SCTE® | STANDARDS

Interface Practices Subcommittee

AMERICAN NATIONAL STANDARD

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Test Method for “F” Connector Return Loss

NOTICE

Document Types and Tags

Document Type: Specification

Document Tags:

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

Document Release History

Release	Date
SCTE 04 1997	*3/11/1998*
SCTE 04 2007	*7/06/2007*
SCTE 04 2014	*3/17/2014*

Note: Standards that are released multiple times in the same year use: a, b, c, etc. to indicate normative balloted updates and/or r1, r2, r3, etc. to indicate editorial changes to a released document after the year.

Table of Contents

Title **Page Number**

List of Figures

Title **Page Number**

1. Introduction

1.1. Executive Summary

The purpose of this document is to provide instructions to measure the return loss characteristics of a single type "F" connector-to-cable interface, at the beginning of a cable, from 5 MHz to 3000 MHz.

1.2. Scope

The purpose of this document is to provide a test method for measuring return loss of “F” male connectors with cable in the frequency range of 5 MHz to 3000 MHz by utilizing the time domain-gating feature of the network analyzer. Male “F” connectors that conform to SCTE 123, Specification for “F” Connector, Male, Feed-Through or SCTE 124, Specification for “F” Connector, Male, Pin Type that are used with 75 ohm flexible RF coaxial cable, such as, but not limited to, SCTE 74, Specification for Braided 75 ohm Flexible RF Coaxial Drop Cable.

1.3. Benefits

Devices which have a poor return loss and voltage standing wave ration (VSWR) result in loss of signal power or degradation of signal information

Return loss is a way to characterize impedance mismatches. There are two major causes of return loss degradation in a network: discontinuities and impedance mismatches. Discontinuities occur at connections where cable is terminated to plugs or jacks and within the plug/jack connection itself. A discontinuity can also occur if a cable is bent too much, kinked or otherwise damaged.

Components need to have acceptable return loss in order to assure proper network operation.

1.4. Intended Audience

The intended audience for this document is for development/design engineers, technical operations and installers.

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. 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

No normative references are applicable.

2.2. Standards from Other Organizations

No normative references are applicable.

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 74] ANSI/SCTE 74 2021, Specification for 75 ohm Braided Flexible RF Coaxial Drop Cable

[SCTE 123] ANSI/SCTE 123 2021, Specification for "F" Connector, Male, Feed-Through

[SCTE 124] ANSI/SCTE 124 2021, Specification for “F” Connector, Male, Pin Type

3.2. Standards from Other Organizations

No informative references are applicable.

3.3. Other Published Materials

[Broadband] https://broadbandlibrary.com/return-loss/

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 weighed 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*” indicate a course of action permissible within the limits of the document.
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

SCTE	Society of Cable Telecommunications Engineers
VNA	vector network analyzer
VSWR	voltage standing wave ratio

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.

gating	Technique used for selectively isolating the response of a connector for 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 used for measuring the swept frequency response of a cable or cable/connector combination

6. Background

Media impedance is measured by return loss. Return loss is the ratio, in decibels, of the incident signal to the reflected signal. This ratio should be as high as possible. When more signal is reflected, less signal is delivered to the load. Signal reflection is due to the discontinuity of the transmission line.

The reflection coefficient, S_{11}, is similar to return loss and is defined as the ratio of reflected voltage $E_{Reflected}$ to incident voltage $E_{Incident}$ as measured at port 1 of a network or device. When the reflected voltage is less than the incident voltage, S_{11} will be a ratio less than one. Thus, in dB terms, S_{11} will be represented by a negative number.

If S_{11}=0 dB, then all the power is reflected from the device and nothing is transmitted.

It important to note that return loss is the inverse of S_{11}. Many models of test equipment display results as a log magnitude (dB) representation of S_{11}. Thus, good performance is indicated by large negative numbers. Since return “loss” is the inverse of S_{11} and is designed to show the “loss” of energy between the incident and reflected signals, good performance is indicated by large positive numbers.

Return loss is related to S_{11} by the following equation:

$$Return\ Loss = -20 \times \log_{10}|(S_{11})| \qquad (1)$$

In this procedure, the S_{11} trace displayed on the test equipment will be called “return loss,” even though it technically is a log magnitude display of S_{11}, which is the inverse of return loss.

7. Equipment

1. RF vector network analyzer (VNA) with the following minimum features[1]:
    a. Minimum RF frequency range of 300 kHz to 3 GHz
    b. 75 ohm impedance
    c. Dynamic range at least 10 dB better than the required perforamance
    d. Integrated S-parameter test set
    e. Time domain capability
2. Type “F” 75 ohm calibration kit with minimum RF frequency range of 300 kHz to 3 GHz[2]:
3. Flexible precision test cable(s) with minimum RF frequency range of 300 kHz to 3 GHz[3]:
4. Precision type “F” termination with minimum RF frequency range of 300 kHz to 3 GHz [4]:
5. Flexible RF coaxial cable and “F” male connectors as required

Figure 1 illustrates a typical test set up.

