Measurement Guide

Vector Network Analyzer

for Anritsu RF and Microwave Handheld Instruments

Time Domain	**Option 2**
Bias Tee	**Option 10**
Vector Voltmeter	**Option 15**
6 GHz VNA Frequency Extension	**Option 16**
Balanced Ports	**Option 77**
Distance Domain	**Option 501**

Note	Option 501, Distance Domain measurements, becomes a standard feature with newer firmware. Refer to Chapter 9. Not all instrument models offer every option or every measurement within a given option. Please refer to the Technical Data Sheet of your instrument for available options and measurements within the options.

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Table of Contents

Chapter 1—General Information

1-1 Introduction 1-1

1-2 Product Information, Compliance, and Safety 1-1

1-3 Contacting Anritsu 1-1

1-4 VNA Master Models 1-2

1-5 Identifying the Connections 1-3

Chapter 2—VNA Display Overview

2-1 Introduction 2-1

2-2 Powerful Display Capabilities 2-1

- Flexible Features For Displaying Results 2-1
- Active Trace 2-2
- Changing the Active Trace 2-2
- Touch Screen Trace Features 2-3
- Trace Description 2-3
- Example Measurement Displays 2-4

2-3 Marker and Limit Capabilities 2-7

- Marker Description 2-7
- Selecting the Readout Style for Each Marker 2-7
- Displaying Markers on the Screen 2-7
- Setting Up Delta Markers 2-8
- Setting Up Limits 2-8
- Markers on a Touch Screen 2-8

2-4 Trace Math Capabilities 2-9

Chapter 3—VNA Fundamentals

3-1 Introduction 3-1

- Option 16 (S412E LMR Master) 3-1

3-2 S-Parameters 3-2

- Additional Examples: 3-2

3-3 VNA Master Architecture 3-3

3-4 Calculating and Displaying S-Parameters 3-6

3-5 Extracting More Information by Using Markers 3-8

3-6 How Bias is Generated 3-8

Chapter 4—VNA Measurements

4-1 Introduction 4-1
Select Measurement Type – VNA versus Field 4-1
Touch Screen Trace Features 4-1
Markers on a Touch Screen 4-1
4-2 1-Port Cable Measurement 4-1
Introduction 4-1
Setup Considerations 4-1
Measurement Readout and Interpretation 4-2
4-3 1-Port Smith Chart Tuning Example 4-5
4-4 2-Port Filter Measurement 4-7
Introduction 4-7
Setup Considerations 4-7
Measurement Readout and Interpretation 4-7
4-5 2-Port Amplifier Measurement 4-10
Introduction 4-10
Setup Considerations 4-10
Measurement Readout and Interpretation 4-10
4-6 Waveguide Considerations 4-13
Introduction 4-13
Setup Considerations 4-13
Measurement Readout and Interpretation 4-14
4-7 Calibration Considerations 4-16
MS20xxB 1-Path 2-Port Calibration 4-17
MS20xxC Full 2-Port Calibration 4-18
Calibration Data and Indications 4-19
Cal Type 4-20

Chapter 5—Field Measurements

5-1 Introduction 5-1
Options 5-1
5-2 Field Measurements View Setting 5-1
Select Measurement Type – Field versus VNA 5-1
Touch Screen Trace Features 5-1
Markers on a Touch Screen 5-1
5-3 Measurement Setup 5-2
Setting the Frequency Range 5-2
Setting the Start and Stop Frequencies 5-3
Setting Data Points 5-3
Calibration 5-3

5-4 Graph Type Selector List Box 5-4
Field Measurements View versus VNA Measurements View 5-4
Insertion Loss in Display Type Single 5-5
VSWR and Return Loss in Display Type Dual 5-6
Insertion Loss and Return Loss in Display Type Overlay 5-7
5-5 Field View Menus 5-8
5-6 VNA Measurements 5-8
5-7 Return Loss/VSWR 5-9
5-8 Cable Loss 5-12
5-9 Distance-To-Fault (DTF) 5-14
DTF Measurement Calculations 5-18
5-10 Phase Measurements 5-19
1-Port Phase Measurement 5-19
2-Port Phase Measurement 5-20
5-11 Smith Chart 5-22
Smith Chart Measurement 5-22
5-12 Log Mag Display Types 5-24
Typical Log Magnitude Measurement 5-24
Dual Channel Filter Tuning Measurement 5-27

Chapter 6—VNA View Menus

6-1 Introduction 6-1
6-2 VNA Key Functions 6-1
Introduction 6-1
6-3 Domain Setup Menus 6-3
Freq Menu 6-4
Setup Domain Menu 6-5
Time Menu 6-6
Time Info List Box 6-7
Windowing Menu 6-8
Distance Setup Menu 6-9
Additional Dist Setup Menu (Coax) 6-10
Cable List Menu (Coax) 6-11
Additional Dist Setup Menu (Waveguide) 6-12
Distance Info List Box for Cable 6-13
Distance Info List Box for Waveguide 6-13
FGT Menu 6-14
Gate Menu 6-15
Gate Setup Menu (continued) 6-16
Gate Shape Menu 6-17

6-4 Calibration Menus 6-18
Calibration Menu 6-19
Calibration Menu with Thru Update 6-25
Calibration Line Setup Menu 6-27
Existing Calibration Information List Box 6-28
Additional Calibration Considerations 6-28
DUT Port Setup Menu (Coax) 6-29
Cal Kit Definition Menus for Coax 6-30
DUT Connector Selector List Box for Coax 6-31
SOLT – Coax Menu 6-32
DUT Port Setup Menu (Waveguide) 6-33
Cal Kit Definition Menus for Waveguide 6-34
DUT Connector Selector List Box for Waveguide 6-35
SOLT – WG Menu 6-36
Calibration Types 6-37
6-5 Limit Menus 6-38
Limit Menu 6-39
Limit Edit Menu 6-40
6-6 Marker Menus 6-41
Marker Menu 6-42
Marker Search Menu 6-43
Readout Format Menu 6-44
6-7 Measurement Menus 6-45
Measure Menu 6-46
S-Parameter List Box 6-47
S-Parameter Menu 6-48
Domain Menu 6-49
Low Pass Mode Menu 6-50
Band Pass Mode Menu 6-50
Number of Traces Menu 6-51
Trace Format Menu 6-52
Sweep Menu — MS20xxC 6-53
Sweep Menu — MS20xxB and S412E 6-54
Configure Ports Menu 6-55
Bias Tee Setup Menu 6-56
Bias Tee Menu (MS20xxC only) 6-57
Source Power Menu (MS20xxC only) 6-58
Source Power Menu (MS20xxB and S412E only) 6-58
Preset Menu 6-59
Scale Menu 6-60
Smith Scale Menu 6-61
Polar Scale Menu 6-62

6-8 System Menus 6-63
System Menu. 6-63
Application Options Menu (VNA Mode). 6-64
Application Options Menu (SPA Mode) VNA Master. 6-65
Application Options Menu (SPA Mode) LMR Master 6-66
Time Domain Options Menu 6-67
Trace Menu 6-68
Display Menu (Trace) 6-68
Trace Math Menu 6-69

Chapter 7—Field View Menus

7-1 Introduction. 7-1
7-2 Field View Menus 7-1
Field View Menu Group (Field View). 7-2
7-3 Field View Frequency Menus 7-3
Freq Menu (Frequency-Based) 7-3
Freq/Dist Menu (Distance-Based) 7-4
7-4 Distance Menus 7-5
DTF Menu Group (Field View). 7-5
DTF Setup Menu 7-6
Cable List Menu. 7-7
Windowing Menu 7-8
7-5 Scale Menus. 7-9
Scale Menu Group (Field View). 7-9
Scale Menu 7-10
Scale Menu – Single 7-10
Scale Menu – Dual or Overlay. 7-11
7-6 Sweep Menus. 7-12
Sweep Menu Group (Field View). 7-12
Sweep Menu 7-13
Avg/Smooth Menu. 7-14
Output Power. 7-14
Source Power Menu 7-14
7-7 Measure Menus 7-15
Measure Menu Group (Field View) 7-15
Measure Menu – Single. 7-15
Measure Menu – Dual 7-16
Measure Menu – Overlay 7-16
Marker Menu 7-17
7-8 Calibration Menu. 7-18
7-9 Existing Calibration Information List Box 7-18

7-10 Application Options Menu 7-19

Chapter 8—Time Domain, Option 2

8-1 Introduction 8-1
8-2 Time Domain Measurements 8-1
8-3 VNA Master Implementation 8-2
One Way versus Round Trip 8-2
Time Domain – Impulse Response 8-5
Step Response versus Impulse Response 8-6
Low Pass versus Band Pass 8-6
Frequency Gated by Time 8-9
Waveguide with Dispersion Compensation 8-11
Phasor Impulse 8-13
8-4 Windowing 8-15
8-5 Distance-to-Fault Measurement Example 8-15
In the Measure Menu: 8-15
In the Sweep Menu: 8-15
In the Freq/Time/Dist Menu: 8-15
In the Additional Dist Setup Submenu: 8-16
8-6 Time and Distance Information 8-17

Chapter 9—Distance Domain

9-1 Introduction 9-1
9-2 Distance Domain Measurements 9-1
9-3 VNA Master Implementation 9-2
One Way versus Round Trip 9-2
9-4 Windowing 9-4
9-5 Distance-to-Fault Measurement Example 9-4
In the Measure Menu: 9-4
In the Sweep Menu: 9-4
In the Freq/Dist Menu: 9-4
In the Additional Dist Setup submenu: 9-4
9-6 Distance Information 9-6

Chapter 10—Bias Tee, Option 10

10-1 Introduction 10-1
10-2 Bias Tee Fundamentals 10-1
10-3 How Bias is Generated 10-2
10-4 Bias Tee when Making 2-Port Gain Measurements 10-5

10-5 Bias Tee Menus (MS20xxC, MS2026B, and MS2028B) 10-7
Bias Tee Setup Menu 10-8
Bias Tee Menu 10-9
10-6 Bias Tee Menus (Field Measurements View) 10-10
Bias Tee Setup Menu 10-11
Bias Tee Menu 10-11
10-7 Bias Tee Menus (MS20xxB and S412E in VNA View) 10-12

Chapter 11—Vector Voltmeter, Option 15

11-1 Introduction 11-1
11-2 Getting Started 11-2
11-3 Using Vector Voltmeter Mode for the First Time 11-3
11-4 How the VVM Function Works 11-4
11-5 Simple Measurement Using CW Display 11-5
11-6 Calibration Correction 11-6
11-7 Relative Measurements using CW Display 11-10
11-8 Measurements Using Comparison Table Display 11-12
11-9 Vector Voltmeter Menus 11-14
CW Menu 11-14
Table Menu 11-15
Save/Recall Menu 11-16
Calibration Menu 11-16

Chapter 12—Balanced Ports, Option 77

12-1 Introduction 12-1
12-2 Procedure For Using Balanced Ports 12-1
12-3 Typical Measurements 12-3

Appendix A—Formulas

A-1 Vector Network Analyzer Formulas A-1
Reflection Coefficient A-1
Return Loss A-1
VSWR A-1
Smith Chart A-1
Inverted Smith Chart A-1
Electrical Length A-1
Propagation A-2
Cable Loss A-2
Fault Resolution A-2
Maximum Horizontal Distance A-2
Suggested Span A-2

Appendix B—Windowing

B-1 Introduction B-1
Rectangular Windowing B-2
Nominal Side Lobe Windowing B-3
Low Side Lobe Windowing B-4
Minimum Side Lobe Windowing B-5

Appendix C—Error Messages

C-1 Introduction C-1
C-2 Reset Options C-1
Reset Via Instrument Menus C-1
Reset from OFF Condition C-1
C-3 Self Test or Application Self Test Error Messages C-2
Self Test C-2
Application Self Test Results Window — VNA C-4
Application Self Test (Vector Network Analyzer mode only) C-4
Application Self Test Results Window — SPA C-5
C-4 Operation Error Messages C-6
Fan Failure C-6
High Temp Warning C-6
Operation not Permitted in Recall Mode C-6
PMON PLD Fail C-7
Power Supply C-7
Error Saving File. General Error Saving File C-7
C-5 Vector Network Analyzer Specific Warning Messages C-7
Bias Tee cannot be enabled for start freq < 2MHz C-7
Bias Tee is not allowed for start freq < 2MHz C-7
Changing Source Power C-7
No valid calibration to change correction C-7
Cannot continue with calculating C-7
Bias Tee state cannot be changed during calibration C-8
Turning Bias Tee to OFF C-8
Turning Bias Tee to OFF C-8
Turning Bias Tee to OFF C-8
Calibration will be lost after change C-8
Changes not allowed during calibration C-8
Option 10 (Bias Tee) not enabled C-8
No External Reference signal detected C-8
Limit is not available for this Graph type C-9

Index

Chapter 1 — General Information

1-1 Introduction

This chapter contains general information about vector network analysis with Anritsu handheld instruments.

1-2 Product Information, Compliance, and Safety

Read the Handheld Instruments Product Information, Compliance, and Safety Guide (PN: 10100-00065) for important safety, legal, and regulatory notices before operating the equipment. For additional information and literature covering your product, visit the product page of your instrument on http://www.anritsu.com/ and select the Library tab.

Not all instrument models offer every option. Please refer to the Technical Data Sheet of your instrument for available options.

1-3 Contacting Anritsu

To contact Anritsu, please visit:

http://www.anritsu.com/contact-us

From here, you can select the latest sales, select service and support contact information in your country or region, provide feedback, complete a "Talk to Anritsu" form to have your questions answered, or obtain other services offered by Anritsu.

Updated product information can be found on the Anritsu web site:

http://www.anritsu.com/

Search for the product model number. The latest documentation is on the product page under the Library tab.

1-4 VNA Master Models

This Measurement Guide is for the following Vector Network Analyzer instrument models:

- MS2024B, MS2025B, MS2034B, MS2035B (MS20xxB), VNA Master
- MS2026C, MS2027C, MS2028C, MS2036C, MS2037C, MS2038C (MS20xxC), VNA Master
- MS2026B and MS2028B VNA Master with Firmware Version 2.0 and higher.
- S412E LMR Master (in VNA mode)

Note	Not all instrument models offer every option. Please refer to the Technical Data Sheet for your instrument to determine the available options.

Throughout this manual, references to Vector Network Analyzer and references to instruments that are two-port, 1-path vector network analyzers include both the MS20xxB compact VNA Master and the S412E LMR Master models.

This guide contains measurement instructions for the available Vector Network Analyzer instrument options. Not all options are available on all models, and your instrument may not have all options installed. Refer to the options sticker on the rear panel or connector panel, or to the Technical Data Sheet and User Guide that were supplied with your instrument to determine which options are available. To view the installed option numbers, you can press **Shift** and **System** (**8**) to display the System menu, and then press Status to view instrument status, which includes a list of option numbers that are active in your instrument. The Technical Data Sheet describes each available option by both its number and its name.

The MS20xxB compact VNA Master and the S412E LMR Master models are two-port, 1-path vector network analyzers that allow S_{11} and S_{21} measurements (Insertion Loss and Return Loss) with a single connection.

The MS2026B, MS2028B, and MS20xxC VNA Master models are full-reversing, two-port vector network analyzers that allow reflection measurements from both ports and allow transmission measurements in both directions (S_{11}, S_{21}, S_{22}, and S_{12} measurements) with a single connection.

Throughout this manual, the terms in Table 1-1 are used to indicate VNA Master models. Most of the measurement screen figures in this manual are taken from the MS20xxC in order to demonstrate the fullest feature set of the VNA Master product. Depending on the model of your VNA Master and the installed options, some features and screen details may differ.

Table 1-1. Instrument Terminology used in this Manual

Term	Instrument Models
VNA Master	MS2024B, MS2025B, MS2034B, MS2035B MS2026B, MS2028B MS2026C, MS2027C, MS2028C, MS2036C, MS2037C, MS2038C
MS202xB	MS2024B and MS2025B
MS203xB	MS2034B and MS2035B
MS20xxB	MS2024B, MS2025B, MS2034B, MS2035B
MS2026B	MS2026B with Firmware Version 2.0 and higher
MS2028B	MS2028B with Firmware Version 2.0 and higher
MS202xC	MS2026C, MS2027C, and MS2028C
MS203xC	MS2036C, MS2037C, and MS2038C
MS20xxC	MS2026C, MS2027C, MS2028C, MS2036C, MS2037C, MS2038C
LMR Master	S412E
S412E	S412E

Note	MS20xxB is used in this manual to refer ONLY to models MS2024B, MS2025B, MS2034B, and MS2035B. When referring to models MS2026B and MS2028B, the full model numbers are specified and are never abbreviated.

1-5 Identifying the Connections

The VNA Master and LMR Master connectors are described in the user guide for your instrument.

Chapter 2 — VNA Display Overview

2-1 Introduction

This chapter provides an overview of the display features that are found in the VNA Master and the S412E LMR Master. The topics include active traces, trace format, number of traces, markers, and limits.

2-2 Powerful Display Capabilities

These vector network analyzers have a flexible display capable of single, dual, tri, and quad displays, meaning that you can subdivide the measurement display area into 2, 3, or 4 sections. In addition, the vector network analyzers support the display of up to four traces in each single, dual, tri, or quad display. Becoming familiar with these flexible display capabilities is important before you begin any calibrations and measurements.

The function hard keys in Vector Network Analyzer mode without Option 2 (Time Domain) are:

Freq/Dist, Scale, Sweep, Measure, Marker

The function hard keys in Vector Network Analyzer mode with Option 2 (Time Domain) are:

Freq/Time/Dist, Scale, Sweep, Measure, Marker

Flexible Features For Displaying Results

If you are not yet familiar with the menus that control trace display, refer to the "Measure Menu" on page 6-46, to the "Number of Traces Menu" on page 6-51, and to the "Trace Format Menu" on page 6-52. To select the Measure soft key menu on your vector network analyzer, press the **Measure** function hard key (you must be in Vector Network Analyzer mode for this example).

Perform the following steps to observe the trace format features:

1. In MS20xxC instruments, the default view uses Trace Format = Quad with Number of Traces = 4. Refer to Figure 2-1 on page 2-4.

   In MS20xxB and S412E instruments, the default view uses Trace Format = Dual with Number of Traces = 2.

2. Beginning with the default view, set Trace Format = Single, and Number of Traces = 4. Notice how all 4 traces are overlaid on a single graph. Refer to Figure 2-2 on page 2-4.

3. Next, set Trace Format = Dual. Note how the 4 traces are assigned to the split display. TR1 (Trace 1) and TR3 are assigned to the top graph. TR2 and TR4 are assigned to the bottom graph. Refer to Figure 2-3 on page 2-5.

4. Next change Trace Format to Tri. Note how the 4 traces are assigned on this display. TR3 and TR4 are now overlaid in the bottom half of the display area. Refer to Figure 2-4 on page 2-5.

5. Now return to the default display of Trace Format = Quad. Change the Number of Traces from 4 to 1. Note how the top left quadrant is filled, while the other three quadrants have no data. Refer to Figure 2-5 on page 2-6.
6. Increment the number of traces from 1 back to 4 and note how the vector network analyzer adds the additional traces to the display. Refer to Figure 2-6 on page 2-6. (Note that Figure 2-1 and Figure 2-6 are the same measurement illustration.)
7. At this point, the display is back to the MS20xxC default setting of Quad with 4 traces.
8. For MS20xxB and S412E instruments, set Trace Format = Dual, and set Number of Traces = 2. At this point, the instrument is back to the default setting of Trace Format = Dual with Number of Traces = 2.

Regardless of the Trace Format that is selected, the number of traces that are displayed is controlled by the Number of Traces soft key. For a brief description, refer to the examples that accompany Figure 6-50, "Trace Format Menu" on page 6-52.

Active Trace

Notice on the Quad trace format that one trace has a red outline box on the graph, and the trace number in the Instrument Settings Summary (on the left side of the sweep window) is outlined with a red rectangle. This is the active trace, and only one trace is active at a time. Any display or format selection is applied only to the active trace.

Changing the Active Trace

You can change the active trace in four ways:

1. In the Measure menu, press the Active Trace soft key to select the trace that you want to be active. The pop-up list box displays the active traces (TR1 through TR4) and parenthetically also lists the unique attributes that are associated with each trace (in other words, S-parameter, graph type, domain, and smoothing percentage). After a selection, notice how the active trace indicator on the display has changed. For example, if the active trace changed from TR1 to TR3, then the red highlight box moved from the upper left quadrant to the lower left quadrant.

   Not only does the graph get highlighted in red, but the Instrument Settings Summary legend on the left side of the sweep window also highlights the active trace. This becomes more important when you are trying to distinguish between active traces and other traces when they are all overlaid on one graph.
2. In the Measure menu, turn the rotary knob clockwise, and the active trace indicator moves clockwise on the quad trace format display. If you turn the rotary knob counterclockwise (CCW), then the active trace indicator moves in a CCW direction on the display.
3. In the Measure menu, use the **Up/Down/Left/Right** arrow keys to select the active trace.
4. On instruments with touch screen displaying multiple traces, touching a trace area causes that trace to become active.

In any menu, when no active parameter is selected, the rotary knob or the arrow keys allow you to select an active trace.

Another powerful feature to become acquainted with is the ability to Maximize and Minimize an active trace. On the quad default display, select Maximize Active Trace from the Measure menu, and note how this feature zooms in on the active trace and uses maximum area to display the measurement results. Next, select Minimize Active Trace to return to the original trace format of quad display. On instruments with touch screen, touching an active trace twice in rapid succession alternately maximizes and minimizes that trace. Note that this touch ability is disabled when the marker menu is active because of the touch and drag ability for markers.

Combining the previously described active trace selection techniques with this Maximize and Minimize active trace feature allows for maximum flexibility in extracting the measurement results from the display.

Touch Screen Trace Features

These touch features differ when the Marker menu is displayed (refer to "Markers on a Touch Screen" on page 2-8).

Selecting a Trace

In VNA Measurements view on touch screen instruments, when Trace Format is Dual, Tri, or Quad, you can touch or tap either the trace itself or the trace data in the Instrument Settings Summary (left edge of sweep window) to select a trace.

These touch points function in the same manner when using the Field Measurements view in Display Type Dual.

In Display Type Overlay, however, only a touch on trace data for TR2 in the Instrument Settings Summary selects Trace 2 as the active trace. Any touch on the sweep window selects Trace 1 (the upper or top trace) as the active trace.

If a Marker is active on a trace, and if the Marker menu is displayed, then after that trace is active, an additional touch within the sweep window affects the location of the active marker (refer to "Markers on a Touch Screen" on page 2-8).

Maximizing and Minimizing Traces

In VNA Measurements view, when a trace is active in Dual, Tri, or Quad format, a quick double tap on either the trace itself or the trace data in the Instrument Settings Summary maximizes the active trace. Another double tap minimizes the trace. When a trace is maximized, touching a different trace in the Instrument Settings Summary displays that touched trace in maximized view. These touch points are not functional when using the Field Measurements view,

This touch feature differs when a Marker is active on a trace and the Marker menu is displayed.

Trace Description

A trace is a measurement result that can have user-defined attributes assigned to it for display purposes. You can assign the following attributes for a trace: S-parameter, Graph Type, Domain, and Smoothing. Using the Scale menu, you can independently set the scale for each trace.

Example Measurement Displays

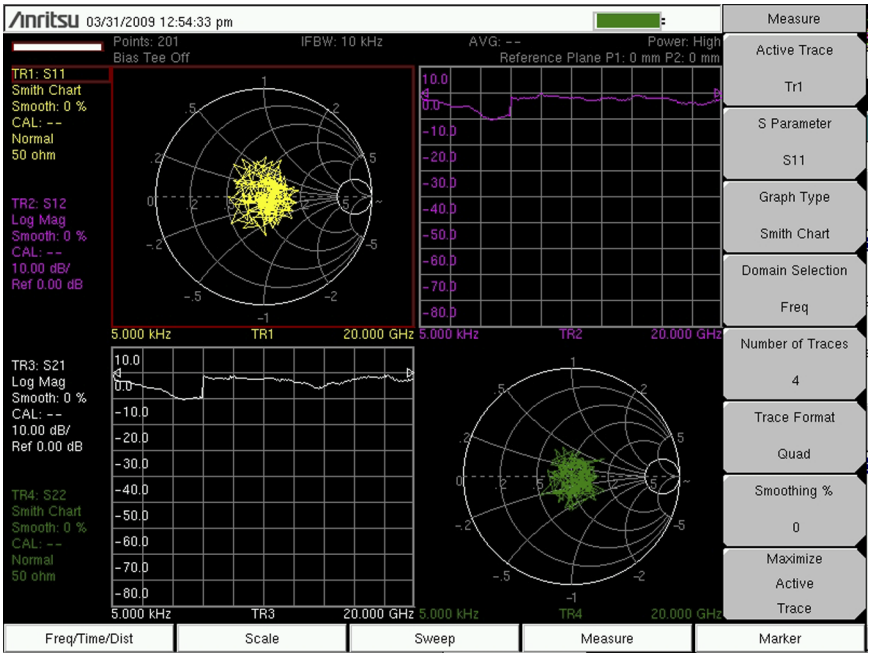


Figure 2-1. Format = Quad, Traces = 4 (MS202xC trace shown)

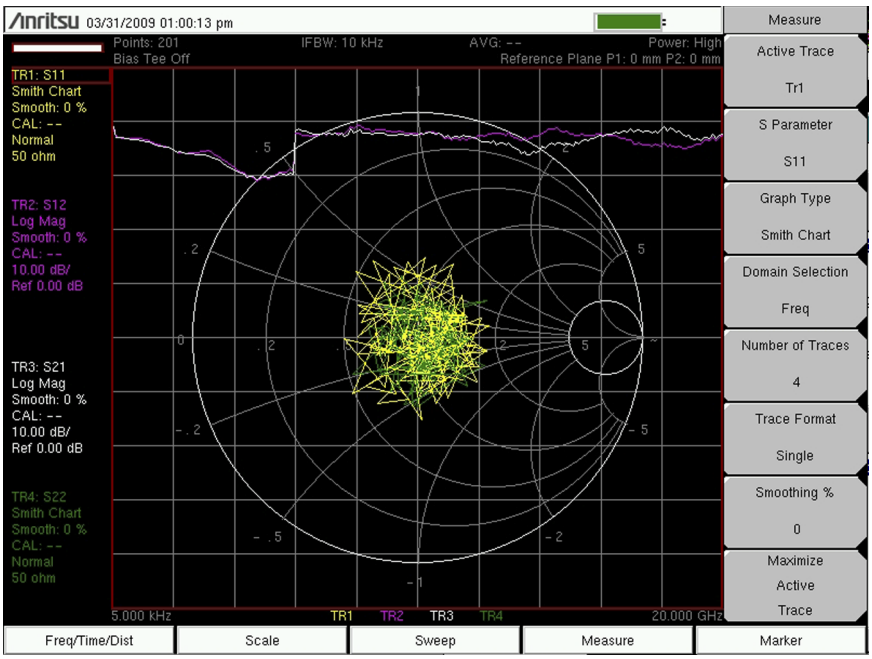


Figure 2-2. Format = Single, Traces = 4 (MS202xC trace shown)

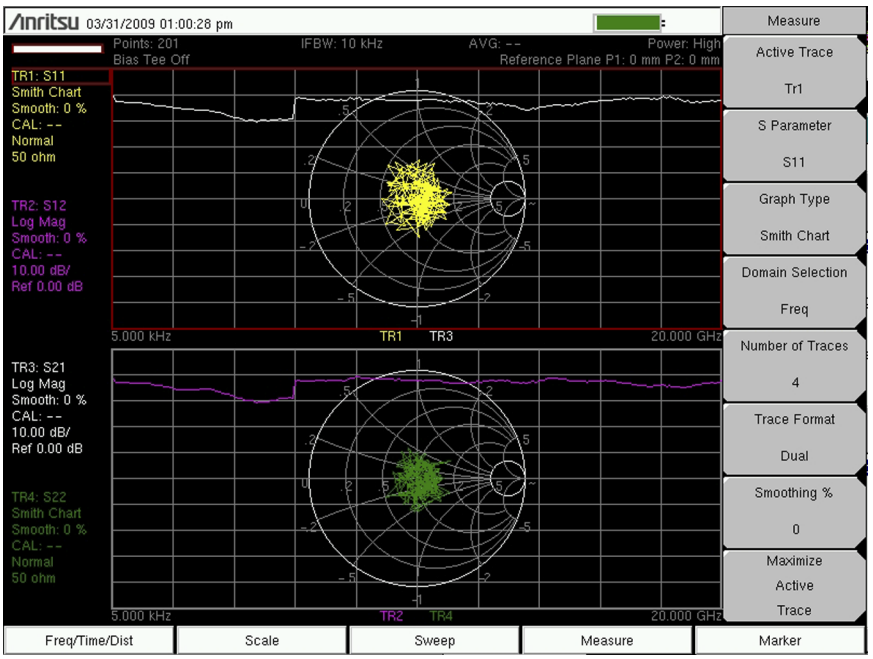


Figure 2-3. Format = Dual, Traces = 4 (MS202xC trace shown)

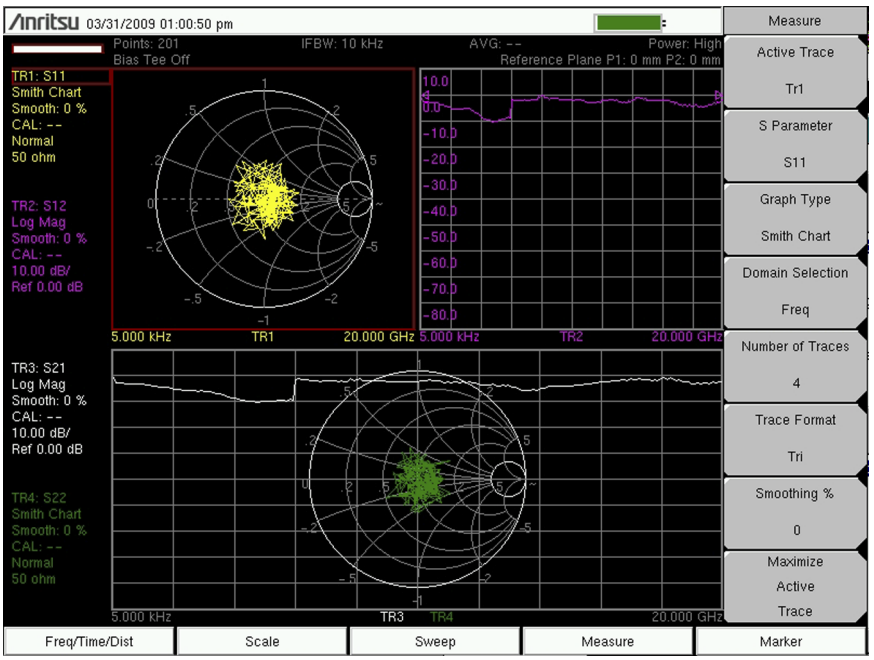


Figure 2-4. Format = Tri, Traces = 4 (MS202xC trace shown)

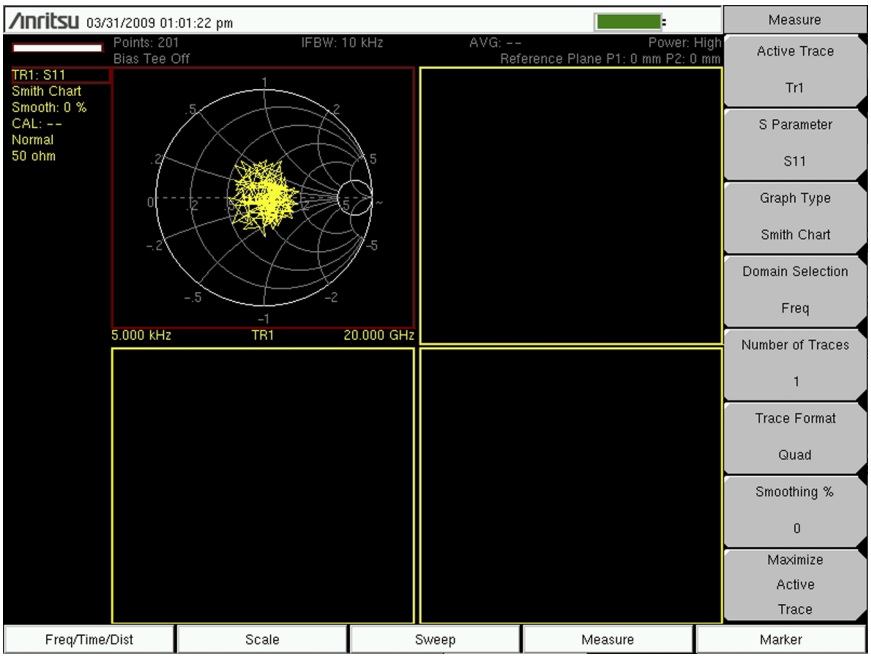


Figure 2-5. Format = Quad, Traces = 1

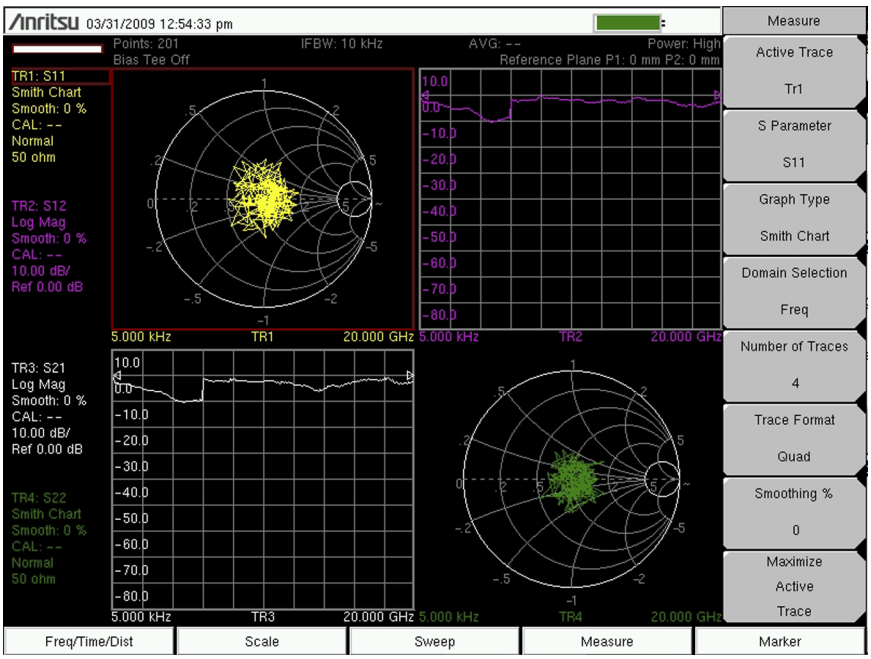


Figure 2-6. Format = Quad, Traces = 4 (MS202xC trace shown, same as Figure 2-1)

2-3 Marker and Limit Capabilities

Marker Description

A marker is a tool for extracting results from traces (or from trace memory). 12 independent markers can be assigned to any one trace (or to all traces). User-defined attributes for a marker include: Marker Type (reference or delta) and Readout Style.

In the marker menu, the markers are selected by using the Marker soft key. Select an active marker with the rotary knob, arrow keys, or key pad (by pressing the marker number). If you select a marker that is Off, then this action will automatically turn On the marker and assign it to the current active trace as a reference marker. After a marker is selected from the Select Marker List Box, an input parameter window (located in the upper left-hand corner of the display and using red font text) displays the current location (frequency, time, or distance) of the marker. The input parameter accepts keypad, rotary knob, or arrow key input to move the marker to the desired location on the active trace.

Selecting the Readout Style for Each Marker

In the Marker menu, press Readout Style to specify a readout style that differs from the current graph type, or select "As Graph Type(GT)" to have the marker use the same readout style as the current graph. For example, if active trace graph type is Log Magnitude, then default Readout Style is Log Magnitude. You can use Readout Style, however, to select any of the available styles for your preferences. In addition to "As Graph Type(GT)", these Readout Style selections include: Log Mag, Log Mag and Phase, Phase, Real and Imaginary, SWR, Impedance, Admittance, Normalized Impedance, Normalized Admittance, Polar Impedance, Group Delay, Log Mag/2, Linear Magnitude, and Linear Magnitude and Phase.

Displaying Markers on the Screen

By default, the active marker is displayed on the active trace. Location can be manipulated by keypad, rotary knob, or arrow key input. Location can also be manipulated by a finger tap on a touch screen. Additional flexibility is offered either to display the marker readout on the Trace, Screen, or Table, or to turn Off the display of marker readout information (displaying only the marker symbol on the trace). Press the Readout Format soft key to make your choice (refer to "Readout Format Menu" on page 6-44).

1. Press Trace to select marker readout on the trace, which overlays the active marker readout directly on the active trace.
2. Press Screen to select marker readout on the screen, which overlays the active marker readout at the upper-left corner of the display screen (sweep window).
3. Press Table to select marker readout in the table, which shrinks the display enough to list marker readouts at the bottom of the display screen. This selection allows easy viewing of not only the active marker, but of all markers. Note that the color of the marker readout in the table corresponds to the color of the trace to which it is assigned. If a marker is set to be on all traces, then the table listing shows that marker readout for the active trace only.

If multiple markers are displayed in the table, and if the marker data is displayed with overlapping text, then the readout format can be set to Small with the Marker Text Size soft key in the Readout Format menu. To see an example of overlapping test that is made more clear with this feature, refer to Figure 12-4 and Figure 12-5 on page 12-5.

Setting Up Delta Markers

If the intent is to conduct a delta measurement, then two markers are necessary: one for the reference and one for the delta. As an example:

1. Turn on Marker 1 (the Ref marker) and assign it to a trace.
2. Turn on Marker 2 and toggle the Marker Type from Ref to Delta.
3. Assign Marker 2 to Marker 1 by specifying the Avail Ref Mkr to Marker 1.

The third step allows you to specify marker delta on one trace, and it also allows you to specify marker delta between two traces.

Note that the Select Marker list box includes the current location, readout style, and delta status (if they exist). Otherwise, it indicates Off.

Setting Up Limits

The following description is a brief reminder. For a more detailed description of limits, refer to section "Limit Menus" on page 6-38.

Each trace with a rectangular graph (not Smith Chart or Polar) can be assigned both an upper limit and a lower limit. The limits can apply to the entire trace or to a portion of the trace, as desired. To set up a simple limit, select the limit menu (refer to "Limit Menu" on page 6-39) by pressing the **Shift** key and the **Limit** (**6**) key, and then select the active trace. Choose Upper or Lower by pressing the Limit soft key. Next, press the Limit State soft key to toggle the limit line from Off to On (Notice how the limit line is now displayed on the active trace). Adjust limit values by using the Limit Edit submenu, which allows you to adjust the entire limit line or each point of the limit line. Limit Alarm and Pass Fail Message can be separately assigned for each limit line or for each limit point.

Markers on a Touch Screen

The touch screen marker placement feature is active only when the Marker menu is displayed. If the Marker menu is not displayed, then the touch screen behavior differs (refer to "Touch Screen Trace Features" on page 2-3).

Moving a Marker

In both VNA Measurements view and Field Measurements view on touch screen instruments, whether Trace Format is Single, Dual, Tri, or Quad (VNA view) or whether Display Type is Single, Dual or Overlay (Field view), you can move an active marker on the active trace by touching anywhere on the sweep window of the active trace, but only when the Marker menu is displayed.

If you touch an inactive trace (when more than one trace window is displayed), your first touch selects the trace as the active trace. Lift your finger and touch again to move the active marker.

You can touch and hold to place the active marker, or you can slide your finger to drag the marker along a trace. Your touch point represents a location on the x-axis, and this touch point may be anywhere on the y-axis, or even within the Marker Table when it is displayed (On).

Note	Note that when Marker Table is displayed with a zero span (start frequency = stop frequency), the marker frequency is labeled with the trace point number in parenthesis. For example: MK1 500 kHz(101) –4.99 dB

2-4 Trace Math Capabilities

Trace math is a powerful tool for comparing two traces to each other by using mathematical operations. To perform trace math, select the trace menu (by pressing the **Shift** key and the **Trace** (**5**) key), and then select the active trace. Press the Save Trace to Memory soft key to save a copy of the trace into the instrument memory. When trace TR1 is saved to memory, an M1 memory trace is produced. Each trace can have one associated memory trace.

You can display Trace Only, Memory Only, or Trace and Memory. Press the Display soft key in the Trace menu to open the Display menu. Then press the desired soft key to select trace or trace memory, or both. To make distinguishing traces easier, the memory trace is assigned a different color than the original trace. The corresponding memory trace number (shown in the Instrument Settings Summary) uses a matching color. When viewing Memory Only, the Instrument Settings Summary displays the information for M1. When viewing Trace and Memory, the M1 information is displayed above the TR1 information.

At this point, the trace has been saved only to memory, and no trace math has been applied to it. Click on the Trace Math soft key to apply one of the following functions: subtraction, addition, multiplication, or division. The mathematical function operates on the complex numbers for each of the traces. When dividing TR1 by M1, the result is the point-by-point division of the complex numbers for each trace. Note that when trace math is applied to a trace, the function is displayed in the instrument status window. In the above example, assuming that S_{11} is the S-parameter that is associated with TR1, the status would display **TR1: S11/M1**.

If a trace is saved to memory, and if some settings on the trace are then changed (such as S-parameters, frequency, or number of points), then a mismatch occurs between the trace and memory. The vector network analyzer allows you to change these trace settings, but it places an asterisk next to the memory trace name in the instrument status window to point out the mismatch. In the previous example, if a setting is changed on TR1 (relative to the memory trace M1), then the listed filename is displayed as: `M1: S11*`. A similar mismatch occurs if you save a measurement when trace math is applied (`TR1: S11/M1`, for example). When that measurement is recalled, the result of the trace math is still stored in the memory location. The trace math function, however, is no longer valid, and the memory trace contains only the resulting S-parameter (S_{11} in this example). To indicate that the data that are stored in the memory location is based on previous measurements and calculations, the ^ sign is placed next to the memory name: `M1: S11^`.

Chapter 3 — VNA Fundamentals

3-1 Introduction

This chapter includes Vector Network Analyzer (VNA) measurement capabilities and instrument architecture information. It also describes calculating and displaying S-parameters, and describes using markers to provide additional measurement information.

The function hard keys (or main menu keys) in Vector Network Analyzer mode **without** Option 2 (Time Domain) are:

Freq/Dist, Scale, Sweep, Measure, Marker

The function hard keys in Vector Network Analyzer mode **with** Option 2 (Time Domain) are:

Freq/Time/Dist, Scale, Sweep, Measure, Marker

VNA is Vector Network Analyzer or Vector Network Analysis. The VNA Master and the LMR Master are Vector Network Analyzers that measure the magnitude and phase characteristics of 1-port or 2-port networks, including cables, antennas, filters, isolators, attenuators, and amplifiers. The Vector Network Analyzer compares the signal that leaves the analyzer port (the reference signal) with either the signal that is transmitted through the test device (the transmitted signal) or the signal that is reflected from the input or the output of the test device (the reflected signal).

Compared to a Scalar Network Analyzer (SNA), a VNA has the added capability for measuring phase characteristics. While phase measurements are important in themselves, the availability of this phase information unlocks many new features for complex measurements. These features include Smith Charts, Time Domain, and Group Delay. Phase information also allows greater accuracy through vector error correction of the measured signal.

A VNA can have 1-port only, in which case it measures only reflection signals. A VNA can have 2-ports, in which case it can measure both reflection and transmission. A 2-port VNA can also have two different capabilities: 1-path 2-port, or full-reversing. The 1-path 2-port design allows reflection measurements only at one of the two ports and allows transmission measurements only in one direction.

The MS20xxB VNA Master and the S412E LMR Master are two-port, 1-path VNA instruments that allow S_{11} and S_{21} measurements with a single connection.

The MS20xxC VNA Master is a full-reversing VNA that allows reflection measurements from both ports and allows transmission measurements in both directions (S_{11}, S_{21}, S_{22}, and S_{12} measurements with a single connection).

Option 16 (S412E LMR Master)

With Option 0016, 6 GHz VNA Frequency Extension, all VNA functionality can be measured to 6 GHz.

3-2 S-Parameters

To simplify the description of the types of measurements a VNA can make, the reflection and transmission measurements are defined in terms of scattering parameters, or S-parameters. For a 2-port network, four fundamental S-parameters can be measured, and they are defined as S_{XY}. For a 2-port VNA, measurements of signals leaving Port 1 are called forward measurements, and those leaving Port 2 are called reverse measurements. Signals that leave and return to the same port are designated reflection measurements, and those that leave one port and return to another port are designated transmission measurements. S-parameters are an abbreviated designation for these measurements, and are used as shown in the following list:

- S_{11}: Forward Reflection
- S_{21}: Forward Transmission
- S_{12}: Reverse Transmission
- S_{22}: Reverse Reflection

The first number (X) in S_{XY} is the port number into which the signal is being injected, and the second number (Y) is the port number from which the signal is leaving. The S-parameter is a ratio of these two signals.

Additional Examples:

S_{11}: Forward Reflection represents the measurement in which the signal leaves port 1 and is reflected back to port 1.

S_{21}: Forward Transmission represents the measurement in which the signal leaves port 1 and is transmitted to port 2.

S_{12}: Reverse Transmission represents the measurement in which the signal leaves port 2 and is transmitted to port 1.

S_{22}: Reverse Reflection represents the measurement in which the signal leaves port 2 and is reflected back to port 2.

3-3 VNA Master Architecture

A VNA can have 1-port only, in which case it measures only reflection signals. A VNA can have 2-ports, in which case it can measure both reflection and transmission. A 2-port VNA can also have two different capabilities: 1-path 2-port, or full-reversing. The 1-path 2-port design allows reflection measurements only at one of the two ports and allows transmission measurements only in one direction. The MS20xxB VNA Master and the S412E LMR Master are two-port, 1-path VNA instruments that allow S_{11} and S_{21} measurements with a single connection. The MS20xxC VNA Master is a full-reversing VNA that allows reflection measurements from both ports and allows transmission measurements in both directions (S_{11}, S_{21}, S_{22}, and S_{12} measurements with a single connection).

The MS20xxB compact VNA Master and the S412E LMR Master have an architecture that automatically measures two S-parameters (S_{11} and S_{21}) with a single connection. Three receivers are used, so the forward sweep from Port 1 simultaneously yields S_{11} and S_{21}.

The MS20xxC VNA Master has an architecture that automatically measures the four S-parameters with a single connection. Three receivers are used, so the forward sweep from Port 1 simultaneously yields S_{11} and S_{21}, and the reverse sweep from Port 2 simultaneously yields S_{22} and S_{12}. Thus, measurement of the four S-parameters for a two-port DUT requires only two sweeps, the forward and reverse transmission.

Figure 3-1 and Figure 3-2 show a general block diagram of the three-receiver architecture that is used in the MS20xxC VNA Master and show how the S-parameters are related to the signals that are being transmitted and received by the ports. From Figure 3-1, you can see how S_{11} and S_{21} are generated by a forward sweep (signal directed from Port 1). Figure 3-2 shows how S_{22} and S_{12} are generated by a reverse sweep (signal directed from Port 2).

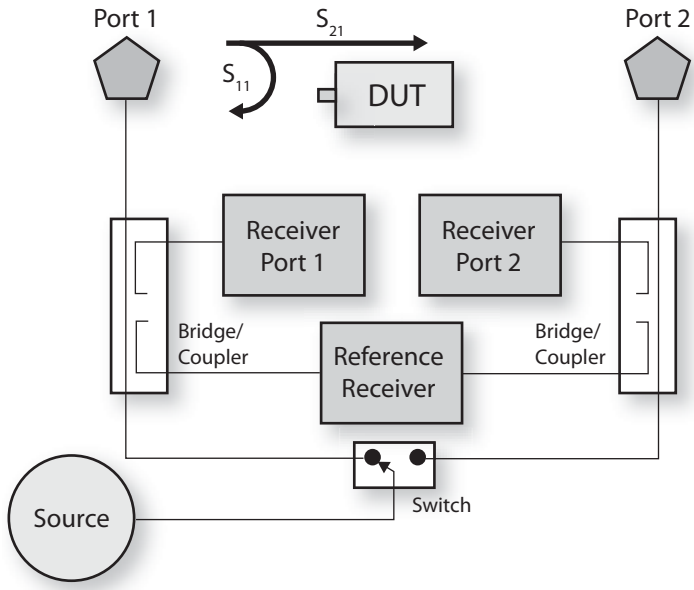


Figure 3-1. MS20xxC VNA Master Block Diagram During Forward Sweep

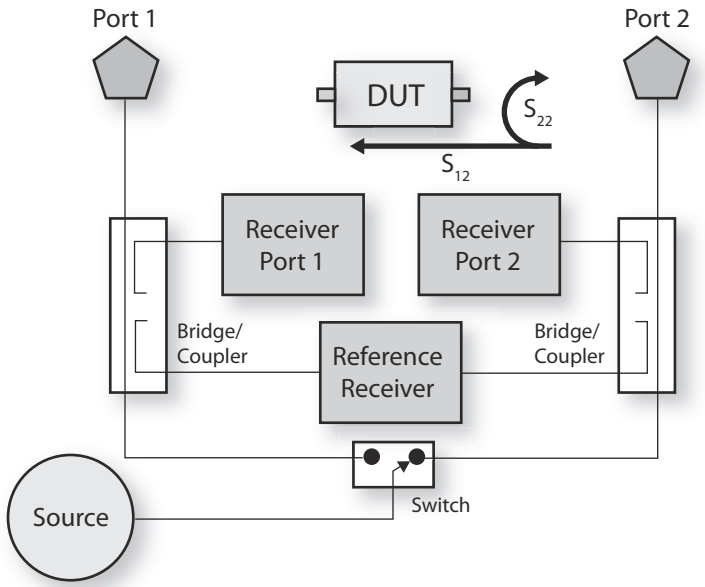


Figure 3-2. MS20xxC VNA Master Block Diagram During Reverse Sweep

Note	The MS20xxC VNA Master, when equipped with Option 77, can calculate the balanced differential, common, and mixed mode S-parameters (S_{d1d1}, S_{c1c1}, S_{c1d1}, S_{d1c1}) using the 4 measured S-parameters S_{11}, S_{21}, S_{12}, and S_{22}). These additional S-parameters can be used to measure reflections from differential cables when the two ends of the cable are connected to Port 1 and Port 2 of the MS20xxC VNA Master. Because these S-parameters are a function of all 4 S-parameters, it requires both a forward and reverse sweep to complete the calculation. For more information about these additional S-parameters, refer to Chapter 12, “Balanced Ports, Option 77”.

Figure 3-3 shows a general block diagram of the three-receiver architecture that is used in the MS20xxB VNA Master and the S412E LMR Master and shows how the S-parameters are related to the signals that are being transmitted and received by the ports.

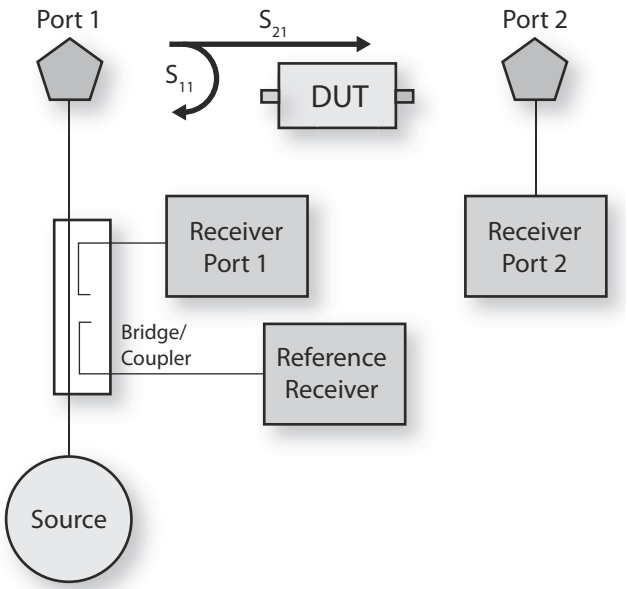


Figure 3-3. MS20xxB VNA Master and S412E LMR Master Block Diagram

3-4 Calculating and Displaying S-Parameters

S-parameters are a measure of the ratio of two complex voltage levels, one measured by the port receiver, and one measured by the reference receiver. S-parameters therefore consist of unitless complex numbers.

Depending on the application, S-parameters can be displayed in many ways and can be used to calculate other parameters. S-parameters consist of real and imaginary numbers. More typically, however, they are represented as magnitude and phase. In most cases, the magnitude is displayed in dB (this term is often called log magnitude). We can display phase as "linear phase". With phase, we cannot tell the difference between one cycle and the next. After going through 360 degrees, we are back to where we began. We can display the measurement from −180 degrees to +180 degrees, which keeps the display discontinuity removed from the important 0 degrees area used as the phase reference.

The VNA Master supports the following display types. Each type is associated with a particular S-parameter, $S_{xy} = S_{\mathbf{Real}} + jS_{Imaginary}$ (where j is the square root of −1).

Table 3-1. Log Magnitude

$$LogMagnitude(dB) = 20Log_{10}|S_{xy}|$$

Application Notes

To measure return loss at Port 1 (or Port 2), use the Log Mag display with S_{11} (or S_{22}).

To measure the gain or loss in a DUT that is connected between Port 1 and Port 2, use the Log Mag display with S_{21} or S_{12}.

Table 3-2. Log Magnitude / 2

$$\frac{LogMagnitude}{2}(dB) = 0.5 \times 20Log_{10}|S_{xy}|$$

Application Note

For measuring 1-port cable loss, use S_{11} or S_{22} with the Log Mag/2 display type to account for the round trip signal path through the cable. When using reflection data to measure cable loss, the end of the cable must be shorted or must be a perfect open.

Table 3-3. Real and Imaginary

$$Phase(degrees) = Tan^{-1}\left|\frac{S_{Imaginary}}{S_{Real}}\right| \times \left(\frac{180}{\pi}\right)$$

SReal = Real S-parameter

SImaginary = Imaginary S-parameter

Table 3-4. SWR

$$SWR = \frac{(1 + |S_{xx}|)}{(1 - |S_{xx}|)}$$

Application Note

SWR, or Standing Wave Ratio, is a measure of the **reflection** from the DUT input port or output port, and it must be used, therefore, with S_{11} or S_{22}.

Table 3-5. Group Delay

Group Delay (sec) = rate of change of phase over a specified frequency aperture

Application Note

Group Delay is a measure of the time delay of the signals that are propagating through the DUT versus frequency (using S_{21} or S_{12}). Group delay is a good measure of phase distortion through the DUT.

Table 3-6. Smith Chart

Smith Chart = graphical tool for plotting impedance or admittance data versus frequency

Application Note

Use Smith Chart with S_{11} or S_{22} to plot the input or output impedance of the DUT.

Use the Inverted Smith Chart to plot admittance data.

Note: The Inverted Smith Chart is available only on VNA Master models MS20xxC.

3-5 Extracting More Information by Using Markers

An S-parameter can be displayed in different formats, as already described. The VNA Master also allows you to extract information from the trace by using markers. By default, the marker presents the trace point information using the graph type format, thereby providing additional flexibility in analyzing S-parameter VNA data. For example, if the graph type is SWR, then the marker readout is in SWR. You can set the marker type to be something other than the graph type. For any graph type that the trace may have, the markers can be used to extract data in any of the following formats:

- Log Magnitude (dB)
- Log Magnitude/2 (dB)
- Log Magnitude (dB) and Phase (deg)
- Linear Magnitude (dB)
- Linear Magnitude (dB) and Phase (deg)
- Phase (deg)
- Real and Imaginary
- SWR
- Group Delay (sec)
- Impedance: $Z_{in} = R + jX$
- Admittance: $Y_{in} = G + jB$
- Normalized Impedance: $Z_{in}/Z_o = (R + jX)/Z_o$
- Normalized Admittance: $Y_{in}/Y_o = (G + jB)Y_o$
- Polar Impedance

3-6 How Bias is Generated

Another important feature of a VNA is the ability to provide DC bias voltage at the RF port. Bias on the RF cable is useful for operating TMA components that are being tested. The architecture of the VNA Master, when equipped with Option 10, allows for bias to be applied to the RF ports. Chapter 10, “Bias Tee, Option 10” describes the Bias Tee functions of the VNA Masters.

Chapter 4 — VNA Measurements

4-1 Introduction

This chapter describes some of the VNA measurements that can be made with the VNA Master. It includes both 1-port and 2-port measurements (coaxial and waveguide) and features the key considerations that you are required to make regarding calibration types, IF Bandwidth (IFBW), power levels, graph types, and graph formats.

This chapter describes the VNA Measurements view. Chapter 5 describes the Field Measurements view.

As stated in the first chapter of this manual, all references to Vector Network Analyzer and references to instruments that are two-port, 1-path vector network analyzers include both the MS20xxB compact VNA Master and the S412E LMR Master models.

Select Measurement Type – VNA versus Field

Change between the Field Measurements view and the VNA Measurements view by pressing the **Shift** key followed by the **System** (**8**) key, and then by pressing the Applications Options soft key (submenu key). Press the Meas Menu soft key to toggle between Field and VNA.

Touch Screen Trace Features

Refer to section "Touch Screen Trace Features" on page 2-3.

Markers on a Touch Screen

Refer to section "Markers on a Touch Screen" on page 2-8.

4-2 1-Port Cable Measurement

Introduction

When cables are installed in the field, one end of the cable is often too far away to allow you to conduct a full 2-port measurement. The 1-port measurement is an ideal technique for this situation.

Setup Considerations

To conduct a 1-port cable measurement, the first step is to set the frequency range of interest and the desired number of points in the sweep. Then set the test port power to high and perform a full S_{11} Open-Short-Load (OSL) calibration by using the appropriate connector type. Connect the easily accessible side of the cable to Port 1 of the VNA Master, and connect a short or an open to the far end of the cable. Finally, set up the instrument to display the measurement results in the desired format.

Measurement Readout and Interpretation

The screen-captured measurement that is shown in Figure 4-1 uses a four-trace display to show S11, a smoothed version of S11/2, a distance-to-fault (DTF) measurement using return loss, and another distance-to-fault measurement using SWR. Note that these four measurements are displayed in Quad format as Trace 1 (upper left quadrant), Trace 2 (upper right quadrant), Trace 3 (lower left quadrant), and Trace 4 (lower right quadrant). For an explanation of trace format versus the number of traces that are displayed, refer to section "Trace Format Menu" on page 6-52. The screen-captured measurements that are shown in this measurement guide are examples and may not match any display on your instrument.

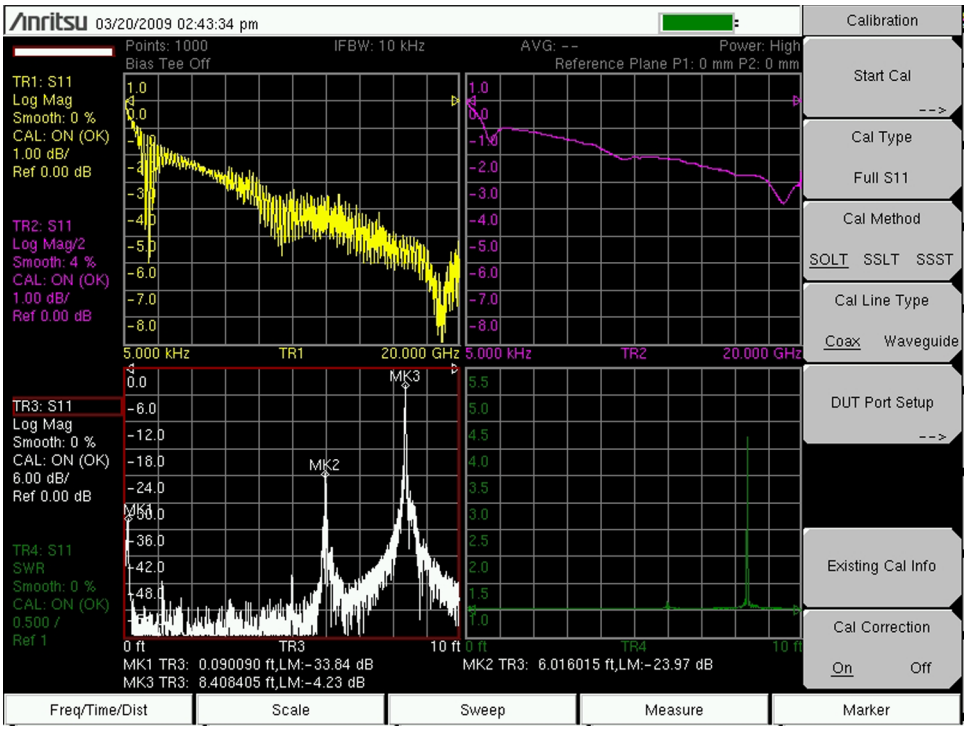


Figure 4-1. Four-Trace S_{11} Display

SWR as a good tool for identifying major discontinuities, and Return Loss is better for identifying minor discontinuities.

To calculate cable loss, the far end of the cable is shorted, and the resulting S_{11} return loss measurement is divided by two ($S_{11}/2$) to compensate for the round-trip loss of the cable. Smoothing can be applied to remove any ripples in the 1-port cable loss response. The ripples that are seen in TR1 (Trace 1) are caused by the phase interactions of the large reflection at the short at the end of the cable and the small reflection of the connector at the near end of the cable. In normal cable use, the far end of the cable is terminated with some device, which would eliminate the large reflection in the image with the short. To accurately measure the loss in the cable, however, the signal must be fully reflected from the far end of the cable, which is why a short or an open is used. The resulting undesired ripple can be removed by using smoothing. A smoothing setting of 2% to 5% is usually sufficient to remove the ripples.

Note	If you apply smoothing when the sweep has more than 2000 points, the smoothing may slow the sweep time of the trace and the responsiveness of the instrument. This slowing can be significant, and it increases as the number of sweep points is increased.

This particular cable shows (at MK2) unwanted dips (troughs) in the insertion loss frequency sweep. The optional time domain or distance-to-fault measurement can reveal potential causes for the poor frequency response of the cable.

In this example, a loose connector that is located 6 feet down the cable was causing a sizable degradation in performance. Marker 1 shows the mismatch of the near end cable connector, Marker 2 highlights the loose connection, and Marker 3 shows the full reflection of the short at the end of the cable. (MK3 is not a full 0 dB reflection, but somewhat less. This can be attributed to the loss of the cable and the previous smaller reflections at MK1 and MK2, which both contribute to the reduced magnitude of the reflected signal at the far-end short.)

After tightening the connector, the insertion loss becomes well behaved, and the mismatch from the connector is significantly reduced, as shown in Figure 4-2.

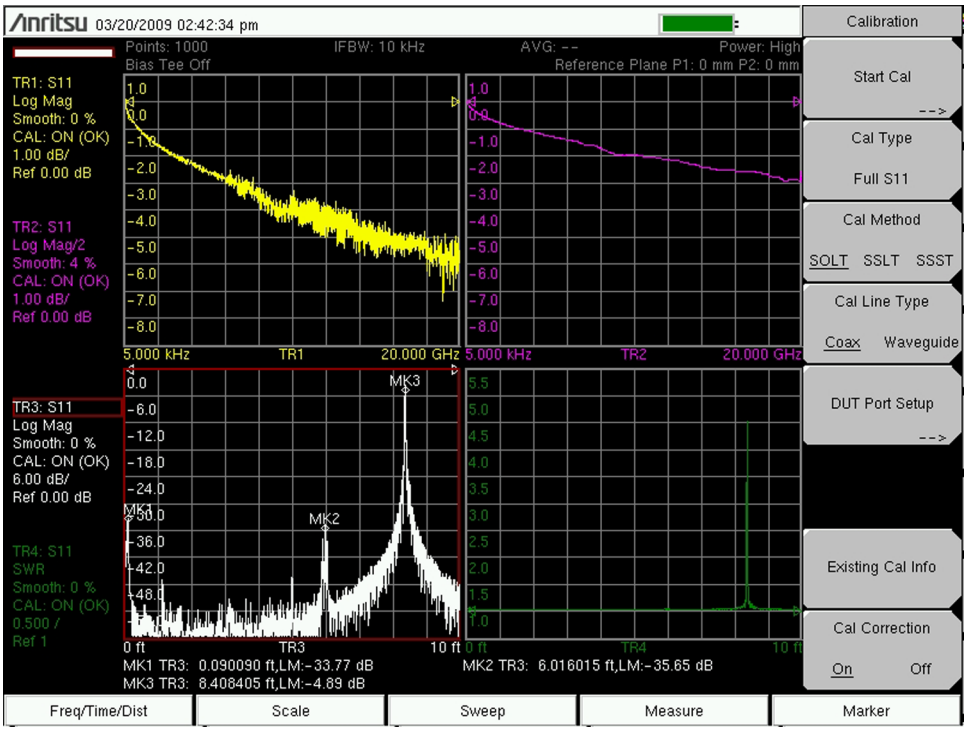


Figure 4-2. Improved Trace with Connector Tightened

The 1-port measurement approach is useful for deployed cables, but does have a practical limitation. Uncertainties become large as the round-trip cable loss exceeds 15 dB. This threshold is easy to surpass for long cable lengths or for high operating frequencies. For longer cables and higher frequencies, a 2-port measurement is required for improved accuracy.

4-3 1-Port Smith Chart Tuning Example

The Smith Chart is a useful tool for tuning input match. This complex impedance plot reveals which matching elements are necessary to match a device under test to the reference impedance (usually 50 ohms). Selecting “Smith Chart” as the graph type provides this tuning-friendly graph.

In Figure 4-3, the untuned blue trace is overlaid on the tuned yellow trace. The untuned response resembles a series capacitance and series resistance (starts as open circuit at low frequency, and approaches center of chart towards higher frequencies). This series capacitance is tuned out at 375 MHz by placing a shunt inductance in the circuit.

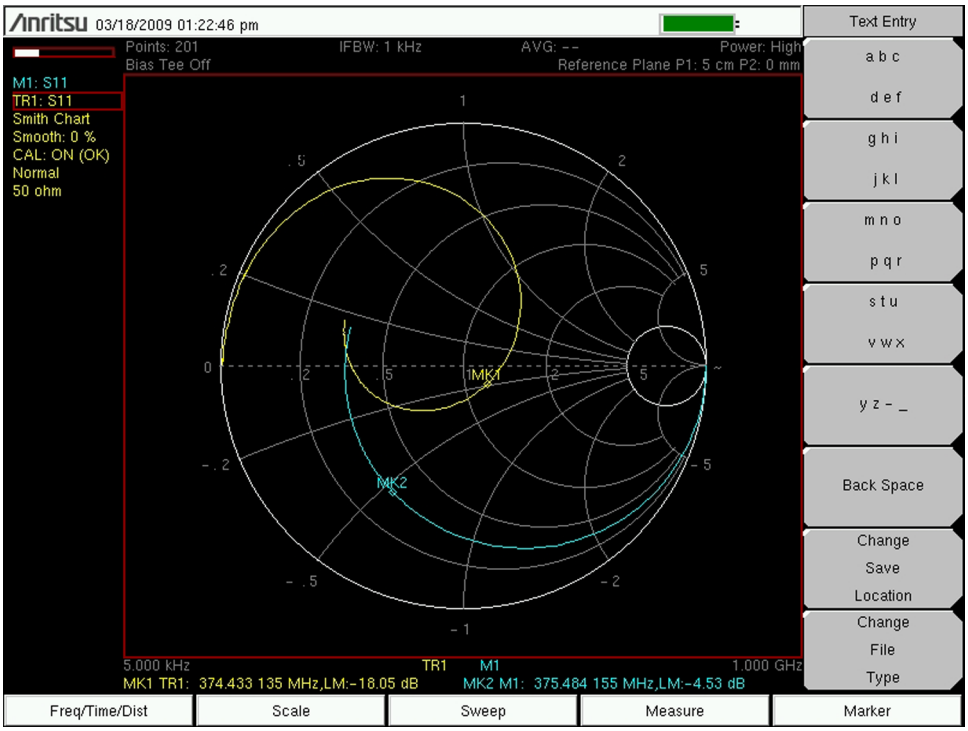


Figure 4-3. Smith Chart Tuning Example

In Figure 4-4, the more familiar log magnitude response is showing the input match improvement at 375 MHz. Trace 1 (shown in yellow with marker MK1) is the trace of the tuned circuit.

