Measurement Guide

Cable and Antenna Analyzer for Anritsu Instruments:

BTS Master MT8221B

	Options
Cable and Antenna Analyzer	Included
Bias-Tee	0010

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NOTICE

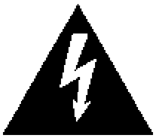
UPDATES

Updates, if any, can be downloaded from the Documents area of the Anritsu web site at:
http://www.us.anritsu.com

To prevent the risk of personal injury or loss related to equipment malfunction, Anritsu Company uses the following symbols to indicate safety-related information. For your own safety, please read the information carefully *before* operating the equipment.

Symbols Used in Manuals

Danger



This indicates a very dangerous procedure that could result in serious injury or death, or loss related to equipment malfunction, if not performed properly.

Warning

This indicates a hazardous procedure that could result in light-to-severe injury or loss related to equipment malfunction, if proper precautions are not taken.

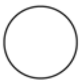
Caution

This indicates a hazardous procedure that could result in loss related to equipment malfunction if proper precautions are not taken.

Safety Symbols Used on Equipment and in Manuals

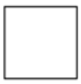
The following safety symbols are used inside or on the equipment near operation locations to provide information about safety items and operation precautions. Ensure that you clearly understand the meanings of the symbols and take the necessary precautions *before* operating the equipment. Some or all of the following five symbols may or may not be used on all Anritsu equipment. In addition, there may be other labels attached to products that are not shown in the diagrams in this manual.

This indicates a prohibited operation. The prohibited operation is indicated symbolically in or near the barred circle.



This indicates a compulsory safety precaution. The required operation is indicated symbolically in or near the circle.

This indicates a warning or caution. The contents are indicated symbolically in or near the triangle.



This indicates a note. The contents are described in the box.

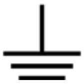
These indicate that the marked part should be recycled.

Warning

Always refer to the operation manual when working near locations at which the alert mark, shown on the left, is attached. If the operation, etc., is performed without heeding the advice in the operation manual, there is a risk of personal injury. In addition, the equipment performance may be reduced. Moreover, this alert mark is sometimes used with other marks and descriptions indicating other dangers.

Warning

or



When supplying power to this equipment, connect the accessory 3-pin power cord to a 3-pin grounded power outlet. If a grounded 3-pin outlet is not available, use a conversion adapter and ground the green wire, or connect the frame ground on the rear panel of the equipment to ground. If power is supplied without grounding the equipment, there is a risk of receiving a severe or fatal electric shock.

Warning

This equipment can not be repaired by the operator. Do not attempt to remove the equipment covers or to disassemble internal components. Only qualified service technicians with a knowledge of electrical fire and shock hazards should service this equipment. There are high-voltage parts in this equipment presenting a risk of severe injury or fatal electric shock to untrained personnel. In addition, there is a risk of damage to precision components.

Caution

Electrostatic Discharge (ESD) can damage the highly sensitive circuits in the instrument. ESD is most likely to occur as test devices are being connected to, or disconnected from, the instrument's front and rear panel ports and connectors. You can protect the instrument and test devices by wearing a static-discharge wristband. Alternatively, you can ground yourself to discharge any static charge by touching the outer chassis of the grounded instrument before touching the instrument's front and rear panel ports and connectors. Avoid touching the test port center conductors unless you are properly grounded and have eliminated the possibility of static discharge.

Repair of damage that is found to be caused by electrostatic discharge is not covered under warranty.

Table of Contents

Chapter 1 — General Information

1-1 Introduction

The BTS Master offers a wide range of display options for 1-port and 1-path 2-port vector corrected measurements.

Cable and antenna analyzer measurements include: Return Loss/VSWR, Cable Loss, Distance-To-Fault (RL and VSWR), 1-Port Phase, Smith Chart, 2-Port Gain, 2-Port Phase.

1-2 General Measurement Setups

Please refer to the BTS Master User Guide for setting frequency, span, amplitude, GPS, limit lines, markers, file management, and system settings. Chapter 2 details Cable and Antenna measurements. Calibration is discussed in Chapter 3.

1-3 Selecting the Cable and Antenna Mode

1. Press the **Shift** key followed by pressing the **Mode** (9) key on the numeric keypad to open the Mode Selector list box.
2. Use the directional arrow keys or the rotary knob to highlight the mode, and press the **Enter** key to select.

Caution	The maximum input power without damage is +30 dBm on the RF In port. To prevent damage, always use a coupler or high power attenuator.

Chapter 2 — Cable and Antenna Analyzer

2-1 Overview

This chapter shows how to setup the instrument and perform basic line sweep measurements.

Note	Confirm that the instrument is in Cable & Antenna Analyzer mode. Refer to “General Measurement Setups” on page 1-1.

For accurate results, the instrument must be calibrated before making any measurements.

The instrument must be re-calibrated whenever the temperature exceeds the calibration temperature range or when the test port extension cable is removed or replaced. Unless the calibration type is Flexcal, the instrument must also be re-calibrated every time the setup frequency changes. See Chapter 3, “Calibration” for details on how to perform a calibration.

2-2 Using Markers

Pressing the **Marker** function hard key below the display will bring up the Marker menu.

Press the Marker submenu key to select a marker. The underlined number indicates the active marker. The On/Off submenu key turns the selected marker On or Off. Use the arrow keys, the keypad or the rotary knob to move the marker. The current value for the selected marker is shown above the upper left corner of the graph.

The Delta submenu key is available for each marker giving a total of 6 Delta markers. The Marker Table submenu key displays a table of up to six Markers and 6 Delta Markers simultaneously, showing frequency and amplitude respectively (Figure 2-1).

The Marker to Peak submenu key moves the currently selected marker to the peak of the trace. The Marker to Valley submenu key moves the currently selected marker to the valley of the trace.

Note	Screen captured images are provided as examples. The image and measurement details shown on your instrument may differ from the examples in this user guide.

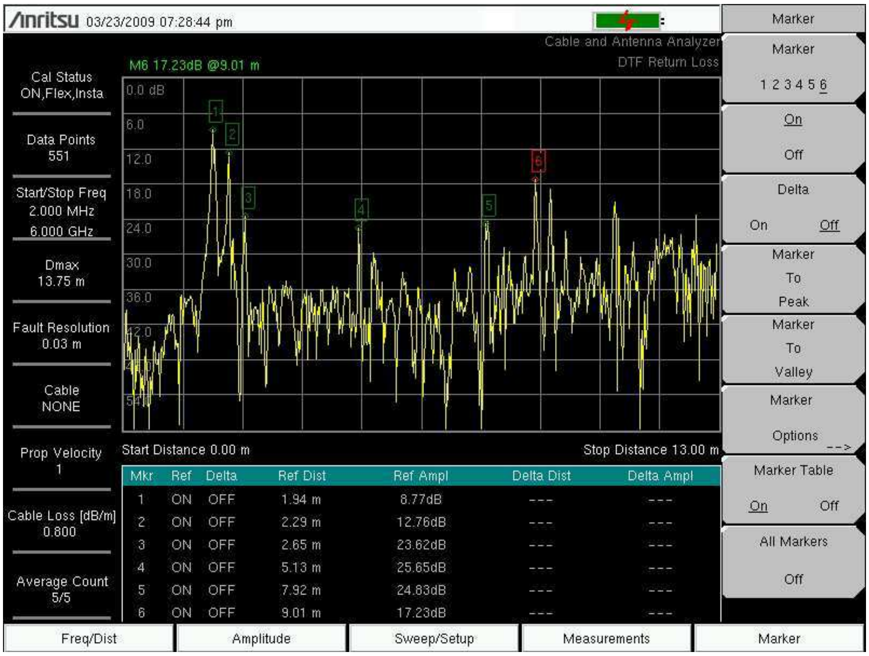


Figure 2-1. Marker Table

2-3 Using Limit Lines

To access the functions under the Limit menu, press the **Shift** key, then the **Limit** (6) key.

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.

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, allowing the configuring of specific limit envelopes at various frequencies of interest without having to re-configure them each time 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 submenu key.

The Limit On/Off submenu key turns the currently limit line on or off.

The Multi-Segment Edit submenu key displays a submenu that allows the creation or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

The Limit Alarm submenu key enables the alarm to beep when a data point exceeds the limit.

The Clear Limit submenu key deletes all limit points for the currently active limit line and defaults to a single limit whose amplitude value will be selected to make it visible on the screen. The other limit line is not altered.

Setting up Non-segmented Limit Lines

1. Press the **Shift** key, then the **Limit** (6) key.
2. Press the Limit On/Off submenu key to turn on the limit line.
3. Press the Single Limit submenu key to set the amplitude value of the limit line.

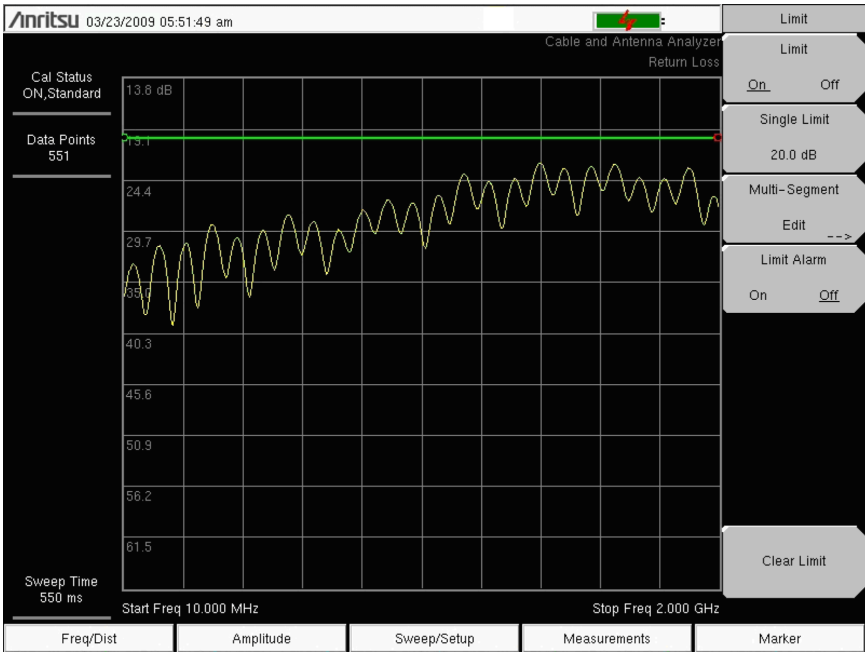


Figure 2-2. Single Limit Lines

Segmented Limit Lines

The following procedure creates limit lines for a Return Loss Measurement. Limits are set to:

- 0 dB between 1800 MHz and 1830 MHz
- 13.5 dB between 1830 and 1870 MHz, and
- 0 dB between 1870 and 1900 MHz.

The frequency is set from 1800 MHz to 1900 MHz.

1. Press **Shift** and then **Limit** (6) to enter the Limit menu.
2. Press the Multi-Segment Edit key/
3. The default limit line has two points. In this example, 3 segments require 6 points. Press the Add Point key four times to add four more points.
4. Press Next Point Left until the highlighted red point is the first point to the left. Press Point Value and enter 0 dB.
5. Press Next Point Right and set the Point Value to 0 dB for the second point from the left. Press Point Freq and enter 1830 MHz.
6. Press Next Point Right and set the Point Value to 13.5 dB for the third point from the left. Press Point Freq and enter 1830 MHz.
7. Press Next Point Right and set the Point Value to 13.5 dB for the fourth point from the left. Press Point Freq and enter 1870 MHz.
8. Press Next Point Right and set the Point Value to 0 dB for the fifth point from the left. Press Point Freq and enter 1870 MHz.
9. Press Next Point Right and set the Point Value to 0 dB for the sixth point from the left. Press Point Freq and enter 1900 MHz.

