**ENERGY STAR® Test Method
for Small Network Equipment**

**Draft 5
Rev. Dec-2011**

1 # 1 OVERVIEW

2 The following protocol shall be followed when testing products for compliance with the Version 1.0
3 ENERGY STAR Small Network Equipment (SNE) specification.

4 # 2 APPLICABILITY

5 ENERGY STAR test requirements are dependent upon the feature set of the product under evaluation.
6 The following guidelines shall be used to determine the applicability of each section of this document:

7 • Section 7.2.A) shall be conducted for all SNE products.

8 • Sections 7.2.B), C), and D) shall be completed for applicable product types as referenced in
9   Table 1.

10 **Table 1: Test Procedure Structure**

Product Type	Test Procedure Section			
	7.2.A) **All Devices – Idle State**	**7.2.B)** **Wired Network – WAN**	**7.2.C)** **Wired Network – LAN**	**7.2.D)** **Wireless Network – LAN**
Modem (DSL, Cable, ONT)	X	X		
Integrated Access Device	X	X	X	X
Switch/Router	X		X	
Wireless Product	X			X
Wired/Wireless Product	X		X	X

11 # 3 DEFINITIONS

12 Unless otherwise specified, all terms used in this document are consistent with the definitions contained
13 in the ENERGY STAR Eligibility Requirements for Small Network Equipment.

14 **Note**: Acronyms referenced in this ENERGY STAR Test Method draft

15 • ANSI: American National Standards Institute

16 • AP: Access Point

17	•	dB: Decibels
18	•	DHCP: Dynamic Host Configuration Protocol
19	•	DSL: Digital Subscriber Line
20	•	EIA: Electronic Industries Alliance
21	•	EPS: External Power Supply
22	•	HPNA: Home Phoneline Networking Alliance
23	•	IAD: Integrated Access Device
24	•	IEC: International Electrotechnical Commission
25	•	IEEE: Institute of Electrical and Electronics Engineers
26	•	IMIX: Internet Traffic Mix
27	•	IPsec: Internet Protocol Security
28	•	ISP: Internet Service Provider
29	•	L2TP: Layer 2 Tunneling Protocol
30	•	LAN: Local Area Network
31	•	LLDP: Link Layer Discovery Protocol
32	•	MAC: Media Access Control
33	•	MIMO: Multiple-Input/Multiple-Output
34	•	MoCA: Multimedia over Coax Alliance
35	•	NAT: Network Address Translation
36	•	ONT: Optical Network Terminal
37	•	PoE: Power over Ethernet
38	•	PON: Passive Optical Network
39	•	POTS: Plain Old Telephone Service
40	•	PPPoX: Point-to-Point Protocol over X
41	•	RF: Radio Frequency
42	•	SSID: Service Set Identifier
43	•	TIA: Telecommunications Industry Association
44	•	TTL: Time To Live
45	•	UDP: User Datagram Protocol
46	•	USB: Universal Serial Bus
47	•	UUT: Unit Under Test
48	•	VoIP: Voice over Internet Protocol
49	•	VPN: Virtual Private Network
50	•	WAN: Wide Area Network
51	•	WLAN: Wireless Local Area Network

52

53   4 **TEST SETUP**

54   A) <u>Test Setup and Instrumentation</u>: Test setup and instrumentation for all portions of this procedure shall
55   be in accordance with the requirements of IEC 62301, Ed. 2.0, "Household electrical appliances –
56   Measurement of standby power", Section 4, "General Conditions for Measurements". In the event of
57   conflicting requirements, the ENERGY STAR test method shall take precedence.

58   B) <u>Input Power</u>: Input power shall be as specified in Table 2.

59   **Table 2: Input Power Requirements**

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 Vac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz and 60 Hz	+/- 1.0 %

60   C) <u>Ambient Temperature</u>: Ambient temperature shall be from 18 $^{\circ}$C to 28 $^{\circ}$C.

61   D) <u>Relative Humidity</u>: Relative humidity shall be from 10% to 80%.

62   E) <u>Power Meter</u>: Power meters shall possess the following attributes:

63   1) <u>Crest Factor</u>: Capability to measure the current waveform without clipping.

64   i)   The peak of the current waveform measured during Idle State shall determine the crest factor
65   rating requirement and the appropriate current range setting.

66   ii)   The full-scale value of the selected current range multiplied by the crest factor for that range
67   shall be at least 15% greater than the peak current.

68   2) <u>Bandwidth</u>: Minimum bandwidth as determined by an analysis of current and voltage to determine
69   the highest frequency component (harmonic) with a magnitude greater than 1% of the
70   fundamental frequency under the test conditions.

