



ENERGY STAR® Test Method for Small Network Equipment

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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) 6.3 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	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.

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

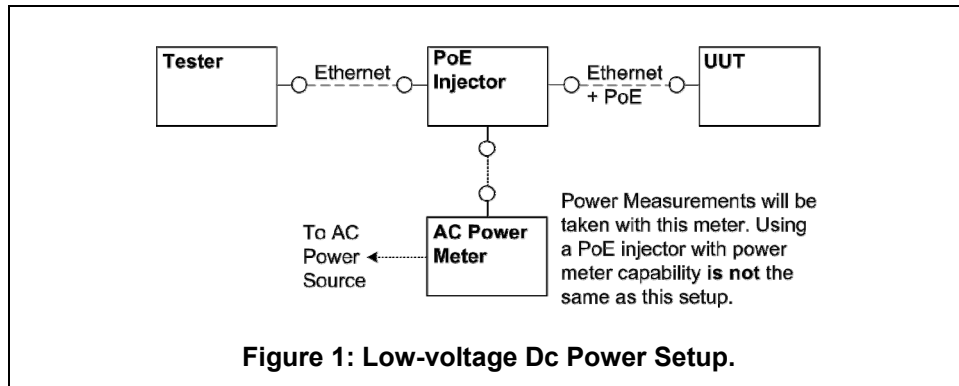
- 73 D) Battery Operated Products: For products designed to operate using batteries either when not
 74 connected to the mains or during a power disruption, the battery shall be fully charged before the start
 75 of testing and shall be left in place for the test.

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 the UUT supports LLDP for PoE for its power supply, the PoE source shall also support
 86 LLDP for PoE. See Figure 1.
- 87 ii) If a manufacturer-supplied low-voltage dc power supply is shipped with the UUT, it shall be
 88 used for testing.
- 89 iii) If there is no power supply shipped with the UUT, a commercially available device (e.g., PoE
 90 power injector or powered USB hub) shall be used to supply power to the UUT for testing. If
 91 the UUT manufacturer sells an appropriate standard low-voltage dc supply, then a model
 92 from the UUT manufacturer shall be used. The brand and model number of the power supply
 93 shall be recorded on the test data sheet. The selected power supply shall be considered the
 94 external power supply for the unit for purposes of testing.
- 95 iv) Power consumption of UUT shall be measured and tested between the ac power source and
 96 the low-voltage dc power supply as identified in Figure 1.



97 **6.2 WIRED PORT UUT CONFIGURATION**

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

- 100 1) Alternative LAN Technologies: Non-Ethernet wired ports (e.g., HPNA, MoCA, USB, analog
 101 connections, POTS, audio) shall not be connected, unless a secondary device and cable are
 102 shipped with the UUT (e.g., an external disk with a USB connection).
- 103 2) Network Link Maintenance: The UUT's WAN port shall be connected to a live source. Network
 104 links shall be continuously maintained, with the exception of brief lapses when transitioning
 105 between link speeds.
- 106 3) Ethernet Port Connection Rate: Ethernet ports shall be connected at the maximum supported link
 107 rate unless otherwise specified in this test procedure.
- 108 4) Ethernet Cabling: All Ethernet cables used for testing shall meet ANSI/EIA/TIA-568 Category 5e
 109 (Cat5e) specifications and shall be no shorter than 2 meters in length.
- 110 5) Power over Ethernet (PoE): PoE capability shall be configured with default as-shipped settings.
- 111 6) Efficient Networking Protocols:
- 112 a. If the UUT supports IEEE 802.3az protocol, all connected devices must support IEEE
 113 802.3az,
- 114 b. If the UUT supports LLDP for 802.3az, all connected devices must support LLDP for
 115 802.3az.

