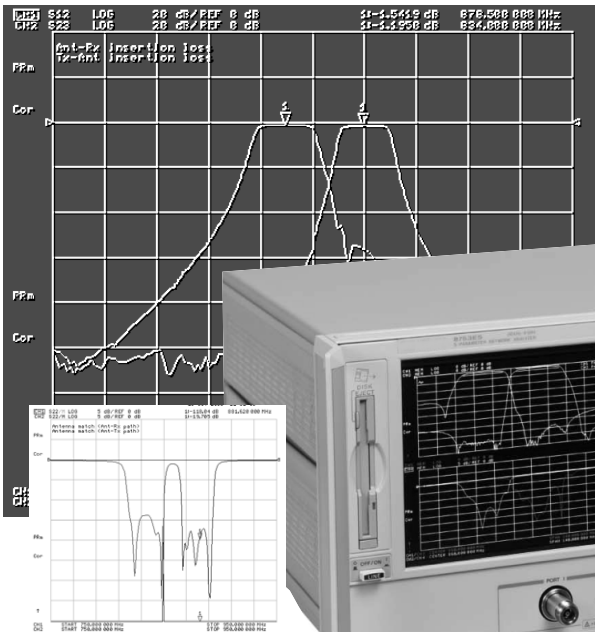
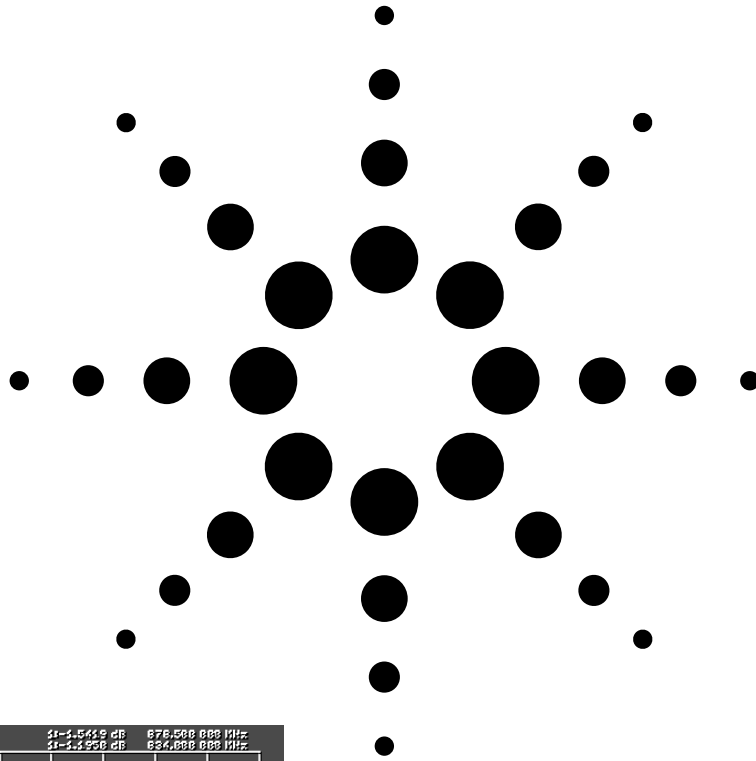


Agilent

8753ES Vector Network Analyzer

Product Note



**Testing Duplexers Using an Agilent 8753ES
Option H39 Three-port Network Analyzer**



Agilent Technologies
Innovating the HP Way

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Introduction

Duplexers are three-port filters that are used in many communication systems. They allow a single antenna to be shared between separate transmit and receive signal paths. Since duplexers are three-port devices, they provide measurement challenges to traditional network analyzers with only two ports. During alignment, it is essential to see both the transmitter-to-antenna (Tx–Ant) and antenna-to-receiver (Ant–Rx) paths, since tuning the response of one path can affect the response of the other path.

Option H39 adds a third test port to a standard 8753ES network analyzer to allow for single-connection measurements of duplexers. With Option H39, you can simultaneously measure the insertion loss from Tx–Ant and from Ant–Rx. Simultaneous measurement of the insertion loss allows observation of path interactions. This eliminates retest and rework that occurs when only measuring one path at a time. In addition, isolation between the transmitter port and receiver port (Tx–Rx) and match of all three ports can be measured.

This product note describes the measurement process and accuracy considerations of testing a duplexer with high dynamic range using an 8753ES with Option H39. The product note examines Ant–Rx, Tx–Ant and Tx–Rx insertion loss and Ant, Rx, and Tx match measurements. Since the duplexer has high dynamic range, swept-list frequency mode is used to optimize measurement speed. In addition, the challenges of testing three-port devices such as couplers are discussed.

The information in this product note is tailored to an 8753ES network analyzer with Option H39. However, most of the information is applicable to 8753ES with Z5621A H39 external three-port test set. To a lesser extent, the information is applicable to 8753ES with Z5621A H36 external duplexer test set. For further differentiation of these options, refer to the *questions and answers* section of this document.

Block Diagram

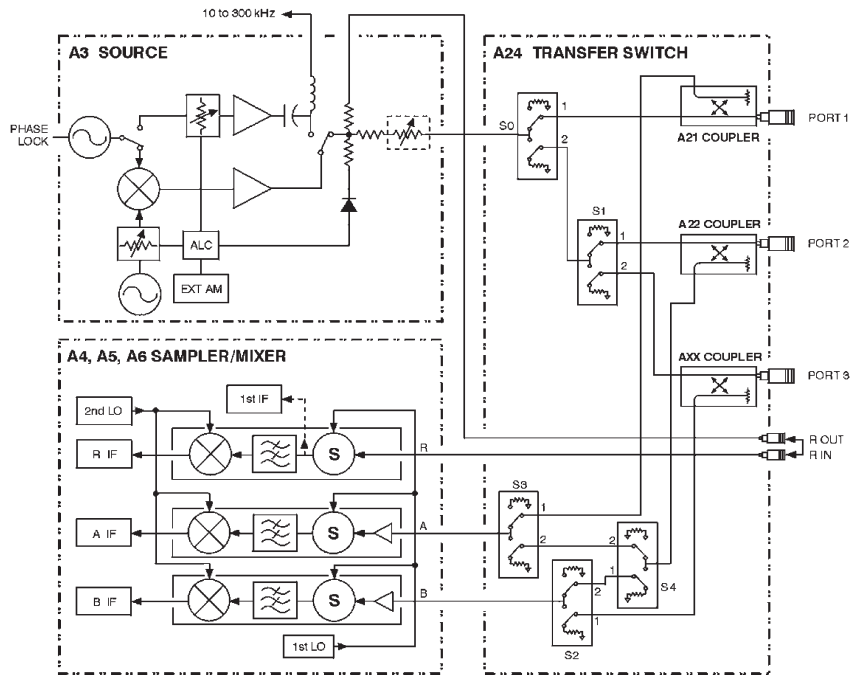


Figure 1. 8753ES Option H39 block diagram.

Measurement paths

Port 1 to port 2	$S_{11}, S_{21}, S_{12}, S_{22}$
Port 1 to port 3	$S_{11}, S_{31}, S_{13}, S_{33}$
Port 2 to port 3	$S_{22}, S_{32}, S_{23}, S_{33}$

Equipment required

The following equipment is required for the measurements described in this note.

- 8753ES Option H39 (or 8753ES with Z5621A H39)
- 85033D calibration kit or appropriate calibration kit
- Cables
- Duplexer or three-port device under test

All measurements described in this note use the 8753ES Option H39 network analyzer. The reader should be familiar with general network analyzer operation. Refer to the 8753ES User's Guide (part number 08753-90007) for a complete description of instrument operation.

