



***Society of Cable
Telecommunications
Engineers***

**ENGINEERING COMMITTEE
Interface Practices Subcommittee**

AMERICAN NATIONAL STANDARD

ANSI/SCTE 05 2008

**Test Method for “F” Connector
Return Loss In-Line Pair**

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1.0 SCOPE

The purpose of this procedure is to provide instructions to measure the Return Loss characteristics of a pair of type “F” connectors and the cable interface, inserted in the middle of a cable, from 5 MHz to 1002 MHz. This test method makes use of the time domain gating feature of the network analyzer to remove the near end and far end test set connector effects from a type “F” pair in the middle of the cable, joined by a type F (female) – type F (female) adapter.

2.0 EQUIPMENT

- 2.1 Vector Network Analyzer (VNA), with Time Domain capability installed; Agilent E5017C ENA Analyzer with Time Domain option 010 or equivalent.
- 2.2 Type “F” Calibration Kit, Agilent 85039A or equivalent:
 - Load - HP#0955-0724 or equivalent
 - Open - HP#0955-0725 or equivalent
 - Short - HP#0955-0726 or equivalent
 - Type N (male) through Type F (male) Adapter - HP#1250-2488 or equivalent
 - Type N (female) through Type F (female) Adapter – HP#1250-2490 or equivalent
 - Type F (female) through Type F (female) Adapter - HP#1250-2489 or equivalent

- 2.3 Type F (female) – type F (female) adapter. The precision one which comes with the calibration kit in 2.2 can be used for this purpose, or equivalent. This adapter must accept the size of cable center conductor to be tested. The above adapter accepts only 0.022” to 0.042” center conductor.

3.0 TEST SAMPLES

- 3.1 The connectors to be tested will be installed in the middle of cable of the type for which they are intended, of approximately 10 feet (3 meters) in length. Before inserting the pair of type “F” connectors in the cable, apply connectors at each end. One end will go to the network analyzer; the other end will be terminated with greater than 20 dB return loss load. This sample will be pre-tested as described in 4.4. After pre-test, prepare this cable as described in 3.2.
- 3.2 A precision type F (female) – type F (female) adapter must be used to complete the in-line connection. The quality of this adapter may limit the quality of the measurement.
- 3.3 Before performing the tests, visually inspect the cable and connectors to ensure that there are no problems (such as cracks, punctures, bruises, dents, or poor contacts), which could affect the readings.

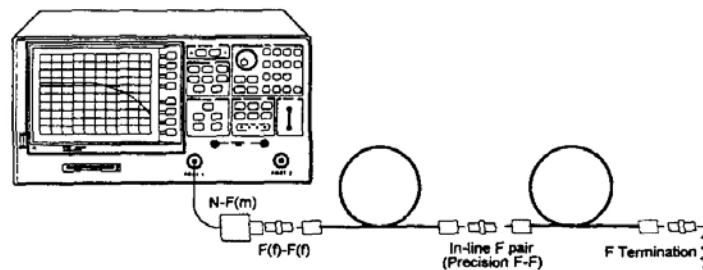


Figure 1: Equipment Set-Up

4.0 MEASUREMENT METHODOLOGY

- 4.1 Load the calibration kit information into the network analyzer, as per the manufacturer's instructions.
- 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 1002.5 MHz, set the number of point to 401. Setting to these values ensures some under- and over-sweep, with a measurement point at exactly 5MHz and 1002 MHz. It is necessary to slightly under-and over-sweep to avoid band edge effects when using the time domain gating function. Check to see that cal kit selected is type "F". If not, select the user cal kit, which should have the type "F" kit loaded (see 4.1).
- 4.3 Perform a 1-port calibration (error correction), using the type "F" calibration kit. First connect the type N (male) – type F (male) adapter to the VNA test port. Next add the type F (female) – type F (female) adapter from the cal kit. This is a precision type "F" female port, and must be used to obtain best results. Select the calibration key, then the calibrate menu softkey, then the 1 port calibration. Measure the open, short and load when prompted by the analyzer. When done, save this instrument state, if desired.
- 4.4 Connect the cable from 3.1 to the network analyzer. Be sure to properly dress the center conductor to avoid damage to the precision "F" test adapter. Be sure a proper termination is applied 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 connection and the far end termination. A typical trace is shown in the upper part of Figure 2. Under the Transform menu, the time domain transform can be turned ON to see the time domain response of the cable and connections. With time domain on, set the start time to –10ns, and the stop time to 40ns. 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 near and far end returns should be less than 0.1 (-20 dB). Any defects in the cable or the connections greater than these values may degrade the measurement. The lower trace of Figure 2 shows a typical domain trace. This pre-test ensures that the cable and end connectors are of sufficient quality to test the in-line "F" connectors. Turn the TRANSFORM OFF when the pre-test is complete.

