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S T A N D A R D S

Network Operations Subcommittee

SCTE OPERATIONAL PRACTICE

SCTE 204 2020

**FCC Proof-of-Performance
Checklist for Analog and Digital Signals**

Operational Practice

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1. Introduction

1.1. Executive Summary

This Operational Practice provides a guide to the Federal Communications Commission (FCC) technical performance requirements for analog and digital signals. This document acts as a complement to *SCTE Measurement Recommended Practices for Cable Systems, Fourth Edition* (“SCTE RP 4th Ed.”) and ANSI/SCTE 40 2016, Digital Cable Network Interface Standard.

1.2. Scope

This Operational Practice highlights FCC technical performance requirements, how often to test for performance, where the testing should take place, and in some instances, references to SCTE RP 4th Ed. on how to conduct testing.

1.3. Benefits

Cable operators in the United States are required to ensure that their systems are designed, installed, and operated in a manner that fully complies with FCC technical performance requirements. The information provided in this Operational Practice will help cable operators maintain the integrity of their networks as well as ensure compliance with applicable FCC regulations.

1.4. Intended Audience

This document is intended for cable system technical personnel such as service and maintenance technicians who are responsible for monitoring and measuring cable system technical performance to ensure compliance with applicable FCC regulations.

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

If the applicable FCC rules change, this document will need to be updated.

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

- ANSI/SCTE 40 2016 – Digital Cable Network Interface Standard
- *SCTE Measurement Recommended Practices for Cable Systems, Fourth Edition* (SCTE RP 4th Ed.), 2011

2.2. Standards from Other Organizations

- CTA 542-D R-2018 – Cable Television Channel Identification Plan¹

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

- No informative references are applicable.

3.2. Standards from Other Organizations

- No informative references are applicable.

3.3. Published Materials

- No informative references are applicable.

4. Compliance Notation

| | |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>shall</i> | This word or the adjective “ <i>required</i> ” means that the item is an absolute requirement of this document. |
| <i>shall not</i> | This phrase means that the item is an absolute prohibition of this document. |
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¹ As of the date of this update the FCC references CTA-542-D, “Cable Television Channel Identification Plan,” June 2013. See §76.602(c)(2).

5. Abbreviations and Definitions

5.1. Abbreviations

| | |
|---------|----------------------------------------------------------------------------------------------------------|
| AM-VSB | amplitude modulation vestigial sideband |
| ANSI | American National Standards Institute |
| CEA | Consumer Electronics Association (now CTA) |
| C/N | carrier-to-noise ratio |
| C/(N+I) | carrier-to-noise-plus-interference ratio |
| CSO | composite second order |
| CTA | Consumer Technology Association (formerly CEA) |
| CTB | composite triple beat |
| CW | continuous wave |
| dB | decibel |
| dBc | decibel carrier |
| dB/Hz | decibel per hertz |
| dBmV | decibel millivolt |
| FAT | forward application transport |
| FCC | Federal Communications Commission |
| HRC | harmonic related carriers (sometimes harmonically related carrier or harmonically related coherent) |
| Hz | hertz |
| IRC | incremental related carriers (sometimes incrementally related carrier or incrementally related coherent) |
| ISBE | International Society of Broadband Experts |
| kHz | kilohertz |
| MHz | megahertz |
| μs | microsecond |
| ms | millisecond |
| ns | nanosecond |
| p-p | peak-to-peak |
| QAM | quadrature amplitude modulation |
| SCTE | Society of Cable Telecommunications Engineers |
| SC-QAM | single carrier quadrature amplitude modulation |
| STD | standard [frequencies or channelization] |
| VSB | vestigial sideband |

6. Analog NTSC TV Signals Performance Checklist

Table 1 summarizes the technical rules in §76.605 of the Federal Communications Commission’s Rules, in effect as of April 2, 2020, and is intended to serve as a checklist for analog TV channel proof-of-performance tests. Additional information is available in §76.601, §76.602, and §76.609. The column labeled “SCTE RP 4th Ed.” guides the reader to applicable sections in *SCTE Measurement Recommended Practices for Cable Systems, Fourth Edition*, which includes measurement procedures for the listed FCC technical standards.