8. Test Samples

8.1. The connector to be tested shall be installed on the near end of a 10’ ± 0.25” length of cable. The connector and cable shall be installed per manufacturer’s instructions.

8.2. The far end of the cable shall be terminated in a precision 75 ohm load. A second connector may be installed at the far end to allow proper termination.

8.3. Before performing the tests, visually inspect the cable and connectors to insure that there are no problems such as cracks, punctures, bruises, dents, or poor contacts which could affect the accuracy of the test.

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[1] Devices that may be compliant include Keysight ENA Series with time domain option and 75 ohm option or the equivalent. This identification of products or services is not an endorsement of those products or services or their suppliers.
[2] Devices that may be compliant include Keysight 85039B or the equivalent. This identification of products or services is not an endorsement of those products or services or their suppliers.
[3] Devices that may be compliant include Keysight 11857B or the equivalent. This identification of products or services is not an endorsement of those products or services or their suppliers.
[4] Devices that may be compliant include Keysight 85039-6004 or the equivalent. This identification of products or services is not an endorsement of those products or services or their suppliers.

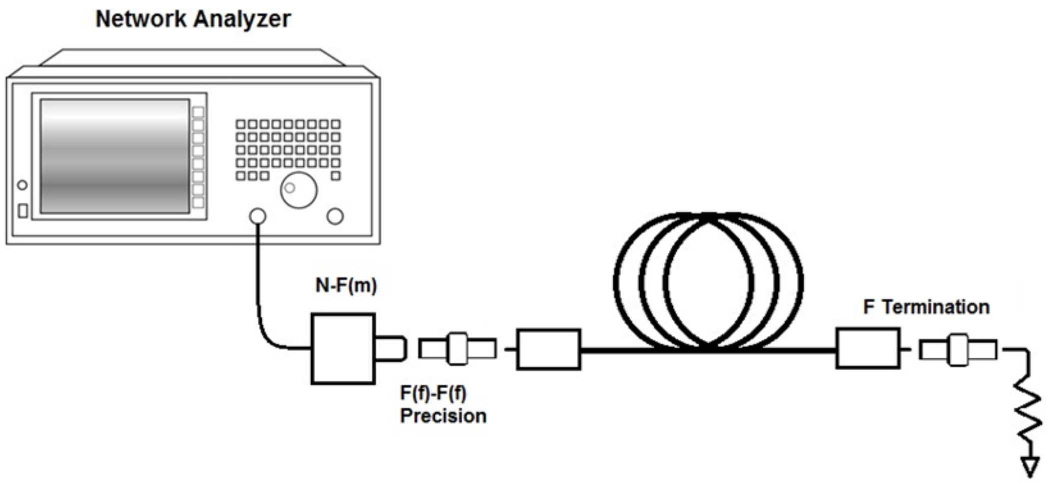

Figure 1 - Equipment Setup

9. Measurement Methodology

9.1. Per the test equipment manufacturers recommended instructions, follow any pre-calibration requirements, including adequate warm-up and stabilization time. Insure that the instrument is properly grounded and that anti-static precautions are maintained at all times.

9.2. Set up the vector network analyzer (VNA) for a reflection measurement, as per the manufacturer's instructions. Set the start frequency at 300 kHz; set the stop frequency at 3000 MHz, set the number of points to 1601.

9.3. Perform a 1-port calibration (error correction), using the type "F" calibration kit. Calibration is performed at the end of the precision adapter that mates with the DUT. Measure the open, short and load when prompted by the analyzer. When done, save this instrument state, if desired.

9.4. Connect the connector/cable interface to be tested to the type "F" test port. Be sure to properly dress the center conductor to avoid damage to the precision "F" test adapter. A precision termination shall be used at the far end of the cable. Check the reflection trace. The upper trace of Figure 2 shows a typical frequency domain trace.

