SCTE · ISBE

STANDARDS

Energy Management Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 231 2019

General Test Procedures for Evaluation of Energy Efficiency Metrics and in Support of Functional Density Metrics

NOTICE

The Society of Cable Telecommunications Engineers (SCTE) / International Society of Broadband Experts (ISBE) Standards and Operational Practices (hereafter called "documents") are intended to serve the public interest by providing specifications, test methods and procedures that promote uniformity of product, interchangeability, best practices and ultimately the long-term reliability of broadband communications facilities. These documents shall not in any way preclude any member or non-member of SCTE•ISBE from manufacturing or selling products not conforming to such documents, nor shall the existence of such standards preclude their voluntary use by those other than SCTE•ISBE members.

SCTE•ISBE assumes no obligations or liability whatsoever to any party who may adopt the documents. Such adopting party assumes all risks associated with adoption of these documents, and accepts full responsibility for any damage and/or claims arising from the adoption of such documents.

Attention is called to the possibility that implementation of this document may require the use of subject matter covered by patent rights. By publication of this document, no position is taken with respect to the existence or validity of any patent rights in connection therewith. SCTE•ISBE shall not be responsible for identifying patents for which a license may be required or for conducting inquiries into the legal validity or scope of those patents that are brought to its attention.

Patent holders who believe that they hold patents which are essential to the implementation of this document have been requested to provide information about those patents and any related licensing terms and conditions. Any such declarations made before or after publication of this document are available on the SCTE•ISBE web site at http://www.scte.org.

140 Philips Road
Exton, PA 19341

Table of Contents

1. Introduction

1.1. Executive Summary

A series of SCTE documents are being created to provide the cable operator with standard references for determining how well a piece of access network equipment performs in terms of minimizing the power required to do its particular job. In addition, the standards provide the means to quantify the amount of useful work the equipment provides per physical space. This document supports the series of supplemental standards by providing a common set of testing procedures and methodologies to be used for evaluating the power consumption metrics defined by those standards.

1.2. Scope

Cable operator networks are large expansive networks that involve hundreds if not thousands of miles of coaxial or fiber cable powered by power supplies in the outside plant and connecting customers to critical infrastructure facilities such as hubs, headends, data centers, regional, and national distribution datacenters. In these facilities is a vast array of equipment responsible for the production and support of the cable operator's products and services such as voice, video, data, home automation and security, and Wi-Fi. The importance of powering all of these devices in the critical facilities is ever increasing as the customer expectation is for 100% availability due to the critical nature of the services being provided to business and residential customers. Standard methodologies are needed to measure the energy consumption for the various network element classes as well as measuring the density of hardware to meet the needs of optimizing critical space.

This document covers the general test procedures that are common to all equipment types and specifies the environmental conditions for evaluating cable equipment energy efficiency metrics. Expectations of measurement equipment as well as guidelines on the recording of results are also covered. This standard will be included as a normative reference in each supplemental standard in the series covering metrics and specific test procedures for the various equipment types.

The requirements in this document are applicable to all equipment types unless superseded by that equipment type's supplemental SCTE standard.

1.3. Benefits

This standard defines general testing configuration and procedures in support of energy-specific performance metrics based on service features that are inherent to the type of equipment. This standard will contribute to improve the overall energy footprint by enabling engineering driven decisions that reduce energy consumption at the source of power consumption.

1.4. Intended Audience

Cable operator headend and hub engineers and testing staff, procurement teams, and operations staff; cable equipment vendor testing staff.

1.5. Areas for Further Investigation or to be Added in Future Versions

As the industry migrates towards Distributed Access Architectures (DAA), these specifications may be expanded to accommodate these changes.

2. Normative References

The following documents contain provisions, which, through reference in this text, constitute provisions of this document. At the time of Subcommittee approval, the editions indicated were valid. All documents are subject to revision; and while parties to any agreement based on this document are encouraged to investigate the possibility of applying the most recent editions of the documents listed below, they are reminded that newer editions of those documents might not be compatible with the referenced version.

2.1. SCTE References

- No normative references are applicable.

2.2. Standards from Other Organizations

- [ATIS-0600015.2018] *Energy Efficiency for Telecommunication Equipment: Methodology for Measurement and Reporting – General Requirements*, May 2018
- [NIST Handbook 150] *NVLAP Procedures and General Requirements*, February 2006, http://www.nist.gov/nvlap/upload/nist-handbook-150.pdf
- [NIST Handbook 150-2A] *NVLAP Calibration Laboratories - Technical Guide for Electromagnetic DC Low Frequency Measurements*, March 2004, http://www.nist.gov/nvlap/upload/hb150-2a-1.pdf

2.3. Published Materials

- No normative references are applicable.

