SCTE® | STANDARDS

Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 264 2020

Broadband Radio Frequency Hardline Taps for Cable Systems

NOTICE

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1. Introduction

1.1. Executive Summary

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

1.2. Scope

The purpose of this document is to recommend mechanical, environmental and electrical standards for broadband radio frequency (RF) devices whose primary purpose is to divide signals presented to an input port among two or more output ports with a fixed division ratio that is nominally independent of frequency within the specified bandwidth limits of the device.

DOCSIS 4.0 specifications include operation at frequencies up to 1794 MHz. Many service providers would like to futureproof their networks for eventual operation up to 3000 MHz. This specification addresses tap faceplates capable of at least 1794 MHz, with a tap housing (base) capable of 3000 MHz.

Products covered by this specification include 2, 4, and 8-way taps.

The devices are intended for an outdoor rated environment.

1.3. Benefits

Signal splitting / combining devices are an integral component of a broadband network that provides a uniform method of interconnecting on hardline plant devices with minimal disruption in signal integrity.

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
- Taps with more than 8 ports
- 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

- [SCTE 81] ANSI/SCTE 81 2018 Surge Withstand Test Procedure
- [SCTE 129] ANSI/SCTE 129 2017 Drop Passives: Bonding Blocks (Without Surge protection)
- [SCTE 143] ANSI/SCTE 143 2018 Test Method for Salt Spray
- [SCTE 144] ANSI/SCTE 144 2017 Test Procedure for Transmission and Reflection

- [SCTE 48-1] ANSI/SCTE 48-1 2015 Test Method for Measuring Shielding Effectiveness of Passive and Active Devices Using a GTEM Cell
- [SCTE 145] ANSI/SCTE 145 2015 Test Method for Second Harmonic Distortion of Passives Using a Single Carrier
- [SCTE 16] ANSI/SCTE 16 2018 Test Procedure for Hum Modulation
- [SCTE 01] ANSI/SCTE 01 2015 Specification for “F” Port, Female, Outdoor
- [SCTE 91] ANSI/SCTE 91 2015 Specification for 5/8-24 RF & AC Equipment Port, Female
- [SCTE 92] ANSI/SCTE 92 2017 Specification for 5/8-24 Plug, (Male), Trunk & Distribution Connectors
- [SCTE 109] ANSI/SCTE 109 2016 Test Procedure for Common Path Distortion (CPD)
- [SCTE 186] ANSI/SCTE 186 2016 Product Environmental Requirements for Cable Telecommunications Facilities

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 and Definitions

5.1. Abbreviations

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

5.2. Definitions

faceplate	A tap 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 tap 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]

6. Mechanical

6.1. Connectivity Bypass Mechanism

With removal of the faceplate the tap housing ***shall*** support an uninterruptable make-before-break bypass connection with a frequency response to 3 GHz. The tap housing with the make-before-break bypass ***shall*** carry at least 15 amperes of through current. The tap housing with the make-before-break bypass ***shall*** provide a connection with < 7 millisecond AC voltage interruption in support of constant operations for any distributed access architecture (DAA) active devices in-line of tap. A cost savings option for a connector seizing mechanism capable of passing frequencies to 1794 MHz *may* be specified for operators planning lower than 3 GHz spectrum operation.

6.2. Power Pass Capability

The complete tap ***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 complete tap ***shall*** meet all manufacturer specifications at the rated minimum continuous current.

The faceplate ***shall*** have a minimum continuous current rating of at least 12 amperes.

The tap housing, connector interface, and make-before-break bypass mechanism ***shall*** have a minimum continuous current rating of at least 15 amperes.

6.3. Power Extracting Tap Port(s)

Power extracting taps provide AC power to one or more F-port connector(s) on the tap faceplate. The selected port(s) can be used to power Wi-Fi access point equipment, cameras, and other cable application equipment. Power extracting taps have similar RF functionality and performance as standard taps.

If a single F port ONLY supports power extraction, then it does not need to have a configuration jumper to disable AC. Such a port ***shall*** be clearly and permanently designated so it can be identified by field technician.

If a tap has multiple ports that can support power extraction, each port ***shall*** support a configuration jumper, but shipped with no more than one enabled. The external ports do not need to be differentiated as to which is enabled for power extraction. The technician *should* mark the powered port based on best practices of the operator.

