SCTE · ISBE
STANDARDS

Interface Practices Subcommittee

SCTE STANDARD

SCTE 125 2018

Hard Line Pin Connector Return Loss

NOTICE

Table of Contents

Title **Page Number**

List of Figures

Title **Page Number**

1. Introduction

1.1. Executive Summary

This test procedure applies as a method to measure the return loss of hard line pin connectors.

1.2. Scope

This document describes a procedure to measure the return loss characteristics of a single hard line pin Connector interfaced between hard line cable and a precision airline. It implements the time domain-gating features of the network analyzers, which removes the interfaces, and far end termination from the DUT (device under test) measurement.

1.3. Benefits

This test procedure provides a common method that can be used by both manufacturers and end users to test whether hard line pin connector models meet return loss specifications. Without such a common test procedure, the testing used to prove Hard Line Pin connector return loss performance can vary and lead to uncertainty as to whether the connector return loss specifications are being met.

1.4. Intended Audience

The intended audience for this test procedure are manufacturers, evaluation laboratories, and end user technician and engineers with the proper equipment to perform this testing.

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

At this time, there are no areas for further investigation for this test procedure.

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 15 2016 Specification for Trunk, Feeder and Distribution Coaxial Cable

2.2. Standards from Other Organizations

- No normative references are applicable.

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
dB	decibel
Div	division
DUT	device under test
GHz	gigahertz

Hz	hertz
MHz	megahertz
mU	milli units
ns	nanosecond
ps	picosecond
SCTE	Society of Cable Telecommunications Engineers
VNA	Vector Network Analyzer

5.2. Definitions

gating	Technique for selectively removing the response of a non-perfect connector from return loss measurements.
directivity	The figure of merit for how well a directional coupler separates forward and reverse waves. The greater the directivity of the device, the better the signal separation. System directivity is the vector sum of all leakage signals appearing at the analyzer receiver input. The error contributed by directivity is independent of the characteristics of the test device and it usually produces the major ambiguity in measurements of low reflection devices.
return loss	The ratio of incident signal to reflected signal, expressed in dB
network analyzer	An instrument for measuring the swept frequency response of a cable or cable/connector combination.

6. Equipment

- vector network analyzer (VNA), with time domain capability: Agilent 8753ES with options 010 (time domain) and 075 (75 ohm ports), Keysight E5061B with options 010 (time domain) and 237 (75 ohm ports) or equivalent.
- Type “N” 75-Ohm Calibration Kit; Agilent 85036B, or equivalent.
- Flexible Precision Test Cables; Type “N”, 75 ohm.
- 5/8-24 female to “N”male, precision adapter, return loss, ≥ 40 dB.
- Hard line cable that meets the requirements of ANSI/SCTE 15 2006, 75 ohm, length, 15 inches ±1/2 inch; cable size matches that of pin connector being tested.
- 5/8-24 female precision airline, return loss, ≥ 40 dB. See Airline Adapter Drawings in Section 8.0.
- 5/8-24 male to “N”male, precision adapter, return loss, ≥ 40 dB.

7. Set-Up

7.1. Vector Network Analyzer

- Allow equipment to warm up per manufacturer’s instructions.
- Preset
- IF bandwidth = 3000 Hz
- Dual Chan = ON; Split Display = ON
- FORMAT – CH 1 = Log Magnitude; CH 2 = Real
- START = 5 MHz; STOP = 3 GHz
- Number of Points = 801
- Set CH1 & CH2 to S11

- SYSTEM – Transform -Low Pass Step
- Set frequency Low Pass
- CH 1 –Transform = OFF; Gate Start = 4.671 ns; Gate Stop = 6.451 ns (actual settings depend on the length of input line)

(Note: Wait to turn gate on until after calibration is completed and the first connection made. This will let you see the frequency response of the open/short/load standards of the test set up without gating. Gating can make it difficult to tell if a standard is connected correctly during calibration).

- CH 2 –Transform, Low Pass Step, Transform = ON; START = 0 ns; STOP = 15 ns; Gate Shape = Normal
- Scale/Div – CH 1 = 10 dB; CH 2 = 5 mU

Install flexible precision test cable to port 1. See Figure 1

Perform an S11 – 1 PORT calibration at the end of the flexible cable with applicable test adapters included. Use OPEN, SHORT and the same LOAD to be used during the test. See Figure 1.