3. Informative References

The following documents might provide valuable information to the reader but are not required when complying with this document.

3.1. SCTE References

- [SCTE 203 2014] *Product Environmental Requirements for Cable Telecommunications Facilities – Test Methods*

3.2. Standards from Other Organizations

- No informative references are applicable.

3.3. Published Materials

- No informative references are applicable.

4. Compliance Notation

shall	This word or the adjective "***required***" means that the item is an absolute requirement of this document.
shall not	This phrase means that the item is an absolute prohibition of this document.
forbidden	This word means the value specified shall never be used.
should	This word or the adjective "*recommended*" means that there may exist valid reasons in particular circumstances to ignore this item, but the full implications should be understood and the case carefully weighted before choosing a different course.
should not	This phrase means that there may exist valid reasons in particular circumstances when the listed behavior is acceptable or even useful, but the full implications should be understood and the case carefully weighed before implementing any behavior described with this label.
may	This word or the adjective "*optional*" means that this item is truly optional. One vendor may choose to include the item because a particular marketplace requires it or because it enhances the product, for example; another vendor may omit the same item.
deprecated	Use is permissible for legacy purposes only. Deprecated features may be removed from future versions of this document. Implementations should avoid use of deprecated features.

5. Abbreviations

ATIS	Alliance for Telecommunications Industry Solutions
DAA	Distributed Access Architectures
EUT	equipment under test
Hz	hertz
NIST	National Institute of Standards and Technology
NVLAP	National Voluntary Laboratory Accreditation Program
SCTE	Society of Cable Telecommunications Engineers

6. Measurements

6.1. Key Performance Metrics

The requirements in this document support the evaluation of key performance metrics for cable network equipment. The key performance metrics for each specific equipment type are documented in a corresponding supplemental standard.

6.2. Environmental Requirements

6.2.1. Temperature

For equipment with forced air cooling as often found in a data center or headend, the Equipment Under Test (EUT) ***shall*** be evaluated at an ambient temperature of 25°C ±3°C (77 ± 5°F). The temperature ***shall*** be measured just in front of (upwind of) an airflow inlet of the EUT at a distance not to exceed 2 cm and with the temperature sensor not touching the EUT.

For equipment with convection cooling as often found in a node or outside cabinet, the EUT ***shall*** be evaluated at an ambient temperature of 25°C ±3°C (77 ± 5°F). The temperature ***shall*** be measured next to the EUT at a distance of 3 inches from the EUT and with the temperature sensor not touching the EUT.

6.2.2. Humidity

The EUT ***shall*** be evaluated at a relative humidity between 10% to 80%.

6.2.3. Barometric Pressure

The EUT ***shall*** be evaluated at a barometric pressure between 1020 and 812 mbar. This corresponds to typical barometric pressure between altitudes of 60m (197ft) below sea level to 1829m (6000ft) above sea level.

6.2.4. Voltage

6.2.4.1. DC Powered Equipment

DC powered EUTs ***shall*** be evaluated per the requirements specified in [ATIS-0600015.2018] – section 5.2.4.1.

6.2.4.2. AC Powered Equipment

AC powered EUTs ***shall*** be evaluated per the requirements specified in [ATIS-0600015.2018] – section 5.2.4.2.

6.3. Measurement Equipment

6.3.1. Calibration and Preparation

All measurement equipment ***shall*** be calibrated per manufacturer recommendations. All measurement equipment ***shall*** be in a current state of calibration traceable to the National Institute of Standards and Technology (NIST) requirements or counterpart national metrology institute in other countries.

The make, model number and date of calibration expiration of each unit of test equipment used for the test ***shall*** be recorded.

6.3.2. Power Meter

A Power Meter ***shall*** be used to measure total *true* power consumption (in **watts**) of the EUT chassis as determined by measurements at the power entry point just outside the chassis.

Power Meters ***shall*** possess the following additional attributes:

A) Minimum Measurement Resolution: Power measurements ***shall*** have a resolution of 5 digits or greater.
B) Measurement Accuracy: Power measurements ***shall*** be reported by the power meter with an overall accuracy of 1% or better.
C) Crest Factor: A 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.
D) Minimum Bandwidth of Input Circuitry: 80 kHz
E) Minimum Frequency Response: 3.0 kHz
   Minimum Digitizing Sampling Rate: 40 kHz
F) Storage of Test Results:
   a. Ability to log and store data for the total measurement period

6.3.3. Temperature Sensor

Ambient temperature measurements ***shall*** be made with a sensor with an accuracy of ±0.5° C or better. Temperature sensors *should* have a response time on the order of 1 second.

6.4. Power Source

DC power sources used to provide power to the equipment under test ***shall*** be capable of providing a minimum of 1.5 times the power rating of the equipment under test.