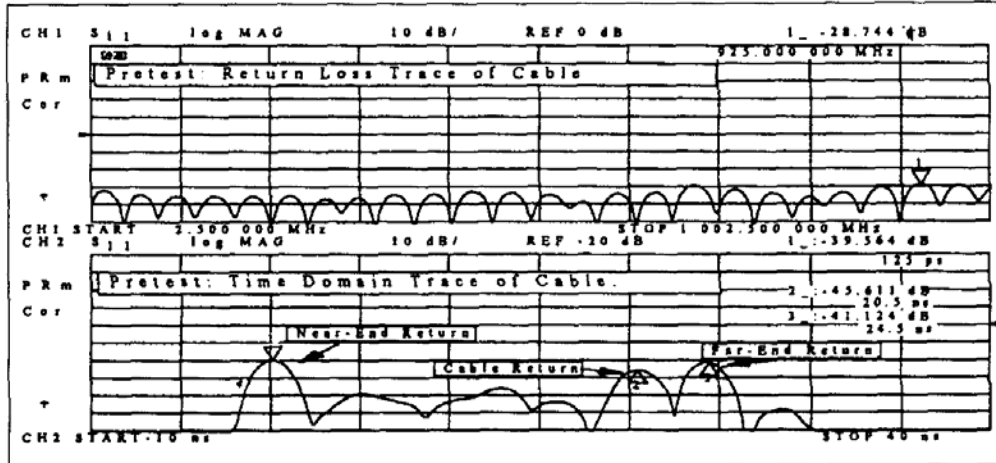


Figure 2: Pre-Test Measurement of Cable Assembly

4.5 Prepare the test sample as described in 3.2. Connect this to the network analyzer. The reflection trace should show a ripple pattern, which is a beat pattern from both ends and the middle connector, as seen in the upper trace in Figure 3.