Figure 1 - Calibration

7.2. DUT Connections

Connect all interfaces required to adapt the near end of the hard line cable to the flexible cable connected to port 1, as shown in Figure 2.

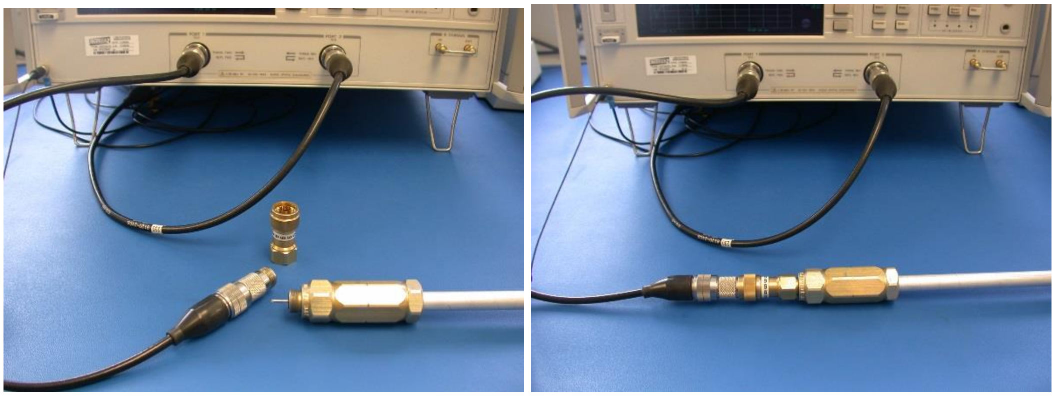


Figure 2 - Interface Calibration

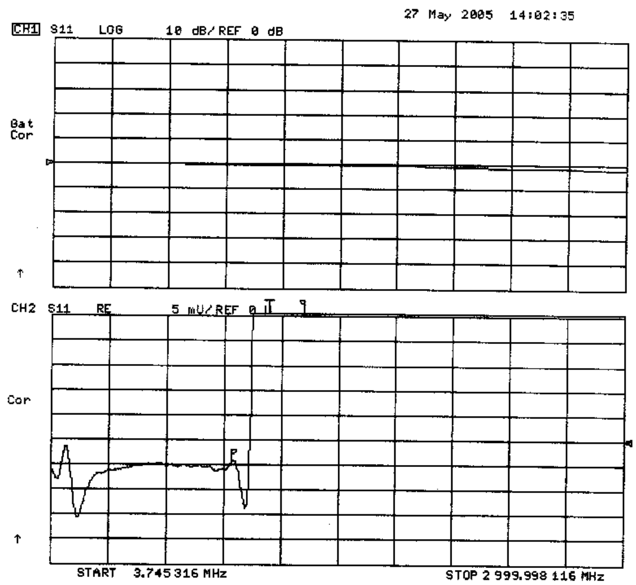


Figure 3 - Open End Gate

Looking at the time domain, observe the open at the far end of the hard line cable and adjust the display to make the gate approximately centered on it. Turn the channel 1 gating on: CH 1 –Transform = OFF; GATE = ON; as shown in Figure 3.

Connect the DUT to the far end of the hard line cable and connect the floating center conductor followed by the threaded outer conductor of the airline to the DUT. Then connect the center and outer conductors of the airline's other end to the 5/8 male to "N" male adapter as shown in Figure 4

