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Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 265 2021

Broadband Radio Frequency Hardline Passives for Cable Systems

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☐ Test or Measurement	☐ Checklist	☐ Facility
☐ Architecture or Framework	☐ Metric	☒ Access Network
☐ Procedure, Process or Method	☐ Cloud	☐ Customer Premises

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1. Introduction

1.1. Executive Summary

The purpose of this document is to identify common characteristics of hardline passives used in hardline broadband HFC Plant networks.

1.2. Scope

The purpose of this document is to recommend mechanical, environmental and electrical standards hardline passives. This specification addresses passives capable of at least 1794 MHz with a housing capable of 3000 MHz.

Products covered by this specification include hardline splitters, directional couplers, equalizers and power inserters. Hardline passives pass RF and AC to some or all of the ports.

A hardline splitter divides an input RF signal to 2 or 3 outputs.

A hardline directional coupler divides an input RF signal to two outputs with a fixed division ratio.

A hardline equalizer provides RF tilt compensation.

A hardline power inserter combines the AC output of a power supply to the RF network.

The devices are intended for an outdoor rated environment.

The standard is not intended to apply to specialty devices, nor is it intended to limit or restrict any manufacturer's innovation and improvement.

1.3. Benefits

Hardline passive devices are an integral component of a broadband network that provides a uniform method of interconnecting on hardline.

1.4. Intended Audience

This document is intended as a technical guide for the minimum device requirements for proper operation on hardline plant network.

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

- 3 GHz faceplates
- Intermodulation distortion requirements with full spectral loading

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

1. [SCTE 81] ANSI/SCTE 81 2018 Surge Withstand Test Procedure
2. [SCTE 129] SCTE 129 2017 Drop Passives: Bonding Blocks (Without Surge protection)
3. [SCTE 143] ANSI/SCTE 143 2018 Test Method for Salt Spray
4. [SCTE 144] ANSI/SCTE 144 2017 Test Procedure for Transmission and Reflection
5. [SCTE 48-1] ANSI/SCTE 48-1 2015 Test Method for Measuring Shielding Effectiveness of Passive and Active Devices Using a GTEM Cell
6. [SCTE 145] ANSI/SCTE 145 2015 Test Method for Second Harmonic Distortion of Passives Using a Single Carrier
7. [SCTE 16] ANSI/SCTE 16 2018 Test Procedure for Hum Modulation
8. [SCTE 91] ANSI/SCTE 91 2015 Specification for 5/8-24 RF & AC Equipment Port, Female
9. [SCTE 92] ANSI/SCTE 92 2017 Specification for 5/8-24 Plug, (Male), Trunk & Distribution Connectors
10. [SCTE 109] ANSI/SCTE 109 2016 Test Procedure for Common Path Distortion (CPD)
11. [SCTE 186] ANSI/SCTE 186 2016 Product Environmental Requirements for Cable Telecommunications Facilities
12. [SCTE 264] SCTE 264 2020 Broadband Radio Frequency Hardline Taps for Cable Systems
13. [SCTE 45] ANSI/SCTE 45 2017 Test Method for Group Delay

2.2. Standards from Other Organizations

- [IEEE C62.41] IEEE C62.41-1991 – IEEE Recommended Practice for Surge Voltages in Low Voltage AC Power Circuits
- [ASTM G 154] ASTM G 154 Weathering/UV
- [RoHS] RoHS Directive 2011/65/EU – RoHS 2
- [GR-2873] Telcordia GR-2873-CORE – Generic Requirements for Coaxial Drop Passive Elements

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

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

ANSI	American National Standards Institute
DAA	distributed access architecture
dB	decibel
GHz	gigahertz
HALT	highly accelerated life test
MHz	megahertz
RF	radio frequency
RoHS	Restriction of Hazardous Substances
SCTE	Society of Cable Telecommunications Engineers
UVB	ultraviolet B
VAC	voltage alternating current

6. Definitions

faceplate	A passive consists of two assemblies, the housing and the faceplate. The housing is the portion that accepts the 5/8-24 hardline connection while the faceplate is the field replaceable portion that can vary in specifications and application.
housing	A passive consists of two assemblies, the housing and the faceplate. The housing is the portion that accepts the 5/8-24 hardline connection while the faceplate is the field replaceable portion that can vary in specifications and application.
KS	5/8-24 UNEF ports compliant with [SCTE 91] or [SCTE 92]

7. Mechanical and Power

7.1. AC Interruption

With removal of the line passive faceplate, the device *may* provide a connection with < 7 millisecond AC voltage interruption in support of constant operations for any DAA active devices in-line of the line passive.

