

Monoblock RF Filter Testing VNA 3.5mm APC Calibration Method

Introduction

Measuring and characterizing high frequency Radio Frequency (RF) filters can sometimes be a difficult and very technical task. The purpose of this application note is to describe a test method that has demonstrated very repeatable and accurate frequency characterization of Monoblock Ceramic RF Filters.

The RF test fixture shown in Figure 1 is used as a method to secure the product being measured. As with any testing apparatus, calibration of the fixture and all associated connections is critical to achieving an accurate result. SMA female connectors are used on the fixture. The 2-port calibration of S₂₁ and S₁₂ requires that the two cables be connected together and this in turn requires the use of a female-to-female adapter. The adapter introduces phase and insertion loss which will affect the measured values of the filter.

If a custom electronic calibration module is used which has two male SMA connectors then there is no issue and the calibration should be accurate. However, it is more common to calibrate with physical standards that can be purchased with a standard calibration kit. The following procedure describes a method for using an Agilent 8753ES VNA and a 3.5 mm APC calibration kit as shown in Figure 2. A phase-matched adapter set is used to eliminate the error for the “Female Thru”.

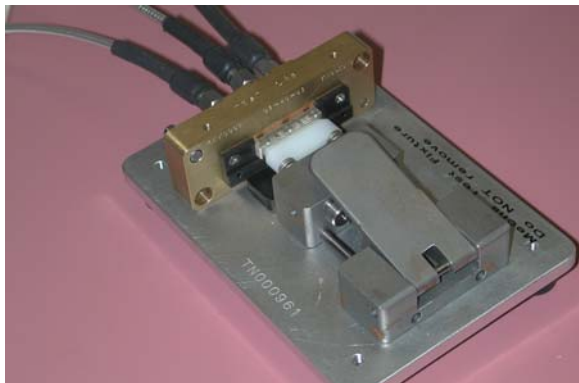


Figure 1 CTS RF Test Fixture



Figure 2 Agilent 3.5 mm Cal Standards

Procedure

1. Resource

- 1.1. (1) Agilent 8753ES Vector Network Analyzer
- 1.2. (3) Cables CTS M0605 N male to SMA male, 12 inch
- 1.3. (1 set) Calibration Standards (Economy)
 - 1.3.1. Agilent 85033-60017 3.5 mm Load
 - 1.3.2. Agilent 85033-60019 3.5 mm Open
 - 1.3.3. Agilent 85033-60021 3.5 mm Short
- 1.4. (1 set) Phase Matched Adapters (Economy)
 - 1.4.1. Agilent 83059C (85027-60006) 3.5 mm M-F
 - 1.4.2. Agilent 83059B (85027-60005) 3.5 mm F-F

2. Setup

- 2.1. Set the following on the VNA prior to calibration
- 2.2. Coupled Channels
- 2.3. Channel 1
- 2.4. For Simplex parts designate Ports 1-3
- 2.5. For Duplex parts designate Channel 1 Ports 1-2 and Channel 2 Ports 1-3
- 2.6. Sweep Start
- 2.7. Sweep Stop
- 2.8. Number of points
- 2.9. Bandwidth (3700 Hz default)

3. Calibration

- 3.1. Transmission
 - 3.1.1. Press **CAL > CAL KIT > 3.5mmD**
 - 3.1.2. Press **CAL > CALIBRATE MENU > FULL 2-PORT > TRANSMISSION**
 - 3.1.3. Connect the two cables with the female/female Phase Matched Adapter (PMA). See Figure 3 and 4.
 - 3.1.4. Press **DO BOTH FWD + REV**