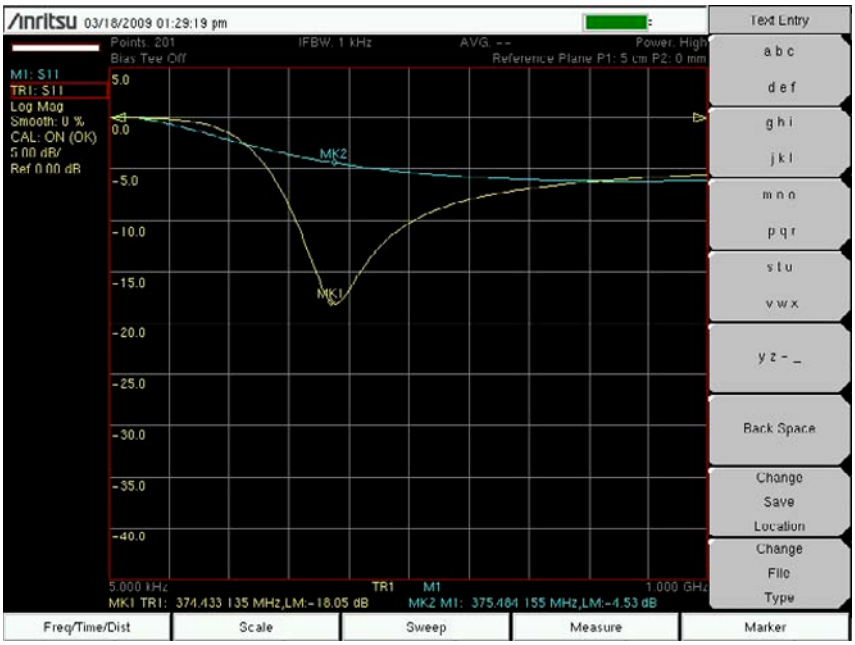


Figure 4-4. Log Magnitude at 375 MHz

Note

Figure 4-4

In the electronic (PDF) file of this user guide, the traces are shown in color, and are therefore easier to distinguish.

In the printed grayscale images, M1 drops smoothly from approximately 0 dB to approximately –6 dB and utilizes marker MK2. Trace 1 (TR1) has nearly the same end points, but dips to –18.05 dB, as shown at marker MK1.

4-4 2-Port Filter Measurement

Introduction

Filters are 2-port devices that lend themselves well to a full 2-port measurement. They are usually compact devices with both sides of the component being easily accessible.

Setup Considerations

To perform the measurement, set the frequency to the range of interest, and set the power level to high. Perform a 2-port calibration by using the appropriate connector type. Also refer to section "Calibration Considerations" on page 4-16.

Measurement Readout and Interpretation

The screen-captured measurement that is shown in Figure 4-5 is an overlay of S_{11} and S_{21} of a highpass filter. This measurement is comparing the transmission response calibration and the full 2-port calibration. The full 2-port calibration offers a dramatic improvement in return loss accuracy. The transmission response calibration is sufficient for a rough measurement of insertion loss.

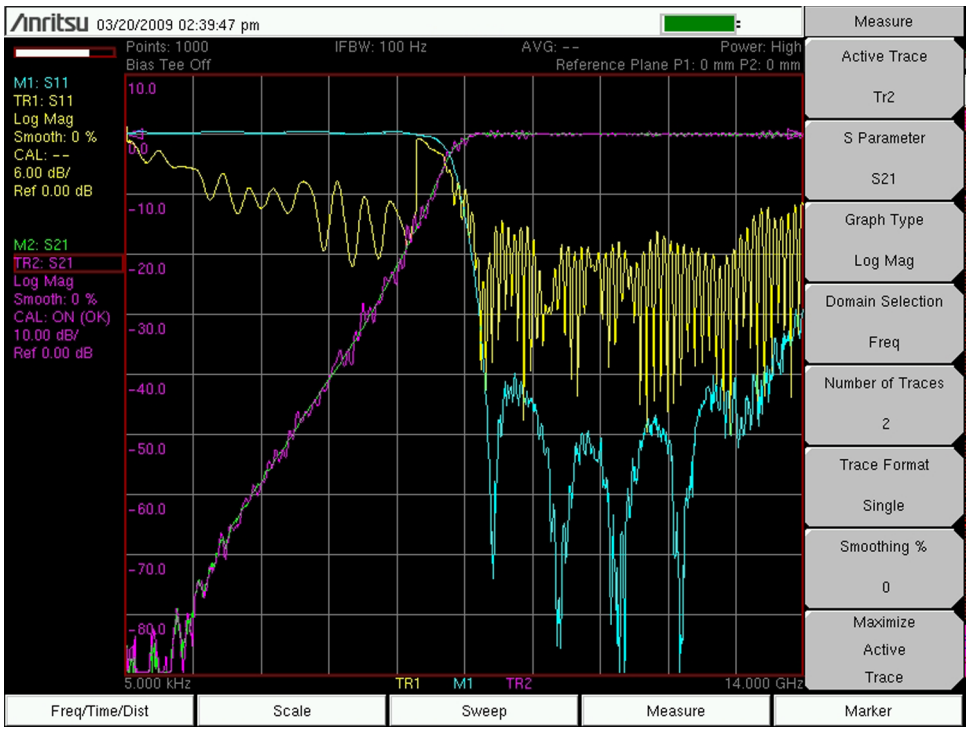


Figure 4-5. High Pass Filter with 2-Port Calibration

M1 and M2 are the full 12-term calibration responses. TR1 and TR2 are the responses from the transmission response calibration.

Figure 4-5

In the electronic (PDF) file of this user guide, the traces are shown in color, and are therefore easier to distinguish.

In the printed grayscale images, M1 and M2 are smoother than traces TR1 and TR2.

Note M1 and TR1 begin at the low end of the frequency range at approximately 0 dB and continue above –20 dB until mid frequency range. Then TR1 ranges between approximately –10 dB and –50 dB, while M1 ranges to the bottom of the sweep window, mostly below –30 dB.

M2 and TR2 begin at the low end of the frequency range below –60 dB and sweep upward to approximately 0 dB at mid frequency range. They continue at approximately 0 dB to the high end of the frequency range.

Because of the increased accuracy, full 2-port calibrations are generally the preferred approach. Figure 4-6 shows a 4-trace display of the same filter (as illustrated in Figure 4-5) showing S_{11} and S_{21} on 10 dB/div and 1 dB/div scales, highlighting the passband, the reject band, and roll-off of the filter.

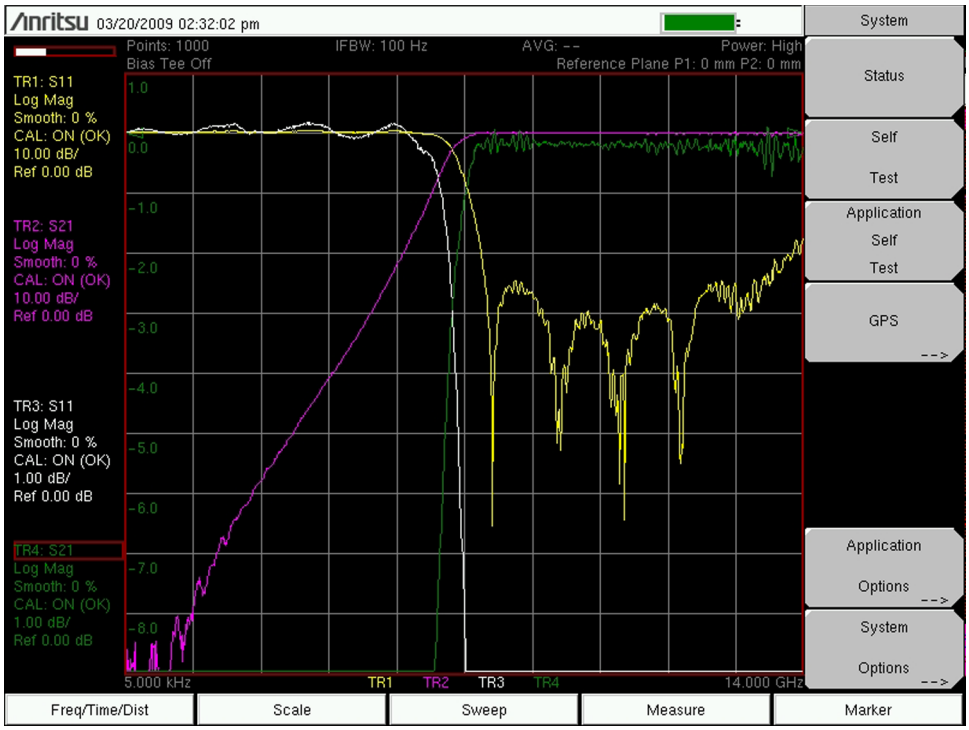


Figure 4-6. Highpass Filter with 2-Port Calibration, 10 dB/div and 1 dB/div

IF-bandwidth can be reduced to lower the noise floor of the instrument. The screen-captured measurement that is shown in Figure 4-7 uses trace memory to show the same measurement taken with a 100 kHz IFBW and with a 100 Hz IFBW measurement. Narrower IF bandwidths slow down the measurement speed, but provide a lower measurement noise floor.

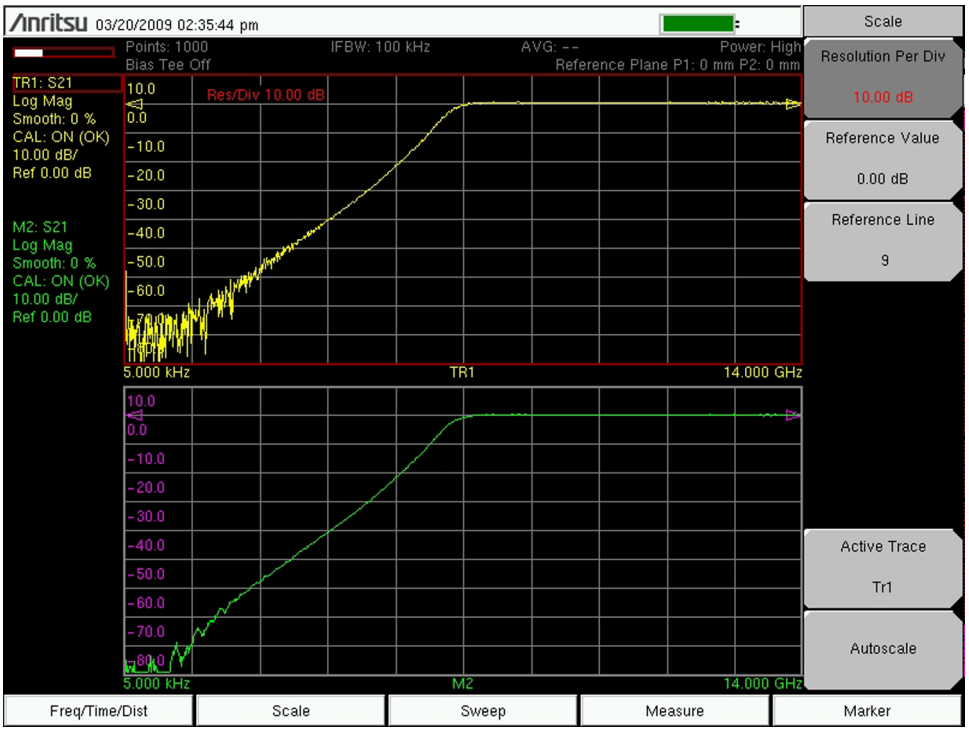


Figure 4-7. 100 kHz (bottom trace) and 100 Hz IFBW (top trace)

4-5 2-Port Amplifier Measurement

Introduction

Another popular 2-port device is the amplifier. For amplifier measurements, configuring the instrument to low power mode is an important step. This reduces the source power to ensure that the amplifier and the VNA Master (or LMR Master) do not go into compression. The screen-captured measurements that are shown in this measurement guide are examples and may not match any display on your instrument.

Setup Considerations

To measure the amplifier, set source power to low and perform a full 2-port calibration by using the appropriate connector type. Connect the amplifier between the test ports, and bias the amplifier. The VNA Master offers both internal and external test port bias supplies. These can be utilized to power devices that accept bias through their test ports. Also refer to section "Calibration Considerations" on page 4-16.

Measurement Readout and Interpretation

The screen-captured measurement that is illustrated in Figure 4-8 shows gain (S_{21} = TR2), input match (S_{11} = TR1), output match (S_{22} = TR4), and isolation (S_{12} = TR3)) of an amplifier all at the same time on different graphs.

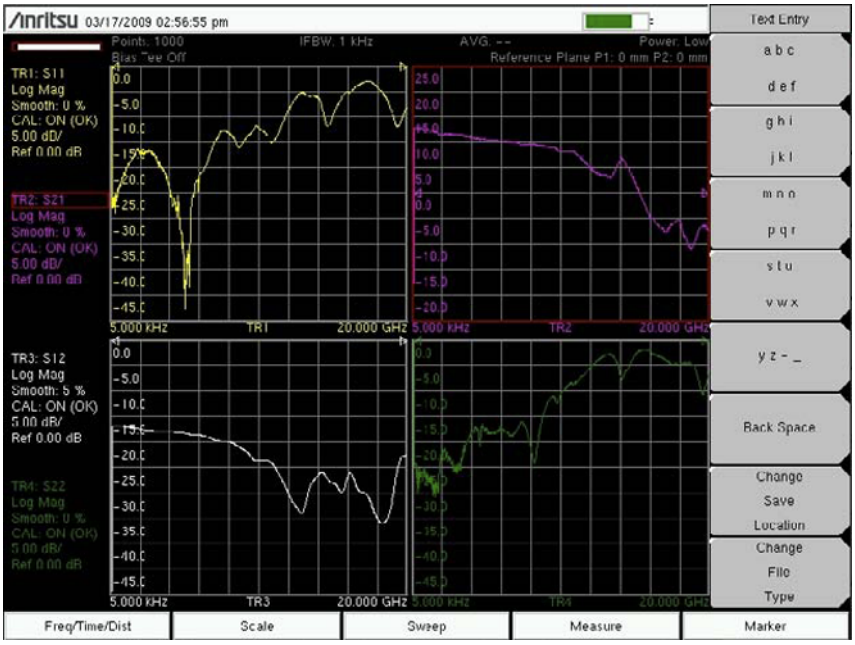


Figure 4-8. Gain, Input Match, Output Match, Isolation of an Amplifier

Group delay is another popular measurement with broadband amplifiers. The two plots that are illustrated in Figure 4-9 and Figure 4-10 show the group delay of the amplifier with 2% aperture and 10% aperture. Increasing the group delay aperture makes the measurement less susceptible to noise, but provides less fine detail in phase linearity.

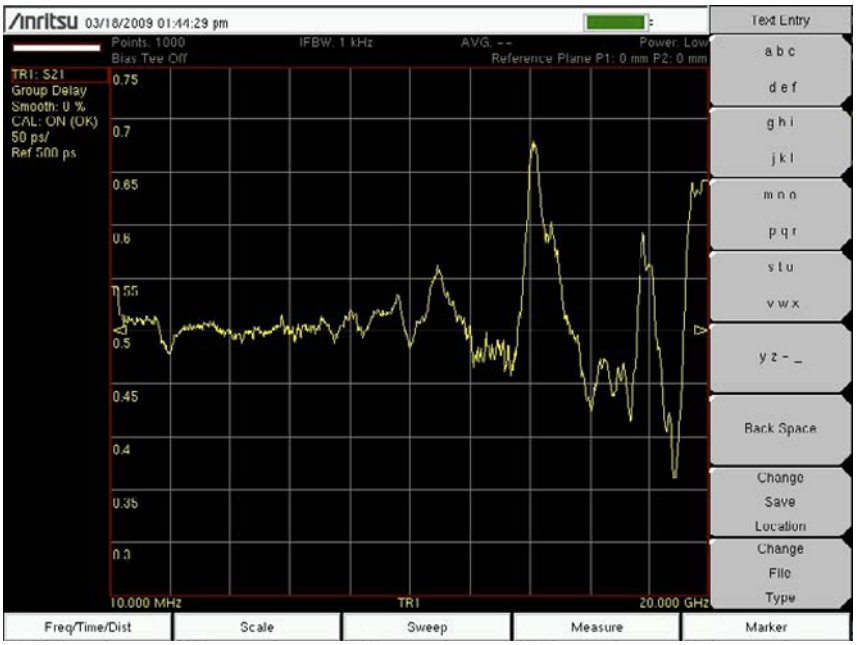


Figure 4-9. 2% Aperture

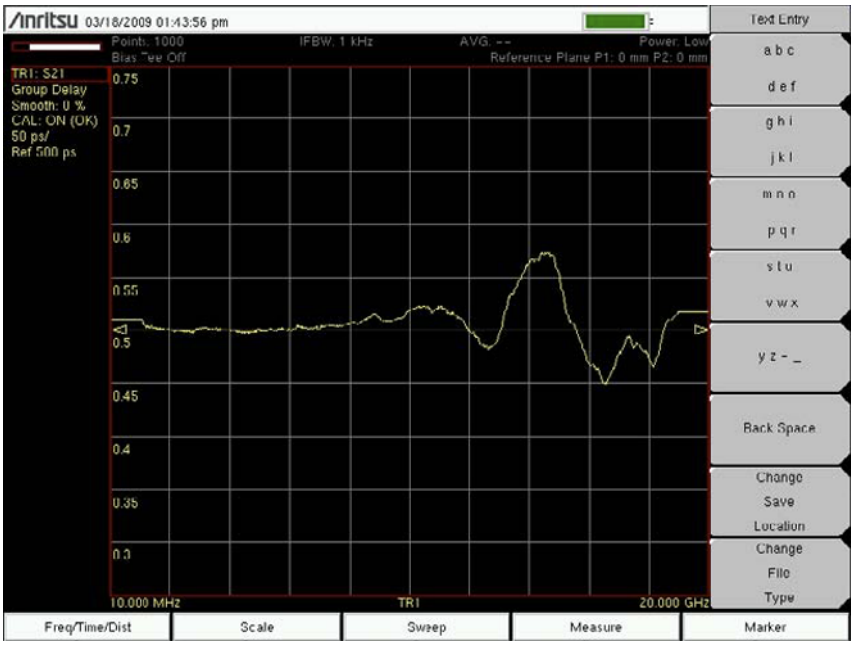


Figure 4-10. 10% Aperture

The 5 kHz low end of the MS20xxC VNA Master facilitates the characterization of low frequency resonances that are commonly caused by bias networks. The screen-captured measurement that is illustrated in Figure 4-11 shows the difference between an amplifier with proper low frequency biasing (TR1) and one with a defective bias inductor (M1).

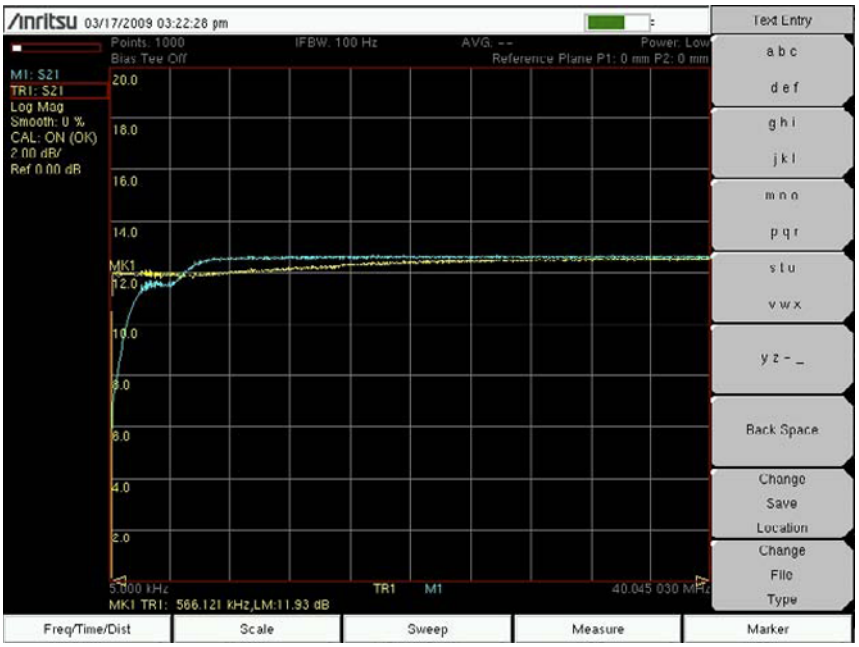


Figure 4-11. Proper Biasing versus Defective Bias Inductor

4-6 Waveguide Considerations

Introduction

Only the MS20xxC VNA Master models accommodates waveguide measurements in addition to the previously discussed coaxial measurements.

Setup Considerations

The primary difference between waveguide and coax measurements is the calibration. Coax is typically calibrated by using an open, short, load, and through line. Waveguide calibration components do not include an open because the open end of a waveguide is actually an effective radiator and does not reflect much of the signal back to the test port. Offset shorts are typically used to replace the open. Short, offset-Short, Load, Through (SSLT) is a common waveguide calibration that is supported by the VNA Master. Triple offset short (SSST) is another calibration option. Because this calibration avoids having a load standard, it can lead to better ultimate directivity. It is, however, more band-limited and is more susceptible to wear on the calibration components. Also refer to section "Calibration Considerations" on page 4-16.

Measurement Readout and Interpretation

In the Distance Domain, the VNA Master includes waveguide dispersion correction to account for different propagation speeds of signals in the waveguide. Dispersion correction is not applied in Time Domain. The S11 measurement of a 15 cm shorted waveguide section (Figure 4-12) shows how dispersion compensation improves distance domain resolution.

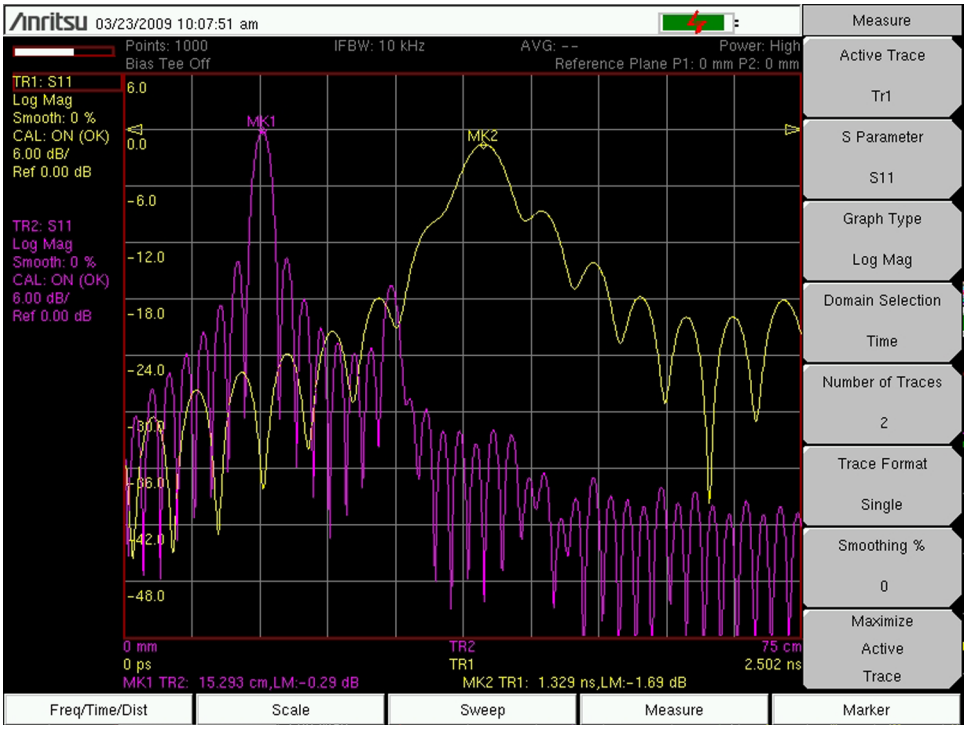


Figure 4-12. S_{11} on 15 cm Shorted Waveguide Section

Trace TR1 (yellow trace) is in the time domain without dispersion correction. Trace TR2 (purple trace) is in the distance domain. Peaks and troughs are better defined in the distance domain (TR2) than in the time domain (TR1). Note that the distance domain response is shown as One-Way, whereas the time domain plot is shown as Round-Trip.

Note

Figure 4-12

Trace 1 (TR1) is smoother than Trace 2 (TR2).

Both traces begin at the low end of the frequency range at approximately –35 dB.

TR1 (time domain) peaks at 1.329 ns and –1.69 dB as shown by Marker MK2. TR2 (distance domain) peaks at 15.293 cm and –0.29 dB as shown by Marker MK1.

Note

When measuring reflection parameters (such as S11 in the Figure 4-12 example), the distance domain measurement is adjusted so that the peak of the signal is at the end of the cable or waveguide (a length of 15 cm in the example). This is called a One-Way representation of the measurement. The signal itself travels round-trip to the end of the cable and then back to the port.

If the VNA Master does not adjust for the round-trip condition, then the peak of the signal will be at a distance that is twice the length of the cable (in which case, the measurement would have been called Round-Trip).

In the time domain, you can choose to set the reflection measurement to be either One-Way or Round-Trip. When set to One-Way (which is the default setting), the VNA Master compensates for the round trip reflection measurement as it does in the Distance Domain. When set to Round-Trip, the VNA Master does not compensate, and the peak of the signal in the time domain therefore represents the time that is taken for the signal to reach the end of the cable and reflect back to the port (1.3 ns in the Figure 4-12 example).

4-7 Calibration Considerations

Various 2-port calibrations are available in the Vector Network Analyzer. Transmission response is the simplest and requires only one connection during calibration, but it does not correct for test port match errors. 1-Path 2-Port calibration requires four calibration connections and corrects for the transmit port match, but does not correct for the receive port. Full 2-port calibration requires seven calibration connections and corrects for both test port match errors (refer to Figure 4-14). The full 2-port calibration technique offers the most accuracy.

Note	The previously described calibration considerations omit isolation steps in which loads are connected to each test port. During the isolation step of the calibration procedure, the Vector Network Analyzer measures the isolation between test ports in order to achieve best dynamic range performance.

Note	The Vector Network Analyzer Calibration menu is the same one that is used in the Vector Voltmeter menu. Refer to section "Calibration Menu" on page 6-19 for more information about the calibration menu. Note that some calibration parameters are shared between the Vector Network Analyzer and Vector Voltmeter mode, and that some parameters are different because they were optimized for the specific mode application.

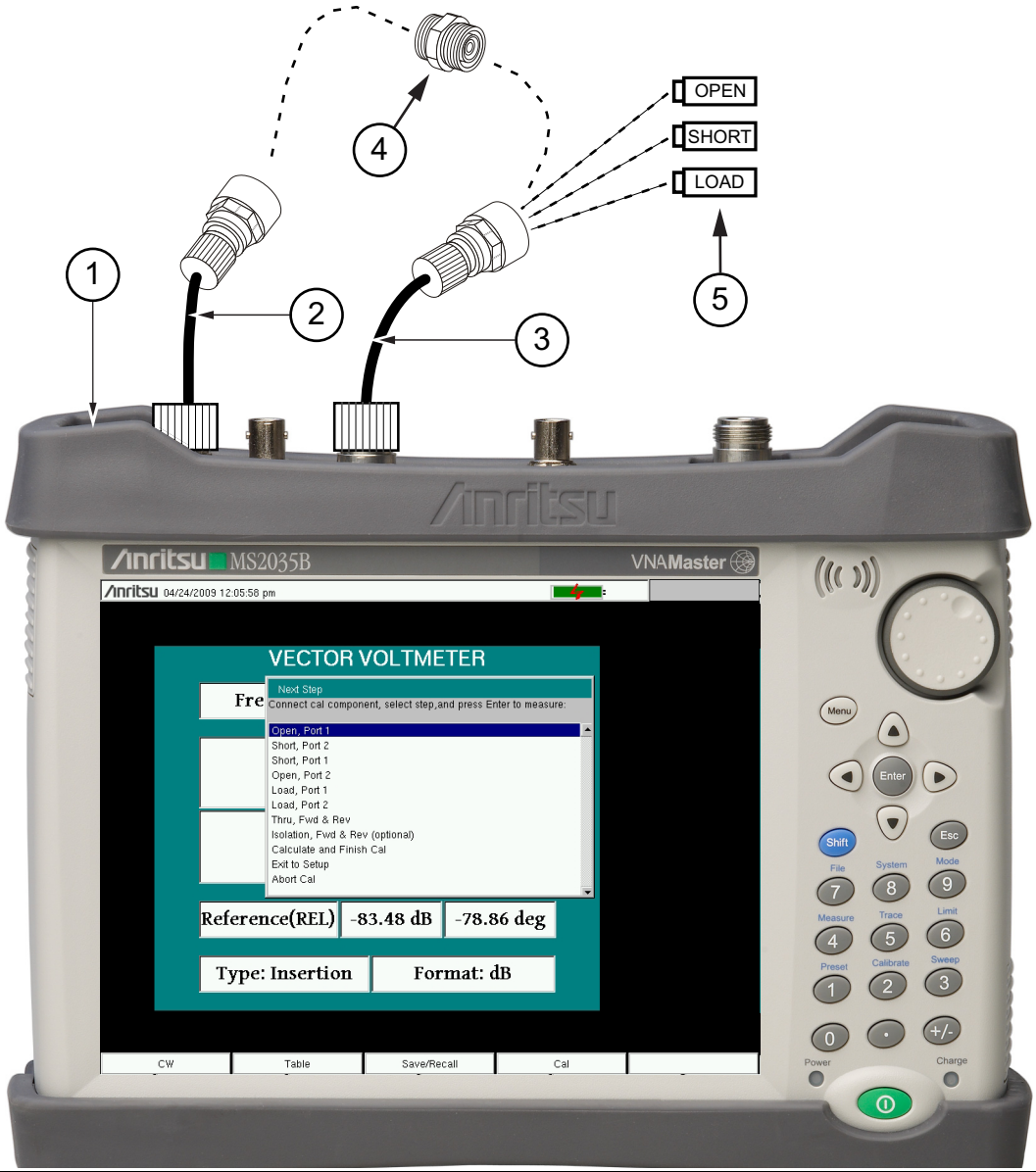
For accurate results, the instrument must be calibrated at the ambient temperature after allowing for warm up time (approximately 15 minutes) and before making any measurements. The instrument must be recalibrated whenever the setup frequency changes, whenever the ambient temperature changes by an amount that has more than likely rendered the calibration invalid, or whenever a test port extension cable is added, removed, or replaced. Refer to "Calibration Data and Indications" on page 4-19.

Caution	Changing from VNA Measurement mode to Field Measurement mode invalidates the instrument calibration.

You can save a Setup with calibration (refer to the file management instructions in the user guide for your instrument). In the Save menu, press the Change Type soft key to open the Select File Type list box. Scroll to Setup (with CAL) and press the **Enter** key.

When you recall a setup, the calibration remains valid if instrument conditions (such as temperature) remain within the calibration tolerance.

MS20xxB 1-Path 2-Port Calibration

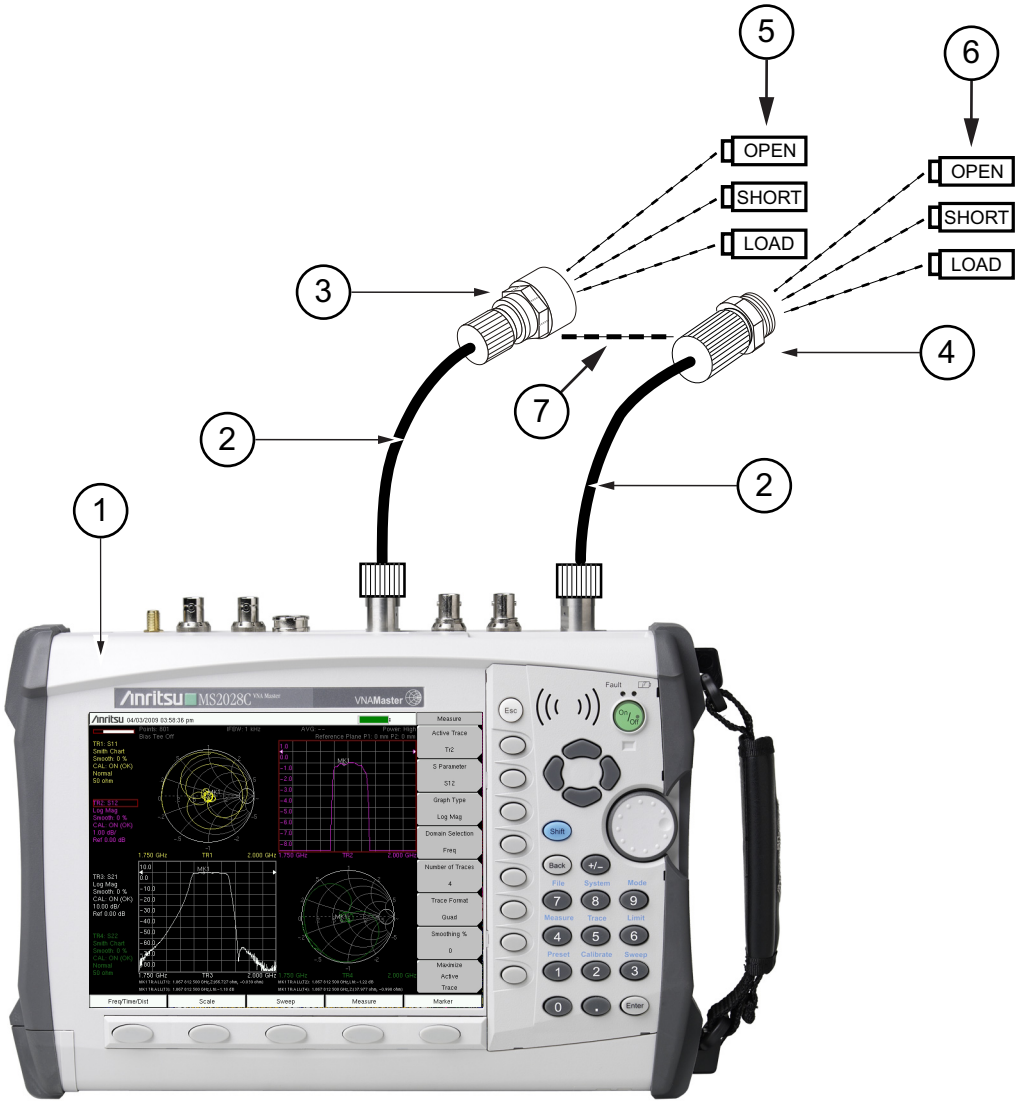


1	VNA Master
2	Optional Test Port Cable at Port 2
3	Optional Test Port Cable at Port 1
4	Through Connection (Port 1 Connects to Port 2)
5	OSL (Open, Short, Load) Precision Calibration Components

Figure 4-13. 2-Port Calibration (LMR Master and MS20xxB)

Note	For a “Through” connection, connect the ends of the Male and Female cables together.

MS20xxC Full 2-Port Calibration



1	The VNA Master
2	Optional Test Port Cable
3	Male Connector
4	Female Connector
5	OSL (Open, Short, Load) Precision Calibration Components, Female
6	OSL (Open, Short, Load) Precision Calibration Components, Male
7	Through Connection (Item 3 Connects to Item 4)

Figure 4-14. Full 2-Port Calibration on MS2028C

Note	For a “Through” connection, connect the ends of the Male and Female cables together.

Calibration Data and Indications

When you perform a calibration, the correction coefficients are calculated for specific S-parameters (depending on the type of calibration chosen) and for instrument settings (frequency range, number of points, and power level). The term "calibration correction" refers to the measurement correction coefficients that are applied to measurements as a result of your calibration.

When calibration correction is On, the correction is applied to all applicable S-parameters. For example, if a Full S_{11} (1-port) calibration is performed, then only traces that measure S_{11} have a valid calibration. For those traces, the calibration information data in the Instrument Settings Summary (described in your instrument user guide) shows "**CAL: ON (OK)**". All other traces that do not measure S_{11} will display "**CAL: --**" to indicate that no valid calibration is available for those traces. The calibration correction can also be turned off manually under the Calibration menu by toggling the Cal Correction soft key from On to Off. In that case, the display will show "**CAL: OFF**" for all traces that have valid correction data available.

Note that "**CAL: OFF**" means that a calibration correction has been created, but it is not currently being used. This is different from "**CAL: --**", which means that no valid calibration correction is available for the current setting.

When you have Cal Correction on, you cannot increase the frequency range or the number of points. You can, however, reduce the frequency range or decrease the number of points without forcing the calibration to become invalid. When reducing the frequency range, the VNA Master uses the appropriate points within the new frequency range that have correction coefficients applied to them. In that case, you can observe that the number of points that are being used for calibration correction are automatically reduced.

If you reduce only the number of points, then the frequency range is not changed. The VNA Master finds a subset of the original points in the sweep that can be used. You can therefore notice that the instrument may not use the exact number of points that you have entered. It picks a specific number of points that allow the calibration correction to continue to be valid. If you use the rotary knob, then you will more easily find the available number of points that can be set. For example, if you calibrated with 201 points, then you can observe that you can reduce the number of points to 101, 68, 51, 41, and so forth.

If you change the source power setting, then the calibration status will be changed to "**CAL: ON (?P)**", which indicates that source power has changed since the instrument was calibrated (from Low to High, or from High to Low). Refer to "Source Power Menu (MS20xxB and S412E only)" on page 6-58. In this case, the calibration may still be valid, but a new calibration is recommended.

Another status information display that you may see is "**CAL: ON (?T)**" which indicates that the instrument temperature has deviated by more than a set amount since the time that the calibration was conducted. The calibration is most likely still valid, but a new calibration is recommended. If you see "**CAL: ON (X)**" on the display, this indicates that the instrument temperature has deviated (since the time the calibration was conducted) by an amount that has more than likely rendered the calibration invalid. When this occurs, a new calibration is highly recommended before further measurements are conducted.

Only one calibration is available at one time. Performing a new calibration overwrites any existing calibration. You can, however, store a measurement setup (with CAL), which also stores the calibration. You can therefore have multiple calibrations available (as long as the calibration settings and conditions continue to apply).

Cal Type

The Cal Type soft key is found in the “Calibration Menu” (shown on page 6-19). The Calibration Type list box provides the complete selection of available calibration types. Refer to section “Calibration Types” on page 6-37

Chapter 5 — Field Measurements

5-1 Introduction

This chapter describes some of the VNA measurements that can be made with the Field measurements view. It includes the differences between VNA measurements view and Field measurements view.

All of the vector network analyzers that are referenced in this measurement guide provide the VNA measurements view (as described throughout this document). Only the S412E LMR Master and the MS2024B, MS2025B, MS2034B, MS2035B (MS20xxB), VNA Master provide the Field measurements view that is described in this chapter.

Options

The Vector Network Analyzer instruments can be configured with VNA options: Bias Tee (Option 0010), Vector Voltmeter (Option 0015), and 6 GHz VNA Frequency Extension (Option 0016). Only the S412E LMR Master requires Option 16.

Note	The LMR Master standard frequency range is 500 kHz to 1.6 GHz. Option 0016 extends this range to 6 GHz in VNA mode.

5-2 Field Measurements View Setting

The Measure menu can be changed between two different settings, Field or VNA. For users already familiar with the Anritsu Site Master measurement nomenclature, the Field measurements view setting will likely be more comfortable. The VNA measurements view setting is designed to more closely resemble the menus of a bench top VNA, and allows access to more advanced features of the Vector Network Analyzer.

The VNA measurements view is the default presentation throughout this manual. This chapter, however, provides the subset of measurements and menus that are specific to the Field measurements view.

Select Measurement Type – Field versus VNA

Change between the Field measurements view and the VNA measurements view by pressing the **Shift** key followed by the **System** (**8**) key, and then by pressing the Applications Options soft key (submenu key). Press the Meas Menu soft key to toggle between Field and VNA.

Touch Screen Trace Features

Refer to section "Touch Screen Trace Features" on page 2-3.

Markers on a Touch Screen

Refer to section "Markers on a Touch Screen" on page 2-8.

5-3 Measurement Setup

Before conducting a measurement, ensure that the instrument is set to Field measurements view. Then select a measurement type, specify the frequency range and sweep parameters (such as number of data points), and perform a calibration. These operations are described further in the following paragraphs. This chapter describes the Field measurements view. Note that the VNA measurements view is the default measurement display type that is described in the other chapters of this measurement guide.

Caution	Changing from VNA Measurement mode to Field Measurement mode invalidates the instrument calibration.

You can save a Setup with calibration (refer to the file management instructions in the user guide for your instrument). In the Save menu, press the Change Type soft key to open the Select File Type list box. Scroll to Setup (with CAL) and press the **Enter** key (refer to the file management instructions in the user guide for your instrument).

When you recall a setup, the calibration remains valid if instrument conditions (such as temperature) remain within the calibration tolerance.

The "Measure Menu – Single" on page 7-15 is accessed by pressing the **Measure** function hard key (main menu key) below the display or by pressing the **Shift** key followed by the **Measure** (**4**) key. All available VNA measurement types are found in the Graph Type Selector list box (which is opened by pressing the Measurement Type soft key in the Measure menu). DTF Return Loss and DTF VSWR measurements are standard.

Setting the Frequency Range

Regardless of the type of measurement that is being made, the frequency range for the desired measurement must be set before calibrating the instrument. Increasing the frequency after calibrating the instrument will invalidate the calibration. Decreasing the frequency does not invalidate the calibration. Press the **Freq/Dist** function hard key (below the sweep window) to display the "Freq Menu (Frequency-Based)" on page 7-3.

Setting the Start and Stop Frequencies

Set the Start Frequency by pressing Start Freq soft key and using the keypad, the arrow keys, or the rotary knob to set a value in Hz, kHz, MHz, or GHz for the desired frequency. Set the Stop Frequency by pressing the Stop Freq soft key.

Note	If a Start Frequency is entered that is higher than the current Stop Frequency, Stop Frequency is automatically adjusted to be equal to the entered Start Frequency. Similarly, if a Stop Frequency that is lower than the current Start Frequency is entered, Start Frequency is automatically adjusted to be equal to the Stop Frequency.

The frequency range can also be set by using the Center Freq and Span soft keys. For example, to set a frequency range of 1850 MHz to 1990 MHz, set the Center Frequency to 1920 MHz and the Frequency Span to 140 MHz.

$$1990 - 1850 = 140$$

$$\frac{140}{2} = 70$$

$$1990 - 70 = 1920 \qquad 1850 + 70 = 1920$$

Setting Data Points

Press the **Sweep** function hard key (main menu key), and then press the Data Points soft key (submenu key). Use the rotary knob, the arrow keys, or the numeric keypad. When you use the numeric keypad to enter a number, an Enter soft key appears in the menu. You can also press the keypad **Enter** key. You can set any number of data points from 2 up to 4001.

Calibration

For accurate results, the instrument must be calibrated at ambient temperature after allowing for warm up time (approximately 15 minutes) and before making any measurements. Refer to "Calibration Considerations" on page 4-16.

The Existing Calibration Information list box is shown in Figure 7-21 on page 7-18.

After calibrating, you can reduce the frequency span or reduce the number of data points without invalidating the calibration (refer to "Calibration Data and Indications" on page 4-19).

Caution	**Increasing** the frequency span or **increasing** the number of data points greater than the values in the original calibration will invalidate the calibration.

5-4 Graph Type Selector List Box

The Graph Type Selector list box is opened by pressing the Measurement Type soft key in the Measure menu.

Field Measurements View versus VNA Measurements View

Three measurement display types are available in Field Measurements view: Single, Dual, and Overlay. Press the Display Type soft key (submenu key).

In the Overlay display type, only two graph types are available, and they are Insertion Loss for Trace 1 (TR1) and Return Loss for Trace 2 (TR2).

Figure 5-1 on page 5-5 provides an example of Insertion Loss in Display Type Single.

Figure 5-2 on page 5-6 provides an example of VSWR and Return Loss in Display Type Dual.

Figure 5-3 on page 5-7 provides an example of Insertion Loss and Return Loss measurements in Display Type Overlay.

Field Measurements View

The following graph types are available in **Field Measurements view**:

When Display Type is set to Overlay, the graph types are always Insertion Loss for Trace 1 and Return Loss for Trace 2.

When Display Type is set to Single or Dual, the following graph types are available**:**

- VSWR
- Return Loss
- Cable Loss
- Insertion Loss
- 1-Port Phase
- 2-Port Phase
- 1-Port Smith
- DTF Return Loss
- DTF VSWR

VNA Measurements View

The following graph types are available in **VNA Measurements view:**

- Log Magnitude
- SWR
- Phase
- Real
- Imaginary
- Group Delay
- Smith Chart
- Inverted Smith Chart

- Log Magnitude/2 (1-Port Cable Loss)
- Linear Polar
- Log Polar
- Real Impedance
- Imaginary Impedance

Insertion Loss in Display Type Single

The screen-captured measurements that are shown in this measurement guide are examples and may not match any display on your instrument.

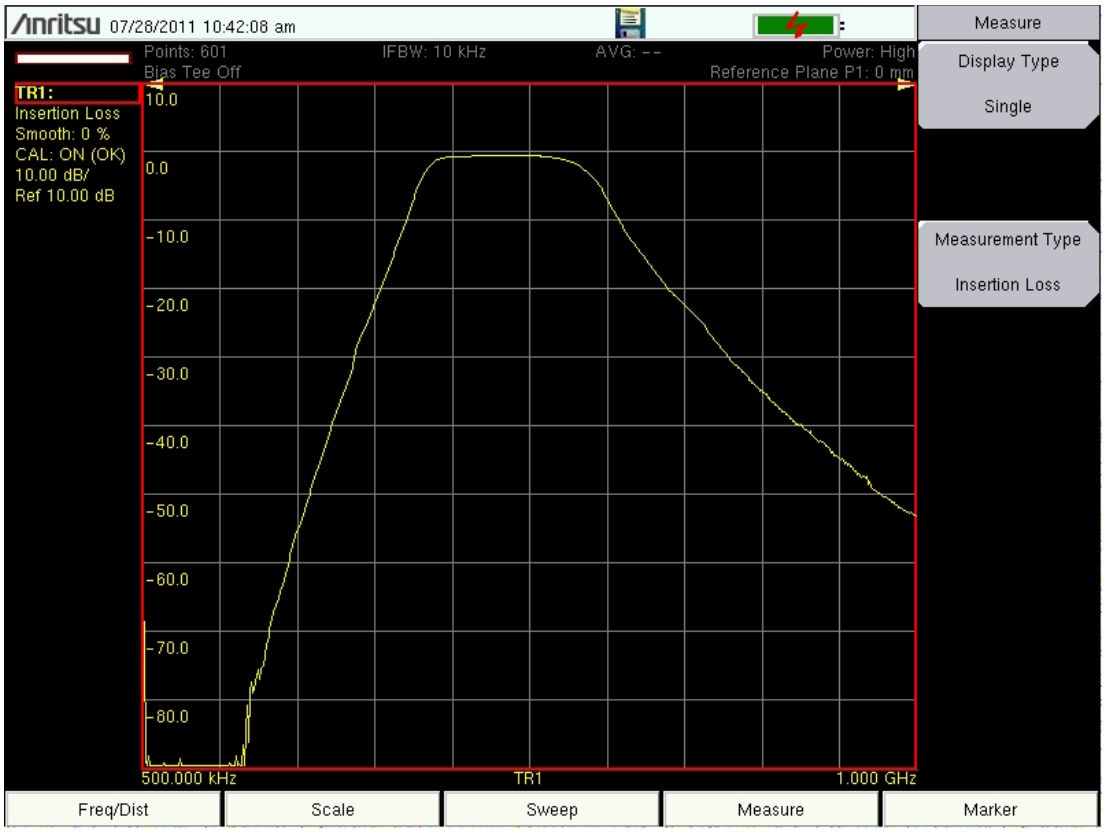


Figure 5-1. Display Type Single – Insertion Loss

VSWR and Return Loss in Display Type Dual

The example in this figure may not match the display on your instrument.

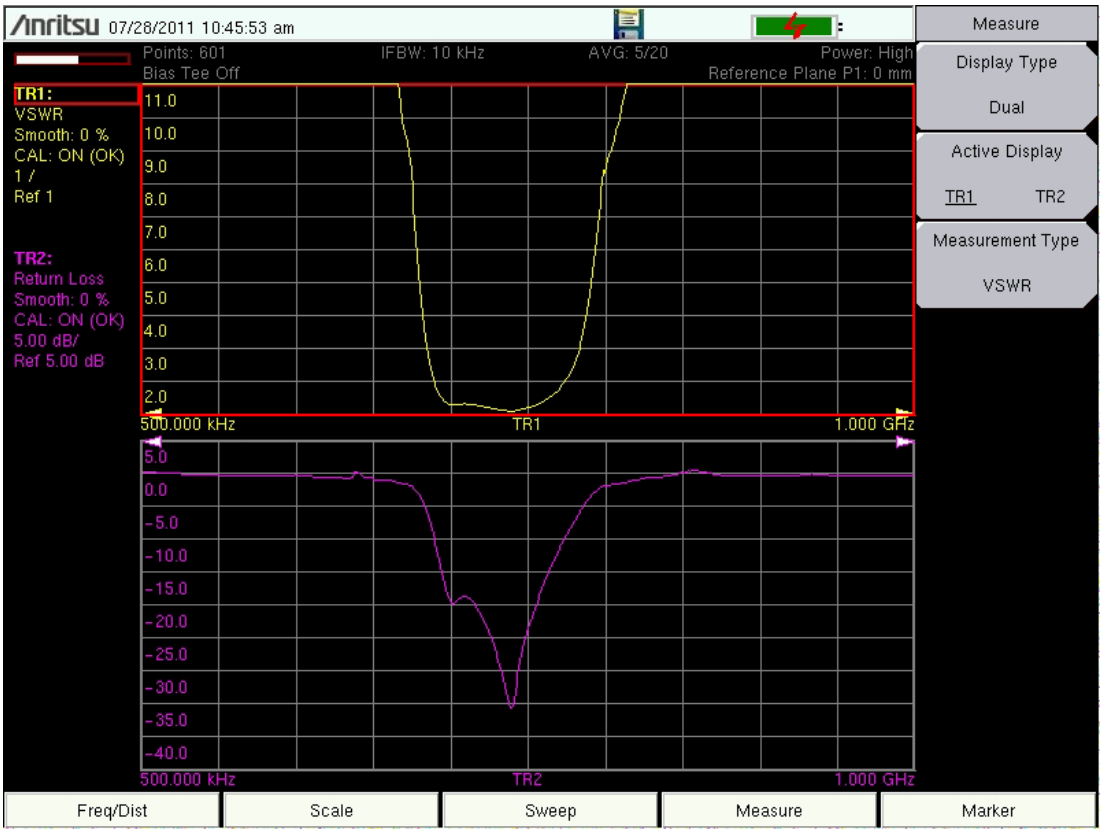


Figure 5-2. Display Type Dual – VSWR and Return Loss

Insertion Loss and Return Loss in Display Type Overlay

The example in this figure may not match the display on your instrument.

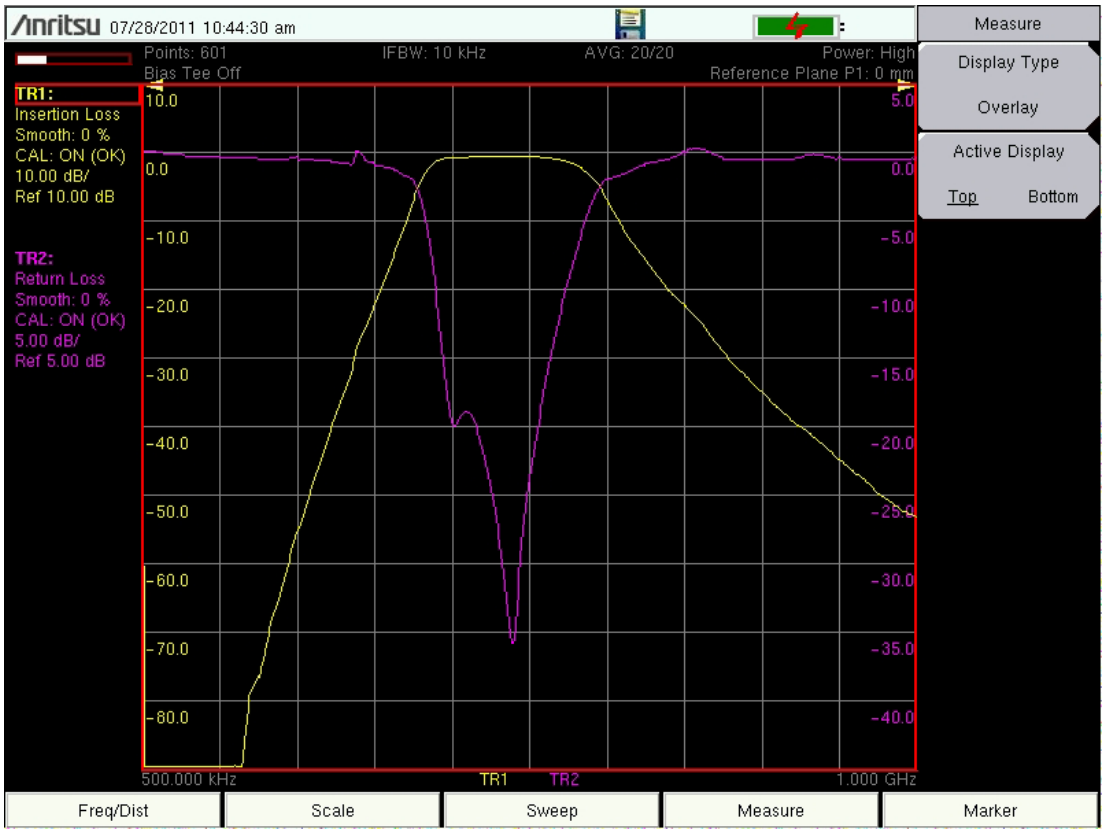


Figure 5-3. Display Type Overlay – Insertion Loss and Return Loss

5-5 Field View Menus

Many menus display limited soft key functionality in Field view. Various keys that are available in VNA measurements view may be in different locations or may not be displayed at all. Refer to Chapter 7, “Field View Menus” and Chapter 6, “VNA View Menus”.

5-6 VNA Measurements

The following sections provide detailed descriptions of the various Vector Network Analyzer measurements. Some of these measurements can be displayed in either Field measurements view or VNA measurements view. The following procedures describe only the Field measurements view.

Sweep averaging can be calculated by a variable number of sweeps. In the Sweep menu, press the Avg/Smooth soft key to open the Avg/Smooth menu. In this menu, you can also set the smoothing percentage from 0% to 20%. To set the number of sweeps that are used to calculate sweep averaging, press the Sweep Averaging soft key and enter a number. Figure 5-4 shows a trace with Sweep Averaging set to 20 sweeps. The example in this figure may not match the display on your instrument.

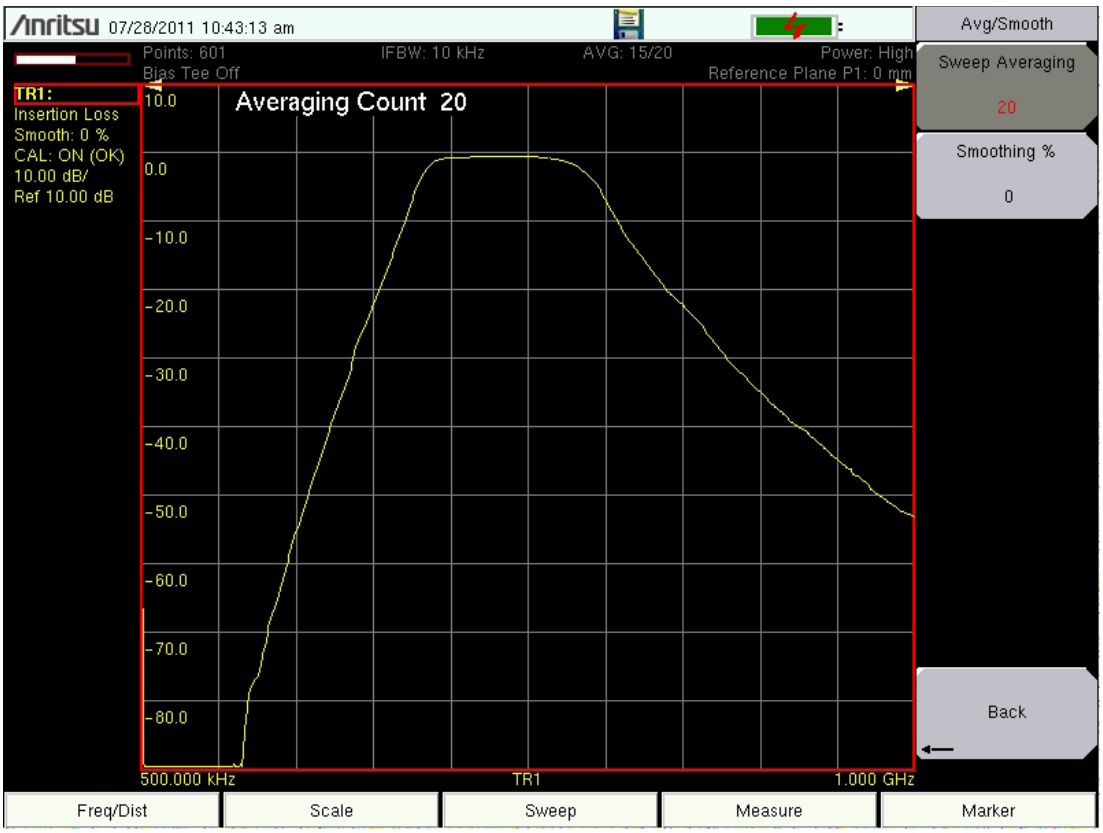


Figure 5-4. Display Type Single – Insertion Loss with Sweep Averaging Set to 20

5-7 Return Loss/VSWR

Return Loss is used to characterize RF components and systems. The Return Loss indicates how well the system is matched by taking the ratio of the reflected signal to the incident signal, measuring the reflected power in dB. The 1-port Measurement data can also be displayed linearly as VSWR. In addition, this information can be transferred to a PC for additional analysis by using Master Software Tools.

Procedure

1. If a test port extension cable is to be used, then connect it to the VNA Port 1 connector on the instrument.
2. Ensure that the instrument is in Vector Network Analyzer mode. Then press the **Shift** key and the **System** (**8**) key.
3. Press the Application Options soft key. The Meas Menu soft key toggles between Field and VNA. The active measurement function is underlined.

   Press the soft key (if necessary) until Field is underlined. The Measure menu now displays Field measurement functions.
4. Press the **Measure** function hard key (main menu key).
5. Pres the Display Type soft key (submenu key) and select Single from the list box.
6. Press the Measurement Type soft key. From the Graph Type Selector list box, select Return Loss.
7. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
8. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
9. Press the **Shift** key, then the **Calibrate** (**2**) key.
10. Press the Start Cal soft key and perform a 1-port calibration at the connector or at end of the extension cable. Follow the instructions on the display or, for more details, refer to "Calibration Considerations" on page 4-16.
11. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.
12. Connect the test port extension cable to the Device Under Test (DUT).
13. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

14. Press the **Measure** function hard key and select VSWR from the Graph Type Selector list box to view the match in VSWR. Figure 5-5 is displaying a VSWR measurement and the Measure menu of the Field setting when Display Type is Single. The example in this figure may not match the display on your instrument..

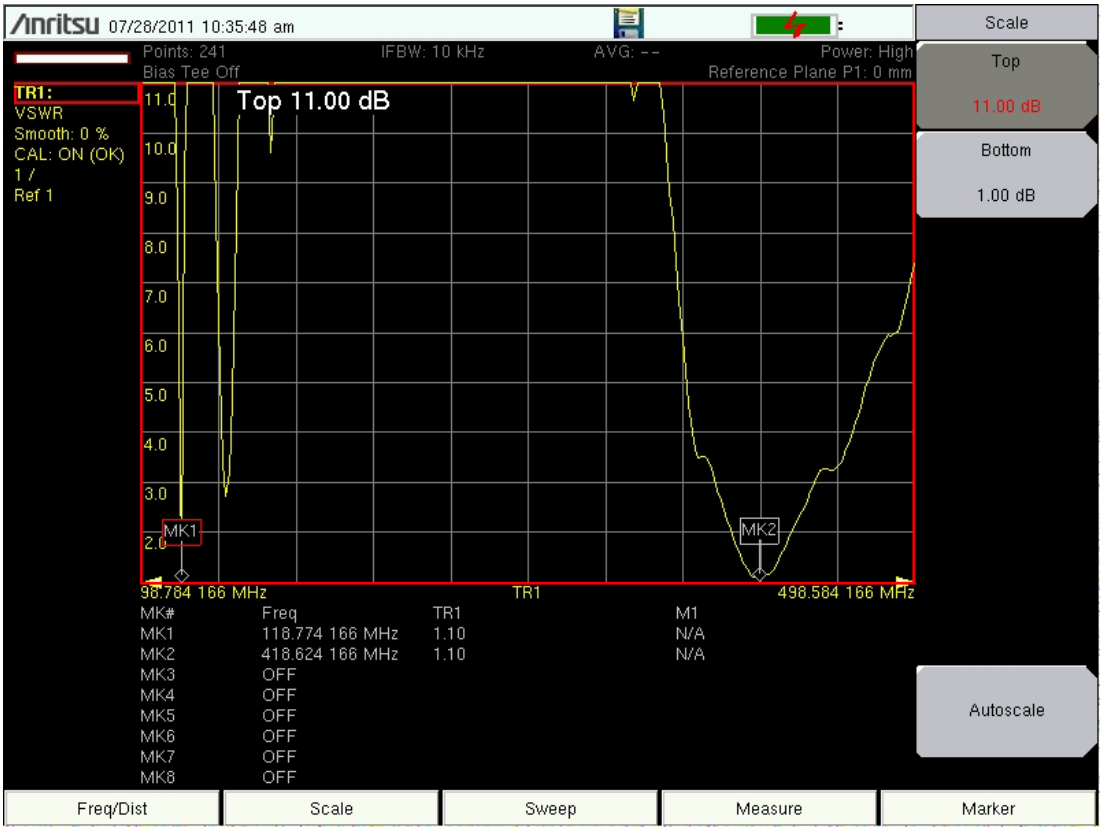


Figure 5-5. Display Type Single – VSWR Measurement

Figure 5-6 is displaying both a VSWR measurement and a Return Loss measurement. Note that the Measure menu of the Field setting shows Display Type is Dual. and that the Active Display soft key provides for selection of TR1 or TR2.

Note	On instruments with a touch screen, you may tap a measurement trace or the trace data in the Instrument Settings Summary to make a trace the active trace.

The example in this figure may not match the display on your instrument.

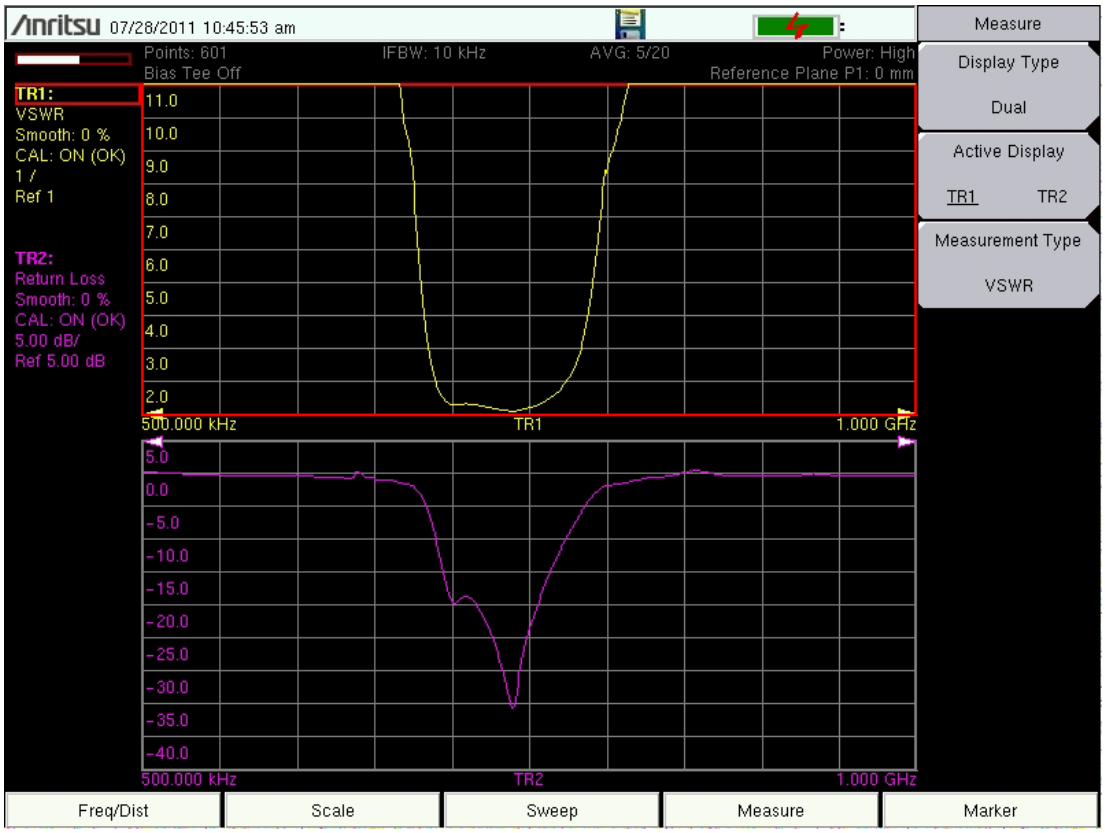


Figure 5-6. Display Type Dual – VSWR and Return Loss

5-8 Cable Loss

The transmission feed line insertion loss test verifies the signal attenuation level of the cable. This test can be done using the Cable Loss or Return Loss Measurement with a short or an open connected at the end of the system. The advantage of using the Cable Loss measurement is that the instrument takes care of the math, and therefore no computations are needed. Cable Loss is a Return Loss measurement that also takes into consideration that the signal travels in both directions. Refer to "Measure Menu – Single" on page 7-15.

Procedure

1. If a test port extension cable is to be used, then connect it to the VNA Port 1 connector on the instrument.
2. Ensure that the instrument is in Vector Network Analyzer mode. Then press the **Shift** key and the **System** (**8**) key.
3. Press the Application Options soft key. The Meas Menu soft key toggles between Field and VNA. The active measurement function is underlined.

   Press the soft key (if necessary) until Field is underlined, then press the Back key. The Measure menu now displays field measurement functions.
4. Press the **Measure** function hard key and then the Measurement Type soft key. From the Graph Type Selector list box, select Cable Loss and press **Enter**.

   The Measurement Type soft key shows Cable Loss in the soft key face.
5. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
6. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
7. Press the **Shift** key, then the **Calibrate** (**2**) key.
8. Press the Start Cal soft key and perform a 1-port OSL calibration at the connector or at end of the extension cable. Follow the instructions on the display.
9. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.

10. Connect the test port extension cable to the Transmission Line to begin the Cable Loss measurement. The example below shows a cable loss measurement in the WiFi band. Average cable loss is calculated and displayed at the top of the graticule.

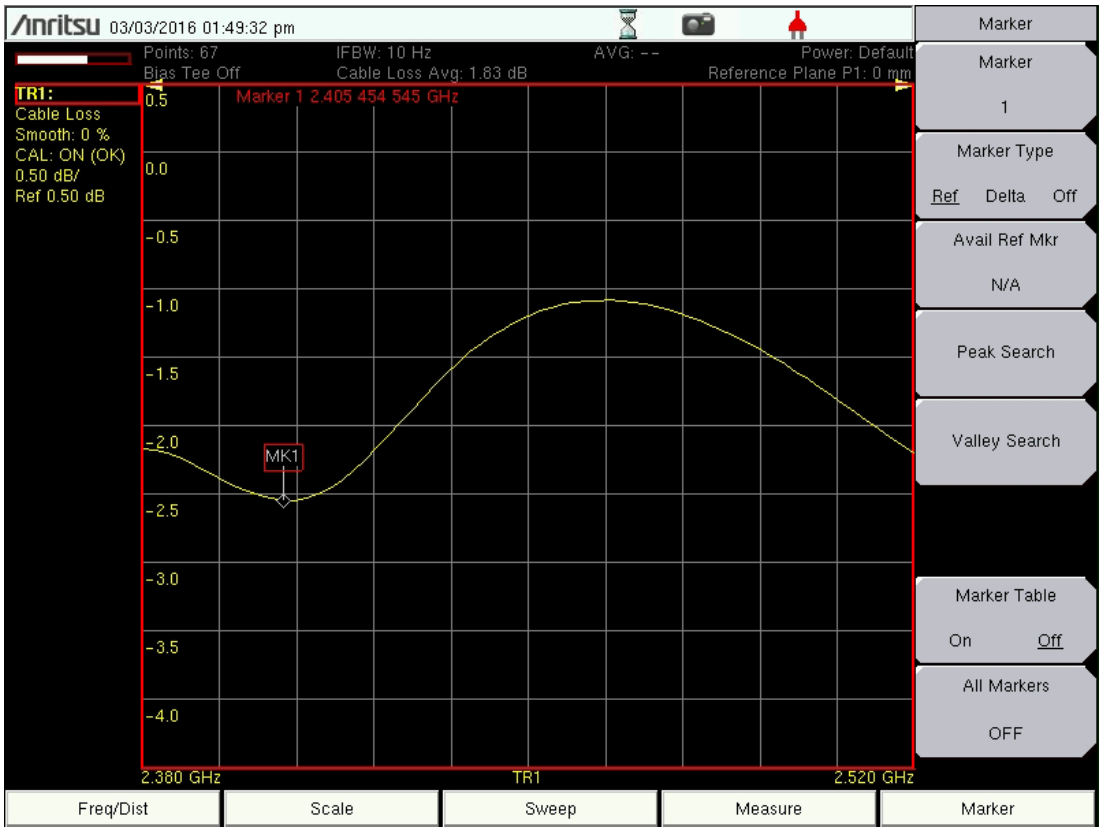


Figure 5-7. Display Type Single – Cable Loss

11. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

5-9 Distance-To-Fault (DTF)

The DTF measurements display Return Loss or VSWR values versus distance. These measurements are standard on the MS20xxB VNA Master and the S412E LMR Master. If frequency measurements fail or indicate a problem in the system, then the DTF measurement can be used to identify and pinpoint the exact location of the problem. The DTF measurement shows the return loss value of all of the individual components, including connector pairs and cable components.