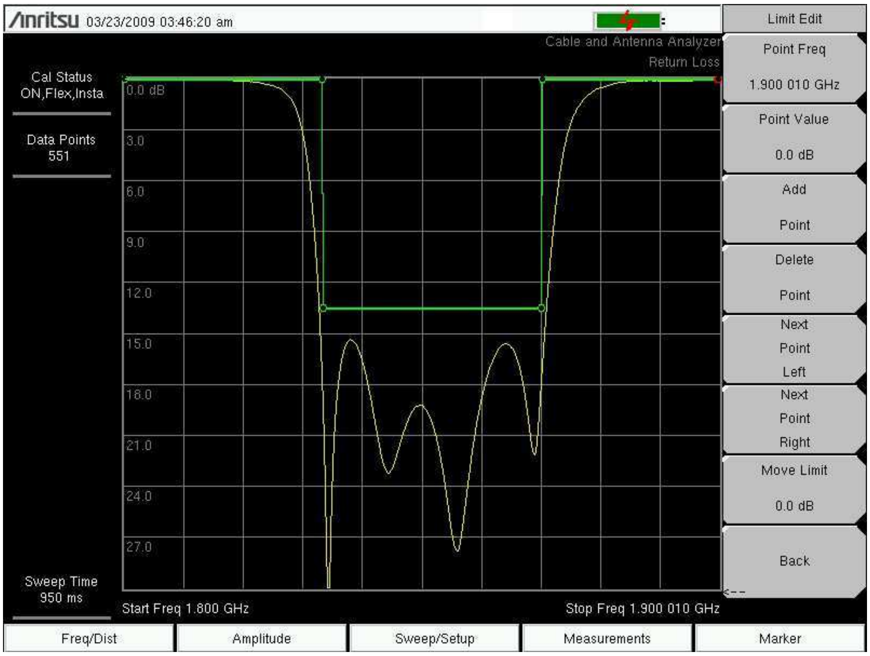


Figure 2-3. Segmented Limit Lines

2-4 Using Trace Math

Trace Math menu is an excellent tool for comparing two traces. It is possible to upload traces using Master Software Tools, store those traces in memory, and compare the stored trace with a more recent trace. It is also possible to use the trace math features to normalize the trace and obtain a reference for S21 measurements where a full 2-port calibration is not needed. The trace math menu can be used to add or subtract logarithmic data (multiply and divide linear data).

The Trace Math menu is accessed by pressing the **Shift** key and the **Trace** (5) key.

Example 1

Comparing the Return Loss data for two five meter cables, Cable A and Cable B (Figure 2-4).

1. Press the **Measurement** main menu key and press the Return Loss submenu key.
2. Connect Cable B to the BTS Master RF Out port.
3. Press the **Shift** key and the **Trace** (5) key.
4. Press the Copy Trace To Display Memory submenu key.
5. Connect Cable A to the BTS Master RF Out port and perform the same Return Loss measurement over the same frequency range.
6. Turn Trace Overlay submenu key On to view the Return Loss measurement of Trace B.
7. Press the Trace + Memory submenu key to view the Return Loss measurement of Trace A and Trace B at the same time.
8. Press the Trace - Memory submenu key to look at the difference in Return Loss between the two cables.

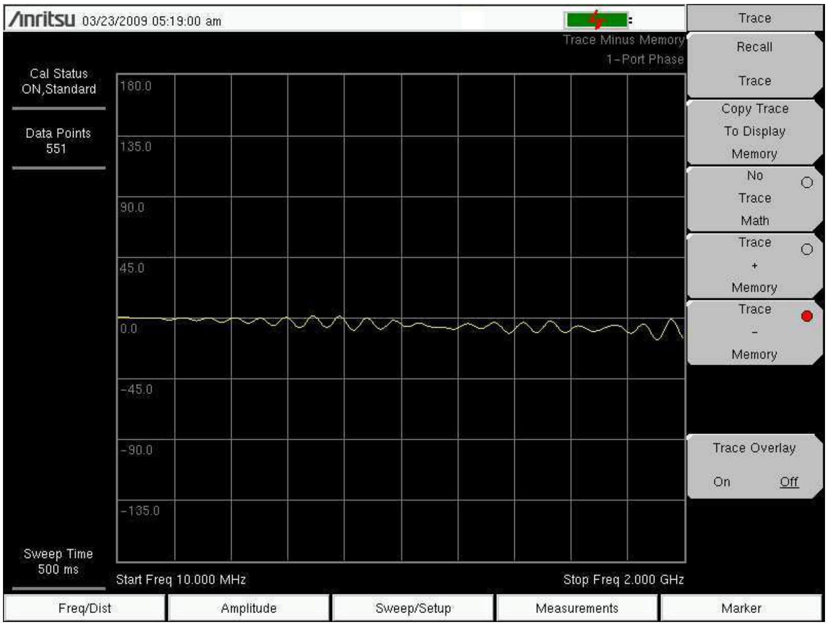


Figure 2-4. Trace Menu Showing Trace – Memory

Example 2

Using the Trace Menu to normalize a trace for Transmission measurement. Please note that normalizing the trace will not give the same accuracy as a calibrated 2-port measurement.

Note	The instrument incorporates internal gain stages that can negatively affect measurement accuracy if used uncalibrated. This effect can be exaggerated when using trace math to compare measurements with different gains.

1. Connect a through cable between Ports 1 and 2 for the normalization procedure.
1. Press the **Measurement** main menu key. Press the 2-Port Gain submenu key.
2. Under the **Freq/Dist** main menu key, use the Start Freq and Stop Freq submenu keys to set the Start and Stop frequencies.
3. Press the **Shift** key and the **Trace** (5) key.
4. Press the Copy Trace To Display Memory submenu key.
5. Press the Trace - Memory submenu key to see the trace normalized around 0 dB (Figure 2-5).

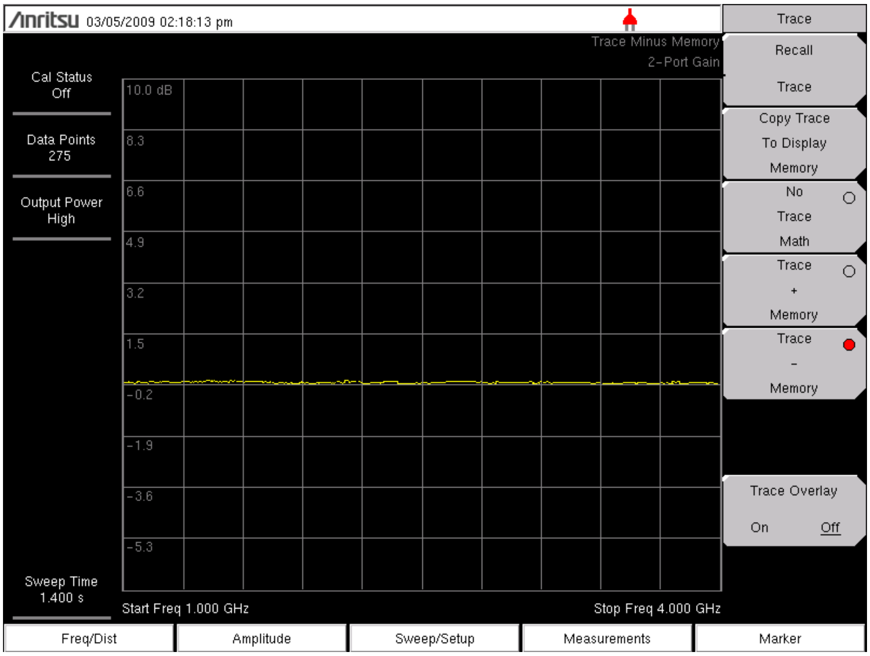


Figure 2-5. Normalizing the Trace Using Trace Math

2-5 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, or by using Master Software Tools to display the reflection coefficient.

Procedure

1. If a test port extension cable is to be used, connect it to the RF Out connector.
2. Press the **Measurement** main menu key and press the Return Loss submenu key.
3. Under the **Freq/Dist** main menu key, use the Start Freq and Stop Freq submenu keys to set the Start and Stop frequencies. Or enter a known signal standard by pressing Signal Standard submenu key followed by Select Standard (Figure 2-6).

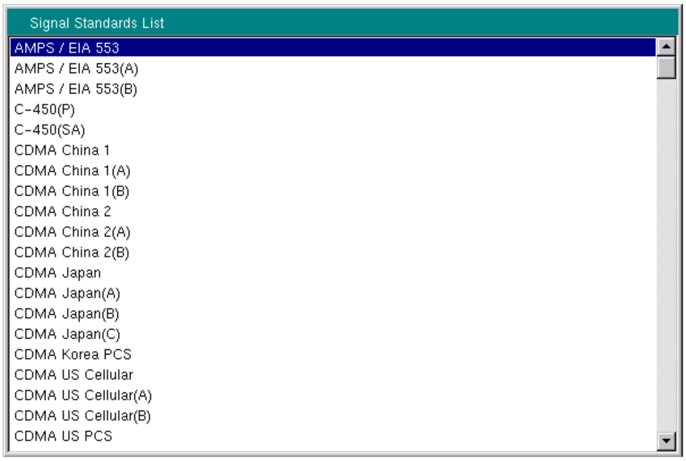


Figure 2-6. Signal Standards

4. Press the Start Cal submenu key and perform a 1-port OSL calibration at the connector or at end of the extension cable. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display and the trace should be centered around 0 dB when the short or open is connected.
5. Connect the test port extension cable to the Device Under Test (DUT).
6. Refer to the Users Guide for saving trace measurements.
7. Press the **Measurement** main menu key and press the VSWR submenu key to view the match in VSWR.

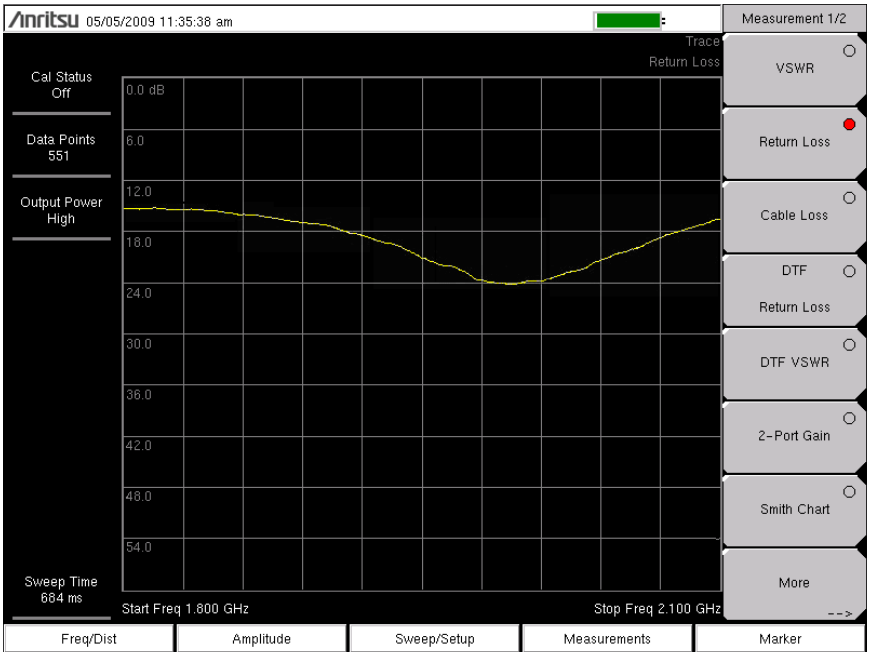


Figure 2-7. Return Loss of an Antenna

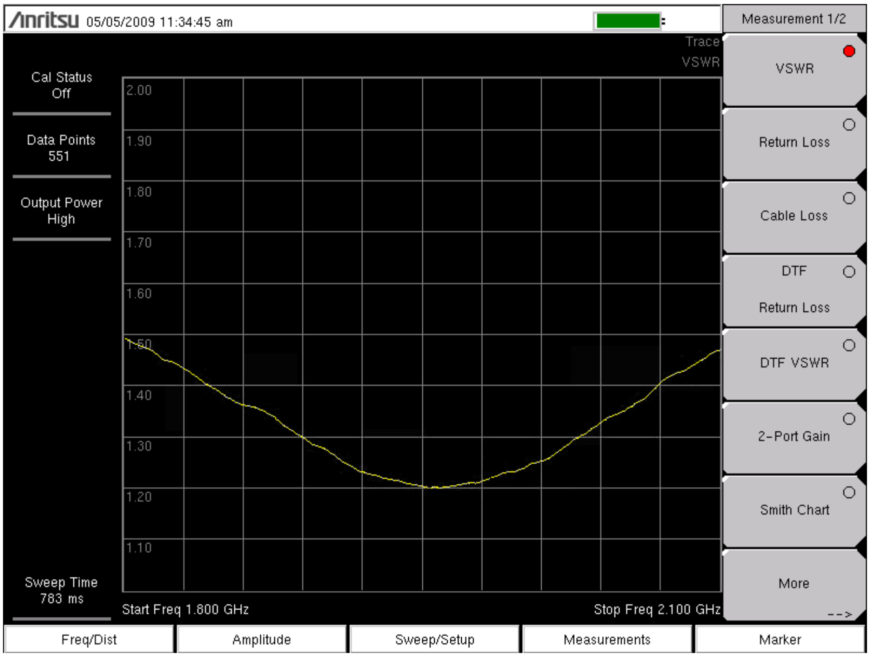


Figure 2-8. VSWR of an Antenna

2-6 Cable Loss

The cable 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 there is no need to compute anything. Cable Loss is a Return Loss measurement, but it also takes into consideration that the signal travels in both directions.

