Society of Cable Telecommunications Engineers

**ENGINEERING COMMITTEE**
**Interface Practices Subcommittee**

## AMERICAN NATIONAL STANDARD

## ANSI/SCTE 04 2007

# Test method for “F” Connector Return Loss

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140 Philips Road
Exton, PA 19341

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## 1.0 SCOPE AND DEFINITIONS

### 1.1 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 1002 MHz by utilizing the time domain-gating feature of the network analyzer.
Male "F" connectors that conform to SCTE 123 2006; *Specification for "F" Connector, Male, Feed-Through* or SCTE 124 2006; *Specification for "F" Connector, Male, Pin Type* that are used with 75 ohm flexible RF coaxial cable, such as, but not limited to, ANSI/ SCTE 74; *Specification for Braided 75 ohm Flexible RF Coaxial Drop Cable* shall be utilized.

### 1.2 Definitions

1.2.1 Gating: Technique for selectively isolating the response of a connector for return loss measurements.

1.2.2 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.

1.2.3 Return Loss: The ratio of incident signal to reflected signal, expressed in dB.

1.2.4 Network Analyzer: An instrument for measuring the swept frequency response of a cable or cable/connector combination.

## 2.0 EQUIPMENT

2.1 Vector Network Analyzer (VNA), with Time Domain capability: Agilent 8753E with option 010 (time domain) and option 075 (75 ohm) or equivalent.

2.2 Type "F" 75-Ohm Calibration Kit, Agilent 85039B or equivalent.

2.3 Flexible Precision Test Cable(s); Agilent-11857B or equivalent.

2.4 Precision type "F" termination, Agilent 85039-6004 or equivalent.

2.5 Flexible RF coaxial cable and "F" male connectors of interest

Figure 1 illustrates a typical test set up.

## 3.0 TEST SAMPLES

3.1 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 manufacturers instructions.

3.2 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.

3.3 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.

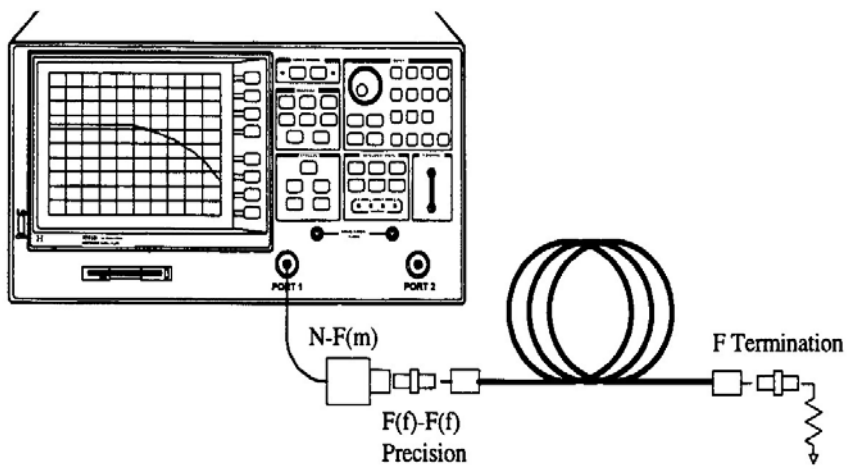


Figure 1: Equipment Set Up

## 4.0 MEASUREMENT METHODOLOGY

4.1 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.

4.2 Set up the vector network analyzer (VNA) for a reflection measurement, as per the manufacturer's instructions. Set the start frequency at 2.5 MHz; set the stop frequency at 1005 MHz, set the number of points to 401. Setting to these values ensures some under-sweep and over-sweep, for the frequency range of 5 MHz to 1002 MHz.

4.3 Perform a 1-port calibration (error correction), using the type "F" calibration kit. Measure the open, short and load when prompted by the analyzer. When done, save this instrument state, if desired.

**4.4** 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. There should be a ripple pattern in the return loss indicating the beat pattern of the near end cable and the far end termination. The upper trace of Figure 2 shows a typical frequency domain trace.