In the following measurement procedures, the 8753 front panel hard keys appear in brackets with bold type (for example **[Display]**). The "softkeys," displayed on the screen, appear in italic type (for example, *LOG MAG*).

Duplexer connection diagram

Connect the network analyzer's port 1 to the duplexer receiver port (Rx), the analyzer's port 2 to the antenna port (Ant), and the analyzer's port 3 to the transmitter port (Tx).

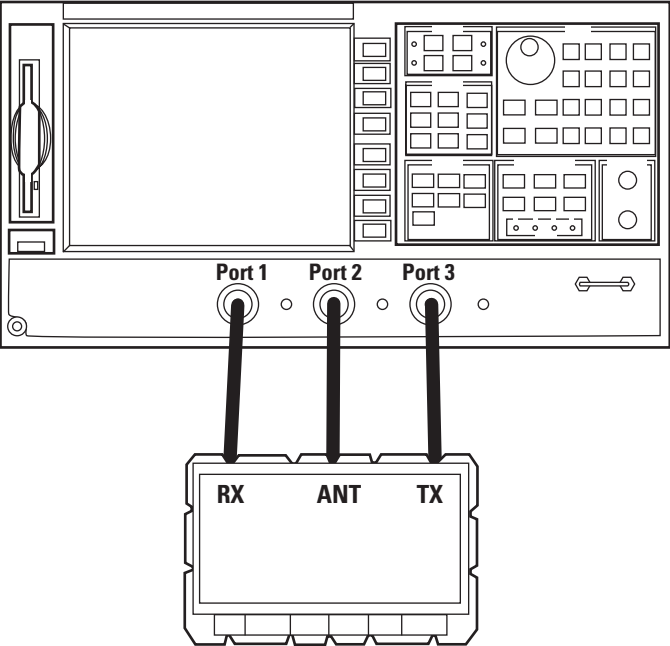


Figure 2. Duplexer connection diagram.

During the following sections, this product note provides detailed instructions for testing an 800 MHz duplexer. *Section A* covers antenna-to-receiver and transmitter-to-antenna insertion loss measurements. *Section B* describes antenna match measurement. *Section C* covers receiver-to-transmitter isolation, and receiver and transmitter match measurements.

In each section, the network analyzer stimulus is initially setup and then a calibration is performed. The product note provides the step-by-step list of keystrokes required for configuring the stimulus.

**Section A.
Measure antenna-to-receiver
and transmitter-to-antenna
insertion loss**

Configure the network analyzer to measure S_{12} and S_{23} on channels 1 and 2 respectively, as shown in Table 2. Channels 1 and 2 must be uncoupled, because each path requires a different calibration. In dual- or quad-channel mode, uncoupling the channels uncouples channels 1 and 3 from channels 2 and 4.

Table 2. Duplexer configuration for insertion loss measurement.

Channel 1	Channel 2
S_{12}	S_{23}
Path 1-2 (Ant-Rx)	Path 2-3 (Tx-Ant)
Two-port calibration	Two-port calibration

The following keystrokes provide instructions for setting up the measurements shown in Table 2. for a duplexer in the frequency range of 700–1000 MHz.

[Preset]

*If you are using the Z5621A H39 external test set, configure the network analyzer initially using **[System]**, CONFIGURE MENU, USER SETTINGS, K39 MODE ON off. With an Option H39, the analyzer is automatically configured as a three-port test set.*

[Start]

[700 M/μ]

[Stop]

[1000 M/μ]

[Sweep Setup]

COUPLED CH on OFF

[Display]

DUAL|QUAD SETUP

DUAL CHAN ON off

SPLIT DISPLAY 1X

[Meas]

[Chan 1]

SELECT PORTS [1-2]

Trans: REV S_{12} (A/R) {Ant-Rx insertion loss}

[Chan 2]

SELECT PORTS [2-3]

Trans: REV S_{23} (A/R) {Tx-Ant insertion loss}

Title the channels.

[Chan 1]

[Display]

MORE

TITLE

ERASE TITLE

“Ant-Rx insertion loss”

[Chan 2]

TITLE

ERASE TITLE

“Tx-Ant insertion loss”

Auto scale all channels. At this point, you should see the common duplexer response shown in Figure 3.

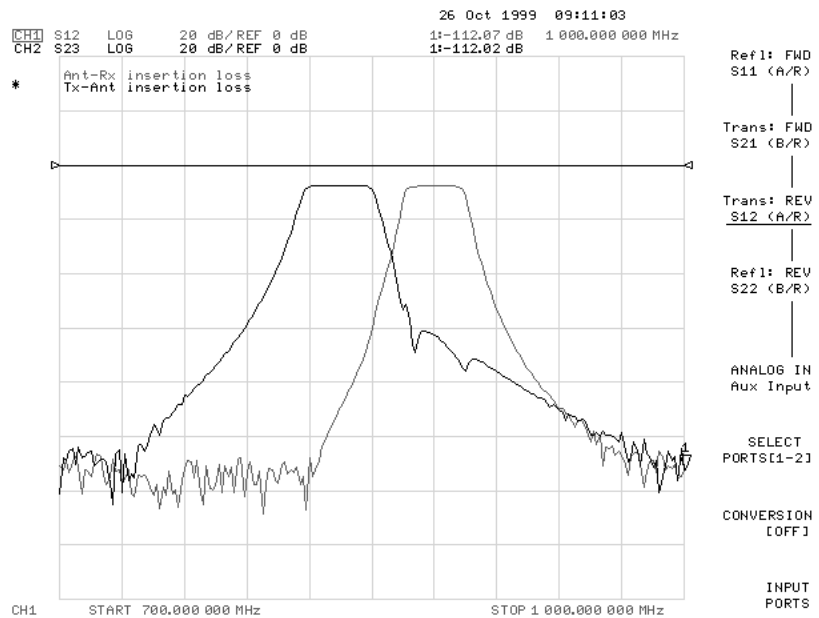


Figure 3. Measurement of Ant-Rx and Tx-Ant insertion loss.

Next set up the power level and IF bandwidth and number of points. The default power level, IF bandwidth, and number of points are 0 dBm, 3700 Hz, and 201 points.

In this example, the duplexer has over 100 dB of dynamic range, so you need to use a narrow IF bandwidth in the stopband for accurate transmission measurements. If you use a narrow IF bandwidth (for example 30 Hz) during the entire frequency sweep, the measurement time will be very long. Instead, use swept-list frequency mode to optimize speed and accuracy. With swept-list mode, you divide the frequency span into multiple segments. You can independently set the IF bandwidth in each segment. So in the stopband, use narrow bandwidths (slow sweep), and in the passband, use wide bandwidths (fast sweep). The swept-list mode setup for this measurement is shown in Table 3.

If you are testing a combination of an amplifier and filter, you can also set the power level in each frequency segment independently to maximize dynamic range. For example, in the passband you can set the power level low (for example -30 dBm), and in the stopband, use maximum power (for example +10 dBm).

Table 3. Swept-list frequency mode setup for duplexer

	Segment	Frequency range (MHz)	IF bandwidth (Hz)	Number of points	Step size (MHz)
Port 1-2, Ant-Rx, Channel 1	1	700–850	30	76	2
	2	850–910	3700	121	0.5
	3	910–1000	30	46	2
Port 2-3, Ant-Tx, Channel 2	1	700–770	30	36	2
	2	770–910	3700	281	0.5
	3	910–1000	20	46	2

**[Chan 1]
[Sweep Setup]**
SWEEP TYPE MENU
EDIT LIST

ADD
SEGMENT: START
[700 M/μ]
SEGMENT: STOP
[850 M/μ]
STEP SIZE
[2 M/μ] #You can either configure the step size or the number of points.