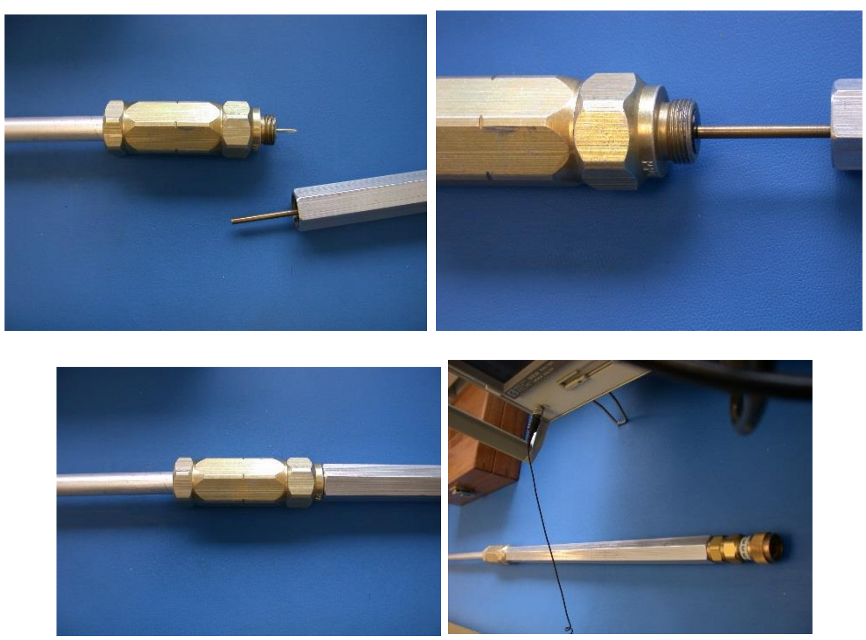


Figure 4 - Connect Precision Airline

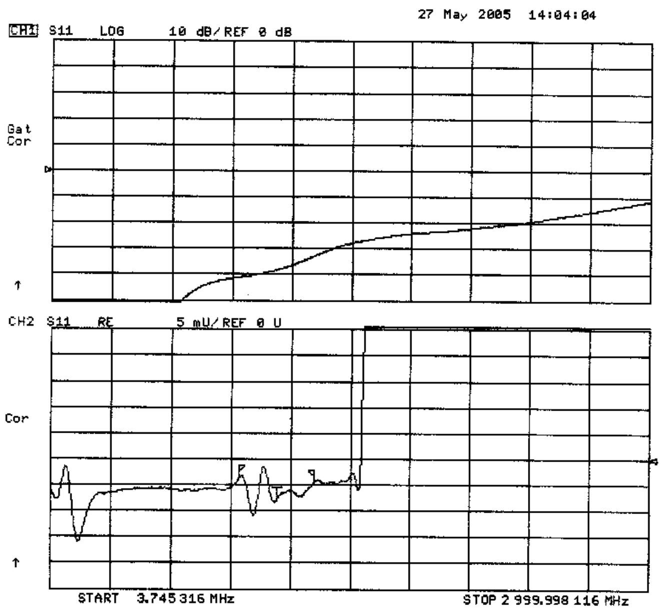


Figure 5 - Open End of Airline Adapter

Observe open now at the end of the last adapter as shown in Figure 5

Connect the same load that was used during calibration as shown in Figure 6

Figure 6 - Connect Load

8. Procedure

Adjust gate as needed to center on DUT, as a minimum; allow 2-3 time constants before and after the 1st gate flag and second gate flag. For these settings, a time constant is equal to approximately 300 ps; therefore leave about 0.6-0.9 ns after the first gate start flag, before the first indication of the connector, and 0.6-0.9 ns after the end of the connector indicator before the gate stop flag as shown in Figure 7.

