

1 DEFINITIONS

A. 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:

- 1) is marketed and sold as a computer server;
- 2) is designed for and listed as supporting one or more computer server operating systems (OS) and/or hypervisors, and is targeted to run user-installed enterprise applications;
- 3) is packaged and sold with one or more ac-dc or dc-dc power supplies; and
- 4) is designed such that all processors have access to shared system memory and are independently visible to a single OS or hypervisor.

Note: The previous reference to ECC memory remains out of this definition for the purposes of data collection. EPA will again consider presence of this type of memory as a core component of all ENERGY STAR Servers after reviewing data provided by manufacturers.

B. Computer Server Types

- 1) Managed Server: A computer server that is designed for a high level of availability in a highly managed environment. For purposes of this specification, a managed server must meet **all** of the following criteria:
 - i) is designed to be configured with redundant power supplies; and
 - ii) contains an installed dedicated management controller (e.g., service processor).
- 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.
 - i) 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.
 - (a) *Multi-bay Blade Server*: A blade server requiring more than one bay for installation in a blade chassis.
 - (b) *Single-wide Blade Server*: A blade server requiring the width of a standard blade server bay.
 - (c) *Double-wide Blade Server*: A blade server requiring twice the width of a standard blade server bay.
 - (d) *Half-height Blade Server*: A blade server requiring one half the height of a standard blade

- 41 server bay.
- 42 ii) Blade Chassis: An enclosure that contains shared resources for the operation of blade
43 servers, blade storage, and other blade form-factor devices. Shared resources provided by a
44 chassis may include power supplies, data storage, and hardware for dc power distribution,
45 thermal management, system management, and network services.
- 46 iii) Blade Storage: A storage device that is designed for use in a blade chassis. A blade storage
47 device is dependent upon shared blade chassis resources (e.g., power supplies, cooling) for
48 operation.
- 49 3) Fully Fault Tolerant Server: A computer server that is designed with complete hardware
50 redundancy, in which every computing component is replicated between two nodes running
51 identical and concurrent workloads (i.e., if one node fails or needs repair, the second node can run
52 the workload alone to avoid downtime). A fully fault tolerant server uses two systems to
53 simultaneously and repetitively run a single workload for continuous availability in a mission critical
54 application.
- 55 4) Resilient Server: A computer server that is designed with resiliency, RAS, and self-correction
56 features integrated in the micro-architecture of the CPU and chipset to ensure data resiliency and
57 accuracy. A resilient server is often used for a limited set of workloads that may include business
58 processing, decision support, or handling of virtualized workloads. For purposes of this
59 specification, a resilient server must meet **all** of the following criteria:
- 60 i) contains hot-swappable components (e.g., I/O, hard drives, and ac-dc power supplies);
61 ii) contains multiple physical banks of memory and I/O busses;
62 iii) provides machine check architecture (i.e., both Fault Isolation and Resiliency;
63 iv) provides memory fault detection and system recovery through DRAM chip sparing, extended
64 ECC, and mirrored memory;
65 v) provides support for error-correcting code (ECC) and/or buffered memory (including both
66 buffered DIMMs and buffered on board (BOB) configurations);
67 vi) provides end-to-end bus retry; and
68 vii) supports on-line expansion/retraction of hardware resources without the need for operating
69 system reboot ("on-demand" features).
- 70 5) Multi-node Server: A computer server that is designed with two or more independent server nodes
71 that share a single enclosure and one or more power supplies. In a multi-node server, power is
72 distributed to all nodes through shared power supplies. Server nodes in a multi-node server are
73 not designed to be hot-swappable.
- 74 i) Dual-node Server: A common multi-node server configuration consisting of two server nodes.
- 75 6) Server Appliance: A computer server that is bundled with a pre-installed operating system and
76 application software that is used to perform a dedicated function or set of tightly coupled functions.
77 Server appliances deliver services through one or more networks (e.g., IP or SAN), and are
78 typically managed through a web or command line interface. Server appliance hardware and
79 software configurations are customized by the vendor to perform a specific task (e.g., name
80 services, firewall services, authentication services, encryption services, and voice-over-IP (VoIP)
81 services), and are not intended to execute user-supplied software.
- 82 7) High Performance Computing (HPC) System: A system designed with multiple, centrally-managed
83 nodes connected with high-speed interconnect technology. An HPC system is intended to
84 maximize performance in parallel and computationally-intensive workloads. HPC system power
85 management features are typically removed or disabled. An HPC system includes a larger
86 number of memory controllers compared to a general-purpose computer server in order to
87 maximize data bandwidth available to the processors. For the purposes of this specification, an
88 HPC server must be clearly identified as an HPC server in marketing literature and product

89 specification sheets, and must be sold as an HPC server or system.