Procedure

1. If a test port extension cable is to be used, connect it to the RF Out connector on the BTS Master.
2. Press the **Measurement** main menu key and press the Cable Loss submenu key.
3. Press the **Freq/Dist** main menu key and set the Start Frequency and Stop Frequency.
4. Press the **Shift** key, then the **Calibrate** (2) key.
5. Press the Cal Type submenu key to set the calibration to 1-Port.
6. Press the Start Cal submenu key and perform a 1-port OSL calibration at the connector or at end of the extension cable. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display and the trace should be centered around 0 dB when the short or open is connected.
7. Connect the test port extension cable to the Feed Line.
8. Refer to the User Guide for saving the trace measurement. Note that average Cable Loss: (peak + valley) / 2 is displayed in the status window.

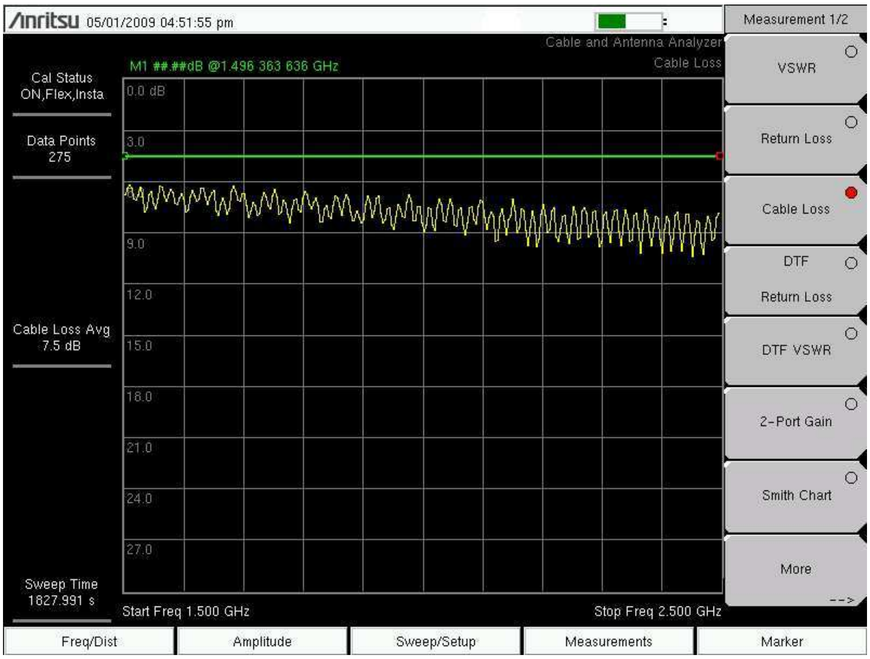


Figure 2-9. Cable Loss

2-7 Distance-to-Fault (DTF)

The DTF measurement displays return loss (or VSWR) values versus distance. If the 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 the individual components including connector pairs and cable components.

To measure the distance of a cable, 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/short will reflect everything and the true value of a connector might be misinterpreted and a good connector could look like a failing connector.

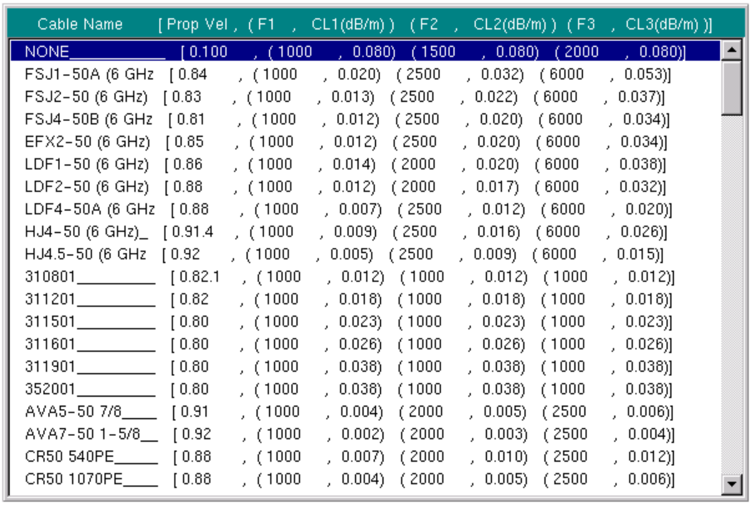
A 50Ω load is the best termination for troubleshooting DTF problems because it will be 50Ω over the entire frequency range. The antenna can also be used as a terminating device but the impedance of the antenna will change over different frequencies because most antennas are only designed to have 15 dB 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 TMAs (Tower Mounted Amplifiers), duplexers, filters, and quarter wave lightning arrestors 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. Appendix B provides TMA details.

Because of the nature of the measurement, maximum distance range and fault resolution is dependent on the frequency range and number of data points. DTF Aid shows how the parameters are related. If the cable is longer than DMax, the only way 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 BTS Master is equipped with a cable list (Figure 2-10) including most of the common cables used today. Once the correct cable has been selected, the measurement parameters will update the propagation velocity and the cable attenuation values to correspond with the cable. These values can also be entered manually. Custom Cable lists can also be created with Master Software Tools and uploaded into the instrument. Incorrect propagation velocity values will affect the distance accuracy and inaccurate cable attenuation values will affect the accuracy of the magnitude value.



Cable Name	[Prop Vel ,	(F1 ,	CL1(dB/m))	(F2 ,	CL2(dB/m))	(F3 ,	CL3(dB/m))]
NONE____________	[0.100 ,	(1000 ,	0.080)	(1500 ,	0.080)	(2000 ,	0.080)]
FSJ1-50A (6 GHz	[0.84 ,	(1000 ,	0.020)	(2500 ,	0.032)	(6000 ,	0.053)]
FSJ2-50 (6 GHz)	[0.83 ,	(1000 ,	0.013)	(2500 ,	0.022)	(6000 ,	0.037)]
FSJ4-50B (6 GHz	[0.81 ,	(1000 ,	0.012)	(2500 ,	0.020)	(6000 ,	0.034)]
EFX2-50 (6 GHz)	[0.85 ,	(1000 ,	0.012)	(2500 ,	0.020)	(6000 ,	0.034)]
LDF1-50 (6 GHz)	[0.86 ,	(1000 ,	0.014)	(2000 ,	0.020)	(6000 ,	0.038)]
LDF2-50 (6 GHz)	[0.88 ,	(1000 ,	0.012)	(2000 ,	0.017)	(6000 ,	0.032)]
LDF4-50A (6 GHz	[0.88 ,	(1000 ,	0.007)	(2500 ,	0.012)	(6000 ,	0.020)]
HJ4-50 (6 GHz)_	[0.91.4 ,	(1000 ,	0.009)	(2500 ,	0.016)	(6000 ,	0.026)]
HJ4.5-50 (6 GHz	[0.92 ,	(1000 ,	0.005)	(2500 ,	0.009)	(6000 ,	0.015)]
310801_________	[0.82.1 ,	(1000 ,	0.012)	(1000 ,	0.012)	(1000 ,	0.012)]
311201_________	[0.82 ,	(1000 ,	0.018)	(1000 ,	0.018)	(1000 ,	0.018)]
311501_________	[0.80 ,	(1000 ,	0.023)	(1000 ,	0.023)	(1000 ,	0.023)]
311601_________	[0.80 ,	(1000 ,	0.026)	(1000 ,	0.026)	(1000 ,	0.026)]
311901_________	[0.80 ,	(1000 ,	0.038)	(1000 ,	0.038)	(1000 ,	0.038)]
352001_________	[0.80 ,	(1000 ,	0.038)	(1000 ,	0.038)	(1000 ,	0.038)]
AVA5-50 7/8____	[0.91 ,	(1000 ,	0.004)	(2000 ,	0.005)	(2500 ,	0.006)]
AVA7-50 1-5/8__	[0.92 ,	(1000 ,	0.002)	(2000 ,	0.003)	(2500 ,	0.004)]
CR50 540PE_____	[0.88 ,	(1000 ,	0.007)	(2000 ,	0.010)	(2500 ,	0.012)]
CR50 1070PE____	[0.88 ,	(1000 ,	0.004)	(2000 ,	0.005)	(2500 ,	0.006)]

Figure 2-10. Cable List

Fault Resolution

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

Fault Resolution (m) = $1.5 \times 10^8 \times vp / \Delta F$

DMax

DMax is the maximum horizontal distance that can be analyzed. The Stop Distance can not exceed Dmax. If the cable is longer than Dmax, Dmax needs to be improved by increasing the number of data points or lowering the frequency span (ΔF). Note that the data points can be set to 137, 275, 551, 1102, or 2204

Dmax = (Datapoints – 1) x Fault Resolution

DTF Setup

1. Press the **Measurements** main menu key and select DTF Return Loss or DTF VSWR.
2. Press the **Freq/Dist** main menu key.
3. Press the Units submenu key and select m to display distance in meters or ft to display distance in feet.
4. Press DTF Aid and use the touch screen, or arrow keys to navigate through all the DTF parameters.
    a. Set Start Distance and Stop Distance. Stop Distance needs to be smaller than Dmax.

Note	If Stop Distance is greater than DMax, increase the number of data points.

b. Enter the Start and Stop frequencies.

c. Press Cable and select the appropriate cable from the cable list (Figure 2-10).

d. Press Continue.

5. Press **Shift** and **Calibrate** (2) to calibrate the instrument. See Chapter 3, "Calibration" for details.

6. Press the **Marker** main menu key and set the appropriate markers as described in "Using Markers" on page 2-1.

7. Press **Shift** and **Limit** (6) to enter and set the limits as described in "Using Limit Lines" on page 2-3.

8. Press **Shift** and **File** (7) to save the measurement. See the User Guide for details.

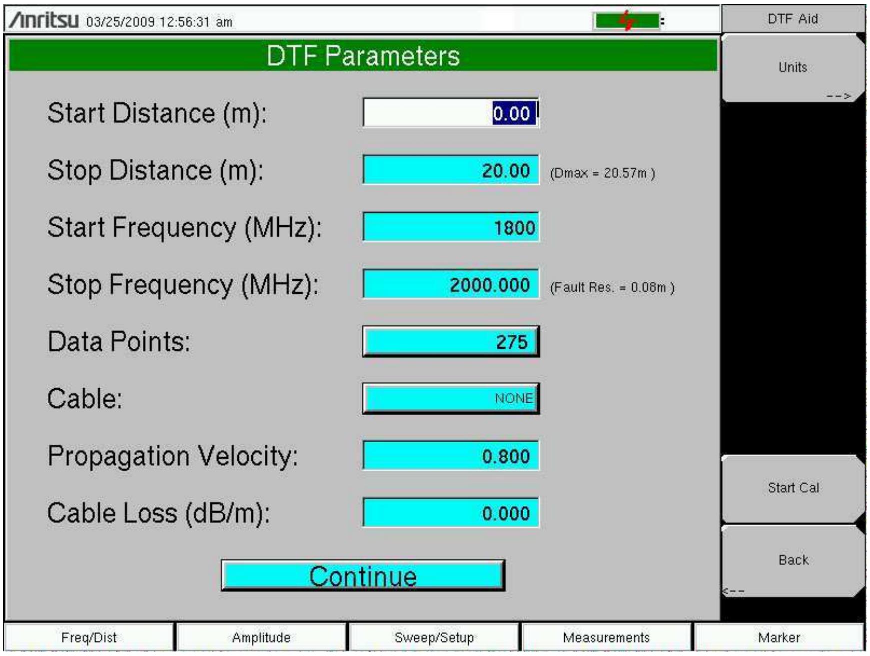


Figure 2-11. DTF Aid

Example 1

Figure 2-12 shows a DTF measurement of a cable with a short at the end of the cable. Figure 2-13 shows a DTF measurement of a good cable with a load. Figure 2-14 shows a DTF measurement of a cable with a fault. This measurement is done to determine the length of the cable. The return loss value marking the end of the cable will be between 0 dB and 5dB.

Procedure

1. Press the **Measurement** main menu key and press DTF Return Loss.
2. Use the Stop Dist submenu key to enter the Stop Distance. Make sure that Stop Distance is smaller than Dmax.
3. Use the Units submenu key to select meters or feet.
4. To change the number of data points, press the **Sweep/Setup** main menu key then Data Points submenu key to select 137, 275, or 551 as the number of data points.
5. Press the **Shift** key, then the **Calibrate** (2) key.
6. Press the Cal Type submenu key to set the calibration to 1-Port.
7. Press the Start Cal submenu key and perform a 1-port OSL calibration at the connector or at end of the extension cable. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display, and the trace should be centered around 0 dB when the short or open is connected.
8. Press the **Marker** main menu key, then press the Peak Search submenu key.