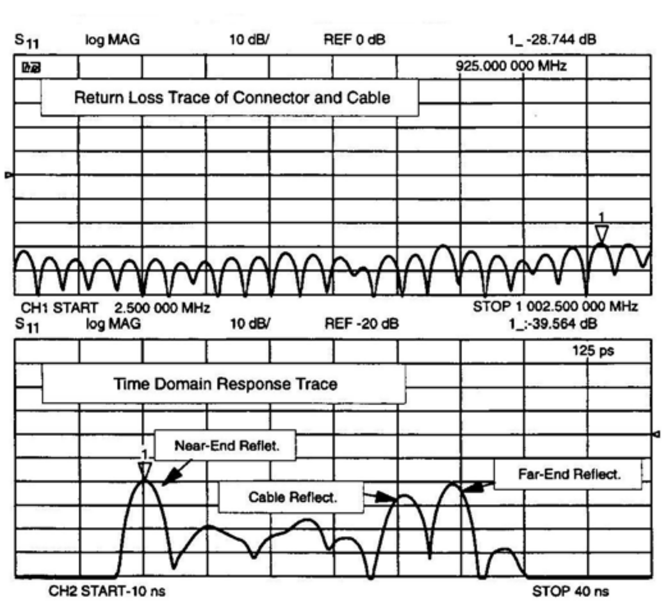


**Figure 2: Time Domain and Frequency Response Trace (no gating)**

4.5 Under the TRANSFORM menu, the time domain transform shall be turned ON to see the time domain response of the cable and connections. With time domain on, set the start time to -10 ns, and the stop time to 40 ns. You should see two returns, one from the near end, and one from the far end. Any returns from the cable should be less than 0.03-reflection coefficient (-30 dB), and the far end return should be less than 0.1 (-20 dB). Any defects in the cable or the far end termination greater than these values may degrade the measurement. The lower trace of Figure 2 shows a typical time domain trace.

**4.6** Select the TRANSFORM menu. In this menu select the GATING menu. Set the gate start time to -5 ns, and the gate stop time to +5 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.

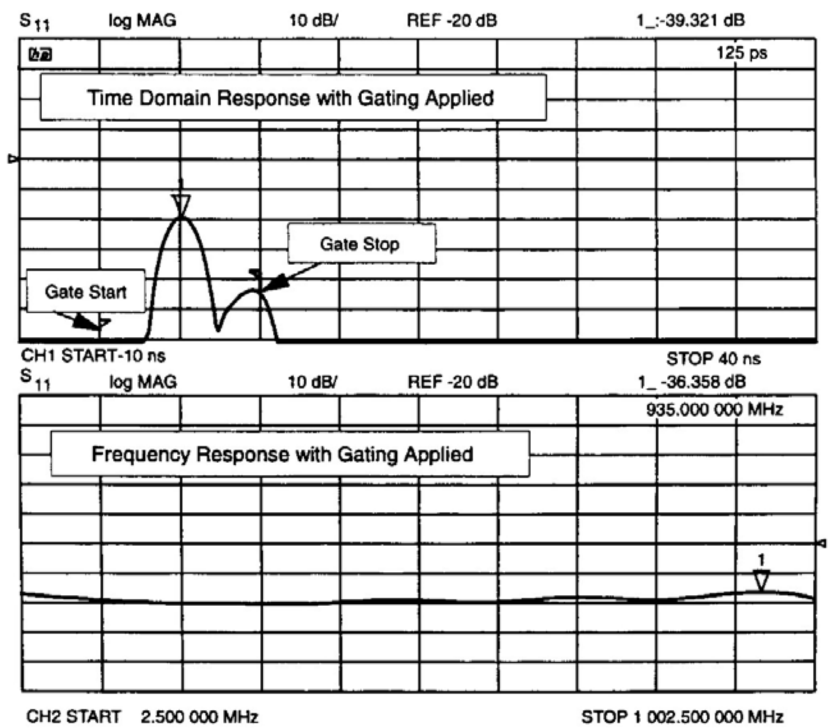


**Figure 3: Time Domain and Frequency Response after Gating**

4.7 With gating left ON, turn the transform OFF to see the time gated frequency response. The ripple pattern of Figure 2 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.

## 5.0 INSPECTION

5.1 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.

5.2 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.

## 6.0 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

## 7.0 ERROR ANALYSIS

The principal error in this measurement is the effective directivity of the measurement system. For error-corrected measurements, this is essentially equal to the return loss of the calibration load. The maximum positive error in the connector measurement is the sum of the connector return loss (expressed in linear terms) added to the effective directivity of the system, then converted back to dB.

$$Error = 20 * \log(10^{(Directivity/20)} + 10^{(C/20)}) - C$$

Where:

| | |
|---|---|
| C = | Connector return loss |
| Directivity = | Directivity of the measurement system |
| log = | Common logarithm (base 10) |

Example: A test system is calibrated and uses a -40 dB load ($10^{(-40/20)}$ = 0.01 linear.) A connector is measured and found to have -35 dB return loss ($10^{(-35/20)}$ = 0.018 linear.) What could the worse case connector return loss be?

*Error* = 20*log(0.018+0.01)-(-35) or *Error* = 20*log(0.028)+35 or
*Error* = 3.94 dB

*Return loss (worse case)* = C-*Error* or -35 + 3.94
*Return loss (worse case)* = -31.06 dB

## 8.0 NORMATIVE REFERENCES

ANSI / SCTE 74 2004, Specification for Braided 75 ohm Flexible RF Coaxial Drop Cable

SCTE 123 2006; Specification for “F” Connector, Male, Feed-Through

SCTE 124 2006; Specification for “F” Connector, Male, Pin Type