7.2. Power Pass Capability

The line passive ***shall*** meet all performance requirements while operating with a voltage of 30 - 89 VAC quasi-square wave, and at temperatures ranging from -40°C (-40°F) to +60°C (140°F).

The line passive ***shall*** meet all manufacturer specifications at its rated current.

The line passive ***shall*** pass continuous current of at least 15 amperes, with the following exceptions:

- 2 port inline equalizers in a tap housing ***shall*** pass continuous current of at least 12 amperes on all ports
- Power Inserters ***shall*** pass continuous current of at least 20 amperes on the AC input port, and at least 15 amperes on each RF/AC port

7.3. AC Power Steering

The default configuration of the passive module is to pass AC power between all active ports. The user must be able to disconnect AC power to/from any desired port in a manner that allows it to be reconnected at a later date.

If this is done with a field replaceable plug in device (henceforth referred to as a shunt) then this shunt placement must be such that a technician can remove or replace the shunt with fingers or standard needle nose pliers without needing to move other components out of the way. Proprietary extraction tools must not be required.

7.4. Assembled Dimensions

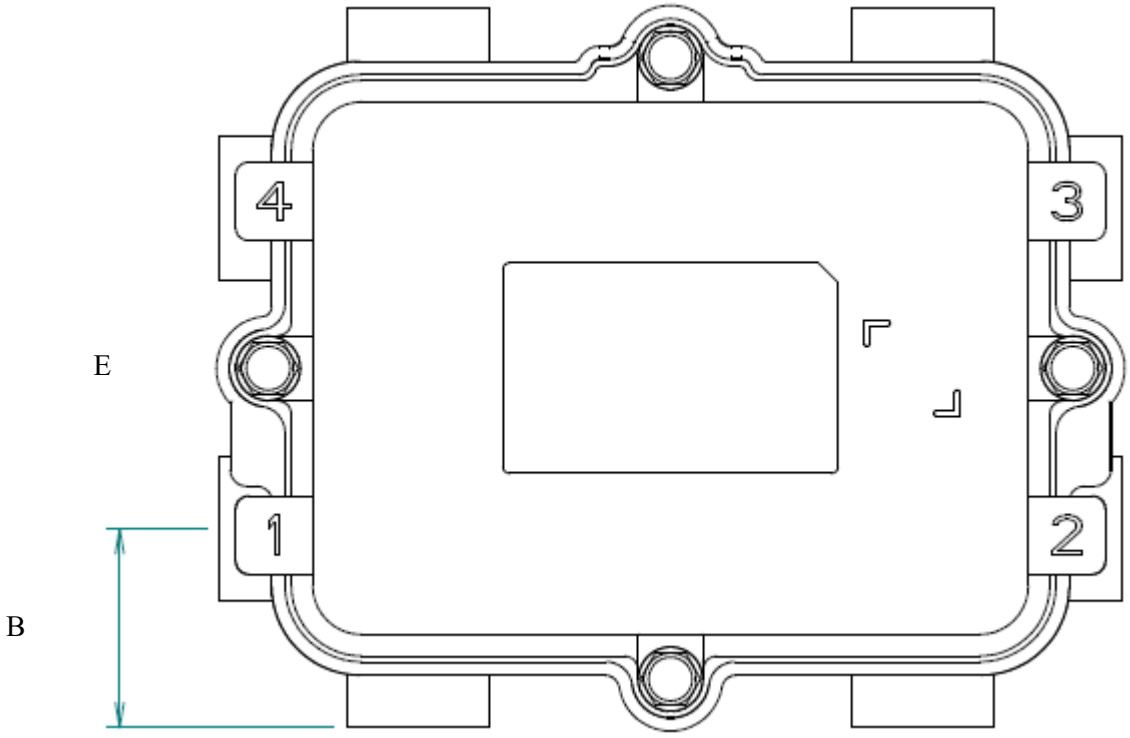

Figure 1 - Mechanical, Passive Front

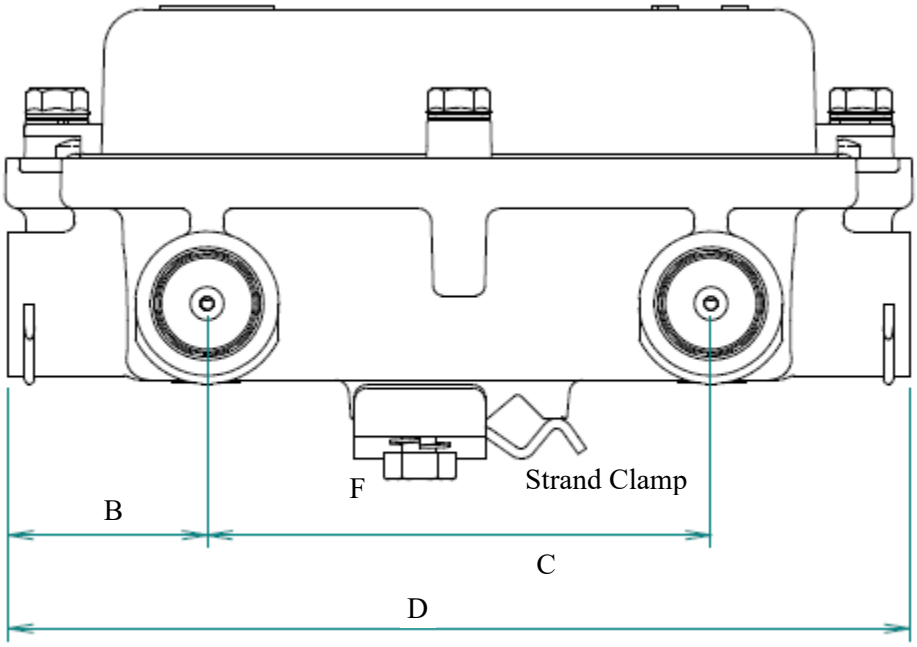

Figure 2 - Mechanical, Passive Bottom

Table 1 - Dimension Table

Description	DIM	mm		Inch		Notes
		MIN	MAX	MIN	MAX	
5/8-24 Entry Port – V/H Spacing	B	28.19	30.61	1.110	1.205	Tight tol.
Vertical 5/8-24 Port Spacing	C	76.07	85.60	2.995	3.370	
Overall Passive Width	D	132.72	144.60	5.225	5.693	Wide tol.
Faceplate Hex Bolt Size	E	5/16" hex				