For more information about distance measurements, refer to Section 9-6 “Distance Information” on page 9-6.

When DTF Return Loss or DTF VSWR is chosen from the Graph Type Selector list box, the **Freq/Dist** function hard key displays the “Freq/Dist Menu (Distance-Based)” on page 7-4, not the Frequency menu.

Windowing is a frequency filter that is applied to the frequency-domain data when it is converted to distance-domain data. When DTF graph types are selected, the Windowing soft key is displayed in the “DTF Setup Menu” on page 7-6. For more details about windowing, refer to Section 9-4 “Windowing” on page 9-4 and to Appendix B.

When measuring cable distance, DTF measurements can be made with an open or a short connected at the end of the cable. The peak indicating the end of the cable should be between 0 dB and 5 dB.

An open or short should not be used when DTF is used for troubleshooting because the open or short will reflect everything, and the true value of a connector might be misinterpreted. A good connector could look like a failing connector.

A 50 ohm load is the best termination for troubleshooting DTF problems because it will be 50 ohm over the entire frequency range. The antenna can also be used as a terminating device, but the impedance of the antenna will change over different frequencies because the antenna is designed to have only 15 dB or better return loss in the passband of the antenna.

DTF measurement is a frequency domain measurement, and the data is transformed to the time domain using mathematics. The distance information is obtained by analyzing how much the phase is changing when the system is swept in the frequency domain.

Frequency selective devices such as Tower Mounted Amplifiers (TMA), duplexers, filters, and quarter wave lightning arrestors will change the phase information (distance information) if they are not swept over the correct frequencies. Care needs to be taken when setting up the frequency range whenever a TMA is present in the path.

Because of the nature of the measurement, maximum distance range and fault resolution are dependent on the frequency range and number of data points. The instrument will take care of all the math, but knowing whether the cable is longer than DMax is important. The only way to be able to improve the horizontal range is to reduce the frequency span or to increase the number of data points. Similarly, the fault resolution is inversely proportional to the frequency range, and the only way to improve the fault resolution is to widen the frequency span.

The MS20xxB VNA Master and the S412E LMR Master are equipped with a cable list, which includes most of the common cables that are used today. After the correct cable has been selected, the instrument updates the propagation velocity and the cable attenuation values to correspond with the cable. These values can also be entered manually and can be uploaded via Master Software Tools. Incorrect propagation velocity values affect the distance accuracy, and inaccurate cable attenuation values affect the accuracy of the magnitude value.

DTF Example

Figure 5-8 on page 5-16 shows a DTF Return Loss measurement.

Procedure

1. If a test port extension cable is to be used, then connect it to the VNA Port 1 connector on the instrument.
2. Ensure that the instrument is in Vector Network Analyzer mode. Then press the **Shift** key and the **System** (**8**) key.
3. Press the Application Options soft key. The Meas Menu soft key toggles between Field and VNA. The active measurement function is underlined.

   Press the soft key (if necessary) until Field is underlined, then press the Back key. The Measure menu now displays field measurement functions.
4. Press the **Measure** function hard key and then the Display Type soft key. From the list box, select Single, and then press **Enter**.
5. Press the **Measure** function hard key and select DTF Return Loss (or DTF VSWR).

   The Measurement Type soft key shows the name in the soft key face.
6. Press the **Freq/Dist** function hard key and set the Start Frequency, and Stop Frequency.
7. Press the Units soft key to select feet.
8. Press the More soft key.
   a. Press the Cable List soft key to select the cable type, then skip to Step d. If the cable is not listed, then set the cable loss and propagation velocity manually, as described in Step b and Step c.
   b. Press the Cable Loss soft key to set a cable loss value.
   c. Press the Propagation Velocity soft key and set Propagation Velocity between 0.001 and 1.000.
   d. If desired, press the Windowing soft key and select a windowing type. Refer to Section 9-4 “Windowing” on page 9-4.
   e. Press the Back soft key to return to the Freq/Dist menu.
9. Press the Distance Info soft key to view settings and parameter values. This window may contain suggestions to improve the measurement results. Use the rotary knob to scroll through the Distance Info window data. For more information about the Distance Info window, refer to Section 9-6 “Distance Information” on page 9-6.
10. Press the **Esc** key to close the Distance Info window.
11. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points to be included in the sweep (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).

12. Press the **Freq/Dist** function hard key and use the Stop Dist soft key to enter the Stop Distance. Make sure that the Stop Distance is smaller than Dmax (refer to "DMax" on page 5-18).
13. Press the **Shift** key, then the **Calibrate** (**2**) key.
14. Press the Start Cal soft key and perform a 1-port OSL calibration at the instrument connector or at end of the extension cable. Follow the instructions on the display.
15. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.

    For examples of the calibration status display, refer to section "Calibration Data and Indications" on page 4-19.
16. Connect the test port extension cable to the Device Under Test (DUT).
17. Press the **Marker** function hard key and then press the Peak Search soft key.
18. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument. Figure 5-8 shows the Port 1 cable connection at MK1, a female-to-female N adapter at MK2, and the open end of cable 2 at MK3. The time delay can be accessed from the left side of the display and also from the marker table.

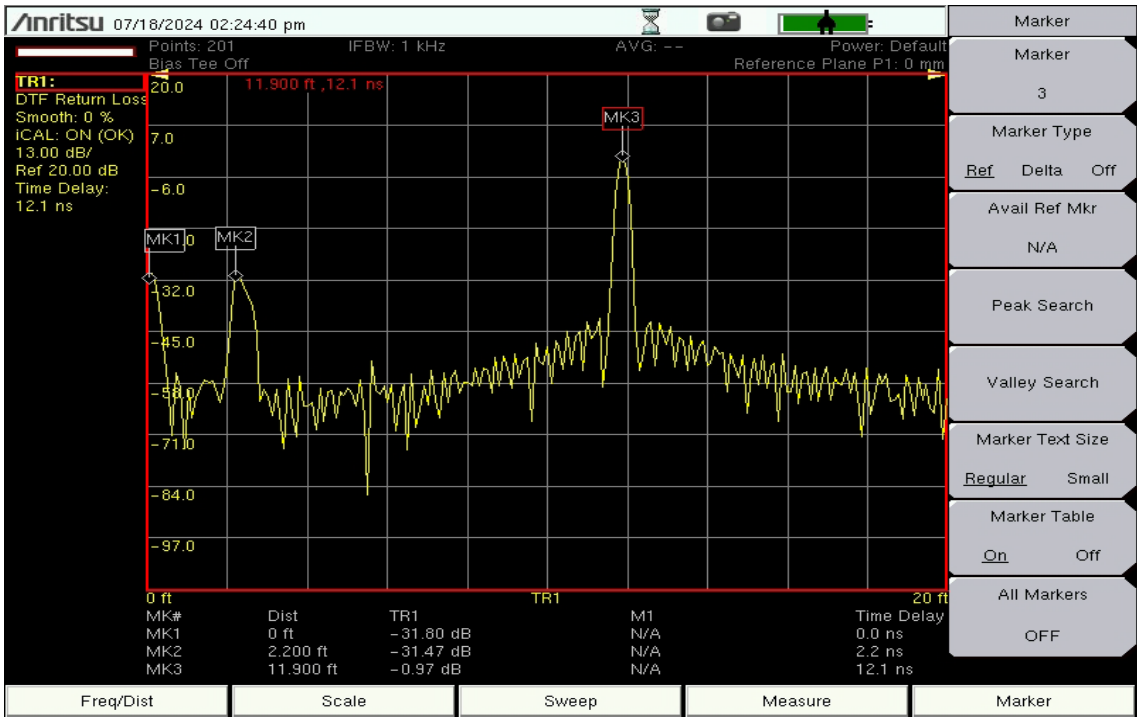


Figure 5-8. DTF Return Loss Measurement with Two Cables and Female N Adapter

DTF Measurement Calculations

Fault Resolution

Fault resolution is the ability of the system to separate two closely spaced discontinuities. If the fault resolution is 10 feet and two faults are 5 feet apart, then the VNA Master will not be able to show both faults unless Fault Resolution is improved by widening the frequency span.

$$\text{Fault Resolution (m)} = \frac{1.5 \times 10^8 \times \text{vp}}{\Delta F}$$

DMax

DMax is the maximum horizontal distance that can be analyzed. The Stop Distance cannot exceed Dmax. If the cable is longer than Dmax, then Dmax needs to be improved by increasing the number of datapoints or by lowering the frequency span (ΔF). Note that the datapoints can be set from 1 to 4001.

$$D_{max} = (\text{Datapoints} - 1) \times \text{Fault Resolution}$$

Suggested Span

If the frequency span is set to the suggested span, the Stop Distance will equal Dmax giving the best fault resolution for the given conditions. With Stop Dist entered in meters, the following relationship can be obtained:

$$\text{Suggested Span (Hz)} = \frac{(\text{Datapoints} - 1) \times (1.5 \times 10^8 \times \text{vp})}{\text{Stop Distance (meters)}}$$

5-10 Phase Measurements

The MS20xxB VNA Master or the S412E LMR Master can display both Return Loss and Insertion Loss phase measurements. 2-Port Phase measurements can use power settings of High (0 dBm), Default (–5 dBm), and Low (–25 dBm).

1-Port Phase Measurement

The following example compares the phase of two cables using a 1-port phase measurement. The dynamic range and phase uncertainty are better with 2-port phase measurements. Figure 5-9 shows a typical 1-Port Phase measurement (Return Loss). This screen display may not match the display on your instrument.

Procedure

1. Press the **Measure** function hard key and then press the Measurement Type soft key and select 1-Port Phase.
2. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
3. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
4. Press the **Shift** key, then the **Calibrate** (**2**) key.
5. Press the Start Cal soft key and perform a 1-port OSL calibration at the desired reference plane (VNA Port 1 connector or end of test port cable).
6. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.
7. Connect Cable A to VNA Port 1 reference plane (or to the end of the test port cable).
8. Press the **Shift** key, then the **Trace** (**5**) key.
9. Press the Save Trace to Memory soft key.
10. Remove Cable A and connect Cable B to VNA Port 1 reference plane (or to the end of the test port cable).
11. Press **Shift** and then **Trace** (**5**) to display the Trace menu. Then press Trace Math.
12. Press the Trace Minus Memory soft key to view the difference in phase between the two cables.
13. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument.

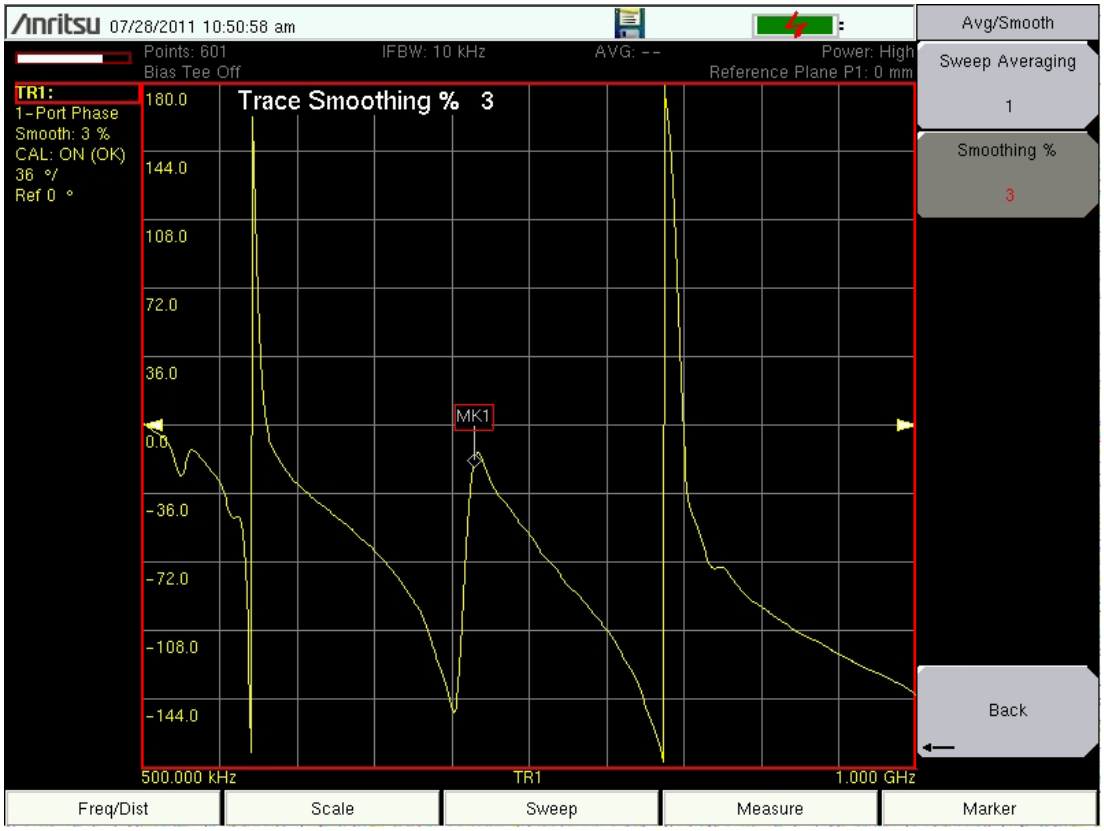


Figure 5-9. Return Loss, 1-Port Phase Measurement

2-Port Phase Measurement

The following example compares the phase of two cables using a 2-port phase measurement. Figure 5-10 shows a typical 2-Port Phase measurement (Insertion Loss). This screen display may not match the display on your instrument.

Procedure

1. Press the **Measure** function hard key and then press the Measurement Type soft key and select 2-Port Phase.
2. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
3. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
4. Press the **Shift** key, then the **Calibrate** (**2**) key.
5. Press the Start Cal soft key and perform a 2-port OSL calibration at VNA Port 1 and VNA Port 2.

6. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.
7. Connect Cable A (the reference cable) between the VNA Port 1 and VNA Port 2 connectors.
8. Press the **Shift** key, then the **Trace** (**5**) key.
9. Select the Save Trace to Memory soft key.
10. Remove Cable A, and connect Cable B (the cable under evaluation).
11. Press **Shift** and then **Trace** (**5**) to display the Trace menu. Then press Trace Math.
12. Press the Trace Minus Memory soft key to view the difference in phase between the two cables.
13. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument.

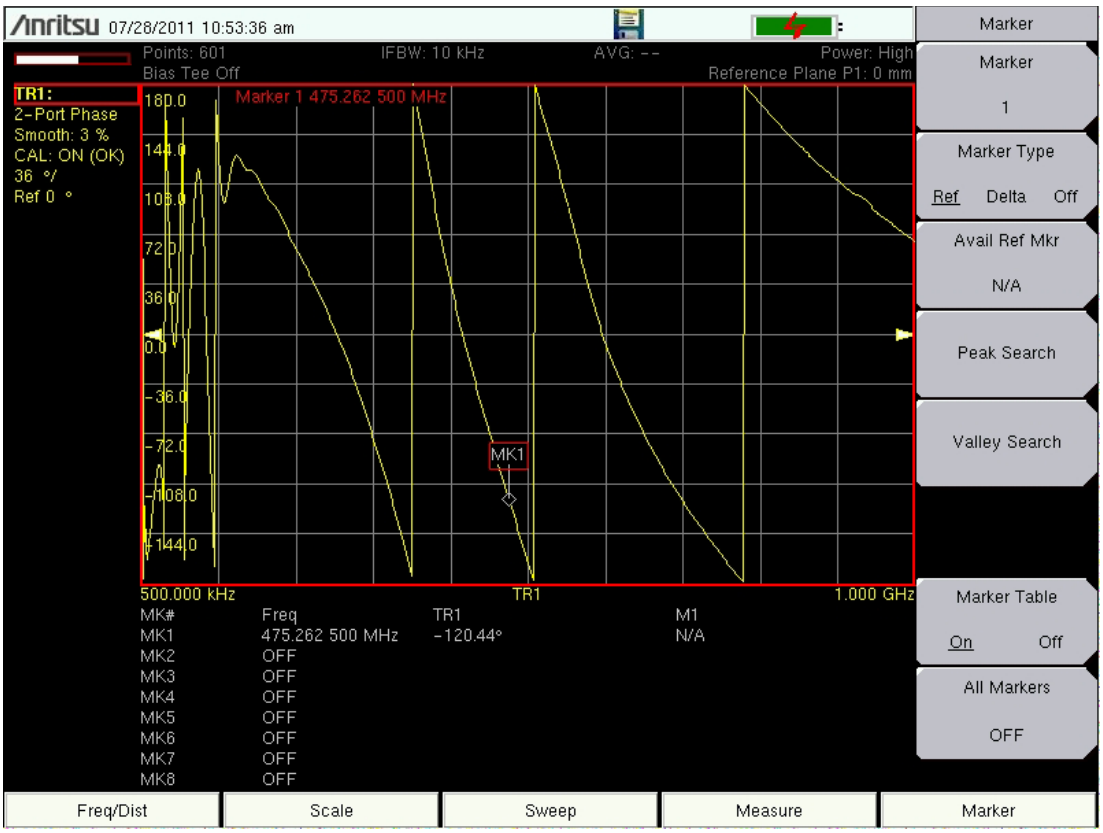


Figure 5-10. Insertion Loss, 2-Port Phase Measurement

5-11 Smith Chart

The MS20xxB VNA Master or the S412E LMR Master can display 1-port measurements in a standard Normalized 50 ohm or 75 ohm Smith Chart. When markers are used, the real and imaginary components of the Smith Chart value are displayed.

Smith Chart Measurement

The following example shows how a Smith Chart can be used to measure the match of an antenna. Figure 5-11 shows a typical 1-port Smith Chart measurement. This screen display may not match the display on your instrument.

Procedure

1. Ensure that the instrument is in Vector Network Analyzer mode, and that the Meas Menu soft key is toggled to **Field**.
2. Press the **Measure** function hard key and then press the Measurement Type soft key and select 1-Port Smith.
3. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
4. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
5. Press the **Shift** key, then the **Calibrate** (**2**) key.
6. Press the Start Cal soft key and perform a 1-port calibration.
7. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window, and the trace should be centered around 0 dB when the short or open is connected.
8. Connect the antenna to the VNA Port 1 connector on the instrument.
9. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument.

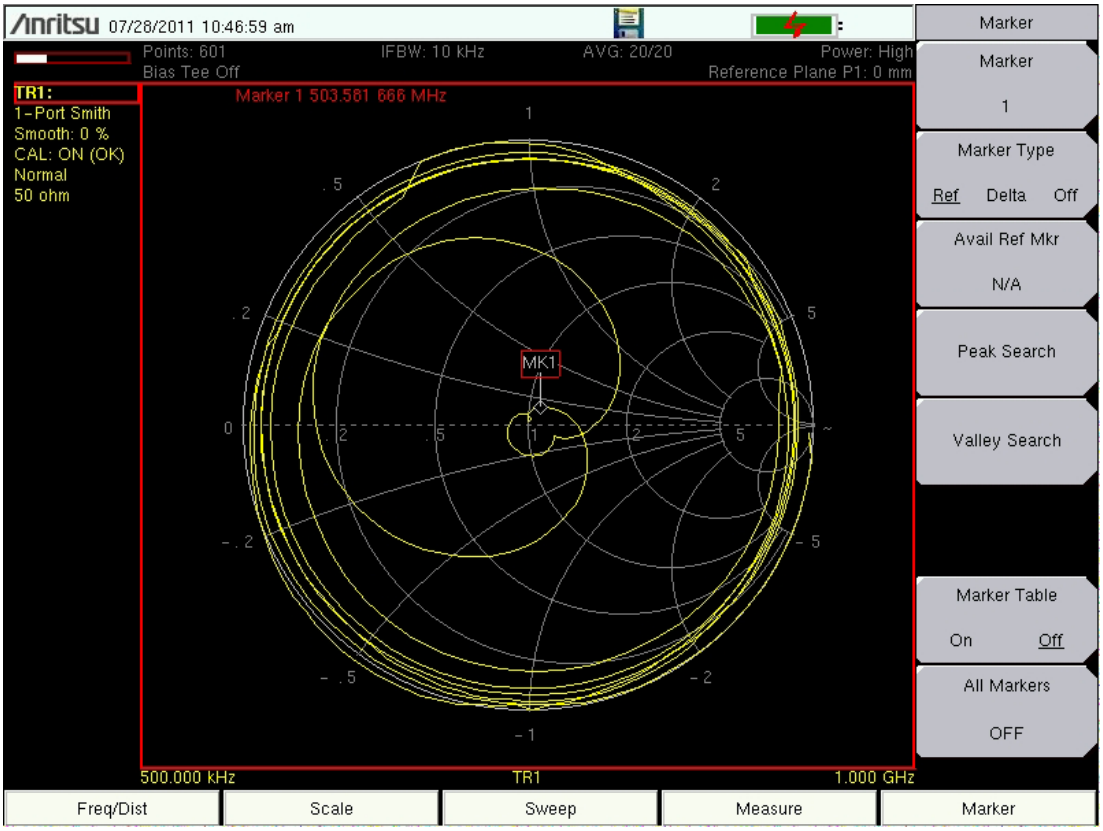


Figure 5-11. 1-Port Smith Chart Measurement

5-12 Log Mag Display Types

The MS20xxB VNA Master and the S412E LMR Master can display 1-port and 2-port measurements (Return Loss and Insertion Loss) in a Single display format (one at a time) or simultaneously in a twofold display format.

The two types of twofold display are: Dual and Overlay. In Display Type Overlay, two traces are shown in a single sweep area (refer to Figure 5-12 on page 5-25). In Display Type Dual, two traces are shown in separate sweep areas (refer to Figure 5-13 on page 5-26). These screen displays are examples that may not match any display on your instrument.

Typical Log Magnitude Measurement

Figure 5-12 shows a typical log magnitude measurement of two traces in Overlay view, and also displays the marker table at the bottom of the sweep window. Figure 5-13 shows the same measurement as Figure 5-12 but in Dual view, which shows the traces in two separate sweep windows on the display screen. These screen displays may not match any display on your instrument.

Procedure

1. Ensure that the instrument is in Vector Network Analyzer mode, and that the Meas Menu soft key is toggled to **Field**.
2. Press the **Measure** function hard key, and then press the Display Type soft key.
3. From the Display Type list box, scroll to Dual and press the **Enter** key.
4. Press the Active Display soft key (if necessary) to select TR1 (Trace 1). Then press the Measurement Type soft key and select Insertion Loss.
5. Press the Active Display soft key to select TR2 (Trace 2). Then press the Measurement Type soft key and select Return Loss.
6. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency.
7. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed).
8. Press the **Shift** key, then the **Calibrate** (**2**) key.
9. Press the Start Cal soft key and perform a 2-port OSL calibration.
10. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window.
11. Connect VNA Port 1 and VNA Port 2 to the DUT.
12. Press the touch screen or the Active Display soft key to toggle between the two traces.
13. Use the File menu to save the measurement. Refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument.

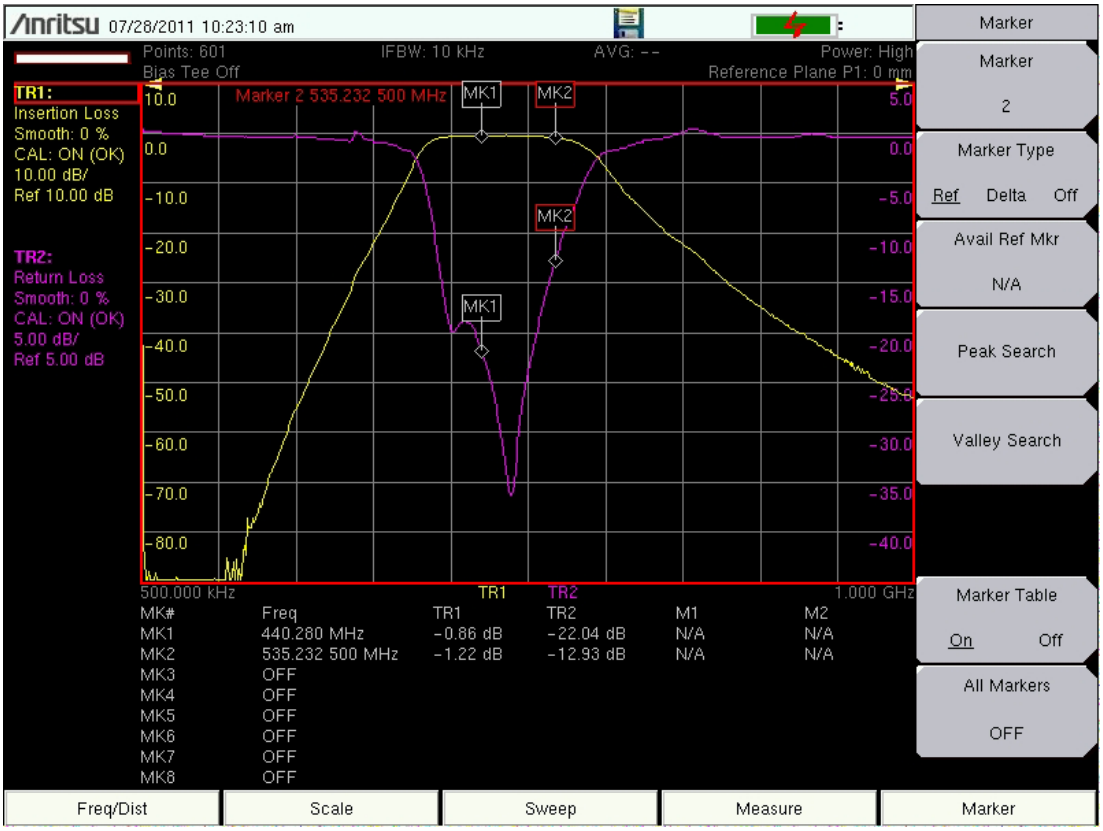


Figure 5-12. Log Mag – Display Type Overlay – Return Loss and Insertion Loss

The example in this figure may not match the display on your instrument.

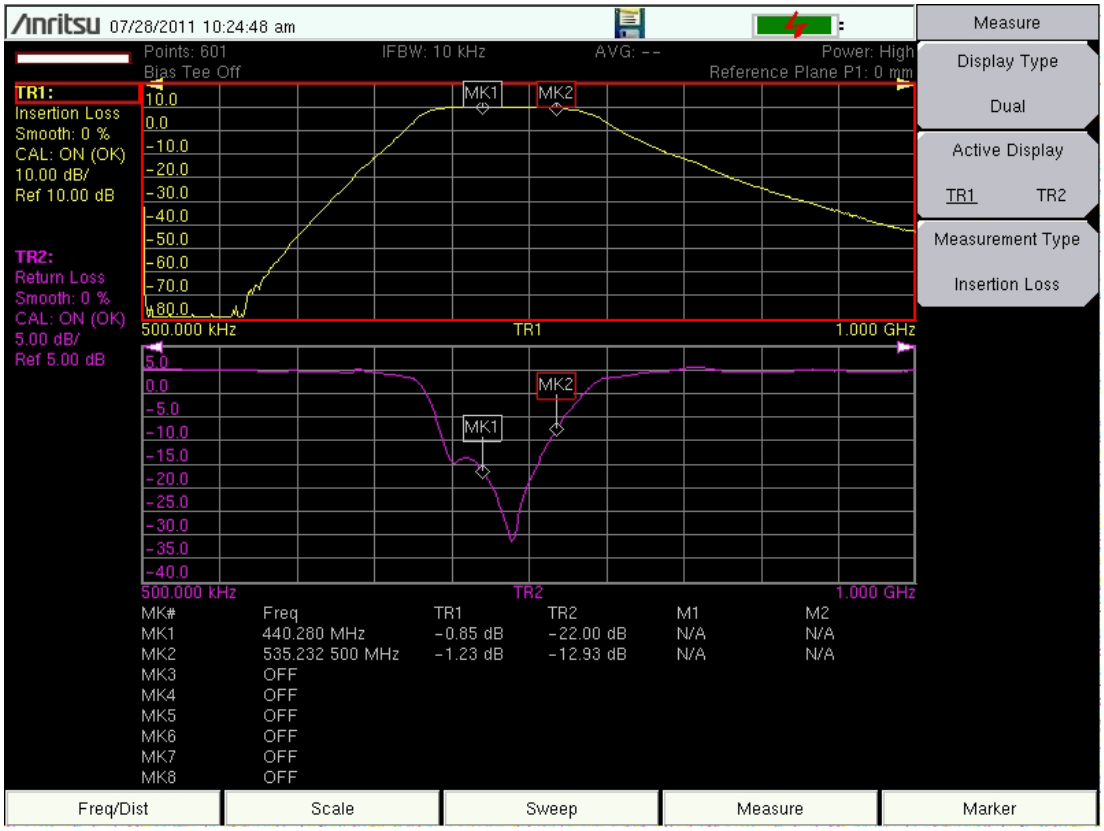


Figure 5-13. Log Mag – Display Type Dual – Return Loss and Insertion Loss

Dual Channel Filter Tuning Measurement

Figure 5-14 shows a typical filter tuning measurement. The marker table is displayed at the bottom of the sweep window. This screen display may not match the display on your instrument.

Procedure

1. Press the **Measure** function hard key, and then press the Display Type soft key.
2. From the Display Type list box, scroll to Dual and press the **Enter** key.
3. Press the Active Display soft key (if necessary) to select TR1 (Trace 1). Then press the Measurement Type soft key and select Insertion Loss.
4. Press the Active Display soft key to select TR2 (Trace 2). Then press the Measurement Type soft key and select Return Loss.
5. Press the **Freq/Dist** function hard key and set the Start Frequency and Stop Frequency. In this example, Start Frequency is set to 750 MHz and Stop Frequency is set to 900 MHz.
6. Press the **Sweep** function hard key and then the Data Points soft key to set the number of data points (the larger the number of data points, the longer the maximum distance, at the expense of a slower sweep speed). In this example, Data Points is set to 401.
7. Press the **Shift** key, then the **Calibrate** (**2**) key.
8. Press the Start Cal soft key and perform a 2-port OSL calibration.
9. When the Calibration is finished, **CAL: ON (OK)** should be displayed with the trace data in the instrument settings summary at the left side of the sweep window.
10. Connect VNA Port 1 and VNA Port 2 to the tuning filter.

    Trace 1 (**TR1: Insertion Loss**) is the transmission. Trace 2 (**TR2: Return Loss**) is the reflection.
11. Press the **Marker** hard key to display the Marker menu. Then press the Marker Table soft key (if necessary) to toggle the marker table to ON.
    a. Press the Marker soft key to display the Select marker list box. Select a marker (MK1 in this example) and use the touch screen or the rotary knob or the numeric keypad to set the marker on the traces.
    b. Press the Marker Search soft key to set this marker at the desired location on the the traces at the lower dB setting that is specified for the filter.
    c. Repeat Step a and Step b as needed to place marker MK2 on the traces at the upper dB setting that is specified for the filter.
    d. Repeat Step a and Step b as needed to place marker MK3 on the traces at a point of interest (depending upon filter specifications).
12. Adjust the tuning of the filter to meet the desired specifications.
13. Press the touch screen or the Active Display soft key to toggle between the two traces.
14. Use the File menu to save measurements. refer to the file management instructions in the user guide for your instrument.

The example in this figure may not match the display on your instrument.

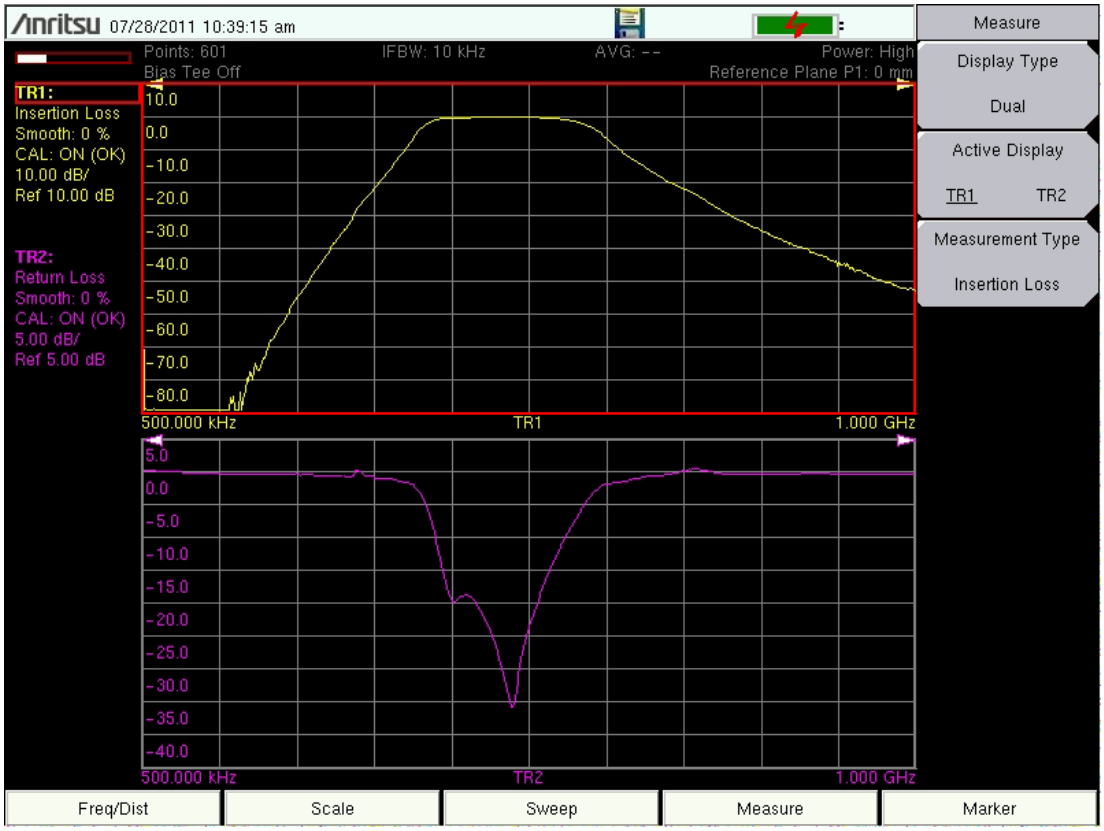


Figure 5-14. Filter Tuning, Log Mag – Display Type Dual – Insertion Loss and Return Loss

The example in this figure may not match the display on your instrument.

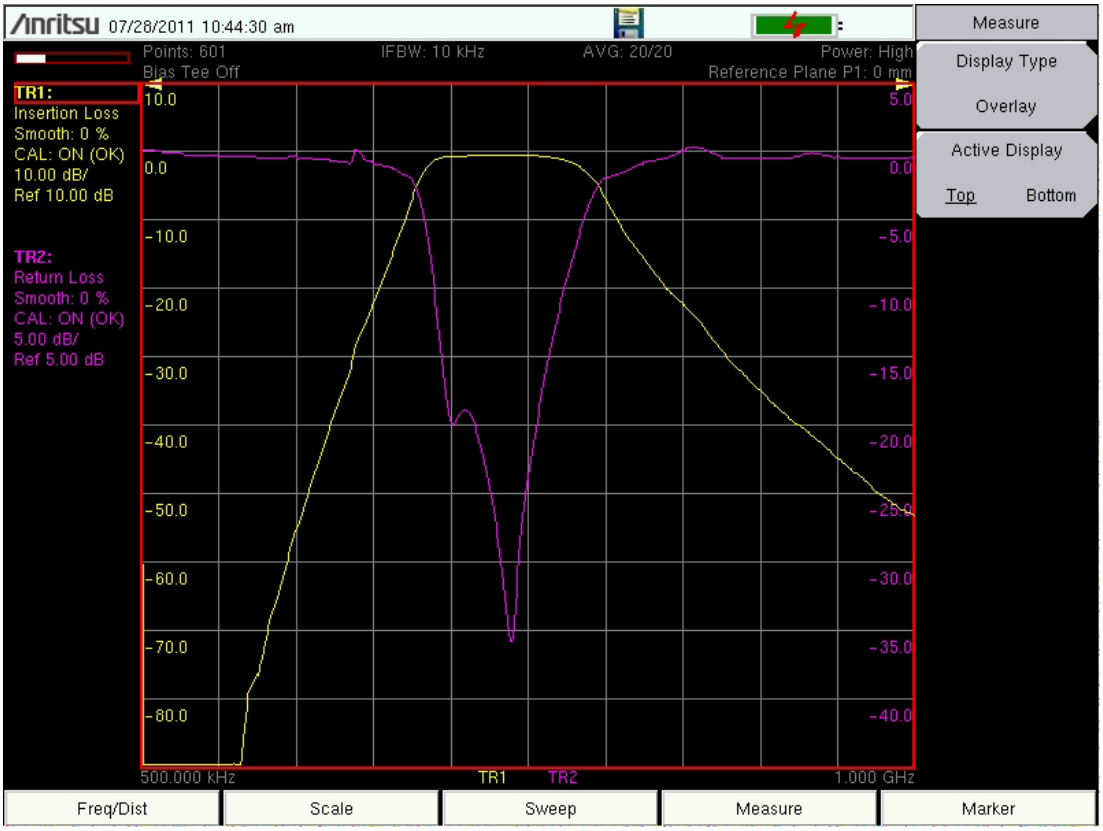


Figure 5-15. Filter Tuning, Log Mag – Display Type Overlay – Insertion Loss and Return Loss

Chapter 6 — VNA View Menus

6-1 Introduction

The menus that are shown in this chapter are found on the Vector Network Analyzer instrument when it is in VNA measurement view. This guide contains measurement instructions for the available Vector Network Analyzer instrument options. Not all options are available on all models, and your instrument may not have all options installed. Refer to the options sticker on the rear panel or connector panel, or to the User Guide that was supplied with your instrument to determine which options are installed.

6-2 VNA Key Functions

Introduction

The following list is a quick reference to the principal menus in the Vector Network Analyzer. For more specific information on a particular measurement, refer to the related chapter for the measurement being made. The key function menus are presented in the following order:

- "Freq Menu" on page 6-4
- "Setup Domain Menu" on page 6-5
- "Time Menu" on page 6-6
- "Time Info List Box" on page 6-7
- "Windowing Menu" on page 6-8
- "Distance Setup Menu" on page 6-9
- "Additional Dist Setup Menu (Coax)" on page 6-10
- "Additional Dist Setup Menu (Waveguide)" on page 6-12
- "Distance Info List Box for Cable" on page 6-13
- "Distance Info List Box for Waveguide" on page 6-13
- "FGT Menu" on page 6-14
- "Gate Menu" on page 6-15
- "Gate Setup Menu (continued)" on page 6-16
- "Gate Shape Menu" on page 6-17
- "Calibration Menus" on page 6-18
- "Calibration Menu" on page 6-19
- "Existing Calibration Information List Box" on page 6-28
- "Additional Calibration Considerations" on page 6-28
- "DUT Port Setup Menu (Coax)" on page 6-29
- "Cal Kit Definition Menus for Coax" on page 6-30
- "DUT Connector Selector List Box for Coax" on page 6-31

- "DUT Port Setup Menu (Waveguide)" on page 6-33
- "Cal Kit Definition Menus for Waveguide" on page 6-34
- "DUT Connector Selector List Box for Waveguide" on page 6-35
- "Calibration Types" on page 6-37
- "Limit Menus" on page 6-38
- "Limit Menu" on page 6-39
- "Limit Edit Menu" on page 6-40
- "Marker Menus" on page 6-41
- "Marker Menu" on page 6-42
- "Marker Search Menu" on page 6-43
- "Readout Format Menu" on page 6-44
- "Measurement Menus" on page 6-45
- "Measure Menu" on page 6-46
- "S-Parameter List Box" on page 6-47
- "S-Parameter Menu" on page 6-48
- "Domain Menu" on page 6-49
- "Low Pass Mode Menu" on page 6-50
- "Band Pass Mode Menu" on page 6-50
- "Number of Traces Menu" on page 6-51
- "Trace Format Menu" on page 6-52
- "Sweep Menu — MS20xxC" on page 6-53
- "Sweep Menu — MS20xxB and S412E" on page 6-54
- "Configure Ports Menu" on page 6-55
- "Bias Tee Setup Menu" on page 6-56
- "Bias Tee Menu (MS20xxC only)" on page 6-57
- "Source Power Menu (MS20xxC only)" on page 6-58
- "Source Power Menu (MS20xxB and S412E only)" on page 6-58
- "Preset Menu" on page 6-59
- "Scale Menu" on page 6-60
- "Smith Scale Menu" on page 6-61
- "Polar Scale Menu" on page 6-62
- "System Menus" on page 6-63
- "System Menu" on page 6-63
- "Application Options Menu (VNA Mode)" on page 6-64
- "Trace Menu" on page 6-68
- "Display Menu (Trace)" on page 6-68
- "Trace Math Menu" on page 6-69

6-3 Domain Setup Menus

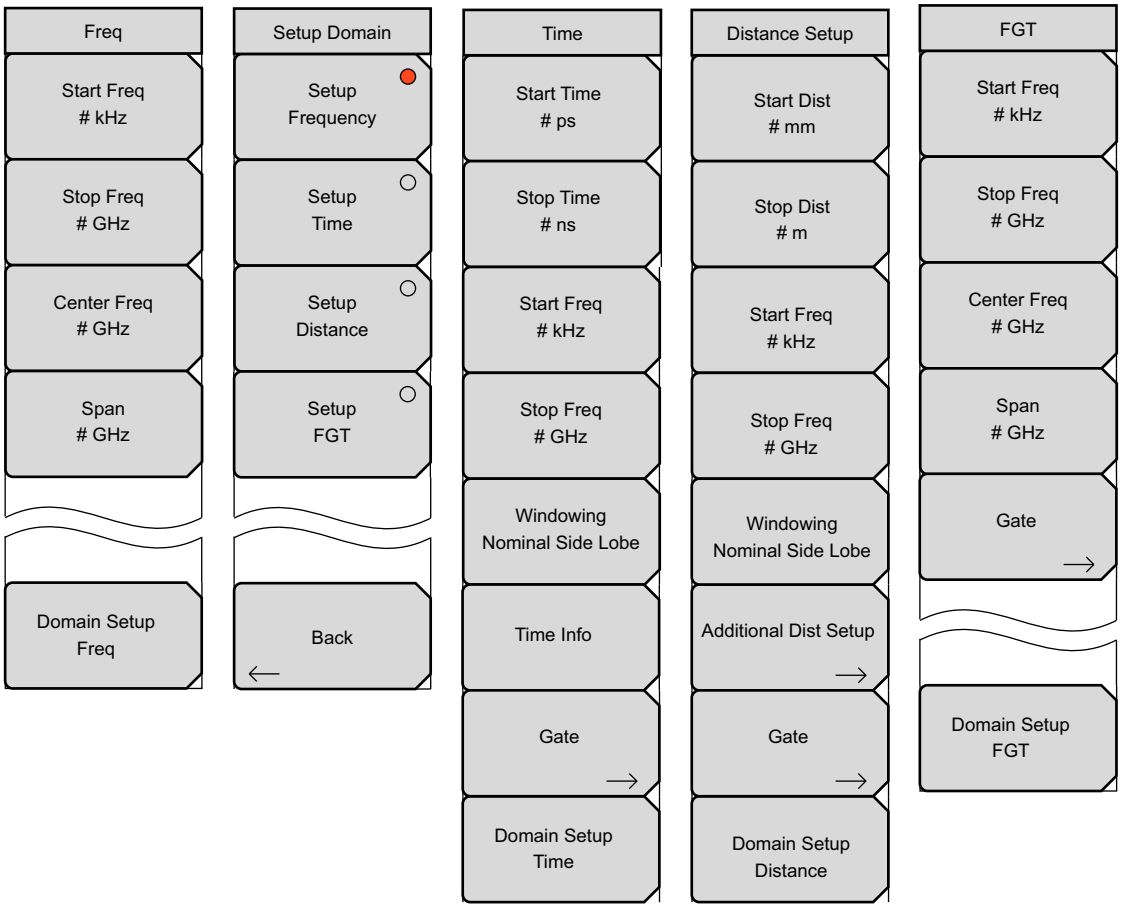


Figure 6-1. Domain Setup Menus Group

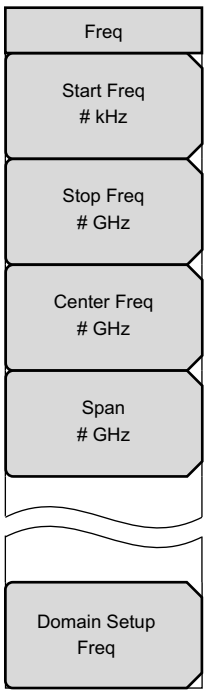
Freq Menu

Preliminary Key Sequence: **Measure** > Domain Selection > Frequency

or

Preliminary Key Sequence: **Freq/Time/Dist** > Domain Setup > Setup Frequency

Key Sequence: **Freq/Time/Dist**



Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = On, then the start frequency is set to the same value as the stop frequency. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = Off, then both start and stop frequency are set to the new frequency.

Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = On, then the stop frequency is set to the same value as the start frequency. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = Off, then both stop and start frequency are set to the new frequency.

Center Freq: Press this soft key to set the center frequency in units of Hz, kHz, MHz, or GHz. The center frequency can be set with the arrow keys, the rotary knob, or the number keypad. When using the number keypad, the menu displays soft keys with Hz, kHz, MHz, and GHz units. Pressing the **Enter** key has the same effect as pressing the MHz soft key.

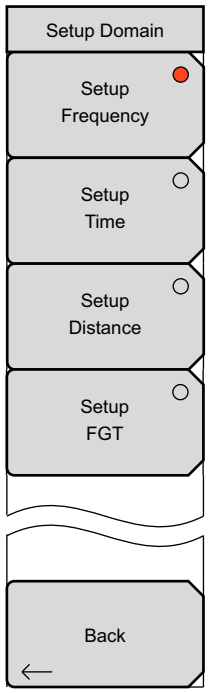
Span: Press this soft key to set the span in units of Hz, kHz, MHz, or GHz. The span setting determines the frequency range over which the instrument sweeps. The span may be set from 0 (zero) to the maximum frequency of the instrument.

Domain Setup: Press this soft key to open the “Setup Domain Menu”. The message on the key face reflects the setup feature (Freq) that is in use.

Figure 6-2. Freq (Frequency) Menu

Setup Domain Menu

Key Sequence: **Freq/Time/Dist** > Domain Setup



Setup Frequency: Press this soft key to open the Frequency menu and to use those soft keys to set start, stop, and center frequencies and frequency span. Choosing Setup Frequency sets the domain (x-axis) of the active trace to Frequency (just as the "Domain Selection" soft key does in the "Measure Menu" on page 6-46).

Setup Time: Press this soft key to open the "Time Menu" and to set the start and stop times, the start and stop frequencies, windowing, and gating. Choosing Setup Time sets the domain (x-axis) of the active trace to Time (just as the "Domain Selection" soft key does in the Measure menu).

Setup Distance: Press this soft key to open the "Distance Setup Menu" and to set the Start and Stop distances, the start and stop frequencies, windowing, and gating. The Start and Stop distances are set in meters (m), centimeters (cm), or millimeters (mm). If the Application Options menu is used to set units in feet rather than meters, the distance settings are in feet (ft) only. Choosing Setup Distance sets the domain (x-axis) of the active trace to Distance (just as the "Domain Selection" soft key does in the Measure menu).

Setup FGT: Press this soft key to open the Frequency Gated by Time (FGT) menu and to use those soft keys to set start, stop, and center frequencies, and to set frequency span and gating. Choosing Setup FGT sets the domain (x-axis) of the active trace to Frequency (just as the "Domain Selection" soft key does in the Measure menu). Note that the frequency data are not the measured frequency data (as in the Setup Frequency case), but they are time or distance domain data that are gated and converted back into the frequency domain. When the trace is in the Time domain and then set to FGT, the frequency data are generated by converting the gated time domain data. When the trace is in the Distance domain and then set to FGT, the frequency data are generated by converting the gated distance domain data. If the trace was set to Frequency and then converted to FGT directly, then the instrument defaults to converting the gated distance domain data.

Back: Press this soft key to return to the previous menu.

Figure 6-3. Setup Domain Menu

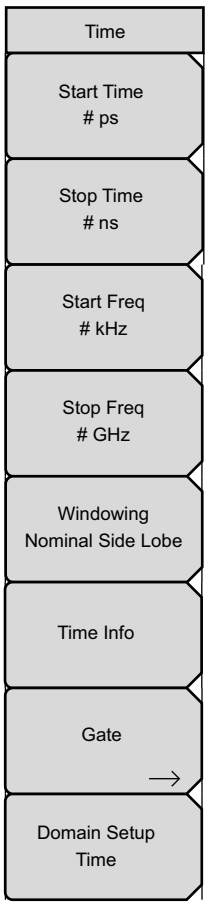
Time Menu

Preliminary Key Sequence: **Measure** > Domain Selection > Time

or

Preliminary Key Sequence: **Freq/Time/Dist** > Domain Setup > Setup Time

Key Sequence: **Freq/Time/Dist**



Start Time: Press this soft key to set the start time in seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps). Use the arrow keys, the rotary knob, or the number keypad to set a time value. When using the number keypad, the menu displays soft keys with s, ms, µs, ns, and ps units. Pressing the **Enter** key has the same effect as pressing the ps soft key. The set value is displayed on the key face.

Stop Time: Press this soft key to set the stop time in seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps). The maximum setting is ±100 µs.

Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz.

Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz.

Windowing: Press this soft key to open the "Windowing Menu" on page 6-8. The window shape value is displayed on the key face, and may be Rectangular, Nominal Side Lobe (as in this example), Low Side Lobe, or Minimum Side Lobe.

Time Info: Press this soft key to display the "Time Info List Box" on page 6-7. This list box displays useful information and suggestions regarding the time domain setup, such as the start and stop frequencies, start and stop time, number of data points, windowing and processing types, maximum time, and time resolution. Use the **Up/Down** arrows or the rotary knob to scroll through the listed parameters.

Gate: Press this soft key to open the "Gate Menu".

Domain Setup: Press this soft key to return to the "Setup Domain Menu". The message on the key face reflects the setup feature (Time, in this example image) that is in use.

Figure 6-4. Time Menu

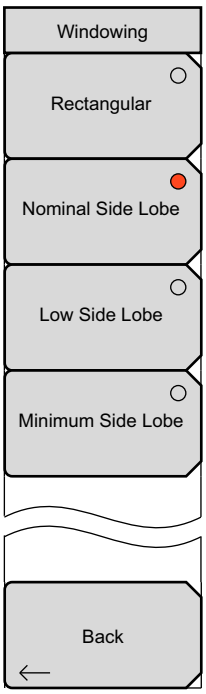
Time Info List Box



Figure 6-5. Time Info List Box (scrolled to view entire list)

Windowing Menu

Key Sequence: **Freq/Time/Dist** > Windowing



Rectangular: Press this soft key to set windowing to the rectangular view for maximum side lobes and maximum resolution. Refer to Figure B-1, “Rectangular Windowing Example”.

Nominal Side Lobe: Press this soft key to set windowing to the Nominal Side Lobe view, which (compared to Rectangular) displays smaller side lobes and slightly less resolution. Refer to Figure B-2, “Nominal Side Lobe Windowing Example”. Nominal Side Lobe is the default setting for the VNA Master.

Low Side Lobe: Press this soft key to set windowing to the Low Side Lobe view for still smaller side lobes than nominal, and also slightly less resolution than the Nominal Side Lobe setting. Refer to Figure B-3, “Low Side Lobe Windowing Example”.

Minimum Side Lobe: Press this soft key to set windowing to the Minimum Side Lobe view for the smallest side lobes, but the least resolution. Refer to Figure B-4, “Minimum Side Lobe Windowing Example”.

Back: Press this soft key to return to the previous menu.

Figure 6-6. Windowing Menu

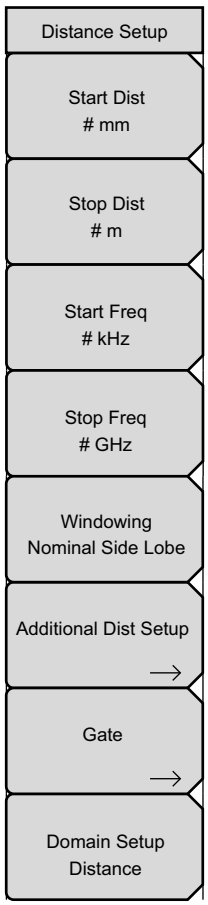
Distance Setup Menu

Preliminary Key Sequence: **Measure** > Domain Selection > Distance

or

Preliminary Key Sequence: **Freq/Time/Dist** > Domain Setup > Setup Distance

Key Sequence: **Freq/Time/Dist**



Start Dist: Press this soft key to set the start distance. Use the arrow keys, the rotary knob, or the number keypad to set a distance value. When using the number keypad, the menu displays soft keys with meters (m), centimeters (cm), or millimeters (mm) as units. Pressing the **Enter** key has the same effect as pressing the meter (m) soft key. If the Application Options menu is used to set units in feet rather than meters, the distance settings are in feet (ft) only, and pressing the Enter key sets the units to feet.

Stop Dist: Press this soft key to set the stop distance in meters (m), centimeters (cm), or millimeters (mm). If the Application Options menu is used to set units in feet rather than meters, the distance settings are in feet (ft) only.

Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz.

Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz.

Windowing: Press this soft key to open the "Windowing Menu". The window shape value is displayed on the key face, and may be Rectangular, Nominal Side Lobe (as in this example), Low Side Lobe, or Minimum Side Lobe.

Additional Dist Setup: Press this soft key to open the"Additional Dist Setup Menu (Coax)" or the "Additional Dist Setup Menu (Waveguide)".

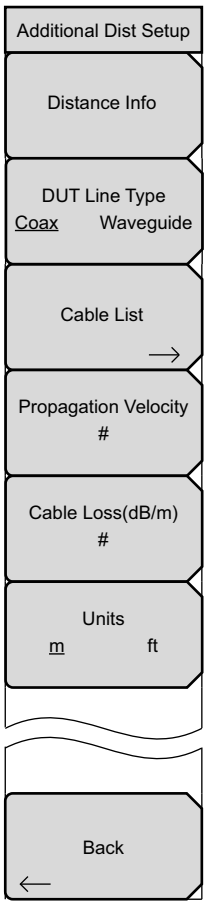
Gate: Press this soft key to open the "Gate Menu".

Domain Setup: Press this soft key to return to the "Setup Domain Menu". The message on the key face reflects the setup feature (Distance) that is in use.

Figure 6-7. Distance Setup Menu

Additional Dist Setup Menu (Coax)

Key Sequence: **Freq/Time/Dist** > Additional Dist Setup



Distance Info: Press this soft key to open the Distance Info List Box to find helpful distance and parameter information. For a view of the list box information, refer to Figure 6-11. The list box contains information such as the start and stop frequencies, start and stop distances, number of data points, windowing and processing types, maximum distance, and distance resolution.

DUT Line Type
Coax Waveguide: Press this soft key to toggle the line type between coaxial cable and waveguide.

Cable List: Press this soft key to open a list box and select a cable type. The "Cable List Menu (Coax)" provides quick navigation aids to search through the list.

Propagation Velocity: Press this soft key to set the fraction of propagation velocity from 0.001 to 1.000. For any fraction less than 1.000, press the decimal key before entering the decimal digits.

Cable Loss(dBm/m): Press this soft key to set the cable loss coefficient from 0.000 dB/m to 5.000 dB/m. (The units are dB/ft if units are set to US units.)

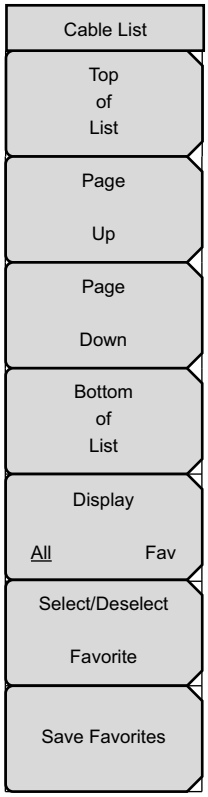
Units
m ft: Press this soft key to toggle the units setting between metric units (meters) and US units (feet).

Back: Press this soft key to return to the "Distance Setup Menu".

Figure 6-8. Additional Dist Setup Menu (Coax)

Cable List Menu (Coax)

Key Sequence: **Freq/Time/Dist** > Additional Dist Setup > Cable List



Top of List: Press this submenu key to jump to the top of the Antenna list.

Page Up: Press this key to skip up through the list.

Page Down: Press this key to skip down through the list.

Bottom of List: Press this submenu key to jump to the bottom of the list.

Display: Press this key to toggle the display of All cables or only cables marked as Favorites.

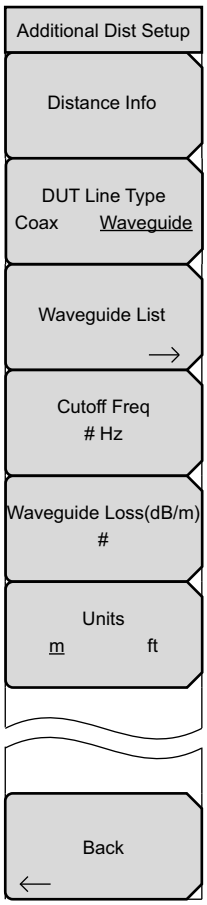
Select/Deselect Favorite: Press this submenu key to add the highlighted cable to the Favorites list. The cable is then marked with an asterisk. If the selected cable is already marked with an asterisk, pressing this key removes it from the Favorites list.

Save Favorites: Press this key to save the changes you have made to the Favorites list.

Figure 6-9. Cable List Menu (Coax)

Additional Dist Setup Menu (Waveguide)

Key Sequence: **Freq/Time/Dist** > Additional Dist Setup



Distance Info: Press this soft key to open the Distance Info List Box to find helpful distance and parameter information. For a view of the list box information, refer to Figure 6-12. The list box contains information such as the start and stop frequencies, start and stop distances, number of data points, windowing and processing types, maximum distance, and distance resolution.

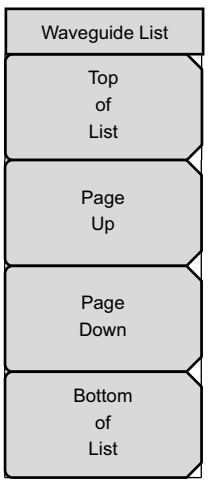
DUT Line Type
Coax Waveguide: Press this soft key to toggle the line type between coaxial cable and waveguide.

Waveguide List: Press this soft key to open a list box and select a waveguide type. The Waveguide List menu provides quick navigation aids to search through the list.

Cutoff Freq: Press this soft key to set the cutoff frequency of the waveguide that is in use.

Waveguide Loss: Press this soft key to set the waveguide loss coefficient from 0.000 dB/m to 5.000 dB/m. (The units are dB/ft if units are set to US units.).

Units
m ft: Press this soft key to toggle the units setting between metric units (meters) and US units (feet).



Back: Press this soft key to return to the "Distance Setup Menu".

Figure 6-10. Additional Dist Setup Menu (Waveguide)

Distance Info List Box for Cable

Key Sequence: **Freq/Time/Dist** > Additional Dist Setup > Distance Info

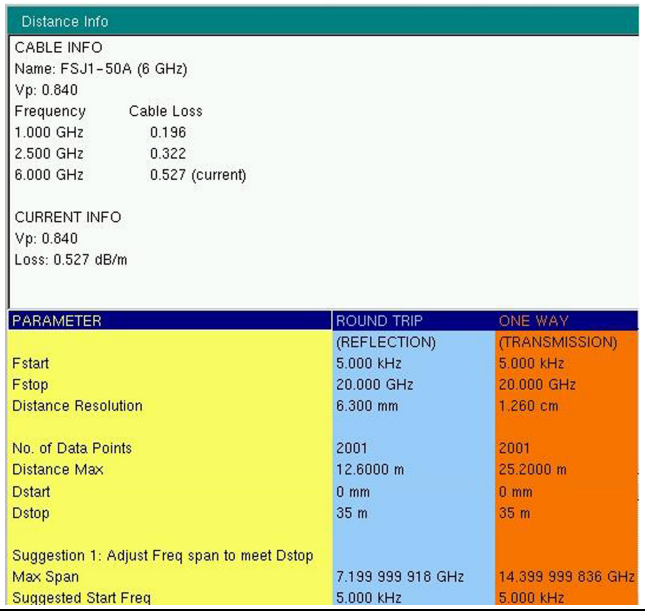


Figure 6-11. Distance Information List Box for Cable

Distance Info List Box for Waveguide

Key Sequence: **Freq/Time/Dist** > Additional Dist Setup > Distance Info

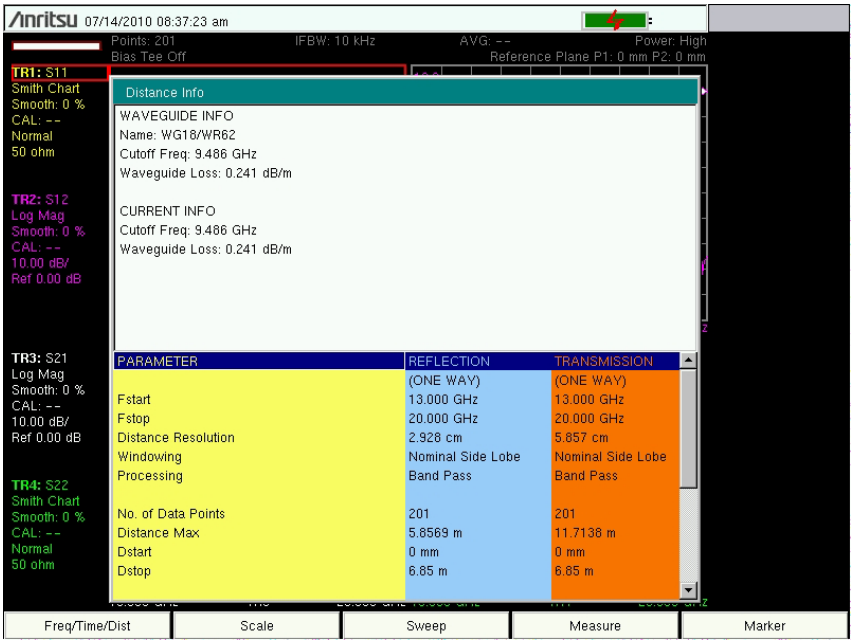


Figure 6-12. Distance Information List Box for Waveguide

(Refer to "Time and Distance Information" on page 8-17.)

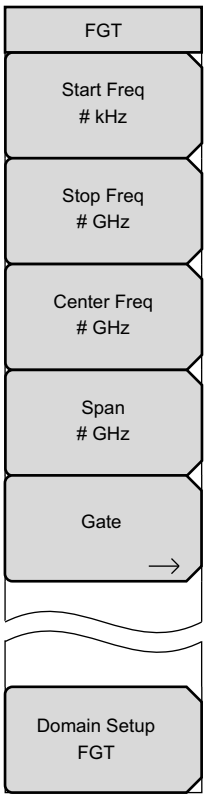
FGT Menu

Preliminary Key Sequence: **Measure** > Domain Selection > FGT

or

Preliminary Key Sequence: **Freq/Time/Dist** > Domain Setup > Setup FGT

Key Sequence: **Freq/Time/Dist**



Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = On, then the start frequency is set to the same value as the stop frequency. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = Off, then both start and stop frequency are set to the new frequency.

Stop Dist: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = On, then the stop frequency is set to the same value as the start frequency. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = Off, then both stop and start frequency are set to the new frequency.

Center Freq: Press this soft key to set the center frequency in units of Hz, kHz, MHz, or GHz. The center frequency can be set with the arrow keys, the rotary knob, or the number keypad. When using the number keypad, the menu displays soft keys with Hz, kHz, MHz, and GHz units. Pressing the **Enter** key has the same effect as pressing the MHz soft key.

Span: Press this soft key to set the span in units of Hz, kHz, MHz, or GHz. The span setting determines the frequency range over which the instrument sweeps. The span may be set from 0 (zero) to the maximum frequency of the instrument.

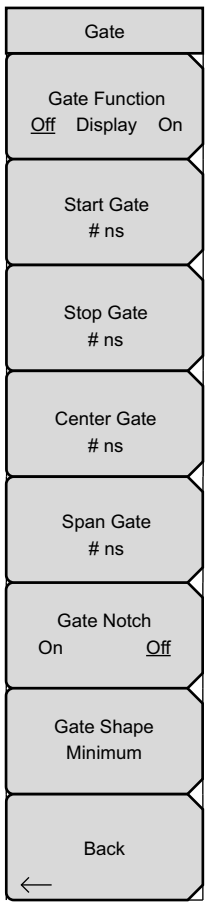
Gate: Press this soft key to display the “Gate Menu”.

Domain Setup: Press this soft key to return to the “Setup Domain Menu”. The message on the key face reflects the setup feature (Distance) that is in use.

Figure 6-13. FGT Menu

Gate Menu

Key Sequence: **Measure** > Domain Selection > Gate



Gate Function
Off Display On: Press this soft key to toggle the Gate Function status to Off, Display, or On.

When set to Off, the gate is not displayed on the screen nor applied to the data.

When set to Display, the gate shape is displayed on the screen but the gate filtering is not applied to the data.

When set to On, the gate shape is displayed on the screen, and the gate filtering is applied to the data.

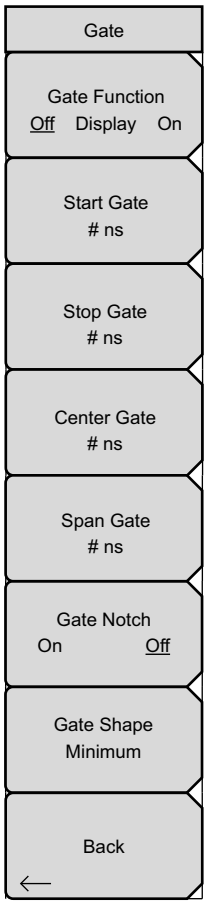
Start Gate: Press this soft key to set the start Gate value. The values will be in units of time if the active trace is in the Time Domain, or in units of distance if the active trace is in the Distance Domain. Use the arrow keys, the rotary knob, or the number keypad to set a Gate value. When using the number keypad, the menu displays soft keys with seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps), if in the Time Domain. Otherwise, it displays meters (m), centimeters (cm), or millimeters (mm) as units, if in Distance Domain. Pressing the **Enter** key has the same effect as pressing the seconds (s) soft key or the meter (m) soft key. If the "Application Options Menu (VNA Mode)" menu is used to set units in feet rather than meters, then the distance settings are in feet (ft) only, and pressing the **Enter** key sets the units to feet.

Stop Gate: Press this soft key to set the stop Gate in either time or distance units, depending on whether the active trace is in the Time Domain or the Distance Domain. In time domain, the units are in seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps). In distance domain, the units are in meters (m), centimeters (cm), or millimeters (mm). If the "Application Options Menu (VNA Mode)" menu is used to set units in feet rather than meters, then the distance settings are in feet (ft) only.

Figure 6-14. Gate Menu

This menu description is continued on the next page.

Gate Setup Menu (continued)



Center Gate: Press this soft key to set the center Gate in either time or distance units, depending on whether the active trace is in the Time Domain or the Distance Domain. In time domain, the units are in seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps). In distance domain, the units are in meters (m), centimeters (cm), or millimeters (mm). If the "Application Options Menu (VNA Mode)" menu is used to set units in feet rather than meters, then the distance settings are in feet (ft) only.

Span Gate: Press this soft key to set the span Gate in either time or distance units, depending on whether the active trace is in the Time Domain or the Distance Domain. In time domain, the units are in seconds (s), milliseconds (ms), microseconds (µs), nanoseconds (ns), or picoseconds (ps). In distance domain, the units are in meters (m), centimeters (cm), or millimeters (mm). If the "Application Options Menu (VNA Mode)" menu is used to set units in feet rather than meters, then the distance settings are in feet (ft) only.

Gate Notch
On Off: Press this soft key to turn On or Off the Gate Notch feature. When Gate Notch is set to OFF, the polarity of the Gate is set to keep everything between start and stop. When the Gate Notch is set to ON, the polarity of the Gate is set to reject everything between start and stop.

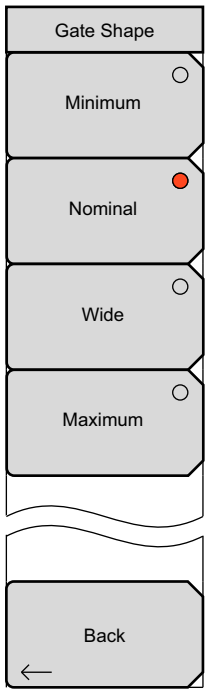
Gate Shape: Press this soft key to open the "Gate Shape Menu". The Gate Shape value is displayed on the key face, and may be Minimum, Nominal, Wide, or Maximum.

Back: Press this soft key to return to the previous menu.

Figure 6-15. Gate Setup Menu (continued)

Gate Shape Menu

Key Sequence: **Measure** > Domain Selection > Gate > Gate Shape



Minimum: Press this soft key to set the gate shape value to Minimum.

Nominal: Press this soft key to set the gate shape value to Nominal. The Nominal gate shape is the default value and most commonly used one.

Wide: Press this soft key to set the gate shape value to Wide.