MORE
LIST IF BW ON off
SEGMENT IF BW
[30 x 1]
RETURN
DONE

ADD
SEGMENT: START
[850 M/μ]
SEGMENT: STOP
[910 M/μ]
STEP SIZE
[0.5 M/μ]
MORE
SEGMENT IF BW
[3700 x 1]
RETURN
DONE

ADD
SEGMENT: START
[910 M/μ]
SEGMENT: STOP
[1000 M/μ]
STEP SIZE
[2 M/μ]
MORE
SEGMENT IF BW
[30 x 1]
RETURN
DONE

DONE
LIST FREQ [SWEPT]
RETURN

**[Chan 2]
[Sweep Setup]**
SWEEP TYPE MENU
EDIT LIST

ADD
SEGMENT: START
[700 M/μ]
SEGMENT: STOP
[770 M/μ]
STEP SIZE
[2 M/μ]
MORE
LIST IF BW ON off
SEGMENT IF BW
[30 x 1]
RETURN
DONE

ADD
SEGMENT: START
[770 M/μ]
SEGMENT: STOP
[910 M/μ]
STEP SIZE
[0.5 M/μ]
MORE
SEGMENT IF BW
[3700 x 1]
RETURN
DONE

ADD
SEGMENT: START
[910 M/μ]
SEGMENT: STOP
[1000 M/μ]
STEP SIZE
[2 M/μ]
SEGMENT IF BW
[30 x 1]
RETURN
DONE
DONE
LIST FREQ [SWEPT]
RETURN

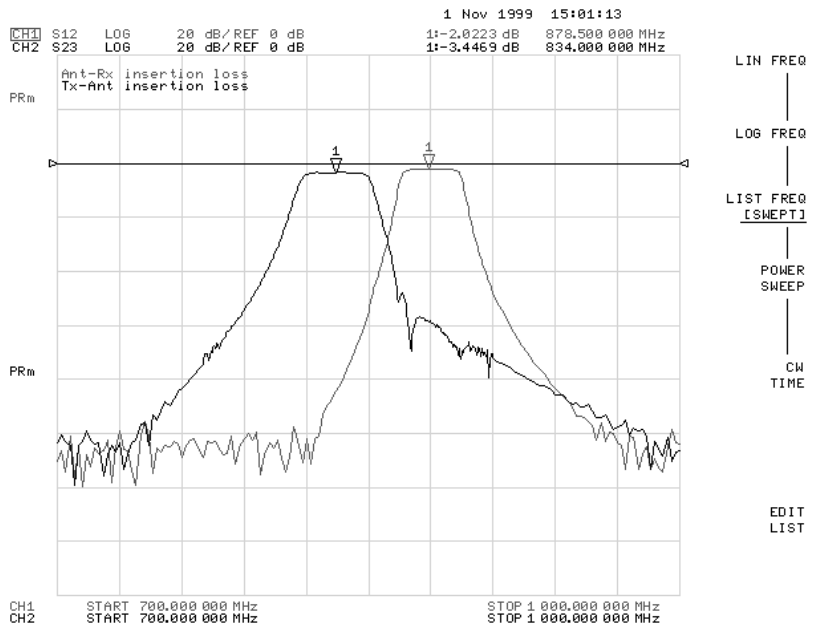


Figure 4. Network analyzer set up for swept-list frequency mode (notice the underlined softkey).

Now the stimulus setup is complete. Make any other stimulus changes, such as power level or number of points before performing the calibration.

Calibrate the port 1 to port 2 and port 2 to port 3 paths. Perform a two-port calibration on each path for maximum accuracy and flexibility. Refer to the 8753ES User's Guide for calibration procedures.

You can choose to use enhanced response calibration for faster measurement speed during tuning. If you choose to use enhanced response calibration, pay special attention to the port selection during the calibration process. The submenus under calibration display forward and reverse terminology instead of port 1, 2, or 3. Therefore, it is easy to connect the standards to the wrong port. You can reduce the chance of error by looking at the active channel on the analyzer screen and noting which parameter is actually measured. If you have made a mistake, simply re-measure that calibration standard.

After you have completed the calibration of your choice, **save the instrument state to internal memory.**

[Save/Recall]
SAVE STATE

The network analyzer display will show you the following information regarding your instrument state.

register name	ch 1 cal, ch 2 cal	ch 1 points, ch 2 points	date	time	register
REG1	FULL/FULL	243/363	20-OCT-99	10:01:34	1

At this point, your measurement setup is complete. Optionally, you can add markers, limit lines, or other functions to your measurement.

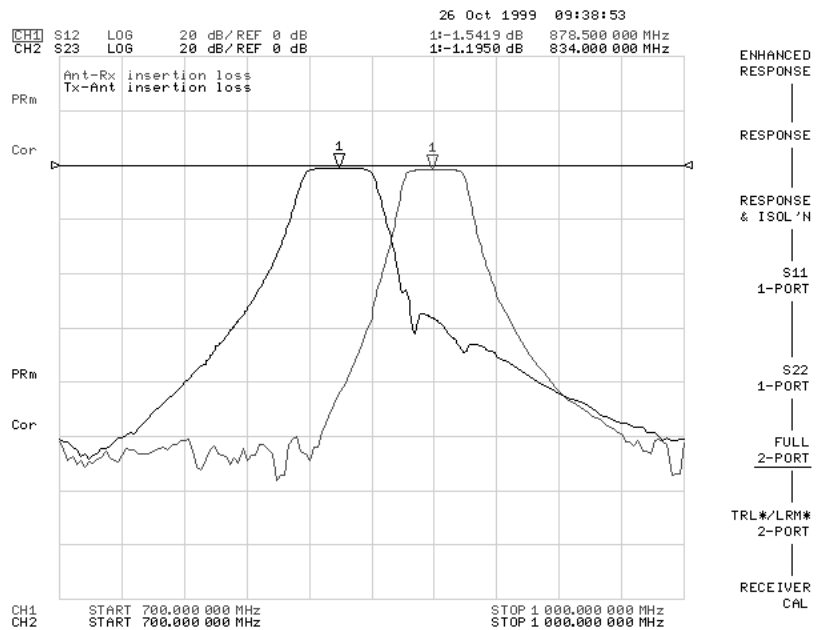


Figure 5. Duplexer setup with calibration completed. Notice the “Cor” annunciators on the left side of the screen, indicating that both channels have error correction turned on.

Section B. Measure the antenna match

This section first explains the steps necessary in measuring antenna match (S_{22}) and then discusses some of the difficulties of measuring S_{22} with the 8753ES Option H39.

Start by configuring the network analyzer to measure S_{22} on both channels 1 and 2. Channels 1 and 2 must be uncoupled, because each path requires a different calibration. Calibrate channel 1 for the Ant–Rx path (port 2 to port 1), and channel 2 for the Tx–Ant path (port 3 to port 2).

If you just completed *Section A*, you may notice that the channel configuration for measuring S_{22} is similar to the configuration for measuring S_{21} and S_{32} . The difference is that the S_{22} measurement does not require a narrow IF bandwidth so there is no advantage to using swept-list frequency mode. Instead, use the default linear frequency sweep.

