SCTE · ISBE

STANDARDS

Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

ANSI/SCTE 101 2019

Hard Line Splice Connector Return Loss

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1. Introduction

1.1. Executive Summary

Gated Return Loss Test Method for Hard Line connector Splice.

1.2. Scope

This document describes a procedure to measure the Return Loss characteristics of a single Hard Line Splice Connector interfaced between (2) Hard Line cables. 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.

This document is intended for testing to 1002 MHz, but extended frequencies up to 1218 MHz, and 1794 MHz are optional.

All requirements of this document are measured after installation per manufactures instructions of the cable into the connector.

1.3. Benefits

This test method is necessary to provide manufacturers and users of this product a test method from which to gauge design performance.
It's useful for cable and equipment manufacturers to ensure proper mating with varied connector manufactured designs. This specification provides confidence to end users that designs which meet these minimum criteria will perform properly in their systems.

1.4. Intended Audience

This document is intended for manufacturers and end users of this product, and products to which this connector type is intended to be used.

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

- None

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.
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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

bps	bits per second
dB	decibel

DUT	device under test
ISBE	International Society of Broadband Experts
MHz	megahertz
GHz	gigahertz
SCTE	Society of Cable Telecommunications Engineers

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 coupler separates forward and reverse waves is directivity. 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 a cable/connector combination

6. EQUIPMENT

- Vector Network Analyzer (VNA), with Time Domain capability: such as Agilent8753S with option –010 (time domain), 075 (75 ohm) and S-Parameter built in or external, or equivalent.
- Type “N” 75-Ohm Calibration Kit; such as Agilent-85036B, or equivalent.
- Flexible Precision Test Cable; such as Agilent-85039-60013, or equivalent.
- (2ea) 5/8-24 to “N” Precision Adapter, Return Loss, ≥ 30 dB
- (2ea) Hard Line SP100 cable, 75 ohm, length, 15 inches ±1/2 inch; cable size matches that of splice connector being tested.
- (2ea) Hard Line Pin Connectors, Return Loss, ≥ 30 dB, cable size matches that of splice connector being tested.

7. SET-UP

7.1. Vector Network Analyzer

1. Allow equipment to warm up per manufacturer’s instructions.
    - Preset
    - IF Band Width = 3000 Hz
    - SYSTEM – Transform -Low Pass Step
    - Set frequency Low Pass
    - 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
    - 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