71   3) <u>Minimum Frequency Response</u>: 3.0 kHz

72   4) <u>Minimum Sampling Frequency</u>: 60 Hz

73   5) <u>Minimum Resolution</u>:

74   i)   0.01 W for measurement values less than 10 W;

75   ii)   0.1 W for measurement values from 10 W to 100 W; and

76   iii)   1.0 W for measurement values greater than 100 W.

77   6)   Measurement Accuracy:

78   i)   Power measurements with a value greater than or equal to 0.5 W shall be made with an
79   uncertainty of less than or equal to 2% at the 95% confidence level.

80   ii)   Power measurements with a value less than 0.5 W shall be made with an uncertainty of less
81   than or equal to 0.01 W at the 95% confidence level.

82 5 **TEST CONDUCT**

83   A) As-shipped Condition: Products must be tested in their "as-shipped" configuration. For products that
84   offer a choice of user-configurable options, all options shall be set to their default condition.

85   B) Test Procedure Order: All portions of this test method shall be followed in the order in which they are
86   written.

87   C) Data Source/Transfer Requirements: A network traffic generator shall be used to simulate traffic and
88   monitor link reliability. The generator shall be configured for the correct traffic topology and traffic
89   profile, and as follows:

90   1) All data transfers shall occur via UDP;

91   2) The "data rate" is the average number of bits per second passing over a link in one direction.
92   Data rates are expressed as the average number of bits found in UDP data frames passing over
93   a link in a one second period;

94   3) The traffic generator shall be able to support the maximum theoretical data rate of the UUT with
95   UDP traffic.

96   4) Test traffic shall contain random data in a variety of datagram (or frame) sizes based on an
97   Internet traffic mix (IMIX) sent at random intervals. See references in Table 3 for more
98   information;

99   5) Data shall be evenly split between both directions (transmission and reception) for a given link
100   unless otherwise specified in this test procedure;

101   6) Port numbers for data traffic shall be randomly selected in advance of each test from the
102   available pool of valid UDP ports. Once selected, port numbers shall not be changed for the
103   duration of testing. If the selected port results in blocked traffic by a UUT firewall, select a
104   different port at random before proceeding with the test.

105   **Table 3: Data Source/Transfer References**

Reference	Description
http://spcprev.spirentcom.com/documents/4079.pdf	Spirent, Test Methodology Journal, IMIX (Internet Mix) Journal, March 2006

| Reference	Description
http://www.ixiacom.com/library/test_plans/display?skey=testing_pppox	IXIA Library: Test Plans, Broadband PPPoX and L2TP Testing

106   D) Battery Operated Products: For products designed to operate using batteries either when not
107   connected to the mains or during a power disruption, the battery shall be fully charged before the start
108   of testing and shall be left in place for the test.

109 6   **UUT CONFIGURATION**

110 **6.1   SUPPLIED POWER CONFIGURATION**

111 A UUT that can be powered by either mains power or low-voltage dc shall be powered from the mains.
112 Low voltage dc shall be used only for devices that do not offer a mains power option.

113   1) Mains-powered: If the UUT is shipped with an external power supply, or powered directly by
114   mains ac, power consumption of the UUT shall be measured and tested between the ac power
115   source and the UUT.

116   2) Low-voltage Dc Powered: For products powered by standard low-voltage dc (e.g., Power over
117   Ethernet [IEEE 802.3af or .3at], or USB), the following protocol applies:

118   i)   If a manufacturer-supplied low-voltage dc power supply is shipped with the UUT, it shall be
119   used for testing.

120   ii) If there is no power supply shipped with the UUT, a commercially available device (e.g., PoE
121   Midspan or powered USB hub) shall be used to supply power to the UUT for testing. If the
122   UUT manufacturer sells an appropriate standard low-voltage dc supply, then a model from
123   the UUT manufacturer shall be used. The brand and model number of the power supply shall
124   be recorded on the test data sheet. The selected power supply shall be considered the
125   external power supply for the unit for purposes of testing.

126   iii) Power consumption of the UUT shall be measured and tested between the ac power source
127   and the low-voltage dc power supply as identified in *Figure 1: Low-voltage Dc Power Setup.*

Figure 1: Low-voltage Dc Power Setup.
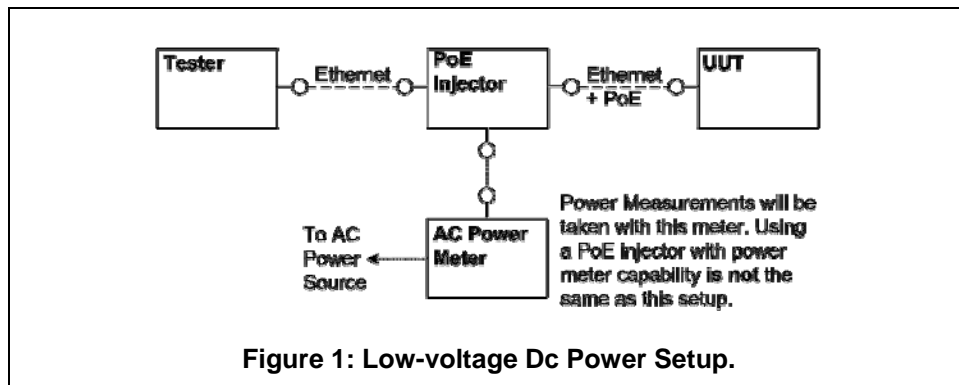
128 **6.2   WIRED PORT UUT CONFIGURATION**

