SCTE · ISBE

STANDARDS

Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

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Test Method Common Mode Disturbance

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Table of Contents

List of Figures

1. Introduction

1.1. Executive Summary

Common mode disturbance is generated by power electronics in all active devices. These are typically in the frequency range from 150 kHz to 30 MHz, though higher frequency disturbances are possible. These disturbances can be radiated and cause interference with wireless signals, or can become differential mode and be coupled into the upstream signal path of the cable plant, cause degradations to upstream signal-to-noise.

1.2. Scope

The purpose of this test is to determine the common mode disturbance generated by power electronics in active CPE equipment. Since conducted disturbances on the AC port is already a part of FCC testing requirements, this method focuses on measurements of the common mode disturbance on the coaxial port. Common mode disturbance from stand-alone power supplies are conducted through a common ground plane on the CPE device to the outer conductor of the coaxial port. Therefore stand-alone power supplies are also within the scope of this standard.

1.3. Benefits

Devices that exhibit excessive amount of common mode disturbance performance can cause potential problems such as:

- AM interference – common mode disturbances in the frequency range from 500 kHz to 1.5 MHz can radiate into the air and cause interference to AM radio.
- CATV upstream SNR (MER) – abrupt impedance changes (such as bad contact from a loose connector) causes the common mode disturbance to become differential mode, which is coupled into the coaxial cable. Common mode disturbance from 5 MHz to 42 MHz affects SNR (MER) of existing CATV upstream signals, causing dropped connections and excessive bit error ratio on a per node basis. (Note: This standard extends testing to 200 MHz to take into account higher frequency splits necessitated by DOCSIS 3.1 and Full Duplex DOCSIS.)

Ensuring that all active devices are tested according to this standard successfully mitigates the problems listed above, which in turns improves the resiliency of the DOCSIS network.

1.4. Intended Audience

The intended audience for this document are development engineers, quality assurance engineers, product managers, and technical operations engineers from both manufacturers and operators. Technicians and installers can benefit from this document as well to help troubleshoot issues in the field.

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

Areas to be investigated or added in future versions include:

- Alternative to the CDN, such as current clamps
- Use of programmable AC supplies instead of LISN to allow for the following test cases:
    - Low voltage
    - High voltage
    - Harmonics

- Other power conditions as relevant

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

- CISPR 22:2008 (EN55022:2010)
- CISPR 16-1-1
- CISPR 16-1-2
- IEC 61000-4-6

2.3. Published Materials

- No informative 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

- No informative references are applicable.

3.2. Standards from Other Organizations

- No informative references are applicable.

3.3. Published Materials

- Y. P. Chan, B. M. H. Pong, N. K. Poon and J. C. P. Liu, "Common-mode noise cancellation in switching-mode power supplies using an equipotential transformer modeling technique", IEEE Tran. Electromagnetic Compatibility, vol. 54, no. 3, pp. 594-602, 2012

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 and Definitions

5.1. Abbreviations

AC	alternating current
AMN	artificial mains network
AE	associated equipment
BER	bit error ratio
CATV	cable television
CDN	coupling decoupling network
CPE	customer premise equipment
DOCSIS	Data-Over-Cable Service Interface Specifications
EUT	equipment under test
FCC	Federal Communications Commission
HFC	hybrid fiber-coax
CISPR	International Special Committee on Radio Interference
kHz	kilohertz
LISN	line impedance stabilization network
MHz	megahertz
SNR	signal to noise ratio
SCTE	Society of Cable Telecommunications Engineers

5.2. Definitions

downstream	Information flowing from the hub to the user
upstream	Information flowing from the user to the hub

6. Test Method

6.1. Key Performance Metrics

Common mode disturbance is measured against the following acceptance limits when measured with a peak detector:

- No peaks above 45 dBµV from 10 MHz to 200 MHz
- No peaks above 74 dBµV to 64 dBµV, decreasing linearly with logarithm of frequency, from 150 kHz to 500 kHz
- No peaks above 64 dBµV from 500 kHz to 10 MHz

The acceptance limits provided above yield approximately 30 dB of SNR with modem transmit levels of 40 dBµV.