1. Install flexible precision test cable to port 1.
2. 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.

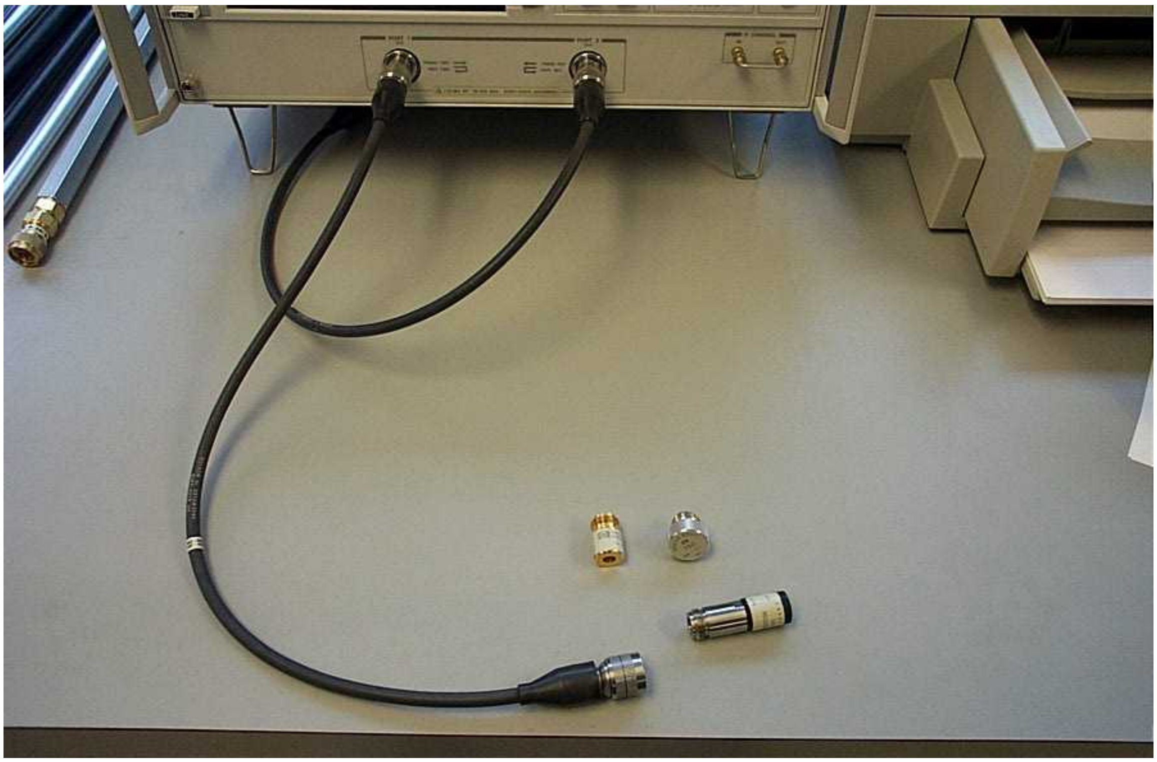

Figure 1 - Calibration Set up

7.2. DUT Connections

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

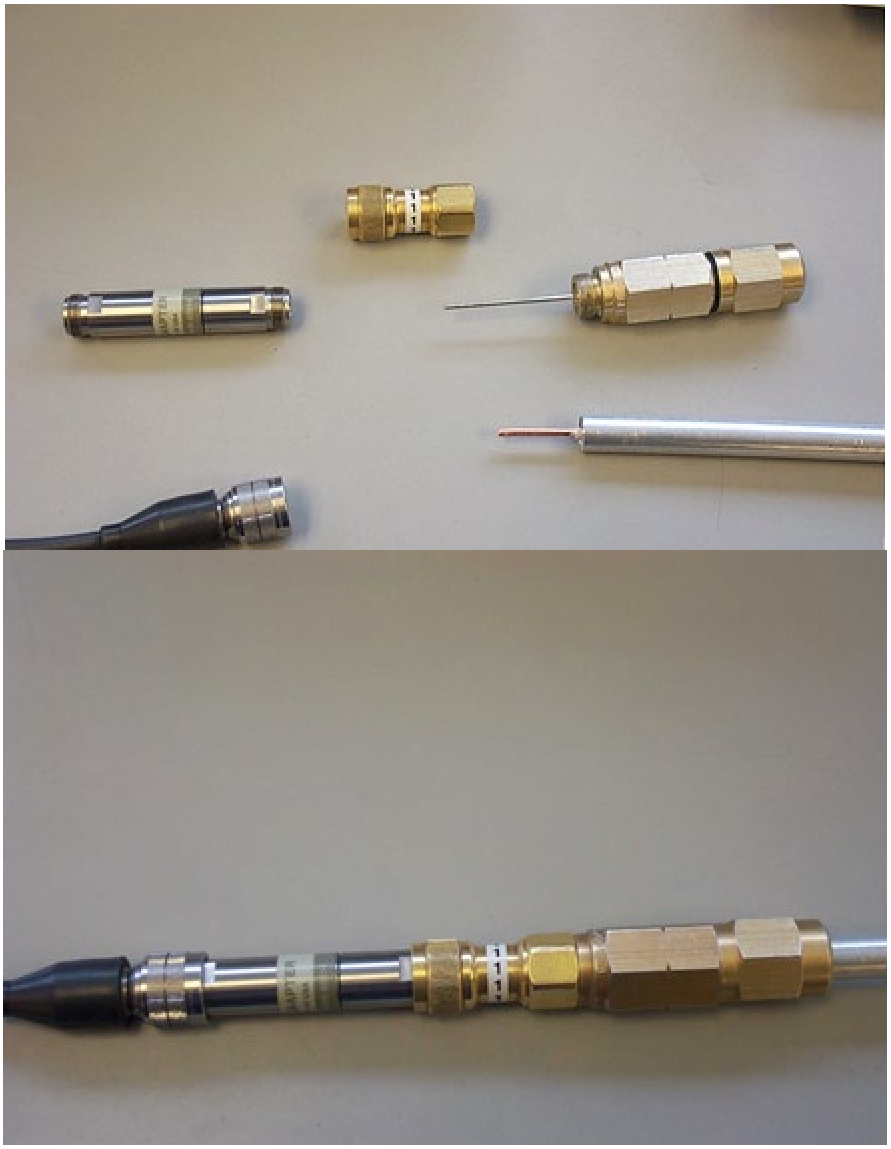

Figure 2 - Calibrate Interfaces

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.

