ENERGY STAR® Program Requirements Product Specification for Large Network Equipment

Draft 2 Test Method Rev. August-2014

1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Large Network Equipment (LNE).

2 APPLICABILITY

The following test method is applicable to all products under the ENERGY STAR Specification Document for Large Network Equipment.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Large Network Equipment Specification.

A) Abbreviations and Units:

1) ac: Alternating current
2) ATIS: Alliance for Telecommunications Industry Solutions
3) bps: Bits per second
4) C: Celsius
5) dc: Direct current
6) FCS: Frame check sequence
7) GBIC: Gigabit interface converter
8) Hz: Hertz
9) IEEE: Institute of Electrical and Electronics Engineers
10) IMIX: Internet mix
11) IP: Internet protocol
12) LNE: Large network equipment
13) MAC: Medium access control
14) NDR: Non-drop rate
15) OSI: Open systems interconnection
16) PDU: Power distribution unit
17) PSU: Power supply unit
18) RMS: Root mean square
19) SFD: Start of frame delimiter

20) SFP: Small form-factor pluggable

21) UPS: Uninterruptible power supply

22) UUT: Unit under test

23) V: Volts

24) VLU: Very low utilization

25) W: Watt

B) Definitions:

1) Internet Mix (IMIX) Traffic: A stateless traffic profile that contains a mixture of frame sizes statistically similar to a composition observed in the Internet[1].

2) Maximum Non-Drop Rate (NDR): The highest observed system throughput, measured in bits per second (bps), at which all data packets received by the unit under test (UUT) are processed and correctly transmitted.

3) System Throughput: The sum of the data link bits processed by the UUT per second in the egress direction, including frame preamble, Start Frame Delimiter (SFD), Frame Check Sequence (FCS), and minimum interpacket gap.

4) System Utilization: The system throughput expressed as a percentage of the system's measured NDR.

5) Traffic Profile: The statistical distribution of the size/type of the data sent through the UUT.

4 TEST SETUP

A) Input Power: Input power for alternating current (ac) LNE shall be as specified in Table 1 and Table 2. Input power for direct current (dc) LNE shall be as specified in Table 3. The input power frequency for ac LNE shall be as specified in Table 4.

Table 1: Input Power Requirements for Ac-powered Products with Nameplate Rated Power Less Than 1500 Watts (W)

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Ac single-phase powered LNE	115 V ac 230 V ac	+/- 1.0%	2.0%, up to and including the 13th harmonic
Ac three-phase powered LNE	208 V ac 400 Vac		

[1] For further information regarding IMIX, refer to Spirent Communications – Test Methodology Journal: IMIX (Internet Mix) Journal, March 2006.

Table 2: Input Power Requirements for Ac-powered Products with Nameplate Rated Power Greater Than or Equal to 1500 W

Product Type	Supply Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion
Ac single-phase powered LNE	115 V ac 230 V ac	+/- 4.0%	5.0%, up to and including the 13th harmonic
Ac three-phase powered LNE	208 V ac 400 Vac		

Table 3: Input Power Requirements for Dc-powered Products

Product Type	Supply Voltage	Voltage Tolerance
Dc powered LNE rated for -48 V dc	-53 V dc	+/- 2.0 V

Note: Table 3 includes the dc-power requirement for LNE, which is harmonized with the dc-power requirement included in 5.2.4.1 of ATIS-0600015.2013. However, other voltages may be commonly supported by LNE products (e.g., 380 V dc), which are not included in the table. DOE requests stakeholder feedback on whether there are voltages missing from Table 3 that are commonly supported by LNE products Additionally, DOE requests stakeholder feedback whether any products exist which would be incapable of being tested according to the current voltage requirements.

Table 4: Input Power Frequency Requirements for Ac-powered Products

Supply Voltage	Frequency	Frequency Tolerance
115 V ac	60 Hertz (Hz)	+/-1.0%
230 V ac	50 Hz or 60 Hz	
208 V ac, Three-phase	60 Hz	
400 V ac, Three-phase	50 Hz or 60 Hz	

B) Ambient Temperature: Ambient temperature shall be 27°C +/- 1°C.