Strand Mount Hex Bolt Size	F	3/8", 7/16", or ½"hex				
5/8-24 entry seizure screw (set screw)		*May* have none, hex head, phillips or both				
5/8-24 Hex Port Plug		3/8", 7/16", 1/2" hex nut				

7.5. Form Factor

The housing form factor ***shall*** have port orientations as shown in Figure 1. An exception to this is the line equalizer which *may* have a form factor as indicated in SCTE 264.

Device ***shall*** be designed to prevent harm to the internal connectors and components when a faceplate is being installed and removed. For passives that include a rotatable faceplate, the faceplate does not need to be keyed. Otherwise, the faceplate ***shall*** be keyed to prevent the faceplate from being installed in a direction that is not intended.

7.6. RF Ports

The passive ***shall*** be compliant with the physical dimensions for all 5/8-24 female RF and AC powering equipment ports as written in [SCTE 91] and [SCTE 92] .

The passive housing ***shall*** accept a male 5/8-24 connector as per [SCTE 92] with dimension 'D', Pin Length, in Table 1 to be 31.75-33.53 mm (1.25" – 1.32").

7.7. Plug-ins

Plug-in options *may* be made available for directivity changes or RF conditioning such as cable equalizers and cable simulators for tilt compensation.

7.8. Attachment Method To Strand & Pedestal

The mounting clamp *may* be located at the manufacturers preferred location provided that they meet the housing requirements herein. An ergonomic method for fastening the device to the strand or pedestal mounting system *may* be incorporated as long as it does not compromise the strand lashing wire or block access to ports or bond wire attachment. The strand mount clamp can also serve as the bond wire attachment. See Figure 2.