6.2. Required Equipment

- CDN with 75 ohm impedance on the EUT and AET interfaces, and frequency range of at least 150 kHz to 200 MHz, meeting the requirements of IEC 61000-4-6.
- EMI receiver per CISPR 16-1-1
- AMN with nominal impedance (50 Ω/50 µH or 50 Ω/50 µH + 5 Ω) as defined in CISPR 16-1-2
- Power supply test fixture (for stand-alone power supplies)

6.3. Calibration and Equipment Preparation

6.3.1. Power Supply Test Fixture

A power supply test fixture as shown in Figure 1 shall be used for testing stand-alone power supplies that do not have F ports.

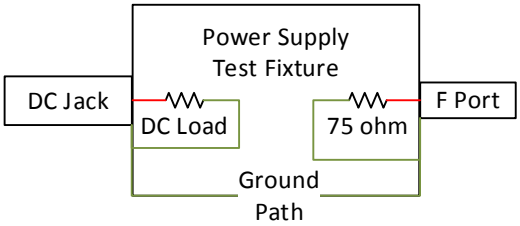

Figure 1 - Power Supply Test Fixture

Key performance parameters of the power supply test fixture shall be:

- Ground path resistance (DC jack to F port) ≤ 50 mΩ
- DC load ≥ 75% of the power supply's maximum rating
- F-port impedance = 75 Ω
- Return Loss >= 10 dB

6.4. Detailed Procedure

6.4.1. EUT Setup

Equipment should be set up per Figure C.1 of the CISPR 22 (EN55022) standard. Key setup parameters are:

- EUT shall be placed 40 cm above the ground plane (note that the EUT includes the power supply test fixture when testing stand-alone power supplies)
- EUT shall be 80 cm from the CDN
- CDN shall be bonded to the ground plane
- LISN or AMN (for filtering AC supply to the EUT) shall be bonded to the ground plane
- It is recommended that CDNs and AMNs shall be internally bonded to a conductive base plate, which shall be placed directly on the ground plane. Additional conductive tape, such as copper tape, may be used to ensure good bonding to ground.
- It is recommended that testing is done in a screen room to minimize interference

Wiring of the EUT shall be as follows:

- Stand-alone power supplies shall be tested in combination with the Power Supply Test Fixture. This combination is considered to be the EUT, and shall be wired according to Figure 2.
- Devices with integrated power supplies (certain modems, set top boxes, etc.) shall be wired according to Figure 3.

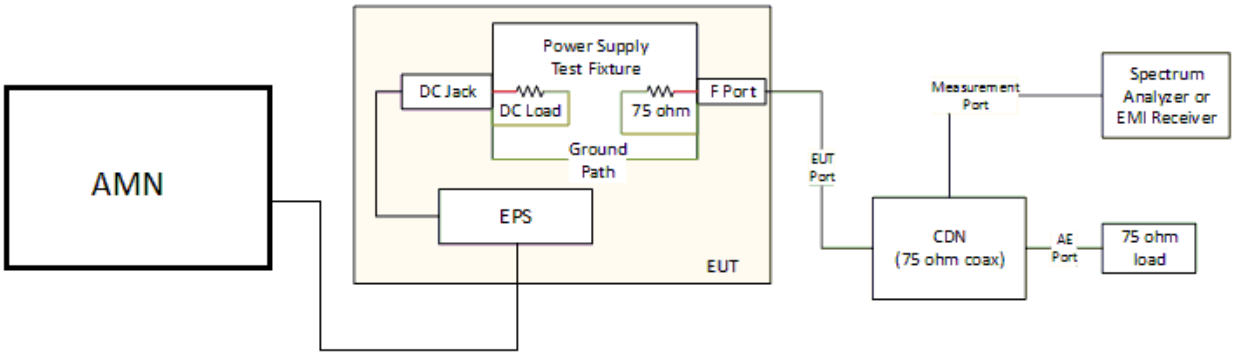

Figure 2 - Setup for Standalone Power Supplies tested with the Power Supply Test Fixture