90 8) Direct Current (Dc) Server: A computer server that is designed solely to operate on a dc power
91 source.

92 **Note:** EPA received a request to include a “Large-scale Server” definition for an additional product
93 classification, with the intention of excluding such products from the program. As data is being collected,
94 EPA welcomes further stakeholder feedback on a) what constitutes a “Large-scale Server” system, and b)
95 examples of such systems that fit in the existing socket bins in the program: 1-2 socket, 3-4 socket.

96 C. Computer Server Form Factors

97 1) Rack-mounted Server: A computer server that is designed for deployment in a standard 19-inch
98 data center rack as defined by EIA-310, IEC 60297, or DIN 41494. For the purposes of this
99 specification, a blade server is considered under a separate category and excluded from the rack-
100 mounted category.

101 2) Pedestal Server: A self-contained computer server that is designed with PSUs, cooling, I/O
102 devices, and other resources necessary for stand-alone operation. The frame of a pedestal server
103 is similar to that of a tower client computer.

104 D. Computer Server Components

105 1) Power Supply Unit (PSU): A device that converts ac or dc input power to one or more dc power
106 outputs for the purpose of powering a computer server. A computer server PSU must be self-
107 contained and physically separable from the motherboard and must connect to the system via a
108 removable or hard-wired electrical connection.

109 i) Ac-Dc Power Supply: A PSU that converts line-voltage ac input power into one or more dc
110 power outputs for the purpose of powering a computer server.

111 ii) Dc-Dc Power Supply: A PSU that converts line-voltage dc input power to one or more dc
112 outputs for the purpose of powering a computer server. For purposes of this specification, a
113 dc-dc converter (also known as a voltage regulator) that is internal to a computer server and is
114 used to convert a low voltage dc (e.g., 12 V dc) into other dc power outputs for use by
115 computer server components is not considered a dc-dc power supply.

116 iii) Single-output Power Supply: A PSU that is designed to deliver the majority of its rated output
117 power to one primary dc output for the purpose of powering a computer server. Single-output
118 PSUs may offer one or more standby outputs that remain active whenever connected to an
119 input power source. For purposes of this specification, the total rated power output from any
120 additional PSU outputs that are not primary and standby outputs shall be no greater than 20
121 watts. PSUs that offer multiple outputs at the same voltage as the primary output are
122 considered single-output PSUs unless those outputs (1) are generated from separate
123 converters or have separate output rectification stages, or (2) have independent current limits.

124 iv) Multi-output Power Supply: A PSU that is designed to deliver the majority of its rated output
125 power to more than one primary dc output for the purpose of powering a computer server.
126 Multi-output PSUs may offer one or more standby outputs that remain active whenever
127 connected to an input power source. For purposes of this specification, the total rated power
128 output from any additional PSU outputs that are not primary and standby outputs is greater
129 than or equal to 20 watts.

130 2) I/O Device: A device which provides data input and output capability between a computer server
131 and other devices. An I/O device may be integral to the computer server motherboard or may be
132 connected to the motherboard via through expansion slots (e.g., PCI, PCIe). Examples of I/O
133 devices include discrete Ethernet devices, InfiniBand devices, RAID/SAS controllers, and Fibre
134 Channel devices.

135 i) I/O Port: Physical circuitry within an I/O device where an independent I/O session can be
136 established. A port is not the same as a connector receptacle; it is possible that a single

- 137 connector receptacle can service multiple ports of the same interface.
- 138 3) Motherboard: The main circuit board of the server. For purposes of this specification, the
139 motherboard includes connectors for attaching additional boards and typically includes the
140 following components: processor, memory, BIOS, and expansion slots.
- 141 4) Processor: The logic circuitry that responds to and processes the basic instructions that drive a
142 server. For purposes of this specification, the processor is the central processing unit (CPU) of the
143 computer server. A typical CPU is a physical package to be installed on the server motherboard
144 via a socket or direct solder attachment. The CPU package may include one or more processor
145 cores.
- 146 5) Memory: For purposes of this specification, memory is a part of a server external to the processor
147 in which information is stored for immediate use by the processor.
- 148 6) Hard Drive (HDD): The primary computer storage device which reads and writes to one or more
149 rotating magnetic disk platters.
- 150 7) Solid State Drive (SSD): A disk drive that uses memory chips instead of rotating magnetic platters
151 for data storage.