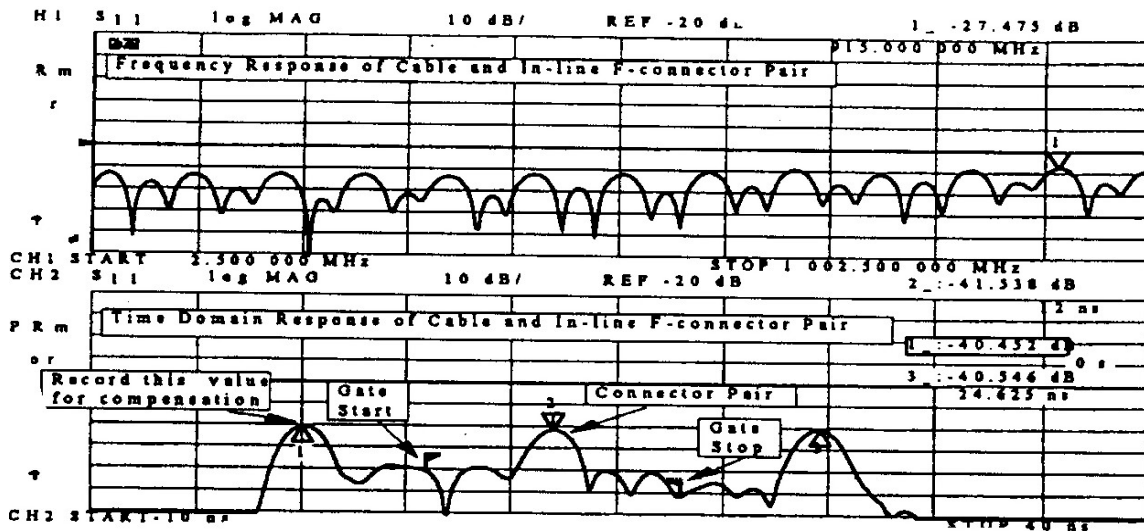


Figure 3: Frequency and Time Response of "F" Connector Pair

- 4.6 Under the System key, select the TRANSFORM menu. In this menu select the TRANSFORM ON. With time domain on, set the start time to -10 ns, and the stop time to 40 ns. You should see three returns, one from the near end, and one from the far end, and one from the middle, at approximately 12 ns. Record the value of reflection for the input connector (at time = 0 sec.). Set the gate start time to halfway between the near end return and the middle return (approx. $+6$ ns), and the gate stop time to halfway between the middle return and the far end return (approx. $+18$ ns). The lower trace of Figure 3 shows a typical example of the three returns.
- 4.7 Turn the gating ON. The time domain pattern of the return loss should change to show only the response of the middle connector. With gating ON, the near and far end return should disappear. A typical example trace is shown in the upper part of Figure 4.

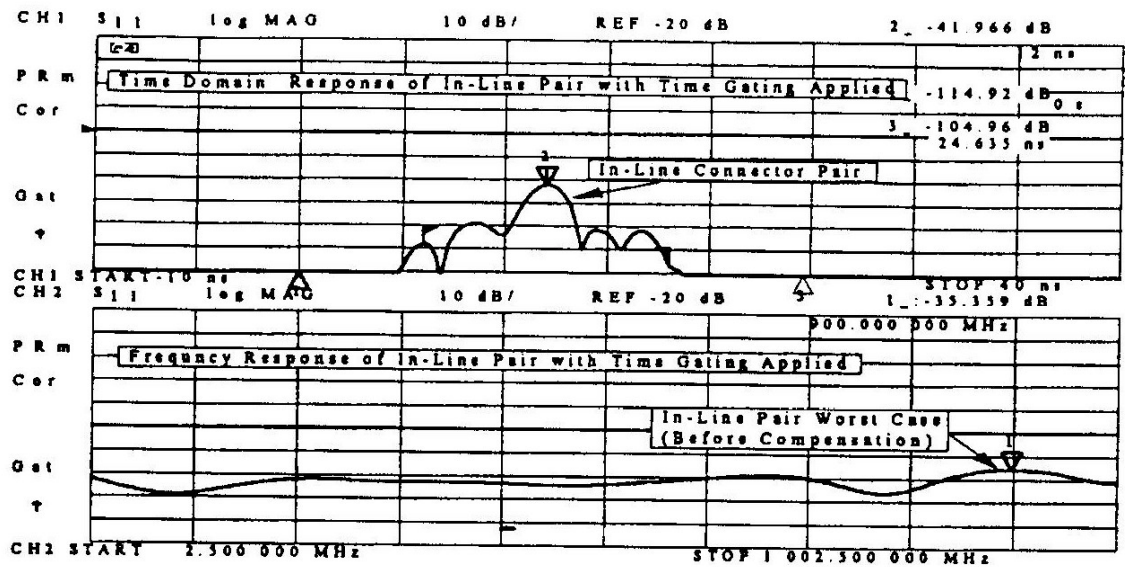


Figure 4: Time Gated Response of In-Line "F" Connector Pair

- 4.8 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 in-line “F” connector pair. The lower track of Figure 4 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.
- 4.9 Once the gate times have been established for one class of cables, it is not necessary to go through step 4.5 to reset the gate start and stop times, as long as subsequent samples have approximately the same velocity factor, length, and position of the middle connector to be tested.

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 time-gated response removes the effect of reflections from the input connector, it is necessary to compensate the result for loss in signal hitting the middle connector. In general, the compensation can be calculated by:

$$p_{in} = 10^{(\text{Return Loss in dB})/20}$$

$$\text{Comp (dB)} = 20 \times (\log(1-p_{in})) \text{ Eq.1}$$

Where p_{in} = input connector return loss, as seen in the time domain trace of Section 4.6. For example shown, $p_{in} = 10^{(-40.42/20)} = 0.0095$ and the compensation value is $\text{Comp} = 20 * (\log(1-0.0095)) = 0.083 \text{ dB}$. If the return loss of the input is better than 20 dB, a compensation of 1 dB is sufficient.

6.0 REPORT

A typical report form might look like the following:

CONNECTOR_____	CABLE_____
TESTER_____	DATE_____
FREQ. (MHz)_____	A. RETURN LOSS_____
INPUT CONN. RET. LOSS_____	B. COMP (from Eq. 1)_____
TOTAL RETURN LOSS (A+B)_____	