Maximum: Press this soft key to set the gate shape value to Maximum.

Back: Press this soft key to return to the previous menu.

Figure 6-16. Gate Shape Menu

Note that the gate shape is analogous to the window selection. If the data are truncated with a sharp gate (minimum, related to rectangular window), then maximum resolution is used in determining the gate, but ripple is introduced in the frequency domain. For more gradual gates, the resolution decreases in separating defects, but the size of the artifacts that are added to the frequency domain data also decreases.

The window and gate shapes cannot be selected entirely independently because they interact through the transform. In particular, the use of a very sharp gate with a low side lobe window can lead to large errors. The following table shows the recommended combinations.

Table 6-1. Window Type and Gate Shape — Recommended Combinations

Window / Gate	Minimum	Nominal	Wide	Maximum
Rectangular	OK	OK	OK	OK
Nominal	OK	OK	OK	OK
Low side lobe		OK	OK	OK
Minimum side lobe			OK	OK

6-4 Calibration Menus

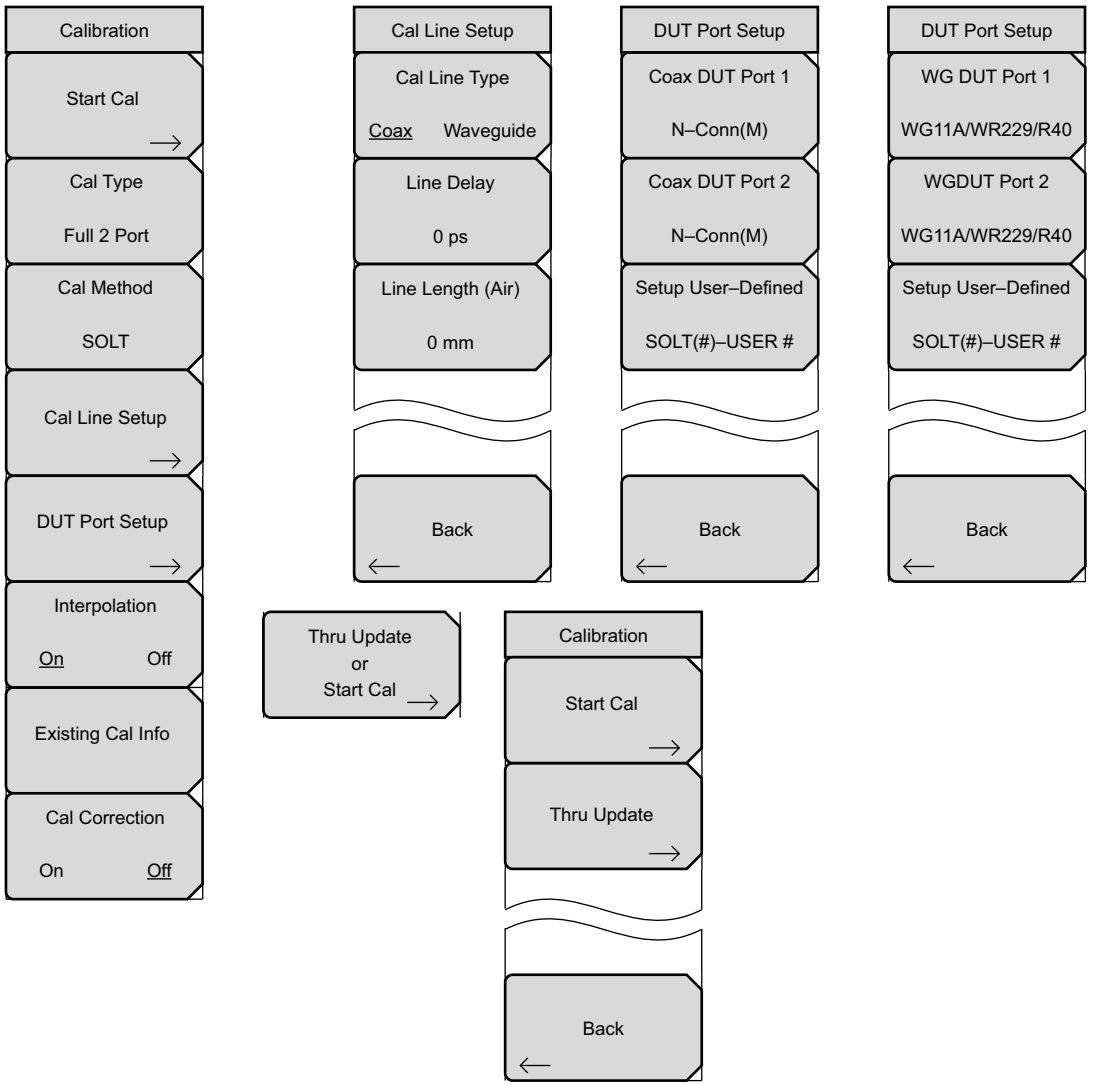
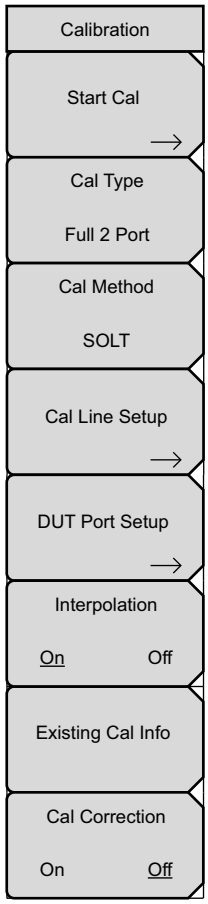


Figure 6-17. Calibration Menus Group

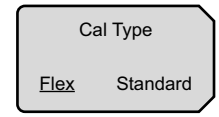
Calibration Menu

Key Sequence: **Shift**, **Calibrate** (**2**)



Start Cal: Press this soft key to open the "Next Step" List Box, which contains the instructions: "Connect cal component, select step, and press **Enter** to measure:" See Figure 6-24 on page 6-25 for examples. Only for MS20xxC instruments, this key changes to "Thru Update or Start Cal" when a completed calibration includes a Thru measurement. See the soft key image at the bottom of this list.

Cal Type: Press this soft key to open the selection list box, then select a calibration type. A soft key offers a toggled selection of Flex or Standard. Refer to "Cal Type Menu". Also refer to Section "Calibration Types" on page 6-37. See Figure 6-19 on page 6-21 for Cal Type examples.



Cal Method: Press this soft key to open the selection list box, then select a calibration method. See Figure 6-22 on page 6-24 for examples. This soft key is displayed only for MS20xxC instruments..

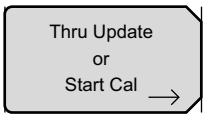
Cal Line Setup: Press this soft key to open the "Calibration Line Setup Menu" on page 6-27. A soft key (Cal Line Type) in the "Calibration Line Setup Menu" on page 6-27 offers a toggled selection of Coax or Waveguide. This soft key is displayed only for MS20xxC instruments.

DUT Port Setup: Press this soft key to open the "DUT Port Setup Menu (Coax)" on page 6-29 or the "DUT Port Setup Menu (Waveguide)" on page 6-33 if the Cal Line Type is set to Waveguide..

Interpolation
On Off: Press this soft key to toggle interpolation On or Off. In Cal Type Flex mode, Interpolation is always On. After performing a Standard calibration, you can turn Interpolation On and then change the frequency range (smaller) or reduce the number of data points. Refer to "Interpolation" on page 6-22.

Existing Cal Info: Press this soft key to open the "Existing Calibration Information" List Box. Press **Enter** or **Esc** to close the list box.

Cal Correction
On Off: Press this soft key to toggle calibration correction On and Off.



Thru Update or Start Cal: This soft key is displayed in place of the Start Cal soft key when a completed calibration includes a Thru measurement. Pressing this key opens the "Calibration Menu with Thru Update" on page 6-25, which offers a Thru update or a new calibration. This soft key is displayed only for MS20xxC instruments.

Figure 6-18. Calibration Menu

Cal Type Menu

This menu offers a choice between Standard, which is the default type, and Flex. When you choose Flex, the instrument performs a calibration over the entire frequency range of the instrument. You can then set any frequency range or any number of points (or both), and the instrument interpolates the calibration coefficients and applies the calibration to the new range or points (or both).

Example of Calibration Steps for S_{11}:

Open, Port 1 (17.830 mm)

Short, Port 1 (17.830 mm)

Load, Port 1

Calculate and Finish Cal

Exit to Setup

Abort Cal

Examples of Calibration Types:

Full 2 Port – (S_{11}, S_{21}, S_{12}, S_{22})

Full S_{11} – Port 1 (S_{11})

Response S_{11} & S_{22} – Refl Resp – Both Ports (S_{11}, S_{22})

1P2P S_{11}, S_{21} – 1 Path 2 Port Forward Path (S_{11}, S_{21})

1P2P S_{22}, S_{12} – 1 Path 2 Port Reverse Path (S_{22}, S_{12})

Calibration Types

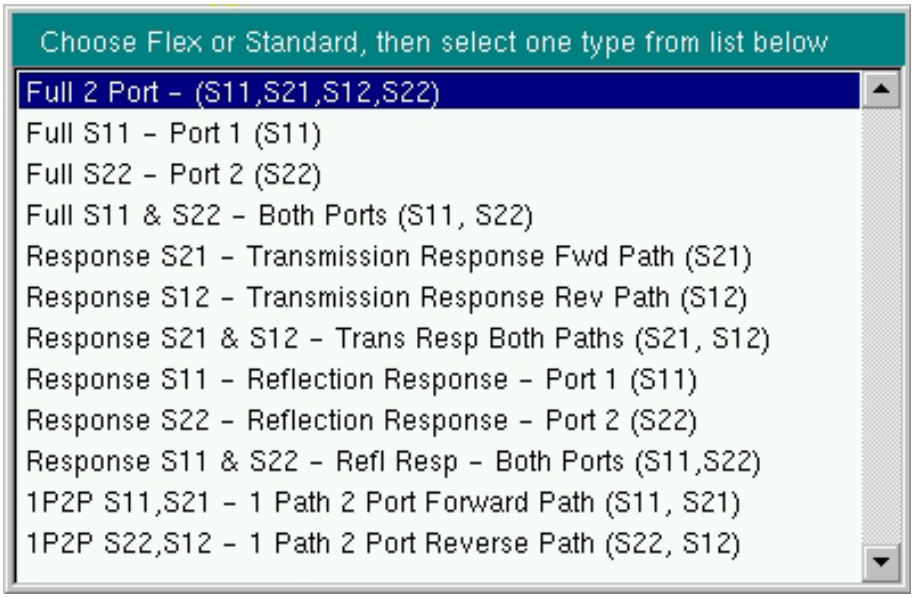


Figure 6-19. Calibration Type List

Interpolation

This feature is used by all Anritsu VNA Masters and by the S412E LMR Master.

You can set your instrument to interpolate the calibration coefficients of a Standard mode calibration. After performing a Standard calibration, you can turn Interpolation On and then change the frequency range (smaller and anywhere within the calibrated range) or increase the number of data points. You cannot increase the frequency range beyond the range that was used during calibration. The soft key is "Interpolation On Off" on page 6-19.

In the example shown in Figure 6-20, a calibration was performed from 5 kHz to 20 GHz using 4001 points. With Interpolation On, a measurement was made by zooming in on a desired frequency range (410 MHz to 435 MHz), as shown in Figure 6-21. The trace in Figure 6-21 shows the use of the full 4001 points within this much narrower frequency range. With Interpolation Off, the instrument would use only the number of points that were calibrated within this frequency band, which would be a much smaller number of points.

In Cal Type Flex mode, interpolation is always on. In this mode, the calibration uses the full frequency range and the maximum number of points that are available in the instrument. This provides the maximum flexibility for measurements without requiring another calibration.

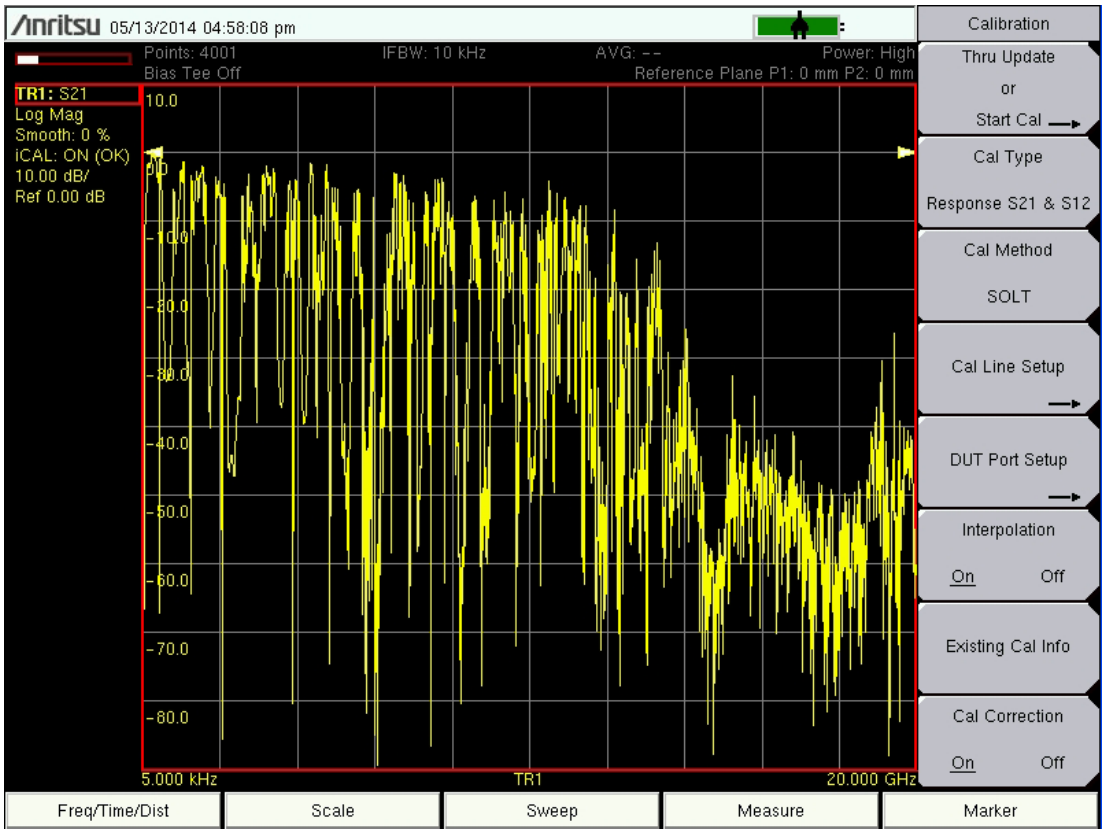


Figure 6-20. Calibration at 5 kHz to 20 GHz Using 4001 Points

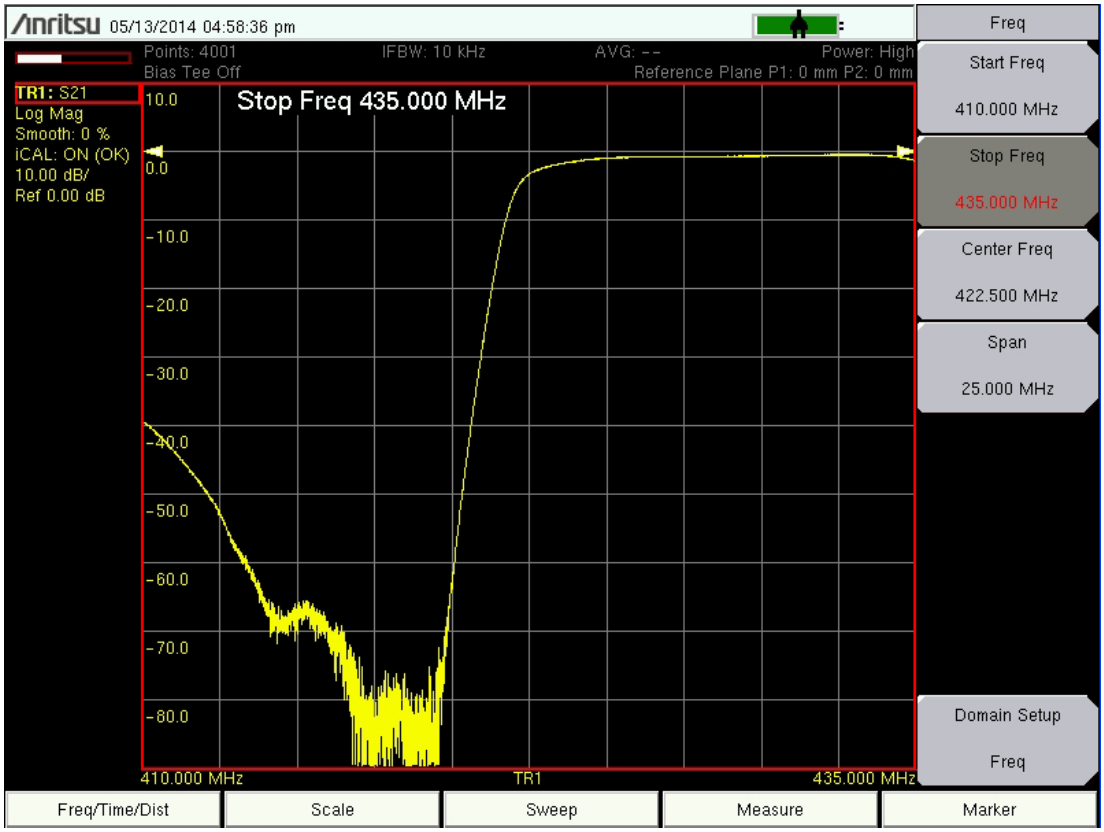


Figure 6-21. Interpolation Allows 410 MHz to 435 MHz with All 4001 Points

Calibration Methods

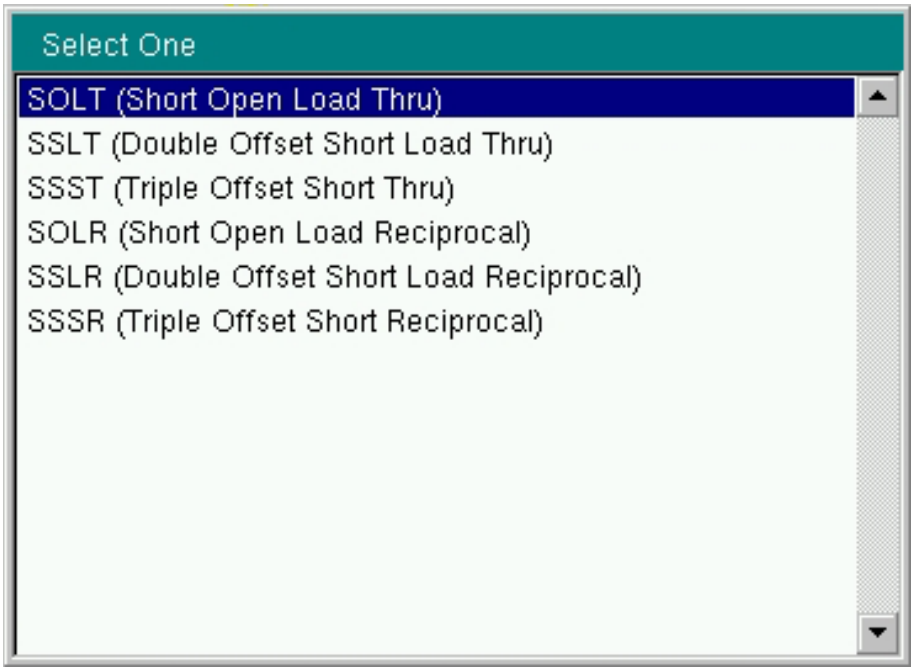
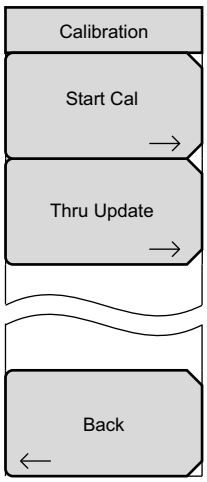


Figure 6-22. Calibration Method List

The Reciprocal is also known as an Unknown Thru. If you do not know the length of the Thru in your setup, and if it is a reciprocal device, then you can choose one of the bottom three calibration methods shown in Figure 6-22. Set the Line Length to zero, and the vector network analyzer will automatically measure (calculate) the length of the Thru.

Calibration Menu with Thru Update

Key Sequence: **Shift**, **Calibrate** (**2**) > Thru Update or Start Cal



Start Cal: Press this soft key to open the "Next Step" List Box (see Figure 6-24), which contains the instructions: "Connect cal component, select step, and press **Enter** to measure:"

Thru Update: Press this soft key to open the selection list box (see Figure 6-25 on page 6-26), then select a calibration type. Refer to Section "Calibration Types" on page 6-37.

Back: This soft key to return to the "Calibration Menu" on page 6-19.

Figure 6-23. Calibration Menu with Thru Update

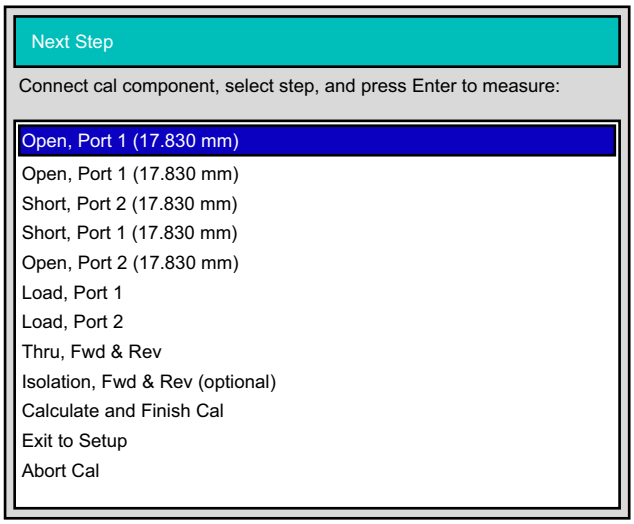


Figure 6-24. Start Cal, Next Step Dialog Box

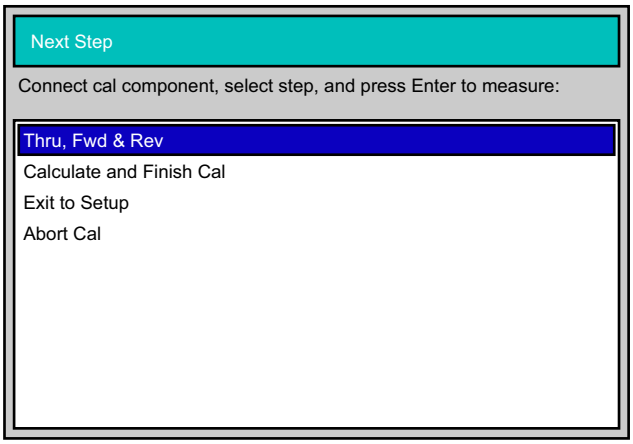
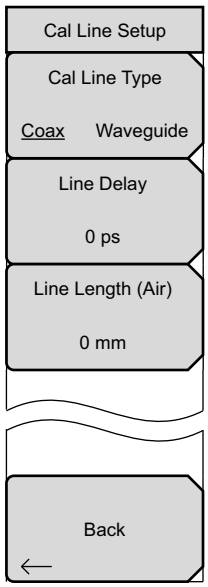


Figure 6-25. Thru Update, Next Step Dialog Box

Calibration Line Setup Menu

Key Sequence: **Shift**, **Calibrate** (**2**) > Cal Line Setup



Cal Line Type
Coax Waveguide: Press this soft key to toggle the line type between Coax and Waveguide.

Line Delay: Press this soft key to set the line delay in seconds. If you use the number keypad, then a Time units menu is displayed with soft keys for s, ms, µs, ns, and ps. The maximum is 100 ms.

Line Length (Air): Press this soft key to set the line length in meters. If you use the number keypad, then a Meters units menu is displayed with soft keys for m, cm, and mm. The maximum is 100 m.

Back: Press this soft key to return to the "Calibration Menu" on page 6-19.

Figure 6-26. Calibration Menu

Line Delay and Line Length

These two settings are for the same parameter, one in distance, and the other in equivalent time. They represent the length of the Thru device that is used during the calibration. Because the length of the Thru device is not always zero, these soft keys allow you to set any additional length that the Thru uses during the calibration that it will not be using during the actual measurement. When you are using a reciprocal calibration method, setting the Line Length or Line Delay to zero prompts the instrument to calculate this length.

Existing Calibration Information List Box

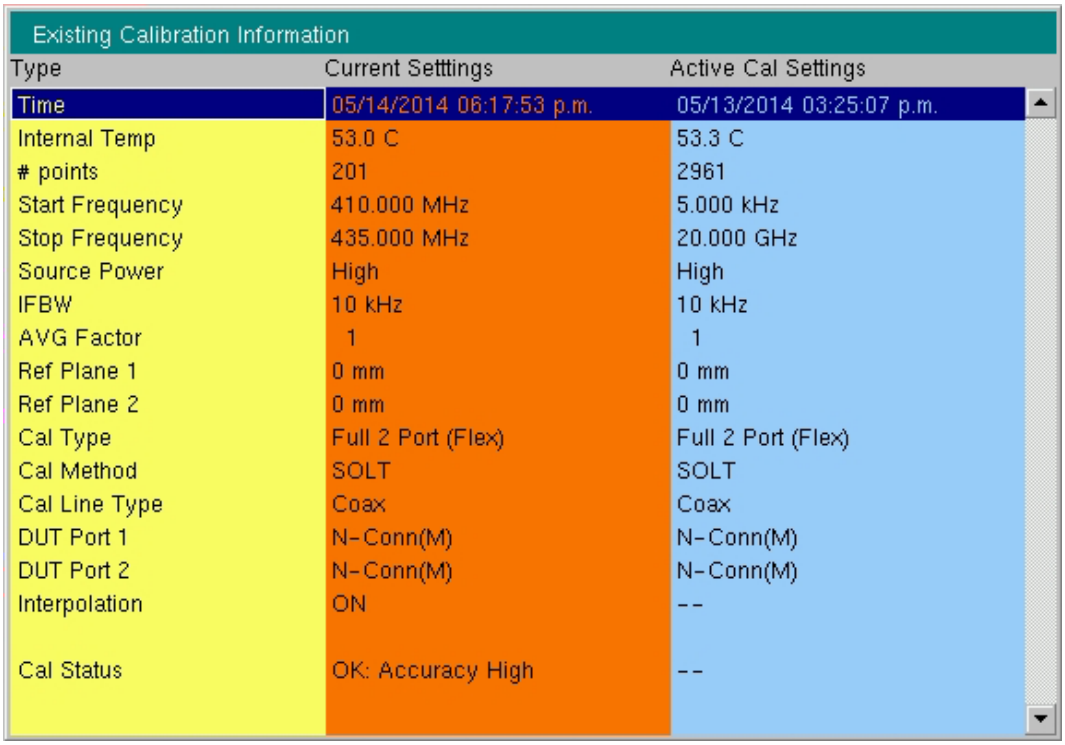


Figure 6-27. Existing Calibration Information List Box

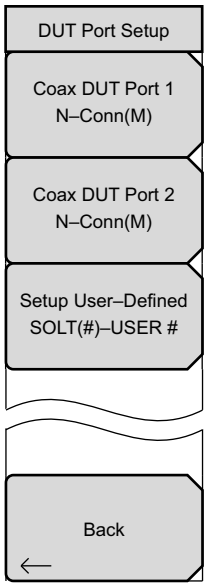
The Existing Calibration Information list box shows the various sweep setting types for the active calibration and compares this information to the current sweep settings. It also displays the Cal Status information and the associated level of accuracy. Interpolation is available in all Anritsu VNA Masters and in the S412E LMR Master, but Flex calibration is available only in the MS20xxC models.

Additional Calibration Considerations

In Vector Network Analyzer mode, refer to section "Calibration Considerations" on page 4-16. In Vector Voltmeter mode, refer to Section 11-6 "Calibration Correction" on page 11-6.

DUT Port Setup Menu (Coax)

Key Sequence: **Shift**, **Calibrate** (**2**) > DUT Port Setup



Coax DUT Port 1: Press this soft key to open the "DUT Connector Selector" List Box for Port 1. Choose the connector type that matches the calibration components that are to be used on Port 1. The standard calibration coefficients are displayed for the calibration kit that is associated with the selected connector type.

Examples:

N-Conn(M)

N-Conn(F)

K-Conn(M)

TNC(F)

SMA(M)

SSST(1) – USER 1

SSST(4) – USER 4

Coax DUT Port 2: Press this soft key to open the "DUT Connector Selector" List Box for Port 2. Choose the connector type that matches the calibration components that are to be used on Port 2. The calibration coefficients are displayed for the calibration kit that is associated with the selected connector type.

Setup User-Defined: Press this soft key to open the "User-Defined Cal Kit Selector" List Box (Figure 6-30). Format: SSST(#) – USER #.

Selecting a user-defined cal displays the cal kit definition menu (see Figure 6-29). In this menu, you can enter the calibration coefficients for the specific calibration kit.

Back: Press this soft key to return to the "Calibration Menu".

Figure 6-28. DUT Port Setup Menu

Cal Kit Definition Menus for Coax

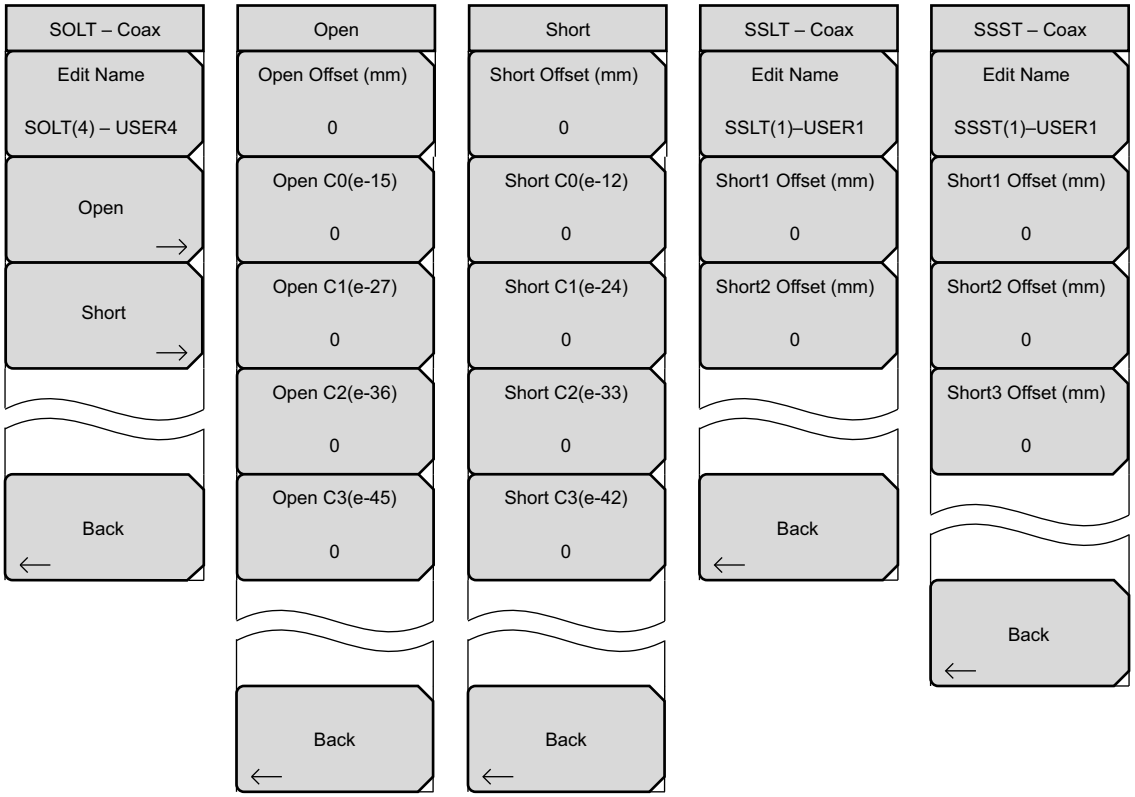


Figure 6-29. Cal Kit Definition Menus for Coax

DUT Connector Selector List Box for Coax

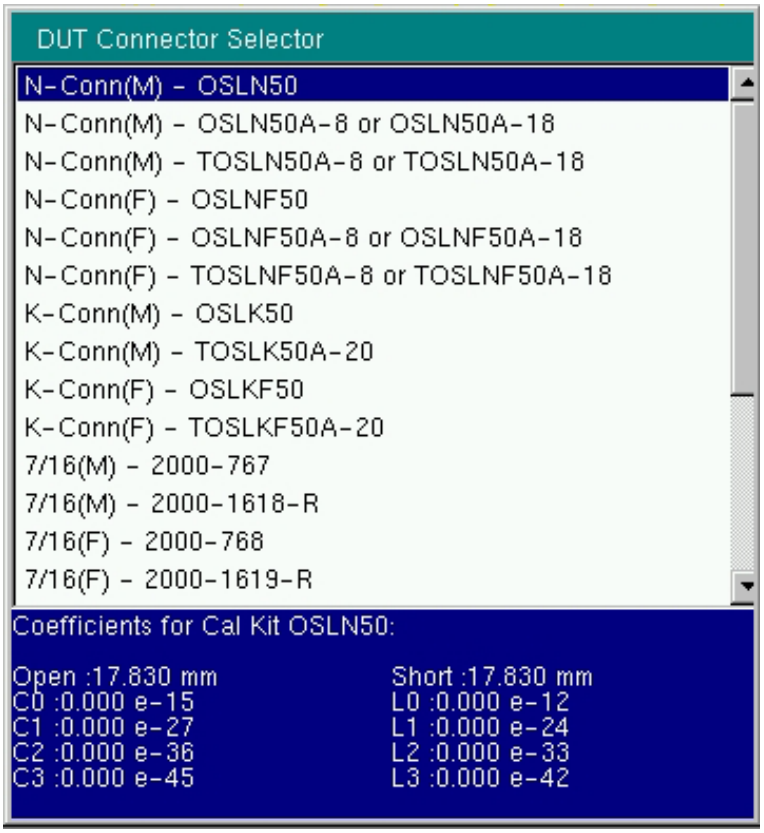


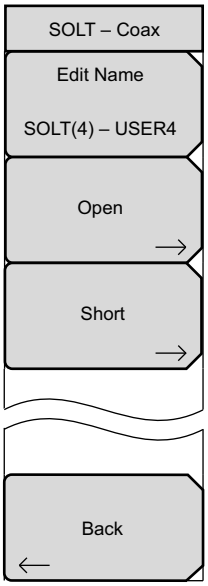
Figure 6-30. DUT Connector Selector List Box for Cable

This list box (Figure 6-30) is opened by the Coax DUT Port # soft key. In this example, the Cal Type is Full 2 Port, and the Cal Method is SOLT. Note that the Cal Kit data includes capacitance coefficients for the Open and inductance coefficients for the Short. Inductance values are provided in all instruments with VNA mode.

This feature is used by all Anritsu VNA Masters and by the S412E LMR Master.

SOLT – Coax Menu

Key Sequence: **Shift**, **Calibrate** (**2**) > DUT Port Setup > Setup User-Defined > Enter



Edit Name: Press this soft key to use the Text Entry feature (refer to the Text Entry section in the user guide for your instrument). Enter a name for your setup.

Open: Press this soft key to display the Open menu. Enter any offset length and capacitance values. See Figure 6-29 on page 6-30.

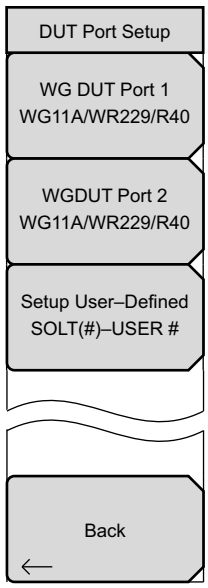
Short: Press this soft key to display the Short menu. Enter any offset length and inductance values. See Figure 6-29.

Back: Press this soft key to return to the “DUT Port Setup Menu (Coax)” on page 6-29.

Figure 6-31. SOLT – Coax Menu

DUT Port Setup Menu (Waveguide)

Key Sequence: **Shift**, **Calibrate** (**2**) > DUT Port Setup



WG DUT Port 1: Press this soft key to open the "DUT Connector Selector" List Box for Port 1. Choose the connector type that matches the DUT connection on Port 1. This indicates that you are using the matching calibration kit, and the VNA Master displays the corresponding calibration coefficients that will be used during the calibration procedure.

Examples:

WG11A

WG12

WG20

SSLT(1) – USER 1

SSLT(4) – USER 4

WG DUT Port 2: Press this soft key to open the "DUT Connector Selector" List Box for Port 2. Choose the connector type that matches the DUT connection on Port 2. This indicates that you are using the matching calibration kit, and the VNA Master displays the corresponding calibration coefficients that will be used during the calibration procedure.

Setup User-Defined: Press this soft key to open the "User-Defined Cal Kit Selector" List Box (Figure 6-34). Format: SSST(#) – USER #. Selecting a user-defined cal kit displays the cal kit definition menu (Figure 6-33). In this menu, you may enter the calibration coefficients for their specific calibration kit.

Back: Press this soft key to return to the "Calibration Menu".

Figure 6-32. DUT Port Setup Menu

Cal Kit Definition Menus for Waveguide

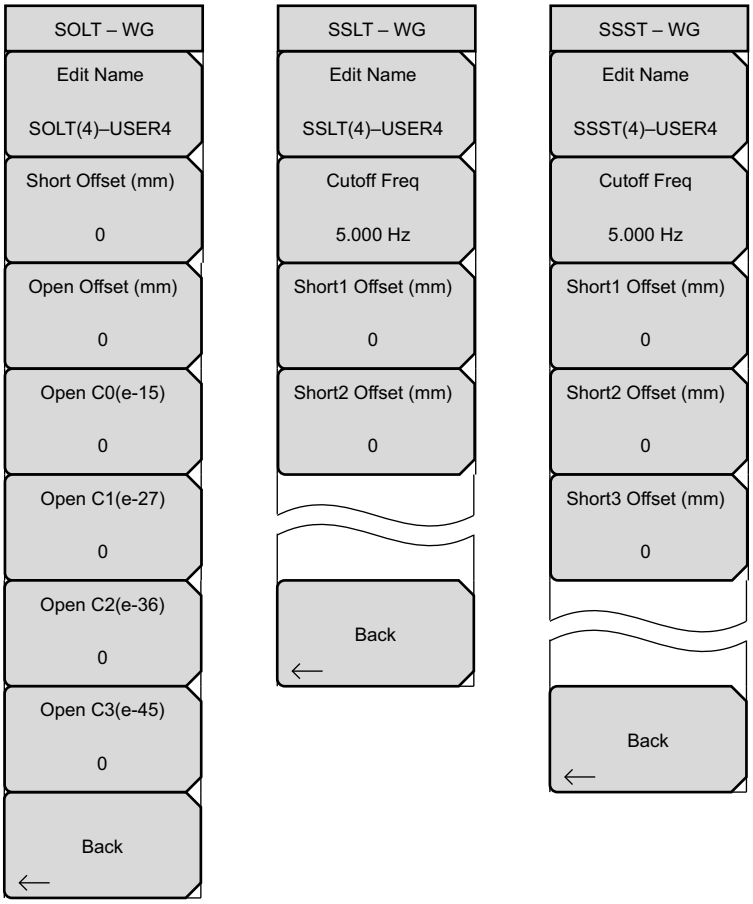


Figure 6-33. Cal Kit Definition Menus for Waveguide

DUT Connector Selector List Box for Waveguide

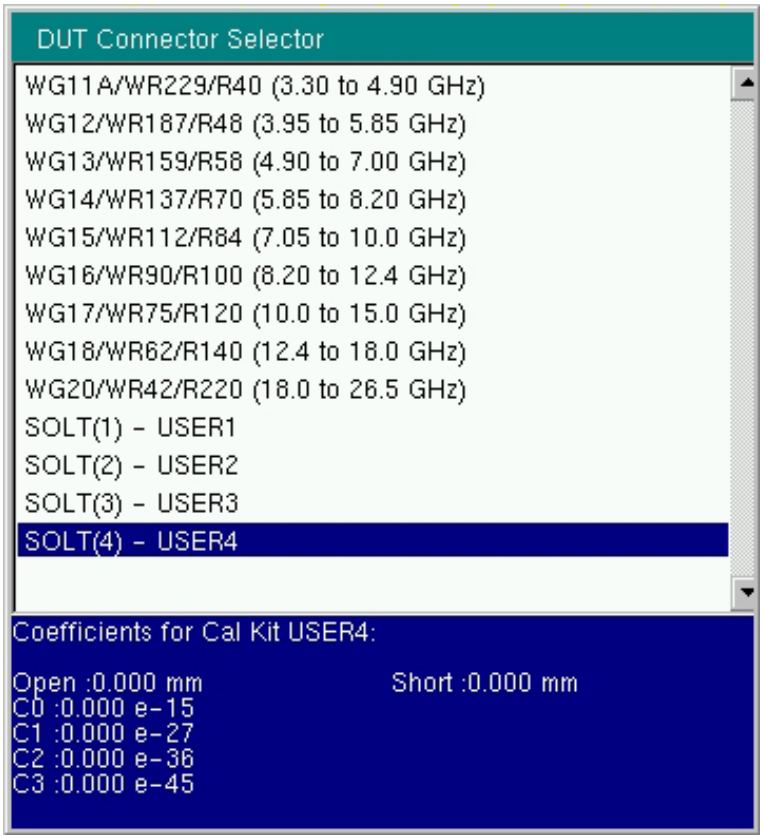


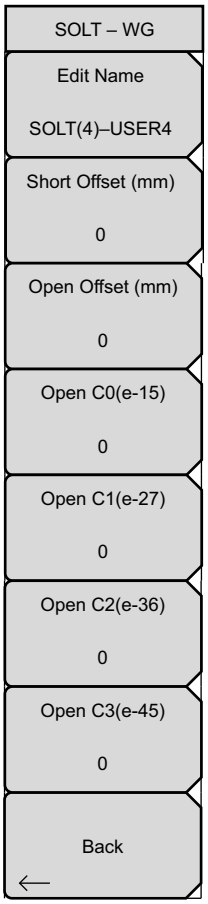
Figure 6-34. DUT Connector Selector List Box for Waveguide

This list box is opened by the WG DUT Port 1 and WG DUT Port 2 soft keys.

This feature is used by all Anritsu VNA Masters and by the S412E LMR Master.

SOLT – WG Menu

Key Sequence: **Shift**, **Calibrate** (**2**) > DUT Port Setup > Setup User-Defined > Enter



Edit Name: Press this soft key to use the Text Entry feature (refer to the Text Entry section in the user guide for your instrument). Enter a name for your setup.

Short Offset (mm): Press this soft key to enter a length for the Short Offset.

Open Offset (mm): Press this soft key to enter a length for the Open Offset.

Open C0(e-15): Press this soft key to enter a capacitance value for Open 0.

Open C1(e-27): Press this soft key to enter a capacitance value for Open 1.

Open C2(e-36): Press this soft key to enter a capacitance value for Open 2.

Open C3(e-45): Press this soft key to enter a capacitance value for Open 3.

Back: Press this soft key to return to the “DUT Port Setup Menu (Waveguide)” on page 6-33.

Figure 6-35. SOLT – WG Menu

Calibration Types

The Calibration Type list box provides the complete selection of available calibration types.

	The MS20xxB compact VNA Master and the S412E LMR Master models are two-port, 1-path vector network analyzers that allow S_{11} and S_{21} measurements with a single connection. Not all calibration types in the following list apply to the MS20xxB VNA Master and the S412E LMR Master.
Note	The MS20xxC VNA Master models are full-reversing, two-port vector network analyzers that allow reflection measurements from both ports and allow transmission measurements in both directions (S_{11}, S_{21}, S_{22}, and S_{12} measurements) with a single connection. This section describes all available calibration types.

The following list describes each calibration type:

- Full 2-Port (S_{11}, S_{21}, S_{12}, S_{22}) calibrates both ports for measurements in both directions, and provides the most accuracy for two-port devices. It requires three calibration components and a through-line.
- Full S_{11} (Port 1) calibrates Port 1 for reflection measurements only. It requires three calibration components.
- Full S_{22} (Port 2) calibrates Port 2 for reflection measurements only. It requires three calibration components.
- Full S_{11} and S_{22} (both Ports) calibrates both ports for reflection measurements only. It requires six calibration components, three calibration components for each port.
- Response S_{21} (Transmission Response Forward Path) performs simple normalization for S_{21} measurements. It requires a through-line.
- Response S_{12} (Transmission Response Reverse Path) performs simple normalization for S_{12} measurements. It requires a through-line.
- Response S_{21} and S_{12} (Transmission Response Both Paths) performs simple normalization for both S_{21} and S_{12} measurements. It requires a through-line.
- Response S_{11} (Reflection Response, Port 1) performs simple normalization for Port 1 reflection measurements only. It requires one short or open.
- Response S_{22} (Reflection Response, Port 2) performs simple normalization for Port 2 reflection measurements only. It requires one short or open.
- Response S_{11} and S_{22} (Reflection Response, Both Ports) performs simple normalization for both ports for reflection measurements only. It requires two components: one short or open for each port.
- 1P2P S_{11}, S_{21} (1 Path, 2 Port Forward Path) calibrates Port 1 for reflection measurements and S_{21} measurements only. It requires three calibration components and a through-line.
- 1P2P S_{22}, S_{12} (1 Path, 2 Port Reverse Path) calibrates Port 2 for reflection measurements and S_{12} measurements only. It requires three calibration components and a through-line.

6-5 Limit Menus

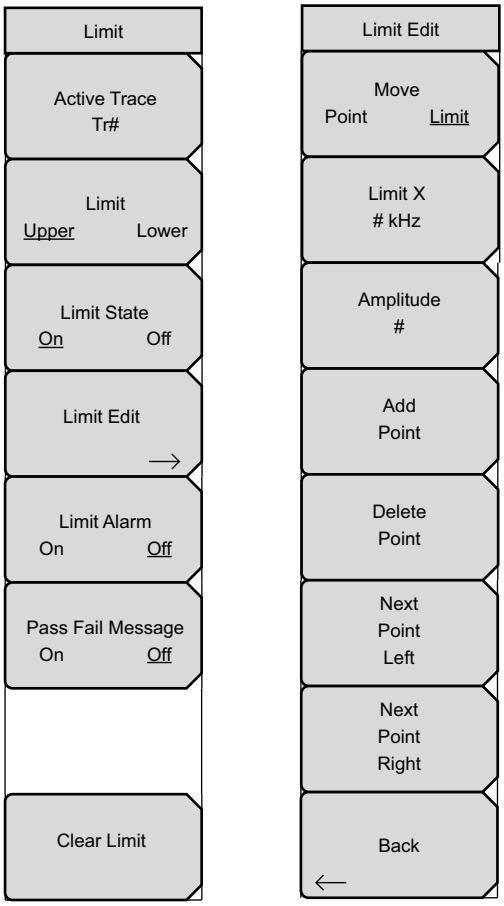


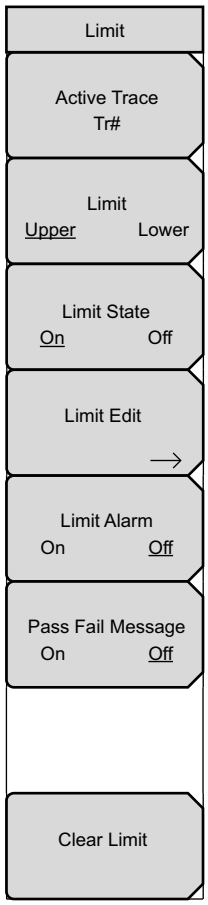
Figure 6-36. Limit Menus Group

To access the Limit Menu, press the **Shift** key, then the **Limit** (**6**) key.

Two types of limit lines can be specified, lower limit lines and upper limit lines. Limit lines can be used for visual reference only, or for pass/fail criteria using the limit alarm. Limit alarm failures are reported whenever a signal is above the upper limit line or below the lower limit line. Limit lines cannot be used with Smith Chart or Polar graphs.

Each limit line can consist of a single segment, or as many as 40 segments across the entire frequency span of the instrument. These limit segments are retained regardless of the current frequency span of the instrument. Limit segments allow the configuring of specific limit envelopes at various frequencies of interest without having to reconfigure them each time that the frequency is changed. To clear the current limit setup configuration and return to a single limit segment (starting at the current start frequency and ending at the current stop frequency), press the Clear Limit soft key.

Limit Menu



Active Trace: Press this soft key to open the "Active Trace Selector" List Box and select a trace. The selected trace number is displayed on the soft key face. Scroll through the list with the arrow keys or the rotary knob, and press the rotary knob or the **Enter** key to select a trace. Press the **Esc** key to cancel and close the list box without changing the previously-selected trace.

Limit
Upper Lower: Press this soft key to toggle the active limit to be the upper or lower limit. The limit line that is currently selected for editing is underlined on the soft key face.

Limit State
On Off: Press this soft key to toggle the Limit State On and Off.

Limit Edit: Press this soft key to open the "Limit Edit Menu". The "Limit Edit Menu" has soft keys for the creating or editing of single limit lines or multi-segment limit lines. The currently active limit point is marked by a red circle on the measurement display.

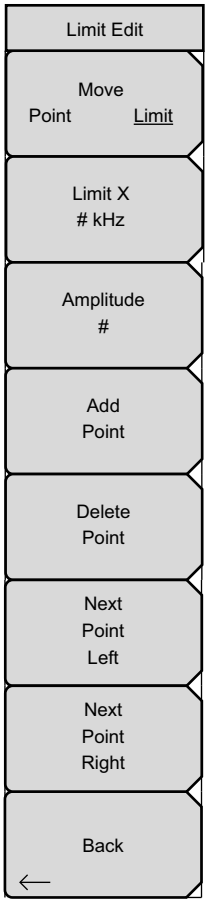
Limit Alarm
On Off: Press this soft key to toggle the Limit Alarm On and Off. For the currently-active limit line, this soft key determines whether an alarm beep occurs when a data point exceeds the limit.

Pass Fail Message
On Off: Press this soft key to toggle the Pass Fail Message feature On and Off. The message indicates "FAIL(Up)" and "FAIL(Low)" for upper and lower limit failures, and it indicates "PASS" for passing measurements. The pass and fail messages are displayed in the same color as the measurement trace. If more than one trace is displayed in a single measurement display window, the message color helps distinguish the trace with which the message is associated.

Clear Limit: Press this soft key to delete all limit points for the currently active limit line. A segmented limit line changes to the default, which is a single limit whose amplitude value is adjusted to make it visible in the sweep window. The other (non active) limit line is not altered.

Figure 6-37. Limit Menu

Limit Edit Menu



Move
Point Limit: Press this soft key to select a single limit point or an entire limit line. Changes in limit frequency or amplitude affect the limit point or limit line that is selected by this soft key. The selected feature is underlined on the key.

Limit X: Press this soft key to change the frequency setting of the limit point or limit line, as determined by the underlined selection on the Move soft key. The current frequency setting is shown on the soft key face.

Amplitude: Press this soft key to change the amplitude setting of the limit point or limit line, as determined by the underlined selection on the Move soft key. The amplitude of each limit point can be individually set. By default, when a new point is added, it takes on the amplitude that is on the limit line at the frequency where the point was added. Use the number keypad, the arrow keys, or the rotary knob to move the point to the desired value. When using the number keypad, use the **+/–** key for entering a minus sign. The unit of the amplitude limit is the same as the current vertical amplitude unit. Refer to the Add Point soft key description for more details. The current amplitude setting is shown on the soft key face.

Add Point: Press this soft key to add a limit point. The precise behavior of this soft key depends upon which limit point is active at the time that the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, then a new limit point will be added halfway between the currently active point and the point immediately to its right. The amplitude of the point will be such that it falls on the limit line. For example, if a limit point is at 2.0 GHz with an amplitude of –30 dBm, and if the next point to its right is 3.0 GHz with an amplitude of –50 dBm, then the added point will be at 2.5 GHz with an amplitude of –40 dBm. The frequency and amplitude values of the new point can be adjusted as needed with the Frequency (Limit X) and Amplitude soft keys.

If the last (furthest right) limit point is active (assuming that it is not at the right edge of the display), then the new limit point will be placed at the right edge of the display at the same amplitude as the point immediately to its left.

Points may not be added beyond the current sweep limits of the instrument.

Delete Point: Press this soft key to delete the active (selected) limit point. The active point becomes the point immediately to the left of the deleted point.

Next Point Left: Press this soft key to select the limit point immediately to the left of the active point, making this point active for editing or deletion. With each key press, the indicator (of which point is active) moves one limit point to the left until it reaches the left edge of the sweep window.

Next Point Right: Press this soft key to select the limit point immediately to the right of the active point, making this point active for editing or deletion. With each key press, the indicator (of which point is active) moves one limit point to the right until it reaches the right edge of the sweep window.

Back: Press this soft key to return to the “Limit Menu”.

Figure 6-38. Limit Edit Menu

6-6 Marker Menus

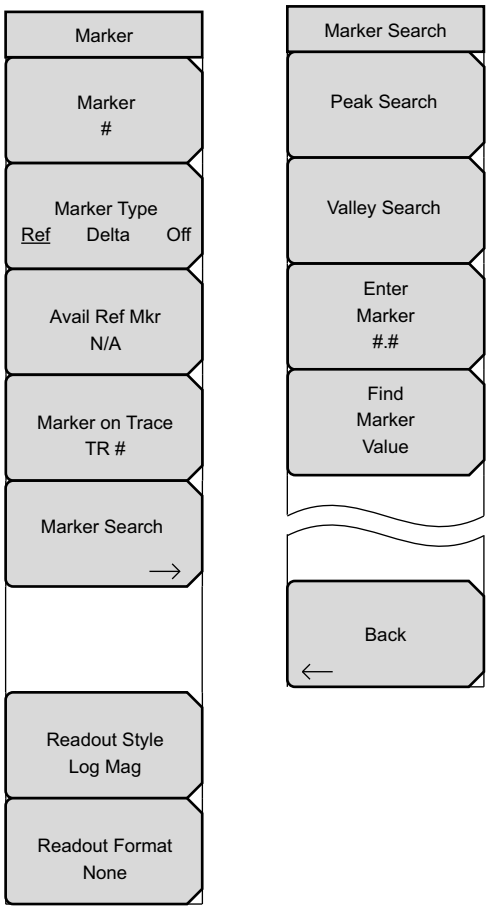
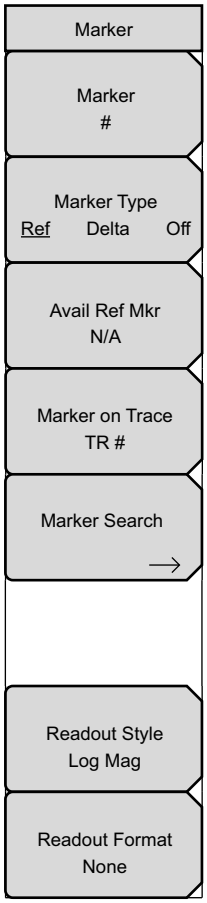


Figure 6-39. Marker Menus Group

To access the functions under the Marker menu, press the **Marker** function hard key.

Marker Menu



Marker: Press this soft key to open the Select Marker List Box and select a marker. The active marker number is displayed on the soft key face.

Marker Type
Ref Delta Off: Press this soft key to toggle the Marker Type selection. The active marker becomes a Reference marker or a Delta marker, or it can be turned off.

Avail Ref Marker: Press this soft key to open a list box and select a reference marker, if one is available.

Marker on Trace: Press this soft key to open a list box and select the trace upon which the marker is located. The active trace number is displayed on the soft key face. Choose from the 4 current traces or 4 memory traces, or all traces.

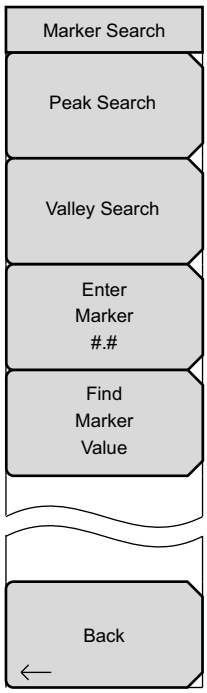
Marker Search: Press this soft key to open the "Marker Search Menu" and to select a search type.

Readout Style: Press this soft key to open a list box and select a chart style. Choose a graph type from the list: Log Mag, Log Mag and Phase, Phase, Real and Imaginary, SWR, Impedance, Admittance, Normalized Impedance, Normalized Admittance, Polar Impedance, Group Delay, Log Mag/2, Linear Magnitude, and Linear Magnitude and Phase. Scroll with the arrow keys or the rotary knob. Press the rotary knob or the **Enter** key to select. Press the **Esc** key to cancel and return to the "Marker Menu" without changing the readout style.

Readout Format: Press this soft key to open the "Readout Format Menu".

Figure 6-40. Marker Menu

Marker Search Menu



Peak Search: Press this soft key to place the currently active marker on the highest signal amplitude that is currently displayed in the sweep window.

Valley Search: Press this soft key to place the currently active marker on the lowest signal amplitude that is currently displayed in the sweep window.

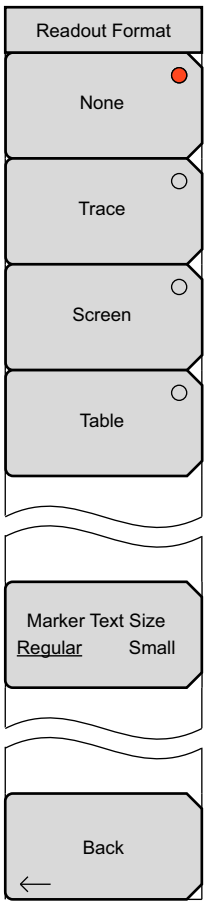
Enter Marker #.#: Press this soft key to enter the marker value that is to be used by the Find Marker Value button. Note that the graph type determines the unit value in the marker. For example, with graph type of Smith Chart, the marker value is unitless, but with graph type Log Mag or Log Polar, the units are dB, and with graph type Group Delay, the units are time (s).

Find Marker Value: Press this soft key to move the active marker to the nearest point that matches the value in the Enter field (set by the Enter Marker #.# soft key).

Back: Press this soft key to return to the "Marker Menu".

Figure 6-41. Marker Search Menu

Readout Format Menu



None: Press this soft key to remove all marker data (except the marker indicator on the measurement trace) from the measurement display screen.

Trace: Press this soft key to display the frequency and value of the current marker at the marker location (on the trace) in the sweep window.

Screen: Press this soft key to display the frequency and value of the current marker at the bottom of the measurement display screen within the sweep window.

Table: Press this soft key to display the frequency and value of all active markers in a table at the bottom of the measurement display screen below the sweep window. In addition to the marker frequency and value, the table also shows delta frequencies and value deltas for all markers that have deltas entered for them. The space that is occupied by the table of marker data is below the measurement data and reduces the sweep window size.

Marker Text Size
Regular Small: Press this soft key to toggle the marker text size between Regular and Small. This allows reading the complete lines of data if 2 lines overlap.

Back: Press this soft key to return to the “Marker Menu”.

Figure 6-42. Readout Format Menu

6-7 Measurement Menus

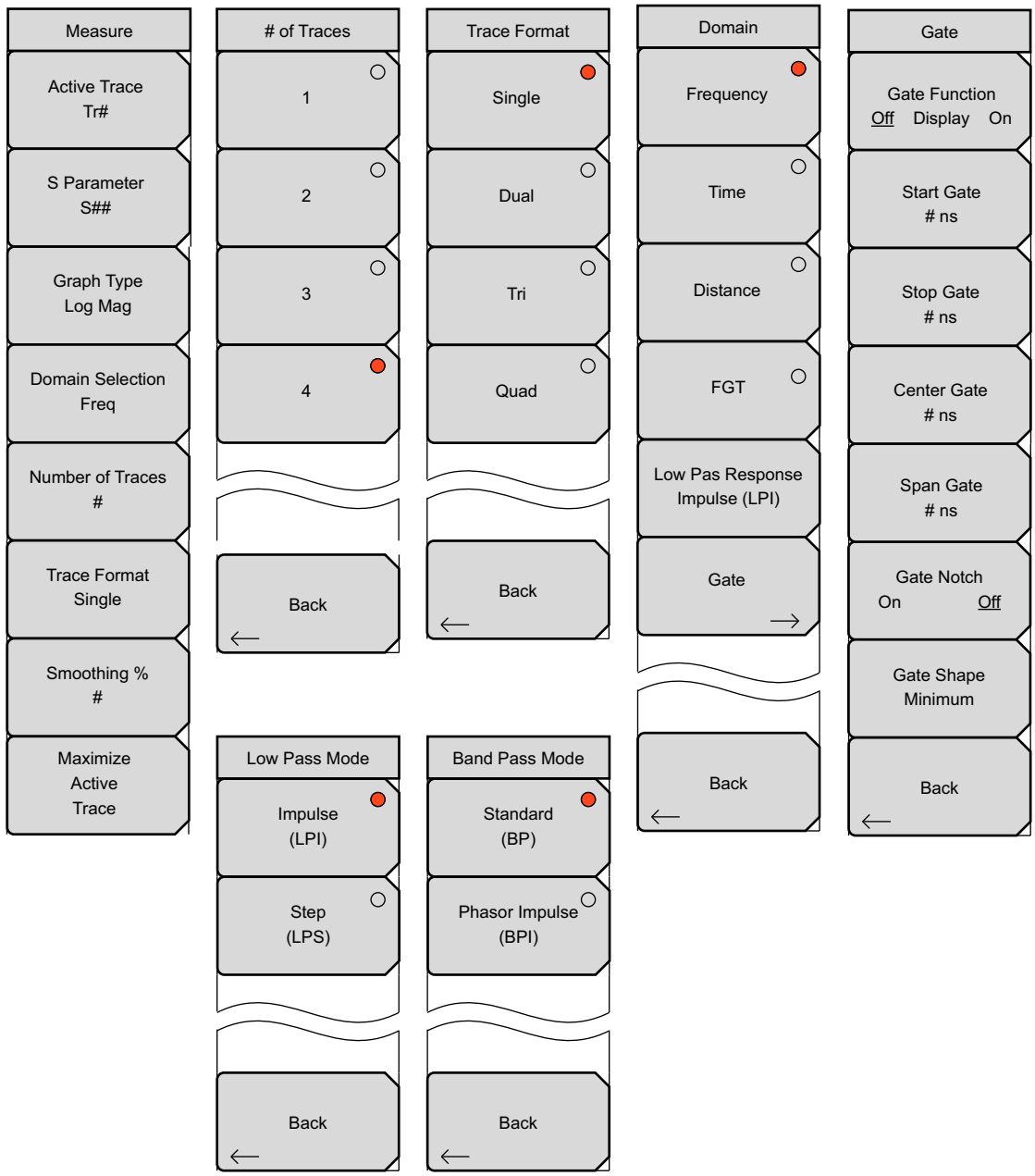
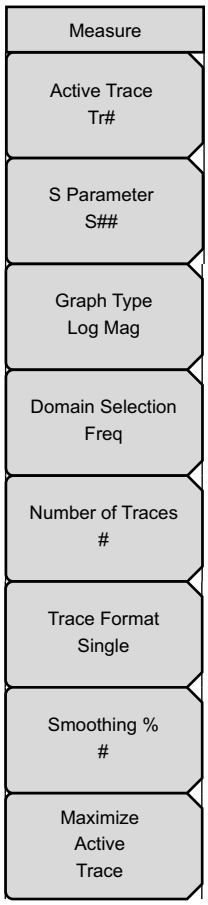


Figure 6-43. Measurement Menus Group

Measure Menu



Active Trace: Press this soft key to open the "Active Trace Selector" List Box and choose a trace. Use the arrow keys or the rotary knob to scroll through the list. Press the rotary knob or the **Enter** key to select a trace. Press the **Esc** key to close the list box and return to the "Measure Menu" without changing the trace selection.

S-Parameter: Press this soft key to open the "S-Parameter List Box" or the "S-Parameter Menu" and select a measurement type. Refer to Section "S-Parameters" on page 3-2 for a description of the S-Parameter settings.

Graph Type: Press this soft key to open the "Graph Type Selector" List Box and choose a graph (trace display) type. Examples of graph type are: Log Mag, Real, Imaginary, and Smith Chart.

Domain Selection: Press this soft key to open the "Domain Menu" and select Frequency, Time, or Distance as the measurement domain. Each trace can use a different domain.

Number of Traces: Press this soft key to open the "Number of Traces Menu" and select the number of traces (1, 2, 3, or 4) to be simultaneously displayed in the sweep window.

Trace Format: Press this soft key to open the "Trace Format Menu" and choose the screen format for trace display. The selected Trace Format is shown on the soft key face.

Smoothing %: Press this soft key to add a smoothing percentage from 0 (zero) to 20%. Use the arrow keys, the rotary knob, or the number keypad to input the value, and then press the rotary knob or the **Enter** key.

Maximize Active Trace: Press this soft key to toggle the display between the active trace at full size in the sweep window and the minimized trace. The Trace Format soft key continues to show the selected Trace Format on the soft key face, and this soft key label changes between Maximize and Minimize Active Trace.

Figure 6-44. Measure Menu

Note	If you apply smoothing when the sweep has more than 2000 points, the smoothing may slow the sweep time of the trace and the responsiveness of the VNA Master. This slowing can be significant, and it increases as the number of sweep points is increased.

If no other feature is currently enabled, then the rotary knob and arrow keys can change the active trace selection. Within the individual menus that are activated from the Measure menu, such as the Trace Format menu, you can select a setting by pressing a soft key or by using the arrow keys or the rotary knob or a number key. Pressing number key 1 in the Trace Format menu, for example, activates the first (top) soft key (Single in this example), and pressing number key 4 activates the fourth soft key parameter (Quad in this example). The Back soft key cannot be selected with the arrow keys, rotary knob, or number keys. Pressing a number key makes the selection and returns focus to the Measure menu. When using the arrow keys or the rotary knob, make your selection and then press the **Enter** key (or the rotary knob of an MS20xxC VNA Master).

S-Parameter List Box

The MS20xxC VNA Master displays the S-Parameter list box when the Measure menu S-Parameter soft key is pressed. For a visual depiction of S-Parameter measurements, refer to Chapter 3. The list box choices are:

S_{11}: Select this parameter to set the measurement to S_{11} Forward Reflection (receive at Port 1, transmit from Port 1).

S_{21}: Select this parameter to set the measurement to S_{21} Forward Transmission (receive at Port 2, transmit from Port 1).

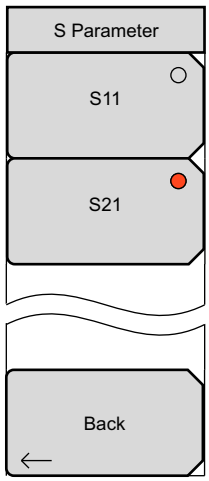
S_{12}: Select this parameter to set the measurement to S_{12} Reverse Transmission (receive at Port 1, transmit from Port 2).

S_{22}: Select this parameter to set the measurement to S_{22} Reverse Reflection (receive at Port 2, transmit from Port 2).

S_{d1d1}: This parameter appears in the list box only if Option 77 is enabled. Select this parameter to set the measurement to S_{d1d1} (differential S_{11}). For more information about the S_{d1d1} parameter, refer to Chapter 12, "Balanced Ports, Option 77".

S-Parameter Menu

The MS20xxB VNA Master and the S412E LMR Master display the S-Parameter menu when the Measure menu S-Parameter soft key is pressed.



For a visual depiction of S-Parameter measurements, refer to Chapter 3.

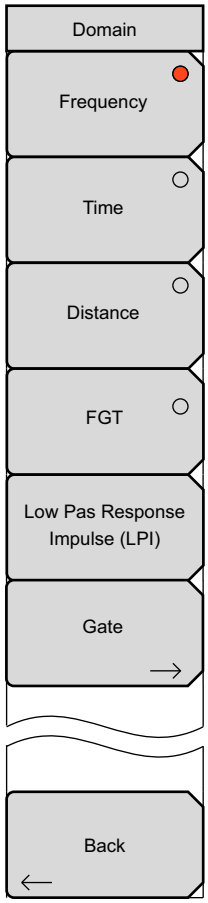
S11: Press this soft key to set the measurement to S_{11} Forward Reflection (receive at Port 1, transmit from Port 1).

S21: Press this soft key to set the measurement to S_{21} Forward Transmission (receive at Port 2, transmit from Port 1).

Back: Press this soft key to return to the "Measure Menu".

Figure 6-45. S-Parameter Menu

Domain Menu



This menu is opened by the Domain Selection soft key of the "Measure Menu".

Frequency: Press this soft key to select Frequency for the x-axis of the active trace. Focus returns automatically to the "Measure Menu".

Time: Press this soft key to select Time for the x-axis of the active trace. Focus returns automatically to the "Measure Menu".

Distance: Press this soft key to select Distance for the x-axis of the active trace. Focus returns automatically to the "Measure Menu".

FGT: Press this soft key to select Frequency Gated by Time (FGT) for the x-axis of the active trace. Focus returns automatically to the "Measure Menu".