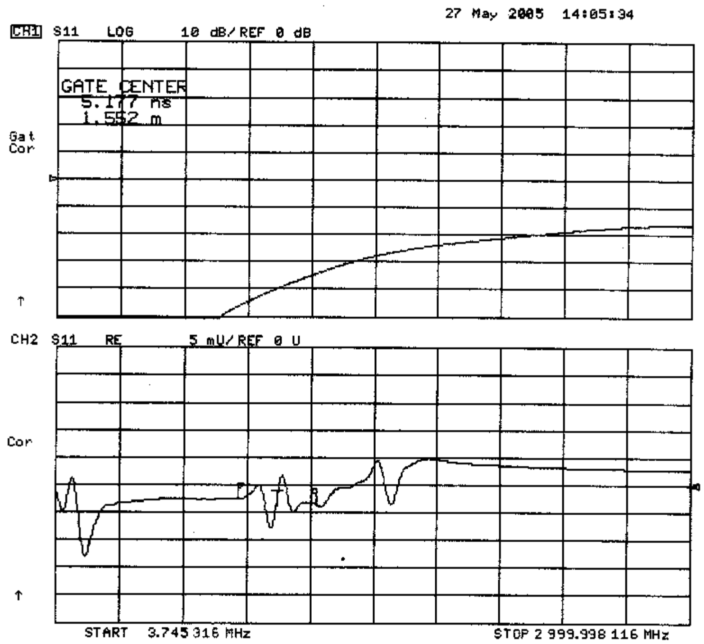


Figure 7 - Adjust Gate to Center DUT

Use markers on CH 1 to indicate frequency range of interest and to display worst case return loss within that range as shown in Figure 8.

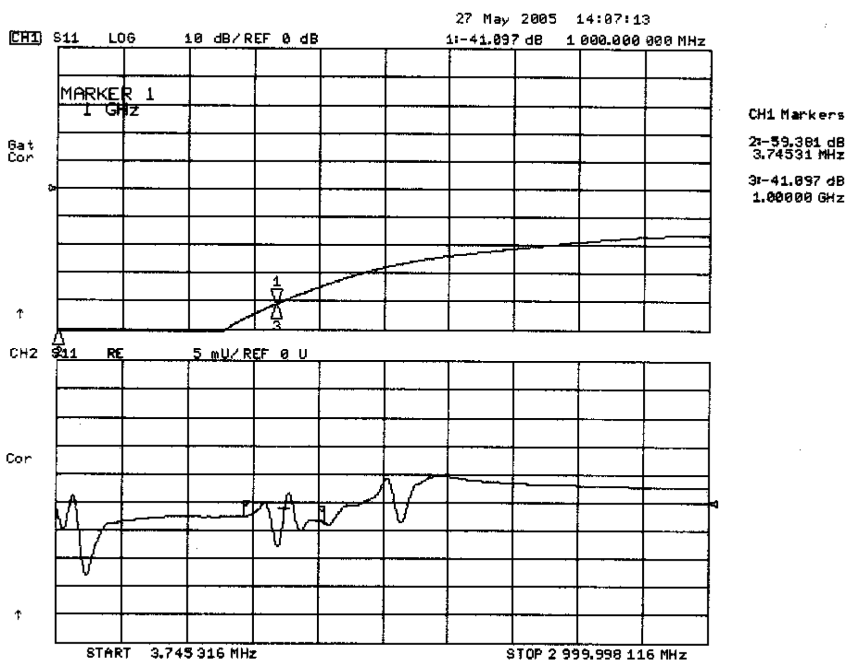


Figure 8 - Worst Case Return Loss

The impedance of the cable can be measured by placing markers on the cable in the time domain (CH 2). Then change the format from real to Smith chart, as shown in Figure 9.