129 Only Ethernet ports are considered wired LAN ports for purposes of testing. Ethernet connectivity and all
130 other wired ports shall be configured for testing as follows:

131   1)   Alternative LAN Technologies: Non-Ethernet wired ports (e.g., HPNA, MoCA, USB, analog
132   connections, POTS, audio) shall not be connected, unless a secondary device and cable are
133   shipped with the UUT (e.g., an external disk with a USB connection).

134   2)   Network Link Maintenance: The UUT's WAN port shall be connected to a live source. Network
135   links shall be continuously maintained, with the exception of brief lapses when transitioning
136   between link speeds.

137   3)   Ethernet Port Connection Rate: Ethernet ports shall be connected at the maximum supported link
138   rate unless otherwise specified in this test procedure.

139   4)   Ethernet Cabling: All Ethernet cables used for testing shall meet ANSI/EIA/TIA-568 Category 5e
140   (Cat5e) specifications and shall be no shorter than 2 meters in length.

141   5)   Power over Ethernet (PoE): PoE capability shall be configured with default as-shipped settings.

142   6)   Efficient Networking Protocols:

143   i.   If the UUT supports IEEE 802.3az protocol, all connected devices must support IEEE
144   802.3az,

145   ii.   If the UUT supports LLDP for 802.3az, all connected devices must support LLDP for 802.3az.

146   **6.3   WIRELESS UUT CONFIGURATION**

147   The UUT shall be tested with wireless network settings in their default as-shipped configuration. Default
148   settings shall not be modified unless modification is necessary to complete this procedure, or if no default
149   setting exists. Any features that require special configuration to achieve intended function (e.g., initial
150   setup before use as indicated in a reference manual) shall be configured per the following requirements.
151   If additional required settings are not listed below, the setting type and option shall be recorded in the test
152   report.

153   1)   SSID: As-shipped, or assigned a random value as required by the UUT;

154   2)   Network Encryption: As-shipped, or 128-bit WPA2 as required by the UUT;

155   3)   Network Key: As shipped, or assigned a random value as required by the UUT;

156   4)   Network Channel: A supported channel shall be selected and maintained for the duration of
157   testing;

158   5)   Interference Mitigation: Interference robustness or other interference mitigation technology shall
159   be as-shipped or set to "ON" if configuration required by UUT.

160   6)   Wireless Link Precedence:

161   i)   *Single instantaneous frequency band support*: The first supported wireless standard and
162   frequency band from Table 4 shall be used for access point testing. Only one band shall be
163   active during the test.

164 **Table 4: Wireless Link Precedence - Single Instantaneous Frequency Band Support**

Wireless Band	Frequency
IEEE 802.11n	5 GHz (2 channels bonded if supported)
IEEE 802.11n	2.4 GHz (single, unbonded channel)
IEEE 802.11g	2.4 GHz
IEEE 802.11b	2.4 GHz
IEEE 802.11a	5 GHz

165   ii)   *Simultaneous instantaneous frequency band support*: The first supported pair of wireless
166   standards and frequency bands from Table 5 shall be used for access point testing.

167 **Table 5: Wireless Link Precedence - Simultaneous Instantaneous Frequency Band Support**

Wireless Band 1	Frequency 1	Wireless Band 2	Frequency 2
IEEE 802.11n	2.4 GHz (single channel, 5 GHz bonded channels if supported)	IEEE 802.11n	2.4 GHz (single channel, 5 GHz bonded channels if supported)
IEEE 802.11g	2.4 GHz	IEEE 802.11n	5 GHz (bonded channels if supported)
IEEE 802.11g	2.4 GHz	IEEE 802.11a	5 GHz
IEEE 802.11b	2.4 GHz	IEEE 802.11a	5GHz

168   iii)   *Alternative configurations*: If a device cannot support any configuration listed in either Table 4
169   (for support of a single instantaneous frequency band) or Table 5 (for support of multiple
170   instantaneous frequency bands), the test client shall provide a configuration. The
171   configuration shall be recorded in the test report.

172 **6.4   UUT WIRED NETWORK SETTINGS**

173 The UUT shall be tested with wired network settings in their default as-shipped configuration. Default
174 settings shall not be modified unless modification is necessary to complete this procedure, or if no default
175 setting exists. Any features that require configuration for the UUT to function (e.g., required setup before
176 use as indicated in a reference manual) shall be configured per the following requirements. If additional
177 required settings are not listed below, the setting type and option shall be recorded in the test report.