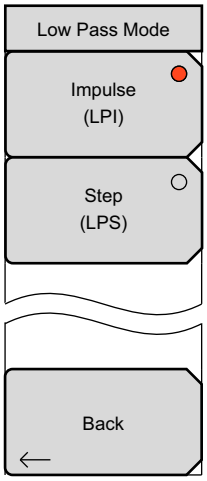
Low Pass Response: Press this soft key to select the type of response to use for Low Pass Time or Distance modes. Available modes are Impulse and Step. The chosen mode is displayed in the button. Note that this button is called "Band Pass Response" when the response type is band pass instead of low pass. In Band Pass mode, the available modes are Standard and Phasor Impulse. Pressing this soft key opens the "Low Pass Mode Menu" on page 6-50 menu or the "Band Pass Mode Menu" on page 6-50 menu.

Gate: Press this soft key to open the "Gate Menu" on page 6-15.

Back: Press this soft key to return to the "Measure Menu".

Figure 6-46. Domain Menu

Low Pass Mode Menu



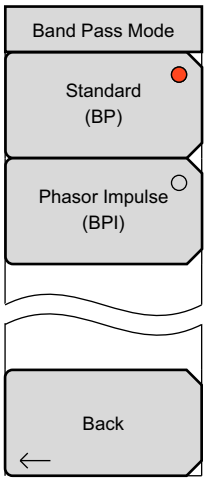
Impulse: Press this soft key to set the response of the low pass time or distance domain to Impulse response. The annotation on the x-axis is (LPI) to indicate Low Pass Impulse response.

Step: Press this soft key to set the response of the low pass time or distance domain to Step response. The annotation on the x-axis is (LPS) to indicate Low Pass Step response.

Back: Press this soft key to return to the "Domain Menu".

Figure 6-47. Low Pass Mode Menu

Band Pass Mode Menu



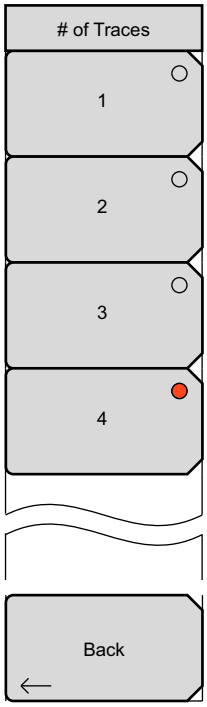
Impulse: Press this soft key to set the response of the Band pass time or distance domain to standard Impulse response. The annotation on the x-axis is (BP) to indicate Band Pass response.

Step: Press this soft key to set the response of the Band pass time or distance domain to Phasor Impulse response. The annotation on the x-axis will be (BPI) to indicate Band Pass Phasor Impulse response.

Back: Press this soft key to return to the "Domain Menu".

Figure 6-48. Band Pass Mode Menu

Number of Traces Menu



1: Press this soft key to display 1 trace in the sweep window. Focus returns automatically to the "Measure Menu".

2: Press this soft key to display 2 traces in the sweep window. Trace 1 and Trace 2 are displayed. Focus returns automatically to the "Measure Menu".

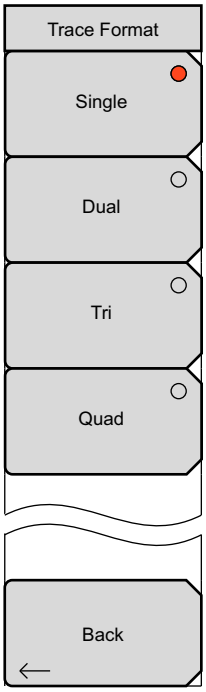
3: Press this soft key to display 3 traces in the sweep window. Trace 1, Trace 2, and Trace 3 are displayed. Focus returns automatically to the "Measure Menu".

4: Press this soft key to display 4 traces in the sweep window. Trace 1, Trace 2, Trace 3, and Trace 4 are displayed. Focus returns automatically to the "Measure Menu".

Back: Press this soft key to return to the "Measure Menu".

Figure 6-49. Number of Traces Menu

Trace Format Menu



Single: Press this soft key to display the active trace (or traces) at full size in the sweep window. If more than one trace is selected by the Number of Traces soft key, then the traces are displayed overlapping in the sweep window.

Dual: Press this soft key to display 2 traces in the sweep window, with the sweep window divided horizontally into 2 equal rectangles.

Tri: Press this soft key to display 3 traces in the sweep window, with the sweep window divided horizontally and vertically so that 2 equal rectangles share the upper half of the window, and one wide rectangle occupies the lower half of the window.

Quad: Press this soft key to display 4 traces in the sweep window, with the sweep window divided horizontally and vertically into 4 equal rectangles.

Back: Press this soft key to return to the "Measure Menu" without changing the Trace Format setting.

Figure 6-50. Trace Format Menu

Regardless of the Trace Format that is selected, the number of traces that are displayed is controlled by the Number of Traces soft key.

Examples:

If 4 traces are displayed in Single Trace Format mode, then all 4 traces are displayed overlapping in the sweep window.

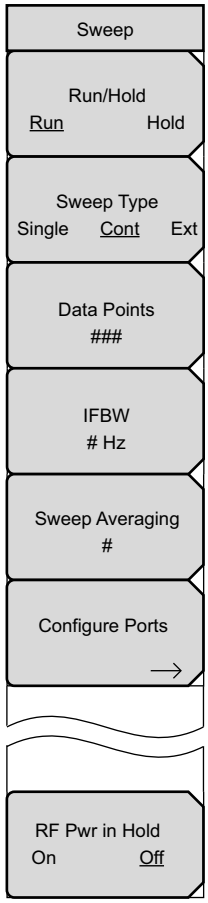
If 4 traces are displayed in Dual Trace Format mode, then traces 1 and 3 are displayed overlapping in the upper sweep window, and traces 2 and 4 are displayed overlapping in the lower sweep window.

If 4 traces are displayed in Tri Trace Format mode, then traces 1 and 2 are displayed individually in the upper half of the sweep window, and traces 3 and 4 are displayed overlapping in the lower sweep window.

If 4 traces are displayed in Quad Trace Format mode, then all 4 traces are displayed individually in the sweep window, each trace occupying one quarter of the sweep window.

If 1 trace is displayed in Dual, Tri, or Quad format, then that trace is displayed in the first section of the sweep window, and any other sections are blank.

Sweep Menu — MS20xxC



Run/Hold
Run Hold: Press this soft key to toggle the sweep to Run or Hold.

Sweep Type
Single Cont Ext: Press this soft key to toggle the sweep type to Single, Continuous, or External. Single sweep sets the VNA Master to make a single sweep and then wait for additional commands. The Continuous mode sweeps continuously. In the External mode, the sweep is set to Hold until an external signal triggers a sweep. This must be a TTL signal, and it will trigger a sweep on the rising edge (> 3 V). At the completion of an externally triggered sweep (or multiple sweeps if averaging is enabled), the instrument returns to Hold.

Data Points: Press this soft key to set the number of data points from 2 to 4001.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz. Select 10 Hz for the maximum dynamic range; select 100 kHz for the maximum speed.

Sweep Averaging: Press this soft key to set the number of sweeps to use for averaging. The minimum number is 1.

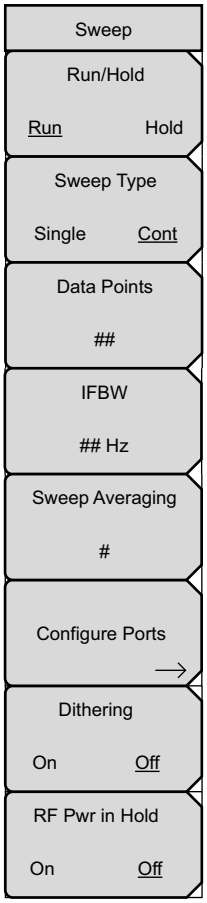
Configure Ports: Press this soft key to open the "Configure Ports Menu".

RF Pwr in Hold
On Off: Press this soft key to toggle On and Off the condition of the RF power transmitted from Port 1 and Port 2 when the instrument is put in Hold mode. The RF power can be set either to stay on or to be turned off during Hold. The default setting is for the RF to stay on during Hold, which helps to stabilize the instrument temperature.

Figure 6-51. Sweep Menu

To access the Sweep Menu, press the **Sweep** function hard key or press the **Shift** key then the **Sweep** (**3**) key. All of the variables that affect the sweep can be found in this menu.

Sweep Menu — MS20xxB and S412E



Run/Hold
Run Hold: Press this soft key to toggle the sweep to Run or Hold.

Sweep Type
Single Cont: Press this soft key to toggle the sweep type to Single or Continuous. Single sweep sets the VNA Master to make a single sweep and then wait for additional commands. The Continuous mode sweeps continuously.

Data Points: Press this soft key to set the number of data points from 2 to 4001.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz. Select 10 Hz for the maximum dynamic range, and select 100 kHz for the maximum speed.

Sweep Averaging: Press this soft key to set the number of sweeps to use for averaging. The minimum number is 1.

Configure Ports: Press this soft key to open the "Configure Ports Menu".

Dithering
On Off: Press this soft key to toggle On and Off the Dithering function. When a signal is dithered, a mathematical process removes the harmonics or other undesirable distortions, and replaces these distortions with a constant, fixed noise level. The result is a better representation of the signal.

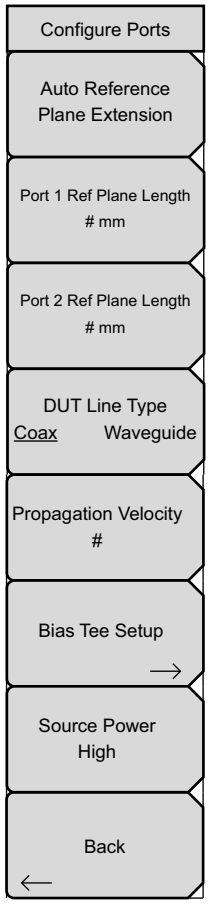
RF Pwr in Hold
On Off: Press this soft key to toggle On and Off the condition of the RF power transmitted from Port 1 and Port 2 when the instrument is put in Hold mode. The RF power can be set either to stay on or to be turned off during Hold. The default setting is for the RF to stay on during Hold, which helps to stabilize the instrument temperature.

Figure 6-52. Sweep Menu

To access the Sweep Menu, press the **Sweep** function hard key or press the **Shift** key then the **Sweep** (**3**) key. All of the variables that affect the sweep can be found in this menu.

Configure Ports Menu

Access to this menu is from the Configure Ports soft key in the "Sweep Menu — MS20xxC".



Auto Reference Plane Extension: Press this soft key to use the active trace data to automatically determine the best length to mathematically extend the reference plane (plane of calibration) in order to remove cable length from the measurement, based on the current value of Propagation Velocity (refer to the description for the "Propagation Velocity" soft key). The resultant display will "unwrap" phase displays to allow a better view of the phase properties of the DUT.

Port 1 Ref Plane Length: Press this soft key to manually enter a distance to which the Reference Plane (Plane of Calibration) is extended. This action calculates and removes (from the measurement data) an appropriate amount of linear phase rotation based on Propagation Velocity and the distance that is entered here.

Port 2 Ref Plane Length: Press this soft key to enter reference plane extension distance for Port 2 (full-reversing, two-port VNA instruments only).

DUT Line Type: Press this soft key to toggle the line type to coaxial cable or to waveguide.

Propagation Velocity: This value is used by the Reference Plane Extension functions. Press this soft key to enter the propagation velocity of electrical signals in the length of cable that is being removed by the Reference Plane Extension calculations. Values are expressed as a decimal ratio compared to the speed of light in a vacuum (examples: 1 = speed of light, and 0.5 = 1/2 the speed of light).

Bias Tee Setup: Press this soft key to open the "Bias Tee Setup Menu".

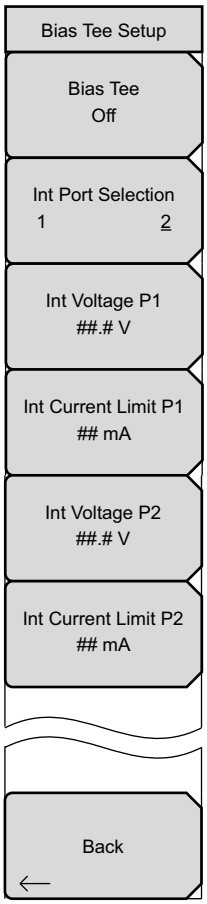
Source Power: Press this soft key to open the "Source Power Menu (MS20xxC only)" or "Source Power Menu (MS20xxB and S412E only)".

Back: Press this soft key to return to the "Sweep Menu — MS20xxC".

Figure 6-53. Configure Ports Menu

Bias Tee Setup Menu

Access to this menu is from the Bias Tee Setup soft key in the "Configure Ports Menu".



Bias Tee: Press this soft key to open the "Bias Tee Menu (MS20xxC only)" to select External, Internal, or Off.

Int Port Selection
1 2: Press this soft key to toggle the internal port selection to Port 1 or Port 2.

Int voltage P1: Press this soft key to set the internal bias tee voltage that is directed onto the center conductor of port 1. The available range is from 12.0 V to 32.0 V in increments of 0.1 V. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for voltage units (V), or press the **Enter** key. Press the **Esc** key to exit without changing the setting.

Int Current Limit P1: Press this soft key to set the internal bias tee current limit for the voltage that is set at Port 1. The available range is from 0 mA to 450 mA in steps of 1 mA. This current limit sets the trip point for the bias tee for this port. When using the number keypad, the soft key menu displays 2 choices for units: A or mA. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for current units (A or mA), or press the **Enter** key to use mA. Press the **Esc** key to exit without changing the setting.

Int voltage P2: Press this soft key to set the internal bias tee voltage that is directed onto the center conductor of Port 2. The available range is from 12.0 V to 32.0 V in increments of 0.1 . Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for voltage units (V), or press the **Enter** key. Press the **Esc** key to exit without changing the setting.

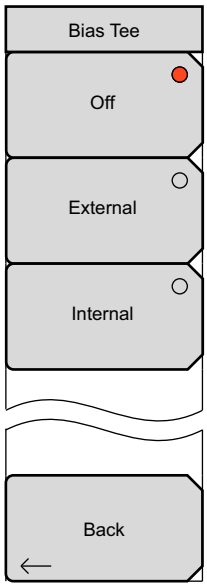
Int Current Limit P2: Press this soft key to set the internal bias tee current limit for the voltage that is set at Port 2. The available range is from 0 mA to 450 mA in steps of 1 mA. This current limit sets the trip point for the bias tee for this port. When using the number keypad, the soft key menu displays 2 choices for units: A or mA. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for current units (A or mA), or press the **Enter** key to use mA. Press the **Esc** key to exit without changing the setting.

Back: Press this soft key to return to the Configure Ports menu.

Figure 6-54. Bias Tee Setup Menu

Bias Tee Menu (MS20xxC only)

Access to this menu is from the Bias Tee soft key in the "Bias Tee Setup Menu".



Off: Press this soft key to turn the Bias Tee function Off.

External: Press this soft key to activate the External Bias Tee connection. Both Port 1 and Port 2 external bias tees are activated.

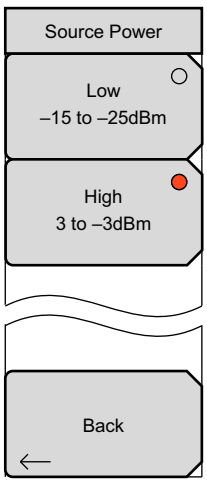
Internal: Press this soft key to select the internal source for Bias Tee voltage. The internal source is directed to either Port 1 or Port 2.

Back: Press this soft key to return to the "Bias Tee Setup Menu" without changing the current Bias Tee setting.

Figure 6-55. Bias Tee Menu

Source Power Menu (MS20xxC only)

Access to this menu is from the Source Power soft key in the "Configure Ports Menu".



Low: Press this soft key to set the Source Power to Low. This setting is for amplified devices.

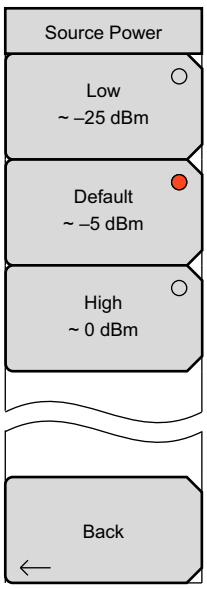
High: Press this soft key to set the Source Power to High. This setting is for passive devices.

Back: Press this soft key to return to the "Configure Ports Menu".

Figure 6-56. Source Power Menu

Source Power Menu (MS20xxB and S412E only)

Access to this menu is from the Source Power soft key in the "Configure Ports Menu".



Low: Press this soft key to set the Source Power to Low, which is approximately –25 dBm. This setting is for amplified devices.

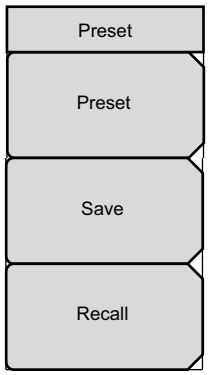
Default: Press this soft key to set the Source Power to Default, which is approximately –5 dBm. This setting is for passive devices.

High: Press this soft key to set the Source Power to High, which is approximately –0 dBm. Use this setting to achieve maximum dynamic range when measuring high-loss devices.

Back: Press this soft key to return to the "Configure Ports Menu".

Figure 6-57. Source Power Menu

Preset Menu



Preset: Press this soft key to preset sweep conditions to the default state of full band sweep, 201 data points, Quad display, 4 traces (S_{11} Smith, S_{21} Log Mag, S_{12} Log Mag, S_{22} Smith), 10 kHz IFBW, S_{21} Log Mag display, High output power, continuous sweep. This also turns off markers, limits, and calibration.

Save: Press this soft key to open a dialog box to name and save the current operating settings, allowing them to be recalled later in order to return the instrument to the state it was in at the time that the setup was saved.

Caution: Use the Change File Type soft key (in the "Save (Text Entry) Menu", refer to the file management instructions in the user guide for your instrument) to set the file type to "Setup (with CAL)", if it is currently set to another file type.

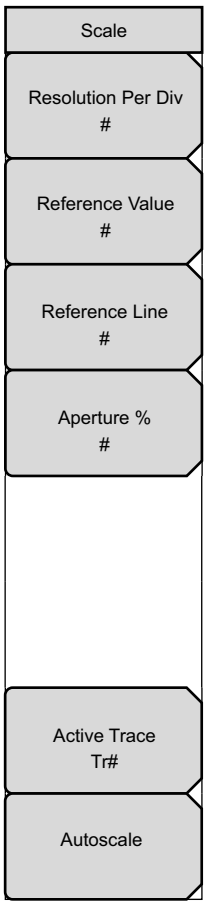
The saved setup is named by entering text. Use the **Shift** key to select an upper case letter. Use the **Left/Right** directional arrows to move the cursor position. Press **Enter** to save the setup.

Recall: Press this soft key to open a selection box that allows selection and recall of a previously stored instrument setup. The Recall menu also opens (refer to the file management instructions in the user guide for your instrument). Use the Recall menu soft keys to work within the selection box. All current instrument settings are replaced by the stored setup information. Press the **Esc** key to cancel the recall.

Figure 6-58. Preset Menu

To access the Preset Menu, press the **Shift** key, then the **Preset** (**1**) key. The Preset menu is used to preset the VNA Master.

Scale Menu



Resolution Per Div: Press this soft key to set the number of units that are displayed between horizontal reticlereticle lines. Units depend upon frequency, time, and distance settings. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter, then press the **Enter** key or the rotary knob.

Reference Value: Press this soft key to set the value of the Reference Line. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter, then press the **Enter** key or the rotary knob.

Reference Line: Press this soft key to set which horizontal graph reticle is at the reference value. The reference line is indicated by a small colored triangle along the right edge of the graph. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter, then press the **Enter** key or the rotary knob.

Aperture %: Press this soft key to set the aperture from 2% to 20% of the display. This soft key appears only when a graph type of Group Delay has been selected in the measurement menu. Group delay is a measurement of "Change in phase / change in frequency." The aperture setting is used by the VNA Master to determine how large a change in frequency to use in this calculation.

Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter. When using the keypad to enter a value, an Enter soft key appears in the active function block. The value can be set by pressing this soft key, the **Enter** key, or the rotary knob. Press the **Esc** key to exit without changing the aperture.

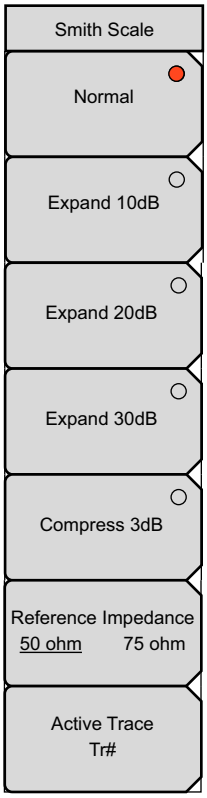
Active Trace: Press this soft key to open the Active Trace Selector List Box and choose a trace.

Autoscale: Press the Autoscale soft key to automatically adjust the Resolution Per Div and Reference Value so that the trace for the current measurement is shown in the middle of the display.

Figure 6-59. Scale Menu

Press the **Scale** hard key to access the "Scale Menu". The Scale menu is used to set the measurement display for optimum viewing. The type of scale menu displayed depends upon the graph type that has been selected in the meas menu. For example, if Graph Type is selected to Smith Chart, then the pressing the **Scale** hard key opens the "Smith Scale Menu". If the Graph Type is selected to a polar graph type (such as Linear Polar), then the pressing the **Scale** hard key opens the "Polar Scale Menu".

Smith Scale Menu



Normal: Press this soft key to display the normal Smith Chart or Inverted Smith Chart.

Expand 10 dB: Press this soft key to display the Smith Chart or Inverted Smith Chart expanded by 10 dB.

Expand 20 dB: Press this soft key to display the Smith Chart or Inverted Smith Chart expanded by 20 dB.

Expand 30 dB: Press this soft key to display the Smith Chart or Inverted Smith Chart expanded by 30 dB.

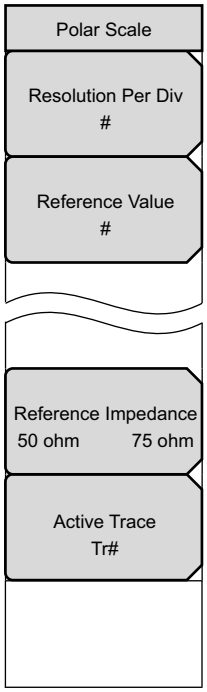
Compress 3 dB: Press this soft key to display the Smith Chart or Inverted Smith Chart compressed by 3 dB.

Reference Impedance
50 ohm 75 ohm: Press this soft key to toggle the reference impedance to 50 ohms or 75 ohms.

Active Trace: Press this soft key to open the “Active Trace Selector” List Box and choose a trace.

Figure 6-60. Smith Scale Menu

Polar Scale Menu



Resolution Per Div: Press this soft key to set the number of units that are displayed between horizontal reticle lines. Units depend upon frequency, time, and distance settings. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter, then press the **Enter** key or the rotary knob.

Reference Value: Press this soft key to set the value of the Reference Line. Use the **Up/Down** arrow keys, the keypad, or the rotary knob to set this parameter, then press the **Enter** key or the rotary knob.

Reference Impedance
50 ohm 75 ohm: Press this soft key to toggle the reference impedance to 50 ohms or 75 ohms.

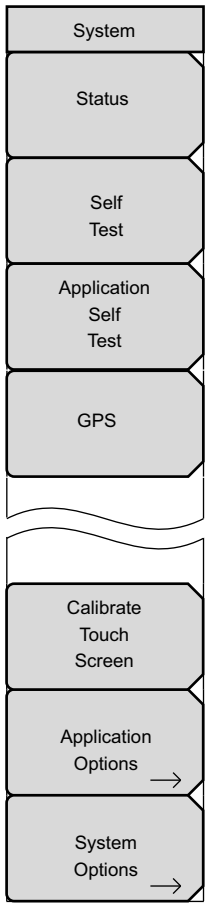
Active Trace: Press this soft key to open the “Active Trace Selector” List Box and choose a trace.

Figure 6-61. Polar Scale Menu

6-8 System Menus

To access the System Menu, press the **Shift** key, then the **System** (**8**) key. The System menu is used to interact with the system attributes of the VNA Master. Self Test, GPS, Application Options, and System Options can be found in this menu. For additional information, refer to the user guide for your instrument.

System Menu



Status: Press this soft key to display the instrument Status window.

Pressing this soft key displays the current system status, including the operating system and firmware versions, temperatures, and other details, such as current battery information. Press **Esc** or **Enter** to return to normal operation.

Self Test: Press this soft key to initiate a series of diagnostic tests that test the components of the instrument. A display lists the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

Application Self Test: Press this soft key to initiate a series of diagnostic tests that are related to the performance of the VNA Master. A display lists the individual tests with a pass or fail indication. Press **Esc** or **Enter** to return to normal operation.

GPS: Press this soft key to open the GPS soft key menu. (This soft key appears only if the GPS option is enabled in your instrument.)

Calibrate Touch Screen: Press this soft key to begin calibration of the touch screen. This calibration procedure can also be initiated by pressing Shift, then 0 (zero). This soft key appears only on touch screen instruments.

Application Options: Press this soft key to open the Application Options soft key menu.

System Options: Press this soft key to open the System Options soft key menu.

Figure 6-62. System Menu

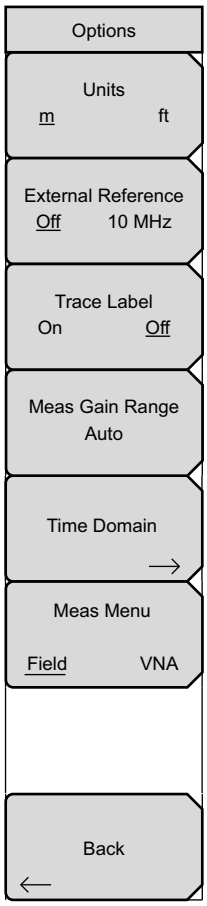
Calibrate Touch Screen Shortcut

Note Press **Shift** then **0** to open the Calibrate Touch Screen display. Press **Enter** to start the calibration, or press **Esc** to cancel.

Application Options Menu (VNA Mode)

The display of this menu varies based on the current instrument measurement mode. The menu shown here is specific to the Vector Network Analyzer application.

Key Sequence: **Shift**, **System** (**8**) > Application Options



VNA Mode selected

Units
m ft: Press this soft key to toggle the measurement units between meters and feet.

External Reference
Off 10 MHz: Press this soft key to toggle between turning Off the external reference or selecting the external reference. This soft key is displayed only for MS20xxC instruments.

Trace Label
On Off: Press this soft key to toggle the trace label On and Off. When On, a label is shown next to each trace (TR1 next to Trace 1, and so forth).

Meas Gain Range: Press this soft key to open the "Mode (Meas Gain Range) Menu". Then select Auto or Fixed. Refer to the user guide for your instrument.

Time Domain: Press this soft key to open the "Time Domain Options Menu". This soft key is displayed only for MS20xxC instruments.

Meas Menu
Field VNA: Press this submenu key to toggle between Field (a simplified subset of the standard VNA menu structure) and VNA (standard menu structure). This soft key is displayed only for MS20xxB and S412E instruments.

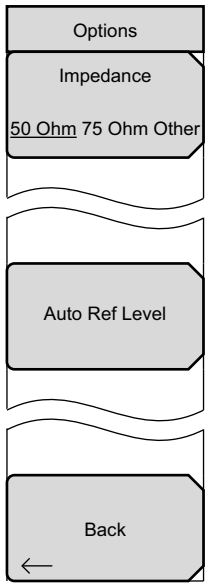
Back: Press this soft key to return to the "System Menu".

Figure 6-63. Application Options Menu (VNA Mode)

Application Options Menu (SPA Mode) VNA Master

The display of this menu varies based on the current instrument measurement mode. The menu shown here is specific to the Spectrum Analyzer application of the VNA Masters.

Key Sequence: **Shift**, **System** (**8**) > Application Options



SPA Mode selected

Impedance
50 Ohm 75 Ohm Other: Press this soft key to toggle the impedance setting to 50 Homs, 75 Ohms, or Other impedance value. Choosing 75 Ohm selects the 7.5 dB loss of the Anritsu 12N50-75B adapter. For other adapters, choose Other and enter the appropriate loss value.

Auto Ref Level: Press this soft key to set the Auto Reference Level, which adjusts the position of a signal on the display screen so that it is approximately two divisions down from the top, if possible. When the key is pressed, the reference level is adjusted once. Auto Ref Level has no effect on the settings for the preamplifier or the vertical scaling. This soft key is displayed only for MS20xxC instruments.

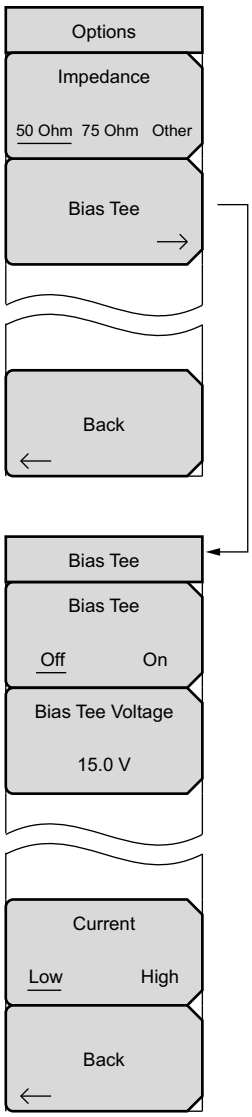
Back: Press this soft key to return to the "System Menu".

Figure 6-64. Application Options Menu (SPA Mode)

Application Options Menu (SPA Mode) LMR Master

The display of this menu varies based on the current instrument measurement mode. The menu shown here is specific to the Spectrum Analyzer application of the S412E LMR Master.

Key Sequence: **Shift**, **System** (**8**) > Application Options



SPA Mode selected

Impedance
50 Ohm 75 Ohm Other: Press this soft key to toggle the impedance setting to 50 Homs, 75 Ohms, or Other impedance value. Selecting 75 Ohm selects the 7.5 dB loss of the Anritsu 12N50-75B adapter. For other adapters, select Other and enter the appropriate loss value.

Bias Tee (Option 10 required): Press this soft key to display the Bias Tee menu.

Back: Press this soft key to return to the "System Menu".

Bias Tee
Off On: Press this soft key to toggle the variable power supply Off and On.

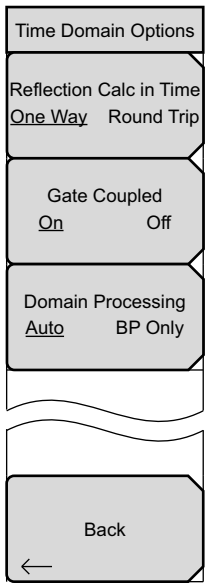
Bias Tee Voltage: Use this soft key to set the power supply voltage.

Current
Low High: Press this soft key to toggle the current between Low and High.

Back: Press this soft key to return to the Application Options menu.

Figure 6-65. Application Options Menu (SPA Mode) LMR Master

Time Domain Options Menu



Reflection Calc in Time: Press this soft key to set the calculation method that is used in the time domain (not distance) reflection measurements. The method can be either One Way (divide the total time by 2) or Round Trip.

Gate Coupled: Press this soft key to toggle the gate coupling to either On or Off. When set to On, the gate settings (start, stop, and so forth) for all traces are the same. When set to Off, each trace has a gate whose settings are independent of any of the other gates that are being used.

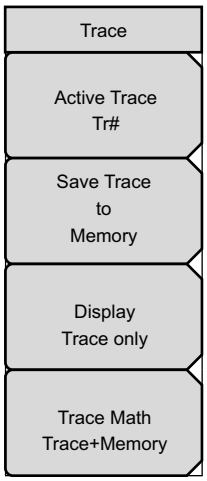
Domain Processing: Press this soft key to set the domain processing to be either Auto (let the instrument decide to use Low Pass processing whenever possible and switch to Band Pass if not possible), or Band Pass only (in which case, the setting will never be Low Pass).

Back: Press this soft key to return to the "Application Options Menu (VNA Mode)".

Figure 6-66. Time Domain Options Menu

Trace Menu

To access the Trace Menu, press the **Shift** key, then the **Trace** (**5**) key.



Active Trace: Press this soft key to open the "Active Trace Selector" List Box and choose a trace. Use the arrow keys, the rotary knob, or the number keypad to select a trace and then press the **Enter** key. Press the **Esc** key to close the list box without changing the active trace.

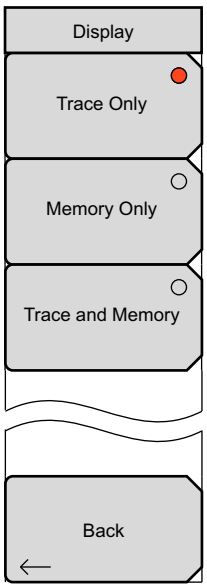
Save Trace to Memory: Press this soft key to save the current trace to memory.

Display: Press this soft key to open the "Display Menu (Trace)".

Trace Math: Press this soft key to open the "Trace Math Menu".

Figure 6-67. Trace Menu

Display Menu (Trace)



Trace Only: Press this soft key to set the trace function to display only the current trace.

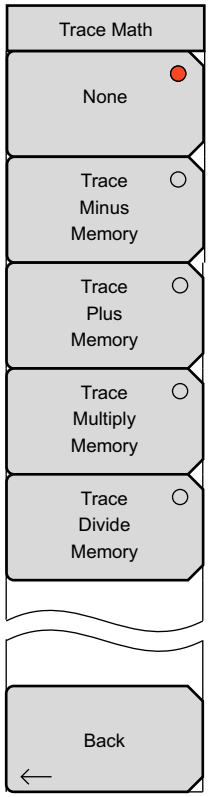
Memory Only: Press this soft key to set the trace function to display only the trace that is in memory.

Trace and Memory: Press this soft key to set the trace function to display the current trace and the trace that is in memory.

Back: Press this soft key to return to the "Trace Menu" without changing the current setting.

Figure 6-68. Display Menu

Trace Math Menu



None: Press this soft key to set the trace math function to use only the current trace.

Trace Minus Memory: Press this soft key to set the trace math function to subtract the trace that is in memory from the current trace.

Trace Plus Memory: Press this soft key to set the trace math function to add the trace that is in memory to the current trace.

Trace Multiply Memory: Press this soft key to set the trace math function to multiply the current trace by the trace that is in memory.

Trace Divide Memory: Press this soft key to set the trace math function to divide the current trace by the trace that is in memory.

Back: Press this soft key to return to the “Trace Menu”.

Figure 6-69. Trace Math Menu

Chapter 7 — Field View Menus

7-1 Introduction

The menus that are shown in this chapter are found on the Vector Network Analyzer instrument when it is in VNA mode. All of the vector network analyzers that are referenced in this measurement guide provide the VNA measurements view (as described throughout this document). Only the MS20xxB VNA Master and the S412E LMR Master provide the Field measurements view that is described in this chapter.

The following list is a quick reference to the principal Field View menus in the Vector Network Analyzer. The menus in this chapter are presented in the following order:

- "Field View Menus, Basic Group" on page 7-2
- "Field View Frequency Menu (Frequency-Based)" on page 7-3
- "Field View Frequency Menu (Distance-Based)" on page 7-4
- "Field View DTF Menu Group" on page 7-5
- "Field View DTF Setup Menu" on page 7-6
- "Field view Windowing Menu" on page 7-8
- "Field View Scale Menu Group" on page 7-9
- "Field View Scale Menu – Single Display Type" on page 7-10
- "Field View Scale Menu – Dual and Overlay Display Type" on page 7-11
- "Field View Sweep Menu Group" on page 7-12
- "Field View Sweep Menu" on page 7-13
- "Field View Avg/Smooth Menu" on page 7-14
- "Field View Source Power Menu" on page 7-14
- "Field View Measure Menu Group" on page 7-15
- "Field View Measure Menu – Single" on page 7-15
- "Field View Measure Menu – Dual" on page 7-16
- "Field View Marker Menu" on page 7-17
- "Calibration Menu" on page 7-18
- "Existing Calibration Information List Box" on page 7-18
- "Application Options Menu – Field versus VNA" on page 7-19

7-2 Field View Menus

The Field View Menu Group is shown in Figure 7-1 on page 7-2.

Field View Menu Group (Field View)

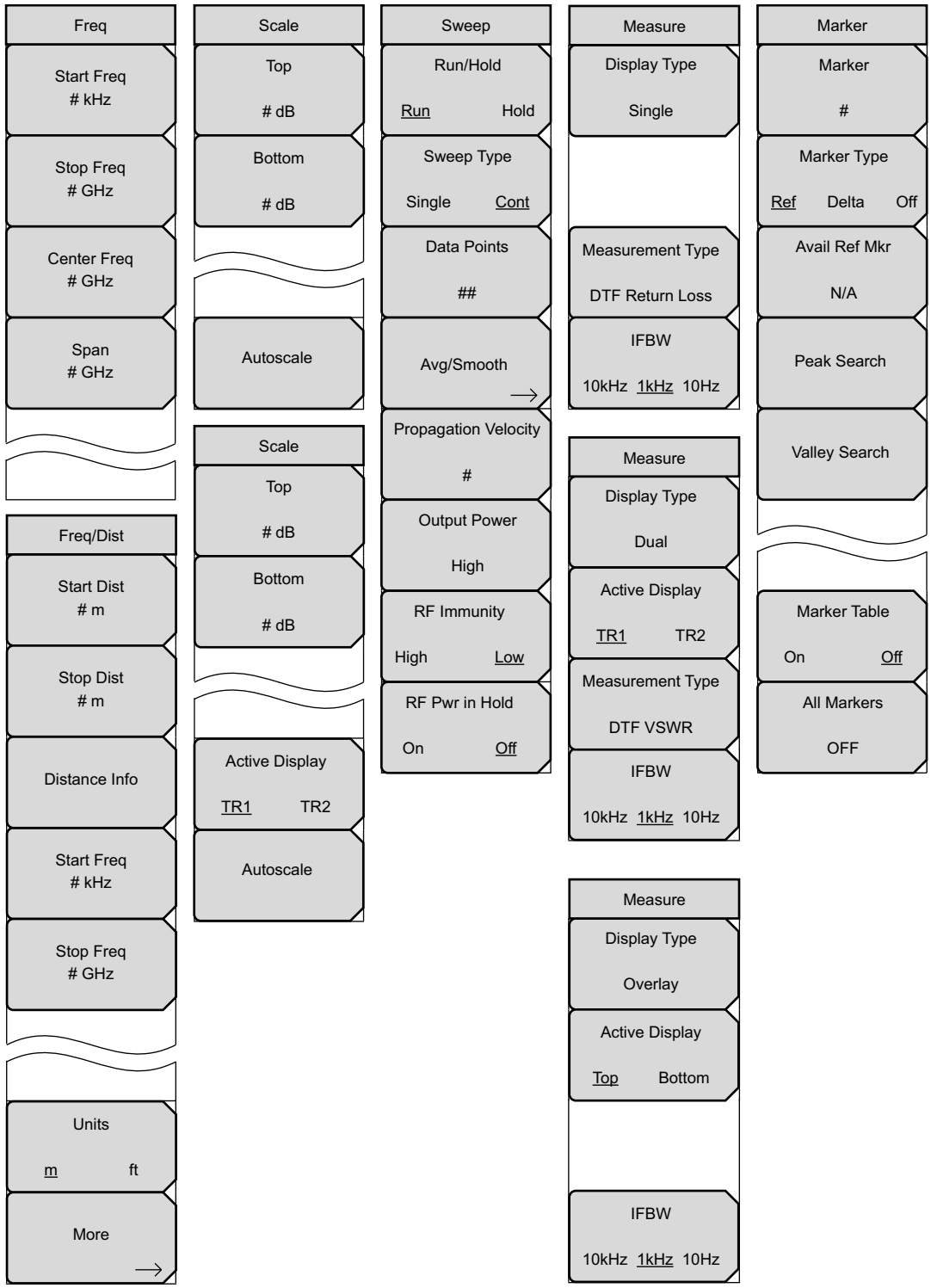
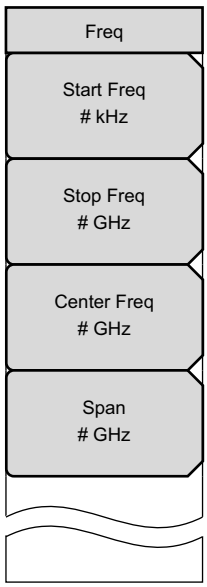


Figure 7-1. Field View Menus, Basic Group

7-3 Field View Frequency Menus

Many menus display limited soft key functionality in Field view. Various keys that are available in VNA measurements view may be in different locations or may not be displayed at all.

Freq Menu (Frequency-Based)



Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = On, then the start frequency is set to the same value as the stop frequency. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = Off, then both start and stop frequency are set to the new frequency.

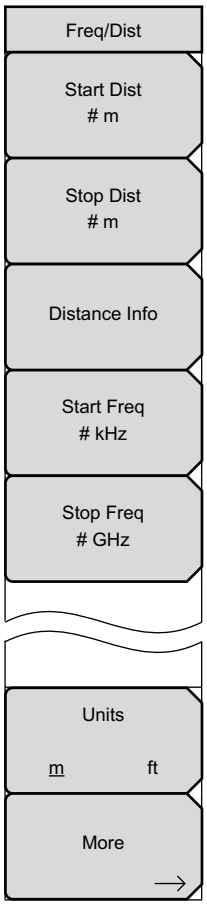
Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = On, then the stop frequency is set to the same value as the start frequency. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = Off, then both stop and start frequency are set to the new frequency.

Center Freq: Press this soft key to set the center frequency in units of Hz, kHz, MHz, or GHz. The center frequency can be set with the arrow keys, the rotary knob, or the number keypad. When using the number keypad, the menu displays soft keys with Hz, kHz, MHz, and GHz units. Pressing the **Enter** key has the same effect as pressing the MHz soft key.

Span: Press this soft key to set the span in units of Hz, kHz, MHz, or GHz. The span setting determines the frequency range over which the instrument sweeps. The span may be set from 0 (zero) to the maximum frequency of the instrument.

Figure 7-2. Field View Frequency Menu (Frequency-Based)

Freq/Dist Menu (Distance-Based)



Start Dist: Press this soft key to set the start distance in units of meters or feet. If you enter a start distance that is higher than the currently-set stop distance, and if CAL = On, then the start distance is set to the same value as the stop distance. If you enter a start distance that is higher than the currently-set stop distance, and if CAL = Off, then both start and stop distance are set to the new distance.

Stop Dist: Press this soft key to set the stop distance in units of meters or feet. If you enter a stop distance that is lower than the currently-set start distance, and if CAL = On, then the stop distance is set to the same value as the start distance. If you enter a stop distance that is lower than the currently-set start distance, and if CAL = Off, then both stop and start distance are set to the new distance.

Distance Info: Press this soft key to open the Distance Info dialog box. The upper portion of the dialog box displays cable information, such as cable loss and propagation velocity. the lower portion of the dialog box displays parameter information. You can use the rotary knob or the arrow keys to scroll through the list, which may have additional information beyond the lower edge of the dialog box. For more information about this dialog box, refer to the images in Section "Distance Info List Box for Cable" on page 6-13 and Section "Distance Info List Box for Waveguide" on page 6-13 and also to the descriptions in Section 8-6 "Time and Distance Information" on page 8-17 and Section 9-6 "Distance Information" on page 9-6.

Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = On, then the start frequency is set to the same value as the stop frequency. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = Off, then both start and stop frequency are set to the new frequency.

Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = On, then the stop frequency is set to the same value as the start frequency. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = Off, then both stop and start frequency are set to the new frequency.

Units

m ft: Press this soft key to set the center frequency in units of Hz, kHz, MHz, or GHz. The center frequency can be set with the arrow keys, the rotary knob, or the number keypad. When using the number keypad, the menu displays soft keys with Hz, kHz, MHz, and GHz units. Pressing the **Enter** key has the same effect as pressing the MHz soft key.

More: Press this soft key to open the "DTF Setup Menu" on page 7-6.

Figure 7-3. Field View Frequency Menu (Distance-Based)

7-4 Distance Menus

These are the menus that are displayed in response to pressing the function hard keys (main menu keys) when making distance-to-fault measurements.

DTF Menu Group (Field View)

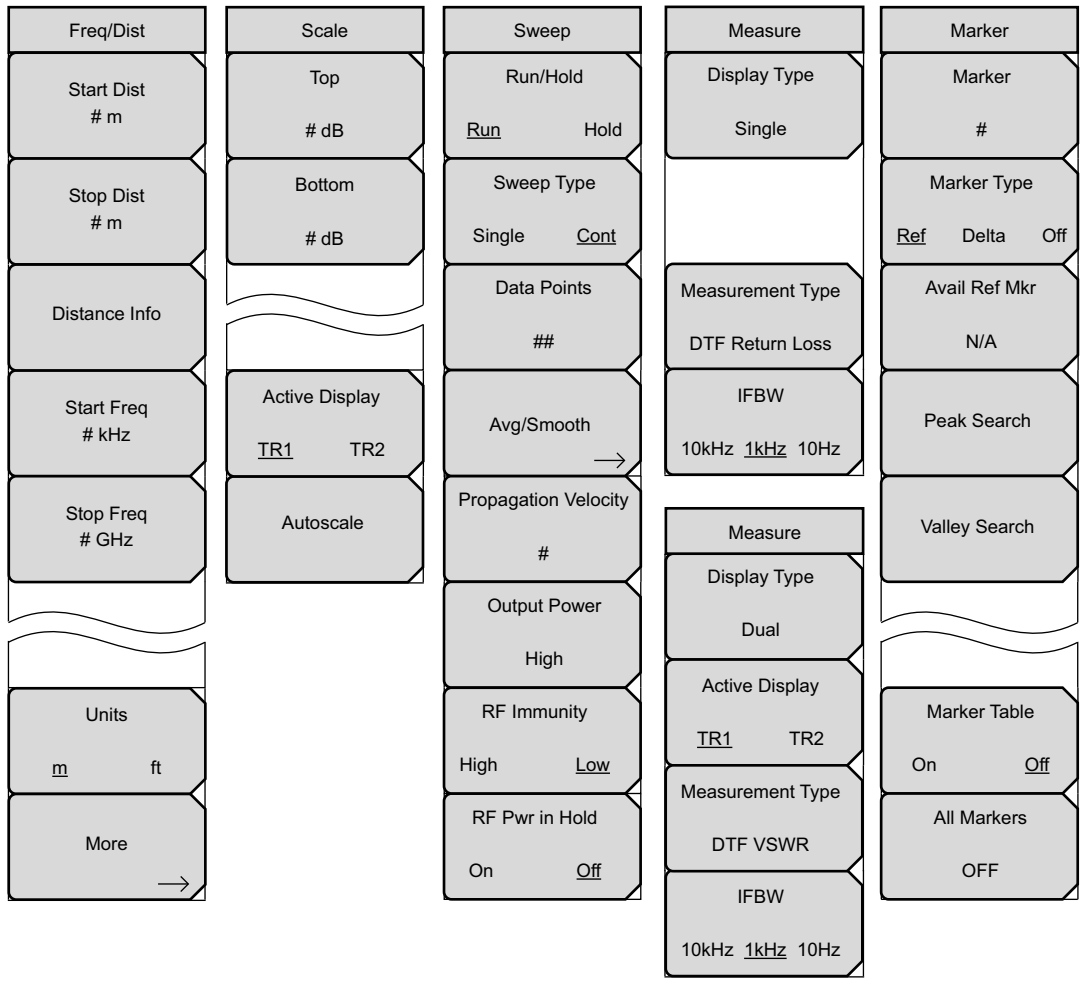
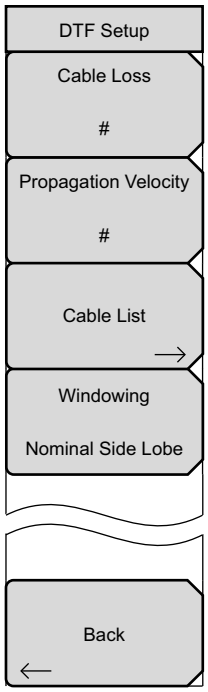


Figure 7-4. Field View DTF Menu Group

DTF Setup Menu

This menu is displayed when a DTF graph type is selected.

Key Sequence: **Freq/Dist** > More



Cable Loss: Press this soft key to set the cable loss coefficient from 0.000 dB/m to 5.000 dB/m. (The units are dB/ft if units are set to US units.)

Propagation Velocity: Press this soft key to set the fraction of propagation velocity from 0.001 to 1.000. For any fraction less than 1.000, press the decimal key before entering the decimal digits.

Cable List: Press this soft key to open a list box and select a cable type. The "Cable List Menu" on page 7-7 provides quick navigation aids to search through the list.

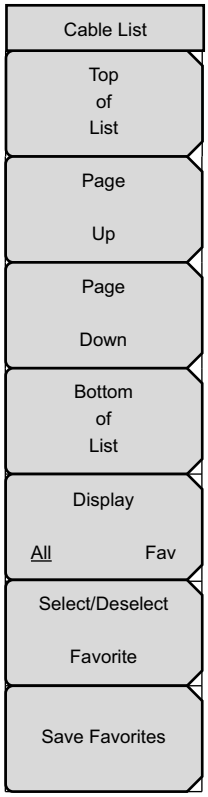
Windowing: Press this soft key to open the "Windowing Menu" on page 7-8. The window shape value is displayed on the key face, and may be Rectangular, Nominal Side Lobe (as in this example), Low Side Lobe, or Minimum Side Lobe.

Back: Press this soft key to return to the Dist/Freq menu.

Figure 7-5. Field View DTF Setup Menu

Cable List Menu

Key Sequence: **Freq/Dist** > More > Cable List



Top of List: Press this submenu key to jump to the top of the Antenna list.

Page Up: Press this key to skip up through the list.

Page Down: Press this key to skip down through the list.

Bottom of List: Press this submenu key to jump to the bottom of the list.

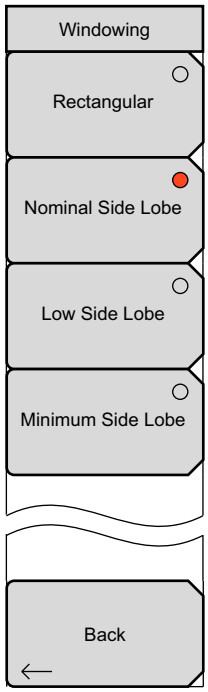
Display: Press this key to toggle the display of All cables or only cables marked as Favorites.

Select/Deselect Favorite: Press this submenu key to add the highlighted cable to the Favorites list. The cable is then marked with an asterisk. If the selected cable is already marked with an asterisk, pressing this key removes it from the Favorites list.

Save Favorites: Press this key to save the changes you have made to the Favorites list.

Figure 7-6. Cable List Menu

Windowing Menu



Rectangular: Press this soft key to set windowing to the rectangular view for maximum side lobes and maximum resolution. Refer to Figure B-1, “Rectangular Windowing Example”.

Nominal Side Lobe: Press this soft key to set windowing to the Nominal Side Lobe view, which (compared to Rectangular) displays smaller side lobes and slightly less resolution. Refer to Figure B-2, “Nominal Side Lobe Windowing Example”. Nominal Side Lobe is the default setting for the VNA Master.

Low Side Lobe: Press this soft key to set windowing to the Low Side Lobe view for still smaller side lobes than nominal, and also slightly less resolution than the Nominal Side Lobe setting. Refer to Figure B-3, “Low Side Lobe Windowing Example”.

Minimum Side Lobe: Press this soft key to set windowing to the Minimum Side Lobe view for the smallest side lobes, but the least resolution. Refer to Figure B-4, “Minimum Side Lobe Windowing Example”.

Back: Press this soft key to return to the previous menu.

Figure 7-7. Field view Windowing Menu

7-5 Scale Menus

The soft keys that are available in the Scale menu depend upon the Display Type setting in the Measure menu.

Scale Menu Group (Field View)

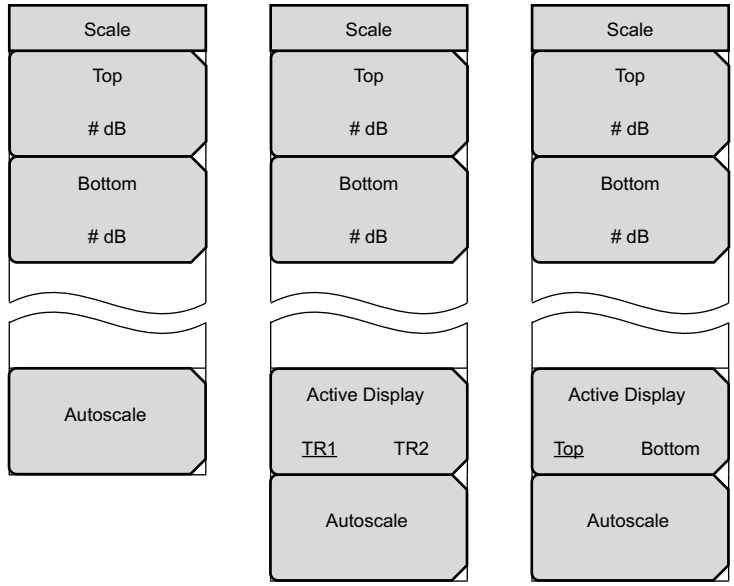
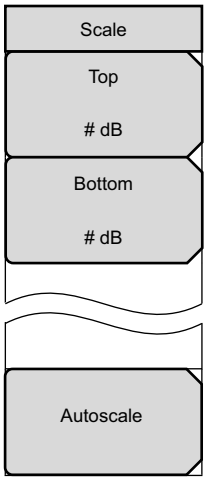


Figure 7-8. Field View Scale Menu Group

Scale Menu

This menu has only three soft keys when Display Type is set to Single. An additional soft key is displayed when Display Type is set to Dual or Overlay.

Scale Menu – Single



Start Freq: Press this soft key to set the start frequency in units of Hz, kHz, MHz, or GHz. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = On, then the start frequency is set to the same value as the stop frequency. If you enter a start frequency that is higher than the currently-set stop frequency, and if CAL = Off, then both start and stop frequency are set to the new frequency.

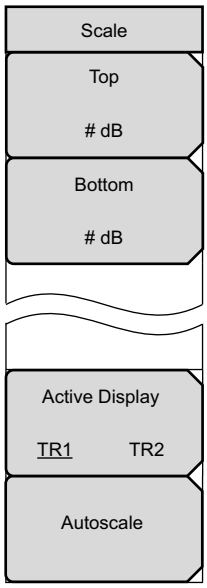
Stop Freq: Press this soft key to set the stop frequency in units of Hz, kHz, MHz, or GHz. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = On, then the stop frequency is set to the same value as the start frequency. If you enter a stop frequency that is lower than the currently-set start frequency, and if CAL = Off, then both stop and start frequency are set to the new frequency.

Center Freq: Press this soft key to set the center frequency in units of Hz, kHz, MHz, or GHz. The center frequency can be set with the arrow keys, the rotary knob, or the number keypad. When using the number keypad, the menu displays soft keys with Hz, kHz, MHz, and GHz units. Pressing the **Enter** key has the same effect as pressing the MHz soft key.

Span: Press this soft key to set the span in units of Hz, kHz, MHz, or GHz. The span setting determines the frequency range over which the instrument sweeps. The span may be set from 0 (zero) to the maximum frequency of the instrument.

Figure 7-9. Field View Scale Menu – Single Display Type

Scale Menu – Dual or Overlay

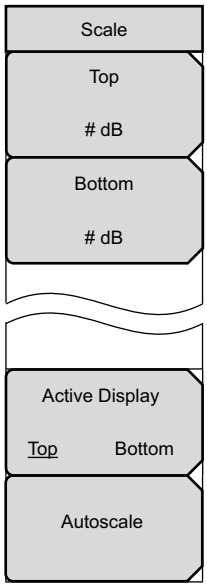


Top: Press this soft key to set the upper value of the y-axis in dB.

Bottom: Press this soft key to set the lower value of the y-axis in dB.

Active Display: Press this soft key to select the trace that you want to be the active trace. When Display Type is set to Dual, the choices are TR1 and TR2.

Autoscale: Press this soft key to automatically adjust the Resolution Per Division and Reference Value so that the trace for the current measurement is shown in the middle of the display.



Active Display: Press this soft key to select the trace that you want to be the active trace. When Display Type is set to Overlay, the choices are Top and Bottom.

Figure 7-10. Field View Scale Menu – Dual and Overlay Display Type

7-6 Sweep Menus

These are the menus that are displayed in response to pressing the Sweep function hard key in Field view.

Sweep Menu Group (Field View)

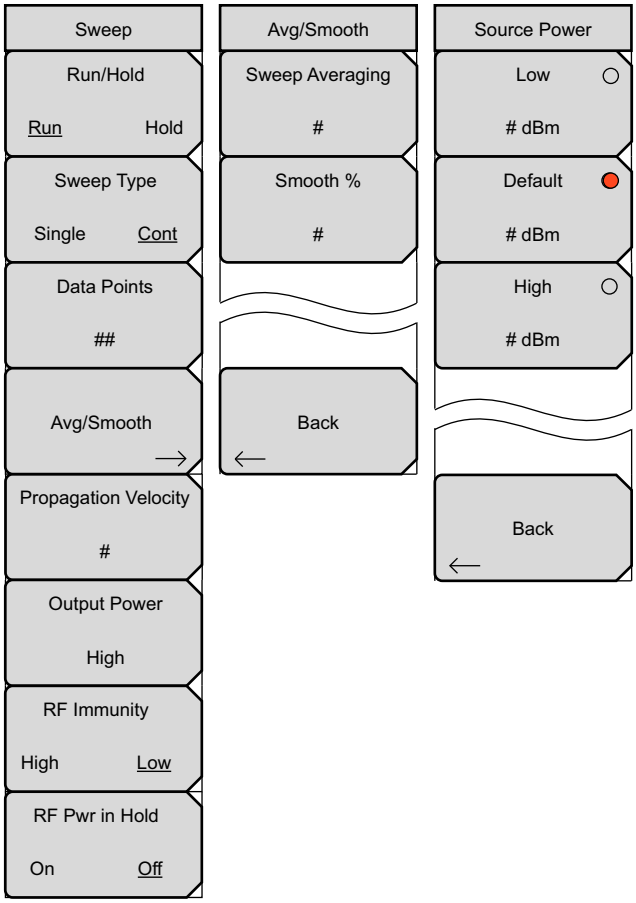
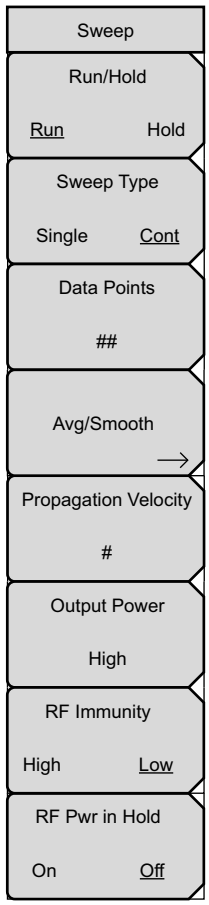


Figure 7-11. Field View Sweep Menu Group

Sweep Menu



Run/Hold
Run Hold: Press this soft key to toggle the sweep setting to Run or Hold.

Sweep Type
Single Cont: Press this soft key to toggle the sweep setting to Single or Continuous (Cont).

Data Points: Press this soft key to set the number of data points to be included in the sweep. You can set any number of data points from 2 up to 4001. The larger the number of data points, the slower sweep speed. In a DTF measurement for example, the larger the number of data points, the longer the maximum distance, but at the expense of a slower sweep speed.

Avg/Smooth: Press this soft key to display the "Avg/Smooth Menu" on page 7-14.

Propagation Velocity: Press this soft key to set the propagation velocity for the cable under test. This value is set automatically when a cable type is selected for a distance measurement (refer to "DTF Setup Menu" on page 7-6).

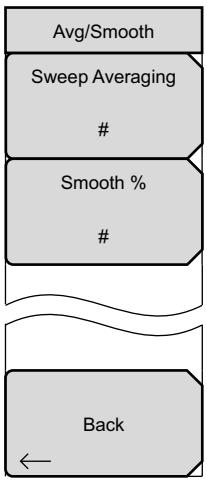
Output Power: Press this soft key to display the "Source Power Menu" on page 7-14.

RF Immunity
High Low: Press this soft key to toggle the RF Immunity setting to High or Low.

RF Pwr in Hold
On Off: Press this soft key to toggle On and Off the condition of the RF power transmitted from Port 1 and Port 2 when the instrument is put in Hold mode. The RF power can be set either to stay on or to be turned off during Hold. The default setting is for the RF to stay On during Hold, which helps to stabilize the instrument temperature.

Figure 7-12. Field View Sweep Menu

Avg/Smooth Menu



Sweep Averaging: Press this soft key to set the number of sweeps to use for averaging. The minimum number is 1.

Smooth %: Press this soft key to add a smoothing percentage from 0 (zero) to 20%. Use the **Arrow** keys, the rotary knob, or the number keypad to input the value, and then press the **Enter** key.

Note: If you apply smoothing when the sweep has more than 2000 points, the smoothing may slow the sweep time of the trace and the responsiveness of the instrument. This slowing can be significant, and it increases as the number of sweep points is increased.

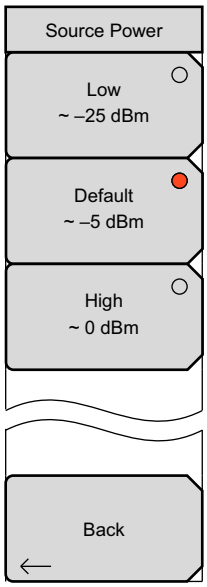
Back: Press this soft key to return to the Sweep menu.

Figure 7-13. Field View Avg/Smooth Menu

Output Power

Press the Output Power soft key in the Sweep menu to display the Source Power menu.

Source Power Menu



Low: Press this soft key to set the Source Power to Low, which is approximately –25 dBm. This setting is for amplified devices.

Default: Press this soft key to set the Source Power to Default, which is approximately –5 dBm. This setting is for passive devices.

High: Press this soft key to set the Source Power to High, which is approximately –0 dBm. Use this setting to achieve maximum dynamic range when measuring high-loss devices.

Note: Changing Source Power while Cal Correction is turned On will affect the accuracy of the current calibration. Refer to “Changing Source Power” on page C-7. Cal Correction is a soft key in the Calibration menu.

Back: Press this soft key to return to the Sweep menu.

Figure 7-14. Field View Source Power Menu

7-7 Measure Menus

Press the **Measure** function hard key (main menu key) to display the Measure menu. The Active Display soft key appears only when the Display Type is Dual or Overlay.

Measure Menu Group (Field View)

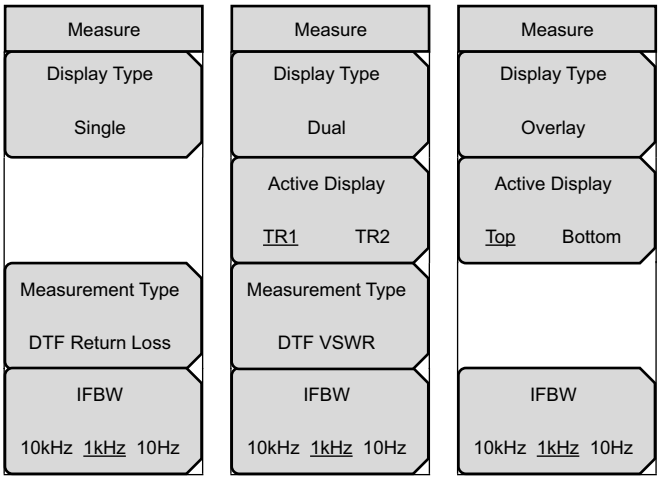
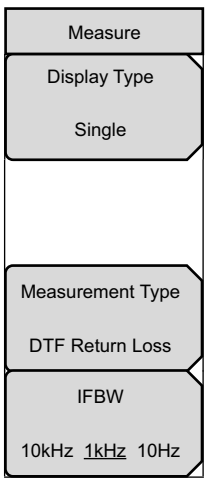


Figure 7-15. Field View Measure Menu Group

Measure Menu – Single



Display Type: Press this soft key to open the Display Type list box and choose a display type. The choices are:

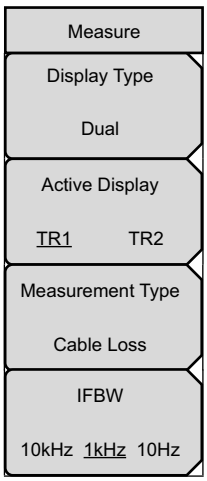
Single, Dual, Overlay.

Measurement Type: Press this soft key to open the Graph Type Selector list box and choose a graph type. Refer to the list in Section 5-4 “Graph Type Selector List Box” on page 5-4. The soft key in this illustration is displaying 1-Port Smith, which is one of the measurement types in the list box.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz for the MS20xxC series instruments and 1 kHz for the MS20xxB and S412E series instruments. Select 10 Hz for the maximum dynamic range; select 100 kHz for the maximum speed.

Figure 7-16. Field View Measure Menu – Single

Measure Menu – Dual



Display Type: Press this soft key to open the Display Type list box and choose a display type. The choices are:

Single, Dual, Overlay.

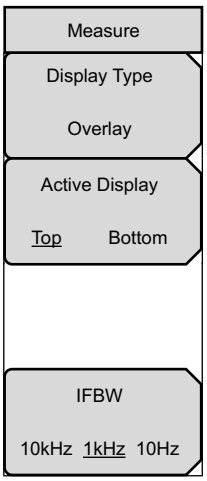
Active Display
TR1 TR2: Press this soft key to toggle the active display to Trace 1 or Trace 2.

Measurement Type: Press this soft key to open the Graph Type Selector list box and choose a graph type. Refer to the list in Section 5-4 “Graph Type Selector List Box” on page 5-4. The soft key in this illustration is displaying 1-Port Smith, which is one of the measurement types in the list box.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz for the MS20xxC series instruments and 1 kHz for the MS20xxB and S412E series instruments. Select 10 Hz for the maximum dynamic range; select 100 kHz for the maximum speed.

Figure 7-17. Field View Measure Menu – Dual

Measure Menu – Overlay



Display Type: Press this soft key to open the Display Type list box and choose a display type. The choices are:

Single, Dual, Overlay.

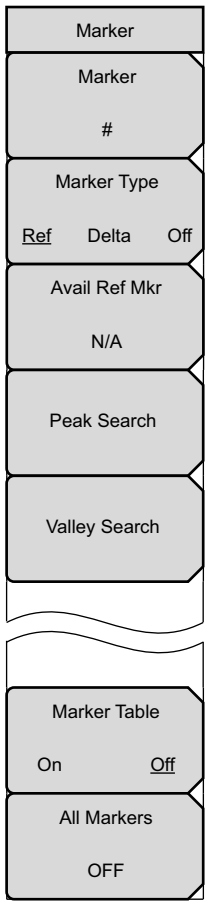
Active Display
Top Bottom: Press this soft key to toggle the active display to Top or Bottom.

Note: The Measurement Type soft key is not displayed because the Overlay display type always presents Insertion Loss as Trace 1 and Return Loss as Trace 2.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz for the MS20xxC series instruments and 1 kHz for the MS20xxB and S412E series instruments. Select 10 Hz for the maximum dynamic range; select 100 kHz for the maximum speed.

Figure 7-18. Field View Measure Menu – Overlay

Marker Menu



Marker: Press this soft key to open the Select Marker List Box and select a one of the 12 markers. The active marker number is displayed on the soft key face.

Marker Type
Ref Delta Off: Press this soft key to toggle the Marker Type selection. The active marker becomes a Reference marker or a Delta marker, or it can be turned Off.

Avail Ref Marker: Press this soft key to open a list box and select a reference marker, if one is available.

Peak Search: Press this soft key to place the currently active marker on the highest signal amplitude that is currently displayed in the sweep window.

Valley Search: Press this soft key to place the currently active marker on the lowest signal amplitude that is currently displayed in the sweep window.

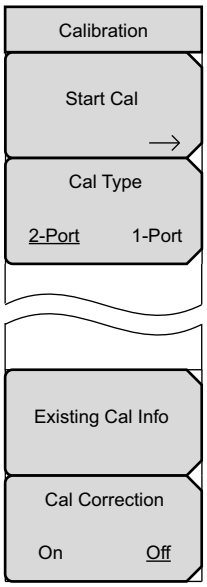
Marker Table
On Off: Press this soft key so that On is underlined to display all marker and delta marker data in a table under the measurement graph. Note that when Marker Table is displayed with a zero span (start frequency = stop frequency), the marker frequency is labeled with the trace point number in parenthesis. For example: MK1 500 kHz(101) –4.99 dB

All Markers OFF: Press this soft key to turn OFF all markers.

Figure 7-19. Field View Marker Menu

7-8 Calibration Menu

To access the Calibration Menu, press the **Shift** key, then the **Calibrate** (**2**) key.



Start Cal: Press this soft key to open the "Next Step" List Box, which contains the instructions: "Connect cal component, select step, and press **Enter** to measure:"

Cal Type
2-Port 1-Port: Press this soft key to toggle the calibration type to 1-Port or 2-Port.

Existing Cal Info: Press this soft key to open the "Existing Calibration Information List Box" on page 7-18. Press **Enter** or **Esc** to close the list box.

Cal Correction
On Off: Press this soft key to toggle calibration correction On and Off.