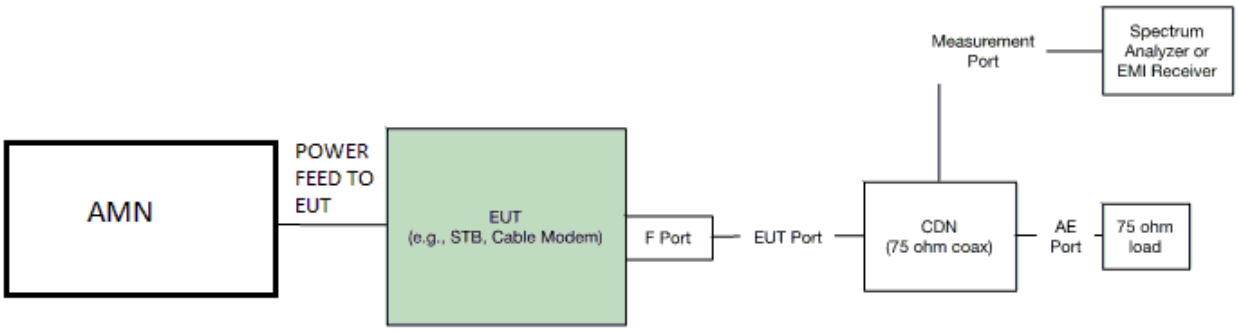

Figure 3 - Setup for Devices with Integrated Power Supplies

6.4.2. Test Equipment Setup

Setup the EMI receiver as follows:

- RBW = 9 kHz
- VBW = 9 kHz
- Detector type = peak
- Sweep range = 150 kHz to 200 MHz
- Set amplitude units to dBµV.
- Correct for the voltage division factor (typically 10 dB). This is typically entered as transducer gain in the EMI receiver.
- Set Trace Mode to Max Hold
- Set limit lines per the requirements in section 6.1

6.4.3. Noise Floor Verification

Noise floor verification shall be accomplished as follows:

- Setup EUT per section 6.4.1
- Do NOT apply AC power (EUT is unpowered)
- Verify that the noise floor on the EMI receiver is at least 10 dB below the limit lines setup in section 6.4.2

6.4.4. Common Mode Disturbance Measurement

Measure common mode disturbance of the EUT by following these steps:

- Setup EUT per section 6.4.1
- Power on EUT and allow a minimum of 5 minutes for equipment to stabilize. Note that certain CPE devices may require longer boot up times.
- With the receiver set up per section 6.4.2, capture data for a minimum of 1000 sweeps and at least 2 minutes.

6.5. Recording of Results

Results shall include both the raw data (typically CSV file with X and Y values for each frequency step) and plot of the measured value. Figure 4 is a sample plot of a device tested per this standard.

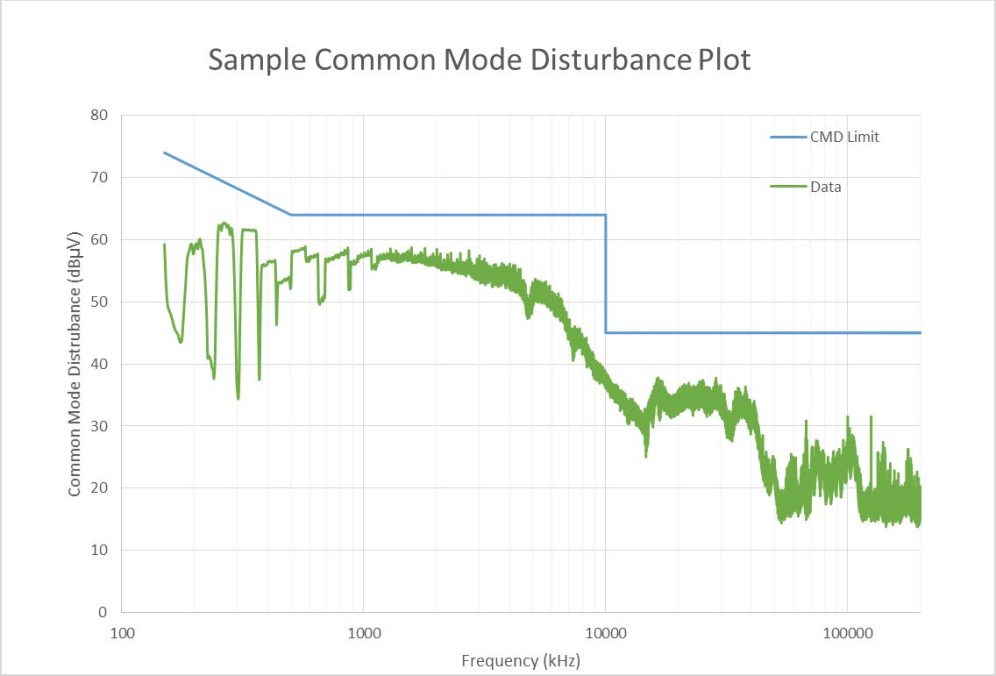

Figure 4 - Sample Common Mode Disturbance Measurement