Table 1 - Analog Signal Performance Checklist

| Parameter | FCC Rule | Required Performance | Channels ¹ | When | Where | SCTE RP 4 th Ed. |
|--------------------------------|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|---------------------------------------------------------------|--------------------------------------------------------|-----------------------------|
| Viewability | §76.605(b)(1) | Capable of being received and displayed by TV broadcast receivers | All | Semi-annual | Subscriber terminal | N/A |
| Channelization | §76.605(b)(1) | Frequency usage comply with CTA-542-D | All | Semi-annual | Subscriber terminal | Section 7.1 |
| Aural Carrier Frequency | §76.605(b)(2) | 4.5 MHz ±5 kHz above visual carrier frequency | All | Semi-annual | Headend, subscriber terminal | Section 7.2 |
| Visual Carrier Level | §76.605(b)(3) | Not less than 0 dBmV | All | Semi-annual | Subscriber terminal | Section 2.1 |
| | | Not less than +3 dBmV | | | End of 30 meter drop cable connected subscriber to tap | |
| 24 Hour Test | §76.605(b)(4) | ≤8 dB variation over 6 months | All | Semi-annual (January or February, again in July or August) | End of 30 meter drop cable connected to subscriber tap | Section 2.1 |
| | | Each channel within 3 dB of adjacent channels | | | | |
| | | Within 10 dB of any other channel to 300 MHz, increased 1 dB per additional 100 MHz of cable network upper frequency limit (e.g., 11 dB for 301-400 MHz, 12 dB for 401-500 MHz, etc.) | | | | |
| | | Maximum level must not overload subscriber's receiver or terminal | | | | |
| Aural Carrier Level | §76.605(b)(5) | -10 to -17 dBc | All | Semi-annual | Headend, subscriber terminal | Section 2.1 |
| | | -6.5 to -17 dBc if baseband converter is being used | | | Subscriber terminal | |
| In-channel response | §76.605(b)(6) | ±2 dB from 0.75 MHz to 5.0 MHz above lower channel boundary | Test channels | Semi-annual | Subscriber terminal | Section 6.1 |
| Visual carrier C/N | §76.605(b)(7) | Not less than 43 dB | Test channels | Semi-annual | Subscriber terminal | Section 3.2 |

| Parameter | FCC Rule | Required Performance | Channels ¹ | When | Where | SCTE RP 4 th Ed. |
|----------------------------------------------------------|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|-------------|---------------------|-----------------------------|
| Visual signal level-to-coherent disturbance ratio | §76.605(b)(8) | Not less than 51 dBc for noncoherent systems (i.e., STD channelization) Not less than 47 dBc for coherent systems (i.e., IRC or HRC channelization) | Test channels | Semi-annual | Subscriber terminal | Section 4.1 |
| Terminal Isolation² | §76.605(b)(9) | At least 18 dB | Test channels | Semi-annual | Subscriber terminal | Section 12.1 |
| Hum and repetitive transients | §76.605(b)(10) | Peak-to-peak variation must be less than 3% of visual carrier level | One channel or CW carrier | Semi-annual | Subscriber terminal | Section 4.4 |
| Chrominance-luminance delay inequality | §76.605(b)(11)(i) | Within 170 nanoseconds | All | Triennial | Headend | Section 10.2 |
| Color subcarrier differential gain | §76.605(b)(11)(ii) | Less than ±20 % | All | Triennial | Headend | Section 10.3 |
| Color subcarrier differential phase | §76.605(b)(11)(iii) | Less than ±10 degrees | All | Triennial | Headend | Section 10.3 |

Notes:

1. See §76.601(b)(2). Proof-of-performance tests to determine the extent to which a cable television system complies with the standards set forth in §76.605(b)(3), (4), and (5) shall be made on each of the NTSC or similar video channels of that system. Unless otherwise noted, proof-of-performance tests for all other standards in §76.605(b) shall be made on a minimum of five (5) channels for systems operating a total activated channel capacity of less than 550 MHz, and ten (10) channels for systems operating a total activated channel capacity of 550 MHz or greater. The channels selected for testing must be representative of all the channels within the cable television system.

