



ENERGY STAR® Test Method for Small Network Equipment

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Data Collection

1 OVERVIEW

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

2 APPLICABILITY

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

- Section 7.2.A) shall be conducted for all SNE products.
- Sections 7.2.B), C), and D) shall be completed for applicable product types as referenced in Table 1.

Table 1: Test Procedure Structure

Product Type	Test Procedure Section			
	7.2.A) All Devices – Idle	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

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions contained in the ENERGY STAR Eligibility Requirements for Small Network Equipment. The following terms are also referenced in this Test Method:

- A) Integrated Access Device (IAD): A device providing one of the following capability combinations: (1) modem and switch, (2) router, or (3) switch and router capability.

- 17 B) Link Rate: The maximum raw bit rate possible on a particular link (e.g., 1000BASE-T Ethernet
 18 supports 1 Gb/s in each direction [2 Gb/s total]; IEEE 802.11g supports 54 Mb/s total).
- 19 C) Unit Under Test (UUT): The network equipment device being tested.
- 20 D) WLAN Test Client: A device that is capable of establishing an 802.11x link with an AP and
 21 transmitting data to and from the AP.

22 4 TEST SETUP

- 23 A) Test Setup and Instrumentation: Test setup and instrumentation for all portions of this procedure shall
 24 be in accordance with the requirements of IEC 62301, Ed. 1.0, "Measurement of Household
 25 Appliance Standby Power", Section 4, "General Conditions for Measurements". In the event of
 26 conflicting requirements, the ENERGY STAR test method shall take precedence.
- 27 B) Input Power: Input power shall be as specified in Table 2.

28 **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 %
China	220 Vac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 Vac	+/- 1.0 %	2.0 %	50 Hz and 60 Hz	+/- 1.0 %

- 29 C) Ambient Temperature: Ambient temperature shall be from 18 °C to 28 °C.
- 30 D) Relative Humidity: Relative humidity shall be from 10% to 80%.
- 31 E) Power Meter: Power meters shall possess the following attributes:
- 32 1) Crest Factor: Capability to measure the current waveform without clipping.
- 33 i) The peak of the current waveform measured during Sleep Mode and On Mode shall
 34 determine the crest factor rating requirement and the appropriate current range setting.
- 35 ii) The full-scale value of the selected current range multiplied by the crest factor for that range
 36 shall be at least 15% greater than the peak current.

- 37 2) Bandwidth: Minimum bandwidth as determined by an analysis of current and voltage to determine
38 the highest frequency component (harmonic) with a magnitude greater than 1% of the
39 fundamental frequency under the test conditions.
- 40 3) Minimum Frequency Response: 3.0 kHz
- 41 4) Minimum Sampling Frequency: 60 Hz
- 42 5) Minimum Resolution:
- 43 i) 0.01 W for measurement values less than 10 W;
- 44 ii) 0.1 W for measurement values from 10 W to 100 W; and
- 45 iii) 1.0 W for measurement values greater than 100 W.
- 46 F) Measurement Accuracy:
- 47 1) Power measurements with a value greater than or equal to 0.5 W shall be made with an
48 uncertainty of less than or equal to 2% at the 95% confidence level.
- 49 2) Power measurements with a value less than 0.5 W shall be made with an uncertainty of less than
50 or equal to 0.01 W at the 95% confidence level.

51 **5 TEST CONDUCT**

- 52 A) As-shipped Condition: Products must be tested in their “as-shipped” configuration. For products that
53 offer a choice of user-configurable options, all options shall be set to their default condition.
- 54 B) Test Procedure Order: All portions of this test method shall be followed in the order in which they are
55 written.
- 56 C) Data Source/Transfer Requirements: A network traffic generator shall be used to simulate traffic and
57 monitor link reliability. The generator shall be configured for the correct traffic topology and traffic
58 profile, and as follows:
- 59 1) All data transfers shall occur via UDP;
- 60 2) The “data rate” is the average number of bits per second passing over a link in one direction.
61 Data rates are expressed as the average number of bits found in UDP data frames passing over
62 a link in a one second period;
- 63 3) Test traffic shall contain random data in a variety of datagram (or frame) sizes based on an
64 Internet traffic mix (IMIX) sent at random intervals. See references in Table 3 for more
65 information;
- 66 4) Data shall be evenly split between both directions (transmission and reception) for a given link
67 unless otherwise specified in this test procedure;
- 68 5) Port numbers for data traffic shall be randomly selected in advance of each test from the
69 available pool of valid UDP ports. Once selected, port numbers shall not be changed for the
70 duration of testing. If the selected port results in blocked traffic by a UUT firewall, select a
71 different port at random before proceeding with the test.