178   1)   Enable Network Address Translation (NAT) for IPv4 networks;

179   2)   Enable IPv6 Link Local, Neighbor Solicitation, Neighbor Discovery, Router Solicitation and Router
180   Advertisement;

181   3)   Enable Single Class C Subnet;

182   4)   Enable single hop (router TTL + 1) to source on WAN side;

183   5) Enable DHCP, if available, and have the UUT autonomously assign each configured test client an
184   address by the DHCP service in the router, or manually assign addresses in a manner typical of
185   DHCP (e.g., incremental, 3 day TTL); the WAN port shall be configured via DHCP or manually
186   assigned if DHCP is not supported;

187   6) Disable Internet Protocol Security (IPsec);

188   7) Disable features not in compliance with IEEE 802.3 standards;

189   8) If the UUT offers more than one WAN connection option, the UUT shall be configured using the
190   first available WAN connection presented in Table 6, from top to bottom.

191   9) The WAN connection shall be configured to operate at the maximum possible speed.

192 **Note**: The US Environmental Protection Agency (EPA) and Department of Energy (DOE) received
193 comments from stakeholders that Table 6 lacked details on sub-types of the technologies listed in the first
194 column. Stakeholders also suggested that using the max capable link speed for each technology would
195 provide the most equitable testing condition and allay concern regarding the specific speeds previously
196 listed. EPA and DOE have edited Table 6 accordingly to provide only a precedence of WAN connection –
197 as now clarified in Steps 8) and 9).

198   **Table 6: WAN Link Precedence**

Connection Type	Media Type
DOCSIS (Cable)	Coax
PON	Fiber
DSL	Copper (Twisted Pair)
MoCA	Coax
HPNA	Coax
WiMAX (802.16e)	Wireless
Ethernet (802.3)	Copper (Twisted Pair)

199 **6.5 UUT PREPARATION**

200 The UUT shall be configured for testing as follows.

201   1) <u>Test Report</u>: Record the manufacturer and model name of the UUT. Record all basic information
202   about the UUT's configuration including, but not limited to, the settings listed Sections 6.1 through
203   6.4.

204   2) <u>Network Connection</u>: Connect the UUT to network resources as follows:

205   i) Modem (DSL, Cable, or ONT): See Figure 2: Modem setup.

Figure 2: Modem setup.

WAN port selected based on Table 6. Only 1 WAN port connected.
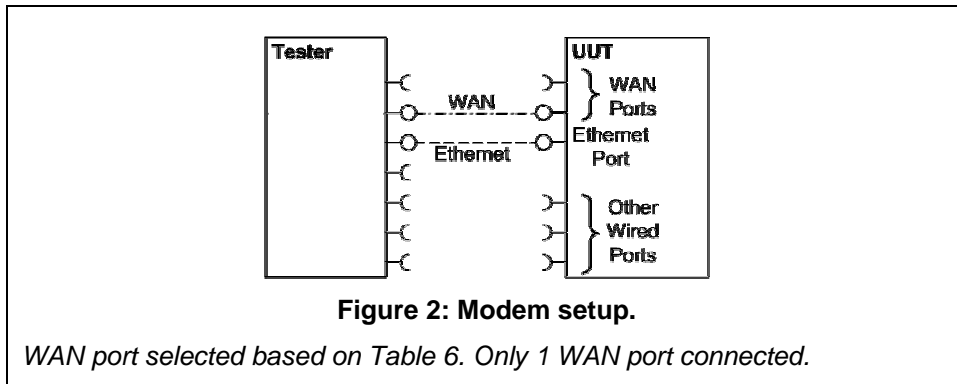
206   (a.) Connect the UUT WAN port to the test client using the priority and link rate specified in
207   Section 6.4.

208   (b.) Connect one LAN port to the test client. If Ethernet is available, the Ethernet port shall be
209   used. If more than one Ethernet port is present, the first non-uplink Ethernet port shall be
210   used.

211   **Note**: The test approach for modems is currently intended to allow only head-end equipment as part of
212   the lab setup, as opposed to ISP-based testing. Stakeholders are encouraged to provide feedback on
213   both of these options and the balance of test setup cost and run-to-run variability.

214   ii)   Switch/Router: See Figure 3: Switch or router test setup.