2. See §76.605(b)(9). In lieu of periodic testing, the cable operator may use specifications provided by the manufacturer for the terminal isolation equipment to meet this standard.

7. Digital Signal Performance Checklist

§76.605(a) of the FCC rules mandates that cable systems that use quadrature amplitude modulation (QAM) to transport video programming adhere to ANSI/SCTE 40 2016.

Table 2 includes the digital forward application transport (FAT) transmission characteristics defined in ANSI/SCTE 40 2016, and can be used as a checklist for characterizing the performance of downstream single carrier QAM (SC-QAM) signals.

A column labeled “SCTE RP 4th Ed.” has been added to the table. The information in the column is intended to guide the reader to applicable sections in *SCTE Measurement Recommended Practices for Cable Systems, Fourth Edition*, which includes measurement procedures for the listed SCTE 40 parameters applicable to digital signals. The comment “see analog table” in the last column refers to Table 1, the FCC Proof-of-Performance Checklist table earlier in this document.

Table 2 - Analog and FAT Channel: RF Transmission Characteristics

| RF Transmission Characteristics | | SCTE RP 4 th Ed. |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------|
| RF Channel Spacing | 6 MHz | N/A |
| RF Frequency Range | 54 MHz to 864 MHz IRC/HRC/Standard Channel Plans. | N/A |
| Transit delay from headend to most distant Customer | < 0.800 ms (typically much less) | N/A |
| Carrier-to-noise ratio, C/(N+I), in a 6-MHz band where C/(N+I) includes the simultaneous presence of all additive impairments in the 6-MHz channel bandwidth including CTB, CSO, other discrete interference. | Not less than 27 dB for 64-QAM; 33 dB for 256-QAM; | Section 3.5 |
| C/N (analog channels) | 43 dB for AM-VSB analog | See analog table |
| CTB | Not worse than -53 dBc referenced to inband carrier levels for analog channels. <i>(Note 1)</i> | Sections 3.5 and 4.1 |
| CSO | Not worse than -53 dBc referenced to inband carrier levels for analog channels. <i>(Note 1)</i> | Sections 3.5 and 4.1 |
| Carrier-to-any other discrete interference (ingress) | Not worse than -53 dBc <i>(Note 1)</i> | Sections 3.5 and 4.1 |
| AM Hum Modulation | Not greater than 3% p-p | Section 4.5 |
| Group Delay Variation | < 0.37 μs/MHz across the 6-MHz channel | Section 11.4 |
| Chroma / Luma Delay | ≤ 170 ns (AM-VSB analog) | See analog table |
| Phase Noise | < -86 dBc/Hz @ 10 kHz offset (relative to the center of QAM signal spectrum) | Section 3.7 |
| Maximum amplitude variation across the 6-MHz channel (digital channels) | ≤ 6 dB p-p | Section 6.4 |
| Maximum amplitude variation across the 6-MHz channel (analog channels) | ≤ 4 dB p-p | See analog table |

| RF Transmission Characteristics | | SCTE RP 4 th Ed. |
|-------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|
| Micro-reflections bound for dominant echo | -10 dB at < 0.5 μs -15 dB at < 1.0 μs -20 dB at < 1.5 μs -30 dB at < 4.5 μs | Section 9.4 |
| | Micro-reflections longer than 4.5 microseconds are included under item 4 (of this table) as a contributor to the interference I in C/(N+I). Micro-reflections, if present, shall not cause the channel Group Delay Variation and Maximum Amplitude Variation in Table 4.9 and 4.12 respectively to be exceeded. | |
| Carrier level at the terminal input (<i>Note 2</i>) | 64-QAM: -15 dBmV to + 15 dBmV | Section 2.2 |
| | 256-QAM: -12 dBmV to +15 dBmV | |
| | Analog Visual Carrier (c): 0 dBmV to +15 dBmV Analog Aural Carrier: -10 dBc to -17 dBc | See analog table |

Notes:

1. For digital channels, CTB, CSO and other discrete interference are included in the overall C/(N+I) parameter.
2. See SCTE RP 4th Ed., section 6.4.1 for the allowable variation in level between adjacent channels.