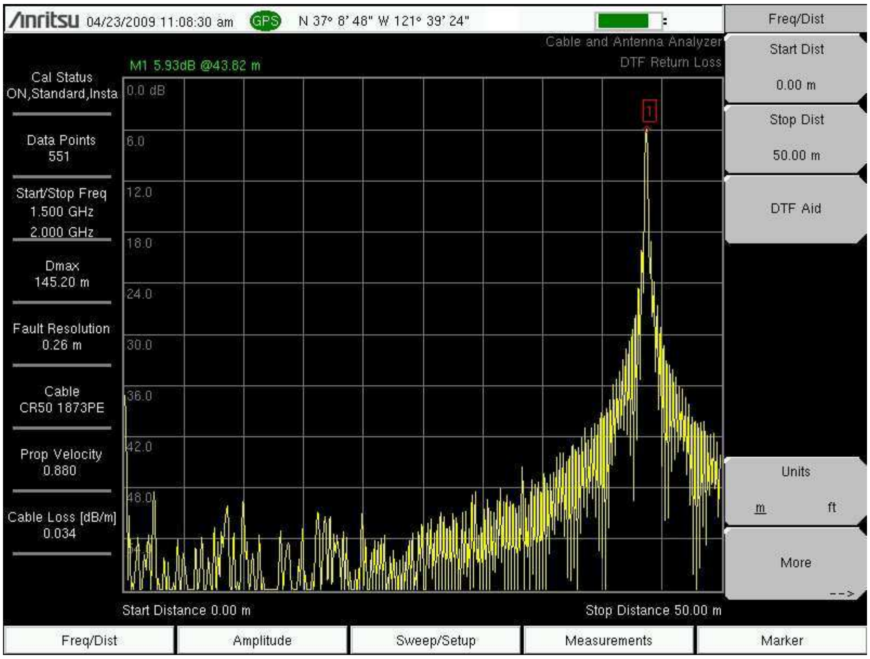


Figure 2-12. DTF with a Short at the End of the Cable

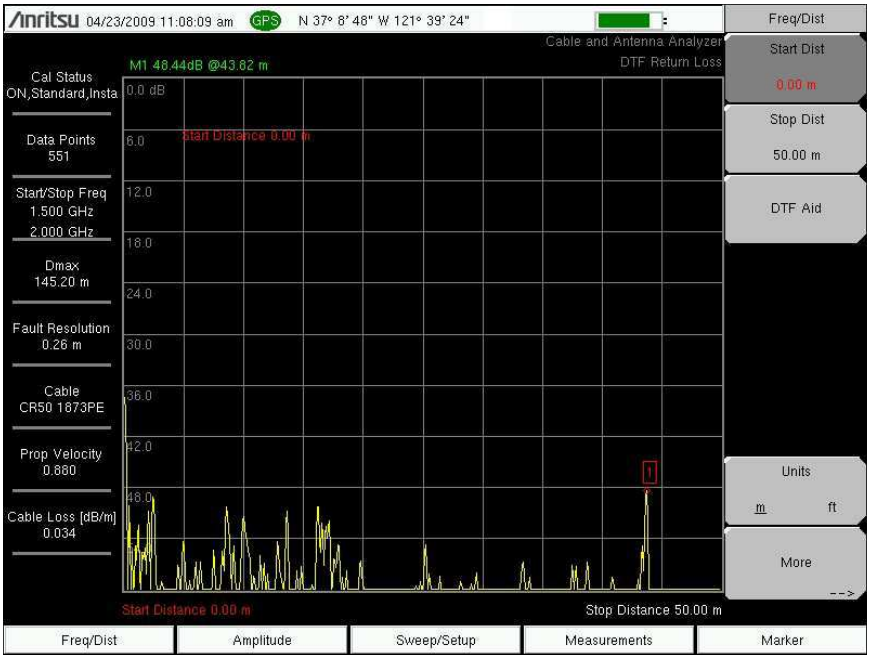


Figure 2-13. DTF of a Good Cable with a Load at the End of the Cable

Figure 2-14 shows an example of a fault at approximately 7.5 meters.

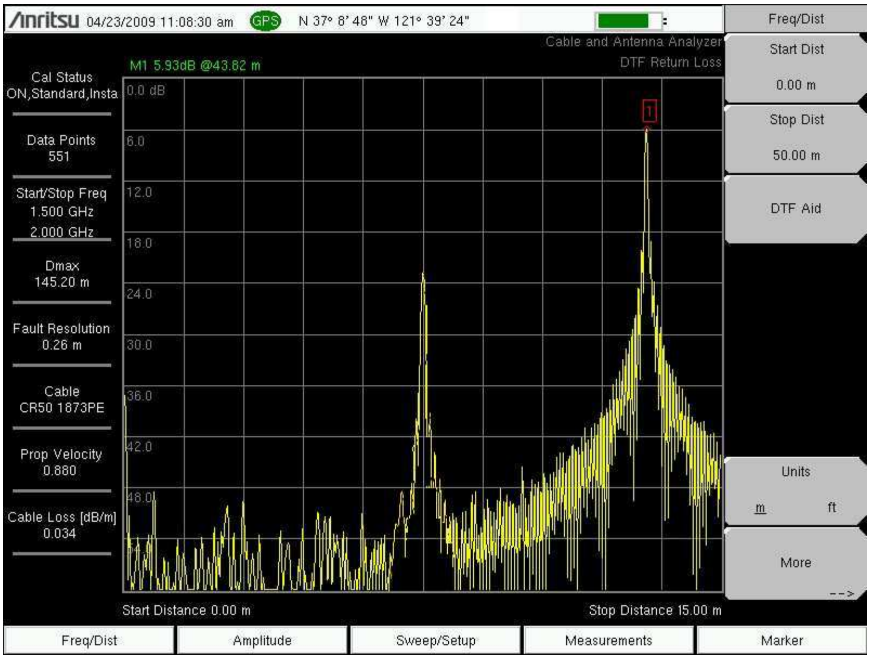


Figure 2-14. DTF with a Fault in the Cable and a Short at the End

Example 2

Distance-To-Fault Transmission Line Test

The Distance-To-Fault transmission line test verifies the performance of the transmission line assembly (for example, RF feedline and jumper cables) and its components and identifies the fault locations in the transmission line system. This test determines the return loss value of each connector pair, cable component and cable to identify the problem location. This test can be performed in the DTF-Return Loss or DTF-VSWR mode. Typically, for field applications, the DTF-Return Loss mode is used. To perform this test, disconnect the antenna and connect the load at the end of the transmission line.

Procedure

1. Press the **Measurement** main menu key and press DTF Return Loss.
2. Press the **Freq/Dist** main menu key and set the Start Dist and Stop Dist.
3. Press the Units submenu key to select meters or feet. The factory default is meters.
4. Press the **Sweep/Setup** main menu, then the Data Points submenu key to select the number of Data Points. The default is 275.
5. Press the Start Freq and Stop Freq submenu keys and enter the desired frequencies.
6. Press the **Measurement** main menu key then press DTF Return Loss.
7. Press the More submenu key.
8. Press the Cable submenu key and select the desired cable. The unit automatically sets the cable propagation velocity and cable loss.

Note	If the desired cable is not on the list, use the Master Software Tools Cable Editor to add the new cable information and load the list into the unit. Selecting the right propagation velocity, attenuation factor and distance is very important for accurate measurements, otherwise the fault can not be accurately identified. Using the MST Cable Editor, all cable parameters may be entered manually.

9. Press the **Shift** key, then the **Calibrate** (2) key.
10. Press the **Cal Type** submenu key to set the calibration to 1-Port.
11. Press the Start Cal submenu key and perform a 1-port OSL calibration at the connector or at end of the extension cable. Follow the instructions on the display. When the Calibration is finished, Cal Status On should be displayed in the upper left part of the display.

Fault Resolution

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

Fault Resolution (m) = $1.5 \times 10^8 \times vp / DF$

DMax

DMax is the maximum horizontal distance that can be analyzed. The Stop Distance can not exceed Dmax. If the cable is longer than Dmax, Dmax needs to be improved by increasing the number of data points or lowering the frequency span (ΔF). Note that the data points can be set to 137, 275, or 551.

Dmax = (Datapoints – 1) x 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:

Suggested Span (Hz) = (Datapoints – 1) x 1.5 x 10^8 x vp / Stop Dist

2-8 2-Port Gain Measurements

There are two power levels available with 2-port measurements: High (approximately 0 dBm) and Low (approximately –35 dBm). The low power setting should be used when making direct gain measurements of amplifiers. This will ensure that the amplifier is operating in the linear region. The High power 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.

The Variable Bias Tee Option (Option 10) can be used to place between +12 V to +32 V, in 0.1 V increments, on the center conductor of the RF In port. It is designed to deliver 500 mA at +12 V and 250 mA at +24 V.

Example

This example describes a Gain measurement of a TMA (Tower Mounted Amplifier) using the built-in bias tee (Option 10).

Procedure

1. Press the **Measurement** main menu key and press 2-port Gain.
2. Press the **Freq/Dist** main menu key and set the Start Frequency and Stop Frequency.
3. Connect test port extension cables to the RF Out port and the RF In port.
4. Press the **Shift** key, then the **Calibrate** (2) key.
5. Press the Cal Type submenu key to set the calibration to 2-Port.
6. Press the Cal Power submenu key and set power to Low.
7. Press the Start Cal submenu key and perform a 2-port OSL calibration at the end of the extension cables. See "2-Port Calibration Procedure (OSLIT)" on page 3-3.
8. Connect the RF Out cable to the ANT port of the TMA..
9. Connect the RF In cable to RX port of the TMA.
10. Open the Bias Tee menu by pressing the following keys: **Shift**, **System** (8), the Application Options submenu key, and then the Bias Tee submenu key.
11. Set the appropriate voltage and current range for the amplifier using the Bias Tee Voltage and Current submenu keys. Note that the voltage will be applied to the center conductor of the RF In port.
12. Turn on the Bias Tee by pressing the Bias Tee On/Off submenu key.

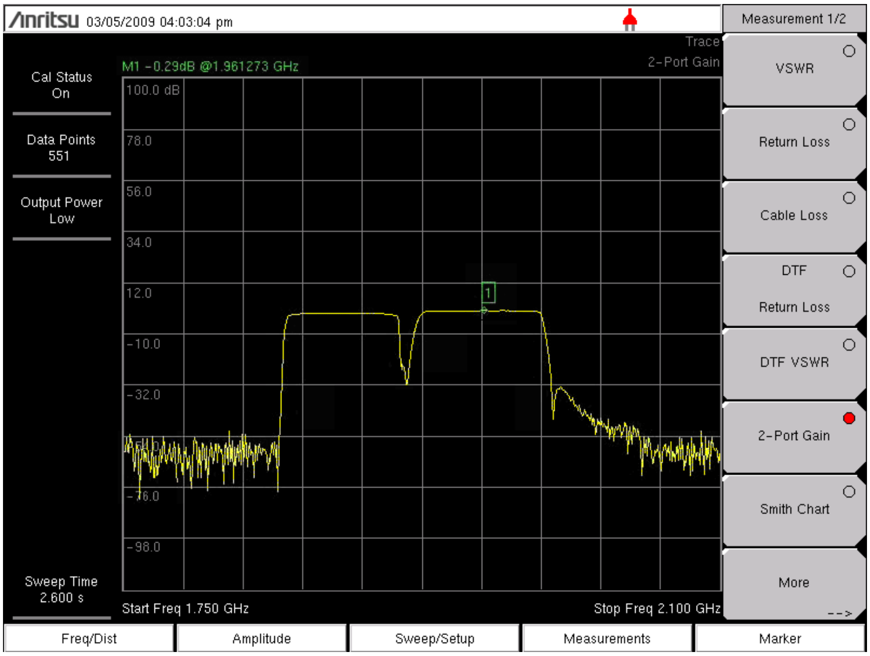


Figure 2-15. 2-Port Gain of a TMA

2-9 Phase Measurements

Phase measurements are available in both S11 and S21 modes. 2-Port Phase measurements can use both High (approximately 0 dBm) and Low (approximately –35 dBm) power settings.

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.

Procedure

1. Press the **Measurement** main menu key
2. Press the More submenu key.
3. Press the 1-port Phase submenu key.
4. Set the Start Frequency and Stop Frequency or press Signal Standard to list the Signal Standard menu. If Signal Standard is pressed, determine the type of signal by pressing Uplink, Downlink, or Uplink plus Downlink. Then press the Select Standard submenu key to choose a signal from the Signal Standards List with the arrow keys or rotary knob and press **Enter**.
5. Press the **Shift** key, then the **Calibrate** (2) key and perform a 1-port calibration at the desired reference plane. See "1-Port Calibration Procedure (OSL)" on page 3-1.
6. Connect Cable A to the RF Out reference plane.
7. Press the **Shift** key, then the **Trace** (5) key.
8. Press the Copy Trace to Display Memory submenu key.
9. Remove Cable A and connect Cable B to the RF Out reference plane.
10. Press the Trace – Memory submenu key to view the difference in phase between the two cables.

2-Port Phase Measurement

The following example compares the phase of two cables using a 2-port phase measurement.

"2-Port Phase" on page 2-21 shows the difference in phase of cable A and cable B. The Trace Math menu is turned on and both Trace A and Trace A – Trace B are displayed.