Figure 3: Switch or router test setup.
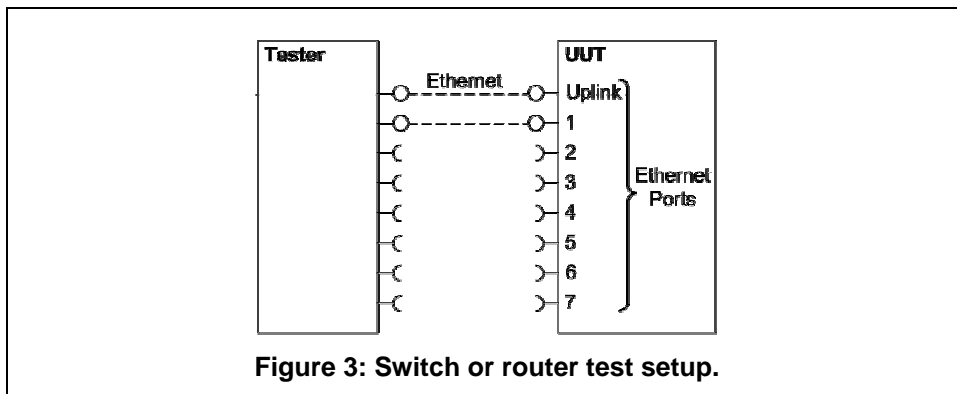
215   (a.) Connect two of the UUT's available ports to the test client and ensure that live links are
216   maintained for the duration of testing on all connections.

217   (b.) If there is a port on the UUT identified as the uplink or WAN port, it shall be selected as
218   one of the two ports connected for testing. Otherwise, the first port shall be used as the
219   uplink port.

220   iii) IAD or Access Point:

221   (a.) *Access Points*: Connect the uplink Ethernet port to the test source at the highest
222   available link rate and ensure that live links are maintained for the duration of testing.

223   (b.) *IADs*: Ensure a WAN port is connected according to the priority specified in Section 6.4
224   and ensure that live links are maintained for the duration of testing. Connect the first
225   Ethernet port to the test source at the highest available link rate. Traffic for this test will
226   pass over the Ethernet link and not the WAN link.

227 **Note**: In testing wireless routers with removable antennas, EPA and DOE experienced inconsistencies in
228 power consumption when removing the antennas and connecting the router directly to the test client via
229 coaxial cables. When attenuators were incrementally added to the line, unpredictable changes in the
230 received signal strength were observed. However, when the same units were tested wirelessly via the
231 unit's antennas, the signal strength and data were consistent and repeatable over a number of tests. The
232 test method has been revised to remove the wired testing option.

233   (c.) *Wireless UUTs*: (see *Figure 4: AP setup with fixed antennas*).

234   (i.) Place the UUT inside a shielded enclosure large enough to fit the UUT without
235   contact with enclosure walls. The enclosure must have sufficient RF absorbing
236   material lining all inside surfaces and also have sufficient RF, Ethernet, and power
237   feed-throughs to service the UUT.

238 **Note**: Guidance on the shielding enclosure has been revised for clarity.

239   (ii.) Connect antennas to the RF feed-throughs on the inside of the enclosure.

240   (iii.) Connect cables to the exterior feed-throughs via appropriate RF attenuators to
241   achieve a signal strength of -50 dBm ± 5 dB. The test client transmit power shall be
242   set to ensure that the received signal strength at the AP is -50 dBm ± 5 dB. Use of
243   RF test equipment (e.g., spectrum analyzer) to determine the appropriate use of
244   attenuation is recommended. The equipment used shall be recorded.

245 **Note**: During validation testing, EPA and DOE observed variations in the signal strength outside the -50
246 dBm ± 3 dB tolerance, indicating that that a 3 dB tolerance is too stringent with standard test equipment.
247 EPA and DOE have therefore increased the tolerance to ± 5 dB to ease the equipment requirement
248 burden on stakeholders and welcome comments on this change.

249   (iv.) If the AP has multiple antennas for a single band, an appropriate number of cables
250   and antennas shall be connected to achieve the maximum supported data rate (i.e.,
251   1 cable/antenna for 802.11a/b/g and ≥1 cable/antenna for 802.11n).
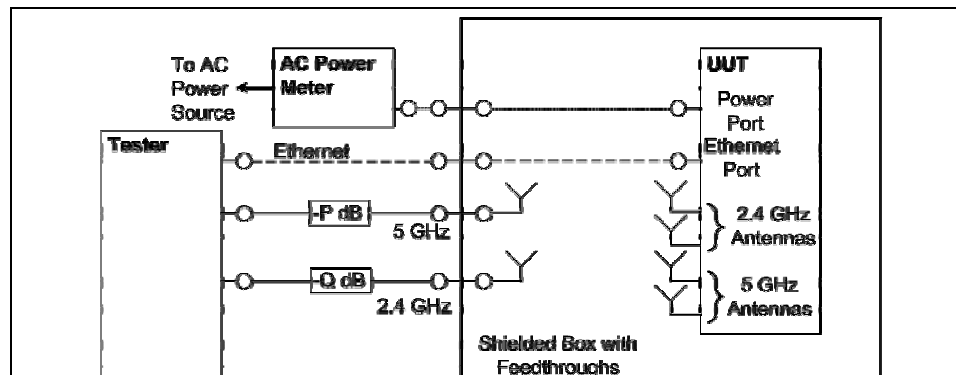

Figure 4: AP setup with fixed antennas.