Table 4. Duplexer configuration for antenna match measurement

Channel 1	Channel 2
S_{22}	S_{22}
Path 1–2 (Ant–Rx)	Path 2–3 (Ant–Tx)
Two-port calibration	Two-port calibration

[Preset]

If you are using the Z5621A H39 external test set, configure the network analyzer initially using [System], CONFIGURE MENU, USER SETTINGS, K39 MODE ON off. When configured with Option H39, the analyzer is automatically configured as a three-port test set.

[Start]
[700 M/μ]
[Stop]
[1000 M/μ]
[Sweep Setup]
 COUPLED CH on OFF

[Display]
 DUAL|QUAD SETUP
 DUAL CHAN ON off
 SPLIT DISPLAY 2X

[Meas]

[Chan 1]
 SELECT PORTS [1-2]
 Refl: REV S_{22} (B/R) {Ant match}

[Chan 2]
 SELECT PORTS [2-3]
 Refl: FWD S_{22} (A/R) {Ant match}

Title the channels.

[Chan 1]
[Display]
 MORE
 TITLE
 ERASE TITLE
 "Antenna match, Ant–Rx path"
 DONE

[Chan 2]
 TITLE
 ERASE TITLE
 "Antenna match, Ant–Tx path"
 DONE

Perform a two-port calibration for each channel and save the instrument state. Scale all channels. At this point, you should see a reflection response similar to Figure 6. The next paragraphs discuss the problem with the reflection response in Figure 6 and the issue related to measuring S_{22} .

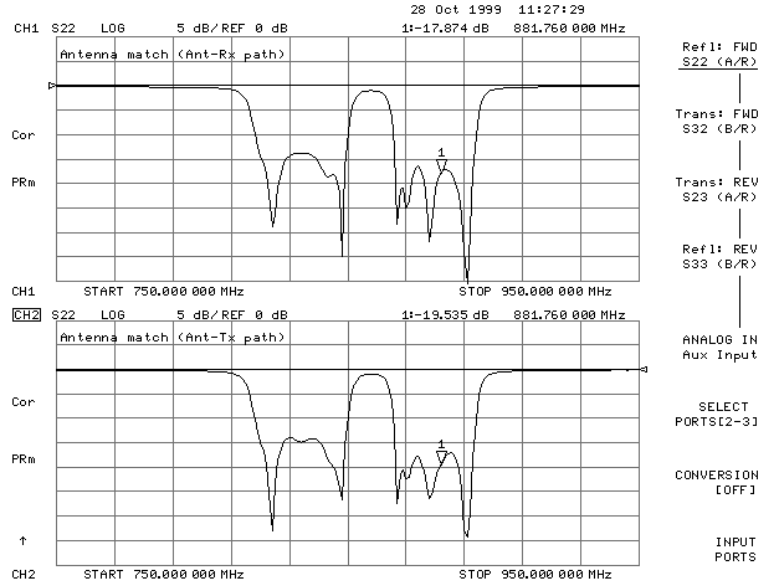


Figure 6. Antenna port-match measurement.

Examine the marker values on Figure 6. Even though both channels (upper and lower graticules) are measuring S_{22} , the response is not exactly the same. Channel 1 marker reads -17.8 dB, while channel 2 marker reads -19.5 dB.

The problem with measuring S_{22} or antenna match is that two ports can be considered load ports. One is the network analyzer port connected to the Rx port of the duplexer (port 1), and the second one is the network analyzer port connected to the Tx port of the duplexer (port 3). During a reflection measurement, the reflection from the uncorrected load port will cause errors in the measurement of antenna match, as shown in Figure 7.

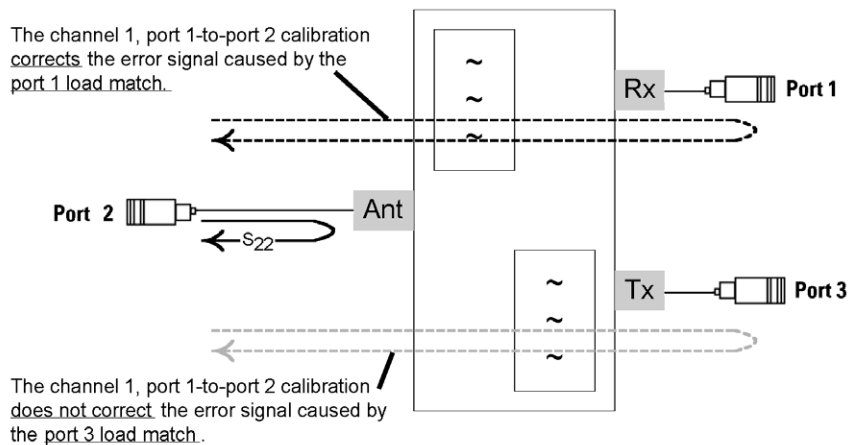


Figure 7. Each load port causes an error signal that interferes with the desired reflection signal from the antenna port. Using two-port calibration, one of these error signals can be significantly reduced. However, the other error signal remains present.

When sweeping the antenna port with frequencies covering both the Tx and Rx bands, the antenna port will first see the load on the Tx port (824 to 849 MHz) and then the load on the Rx port (849 to 869 MHz). See Figure 8.

Since the analyzer can only correct for two ports at a time, only one of the load ports can be corrected. The other load port will present its uncorrected value to the measurement. Consequently, one half of the trace of the antenna match will be accurate (due to the error-corrected load match), and one half of the trace will be inaccurate (due to the uncorrected load match).

In this case, you have performed a two-port calibration on the Ant-Rx path (channel 1) so the portion of the trace corresponding to the Ant-Rx path (higher frequency) will be accurate, and the Tx-Ant path (lower frequency) will be inaccurate (upper graticule of Figure 8).

Similarly on channel 2, you have performed a two-port calibration on the Tx-Ant path so the portion of the trace corresponding to the Ant-Rx path (higher frequency) will be inaccurate, and the Tx-Ant path (lower frequency) will be accurate (lower graticule of Figure 8).

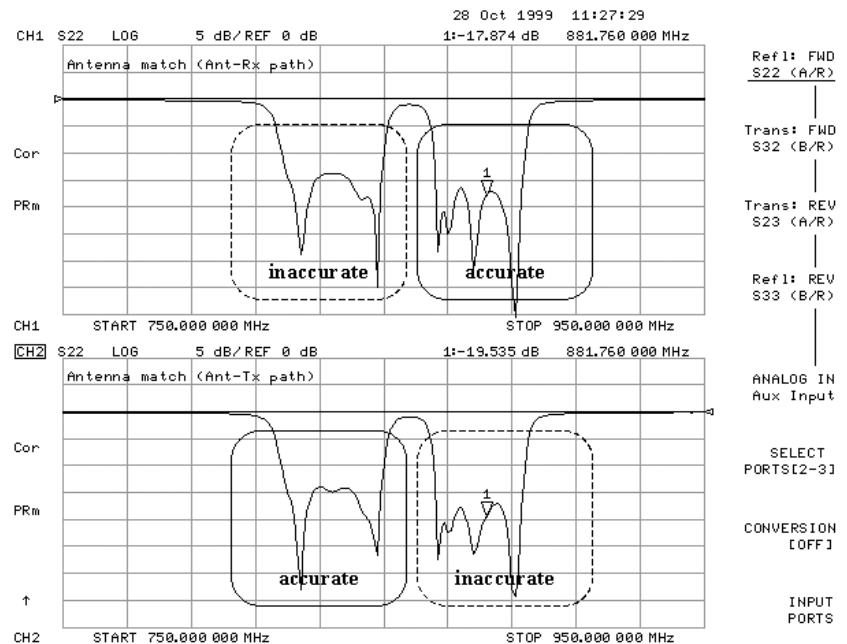


Figure 8. Duplexer antenna match measurements.