Procedure

1. Press the **Measurement** main menu key
2. Press the More submenu key.
3. Press the 2-port Phase submenu key.
4. Set the Start Frequency and Stop Frequency or press Signal Standard to list the Signal Standard menu. If Signal Standard is pressed, determine the type of signal by pressing Uplink, Downlink, or Uplink plus Downlink. Then press the Select Standard submenu key to choose a signal from the Signal Standards List with the arrow keys or rotary knob and press **Enter**.

5. Press the **Shift** key, then the **Calibrate** (2) key and perform a 2-port calibration at the end of a phase stable cable. See "2-Port Calibration Procedure (OSLIT)" on page 3-3.
6. Connect Cable A (the reference cable) between the RF Out and RF In connectors.
7. Press the **Shift** key, then the **Trace** (5) key.
8. Press the Copy Trace to Display Memory submenu key.
9. Remove Cable A and connect Cable B (the cable under evaluation).
10. Press the Trace – Memory submenu key to view the difference in phase between the two cables.

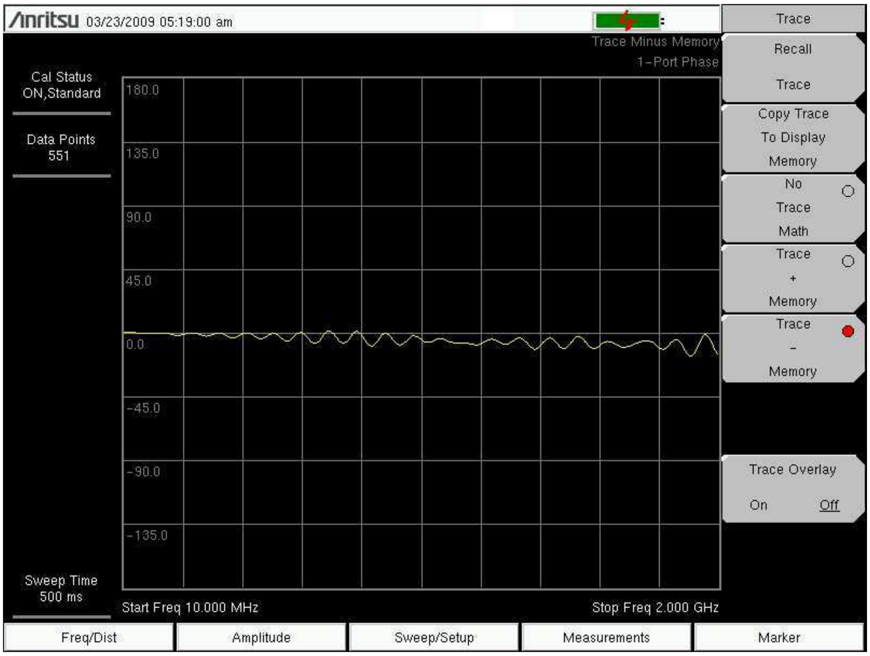


Figure 2-16. 2-Port Phase

2-10 Smith Chart

1-port measurements can be displayed in a standard normalized 50Ω Smith Chart. When markers are used, the real and imaginary components of the Smith Chart value are displayed.

Anritsu Master Software Tools includes more options and a calculator that can easily show what the return loss, VSWR, or reflection coefficient values of a specific Smith Chart value.

Limit Lines in a Smith Chart will appear as circles (constant reflection coefficient) and can be entered in VSWR units.

Smith Chart Measurement

The following example shows how a Smith Chart can be used to measure the match of an antenna.

Procedure

1. Press the **Measurement** main menu key.
2. Press the Smith Chart submenu key.
3. Press the **Freq/Dist** main menu key and set the Start Frequency and Stop Frequency.
4. Press the Start Cal submenu key and perform a 1-port calibration. See "1-Port Calibration Procedure (OSL)" on page 3-1.
5. Connect the antenna to the RF Out connector on the BTS Master.

Figure 2-17 represents a typical Smith Chart display. This is an example only. The measurement that is displayed on your instrument may be different.

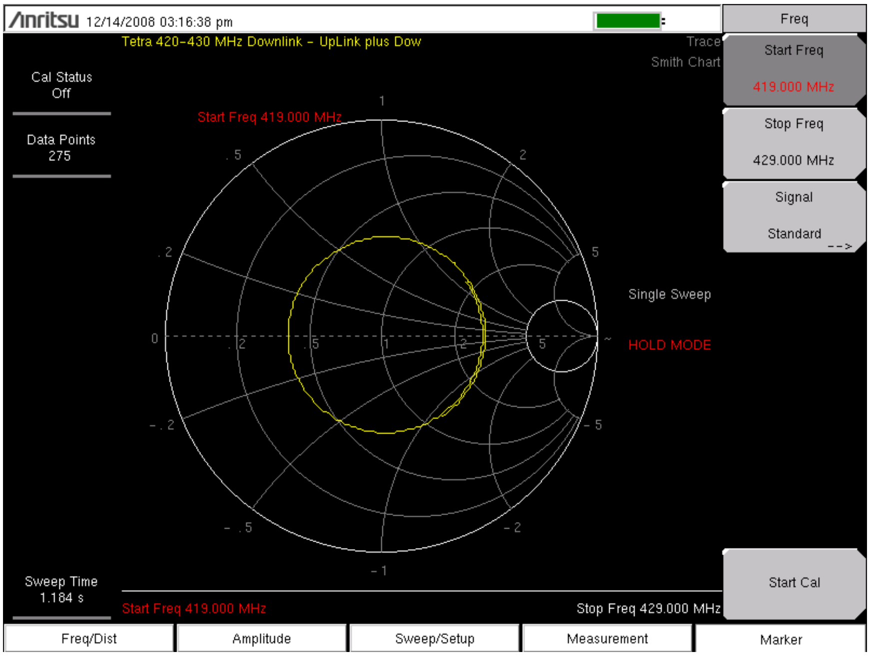


Figure 2-17. Smith Chart

2-11 Cable and Antenna Analyzer Menus

Figure 2-18 and Figure 2-19 show the map of the Cable and Antenna Analyzer menus. The following sections describe main menus and associated submenus. The submenus are listed in the order they appear on the display from top to bottom under each main menu.

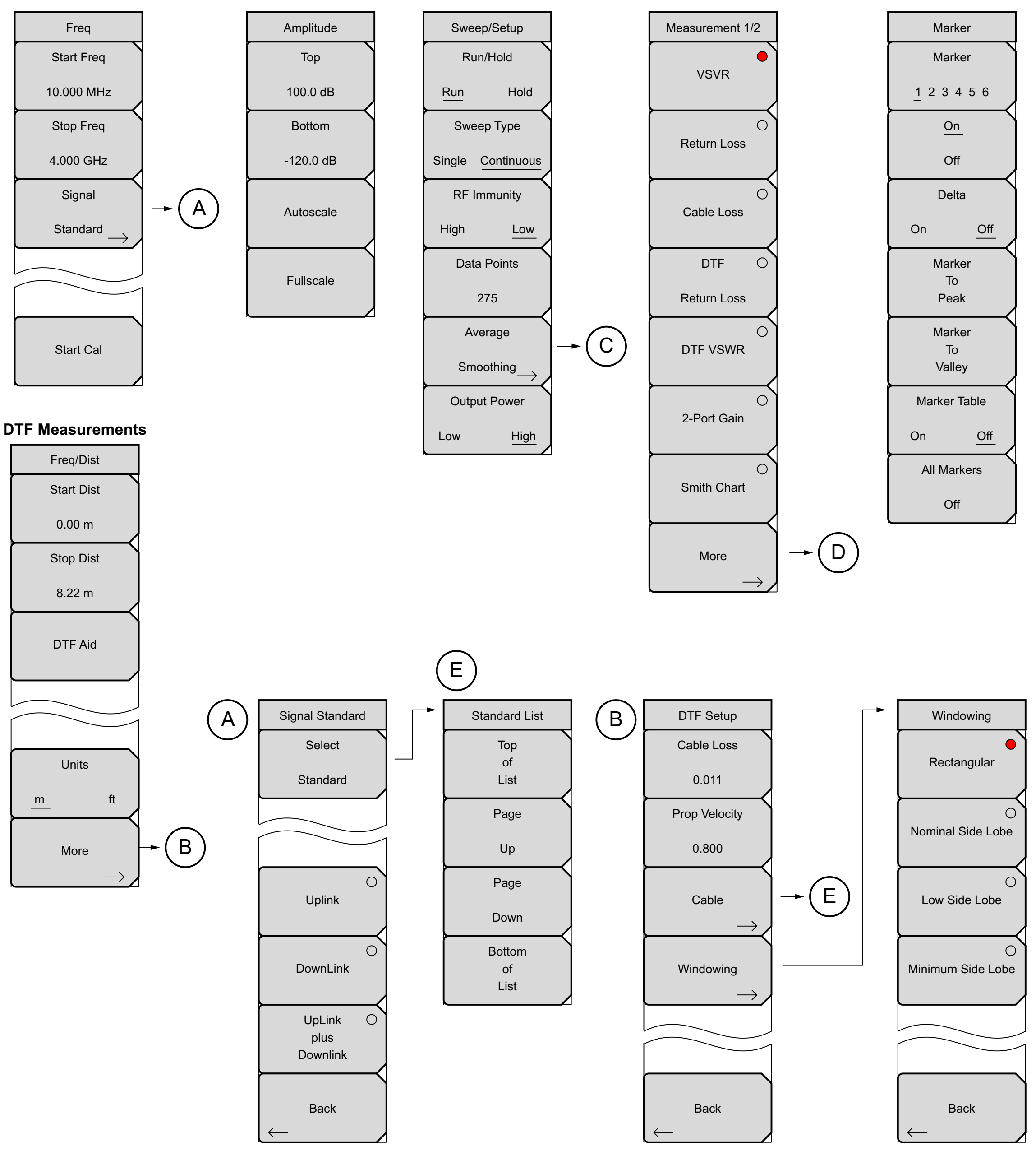


Figure 2-18. Main Menu Keys (1 of 2)

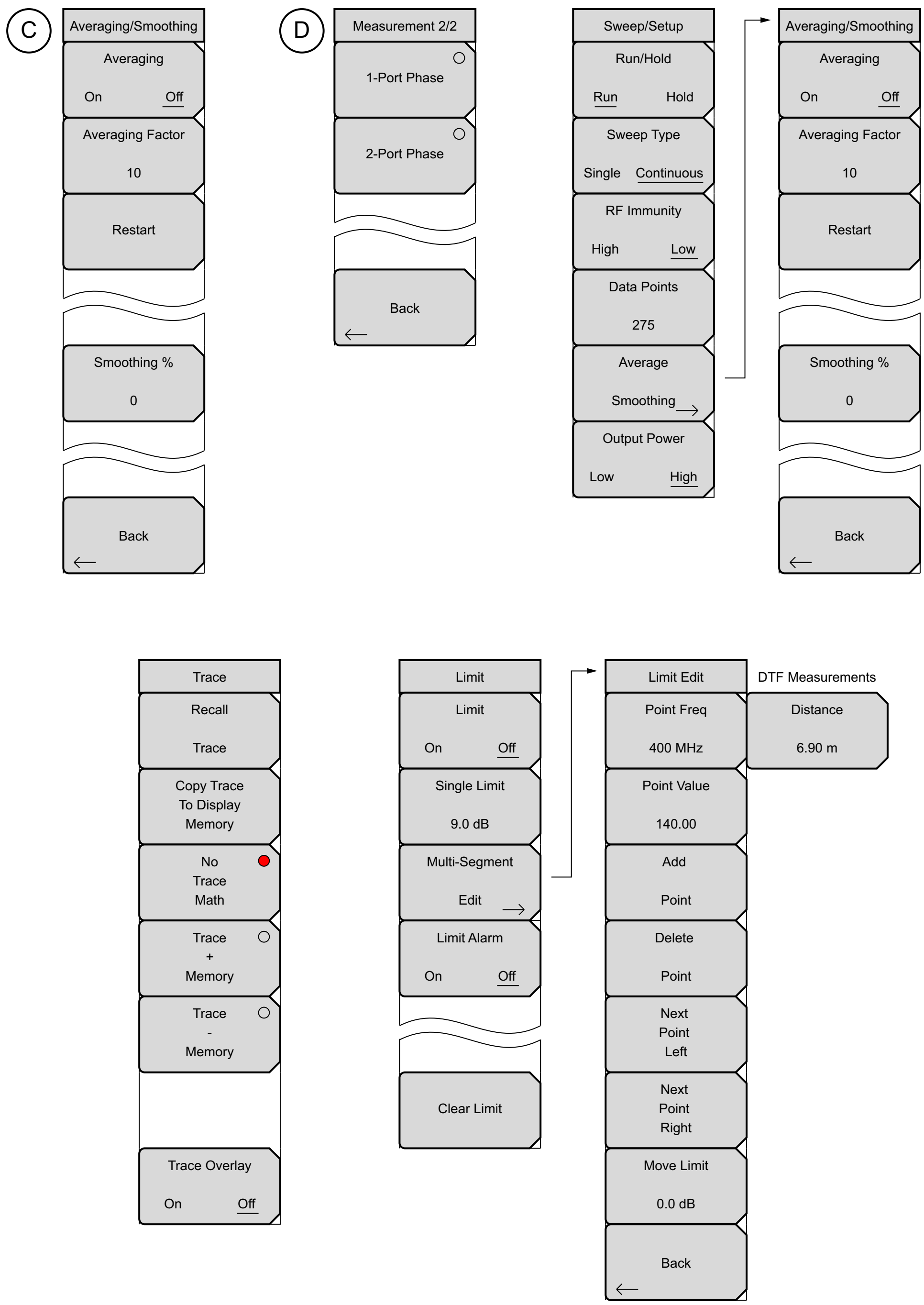


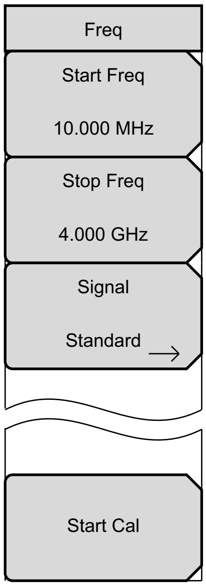
Figure 2-19. Main Menu Keys (2 of 2)

2-12 Freq Menu

The **Freq/Dist** main menu key opens the Freq menu, or the Freq/Dist menu, depending upon the type of measurement selected with the “Measurement Menu” on page 2-31.