*Attenuation is set according to Section 6.5.c.ii. Test configured for 802.11g
(2.4 GHz) and 802.11a (5 GHz) with one antenna connection required for each
to achieve maximum throughput.*

252   (d.) If the UUT requires an access point controller for normal operation, an access point
253   controller from the same manufacturer as the UUT shall be added to the network for
254   testing. If the UUT is capable of full operation without an access point controller, it shall
255   be tested without a controller on the test network.

256   (e.) Record sufficient details of the test setup to allow for the test to be independently re-
257   created and verified.

258   3) Power Meter Connection:

259   i) Connect the power meter(s) to an ac or dc voltage source set to the appropriate voltage and
260   frequency for the test.

261   ii) Plug the UUT into the measurement power outlet on the power meter, as follows:

262   (a.) No other devices (e.g., power strips or UPS units) may be connected between the meter
263   and the UUT;

264   (b.) If the UUT uses an external power supply (EPS), the EPS is considered part of the UUT.
265   Plug the EPS input into the measurement power outlet on the meter;

266   (c.) The power meter shall remain connected until all testing is complete.

267   **6.6   TEST CLIENT SETUP**

268   The tests outlined in Section 7 require the use of network tester equipment (the test client) capable of
269   supporting the protocols used during testing. The test client may consist of several discrete pieces of test
270   equipment used together to test Ethernet, WAN, and wireless links. This section is intended to provide
271   guidelines for test client configuration to be applied to the specific pieces of equipment serving the UUT.

272   1) Configure the test client Ethernet ports to be DHCP clients with unique, random MAC addresses.

273   2) Configure the WAN port or uplink Ethernet port to assign a random IPv4 address to the UUT. A
274   static IPv4 address may be set in the UUT if the test client is unable to support random address
275   assignment. IPv6 may be used if IPv4 support is not present in the test client hardware. If the
276   device is configured for DHCP pass-through functionality, the test client shall assign addresses
277   through the UUT.

278   3) Configure the test client to send traffic using UDP.

279   4) Configure the test client to provide statistics on data reliability (% of packets received
280   successfully).

281   5) Configure the test client to transmit variable length packets or frames using the basic IMIX given
282   in Table 7 (see Table 3 for references). The packet content shall be random as specified in
283   Section 5.C).4).

284   **Table 7: IMIX Packet Length Distribution**

Datagram Size (IP Length in Bytes)	Frame Length (Bytes)	% of total packets
40	64	61%
576	594	23%
1500	1518	16%

285 | **Note**: IMIX, otherwise known as "Internet Mix," is a methodology for generating packets of random sizes
286 | and types in appropriate proportions to those found in general Internet IP traffic. This test suite is
287 | documented in the following technical document: http://spcprev.spirentcom.com/documents/4079.pdf.

288 | DOE and EPA are aware of multiple manufacturers of traffic generators that are available commercially,
289 | either for purchase or lease, which should be capable of supporting IMIX traffic. DOE and EPA believe
290 | that this availability, combined with the existing expectation that IMIX traffic patterns can be generated by
291 | scripting and existing laboratory equipment, is sufficient to support laboratories interested in SNE testing.

292 | DOE and EPA welcome feedback on the level of resource burden related to IMIX traffic generation in
293 | support of this testing requirement. DOE and EPA are open to alternative options, which could potentially
294 | be utilized if IMIX traffic is considered too burdensome for testing purposes. Testing alternatives could be
295 | multipart and use partially calculated results, but testing must be repeatable and representative of typical
296 | network traffic. DOE and EPA welcome feedback on methods for traffic generation.

297 6) Configure the test client to test in a modified aggregation mode. All traffic will pass over a single
298   link (the uplink or WAN port), and this traffic will be evenly divided between the other connected
299   Ethernet ports. See *Figure 5: Data distribution for multilink tests.*

Figure 5: Data distribution for multilink tests.