Since we can sweep both paths and display the data in one window, we have information that is accurate across the full frequency sweep. However, if we superimpose the two traces, you cannot easily distinguish between the accurate and inaccurate data for each path, as shown in Figure 9.

[Display]
DUAL/QUAD SETUP
1X

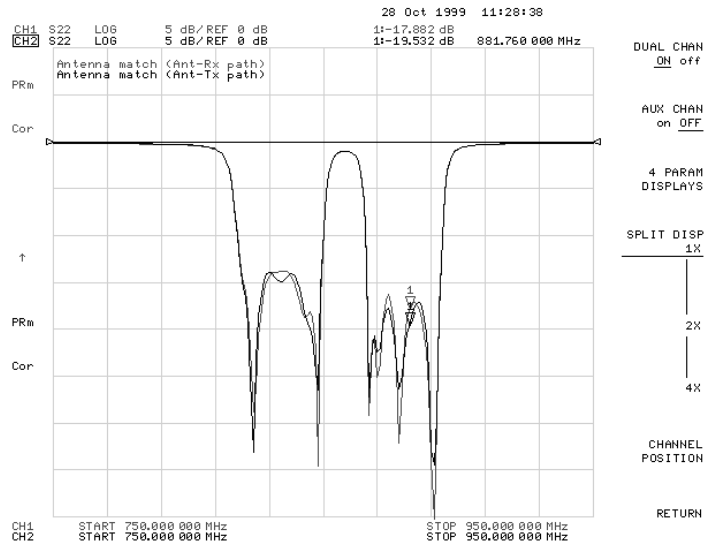


Figure 9. Without masking, the accurate and inaccurate portions of each trace cannot be distinguished.

By using the “memory” channel as a “mask” to remove the unwanted half of each trace, we can superimpose the two traces and see error-corrected accuracy across the full sweep. Note that we must display data divided by memory for the mask to have effect (Figure 10).

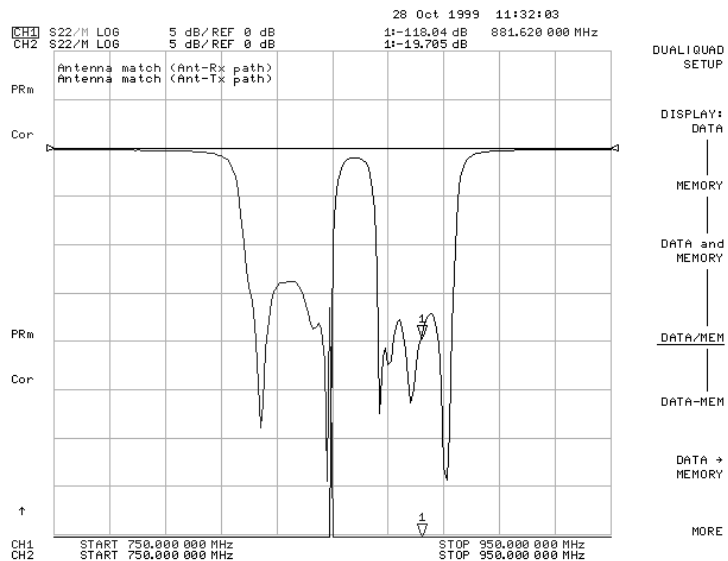


Figure 10. With masking, only accurate data is display. Notice that you are viewing DATA/MEM.

The memory trace used to “mask” half the trace was created in Agilent VEE. The program creates a memory trace with half 1, and half 100,000s. As a result if you are looking data divided by memory, the portion of the trace that is divided by 1 remains the same and the portion that is divided by 100,000 is essentially zero.

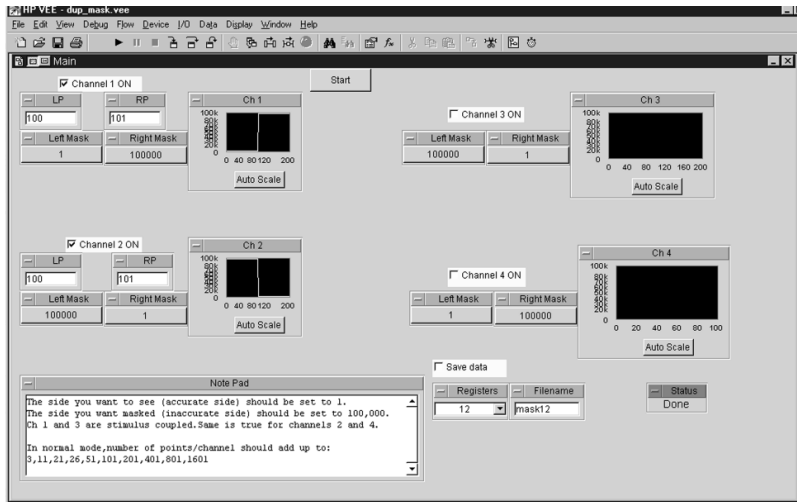


Figure 11. Agilent VEE program.

The Agilent VEE program is available via the web at:

http://www.agilent.com/find/8753_demo

If you do not have Agilent VEE or a measurement automation program, an assortment of masks has been supplied as instrument states on the web.

You can download them from: **http://www.agilent.com/find/8753_demo**

Figure 12 shows an example of the masks available on the web.

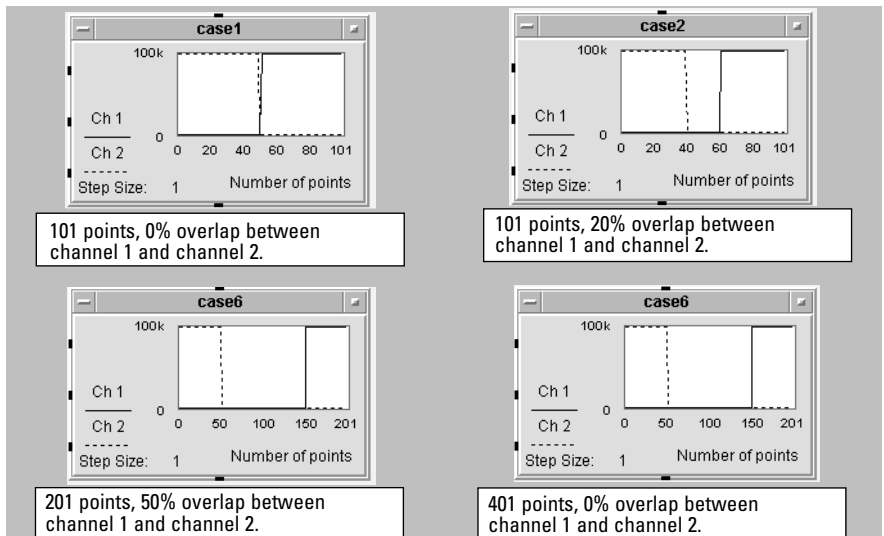


Figure 12. Example of masks available as memory traces.

If you decide to use the masks available on the web, first recall the instrument state that has the desired mask. The masks vary based on number of points and percentage of overlap between the two traces. You would recall the instrument state at the same location (time) as the [Preset] key in the instructions in this product note. You cannot change the number of points once you have recalled the mask. The memory trace will be erased if you change the number of points. However, you can set the other stimulus parameters such as frequency and power level, and the memory trace will not be affected. If you are using swept-list frequency mode and your total number of points is different from the standard 101, 201, etc., you must use a program to generate the memory trace.