1) Measurement Location and Accuracy: Temperature must be measured no more than 50 millimeters in front of (upwind of) the main airflow inlet of the UUT and reported by the sensor with an overall accuracy of ± 0.5 °C or better.

Note: DOE received a stakeholder comment that the Draft 1 Test Method's ambient temperature requirements may be too relaxed to achieve repeatable results. The power consumption of LNE with variable fan speeds may be correlated with the ambient temperature. Therefore, DOE believes that test repeatability can be improved by narrowing the allowable ambient temperature range. The center-temperature has also been raised from 25°C to 27°C. DOE believes that this increased temperature might be more representative of current and future data center conditions. It is worth noting that the ambient temperature range proposed in the Draft 2 Test Method (26°C to 28°C) falls within the allowable ranges proposed in the Draft 1 Test Method (20°C to 30°C) and included in ATIS-0600015.2013 (22°C to 28°C). Finally, due to the narrowed range of allowable ambient temperature, the Draft 2 Test Method requires that the ambient temperature be measured close to the UUT's air intake.

DOE requests stakeholder feedback on the ambient temperature requirement included in the Draft 2 Test Method. Specifically, is the requirement representative of environments in which LNE products are deployed? Would there be any difficulty in achieving the proposed temperature requirements?

C) Relative Humidity: Relative humidity shall be within 15% and 80%.

D) Power Meter: Power meters shall possess the following attributes:

1) Reporting and Measurement Units:

a) If the UUT is a dc powered LNE, the power meter shall report power, voltage, and current.

b) If the UUT is an ac powered LNE, the power meter shall report true root mean square (RMS) power, voltage, current, and power factor.

2) Calibration: The meter shall have been calibrated within a year of the test date, by a standard traceable to National Institute of Standards and Technology [USA] or a counterpart national metrology institute in other countries.

3) Crest Factor (ac powered LNE only): An available current crest factor of 3 or more at its rated range value. For power meters that do not specify the current crest factor, the power meter must be capable of measuring an amperage spike of at least 3 times the maximum amperage measured during any 1 second sample.

4) Minimum Bandwidth of Input Circuitry: 80.0 kHz.

5) Minimum Digitizing Sample Rate: 40.0 kHz.

6) Minimum Resolution:

a) 0.01 W for measurement values less than 10 W;

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

c) 1.0 W for measurement values greater than 100 W.

7) Measurement Accuracy: Power measurements shall be reported by the power meter with an overall accuracy of 1% or better for all measured power values.

E) Network Test Equipment (Test Equipment): The Test Equipment used for Section 6.1 must comply with the following requirements:

1) Number of Ports: For each data port present on the UUT, there shall be at least one corresponding data port on the Test Equipment capable of sending and receiving data to and from the UUT at the highest operable line-rate standard.

Note: DOE recognizes that some LNE products have a large number of ports, and that test equipment with an equally large number of ports can be costly. DOE received stakeholder feedback that adopting the "Modular Method" guidelines from Section 6.3 of the ATIS-0600015.03.2013 test procedure would reduce the number of ports required on the test equipment. However, the ATIS test method states that "snaked traffic" is only acceptable for "base chassis power measurements that are not throughput related" during modular testing. Therefore, DOE believes that such a method would not be permitted for these measurements as they have throughput requirements.

DOE requests stakeholder feedback regarding possible methods for reducing the cost of testing LNE products with many data ports. Specifically, do alternative methods exist which can reduce the required number of test equipment ports while still maintaining a representative test scenario for the UUT?

2) Traffic Generation: The Test Equipment must be capable of generating traffic that complies with the requirements in Section 5.1.A)5)d).