Half port test case shown. R is the rate specified in the procedure.
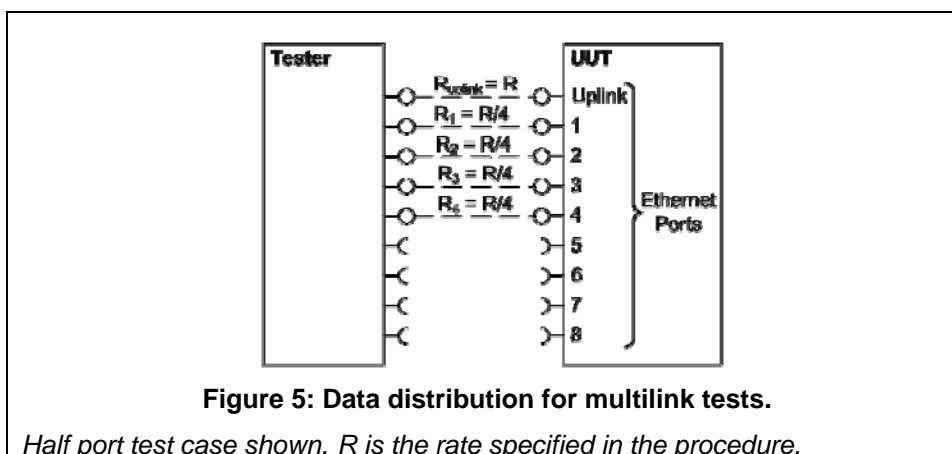
300 7) If the UUT has wireless capability, the test client shall be capable of functioning as a wireless
301   client for the wireless standard(s) specified in Section 6.3.

302 8) Configure data connections to the test client as specified in Section 6.5.

303 9) Record the test equipment used for the test client and provide a functional diagram of the test
304   equipment and UUT configuration, including all connections in the test setup.

305 # 7 TEST PROCEDURES FOR ALL PRODUCTS

306 **7.1 POWER MEASUREMENT GUIDELINES**

307 A) Tests are performed at two data rates, 1 kb/s (0.5 kb/s in each direction), and the highest rate
308   supported by the link shown in Table 8. The 1 kb/s rate shall be achieved as a moving average,
309   where the data rate averages 1 kb/s in any 30 second window. If the link has asymmetric data rate
310   support (e.g., DSL, with a higher download rate than upload rate), choose the highest rate supported
311   for the direction shown in the table. For data rates higher or lower than those shown in the chart,
312   choose the highest data rate according to Equation 1 and adjusting the variable Y as required to
313   achieve the desired data rate. **Note**: A link with 100 Mb/s raw throughput will not support 100 Mb/s of
314   traffic as specified in this procedure. In this case the traffic rate should be set to 50 Mb/s.

315 **Equation 1**

316 $$DataRate = Z \times 10^Y \quad \text{(in bits per second)}$$

317 *Where:*
318 • *Z is 1, 2, or 5, and*
319 • *Y is an integer. Adjust as required to achieve the desired data*
320   *rate*

321 **Table 8: Test Rate Selection**

Direction	Rate (Mb/s)								
Downlink or Symmetric link	1.0	2.0	5.0	10	20	50	100	200	500
Uplink	0.5	1.0	2.0	5.0	10	20	50	100	200

322 B) If there is a port on the UUT identified as the uplink or WAN port, it shall be selected as the uplink port
323   in Section 7.2.C). Otherwise, the first port shall be used as the uplink port. If present, additional
324   Ethernet ports shall be connected sequentially, and there shall be no open Ethernet ports between
325   occupied Ethernet ports.

326 C) If any standard power reduction mechanisms are supported by the UUT, such features may be
327   enabled during testing in both the UUT and test equipment, provided that all enable features are
328   disclosed along with reported test results.

329 D) The following procedure shall be used for each test component in Section 7.2:

330   1) Reset the power meter (if necessary).

331   2) Begin recording elapsed time.

332   3) After 5 minutes have elapsed, set the meter to begin accumulating true power values at a rate of
333   greater than or equal to 1 Hz (1 reading per second).

334 **Note**: EPA and DOE have added a 5 minute period to allow the UUT to achieve a steady state prior to
335 measurement (e.g., to allow for integral storage spin down, etc.).

336   4) Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed
337   during the 5 minute period.

338   5) Record the test procedure step and measurements on the test report. If a step is repeated at a
339   different link rate, record the additional measurements in the test report.

340 **7.2   POWER CONSUMPTION TESTS**

341 A) All Devices – Idle State

342   1) Turn on the UUT and configure the UUT per the requirements in Section 6.

343   2) Measure and record UUT power per Section 7.1.

344 B) Wired Network – WAN

345   1) If the UUT only supports WAN connection (IADs only), connect one Ethernet port. Ensure all
346   Ethernet ports are connected at their highest supported link rate. Measure and record power per
347   Section 7.1.

348   2) Run data at 1 kb/s (0.5 kb/s in each direction) between the WAN and LAN ports. Measure and
349   record power per Section 7.1.

350   3) Run data at the rate specified in Section 7.1 between the WAN and LAN ports. Measure and
351   record power per Section 7.1.

352 C) Wired Network – LAN:

353   1) <u>Half-Ports Test</u>: Test with half of ports in use, at all supported speeds, as applicable. See Figure
354   5: Data distribution for multilink tests.