Section C.
Measure receiver-to-transmitter isolation, receiver match, and transmitter match

Configure the network analyzer to measure S_{11} and S_{33} on channels 1 and 3, and S_{31} on channel 2. Calibrate the channels for port 1-3 path (Rx-Tx).

Table 5. Duplexer configuration for receiver and transmitter measurements.

Channel 1	Channel 3	Channel 2
S_{11}	S_{33}	S_{31}
Path 1-3 (Rx-Tx)		
Two-port calibration		

[Preset]

If you are using the Z5621A H39 external test set, configure the network analyzer initially using **[System]**, *CONFIGURE MENU*, *USER SETTINGS*, *K39 MODE ON off*. With Option H39 installed, the analyzer is automatically configured as a three-port test set.

[Start]
[750 M/μ]
[Stop]
[950 M/μ]

[Display]
DUAL/QUAD SETUP
4 PARAM DISPLAYS
SETUP F

[Meas]

[Chan 1]
SELECT PORTS [1-3]
Refl: FWD S_{11} (A/R) {Rx match}

[Chan 2]
Trans: REV S_{31} (A/R) {Rx-Tx isolation}

[Chan 3]
Refl: REV S_{33} (B/R) {Tx match}

[Chan 1]
[Format]
LOG MAG

[Chan 3]
LOG MAG

Title all channels.

[Chan 1]
Display
MORE
TITLE
ERASE TITLE
“Receiver match”

[Chan 2]
TITLE
ERASE TITLE
“Rx-Tx isolation”

[Chan 3]
TITLE
ERASE TITLE
“Transmitter match”

Perform a two-port calibration on the port 1 to 3 path. If necessary, reduce the IF bandwidth on channel 2 for an accurate Rx-Tx isolation measurement.

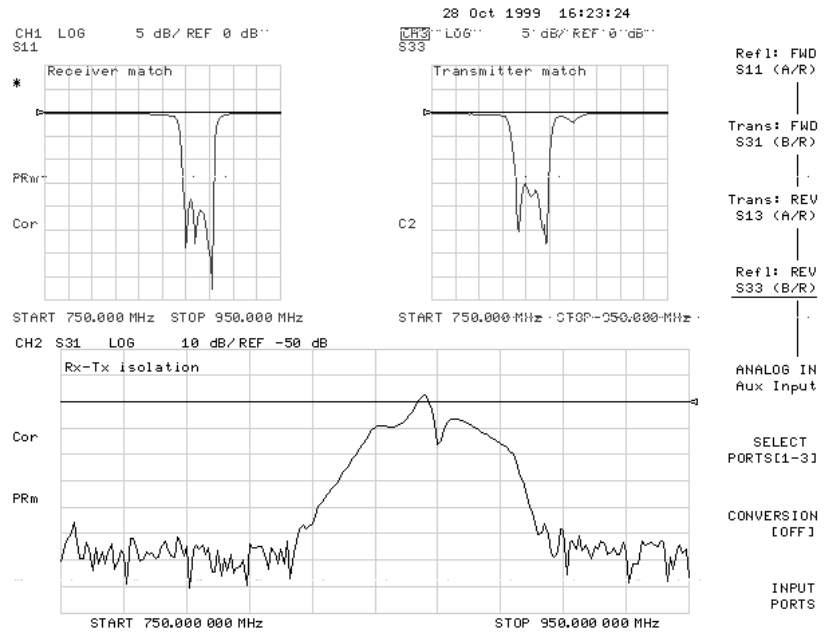


Figure 13. Receiver and transmitter match, and Rx-Tx isolation.

Accuracy considerations of a three-port measurement

The accuracy of measuring a three-port device while applying a two-port calibration is dependent on the uncorrected match and isolation of the third port. The following graphs show typical measurement uncertainties of a three-port device after two-port error correction. The curves utilize a root-sum-square model for the contribution of residual systematic errors, dynamic accuracy, and switch repeatability. The isolation values on the curves represent the isolation that the device presents to the uncorrected port outside of the measurement path.

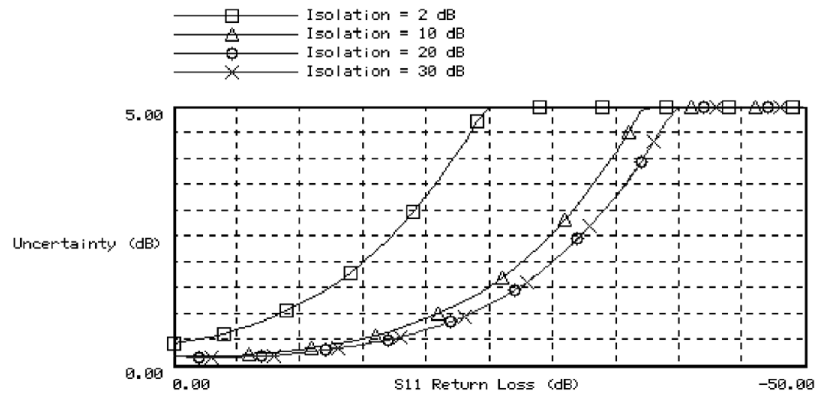


Figure 14. S_{11} measurement uncertainty.

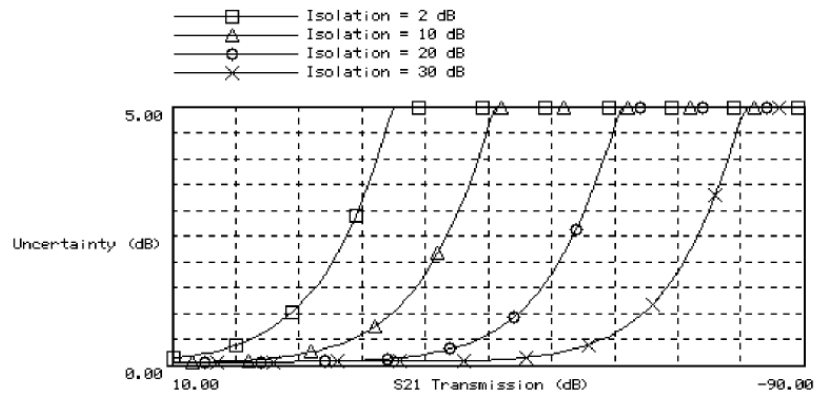


Figure 15. S_{21} measurement uncertainty.

**Example:
Receiver-to-transmitter isolation**

This section describes the measurement uncertainty associated with the uncorrected port mismatch. This section does not discuss the common systematic errors that are removed with a two-port calibration. The common systematic errors are documented in the 8753ES User's Guide.