72

Table 3: Data Source/Transfer References

Reference	Description
http://spcprev.spirentcom.com/documents/4079.pdf	<u>Spirent</u> , Test Methodology Journal, IMIX (Internet Mix) Journal, March 2006
http://www.ixiacom.com/library/test_plans/display?skey=testing_pppox	<u>IXIA Library: Test Plans</u> , Broadband PPPoX and L2TP Testing

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

76 6 UUT CONFIGURATION

77 6.1 SUPPLIED POWER CONFIGURATION

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

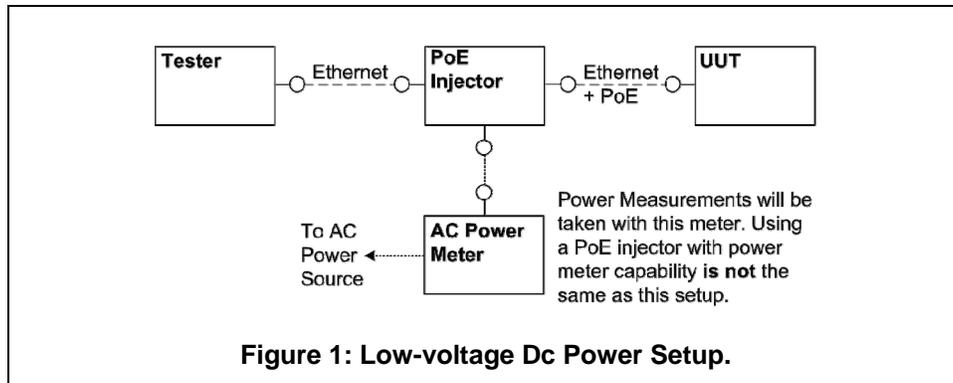
80 1) Mains-powered: If the UUT is shipped with an external power supply, or powered directly by
 81 mains ac, power consumption of UUT shall be measured and tested between the ac power
 82 source and the UUT.

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

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

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

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



95 **6.2 WIRED PORT UUT CONFIGURATION**

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

- 98 1) Alternative LAN Technologies: Non-Ethernet wired ports (e.g., HPNA, MoCA, USB, analog
 99 connections, POTS, audio) shall not be connected, unless a secondary device and cable are
 100 shipped with the UUT (e.g., an external disk with a USB connection).
- 101 2) Network Link Maintenance: The UUT's WAN port shall be connected to a live source. Network
 102 links shall be continuously maintained, with the exception of brief lapses when transitioning
 103 between link speeds.
- 104 3) Ethernet Port Connection Rate: Ethernet ports shall be connected at the maximum supported link
 105 rate unless otherwise specified in this test procedure.
- 106 4) Ethernet Cabling: All Ethernet cables used for testing shall meet ANSI/EIA/TIA-568 Category 5e
 107 (Cat5e) specifications and shall be no shorter than 2 meters in length.
- 108 5) Power over Ethernet (PoE): PoE capability shall be configured with default as-shipped settings.
- 109 6) Efficient Networking Protocols:
- 110 a. If the UUT supports IEEE 802.3az protocol, all connected devices must support IEEE
 111 802.3az,
- 112 b. If the UUT supports LLDP for 802.3az, all connected devices must support LLDP for
 113 802.3az.