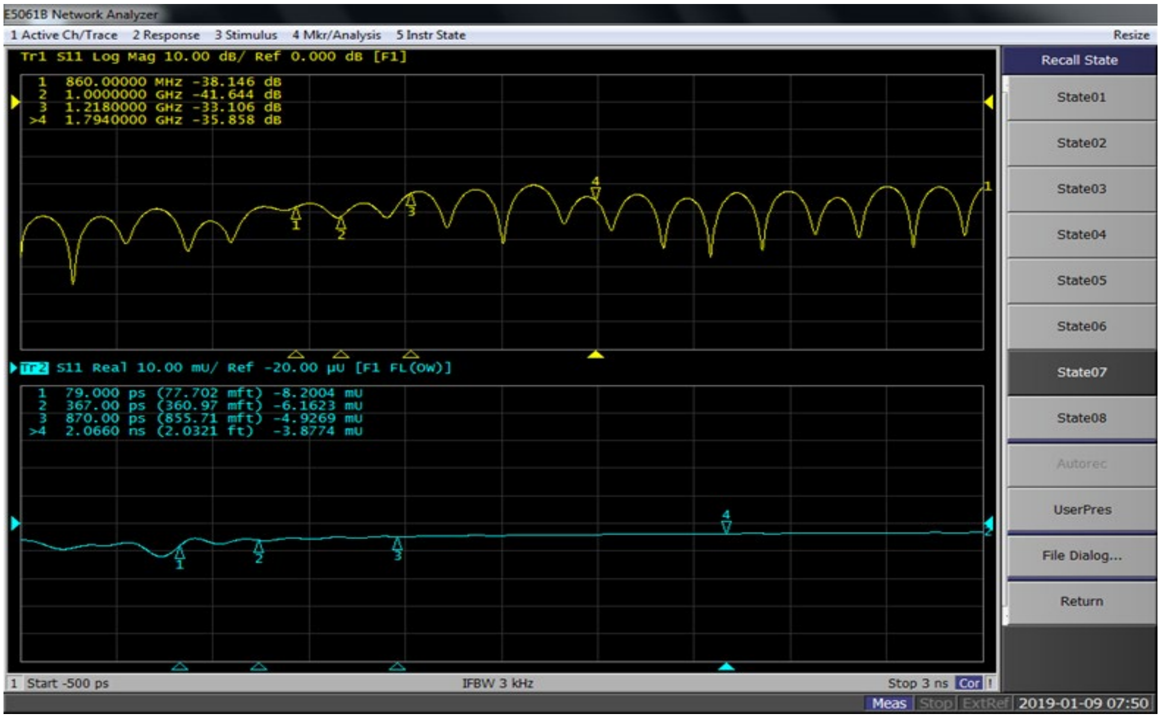

Figure 2 - Time Domain and Frequency Response Trace (no gating)

9.5. Select the ANALYSIS menu. In this menu select the GATING menu. Set the gate start time to -2 ns, and the gate stop time to +2.6 ns. Turn the gating ON. This should remove the far end termination response. The upper trace of Figure 3 shows a typical time gated trace.

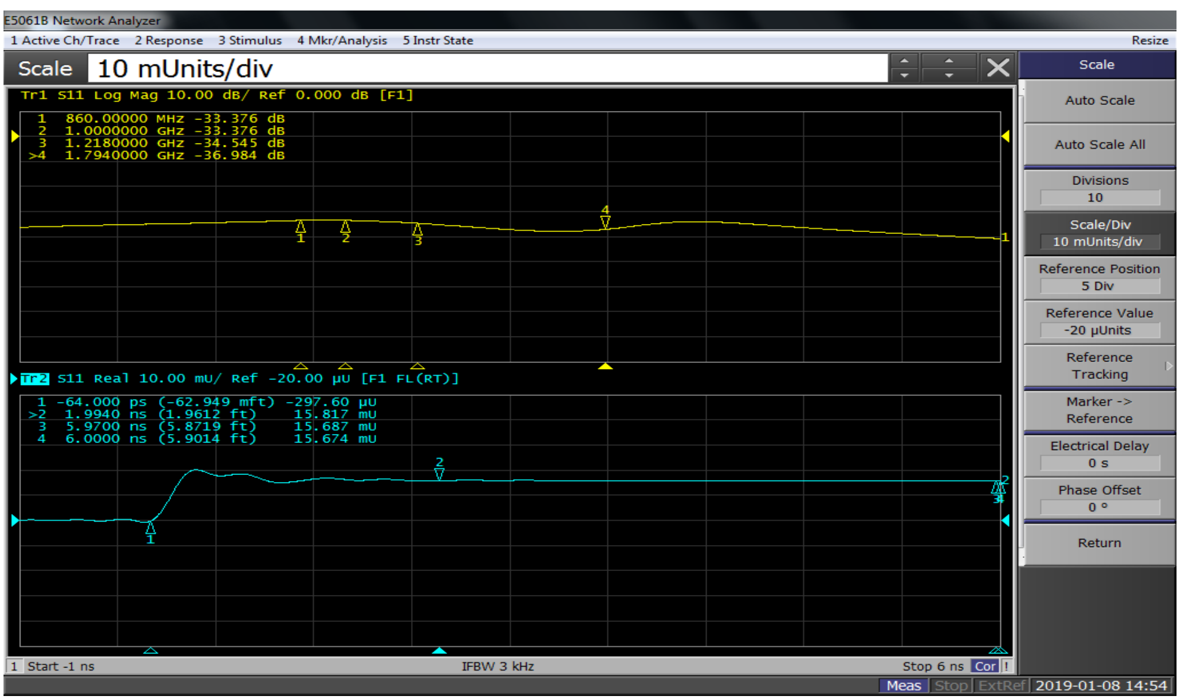

Figure 3 - Time Domain and Frequency Response and Gating

9.6. With gating left ON, turn the transform OFF to see the time gated frequency response. The ripple pattern of Figure 3 should change to show the frequency response of only the near end connector. The lower trace of Figure 3 shows a typical time gated frequency response. A marker is positioned at the worst case point. Note that there may be some small edge effect at the start and stop of the trace.

10. Inspection

10.1. 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.

10.2. 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.

11. Documentation

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