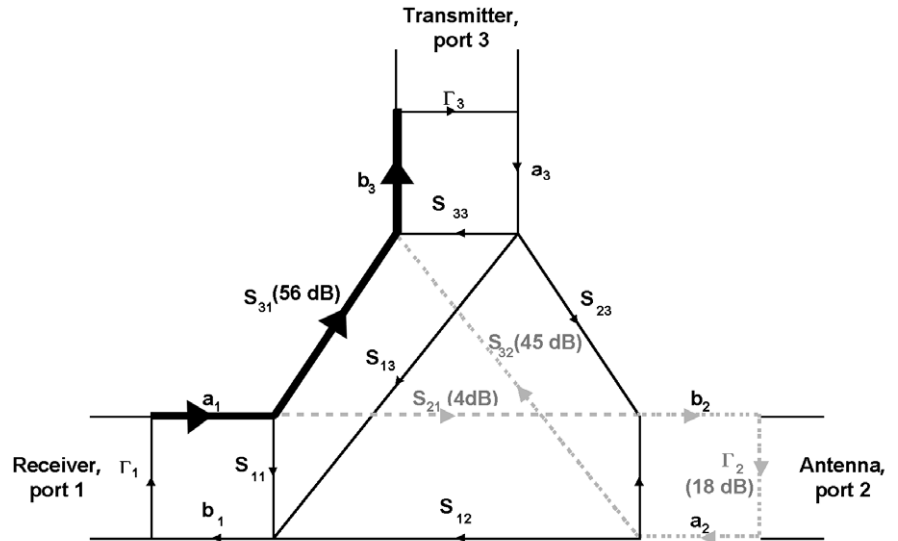


Figure 16. Flow diagram of a duplexer.

The flow diagram above represents a duplexer, with port 1 connected to the receiver, port 2 connected to the antenna, and port 3 connected to the transmitter.

The dark trace shows the Rx–Tx isolation (S_{31}) measurement. This signal starts at port 1 (Rx) and travels the dark path to port 3 (Tx). A closer look at the flow graph shows us another possible signal path from port 1 to port 3. The second (error) path is shown in a lighter color. The signal flows from the port 1 to port 2, is reflected off the network analyzer port 2, and flows from port 2 to port 3, where it is received.

The mismatch error vector is $S_{21} \times \Gamma_2 \times S_{32}$. The unwanted signal from the light colored path adds to the signal from the dark path, resulting in measurement error. In order to determine the maximum uncertainty, determine the worst case (maximum) value of the mismatch error term: $S_{21} \times \Gamma_2 \times S_{32}$.

For Γ_2 , use the uncorrected port match value given in the specifications, which is 18 dB. For S_{21} and S_{32} , you have to determine the maximum of $S_{21} \times S_{32}$. Using the maximum value of S_{21} and S_{32} individually is not appropriate since it is not possible for both traces to have their maximum values at the same frequency. So you have to determine the maximum value of $S_{21} \times S_{32}$ (see Figure 7).

Intuitively you would expect the maximum to occur at the crossover point (~28 dB loss on each trace). However, actual multiplication of the traces shows the maximum of 49 dB. The linear data for both S_{21} and S_{31} were read into Excel 97 and multiplied. Figure 7 shows the results. The maximum value of $S_{21} \times S_{32}$ occurs at the 866 MHz where S_{21} and S_{32} are 4 and 45 dB.

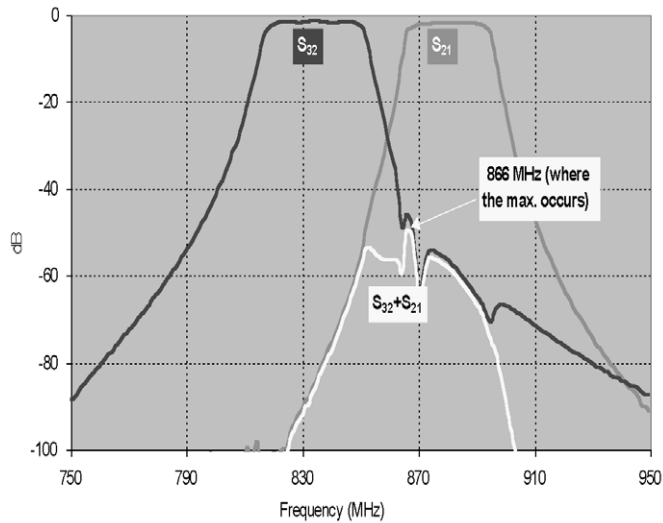


Figure 17. The maximum mismatch uncertainty occurs at 866 MHz. This is the maximum point for the $S_{21} \times S_{32}$ trace.

Table 6 shows the uncertainties associated with the isolation measurement that are due to the uncorrected port match. The nominal or worst case values are given in parentheses. The mismatch error calculation for the Rx–Tx isolation is shown below.

A note on usage of linear versus logarithmic values:

By definition, S-parameters are linear terms, and linear terms are often used in uncertainty calculations. However, most users view the logarithmic equivalent of S-parameters on network analyzers (insertion loss and return loss). During calculations, using either linear or logarithmic values is correct. Just make sure you multiply linear S-parameters or add the logarithmic values. In this section, logarithmic S-parameters are shown in *Italics*.

$$\begin{aligned} \text{Mismatch error using linear values} &= [S_{21} \times \Gamma_2 \times S_{32}] \\ \text{Mismatch error using log values} &= 20 \times \log \{1 \pm 10^{[S_{21} + \Gamma_2 + S_{32} - S_{31}] / 20}\} \\ \text{Using log values:} \\ \text{Mismatch error} &= 20 \times \log \{1 \pm 10^{[-4 + -18 + -45 - (-49)] / 20}\} \\ &= 20 \times \log \{1 \pm 10^{[-18/20]}\} = 1.03 / 1.17 \text{ dB} \end{aligned}$$

Table 6. Duplexer measurement uncertainty due to uncorrected port match.

Measure	S-parameter	Mismatch error terms (log values)	Mismatch error
Rx–Tx	S_{31} (<i>-49 dB</i>)	$S_{21} + \Gamma_2 + S_{32}$ (<i>-4 dB + -18 dB + -45 dB</i>)	1.17 dB

Table 7 shows the uncertainties associated with measuring Ant–Rx and Tx–Ant insertion loss. As you can see, the uncertainty due to the uncorrected port match is minimal.

Table 7. Duplexer measurement uncertainty due to uncorrected port match.

Measure	S-parameter	Mismatch error terms	Mismatch error
Ant–Rx	S_{12} (<i>-3 dB</i>)	$S_{32} + \Gamma_3 + S_{13}$ (<i>-47 dB + -18 dB + -49 dB</i>)	0.00002 dB
Tx–Ant	S_{23} (<i>-2 dB</i>)	$S_{13} + \Gamma_1 + S_{21}$ (<i>-60 dB + -18 dB + -57 dB</i>)	0.000002 dB

Example: Coupler isolation

You can easily measure a coupler's insertion loss and coupling factor using an 8753ES with Option H39. However, measuring the isolation is more challenging. The difficulty of measuring isolation can be traced to the mismatch effects of the third uncalibrated load port. Figure 18 shows the setup for measuring the isolation of a coupler.

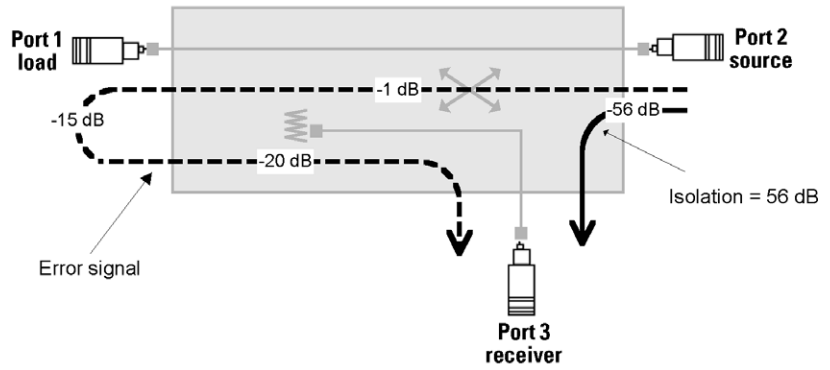


Figure 18. Coupler connection diagram for measuring isolation.