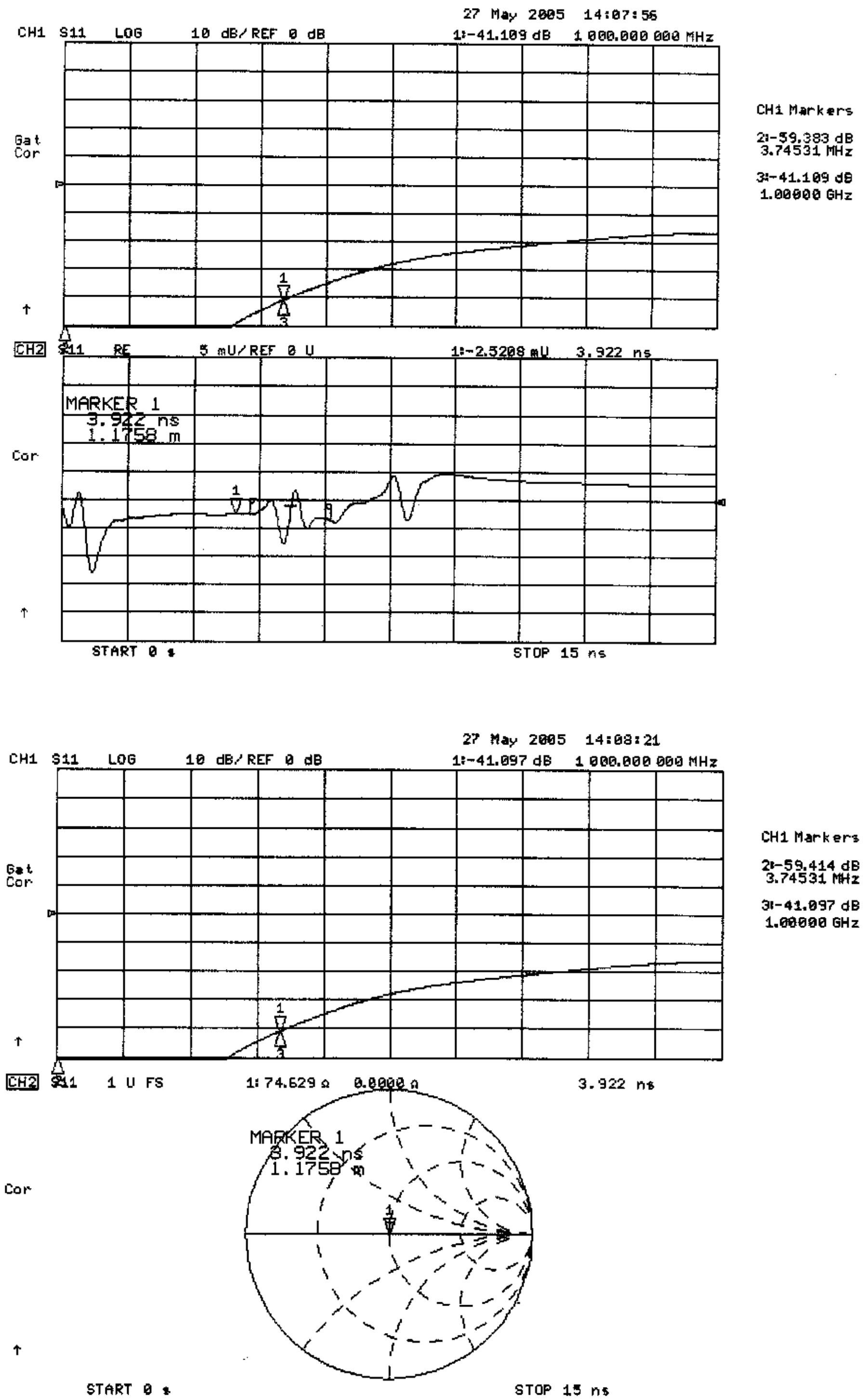


Figure 9 - Cable Impedance

9. Inspection

After a sweep has completed, use the markers to find the worst case (highest point) of the return loss. You may wish to put the analyzer into hold sweep mode.

Record the worst case return loss and frequency. Because the gating window includes all reflections from the test port to the test connector, there is no need to compensate for any gating signal loss.

10. Report

A typical report form should include the following information as a minimum:

Test technician:________________ Date of test:__________________

Connector:____________________ Cable:_______________________

Test start frequency:___________ Test stop frequency:___________

Worse case return loss:_________dB @ ___________MHz

11. Error Analysis

11.1 An uncertainty analysis reveals two sources of errors in the measurement. The first source of error is due to the slight amount of energy reflected from the input connection, which is gated out of the response. Since a small amount of energy is reflected, not all the input signal is transmitted to the connector under test. The error due to this term can be determined by taking from the return loss spec of the input connector (30 dB).