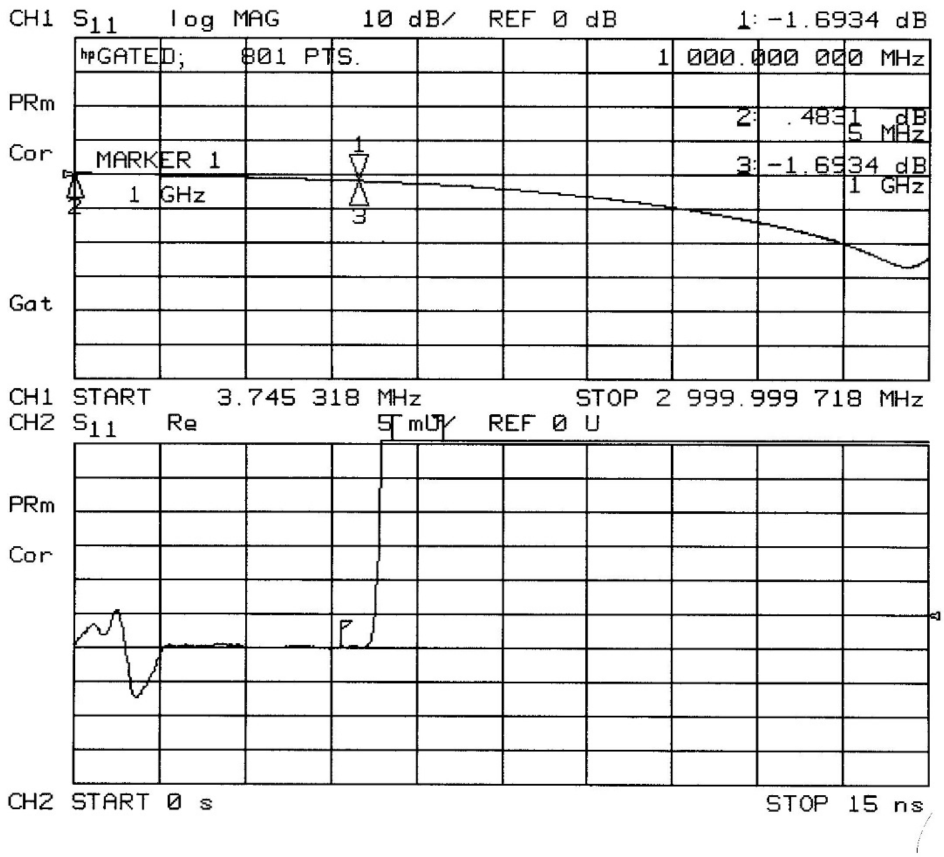

Figure 3 - Open End Gate Adjust

Connect the DUT to the far end of the first Hard Line cable and connect the second Hard Line cable to the far end of the DUT as shown in Figure 4.