A power extracting F port on the tap faceplate ***shall*** be able to pass a minimum of 2 amperes continuous of quasi-square wave AC, over the entire operating temperature range of the device.

Additional through line insertion loss is allowed for power extraction taps resulting from the power choke insertion loss.

Non-self-resettable fuse elements ***shall not*** be installed in default configuration of product to avoid the problem of nuisance blown fuses due to surges and other electrical disturbances.

6.4. Assembled Dimensions

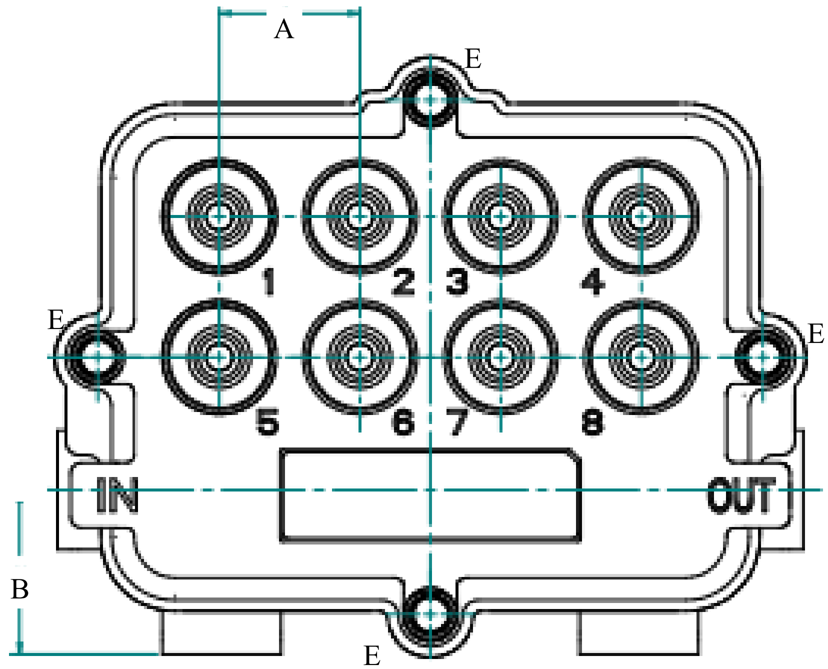

Figure 1 - Mechanical, Tap Front

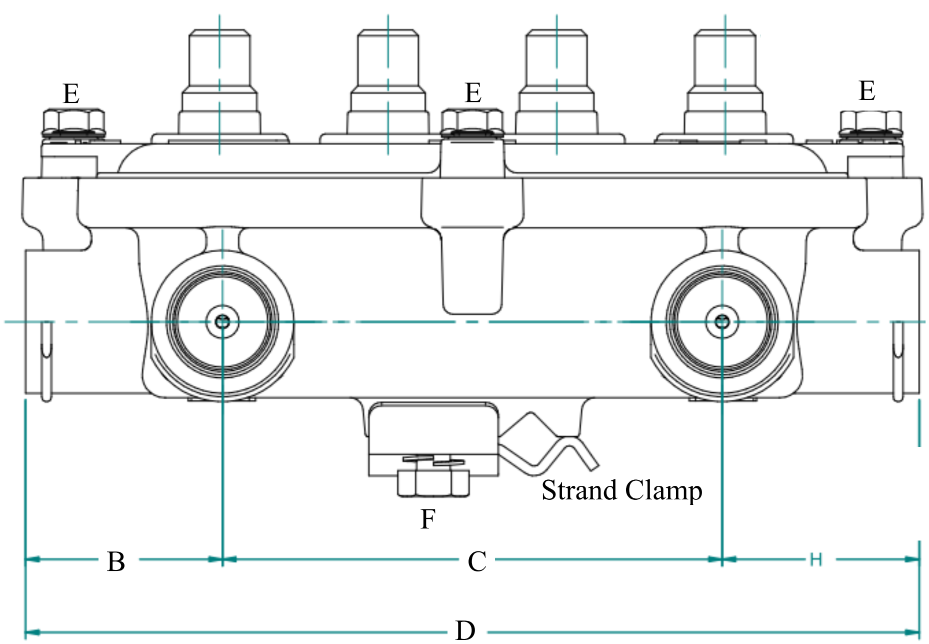

Figure 2 - Mechanical, Tap Bottom

Table 1 - Dimension Table

Description	DIM	mm		Inch		Notes
		MIN	MAX	MIN	MAX	
F Port Pitch	A	24.89	26.67	0.980	1.050	Wide tol.
KS Entry Port – V/H Spacing	B	28.19	30.61	1.110	1.205	Tight tol.
Vertical KS Port Spacing	C	76.07	85.60	2.995	3.370	
Overall Tap 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				
KS entry seizure screw (set screw)		May have none, hex head, or phillips				
KS Hex Port Plug		3/8”, 7/16”, 1/2” hex nut				

6.5. Form factor

The housing form factor ***shall*** have port orientations as shown in Figure 1.

The tap faceplate *may* allow for a signal direction change utilizing one of the following methods:

- Option 1: An internal plug-in reversible directional coupler.
- Option 2: Fixed direction tap faceplates available for left to right or right to left.

Ergonomic mechanical guides ***shall*** be incorporated to prevent harm to the internal connectors and components when a faceplate is being installed and removed. A keyed housing makes for repeatable faceplate changes by technicians in precarious positions.

6.6. RF Ports

The tap ***shall*** be compliant with the physical dimensions for all F ports as written in [SCTE 01].

The tap ***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 tap 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”).

6.7. Plug-ins

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