355   i) If the UUT has more than two Ethernet ports, connect half of the Ethernet ports (round up to
356   the nearest whole number of ports). Connect each port sequentially (e.g., a 5-port product
357   would have ports 1-3 connected and ports 4 and 5 disconnected). Ethernet and other LAN
358   ports on the UUT must be connected at their highest supported link rate. If a port on the UUT
359   is specified as the uplink port, it shall be used as the uplink port for testing; otherwise, the first
360   port shall be used as the uplink port. Measure and record power per Section 7.1.

361   ii) Run data at 1 kb/s (0.5 kb/s in each direction) between the LAN ports. Measure and record
362   power per Section 7.1.

363   iii) Run data at the rate specified in Section 7.1 between the LAN ports. Measure and record
364   power per Section 7.1.

365 D) Wireless Network - WLAN

366   1) Ensure only one Ethernet port is connected to the UUT.

367   2) Establish a single client device in the test client. The WLAN type must be consistent with the
368   priority specified in Section 6.3 and shall be configured for the highest supported link rate. Record
369   the supported rate for the network port, the wireless link, and the version of 802.11 being used for
370   this test. Measure and record power per Section 7.1.

371   3) Run data at 1 kb/s (0.5 kb/s in each direction) between the LAN port and the WLAN client.
372   Measure and record power per Section 7.1.

373   4) Run data at the rate specified in Section 7.1 between the LAN port and the WLAN client. Measure
374   and record power per Section 7.1.

375 8 **PERFORMANCE EVALUATION**

376 Performance capabilities shall be evaluated using the tests listed below as applicable to the functions and
377 features of the UUT. UUT configuration shall be as specified in Section 6.

378 A) <u>Ethernet Throughput</u> - Using a test setup consistent with Section 7.2.C), determine the maximum
379   data rate supported by the UUT for which there is no packet loss. Record this rate as the measured
380   maximum throughput.

381 B) <u>Maximum Number of Wireless Clients</u> - Using a test setup consistent with Section 7.2.D), determine
382 the maximum number of clients supported by the UUT. Clients shall be evenly split between bands if
383 there is simultaneous dual band support. No data shall be passed other than that required to setup
384 clients. The data rate shall be set to the maximum rate utilized in Section 7.2.D).4). Record this
385 number as the maximum number of wireless clients.

386 C) <u>Maximum Number of NAT Clients</u>

387   1) Record the maximum number of supported NAT clients.

388   2) The addition of downstream switches to the test setup and/or combination of tests similar to
389 Sections 7.2.C) and 7.2.D) may be required to achieve a large number of NAT clients. No data
390 shall be passed other than that required to configure the clients. The data rate shall be set to the
391 maximum rate utilized in Section 7.2.B).3) If an additional switch is required, record the number of
392 wireless NAT and the number of wired NAT clients.

393 ## 9   REPORTING

394 ### 9.1   REPORTED UUT INFORMATION AND FUNCTIONALITY

395 The following characteristics are recommended for reporting using this procedure:

396   1.   Manufacturer and model name;

397   2.   Basic configuration information;

398   3.   Powering options (e.g., direct ac, external ac-dc power supply, standard low-voltage dc). If
399 powered over Ethernet, report whether LLDP for PoE is supported;

400   4.   Number and type of all wired data and network ports. Additional related details (e.g.,
401 Ethernet speed, 802.3az, LLDP for 802.3az);

402   5.   Feature activity conflicts;

403   6.   Number and type of wireless network support including supported bands, simultaneous
404 band support, supported standards, and MIMO configuration. Additional details as required;

405   7.   Supported network traffic functions (e.g., firewall, VPN, VOIP functionality for POTS ports);

406   8.   Mass storage options integral to or shipped with the UUT;

407   9.   Any special equipment ratings (e.g., IEC 61850 / IEC61000 and IEEE1613, KEMA).

408 ### 9.2   REPORTED TEST RESULTS

409   1.   Voltage and frequency used in test;

410   2.   If low-voltage dc, type of supply used;

411   3.   Wireless Link information from Table 4 or Table 5;

412   4.   Any settings changed per Section 6.4;

413   5.   Uplink link rate;

414   6.   Uplink and downlink data rates;

415   7.   Power levels - Report all that apply:

416   • One port: Idle State, low data rate, high data rate;

417   • Half ports: Idle State, low data rate, high data rate;

418   • Wireless: Idle State, low data rate, high data rate;

419   8.   Ethernet throughput - Maximum data rate in UDP data payload (expressed in b/s);

420   9.   Maximum wireless clients;

421   10.   Maximum NAT clients.
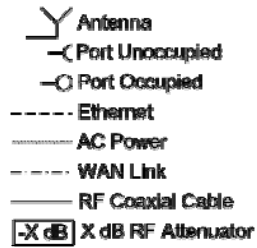
422 **10 TEST CONFIGURATION REFERENCES**

Figure 6: Legend for all figures.

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