, UUT, or its internal and external environment is prohibited during the execution of SERT.
- D) Once SERT is completed, include the following output files with all testing results:
- 1) Results.xml
 - 2) Results.html
 - 3) Results.txt
 - 4) All results-chart png files (e.g. results-chart0.png, results-chart1.png, etc.)
 - 5) Results-details.html
 - 6) Results-details.txt
 - 7) All results-details-chart png files (e.g. results-details-chart0.png, results-details-chart1.png, etc.)
- E) When testing a Multi-node or Blade System, proceed as follows to derive single node or single Blade Server power:
- 1) Divide the measured total idle power in Section 6.1.C by the number of nodes/Blade Servers installed for the test;
 - 2) Record the measured total and per-node/per-Blade Server idle power values as calculated in Section 6.1.C for each measurement.

⁵ http://www.spec.org/sert/docs/SERT-User_Guide.pdf