114 **6.3 WIRELESS UUT CONFIGURATION**

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

- 121 1) SSID: As-shipped, or assigned a random value as required by the UUT;
- 122 2) Network Encryption: As-shipped, or 128-bit WPA2 as required by the UUT;
- 123 3) Network Key: As shipped, or assigned a random value as required by the UUT;

- 124 4) Network Channel: A supported channel shall be selected and maintained for the duration of
125 testing;
- 126 5) Interference Mitigation: Interference robustness or other interference mitigation technology shall
127 be as-shipped or set to “ON” if configuration required by UUT.
- 128 6) Wireless Link Precedence:
- 129 i) *Single instantaneous frequency band support*: The first supported wireless standard and
130 frequency band from Table 4 shall be used for access point testing. Only one band shall be
131 active during the test.

132 **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

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

135 **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

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

140 **6.4 UUT WIRED NETWORK SETTINGS**

141 The UUT shall be tested with wired network settings in their default as-shipped configuration. Default
142 settings shall not be modified unless modification is necessary to complete this procedure, or if no default

143 setting exists. Any features that require configuration for the UUT to function (e.g., required setup before
144 use as indicated in a reference manual) shall be configured per the following requirements. If additional
145 required settings are not listed below, the setting type and option shall be recorded in the test report.

- 146 1) Enable Network Address Translation (NAT) for IPv4 networks;
- 147 2) Enable IPv6 Link Local, Neighbor Solicitation, Neighbor Discovery, Router Solicitation and Router
148 Advertisement;
- 149 3) Enable Single Class C Subnet;
- 150 4) Enable single hop (router TTL + 1) to source on WAN side;
- 151 5) Enable DHCP, if available, and have the UUT autonomously assign each configured test client an
152 address by the DHCP service in the router, or manually assign addresses in a manner typical of
153 DHCP (e.g., incremental, 3 day TTL); the WAN port shall be configured via DHCP or manually
154 assigned if DHCP is not supported;
- 155 6) Disable Internet Protocol Security (IPsec);
- 156 7) Disable features not in compliance with IEEE 802.3 standards;
- 157 8) If the UUT offers more than one WAN connection option, the UUT shall be configured using the
158 first available WAN connection presented in Table 6, from top to bottom.
- 159 9) The WAN connection shall be configured to operate at the maximum possible speed.

160 **Note:** EPA received comments from stakeholders that Table 6 lacked details on sub-types of the
161 technologies listed in the first column. Stakeholders also suggested that using the max capable link speed
162 for each technology would provide the most equitable testing condition and allay concern regarding the
163 specific speeds previously listed. EPA has edited Table 6 accordingly to provide only a precedence of
164 WAN connection – as now clarified in Steps 8) and 9).

165 **Table 6: WAN Link Precedence**

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

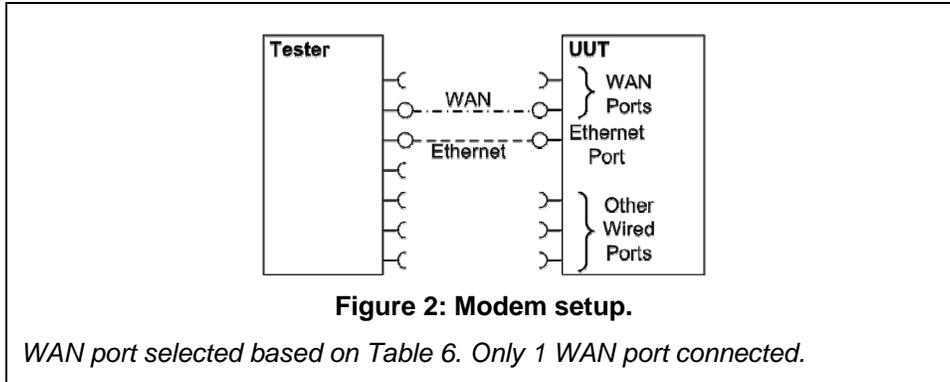
166 **6.5 UUT PREPARATION**

167 The UUT shall be configured for testing as follows.

168 1) Test Report: Record the manufacturer and model name of the UUT. Record all basic information
169 about the UUT's configuration including, but not limited to, the settings listed Sections 6.1 through
170 6.4.