Error1=20•log(1-p) = -0.3 dB, where p = 10 –30/20 = 0.032

11.2 The second source of error is due to the impedance of the hard line cable connected to the connector under test. This cable becomes the reference impedance for the connector. If this cable is not exactly 75 ohms, the connector return loss will have some error in its measurement. This is an additive error, and the dB value depends upon the value of the connector being measured. Using the values from Figure 9 in section 4.3, the reflection error for each of the input and output cable is

$$\rho_{in} = \left|\frac{74.7-75}{74.7+75}\right| = 0.002, \quad \rho_{out} = \left|\frac{74.8-75}{74.8+75}\right| = 0.0013$$

This is added to the linear reflection coefficient of the connector: Return loss = 33 dB, linear reflection = 0.022. Upper error limit for the reflection coefficient is

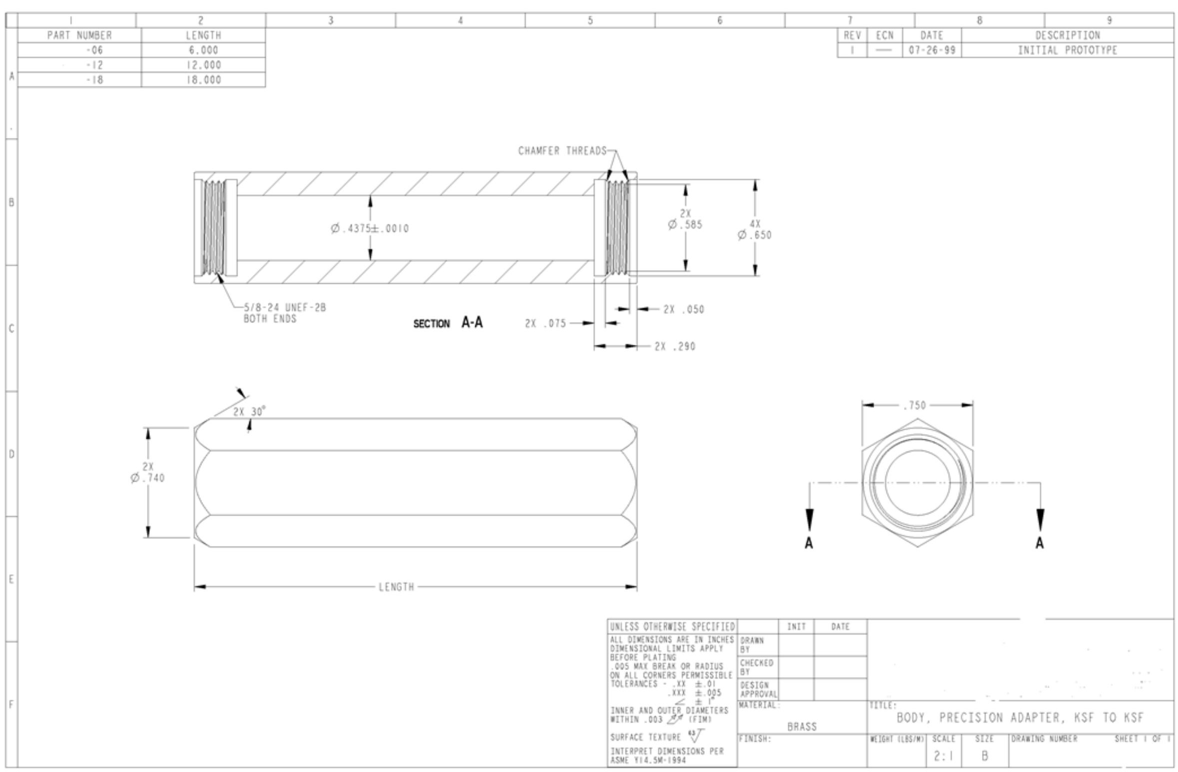
0.002+0.022+0.001= 0.025, or 32 dB return loss. To this add Error1 from above to get overall maximum of 31.7 dB.