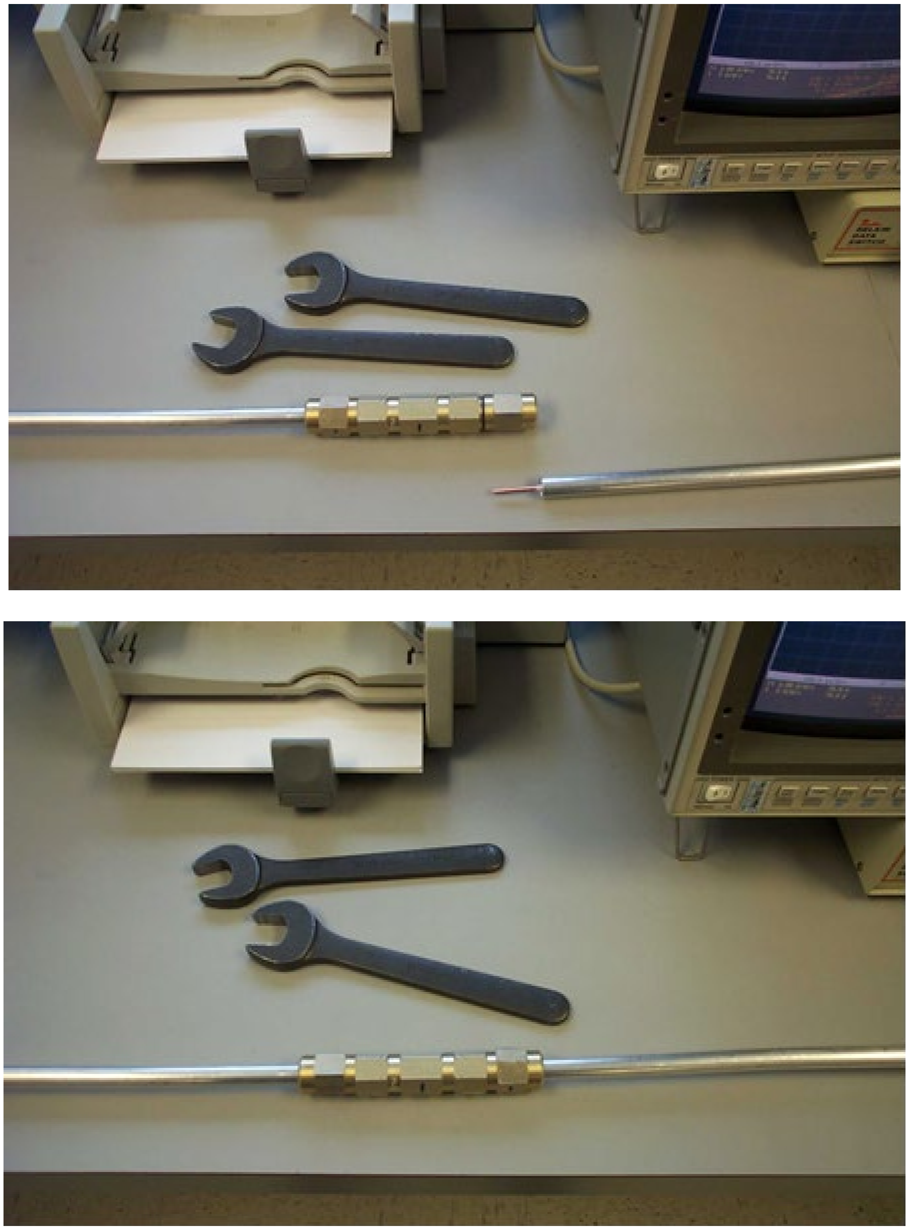

Figure 4 - Connect DUT

Observe open now at the end of the second Hard Line cable as shown in Figure 5.

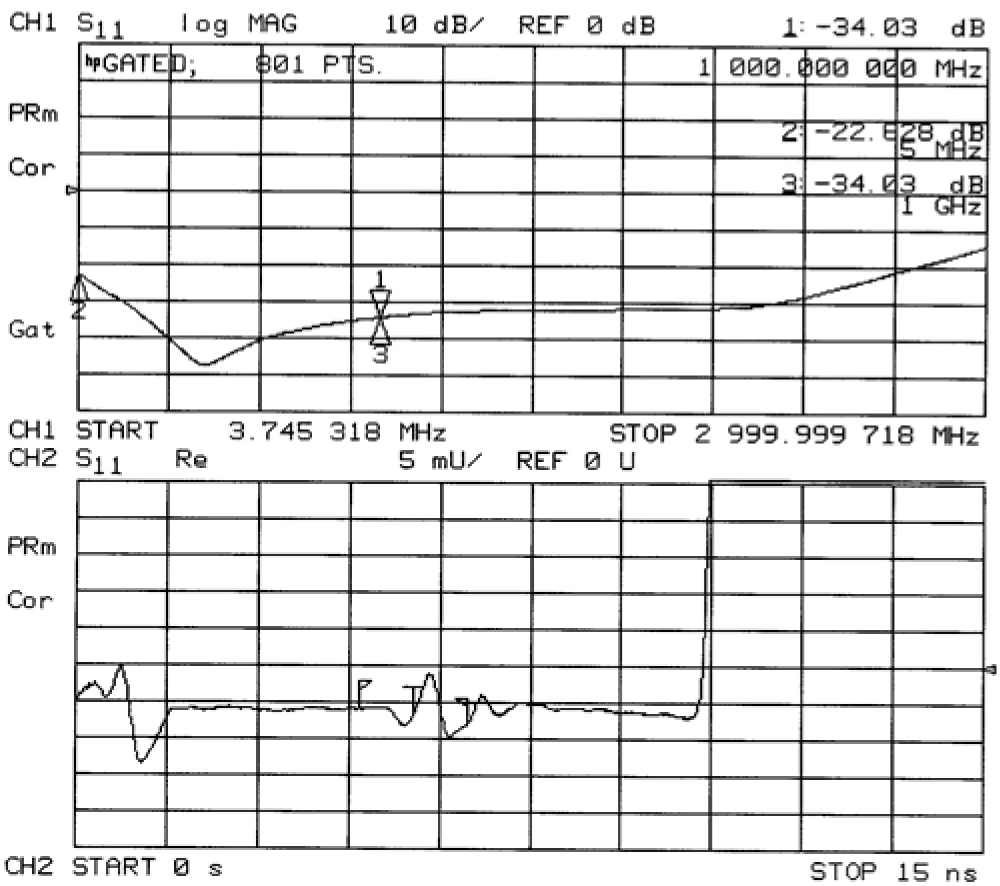

Figure 5 - Observe Open End

Connect all interfaces required to adapt the far end of the second Hard Line cable to the same load that was used during calibration as shown in Figure 6.