171 2) Network Connection: Connect the UUT to network resources as follows:

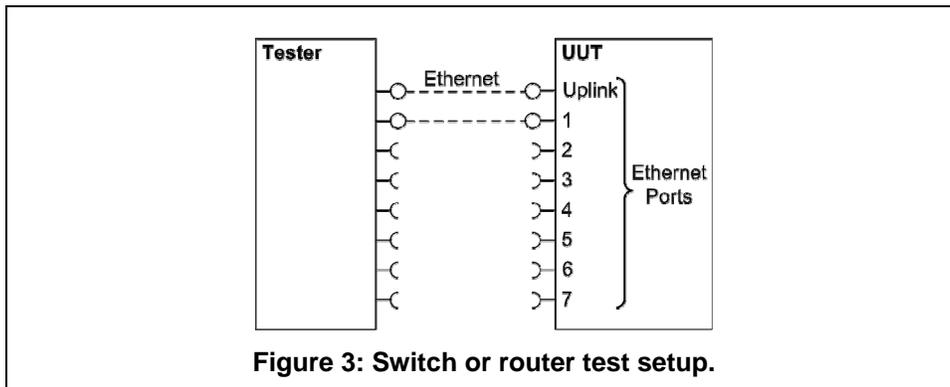
172 i) *Modem (DSL, Cable, or ONT): See Figure 2: Modem setup.*



173 (a.) Connect the UUT WAN port to the test client using the priority and link rate specified in
174 Section 6.4.

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

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



179 (a.) Connect two of the UUT's available ports to the test client and ensure that live links are
180 maintained for the duration of testing on all connections.

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

184 iii) *IAD or Access Point:*

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

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

191 (c.) UUTs with external removable antennas: (see Figure 4: AP setup with removable
192 antennas shown and Figure 5: IAD test setup for wireless testing with removable
193 antennas)

194 (i.) Remove all antennas.

195 (ii.) Connect an RF coaxial cable to each antenna port. The cable shall be connected
196 through an appropriate RF attenuator to a WLAN client simulator. The attenuation
197 and test client transmit power shall be set such that the received signal strength is
198 $-50 \text{ dBm} \pm 3 \text{ dB}$ at both the test client and the AP. If received signal strength
199 information is unavailable from the AP and/or the test client, use RF test equipment
200 to determine the appropriate settings.

201 (iii.) If the AP has multiple antennas for a single band, an appropriate number of cables
202 shall be connected to achieve the maximum supported data rate (i.e., one cable for
203 802.11a/b/g and ≥ 1 cable for 802.11n).

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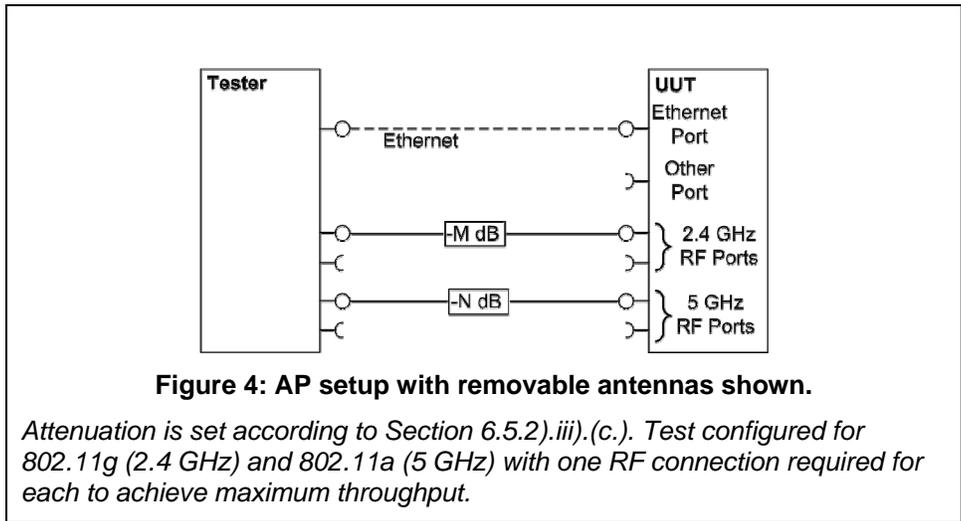


Figure 4: AP setup with removable antennas shown.