Note: Based on stakeholder feedback and internal investigations, DOE believes that most of the power loss occurring in PoE delivery can be attributed to PSU inefficiency. Furthermore, stakeholders have commented that the requirements for performing PoE load testing properly would be fairly complex. Finally, DOE recognizes that the inclusion of a PoE load test increases the overall test burden, concerning the test equipment required and the total time needed to complete testing. For these reasons, the Draft 2 Test Method does not include PoE load testing.

5 TEST CONDUCT

5.1 UUT and Test Equipment Configuration

A) Variable Load Testing: Power consumed by the UUT shall be measured while processing different data traffic levels. All testing during the Variable Load Test shall adhere to the requirements provided in the Alliance for Telecommunications Industry Solutions (ATIS)-0600015.03.2013 standard unless otherwise specified in this document. Variable Load Testing shall be conducted as follows:

1) As-shipped Condition: Products shall be tested in their "as-shipped" configuration, which includes both hardware configuration and system settings, unless otherwise specified in this test method.

a) LNE Requiring Initial Configuration: If the UUT cannot be tested in its "as-shipped" condition without additional initial configuration, then the UUT shall be configured according to the instructions provided in the UUT's user manual. Any supporting materials (e.g., configuration files) that are included with the UUT or publicly available may be used if required for correct UUT functionality.

b) Mid-test UUT Reconfiguration: The UUT shall be configured prior to running the test procedure in Section 6. No reconfiguration of the UUT shall occur following the commencement of Section 6.

Note: DOE received a stakeholder comment stating that some LNE products might be capable of being configured in such a way as to optimize for a certain portion of the test procedure (e.g., low utilization, high utilization). The Draft 2 Test Method therefore requires that all configuration of the UUT shall occur prior to start of testing. Reconfiguring the UUT after the test has started is prohibited.

DOE requests stakeholder feedback regarding the prohibition of mid-test UUT reconfiguration.

2) Measurement Location: All power measurements shall be taken at a point between the ac or dc power source and the UUT. No uninterruptible power supply (UPS) units may be connected between the power meter and the UUT.

3) Air Flow Management: Any airflow directly surrounding the UUT during testing shall only be generated by fans or cooling devices that are standard components of the UUT. The use of

external fans or cooling devices in a manner that is inconsistent with normal data center practices is prohibited.

4) Power Supplies: All installed PSUs included with the UUT must be operational and connected to an appropriate power source, unless otherwise specified in this test method.

a) UUTs with Multiple PSUs: If the UUT has more than one PSU, then any combination of the following can be used to accurately measure and record the power consumption:

i. Connecting each PSU to a separate power meter and then sum the resulting measurements; or

ii. Connect each PSU to a separate channel on a single power meter and then sum the resulting measurements;

Note: DOE received stakeholder feedback stating that including PDU overhead power might be inappropriate, since a system with one PSU should be measured the same way as a system with two. For this reason, the use of PDUs is no longer permitted in the Draft 2 Test Method. Further, the Draft 2 Test Method allows new methods by which to handle a UUT with multiple PSUs. DOE believes that these modifications will allow greater flexibility and improve test reproducibility.

DOE requests stakeholder feedback regarding the modification of permitted methods for handling multiple PSUs.

5) I/O and Network Connection: UUT ports shall be connected as indicated in Section 5.2.A)4). All UUT ports connected to the Test Equipment shall be ready to pass traffic for the entirety of the testing performed in Section 6.

a) Number of Ports Connected: The number of ports required to be connected to the Test Equipment are as follows:

i. Full-port Test: Section 6.1 shall be performed with all traffic-capable UUT ports connected to the Test Equipment.

ii. Half-port Test in Full-mesh Configuration: If the UUT is tested in the Full-mesh configuration according to Section 5.2.A)4), then Section 6.2 shall be performed with half of the traffic-capable UUT ports connected to the Test Equipment. Round up to the nearest integer value if there are an odd number of ports. The ports to be connected shall be chosen at random.

iii. Half-port Test in Dual-group Partial Mesh Configuration: If the UUT is tested in the Dual-group Partial Mesh configuration according to Section Section 5.2.A)4), then Section 6.2 shall be performed with half of the UUT downlink ports connected to the Test Equipment. Round up to the nearest integer value if there are an odd number of ports. The ports to be connected shall be chosen at random. All of the UUT uplink ports shall be connected during testing.