Pressing the **Freq/Dist** main menu key after selection of DTF Return Loss, DTF VSWR, 2-Port Gain, Smith Chart, or More on the **Measurement** main menu will open the “Freq/Dist Menu” on page 2-27.

Key Sequence: **Freq**



Start Frequency: Press the Start Freq submenu key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a start frequency higher than the current stop frequency is entered, the stop frequency will be changed to yield a 10 Hz span.

Stop Frequency: Press the Stop Freq submenu key and enter the desired frequency using the keypad, the arrow keys, or the rotary knob. If a stop frequency lower than the current start frequency is entered, the start frequency will be changed to yield a 10 Hz span.

Signal Standard: Opens the .

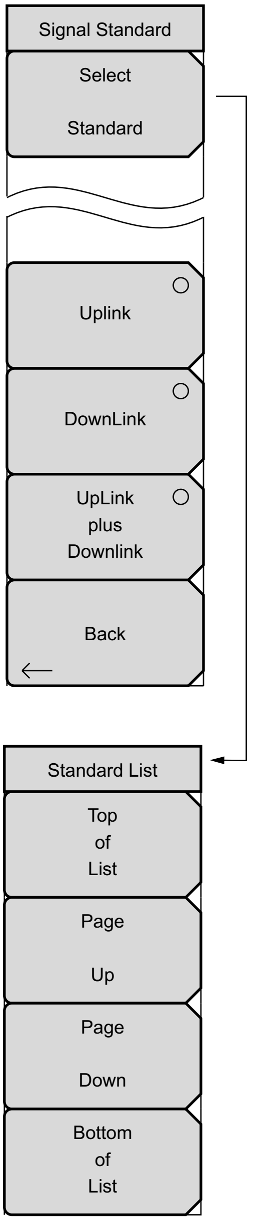
When a signal standard is selected, the center frequency and span for the first channel of the particular standard is automatically tuned. Other settings, such as channel spacing and integration bandwidth, are also automatically entered.

Start Cal: Press this submenu key and follow the instruction on screen to begin calibration. See Chapter 3 details.

Figure 2-20. Freq Menu

Signal Standard Menu

Key Sequence: **Freq/Dist** > Signal Standard



Select Standard: Opens the Signal Standards dialog box. Select the signal standard using the arrow keys, the rotary knob, or the touch screen. When a signal standard is selected, the start and stop frequency is automatically set. Other settings, such as channel spacing and integration bandwidth, are also automatically entered.

> **Top of List:** Moves the selection to the first signal standard in the list.
>
> **Page Up:** Moves up one page view from the current signal name.
>
> **Display:** Moves down one page view from the current signal name.
>
> **Bottom of List:** Moves the selection to the last signal standard in the list.
>
> Press **Esc** to return to the Signal Standard menu.

Uplink: Press to display only uplink frequencies.

Downlink: Press to display only downlink frequencies.

UpLink plus Downlink: Press to display both uplink and downlink frequencies.

After pressing one of the above three keys, press Select Standard to see the results reflected in the Signal Standard dialog box.

Back: Returns to the "Freq Menu" on page 2-25.

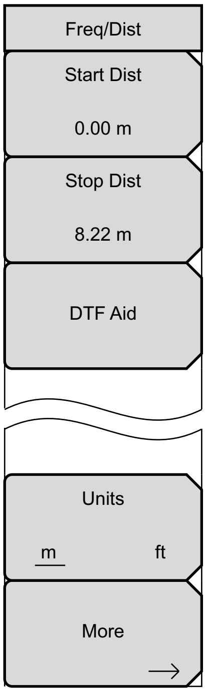
Figure 2-21. Signal Standard Menu

2-13 Freq/Dist Menu

The **Freq/Dist** main menu key opens the Freq menu, or the Freq/Dist menu, depending upon the type of measurement selected with the “Measurement Menu” on page 2-31.

Pressing the **Freq/Dist** main menu key after selection of VSWR, Return Loss, or Cable Loss on the **Measurement** main menu will open the “Freq Menu” on page 2-25.

Key Sequence: **Freq/Dist**



Start Freq: Press the Start Freq submenu key and enter the desired start frequency using the keypad, the arrow keys, or the rotary knob.

Stop Freq: Press the Stop Freq submenu key and enter the desired stop frequency using the keypad, the arrow keys, or the rotary knob.

DTF Aid: Opens the DTF Aid dialog box (Figure 2-11) for entering parameters.

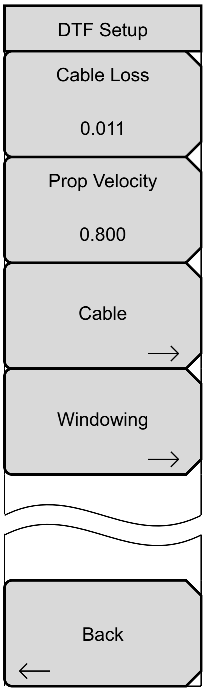
Units: Toggles between meters and feet.

More: Opens the “DTF Setup Menu” on page 2-28.

Figure 2-22. Freq/Dist Menu

DTF Setup Menu

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



Cable Loss: Press the Cable Loss submenu key and enter the loss in dB/ft or dB/m for the selected cable using the keypad, the arrow keys, or the rotary knob and press **Enter**.

Prop Velocity: Press the Prop Velocity submenu key and enter the applicable propagation velocity for the selected cable using the keypad, the arrow keys, or the rotary knob and press **Enter**.

Cable: The Cable submenu key opens a list of available cable specifications (see Figure 2-10). Using the arrow keys, the rotary knob, or the touch screen, select the desired cable and press **Enter**.

Note: When a cable is selected from this list, propagation velocity and cable loss are automatically set by the unit.

Windowing: Opens the Windowing menu. Options are:

- Rectangular
- Nominal Side Lobe
- Low Side Lobe
- Minimum Side Lobe

Refer to Appendix A for more information on windowing.

Back: Returns to "Freq/Dist Menu" on page 2-27.

Figure 2-23. DTF Setup Menu

2-14 Amplitude Menu

Key Sequence: **Amplitude**

Top: Sets the top amplitude value.

Bottom: Sets the bottom amplitude value.

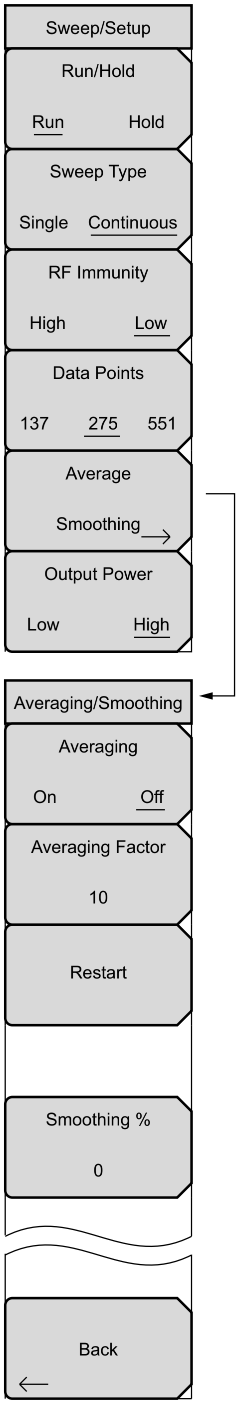
Autoscale: Adjusts the Top and Bottom values so that the trace will be shown in the middle of the display.

Fullscale: Fullscale automatically sets the scale to the default setting (0 dB to 60 dB for Return Loss and 1 dB to 65 dB for VSWR).

Figure 2-24. Amplitude Menu

2-15 Sweep/Setup Menu

Key Sequence: **Sweep/Setup**



Run/Hold: Toggles between Run and Hold. When in Hold mode, pressing this key starts the sweeping and provides a trigger. When in the Run mode, pressing this key pauses the sweep.

Sweep Type: This toggles the sweep between single sweep and continuous sweep. In single sweep mode, each sweep must be activated by the Run/Hold key.

RF Immunity, High / Low: The instrument defaults to RF Immunity High and is the suggested setting.

Data Points: Opens the data points dialog box. Use the touch screen to set the number of data points: 137, 275, 551, 1102, or 2204.

Average/Smoothing: Opens the Average/Smoothing submenu.

Averaging: Toggles Averaging on or off.

Averaging Factor: Enter the number of running averages using the arrow keys, rotary knob, or the keypad.

Restart: Press the Restart key to start the averaging sequence from the beginning.

Smoothing %: Smoothing calculates a rolling average of the trace data. Valid entries range from 0% (no smoothing) to 10% (max. smoothing).

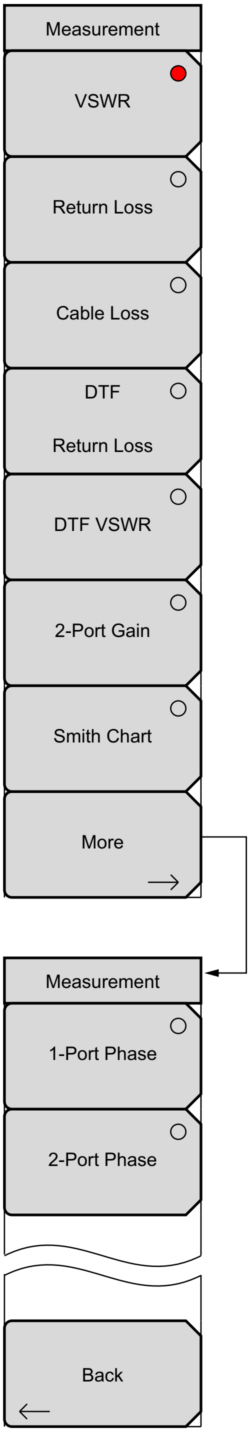
Back: Returns to the Sweep/Setup menu.

Output Power: The power level defaults to High for all 1-port measurements (~ 0 dBm). It can be changed to Low (~ –35 dBm) if needed.

Figure 2-25. Sweep/Setup Menu

2-16 Measurement Menu

Key Sequence: **Measurement**.



VSWR: Press the VSWR submenu key to view the match in VSWR.

Return Loss: 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, and measuring the reflected power in dB.

Cable Loss: The cable loss test verifies the signal attenuation level of the cable.

DTF Return Loss: The DTF measurement displays return loss (or VSWR) values versus distance. If the 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 the individual components including connector pairs and cable components.

DTF VSWR: The DTF measurement displays return loss (or VSWR) values versus distance. If the 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 the individual components including connector pairs and cable components.

2-Port Gain: Used to measure the gain of tower mounted amplifiers.

Smith Chart: Displays the measurement results as a Smith Chart.

More: Opens an additional menu.

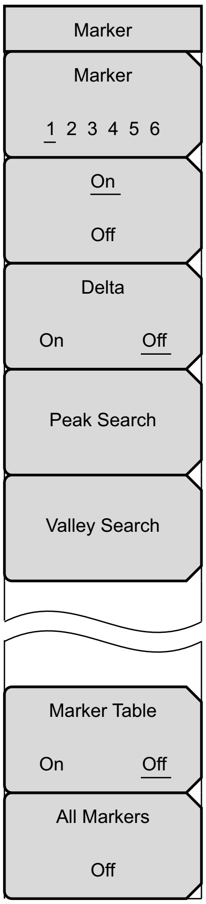
> **1-Port Phase:** Used for phase matching of cables.
>
> **2-Port Phase:** Used for phase matching of cables.
>
> **Back:** Returns to the **Measurement** Menu.