Attenuation is set according to Section 6.5.2).iii).(c.). Test configured for 802.11g (2.4 GHz) and 802.11a (5 GHz) with one RF connection required for each to achieve maximum throughput.

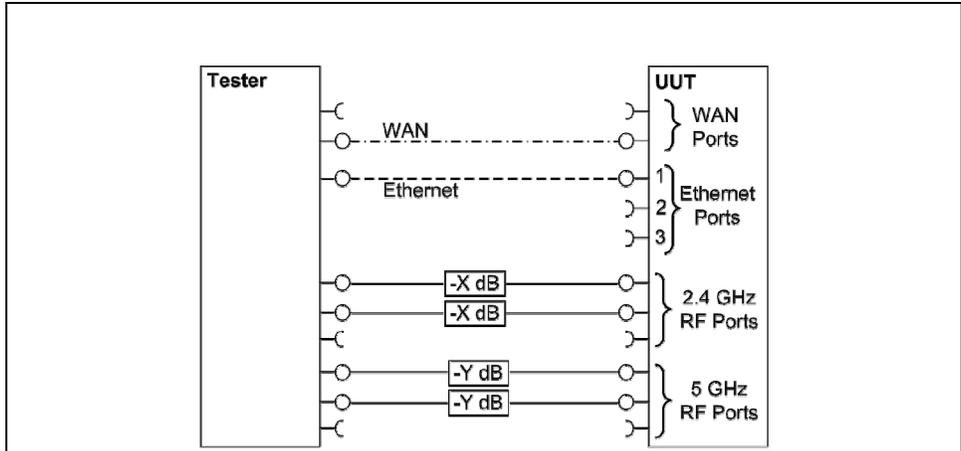


Figure 5: IAD test setup for wireless testing with removable antennas.

Use WAN port identified in Table 6 but no data passes over the WAN link. The first Ethernet shall be used for data transfer. Test configured for 2x3 MIMO (802.11n). Two streams are supported requiring two RF connections for maximum throughput in each band.

- 205 (d.) UUTs without removable antennas: (see Figure 6: AP setup with fixed antennas)
- 206 (i.) Place the UUT inside a shielded enclosure large enough to fit the UUT without
- 207 contact with enclosure walls. The enclosure must sufficient have RF, Ethernet, and
- 208 power feed-throughs to service the UUT.
- 209 (ii.) Connect antennas to the RF feed-throughs on the inside of the enclosure.
- 210 (iii.) Connect cables to the exterior feed-throughs via appropriate RF attenuators to
- 211 achieve a signal strength of $-50\text{dBm} \pm 3\text{dB}$. The test client transmit power shall be set
- 212 to ensure that the received signal strength at the AP is $-50\text{ dBm} \pm 3\text{ dB}$. If received
- 213 signal strength information is unavailable from the AP and/or the test client, use RF
- 214 test equipment to determine the appropriate settings.
- 215 (iv.) If the AP has multiple antennas for a single band, an appropriate number of cables
- 216 and antennas shall be connected to achieve the maximum supported data rate (i.e.,
- 217 1 cable/antenna for 802.11a/b/g and ≥ 1 cable/antenna for 802.11n).

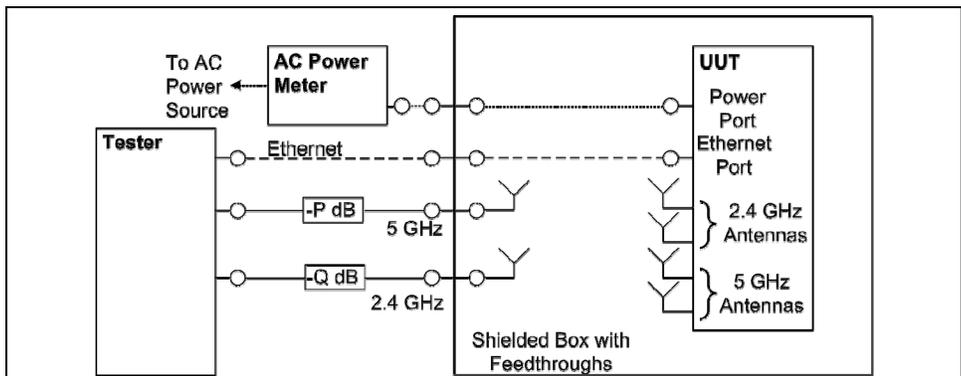


Figure 6: AP setup with fixed antennas.