Note: DOE received a stakeholder comment stating that although it may be common for an LNE product to have only half of the downlink ports connected, all of the uplink ports typically would be connected in such a scenario. Furthermore, the max NDR throughput is more strongly related to the total uplink bandwidth than that of the downlink. For this reason, the Draft 2 Test Method requires products that are tested in the half-port, dual-group partial mesh configuration to have half of the downlink ports connected, and all of the uplink ports connected.

b) System Management Ports: Any port on the UUT that does not pass traffic, and is solely intended for device management may be connected as instructed by the manufacturer during testing. If no manufacturer instruction is provided, system management ports shall be disconnected during testing.

c) Energy Efficient Ethernet (EEE): If the UUT has ports that provide EEE[2], the UUT shall be connected to network ports that also support EEE. This can be done either by having the traffic source provide the EEE ports, or placing an intermediate network device between the traffic source and UUT.

d) Traffic Generation: The traffic generated by the Test Equipment for Section 6 must comply with the following requirements:

i. Packet Format: The traffic shall be formatted as Internet Protocol (IP) version 4 (IPv4[3]) with randomized IPv4 data field values. The IPv4 packets shall be transported using Ethernet[4].

Note: The ATIS-0600015.03.2013 test procedure includes requirements for how generated test traffic should be formatted: network switches are tested with Ethernet, while routers are tested with IPv4, IP version 6 (IPv6), or multiprotocol label switching (MPLS). The Draft 2 Test Method includes requirements for how test traffic should be formatted in order to ensure testing consistency across all products. DOE believes that IPv4 is more commonly supported across all LNE products. Furthermore, IPv4 is being required for switches as well as routers, since some network switches may be capable of handling layer-3 traffic.

DOE requests stakeholder feedback regarding the packet format requirement. Is there any benefit to allowing other data standards such as MPLS and IPv6, which are included in the ATIS test procedure?

ii. Generated Packet Size Statistical Distribution: The traffic shall consist of packet sizes whose generation frequency is statistically described by the Simple IMIX distribution, defined in Table 5.

iii. Idle-link Period Distribution: All traffic shall be generated so that the same interpacket gap separates each transmitted Ethernet packet. In other words, there should be a fixed spacing in time between Ethernet frames. However, frames shall not be sent to all ports simultaneously (i.e. the fixed spacing in time should not occur simultaneously on all ports).

Note: DOE received a stakeholder comment noting that the idle-link period distribution can be modeled using a Poisson distribution, but not all test equipment is capable of generating that type of distribution. However, most equipment is capable of generating a uniform distribution. In order to create more comparable results amongst all tested products, the Draft 2 Test Method requires that generated traffic have a uniformly distributed idle-link period.

[2] As defined in Clause 78 of IEEE 802.3 (originally specified in IEEE 802.3az).
[3] "Internet Protocol". Sep 1981. RFC 791.
[4] As defined in IEEE 802.3.

Table 5: Simple IMIX Packet Distribution[5]

IP Packet Size (Bytes)	Ethernet Frame Size[6] (Bytes)	Proportion of Total Generated IP Packets	Proportion of Total Generated Ethernet Packet Throughput[7]
40	64	7 parts (~58.33%)	~12.83%
576	594	4 parts (~33.33%)	~53.60%
1500	1518	1 part (~8.33%)	~33.57%

Note: In order to provide clarification regarding the makeup of the Simple IMIX packet distribution, Table 5 in the Draft 2 Test Method includes a column to show the required Ethernet frame size associated with each generated IPv4 Packet.