152 E. Other Data Center Equipment

- 153 1) Network Equipment: A device whose primary function is to pass data among various network
154 interfaces, providing data connectivity among connected devices (e.g., routers and switches).
155 Data connectivity is achieved via the routing of data packets encapsulated according to Internet
156 Protocol, Fibre Channel, InfiniBand or similar protocol.
- 157 2) Storage Equipment: A system composed of integrated storage controllers, storage devices (e.g.,
158 hard drives or solid state storage) and software that provides data storage services to one or more
159 computer servers. While storage equipment may contain one or more embedded processors,
160 these processors do not execute user-supplied software applications but may execute data-
161 specific applications (e.g., data replication, backup utilities, data compression, install agents).
- 162 3) Uninterruptible Power Supply (UPS): A device intended to maintain continuity of power to
163 electrical loads in the event of a disruption to expected utility power supply. The ride-through time
164 of a UPS varies from seconds to tens of minutes. UPS designs offer a range of features, from
165 acting as a temporary power source to the load during a power disruption, to conditioning the
166 power reaching the load under normal operation. UPSs contain energy storage mechanisms to
167 supply power to the attached load in the event of full disruption from the utility.

168 F. Computer Server Power States

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

178 G. Other Key Terms:

- 179 1) Controller System: A computer or computer server that manages a benchmark evaluation
180 process. The controller system performs the following functions:
- 181 i) start and stop each segment (phase) of the performance benchmark;
- 182 ii) control the workload demands of the performance benchmark;
- 183 iii) start and stop data collection from the power analyzer so that power and performance data

- 184 from each phase can be correlated;
- 185 iv) store log files containing benchmark power and performance information;
- 186 v) convert raw data into a suitable format for benchmark reporting, submission and validation;
- 187 and
- 188 vi) collect and store environmental data, if automated for the benchmark.
- 189 2) Network Client (Testing): A computer or computer server that generates workload traffic for
- 190 transmission to a UUT connected via a network switch.
- 191 3) RAS Features: An acronym for reliability, availability, and serviceability features. RAS is
- 192 sometimes expanded to RASM, which adds “Manageability” criteria. The three primary
- 193 components of RAS as related to a computer server are defined as follows:
- 194 i) *Reliability Features*: Features that support a server’s ability to perform its intended function
- 195 without interruption due to component failures (e.g., component selection, temperature and/or
- 196 voltage de-rating, error detection and correction).
- 197 ii) *Availability Features*: Features that support a server’s ability to maximize operation at normal
- 198 capacity for a given duration of downtime (e.g., redundancy [both at micro- and macro-level]).
- 199 iii) *Serviceability Features*: Features that support a server’s ability to be serviced without
- 200 interrupting operation of the server (e.g., hot plugging).
- 201 4) Server Processor Utilization: The ratio of processor computing activity to full-load processor
- 202 computing activity at a specified voltage and frequency, measured instantaneously or with a short
- 203 term average of use over a set of active and/or idle cycles.

204 H. System Configuration

- 205 1) Product Family: A group of models/configurations that share a set of common attributes that are
- 206 variations on a basic design.
- 207 2) Common Product Family Attributes: A set of features common to all models/configurations within
- 208 a product family that constitute a common basic design. All models/configurations within a product
- 209 family must share the following:
- 210 i) Be from the same model line or machine type;
- 211 ii) Share the same form factor (i.e., rack-mounted, blade, pedestal);
- 212 iii) Either share processors from a single defined processor series or share processors that plug
- 213 into a common socket.
- 214 iv) share PSUs that perform with efficiencies greater than or equal to the efficiencies at all
- 215 required load points specified in Section 3.2 (i.e., 10%, 20%, 50%, and 100% of maximum
- 216 rated load for single-output; 20%, 50%, and 100% of maximum rated load for multi-output).
- 217 3) Product Family Tested Product Configurations:
- 218 i) Purchase Consideration Variations:
- 219 (a) Low-end Performance Configuration: The combination of Processor Socket Power, PSUs,
- 220 Memory, Storage (HDD/SDD), and I/O devices that represents the lowest-price computing
- 221 platform within the Product Family.
- 222 (b) High-end Performance Configuration: The combination of Processor Socket Power,
- 223 PSUs, Memory, Storage (HDD/SDD), and I/O devices that represents either the highest-
- 224 price or highest-performance computing platform within the Product Family.
- 225 ii) Typical Configuration:
- 226 (a) Typical Configuration: A product configuration that lies between the Minimum and
- 227 Maximum Power configurations and is representative of a deployed product with high
- 228 volume sales.