6.8. Attachment Method to Strand and Pedestal

The tap mounting clamp *may* be located at the manufacturers preferred location provided that they meet the tap housing requirements herein. An ergonomic method for fastening the tap 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.

6.9. Labeling Designations

The tap 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.

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

The function of each tap port ***shall*** be clear and understandable to include labeling of power passing ports. The product ***shall*** indicate downstream direction flow on the faceplate with either an arrow indicating RF direction flow or "IN" and "Out".

7. Electrical

7.1. RF Performance of Housing

The tap housing ***shall*** be fully specified to 3 GHz. The insertion loss from IN to OUT and return loss at IN and OUT ports ***shall*** be measured in four scenarios:

a) Horizontal KS entry ports, with no faceplate installed (make before break RF test)
b) Vertical KS entry ports, with no faceplate installed (make before break RF test)
c) Horizontal KS entry ports, with a 3 GHz bypass faceplate installed
d) Vertical KS entry ports, with a 3 GHz bypass faceplate installed

All measurements ***shall*** be made in accordance to the procedures outlined in [SCTE 144].

The bypass faceplate is defined as any faceplate made by the tap manufacturer that can conduct RF and AC power through the interconnect between housing and faceplate, and pass through a 75 ohm circuit to the opposite port. F ports do not need to be part of this test. The intent is only to prove that the housing can support a future faceplate upgrade of 3 GHz.

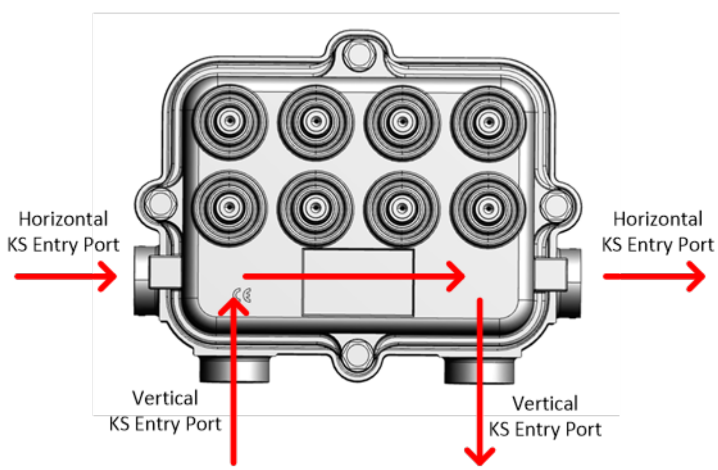

Figure 3 - Housing Bandwidth Test Diagram

7.2. RF Performance of Tap/Faceplate

RF performance for the complete tap with faceplate installed ***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 and tap loss ***shall*** be published with frequency points defined in Table 2. All measurements ***shall*** be made in accordance to the procedures outlined in [SCTE 144].