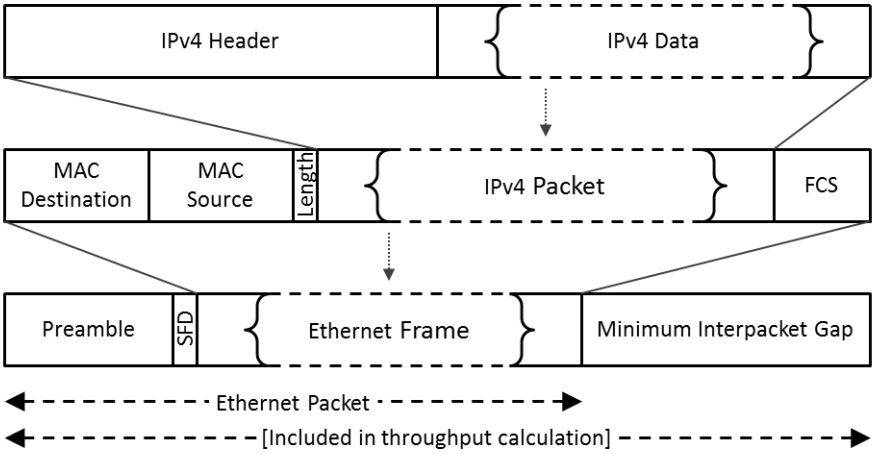

Figure 1: Relationship of Different Components of Test Data[8]

[5] "Table D.1: Simple IMIX", Annex D: IMIX Traffic, ATIS – 0600015.03.2013
[6] Ethernet frame sizes do not include preamble, start of frame delimiter (SFD), or minimum interpacket gap.
[7] Throughput is based on the listed Ethernet frame size plus 7-byte preamble, 1-byte SFD, and 12-byte minimum interpacket gap per transmitted packet.
[8] The diagram is included as an example to clarify certain terms, and is not drawn to scale. Certain optional elements not included in the diagram, such as VLAN tagging, may be used when appropriate.

Note: DOE received stakeholder feedback stating that the terminology used to describe the different components of generated test data were unclear in the Draft 1 Test Method. In order to provide clarification, the Draft 2 Test Method includes a reference in **Figure** 1 that shows the relationship between this these different terms. DOE requests stakeholder feedback on the accuracy and usefulness of the information provided in **Figure** 1.

e) Physical Interface Requirements:

i. If the UUT includes interchangeable modules that change the port configuration (e.g., 8x1000BASE-T; 16x1000BASE-T; 8xgigabit small form-factor pluggable (SFP); 16xgigabit SFP; 2x10GBASE-T; or 2x10 gigabit SFP+), then the modules shall be chosen according to the following requirements:

a. If the UUT is tested using the full mesh configuration according to Section 5.2.A)4)a), then all data ports on the UUT must be of the same type and speed.

b. If the UUT is tested using the dual-group partial mesh configuration according to Section 5.2.A)4)b), then all downlink ports on the UUT must be of the same type and speed, and all uplink ports on the UUT must be of the same type and speed.

Note: DOE recognizes that many LNE products can use interchangeable modules to expand or change the available data port configuration. The Draft 2 Test Method does not include requirements for such products, regarding which configuration should be used for each product. This is typically treated as a "product configurability" issue, and is handled in the Specification document. However, the Draft 2 Test Method does require that if interchangeable modules are used, all data ports be of the same type and speed (for each group, if dual-group partial mesh configuration is used). This requirement is intended to simplify the test setup, and reduce potential complications that might arise from using "mixed" port-types.

DOE requests stakeholder feedback regarding the requirement that data ports on interchangeable modules be chosen such that all data ports are of the same type and speed. Specifically, would such a requirement be representative of a product's typical deployment?

ii. If a data port is capable of functioning with either a pluggable module (e.g., SFP transceiver, gigabit interface converter [GBIC], XENPAK, etc.) or a non-pluggable interface, the pluggable module shall be used if it is included with the UUT. Otherwise, the non-pluggable interface shall be used.