Figure 7-20. Calibration Menu

7-9 Existing Calibration Information List Box

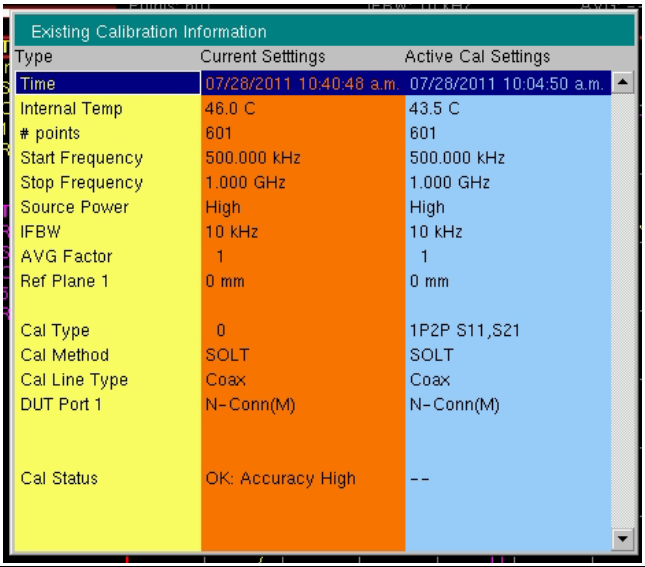
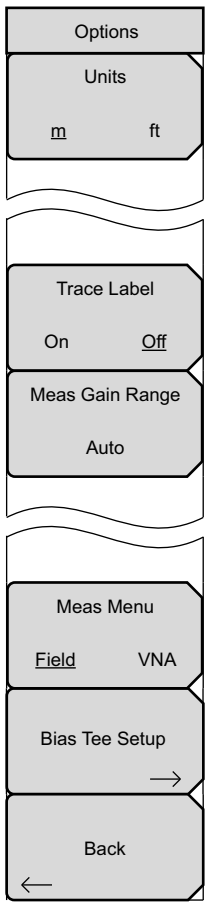


Figure 7-21. Existing Calibration Information List Box

The Existing Calibration Information list box shows the various sweep setting types for the active calibration and compares this information to the current sweep settings. It also displays the Cal Status information and the associated level of accuracy.

7-10 Application Options Menu

To choose between the Field Measurements view and the VNA Measurements view, open the System menu, then the Application Options menu, then press the Meas Menu key to toggle the setting to Field.



Units
m ft: Press this soft key to select meters or feet as the displayed unit.

Trace Label
On Off: Press this soft key to toggle trace labels On or Off.

Meas Gain Range: Press this soft key to open the Mode (Meas Gain Range) Menu. Then select Auto or Fixed.

Meas Menu
Field VNA: Press this soft key to toggle the measurements to Field view or VNA view.

Bias Tee Setup: Press this soft key to display the Bias Tee Setup menu.

All Markers OFF: Press this soft key to turn OFF all markers.

Back: Press this soft key to return to the System menu.

Figure 7-22. Application Options Menu – Field versus VNA

Chapter 8 — Time Domain, Option 2

8-1 Introduction

This chapter describes the optional Time Domain feature in the Vector Network Analyzer. General descriptions, key concepts, and examples are presented for time and distance measurements for both coaxial and waveguide media.

The function hard keys in Vector Network Analyzer mode with Option 2 are:

Freq/Time/Dist, Scale, Sweep, Measure, Marker

8-2 Time Domain Measurements

The Option 2 Time Domain feature provides the ability to transform the native frequency domain data (that is measured by the Vector Network Analyzer) into time domain or distance domain information to help in determining the location of impedance discontinuities. Some typical applications are: distance-to-fault (DTF) in cables and waveguides, characterizing antennas, isolating and analyzing a desired response in a one-port or two-port network, and identifying and analyzing circuit elements.

The relationship between the frequency-domain response and the time-domain response of a network is described mathematically by the Fourier transform. The instrument makes measurements in the frequency domain, then transforms that data into its time-domain response, which can be displayed as a function of time or distance. This computational technique benefits from the wide dynamic range of the instrument (and its measurement data) and from the error correction of the frequency-domain data.

The transformation technique that is used by the instrument (in most cases) is the chirp-Z transform of the available frequency domain data for that parameter. Because the transform simply treats the frequency domain values as input data, any S-parameter can be transformed (including differential S-parameters). The chirp-Z transform is (in a macro sense) very similar to the Fast Fourier Transform with the exception that the output range can be variable. This permits you to zoom in on a specific time (distance) range of interest for the data display. A different algorithm is used with the waveguide dispersive media, where the time-frequency relationship is more complex, but the functionality remains the same.

Two of the fundamental properties of time-domain conversion are resolution and maximum (alias-free) range. Resolution is the ability to resolve one discontinuity from another. Resolution is limited by the frequency span of the measurement. Maximum range defines how far you can see discontinuities on the media you are measuring. Beyond the maximum range, the data just repeats itself, and you start seeing the same discontinuities from closer ranges. The maximum range is determined by the frequency step size.

For more details about time domain fundamentals, refer to the following application notes:

- *Reflectometer Measurements — Revisited* - Anritsu Application Note 11410-00214
- *Time Domain Measurements Using Vector Network Analyzers* - Anritsu Application Note 11410-00206
- *Distance to Fault* - Anritsu Application Note 11410-00373

8-3 VNA Master Implementation

The Time Domain implementation in the VNA Master is trace based, which makes it very flexible to use. Each of the four traces in the VNA Master can be configured independently and can be in the frequency, time, or distance domain. Each trace can also be configured to represent any of the S-parameters. The VNA Master (as an example) can simultaneously view S_{11} in the frequency, distance, and time domains using three traces. Alternatively, you can view all four of the S-parameters in the distance domain or the time domain or both. This flexibility could be useful when tuning complex filters or analyzing long cable problems with multiple discontinuities.

One Way versus Round Trip

With the ability to transform any S-parameter, one question that arises is whether the time or distance that is plotted represents a one-way or a round-trip propagation. The one-way propagation represents the transmission (or 2-port) measurement, in which the signal is transmitted from one port, propagates through the device under test, and is received on the second port. One-way propagation occurs when transforming S_{21} or S_{12}.

The round-trip propagation represents a reflection (1-port) measurement, in which the signal is transmitted from one port, propagates through the device under test, fully reflects at the end of the device, and is received back at the same port. Round-trip propagation occurs when transforming S_{11} or S_{22}.

For reflection measurements, the VNA Master can handle the two cases of one-way and round-trip propagation differently in the Time and Distance domains. In the distance domain, the VNA Master compensates for the round trip reflection propagation by showing the actual length of the device under test (essentially dividing the distance by 2 for the reflection measurements). This compensation renders the distance reflection measurement as a One-Way measurement in terms of the distance value that is reported. In the Time Domain, you can choose to set the reflection measurement to be either One-Way or Round-Trip (press the following keys: **Shift 8** (System), Application Options, Time Domain, and Reflection Calc in Time). When set to One Way (which is the default setting), the VNA Master compensates for the round-trip reflection measurement as it does in the Distance Domain. When set to Round Trip, the VNA Master plots the response against the actual time that the signal travels from the transmission port to the receiving port, without accounting for the 2-way propagation (reflection and return).

For example, look at the results of measuring a cable that is 3.05 meters (10 ft) long. For a transmission measurement, approximately 14.4 ns are taken by a signal when traveling from one end of the cable to the other end of the cable. For a reflection measurement, the time is twice as long, or approximately 29 ns are taken by a signal when traveling from one end of the cable, reflecting from the far end, and returning. Figure 8-1 shows a measured time domain response of a cable of this length for both reflection (S11) and transmission (S21). Note that for this example, the VNA Master Reflection Calc in Time parameter is set to Round Trip. The top trace of Figure 8-1 is the S11 plot showing the reflections from both ends of the cable (MK1 at the near end, and MK2 at the far end). You can see that the far end peak at MK2 is at approximately 29 ns. Looking at the bottom trace, you can see that the peak at MK3 (which represents the signal received at the end of the cable) is at approximately 14.4 ns.

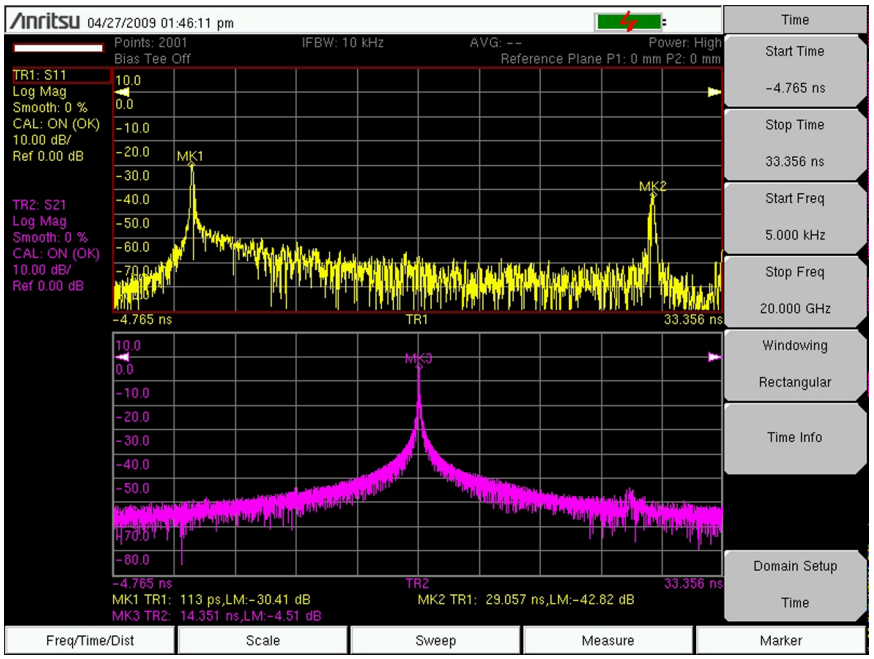


Figure 8-1. Time Domain Measurements of a 3.05 m Cable Showing S_{11} and S_{21}

Take a look at what happens in the distance domain for the same cable. As a user, you want the reflection and transmission measurements to show you where the end of the cable is located. Figure 8-2 shows a measured distance domain response of this cable for both reflection (S11) and transmission (S21). The top trace is the S11 plot showing the reflections from both ends of the cable (MK1 at the near end, and MK2 at the far end). The bottom trace shows the transmission S21 measurement with the peak representing the signal received at the end of the cable (MK3). Looking at the signal at MK2 and MK3, you can see that the reflection and transmission measurements produced the same result for the length of the cable. The VNA Master compensated for the round-trip condition in the S11 measurement so that the distance information matches the physical length of the cable, just as it does in the S21 measurement. Note that if the option parameter Reflection Calc in Time is set to One Way, then the time domain example shown in Figure 8-1 would look more like the result shown in Figure 8-2.

Caution	The measured cable had a propagation velocity of 70%, which was entered into the VNA Master. Measurements in the distance domain use the entered propagation velocity value to calculate the actual physical length of cables. If the default value of 100% were used, then the measured cable length would be wrong (4.4 meters in the above example). Time domain measurements are not dependent on the propagation velocity values.

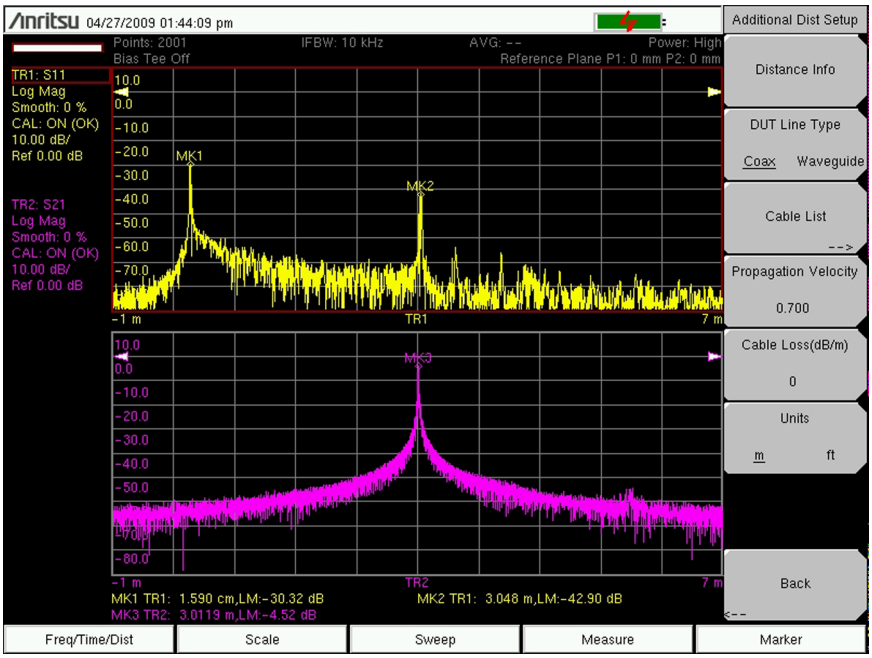


Figure 8-2. Distance Domain Measurements of a 3.05 m Cable Showing S_{11} and S_{21}

Time Domain – Impulse Response

The screen capture in Figure 8-3 shows both frequency and time domain measurements of a Beatty standard (a transmission line with a low impedance section in the middle). The left quadrants shows the frequency response of S_{11} and S_{21}, and the right quadrants show the impulse response of S_{11} and S_{21}. Time domain responses offer insights about the physical characteristics of the DUT.

For example, in the upper right graph, the negative pulse at approximately 1.3 cm is caused by the reflection from the 50 ohm to low-impedance step in the transmission line. A positive pulse at approximately 6.3 cm is caused by the reflection from the low-impedance to 50 ohm step in the transmission line. The bottom right trace shows the impulse response of S_{21} versus distance. A positive pulse at approximately 7.5 cm indicates the total length of the Beatty standard. The pulse amplitude is slightly less than unity because some of the energy from the transmitted impulse was reflected back to Port 1 (the excitation port of S_{21} measurements).

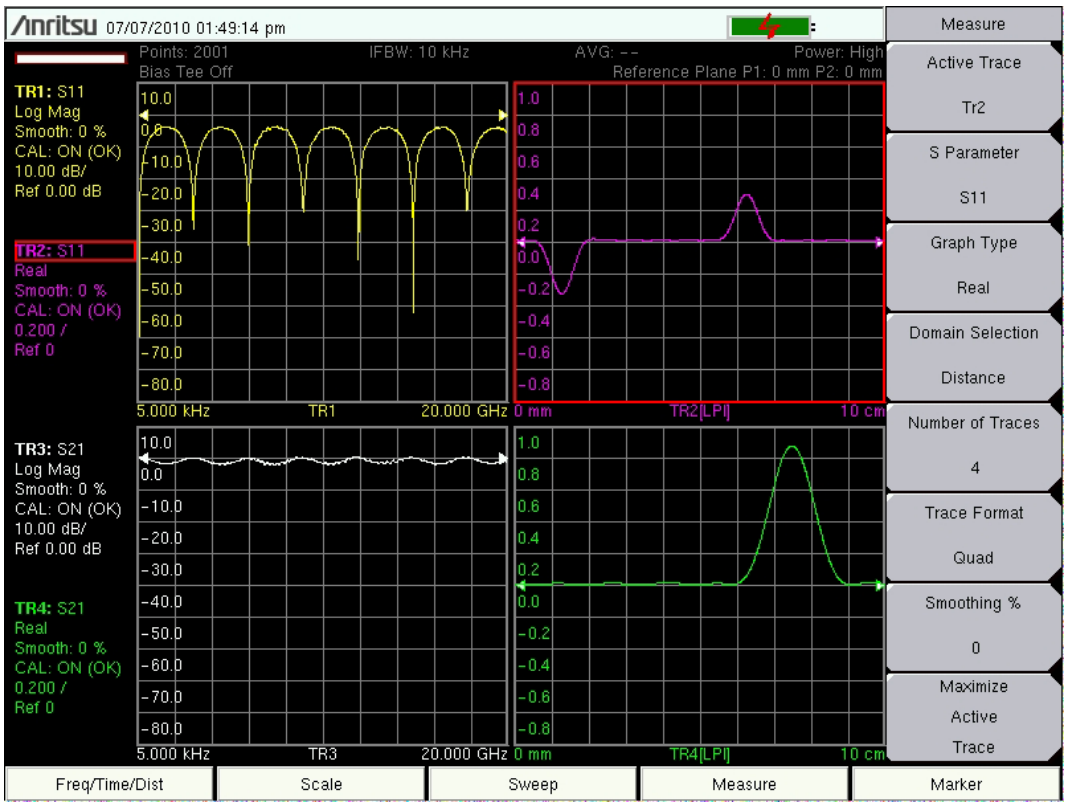


Figure 8-3. Beatty Standard – Frequency Response versus Impulse Response

Step Response versus Impulse Response

The screen capture in Figure 8-4 shows both impulse and step responses of the same Beatty standard. Step responses may seem more intuitive because they are a representation of impedance versus distance. A negative reflection off the leading edge of the low-impedance section of transmission line causes the purple step response to drop down as the step travels through the low-impedance portions of the Beatty standard. A positive reflection off the trailing edge of the low-impedance section of transmission line causes the step response to rise back up. A secondary reflection off the trailing edge eventually brings the step response back to zero. Secondary reflections can be seen with large impedance mismatches such as the Beatty standard.

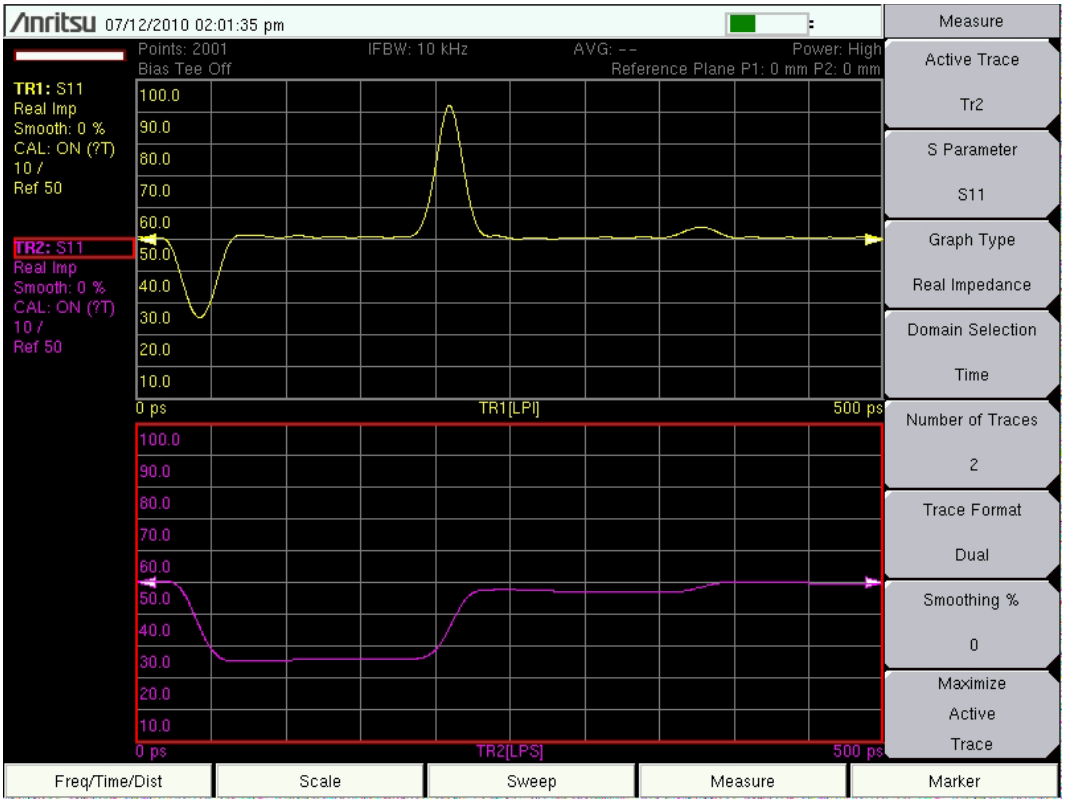


Figure 8-4. Beatty Standard – Impulse and Step Response

Low Pass versus Band Pass

The VNA Master uses two types of processing to transform frequency domain data to time data (or distance data). Bandpass processing is the standard processing technique that can be applied to all frequency sweep setups. Only impulse response can be displayed in this mode. Lowpass processing is a technique that can be used only where frequency content that is fairly close to DC is available. This technique creates a pure real transform and can produce a step response in addition to an impulse response. For the same frequency sweep width, lowpass processing produces time (or distance) resolution that is a factor of 2 better than that of bandpass processing.

The VNA Master (when Domain Processing is set to Auto) always tries to use lowpass processing whenever the frequency sweep has low frequency content. For band-limited sweeps with a starting frequency not near DC (such as for waveguide devices), the VNA Master automatically defaults to bandpass processing.

You can force the instrument to always use bandpass processing as follows: go to Application Options (press **Shift 8** (System), Application Options, Time Domain). In the Time Domain Options menu, press Domain Processing to select BP Only). For most setups, however, you should take advantage of lowpass processing whenever possible.

The screen capture in Figure 8-5 shows a DUT with a 6 dB return loss measured in lowpass time domain mode using an impulse response. A clear 6 dB reflection is shown at approximately 6 cm from the test port.

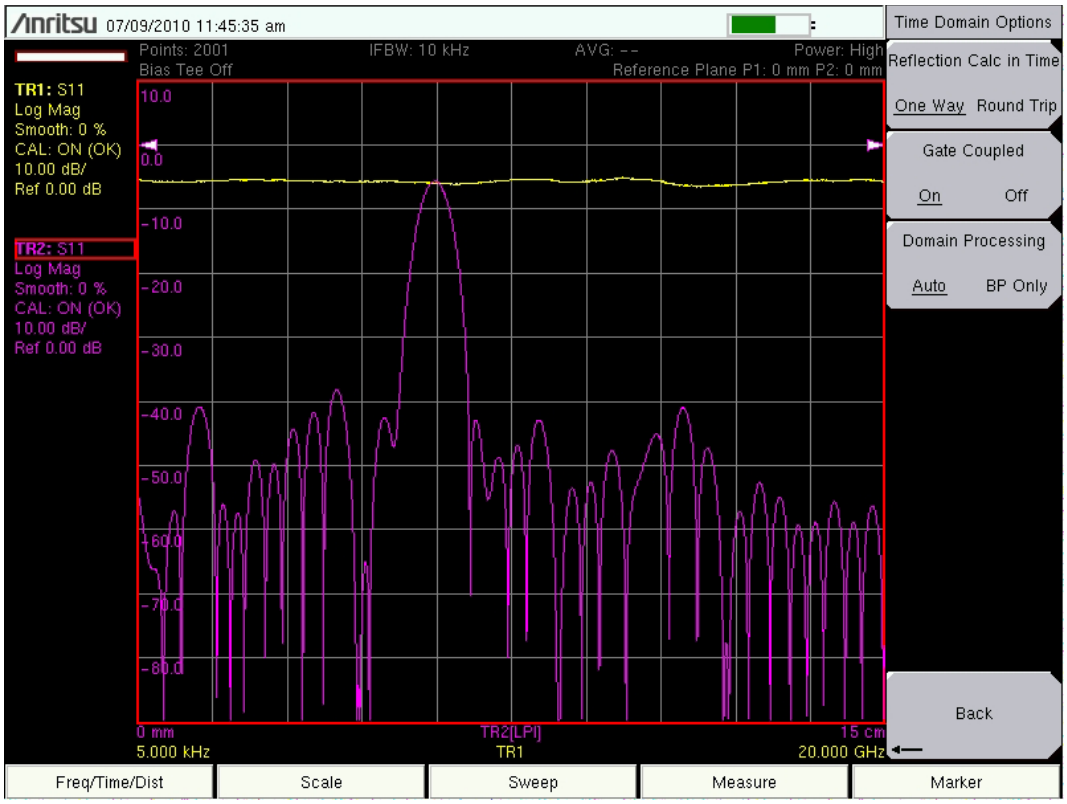


Figure 8-5. Low Pass Return Loss Using Impulse Response

The same DUT measured with bandpass time domain processing is shown in Figure 8-6. The reduced resolution in this mode is apparent as the 6 dB reflection becomes spread out (wider peak).

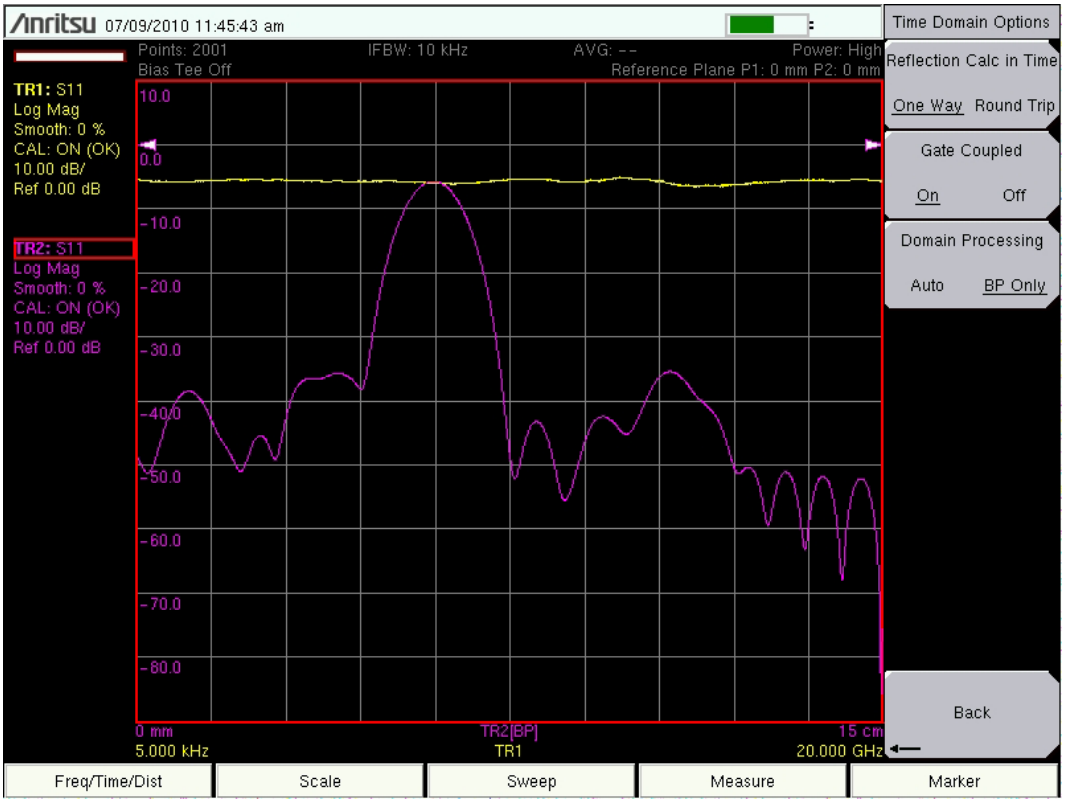


Figure 8-6. Band Pass Return Loss Using Impulse Response

Frequency Gated by Time

Often times, you would like to measure the characteristics of a DUT by connecting to it with a cable. Unfortunately, the cable is not ideal and degrades the measurement of the DUT. Frequency Gated by Time (FGT) is a feature that allows the unwanted characteristics of the devices surrounding the DUT to be “gated” out of the measurement. FGT first transforms the frequency data into the time domain, “gates” out the unwanted time domain data, and then transforms the gated time domain data back into the frequency domain.

The screen capture in Figure 8-7 shows the measurement of a DUT at the far end of a 30 cm cable. The top-left graph shows that the cable and DUT together have a worst-case return loss of approximately 13 dB. The top-right graph shows the time domain step response of the cable and DUT along with a gate that is placed around the DUT from 29 cm to 33 cm. The bottom-right graph shows how the gated time domain step response appears. The mismatches and reflections of the cable leading up to the DUT are now gone. The bottom-left graph shows the Frequency Gated by Time response of the DUT with the degradations of the cable removed. The worst-case return loss is improved by approximately 21 dB.

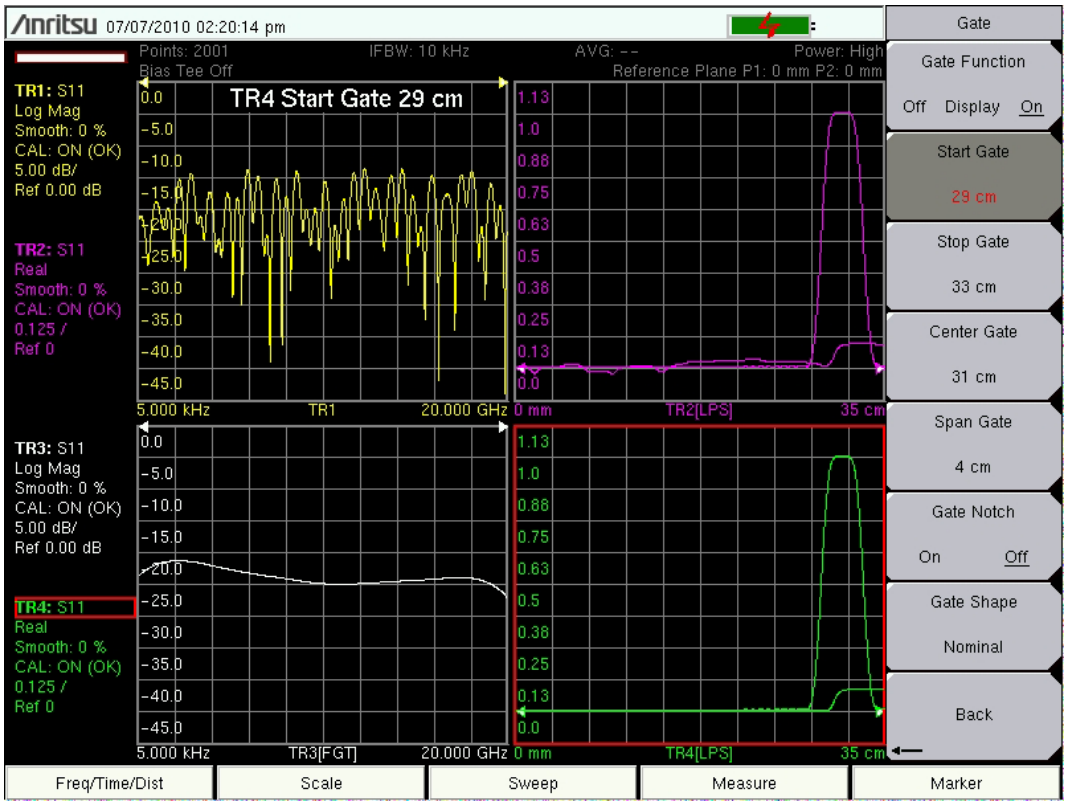


Figure 8-7. DUT at Far End of Cable Measurement – Frequency Gated by Time (FGT)

Another feature that is related by FGT is called “notch”. Instead of gating the desired portion of the time domain response, notch allows you to suppress an unwanted portion of the time domain response.

For illustration purposes, the screen capture in Figure 8-8 places a “notch” on the DUT location, leaving just the cable in the time domain response. The bottom-left graph shows the FGT return loss of the cable (approximately 15 dB) with the DUT “notched” out of the response.

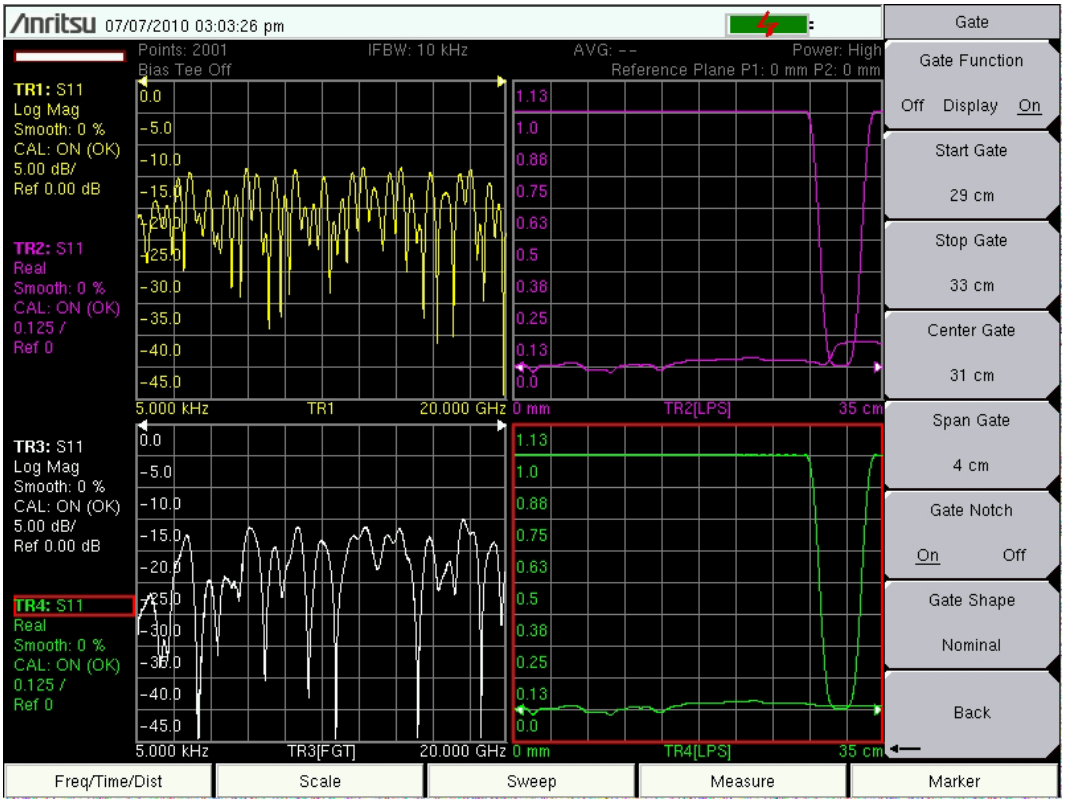


Figure 8-8. DUT at Far End of Cable Measurement – Notch with Frequency Gated by Time

Waveguide with Dispersion Compensation

Waveguide media suffers from frequency dispersion, which basically means that signals at different frequencies that are launched at the same time into a waveguide will arrive at different times at the output of that waveguide. This phenomenon is not evident when looking at the frequency response of the waveguide. When looking at the time or distance response, however, you will see the effect of this dispersion. The VNA Master uses a special frequency-to-time conversion technique to compensate for this dispersion in waveguide media. This compensation is applied only in the distance domain.

Figure 8-9 shows the reflection response (S11) from a 32 cm-long waveguide. The distance response shows a sharp peak at 32 cm, as expected. The time domain response shows a spread-out peak at approximately 1.17 ns, which is the equivalent of 35 cm distance. Ideally, the S11 time domain response should be equivalent to the distance domain response. Because of the dispersion, however, the time domain response is spread out and inaccurate. The distance domain response, which has dispersion compensation, produces the corrected response. FGT is used in this screen capture to again illustrate how gating a DUT in the time domain will smooth out its response in the frequency domain. (Compare the measured response in TR4 with the FGT modified version shown in TR1).

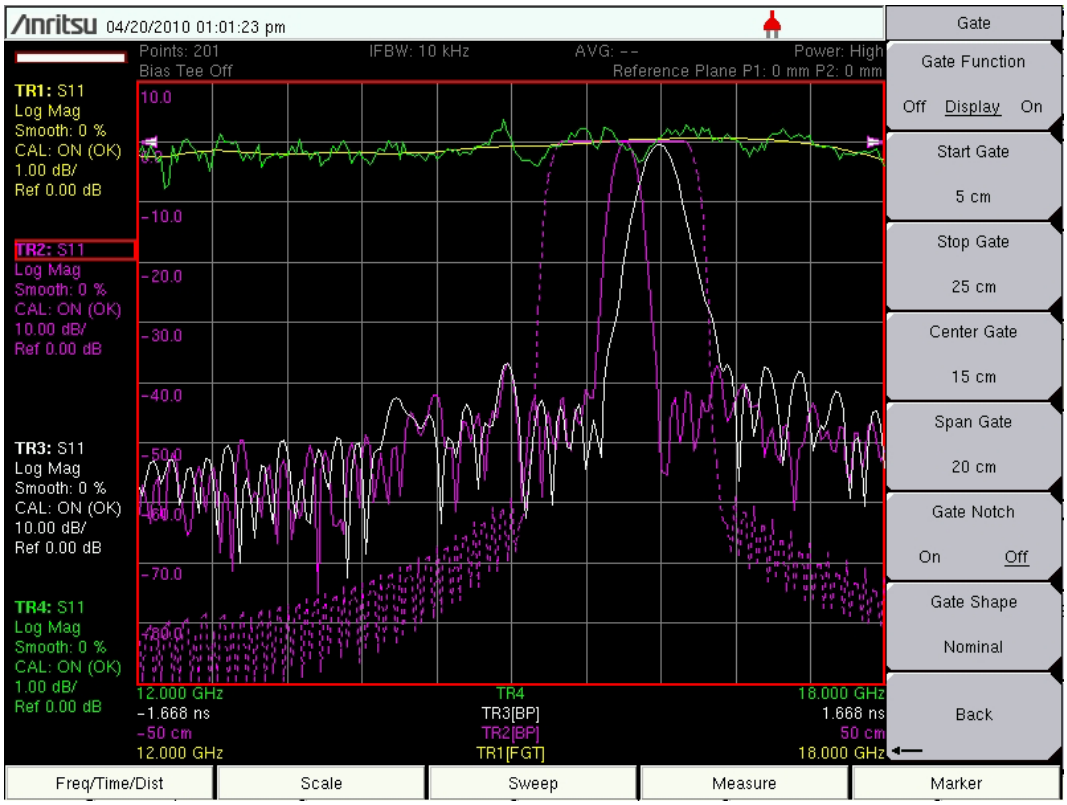


Figure 8-9. S_{11} Measurement of 32 cm Long Waveguide Showing Dispersion Compensation

Similarly, the effect of the dispersion compensation can be seen in the transmission response (S21) of a 15 cm long waveguide, as shown in Figure 8-10. Note how the distance response is sharp and centered at 15 cm, whereas the time response is spread out and inaccurate.

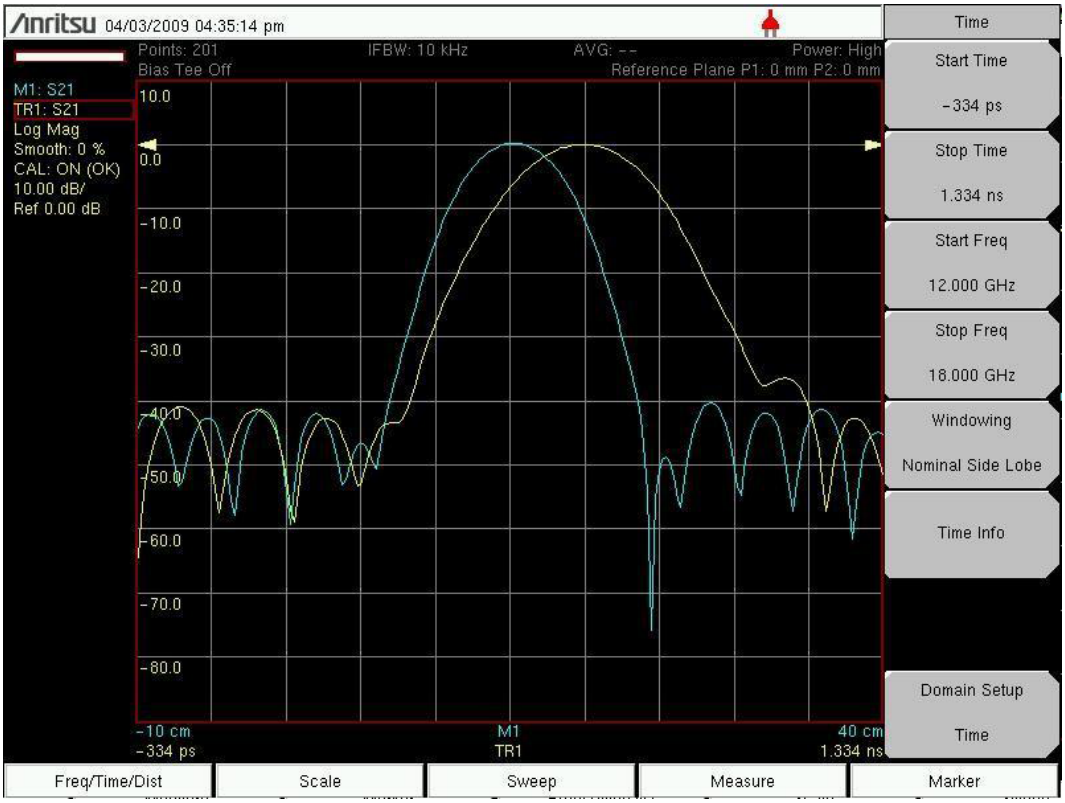


Figure 8-10. S_{21} Measurement of 15 cm Long Waveguide Showing Dispersion Compensation

Note	As shown in the above examples, the VNA Master does not alter the time domain measurement. (This provides a pure unmodified measurement for sophisticated users.) This is consistent with display selections on equivalent bench-top instruments. In the distance domain, the VNA Master performs both round-trip and dispersion compensations to provide you with more practical and easy-to-interpret results.

Phasor Impulse

Impedance discontinuities are more difficult to analyze in the time domain with bandpass processing because the phase of the discontinuity cannot easily be extrapolated to DC. A technique called phasor impulse allows you to determine whether a mismatch is caused by a low impedance line or a high impedance line by using a special technique to “unwrap” the phase by using the peak reflection as the starting point. Phasor impulse is available in the Bandpass Mode menu. The graph in the lower-left corner of Figure 8-11 uses phasor impulse to reveal a low impedance mismatch in a waveguide measurement.

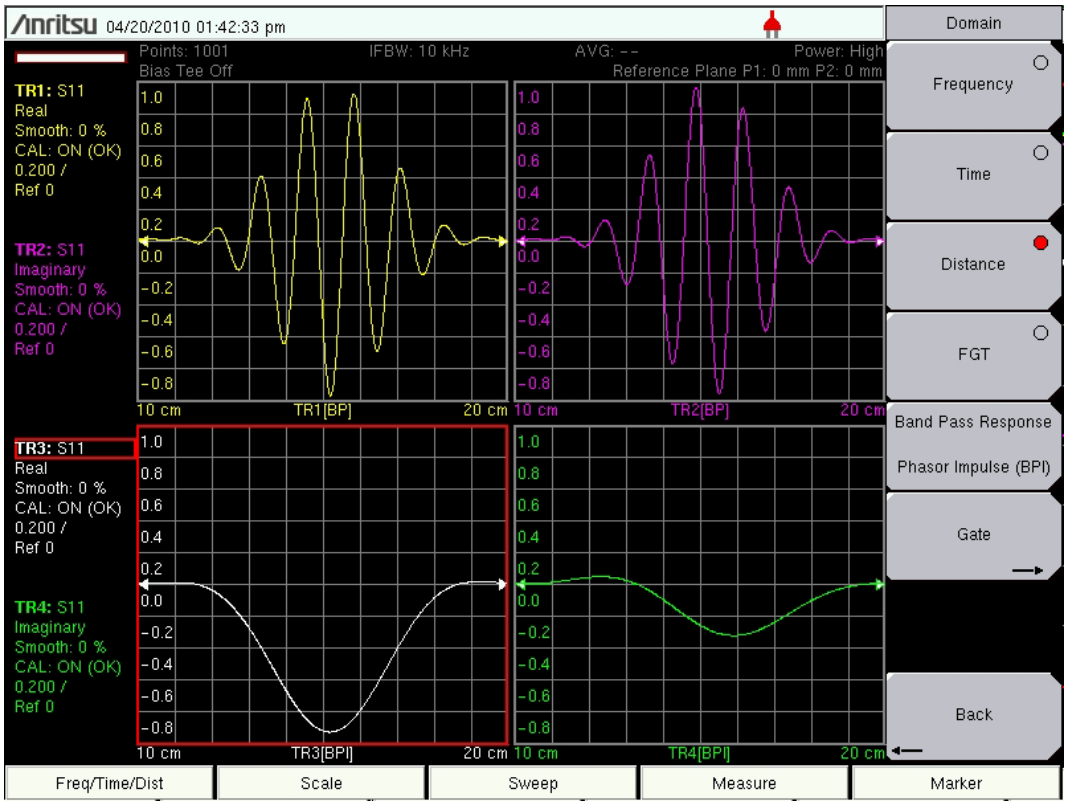


Figure 8-11. Phasor Impulse Revealing a Low Impedance Mismatch

Phasor impulse can also be viewed in a polar plot, as shown in Figure 8-12. The lower plots use phasor impulse to show a clear reflection with approximately 180 degrees phase, indicating a low-impedance mismatch. The upper plots use standard bandpass mode and do not adequately reveal the phase of the reflection.

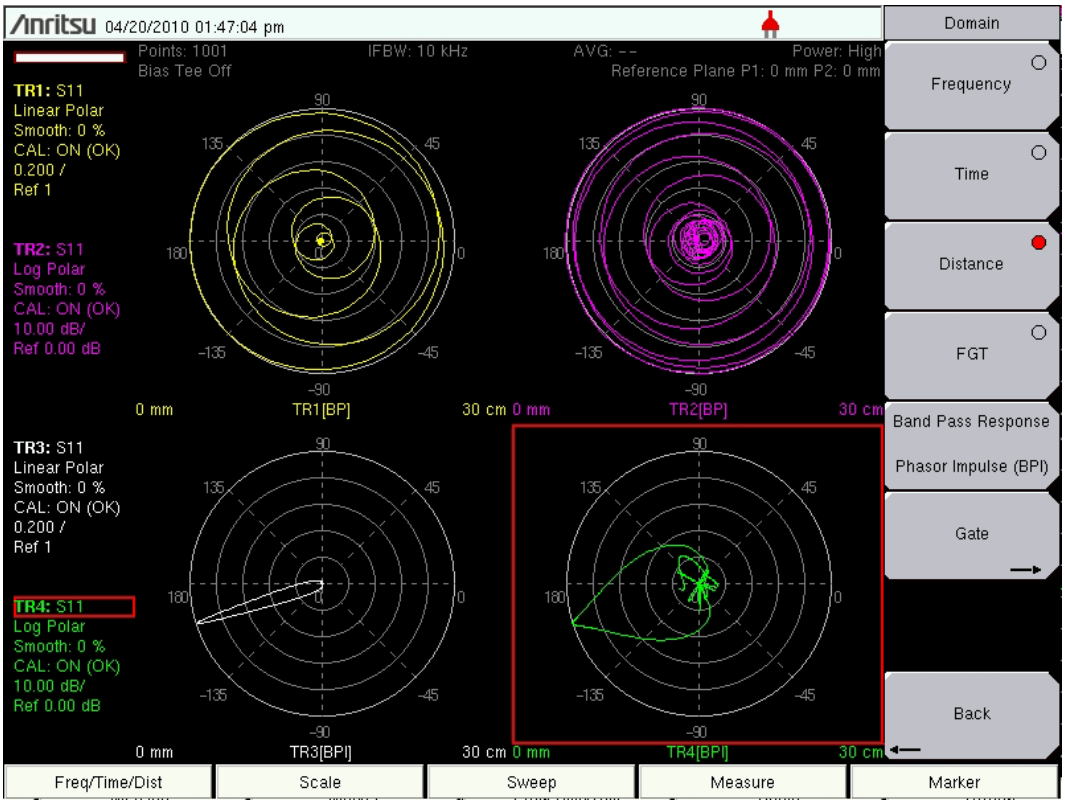


Figure 8-12. Polar Phasor Impulse Revealing a Low Impedance Mismatch

8-4 Windowing

Windowing is a frequency filter that is applied to the frequency-domain data when it is converted to time-domain data. This filtering rolls off the abrupt transition that occurs at the start and stop frequencies. This effectively produces a time-domain response with lower sidelobes. Windowing allows a limited degree of control over the pulse shape, trading ringing (sidelobes) for pulse width. Four different windows are available: Rectangular, Nominal Sidelobe, Low Sidelobe, and Minimum Sidelobe. The Rectangular option provides the narrowest pulse width, and the Minimum Sidelobe option provides the least ringing (fewest sidelobes). For more details on Windowing, refer to Appendix B.

8-5 Distance-to-Fault Measurement Example

The most common time domain and distance domain measurement that is made by using a handheld VNA is distance-to-fault (DTF). Using this measurement, you can find the location of faults (or discontinuities) along the length of a cable or waveguide. This measurement is typically performed as a reflection measurement (S_{11} or S_{22}).

The VNA Master can be easily set to perform distance-to-fault measurements. Following are the key parameters that need to be set for these types of measurements:

In the Measure Menu:

- S-parameter = set to S11 if the cable or waveguide is connected to Port 1 (or S22 for Port 2)
- Domain Selection = Distance
- Graph Type = Log Mag, SWR, or Real (depending on preference)

In the Sweep Menu:

- Number of Points (Data Points) = the larger the number, the longer the maximum distance (at the expense of a slower sweep speed)

In the Freq/Time/Dist Menu:

- Start Freq/Stop Freq = set to within the frequency range of the device under test (the wider the frequency range, the better the distance resolution, but the shorter the maximum distance)
- Start Dist/Stop Dist = set to view the specific length that you want to view
- Windowing = Rectangular is the default window (set to other windows if sidelobe levels are too high)

In the Additional Dist Setup Submenu:

(under Freq/Time/Dist Menu)

- DUT Line Type = set to Coax or Waveguide
- Cable List/Waveguide List = pick a cable or waveguide from a list to capture its propagation velocity and cable loss (if it is coax) or its cutoff frequency and waveguide loss (if it is waveguide). Alternatively, just enter these parameters directly if the specific cable or waveguide that you are testing is not in the list. Note that you can add coax entries into the list via the Master Software Tools program.
- Units = choose between m (meters) or ft (feet)

Figure 8-13 shows a typical distance-to-fault measurement result. The device under test is a 3.7 m long cable with a discontinuity close to the end of the cable, at 3.1 m. The display shows the Log Mag (top) and SWR (bottom) responses. In both results, the ends of the cable and the discontinuity are all clearly identifiable.

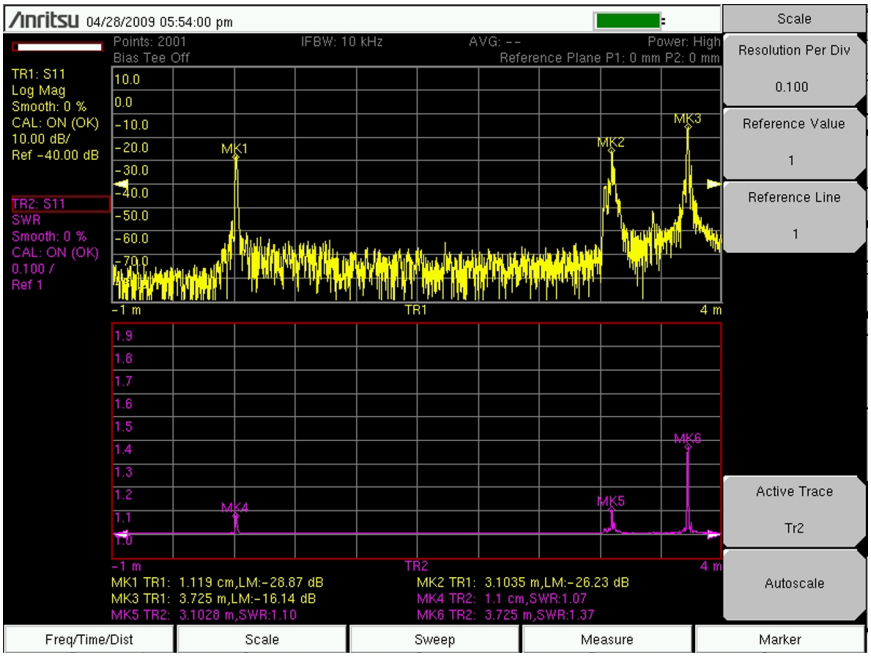


Figure 8-13. Distance Domain Measurements of 3.7 m Cable Showing S_{11} (Log Mag and SWR)

8-6 Time and Distance Information

To help you with the time and distance setup, the VNA Master provides a helpful aid that provides information on the resolution and maximum range.

Figure 8-14 shows the Distance Info window (which can be displayed from the Additional Dist Setup submenu under the Distance Setup menu). This window provides information to help you with the distance domain setup. The top portion of the window displays information about the selected Cable or Waveguide. If you select a cable from the cable list (or a waveguide from the waveguide list), then the name of the cable and its associated parameters are displayed under the heading CABLE INFO (or WAVEGUIDE INFO). Below that heading is the CURRENT INFO section, which summarizes the actual parameters being used in the measurements. For cables, the parameters are propagation velocity and cable loss. For waveguide, they are cut-off frequency and waveguide loss. These current parameters are either the values that are associated with the chosen cable or waveguide from the list, or they are the values that are entered directly by the user.

The bottom part of the list provides information about the settings and suggestions for meeting the maximum required distance. This section is divided into three columns, headed: PARAMETER, ROUND TRIP, and ONE WAY for one-way measurements. They key parameters that are displayed are the Distance Resolution and the Distance Max. The following list includes all of the items in the Distance Info window with a brief description of each item:

Fstart: the start frequency

Fstop: the stop frequency

Distance Resolution: the calculated distance resolution based on the frequency range

No. of Data Points: number of points in the sweep

Distance Max: maximum usable distance based on frequency span and number of points

Dstart: the start distance

Dstop: the stop distance (when set greater than Dmax, the following suggestions can be used to increase Dmax to make it equal to Dstop)

Suggestion 1: Adjust Freq span to meet Dstop

Max Span: suggested frequency span (within allowable range) to make Dmax = Dstop

Suggested Start Freq: typically equal to the Fstart that was set by user

Suggested Stop Freq: suggested stop frequency based on calculated Max Span and Fstart

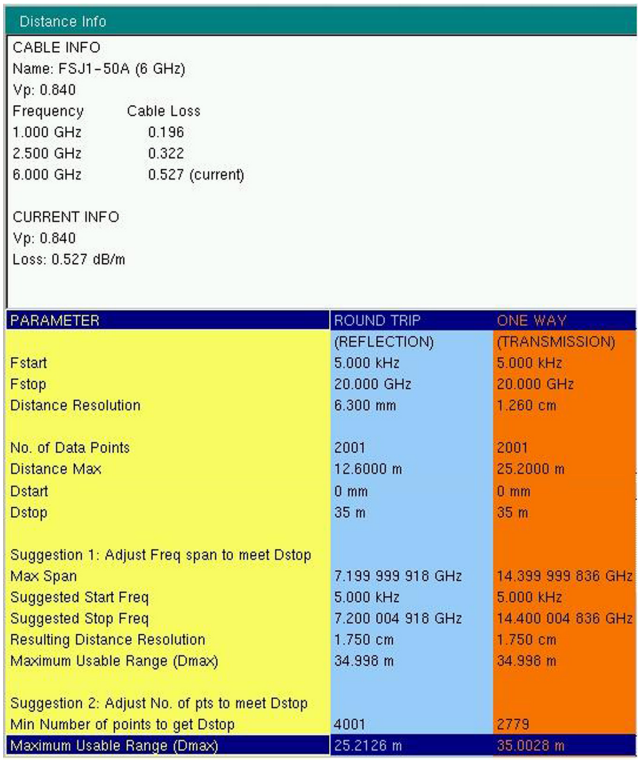
Resulting Distance Resolution: resulting resolution if new Fstart and Fstop are used

Maximum Usable Range (Dmax): resulting Dmax if new Fstart and Fstop are used

Suggestion 2: Adjust No. of pts to meet Dstop (using current Fstart and Fstop)

Min Number of points to get Dstop: suggested number of points to make Dmax = Dstop

Maximum Usable Range (Dmax): resulting Dmax if the new number of points are used



Distance Info

CABLE INFO
Name: FSJ1-50A (6 GHz)
Vp: 0.840

Frequency	Cable Loss
1.000 GHz	0.196
2.500 GHz	0.322
6.000 GHz	0.527 (current)

CURRENT INFO
Vp: 0.840
Loss: 0.527 dB/m

PARAMETER	ROUND TRIP (REFLECTION)	ONE WAY (TRANSMISSION)
Fstart	5.000 kHz	5.000 kHz
Fstop	20.000 GHz	20.000 GHz
Distance Resolution	6.300 mm	1.260 cm
No. of Data Points	2001	2001
Distance Max	12.6000 m	25.2000 m
Dstart	0 mm	0 mm
Dstop	35 m	35 m
Suggestion 1: Adjust Freq span to meet Dstop		
Max Span	7.199 999 918 GHz	14.399 999 836 GHz
Suggested Start Freq	5.000 kHz	5.000 kHz
Suggested Stop Freq	7.200 004 918 GHz	14.400 004 836 GHz
Resulting Distance Resolution	1.750 cm	1.750 cm
Maximum Usable Range (Dmax)	34.998 m	34.998 m
Suggestion 2: Adjust No. of pts to meet Dstop		
Min Number of points to get Dstop	4001	2779
Maximum Usable Range (Dmax)	25.2126 m	35.0028 m

Figure 8-14. Distance Info Window

Note

As you can see in Figure 8-14, the user has entered a Dstop value of 35 m, whereas the calculated maximum usable range (Distance max) is 12.6 m for a reflection measurement and is 25.2 m for a transmission measurement. As the user, you need to make some adjustments either to the frequency range or to the number of data points in order to increase Dmax to 35 m. Suggestion 1 (of the Distance Info) tells you that you need to reduce your frequency span to 7.199 GHz (14.399 GHz for transmission). You can do that by changing just the stop frequency, or you can change both the start and stop frequencies such that the difference between them equals the calculated Max Span. By making that adjustment, you can achieve a Dmax of 35 m. What you give up is distance resolution. In the example in Figure 8-14, the resolution will degrade to 17.5 mm. To avoid changing the frequency span (and thereby degrading the resolution), you can increase the number of points (at the expense of slower sweep speed). In the example in Figure 8-14, however, even if you increase the number of points to the maximum allowable number of 4001 (for reflection), you can achieve only a Dmax of 25.2 m. For a transmission measurement, 2779 points will let you achieve 35 m. In this case, you should either use a transmission measurement or adjust the frequency span to meet your goal.

The Time Info window does not contain any cable or waveguide information because those parameters affect only the distance setup. Also, in the Time Info window, the two columns for round trip and one way are identical because the time domain has no round trip compensation.

Chapter 9 — Distance Domain

9-1 Introduction

This chapter describes the Distance Domain feature in the Vector Network Analyzer. General descriptions, key concepts, and examples are presented for distance measurements for both coaxial and waveguide media. The Distance Domain was previously Option 501, but is now standard in newer firmware. The firmware revision must be equal to or greater than the following versions to have Distance Domain as a standard feature:

MS20xxC	V1.14
MS20xxB	V1.18
S412E	V1.11

9-2 Distance Domain Measurements

The Distance Domain feature provides the ability to transform the native frequency domain data (that is measured by the Vector Network Analyzer) into distance domain information. Some typical applications are: help in determining the location of impedance discontinuities, distance-to-fault (DTF) in cables, characterizing antennas, isolating and analyzing a desired response in a one-port or two-port network.

The relationship between the frequency-domain response and the distance-domain response of a network is described mathematically by the Fourier transform. The Vector Network Analyzer makes measurements in the frequency domain, then transforms that data into its distance-domain response, which can be displayed. This computational technique benefits from the wide dynamic range of the instrument (and its measurement data) and from the error correction of the frequency-domain data.

The transformation technique that is used by the Vector Network Analyzer (in most cases) is the chirp-Z transform of the available frequency domain data for that parameter. Because the transform simply treats the frequency domain values as input data, any S-parameter can be transformed. The chirp-Z transform is (in a macro sense) very similar to the Fast Fourier Transform with the exception that the output range can be variable. This permits you to zoom in on a specific range of interest for the data display.

Two of the fundamental properties of distance-domain conversion are resolution and maximum (alias-free) range. Resolution is the ability to resolve one discontinuity from another. Resolution is limited by the frequency span of the measurement. Maximum range defines how far you can see discontinuities on the media you are measuring. Beyond the maximum range, the data just repeats itself, and you start seeing the same discontinuities from closer ranges. The maximum range is determined by the frequency step size.

For more details about distance domain fundamentals, refer to the following application notes:

- *Reflectometer Measurements — Revisited* - Anritsu Application Note 11410-00214
- *Distance to Fault* - Anritsu Application Note 11410-00373

9-3 VNA Master Implementation

The Distance Domain implementation in the Vector Network Analyzer is trace based, which makes it very flexible to use. Each of the four traces in the instrument can be configured independently and can be in the frequency or distance domain. Each trace can also be configured to represent any of the S-parameters. The Vector Network Analyzer (as an example) can view S_{11} in the frequency domain using traces.

One Way versus Round Trip

With the ability to transform any S-parameter, one question that arises is whether the time or distance that is plotted represents a one-way or a round-trip propagation. The one-way propagation represents the transmission (or 2-port) measurement, in which the signal is transmitted from one port, propagates through the device under test, and is received on the second port. One-way propagation occurs when transforming S_{21}.

The round-trip propagation represents a reflection (1-port) measurement, in which the signal is transmitted from one port, propagates through the device under test, fully reflects at the end of the device, and is received back at the same port. Round-trip propagation occurs when transforming S_{11}.

For reflection measurements, the Vector Network Analyzer can handle the two cases of one-way and round-trip propagation differently in the Distance domain. In the distance domain, the instrument compensates for the round trip reflection propagation by showing the actual length of the device under test (essentially dividing the distance by 2 for the reflection measurements). This compensation renders the distance reflection measurement as a One-Way measurement in terms of the distance value that is reported.

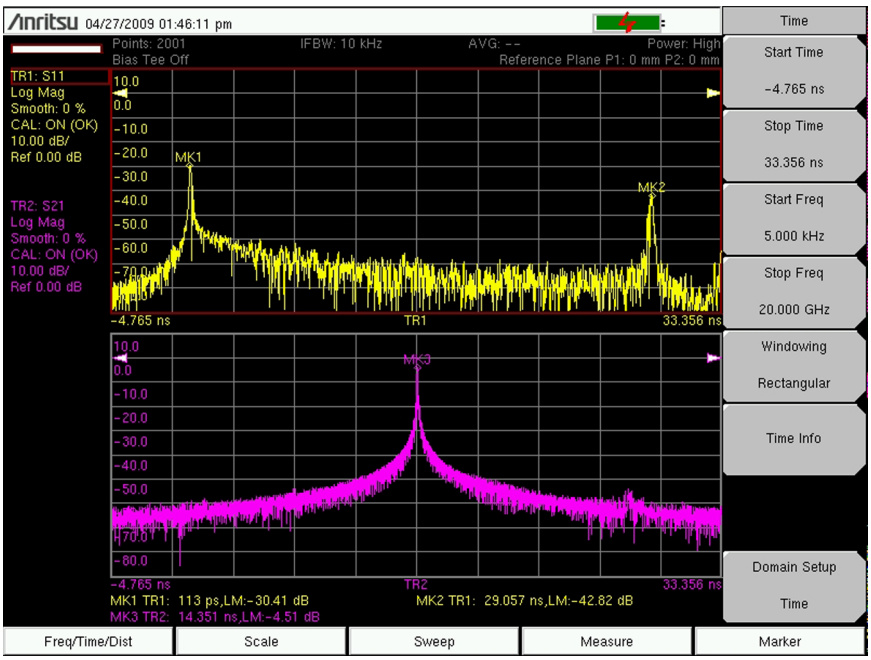


Figure 9-1. Time Domain Measurements of a 3.05 m Cable Showing S_{11} and S_{21}

Note	The measured cable had a propagation velocity of 70%, which was entered into the Vector Network Analyzer. Measurements in the distance domain use the entered propagation velocity value to calculate the actual physical length of cables. If the default value of 100% were used, then the measured cable length would be wrong (4.4 meters in the above example).

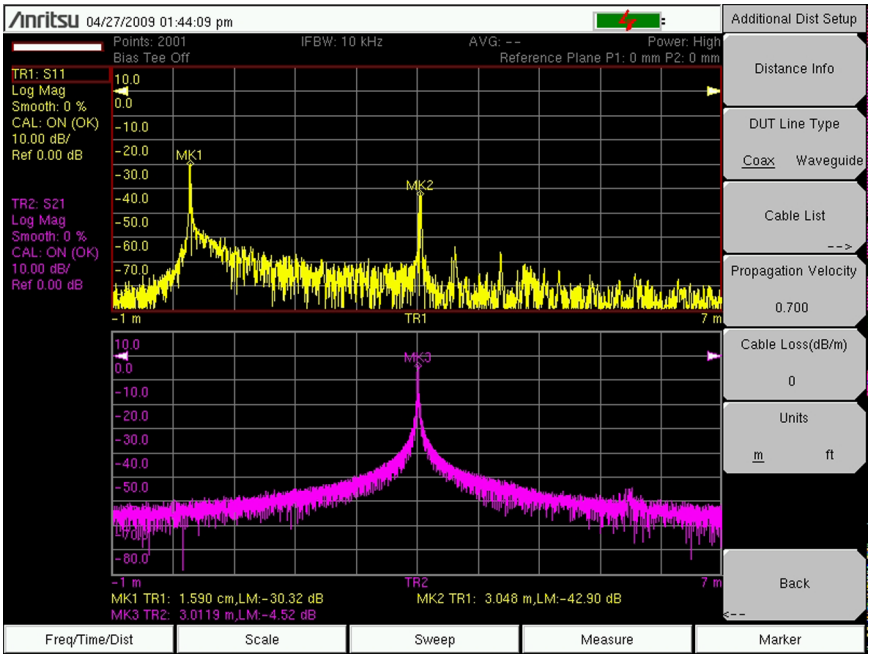


Figure 9-2. Distance Domain Measurements of a 3.05 m Cable Showing S_{11} and S_{21}

9-4 Windowing

Windowing is a frequency filter that is applied to the frequency-domain data when it is converted to distance-domain data. This filtering rolls off the abrupt transition that occurs at the start and stop frequencies. This effectively produces a distance-domain response with lower sidelobes. Windowing allows a limited degree of control over the pulse shape, trading ringing (sidelobes) for pulse width. Four different windows are available: Rectangular, Nominal Sidelobe, Low Sidelobe, and Minimum Sidelobe. The Rectangular option provides the narrowest pulse width, and the Minimum Sidelobe option provides the least ringing (fewest sidelobes). For more details on Windowing, refer to Appendix B.

9-5 Distance-to-Fault Measurement Example

The most common distance domain measurement that is made by using a handheld VNA is distance-to-fault (DTF). Using this measurement, you can find the location of faults (or discontinuities) along the length of a cable or waveguide. This measurement is typically performed as a reflection measurement (S_{11}).

The Vector Network Analyzer can be easily set to perform distance-to-fault measurements. Following are the key parameters that need to be set for these types of measurements:

In the Measure Menu:

- S-parameter = set to S11 if the cable is connected to Port 1
- Domain Selection = Distance
- Graph Type = Log Mag, SWR, or Real (depending on preference)

In the Sweep Menu:

- Number of Points (Data Points) = the larger the number, the longer the maximum distance (at the expense of a slower sweep speed)

In the Freq/Dist Menu:

- Start Freq/Stop Freq = set to within the frequency range of the device under test (the wider the frequency range, the better the distance resolution, but the shorter the maximum distance)
- Start Dist/Stop Dist = set to view the specific length that you want to view
- Windowing = Rectangular is the default window (set to other windows if sidelobe levels are too high)

In the Additional Dist Setup submenu:

(under Freq/Dist Menu)

- Cable List = pick a cable from a list to capture its propagation velocity and cable loss. Alternatively, just enter these parameters directly if the specific cable that you are testing is not in the list. Note that you can add coax entries into the list via the Master Software Tools program.
- Units = choose between m (meters) or ft (feet)

Figure 9-3 shows a typical distance-to-fault measurement result. The device under test is a 3.7 m long cable with a discontinuity close to the end of the cable, at 3.1 m. The display shows the Log Mag (top) and SWR (bottom) responses. In both results, the ends of the cable and the discontinuity are all clearly identifiable.

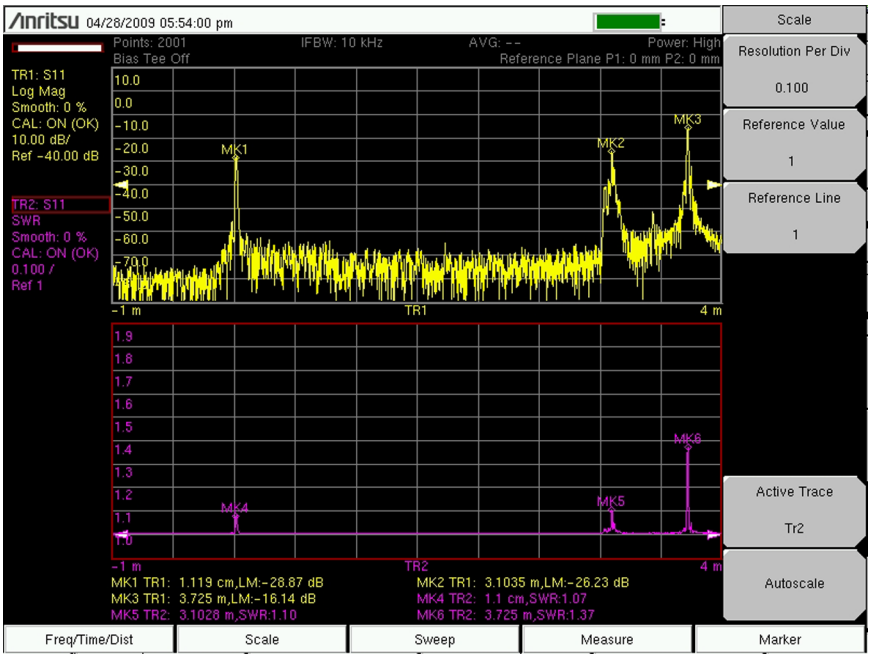


Figure 9-3. Distance Domain Measurements of 3.7 m Cable Showing S_{11} (Log Mag and SWR)

9-6 Distance Information

To help you with the distance setup, the Vector Network Analyzer has an aid that provides information on the resolution and maximum range.