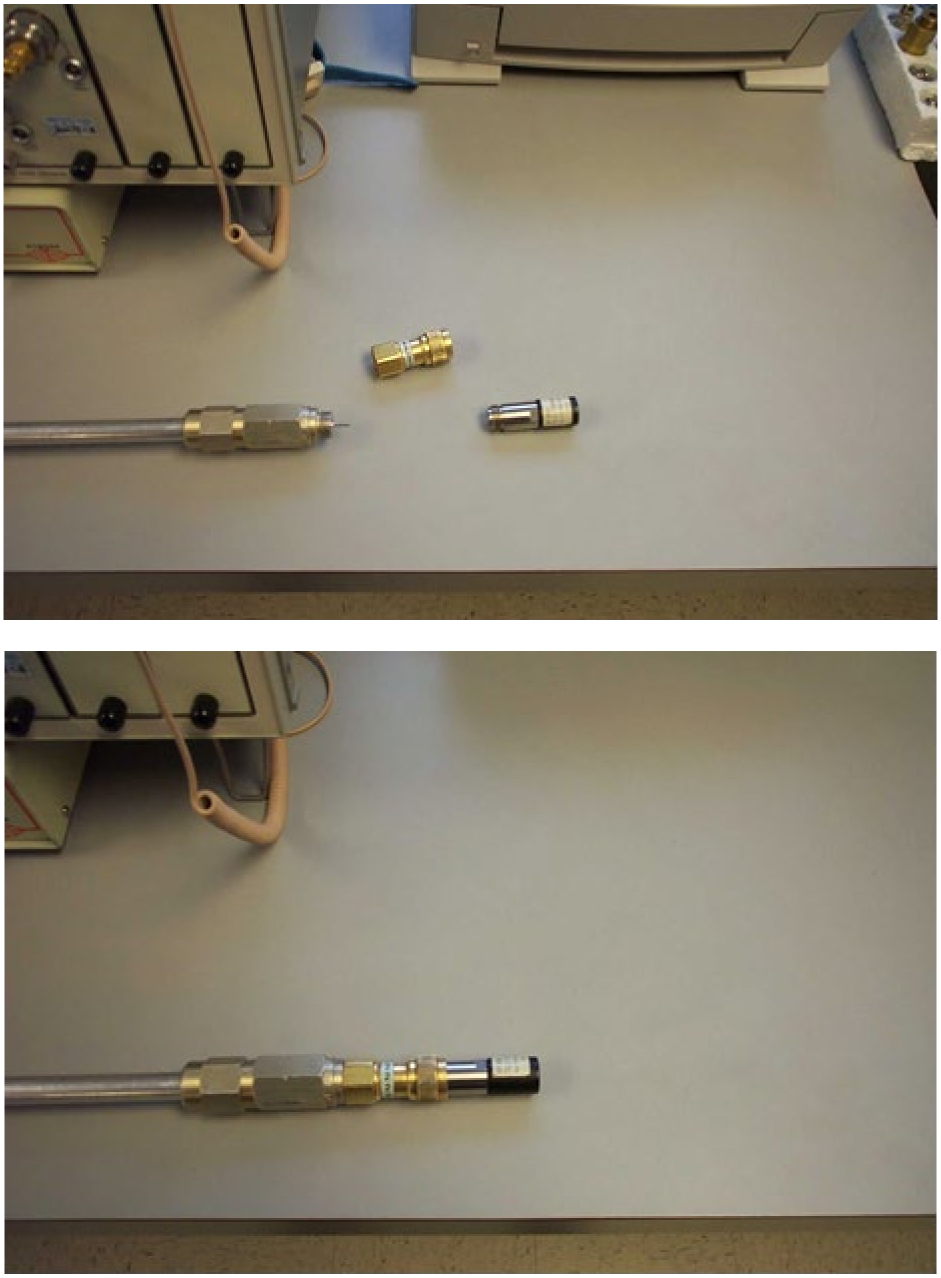

Figure 6 - Connect Interfaces and Load

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 nsec after the first gate start flag, before the first indication of the connector, and 0.6-0.9 nsec after the end of the connector indicator before the gate stop flag as shown in Figure 7.