Table 2 - Frequency Points for Insertion Loss and Tap 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
372	DS start	ultra high-split
396	US end	FDD D4.0
492	DS start	ultra high-split
492	US end	FDD D4.0
588	DS start	ultra high-split
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	

7.2.1. Insertion Loss

The insertion loss is the measured forward transmission from the input port to the output port with all other RF ports terminated into 75 ohms. The maximum and typical insertion loss ***shall*** be specified at the frequency points listed in Table 2. The insertion loss specification is bi-directional.

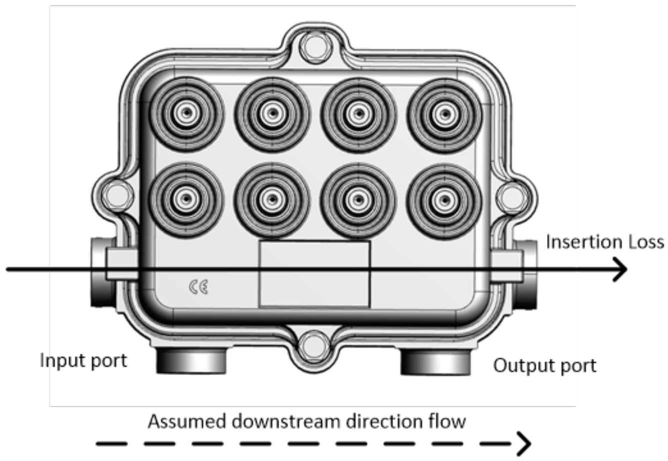

Figure 4 - Insertion Loss Diagram

7.2.2. Tap Loss

The tap loss is the measured forward transmission from the input port to tap ports with all other RF ports terminated into 75 ohms. The maximum and typical tap loss ***shall*** be specified. The maximum and typical tap loss ***shall*** be specified at the frequency points listed in Table 2. The tap loss specification is bi-directional.

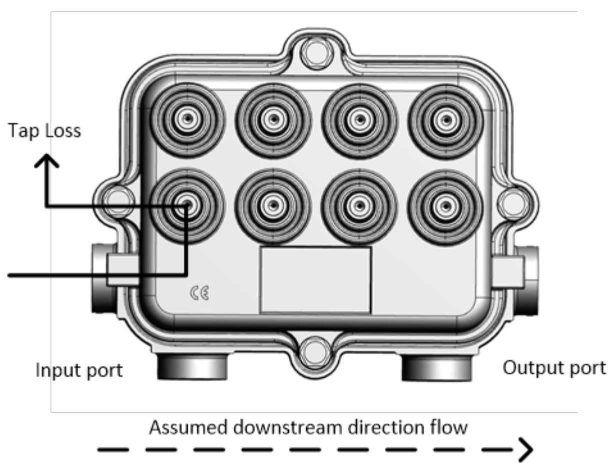

Figure 5 - Tap Loss Diagram

7.2.3. Return Loss

The return loss is the measured one port reflection with all other RF ports terminated into 75 ohms. The minimum return loss ***shall*** be specified for the input port, output port, and tap ports.

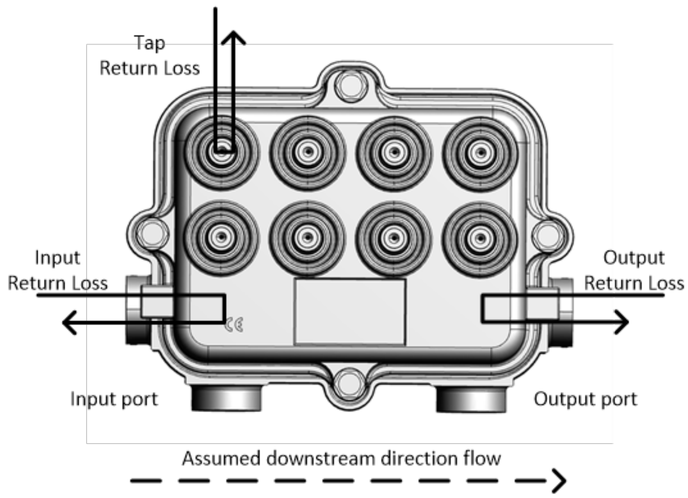

Figure 6 - Return Loss Diagram

7.2.4. Output to Tap Isolation

The output to tap isolation is the measured forward transmission from the output port to the tap port with all other RF ports terminated into 75 ohms. The minimum output to tap isolation ***shall*** be specified for any tap ports.