Figure 9-4 shows the Distance Info window (which can be displayed from the Additional Dist Setup submenu under the Distance Setup menu). This window provides information to help you with the distance domain setup. The top portion of the window displays information about the selected Cable. If you select a cable from the cable list, then the name of the cable and its associated parameters are displayed under the heading CABLE INFO. Below that heading is the CURRENT INFO section, which summarizes the actual parameters being used in the measurements. For cables, the parameters are propagation velocity and cable loss. These current parameters are either the values that are associated with the chosen cable from the list, or they are the values that are entered directly by the user.

The bottom part of the list provides information about the settings and suggestions for meeting the maximum required distance. The key parameters that are displayed are the Distance Resolution and the Distance Max. For a description of the information that is provided in the Distance Info box, refer to the note on page 8-18.

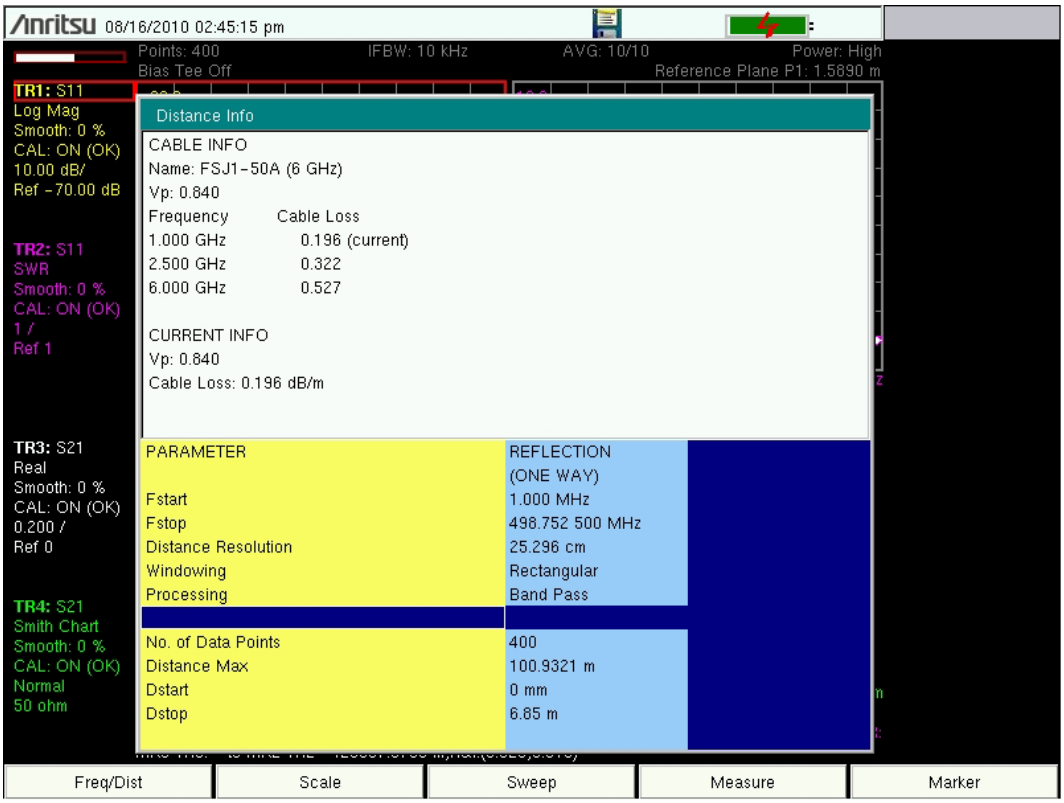


Figure 9-4. Distance Info Window

Chapter 10 — Bias Tee, Option 10

10-1 Introduction

Option 10 provides an internal bias tee for the VNA Master or for the S412E LMR Master. In Vector Network Analyzer mode, the internal bias tee permits testing of amplifiers that require their system power to be supplied from their RF signal port.

In addition to the internal bias tee, the MS20xxC VNA Master features two input ports (BNC(f)) that offer you the ability to supply external bias current to the unit under test.

In the MS20xxB VNA Master and the S412E LMR Master only, the internal bias tee can be used in both the Vector Network Analyzer and the Spectrum Analyzer. The bias voltage is available to both the VNA Port and the SPA RF In port.

To access the Bias Tee menu in the MS20xxC, MS2026B, or MS2028B VNA Master, the MS20xxB VNA Master, or the S412E LMR Master while in the VNA Measurements view (**not** the Field Measurements view), press the **Sweep** function hard key to open the Sweep menu (refer to "Bias Tee Menus (MS20xxC, MS2026B, and MS2028B)" on page 10-7), then the Configure Ports soft key, then the Bias Tee Setup soft key. The Bias Tee menu ("Bias Tee Menu" on page 10-9) is opened with the Bias Tee soft key in the Bias Tee Setup menu ("Bias Tee Setup Menu" on page 10-8).

To access the Bias Tee menu in the MS20xxB VNA Master and the S412E LMR Master in the Field Measurements view, press the **Shift** key and then the **System** (**8**) key to open the System menu (refer to "Bias Tee Menus (Field Measurements View)" on page 10-10). Then press the Application Options soft key, and then the Bias Tee Setup soft key. The Bias Tee menu ("Bias Tee Menu" on page 10-11) is opened with the Bias Tee soft key in the Bias Tee Setup menu ("Bias Tee Setup Menu" on page 10-11).

10-2 Bias Tee Fundamentals

For the internal function, the bias arm is connected to an internal power source that can be turned on as needed to place the voltage on the center conductor of VNA Port 2 for the MS20xxB or the S412E or on either of the VNA ports for the MS20xxC. Because the MS20xxC features full S-parameter testing at both Port 1 and Port 2, the bias voltage for these models is also available from either port upon selection by the user. This voltage can be used to provide power to block down-converters in satellite receivers and can be used to power some tower-mounted amplifiers.

The bias can be turned on only when the instrument is in vector network analyzer mode and when the lowest frequency is set greater than or equal to 2 MHz. Below 2 MHz, both internal and external bias tee are not supported. When bias is turned on, the LED indicator on the MS20xxC connector panel turns green, and the actual bias voltage and current are displayed in the upper left corner of the measurement display screen. The display shows the voltage and current for the selected port when using internal bias tee, and for both ports when using external bias tee.

Caution	Depending on the load that is presented by the device under test, the bias voltage value that is displayed on the screen may be different than the value that was set using the soft key menu. The value that is displayed on the screen is the actual measured value of the voltage that is being delivered to the device under test.

The internal bias tee is designed to continuously deliver a maximum of 450 mA between 12 VDC and 32 VDC in steps of 0.1 V.

Warning	When using external bias tee on MS20xxC models, a maximum of ± 50 VDC at 500 mA is supported.

Figure 10-2 shows the bias tee architecture within the VNA Master. Figure 10-3 shows a variable bias tee on a Tower Mounted Amplifier (TMA-DD).

10-3 How Bias is Generated

The ability to provide DC bias voltage at the RF port is an important feature of a VNA. The architecture of the VNA Master, when equipped with Option 10, allows for internal and external bias at both RF ports.

Figure 10-1 shows how the MS20xxB and the S412E can provide an internal voltage between 12 volts and 32 volts that is applied to the center conductor of VNA Port 2 or of the RF In port (SPA Input). That voltage would be available at the port along with the RF signals.

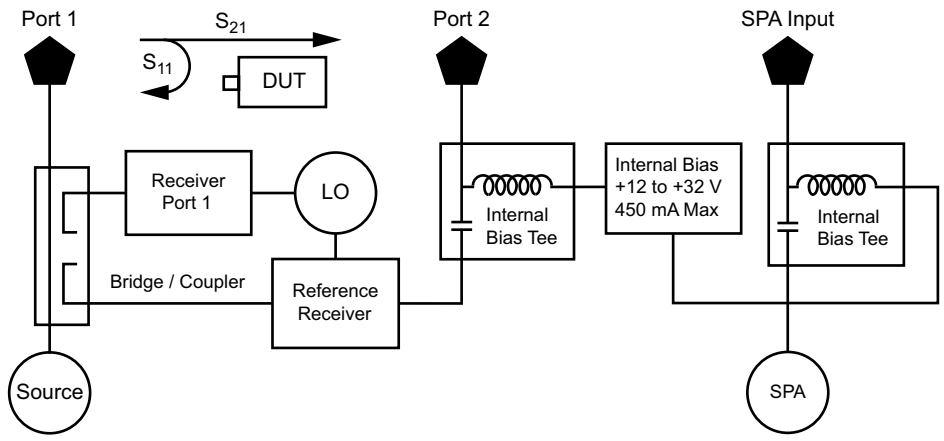


Figure 10-1. Internal Bias (MS20xxB and S412E shown)

Figure 10-2 shows how the MS20xxC can provide an internal voltage between 12 volts and 32 volts that can be switched between Port 1 and Port 2. That voltage would be available at the port along with the RF signals. Alternatively, an external voltage source could be connected to the Bias Tee input ports in order to provide a bias voltage between +50 volts and –50 volts at both ports simultaneously, if desired.

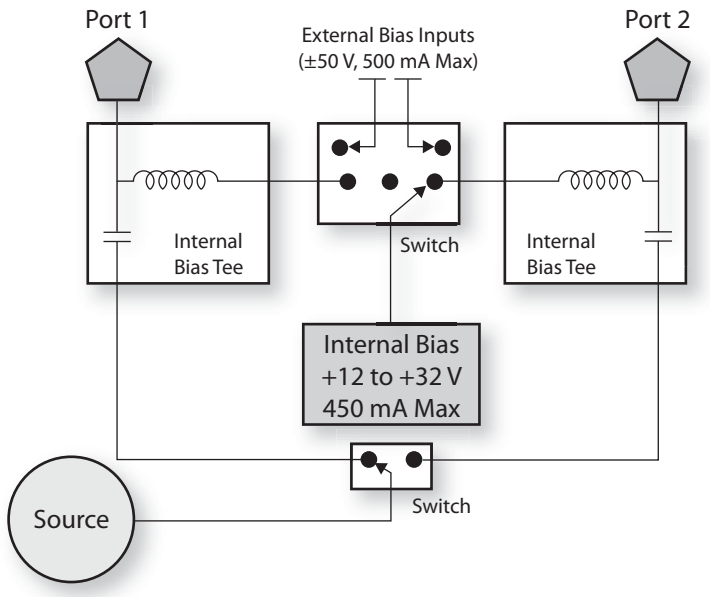
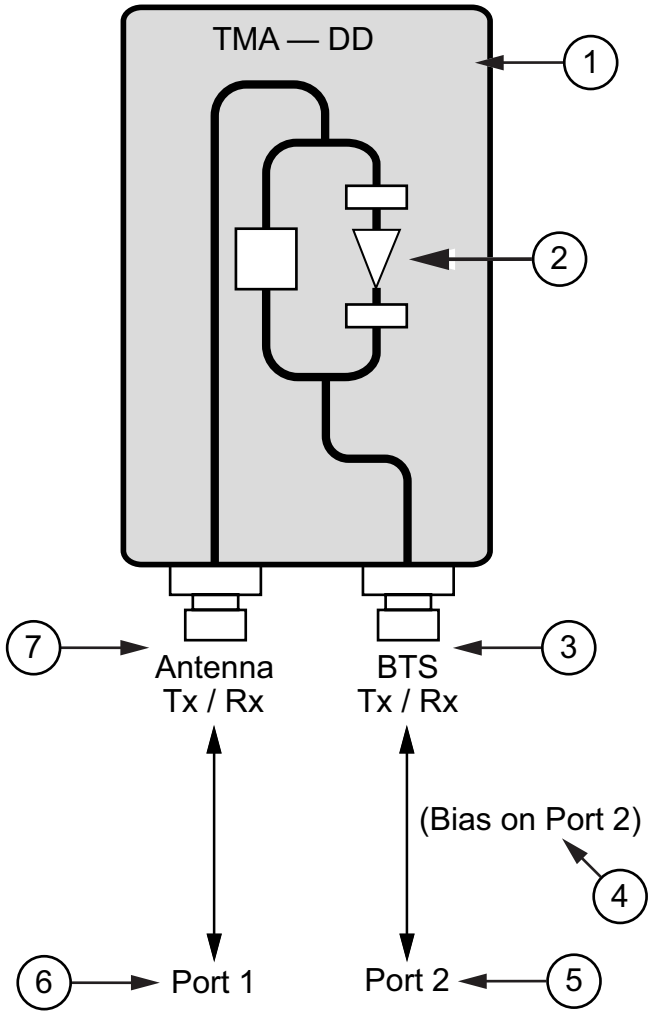


Figure 10-2. Internal or External Bias (MS20xxC shown)



1	TMA–DD (Tower Mounted Amplifier – Dual Duplex)
2	Internal Components
3	Base Station Transmit and Receive Connection
4	Bias voltage is on Port 2
5	Port 2 of VNA Master
6	Port 1 of VNA Master
7	Antenna Transmit and Receive Connection

Figure 10-3. Variable Bias Tee on TMA-DD

Figure 10-3 shows a variable bias tee supplying bias power out of Port 2 to the test unit, which is a dual duplex tower-mounted amplifier.

10-4 Bias Tee when Making 2-Port Gain Measurements

Two power levels are available with 2-port measurements: High and Low. The Low Port Power setting should be used when making direct gain measurements of amplifiers. This will help to ensure that the amplifier is operating in the linear region. The High Port Power setting (default setting) is ideal when characterizing passive devices but can also be used when making relative gain or antenna-to-antenna isolation measurements in the field. For performance details and measurement uncertainties, refer to the Technical Data Sheet (Anritsu part number 11410-00501).

The internal bias tee is typically used to put voltage on the RF port that is feeding the bias to the amplifier under test. Because of its full reversing architecture, the MS20xxC VNA Master can support amplifier measurements with the amplifier input connected either to Port 1 or to Port 2. To support this flexibility, the internal bias tee can be directed to either port via a user selection. Each port selection has its own Voltage setting and Current Limit setting that can be saved with the setup (refer to Figure 10-4).

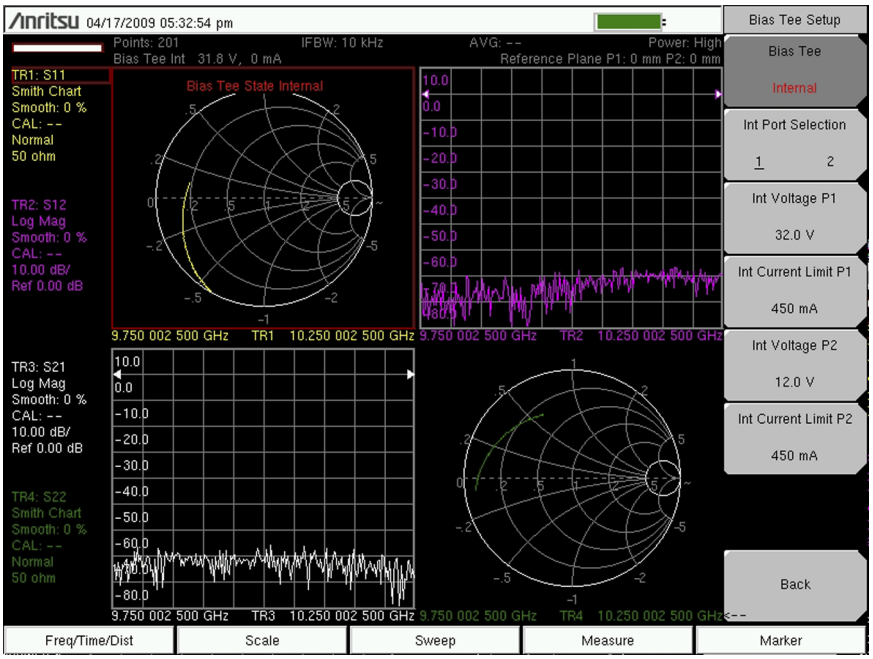


Figure 10-4. S21 Log Magnitude (VNA Measurement Menu)

The voltage setting for the internal bias tee, when selected for either port, can be set from 12.0 VDC to 32.0 VDC in steps of 0.1 V. The Current Limit value, with a maximum setting of 450 mA, sets the trip point. If the current draw of the device under test exceeds this trip point level, then the VNA Master shuts off the internal bias tee, the LED indicator on the connector panel turns from green to flashing red, and the actual voltage and current readings that are displayed on the screen turn red.

With external bias tee voltage input, you can connect an external voltage of ±50 VDC to both ports simultaneously, although for most applications biasing is required on only one port. When the bias tee is set to External, the actual measured voltage and current at both ports are displayed on the screen, as shown in Figure 10-5. The maximum current that is allowed when using external bias tee is 500 mA. If that current level is exceeded, then the VNA Master switches the external bias tee away from the ports, the LED indicator on the connector panel turns from green to flashing red, and the actual voltage and current readings that are displayed on the screen turn red.

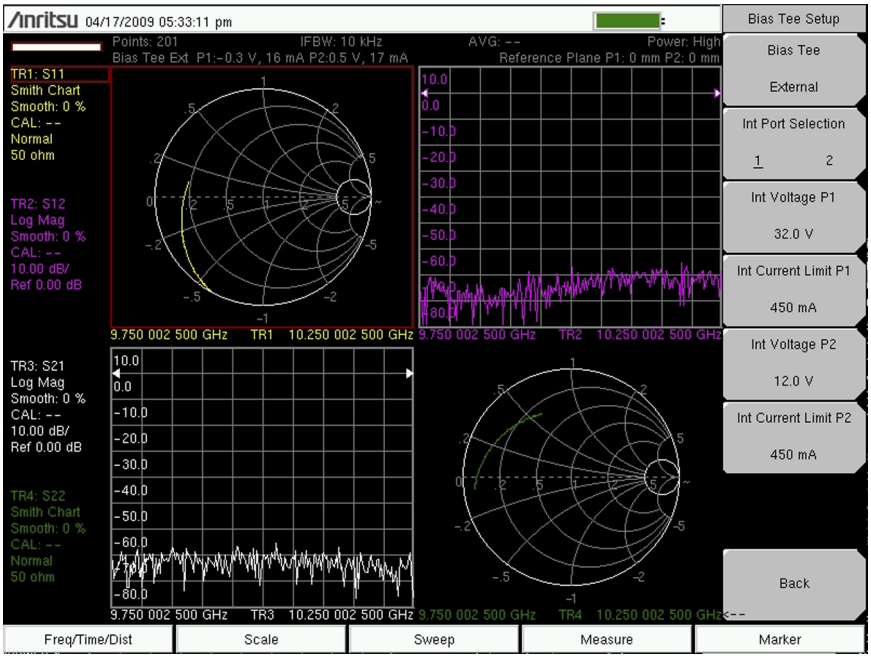


Figure 10-5. Bias Tee Set to External (MS20xxC models only)

10-5 Bias Tee Menus (MS20xxC, MS2026B, and MS2028B)

To access the Bias Tee menu, press the **Sweep** function hard key (or press the **Shift** key then the **Sweep** (**3**) key). Press the Configure Ports soft key, and then press the Bias Tee Setup soft key to open the Bias Tee Setup menu. Press the Bias Tee soft key to select Internal, External, or Off.

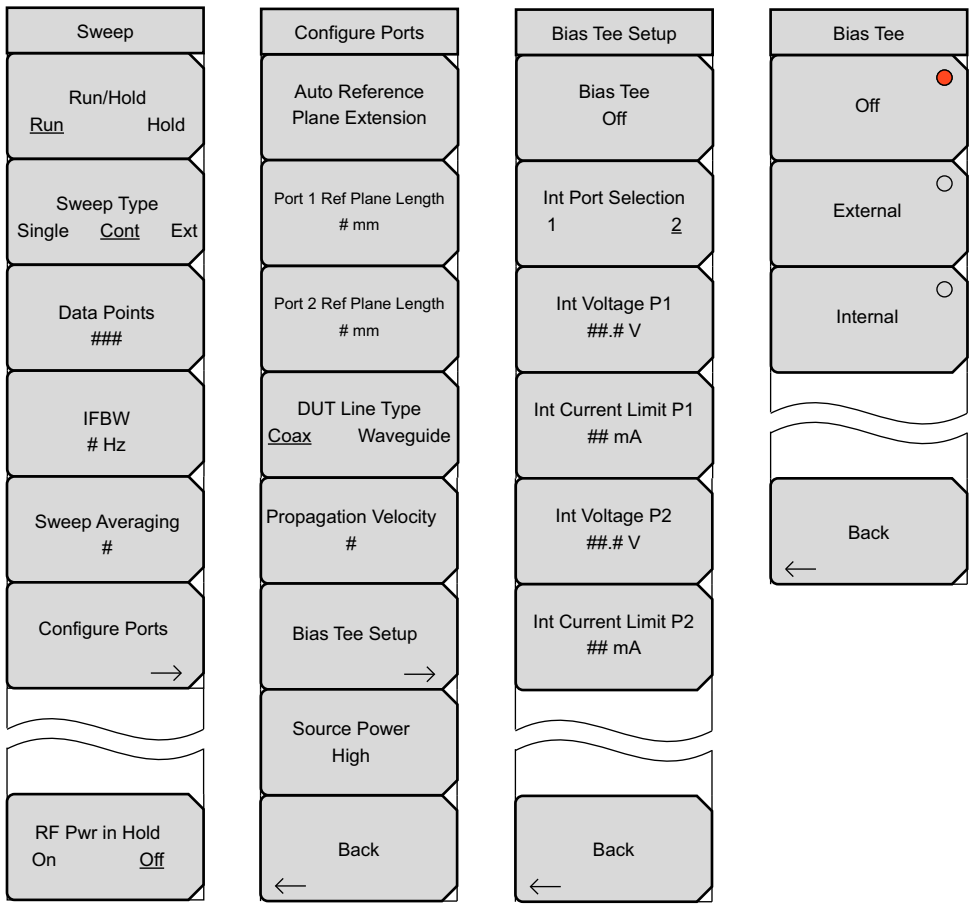
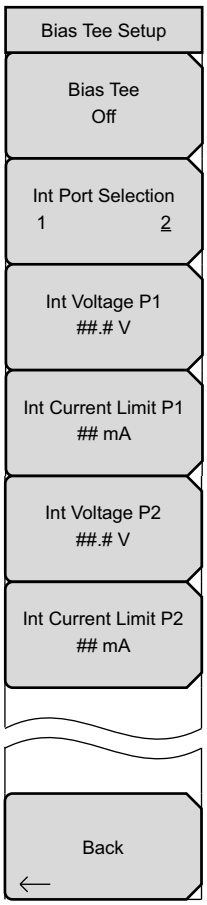


Figure 10-6. Bias Tee Menu Group (MS20xxC, MS2026B, and MS2028B)

For additional information about the Sweep menu, refer to "Sweep Menu — MS20xxC" on page 6-53 and to "Sweep Menu — MS20xxB and S412E" on page 6-54.

Bias Tee Setup Menu



Bias Tee (On/Off): Press this soft key to open the "Bias Tee Menu" to select External, Internal, or Off.

Int Port Selection
1 2: Press this soft key to toggle the internal port selection to Port 1 or Port 2.

Int voltage P1: Press this soft key to set the internal bias tee voltage that is directed onto the center conductor of port 1. The available range is from 12.0 V to 32.0 V in increments of 0.1 V. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for voltage units (V), or press the **Enter** key. Press the **Esc** key to exit without changing the setting.

Int Current Limit P1: Press this soft key to set the internal bias tee current limit for the voltage that is set at Port 1. The available range is from 0 mA to 450 mA in steps of 1 mA. This current limit sets the trip point for the bias tee for this port. When using the number keypad, the soft key menu displays 2 choices for units: A or mA. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for current units (A or mA), or press the **Enter** key to use mA. Press the **Esc** key to exit without changing the setting.

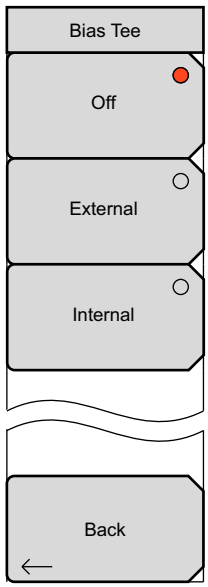
Int voltage P2: Press this soft key to set the internal bias tee voltage that is directed onto the center conductor of Port 2. The available range is from 12.0 V to 32.0 V in increments of 0.1 . Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for voltage units (V), or press the **Enter** key. Press the **Esc** key to exit without changing the setting.

Int Current Limit P2: Press this soft key to set the internal bias tee current limit for the voltage that is set at Port 2. The available range is from 0 mA to 450 mA in steps of 1 mA. This current limit sets the trip point for the bias tee for this port. When using the number keypad, the soft key menu displays 2 choices for units: A or mA. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for current units (A or mA), or press the **Enter** key to use mA. Press the **Esc** key to exit without changing the setting.

Back: Press this soft key to the Sweep menu.

Figure 10-7. Bias Tee Setup Menu – MS20xxC

Bias Tee Menu



Off: Press this soft key to turn the Bias Tee function Off.

External: Press this soft key to activate the External Bias Tee connection. Both Port 1 and Port 2 external bias tees are activated.

Internal: Press this soft key to select the internal source for Bias Tee voltage. The internal source is directed to either Port 1 or Port 2. Use the Int Port Selection soft key in the Bias Tee Setup menu to select a port.

Back: Press this soft key to return to the "Bias Tee Setup Menu" without changing the current Bias Tee setting.

Figure 10-8. Bias Tee Menu – MS20xxC

10-6 Bias Tee Menus (Field Measurements View)

These Bias Tee menus are used only in the Field Measurements view of the MS20xxB VNA Master and the S412E LMR Master.

To access the Bias Tee menu, press the **Shift** key and then the **System** (**8**) key). Then press the Application Options soft key, and then the Bias Tee Setup soft key to open the Bias Tee Setup menu. In the Bias Tee Setup menu, press the Bias Tee soft key to open the Bias Tee menu to turn Bias Tee On or Off.

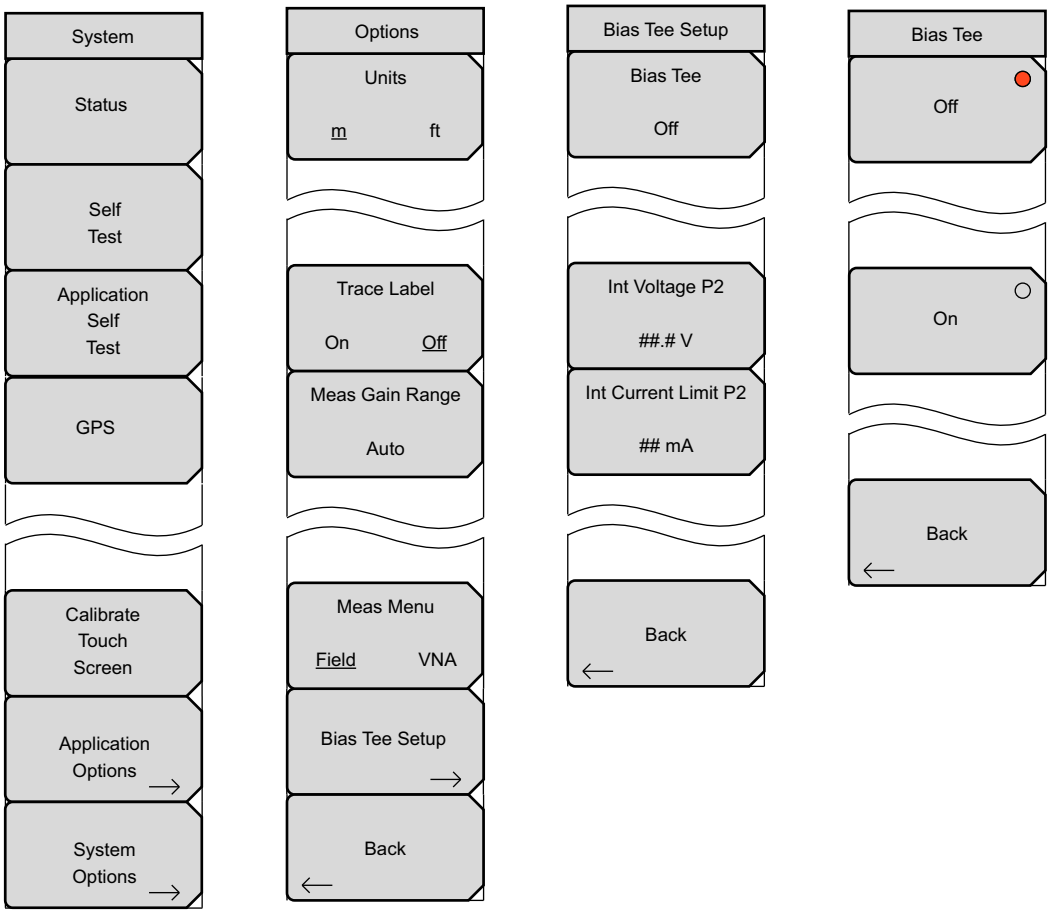
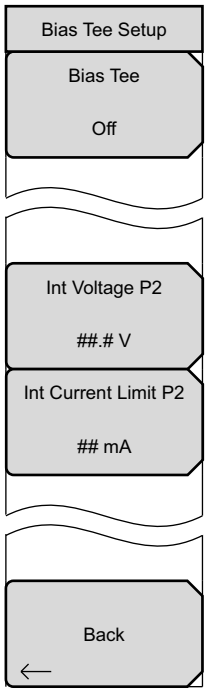


Figure 10-9. Bias Tee Menu Group — Field Measurements – MS20xxB and S412E

For additional information about the System menu, refer to "System Menu" on page 6-63. For additional information about the Application Options menu, refer to "Application Options Menu" on page 7-19.

Bias Tee Setup Menu



Bias Tee (On/Off): Press this soft key to open the "Bias Tee Menu" to turn On or Off the Bias Tee voltage.

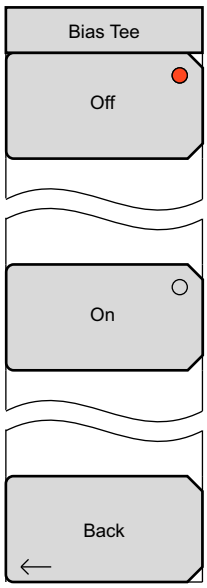
Int voltage P2: Press this soft key to set the internal bias tee voltage that is directed onto the center conductor of Port 2. The available range is from 12.0 V to 32.0 V in increments of 0.1 . Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for voltage units (V), or press the **Enter** key. Press the **Esc** key to exit without changing the setting.

Int Current Limit P2: Press this soft key to set the internal bias tee current limit for the voltage that is set at Port 2. The available range is from 0 mA to 450 mA in steps of 1 mA. This current limit sets the trip point for the bias tee for this port. When using the number keypad, the soft key menu displays 2 choices for units: A or mA. Use the arrow keys, the rotary knob, or the number keypad to change the setting. When using the number keypad, press the soft key for current units (A or mA), or press the **Enter** key to use mA. Press the **Esc** key to exit without changing the setting.

Back: Press this soft key to the Sweep menu.

Figure 10-10. Bias Tee Setup Menu – MS20xxB and S412E

Bias Tee Menu



Off: Press this soft key to turn Off the Bias Tee function.

On: Press this soft key to turn ON the Bias Tee function.

Back: Press this soft key to return to the "Bias Tee Setup Menu" without changing the current Bias Tee setting.

Figure 10-11. Bias Tee Menu – MS20xxB and S412E

10-7 Bias Tee Menus (MS20xxB and S412E in VNA View)

In VNA Measurements mode (as opposed to Field Measurements mode), the Bias Tee Setup soft key is in the Configure Ports menu. The Bias Tee Setup menu and the Bias Tee menu have the same keys as in the Field Measurements mode.

To access the Bias Tee menu in VNA Measurements mode, press the **Sweep** function hard key (or press the **Shift** key then the **Sweep** (**3**) key). Press the Configure Ports soft key, and then press the Bias Tee Setup soft key to open the Bias Tee Setup menu. Press the Bias Tee soft key to open the Bias Tee menu. Then select On or Off by pressing the appropriate soft key, or press the Back soft key to exit the menu without changing the setting.

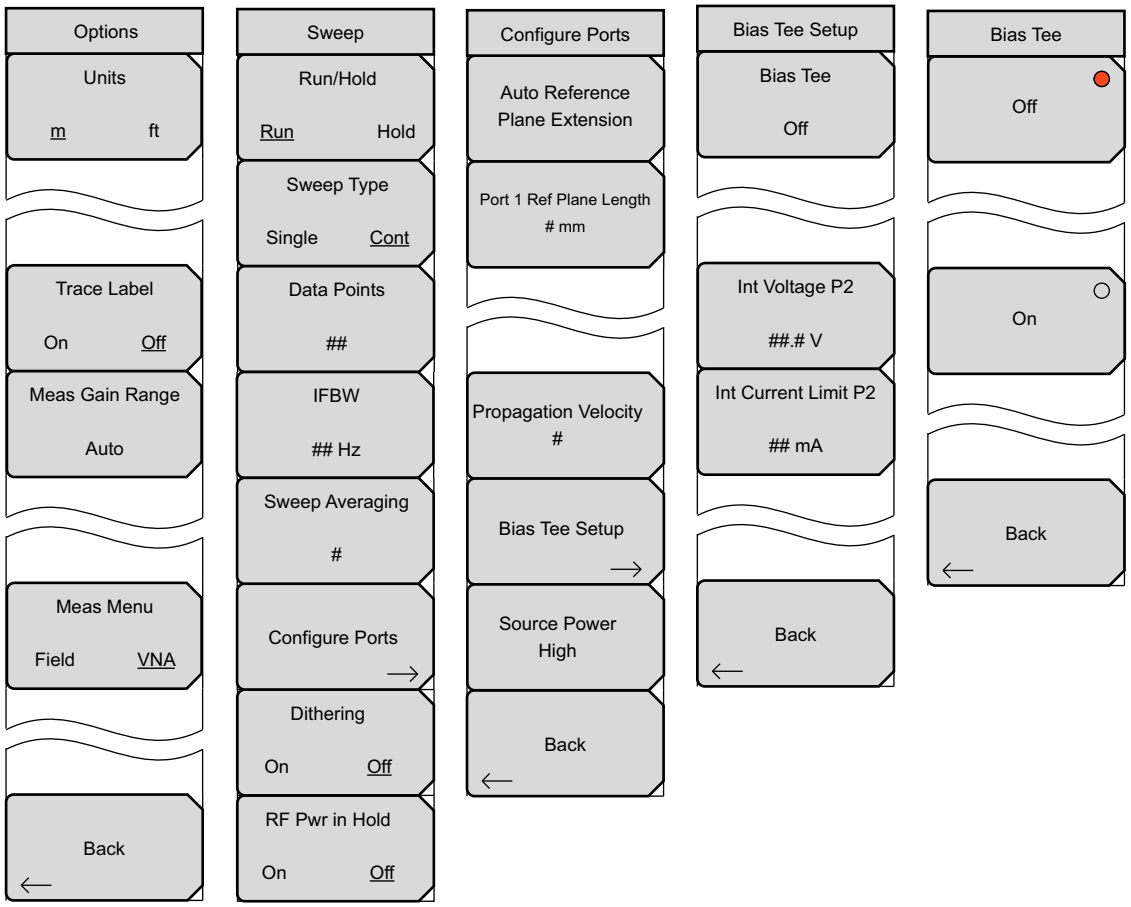


Figure 10-12. Bias Tee Menu Group — VNA Measurements – MS20xxB and S412E

For additional information about the Application Options menu, refer to "Application Options Menu" on page 7-19. For additional information about the Sweep menu, refer to "Sweep Menu — MS20xxB and S412E" on page 6-54.

Chapter 11 — Vector Voltmeter, Option 15

11-1 Introduction

When equipped with Option 15, the Vector Network Analyzer is a convenient tool for ensuring phase match between RF cables, especially in the field where access to AC power is typically limited. This mode is called Vector Voltmeter mode (VVM) because it can replace a vector voltmeter, which is becoming obsolete. With the convenience of a user interface that is similar to a vector voltmeter, an engineer or technician can use a familiar display and highly integrated solution for phase matching cables.

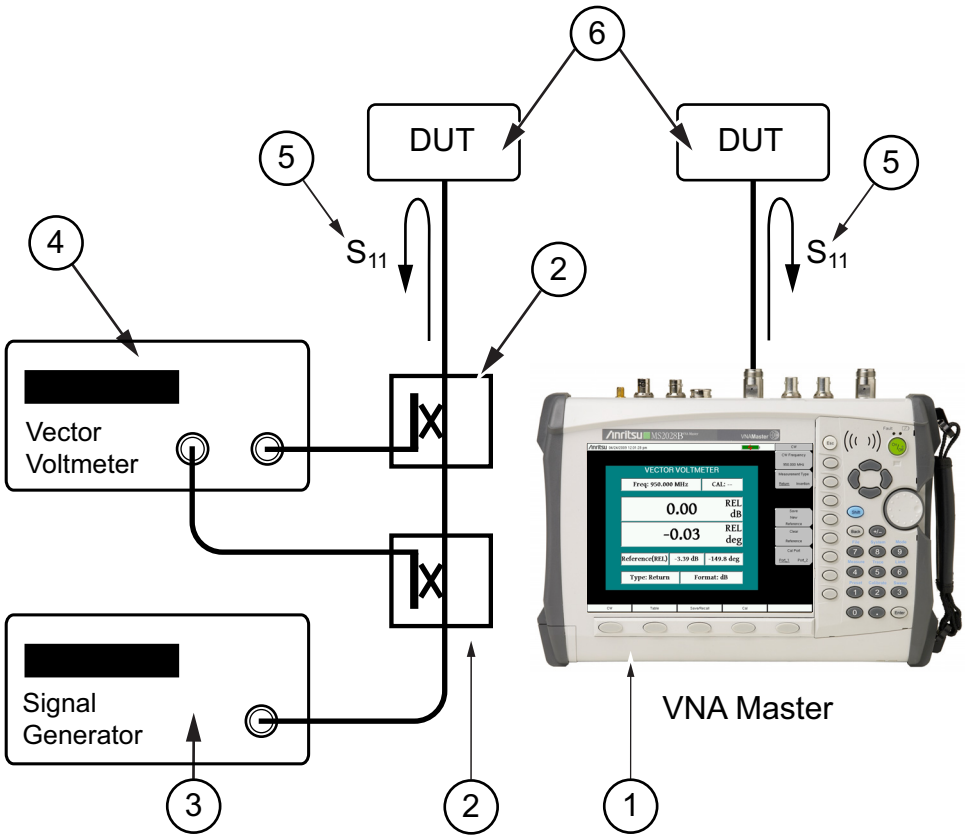
The function hard keys in Vector Voltmeter mode are:

CW, Table, Save/Recall, Cal, [BLANK]

The fifth key is not used in Vector Voltmeter mode.

11-2 Getting Started

Figure 11-1 shows a block diagram comparison of the test configuration for the Vector Voltmeter instrument method (left) and the Vector Network Analyzer (right) when used for an S_{11} measurement. The Vector Network Analyzer (when equipped with Option 15) contains not only the Vector Voltmeter receiver, but also the signal source and couplers that are necessary for conducting both 1-port and 2-port measurements at a selected CW frequency.



1	VNA Master
2	Couplers
3	Signal Generator
4	Vector Voltmeter
5	S_{11} Reflection Measurement
6	DUT (Device Under Test)

Figure 11-1. Vector Voltmeter within VNA Master

While phase sensitive cabling is used primarily in lower frequency applications that are typical in air navigation systems such as VOR (VHF Omnirange), the Option 15 software VVM procedures are applicable for the entire frequency coverage of the Vector Network Analyzer

Note	Disclaimer (an important distinction): The Vector Voltmeter Option 15 in the Anritsu VNA Master and LMR Master does not measure RF voltages. The traditional vector voltmeter function of probing RF voltages (A and B) in two channels, and displaying A, B, A/B, B/A, and the phase difference between them is now obsolete, and those instruments are no longer available. The Vector Network Analyzer has replaced the ratio functions of the vector voltmeters. The Vector Network Analyzer measures those amplitude and phase ratios very accurately. Thus it is a suitable replacement for the most used ratio function of VVMs, that of measuring component parameters.

11-3 Using Vector Voltmeter Mode for the First Time

Before conducting a measurement in Vector Voltmeter mode, select a CW frequency and perform a calibration. During calibration, choose between a 1-port or 2-port calibration depending upon whether return or insertion type measurements (respectively) are desired.

The choice of whether to use a 1-port or a 2-port measurement is usually dictated by the physical site configuration. If the DUT (device under test) is compact, such as cables or amplifiers or filters, then the 2-port measurement may be used because both ends are available near the Vector Network Analyzer. If a cable is already installed permanently, then the 1-port methods are indicated because only the one end of the DUT is convenient to the test port.

When making a 1-port connection to the DUT, select the Return measurement type and perform a 1-port calibration. When making a 2-port connection to the DUT, select the Insertion measurement type and perform a 2-port calibration. The following paragraphs further explain these steps.

11-4 How the VVM Function Works

1. Insertion technique (2-port). One technique uses the Vector Network Analyzer in a straightforward manner with its 2-port setup. By characterizing the insertion phase delay of a signal by measuring S_{21} or S_{12} through the cable, the operator can determine the phase shift of the component or cable from input connector to output connector. The Vector Network Analyzer Option 15 display presents those S_{21} or S_{12} data as insertion loss in dB and insertion phase in degrees.
2. Reflection technique (1-port). The second technique (using the Vector Network Analyzer) measures the S_{11} or S_{22} reflected signal on a component or cable, and depends upon the procedure in which the far end of the cable is deliberately mismatched, either shorted or left open-circuited. This reflects virtually 100% of the input signal, and the phase delay of the measured reflected signal is therefore equal to twice the one-way phase of the cable. Likewise, the cable attenuation is twice the one-way loss. This technique is especially useful for situations in which you must manually create multiple phase matched cables. This would be done by carefully snipping small amounts of cable with a diagonal cutters, perhaps 1/8th inch at a time, and re-measuring the effect on the 2-way phase.

Note	The MS20xxC VNA Master features a fully-reversing architecture, which allows for measurements (on Port 1 and Port 2) of all four S-parameters without reconnecting the DUT. With Option 15 VVM, you can make a Return measurement type (amplitude and phase) on either Port 1 (S_{11}) or Port 2 (S_{22}). Similarly, you can make an Insertion measurement type (amplitude and phase) either with Port 1 transmitting (S_{21}) or with Port 2 transmitting (S_{12}). You select the Port using the Cal Port soft key under the CW menu. When making Return measurements, you can connect two cables (one to each port) and then toggle the Cal Port setting to look at the Return results of both cables without having to disconnect and reconnect.

11-5 Simple Measurement Using CW Display

1. Press **Shift** and **Mode** and **Enter** to use the Vector Voltmeter function.
2. Press the **CW** function hard key.
3. Press CW Frequency soft key and enter the desired frequency.
4. Press the **Cal** function hard key.
5. Press the Cal Type soft key and select the type of calibration from the selection list box.
6. For typical VVM applications, the Cal Method should be SOLT, and the Cal Line Type should be Coax.
7. Press the DUT Port Setup soft key to select a specific connector type for each port. Select (from the list) the connector type of the device under test (or equivalently, the calibration component connector type).
8. Press the Start Cal soft key to begin the calibration. Figure 11-2 on page 11-7 shows a typical setup for a 1-port Open-Short-Load calibration at Port 1.

   For two-port measurements, refer to Figure 11-3 on page 11-8, which shows a setup for 2-port calibration using Open-Short-Load-Isolation-Through. In order to ensure a good calibration, be careful to follow the on-screen instructions for connecting the calibration components.
9. After calibration, press the **CW** function hard key to display the CW menu.
10. Connect the DUT for measurement at the desired Port. The display should appear similar to the image in Figure 11-4 on page 11-9. The measurements and display parameters on your instrument display may differ from those in this user guide.
11. Specify Measurement Type to be Return for a 1-port DUT. After a 2-port calibration, both Return and Insertion measurement types can be viewed.
12. Choose to view the measurement results for the return measurement as dB, VSWR, or Impedance by pressing the Return Meas. Format soft key. For insertion measurements, only the dB selection is available.
13. Choose the Cal Port to be Port 1 or Port 2. If you performed a Full S_{11} calibration, then choose Port 1 to have that calibration apply. If you performed a Full S_{22} calibration, then choose Port 2 to have that calibration apply. If you performed a Full S_{11} and S_{22} calibration, or a full 2-Port calibration, then you will be able to make calibrated measurements using both Port 1 and Port 2. For Insertion measurements on a symmetric cable with a full 2-Port calibration, using Cal Port 1 or Cal Port 2 should give you the same results.

This completes the procedure for performing a simple measurement using the Vector Voltmeter mode.

11-6 Calibration Correction

Table 11-1 summarizes the meaning of the calibration correction status displays.

When you choose the Measurement Type and the Cal Port, the Vector Network Analyzer compares these measurement settings with the current calibration. If a match is found, then the current calibration is applied to the measured data, and the Cal info box on the display (refer to Figure 11-4 on page 11-9) shows "**CAL: ON (OK)**". If no match is found (for example, the calibration was for S_{11}, but the Cal Port is set to Port 2), then the display shows "**CAL: --**". Adjusting the setting (the Measurement Type or the Cal Port) to match the calibration automatically applies the correction. The calibration correction can also be turned off manually under the Calibration menu by toggling the Cal Correction soft key from On to Off. In that case, the display shows "**CAL: OFF**".

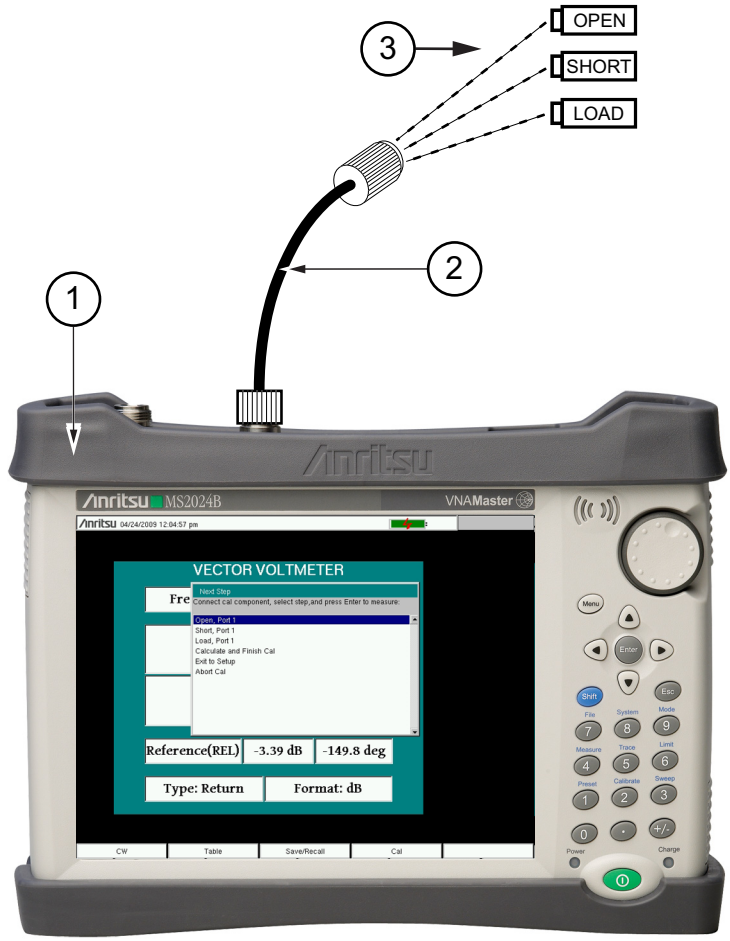
Note that "**CAL: OFF**" means that a calibration correction has been created, but it is not currently being used. This is different from "**CAL: --**", which means that no valid calibration correction is available for the current setting.

Another status information display that you may see is "**CAL: ON (?T)**" which indicates that the instrument temperature has deviated by more than a set amount since the time the calibration was conducted. The calibration is most likely still valid, but a new calibration is recommended. If you see "**CAL: ON (X)**" on the display, this indicates that the instrument temperature has deviated (since the time that the calibration was conducted) by an amount that has more than likely rendered the calibration invalid. When this occurs, a new calibration is highly recommended before further measurements are conducted.

Only one calibration is available at one time. Performing a new calibration overwrites any existing calibration. You can, however, store a measurement setup, which also stores the calibration. You can therefore have multiple calibrations available (as long as the calibration settings and conditions continue to apply).

Table 11-1. Calibration Status Display

Cal Status	Description
CAL: ON (OK)	current calibration is applied to the measured data
CAL: ON (?T)	instrument temperature has deviated by more than a set amount since the time the calibration was conducted
CAL: ON (X)	instrument temperature has deviated (since the time that the calibration was conducted) by an amount that has probably rendered the calibration invalid
CAL: OFF	a calibration correction has been created, but is not currently being used
CAL: --	no valid calibration correction is available for the current setting



1	The VNA Master
2	Optional Test Port Cable
3	OSL (Open, Short, Load) Precision Calibration Components

Figure 11-2. 1-Port Calibration, using MS2024B



1	The VNA Master
2	Optional Test Port Cable
3	Optional Adapter for Through Connection
4	OSL (Open, Short, Load) Precision Calibration Components

Figure 11-3. 2-Port Calibration, using MS2028C

Note Figure 11-3 shows an optional adapter for the Through connection. If you are using test port cables, and if you have sufficient calibration components, then using male OSL standards on one port and female OSL standards on the other port allows you to connect the cable ends together without the adapter. This becomes more important at higher frequencies.

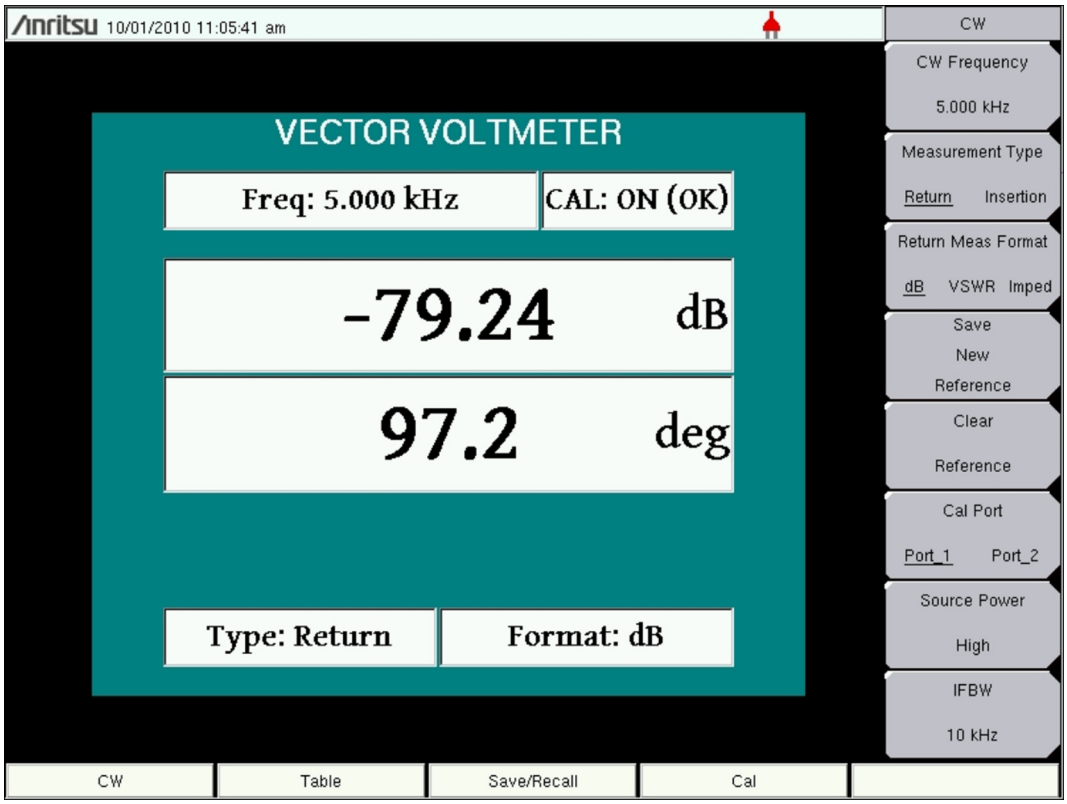


Figure 11-4. Continuous Wave Menu – MS20xxC VNA Master

Note	The Cal Port soft key is available only on the MS20xxC VNA Master. The MS20xxB VNA Master and the S412E LMR Master calibrate only on Port 1, so they do not use this soft key.

11-7 Relative Measurements using CW Display

For many phase-sensitive applications, absolute phase shift of a cable is not as critical as the phase matching among multiple cables. For this application, the Vector Network Analyzer relative phase measurement is preferred.

The operations for relative measurements are described in the following steps.

1. From the **CW** menu, preset the Vector Voltmeter for relative (by an amount) measurements by pressing the Clear Reference soft key.
2. Connect the first DUT (device under test).
3. Save the measurement result of the first DUT by pressing the Save New Reference soft key.
4. As shown in Figure 11-5, the Vector Voltmeter saves the current measurement in a new reference window and converts the main measurement window to display the difference between the current measurement and the saved reference. In other words, saving a reference will normalize the results to the current measurement. When relative measurements are displayed, REL is indicated in the main measurement window.

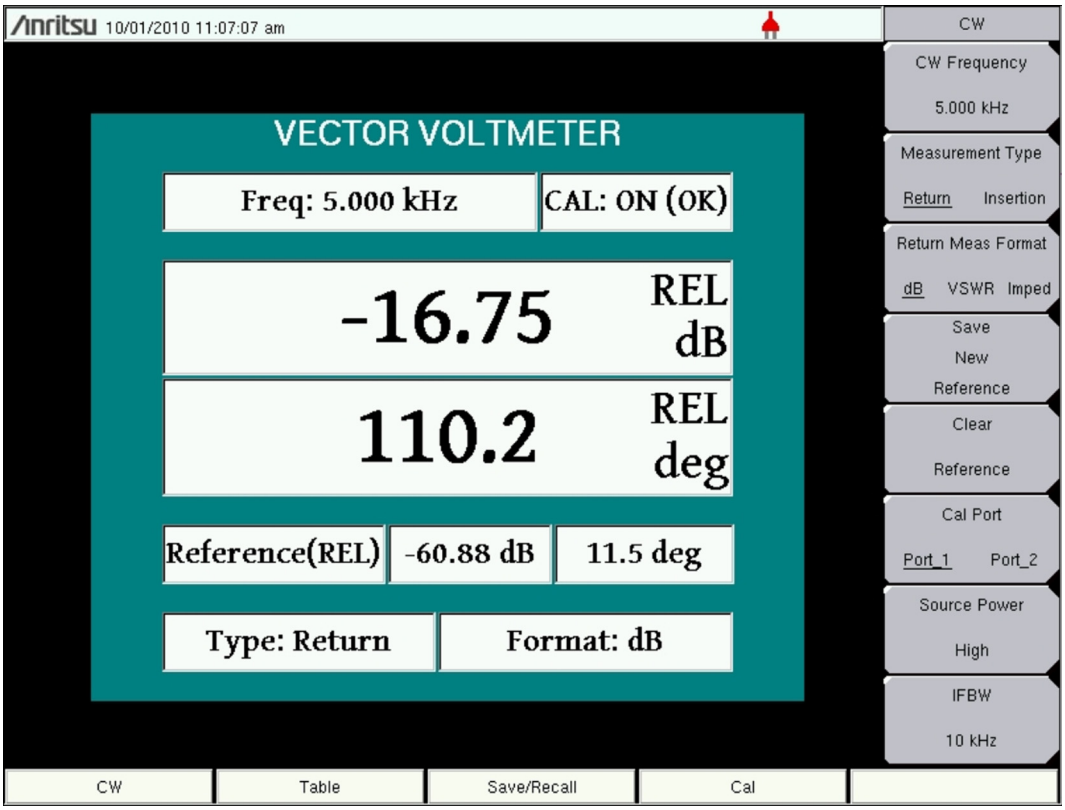


Figure 11-5. Continuous Wave Menu with Relative Measurements – MS20xxC VNA Master

5. Connect the second DUT and view the difference between the first and second DUT measurements.
6. To create a new reference, press the Clear Reference soft key followed by the Save New Reference soft key

This completes the procedure for relative measurements.

11-8 Measurements Using Comparison Table Display

The Vector Voltmeter procedure includes a convenient table display for comparing up to twelve cables. With this feature, the user can save the first cable measurement as a reference, can view the differences among the other cables, and can output a final report showing both absolute and relative values of all the cables. The following steps describe an overview of the procedure for using this feature.

1. Press the **Table** function hard key.
2. The setup procedure, including calibration, is the same as Step 4 through Step 9. in the procedure described in section "Simple Measurement Using CW Display" on page 11-5. Specify CW Frequency and perform the appropriate 1-port or 2-port calibration.
3. After calibration, press the **Table** function hard key.
4. Preset the Vector Voltmeter Mode for relative measurements by pressing the Clear Reference soft key.
5. Connect the DUT for measurement. The display appears similar to that shown in Figure 11-6.

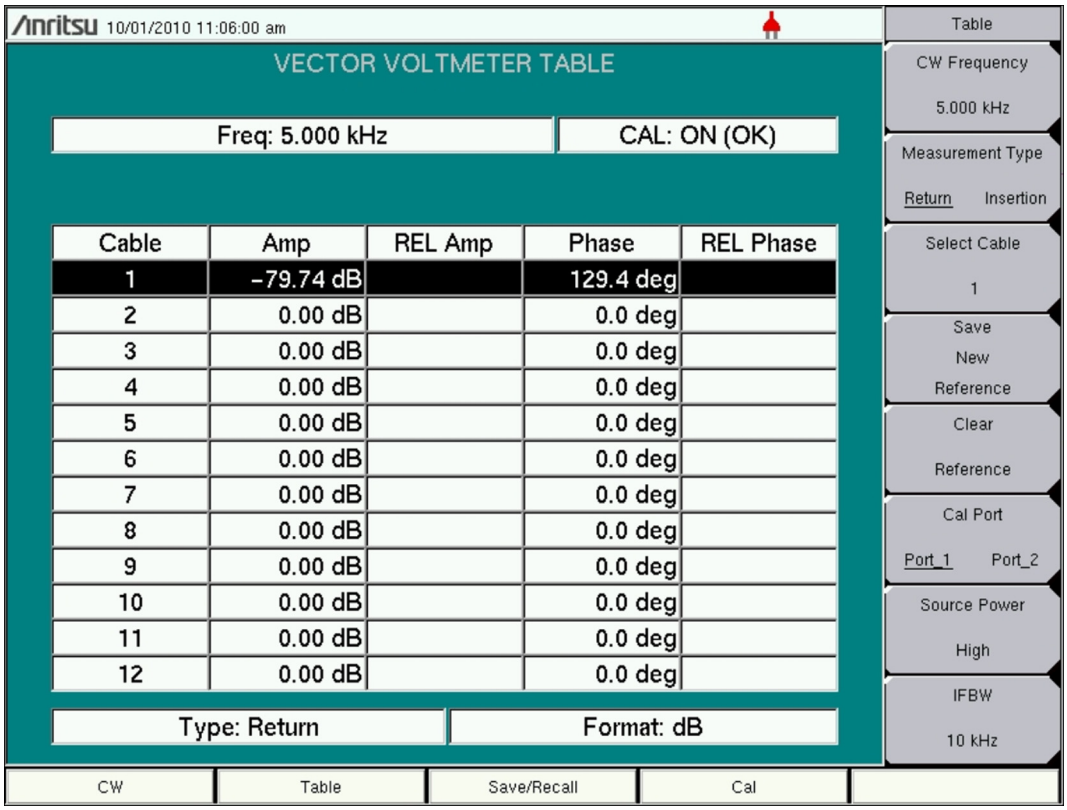


Figure 11-6. Vector Voltmeter Measurement Table – MS20xxC VNA Master

6. Save the measurement result of the first DUT by pressing the Save New Reference soft key.

7. As shown in Figure 11-7, the Vector Network Analyzer saves the current measurement in a new reference window above the table and updates the REL Amp and REL Phase columns to display the difference between the current measurement and the saved reference measurement.

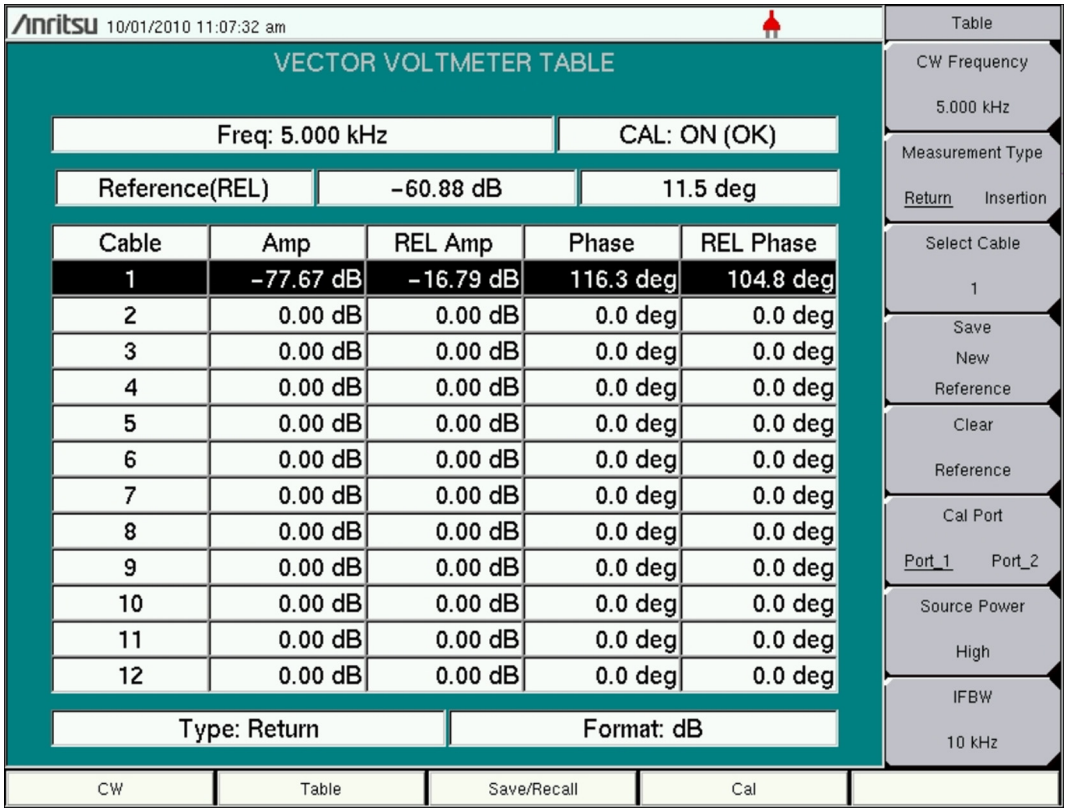


Figure 11-7. Vector Voltmeter Relative Measurement Table – MS20xxC VNA Master

8. Before disconnecting the first DUT, save the results in the current row by using the Select Cable soft key to move to another row in the table. When selecting a new cable, the Vector Network Analyzer saves the results and updates measurements for the next cable in the table.

Note	Be sure to keep the DUT connected until a new cable has been selected in order to ensure that the proper values are saved in the table for the final report.

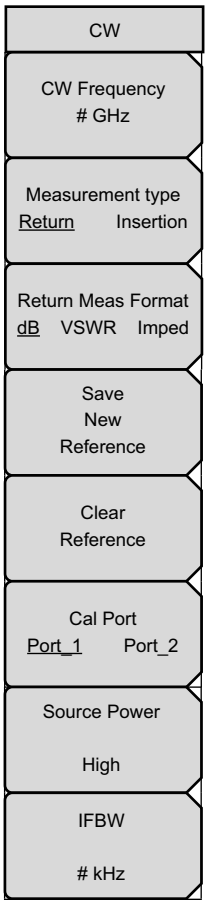
9. Connect the second DUT and view the difference between the first and second DUT measurements. Be careful to avoid selecting another cable when you are done with the measurement. Saved data can be overwritten.
10. To create a new reference, press the Clear Reference soft key followed by the Save New Reference soft key. Consider the possibility of changing the reference by using Select Cable to choose cable 1 again.

This completes the procedure for relative measurements using the table display.

11-9 Vector Voltmeter Menus

In the Vector Voltmeter mode, the function hard keys display the following labels: **"CW", "Table", "Save/Recall",** and **"Cal".** The fifth function hard key has no function in the Vector Voltmeter mode.

CW Menu



CW Frequency: Press this soft key to set the desired measurement frequency. Enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as using the MHz soft key.

Measurement Type
Return Insertion: Press this soft key to toggle between Return and Insertion measurements. When Return is selected, the Return Meas Format soft key is displayed.

Return Meas Format
dB VSWR Imped: Press this soft key to toggle among dB, VSWR, and Imped (impedance) measurements formats. This setting is relevant (and the soft key is displayed) only when the Measurement Type soft key is set to Return.

Save New Reference: Press this soft key to save the current measurement as the reference measurement. Entering a reference puts the Vector Voltmeter in relative measurement mode.

Clear Reference: Press this soft key to remove the reference measurement from memory. The Vector Voltmeter exits the relative measurement mode.

Cal Port
Port_1 Port_2: Press this soft key to set the transmission port for subsequent measurements. For making S_{11} or S_{21} measurements, set this to Port 1. For S_{22} or S_{12} measurements, set this to Port 2. This soft key is displayed only with the MS20xxC VNA Master and is not relevant to the MS20xxB VNA Master.

Source Power: Press this soft key to open the "Source Power Menu (MS20xxB and S412E only)" on page 6-58. The Source Power menu in VVM mode is the same as in VNA mode.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz for the MS20xxC series instruments and 1 kHz for the MS20xxB and S412E series instruments. Select 10 Hz for the maximum dynamic range; select 100 kHz for the maximum speed.

Figure 11-8. CW Menu

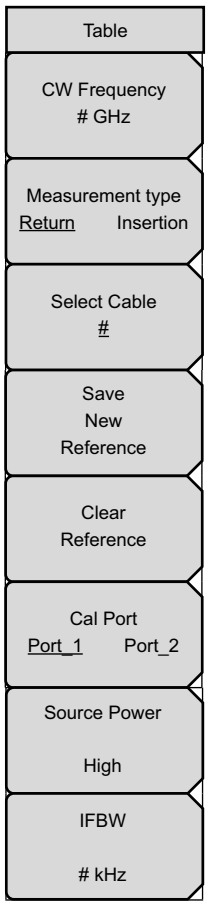
Continuous Wave (CW) Measurements

In Continuous Wave, the meter displays the selected frequency and indicates if calibration is On or Off for that specific frequency. The instrument must be calibrated for each chosen frequency.

The return measurement format units are displayed near the center of the Vector Voltmeter window. For dB format, the units are dB and deg (degrees). For VSWR format, the voltage standing wave ratio values are unitless. For Imped (impedance) format, the units are Ohms and jOhms.

The measurement type and format are displayed at the bottom of the Vector Voltmeter window.

Table Menu



CW Frequency: Press this soft key to set the desired measurement frequency. Enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If entering a frequency using the keypad, then the soft key labels change to GHz, MHz, kHz, and Hz. Press the appropriate units key. Pressing the **Enter** key has the same affect as using the MHz soft key.

Measurement Type
Return Insertion: Press the Measurement Type soft key to toggle between return and insertion.

Select Cable: Press this soft key to open the Select Cable List Box.

One of the twelve cable numbers is underlined to indicate which cable is selected. Change to a different cable by pressing the Select Cable soft key. The data for the selected cable is highlighted in that cable row within the displayed table.

Save New Reference: Press this soft key to save the current measurement as the reference measurement. Entering a reference puts the Vector Voltmeter in relative measurement mode.

Clear Reference: Press this soft key to remove the reference measurement from memory. The Vector Voltmeter exits the relative measurement mode.

Cal Port
Port_1 Port_2: Press this soft key to set the transmission port for subsequent measurements. For making S_{11} or S_{21} measurements, set this to Port 1. For making S_{22} or S_{12} measurements, set this to Port 2. This soft key is displayed only with the MS20xxC VNA Master and is not relevant to the MS20xxB VNA Master.

Source Power: Press this soft key to open the “Source Power Menu (MS20xxB and S412E only)” on page 6-58. The Source Power menu in VVM mode is the same as in VNA mode.