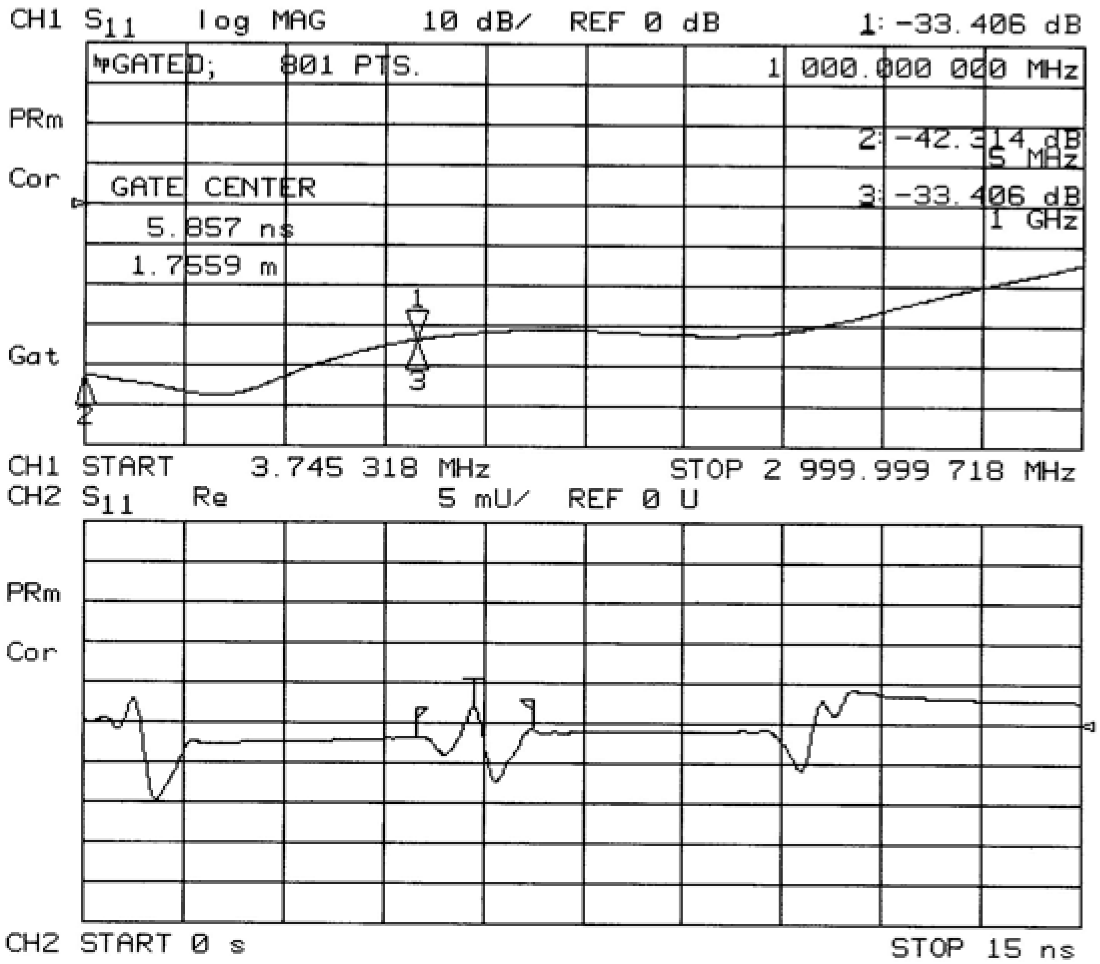

Figure 7 - Adjust Gate to center

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.