- 229 iii) Power Utilization Variations:
- 230 (a) Minimum Power Configuration: The minimum configuration that is able to boot and
- 231 execute supported OSs. The Minimum Configuration contains the lowest Processor
- 232 Socket Power, least number of installed PSUs, Memory, Storage (HDD/SDD), and I/O
- 233 devices, that is both offered for sale and capable of meeting ENERGY STAR
- 234 requirements.
- 235 (b) Maximum Power Configuration: The vendor-selected combination of components that
- 236 maximize power usage within the Product Family once assembled and operated. The
- 237 Maximum Configuration contains the highest Processor Socket Power, greatest number
- 238 of installed PSUs, Memory, Storage (HDD/SDD), and I/O devices that is both offered for
- 239 sale and capable of meeting ENERGY STAR requirements.

240 **2 QUALIFYING PRODUCTS**

241 **2.1 INCLUDED PRODUCTS**

242 A product must meet the definition of a Computer Server provided in *Section 1* of this document to be

243 eligible for ENERGY STAR qualification under this specification. Eligibility under Version 2.0 is limited to

244 blade-, rack-mounted, or pedestal form factor computer servers with no more than four processor sockets.

245 Products explicitly excluded from Version 2.0 are identified in *Section 2.2*.

246 **2.2 EXCLUDED PRODUCTS**

247 Products that are covered under other existing ENERGY STAR product specifications are not eligible for

248 qualification under the ENERGY STAR Computer Server specification. The list of specifications currently

249 in effect can be found at www.energystar.gov/products.

250 The following products are specifically excluded from qualification under this specification:

- 251 • Fully Fault Tolerant Servers;
 - 252 • Server Appliances;
 - 253 • Storage Equipment including Blade Storage; and
 - 254 • Network Equipment.
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Appendix A: ENERGY STAR Computer Server Test Method

259 **1 OVERVIEW**

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

263 **2 APPLICABILITY**

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

266 Products must be tested with hardware and software features and capabilities in the default, or “as-
267 shipped” configuration, unless otherwise specified in this document. This procedure is intended to be
268 followed in the specified sequence for UUT configuration in Appendix A *Section Error! Reference source*
269 **not found.** and testing in *Section 6*.

270 **3 DEFINITIONS**

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

273 **4 TEST SETUP**

274 A) Input Power: Input power shall be as specified in Table 1.
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Table 1: Input Power Requirements for Computer Servers

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
Servers with Ac-Dc Single-Output PSUs	230 Vac	+/- 1.0 % (for products which are rated for ≤ 1.5 kW maximum Power) or	2.0 % (for products which are rated for ≤ 1.5 kW maximum Power) or	50 Hz or 60 Hz	+/- 1.0 %
Servers with Ac-Dc Multi-Output PSUs ¹	230 Vac and/or	+/- 4.0 % (for products which are rated for > 1.5 kW maximum Power)	5.0 % (for products which are rated for > 1.5 kW maximum Power)	@ 230 Vac: 50 Hz or 60 Hz	+/- 1.0 %
	115 Vac			@ 115 Vac: 60 Hz	
Optional Testing Conditions For Ac-Dc Japanese Market	100 Vac			50 Hz or 60 Hz	+/- 1.0 %
Dc Servers	+/- 53 Vdc	+/- 1.0 V		N/A	N/A