Note: The Draft 1 Test Method includes requirements for how pluggable modules shall be selected for testing if none are included with the product. Specifically, preference is given to copper-based pluggable modules. However, DOE recognizes that there are different types of pluggable modules available for LNE products, and that certain types of pluggable modules may be more appropriate for a given deployment scenario than others. Furthermore, certain products might not support copper-based modules. For this reason, the Draft 2 Test Method does not include requirements regarding the type of pluggable modules that must be used. DOE recognizes that type of pluggable module used during testing affects a product's power consumption and performance. Therefore, the selection of pluggable modules will likely be addressed at a later date.

f) Cabling Requirements: Each copper-based cable used during testing shall be no longer than 5 meters in length.

Note: DOE received stakeholder feedback that some network switches can be connected in groups via a proprietary connection on the backplane. This configuration allows the multiple "stacked" devices to function as if they were a single unit.

The Draft 2 Test Method treats each stackable switch as a separate product, and therefore requires each be tested individually. However, DOE would like to understand better the power usage and performance of stackable products. For this reason, DOE is considering adding additional guidelines for testing stackable switches in a future draft of version of the test method.

5.2 UUT and Test Equipment Preparation

A) Variable Load Test Preparation: Prior to performing testing outlined in Section 6, prepare the UUT according to the following steps:

1) Record the UUT manufacturer, model name, and configuration details including, but not limited to, number of ports, port throughput, additional built in interface ports, and number of fans.

2) If the UUT is a rack device, install it in a test rack. If the UUT is not a rack device, place it in a stable location where it will not be disturbed. Once set up, the UUT shall not be physically moved until testing is complete.

3) Configure the Test equipment for the correct traffic workload and profile as described in 5.1A)5)d).

4) Connect UUT ports to the Test equipment in the appropriate topology according to the following:

   a) The dual-group partial mesh topology shall be used if there are clear designations between downlink and uplink ports listed on the UUT. In this configuration, traffic must always flow from an uplink port to a downlink port or vice versa.

   b) The full mesh topology shall be used if there are no clear designations between downlink and uplink ports listed on the UUT. In this configuration, traffic from each data port is permitted to flow to any other data port on the UUT.

Note: DOE received stakeholder feedback requesting that the dual-group partial mesh requirements that were included in the Draft 1 Test Method be refined, since some LNE products can have their ports arbitrarily partitioned. DOE recognizes that the concepts of "uplink" and "downlink" may not be as readily applicable to these types of products. For this reason, the Draft 2 Test Method requires that products be tested in the dual-group partial mesh configuration only if there are clear designations between downlink and uplink ports listed on the product. All other products, including those with ports that can be arbitrarily partitioned, shall be tested using the full mesh configuration.

DOE requests stakeholder feedback regarding the guidelines for determining when the dual-group partial mesh configuration is to be used. Specifically, are the uplink and downlink ports typically indicated on LNE products? Is there another method by which to determine whether a product should be tested using the full mesh or dual-group partial mesh configuration?

5) Connect the UUT to an appropriate ac or dc voltage source using the following guidelines:

   a) No devices shall be connected between the power meter(s) and the UUT, except for PDUs as described in section 5.1.A)4)a), if applicable;

   b) The power meter shall remain connected until all testing is complete;

   c) Power values shall be recorded from the power meter in compliance with Section 4.D).

6) If applicable, prepare the UUT according to the requirements provided in Section 5.1.A)1)a).

7) If the input voltage is ac, then record the input RMS voltage and input frequency. If the input voltage is dc, then record the reported input voltage.

6 TEST PROCEDURES FOR ALL PRODUCTS

Note: The Draft 2 Test Method includes two distinct procedures. The first procedure, Section 6.1, is intended to be representative high utilization scenarios. This procedure uses the full-port configuration and includes a 30% load test. The second procedure, Section 6.2, is intended to be representative low utilization scenarios. This procedure uses the half-port configuration and includes a 10% load test.