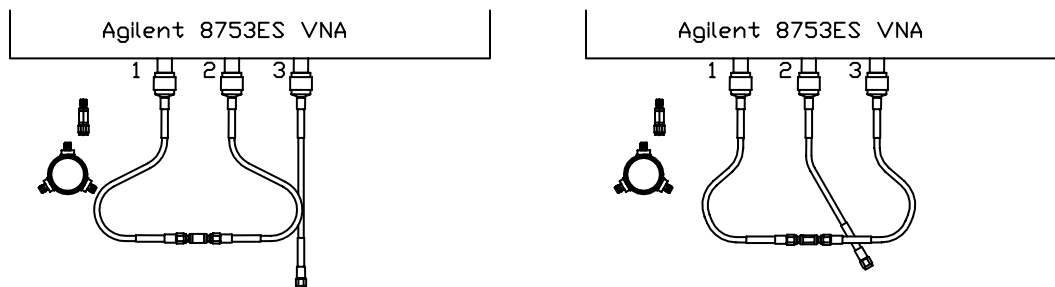


Figure 3 and 4 Calibrate Transmission with a F-F Phase Matched Adapter

3.2. Reflection

- 3.2.1. Remove the female/female PMA and connect the male/female PMA to the cable that is connected to Port 1 on the analyzer. Leave this PMA on the cable for the rest of the procedure.
- 3.2.2. Press **REFLECTION**.
- 3.2.3. See Figures 5 and 6 for proper configuration.
- 3.2.4. Connect the OPEN onto Port 1 and Press **FORWARD OPEN**.
- 3.2.5. Connect the OPEN onto Port 2 and Press **REVERSE OPEN**.
- 3.2.6. Connect the SHORT onto Port 1 and Press **FORWARD SHORT**.
- 3.2.7. Connect the SHORT onto Port 2 and Press **REVERSE SHORT**.
- 3.2.8. Connect the LOAD onto Port 1 and Press **FORWARD LOAD**.
- 3.2.9. Connect the LOAD onto Port 2 and Press **REVERSE LOAD**.
- 3.2.10. Press **STANDARDS DONE**.

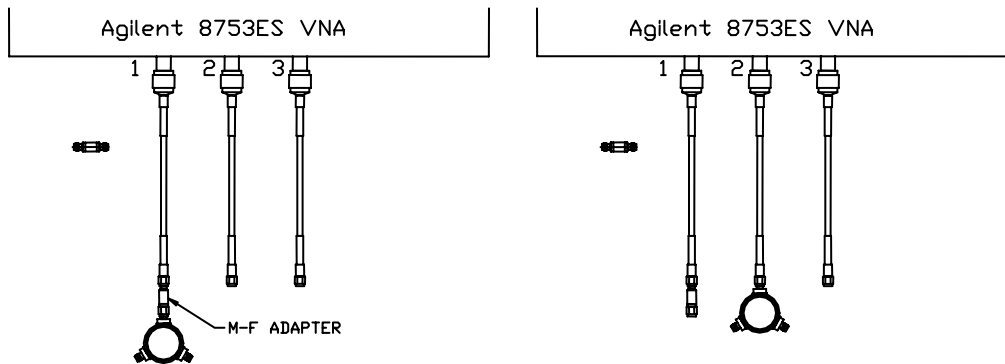


Figure 5 and 6 Calibrate Reflection with Phase Matched Adapter in-place

3.3. Isolation

- 3.3.1. Press **ISOLATION > OMIT ISOLATION**
- 3.3.2. Press **DONE 2-PORT CAL**

3.4. Duplex parts

- 3.4.1. Press **Channel 2**
- 3.4.2. Repeat step 3

4. Measure Parts

- 4.1. Connect the VNA to the fixture as shown in Figure 7

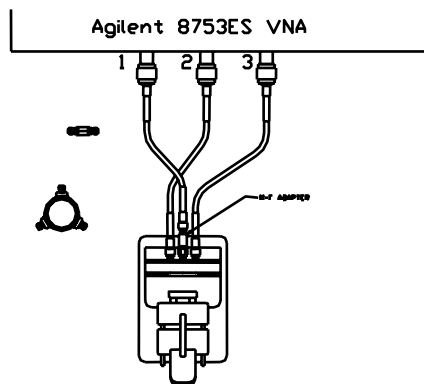


Figure 7 Fixture with Phase Matched Adapter in-place

Conclusion

An accurate 3.5 mm APC calibration for the measurement of same-sex fixtures requires a slightly more complicated procedure and the use of phase-matched adapters. The benefit is the removal of both phase and insertion loss errors from the measurement.

Bibliography

1. Agilent Application Note 1287-3, 5965-7709E, Applying Error Correction to Network Analyzer Measurements
2. Agilent 8753ET/ES Network Analyzers User's Guide Part Number 08753-90472, Section 6. Calibrating for Increased Measurement Accuracy.

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