Figure 2-26. Measurement Menu

2-17 Marker Menu

Key Sequence: **Marker**

Press the **Marker** main menu key to open the Marker menu. The MT8222A is equipped with six markers. Any or all markers can be employed simultaneously.



Marker: Selects the active marker (1 to 6). The underlined marker number is the active marker. Each press of the submenu key moves the underline to the next marker number. Pressing **Shift** causes reverses the direction of marker selection. Press the **Shift** button again to change back to the original direction.

On/Off: Turns the selected marker underlined in the Marker soft key On or Off.

Delta: Turns on a delta marker and prompts for a delta offset frequency, either positive or negative from the frequency of the currently active marker.

Peak Search: This soft key places the currently active marker on the highest signal amplitude currently displayed on screen.

Valley Search: This soft key places the currently active marker on the lowest signal amplitude currently displayed on screen.

Marker Table: Causes a table to be displayed below the sweep window. The table is automatically sized to display all markers that are turned on. In addition to the marker frequency and amplitude, the table also shows delta frequencies and amplitude deltas for all markers that have deltas entered for them.

All Markers Off: Turns off all markers.

Figure 2-27. Marker Menu

2-18 Sweep Menu

This menu open the “Sweep/Setup Menu” on page 2-30.

2-19 Measure Menu

This menu open the “Measurement Menu” on page 2-31.

2-20 Trace Menu

Key Sequence: **Shift** > **Trace** (5) key

Recall Trace: Opens the Recall dialog box to recall a previously saved measurement. See the User Guide for more information about recalling measurements. If the setup of the recalled trace is the same and the current settings, the trace is displayed in white and copied to display memory for use in Trace Math.

Copy Trace to Memory: Copies the current trace display to memory for use in Trace Math.

No Trace Math: The active trace is shown with as is with no math functions.

Trace + Memory: Displays the results of logarithmic adding of the active trace and the trace in memory.

Trace – Memory: Displays the difference between the active trace and the trace in memory.

Trace Overlay: Displays both the recalled trace (white) if a trace is stored in memory and the current trace (yellow).

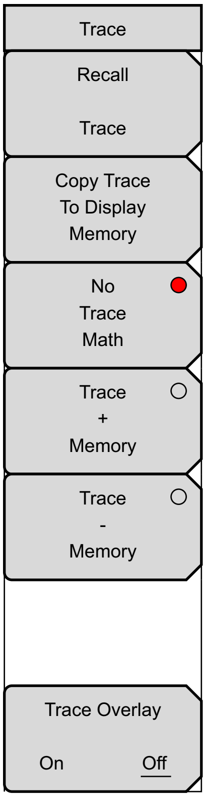


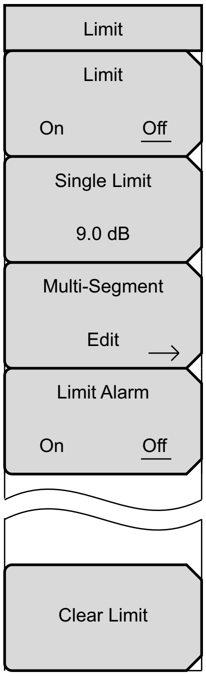
Figure 2-28. Trace Menu

2-21 Limit Menu

A limit line 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.

A 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, allowing the configuring of specific limit envelope at various frequencies of interest without having to re-configure them each time 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 submenu key.

Key Sequence: **Shift > Limit**



Limit: This submenu key turns the limit line on or off.

Single Limit: This key create a single segment limit line. The amplitude of the limit line is adjusted with the arrow keys, rotary knob, or the numeric keypad.

Multi-Segment Edit: The "Limit Edit Menu" on page 2-35 is displayed to allow the creation or editing of single or multi-segment limit lines. The currently active limit point is marked by a red circle on the display.

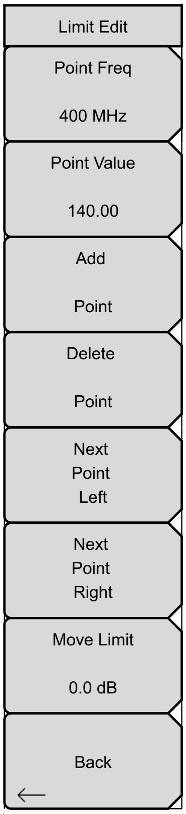
Limit Alarm: This submenu key selects, for the currently active limit line, if an alarm beep will occur when a data point exceeds the limit.

Clear Limit: This submenu key deletes all limit points for the currently active limit line.

Figure 2-29. Limit Menu

Limit Edit Menu

Key Sequence: **Shift** > **Limit** (5) key > Limit Edit



Point Frequency: The frequency of each point in a limit line can be individually set. When a new point is added, it takes on a value halfway between two existing points, or the stop frequency of the current sweep if there is no point higher in frequency than the one being added. See the Add Point submenu key description for more details. Use the keypad, the **Left**/**Right** arrow keys or the rotary knob to change the frequency of a point.

Point Value: The amplitude of each limit point can also 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 keypad, using the ± key as the minus sign, the **Up**/**Down** arrow keys or the rotary knob to move the point to the desired value. The unit of the amplitude limit is the same as the current vertical amplitude unit. See the Add Point submenu key description for more details.

Add Point: The precise behavior of this submenu key depends on which limit point is active at the time the key is pressed. If the active limit point is somewhere in the middle of a multi-segment limit line, a new limit point will be added that is 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 there is a limit point at 2.0 GHz with an amplitude of –30 dBm and the next point is 3.0 GHz with an amplitude of –50 dBm, 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 and Amplitude submenu keys. If the last limit point is active (assuming it is not at the right edge of the display) 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: This submenu key deletes the currently active point. The active point becomes the one immediately to the left of the point that was deleted.

Next Point Left: This submenu key selects the limit point immediately to the left of the active point, making it 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 screen.

Next Point Right: This submenu key selects the limit point immediately to the right of the active point, making it 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 screen.

Move Limit: This submenu key allows an entire single or multi-segment limit line to be moved up or down by the number of dB entered using the keypad, the **Up**/**Down** arrow keys, or the rotary knob. The units for this amount will be the current display units as selected under the **Amplitude** menu.

Back: Returns to "Limit Menu" on page 2-34.

Figure 2-30. Limit Edit Menu

2-22 Other Menus

Preset, **File**, **Mode** and **System** are described in the User Guide. **Calibrate** is described in Chapter 3.

Chapter 3 — Calibration

3-1 Calibration

For accurate results, the BTS Master must be calibrated at the ambient temperature after allowing for warm up time and before making any measurements. The BTS Master must be re-calibrated whenever the setup frequency changes or when a test port extension cable is added, removed or replaced. If FlexCal for 1-port was performed, frequency changes do not require re-calibration.

The 1-port calibration is an Open-Short-Load (OSL) calibration removing source match, directivity, and frequency response errors.

The 2-port calibration is a 1-path 2-port calibration and removes transmission response errors and transmission source match errors in addition to reflection error terms.

Users can perform a standard open, short, load cal or a FlexCal for 1-port measurements. FlexCal eliminates the need to perform multiple calibrations after changing the frequency. It is more time efficient than the standard cal and is recommended for troubleshooting. For optimum accuracy, the standard cal should be used. FlexCal is appropriate for large frequency spans but will less precise at very narrow spans due to the fixed number of calibration points used during the FlexCal operation.

Note	If a Test Port Extension Cable is to be used, the BTS Master must be calibrated with the Test Port Extension Cable in place. The Test Port Extension Cable is a phase stable cable and is used as an extension cable on the test port to ensure accurate and repeatable measurements. This phase stable cable can be moved and bent while making a measurement without causing errors in the measurement.

1-Port Calibration Procedure (OSL)

1. If a test port extension cable is to be used, connect the cable to the RF Out connector on the BTS Master. The calibration components will be connected at the end of the cable (Figure 3-1).
2. Set the frequency range. Chapter 3 of the BTS Master User Guide provides information on setting the frequency range.
3. Press the **Shift** key and then the **Calibrate** (2) key.
4. On the Cal Mode submenu key, select Standard or FlexCal . (Flexcal is a broadband calibration that allows you to change the frequency after calibration. It is more time efficient and particularly helpful if you are troubleshooting the system. For optimum accuracy, the Standard Cal method is recommended).

5. Verify that the Device Under Test (DUT) connector, as shown on the DUT Connector submenu key, is appropriate for the test setup. To choose a different connector, press the DUT Connector submenu key and use the rotary knob or **Up**/**Down** arrow keys to highlight the appropriate connector and press the rotary knob or **Enter** to select.

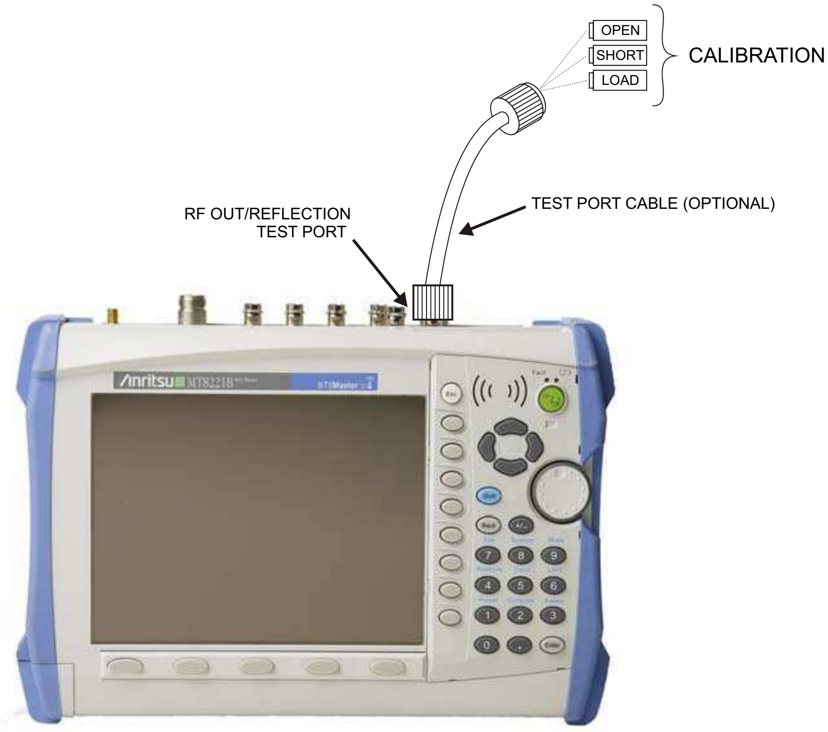


Figure 3-1. 1-Port Calibration

6. Press the Start Cal submenu key.
7. Connect the Open to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
8. When prompted, connect the short to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
9. When prompted, connect the Load to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
10. Verify that calibration has been performed properly by checking that the Cal Status On message is now displayed at the top of the status window.

2-Port Calibration Procedure (OSLIT)

1. If a test port extension cable is to be used, connect the cable to the RF Out and/or RF In connector on the BTS Master. The calibration components will be connected at the end of the cable (Figure 3-2).
2. Set the frequency range. Chapter 3 of the BTS Master User Guide provides information on setting the frequency range.
3. Press the **Shift** key and then the **Calibrate** (2) key.
4. If none of the connectors shown in the DUT Connector Selector list are suitable for the application, there are two selections, User 1 and User 2, that can be custom defined. To edit the characteristics, select the User 1 or User 2 submenu key. The menu allows editing the offset lengths for the Open and Short, and the capacitance values for the Open. To change a value, press the appropriate submenu key, enter the desired value using the numeric keypad, and press **Enter** to accept. When all values are correct, press the Back submenu key to return to the Calibration menu.