7.9. Labeling Designations

The passive housing ports ***shall*** be clearly labeled, and any stickers ***shall*** withstand exposure to extreme environmental conditions and be legible for a minimum of 25 years under typical handling.

Passive labels ***shall*** incorporate the RF dB value (where applicable), manufacturer's model number, date code and rated bandwidth of the device. All relevant safety marks shall be permanently affixed and located in an easily observable location.

Table 2 - Port Branding

Product Type	Faceplate Port Branding [1]
DCs	IN, OUT, TAP or [nominal DC loss as per part number, ex -12dB]
Power Inserter	AC, AC/RF x2
2 way splitter	IN, OUT x2
3 way splitter, balanced	IN, OUT x 3
3 way splitter, unbalanced	IN, [dB value] x 3 or IN, HIGH x2, LOW
Equalizer	IN, OUT

1) No requirement for housing port branding
2) Product *may* have an external QR code label, which *may* contain any of the following:
    a. Serial Number
    b. Part Number
    c. Manufacturer
    d. Date Code (any standard here, WWYY, YYWW,….)
    e. dB loss at some freq points
    f. Datasheet web link
    g. Amp rating
    h. Country of Origin

8. RF

8.1. RF Performance of Housing

The passive housing ***shall*** be fully specified to 3 GHz. The Insertion Loss between any two ports and return loss at all ports ***shall*** be measured in any combination of 5/8-24 ports with a 3 GHz bypass installed

The bypass is defined as any faceplate or internal housing mounted circuitry made by the device manufacturer that can conduct RF between ports. The intent is only to prove that the housing can support a future faceplate upgrade of 3 GHz.

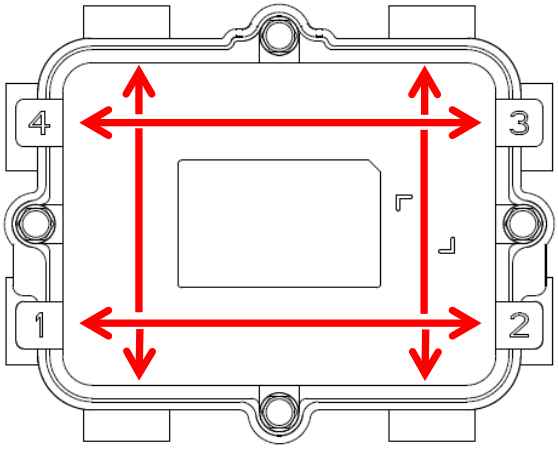

Figure 3 - Housing Bandwidth Test Diagram

8.2. RF Performance of Passive

RF performance for the device ***shall*** be fully specified to at least 1794 MHz, as measured installed in the 3 GHz housing. All RF performance ***shall*** meet manufacturers specifications in both horizontal and vertical configuration.

- The maximum and typical insertion loss
- The minimum return loss
- The minimum isolation
- AC/RF to AC port isolation for power inserters only

All measurements above ***shall*** be published with frequency points defined in Table 2 and in accordance to the procedures outlined in [SCTE 144] .

Table 3 - Frequency Points for Insertion Loss

Frequency (MHz)	Rationale for Frequency	Notes
5	lowest US	
10	alt. lowest US	
42	US end	sub-split
54	DS start	
65	US end	euro-split
88	DS start	
85	US end	mid-split
108	DS start	
204	US end	high-split
258	DS start	
300	US end	FDD D4.0 ultra high-split
372	DS start	
396	US end	FDD D4.0 ultra high-split
492	DS start	
492	US end	FDD D4.0 ultra high-split
606	DS start	
684	US end	FDD D4.0 ultra high-split
750	legacy DS comparison	
834	DS start	
870	legacy DS comparison	
1002	legacy DS comparison	
1026	OFDM ch start	DS Extended Spectrum
1218	OFDM ch end/start	
1410	OFDM ch end/start	
1602	OFDM ch end/start	
1794	OFDM ch end	

8.2.1. Passband Response

The passband response measured from the input port to any output port ***shall not*** exceed ±0.5 dB relative to the slope loss of the device.

8.2.2. Group Delay

The group delay is to be measured in accordance with [SCTE 45] .If a plug in option is available for RF conditioning, group delay ***shall*** be measured with a jumper installed. The group delay variation ***shall not*** exceed 5 ns over any 6 MHz span for frequencies between 12 MHz and 1794 MHz. The group delay variation ***shall not*** exceed 30 ns over any 1 MHz span for frequencies between 5 MHz and 12 MHz.