116 **6.3 WIRELESS UUT CONFIGURATION**

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

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

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

134 **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

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

137 **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

- 138 iii) *Alternative configurations*: If a device does not support any configuration listed above, the
139 test client shall provide a configuration. The 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) WAN connections and corresponding link speeds shall be selected in the order specified in Table
 158 6 rather than using as shipped default valuesTable 6. If UUT is not capable of the specified link
 159 speed, set the UUT to operate at the maximum possible speed.

160 **Table 6: WAN Connection Precedence and Default Link Speeds**

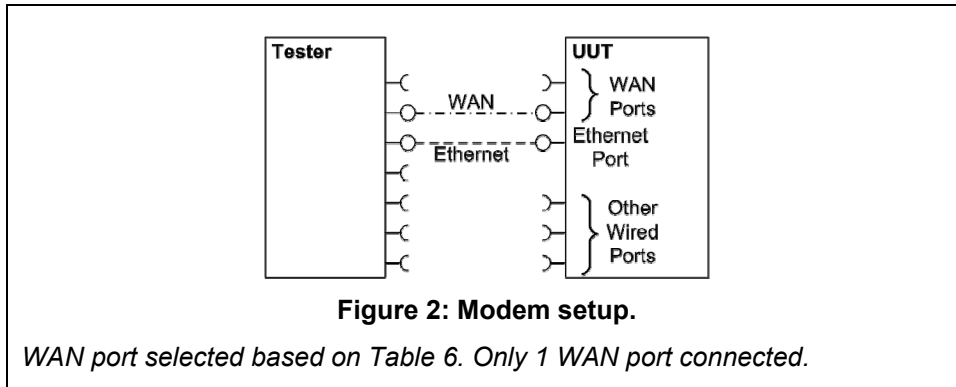
	Connection Type	Test Speed Down	Test Speed Up	Media Type
1	DOCSIS (Cable)	12 Mbps	3 Mbps	Coax
2	PON	1 Gbps	1 Gbps	Fiber
3	MoCA	20 Mbps	20 Mbps	Coax
4	DSL	6 Mbps	1 Mbps	Copper (Twisted Pair)
5	HPNA	60 Mbps	60 Mbps	Coax
6	WIMAX (802.16e)	60 Mbps	15 Mbps	Wireless
7	Ethernet (802.3)	1 Gbps	1 Gbps	Copper (Twisted Pair)

161 **6.5 UUT PREPARATION**

162 The UUT shall be configured for testing as follows.

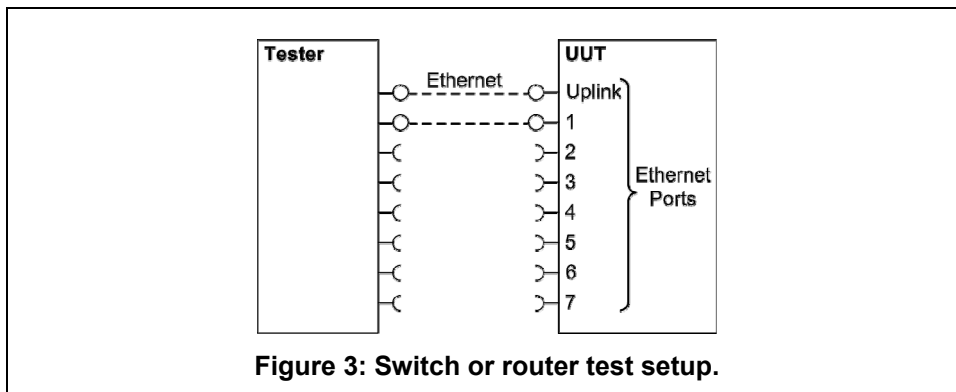
- 163 1) Test Report: Record the manufacturer and model name of the UUT. Record all basic information
 164 about the UUT's configuration including, but not limited to, the settings listed Sections 6.1 through
 165 6.4.
- 166 2) Network Connection: Connect the UUT to network resources as follows:

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



- 168 (a.) Connect the UUT WAN port to the test client at the rate specified in Table 6. If the UUT
169 has multiple WAN connections, select according to the precedence specified in Table 6.
170 (b.) Connect one LAN port to the test client. If Ethernet is available, the Ethernet port shall be
171 used. If more than one Ethernet port is present, the first non-uplink Ethernet port shall be
172 used.

