

SCTE | **STANDARDS**

Interface Practices Subcommittee

SCTE STANDARD

SCTE 279 2022

**1.8 GHz Broadband Radio Frequency Hardline
Amplifiers for Cable Systems**

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Document Type: Specification

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1. Introduction

1.1. Executive Summary

The purpose of this document is to identify common characteristics of hardline amplifiers to be used in 1.8 GHz broadband hybrid fiber coax (HFC) networks.

1.2. Scope

This document recommends mechanical, environmental, and electrical standards for broadband radio frequency (RF) amplifiers that support DOCSIS[®] 4.0 frequency division duplex (FDD) capabilities, with downstream operation at frequencies up to 1794 MHz and upstream operation at frequencies up to 684 MHz.

Products covered by this document include the high gain single and multiport amplifiers required to support drop-in upgrades at legacy amplifier locations, as well as the lower gain booster amplifiers that may be required between amplifier locations with very long spacings. The devices are intended for an outdoor rated environment.

This document does not cover amplifiers with echo cancellation (required to support full duplex (FDX)), amplifiers used in nodes (commonly referred to as launch amplifiers), or other variations of low gain amplifiers that may be required for a full distributed gain amplifier (DGA) architecture.

1.3. Benefits

Broadband RF amplifiers are an integral part of an HFC network and enable signals to be carried greater distances along coax with minimal degradation in signal integrity. Identifying key characteristics of the amplifiers required to support DOCSIS 4.0 FDD will assist manufacturers by defining their requirements, which will benefit the industry by increasing the capacity and extending the useful life of the HFC network.

1.4. Intended Audience

Cable, fiber and telecommunications designers, operators, and engineers.

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

Consideration may be given to adding launch amplifiers used in nodes and additional varieties of lower gain amplifiers required for full DGA architectures that may support downstream frequencies up to 3 GHz.

2. Normative References

The following documents contain provisions which, through reference in this text, constitute provisions of this document. The editions indicated were valid at the time of subcommittee approval. 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

- [SCTE 43] ANSI/SCTE 43 2015 (R2021), Digital Video Systems Characteristics Standard for Cable Television
- [SCTE 45] ANSI/SCTE 45 2017, Test Method for Group Delay
- [SCTE 46] ANSI/SCTE 46 2014 (R2021), Test Method for AC to DC Outdoor Power Supplies
- [SCTE 48-1] ANSI/SCTE 48-1 2021, Test Method for Measuring Shielding Effectiveness of Passive and Active Devices Using a GTEM Cell
- [SCTE 62] ANSI/SCTE 62 2018, Measurement Procedure for Noise Figure
- [SCTE 81] ANSI/SCTE 81 2018, Surge Withstand Test Procedure
- [SCTE 91] ANSI/SCTE 91 2015, Specification for 5/8-24 RF & AC Equipment Port, Female
- [SCTE 143] ANSI/SCTE 143 2018, Test Method for Salt Spray
- [SCTE 144] ANSI/SCTE 144 2017, Test Procedure for Measuring Transmission and Reflection
- [SCTE 186] ANSI/SCTE 186 2021, Product Physical, Environmental, Electrical, Sustainability, and Quality Requirements for Cable Telecommunications

2.2. Standards from Other Organizations

- [ASTM] ASTM G 154, Standard Practice For Operating Fluorescent Light Apparatus For UV Exposure Of Nonmetallic Materials
- [GR-2873] GR-2873, July 1995, Generic Requirements for Coaxial Drop Passive Elements
- [IEC 60529] IEC 60529, 2001; Degrees Of Protection Provided By Enclosures (IP Code)
- [IEC 61000] IEC/EN 61000-4-2 ESD, Lightning Testing and Surge Immunity Testing
- [IEEE C62.41] IEEE C62.41, IEEE Recommended Practice For Surge Voltages In Low-Voltage AC Power Circuits
- [MIL 889] MIL-STD-889, July 21, 2021, Galvanic Compatibility Of Electrically Conductive Materials
- [NADCA] NADCA G-6-6-15, NADCA Product Specification Standards for Die Casting

2.3. Other 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 17] ANSI/SCTE 17 2018, Test Procedure for Carrier to Noise (C/N, CCN, CIN, CTN)

3.2. Standards from Other Organizations

No informative references are applicable.

3.3. Other 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.
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<i>Forbidden</i>	This word means the value specified <i>shall</i> never be used.
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<i>May</i>	This word or the adjective “ <i>optional</i> ” indicate a course of action permissible within the limits of the document.
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5. Abbreviations and Definitions

5.1. Abbreviations

AC	alternating current
AGC	automatic gain control
ALSC	automatic level/slope control
CATV	community antenna television
CCN	carrier to composite noise
CIN	carrier to intermodulation noise
CTN	carrier to thermal noise
CW	continuous wave
dB	decibel
dBmV	decibels relative to 1 millivolt
DC	direct current
DGA	distributed gain amplifier
DOCSIS	Data Over Cable Service Interface Specification
ES	extended spectrum

ESD	electrostatic discharge
FDD	frequency division duplex
F _{DS-LBE}	frequency, downstream lower band edge
F _{US-LBE}	frequency, upstream lower band edge
F _{US-UBE}	frequency, upstream upper band edge
FDX	full duplex
FTEC	fast-transfer electronic-crowbar surge protector
GHz	gigahertz
HALT	highly accelerated life testing
HFC	hybrid fiber coax
MHz	megahertz
ns	nanosecond
OFDM	orthogonal frequency-division multiplexing
psi	pounds per square inch
RF	radio frequency
RMS	root mean square
RoHS	restriction of hazardous substances
SC-QAM	single-carrier quadrature amplitude modulation
SCTE	Society of Cable Telecommunications Engineers
TCP	total composite power
UHS	ultra-high split
UI	user interface
UVB	ultraviolet B
USB	universal serial bus

5.2. Definitions

Definitions of terms used in this document are provided in this section. Defined terms that have specific meanings are capitalized. When the capitalized term is used in this document, the term has the specific meaning as defined in this section.

downstream	The direction of signal transmission from the headend, hub site, or optical node to the subscriber. Also called forward.
upstream	The direction of signal transmission from the subscriber to the headend, hub site, or node. Also called return or reverse.
frequency division duplex (FDD)	This describes a bi-directional broadband RF communications system where the downstream and upstream each have their own dedicated, non-overlapping frequency spectrums.