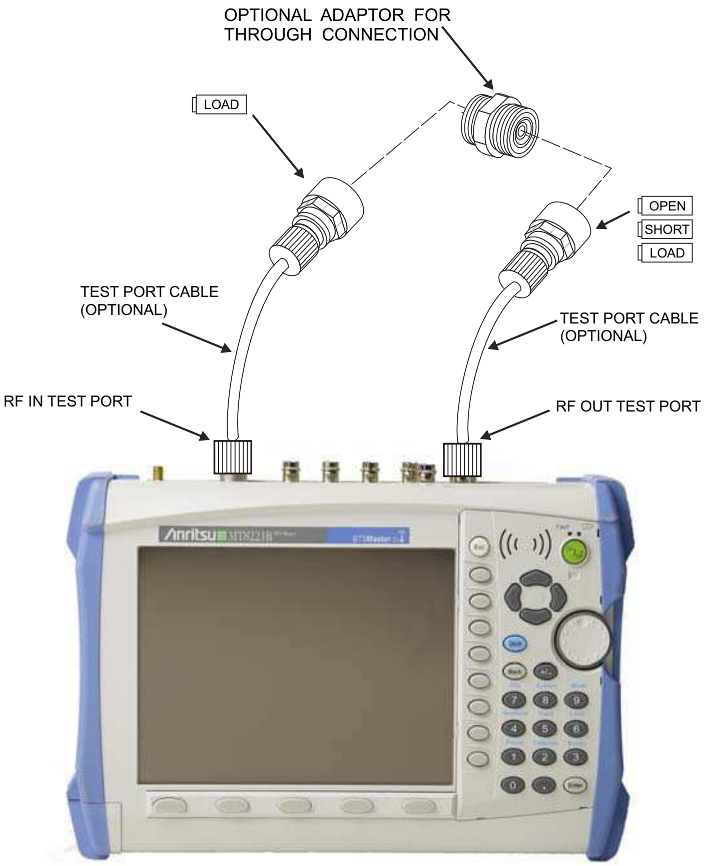


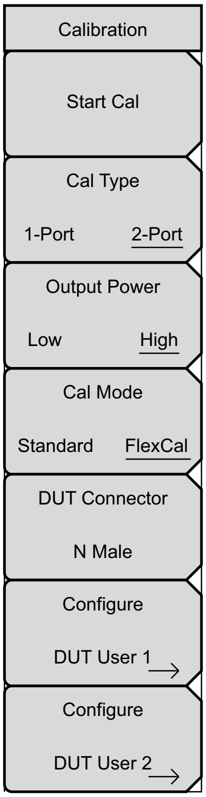
Figure 3-2. 2-Port Calibration

5. Press the Output Power submenu key to set the power level to Low (–40 dBm) or High (–7 dBm).

6. Press the Start Cal submenu key.
7. Connect the Open to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
8. When prompted, connect the short to the RF Out port (or to the end of the test port extension cable) and press the **Enter** key.
9. When prompted, connect the Loads to the RF Out port (or to the end of the test port extension cable) and to the RF In port (or to the end of the test port extension cable) and press the **Enter** key.
10. Connect the RF Out port to the RF In port, including any test port extension cables used in the prior steps, and press the **Enter** key.
11. Verify that calibration has been performed properly by checking that the Cal Status On message is now displayed at the top of the status window.

3-2 Calibration Menu

Key Sequence: **Calibrate** .



Start Cal: Press this submenu key and follow the instruction on screen.

Cal Type: Toggles between 1-Port and 2-Port calibration.

Output Power: Toggles between Low (–40 dBm) or High (–7 dBm) output power.

Cal Mode: Toggles between Standard Cal and FlexCal.

DUT Connector: Opens the DUT Connector Selector dialog box for selecting the connector type. Open, Short, C0, C1, C2, and C3 information is provided for each connector type.

Configure DUT User 1: Opens the User 1 submenu where a custom connector type can be specified. Open, Short, C0, C1, C2, and C3 information can be created for the connector.

Configure DUT User 2: Opens the User 2 submenu where a custom connector type can be specified. Open, Short, C0, C1, C2, and C3 information can be created for the connector.

Figure 3-3. Calibrate Menu

Appendix A — Windowing

A-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 due to the fact that the spectrum is cut off at a finite frequency. Windowing reduces the side lobes by smoothing out the sharp transitions at the beginning and at 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 should be used. When distance resolution is critical, windowing can be reduced.

A-2 Examples

The types of windowing in order of increasing side lobe reduction are: rectangular, nominal side lobe, low side lobe, and minimum side lobe. Figure A-1 through Figure A-4 show examples of the types of windowing.

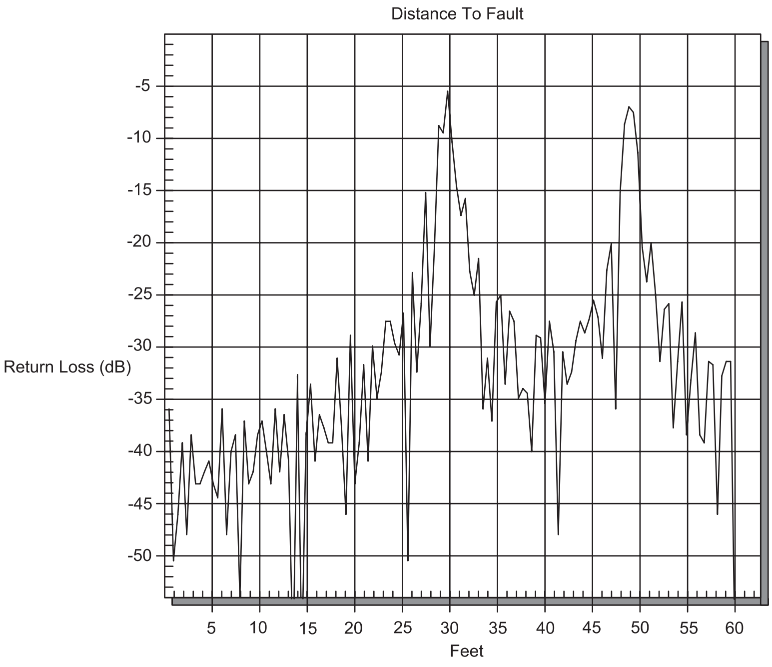


Figure A-1. Rectangular Windowing

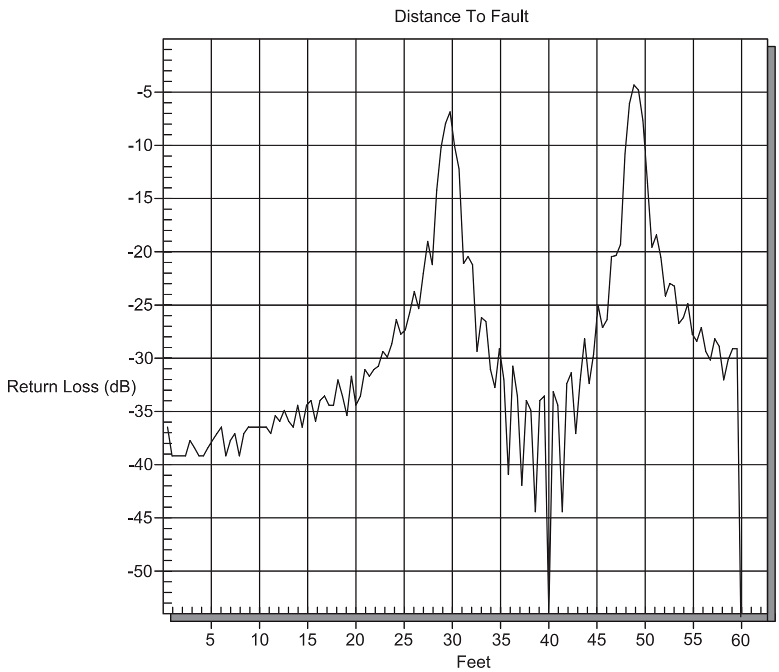


Figure A-2. Nominal Side Lobe Windowing

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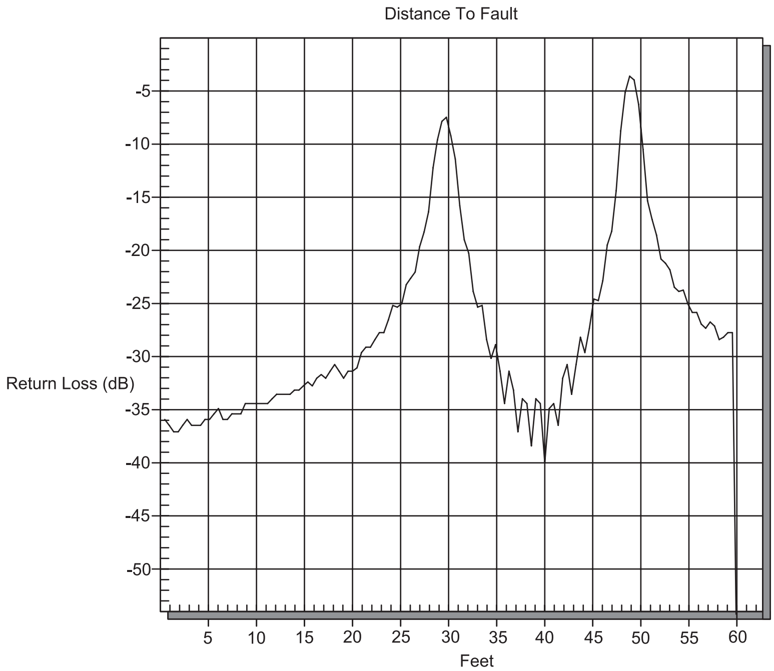

Figure A-3. Low Side Lobe Windowing

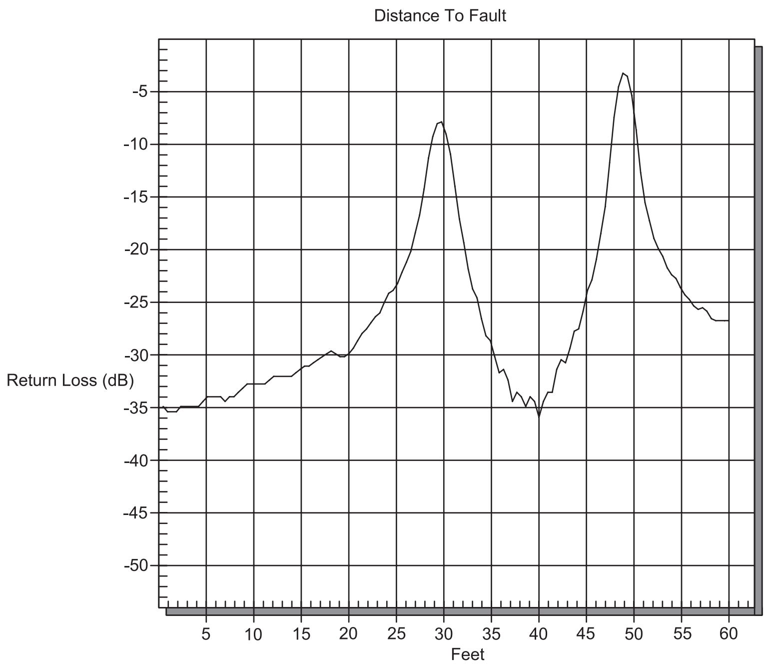

Figure A-4. Minimum Side Lobe Windowing

Appendix B — Tower Mounted Amplifiers

B-1 Introduction

A Tower Mounted Amplifier (TMA) can be used to amplify the received signal. There are different types of TMA depending upon the system requirements. Three commonly used types are:

- **TMA-D:** A duplex tower mounted amplifier that combines transmit and receive ports from the radio system and connects to a single antenna. This configuration is specific to systems that use a single antenna configuration.
- **TMA-S:** A receive-only tower mounted amplifier is installed between the receiving antenna and the radio to boost weak signals. This configuration is common on systems that implement separate antennas for transmitting and receiving.
- **TMA-DD:** A dual-duplex tower mounted amplifier used for radios systems with a single transmission line connection for transmit and receive. These systems are commonly called transceivers.

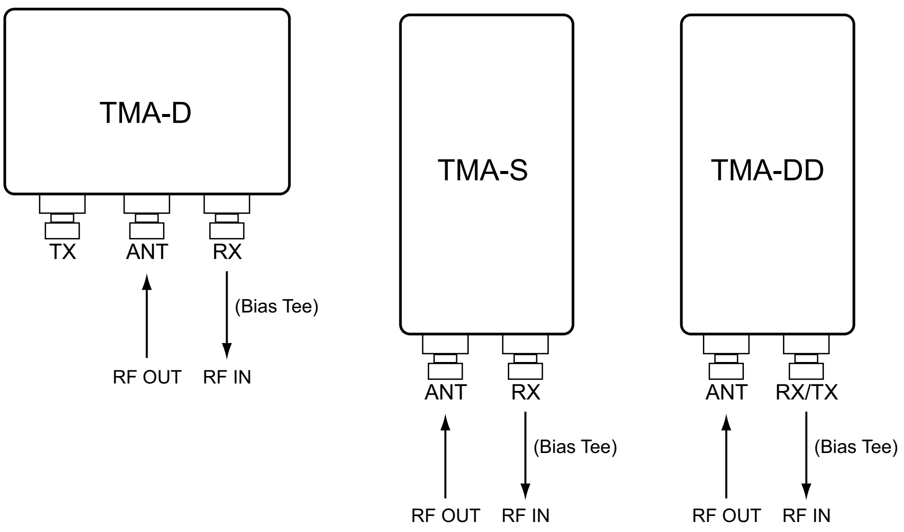

Figure B-1. Tower Mounted Amplifiers

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