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



- 174 (a.) Connect two of the UUT's available ports to the test client and ensure that live links are
175 maintained for the duration of testing on all connections.
176 (b.) If there is a port on the UUT identified as the uplink or WAN port, it shall be selected as
177 one of the two ports connected for testing. Otherwise, the first port shall be used as the
178 uplink port.

179 iii) *IAD or Access Point:*

- 180 (a.) *Access Points:* Connect the uplink Ethernet port to the test source at the highest
181 available link rate and ensure that live links are maintained for the duration of testing.
182 (b.) *IADs:* Ensure a WAN port is connected according to the priority outlined in Table 6
183 Table 6 and ensure that live links are maintained for the duration of testing. Connect the first
184 Ethernet port to the test source at the highest available link rate. Traffic for this test will
185 pass over the Ethernet link and not the WAN link.
186 (c.) *UUTs with external removable antennas:* (see Figure 4: AP setup with removable
187 antennas shown and Figure 5: IAD test setup for wireless testing with removable
188 antennas)

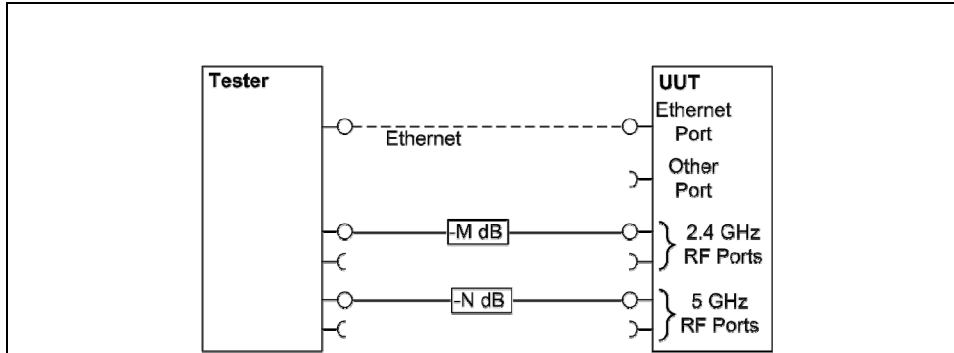


Figure 4: AP setup with removable antennas shown.

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

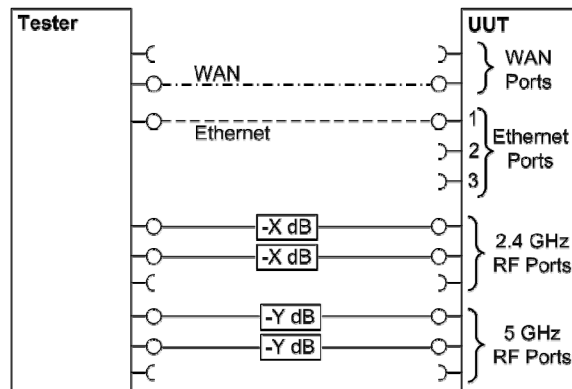


Figure 5: IAD test setup for wireless testing with removable antennas.

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.