6.5. Environmental and Equipment Stabilization

The environmental conditions of section 6.2 ***shall*** be allowed to stabilize as long as necessary in order to maintain steady values within their required ranges. Subsequent to environmental stabilization, the EUT and test equipment ***shall*** be allowed to stabilize and then operate for a minimum of 30 minutes before the specified measurements are taken, except where otherwise required in a supplemental standard.

6.6. Minimum Measurement Duration

The following is per [ATIS-0600015.2018] – section 5.6:

Measurements ***shall*** be performed over a minimum period of 5 minutes, except where otherwise noted in a supplemental standard. For equipment whose cycle time or energy saving mode requires a longer measurement period, the minimum measurement period ***shall*** be increased to provide an accurate indication of energy consumption.

6.7. Test Configuration

The following has been adapted from [ATIS-0600015.2018] – section 5.7:

Equipment under test (EUT) with multiple power connections (including redundant connections) ***shall*** have all feeds connected, and the power flow from all feeds ***shall*** be summed to obtain total system power.

Within this document, the typical environment in a cable facility has an ambient temperature as specified in section 6.2.1. The energy consumed by fans may be higher when operating at this temperature range than at lower temperatures. To capture this potential higher energy consumption, the EUT ***shall*** be tested in a thermally controlled environment (for example, a thermal chamber) of no less than the low end of the temperature range specified in section 6.2.1.

Traffic ***shall*** flow throughout the system and ***shall*** exercise the set of features and functions defined in the supplemental standard for the specific type of equipment. Traffic parameters ***shall*** also be defined in each supplemental standard.

6.7.1. System Definition and Determination of Test Scenarios

The equipment vendor will choose the set of hardware and software components comprising the system being submitted for testing. In general, these components can be a mixture of hardware versions and software versions. However, from the standpoint of **power consumption** characteristics, the vendor will deem a particular *system definition* as a product generation. A *product generation definition date*, representing the date this product generation was available for power consumption characteristic testing, ***shall*** be identified by the vendor. In equipment-specific supplemental standards where the applicable test configuration scenarios are dependent on a time range (e.g. 2015-2017), the scenario(s) ***shall*** be determined based on the product generation definition date. Note that the product generation definition date may apply even if hardware or software components are included in the tested system that were introduced by the vendor prior to that date. The system definition may be amended to include new hardware and software components that do not significantly affect the power consumption characteristics. These may include but are not limited to obsolete parts replacement, defect fixes, and/or software updates that apply to the same product generation and do not change the product generation definition date.

6.8. Power Measurements

Per [ATIS-0600015.2018] – section 5.8, power measurements ***shall*** be performed for traffic conditions (line rate, profile, pattern, etc.) specific to the equipment type. For each traffic condition, power measurements ***shall*** be averaged over the recommended test interval. The SCTE standards specific to the equipment type will further define the traffic conditions and requirements.

All power measurements ***shall*** be taken at the main system power input of the EUT (i.e. just outside the EUT chassis). This implies that the measurement does *not* include the power consumption of devices external to the EUT chassis such as power supplies/rectifiers.

6.9. Evaluation of Functional Density Metrics

Guidance on the evaluation of the functional density metric(s) for a given equipment type is covered in the equipment-specific supplemental standard in the corresponding section that defines the metric(s).

6.10. Recording of Results

A test report ***shall*** be prepared that minimally includes the following information. (This list is consistent with the requirements specified in [ATIS-0600015.2018] – section 7). An example reporting form can be found in [ATIS-0600015.2018] – Annex A.

- Any relevant supplemental standard used
- Date and location of test
- Physical equipment configuration including physical dimensions and mounting used for testing (e.g., shelf level, frame, wall mount). The number of chassis rack units of the EUT must be recorded.
- Software version operating on the system
- Hardware version of the major system components (e.g. cards)
- Activated features and functions during testing
- Explanation of configuration chosen/tested
- The port or channel utilization that was applied during testing
- Method used to validate stated traffic flow under specified conditions. For example, describe how the laboratory verified that the recommended traffic patterns met the conditions of the test plan.
- Support equipment used to verify operation of the equipment
- Description of test equipment used for making measurements with calibration dates
- A block diagram with connection information. It is recommended that traffic flow be indicated
- Energy measurement results (i.e. evaluation of the energy metrics) for all applicable test conditions as defined in the relevant supplemental standard (70% utilization load, idle load, alternate configurations, etc.)
- Duration of actual energy measurement tests
- Identification of environmental conditions as defined in section 6.2
- Report of any engineering judgment used during the evaluation

  Notes:
  - Storage of relevant raw test results may be useful