IFBW: Press this soft key to open a list box and set the Intermediate Frequency bandwidth. The default is 10 kHz. Select 10 Hz for the maximum dynamic range, and select 100 kHz for the maximum speed.

Figure 11-9. Table Menu

Save/Recall Menu

'Pressing the **Save/Recall** function hard key opens the File menu. For a description of the soft keys in the File menu, refer to the file management instructions in the user guide for your instrument.

Calibration Menu

For descriptions of the Calibration menu items and options, refer to "Calibration Menu" on page 6-19. The Calibration menu in Figure 11-10 is from the MS20xxC VNA Master.

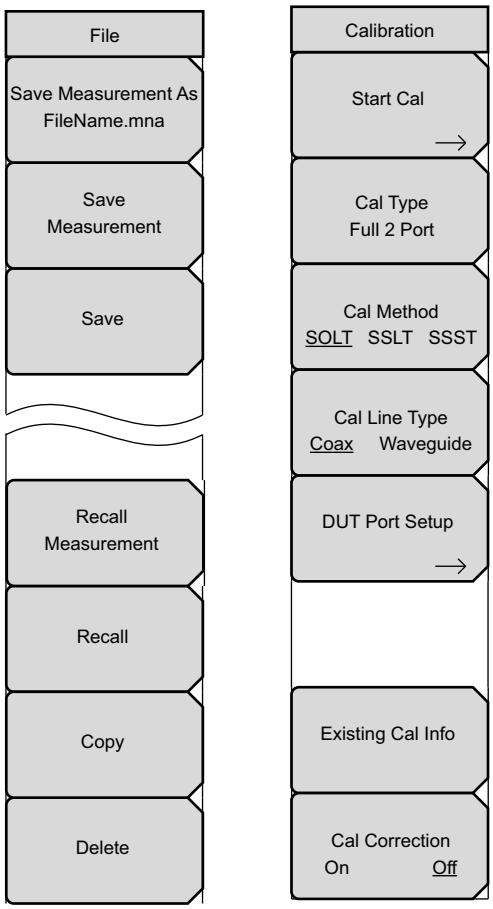


Figure 11-10. File and Calibration Menus

Chapter 12 — Balanced Ports, Option 77

12-1 Introduction

When equipped with Option 77, the Vector Network Analyzer is able to leverage both of its test ports in order to measure the S-parameters of balanced and differential test configurations. Using mathematical transformations, the Vector Network Analyzer can convert single-ended S-Parameters into the equivalent balanced differential, common, and mixed mode S-parameters: S_{d1d1}, S_{c1c1}, S_{c1d1}, S_{d1c1}. This approach provides accurate results for passive measurements. Note that the Vector Network Analyzer is **not** simultaneously transmitting from both Port 1 and Port 2 during this measurement. This measurement can be used as an alternative to a sampling oscilloscope for verifying performance and discontinuities in differential cables.

12-2 Procedure For Using Balanced Ports

With Option 77, the Vector Network Analyzer enables measurements with four additional S-parameters: the differential reflection coefficient (S_{d1d1}), the common mode reflection coefficient (S_{c1c1}), and the mixed mode reflection coefficients (S_{c1d1} and S_{d1c1}). These S-parameters can be applied to any trace with any graph type, in the same manner as the other standard S-parameters.

1. Press the **Measure** function hard key.
2. Choose the desired active trace.
3. Press the S-parameter soft key and then choose the desired S-parameter from the pop-up list box.
4. Choose the desired Graph Type and Domain.

Note	A full 2-Port calibration is required for balanced or differential S-parameter measurements.

Markers, limits, and all other features that can be used with the standard S-parameters also can be used with the balanced or differential S-parameters.

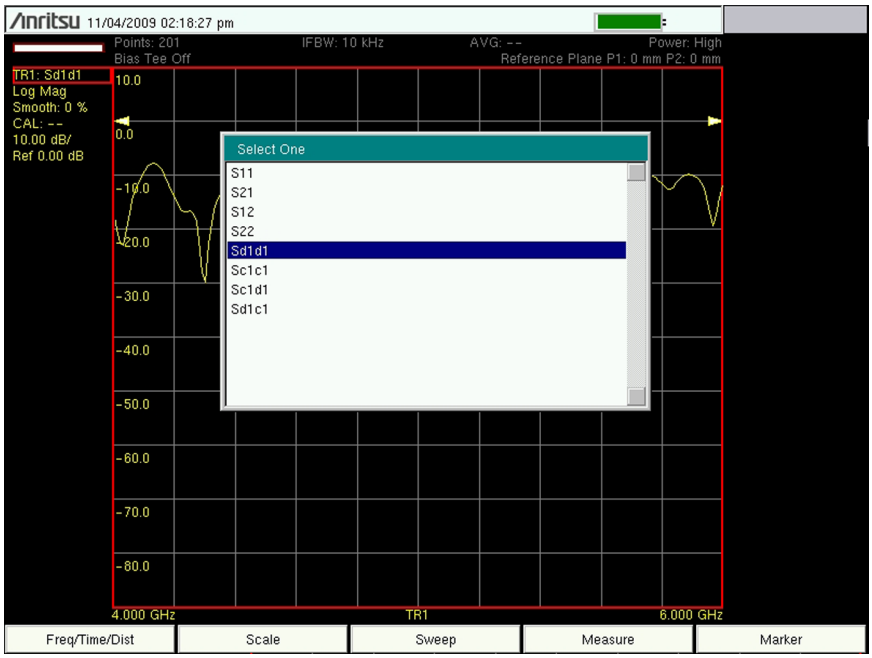


Figure 12-1. Differential S-Parameter Selection List Box (no soft key menu)

With Option 77, the S-parameter submenu uses the selection list box instead of the standard soft keys for choosing the desired S-parameter, even for non-differential S-parameters.

12-3 Typical Measurements

The following description uses S_{d1d1} as an example. The same measurements can be made on any of the other parameters: S_{c1c1}, S_{c1d1}, or S_{d1c1}.

The differential match, or Sd1d1, can be viewed in the frequency domain. It represents the reflections from the differential port of the device under test. Figure 12-2 shows the Log Magnitude display of Sd1d1 (essentially the return loss) of a differential cable. A segmented limit line with pass/fail alarm is used to verify that this cable meets its specifications.

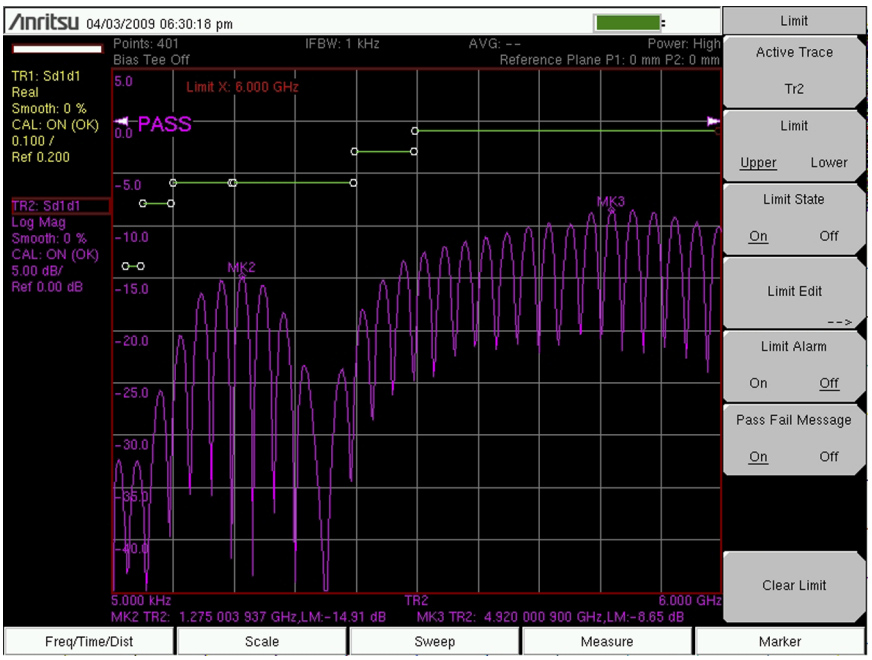


Figure 12-2. Differential S_{11} Log Magnitude Display of S_{d1d1}

In addition to looking at the frequency response of S_{d1d1}, the VNA Master (when equipped with Option 2) can display the time or distance domain response (or both) of S_{d1d1}. This powerful display allows you to check for impedance discontinuities on the differential line.

Figure 12-3 shows both the frequency and distance domain responses of the differential cable under test. Markers are used in the frequency domain to check for the return loss values at different frequency points. In the distance domain, a marker is used to check the impedance value at the end of the cable under test. The marker readout can be set independently of the graph type, and in this case (Figure 12-3), it was set to Impedance. In the example in Figure 12-3, the impedance readout at the end of that cable is 115 ohm, which is a good termination for this 100 ohm differential cable.

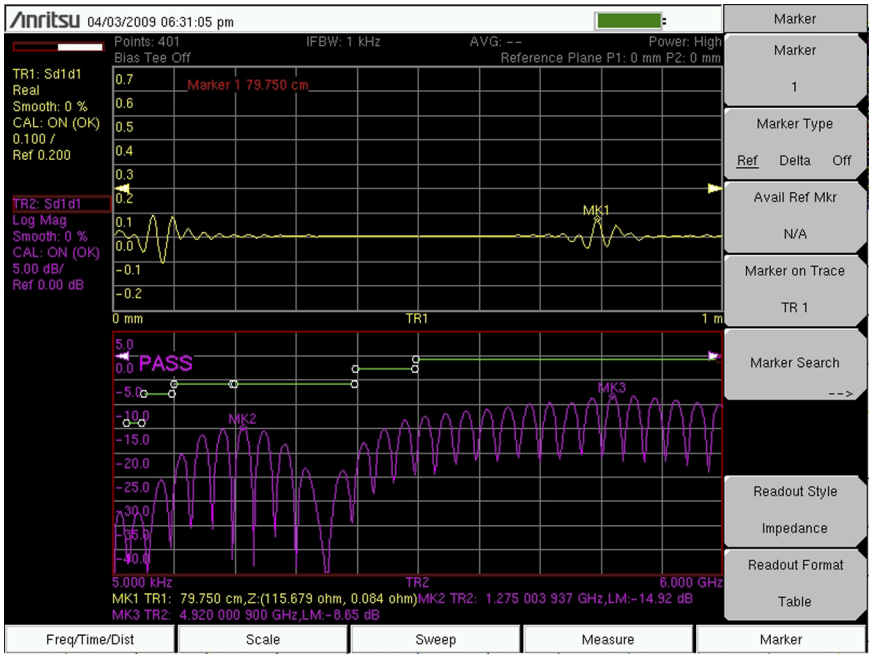


Figure 12-3. Frequency and Distance Domain Responses of Differential Cable

Figure 12-4 shows a cable that fails its return loss specification limits. Looking at the distance domain plot, you can see that the cable has a large mismatch at the end of the cable. The marker reading validates this by providing the impedance value at the end of the cable. In this case, the results point to an open condition at the end of the cable. With its flexible, yet powerful display, and with marker and limits capabilities, the Vector Network Analyzer is able to test differential cables against their specifications, and also it is able to troubleshoot any failures that are identified.

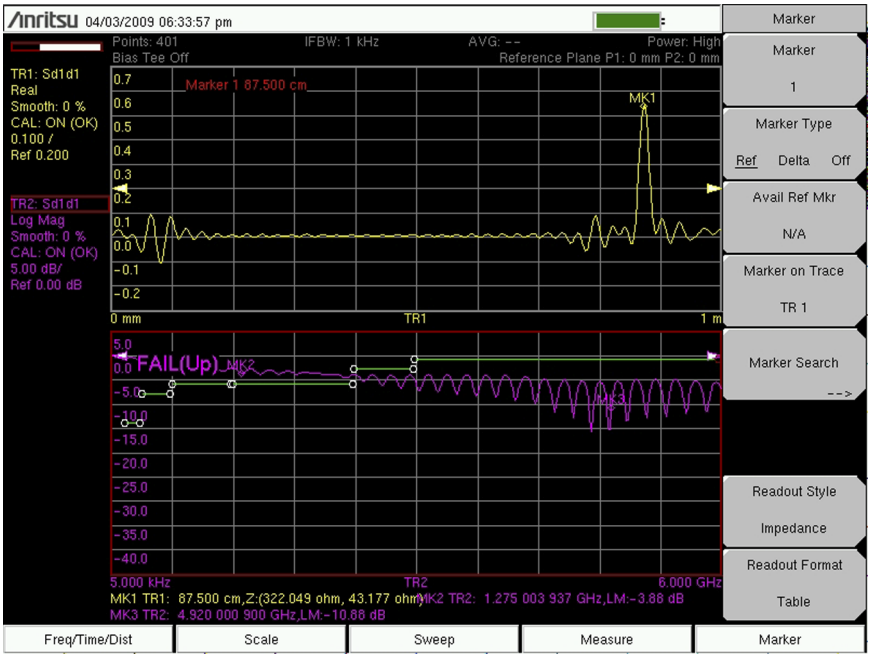


Figure 12-4. Cable with Failing Return Loss (Marker Text Size = Regular)

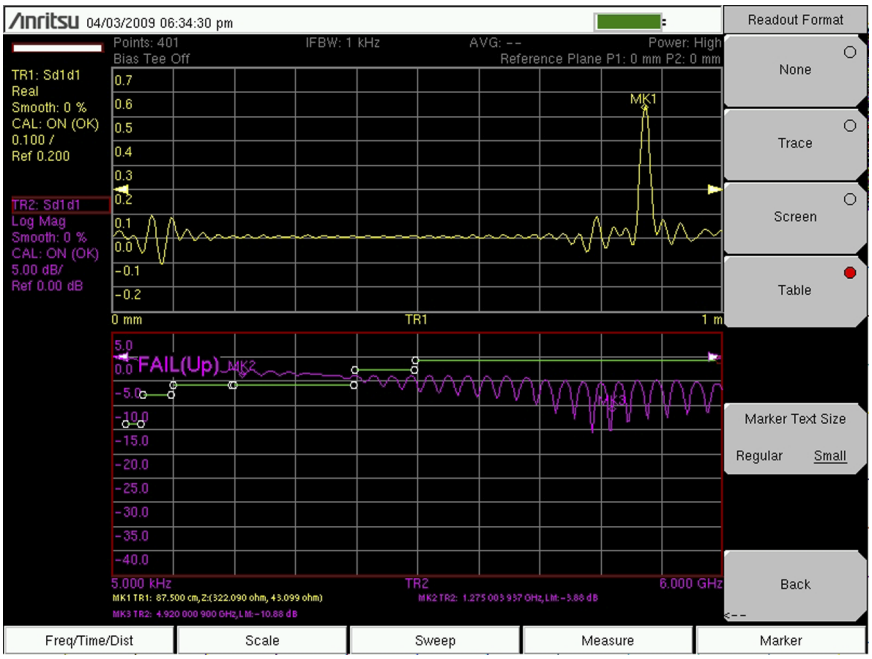


Figure 12-5. Cable with Failing Return Loss (Marker Text Size = Small)

Compare the table of marker data at the bottom of the sweep windows in Figure 12-4 and Figure 12-5. Figure 12-5 shows marker text size set to small (the Marker Text Size soft key is shown in the figure). The key path to this setting is:

Marker — Readout Format — Marker Text Size (Regular or Small)

Appendix A — Formulas

A-1 Vector Network Analyzer Formulas

The following formulas can be used with the Vector Network Analyzer (VNA Master and LMR Master).

Reflection Coefficient

Reflection coefficient is the ratio of the amplitude of the reflected wave to the amplitude of incident wave.

$$\text{Reflection Coefficient} = \rho$$

$$\text{where: } 0 \le \rho \le 1$$

Return Loss

$$\text{Return Loss (dB)} = -20\log|\rho|$$

$$\text{where: } 0 \le \text{Return Loss} < \infty$$

VSWR

$$\text{VSWR} = \frac{(1+\rho)}{(1-\rho)}$$

$$\text{where: } 1 \le \text{VSWR} < \infty$$

Smith Chart

$$\text{Smith Chart: } z = r + jx$$

$$\rho = \frac{(z-1)}{(z+1)}$$

Inverted Smith Chart

$$\text{Inverted Smith Chart: } Y = G + jB$$

Electrical Length

The length of the cable as seen by the electrical signal. The electrical length is always greater than 1 for practical dielectric materials.

$$\text{Electrical Length} = L_{el} = L_{mech} \times \sqrt{\varepsilon}$$

Propagation

Propagation is the propagation velocity expressed as a ratio to the speed of light.

$$\text{Propagation Constant} = vp = \frac{1}{\sqrt{\varepsilon}}$$

where: $0 \le v < 1$

Cable Loss

$$\text{Cable Loss} = \frac{\text{Return Loss (dB)}}{2}$$

$$\text{Cable Loss Average} = \frac{(\text{Peak} + \text{Valley})}{2}$$

Fault Resolution

Fault resolution (in the distance domain) is the ability of the system to separate two closely-spaced discontinuities. Calculations for distance utilize the speed of light (c), which is 2.99792458×10^8 meters per second (for light in vacuum). F is frequency (in Hertz).

$$\text{Fault Resolution Round-Trip (m)} = \frac{0.5 \times c \times vp}{\Delta F}$$

$$\text{Fault Resolution One-Way (m)} = \frac{c \times vp}{\Delta F}$$

Maximum Horizontal Distance

D_{max} is the maximum horizontal distance that can be analyzed in DTF.

$$D_{max(m)} = (\text{Datapoints} - 1) \times \text{Fault Resolution}$$

Suggested Span

Suggested Span is the span needed to get Max Distance to equal Stop Distance.

$$\text{Suggested Span Round-Trip (Hz)} = \frac{(\text{Datapoints} - 1) \times 0.5 \times c \times vp}{\text{Stop Distance}}$$

$$\text{Suggested Span One-Way (Hz)} = \frac{(\text{Datapoints} - 1) \times c \times vp}{\text{Stop Distance}}$$

Appendix B — Windowing

B-1 Introduction

The theoretical requirement for inverse FFT is for the data to extend from zero frequency to infinity. Side lobes appear around a discontinuity because the spectrum is cut off at a finite frequency. Windowing reduces the side lobes by smoothing out the sharp transitions at the beginning and the end of the frequency sweep. As the side lobes are reduced, the main lobe widens, thereby reducing the resolution.

In situations where a small discontinuity may be close to a large one, side lobe reduction windowing helps to reveal the discrete discontinuities. If distance resolution is critical, then reduce the windowing for greater signal resolution.

If strong interfering frequency components are present, but are distant from the frequency of interest, then use a windowing format with higher side lobes, such as Rectangular Windowing or Nominal Side Lobe Windowing.

If strong interfering signals are present and are near the frequency of interest, then use a windowing format with lower side lobes, such as Low Side Lobe Windowing or Minimum Side Lobe Windowing.

If two or more signals are very near to each other, then spectral resolution is important. In this case, use Rectangular Windowing for the sharpest main lobe (the best resolution).

If the amplitude accuracy of a single frequency component is more important than the exact location of the component in a given frequency bin, then choose a windowing format with a wide main lobe.

If you are examining a single frequency, and if the amplitude accuracy is more important than the exact frequency, then use Low Side Lobe Windowing or Minimum Side Lobe Windowing.

Rectangular Windowing

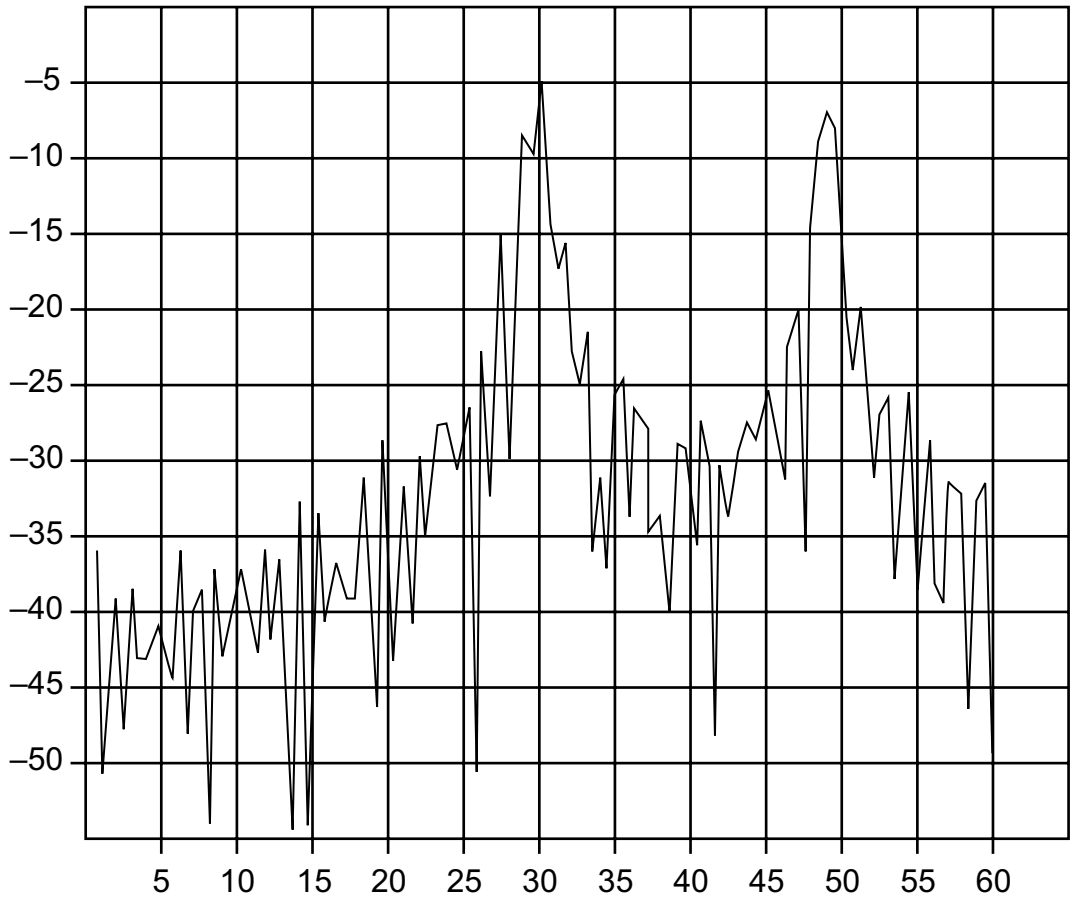


Figure B-1. Rectangular Windowing Example

This Distance To Fault graph has Return Loss (dB) on the vertical scale (y-axis) and distance in feet on the horizontal scale (x-axis).

This view of Rectangular Windowing shows the maximum side lobe display and the greatest waveform resolution.

Nominal Side Lobe Windowing

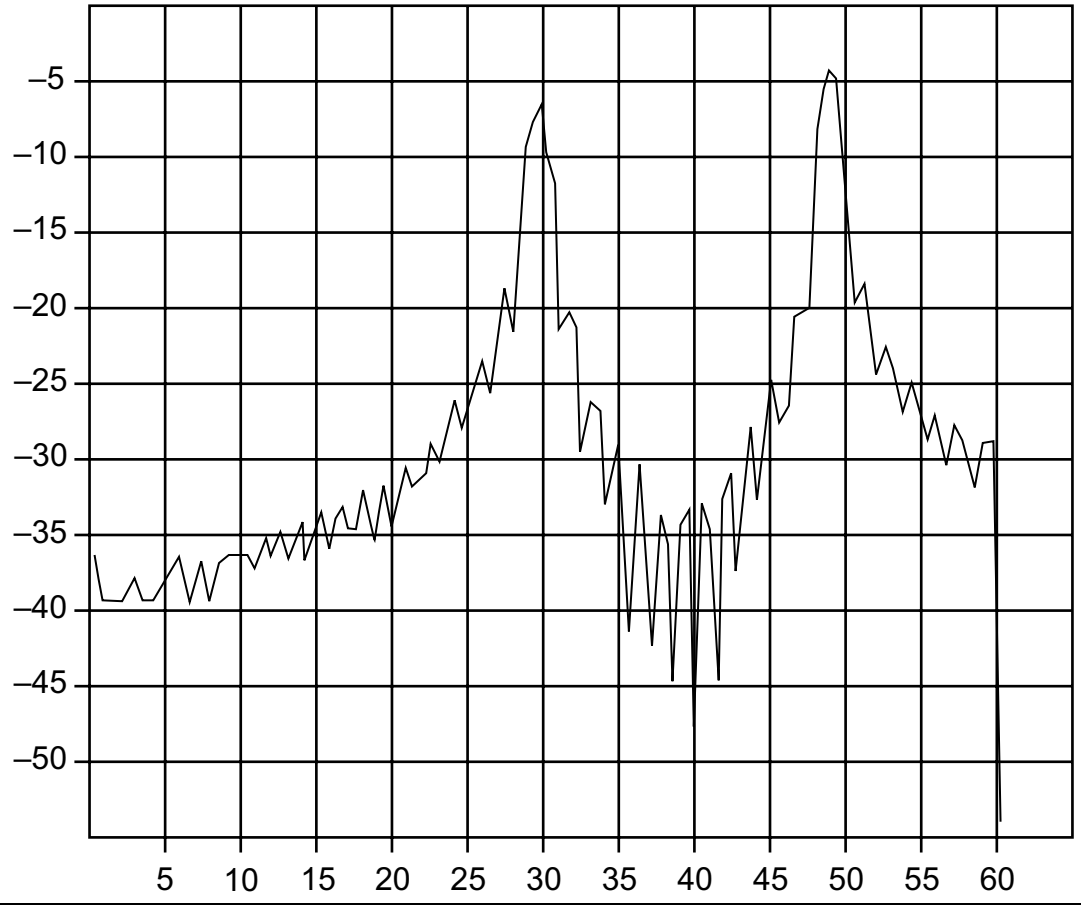


Figure B-2. Nominal Side Lobe Windowing Example

This Distance To Fault graph has Return Loss (dB) on the vertical scale (y-axis) and distance in feet on the horizontal scale (x-axis).

This view of Nominal Side Lobe Windowing shows less side lobe resolution than Rectangular Windowing and more side lobe resolution than Low Side Lobe Windowing. This level of windowing displays intermediate resolution.

Low Side Lobe Windowing

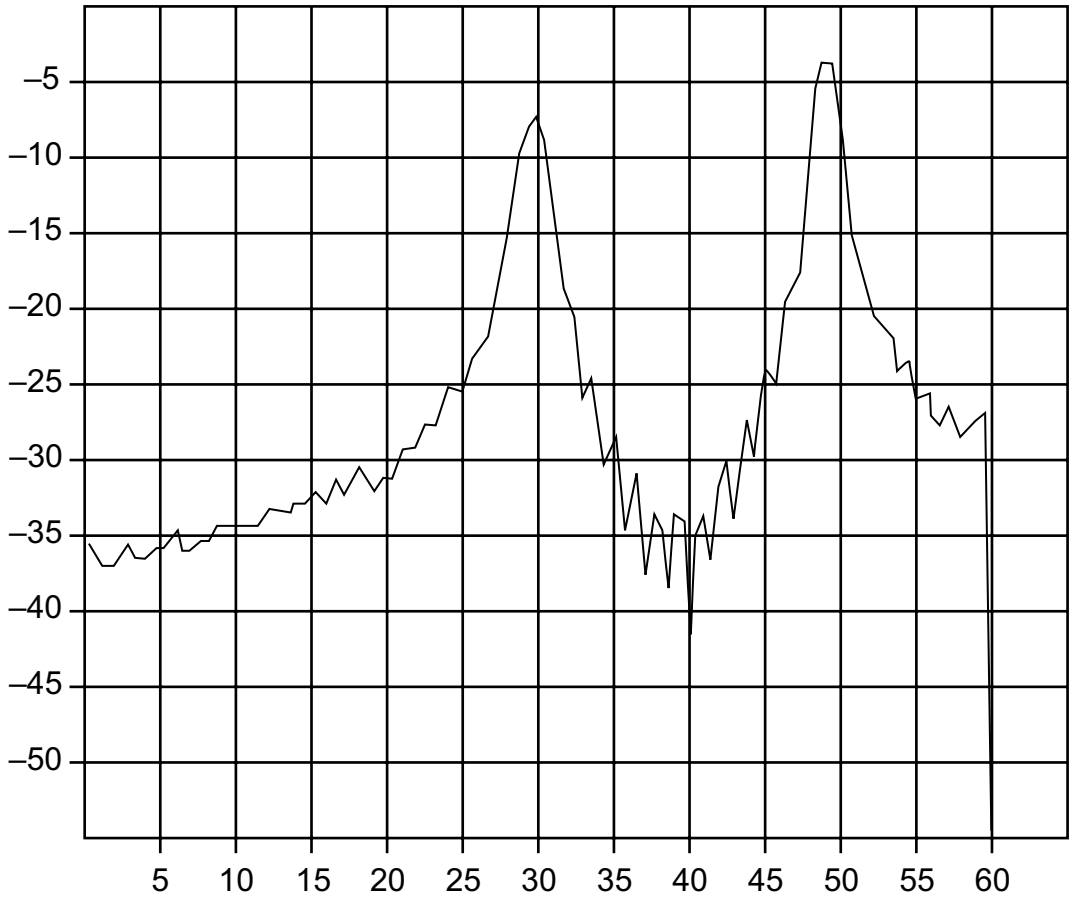


Figure B-3. Low Side Lobe Windowing Example

This Distance To Fault graph has Return Loss (dB) on the vertical scale (y-axis) and distance in feet on the horizontal scale (x-axis).

This view of Low Side Lobe Windowing shows less side lobe resolution than Nominal Side Lobe Windowing and more side lobe resolution than Minimum Side Lobe Windowing. This level of windowing displays intermediate resolution.

Minimum Side Lobe Windowing

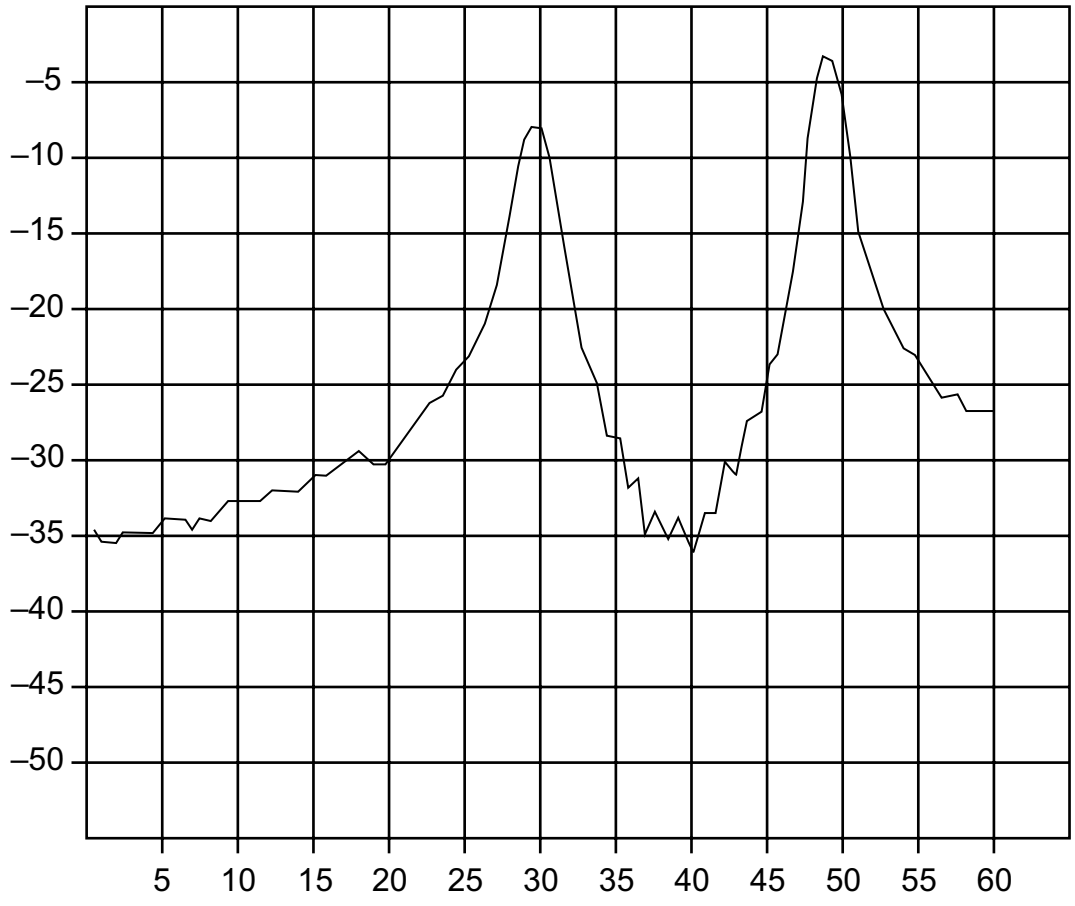


Figure B-4. Minimum Side Lobe Windowing Example

This Distance To Fault graph has Return Loss (dB) on the vertical scale (y-axis) and distance in feet on the horizontal scale (x-axis).

This view of Minimum Side Lobe Windowing shows less side lobe resolution than Low Side Lobe Windowing and displays the lowest side lobe and waveform resolution.

Appendix C — Error Messages

C-1 Introduction

This appendix provides a list of information and error messages that could be displayed on the test instrument. If any error condition persists, then contact your local Anritsu Service Center.

C-2 Reset Options

You can reset your instrument to Factory Defaults or use a Master Reset to return to the FULL Factory Default condition from the menu system or from the Off condition.

Reset Via Instrument Menus

From the instrument menu system, press the **Shift** key, then the **System** (**8**) key to open the System menu. Then press the System Options soft key to open the System Options menu. Then press the Reset soft key to open the Reset menu (refer to your user guide). From the Reset menu, press either the Factory Defaults soft key or the Master Reset soft key.

Reset from OFF Condition

You can also reset the instrument by turning it Off and then restarting under one of the following conditions:

Factory Defaults Reset:

Hold the **Esc** button while pressing the **On/Off** button. Continue holding the **Esc** button until the Anritsu splash screen appears. You can then release the button. The instrument starts up with many Factory Default settings (refer to your user guide). Throughout this appendix, this sequence is abbreviated as Factory Defaults (**Esc**+**On**).

Master Reset:

Hold the **8** key in the number keypad (also referred to as the **System** (**8**) key) while pressing the **On/Off** button. Continue holding the **8** key until the Anritsu splash screen appears. You can then release the key. The instrument starts up in FULL Factory Default condition (refer to your user guide). Throughout this appendix, this sequence is abbreviated as Master Reset (**System**+**On**).

C-3 Self Test or Application Self Test Error Messages

Self Test

To run self test, press **Shift** and **System** (**8**) and then Self Test. Refer to the results window in Figure C-1, which summarizes the status of several key functions in the instrument that are common to all applications (note that your instrument display may differ from this image). If any subtest shows FAILED, then check that the battery level is adequate for operation, or check that the temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults (**Esc**+**On**), or Master Reset (**System**+**On**).

Caution	Use of Master Reset (**System**+**On**), will erase all user saved setups and measurement traces and will return the instrument to a full Factory Default condition. If the error persists, then contact your Anritsu Service Center.

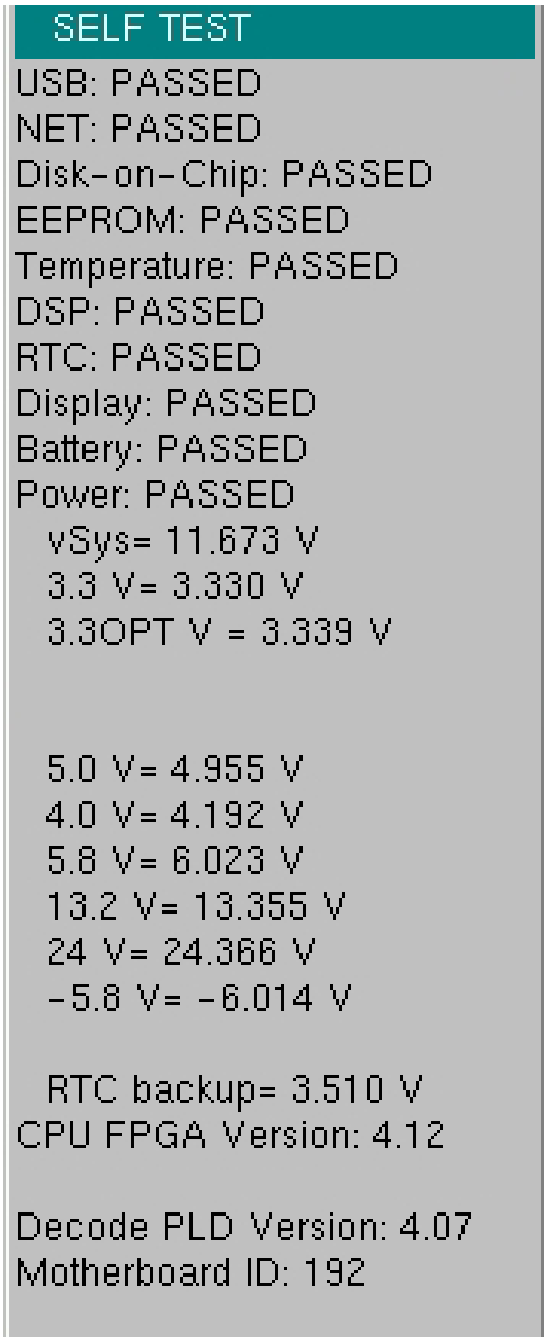


Figure C-1. Self Test Results Window (Vector Network Analyzer mode)

Application Self Test Results Window — VNA

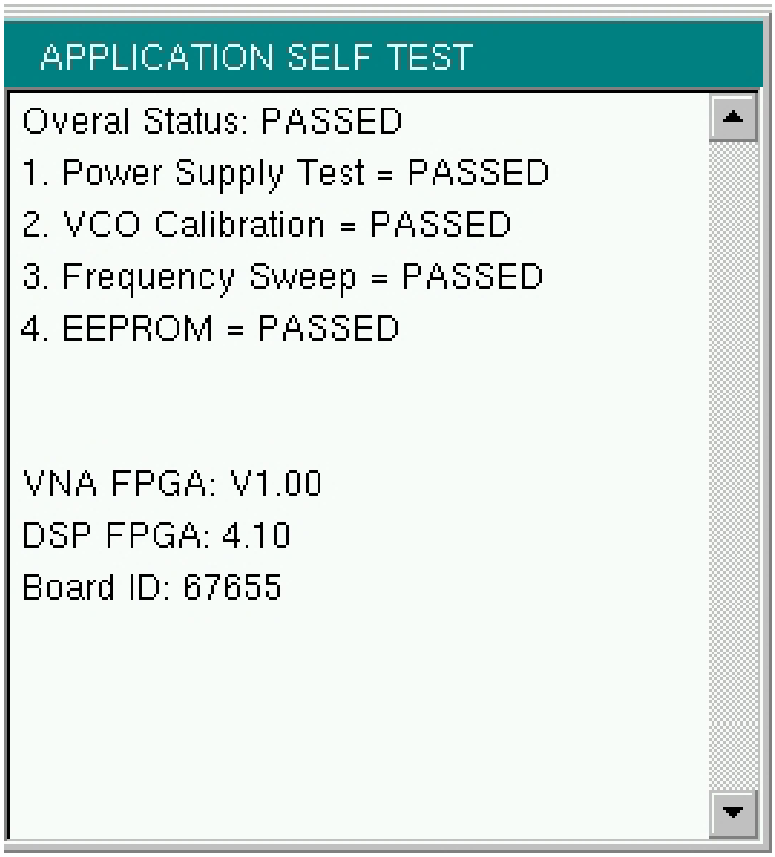


Figure C-2. Application Self Test Results Window (Vector Network Analyzer mode)

Application Self Test (Vector Network Analyzer mode only)

To run the application self test, press **Shift** and **System** (**8**) and then Application Self Test from within the desired mode. When you are in Vector Network Analyzer mode, you will see the results window that is shown in Figure C-2 (note that your instrument display may differ from this image), which summarizes the status of several key functions that are specific to this application.

If the Overall Status shows Failed, then one or more elements of the Application Self Test have failed. This self test consists of 4 subtests:

Power Supply Test: Lists any power supply voltages that are not meeting tolerance specification

VCO Calibration: Lists any frequency range over which the VCO calibration is failing

Frequency Sweep: Lists any frequency range over which errors in the sweep are occurring

EEPROM: Indicates whether reading or writing (or both) to the EPPROM has failed

If any of the subtests shows FAILED, then check that the battery level is adequate for operation or that temperature is within acceptable limits. Reset to factory defaults with either Factory Defaults (**Esc**+**On**), or Master Reset (**System**+**On**).

Caution	Use of Master Reset (**System**+**On**), will erase all user saved setups and measurement traces and will return the instrument to a full Factory Default condition. If the error persists, then contact your Anritsu Service Center.

Application Self Test Results Window — SPA

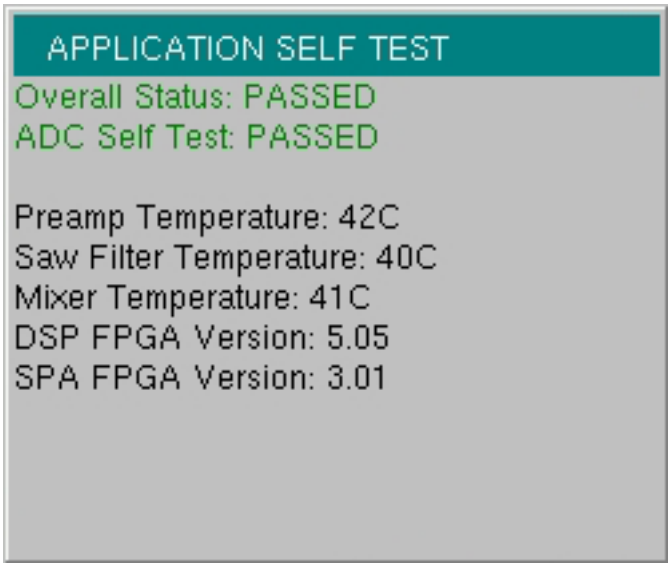


Figure C-3. Application Self Test Results Window (Spectrum Analyzer mode)

C-4 Operation Error Messages

Fan Failure

The system has determined that the fan should be running due to the internal temperature of the unit, but cannot detect that the fan is actually running.

It is important to keep the fan inlet and exhaust ports clear of obstructions. The cooling fan will vary the speed in relation to the internal temperature of the instrument (refer to Figure C-4). The fan will turn on at low speed when the internal temperature of the instrument reaches 44°C, and will increase the fan speed to maximum at 54°C. As the internal temperature of the instrument decreases, the fan will reduce speed until the temperature reaches 39°C, at which point the fan will turn off.

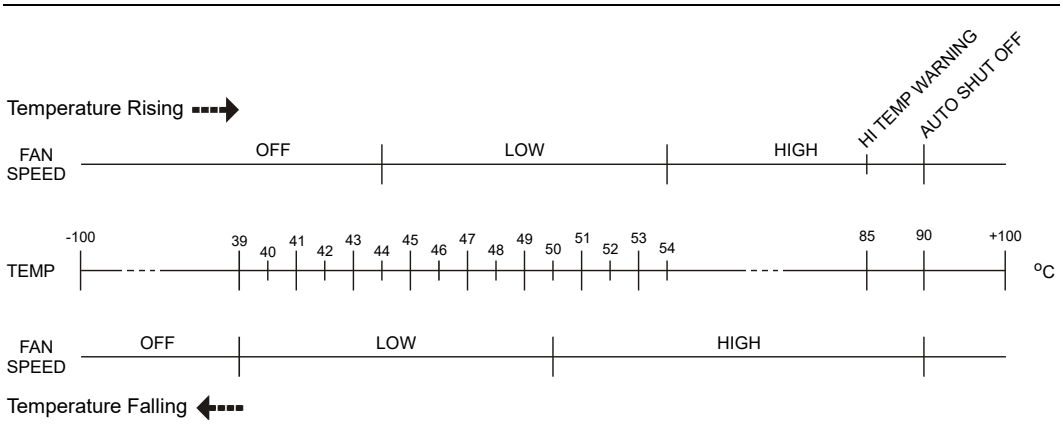


Figure C-4. Fan Speed vs. Temperature

High Temp Warning

The internal temperature has reached an excessive level, 85°C. Verify that the ventilation openings are unobstructed and that the fan is running. Internal temperatures may be manually verified by using the SELF TEST function. Turn off the unit and allow the temperature to cool down. If the fault is not resolved and the internal temperature reaches 90°C, then a countdown of 10 seconds will begin. The countdown gives the user a chance to save the current setup before the instrument turns itself off (before internal temperatures can cause any damage). If the error persists after removing any obstructions and allowing the unit to cool, then reset to the factory defaults with Factory Defaults (**Esc**+**On**), or Master Reset (**System**+**On**).

Caution	Use of Master Reset (**System**+**On**), will erase all user saved setups and measurement traces and will return the instrument to a full Factory Default condition. If the error persists, then contact your Anritsu Service Center.

Operation not Permitted in Recall Mode

Attempted to perform an operation on a recalled trace. Many operations are valid only on a live or active trace.

PMON PLD Fail

Unable to communicate with the Power Monitor PCBA.

Power Supply

Power Supply failed. Charge the battery.

Error Saving File. General Error Saving File

An error was detected while saving a file. Try again.

C-5 Vector Network Analyzer Specific Warning Messages

Bias Tee cannot be enabled for start freq < 2MHz

Adjust frequency before turning On the Bias Tee.

The start frequency cannot be set less than 2 MHz when the internal or external Bias Tee is turned On. Set the frequency to a value larger than or equal to 2 MHz, and then turn on the Bias Tee.

Bias Tee is not allowed for start freq < 2MHz.

Turn Off Bias Tee before changing the freq.

The internal or external Bias Tee cannot be turned on when the start frequency is set to less than 2 MHz. Turn off the Bias Tee, and then adjust the start frequency to the desired value less than 2 MHz.

Changing Source Power

Changing Source Power will affect the accuracy of the current calibration.

While Cal Correction is turned On, changing the source power level will affect the accuracy of the current calibration. The correction will remain On and can be used, but an indicator (**?P**) will appear next to the left-hand status column (**CAL: ON**) to note that the current power setting is different from the one used during the calibration processes.

No valid calibration to change correction

There is no valid calibration in volatile memory that can be used to turn Cal Correction On. A new calibration must be performed.

Cannot continue with calculating

Cannot continue with calculating. Not all required cal steps are completed.

When performing a calibration, you must complete all of the required steps before applying the “Calculate and Finish Cal” step.

Bias Tee state cannot be changed during calibration.

While performing a calibration, and before completing all of the calibration steps, you cannot turn on the Bias Tee. You must wait till after all of the calibration steps are complete before turning on the Bias Tee. This precaution is enforced to protect the calibration components from getting damaged by the Bias Tee current.

Turning Bias Tee to OFF.

Bias Tee was turned on when a new calibration sequence was started. The Bias Tee was turned off to protect the calibration components. After all the calibration steps are completed, you can turn the Bias Tee back on as required.

Turning Bias Tee to OFF.

Turning Bias Tee to OFF. Recalling measurement does not match with current setup.

The recalled measurement file does not match the current setup. To ensure DUT safety, the Bias Tee function is turned off.

Turning Bias Tee to OFF.

Turning Bias Tee to OFF. Recalling setup does not match with current setup.

The recalled setup file does not match the current setup. To ensure DUT safety, the Bias Tee function is turned off.

Calibration will be lost after change.

Calibration will be lost after change. Press the button again to continue.

While performing a calibration, and before completing all the calibration steps, if you change any of the frequency parameters (start, stop, center, span) or the number of points, then the calibration must be invalidated.

Changes not allowed during calibration.

Changes not allowed during calibration. Press Esc to abort calibration.

Certain parameters (such as frequency and number of points) can be changed while the calibration process is underway. Changing these parameters is not allowed unless the calibration is aborted first.

Option 10 (Bias Tee) not enabled.

To turn on the internal or external Bias Tee, Option 10 must be enabled in the instrument. Contact your Anritsu Service Center to inquire about enabling this option.

No External Reference signal detected.

External Reference was switched to 10 MHz but no external 10 MHz signal was detected. The External Reference setting is turned back to Off. Check the external reference level and frequency, and then try again.

Limit is not available for this Graph type.

Limits are supported only for rectilinear graph types (not for Smith Charts, for example).

Index

Numerics

1-port
- cable measurement 4-1
- log mag measurement, Field view 5-24
- phase measurement, Field view . 5-19
- port configuration 6-55
- Smith Chart tuning example 4-5
- Smith Chart, Field view 5-22
- tuning example 4-5

2-port
- amplifier measurement 4-10
- calibration considerations 4-16
- filter example 4-7
- gain, Bias Tee 10-5
- log mag measurement, Field view 5-24
- phase measurement, Field view . 5-19
- port configuration 6-55
- Smith Chart, Field view 5-22

6 GHz freq extension, option 16 3-1

A

active trace
- defined 2-2
- identify or select 2-2

Additional Dist Setup menu
- coax 6-10
- coax cable list 6-11, 7-7
- waveguide 6-12

admittance
- Inverted Smith Chart calculation . 3-7
- marker data format 3-8

amplified devices, source power, testing
- MS20xxB and S412E, field view . 7-14
- MS20xxB and S412E, VNA view . 6-58
- MS20xxC 6-58

amplifier
- measurement, 2-port 4-10

Anritsu contact 1-1
Anritsu, contact 1-1
application options
- Field view 5-1
- menu, SPA 6-65, 6-66
- menu, VNA mode 6-64

application options menu 7-19
architecture of the VNA Master 3-3
attenuation
- Field view cable loss 5-12
- Field view DTF 5-15

attributes of a trace 2-3
avg/smooth menu, Field view 7-14

B

balanced ports, Option 77, main topic 12-1
balanced test configuration 12-1
band pass mode menu 6-50
bandpass and domain processing 8-6
bandpass vs lowpass, example 8-6
battery
- status information 6-63

Beatty standard
- impedance mismatch 8-6
- measurement example 8-5, 8-6

bias
- external 3-8, 10-2
- internal 3-8, 10-2
- networks, low frequency resonances 4-12

bias tee
- Option 10, main topic 10-1
- 2-port gain, VNA measurement . 10-5
- block diagram, TMA-DD 10-4
- freq limitation 10-1
- if current level is exceeded 10-6
- internal, max current 10-2
- menu 6-57
- menus, Field 10-10
- menus, VNA, MS20xxB, S412E 10-12
- menus, VNA, MS20xxC 10-7
- power to block down-converters . 10-1
- power to some TMAs 10-1
- setup menu 6-56, 10-8, 10-11
- soft key 7-19
- VNA Master architecture . . . 3-8, 10-2

block diagram
- forward sweep 3-3
- internal/external bias 3-8, 10-2
- reverse sweep 3-4
- TMA-DD with bias 10-4
- VNA vs vector voltmeter 11-2

C

cable loss
- Field view description 5-12
- formula A-2
- log magnitude/2 formula 3-6
- soft key 7-6
- VNA view example 4-3

cables, differential, S-parameter 3-4
cal line setup
menu 6-27
calculating
center frequency 5-3
DTF measurements, Field view . . 5-18
frequency range 5-3
span 5-3
S-parameters 3-6
calibration
2 port, considerations 4-16
capacitance and inductance .6-32, 6-36
comparing S_{11} and S_{21} 4-7
correction, VVM description 11-6
existing cal info, Field view 7-18
existing cal info, VNA view 6-28
interpolation 6-22
invalidating 5-3
menu 6-19
menu group 6-18
menu, Field view 7-18
menu, functions overview 6-18
reciprocal 6-27
reducing data points 4-19
standard vs flex 6-20
thru correction 6-27
thru menu 6-25
touch screen shortcut 6-63
transmission response vs full 2-port 4-7
type examples 6-20
types 6-37
waveguide, considerations 4-13
capacitance of Open 6-32, 6-36
cautions
bias voltage 10-2
calibration invalid 4-16, 5-2, 5-3
master reset and user data C-2, C-5, C-6
propagation velocity of cable . .8-3, 9-3
saving calibration 6-59
center frequency calculation 5-3
chirp-Z transform
distance domain 9-1
time domain 8-1
common mode reflection coefficient . . 12-1
complex numbers, S-parameters 3-6
configure ports menu 6-55
connectors
Bias Tee LED indication 10-1
DUT Connector Selector . . .6-29, 6-33
example - detecting loose connector 4-3
list box, for Coax 6-31
list box, for waveguide 6-35
contacting Anritsu 1-1
current
bias tee limit setting 10-5
bias tee on display screen 10-1
internal bias tee (menu) 6-56
maximum exceeded for bias tee . . 10-6
maximum for bias tee 10-2
soft keys in bias tee menu .10-8, 10-11
CW menu, VVM 11-14

D

data points
calibration considerations 4-19
DTF, Field view 5-14
effect with smoothing 4-3
invalidating calibration 5-3
setting in Field view 5-3
versus sweep speed 5-15, 8-15
delta marker
marker menu 6-42
setup 2-8
differential reflection coefficient 12-1
differential S-parameter, S_{d1d1}
defined 3-4
Option 2 8-1
Option 77 3-4
differential test configuration 12-1
dip, DTF, loose connector 4-3
dispersion compensation on waveguide 8-11
dispersion correction, waveguide 4-14
display menu (trace) 6-68
distance
Field view, DTF measurement . . 5-16
horizontal D-Max, Field view . . . 5-18
resolution, windowing B-1
setup menu 6-9
stop, span formula A-2
distance domain
main topic 9-1
measurements 9-1
distance-to-fault (DTF)
dip, loose connector 4-3
distance domain 9-1
DTF menus, Field view 7-5
DTF Setup menu, Field view 7-6
example, distance domain 9-4
example, time domain 8-15
Field measurements 5-14
Field view calculations 5-18

mismatch (example) 4-3
reading and interpreting 4-2
ripples (example) 4-3
smoothing (example) 4-3
time domain 8-1
DMax
defined, Field view 5-18
DTF, Field view 5-14
formula 5-18, A-2
domain menu 6-49
domain processing
lowpass and bandpass 8-6
DTF menus, Field view 7-5
DTF Setup menu, Field view 7-6
dual channel filter tuning, Field view 5-27
DUT port setup menu 6-29

E

electrical length formula A-1
examples
1-Port Phase Meas, Field view . . 5-19
1-port phase, Field view 5-19
1-port Smith, antenna match . . . 5-22
2-Port Phase Meas, Field view . . 5-20
2-port phase, Field view 5-20
Beatty standard measurement 8-5, 8-6
cable loss, Field view 5-12
cable loss, VNA view 4-3
calibration types 6-20
detecting loose connector 4-3
DTF formula A-2
DTF in distance domain 9-4
DTF in time domain 8-15
DTF mismatch 4-3
DTF ripples 4-3
DTF smoothing 4-3
DTF with cable, Field view 5-15
DTF, 1-port 4-2
Dual Channel Filter Tuning 5-27
FGT for smoothing in waveguide 8-11
filter tuning, dual channel, ... 5-27
log mag dual overlay, Field view . 5-24
Log Magnitude Meas, Field view 5-24
lowpass vs bandpass 8-6
phasor impulse on waveguide . . . 8-13
return loss, VSWR, Field view . . . 5-9
S_{11} calibration 6-20
S_{11} interpretation 4-2
setting a freq range 5-3
setting up delta markers 2-8
Smith Chart Meas, Field view . . . 5-22
Smith Chart, 1-port 4-5
smoothing 4-3
S-parameters 3-2
trace format, VNA 2-1
tuning, 1-port 4-5
VNA measurement displays 2-4
windowing, 4 example figures B-1
existing cal info list box, Field view . . 7-18
existing cal info list box, VNA view . . 6-28
external bias 3-8, 10-2

F

fault resolution
defined, Field view 5-18
DTF, example formula A-2
DTF, Field view 5-14
formula 5-18, A-2
FGT menu 6-14
field measurements
description 5-1
menus 7-1
field view menu
avg/smooth 7-14
calibration 7-18
DTF Setup 7-6
group, basic 7-2
group, DTF 7-5
group, measure 7-15
group, scale 7-9
group, sweep 7-12
measure 7-15, 7-16
scale 7-10, 7-11
source power 7-14
sweep 7-13
windowing 7-8
filter tuning, dual channel, Field view 5-27
firmware
version 2.0 for MS2026B 1-3
version 2.0 for MS2028B 1-3
version information display 6-63
version requirement for V2.0 1-2
flex cal type 6-28
formula
a list A-1
cable loss A-2
DMax 5-18, A-2
electrical length A-1
fault resolution 5-18, A-2
Group delay 3-7
Inverted Smith Chart A-1
Log Mag 3-6

Log Mag/2 3-6
log magnitude (return loss) 3-6
log magnitude⁄2 (cable loss) 3-6
Phase in degrees (S-Parameter) . . 3-6
propagation velocity A-2
reflection coefficient A-1
return loss A-1
SImaginary 3-6
Smith Chart A-1
SReal 3-6
suggested span 5-18, A-2
SWR 3-7
SWR (reflection) 3-7
VSWR A-1
forward reflection or transmission 3-2
Fourier transform
distance domain 9-1
time domain 8-1
Freq menu, Field view 7-3
Freq/Dist menu, Field view 7-4
frequency
1-port cable measurement 4-1
2-port amplifier measurement . . . 4-12
2-port filter measurement 4-7
additional dist setup menu (WG) 6-12
bias tee fundamentals 10-1
calibration considerations 4-19
differential cable example 12-4
differential match, S_{d1d1} 12-3
dispersion, waveguide 8-11
distance information 9-6
distance setup menu 6-9
domain menu 6-49
FGT menu 6-14
freq menu 6-4
Freq menu, Field view 7-3
Freq/Dist menu, Field view 7-4
group delay calculation 3-7
IFBW in sweep menu 6-53, 6-54
insertion loss sweep example 4-3
limit edit menu 6-40
limit line and freq span 6-38
marker capabilities 2-7
measure menu, domain 6-46
menu group 6-3
range calculation 5-3
setup domain menu 6-5
Smith Chart calculation 3-7
Smith Chart tuning example 4-5
span, invalidating calibration 5-3
time and distance information . . 8-17
time menu 6-6
trace math 2-9
transforming to distance 9-1
transforming to time or distance . . 8-1
windowing 8-15, 9-4
windowing (appendix) B-1
Frequency Gated by Time (FGT)
measurement description 8-9
menu 6-14
notch measurement description . 8-10
full 2-port calibration
amplifier measurement 4-10
calibration considerations 4-16
filter measurement 4-7
increased accuracy 4-8
vector voltmeter 11-5

G

gain
2-port bias tee 10-5
2-port S_{21} 4-10
calculating 3-6
gate setup menu 6-15
gate shape menu 6-17
group delay
2-port amplifier measurement . . . 4-11
Aperture % soft key 6-60
formula 3-7
marker data format 3-8
VNA phase measurement 3-1

H

High Port Power setting 10-5
high-loss devices, source power, testing
MS20xxB and S412E, field view . 7-14
MS20xxB and S412E, VNA view . 6-58
http, contacting Anritsu 1-1

I

imaginary numbers, S-parameters . . . 3-6
impedance
marker data format 3-8
mismatch example, Beatty std . . . 8-6
impulse response
example with Beatty std 8-5, 8-6
inductance of Short 6-32, 6-36
internal bias 3-8, 10-2
Internal, Bias Tee soft key 10-9
interpolation,extending calibration . . 6-22
interpretation

1-port cable meas 4-2
2-port amplifier measurement . . 4-10
waveguide measurements 4-14
Inverted Smith Chart
applications 3-7
formula A-1
smith scale menu 6-61

K

key presses to select a setting 6-47

L

limit
alarm, on/off soft key 6-39
limit edit menu 6-40
menu 6-39
menu group 6-38
menu, functions overview 6-38
setting up 2-8
limit line (rectangular graphs only) . . 2-8
line delay, thru correction 6-27
line length, thru correction 6-27
linear magnitude
marker data format 3-8
links
contacting Anritsu 1-1
links, contact 1-1
list box
existing cal info, Field view 7-18
existing cal info, VNA view 6-28
log mag dual display measurement . . 5-24
log magnitude
(return loss) formula 3-6
image, differential S_{d1d1} display . 12-3
image, input match at 375 MHz . . 4-6
image, VNA S_{21} measurement . . 10-5
log mag formula, S_{xy} 3-6
marker data format 3-8
log magnitude/2 (cable loss) formula . . 3-6
loose connector, dip, DTF 4-3
low pass mode menu 6-50
low port power setting 10-5
lowpass and domain processing 8-6
lowpass vs bandpass, example 8-6

M

marker
defined 2-7
delta, setup 2-8
location control 2-7, 2-8
marker search menu 6-43
menu 6-42
menu group 6-41
menu, Field view 7-17
readout format 2-7
readout style 2-7
touch screen control 2-7, 2-8
math, trace math described 2-9
maximize an active trace 2-3
measure
menu, Field view 7-15, 7-16
measure group menus, Field view . . . 7-15
measurement
1-port cable measurement 4-1
1-port, 2-port phase 5-19
2-port amplifier 4-10
distance domain 9-1
FGT description 8-9
FGT notch description 8-10
log mag dual display 5-24
menu 6-46
menu group 6-45
return loss described 5-9
selection, Field or VNA 4-1, 5-1
Smith Chart, Field view 5-22
time domain 8-1, 8-5
trace description 2-3
menu
additional dist setup (coax) 6-10
additional dist setup (waveguide) 6-12
application options 7-19
application options, SPA . . . 6-65, 6-66
application options, VNA 6-64
avg/smooth, Field view 7-14
band pass mode 6-50
basic group, Field view 7-2
bias tee setup 6-56, 10-8, 10-11
bias tee, Field 10-10
bias tee, MS20xxC 6-57
bias tee, VNA 10-7
cable list (coax) 6-11, 7-7
cal line setup 6-27
calibration 6-19
calibration with thru 6-25
calibration, Field view 7-18
configure ports 6-55
CW menu, VVM 11-14
display, Trace 6-68
distance setup 6-9
domain 6-49
DTF setup, Field view 7-6

DUT port setup 6-29
FGT 6-14, 6-15
freq 6-4
freq, Field view 7-3
Freq/Dist, Field view 7-4
gate shape 6-17
limit 6-39
limit edit 6-40
low pass mode 6-50
marker 6-42
marker search 6-43
marker, Field view 7-17
measure group, Field view 7-15
measure, Field view 7-15, 7-16
measurement 6-46
number of traces 6-51
polar scale 6-62
preset 6-59
scale 6-60
scale group, Field view 7-9
scale, Field view 7-10, 7-11
setup domain 6-5
Smith scale 6-61
Smith scale, Inverted 6-61
SOLT-Coax 6-32, 6-36
source power, Field view 7-14
source power, MS20xxB, S412E . 6-58
source power, MS20xxC 6-58
sweep group, Field view 7-12
sweep, Field view 7-13
sweep, MS20xxB, S412E 6-54
sweep, MS20xxC 6-53
system 6-63
table, VVM 11-15
time 6-6
time domain options 6-67
trace 6-68
trace format 6-52
trace math 6-69
windowing 6-8
windowing, Field view 7-8
menu groups
calibration 6-18
field view, DTF 7-5
frequency 6-3
limit 6-38
marker 6-41
measurement 6-45
minimize an active trace 2-3
mismatch
determination
with phasor impulse 8-13
DTF example 4-3
mixed mode reflection coefficients
S_{c1d1} and S_{d1c1} 12-1

N

number of traces menu 6-51

O

offset short 4-13
option
02, time domain 8-1
10, bias tee 10-1
15, vector voltmeter 11-1
16, 6 GHz freq extension 3-1
77, balanced ports 12-1
501, distance domain 9-1

P

passive devices, source power, testing
MS20xxB and S412E, field view . 7-14
MS20xxB and S412E, VNA view . 6-58
MS20xxC 6-58
peak search
DTF, Field view 5-16
phase
distortion, group delay measurement 3-7
in degrees (S-Parameter) formula . 3-6
marker data format 3-8
match between RF cables, VVM . 11-1
matching, CW display 11-10
measurement, Field view 5-19
phase of discontinuity
phasor impulse 8-13
properties of DUT
configure ports menu 6-55
phasor impulse
impedance discontinuities 8-13
mismatch determination 8-13
polar plot 8-14
plane of calibration
reference plane soft keys 6-55
polar impedance
marker data format 3-8
polar scale menu 6-62
power
High Port Power 10-5
level, 2-port gain, bias tee 10-5
Low Port Power 10-5
phase measurement settings 5-19

power supply, failure C-7
reflected, return loss/VSWR 5-9
preset menu 6-59
propagation velocity
caution 8-3, 9-3
DTF, Field view 5-15
formula A-2

R

real and imaginary
marker data format 3-8
numbers, S-parameters 3-6
reciprocal calibration 6-27
reference plane
soft keys in configure ports menu 6-55
reflection coefficient formula A-1
reflection coefficients 12-1
reflection measurement
one way vs round trip 4-15
reflection parameters 3-2
resolution
distance domain 9-1
fault, DTF, Field view 5-18
fault, DTF, Field view, description 5-14
time domain 8-1
windowing B-1
resonances, low frequency
in bias networks 4-12
return loss
described 5-9
DTF, Field view 5-14
Field view 5-9
formula A-1
log magnitude formula 3-6
versus SWR 4-2
vs cable loss, Field view 5-12
reverse reflection or transmission 3-2
ripples, phase interactions 4-3

S

S_{11}
block diagram 3-3
calibration example 6-20
description 3-2
Log Mag formula 3-6
trace math 2-9
S_{12}
block diagram 3-4
description 3-2
S_{21}
block diagram 3-3
description 3-2
S_{22}
block diagram 3-4
description 3-2
sampling oscilloscope alternative . . . 12-1
Scalar Network Analyzer (SNA) 3-1
scale menu 6-60
scale menu group, Field view 7-9
scale menu, Field view 7-10, 7-11
S_{c1c1} reflection coefficient 12-1
S_{d1d1} reflection coefficient 12-1
S_{d1d1}, differential S-parameter
Option 2 8-1
Option 77 . . . . . 3-4, 12-1
selecting a setting, key presses 6-47
selecting field or VNA measurement 4-1, 5-1
setup domain menu 6-5
shortcut to touch screen calibration . 6-63
Smith Chart
applications 3-7
applications, Inverted Smith Chart 3-7
example, 1-port 4-5
formula A-1
formula, Inverted Smith Chart . . . A-1
measurement, Field view 5-22
smith scale menu 6-61
VNA phase measurement 3-1
smoothing
example 4-3
greater than 2000 sweep pts . 4-3, 6-46
SOLT-Coax menu 6-32, 6-36
source power menu, Field view 7-14
Source Power menu, MS20xxB, S412E 6-58
Source Power menu, MS20xxC 6-58
span
calculation 5-3
frequency, DTF, Field view 5-14
S-parameters
calculating and displaying 3-6
calibration 4-19
defined 3-2
differential, Option 77 12-1
differential, S_{d1d1}, Option 2 8-1
differential, S_{d1d1}, Option 77 3-4
examples 3-2
SSLT
waveguide calibration 4-13
SSST
waveguide calibration 4-13
step response

example with Beatty std 8-6
measurement uses 8-6
versus impulse response 8-6
suggested span formula 5-18, A-2
sweep
menu, MS20xxC 6-53
menu, VNA, MS20xxB, S412E . . 6-54
preset resets sweep conditions . . 6-59
sweep menu, Field view 7-13
sweep speed versus data points .5-15, 8-15
SWR
marker data format 3-8
SWR (reflection) formula 3-7
SWR formula 3-7
SWR versus return loss 4-2
system
menu 6-63
menu, overview 6-63

T

table menu, VVM 11-15
thru correction for calibration 6-27
time
FGT menu 6-14
menu 6-6
time domain
example with Beatty std 8-5
measurement uses 8-5
measurements 8-1
Option 2, main topic 8-1
options menu 6-67
VNA phase measurement 3-1
touch screen
calibration shortcut 6-63
marker manipulation 2-7, 2-8
maximizing and minimizing traces 2-3
selecting a trace 2-3
trace
active, identify or select 2-2
format menu 6-52
math menu 6-69
measurement description 2-3
menu 6-68
touch screen controls 2-3
touch screen marker control 2-8
trace math, described 2-9
transmission parameters 3-2
transmission response calibration 4-7
triple offset short (SSST) 4-13
tuning example
1-port, VNA view 4-5
dual channel, Field view 5-27

U

units
DTF, Field view 5-15
URL contacting Anritsu 1-1

V

vector voltmeter, Option 15, main topic 11-1
version, refer to firmware
VNA
defined 3-1
measurement selection 4-1, 5-1
phase measurement 3-1
voltage, bias tee 10-2
VSWR
DTF, Field view 5-14
formula A-1
VVM mode
calibration correction 11-6
comparison measurements, table 11-12
CW menu 11-14
how it works 11-4
relative measurements, CW . . . 11-10
table menu 11-15

W

warnings
external bias tee power 10-2
high temperature C-6
VNA-specific messages C-7
waveguide
dispersion compensation 8-11
dispersion correction 4-14
FGT for smoothing, example 8-11
measurement considerations 4-13
web links, contact 1-1
Web site, contacting Anritsu 1-1
windowing
distance domain 9-4
menu 6-8
menu, Field view 7-8
resolution B-1
time domain 8-15

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