- 189 (i.) Remove all antennas.
- 190 (ii.) Connect an RF coaxial cable to each antenna port. The cable shall be connected
- 191 through an appropriate RF attenuator to a WLAN client simulator. The attenuation
- 192 and test client transmit power shall be set such that the received signal strength is
- 193 $-50 \text{ dBm} \pm 3 \text{ dB}$ at both the test client and the AP. If received signal strength
- 194 information is unavailable from the AP and/or the test client, use RF test equipment
- 195 to determine the appropriate settings.
- 196 (iii.) If the AP has multiple antennas for a single band, an appropriate number of cables
- 197 shall be connected to achieve the maximum supported data rate (i.e., one cable for
- 198 802.11a/b/g and ≥ 1 cable for 802.11n).
- 199 (d.) *UUTs without removable antennas:* (see Figure 6: AP setup with fixed antennas)

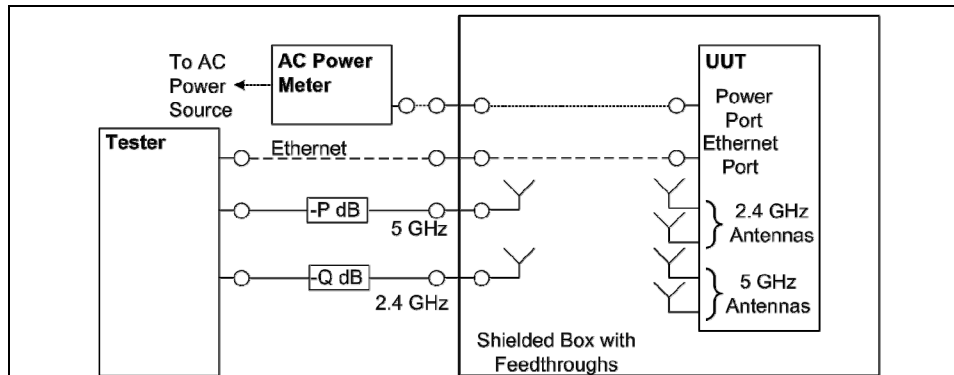


Figure 6: AP setup with fixed antennas.

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

- 200 (i.) Place the UUT inside a shielded enclosure large enough to fit the UUT without
 201 contact with enclosure walls. The enclosure must sufficient have RF, Ethernet, and
 202 power feed-throughs to service the UUT.
- 203 (ii.) Connect antennas to the RF feed-throughs on the inside of the enclosure.
- 204 (iii.) Connect cables to the exterior feed-throughs via appropriate RF attenuators to
 205 achieve a signal strength of $-50\text{dBm} \pm 3\text{dB}$. The test client transmit power shall be set
 206 to ensure that the received signal strength at the AP is $-50\text{ dBm} \pm 3\text{ dB}$. If received
 207 signal strength information is unavailable from the AP and/or the test client, use RF
 208 test equipment to determine the appropriate settings.
- 209 (iv.) If the AP has multiple antennas for a single band, an appropriate number of cables
 210 and antennas shall be connected to achieve the maximum supported data rate (i.e.,
 211 1 cable/antenna for 802.11a/b/g and ≥ 1 cable/antenna for 802.11n).
- 212 (e.) If the UUT requires an access point controller for normal operation, an access point
 213 controller from the same manufacturer as the UUT shall be added to the network for
 214 testing. If the UUT is capable of full operation without an access point controller, it shall
 215 be tested without a controller on the test network.
- 216 (f.) Record sufficient details of the test setup to allow for the test to be independently re-
 217 created and verified.

218 3) Power Meter Connection:

- 219 i) Connect the power meter(s) to an ac or dc voltage source set to the appropriate voltage and
 220 frequency for the test.
- 221 ii) Plug the UUT into the measurement power outlet on the power meter, as follows:
- 222 (a.) No other devices (e.g., power strips or UPS units) may be connected between the meter
 223 and the UUT;
- 224 (b.) If the UUT uses an external power supply (EPS), the EPS is considered part of the UUT.
 225 Plug the EPS input into the measurement power outlet on the meter;
- 226 (c.) The power meter shall remain connected until all testing is complete.