Attenuation is set according to Section 6.5.2).iii).(d.). Test configured for 802.11g (2.4 GHz) and 802.11a (5 GHz) with one antenna connection required for each to achieve maximum throughput.

218 (e.) If the UUT requires an access point controller for normal operation, an access point
219 controller from the same manufacturer as the UUT shall be added to the network for
220 testing. If the UUT is capable of full operation without an access point controller, it shall
221 be tested without a controller on the test network.

222 (f.) Record sufficient details of the test setup to allow for the test to be independently re-
223 created and verified.

224 3) Power Meter Connection:

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

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

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

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

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

233 6.6 TEST CLIENT SETUP

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

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

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

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

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

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

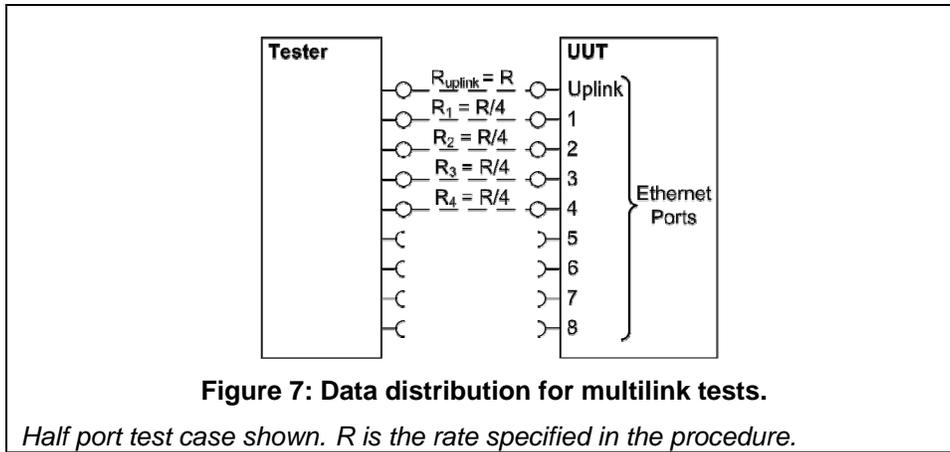
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Table 7: IMIX Packet Length Distribution

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

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- 6) Configure the test client to test in a modified aggregation mode. All traffic will pass over a single link (the uplink or WAN port), and this traffic will be evenly divided between the other connected Ethernet ports. See *Figure 7: Data distribution for multilink tests*.



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- 7) If the UUT has wireless capability, the test client shall be capable of functioning as a wireless client for the wireless standard(s) specified in Section 6.3.
- 8) Configure data connections to the test client as specified in Section 6.5.
- 9) Record the test equipment used for the test client and provide a functional diagram of the test equipment and UUT configuration, including all connections in the test setup.

259 7 TEST PROCEDURES FOR ALL PRODUCTS

260 7.1 POWER MEASUREMENT GUIDELINES

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- A) Tests are performed at two data rates, 1 kb/s (0.5 kb/s in each direction), and the highest rate supported by the link shown in Table 8. If the link has asymmetric data rate support, choose the highest rate supported for the direction shown in the table. For data rates higher or lower than those shown in the chart, choose the highest data rate according to Equation 1 and adjusting the variable Y as required to achieve the desired data rate. **Note:** A link with 100 Mb/s raw throughput will not support 100 Mb/s of traffic as specified in this procedure. In this case the traffic rate should be set to 50 Mb/s.

268

Equation 1

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

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Where:

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• *Z* is 1, 2, or 5, and

272

• *Y* is an integer. Adjust as required to achieve the desired data rate

273

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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

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

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

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

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1) Reset the power meter (if necessary).

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2) Begin recording elapsed time.