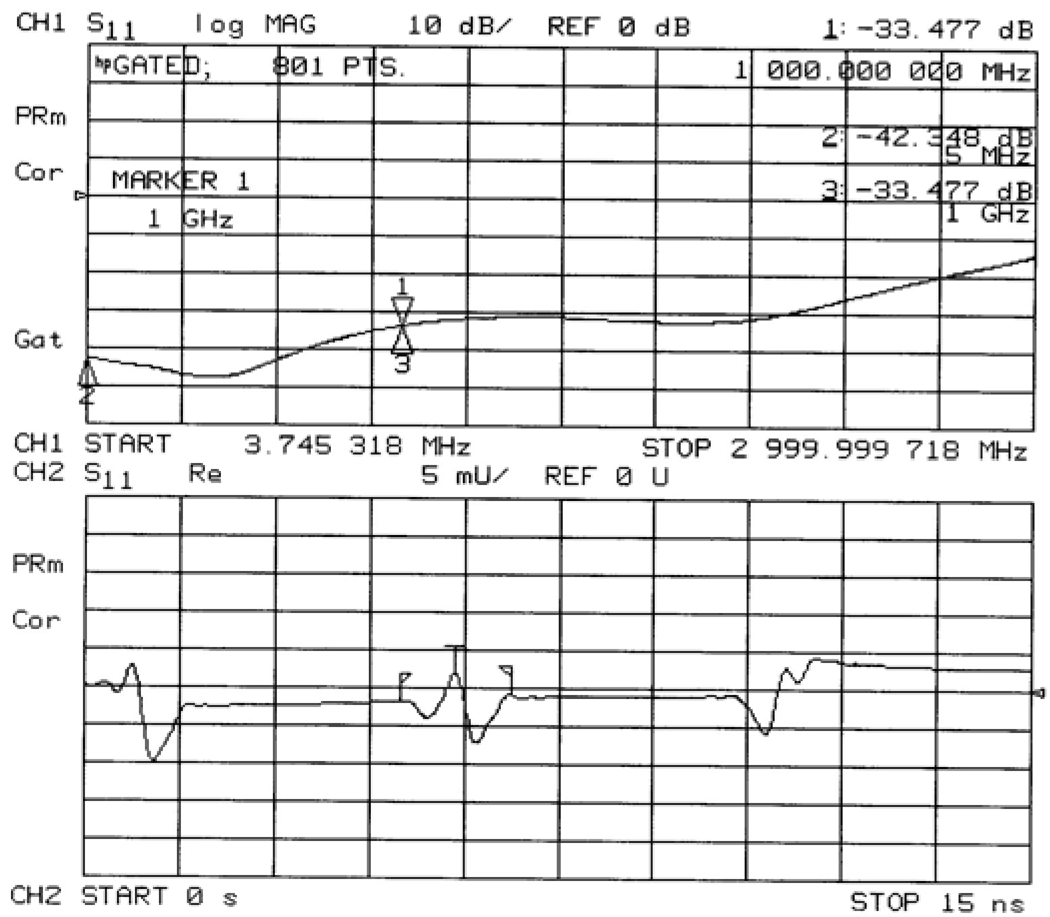

Figure 8 - Worst Case SRL

The impedance of the cable can be measured by placing markers on the cable in the time domain (CH 2), as shown in Figure 9.