227 **6.6 TEST CLIENT SETUP**

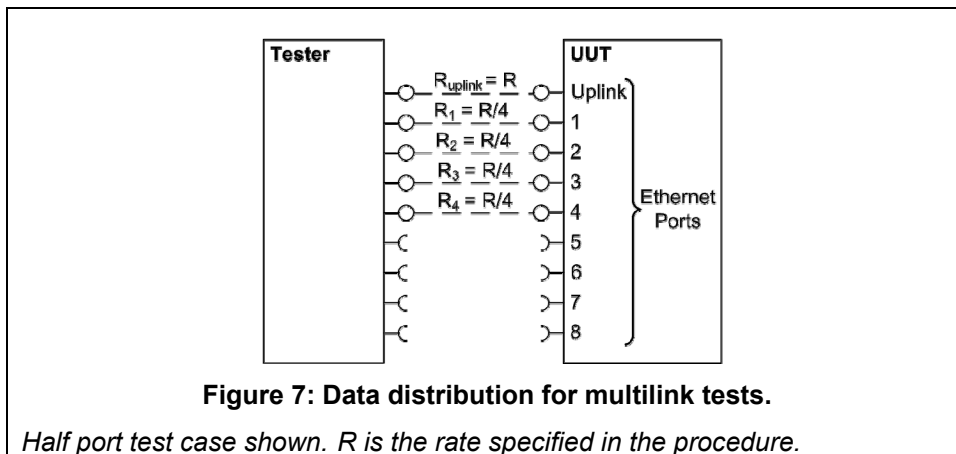
228 The tests outlined in Section 7 require the use of network tester equipment (the test client) capable of
 229 supporting the protocols used during testing. The test client may consist of several discrete pieces of test
 230 equipment used together to test Ethernet, WAN, and wireless links. This section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

- 232 1) Configure the test client Ethernet ports to be DHCP clients with unique, random MAC addresses.
- 233 2) Configure the WAN port or uplink Ethernet port to assign a random IPv4 address to the UUT. A
 234 static IPv4 address may be set in the UUT if the test client is unable to support random address
 235 assignment. IPv6 may be used if IPv4 support is not present in the test client hardware. If the
 236 device is configured for DHCP pass-through functionality, the test client shall assign addresses
 237 through the UUT.
- 238 3) Configure the test client to send traffic using UDP.
- 239 4) Configure the test client to provide statistics on data reliability (% of packets received
 240 successfully).
- 241 5) Configure the test client to transmit variable length packets or frames using the basic IMIX given
 242 in Table 7 (see Table 3 for references).

243 **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%

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



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

252 7 TEST PROCEDURES FOR ALL PRODUCTS

253 7.1 POWER MEASUREMENT GUIDELINES

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

260 Equation 1

$$261 \text{DataRate} = Z \times 10^Y \text{ (in bits per second)}$$

262 *Where:*

- 263 • Z is 1, 2, of 5, and
- 264 • Y is an integer. Adjust as required to achieve the desired data
265 rate

266 **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

- 267 B) If there is a port on the UUT identified as the uplink or WAN port, it shall be selected as the uplink port
268 in Section 7.2.C). Otherwise, the first port shall be used as the uplink port. If present, additional
269 Ethernet ports shall be connected sequentially, and there shall be no open Ethernet ports between
270 occupied Ethernet ports.
- 271 C) The following procedure shall be used for each test component in Section 7.2:
- 272 1) Reset the power meter (if necessary).
- 273 2) Begin recording elapsed time.
- 274 3) Set the meter to begin accumulating true power values at a rate of greater than or equal to 1 Hz
275 (1 reading per second).
- 276 4) Accumulate power values for 5 minutes and record the average (arithmetic mean) value observed
277 during the 5 minute period.

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

280 7.2 POWER CONSUMPTION TESTS

281 A) All Devices – Idle

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

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

284 B) Wired Network – WAN

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

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

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

292 C) Wired Network – LAN:

293 1) Half-Ports Test: Test with half of ports in use, at all supported speeds, as applicable. See Figure
294 7: *Data distribution for multilink tests*.