8.3. Hum Modulation

The maximum hum modulation ***shall*** be reported at the maximum rated current. All measurements ***shall*** be made in accordance to the procedures outlined in [SCTE 16] .

8.4. Shielding Effectiveness

The shielding effectiveness of components when measured in accordance with [SCTE 48-1] ***shall*** be defined in Table 4.

Table 4 - Shielding Effectiveness

Frequency (MHz)	Shielding Effectiveness (dB)
5 - 1002	≥ 120
1002 - 1218	≥ 110
1218 - 1794	≥ 100

8.5. Surge Withstand

The surge withstand of components when measured in accordance with [SCTE 81] ***shall*** be at minimum compliant with IEEE C62.41-1991 Category B3, Combination Wave 6 kV/3 kA (2 ohm) at all ports

All ports ***shall not*** suffer any physical or functional damage after exposure to surge testing.

8.6. Second Harmonic Distortion

The Second Harmonic Distortion of the device ***shall*** be reported relative to the injected signal of +60 dBmV at any RF coupled port when tested in accordance with [SCTE 145] . Second Harmonic Distortion Test ***shall*** be performed immediately after Surge Withstand Test in order to test for any Ferrite Magnetization detrimental effects.

8.7. Common Path Distortion

The common path distortion of the device ***shall*** be reported when tested in accordance with [SCTE 109] section 8.5 with signal sources at 1782 MHz and 1794 MHz and measured at room temperature only.

9. Environmental

9.1. Salt Spray

The device ***shall*** meet all performance requirements after a minimum of 1000 hours of salt spray when tested in accordance with [SCTE 143] . The device ***shall*** exhibit corrosion penetration of less than 50% metal thickness and show no evidence of internal damage. Any unused ports ***shall*** be appropriately sealed during testing to prevent saltwater compound entry.

9.2. Temperature

The device ***shall*** meet all performance requirements during and after temperature cycles ranging from -40 °C (-40 °F) to +60 °C (+140 °F) inclusive Outdoor Rated Devices with 95% relative humidity at both types of devices at the high temperature limit.

Temperature Cycles ***shall*** be at a minimum:

- 2 hours at the low limit
- 1 hour transition to high limit
- 2 hours at the high limit
- 1 hour transition to the low limit; repeat for 15 cycles

9.3. Galvanic Compatibility

The device manufacturer ***shall*** use the methodology within the Galvanic Compatibility section of [SCTE 129] to determine and report the anodic index for each metal to metal interface, inclusive of plating.

9.4. Ultraviolet B (UVB) Rays

All externally exposed components (e.g. coatings, plastics, labels, etc.) of the tap ***shall*** incorporate UV protection and ***shall not*** lose functional integrity after UV exposure per Telcordia GR-2873-CORE and ASTM G 154.

9.5. Pressure Testing

Devices with no additional sealant materials, such as tape, silicone, epoxy, etc. ***shall not*** produce air bubbles when submerged under 1 meter of water for 10 minutes and pressurized to 15 pounds per square inch (psi).

9.6. Vacuum Testing

Devices with no additional sealant materials, such as tape, silicone, epoxy, etc. ***shall*** show no presence of water inside the housing when submerged under 1 meter of water for 10 minutes with an internal vacuum of 30 inches of mercury (in-Hg).

9.7. Chemical Resistance

Labels ***shall*** remain legible after exposure to common cleaning chemicals, insecticides and pesticides.

9.8. Highly Accelerated Life-cycle Testing (HALT)

Devices ***shall*** be subjected to Highly Accelerated Life-cycle Testing (HALT) and test results provided to customer.

9.9. Restriction of Hazardous Substances (RoHS)

Devices ***shall*** be compliant with Restriction of Hazardous Substances (RoHS) directive.

9.10. Unboxed Drop Test

Devices ***shall*** operate normally and meet vendors specifications after exposure to a free fall drop onto a concrete surface at a drop height of 36 inches (91.44 cm).

9.11. Transportation Mechanical Vibration

Devices ***shall*** operate normally and meet vendors specifications after exposure to Transportation Mechanical Vibration per [SCTE 186]