6. Amplifier Types

The amplifier types listed below are the types that apply for this document.

6.1. Multiport Amplifier

A multiport amplifier (also known as system amplifier, bridger, or trunk/bridger) is a high gain amplifier that has at least two RF output ports driven by independent power amplifiers. The housing is intended for outdoor use and can be strand or pedestal mounted. The amplifier is normally alternating current (AC) line powered.

6.2. Line Extender Amplifier

A line extender is a high gain amplifier that has one or two RF output ports driven by a single power amplifier. The housing is intended for outdoor use and can be strand or pedestal mounted. The amplifier is normally AC line powered.

6.3. Booster Amplifier

A booster amplifier is a single RF output amplifier, smaller in size than a line extender with lower power consumption and lower gain. The booster amplifier is intended to boost the signal between legacy high gain amplifier locations for scenarios where it is needed due to very long amplifier spacings. The housing is intended for outdoor use and can be strand, pedestal, or cabinet mounted. The amplifier is normally AC line powered.

6.4. Compact Amplifier

A compact amplifier has one, two, or three RF output ports in a ports-down configuration with high gain. The ports-down housing type is intended for outdoor use and can be cabinet mounted. The amplifier is normally AC line powered and/or mains powered. The compact amplifier form factor can include bridger, trunk/bridger or line extender configurations.

7. Electrical – for High Gain Amplifiers

7.1. Upstream / Downstream Frequency Splits & Diplexers

This section pertains to the upstream / downstream frequency split options and associated diplex filters and other low-pass/high-pass filters.

7.1.1. Upstream / Downstream Frequency Split Options

The upstream / downstream frequency split options and their associated requirements are listed in Table 1. The available frequency split options *shall* be listed in published specifications.

Table 1 – Upstream / Downstream Frequency Split Options

Split Name	Requirement as an Option for the Amplifier	Upstream Upper Band Edge Frequency (F_{US-UBE})	Downstream Lower Band Edge Frequency (F_{DS-LBE})	Notes
Sub-split	<i>should</i> be supported	42 MHz	54 MHz	Note 1, 2
Euro-split	<i>should</i> be supported	65 MHz	85 MHz	Note 1, 2
Mid-split	<i>shall</i> be supported	85 MHz	108 MHz	Note 1
High-split	<i>shall</i> be supported	204 MHz	258 MHz	Note 1
UHS-300	<i>may</i> be supported	300 MHz	372 MHz	Note 1
UHS-396	<i>shall</i> be supported	396 MHz	492 MHz	Note 1
UHS-492	<i>shall</i> be supported	492 MHz	606 MHz	Note 1
UHS-684	<i>should</i> be supported	684 MHz	834 MHz	Note 1

Notes:

1. Downstream *may* start lower in frequency
2. This frequency split is required to support a transition from these existing legacy splits to the higher frequency splits that *may* be activated later (after initial installation).

7.1.2. Diplex Filters

This section pertains to the diplex filters and associated low-pass/high-pass filters required to keep the downstream and upstream RF paths isolated in a high gain FDD amplifier.

Diplex filters and any associated low-pass/high-pass filters **shall** be modular plug-in type assemblies.

Diplex filters and any associated low-pass/high-pass filters **shall** be field upgradeable, meaning that the plug-in filters can be changed out in the field without the need for any retuning or verification testing on a bench.

Diplex filters and any associated low-pass/high-pass filters *may* be remotely switchable. For switchable filters, at least a pair of filter sets (each associated with a different upstream/downstream frequency split) would be able to be plugged into the amplifier for all applicable input/output RF ports. One frequency split would be selected as the starting split, and the alternate split with increased upstream spectrum could be remotely switched into operation in the future.

7.2. Downstream RF Parameters

This section pertains to the downstream (forward path) RF parameters associated with the various high gain amplifier types. Unless otherwise noted, all of the following downstream RF parameters **shall** apply for the full downstream passband.

7.2.1. Passband

Downstream passband **shall** be 108 to 1794 MHz and *should* be 54 or 85 to 1794 MHz to support the upstream/downstream frequency splits in section 7.1.1.

Downstream passband **shall** be specified in published specifications.

7.2.2. Operational Gain

Downstream operational gain is the station gain at highest rated frequency from downstream input to downstream output, with all other ports terminated. Where applicable, it includes a sufficient back-off from full gain to accommodate the gain reserves required to accommodate AGC level control.

The amount of downstream operational gain is not specified (left to manufacturer discretion). However, at the time of publication it was anticipated that the operational gain at 1794 MHz for the highest gain amplifiers might need to be in the 48 to 50 dB range to meet industry drop-in architecture requirements while minimizing amplifier re-spacing and the need for booster amplifiers.

The minimum operational gain at room temperature at the highest rated downstream frequency for each operating mode supported **shall** be specified in published specifications.

The specification **shall** note that the operational gain is for the station and is specified with 0 dB input equalization and 0 dB input attenuation settings.

Operational gain **shall** be measured in accordance with [SCTE 144].