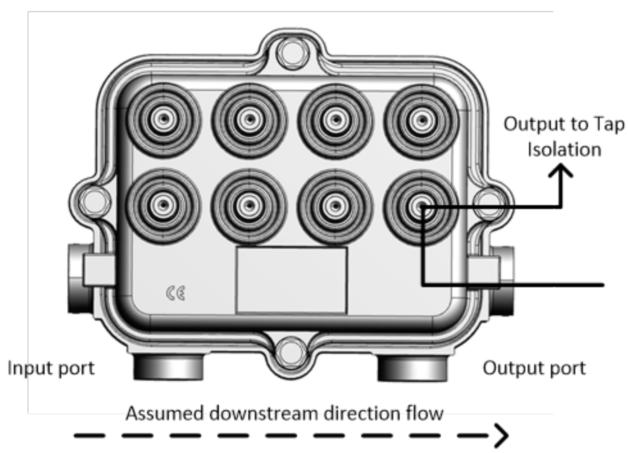

Figure 7 - Output to Tap Isolation Diagram

7.2.5. *Tap to Tap Isolation*

The tap to tap isolation is the measured forward transmission from one tap port to another tap port with all other RF ports terminated into 75 ohms. The minimum tap to tap isolation ***shall*** be specified for any tap port pair combinations.

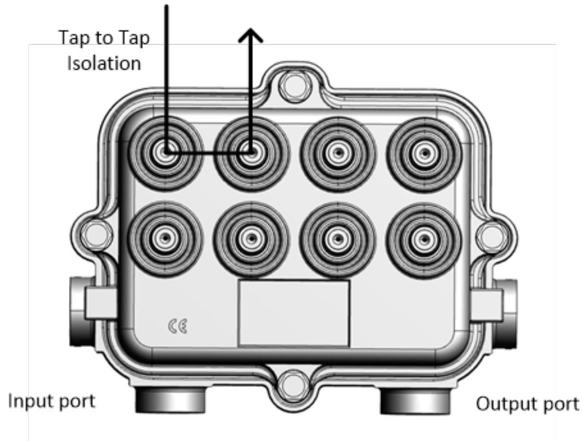

Figure 8 - Tap to Tap Isolation Diagram

7.2.6. *Passband Response*

The passband response measured from the input port to any output port ***shall not*** exceed ±0.5 dB relative to a best fit linear trend line of that response within the operating bandwidth of the device.

7.2.7. *Group Delay*

The group delay ***shall*** 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.

7.3. 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].

7.4. Shielding Effectiveness

The shielding effectiveness of components when measured in accordance with [SCTE 48-1] ***shall*** be defined in Table 3.

Table 3 - Shielding Effectiveness

Frequency (MHz)	Shielding Effectiveness (dB)
5 - 1002	$\geq$ 120
1002 - 1218	$\geq$ 110
1218 - 1794	$\geq$ 100

7.5. Surge Withstand

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

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

7.6. Second Harmonic Distortion at the Tap F Port

The second harmonic distortion of the device ***shall*** be reported relative to the injected signal of +60 dBmV at the F port when tested in accordance with [SCTE 145]. The second harmonic distortion test ***shall*** be performed immediately after the surge withstand test in section 7.5 of this standard in order to test for any ferrite magnetization detrimental effects.

7.7. 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.

8. Environmental

8.1. 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. All unused ports (F/KS) ***shall*** be appropriately sealed during testing to prevent saltwater compound entry via the ports.

8.2. Temperature

The device ***shall*** meet all performance requirements during and after temperature cycles ranging from -40 °C (-40 °F) to +60 °C (+140 °F).

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

8.3. 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.

8.4. 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 [GR-2873] and [ASTM G 154].

8.5. 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).

8.6. 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).

8.7. Chemical Resistance

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

8.8. Highly Accelerated Life Testing (HALT)

Devices ***shall*** be subjected to highly accelerated life testing (HALT) and test results provided to customer.

8.9. Restriction of Hazardous Substances (RoHS)

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

8.10. 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).

8.11. Transportation Mechanical Vibration

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