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

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

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

305 D) Wireless Network - WLAN

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

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

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

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

315 **8 PERFORMANCE EVALUATION**

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

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

321 B) Maximum Number of Wireless Clients - Using a test setup consistent with Section 7.2.D), determine
322 the maximum number of clients supported by the UUT. Clients shall be evenly split between bands if
323 there is simultaneous dual band support. No data shall be passed other than that required to setup
324 clients. Record this number as the maximum number of wireless clients.

325 C) Maximum Number of NAT Clients

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

327 2) The addition of downstream switches to the test setup and/or combination of tests similar to
328 Sections 7.2.C) and 7.2.D) may be required to achieve a large number of NAT clients. No data
329 shall be passed other than that required to configure the clients. If an additional switch is
330 required, record the number of wireless NAT and the number of wired NAT clients.

331 **9 REPORTING**

332 **9.1 UUT INFORMATION AND FUNCTIONALITY**

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

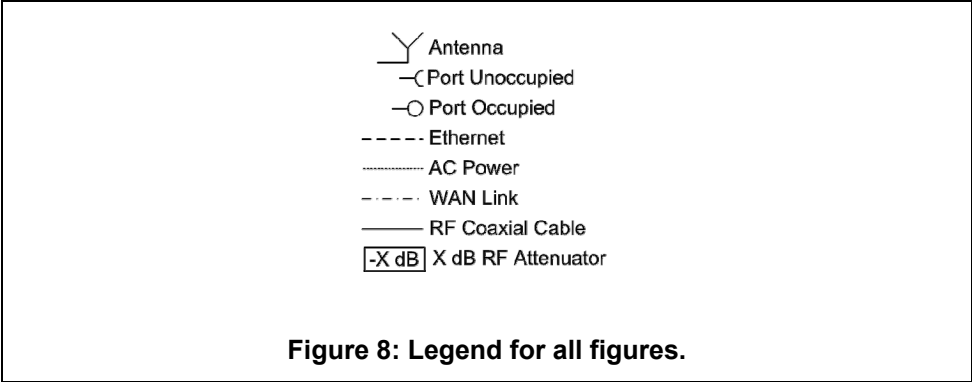
- 334 1. Manufacturer and model name;
- 335 2. Basic configuration information;
- 336 3. Powering options (e.g., direct ac, external ac-dc power supply, standard low-voltage dc). If
337 powered over Ethernet, whether LLDP for PoE is supported;
- 338 4. Number and type of all wired data and network ports. Additional related details (e.g.,
339 Ethernet speed, 802.3az, LLDP for 802.3az);
- 340 5. Feature activity conflicts;
- 341 6. Number and type of wireless network support including supported bands, simultaneous
342 band support, supported standards, and MIMO configuration. Additional details as required;
- 343 7. Supported network traffic functions (e.g., firewall, VPN, VOIP functionality for POTS ports);
- 344 8. Mass storage options integral to or shipped with the UUT;
- 345 9. Any special equipment ratings (e.g., IEC 61850 / IEC61000 and IEEE1613, KEMA).

346 **9.2 REPORTED TEST RESULTS**

- 347 1. Voltage and frequency used in test;
- 348 2. If low-voltage dc, type of supply used;
- 349 3. Wireless Link information from Table 4 or Table 5;
- 350 4. Any settings changed per Section 6.4;
- 351 5. Uplink link rate;

- 352 6. Uplink and downlink data rates;
- 353 7. Power levels - Report all that apply:
- 354 • One port: Idle, low data rate, high data rate;
- 355 • Half ports: Idle, low data rate, high data rate;
- 356 • Wireless: Idle, low data rate, high data rate;
- 357 8. Ethernet throughput - Maximum data rate in UDP data payload (expressed in b/s);
- 358 9. Maximum wireless clients;
- 359 10. Maximum NAT clients.

360 **10 TEST CONFIGURATION REFERENCES**



361