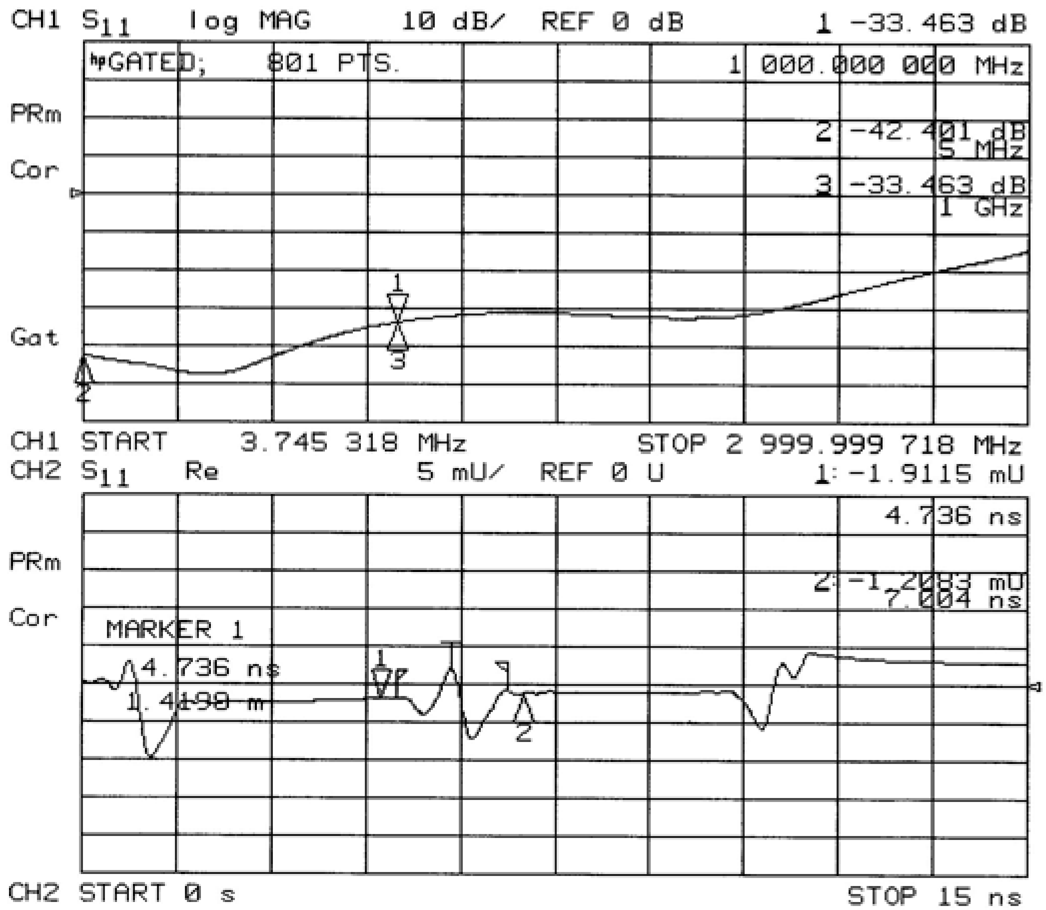

Figure 9 - Marker placement

Then change the format from real to smith chart, as shown in Figure 10.

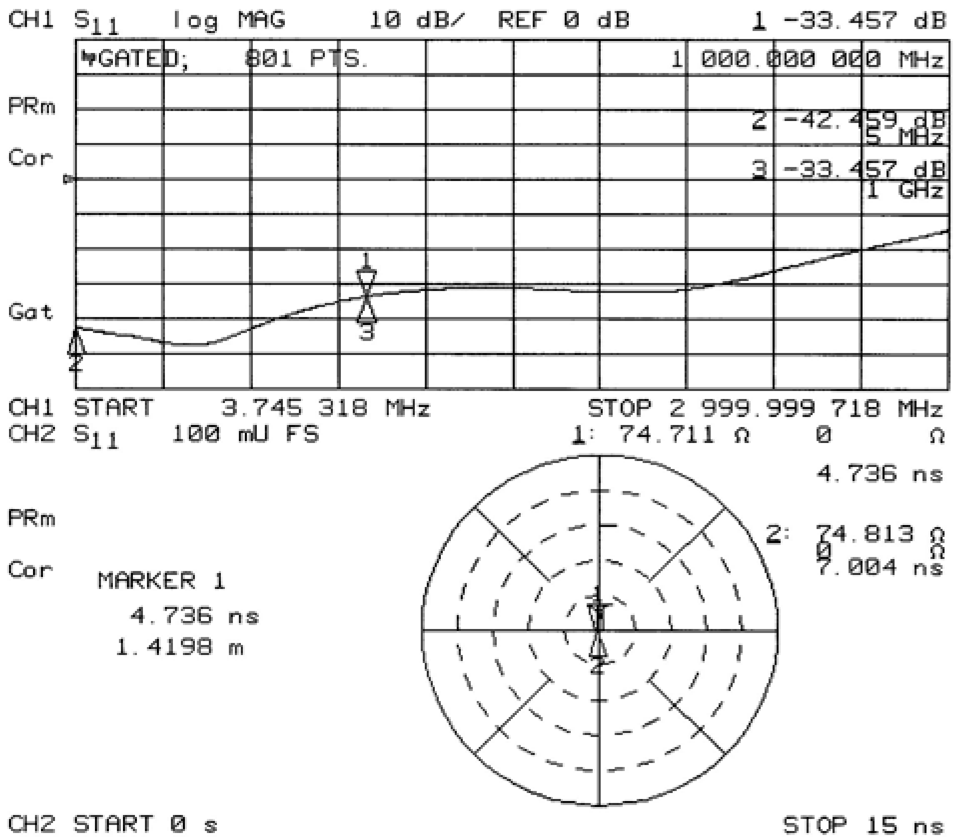

Figure 10 - Cable Impedance

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

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) = -0.3dB, where p = 10 –30/20 = 0.032

The second source of error is due to the impedance of the 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 8, the reflection error for each of the input and output cable is

$$\rho_{in} = \left|\frac{74.7-75}{74.7+75}\right| = .002, \quad \rho_{out} = \left|\frac{74.8-75}{74.8+75}\right| = .0013$$

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.

Examples: 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

Table 1 - Table Name Needed

Measured Return Loss	Upper limit maximum	Error Value
30 dB	28 dB	2 dB
33 dB	30.4 dB	2.6 dB
36 dB	32.6 dB	3.4 dB
40 dB	35.3 dB	4.7 dB