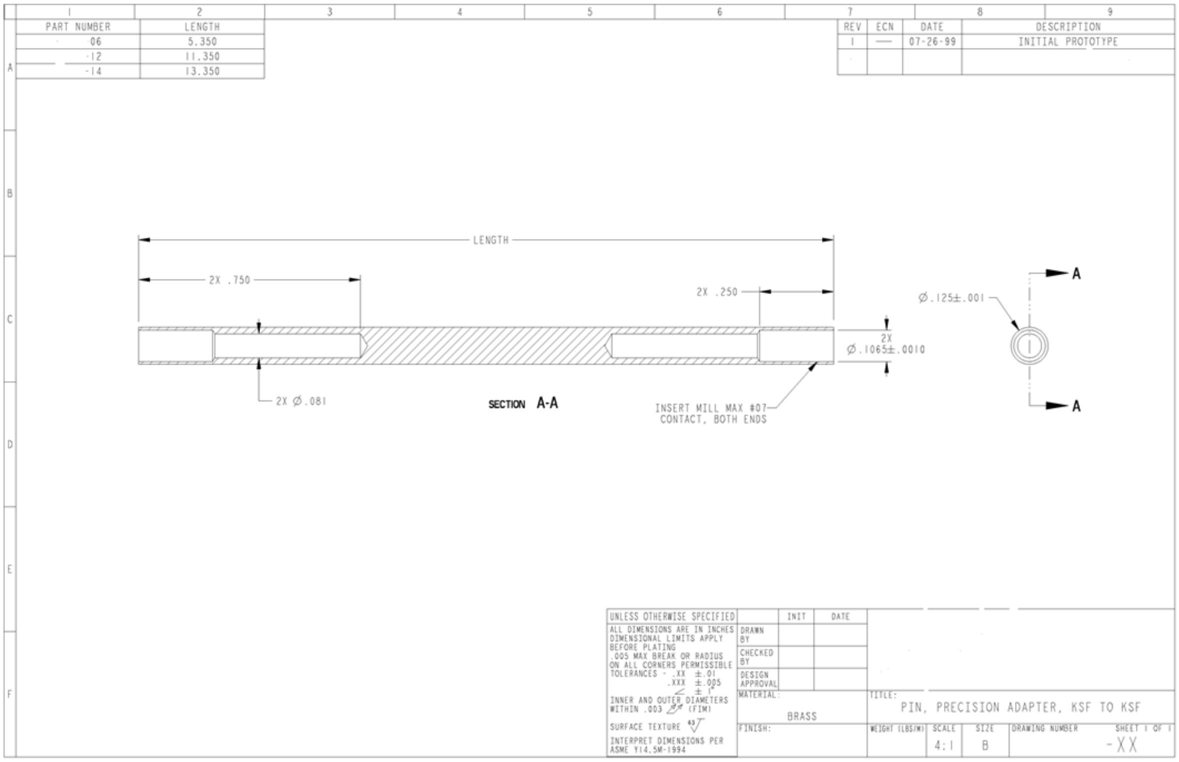
11.3 Reference Table: The table below gives maximum error limits for the case of using a 30 dB return loss input connector, and input and output cable impedance of 75 ohms ± 0.5 ohms.

Measured Return Loss	Upper limit maximum	Error Value
33 dB	30.4 dB	2.6 dB
36 dB	32.6 dB	3.4 dB
40 dB	35.3 dB	4.7 dB

12. Airline Adapter Drawings

Note: Due to various design elements of the interfaces, the user shall consider adjusting the physical length of the pin to accommodate the design.





PART NUMBER
LENGTH
-06
5.350
-12
11.350
-14
13.350
REV
ECN
DATE
DESCRIPTION
1
07-26-99
INITIAL PROTOTYPE
LENGTH
2X .750
2X .250
2X Ø.1065±.0010
Ø.125±.001
2X Ø.081
SECTION A-A
INSERT MILL MAX #07 CONTACT, BOTH ENDS
A
UNLESS OTHERWISE SPECIFIED
ALL DIMENSIONS ARE IN INCHES
DIMENSIONAL LIMITS APPLY BEFORE PLATING
.005 MAX BREAK OR RADIUS ON ALL CORNERS PERMISSIBLE
TOLERANCES - .XX ±.01
.XXX ±.005
INNER AND OUTER DIAMETERS WITHIN .003 (FIM)
SURFACE TEXTURE 63
INTERPRET DIMENSIONS PER ASME Y14.5M-1994
INIT
DATE
DRAWN BY
CHECKED BY
DESIGN APPROVAL
MATERIAL:
BRASS
FINISH:
TITLE:
PIN, PRECISION ADAPTER, KSF TO KSF
WEIGHT (LBS/M)
SCALE
4:1
SIZE
B
DRAWING NUMBER
-XX
SHEET 1 OF 1