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

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

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

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

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7.2 POWER CONSUMPTION TESTS

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A) All Devices – Idle

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

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2) Measure and record UUT power per Section 7.1.

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B) Wired Network – WAN

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

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

303 3) Run data at the maximum data rate supported between the WAN and LAN ports. Measure and
304 record power per Section 7.1.

305 C) Wired Network – LAN:

306 1) Half-Ports Test: Test with half of ports in use, at all supported speeds, as applicable. See *Figure*
307 *7: Data distribution for multilink tests*.

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

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

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

318 D) Wireless Network - WLAN

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

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

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

326 4) Run data at maximum data rate supported between the LAN port and the WLAN client. Measure
327 and record power per Section 7.1.

328 8 PERFORMANCE EVALUATION

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

331 A) Ethernet Throughput - Using a test setup consistent with Section 7.2.C), determine the maximum
332 data rate supported by the UUT for which there is no packet loss. Record this rate as the measured
333 maximum throughput.

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

339 C) Maximum Number of NAT Clients

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

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

346 9 REPORTING

347 9.1 REPORTED UUT INFORMATION AND FUNCTIONALITY

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

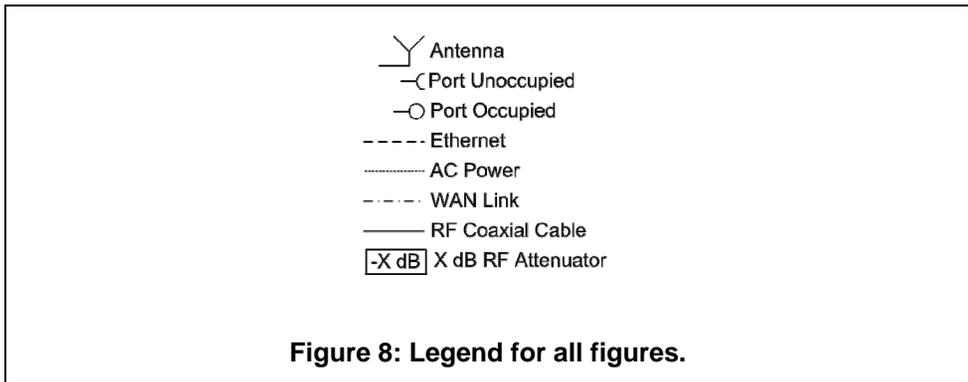
- 349 1. Manufacturer and model name;
- 350 2. Basic configuration information;
- 351 3. Powering options (e.g., direct ac, external ac-dc power supply, standard low-voltage dc). If
352 powered over Ethernet, report whether LLDP for PoE is supported;
- 353 4. Number and type of all wired data and network ports. Additional related details (e.g.,
354 Ethernet speed, 802.3az, LLDP for 802.3az);
- 355 5. Feature activity conflicts;
- 356 6. Number and type of wireless network support including supported bands, simultaneous
357 band support, supported standards, and MIMO configuration. Additional details as required;
- 358 7. Supported network traffic functions (e.g., firewall, VPN, VOIP functionality for POTS ports);
- 359 8. Mass storage options integral to or shipped with the UUT;
- 360 9. Any special equipment ratings (e.g., IEC 61850 / IEC61000 and IEEE1613, KEMA).

361 9.2 REPORTED TEST RESULTS

- 362 1. Voltage and frequency used in test;
- 363 2. If low-voltage dc, type of supply used;
- 364 3. Wireless Link information from Table 4 or Table 5;
- 365 4. Any settings changed per Section 6.4;
- 366 5. Uplink link rate;
- 367 6. Uplink and downlink data rates;
- 368 7. Power levels - Report all that apply:
 - 369 • One port: Idle, low data rate, high data rate;
 - 370 • Half ports: Idle, low data rate, high data rate;
 - 371 • Wireless: Idle, low data rate, high data rate;

- 372 8. Ethernet throughput - Maximum data rate in UDP data payload (expressed in b/s);
373 9. Maximum wireless clients;
374 10. Maximum NAT clients.

375 **10 TEST CONFIGURATION REFERENCES**



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