- 277 B) Ambient Temperature: Ambient temperature shall remain between 18 °C to 28 °C, inclusive, for the
 278 duration of the test.
- 279 C) Relative Humidity:
- 280 1) *Low-End Moisture*: 5.5 °C Dew Point
- 281 2) *High-End Moisture*: 60% Relative Humidity, 15 °C Dew Point.
- 282 D) Power Meter: Power meters shall possess the following attributes:
- 283 1) Crest Factor: An available current crest factor of 3 or more at its rated range value. For analyzers
 284 that do not specify the current crest factor, the analyzer must be capable of measuring an
 285 amperage spike of at least 3 times the maximum amperage measured during any 1-second
 286 sample.
- 287 2) Minimum Frequency Response: 3.0 kHz
- 288 3) Minimum Resolution:
- 289 a) 0.01 W for measurement values less than 10 W;
- 290 b) 0.1 W for measurement values from 10 W to 100 W; and
- 291 c) 1.0 W for measurement values greater than 100 W.
- 292 4) Measurement Accuracy: Measurement uncertainty as introduced by the instrument that measures
 293 the input power to the product under test, including any external shunts.
- 294 a) Power measurements with a value greater than or equal to 0.5 W shall be made with an
 295 uncertainty of less than or equal to 2% at the 95% confidence level.

- 296 b) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less
297 than or equal to 0.01 W at the 95% confidence level.

298 5 TEST CONDUCT

299 5.1 PSU TEST CONFIGURATION

300 **Note:** Removed from this document as it does not apply to system testing.

301 5.2 ACTIVE MODE EFFICIENCY TEST CONFIGURATION

302 The Partner must test and report power and efficiency test results for all computer servers. Testing shall
303 be conducted as follows:

- 304 A) As-shipped Condition: Products shall be tested in their “as-shipped” configuration, which includes both
305 hardware configuration and system settings, unless otherwise specified in this test method. Where
306 relevant, all options and software shall be set to their default condition.
- 307 B) Measurement Location: All power measurements shall be taken at a point between the ac or dc power
308 source and the unit under test (UUT). No UPS units may be connected between the power meter and
309 the UUT. The power meter shall remain in place until all Idle and full load power data is fully recorded.
- 310 C) Power Supplies: All PSUs must be connected and operational.
- 311 1) UUTs with Multiple PSUs: All power supplies must be connected to the ac or dc power source and
312 operational during the test. If necessary, a Power Distribution Unit (PDU) may be used to connect
313 multiple power supplies to a single source. If a PDU is used, any overhead electrical use from the
314 PDU shall be included in the measurement of Idle power for the UUT.
- 315 D) Power Management and Operating System: The as-shipped operating system or a representative
316 operating system must be installed. Products that are shipped without operating systems must be
317 tested with a representative OS installed. For all tests, manufacturers must ensure that only the power
318 management techniques and/or power saving features which are enabled on shipment are those
319 enabled on systems under test. Any power management features which require the presence of an
320 operating system (i.e. those that are not explicitly controlled by the BIOS or management controller)
321 must be tested using only those power management features enabled by the operating system by
322 default.
- 323 E) Storage (HDD, SSD): Products that do not include pre-installed hard drives (HDD or SSD) must have
324 an identical hardware and software configuration as a product that was tested and qualified with at
325 least one installed hard drive.
- 326 F) Blade and Dual/Multi-Node Servers: A Blade or Dual/Multi-Node Server must have identical
327 configurations for each node or blade including all hardware components and software/power
328 management settings. These systems must also be measured in a way to ensure that all power from
329 all tested nodes/blades is being captured by the power meter the entire test.
- 330 G) Blade Chassis: [TBD]
- 331 H) BIOS and UUT System Settings: [TBD]

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

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

342 5.3 UUT PREPARATION

343 The Partner must test and report power and efficiency test results for a computer server under the
344 following conditions:

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

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

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

352 **Note:** EPA has received useful feedback in recent weeks from stakeholders regarding original Blade
353 Server testing proposals and the results gleaned from stakeholder evaluative testing. Testing has
354 indicated that the original proposal to repeat tests with a single blade removed ("N-1") does not yield
355 consistent results. As an alternative, stakeholders expressed to EPA that a single test would be
356 preferable, with total power entering the chassis divided by the number of installed blades to generate a
357 per-blade power value. This approach would further amortize chassis overhead across installed blades.

358 Remaining to be determined is the number of blade servers installed during testing. Early suggestions
359 from industry indicated that a full chassis would be optimal. Full chassis testing offers the most testing
360 accuracy, but significant concerns exist over the cost and resources required to support this method.