Table 8. Coupler isolation measurement uncertainty.

Measure	S-parameter	Mismatch error terms	Mismatch error
Isolation	S_{32} (-56 dB)	$S_{12} + \Gamma_1 + S_{31}$ (-1 dB + -15 dB + -20 dB)	21 dB

Table 8 shows the isolation measurement error due to port 1 uncorrected mismatch. The uncertainty of this measurement is so high (+21 dB) that it is simply not adequate for today's test requirements. With 21 dB of mismatch error, the coupler isolation can be as high as -35 dB (-56 + 21 dB.)

Fortunately, the addition of a good load or attenuator to the third port can significantly reduce the mismatch uncertainty. Figure 19 shows the isolation of a 20-dB coupler. The trace with the mismatch ripple pattern shows the measurement with the third port (coupler input port) connected directly to the network analyzer third port. The dark and light smooth traces shows the measurement with the third coupler port connected to a 50-ohm load and 20-dB attenuator, respectively.

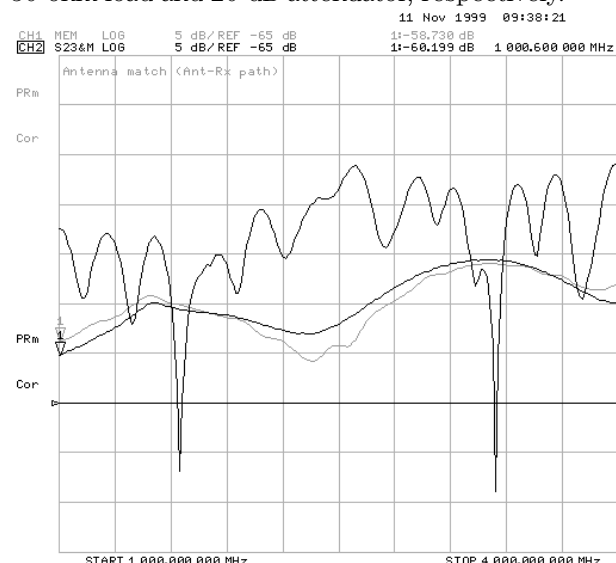


Figure 19. Isolation measurement uncertainty can be significantly improved by adding a well-matched load to the third port.

8753ES Option H39 Specifications

Table 1. Uncorrected performance characteristics ¹

Terms	30 kHz to 300 kHz ²	300 kHz to 1.3 GHz	1.3 GHz to 3 GHz	3 GHz to 6 GHz
Directivity (dB)	20 ³	35	30	20
Source match (dB)	10 ⁴	16	16	12
Load match (dB) ⁵	18	18	16	14
Reflection tracking (dB)	±3.5	±1.5	±1.5	±2.5
Transmission tracking (dB)	±3.5	±1.5	±1.5	±2.5
Crosstalk (dB)	90 ⁶	100	100	90

The corrected specifications depend on the calibration kit that is used. Refer to the 8753ES Option H39 User's Guide (part number 08753-90009) for the corrected specifications.

Output power

Port 1 –85 to +10 dBm
 Port 2 and port 3 –85 to +7 dBm

Average noise level

300 kHz to 3 GHz –81 dBm (3 kHz BW)
 300 kHz to 3 GHz –102 dBm (10 Hz BW)
 3 GHz to 6 GHz –76 dBm (3 kHz BW)
 3 GHz to 6 GHz –97 dBm (10 Hz BW)

Maximum input power +10 dBm

1. Applies at 25 ±5 °C
2. Typical
3. 15 dB, 30 kHz to 50 kHz
4. 10 dB, 30 kHz to 50 kHz
5. Off-state load match typically ≥18 dB for 100 kHz to 3 GHz, ≥16 dB for 3 GHz to 6 GHz
6. 60 dB for 30 kHz to 100 MHz

Questions and answers

How can I speed up the measurement?

Two-port calibration provides the best measurement accuracy. However, it also requires two sweeps per path, one forward and one reverse sweep. Response and enhanced response calibrations are less accurate than two-port. However, they only require one sweep per trace update. The accuracy difference between response, enhanced response, and two-port calibration depends on the device. Thus, you should determine whether your accuracy constraints require a two-port calibration. For further information on this topic, please refer to the 8753ES User's Guide.

What is the optimum way to measure a high dynamic range filter (>90 dB)?

Accurate measurement of duplexers with high dynamic range (90 dB) require sweeping using narrow IF bandwidths. Narrow IF bandwidths significantly increase measurement time. The 8753ES swept-list-frequency mode allows optimization of speed, dynamic range and accuracy of duplexer measurements.

What are the differences between an 8753ES Option H39, 8753ES with Z5621A H36 or 8753ES with Z5621A H39?

The Z5621A H39 is a three-port external test set that connects to port 1 and port 2 of a standard 8753 network analyzer, and it can measure all the same parameters as 8753ES H39. Z5621A H36 is a three-port external test set that can be used to measure Tx–Ant and Ant–Rx paths, but not the Tx–Rx path.

With Z5621A H39, measurement accuracy is slightly degraded relative to 8753ES H39. With 8753ES H39, the switches are behind the coupler, as opposed to Z5621A H39, where the switches are in front of the coupler. The loss of the switches after the coupler reduces the uncorrected directivity of the coupler, and the reduced uncorrected directivity degrades measurement accuracy. The article “Effects of Uncorrected RF Performance in a Vector Network Analyzer”¹ describes the accuracy considerations in detail.

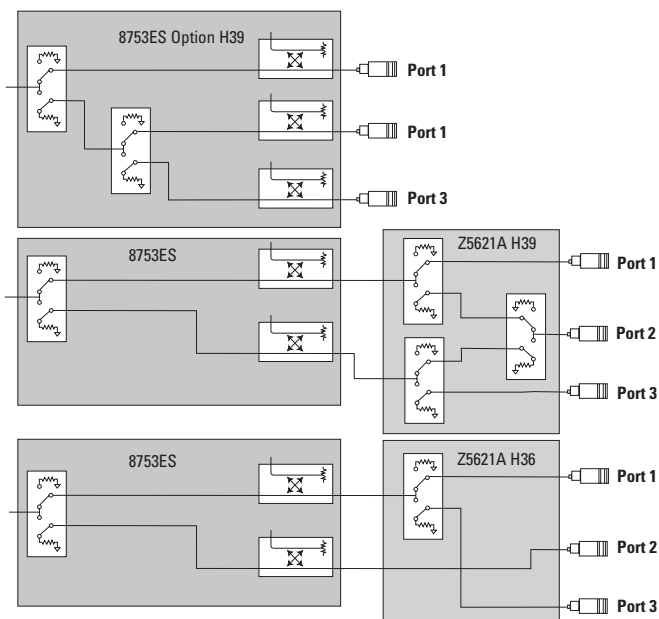


Figure 20. Block diagram of 8753ES Option H39, 8753ES with Z5621A H39, 8753ES with Z5621A H36.

1. “Effects of Uncorrected RF Performance in a Vector Network Analyzer,” Doug Rytting, Microwave Journal, April 1991

What is the recommended solution for measuring couplers?

The ATN-4000 series of multiport test systems from ATN Microwave combines a 8753ES with a four-port test set and Windows® based software. The test systems incorporate full four-port error correction to provide exceptional measurement accuracy.

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