DOE requests stakeholder feedback regarding the two distinct test procedures. Specifically, are the requirements for each procedure consistent with the intended respective scenarios?

6.1 Full-port Variable Load Energy Efficiency Test

A) Power on the UUT, either by switching it on or connecting it to mains power.

B) Let the UUT stabilize for 15 minutes.

C) Qualification: Determine the maximum load (L_{max}) that can be sustained at Non-Drop Rate (NDR). Any method may be used to obtain this value, but the method used shall be reported. There is no time limit for this run. The run is complete after L_{max} is determined. Record L_{max}.

D) The following tests shall be completed in the order specified and shall have no greater than 300 seconds idle time between them.

1) Full Load:

a) Apply L_{max}, obtained in Section 6.1.B) to the UUT for 15 minutes.

b) Record power values for the entire 15-minute test period.

c) Calculate and report the average power value (P_{100}).

2) Thirty Percent Load:

a) Calculate and report the Thirty Percent Load throughput (L_{30}), by multiplying L_{max} by 0.30 ($L_{30} = 0.30 * L_{max}$)

b) Run the test for 15 minutes, applying a traffic load of L_{30}.

c) Record power values for the entire 15 minute period.

d) Calculate and report the average value (P_{30}).

3) Very Low Utilization (VLU):

a) Calculate and report the VLU throughput (L_{VLU}), by multiplying L_{max} by 10^{-4} ($L_{VLU} = 10^{-4} * L_{max}$)

b) Run the test for 15 minutes, applying a traffic load of L_{VLU}.

c) Record power values for the entire 15 minute period.

d) Calculate and report the average value (P_{VLU}).

E) If packet loss occurs during any of the tests specified in Section 6.1.D), the UUT must be retested beginning with Section 6.1.B).

6.2 Half-port Variable Load Energy Efficiency Test

A) Power on the UUT, either by switching it on or connecting it to mains power.

B) Let the UUT stabilize for 15 minutes.

C) Qualification: Determine the maximum load (L_{max}) that can be sustained at Non-Drop Rate (NDR). Any method may be used to obtain this value, but the method used shall be reported. There is no time limit for this run. The run is complete after L_{max} is determined. Record L_{max}.

D) The following tests shall be completed in the order specified and shall have no greater than 300 seconds idle time between them.

1) Full Load:

a) Apply L_{max}, obtained in Section 6.2.B) to the UUT for 15 minutes.

b) Record power values for the entire 15 minute test period.

c) Calculate and report the average power value (P_{100}).

2) Ten Percent Load:

a) Calculate and report the Thirty Percent Load throughput (L_{10}), by multiplying L_{max} by 0.10 ($L_{10} = 0.10 * L_{max}$)

b) Run the test for 15 minutes, applying a traffic load of L_{10}.

c) Record power values for the entire 15 minute period.

d) Calculate and report the average value (P_{10}).

3) Very Low Utilization (VLU):

a) Calculate and report the VLU throughput (L_{VLU}), by multiplying L_{max} by 10^{-4} ($L_{VLU} = 10^{-4} * L_{max}$)

b) Run the test for 15 minutes, applying a traffic load of L_{VLU}.

c) Record power values for the entire 15 minute period.

d) Calculate and report the average value (P_{VLU}).

E) If packet loss occurs during any of the tests specified in Section 6.2.D), the UUT must be retested beginning with Section 6.2.C)

7 REFERENCES

A) Alliance for Telecommunications Industry Solutions (ATIS) – 0600015.03.2013 Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting for Router and Ethernet Switch Products

B) Spirent Communications – Test Methodology Journal: IMIX (Internet Mix) Journal, March 2006.

C) IEEE 802.3-2012: IEEE Standard for Ethernet.