361 With this draft test method, EPA is requesting data in *both* a full and half populated configuration. This
362 approach is being taken only for this initial dataset development effort and it is EPA's intent to work with
363 stakeholders to choose and implement a single population scenario for qualification testing once the
364 specification is effective. EPA believes that once the resources are expended to populate a full chassis,
365 removing half of the blades requires reasonable additional effort. Having both sets of data at the
366 conclusion of dataset assembly will allow EPA and stakeholders to evaluate the benefits and costs of each
367 approach, selecting the option that strikes the appropriate balance between accuracy and testing burden.

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

370 b) When testing a single blade, install it in the chassis location that is recommended in the
371 manufacturer's documentation for optimal thermal performance. If manufacturer documented
372 recommendations either do not exist or are not available, install the blade in a top corner
373 position in the chassis.

374 c) Chassis Population

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- i. When testing a blade system, first populate all available chassis bays. Proceed with all required tests in the test procedure.
 - ii. After testing on the full chassis concludes, populate half of available chassis bays, rounding up to the nearest whole power domain if necessary. Populate bays using the following guidelines:
 - (a.) According to the blade chassis manufacturer recommendations, with all blades in the same power domain.
 - (b.) If manufacturer documented recommendations either do not exist or are not available: Fill the top row of the chassis first, then proceed downward. For partially-populated rows, fill from the center outward. For example, when installing six blades in a chassis with 3 rows and 4 bays per row, four blades must be installed into the top row, and two blades must be installed into the center two positions of the middle row.
 - iii. Fill all empty bays with blanking panels or an equivalent airflow restriction for the duration of testing.
- 3) 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.
 - 4) Connect the power analyzers to an ac or dc voltage source set to the appropriate voltage and frequency for the test.
 - 5) Plug the UUT into the measurement power outlet on the power analyzer, as follows:
 - a) no UPS units shall be connected between the power analyzer and the UUT;
 - b) the power analyzer shall remain connected until all testing is complete;
 - c) when testing a single blade server, the UUT shall be metered independently of the blade chassis;
 - d) 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).
 - 6) 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..
 - 7) Install the workload software on the UUT. Record the installed workload and configuration, including any custom parameters or settings.
 - 8) Record the input voltage and frequency.
 - 9) Verify that the UUT is configured in its as-shipped configuration.
 - 10) Verify that only those system and hard drive power management features that are enabled upon shipment to a customer are enabled for testing.

413 **6 TEST PROCEDURE**

414 **6.1 POWER AND EFFICIENCY TESTING**

- 415 1. Power up the UUT, either by switching it on or connecting it to mains power.
- 416 2. If necessary, power up the controller system.
- 417 3. Begin recording elapsed time.
- 418 4. Between 5 and 15 minutes after the initial boot or log in, set the analyzer to begin accumulating
419 power values at an interval of greater than or equal to 1 reading per second.
 - 420 a. When testing using a controller system, the controller system may automate data
421 accumulation and benchmark workload operation provided the measurement interval
422 requirements are met.
- 423 5. Engage workload operation.
 - 424 a. If the workload does not automate measurement of Idle power, between 5 and 15 minutes
425 after the workload has completed operation, accumulate Idle power values for 5 additional
426 minutes. The UUT must maintain an Idle state throughout this period and must not enter
427 lower power states with limited availability (e.g., server sleep or hibernate states).
- 428 6. Record the following data at the end of workload operation:
 - 429 a. Average Idle power (arithmetic mean) during either the automated Idle state period or 5
430 minute test period;
 - 431 b. Full power (the maximum power value measured during workload operation).
- 432 7. When testing a Blade System, proceed as follows to derive single blade power:
 - 433 a. Divide the measured total power into the chassis by the number of blades installed during
434 the test;
 - 435 b. Report the per-blade power values for each measurement and the total measured power
436 into the chassis.

437 **7 REPORTING**

438 **7.1 BLADE CHASSIS**

- 439
- 440 1. Report the following details:
 - 441 a. Fan speed control features;
 - 442 b. Available chassis cooling options;
 - 443 c. Chassis reporting capability (e.g., input power, inlet air temperature or other thermal
444 information, utilization, etc.)
- 445